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Main photo (coarse-textured site) by Ross McKenzie; insert photos by Barry Olson and Murray Riddell.

ABSTRACT

The most efficient and simplest means of utilizing livestock manure is to apply it on agricultural land. The regionalization and growth of the livestock sector in many areas has resulted in large, concentrated volumes of manure. There is concern that manure can pose a serious threat to soil, water, and quality resources if manure is not managed properly. The livestock sector is an important part of Alberta's agricultural industry. Sustainable management of manure generated by confined feeding operations is essential to the industry, in terms of environmental protection, social acceptance, and economical viability. Practices that integrate manure as a nutrient resource into cropping systems, without adversely affecting soil and water resources, need to be developed. To address this, a field study was started in southern Alberta in 1993. The study had two overall objectives: (1) to determine the effects of repeated application of cattle manure on soil quality, shallow groundwater quality, and crop production on two soil types under irrigated conditions; and (2) based on the results, to make appropriate recommendations for the management of manure application on land to minimize or prevent detrimental effects on soil and groundwater resources.

Two field sites were established near Lethbridge, Alberta, Canada: one on a sandy-loam soil (coarse-textured site) and the other on a loam to clay-loam soil (medium-textured site). The experimental design included a control, three rates of fertilizer-N (60, 120, 180 kg ha^{-1} y^{-1} nitrogen as urea), and four rates of cattle manure (20, 40, 60, and 120 Mg ha^{-1} y^{-1}; wet-weight basis). Manure treatments were applied each fall from 1993 to 2000, and the fertilizer-N treatments were applied each spring from 1994 to 2001. Treatments were replicated five times in a randomized complete block design. Soil samples were taken annually after harvest, but prior to manure application. Soil samples were also collected in the spring and during the growing season for selected years. Soil analyses included nitrate-N, ammomium-N, orthophosphate-P, calcium, magnesium, potassium, sodium, sulphate-S, and bicarbonate, pH, electrical conductivity, total nitrogen, and total phosphorus. Aggregate size distribution was also measured. Groundwater wells were installed in the centre of each plot, and groundwater samples were collected once per month from about April to November of each year. Groundwater samples were analysed for nitrate-N and chloride content. The sites were seeded to either barley or triticale from 1994 to 2001. The crops were harvested at the silage stage, and both sites were irrigated as required. Crop yield was recorded and crop-tissue samples were analysed for total nitrogen, total phosphorus, and total calcium.

Eight years of manure application significantly increased soil nitrate-N, orthophosphate-P, total nitrogen, total phosphorus, sodium, potassium, magnesium, chloride, bicarbonate, sodium adsorption ratio, and electrical conductivity. Extractable soil calcium, sulphate-S, and pH, for the most part, were not affected by manure application. The fertilizer-N treatments essentially had no effect on soil properties or groundwater quality, with the exception of nitrate-N cumulation in the soil profile.

The addition of salts from the manure caused soil salinity to increase and the dominant extractable cation to shift from calcium to potassium. The application of manure also increased soil sodicity, which may result in degradation in soil structure. Degradation in soil structure may not necessarily occur if salt content is also increased. A one-time assessment of aggregate size

distribution in the soil surface layer showed that manure application promoted aggregate formation at both sites. This may be a temporary benefit due to the added organic matter, but if soil sodicity levels are allowed to continue to build-up from heavy manure application, potassium and sodium may cause degradation of soil structure in the long term.

Repeated manure and fertilizer-N applications caused a build-up of nitrate-N in the soil profile. The excess nitrate-N leached through the soil profile at both sites. Nitrate-N moved downward at about 0.3 to 0.35 m per year at the medium-textured site, whereas nitrate-N moved throughout the soil profile (1.5 m) at the coarse-textured site within one year. For every megagram of total nitrogen added from manure, soil extractable nitrate-N increased by 40.7 to 95.1 kg ha^{-1} in the 0 to 1.5-m layer.

Net phosphorus cumulation from manure in the 0 to 0.15-m soil layer increased by 64 kg ha^{-1} for the 20 Mg ha^{-1} manure rate and 730 kg ha^{-1} for the 120 Mg ha^{-1} manure rate at the coarse-textured site after eight years of manure application. Corresponding net increases at the medium-textured site were 131 and 1127 kg ha^{-1}, respectively. The extractable orthophosphate-P status in the 0 to 0.15-m soil layer at the end of the study was well above the agronomic requirements for crops, even for the 20 Mg ha^{-1} y^{-1} rate. The vast majority of cumulated orthophosphate-P remained in the 0 to 0.15-m soil layer at the medium-textured site, whereas some orthophosphate-P leached into the 0.15 to 0.6-m layer at the coarse-textured site. For every megagram of total phosphorus added from manure, soil extractable orthophosphate-P increased by 400 to 421 kg ha^{-1} in the 0 to 0.6-m layer.

Groundwater nitrate-N content was not affected by the manure or fertilizer-N treatments at the medium-textured site. Groundwater nitrate-N and chloride concentrations at the coarse-textured site were affected by the cumulation of nitrate-N and chloride from manure application and subsequent movement downward through the soil profile. Results from this site for the first four years were confounded by initially high levels of nitrate and chloride in the soil, presumably from past manure applications by the land owner. However, there was a clear relationship between the build-up and removal of nitrate-N and chloride in the soil and what was observed in the groundwater. As the initially high amounts of the nitrate-N and chloride were leached from the soil profile during the first fours years of the study, a corresponding increase was observed in the groundwater. In the subsequent three years, nitrate-N and chloride began to re-cumulate in the soil profile, and as a result, less nitrate-N and chloride entered the groundwater.

The results from the two sites showed that after a few years of annual manure application there were essentially no crop-yield differences among the three fertilizer-N and four manure rates, but they yielded significantly more than the control. Under the application regime of our study, the 20 Mg $ha^{-1}y^{-1}$ treatment provided the nutrient requirements for the crop within a few years of repeated applications. The only time that a negative effect was observed was in 1998 when manure and fertilizer-N caused the crop to lodge, and the extent of lodging increased with application rate. The application of manure and fertilizer-N caused an increase in total nitrogen content in crop tissue, whereas there was minimal effect on total phosphorus and total calcium content in crop tissue.

Discontinuing the application on manure for two years had limited effects on some measured parameters. Soil nitrate-N, orthophosphate-P, chloride, sodium adsorption ratio, and electrical conductivity decreased significantly two years after manure application was discontinued. Residual manure was able to maintain crop yield for two years at the same level as plots that continued to receive manure.

Repeated application of manure, particularly at high annual rates (60 to 120 Mg ha^{-1} y^{-1}), significantly affected soil and groundwater quality, with a build-up of nutrients in soil and the movement of nitrate and chloride into groundwater. Soil texture affected the distribution and movement of excess nutrients derived from manure. Clearly, manure applied to coarse-textured soils under irrigation poses the greatest risk to shallow groundwater. Knowledge of soil type, including texture, and depth to water table is required to assess the vulnerability of a site to nutrient loss. Based on our study, we recommend that repeated annual rates of manure in the short term (three to five years) should be less than 40 Mg ha^{-1} (based on approximately 50% moisture content), particularly on coarse-textured, irrigated soils over shallow groundwater. However, agronomically, annual applications in the 15 to 25 Mg ha^{-1} range may be sufficient to meet crop requirements and to prevent a build-up of excess nitrogen. However, even at these lower rates, the build-up of phosphorus in the surface soil layer will occur and this is a concern for potential phosphorus contamination of surface water through surface runoff. If manure application rates are eventually based on phosphorus, then risk of excess nitrate build-up would be greatly reduced, if not eliminated. The key for nutrient management is to apply manure and commercial fertilizers at rates that will meet, but not exceed, crop nutrient requirements.

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INTRODUCTION

The animal sector is a significant part of Alberta's agricultural industry. The number of cattle in Alberta has increased by more than 50 percent in the last 25 years (CAESA 1998). Favourable climate and good access to feed and water have resulted in concentrations of confined feeding operations in certain regions of Alberta. This is particularly true for a large portion of the County of Lethbridge (Bennett and McCarley 1995). The County of Lethbridge, which covers an area of approximately 3,080 km^2, contains about 699,246 feedlot cattle; 14,760 dairy cattle; 3,424 cow/calf; 47,269 feeder hogs; 25,484 farrow-to-finish hogs; 4,530 farrow-to-wean hogs; 1,091,400 poultry; and 3,825 sheep (unpublished data, County of Lethbridge, 2003). The majority of the manure produced from confined feeding operations in the county is applied to agricultural land, of which a significant portion is irrigated.

Utilization of manure from confined feeding operations is recognized as a growing problem, particularly in areas where high densities of sizeable operations exist, and the availability of land for manure application is limited (Power and Schepers 1989; Barnett 1991; Goss et al. 1994; Power et al. 1994; Chang 1997; Dickson 1996; Sharpley et al. 1998). Even though manure can benefit crop production in terms of its fertilizer and soil-amendment qualities, research has shown that excess livestock manure can have a negative impact on soil, water, and air quality (Loehr 1972; Barnett 1991; Steele 1995; Agriculture and Agri-Food Canada 1996; Hatfield 1997; Pell 1997; Caldwell 1998; Power and Dick 2000).

Runoff from feedlots and manure storage facilities poses a threat to surface waters (nitrate and phosphorus pollution), whereas overloading of land with manure is the greatest concern for groundwater resources (nitrate pollution) in Alberta (Paterson and Lindwall 1992). The potential for nitrate contamination of groundwater is greater in irrigated areas than in dryland areas due to shallower depths to groundwater and periodic leaching required to control salt cumulation (Power and Schepers 1989). Nitrate contamination of surface water and groundwater has been attributed to a number of farming practices, including summerfallow, overapplication of fertilizers, and improper handling and disposal of manure (Spalding and Exner 1991; CAESA 1998).

In recent years, phosphorus loss to surface water has become a concern in Alberta. The movement of phosphorus from agricultural land to surface water can lead to accelerated eutrophication, which is recognized as a significant water quality problem in the many parts of the world (Johnston et al. 1997; Correll 1998; Haygarth and Jarvis 1999; Haygarth et al. 2000; Sharpley et al. 2000; Campbell and Edwards 2001).

There has been limited work on the environmental effects of manure application on agricultural land in southern Alberta. Riddell and Rodvang (1992) monitored selected sites in southern Alberta and found that soil nitrate-nitrogen (nitrate-N) in excess of 200 kg ha^{-1} in the lower root zone and groundwater nitrate concentrations near 100 mg L^{-1} at three of seven sites investigated. Nitrate contamination of groundwater was most evident beneath sandy-loam soils to which high rates (60 to 150 Mg ha^{-1}) of cattle manure had been applied annually for extended periods. A 30-year plot study has been carried out at the Agriculture and Agri-Food Canada Research Centre at Lethbridge, Alberta, where beef manure has been applied annually since

1973. Manure rates (wet weight) used were 0, 30, 60, and 120 Mg ha^{-1} y^{-1} on nonirrigated plots and 0, 60, 120, and 180 Mg ha^{-1} y^{-1} on irrigated plots (Sommerfeldt and Chang 1985). The 30 and 60 Mg ha^{-1} y^{-1} rates were within the maximum ranges of the previous Alberta manure application guidelines for nonirrigated (maximum 22 to 27 Mg ha^{-1} y^{-1}) and irrigated (maximum 56 to 67 Mg ha^{-1} y^{-1}) Brown and Dark Brown soils (Intensive Livestock Operations Committee 1973). Numerous papers from this study have reported that these manure application rates are not sustainable and resulted in an excess build-up and leaching of nitrogen and phosphorus (Chang et al. 1991; Dormaar and Chang 1995; Chang and Entz 1996; Chang and Janzen 1996; Whalen and Chang 2001; Whalen and Chang 2002a; Hao et al. 2003) and a build-up of salts (Chang et al. 1991; Hao and Chang 2003) in the soil. Chang and Entz (1996) estimated that an annual rate of 13.77 Mg ha^{-1}, or less, would prevent leaching of nitrate-N under the irrigated plots. Long-term manure application at the study site also affected soil physical properties (Sommerfeldt and Chang 1987; Gao and Chang 1996; Miller et al. 2002a,b; Whalen and Chang 2002b). Additional work in southern Alberta has focused on the effectiveness of manure in the reclamation of eroded land (Larney and Janzen 1996; Larney and Janzen 1997; Larney et al. 2000a,b).

To address the increasing concerns about land-applied manure on groundwater quality, a long-term field study was started in 1993 and conducted for eight years under irrigated cereal silage conditions in the County of Lethbridge in southern Alberta. This field study was initiated to expand on the work carried out with the long-term manure study at the Agriculture and Agri-Food Canada Research Centre at Lethbridge, as described above. The original four-year focus was to study the effects of repeated manure application on nitrate leaching to shallow groundwater under irrigated conditions. Fortunately, the study was continued for an additional four years. This document is a comprehensive summary of the eight-year study. This report includes the data from two previous reports, which reported on the earlier phases of this study (Olson et al. 1998; Olson et al. 1999).

This study had two overall objectives: (1) to determine the effects of repeated application of cattle manure on soil quality, shallow groundwater quality, and crop production on two soil types under irrigated conditions; and (2) based on the results, to make appropriate recommendations for the management of manure application on land to minimize or prevent detrimental effects on soil and groundwater resources.

MATERIALS AND METHODS

Field Sites

Two sites were established about 25 km northeast of Lethbridge in 1993: one located about 11.5 km east of Picture Butte (NE Quarter - Sec. 2 - Tp.11 - R.20 W4th), and the other located about 5.4 km east-northeast of Picture Butte (NE Quarter - Sec. 7 - Tp.11 - R.20 W4th). The former site was identified as the coarse-textured (loamy-sand soil) site and the latter was identified as the medium-textured (loam to clay-loam soil) site. The coarse-textured site was located in the southeast corner of the quarter-section field, which contained a centre-pivot irrigation system. The medium-textured site was located south of centre and along the east side of the quarter-section field (Appendix 1).

Land at both sites was Orthic Dark Brown Chernozemic soils. The coarse-textured site was in the KSR5/H1l soil landscape model as classified by the Agricultural Region of Alberta Soil Inventory Database (AGRASID) (Alberta Soil Information Centre 2001). The dominant soil series (i.e. ≥ 60 percent) was Kessler with Lethbridge as a significant (≥ 10 to ≤ 30 percent) soil series. The Kessler soil series has a moderately coarse sediment parent material (C3) deposited by wind or water, but is most likely a fluvial deposit. The Lethbridge soil series has a medium-textured sediment parent material (M2) deposited by wind and water. The landscape for this soil landscape model is hummocky with low relief. The medium-textured site was in the LET5/U1l AGRASID soil landscape model designation (Alberta Soil Information Centre 2001). The dominant soil series was Lethbridge with a miscellaneous undifferentiated fine soil (ZFIzdb) as a significant soil series. The Lethbridge soil series has a medium-textured sediment parent material (M2) deposited by wind and water, but is most likely a fluvial-lacustrine deposit. The landscape for this soil landscape model is undulating with low relief.

The coarse-textured site was under long-term crop production for several decades. A centre-pivot irrigation system was installed on the quarter section in 1980. However, the southeast corner of the quarter section (pivot corner), where the plots were located, remained under rainfed conditions. The pivot corner was under continuous barley (*Hordeum vulgare* L.) production since 1980. The rest of the quarter section had also been mainly in barley production. Commercial fertilizer was applied to the pivot corner once every two or three years depending on soil moisture conditions. Manure was applied to the entire quarter section once every five or six years. The last time the landowner applied manure to the quarter section may have been in 1991. About 20 truck loads of manure were stockpiled in two rows along the east side of the plot area for about one week in either 1990, 1991, or 1992. Climatic conditions were dry during the period of manure storage.

The medium-textured site was also under crop production for several decades. The site was flood-irrigated from about 1935 until 1972, and side-roll sprinkler-irrigated after 1972. The crop rotation prior to 1972 was four years of alfalfa (*Medicago sativa* L.), one year grain, one year summerfallow, one year sugarbeet (*Beta vulgaris* L.), and one year grain. The alfalfa phase was removed after 1972. The crop sequence after 1983 was one year sugarbeet, two years soft white spring wheat (*Triticum aestivum* L.), and one year barley. Manure was applied during the summerfallow phase prior to 1983. The rate and frequency of manure application is unknown.

Commercial fertilizers were applied based on soil testing for 10 years prior to the start of the study. The use of commercial fertilizers prior to 1983 is unknown.

Experimental Design

The original experimental design included six main treatments: control (received no nitrogen inputs), 60 kg ha^{-1} of inorganic nitrogen (N) fertilizer, and 20, 40, 60, and 120 Mg ha^{-1} of wet cattle manure. The main plots were 16 by 16 m in size, and they were separated by 1-m borders. The main treatments were split into two subplots, with each subplot 8 by 16 m in size. One half of the control and 60 kg N ha^{-1} main plots received 120 kg ha^{-1} inorganic nitrogen fertilizer, to give a total of four fertilizer-N rates (0, 60, 120, and 180 kg N ha^{-1}). One half of the manure plots received no further additions (other than manure), while the other half was designated as a better management practice (BMP) subtreatment in terms of crop-nitrogen requirements. In the original design commercial fertilizer nitrogen was to be added to the BMP-manure subplots if the estimated amount of available nitrogen was less than 180 kg ha^{-1}. Available nitrogen estimates were based on spring soil testing and the theoretical amount of mineralized nitrogen from added manure. An example calculation and summary of the available-nitrogen estimates are shown in Appendix 2. In practice, however, only the 20 Mg ha^{-1} BMP-manure subtreatment at both sites required additional nitrogen (60 kg N ha^{-1}) in the first crop year (1994). Otherwise, the BMP-manure and non-BMP-manure subplots were treated the same until October, 1999. Manure application was discontinued on the BMP-manure subplots after the 1998 manure application, and these subplots became residual-manure subtreatments.

The plots were arranged in a randomized block design with five replicates (Figs. 1 and 2).

Water-Table Well Installation

Water-table wells were installed at the centre of each subplot in mid-May, 1993 (Figs. 1 and 2). Plastic PVC pipe (5.08 cm diameter) was used as well-casing material. The wells were slotted to within 1 m below the soil surface. The well casings were covered with a filter sock. The sides of the wells were back-filled with sand to within 0.5 m below the soil surface. The remaining distance was back-filled with bentonite clay. The well casings were 3 m long and protruded (wellhead) about 0.11 to 0.14 m above the soil surface. The wells were capped when not in use.

It was discovered after the wells were installed at the medium-textured site that the water-table level dropped below 3 m from the soil surface. Because of this, deeper piezometer wells were installed in September and October, 1993 (nine subplots: A2, A3, B2, B3, C2, D2, E2, E11, and E12) and in the spring of 1994 (the remaining 51 subplots). The bottom 1 m of each piezometer was slotted and covered with a filter sock. The sides of the piezometers were back-filled with sand to within 0.5 m below the soil surface. The remaining distance was back-filled with bentonite clay. The piezometer casings were about 4.7 m long and protruded (wellhead) about 0.1 m above the soil surface.

The well in subplot D3 at the coarse-textured site (Fig. 1) was damaged during 1995, and was replaced with a new well on September 7, 1995.

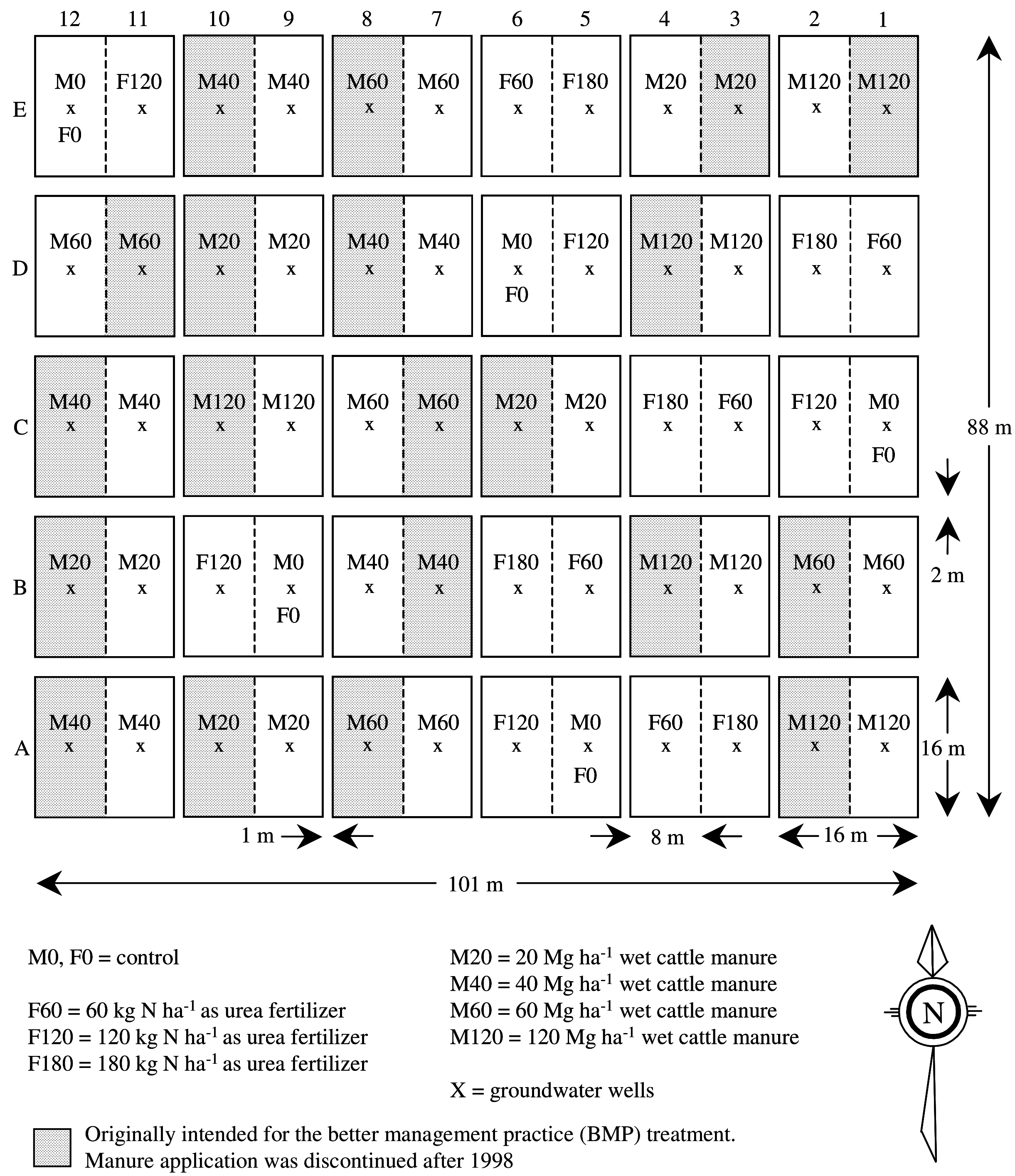
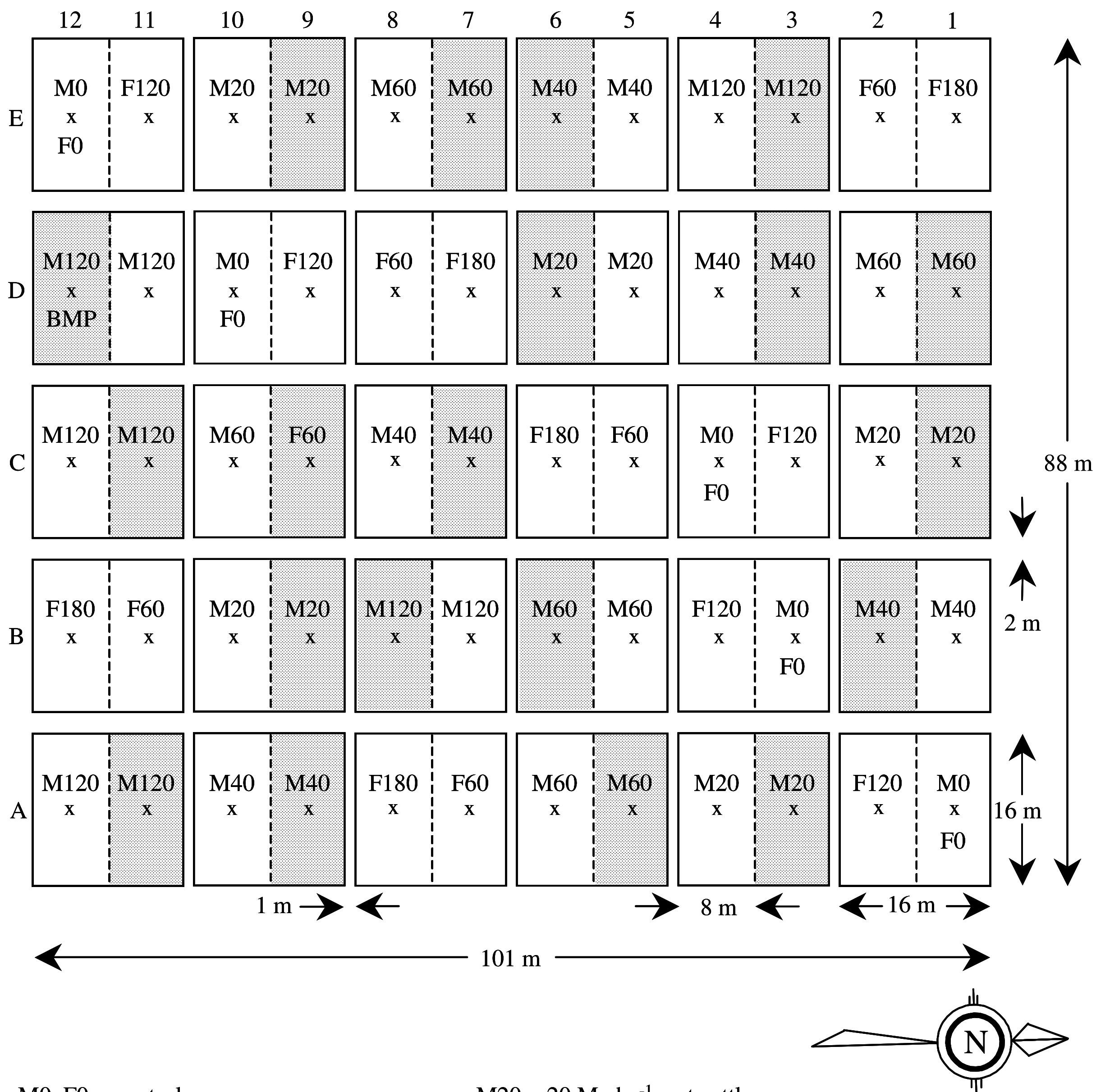


Fig. 1. Plot design, plot layout, and treatment randomization at the coarse-textured site.



M0, F0 = control

F60 = 60 kg N ha^{-1} as urea fertilizer
F120 = 120 kg N ha^{-1} as urea fertilizer
F180 = 180 kg N ha^{-1} as urea fertilizer

M20 = 20 Mg ha^{-1} wet cattle manure
M40 = 40 Mg ha^{-1} wet cattle manure
M60 = 60 Mg ha^{-1} wet cattle manure
M120 = 120 Mg ha^{-1} wet cattle manure

X = groundwater wells

Originally intended for the better management practice (BMP) treatment. Manure application was discontinued after 1998

Fig. 2. Plot design, plot layout, and treatment randomization at the medium-textured site.

Soil-log notes were recorded during the installation of the water-table wells. The soil-log notes are summarized in Appendix 3. Selected soil samples were collected during the installation of the wells, and these samples were analysed for particle-size distribution (Gee and Bauder 1979).

Manure Application and Analysis

Cattle feedlot manure was applied (20, 40, 60, and 120 Mg ha^{-1} wet weight) annually in late October or early November from 1993 to 2000 (Tables 1 and 2). Fresh manure was supplied by three local feedlot operations. The manure was initially stockpiled for a few days beside the plot area at each site. A tractor-pulled, rear-delivery manure spreader was used to apply the manure. The manure spreader and manure were weighed with in-field, portable scales from 1993 to 1997 to ensure accurate application rates. From 1998 to 2000, the manure-spreader was equipped with load cells and in-field scales were no longer needed. The manure was incorporated on the same day as application using a tractor and double disk. Incorporation involved two tillage passes perpendicular to each other.

The 16 by 16 m manure plots (Figs. 1 and 2) received manure each year from 1993 to 1998. In 1999, the manure plots were split into two halves (each 8 by 16 m) and manure was not applied on one half of each manure plot in 1999 and 2000.

Five manure subsamples were collected annually from each site at the time of application. The manure samples were analysed by the Alberta Agriculture, Food and Rural Development Agri-Food Laboratories Branch, Soil and Crop Unit in Edmonton, Alberta. Manure samples were either frozen or kept cool (4 ^{o}C) until transportation to the laboratory. The samples were placed in a cooler, with ice, and transported by courier. Delivery time was usually about 24 hours.

Wet subsamples were analysed for total N, extractable ammonium-nitrogen (ammonium-N), and moisture contents. The remainder were oven-dried (105 °C) and then ground using a Wiley Mill with a 1-mm screen. Additional analyses were carried out using the oven-dried samples. Annual analyses of the wet and oven-dried samples included the following:

- Extractable ammonium-N using 5:1 2-M KCl extractant. Extracted ammonium-N was determined using the Bertholet colorimetric method and the Technicon Gtpc AutoAnalyzer System.
- Extractable nitrate-nitrogen (nitrate-N) and orthophosphate-phosphorus (orthophosphate-P or PO_4-P) using 5:1 Miller-Axley 0.03-M NH_4F/0.015M H_2SO_4 extractant. Extracted nitrate-N was determined using the cadmium reduction colorimetric method and Technicon Gtpc AutoAnalyzer System, and extracted orthophosphate-P was determined using the ammonium molybdate/ascorbic acid/antimony colorimetric method and the Technicon Gtpc AutoAnalyzer System.
- Exchangeable sodium, potassium, calcium, and magnesium using 1-M NH_4-acetate extractant. Extracted cations were measured using a JY70Plus inductively coupled plasma (ICP) spectrometer.
- Extractable micronutrients (copper, zinc, manganese, and iron) using 2:1 0.005-M diethylene triamine pentaacetic acid (DTPA)/0.1-M triethanolamine (TEA)/0.01-M

Table 1. Dates of sampling and agronomic events at the coarse-textured site.

Event	1993 [z]	1994	1995	1996	1997	1998	1999	2000	2001
Seedbed tillage	-	unknown	May 17	April 29	April 29	May 7	May 19	May 15	May 10
Fertilizer-N application [y]	-	April	April 21	April 26	April 24	April 20	May 4	April 28	April 26
Seeding	-	late April	May 17	April 30 [x]	April 29	May 7	May 20	May 16	May 15
Herbicide application	-	June [w]	June 14 [v]	June 6, 31 [v]	June 7 [u]	June 9 [u]	June 17 [u]	June 17 [t]	June 18 [t]
Silage harvest	-	July 21-22	Aug 1	- [s]	July 28-31	Aug 5	Aug 19-20	Aug 4	Aug 14
Fall soil sampling	Oct 13-15	Sept 19-23	Sept 7-14	Oct 29-31	Sept 22-23	Sept 21-22	Sept 20-21	Sept 18	Sept 17
Manure application [r]	Oct 19	Oct 20	Oct 17	Nov 8	Oct 9	Oct 8	Oct 21	Oct 12	-
Groundwater sampling	June 2	April 11	Jan 24	Mar 19	May 7	Mar 31	April 21	April 25	May 2
"	July 5	May 31	April 3	April 30	June 2	April 28	June 2	May 30	May 30
"	July 27	June 27	May 4	May 27	June 23	May 27	July 7	June 28	June 27
"	Oct 18	July 25	May 31	June 25	Aug 11	July 7	July 27	Aug 1	Aug 1
"	-	Aug 29	June 27	Aug 6	Sept 8	July 29	Aug 25	Aug 28	Aug 29
"	-	Sept 28	July 25	Aug 27	Sept 30	Aug 25	Sept 29	Sept 27	Sept 26
"	-	Nov 1	Aug 30	Sept 24	Oct 28	Sept 30	Oct 20	Nov 2	Nov 7
"	-	-	Sept 27	-	Dec 2	Oct 27	Nov 23	-	-
"	-	-	Nov 15	-	-	Dec 2	-	-	-
First irrigation event	-	unknown	July 17	June 7	June 23	June 22	June 24	June 19	May 22
Last irrigation event	-	unknown	July 18	Aug 27	July 22	July 27	Aug 6	July 28	July 25
Water applied (mm)	-	unknown	60	357	355	172	257	227	431

[z] Establishment year.
[y] Banded urea fertilizer (46-0-0) treatments at 0, 60, 120, and 180 kg ha^{-1} y^{-1} nitrogen.
[x] The crop was disced on June 28, and the site reseeded on July 4 with no phosphorus fertilizer.
[w] Buctril M/Achieve tank mixture.
[v] Buctril M.
[u] Achieve Extra Gold.
[t] Prestige A; 2,4-D ester, Lontrel; Achieve 40DG; Turbocharge adjuvant.
[s] Crop failure due to poor germination.
[r] Manure application rate treatments at 0, 20, 40, 60, and 120 Mg ha^{-1} y^{-1}, on a wet-weight basis.

Table 2. Dates of sampling and agronomic events at the medium-textured site.

Event	1993 [z]	1994	1995	1996	1997	1998	1999	2000	2001
Seedbed tillage	-	unknown	May 17	April 29	April 29	May 7	May 19	May 16	May 10
Fertilizer-N application [y]	-	April	April 21	April 26	April 24	April 20	May 4	April 28	April 26
Seeding	-	late April	May 17	April 30	April 29	May 7	May 20	May 16	May 15
Herbicide application	-	June [x]	June 14 [w]	June 6 [w]	June 7 [v]	June 9 [v]	June 17 [v]	June 17 [u]	June 18 [u]
Silage harvest	-	July 21-22	Aug 1	July 30	July 31	Aug 5	Aug 20	Aug 4	Aug 14
Fall soil sampling	Oct 5-7	Sept 12-16	Sept 21-Oct 6	Oct 21-23	Sept 16-17	Sept 14-15	Sept 13-14	Sept 11-12	Sept 10-11
Manure application [t]	Oct 13	Oct 21	Oct 18	Nov 7	Oct 8	Oct 8	Oct 21	Oct 13	-
Groundwater sampling	May 31	April 11	Jan 25	Mar 20	May 6	April 2	April 20	April 26	May 1
“	June 28	May 31	April 4	May 1	June 3	April 29	June 1	May 31	May 29
“	July 28	June 28	May 3	May 28	June 24	May 26	July 6	June 27	June 26
“	Oct 19	July 26	May 30	June 27	Aug 12	July 6	July 28	July 25	July 31
“	-	Aug 30	June 28	Aug 7	Sept 9	July 28	Aug 24	Aug 25	Aug 28
“	-	Sept 27	July 26	Aug 28	Sept 29	Aug 26	Sept 28	Sept 26	Sept 25
“	-	Nov 2	Aug 29	Sept 25	Oct 29	Sept 29	Oct 19	Oct 30	Nov 6
“	-	-	Sept 26	-	Dec 3	Oct 28	Nov 24	-	-
“	-	-	Nov 16	-	-	Dec 1	-	-	-
First irrigation event	-	unknown	July 20	June 11	June 25	June 20	June 22	June 21	May 25
Last irrigation event	-	unknown	July 21	July 23	July 17	July 21	Aug 4	July 27	July 26
Water applied (mm)	-	unknown	64	200	223	105	197	243	413

[z] Establishment year.
[y] Banded urea fertilizer (46-0-0) treatments at 0, 60, 120, and 180 kg ha^{-1} y^{-1} nitrogen.
[x] Buctril M/Achieve tank mixture.
[w] Buctril M.
[v] Achieve Extra Gold.
[u] Prestige A; 2,4-D ester, Lontrel; Achieve 40DG; Turbocharge adjuvant.
[t] Manure application rate treatments at 0, 20, 40, 60, and 120 Mg ha^{-1} y^{-1}, on a wet-weight basis.

calcium dichloride ($CaCl_2$) extractant. Extracted micronutrients were measured using a JY70Plus ICP spectrometer.
- Extractable boron using 5:1 hot water extractant. Extracted boron was measured using a JY70Plus ICP spectrometer. Only the 1993, 1997, and 1998 manure samples were analysed for extractable boron.
- Organic matter using the loss-on-ignition method.
- Total nitrogen using the Kjeldahl digestion method.
- Electrical conductivity and pH using a 2:1 water mixture.
- Saturated-paste water extractable calcium, magnesium, sodium, and potassium. Extracted cations were measured using a JY70Plus ICP spectrometer.
- Total elemental analysis (aluminum, iron, magnesium, sulphur, copper, potassium, phosphorus, manganese, sodium, boron, calcium, and zinc) using a nitric acid - perchloric acid digest, followed by JY70Plus ICP spectrometric analysis.

Sodium adsorption ratio (SAR) was calculated using the following formula:

$$SAR = \frac{Na^{+}}{\sqrt{(Ca^{2+} + Mg^{2+})/2}} \quad (1)$$

where Na^+, Ca^{2+}, and Mg^{2+} are expressed in $mmol_c\ L^{-1}$ measured from saturated-paste extracts.

Groundwater Sampling and Analysis

Groundwater was sampled on a monthly basis from about April to November. A total of 66 sample sets were collected from 1993 to 2001 (Tables 1 and 2), including four baseline sample sets prior to the first annual application of manure in 1993. The sampling protocol involved a three-day procedure. On the first day, water-table depths were measured and the wells were bailed to dryness at both sites. Water-table depths were measured with a Solinst™ water-level recorder. Depths were recorded from the top of the wellhead. Wells were hand-bailed with a PVC Waterra™ foot value, which was attached to high-density polyethylene tubing. Groundwater samples were collected on the second and third days (one site per day) using the Waterra foot value hand-pump. The Waterra pump and tubing were first flushed with well water and the plastic sample bottles rinsed once with well water before collecting the final sample volume. The samples were placed in coolers with ice-packs and transported to the Alberta Agriculture, Food and Rural Development Soil and Water Laboratory in Lethbridge. The samples were filtered under vacuum through 0.45 µm filter paper and analysed for nitrate-N (hydrazine reduction colorimetric method using the Technicon TrAAcs 800™) and chloride (thiocyanate colorimetric method using the Technican TrAAcs 800™) content within 24 hours of sampling (Technicon Industrial Systems 1986, 1987b).

Additional samples were collected during three sampling sessions in 1994 (May 30-31, July 25-26, and September 28-29) and in 1995 (May 30-31, July 25-26, and September 26-27). These samples were submitted to the University of Alberta Hospitals for detailed analyses. The Trace Elements/Environmental Toxicology Laboratory analysed the samples for pH, electrical conductivity, sodium, potassium, calcium, magnesium, hardness (total $CaCO_3$), total alkalinity, carbonate, bicarbonate, hydroxide, chloride, fluoride, nitrate-N plus nitrite-N, sulphate, total dissolved solids (calculated), and 21 trace elements (Al, Sb, As, Ba, Be, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Mo, Ni, Se, Ag, Tl, Ti, V, and Zn). The Medical Microbiology Laboratory analysed the samples for total and faecal coliforms using the multiple-tube method.

Soil Sampling and Analysis

Annual soil sampling. Soil samples were collected annually from each subplot (60 per site) in either September or October starting in 1993 (baseline samples) and continuing from 1994 to 2001 (Tables 1 and 2). Two soil cores were collected from each plot to a depth of 1.5 m using a truck-mounted, hydraulically-powered, core-tube sampler. The cores were divided into six incremental layers (0 to 0.15, 0.15 to 0.3, 0.3 to 0.6, 0.6 to 0.9, 0.9 to 1.2, and 1.2 to 1.5 m) and a composite sample was prepared for each layer. In 2000 and 2001, two additional soil cores were collected from each plot to a depth of 0.3 m. This was done to increase the total mass of soil obtained for the 0 to 0.15 m and 0.15 to 0.3 m composite sample layers. A total of 360 soil samples were collected from each site per year. The samples were placed in coolers with ice-packs and transported to the Alberta Agriculture, Food and Rural Development Soil and Water Laboratory in Lethbridge.

Moist subsamples (10 g) were extracted with 2-M KCl (100 mL) by shaking for 60 minutes. The mixtures were filtered through pre-washed (with distilled water and KCl solution) filter paper (Whatman #42). The filtrates were then analysed for nitrate-N and ammonium-N contents using a Technicon TrAAcs 800™. The hydrazine reduction colorimetric method was used for the nitrate-N analysis (Technicon Industrial Systems 1986), and the indophenol blue colorimetric method (phenate method) was used for the ammonium-N analysis (Technicon Industrial Systems 1987a). Moisture content of the soil samples was also determined by drying another subsample at 105 °C for 24 hours.

Soil profile (0 to 1.5 m) ammonium-N content was 2.5 to 11 times greater in 1993 as compared to the maximum values measured in the other years at both sites. Prior to 1994, filter paper was not washed with distilled water and KCl solution, and no blanks were included in the analysis. It was realized in 1994 that the filter paper was a source of ammonium contamination. The extractable ammonium procedure was modified by including blanks and by pre-washing the filter paper with distilled water and KCl solution. The 1993 ammonium-N data were treated as missing data.

The remaining samples were air-dried and ground (<2 mm). Saturated-paste water extracts were obtained on air-dried subsamples (200 or 300 g). The saturated-paste extracts were analysed for the following parameters:

- pH using an Orion pH meter or the PC-TitrateIon Plus™ (Man-Tech Associates Inc.).
- Electrical conductivity using a Radiameter CDM 83 conductivity meter or the PC-TitrateIon Plus™ (Man-Tech Associates Inc.).
- Calcium by atomic absorption using a Philips PU9400X.
- Magnesium by atomic absorption using a Philips PU9400X.
- Sodium by flame photometry using an IL 943.
- Potassium by flame photometry using an IL 943.

- Sulphate-S by the turbidimetric method using a Milton Roy Spectronic 1001 Plus.
- Chloride by the thiocyanate colorimetric method using the Technicon TrAAcs 800™ (Technicon Industrial Systems 1987b).
- Carbonate by acid titration using a Fisher titration unit or the PC-TitrateIon Plus™ (Man-Tech Associates Inc.).
- Bicarbonate by acid titration using a Fisher titration unit or the PC-TitrateIon Plus™ (Man-Tech Associates Inc.).
- Sodium adsorption ratio (SAR) was calculated from the saturated-paste data (Equation 1).

Soil total nitrogen and phosphorus. A subset of soil samples from each year was analysed for total nitrogen and total phosphorus. Samples from the control and manure subplots were selected. Samples from only the top four layers (0 to 0.15, 0.15 to 0.3, 0.3 to 0.6, and 0.6 to 0.9 m) were analysed. A total of 1800 samples were analysed (5 treatments x 5 reps x 2 sites x 4 layers x 9 years). The Kjeldhal digestion method was used for the analyses, and the analyses were carried out by the Alberta Agriculture, Food and Rural Development Agri-Food Laboratories Branch, Soil and Crop Unit in Edmonton. A pre-treatment procedure was used to include nitrate-N in the Kjeldhal digestion method.

Soil extractable orthophosphate-P. Extractable orthophosphate-P (or PO_4-P) was determined on selected soil samples using a version of the modified-Kelowna extraction method (0.015 M ammonium fluoride, 0.25 M ammonium acetate, 0.25 M acetic acid; Qian et al. 1991). The top three incremental layers (0 to 0.15 m, 0.15 to 0.3 m, 0.3 to 0.6 m) from the control and non-BMP-manure subplots from 1993 to 1998 were analysed (900 samples). From 1999 to 2001, samples from all six incremental layers from the control, non-BMP-manure, and BMP-manure (i.e. residual-manure) plots were analysed (1,620 samples). Air-dried and ground (< 2 mm) subsamples (10 g) were extracted with the modified-Kelowna extraction solution (100 mL) by shaking for 30 minutes. The mixtures were then filtered through #42 Whatman filter paper. The filtrates were analysed for orthophosphate-P using the molybdate/antimony/ascorbic acid colorimetric method with the Technicon TrAAcs 800™ (Technicon Industrial Systems 1987c).

Baseline soil composite samples. Composite samples were also prepared from the baseline soil samples (1993 sample set) to determine additional site characteristics. Composite samples were prepared only for the 0 to 0.15-m and 0.15 to 0.3-m soil layers. Subsamples from the 12 subplots within each replicate were mixed to give a total of 10 composite samples (five replicates by two layers) per site. These samples were analysed by the Alberta Agriculture, Food and Rural Development Agri-Food Laboratories Branch, Soil and Crop Unit in Edmonton. The only parameter determined for these samples and reported in this report is organic matter content, which was measured using the loss-on-ignition method.

Spring soil sampling. The original design required that soil samples be collected in the spring to measure plant-available nitrogen, which was used to determine whether or not supplemental inorganic nitrogen fertilizer had to added to the BMP-manure subplots. Either in March or April from 1994 to 1999, two soil cores were taken from the BMP-manure subplots plots using a truck-mounted, hydraulically-powered, core-tube sampler. Five incremental layers were sampled in 1994 and 1995 (0 to 0.15, 0.15 to 0.3, 0.3 to 0.6, 0.6 to 0.9, 0.9 to 1.2 m) and three incremental layers were sampled in 1996-1999 (0 to 0.15, 0.15 to 0.3, 0.3 to 0.6 m). The two cores per plot were made into composite samples for each layer. Extractable nitrate-N, extractable ammonium-N, and soil moisture were measured on moist subsamples as previously described, using the 2-M KCl extraction method. This sampling procedure was discontinued after 1999 because the BMP-manure treatments were essentially not applied after 1994.

Monthly soil sampling. Starting in 1999, selected plots were sampled on a monthly basis during the growing season and into the fall. A hand-probe with a core tube (19 mm diameter) was used to take six core samples (0 to 0.15 m deep) from each selected plot. The six cores within each plot were made into a composite sample. The plots sampled included the control and the BMP-manure subplots. Samples were collected using this method in June, July, August, October, and November, 1999. Monthly soil sampling was continued in 2000 and 2001 with some changes. Instead of six cores per plot, only four cores were collected. Samples were collected from the 0- to 0.15 and 0.15 to 0.3 m layers. Instead of the BMP-manure subplots, the non-BMP-manure subplots were sampled in 2000 and 2001, because manure application was discontinued on the BMP-manure subplots. Samples were collected in April to August and October, 2000 and in April to August, 2001. Soil samples were brought to the laboratory and subsamples of moist soil were analysed for extractable nitrate-N, using the KCl extraction method and for soil moisture content. The remainder of each soil sample was then air dried and ground to pass through a 2-mm sieve. Extractable orthophosphate-P content was determined on the air-dried subsamples using the modified-Kelowna extraction procedure.

Soil bulk density. Soil chemistry data were expressed on a kg ha^{-1} basis using field-measured soil bulk density values. Twelve soil cores (3.9, 6.4, or 6.7 cm diameter) were taken, using a truck-mounted, hydraulically-powered, core-tube sampler, to determine bulk density at each site in the pathways between the replicate blocks. Three cores were taken in the pathway between reps A and B, B and C, C and D, and D and E. The cores were located between subplots 2 and 3, 6 and 7, and 10 and 11 within each pathway (Figs. 1 and 2). The cores were divided into six incremental layers (0 to 0.15, 0.15 to 0.3, 0.3 to 0.6, 0.6 to 0.9, 0.9 to 1.2, and 1.2 to 1.5 m). The length of core subsamples was measured from each incremental layer, and the measured subsamples were then oven-dried. Soil bulk density values were calculated using the measured lengths, air-dried soil weights, and core diameter. Bulk density values used are shown in Table 3, and further details are in Appendix 4.

Table 3. Mean soil bulk density values used for the coarse- and medium-textured sites.

Incremental layer (m)	Coarse-textured site bulk density ($Mg\ m^{-3}$)	Medium-textured site bulk density ($Mg\ m^{-3}$)
0 - 0.15	1.55	1.40
0.15 - 0.3	1.62	1.28
0.3 - 0.6	1.55	1.27
0.6 - 0.9	1.58	1.42
0.9 – 1.2	1.60	1.43
1.2 – 1.5	1.56	1.45

Soil phosphorus and soil aggregate samples. Additional soil samples were collected in 2000 and 2001 to support a province-wide soil phosphorus study (Li 2001). In July 2000, October 2000, and September 2001, the control and the four manure-rate plots were sampled at both sites. Samples were collected from the 0 to 0.05-m and 0.05 to 0.15-m layers. A hand-probe with a core tube (19 mm diameter) was used to take eight core samples from each selected plot. The eight cores within each plot were made into a composite sample for each soil layer. The exception to this was for the coarse-textured site in September 2001, when the soil was too dry for the hand-probe and a truck-mounted, hydraulically-powered, core-tube sampler was used. Instead of eight cores per plot, only four cores per plot were taken to make composite samples. The soil samples were air dried and sieved (< 2 mm). The samples were analysed for extractable orthophosphate-P content using two methods: (1) modified-Kelowna, as described above, and (2) water extractable. Water extractable phosphorus was determined by shaking 4 g of air-dried soil in 100 mL of deionized water in a conical flask for 60 minutes. The mixtures were filtered and the filtrate analysed colorimetrically for orthophosphate-P content. Values were calculated on a kilogram-per-hectare basis, assuming the soil bulk density was the same for the 0 to 0.05-m and 0.05 to 0.15-m layers as reported for the 0 to 0.15-m layer (Table 3).

Surface (0 to 0.05 m) soil samples were also collected in October 2000 using a narrow shovel. Three shovel samples were collected from each plot and made into one composite sample (2 to 3 kg) per plot. The control and the four manure-rate plots were sampled at both sites. The samples were stored for three months at field-moist conditions in an unheated storage building. These samples were used to determine aggregate-size distribution and the phosphorus content in the different aggregate-size fractions. Subsamples (600 g) were separated into aggregate size fractions using an Endecotts Limited shaker, model EVT1 (Endecotts Ltd., London, England). The subsamples were placed on a stack of three sieves (1.0 mm, 0.5 mm, and 0.177 mm) and shaken for 5 minutes at a power setting of 30. This generated four aggregate-size fractions: >1.0 mm, 1.0 to 0.5 mm, 0.5 to 0.177 mm, and <0.177 mm. After shaking, each fraction was weighed. The >1.0-mm fraction was then discarded, while the other three fractions were air dried. The remaining soil in the field sample was subsampled for moisture content and then air dried. We assumed that the moisture content in the fractions was the same as in the unfractionated subsamples. The air-dried, unfractionated soil was ground to pass through a 2-mm sieve. The unfractionated samples and the 1.0 to 0.5-mm, 0.5 to 0.177-mm, and <0.177-mm fractions were analysed for total phosphorus (Kjeldhal digestion method) and extractable orthophosphate-P (modified-Kelowna method) contents. Total phosphorus and extractable orthophosphate-P contents in the >1.0-mm fraction were calculated by difference.

Nitrogen Fertilizer Treatment Application

The nitrogen fertilizer treatments (60, 120, and 180 kg ha^{-1} of nitrogen) were banded (about 0.08 to 0.1 m deep) each spring in 1994 to 2001 (Tables 1 and 2) using urea-N fertilizer (46-0-0). A tractor-mounted (three-point-hitch) fertilizer-banding applicator was used, and the fertilizer was applied prior to seeding. The applicator was 2-m wide with two rows of five shanks/blades. The distance between bands was about 0.22 m. Four passes were required to cover each subplot.

Seeding

Both sites were tilled with a light-duty cultivator with packers each spring prior to seeding. The sites were seeded annually to a cereal in the spring of 1994 to 2001 (Tables 1 and 2). Barley (*Hordeum vulgare* L.) was used in 1994 to 1998 and 2000. The Duke cultivar was used from 1994 to 1998 and AC Harper was used in 2000. Triticale (*X Triticosecale rimpaui* Wittm. var. AC Alta) was used in 1999 and 2001. A 3.31-m wide, tractor-pulled, Noble 2300 high clearance hoe-drill was used to seed the crops from 1994 to 1999. The drill had 10 shanks with a row spacing of 0.178 m. In 2000 and 2001, a self-propelled hoe-drill plot seeder was used for seeding. The seeding rate was 112 to 117 kg ha^{-1} for barley and 130 kg ha^{-1} for triticale to achieve about 250 seeds per square metre. Seeding depth was about 0.038 m, and seeding direction was across the replicate blocks. The seed was treated with carbathiin (Vitavax™) in 1994, 1995, and 1996. The seed was treated with carbathiin/thiram/lindane mixture (Vitavax Dual Powder™) from 1997 to 2001, except in 2000 when carbathiin/thiram mixture (Vitavax™ 280 flowable) was used.

Phosphorus fertilizer (0-45-0) was added with the seed at a rate of 13 kg ha^{-1} of phosphorus (i.e. 30 kg P_2O_5 ha^{-1}) at the medium-textured site in 1994. Soil testing in 1993 indicated that phosphorus levels were adequate at the coarse-textured site and no phosphorus fertilizer was added in 1994. Phosphorus fertilizer (13 kg ha^{-1} of phosphorus) was applied with the seed at both sites from 1995 to 1999. In 2000 and 2001, phosphorus fertilizer was added only to the three nitrogen fertilizer treatment plots at a rate of 13 kg ha^{-1} of phosphorus. The application of phosphorus fertilizer to the manure plots was discontinued because of the excessive cumulation of phosphorus from the manure.

During the years (1994 to 1999) when the Noble 2300 hoe-drill was used, a lens-shaped area at the centre of each subplot was missed during seeding because of the water-table wells. These areas were seeded with a hand-pushed, single-row seeder. This operation was carried out within three weeks of the main seeding. These missed areas were reduced in size when the plot seeder was used in 2000 and 2001, and as a result, filling in these areas was discontinued.

Poor crop emergence occurred at the coarse-textured site in 1996. Approximately 50 percent of the site had no crop emergence three weeks after seeding. The site was tilled on June 28, 1996, and re-seeded to barley on July 4. We suspected that a soil insect may have caused poor crop emergence. Another possibility is the crop may have been seeded too deep. The seed used for the second planting was treated with carbathiin/thiram/lindane mixture (Vitavax Dual Powder™). Emergence was much better, but the site was plagued with a heavy infestation of redroot pigweed (*Amaranthus retroflexus* L.). The purpose of re-seeding the site was to provide a protective cover crop, and to remove some of the added nutrients. Crop yield was not measured at the coarse-textured site in 1996.

Weed Control

Herbicides used during the study and the application dates are reported in Tables 1 and 2. The sites were sprayed with a tank mix of bromoxynil/MCPA (Buctril M™) and tralkoxydin (Achieve™) in 1994. Bromoxynil/MCPA (Buctril M™) was applied in 1995 and 1996 at both sites. A second application of bromoxynil/MCPA (Buctril M™) was carried out in late July, 1996 at the coarse-textured site due to a heavy infestation of redroot pigweed. Both sites were sprayed with bromoxynil/MCPA/tralkoxydin (Achieve Extra Gold™) in 1997, 1998, and 1999. In 2000 and 2001, a combination of four herbicides was used at both sites: fluroxpyr (Prestige A™), 2,4-D ester, clopyralid (Lontrel™), and tralkoxydin (Achieve 40DG™). Periodically, glyphosate (Roundup™) was used for non-selective vegetative control before seeding or after harvest.

Irrigation

Each site was irrigated using solid-set irrigation systems. Water was withdrawn from a nearby irrigation canal at the coarse-textured site (a few metres along the south side of the plot area). A 0.102-m diameter pipeline, with value openers, was laid along the west side of the plot area. This pipeline delivered water from the pump. Six 0.051-m diameter lateral pipelines were attached to value openers (0.102 m to 0.051 m) and extended east through the plot area in the pathways. One lateral was placed along the south side of rep A and another lateral was placed along the north side of rep E. The other four lateral pipelines were placed in the four pathways within the plot area (Fig. 1). Each lateral pipeline had nine 0.91-m long riser pipes with single-nozzle impact sprinkler heads. Sprinkler nozzle size was 5.56 mm, with an application rate of about 13 mm h^{-1}.

The medium-textured site was located about 225 m north of an irrigation canal. A 0.152-m diameter pipeline was used to deliver water from the pump at the irrigation canal to the plot area. The delivery pipe was turned with a 90-degree elbow near the southeast corner of the plot area. The pipeline was then stepped down to a 0.102-m diameter pipeline with value openers and extended along the south side of the plot area. Six 0.051-m diameter lateral pipelines were attached to value openers (0.102 m to 0.051 m) and extended north through the plot area in the pathways. One lateral was placed along the east side of rep A and another lateral was placed along the west side of rep E. The other four lateral pipelines were placed in the four pathways within the plot area (Fig. 2). Each lateral pipeline had nine 0.91-m long riser pipes with impact sprinkler heads. The application rate was about 13 mm h^{-1}.

A Campbell-Pacific 503 neutron probe was used to monitor soil moisture and to schedule irrigation events in 1994. Aluminum neutron probe access tubes were installed near the centre of each plot in reps A, C, and E at both sites. The 180 kg ha^{-1} N-fertilizer subplots were used to determine when to apply water. Because of the wet spring and early summer, only one irrigation event was carried out in 1995. Because of concerns about the accuracy of the neutron probe, irrigation scheduling was determined from 1996 to 2001 by collecting soil samples with a hand probe and using the hand-feel method. Four rain gauges were placed in the plot area to record the amount of water applied during each irrigation event. The irrigation events are summarized in Appendix 5.

Harvesting

The crop was harvested at the silage stage each year (Tables 1 and 2). Two, 1-m square samples, representing about 1.6 percent of the plot area, were collected from each plot in 1994. The two square-metre samples from each plot were placed into separate harvest bags and weighed. Subsamples were collected from each bag and oven-dried to determine moisture content.

A Hege™ 212 Forage Harvester was used from 1995 to 2001, to remove two, 1.55-m wide strips from each subplot. The strips were cut along the short dimension (8 m) of the subplots. The 1-m borders between the main plots were trimmed with a Jerrie Mower prior to harvest. A 1-m strip was also cut between the subplots within each main plot. These trimmed borders allowed the forage harvester to start and stop as it progressed through the plots. First one strip was harvested from each subplot within a replicate. Then the forage harvester turned around and harvested a second strip before moving to the next replicate. The amount of harvested material was automatically weighed by on-board scales and recorded by a data logger. About 18 percent of the subplot area was harvested. Harvested strip lengths were measured for each subplot so that accurate yields could be calculated. A chopped subsample (about 1 kg) was automatically taken by the forage harvester during the harvest of each strip. The exception was in 1996 when the chopping mechanism on the harvester failed. Unchopped hand subsamples were collected after the harvester unloaded the harvested material. The subsamples were collected in paper hardware bags, which were perforated with 0.5 mm diameter holes. Two subsamples were obtained from each subplot (i.e. one from each harvest strip). The subsamples were combined and weighed in the field using a top-load balance. The plant subsamples were oven dried (60 °C), re-weighed, and moisture content calculated.

The 1995 to 2001 dried plant subsamples were finely ground and analysed for total nitrogen, phosphorus, and calcium content by the Alberta Agriculture, Food and Rural Development Agri-Food Laboratories Branch, Soil and Crop Unit in Edmonton. A non-destructive near infrared reflection spectroscopy method was used for the analysis.

No crop data were obtained in 1996 from the coarse-textured site due to poor crop establishment, which led to crop failure.

Site Elevations

Site elevations were measured on August 18 and 19, 1993 at the medium- and coarse-textured sites, respectively. Nearby benchmarks of known elevation were used for both sites. Marker #124-1 (866.426 m) was used for the medium-textured site, and marker #125 (868.635 m) was used for the coarse-textured site. Elevation of the top of each wellhead (with the cap off) was measured. The length of the well casing protruding above the ground surface (i.e. wellhead) was also measured. Ground-surface elevation at each well was then calculated by subtracting the wellhead length from the elevation of the top of the wellhead.

Statistical Analyses

Data from the non-BMP-manure and BMP-manure subplots were averaged for each manure rate since these two subtreatment factors were the same in practice. The intent was the BMP-manure treatments were to receive supplemental inorganic nitrogen fertilizer if the spring soil nitrogen plus estimated mineralized nitrogen from added manure was less than 180 kg ha^{-1}. As it turned out, no supplemental N fertilizer was added to the BMP-manure subplots, except for the

20 Mg ha^{-1} manure-BMP subplot (60 kg ha^{-1} N fertilizer) at both sites in 1994 (i.e. the first crop year). Therefore, the data for the four manure rates came from the 16 by 16 m main plots, and the BMP split design was ignored. Data were combined from the two subplots for groundwater chemistry, soil chemistry, and silage yield and tissue data, but not for groundwater elevation data. Even though the BMP split was ignored, data were collected separately from non-BMP-manure and the BMP-manure subplots because there was a groundwater well in the center of each subplot. Averaging the non-BMP-manure and BMP-manure subplots was carried out for the 1993 to 1999 data. After October, 1999, the former BMP-manure plots became the residual-manure subplots. Manure was not applied to these subplots in 1999 and 2000. Continuous data sets from 1993 to 2001 included averaged values of the non-BMP-manure subplots and the BMP-manure subplots from 1993 to 1999, and the values from the non-BMP-manure subplots in 2000 and 2001.

The split design among the nitrogen-fertilizer treatments was not used. There was no statistical basis for having the same factor (i.e. nitrogen fertilizer) for the mean treatments and for the split treatments. The control and fertilizer treatments were thus treated as four separate and assumed randomized plots. We assumed the control, the three fertilizer levels, and the four manure levels were eight treatments in a randomized block design.

The PROC MIXED procedure in the Statistical Analysis System (SAS Institute Inc. 2000) was used to analyse the annual soil and crop data. The CLASS statement included treatment and year, with year as a repeated measure. Significant treatment, year, and treatment-by-year effects were tested. Significant differences were determined between the control and the treatments using the ESTIMATE statement, and among treatments using LSMEANS. The Bonferroni correction method was used in the analysis. The soil data were analysed separately by soil layer.

The 1999, 2000, and 2001 data were used to determine the effect of residual manure. The 1999 data was considered the baseline comparison between the manured (i.e. non-BMP-manure subplots) and the residual-manure subplots (i.e. BMP-manure subplots). This was the last year the non-BMP-manure and BMP-manure subplots were treated the same (i.e. both received manure in 1998). Comparisons were made between manure and residual-manure subplots for each year (1999, 2000, 2001), and comparisons were made among the three years for the manured and residual-manure subplots using the PROC MIXED procedure, with the Bonferroni correction method.

The General Linear Model procedure in the Statistical Analysis System (SAS Institute Inc. 2000) was used to determine treatment differences for the groundwater chemistry data. The Tukey studentized range test was used for significant mean separation. The groundwater chemistry data were analysed separately for each sampling date.

The General Linear Model procedure was also used to analyse the soil aggregate distribution and aggregate phosphorus content data.

RESULTS AND DISCUSSION

Site Characteristics

Soil. Baseline soil characteristics are summarized in Table 4. Soil at the medium-textured site contained more organic matter in the 0 to 0.6 m layer than at the coarse-textured site. The soil at the medium-textured site also contained more total nitrogen and total phosphorus than the coarse-textured site. However, the coarse-textured site contained more extractable nitrate-N and extractable orthophosphate-P. In fact, the high orthophosphate-P in the two top soil layers may be the result of heavy manure application on this site in the past. The nitrate-N content increased with depth at the coarse-textured site. Soil pH was similar at both sites, whereas electrical conductivity was higher at the medium-textured site, particularly with depth.

Table 4. Some soil characteristics of the 1993 baseline soil samples from the coarse- and medium-textured sites.

Soil layer (m)	Organic matter ^{z} (Mg ha^{-1})	Total N ^{y} (kg ha^{-1})	Total P ^{y} (kg ha^{-1})	Extractable NO_3-N $^{x, w}$ (kg ha^{-1})	Extractable PO_4-P $^{y, w}$ (kg ha^{-1})	Extractable K $^{y, w}$ (kg ha^{-1})	pH ^{x}	Electrical conductivity (dS m^{-1}) ^{x}
				Coarse-textured site				
0-0.15	59	3276	1605	20	289	63	7.2	0.89
0.15-0.3	46	1952	1141	14	94	14	7.4	0.71
0.3-0.6	na ^{v}	2282	1994	24	28	31	7.7	0.59
0.6-0.9	na	1023	1955	55	na	7.9	7.7	0.86
0.9-1.2	na	na	na	99	na	5.7	7.7	1.33
1.2-1.5	na	na	na	125	na	10	7.8	1.58
				Medium-textured site				
0-0.15	94	4468	1407	8.6	59	18	7.7	0.76
0.15-0.3	82	2925	1188	6.9	13	41	7.8	0.74
0.3-0.6	na	3261	2473	11	11	4.3	7.9	1.07
0.6-0.9	na	1447	2350	5.8	na	7.2	7.9	1.64
0.9-1.2	na	na	na	1.7	na	15	8.0	2.53
1.2-1.5	na	na	na	1.1	na	28	7.9	3.27

^{z} n = 5 per layer.
^{y} n = 25 per layer.
^{x} n = 60 per layer.
^{w} Nitrate-N determined by KCl extraction method, orthophosphate-P determined by the modified Kelowna extraction method, and potassium determined by the saturated-paste water extraction method.
^{v} na = not analysed.

Soil texture ranged from sand to sandy-loam within the root zone (0 to 1.2 m) at the coarse-textured site (Appendix 6). The average texture was a loamy sand, with an average sand content of 81 percent and an average clay content of 8 percent. The sand content decreased in the 2 to 3 m layer at some locations within the site (Appendix 6, Table 6.1). The medium-textured site had an average sand content of 32 percent and an average clay content of 24 percent in the root zone (0 to 1.2 m). Loam was the average textural class in the root zone. However, sand lenses were encountered at the site. For example, the 0.9 to 1.2 m layer in subplot A1 contained 88 percent sand (Appendix 6, Table 6.2).

Ground-surface elevations. Both sites were relatively level. The difference between the highest and lowest elevation points was 0.54 m at the coarse-textured site and a 0.26 m at the medium-textured site (Appendix 7). There was no dominant gradient at the coarse-textured site (Fig. 3a). A slight depression was present along the southwest-northeast diagonal of the plot area at the medium-textured site (Fig. 3b).

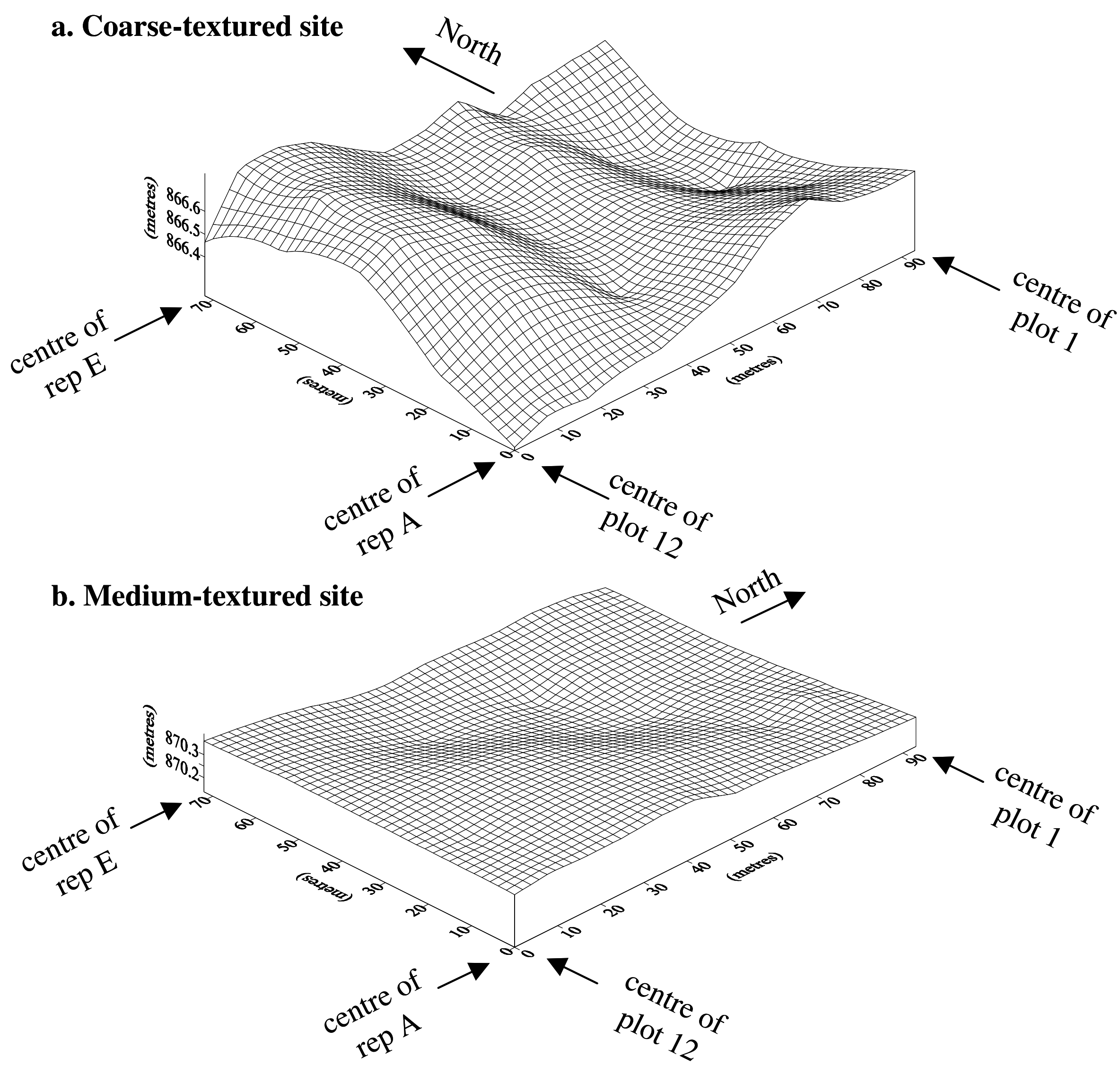


Fig. 3. Ground-surface elevation at the (a) coarse-textured site and (b) at the medium-textured site. The vertical scale is exaggerated by 47.5 times relative to the two horizontal scales.

Climate. Selected climatic data for the Lethbridge region are shown in Appendix 8. These data were collected at the Agriculture and Agri-Food Canada Lethbridge Research Centre, which was located about 23 km south-southwest from the two experimental sites. The climatic data collection station is located on the border between the northwest and northeast quarter sections of section 34, township 8, range 21, W of the fourth.

Precipitation was above the 30-year normal in 1993, 1995, 1998 and below the 30-year normal in 1994, 1996, 1997, and 1999 to 2001 (Appendix 8). However, precipitation was above the 30-year normal in 1994 and 1997 during the early growing season (May and June), but fell below the 30-year normal in July and August. Precipitation was generally low throughout the growing season in 1997 and 2001. May and July were particularly dry months in 2000 and 2001, and August and September were extremely dry in 2001. Growing season temperature was the lowest in 1993. The mean monthly temperatures were higher than average from April to September in 1994, 1997, 1998, 2000, and 2001. The 1997 to 2001 period tended to be warmer than the 1993 to 1996 period. The July to October period was particularly warm in 1997 to 2001. In 1999, February, March, November, and December mean temperatures were well above the 30-year normal values. Higher temperatures reflect the higher evaporation values in 1997 to 2001 as compared to the average, particularly for 2001.

Water-table Depths and Elevations

Water-table elevation and depth to water table data are shown in Appendix 9.

Coarse-textured site. The water table was, on average, 2.06 m below the soil surface during the measurement period (1993 to 2001). The shallowest depth measured was 1.45 m in well D2 on August 23, 1999. The deepest depth measured as 2.70 m in well C11 on March 18, 1996. The maximum fluctuation of 0.95 m was observed in well D11 during the eight-year period. The least fluctuation of 0.55 m was observed in well C1.

Water-table elevations are shown in Figs. 4 and 5 for the last measuring date of each year. The water-table gradient was shallow, with a slight slope towards the southwest. The difference between the lowest and highest elevation on a given sample date generally ranged from 0.19 to 0.76 m. However, on November 15, 1993, this difference was 1.14 m. The rise and fall of the water-table elevation followed an annual cycle (Fig. 6a). Annual peak elevations were observed from June to August, whereas the lowest water-table elevations occurred during the February to April period of each year.

Medium-textured site. The water table was deeper at the medium-textured site, with an average depth of 2.49 m below the soil surface during the measurement period. The shallowest depth measured was 0.58 m in well E2 on July 30, 2001. The deepest depth measured was 4.33 m in well D11 on May 5, 1997. The greatest difference in water-table elevation in a single well was 3.62 m (well E9) within the eight-year period. The minimum difference observed in a single well was 1.62 m (well A5).

Water-table elevation also varied more with time (Fig. 6b). The difference between the lowest and highest elevation on a given sample date ranged from 0.42 to 2.13 m. Annual peak

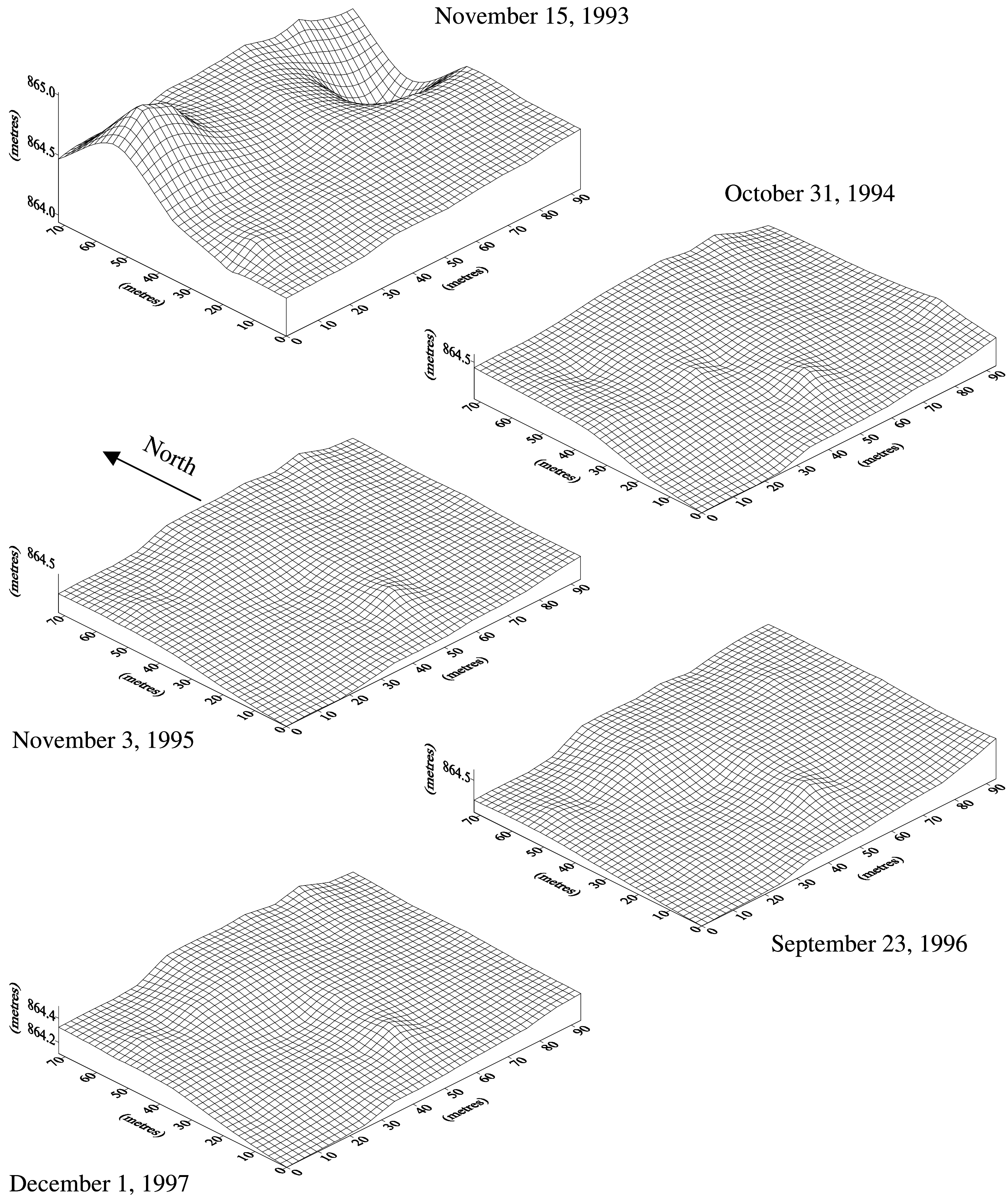


Fig. 4. Water-table elevations at the coarse-textured site from 1993 to 1997. The vertical scale is exaggerated by 31 times relative to the two horizontal scales.

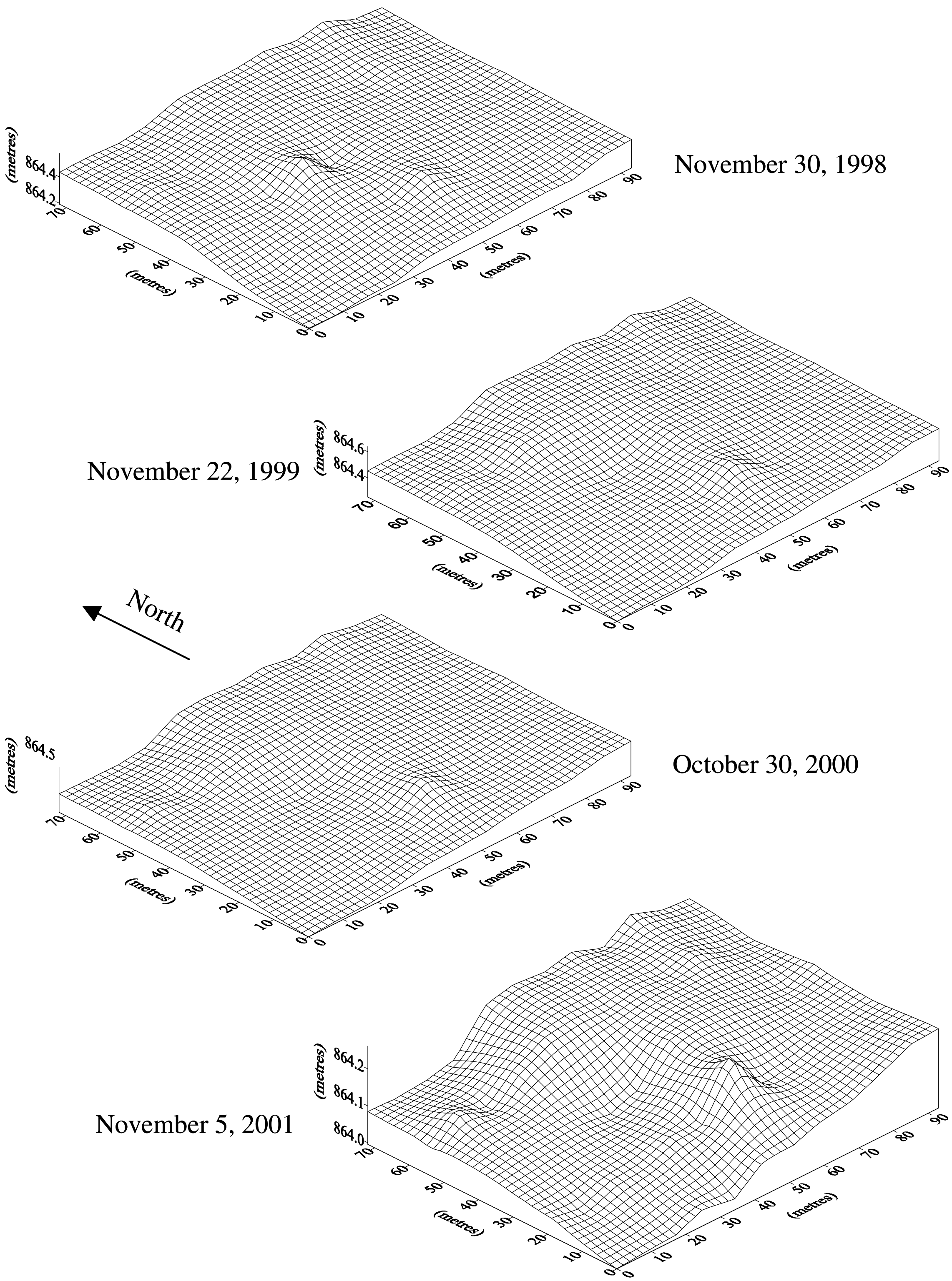
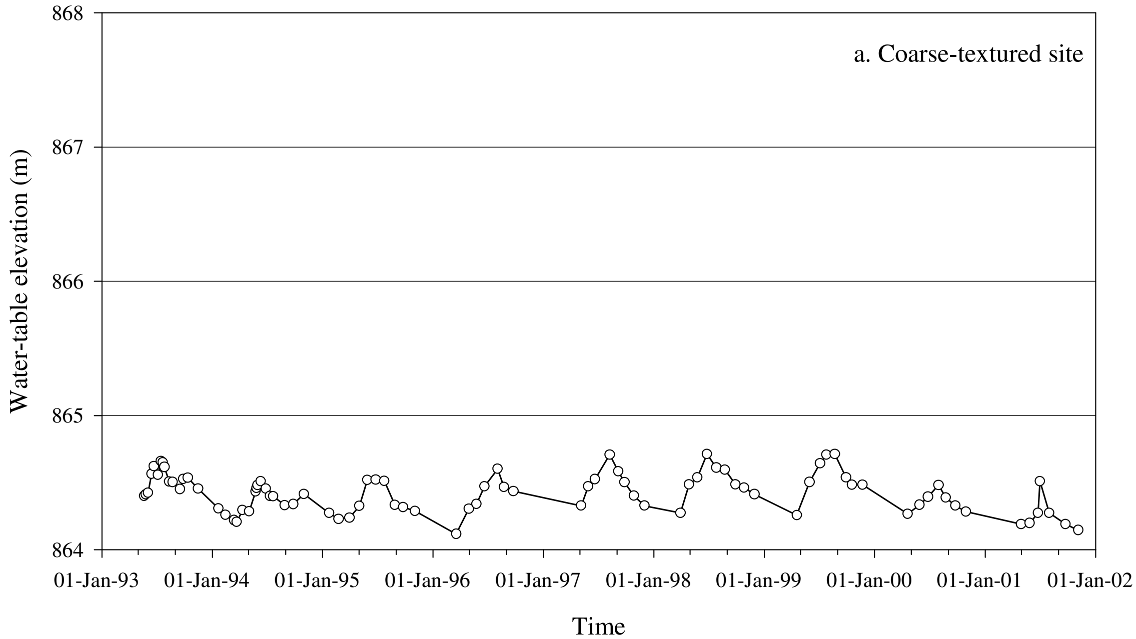


Fig. 5. Water-table elevations at the coarse-textured site from 1998 to 2001. The vertical scale is exaggerated by 31 times relative to the two horizontal scales.



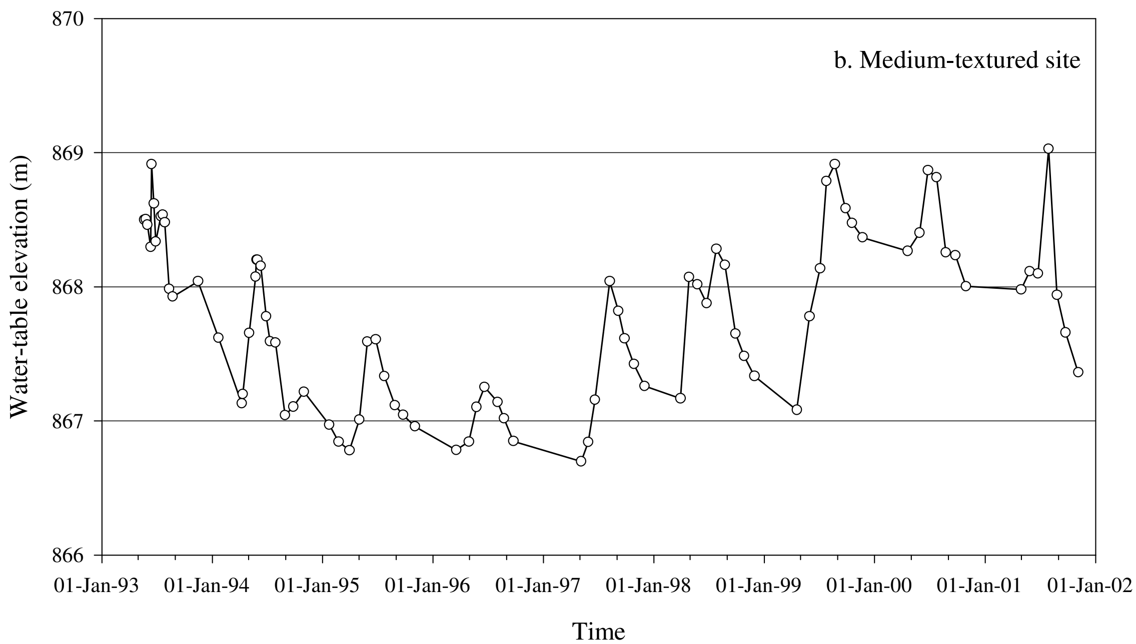


Fig. 6. Average (n=60) water-table elevations with time at the (a) coarse-textured site and (b) medium-textured site.

elevations were observed from late May to August, whereas the lowest water-table elevations occurred during the March to early May period of each year. Water-table gradients were generally shallow within the site (Figs. 7 and 8). The water table sloped slightly towards the southwest in November, 1993. At the end of 1995, and to the lesser extent in 1996, the water table sloped towards the north-south centre line of the plot area. By the end of 1997, the water table sloped towards the southwest and towards the north. Except for the slope towards north, the water table was relatively flat at the end of 1999, 2000, and 2001 (Fig. 8).

Manure Chemistry

Cattle manure was obtained from three separate nearby feedlots during the study. Selected parameters from manure analysis are shown in Table 5, and more detailed results are summarized in Appendix 10.

Manure moisture content averaged 48.8 percent on a wet-weight basis (Table 5) with a range of 21.5 to 74.6 percent (Appendix 10). The driest manure was applied in 1998. The manure tended to be wetter in the first four years (1993 to 1996) than in the latter four years.

Ammonium-N accounted for about 92 to greater than 99.9 percent of the extractable nitrogen fractions (i.e. ammonium-N and nitrate-N). Total nitrogen (i.e. total Kjeldahl nitrogen) ranged from 1.35 to 4.59 percent (Appendix 10). Total nitrogen content was lower in 1994 and from 1996 to 1998 compared to other years at the coarse-textured site (Appendix 10, Table 10.1). Total nitrogen content was much higher (4.59 percent) in 1995 compared to the other seven years (1.38 to 2.94 percent) at the medium-textured site. Two of the five 1995 manure subsamples collected from the medium-textured site contained 6.40 and 7.28 percent total nitrogen, whereas total nitrogen content of the other three subsamples ranged from 2.43 to 3.16 percent. Extractable ammonium-N accounted for 4 to 25 percent of the total nitrogen. Carbon-to-nitrogen (C:N) ratios were calculated by first converting percent organic matter values, reported in Appendix 10, to percent carbon values by dividing by 1.72, and then dividing by percent total nitrogen (Sommerfeldt et al. 1988). Carbon-to-nitrogen ratios generally ranged from 12 to 16. The C:N ratio at the medium-textured site in 1995 was 7.8, and this lower ratio was caused by the higher total nitrogen content in the manure. These C:N ratios are similar to the 7.5 to 13.3 range reported by Sommerfeldt et al. (1988) for 11 years of applied cattle feedlot manure.

Manure pH ranged from 6.7 to 8.6, and electrical conductivity (EC) ranged from 8.3 to 25.7 dS m^{-1} (Table 5). Manure pH was higher and EC slightly lower compared to values reported by Chang et al. (1991). They reported an average pH of 7.2 (S.E. = 0.3), and an average EC of 23.0 dS m^{-1} (S.E. = 6.6) for cattle feedlot manure applied annually for 11 years at an experimental site in southern Alberta. Chang et al. (1991) measured pH and EC using saturated-paste water extracts, whereas we used 2:1 water extracts. Extraction ratio methods (e.g. 1:1, 1:2) tend to give lower EC values compared to the saturated-paste extraction method (Hogg and Henry 1984). Sodium adsorption ratios were between 5.7 and 18.6, except in 1995 when ratios of more than 30 were measured in the manure.

Total sodium, potassium, magnesium, and calcium contents were the highest in 1995 for both sites (Appendix 10). Total phosphorus ranged from 3299 to 11,519 mg kg^{-1}. Extractable

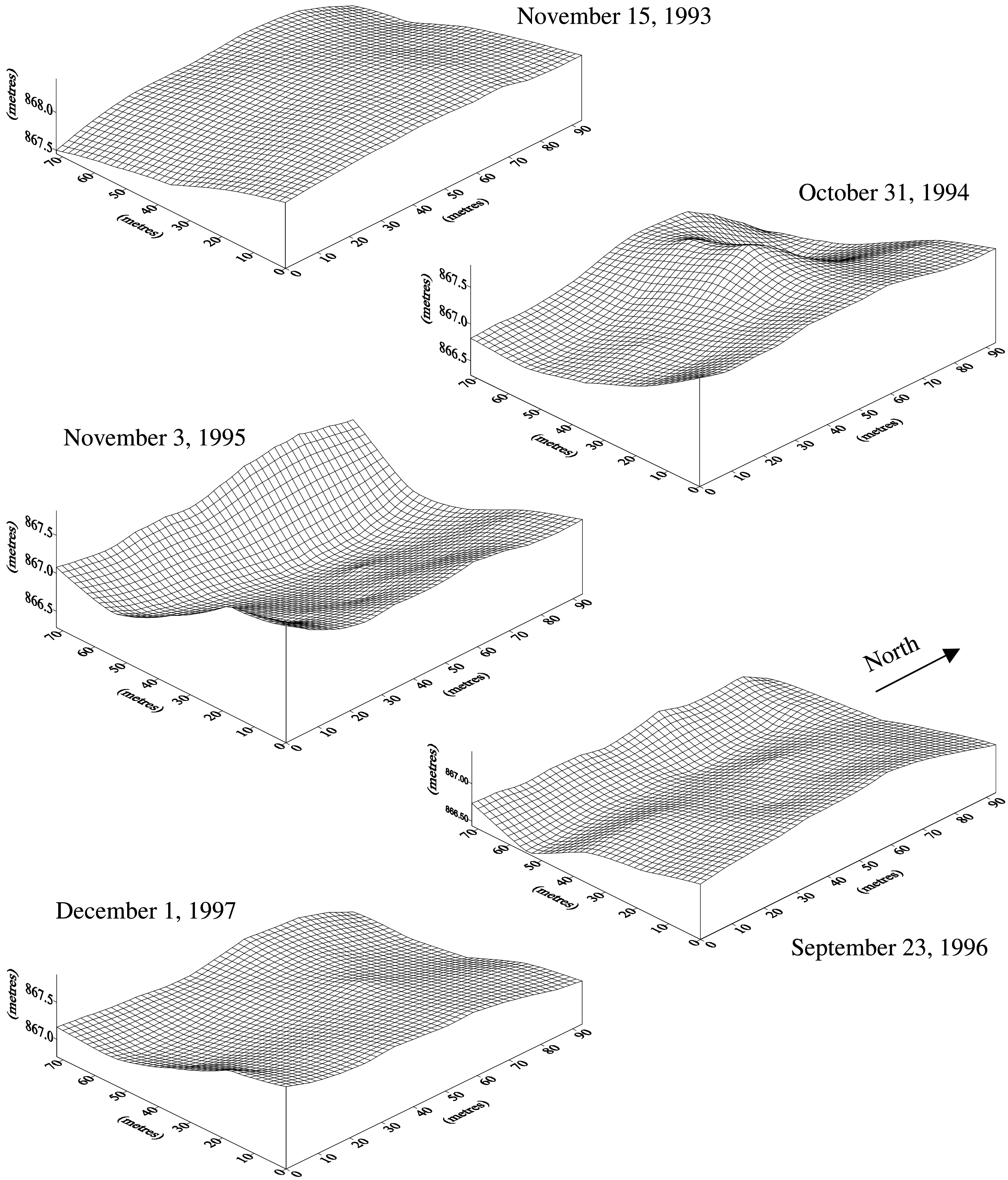


Fig. 7. Water-table elevations at the medium-textured site from 1993 to 1997. The vertical scale is exaggerated by 19.4 times relative to the two horizontal scales.

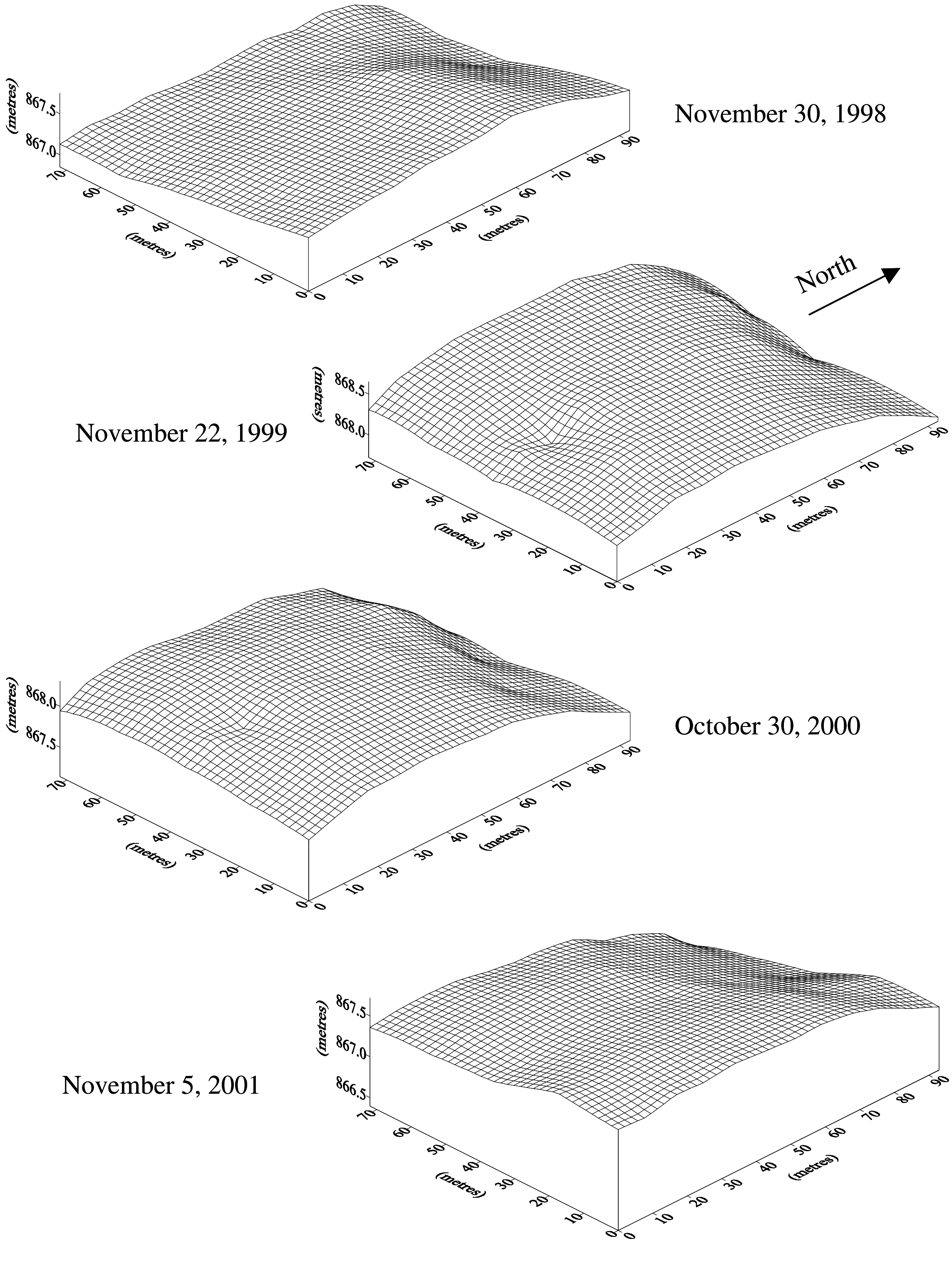


Fig. 8. Water-table elevations at the medium-textured site from 1998 to 2001. The vertical scale is exaggerated by 19.4 times relative to the two horizontal scales.

orthophosphate-P accounted for 16 to 64 percent of the total phosphorus, with an average of 37 percent for the two sites.

Table 5. Selected parameters of cattle manure used at the two field sites from 1993 to 2000.

Parameter [z]	Mean	Range
Moisture (%)	48.8	21.5 – 74.6
Total nitrogen (%)	2.34	1.35 – 4.59
Total phosphorus (mg kg^{-1})	7544	3,299 – 11,519
Extractable ammonium-N (mg kg^{-1})	2682	986 – 5,938
Extractable nitrate-N (mg kg^{-1})	19	0.0 – 144
Extractable orthophosphate-P (mg kg^{-1})	2793	993 – 6,068
Organic matter (%)	53.6	30.3 – 75.0
pH	7.7	6.7 – 8.6
Electrical conductivity (dS m^{-1})	13.0	8.3 – 25.7
C:N ratio	13.7	7.8 – 15.7

[z] Percent moisture is expressed on a wet-weight basis. All other parameters are expressed on a dry-weight basis.

Soil Chemistry

All the soil chemistry data are summarized in Appendix 11.

Extractable nitrate-N. Soil at the coarse-textured site contained large amounts of extractable nitrate-N prior to the application of the treatments (Fig. 9). Nitrate-N increased with depth. The

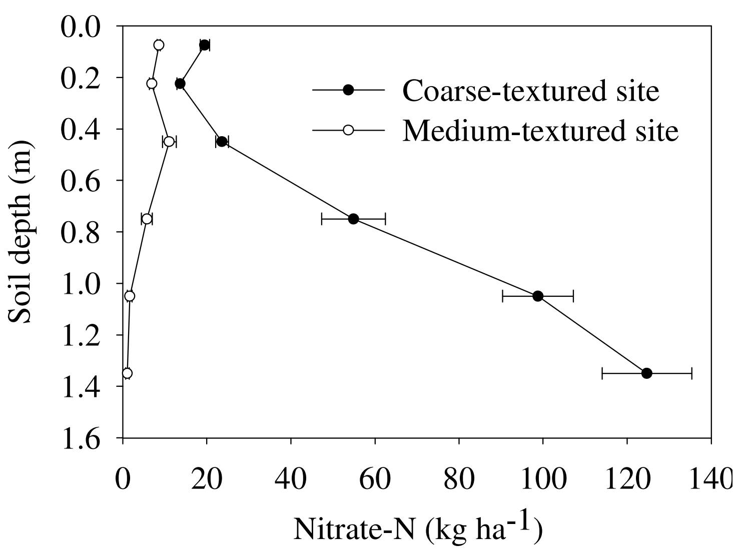


Fig. 9. Mean nitrate-N content in soil at the start of the study in 1993 at the coarse-textured and medium-textured sites. Horizontal bars are standard errors.

baseline (1993) mean was 20 kg ha^{-1} nitrate-N in the 0 to 0.15-m layer, and 125 kg ha^{-1} nitrate-N in the 1.2 to 1.5-m layer. Variability was low in the top 0.5 m, but was more variable with depth below 0.5 m. The average nitrate-N content in the soil profile (0 to 1.5 m) for the site was 335 kg ha^{-1} in 1993.

The nitrate-N content decreased in the lower profile during the first four crop years, from 1994 to 1997 (Figs. 10 and 11). The coarse-textured site was located on a rainfed corner of a quarter-section field, which had a centre-pivot irrigation system installed in 1980. Commercial fertilizer was applied to the pivot corner once every two or three years depending on soil moisture conditions. Manure was applied to the entire quarter section once every five or six years. The last time the landowner applied manure to the quarter section may have been in 1991. The 1993 nitrate-N measured in the soil profile may have been due to previous nitrogen inputs. The first four years of irrigated barley during the study may have leached the nitrate out of the measured soil profile, promoted denitrification, and increased plant uptake of nitrogen. The result was an overall decrease in extractable nitrate-N in the root zone from 1993 to 1997. The control-treatment plots at the coarse-textured site contained only 25 kg ha^{-1} of extractable nitrate-N (0 to 1.5 m) after the growing season in 1997.

There were few significant treatment effects prior to 1997 at the coarse-textured site. The exception was in 1995 when the 120 Mg ha^{-1} manure treatment had significantly greater nitrate-N content in the 0 to 0.15-m layer than the other treatments, except for the 180 kg ha^{-1} nitrogen fertilizer treatment. Because of the confounding effects of large amounts of nitrate-N at the start of the study and the overall reduction that occurred during the first four years, treatment effects can not be considered until after 1996. This resulted in significant treatment-by-year interactions (Appendix 12, Table 12.1). In 1997, the nitrate-N content was low in most of the incremental soil layers and there were no significant differences among the treatments below the 0.3-m depth (Table 6). The 60 and 120 Mg ha^{-1} manure treatments had significantly more nitrate-N in the 0 to 0.15-m layer, and the same was true for the 120 Mg ha^{-1} manure treatment for the 0.15 to 0.3-m layer (Table 6). There were no significant differences among the treatments in 1997 for nitrate-N in the entire 0 to 1.5-m soil profile (Table 7). From 1997 to 2001, nitrate-N content increased in the soil profile, and the amount that cumulated increased with manure application rate (Fig. 11a). However, there was a decrease for the highest manure rate from 2000 to 2001. The profile distributions showed dynamic changes from year to year (Figure 10e-i). Figures 10e and 10f clearly show that within one year a large amount of nitrate-N, derived from the 120 Mg ha^{-1} manure treatment, cumulated and leached through the soil profile.

Nitrate-N increased linearly with the cumulative manure total nitrogen added (Fig. 12). The relationship was modest with an r-squared value of 0.39 ($P<0.0001$). For every megagram of manure total nitrogen added per hectare, net nitrate-N content increased by 40.7 kg ha^{-1}(Fig. 12g).

The fertilizer-N treatments generally did not significantly affect soil nitrate-N content at the coarse-textured site (Table 6). The only exception was in 1995 when all three fertilizer-N treatments had significantly higher nitrate-N in the 0.3 to 0.9-m layer compared to the control (data not shown).

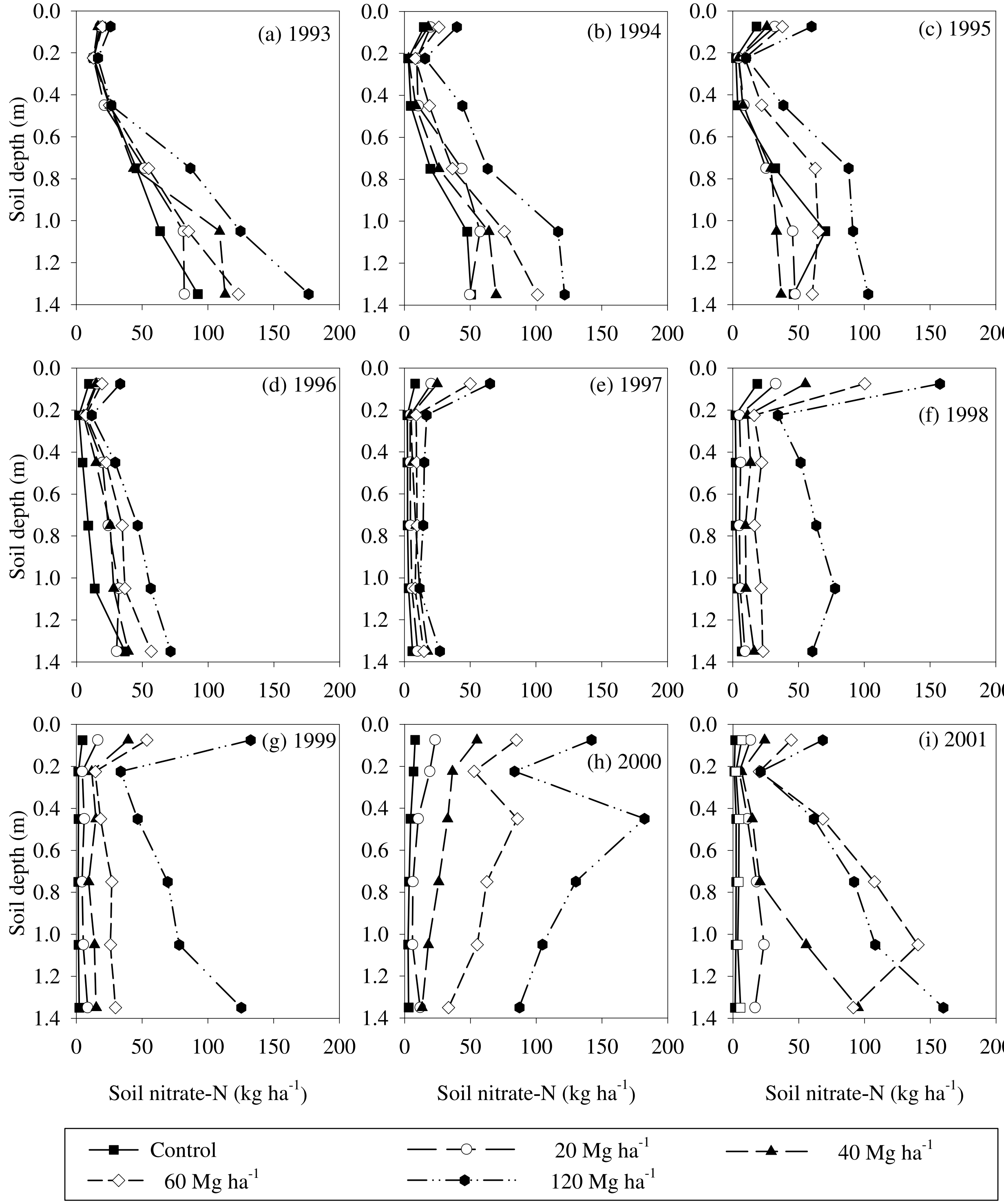


Fig 10. Soil extractable nitrate-N content of the control and manure treatments at the coarse-textured site.

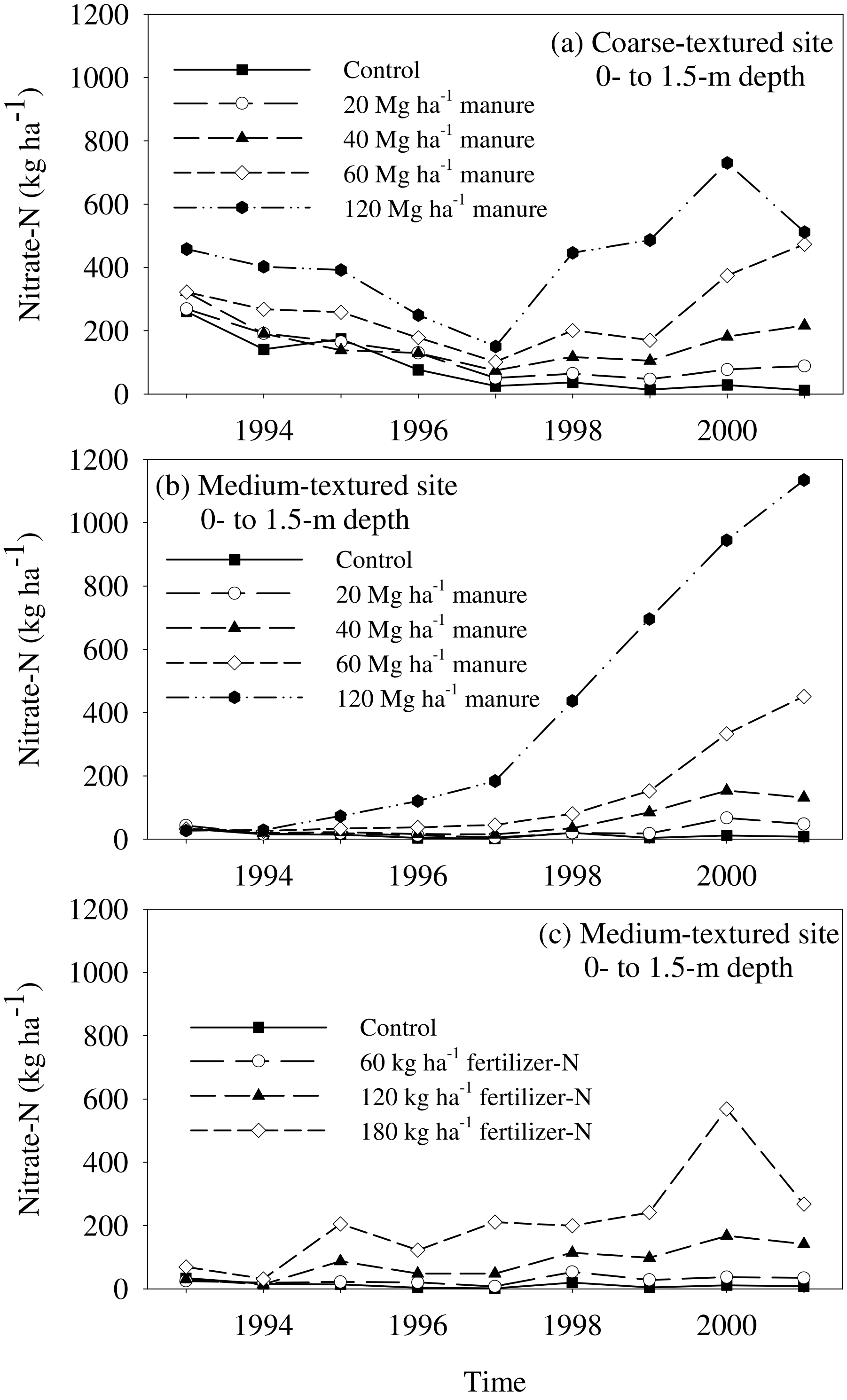


Fig. 11. Soil extractable nitrate-N content of the (a) control and manure treatments at the coarse-textured site, (b) control and manure treatments at the medium-textured site, and (c) control and fertilizer-N treatments at the medium-textured site**.**

Table 6. Mean extractable nitrate-N content (kg ha^{-1}) in soil at the coarse-textured site from 1997 to 2001.

Layer		Fertilizer-N rates (kg ha^{-1})			Manure rates (Mg ha^{-1})			
(m)	Control	60	120	180	20	40	60	120
				1997 [z]				
0-0.15 [y]	8.2 a	17 a	20 a	19 a	20 a	25 ab	50 bc	65 c
0.15-0.3	2.1 a	3.7 a	4.8 a	4.7 a	4.6 a	5.0 a	9.1 a	17 b
0.3-0.6	2.4 a	4.3 a	5.2 a	6.4 a	4.4 a	6.3 a	9.3 a	15 a
0.6-0.9	2.4 a	3.6 a	5.6 a	13 a	3.9 a	8.7 a	9.7 a	14 a
0.9-1.2	3.2 a	4.4 a	6.3 a	23 a	5.9 a	12 a	8.2 a	12 a
1.2-1.5	6.1 a	9.7 a	11 a	36 a	10 a	18 a	15 a	27 a
				1998				
0-0.15	19 a	23 a	36 a	42 a	33 a	55 a	100 a	158 b
0.15-0.3	2.1 a	3.9 a	8.6 a	7.6 a	5.0 a	11 a	16 a	34 a
0.3-0.6	2.5 a	5.1 a	11 a	13 a	6.2 a	14 a	22 a	52 a
0.6-0.9	2.5 a	4.0 a	15 a	14 a	5 a	9.8 a	17 a	64 a
0.9-1.2	3.7 a	5.6 a	5.9 a	20 ab	5.8 a	10 ab	22 ab	78 b
1.2-1.5	6.8 a	10 a	17 a	32 a	9.5 a	16 a	23 a	61 a
				1999				
0-0.15	4.7 a	11 a	8.7 a	23 ab	16 ab	39 bc	54 c	133 d
0.15-0.3	1.6 a	2.9 a	3.2 a	6.4 a	4.6 a	12 a	14 a	34 b
0.3-0.6	1.7 a	4.7 a	5.9 a	20 a	6.3 a	15 a	19 a	47 a
0.6-0.9	1.5 a	4.2 a	9.6 ab	14 ab	4.6 a	9.4 ab	27 ab	70 b
0.9-1.2	1.7 a	5.5 a	9.8 ab	23 ab	5.5 a	14 ab	26 ab	78 b
1.2-1.5	2.4 a	14 a	16 a	41 a	8.7 a	15 a	30 a	126 b
				2000				
0-0.15	7.9 a	14 a	16 a	19 a	23 a	55 b	85 c	142 d
0.15-0.3	6.8 a	13 ab	22 bcd	29 cd	19 abc	36 d	53 e	84 f
0.3-0.6	4.4 a	9.2 a	34 a	30 a	10 a	33 a	86 b	182 c
0.6-0.9	3.3 a	4.8 a	27 a	37 a	6.2 a	26 a	62 a	130 b
0.9-1.2	2.6 a	6.6 a	18 a	37 ab	6.0 a	18 a	55 ab	105 b
1.2-1.5	3.0 a	10 a	20 a	35 a	12 a	13 a	33 a	87 a
				2001				
0-0.15	1.7 a	5.8 a	4.4 a	6.4 a	13 a	24 ab	44 bc	68 c
0.15-0.3	1.1 a	2.5 a	2.4 a	2.9 a	4.9 a	6.6 ab	20 bc	21 c
0.3-0.6	2.4 a	4.2 a	7.2 a	17 ab	11 ab	15 ab	68 c	61 bc
0.6-0.9	2.5 a	5.4 a	21 a	23 a	10 a	20 a	108 b	92 b
0.9-1.2	2.2 a	18 a	20 a	31 a	24 a	44 ab	141 c	108 bc
1.2-1.5	1.6 a	24 abc	26 abc	35 abc	17 ab	106 cd	92 bcd	160 d

[z] There were no significant differences in 1994, 1995, and 1996.
[y] Means within the same row (soil layer) followed by the same letter are not significantly different ($P<0.05$).

Table 7. Mean extractable nitrate-N content (kg ha^{-1}) in the 0 to 1.5-m soil profile at the coarse- and medium-textured sites from 1993 to 2001.

		Fertilizer-N rates (kg ha^{-1})			Manure rates (Mg ha^{-1})			
Year	Control	60	120	180	20	40	60	120
				Coarse-textured site				
1993[z]	260 a	368 ab	334 ab	324 ab	268 a	321 ab	322 ab	457 b
1994	141 a	210 a	244 ab	190 a	190 a	190 a	267 ab	402 b
1995	174 ab	248 abc	384 c	382 bc	164 a	138 a	258 abc	392 c
1996	76 a	114 a	137 a	151 a	129 a	129 a	178 a	249 a
1997	24 a	43 a	53 a	103 a	49 a	74 a	101 a	150 a
1998	36 a	52 a	93 a	129 a	64 a	117 a	200 a	446 b
1999	13 a	42 a	53 a	126 a	46 a	105 a	170 a	486 b
2000	28 a	58 a	138 a	188 ab	77 a	181 a	374 b	730 c
2001	11 a	60 ab	81 ab	115 ab	88 ab	217 b	472 c	512 c
				Medium-textured site				
1993	33 a	24 a	29 a	68 a	43 a	32 a	32 a	26 a
1994	15 a	18 a	14 a	31 a	16 a	19 a	25 a	28 a
1995	14 a	21 a	86 ab	204 b	18 a	21 a	34 a	73 ab
1996	3.2 a	20 a	48 a	122 a	12 a	16 a	37 a	120 a
1997	1.4 a	6.9 a	48 ab	210 c	5.2 a	14 a	45 ab	183 bc
1998	20 a	53 ab	114 ab	199 b	19 a	34 a	80 ab	437 c
1999	3.7 a	27 a	97 ab	240 b	17 a	85 a	152 ab	696 c
2000	11 a	36 ab	167 b	569 d	66 ab	153 ab	332 c	945 e
2001	7.5 a	34 a	141 ab	267 b	47 a	131 ab	451 c	1135 d

[z] Mean values within the same row followed by the same letter are not significantly different (P<0.05).

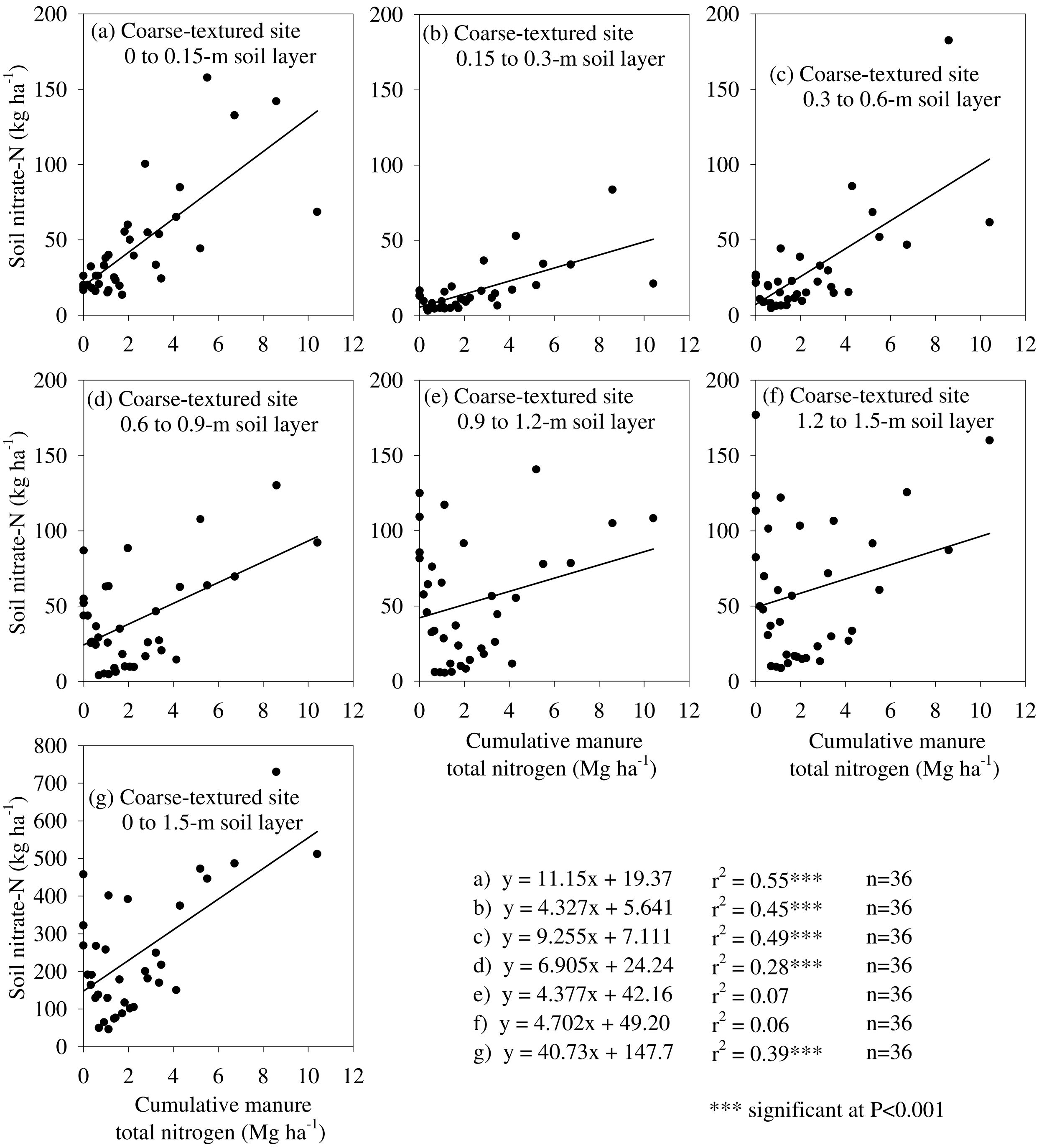


Fig. 12. Soil nitrate-N content versus added cumulative manure total nitrogen for (a-f) each incremental soil layer and (g) for the entire soil profile (0 to 1.5 m) at the coarse-textured site.

The baseline (1993) nitrate-N content in the soil profile was lower and less variable at the medium-textured site (Fig. 9) compared to the coarse-textured site. The mean nitrate-N content in the soil profile (0 to 1.5 m) was 35.2 kg ha^{-1}, with a standard error of 4.0.

There were no treatment effects on nitrate-N content after the first crop year in 1994 at the medium-textured site (Figs. 13 and 14). Nitrate-N content in the top soil layers for the 120 and 180 kg ha^{-1} fertilizer-N and the 60 and 120 Mg ha^{-1} manure treatments were significantly higher than the control in 1995 (Table 8). There were significant treatment-by-year interactions (Appendix 12, Table 12.2). Annual applications of manure during the study significantly increased nitrate-N content in the soil profile (Fig. 13, Table 8). The amount of net cumulated nitrate-N increased with manure application rate. By 2001, net cumulated nitrate-N in the 1.5-m soil profile was more than 1100 kg ha^{-1} for the 120 Mg ha^{-1} manure treatment and about 450 kg ha^{-1} for the 60 Mg ha^{-1} manure treatment. The excess nitrate first built-up in the upper soil profile and then slowly moved down the profile with time. The leaching front of the excess nitrate-N in the 120 Mg ha^{-1} manure treatment took about four to five years to reach the 1.2 to 1.5-m soil layer. Under the experimental conditions at the medium-textured site, this represents a rate of about 0.3 to 0.35 m y^{-1}. This contrasts the coarse-textured site where nitrate-N leached through the entire 1.5-m soil profile within one year (Fig. 10e-f).

Quadratic equations better described the relationship between nitrate-N and cumulative manure total nitrogen added (Fig. 15). The data were also less scattered compared to the coarse-textured site (Fig. 12). Perhaps this reflects slower leaching rate at the medium-textured site. A linear equation (r^2=0.89; p<0.0001) showed that for every megagram of manure total nitrogen added per hectare, net nitrate-N content increased by 95.1 kg ha^{-1}, which is more than double the rate observed at the coarse-textured site. The difference may be caused by greater leaching of nitrate below the 1.5-m depth and by greater denitrification in wet subsoil at the coarse-textured site.

Fertilizer-N application also caused a net cumulation of nitrate-N in the soil at the medium-textured site (Fig. 11c), though the amount was not as extensive as for the manure treatments. Generally, the amount of nitrate-N that cumulated increased as fertilizer-N rate increased. However, there often were no statistically significant differences between the control and the fertilizer-N treatments on a per soil incremental layer basis (Table 8). The nitrate-N build up in the 0 to 1.5-m soil profile for the 180 kg ha^{-1} fertilizer-N treatment was significantly higher than the control after 1996 (Table 7). The reason why nitrate-N cumulated from the fertilizer-N treatments at the medium-textured site and not at the coarse-textured site may be due to different leaching rates between the two sites. Any excess nitrate-N from the fertilizer-N treatments may have quickly leached through the soil at the coarse-textured site. Davis et al. (1997) sampled 41 manured fields in Colorado, and found that soil nitrate-N in the 0.6 to 1.2-cm layer was significantly higher in clayey soils than in sandy soils. They found no difference between the two soil groups in the 0 to 0.6-cm layer. Lower nitrate-N in sandy soils may be caused by more rapid leaching.

Figure 11c shows a large increase in nitrate-N in 2000 for the 180 kg ha^{-1} fertilizer-N treatment, from 240 kg ha^{-1} in 1999 to 569 kg ha^{-1} in 2000. This increase is difficult to explain

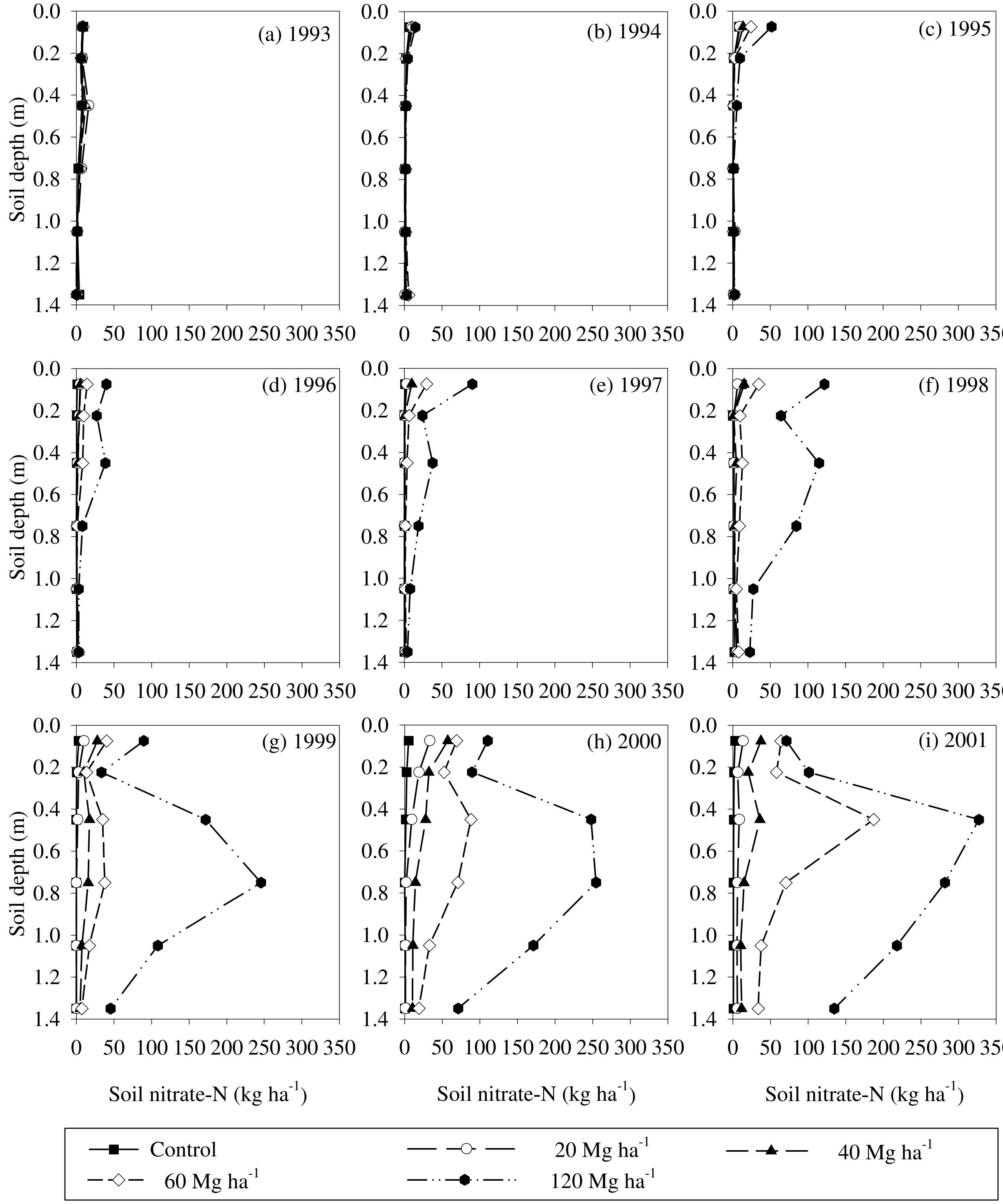


Fig. 13. Soil extractable nitrate-N content of the control and manure treatments at the medium-textured site.

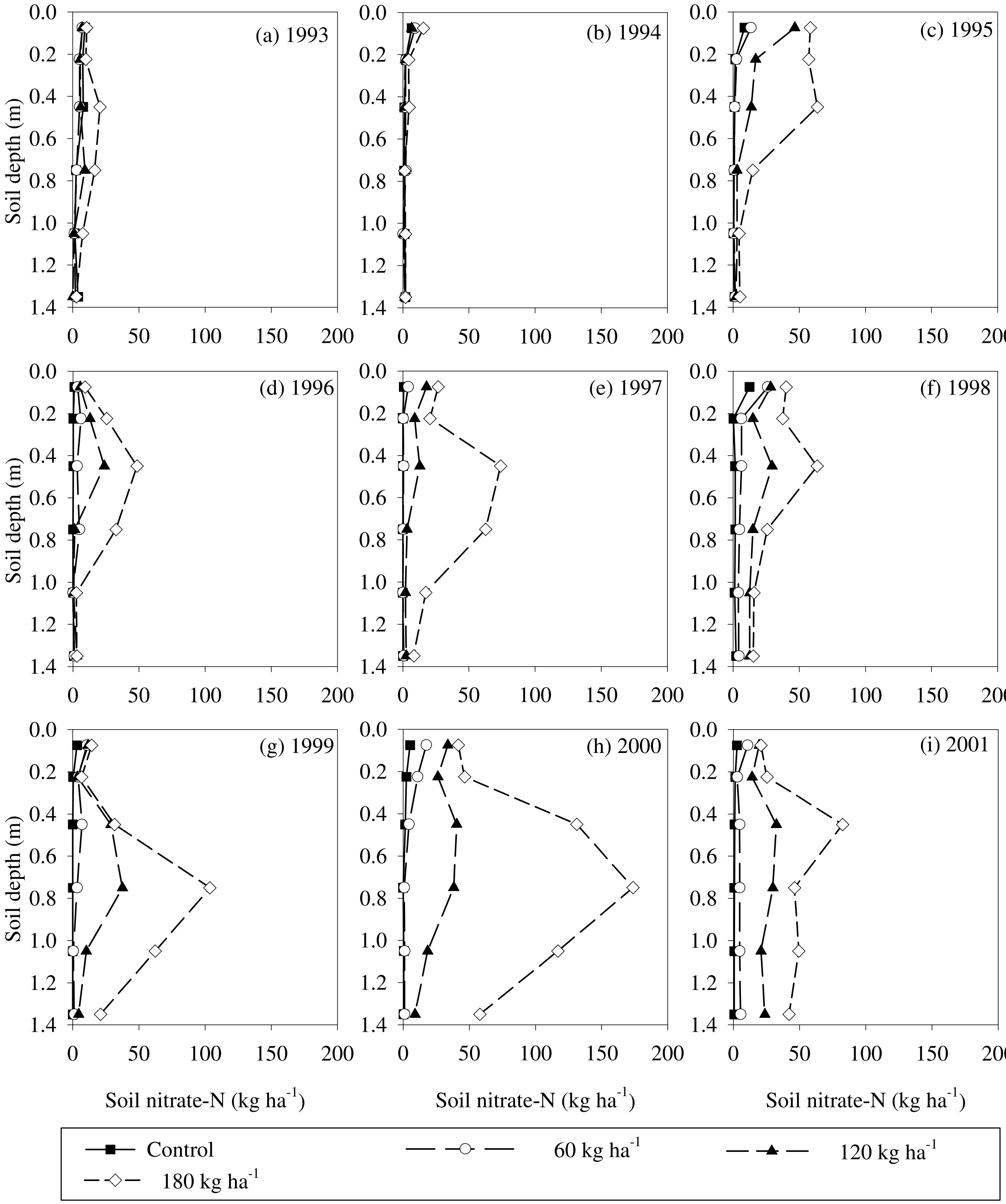


Fig. 14. Soil extractable nitrate-N content of the control and fertilizer-N treatments at the medium-textured site**.**

Table 8. Mean extractable nitrate-N content (kg ha^{-1}) in soil at the medium-textured site from 1995 to 2001.

Layer		Fertilizer-N rates (kg ha^{-1})			Manure rates (Mg ha^{-1})			
(m)	Control	60	120	180	20	40	60	120
				1995 [z]				
0-0.15 [y]	8.7 a	13 a	47 bc	59 c	9.6 a	14 a	24 ab	52 c
0.15-0.3	1.7 a	2.7 a	17 a	57 b	2.2 a	2.5 a	3.1 a	9.8 a
				1996				
0-0.15	1.2 a	3.6 a	5.6 a	9.3 a	4.8 a	5.5 a	14 a	40 b
0.15-0.3	0.4 a	6.2 abc	13 abc	26 bc	3.9 ab	4.1 ab	9.7 abc	27 c
				1997				
0-0.15	0.8 a	4.1 ab	18 abc	27 bc	2.9 ab	10 abc	30 c	90 d
0.15-0.3	0.1 a	0.4 a	9.0 ab	21 ab	0.6 a	7.8 a	6.3 ab	24 b
0.3-0.6	0.2 a	0.7 a	13 a	74 a	0.4 a	0.8 a	3.6 a	37 a
0.6-0.9	0.1 a	0.5 a	3.3 a	63 b	0.3 a	0.8 a	1.6 a	19 ab
0.9-1.2	0.1 a	0.2 a	2.2 a	17 a	0.3 a	0.6 a	1.2 a	7.8 a
1.2-1.5	0.2 a	1.0 a	2.6 a	8.4 a	0.7 a	1.1 a	2.6 a	4.3 a
				1998				
0-0.15	12 ab	26 abc	29 abc	40 c	8.1 a	15 ab	35 bc	122 d
0.15-0.3	0.3 a	6.4 a	15 ab	38 b	1.5 a	1.7 a	9.6 a	64 c
0.3-0.6	1.6 a	6.3 a	30 a	64 ab	1.9 a	5.3 a	13 a	115 b
0.6-0.9	1.7 a	5.0 a	15 a	26 a	2.2 a	3.1 a	9.4 a	85 b
0.9-1.2	1.3 a	4.1 a	13 a	16 a	2.7 a	3.3 a	5.0 a	27 a
1.2-1.5	2.3 a	4.5 a	13 a	15 a	2.9 a	5.7 a	7.9 a	23 a
				1999				
0-0.15	3.3 a	11 a	12 a	14 a	10 a	28 ab	40 b	90 c
0.15-0.3	0.5 a	4.2 a	3.7 a	6.7 a	3.4 a	10 a	14 ab	34 b
0.3-0.6	0.0 a	7.2 a	29 a	32 a	2.0 a	18 a	35 a	172 b
0.6-0.9	0.0 a	3.4 a	38 a	104 b	0.2 a	16 a	38 a	246 c
0.9-1.2	0.0 a	0.5 a	10 a	62 b	0.2 a	7.6 a	17 a	109 c
1.2-1.5	0.0 a	1.2 a	4.6 a	21 ab	0.6 a	5.3 a	7.3 a	46 b
				2000				
0-0.15	5.3 a	18 ab	34 bc	42 bc	33 bc	57 cd	69 d	110 e
0.15-0.3	2.5 a	11 ab	26 bc	47 cd	19 ab	32 bcd	53 d	90 e
0.3-0.6	1.6 a	4.04 a	41 ab	131 c	9.6 a	28 ab	88 bc	248 d
0.6-0.9	0.7 a	0.9 a	38 ab	174 c	2.1 a	14 a	71 b	255 d
0.9-1.2	0.6 a	1.3 a	19 a	117 b	1.1 a	11 a	33 a	171 c
1.2-1.5	0.5 a	1.1 a	9.1 a	58 b	1.3 a	11 a	19 a	71 b
				2001				
0-0.15	2.8 a	11 ab	20 bc	21 bcd	13 abc	37 e	64 f	71 f
0.15-0.3	1.5 a	3.1 a	14 ab	25 ab	6.7 ab	21 b	58 c	101 c
0.3-0.6	1.1 a	4.8 a	33 ab	83 b	8.7 ab	36 ab	187 c	327 d
0.6-0.9	0.8 a	4.9 a	30 ab	46 ab	6.2 a	15 a	70 b	283 c
0.9-1.2	0.7 a	4.8 a	21 abc	50 c	5.7 ab	10 ab	38 bc	218 d
1.2-1.5	0.7 a	5.5 a	24 abc	42 c	6.1 a	12 ab	34 bc	135 d

[z] There were no significant differences in 1994 and below 0.3 m in 1995 and 1996.
[y] Means within the same row (soil layer) followed by the same letter are not significantly different ($P<0.05$).

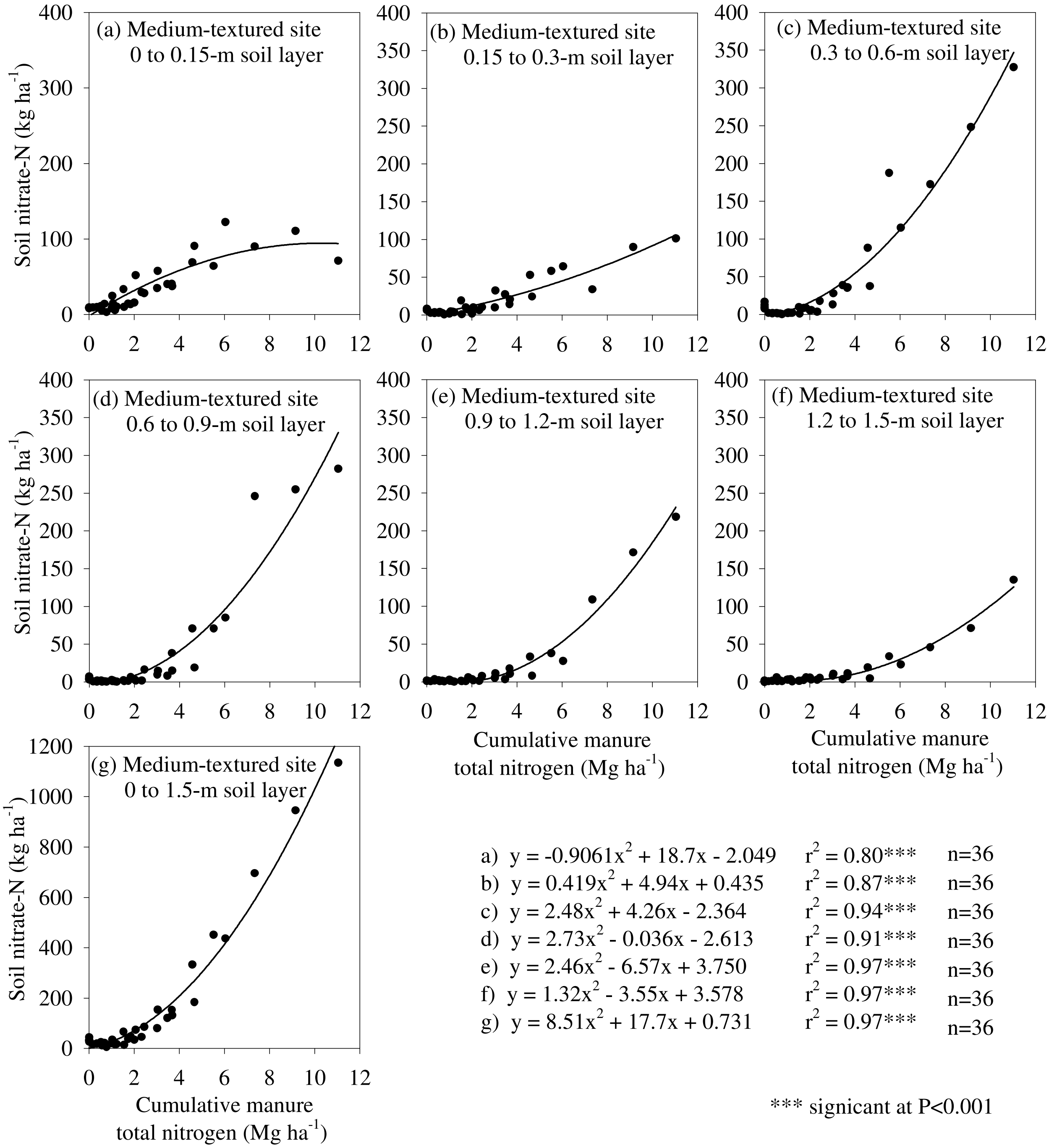


Fig. 15. Soil nitrate-N content versus added cumulative manure total nitrogen for (a-f) each incremental soil layer and (g) for the entire soil profile (0 to 1.5 m) at the medium-textured site.

since only 180 kg ha^{-1} of nitrogen was added in the form of urea fertilizer. The value for replicate B was higher (816 kg ha^{-1}) than the other four replicate values (340 to 637 kg ha^{-1}), but the removal of replicate B reduced the mean to only 506 kg ha^{-1}, which is still too high to be explained based on urea-fertilizer application.

The nitrate-N profile distributions in Figs. 10 and 13 often show higher nitrate-N content in the 0 to 0.15-m soil layer then in the 0.15 to 0.3-m soil layer. Below the 0.3-m depth the nitrate-N content increased and then decreased again forming a characteristic nitrate-N bulge, particularly at the medium-textured site. The difference between the two top soil layers in the manure treatments were not observed for the fertilizer-N treatments (Fig. 14). The different distribution of the cumulated nitrate-N may reflect the source type. Manure can provide a continuous source of nitrate-N throughout the growing season by mineralization. Chang et al. (1991) applied cattle manure (30 to 180 Mg ha^{-1}) annually for 11 years to a clay-loam soil in southern Alberta. They found that soil nitrate-N was significantly increased throughout the measured layer of 1.5 m. The greatest cumulation of nitrate-N was in the 0.3 to 0.6-m soil layer under nonirrigation, and in the 0.6 to 0.9-cm layer under irrigation. The difference in nitrate-N distribution between the study by Chang et al. (1991) and our study may be due to differences in cropping systems and duration of the studies. In the study by Chang et al. (1991), barley was grown to maturity and harvested in late August or early September (Chang et al. 1993). Barley was harvested at the silage stage in late July or early August in our study. Our fall soil sampling occurred from mid-September to mid-October, depending on the year (Tables 1 and 2). Therefore, nearly two months were available after harvest for nitrogen mineralization from manure to continue without an active crop growing for nutrient uptake and without irrigation to facilitate leaching. This may be why the nitrate-N content in the manured plots was higher in the top soil layer (0 to 0.15 m), particularly for the medium-textured site, and for the coarse-textured site after the initial high nitrate-N levels were removed. A characteristic nitrate-N bulge with depth was not reported by Chang et al. (1991).

The difference in duration between the two studies may be a factor as well. In a more recent paper, Chang and Entz (1996) reported the nitrate-N soil profile distribution with time. Similar nitrate-N distributions were observed after four annual manure applications, with nitrate-N content decreasing with depth, particularly in the nonirrigated manured plots. However, the nitrate-N bulge in the 0.5 to 1.0-m layer began to develop for the 90 Mg ha^{-1} manure treatment after five annual applications (Chang and Entz 1996).

Flynn and Cho (1996) applied liquid hog manure (150 and 300 kg ha^{-1} nitrogen) in the fall on a clay-loam soil and a loamy-sand soil. They monitored soil nitrate-N during the following year and found similar nitrate-N distribution patterns between the two soil types, with lower nitrate-N in the loamy-sand as compared to the clay-loam soil. They also irrigated (4 cm water applied) subplots within the plots that received the highest manure rate. Irrigation caused a nitrate-N bulge to form in the 1.0 to 1.5-m layer in the clay-loam soil, whereas in the loamy-sand soil, nitrate-N decreased below the 0.2-m depth under irrigation (compared to nonirrigation) at the highest manure rate.

In 1999, each manure-treatment plot was split into two subplots. One subplot continued to receive annual applications of manure, whereas manure application was discontinued for the other subplot. These subplots became the residual-manure treatment, one for each manure application rate. Soil data from 1999, 2000, and 2001 were examined to determine the short-term effects of discontinuing manure application. The 1999 data served as the baseline for the residual-manure treatment. Comparing the manure and residual-manure subplots in 1999 was expected to show no differences. This was true for the medium-textured site and in most cases for the coarse-textured site (Table 9). The exceptions were for the 60 Mg ha^{-1} manure treatment in the top soil layer, and for the 120 Mg ha^{-1} manure treatment in the top and bottom soil layers at the coarse-textured site. These differences were generally small. Nitrate-N content, in several of the soil layers, was significantly higher in the manure subplots for the 60 and 120 Mg ha^{-1} manure treatments in 2000 and 2001. This tendency was also true for the two lower rates of manure, but was generally not significant. The differences between the manure subplots and the residual-manure subplots were more apparent in 2001 than in 2000 at both sites. These results are not particularly surprising considering the manure subplots continued to receive an annual source of nitrogen, i.e. cattle manure.

In Table 10, the nitrate-N means for the residual-manure subplots are compared with time. There was a strong tendency, particularly in the 0 to 0.6-m soil layer, for the nitrate-N levels to increase from 1999 to 2000 and then decrease in 2001. The 2001 nitrate-N levels were often lower than the 1999 nitrate-N levels, though not always significantly. In the lower soil layers of the soil profile at both sites nitrate-N tended to either increase or decrease from 1999 to 2001. Again there were few significant differences. These changes with time among the various soil layers in the residual-manure treatments may be caused by redistribution of the residual nitrate-N. The bottom part of Table 10 shows the nitrate-N data for the entire soil layer of 1.5 m. Though there were no significant differences among the years, the tendency for nitrate-N to increase from 1999 to 2000 and then decrease in 2001 was consistent among the manure application rates and between the two sites. These results may imply that after six annual applications (1993 to 1998) of manure, enough residual organic nitrogen was present to continue the increase in net build-up of nitrate-N in 2000 even though no manure was applied in 1999. Then by 2001, the net build-up of nitrate-N began to decrease.

The above results are based on the annual soil sampling that was carried out each year after harvest and before manure application (i.e. usually in September). To obtain a better assessment of nitrate-N dynamics within a shorter time frame, surface soil samples (0 to 0.15 m) were collected about once per month during the frost-free periods in 1999, 2000, and 2001. The 0.15 to 0.3-m layer was also sampled in 2000 and 2001. Only the control and manure-treatment plots were sampled. The results in Fig. 16 show that nitrate-N content varied widely in the 0 to 0.15-m soil layer (Fig. 16a and c). However, the data shows an annual cycle. Nitrate-N content was usually the highest in the spring period, as much as a few hundred kilograms per hectare of nitrate-N for the higher manure application rates. Then by July, the nitrate-N content in the top soil layer decreased substantially. For example, in 2000 the nitrate-N content for the four manure treatments ranged from 35 to 338 kg ha^{-1} by June at the coarse-textured site. The amount increased as manure rate increased. By July of the same year, the range was 10 to 41 kg ha^{-1}. The same was true for the medium-textured site in 2000, except the decrease occurred from May to July. After July, the nitrate-N levels increased again. A similar pattern was observed in the 0.15 to 0.3-m soil layer as well, but the magnitude of the cycle was less (Fig. 16b and d). The large

Table 9. Comparison of nitrate-N mean values (kg ha^{-1}) between the manure and residual-manure subplots.

layer	20 Mg ha^{-1}manure [z]		40 Mg ha^{-1}manure		60 Mg ha^{-1}manure		120 Mg ha^{-1}manure	
(m)	Manure	Residual [y]	Manure	Residual	Manure	Residual	Manure	Residual
				Coarse-textured site 1999 (baseline)				
0-0.15	18 a	14 a	37 a	42 a	65 b	42 a	100 a	165 b
0.15-0.3	4.6 a	4.7 a	9.8 a	14 a	15 a	17 a	31 a	37 a
0.3-0.6	6.3 a	6.2 a	12 a	18 a	20 a	17 a	42 a	51 a
0.6-0.9	3.9 a	5.3 a	8.5 a	10 a	42 a	12 a	60 a	79 a
0.9-1.2	3.7 a	7.3 a	8.0 a	20 a	30 a	22 a	59 a	97 a
1.2-1.5	8.2 a	9.2 a	14 a	16 a	33 a	27 a	160 b	91 a
				Coarse-textured site 2000				
0-0.15	23 a	19 a	55 a	28 a	85 a	45 a	142 a	118 a
0.15-0.3	19 a	17 a	36 a	32 a	53 b	27 a	83 b	61 a
0.3-0.6	10 a	15 a	32 a	30 a	86 b	23 a	182 b	111 a
0.6-0.9	6.2 a	12 a	26 a	30 a	62 b	14 a	130 b	83 a
0.9-1.2	6.0 a	11 a	18 a	20 a	55 a	17 a	105 a	106 a
1.2-1.5	12 a	11 a	13 a	18 a	33 a	24 a	87 a	98 a
				Coarse-textured site 2001				
0-0.15	13 a	6.5 a	24 a	12 a	44 b	8.8 a	68 b	22 a
0.15-0.3	4.9 a	2.2 a	6.6 a	4.7 a	20 b	4.0 a	21 b	7.2 a
0.3-0.6	11 a	4.7 a	15 a	11 a	68 b	12 a	61 a	56 a
0.6-0.9	18 a	4.3 a	20 a	16 a	108 b	23 a	92 a	152 b
0.9-1.2	24 a	3.7 a	44 a	27 a	141 b	17 a	108 a	110 a
1.2-1.5	17 a	5.7 a	106 a	29 a	92 b	35 a	160 a	164 a
				Medium-textured site 1999 (baseline)				
0-0.15	11 a	10 a	24 a	32 a	38 a	42 a	90 a	90 a
0.15-0.3	3.1 a	3.7 a	7.0 a	13 a	15 a	13 a	32 a	35 a
0.3-0.6	2.4 a	1.5 a	10 a	25 a	36 a	34 a	167 a	177 a
0.6-0.9	0.0 a	0.4 a	12 a	20 a	39 a	37 a	248 a	244 a
0.9-1.2	0.0 a	0.4 a	8.3 a	6.8 a	25 a	9.8 a	94 a	124 a
1.2-1.5	0.6 a	0.6 a	5.5 a	5.2 a	7.2 a	7.5 a	33 a	58 a
				Medium-textured site 2000				
0-0.15	33 a	17 a	58 a	46 a	69 a	69 a	110 a	95 a
0.15-0.3	19 a	9.7 a	32 a	27 a	53 a	40 a	90 b	66 a
0.3-0.6	9.6 a	5.0 a	28 a	19 a	88 a	70 a	248 a	283 a
0.6-0.9	2.1 a	1.3 a	14 a	11 a	71 a	53 a	255 a	265 a
0.9-1.2	1.1 a	0.7 a	11 a	7.5 a	33 a	43 a	171 b	111 a
1.2-1.5	1.2 a	0.7 a	11a	5.8 a	19 a	32 a	71 a	59 a
				Medium-textured site 2001				
0-0.15	13 a	7.0 a	37 b	15 a	64 b	29 a	71 b	36 a
0.15-0.3	6.7 a	1.7 a	21 a	4.5 a	58 b	17 a	101 b	50 a
0.3-0.6	8.7 a	1.5 a	36 a	5.8 a	187 b	42 a	327 b	233 a
0.6-0.9	6.2 a	2.4 a	15 a	5.2 a	70 a	36 a	282 b	233 a
0.9-1.2	5.7 a	2.1 a	10 a	4.8 a	38 a	34 a	218 b	171 a
1.2-1.5	6.1 a	1.7 a	12 a	4.0 a	34 a	24 a	135 a	124 a

[z] Mean values for each manure and residual-manure pair (i.e. for each manure rate, year, soil layer combination) followed by the same letter are not significantly different (P<0.05).
[y] Residual = residual-manure subplots when manure application was discontinued after 1998.

Table 10. Changes in soil nitrate-N content with time (1999-2001) in the residual-manure subplots at both sites.

	Coarse-textured site				Medium-textured site			
Year	20 [z]	40	60	120	20	40	60	120
				0.0 – 0.15 m layer				
1999 [y]	14 a	42 b	42 b	165 c	10 a	32 ab	42 ab	90 b
2000	19 a	28 ab	45 b	118 b	17 a	46 b	69 b	95 b
2001	6.5 a	12 a	8.8 a	22 a	7.0 a	15 a	29 a	36 a
				0.15 – 0.3 m layer				
1999	4.7 ab	14 a	14 a	37 b	3.7 a	13 ab	13 a	35 a
2000	17 b	32 b	27 b	62 c	9.7 a	27 b	40 b	66 b
2001	2.2 a	4.7 a	4.0 a	7.2 a	1.7 a	4.5 a	17 a	50 ab
				0.3 – 0.6 m layer				
1999	6.2 a	18 a	17 a	51 a	1.5 a	25 a	34 a	177 a
2000	15 a	30 a	23 a	111 b	5.0 a	19 a	70 a	283 b
2001	4.7 a	11 a	12 a	56 a	1.5 a	5.8 a	42 a	233 ab
				0.6 – 0.9 m layer				
1999	5.3 a	10 a	12 a	79 a	0.4 a	20 a	37 a	244 a
2000	12 a	30 a	14 a	83 a	1.3 a	11 a	53 a	265 a
2001	4.3 a	16 a	23 a	152 b	2.4 a	5.2 a	36 a	233 a
				0.9 – 1.2 m layer				
1999	7.3 a	20 a	22 a	97 a	0.4 a	6.8 a	9.8 a	124 a
2000	11 a	20 a	17 a	106 a	0.7 a	7.5 a	43 a	111 a
2001	3.7 a	27 a	17 a	110 a	2.1 a	4.8 a	34 a	171 b
				1.2 – 1.5 m layer				
1999	9.2 a	16 a	27 a	91 a	0.6 a	5.2 a	7.5 a	58 a
2000	11 a	18 a	24 a	98 a	0.7 a	5.8 a	32 a	59 a
2001	5.7 a	29 a	35 a	164 b	1.7 a	4.0 a	24 a	124 b
				0.0 – 1.5 m layer				
1999	47 a	120 a	134 a	520 a	17 a	102 a	144 a	728 a
2000	85 a	158 a	152 a	577 a	34 a	117 a	307 a	879 a
2001	27 a	101 a	101 a	511 a	16 a	39 a	182 a	847 a

[z] Residual-manure subplot treatments, which received annual application (20, 40, 60, and 120 Mg ha^{-1} y^{-1}) from 1993 to 1998. Manure application was discontinued after 1998 (i.e. no manure applied in 1999 and 2000).
[y] Means within the three-year period, for each residual-manure rate, site and layer combination, followed by the same letter are not significantly different (P<0.05).

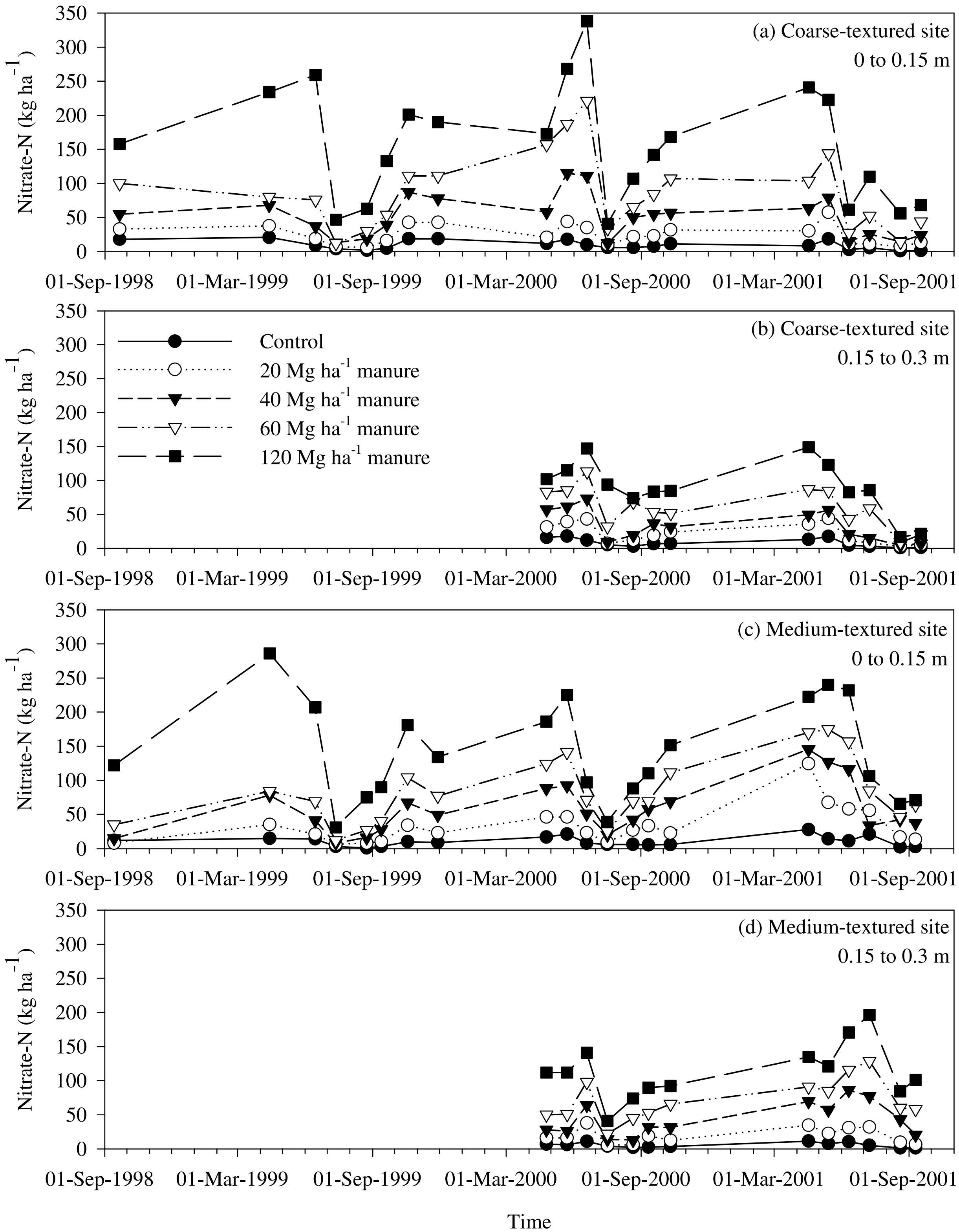


Fig. 16. Seasonal changes in nitrate-N content in the 0 to 0.15-m and 0.15 to 0.3-m soil layers at the coarse- and medium-textured sites.

decrease in nitrate-N during the May to June period was probably the result of several factors, including crop uptake, leaching and denitrification due to irrigation and rainfall. In late July or early August, irrigation was stopped and the crop harvested at the silage stage. Usually very little precipitation fell after harvest in late summer and fall. However, the soil was relatively moist (due to irrigation) and warm, factors that most likely promoted mineralization and caused a build-up of nitrate during this period. Plus, without the presence of a crop, essentially no nitrogen was taken up by plants after harvest. Provided the soil temperature remained high enough, mineralization continued into the fall, as was the case in 1999. Mineralization and nitrate-N build-up also continued in the spring.

Extractable ammonium-N. Extractable ammonium-N content was not affected by nutrient additions at either site. This supports the results reported by Hao et al. (2003) who found that 25 annual applications of cattle manure in a southern Alberta study showed no effect on soil ammonium-N content.

Ammonium-N content remained low and uniform throughout the soil profile at both sites. More than 99 percent of the 6480 soil samples analysed contained less than 10 kg ha^{-1} ammonium-N and 46 percent contained less than 1 kg ha^{-1}. The annual average per site, for the 0 to 1.5-m layer, ranged from 1.2 to 13.5 kg ha^{-1} at the coarse-textured site, and 2.2 to 22.9 kg ha^{-1} at the medium-textured site.

Extractable orthophosphate-P. The coarse-textured site contained a large amount of extractable orthophosphate-P at the start of the study (Fig. 17a). The site average in 1993 was 293 kg ha^{-1} of orthophosphate-P in the 0 to 0.15-m soil layer. There was 94 kg ha^{-1} in the 0.15 to 0.3-m soil layer and 28 kg ha^{-1}in the 0.3 to 0.6-m soil layer. The orthophosphate-P content in the control treatment was reduced by 69 percent in the 0 to 0.6-m layer by 2001. The initial high level of orthophosphate-P was probably caused by previous applications of manure by the land owner. The initial orthophosphate-P content at the medium-textured site was lower than the coarse-textured site, with a site average of 59 kg ha^{-1} in the 0 to 0.15-m soil layer, 13 kg ha^{-1} in the 0.15 to 0.3-m soil layer, and 11 kg ha^{-1} in the 0.3 to 0.6-m soil layer. The orthophosphate-P content in the control treatment was reduced by 59 percent in the 0 to 0.6-m layer by 2001.

Manure application caused a net build-up of orthophosphate-P at both sites (Figs. 17 and 18). Most of the orthophosphate-P build up occurred in the 0 to 0.6-m layer. Generally, orthophosphate-P increased with time, with some year-to-year variations (Fig. 19). The amount of orthophosphate-P build-up increased with manure rate. However, there were treatment-by-year interactions (Appendix 12, Tables 12.3 and 12.4). In 1994, there were no significant effects. The first significant treatment effects were observed in the top soil layer at both sites in 1995 (Table 11). Treatment effects were not observed in deeper soil layers until later in the study. For example, significant treatment effects did not occur in the 0.3 to 0.6-m soil layer until 1999 at the coarse-textured site and in 2000 at the medium-textured site (Table 11).

To determine phosphorus-fertilizer requirements, soil samples are usually collected from the 0 to 0.15-m layer for laboratory analysis. After eight annual applications of cattle manure at the 120 Mg ha^{-1} rate, the net build-up of orthophosphate-P was greater than 1000 kg ha^{-1} at both sites in the 0 to 0.15-m layer. Even at the lowest application rate of 20 Mg ha^{-1}y^{-1}, the orthophosphate-

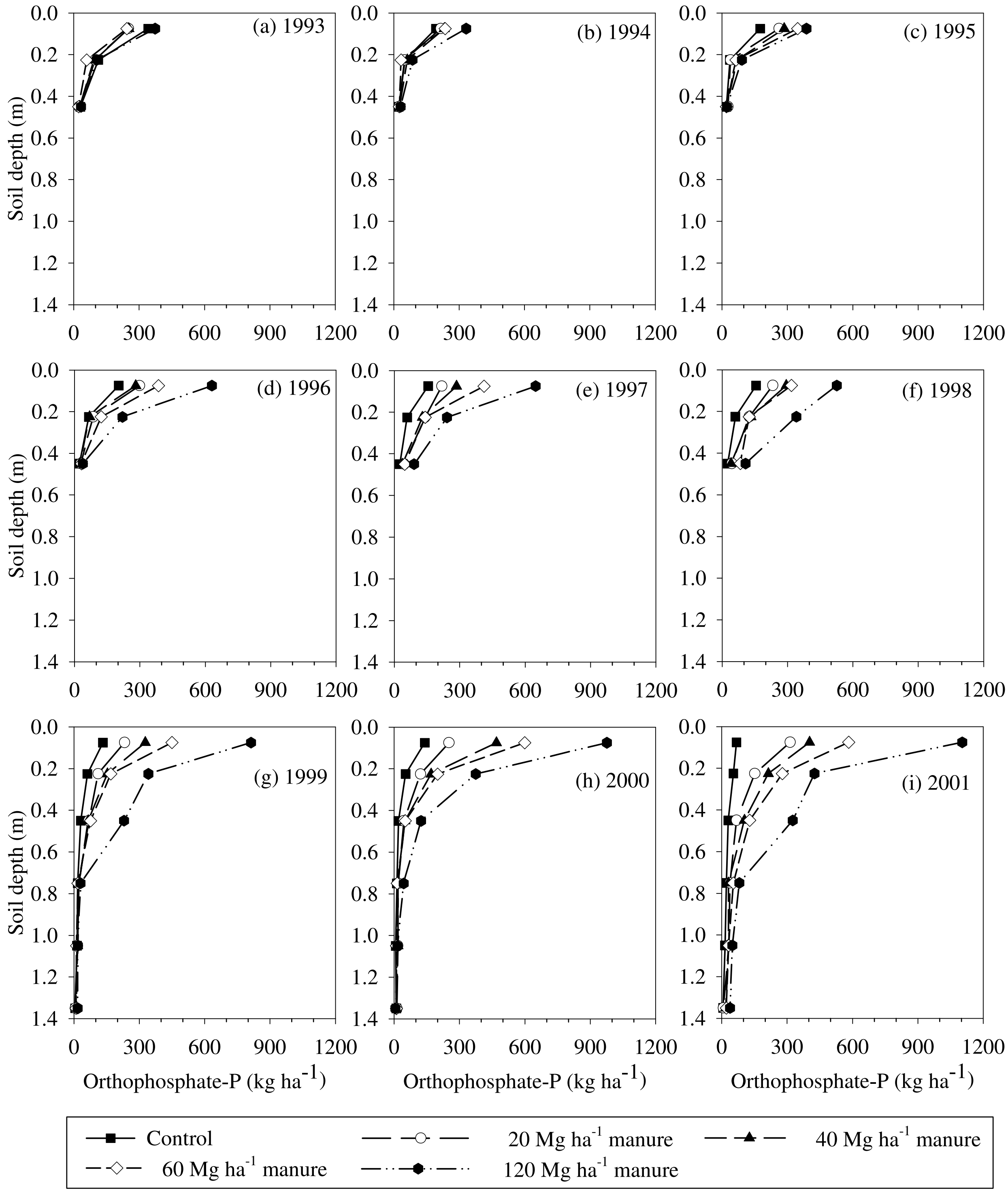


Fig. 17. Soil extractable orthophosphate-P content of the control and manure treatments at the coarse-textured site.

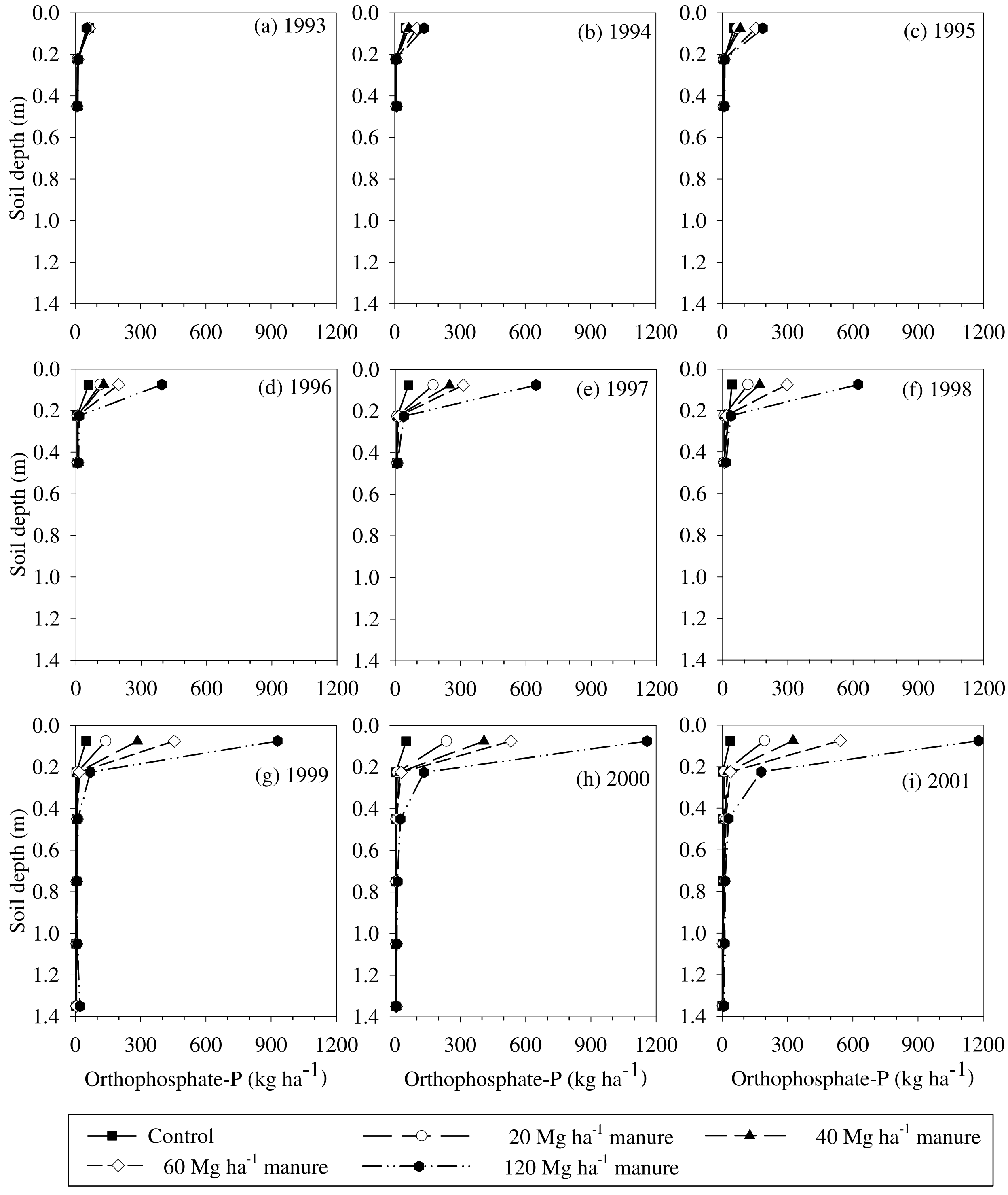


Fig. 18. Soil extractable orthophosphate-P content of the control and manure treatments at the medium-textured site.

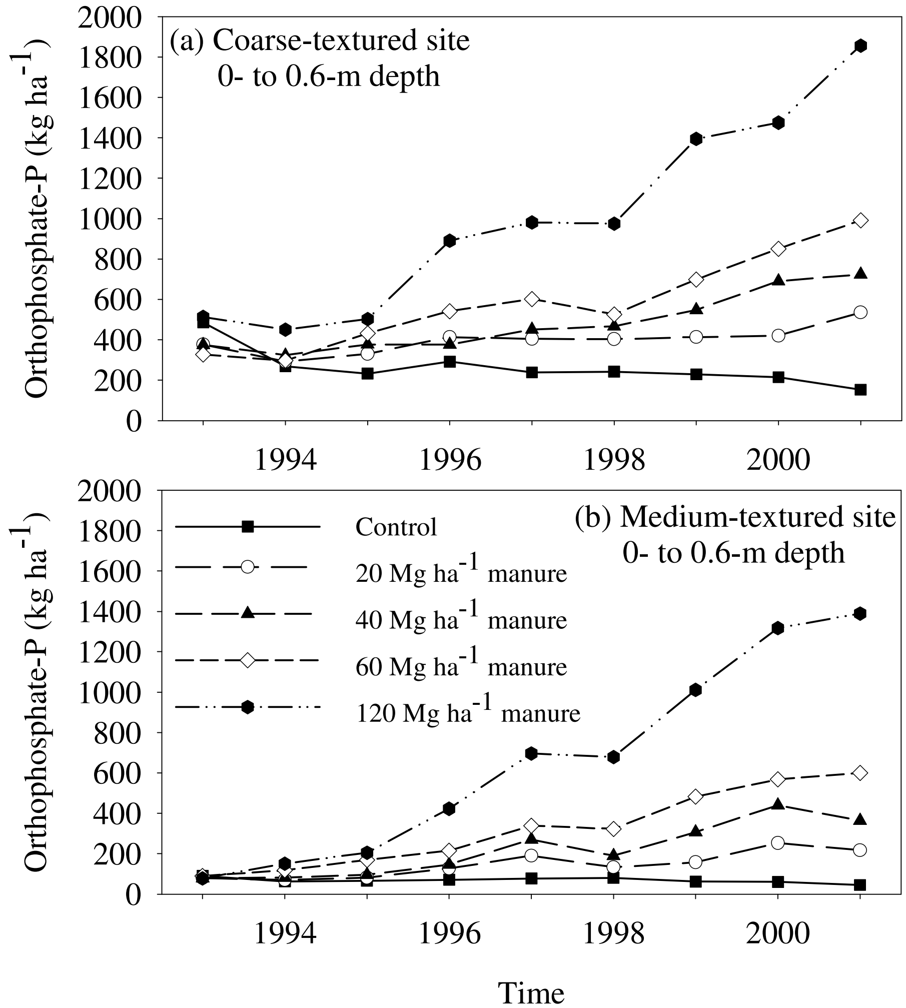


Fig. 19. Soil extractable orthophosphate-P content in the 0 to 0.6-m soil layer for the control and manure treatments at (a) the coarse-textured site, and (b) the medium-textured site.

Table 11. Mean extractable orthophosphate-P content (kg ha^{-1}) in soil at the coarse- and medium-textured sites from 1995 to 2001.

Layer	Coarse-textured site					Medium-textured site				
(m)	0[z]	20	40	60	120	0	20	40	60	120
					1995					
0-0.15[y]	175 a	262 ab	286 ab	348 b	388 b	53 a	69 ab	82 ab	154 ab	185 b
0.15-0.3	36 a	40 a	69 a	64 a	91 a	6.6 a	5.7 a	6.5 a	8.2 a	11 a
0.3-0.6	20 a	27 a	22 a	21 a	23 a	6.3 a	6.5 a	7.1 a	6.9 a	9.5 a
					1996					
0-0.15	203 a	298 ab	282 ab	385 b	630 c	58 a	111 ab	128 ab	197 b	395 c
0.15-0.3	66 a	86 a	69 a	123 ab	221 b	5.9 a	8.2 a	7.9 a	8.0 a	15 a
0.3-0.6	23 a	29 a	25 a	32 a	39 a	6.9 a	7.5 a	10 a	9.2 a	13 a
					1997					
0-0.15	155 a	218 a	285 ab	412 b	648 c	60 a	174 ab	250 dc	313 c	647 d
0.15-0.3	59 a	141 ab	129 a	142 ab	241 b	9.8 a	7.9 a	9.9 a	17 a	39 a
0.3-0.6	24 a	46 a	37 a	47 a	91 a	7.5 a	8.5 a	11 a	9.2 a	11 a
					1998					
0-0.15	156 a	233 a	294 a	318 a	526 b	44 a	117 a	171 ab	296 b	623 c
0.15-0.3	61 a	125 a	131 a	124 a	341 b	29 a	8.3 a	9.8 a	18 a	38 a
0.3-0.6	25 a	44 a	41 a	83 a	108 a	6.9 a	7.45 a	9.3 ab	9.2 ab	16 b
					1999					
0-0.15	134 a	223 ab	347 bc	415 c	855 d	49 s	135 a	314 b	422 b	924 c
0.15-0.3	62 a	108 ab	151 ab	181 b	349 c	5.5 a	7.9 a	14 a	18 a	97 b
0.3-0.6	32 a	56 a	67 a	66 a	201 d	6.9 a	7.7 a	8.9 a	8.7 a	14 a
0.6-0.9	17 a	21 a	21 a	17 a	30 a	6.8 a	6.0 a	6.4 a	6.2 a	8.5 a
0.9-1.2	15 a	15 a	19 a	14 a	18 a	4.0 a	4.7 ab	6.5 ab	6.0 ab	9.9 b
1.2-1.5	6.3 a	7.2 a	12 a	8.4 a	12 a	3.7 a	4.4 a	5.5 ab	4.4 a	16 b
					2000					
0-0.15	141 a	253 a	470 b	599 b	976 c	51 a	236 b	409 c	532 c	1158 d
0.15-0.3	53 a	122 ab	170 b	200 b	375 c	4.0 a	10 a	22 a	29 a	134 ab
0.3-0.6	20 a	45 ab	50 ab	51 ab	124 b	5.0 a	5.7 a	8.5 a	7.5 a	26 b
0.6-0.9	13 a	19 a	19 a	15 a	44 a	6.0 a	7.0 a	6.9 a	5.7 a	12 a
0.9-1.2	7.8 a	17 a	18 a	11 a	16 a	2.8 a	5.1 a	6.2 a	6.5 a	8.2 a
1.2-1.5	10 a	13 a	11 a	11 a	7.0 a	3.6 a	5.6 a	5.1 a	6.2 a	5.8 a
					2001					
0-0.15	68 a	314 b	404 b	584 c	1104 d	37 a	196 b	326 b	543 c	1179 d
0.15-0.3	54 a	152 ab	215 bc	279 c	426 d	3.5 a	10 ab	25 ab	38 b	181 c
0.3-0.6	30 a	68 ab	105 ab	129 b	326 c	4.0 a	9.9 ab	12 bc	18 c	29 d
0.6-0.9	22 a	39 a	32 a	54 ab	82 b	3.8 a	10 ab	8.3 ab	11 b	14 b
0.9-1.2	15 a	33 a	32 a	32 a	49 a	1.9 a	7.6 bc	4.7 ab	5.3 ab	12 c
1.2-1.5	7.0 a	8.1 a	19 a	22 a	39 a	1.3 a	6.1 a	4.4 a	3.7 a	9.8 a

[z] Manure application rates (0, 20, 40, 60, and 120 Mg ha^{-1} y^{-1}) from 1993 to 2000.
[y] Mean values, for each soil layer per site per year, followed by the same letter are not significantly different ($P<0.05$). There were no significant differences in 1994.

P level was 314 kg ha^{-1} at the coarse-textured site and 196 kg ha^{-1} at the medium-textured site in 2001. After allowing for the initial orthophosphate-P levels in 1993, the net build-up of orthophosphate-P in the 0 to 0.15-m soil layer for the 20 Mg ha^{-1} manure treatment was 63 kg ha^{-1} at the coarse-textured site and 138 kg ha^{-1} at the medium-textured site. Howard (2001) reported that for the major annual crops in the Alberta the agronomic threshold for extractable orthophosphate-P in soil (0 to 0.15-m layer) is about 60 mg kg^{-1}, which is about 100 to 135 kg ha^{-1}, depending on soil bulk density. The agronomic threshold for soil extractable orthophosphate-P is the level above which the addition of phosphorus will not generally increase crop yield. The coarse-textured site was well above this threshold level at the start of the study. But eight years of manure application at the lowest rate more than kept orthophosphate-P at an excessive level. The medium-textured site was well below the agronomic threshold in 1993. But even at the lowest application rate, the orthophosphate-P level increased to, or slightly above the agronomic threshold level in the top soil layer. The other three manure-treatment rates resulted in even more excessive levels of orthophosphate-P in the soil at both sites, relative to crop requirements.

As stated above, most of the net build-up in orthophosphate-P occurred in the 0 to 0.6-m soil layer. However, the distribution of the orthophosphate-P among the three incremental soil layers in this zone was different between the two sites. After subtracting the initial (1993) orthophosphate-P levels from the 2001 values, the proportion of net build-up of orthophosphate-P in the top soil layer for the four manure treatments ranged from -59 to 56 percent at the coarse-textured site, and from 86 to about 100 percent at the medium-textured site. The proportion in the top soil layer increased with manure application rate at the coarse-textured site, whereas the opposite was true at the medium-textured site. About 23 to 82 percent of net cumulated orthophosphate-P was in the 0.15 to 0.3-m soil layer, and about 19 to 77 percent of net cumulated orthophosphate-P was in the 0.3 to 0.6-m soil layer at the coarse-textured site. The proportion of net cumulated orthophosphate-P in these two soil layers at the medium-textured site was much lower, generally below five percent or even a net depletion relative to 1993 levels. These results indicate that excess orthophosphate-P from added manure moved to at least the 0.3 to 0.6-m soil layer, and a higher proportion moved to this soil layer at the coarse-textured soil. While most of the net cumulated orthophosphate-P resided in the 0 to 0.6-m layer, significant treatment effects were observed in deeper soil layers in 2001, though they were small. At the coarse-textured site, the 120 Mg ha^{-1} manure treatment had significantly higher orthophosphate-P levels than the control and the two lower manure-rate treatments in the 0.6 to 0.9-m soil layer (Table 11). At the medium-textured site, the 60 and 120 Mg ha^{-1} manure treatments were significantly higher than the control in the 0.6 to 0.9-m layer, and the 20 and 120 Mg ha^{-1} manure treatments were significantly higher than the control in the 0.9 to 1.2-m soil layer.

Net orthophosphate-P in the 0 to 0.6-m soil layer increased linearly with the amount of cumulated manure total phosphorus added at both sites (Figs. 20 and 21). For every megagram of manure total phosphorus added per hectare, orthophosphate-P increased by 421 kg ha^{-1} at the coarse-textured site, and by 400 kg ha^{-1}at the medium-textured site. The two rates are very similar for the two sites. However, regression analysis for the 0 to 0.15-m soil layer showed that for every megagram of manure total phosphorus added per hectare, orthophosphate-P increased by 245 kg ha^{-1} at the coarse-textured site (Fig. 20a), and by 353 kg ha^{-1}at the medium-textured

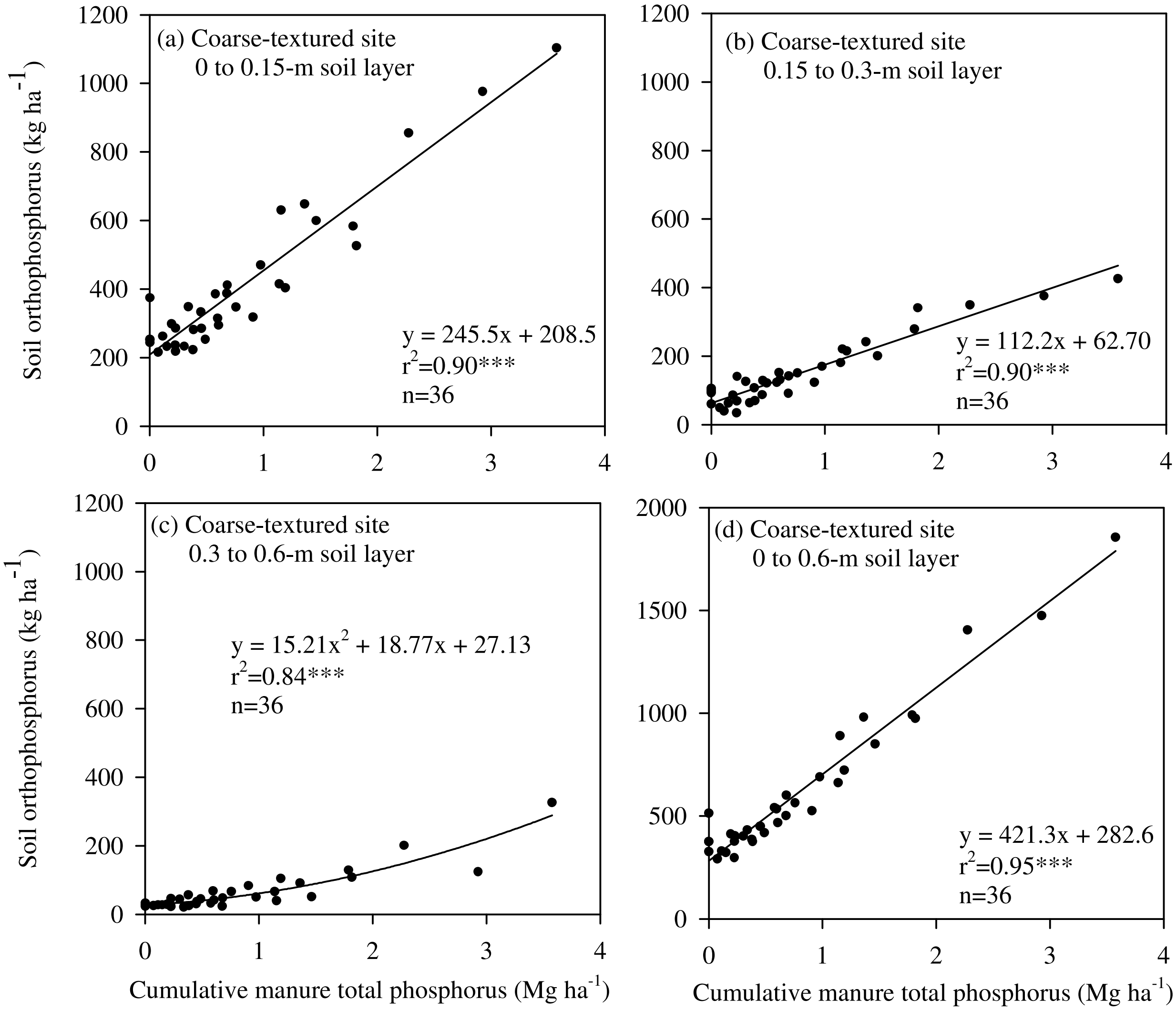


Fig. 20. Soil orthophosphate-P content versus added cumulative manure total phosphorus at the coarse-textured site in the (a) 0 to 0.15-m soil layer, (b) 0.15 to 0.3-m soil layer, (c) 0.3 to 0.6-m soil layer, and (d) 0 to 0.6-m soil layer. Triple asterisks indicates significance at $P<0.001$.

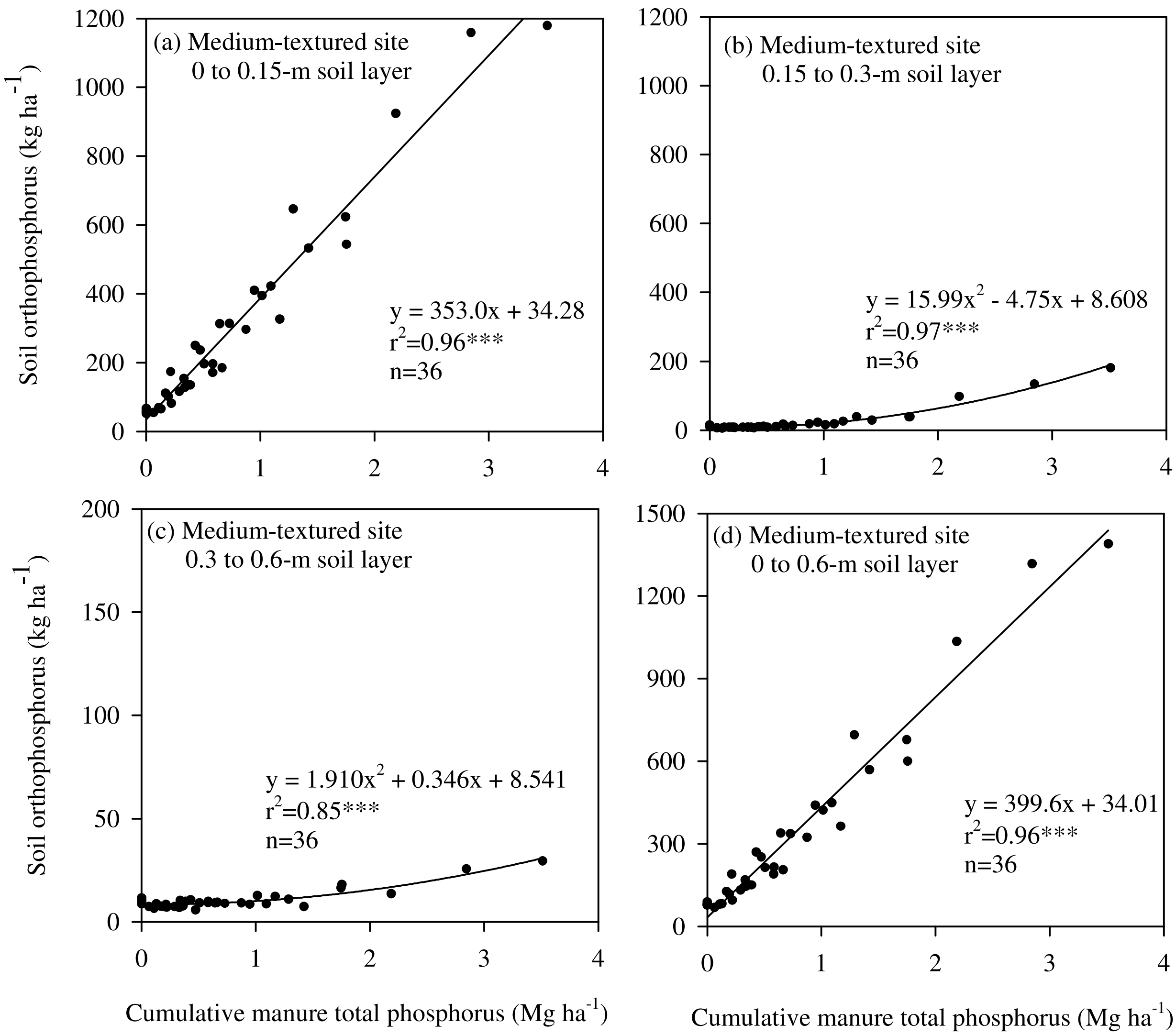


Fig. 21. Soil orthophosphate-P content versus added cumulative manure total phosphorus at the medium-textured site in the (a) 0 to 0.15-m soil layer, (b) 0.15 to 0.3-m soil layer, (c) 0.3 to 0.6-m soil layer, and (d) 0 to 0.6-m soil layer. Triple asterisks indicates significance at $P<0.001$.

site (Fig. 21a). This shows that within the top 0.6-m layer, more phosphorus remained in the 0 to 0.15-m layer at the medium-textured site compared to the coarse-textured site.

The largest cumulation of phosphorus occurred in the 0 to 0.15-m soil layer at both sites. On three occasions (twice in 2000 and once in 2001) soil samples were collected to determine the phosphorus distribution in the 0 to 0.05-m and the 0.05 to 0.15-m soil layers. Extractable orthophosphate-P increased as the manure rate increased in both soil layers at both sites (Fig. 22a and b). This effect and the amount of orthophosphate-P in each treatment were similar among the three sampling dates. The ratios of orthophosphate-P between the two layers show there was more orthophosphate-P in the lower layer at the coarse-textured site and more orthophosphate-P in the top layer at the medium-textured site when expressed on a mass basis (i.e. kilograms per hectare) (Table 12). When expressed on a concentration basis (i.e. milligrams per kilogram), orthophosphate-P concentration was higher in the top 0 to 0.05-m layer at both sites. Concentration values are particularly important when considering the potential loss of phosphorus from surface soil to runoff water.

Table 12. Ratios of phosphorus content between the 0 to 0.05-m soil layer and the 0.05 to 0.15-m soil layer at the coarse-textured and medium-textured sites.

Site	Modified-Kelowna extractable orthophosphate-P [z]	Water-extractable orthophosphate-P [z]	Total phosphorus [y]
	Mass basis (kg ha^{-1})		
Coarse-textured	0.83 (0.03)[x]	0.67 (0.02)	0.65 (0.02)
Medium-textured	1.36 (0.07)	1.16 (0.05)	0.71 (0.02)
	Concentration basis (mg kg^{-1})		
Coarse-textured	1.66 (0.06)	1.35 (0.05)	1.31 (0.04)
Medium-textured	2.72 (0.15)	2.32 (0.10)	1.41 (0.05)

[z] Mean values (n = 75) of the five manure application rates and three sampling dates (July 2000, October 2000, and September 2001).
[y] Mean values (n = 25) of the five manure application rates and one sampling date (September 2001).
[x] Numbers in parentheses are standard error values.

Water extractable orthophosphate-P was about one-third the amount of modified-Kelowna extractable orthophosphate-P (Fig. 23). The mean ratios between the 0 to 0.05-m layer and the 0.05 to 0.15-m layer were smaller than for the modified-Kelowna extractable orthophosphate-P (Table 12). The mean ratios between the 0 to 0.05-m layer and the 0.05 to 0.15-m layer for total phosphorus were even smaller. A reduction in ratios indicates that more phosphorus had moved into the lower layer (0.05 to 0.15 m layer). It would appear that the additional phosphorus extracted by the modified-Kelowna method is less mobile than the phosphorus extracted by water. Likewise, there are phosphorus components in total phosphorus, that are extracted by the modified-Kelowna and water methods, that are more mobile than the phosphorus in the two extraction methods. Also, all of the ratios were lower at the coarse-textured site than at the medium-textured site, indicating greater leaching of phosphorus at the former site.

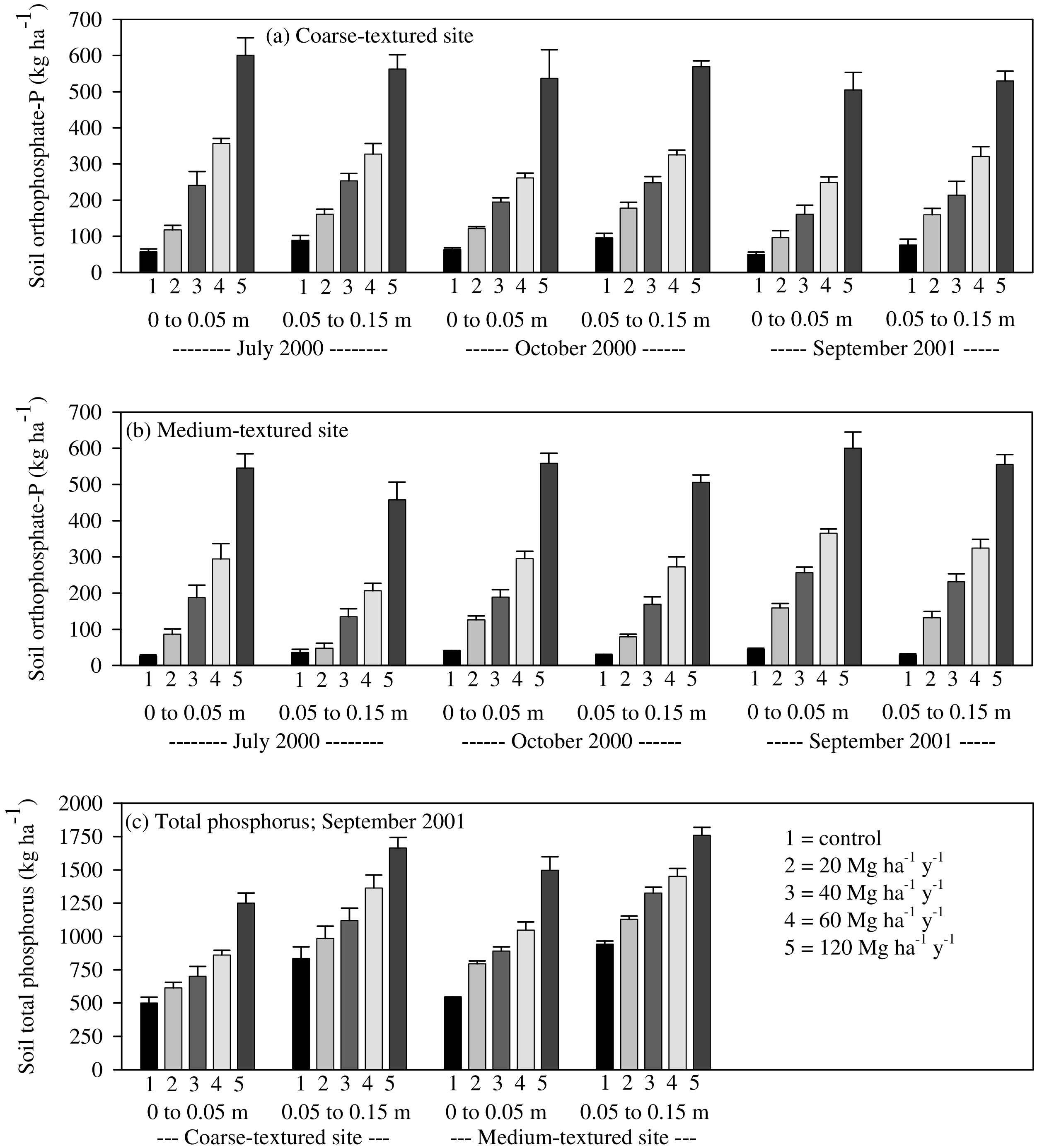


Fig. 22. Extractable orthophosphate-P in the 0 to 0.05-m and 0.05 to 0.15-m soil layers at the (a) coarse-textured site and (b) medium-textured site, and total phosphorus content in the 0 to 0.05-m and 0.05 to 0.15-m soil layers at (c) both sites. The t-bars are standard errors.

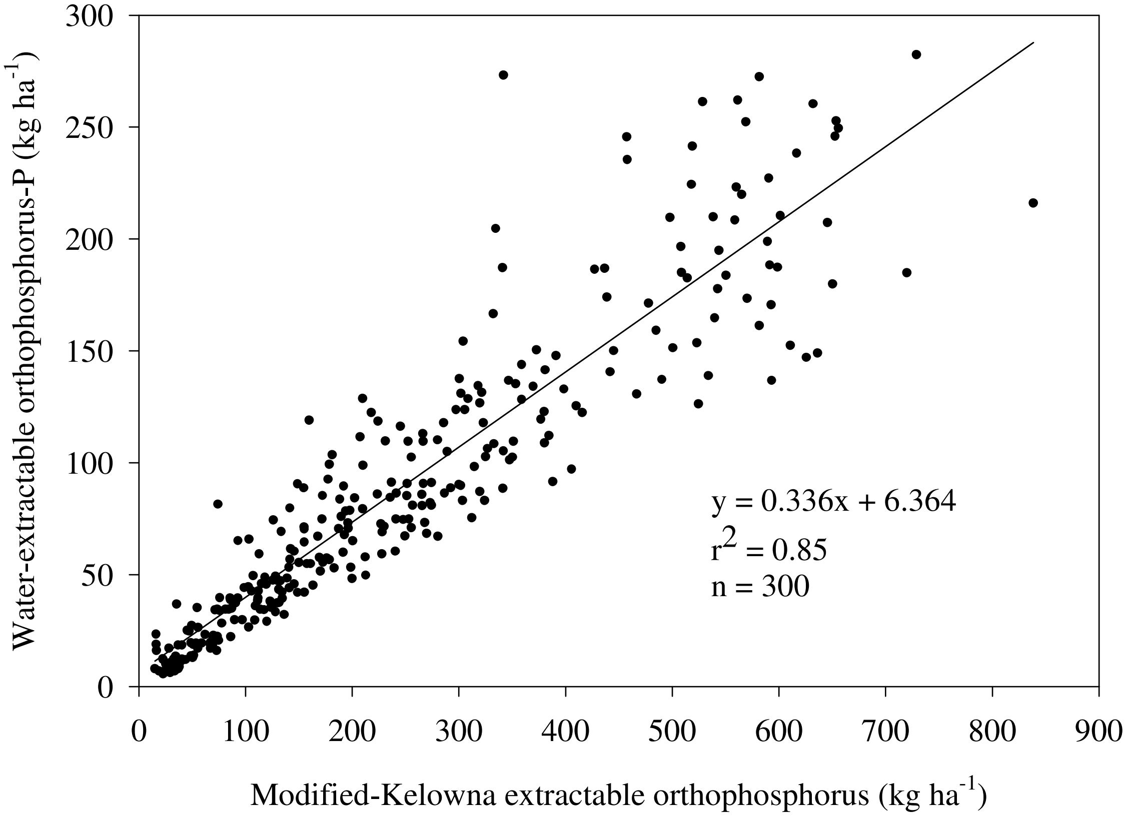


Fig. 23. Water-extractable orthophosphate-P versus modified-Kelowna extractable orthophosphate-P in soil samples (0 to 0.05-m and 0.05 to 0.15-m layers) collected in July 2000, October 2000, and September 2001 from the coarse- and medium-textured sites.

Our results support others who have shown that the application of manure on agricultural land causes phosphorus cumulation in soil (Sharpley et al. 1993; Breeuwsma et al. 1995; Dormaar and Chang 1995; James et al. 1996; Whalen and Chang 2001; Parham et al. 2002). The main environmental risk of high phosphorus levels in soil is the potential movement of this phosphorus to surface water bodies though runoff and erosion processes, and accelerated eutrophication in water (Daniel et al. 1994; Sharpley et al. 1994; Sturgul and Bundy 2002). It was generally thought that phosphorus added to calcareous soils, which have large capacities to adsorb phosphorus, will remain near the soil surface with very little movement downward (Ryden et al. 1973; Sims et al. 1998; Whalen and Chang 2001). After applying cattle manure at rates ranging from 30 to 180 Mg ha^{-1} y^{-1} to a calcareous soil in southern Alberta, Whalen and Chang (2001) found that total phosphorus and extractable orthophosphate-P were elevated throughout the 1.5-m soil profile. They reported that under rainfed conditions all of the added phosphorus from manure could be accounted for in the soil and in crop removal. However, they reported that 7 to 15 percent of phosphorus applied to irrigated plots could not be accounted for in the soil and crop. Whalen and Chang (2001) speculated that this phosphorus was lost by surface runoff or by leaching below the 1.5-m depth. In our study, we found that orthophosphate-P leached to the 0.9 to 1.2-m layer after eight annual applications of manure under irrigated conditions at the coarse-textured site. Others have also reported the movement of phosphorus downward through soil after the application of animal manure (King et al. 1990; Kingery et al. 1994; Breeuwsma et al. 1995; Heckrath et al. 1995; Eghball et al. 1996; Graetz et al. 1999). Eghball et al. (1996) concluded that phosphorus from manure and inorganic fertilizer sources can leach into groundwater in areas with shallow water tables or coarse-textured soils. Geohring et al. (2001) believe soil macropore flow may be a mechanism for downward movement of phosphorus. Dissolved organic phosphorus may be important to the movement of phosphorus into soil (James et al. 1996; Chardon et al. 1997; Parham et al. 2002).

Orthophosphate-P levels in the manured subplots continued to increase in 2000 and 2001 compared to the residual-manure subplots (Table 13). This trend was true for all manure application rates, however, significant differences were only observed for the highest manure application rate in 2000 at both sites, for the 20, 60, and 120 Mg ha^{-1} manure treatments in 2001 at the coarse-textured site, and for the 60 and 120 Mg ha^{-1} manure treatments at the medium-textured site in 2001.

Orthophosphate-P content in the 0 to 0.15-m soil layer tended to decrease from 1999 to 2001 in the residual-manure subplots after manure application was discontinued. Statistically significant differences were observed only for the 120 Mg ha^{-1} manure treatment at both sites (Table 14). Only a few significant differences occurred in deeper soil layers and the trends did not always follow what was observed in the top soil layer. For example, orthophosphate-P content in the 0.6 to 0.9-m soil layer for the 120 Mg ha^{-1} manure treatment at the coarse-textured site was significantly higher in 2001 than in 1999 or 2000 (Table 14). The decrease in orthophosphate-P was still evident for the 0 to 0.6-m soil layer at both sites, particularly for the highest manure application treatment. Orthophosphate-P content, for the 120 Mg ha^{-1} manure treatment, in 2001 was reduced 15 percent at the coarse-textured site and reduced 19 percent at the medium-textured site compared to the controls.

Table 13. Comparison of orthophosphate-P levels (0 to 0.6-m soil layer; kg ha^{-1}) in the manure and residual-manure subplots in 1999 (baseline), 2000, and 2001 ^{z}.

Subplot	20 Mg ha^{-1} manure treatment	40 Mg ha^{-1} manure treatment	60 Mg ha^{-1} manure treatment	120 Mg ha^{-1} manure treatment
		Coarse-textured site		
1999 manure	459	601	739	1460
1999 residual-manure	400	631	664	1470
2000 manure	469	738	887	1542
2000 residual-manure	404	559	614	1297*
2001 manure	615	805	1099	2025
2001 residual-manure	407*	626	681*	1249*
		Medium-textured site		
1999 manure	174	326	500	1051
1999 residual-manure	158	384	430	1086
2000 manure	270	458	587	1343
2000 residual-manure	168	364	555	1005*
2001 manure	240	381	620	1425
2001 residual-manure	132	254	386*	878*

^{z} Asterisks indicate the residual-manure subplot is significantly different (P<0.05) than the corresponding manure subplot.

Table 14. Changes in soil orthophosphate-P content in the residual-manure subtreatments from 1999 to 2001 at the coarse- and medium-textured sites.

	Coarse-textured site				Medium-textured site			
Year	20 [z]	40	60	120	20	40	60	120
				0.0 – 0.15 m layer				
1999 [y]	213 a	367 a	379 a	897 b	131 a	342 a	389 a	919 b
2000	234 a	334 a	385 a	796 b	137 a	325 a	491 a	849 ab
2001	209 a	306 a	337 a	661 a	96 a	211 a	331 a	708 a
				0.15 – 0.3 m layer				
1999	104 a	148 a	191 a	256 a	6.9 a	15 a	17 a	124 a
2000	101 a	135 a	159 a	344 a	7.4 a	15 a	40 a	120 a
2001	109 a	159 a	197 a	346 a	6.9 a	13 a	27 a	115 a
				0.3 – 0.6 m layer				
1999	44 a	67 a	56 a	163 b	7.2 a	10 a	8.6 a	16 a
2000	22 a	38 a	35 a	97 a	6.6 a	8.7 a	9.4 a	14 a
2001	42 a	74 a	86 a	132 ab	8.5 a	11 a	10 a	22 a
				0.6 – 0.9 m layer				
1999	18 a	19 ab	16 a	29 a	5.7 a	6.9 a	5.6 a	9.2 a
2000	18 a	17 a	14 a	25 a	6.9 a	5.4 a	4.9 a	7.1 a
2001	27 a	43 b	32 a	54 b	6.9 a	6.5 a	7.6 a	18 b
				0.9 – 1.2 m layer				
1999	14 a	20 a	16 a	18 a	3.8 a	4.6 a	5.4 a	9.3 a
2000	12 a	21 a	12 a	23 a	6.2 a	5.5 a	4.6 a	9.4 a
2001	14 a	28 a	21 a	41 b	8.3 a	4.9 a	7.1 a	9.9 a
				1.2 – 1.5 m layer				
1999	8.0 a	11 a	6.5 a	7.1 a	3.8 a	5.6 a	5.2 a	9.9 a
2000	17 a	14 a	8.5 a	12 a	4.4 a	4.7 a	5.2 a	5.8 a
2001	5.9 a	16 a	8.7 a	15 a	5.0 a	6.8 a	3.9 a	4.9 a
				0.0 – 0.6 m layer				
1999	400 a	631 a	664 a	1470 b	158 a	384 a	430 a	1086 b
2000	404 a	559 a	614 a	1297 ab	168 a	364 a	555 a	1005 ab
2001	407 a	626 a	681 a	1249 a	132 a	254 a	386 a	878 a

[z] Residual-manure subplot treatments, which received annual application (20, 40, 60, and 120 Mg ha^{-1} y^{-1}) from 1993 to 1998. Manure application was discontinued after 1998 (i.e. no manure applied in 1999 and 2000).
[y] Means within the three-year period, for each residual-manure rate, site and soil layer combination, followed by the same letter are not significantly different (P<0.05).

The seasonal variations in orthophosphate-P levels were more attenuated compared to nitrate-N (Fig. 24). There did not appear to be any obvious annual cycle in orthophosphate-P content variation. Two peaks were observed in 2000: one in May and the other in August. A single peak in the orthophosphate-P content occurred in 2001.

Total nitrogen and phosphorus. Annual manure application increased total nitrogen and total phosphorus in the soil at both sites. Significant differences were observed only in the top soil layer (0 to 0.15 m) for total nitrogen (Table 15) and only in the top two soil layers (0 to 0.3 m) for total phosphorus (Table 16). There were treatment-by-year interactions (Appendix 12, Tables 12.5 to 12.8). Differences were often not significant in 1994 to 1996, depending upon the site and soil parameter. Total nitrogen and total phosphorus content increased with manure application rate (Tables 15 and 16) and increased with time (Figs. 25 and 26), though there was some year-to-year variation, particularly for total nitrogen at the medium-textured site (Fig. 25b). Chang and Janzen (1996) reported a gradual increase in soil organic nitrogen during a 19-year period of annual cattle manure applications. Their data also showed some year-to-year variations relative to the general trend.

In the 0 to 0.15-m soil layer, the baseline (1993) average total nitrogen was 3.28 Mg ha^{-1} at the coarse-textured site and 4.46 Mg ha^{-1} at the medium-textured site. By 2001, total nitrogen content had increased from 1.5 (lowest manure rate) to 2.4 (highest manure rate) times at both sites. In the 0 to 0.3-m soil layer, the baseline average phosphorus content was 2.75 Mg ha^{-1} at the coarse-textured site and 2.60 Mg ha^{-1} at the medium-textured site. By 2001, total phosphorus content had increased from 1.1 to 1.7 times at the coarse-textured site and from 1.1 to 1.9 times at the medium-textured site.

Total nitrogen and phosphorus in the 0 to 0.15-m soil layer increased linearly with the amount of cumulative manure total nitrogen and phosphorus added (Fig. 27). For every megagram of total manure nitrogen added per hectare, soil total nitrogen increased by 465 kg ha^{-1} at the coarse-textured site, and by 435 kg ha^{-1} at the medium-textured site. For every megagram of total manure phosphorus added per hectare, soil total phosphorus increased by 488 kg ha^{-1} at the coarse-textured site, and by 575 kg ha^{-1} at the medium-textured site. Hao et al. (2003) reported an increase of 0.192 g total nitrogen per kilogram of soil (0.15 m layer) for every megagram of total manure nitrogen added, after 25-years of annual cattle-manure application. If one assumes a soil bulk density of 1.4 Mg m^{-3}, then the value reported by Hao et al. (2003) converts to 403 kg ha^{-1}, which is similar to our results for total nitrogen.

Extractable nitrate-N, extractable orthophosphate-P, total nitrogen, and total phosphorus were only measured on the same samples from the top three incremental soil layers (0 to 0.15, 0.15 to 0.3, and 0.3 to 0.6 m) for the control and four manure-rate treatments. In the baseline year (1993), nitrate-N was 0.61 percent of total nitrogen in the 0 to 0.15-m layer at the coarse-textured site. This value was 0.20 percent at the medium-textured site. At both sites, nitrate-N as a percentage of total nitrogen increased slightly with depth. In the 0.3 to 0.6-m layer, the percentage was 1.15 at the coarse-textured site and 0.34 at the medium-textured site. Extractable orthophosphate-P was 18.1 percent of total phosphorus in the top soil layer at the coarse-textured site in 1993. The percentage was lower (8.3 percent) at the medium-textured site. In contrast to

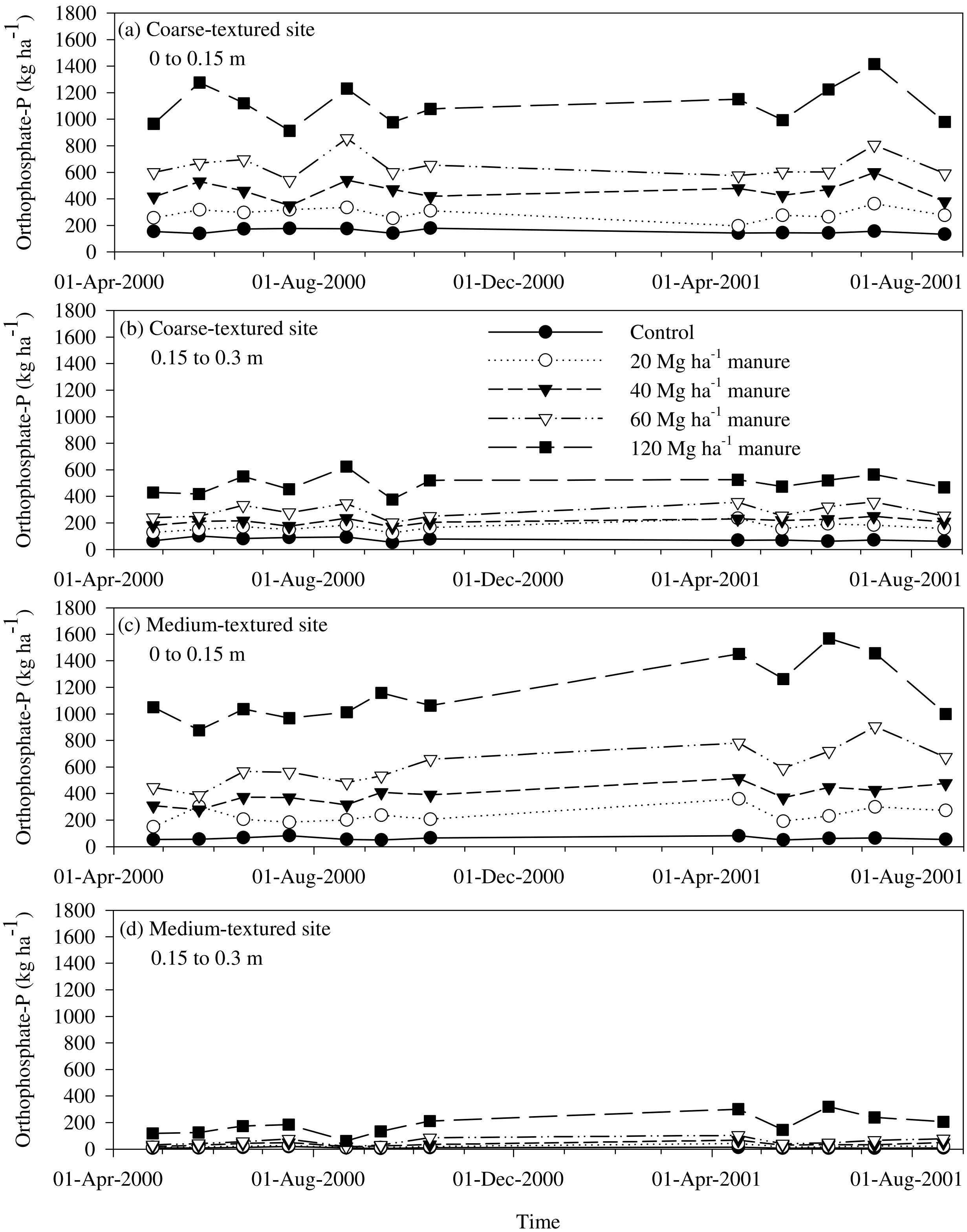


Fig. 24. Seasonal variation in orthophosphate-P content in the 0 to 0.15-m and 0.15 to 0.3-m soil layers at the coarse- and medium-textured sites.

Table 15. Means of total nitrogen (Mg ha^{-1}) in the 0 to 0.15-m soil layer at coarse- and medium-textured sites.

Year	Coarse-textured site					Medium-textured site				
	0 [z]	20	40	60	120	0	20	40	60	120
1993	3.49 a	3.26 a	3.21 a	2.73 a	3.72 a	4.35 a	4.28 a	4.62 a	4.70 a	4.36 a
1994	3.77 ab	4.51 ab	3.58 a	5.02 ab	5.49 b	5.61 ab	6.51 ab	5.25 a	8.27 b	6.55 ab
1995	3.77 a	4.19 a	4.93 a	4.37 a	4.93 a	6.84 ab	8.69 ab	7.55 ab	5.96 a	9.07 b
1996	3.63 a	4.46 a	4.24 a	4.11 a	6.16 a	6.30 a	6.38 a	6.84 a	6.63 a	7.34 a
1997	4.05 a	5.25 a	4.51a	5.58 ab	7.27 b	6.55 a	8.44 ab	9.02 ab	7.89 a	10.95 b
1998	3.58 a	4.37 a	4.28 a	4.98 ab	6.74 b	4.07 a	4.95 ab	5.33 ab	5.37 ab	7.39 b
1999	3.35 a	3.91 a	4.70 a	5.44 b	7.53 c	6.25 a	7.76 ab	9.07 ab	8.90 ab	9.61 b
2000	3.21 a	3.95 ab	5.12 bc	6.28 cd	7.91 d	6.80 a	7.81 a	7.55 a	8.81 a	9.57 a
2001	3.63 a	4.98 ab	5.44 b	6.14 bc	7.81 c	4.99 a	6.84 ab	6.80 ab	8.56 bc	10.74 c

[z] Manure application rates (0, 20, 40, 60, and 120 Mg ha^{-1} y^{-1}) from 1993 to 2000.

[y] Mean values, for each site per year, followed by the same letter are not significantly different (P<0.05). There were no significant differences below the 0.15-m soil layer.

Table 16. Means of total phosphorus (Mg ha^{-1}) in the 0 to 0.15-m and 0.15 to 0.3-m soil layers at the coarse- and medium-textured sites.

Layer	Coarse-textured site					Medium-textured site				
(m)	0 [z]	20	40	60	120	0	20	40	60	120
					1993					
0-0.15 [y]	1.73 a	1.59 a	1.52 a	1.53 a	1.69 a	1.47 a	1.57 a	1.34 a	1.38 a	1.29 a
0.15-0.3	1.13 a	1.16 a	1.04 a	1.14 a	1.23 a	1.13 a	1.11 a	1.19 a	1.22 a	1.29 a
					1994					
0-0.15 [y]	1.43 a	1.45 a	1.42 a	1.65 a	1.63 a	1.39 a	1.42 a	1.39 a	1.55 a	1.55 a
0.15-0.3	1.09 a	1.10 a	1.08 a	1.15 a	1.16 a	1.20 a	1.18 a	1.22 a	1.20 a	1.22 a
					1995					
0-0.15	1.34 a	1.47 a	1.51 a	1.53 a	1.73 a	1.41 a	1.46 a	1.39 a	1.23 a	1.62 a
0.15-0.3	1.11 a	1.09 a	1.09 a	1.29 a	1.13 a	1.25 a	1.23 a	0.96 a	1.20 a	1.24 a
					1996					
0-0.15	1.36 a	1.67 a	1.69 a	1.64 a	2.30 b	1.50 a	1.50 a	1.56 a	1.63 a	1.85 a
0.15-0.3	1.20 a	1.13 a	1.15 a	1.05 a	1.27 a	1.19 a	1.27 a	1.17 a	1.18 a	1.19 a
					1997					
0-0.15	1.58 a	1.60 a	1.63 a	1.84 a	2.27 b	1.41 a	1.71 ab	1.74 ab	1.86 b	2.33 c
0.15-0.3	1.16 ab	1.17 ab	1.13 a	1.29 ab	1.42 b	1.21 a	1.22 a	1.18 a	1.18 a	1.28 a
					1998					
0-0.15	1.46 a	1.66 ab	1.69 ab	1.90 b	2.41 c	1.41 a	1.54 a	1.54 a	1.82 a	2.40 b
0.15-0.3	1.12 a	1.30 ab	1.34 ab	1.42 b	1.46 b	1.12 a	1.16 a	1.13 a	1.07 a	1.14 a
					1999					
0-0.15	1.16 a	1.56 ab	1.72 b	1.94 b	2.76 c	1.49 a	1.68 ab	2.00 bc	2.21 c	2.87 d
0.15-0.3	1.13 a	1.25 ab	1.20 ab	1.44 bc	1.63 c	1.16 a	1.20 a	1.19 a	1.17 a	1.31 a
					2000					
0-0.15	1.34 a	1.53 a	2.00 b	2.22 b	2.98 c	1.46 a	1.79 ab	2.01 bc	2.25 c	2.82 d
0.15-0.3	1.05 a	1.16 ab	1.21 ab	1.37 bc	1.60 c	1.21 a	1.25 a	1.19 a	1.13 a	1.71 b
					2001					
0-0.15	1.35 a	1.77 b	1.95 bc	2.34 c	3.02 d	1.42 a	1.72 ab	2.00 bc	2.31 c	3.40 d
0.15-0.3	1.17 a	1.31 a	1.33 ab	1.59 bc	1.73 c	1.24 a	1.19 a	1.22 a	1.27 a	1.62 b

[z] Manure application rates (0, 20, 40, 60, and 120 Mg ha^{-1} y^{-1}) from 1993 to 2000.
[y] Mean values, for each soil layer per site per year, followed by the same letter are not significantly different ($P<0.05$). There were no significant differences below the 0.3-m soil depth.

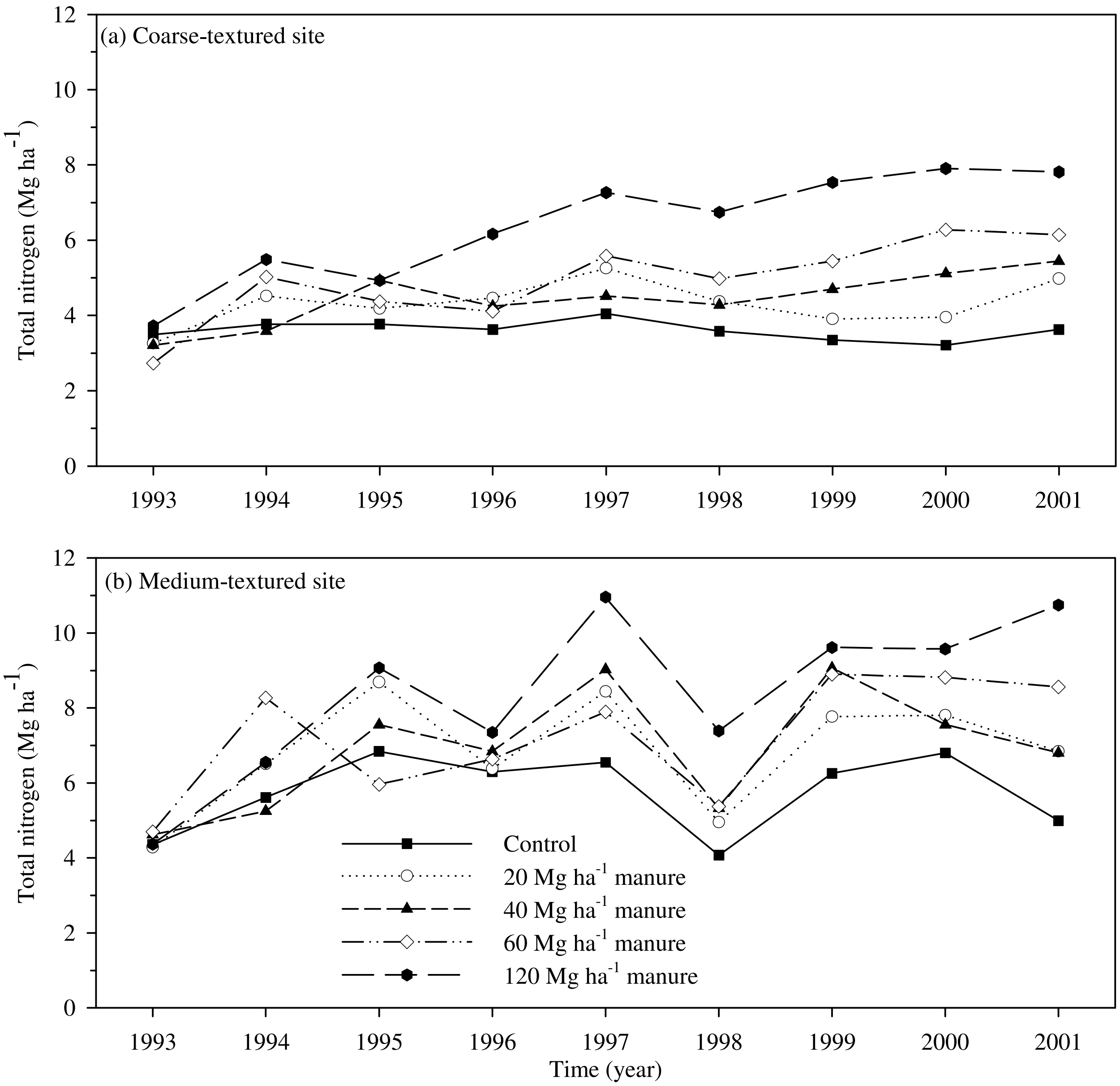


Fig. 25. Mean total nitrogen content in the 0 to 0.15-m soil layer at the (a) coarse- and (b) medium-textured sites.

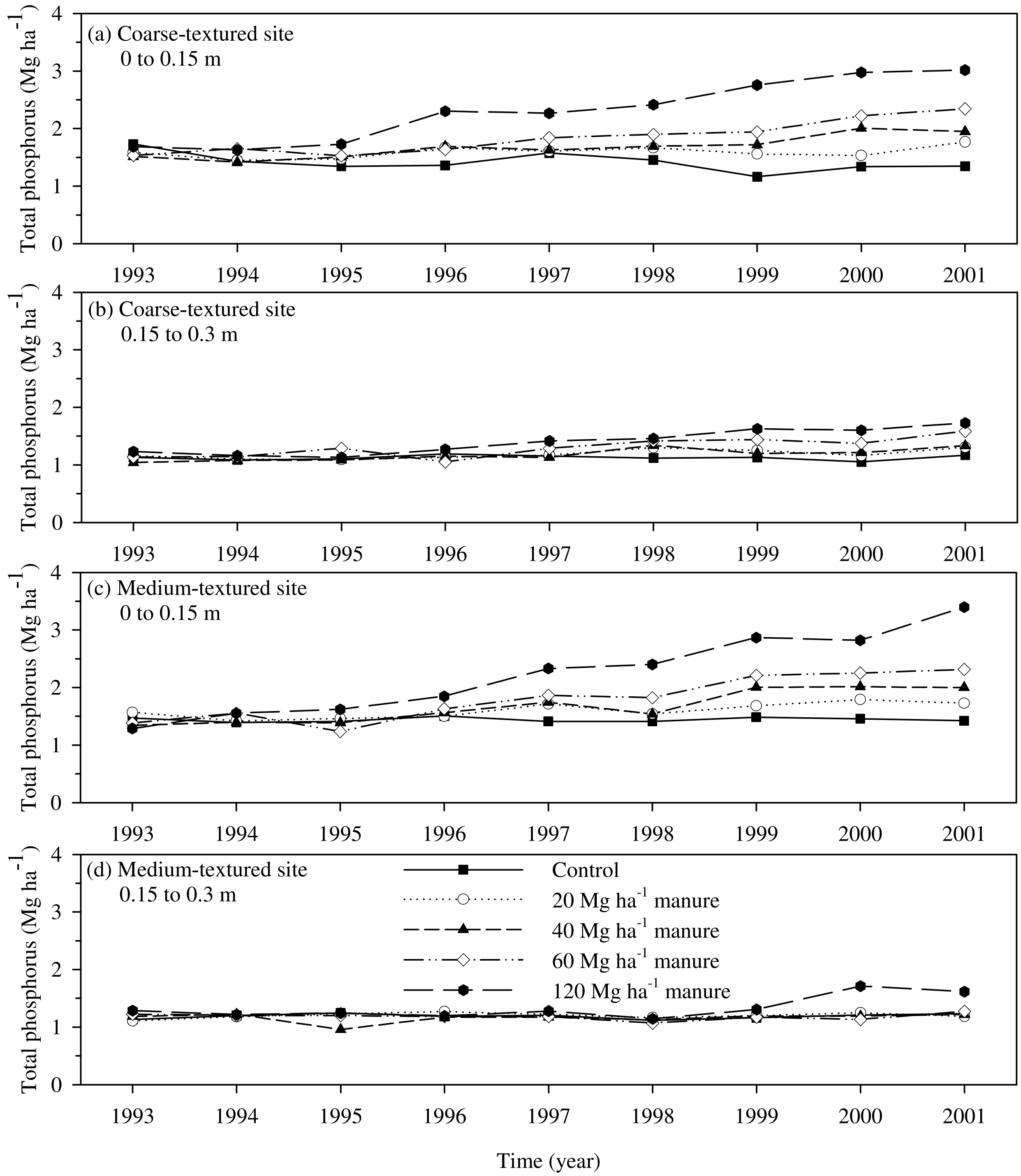


Fig. 26. Mean total phosphorus content at the coarse-textured site in the (a) 0 to 0.15-m and (b) 0.15 to 0.3-m soil layers, and at the medium-textured site in the (c) 0 to 0.15-m and (d) 0.15 to 0.3-m soil layers.

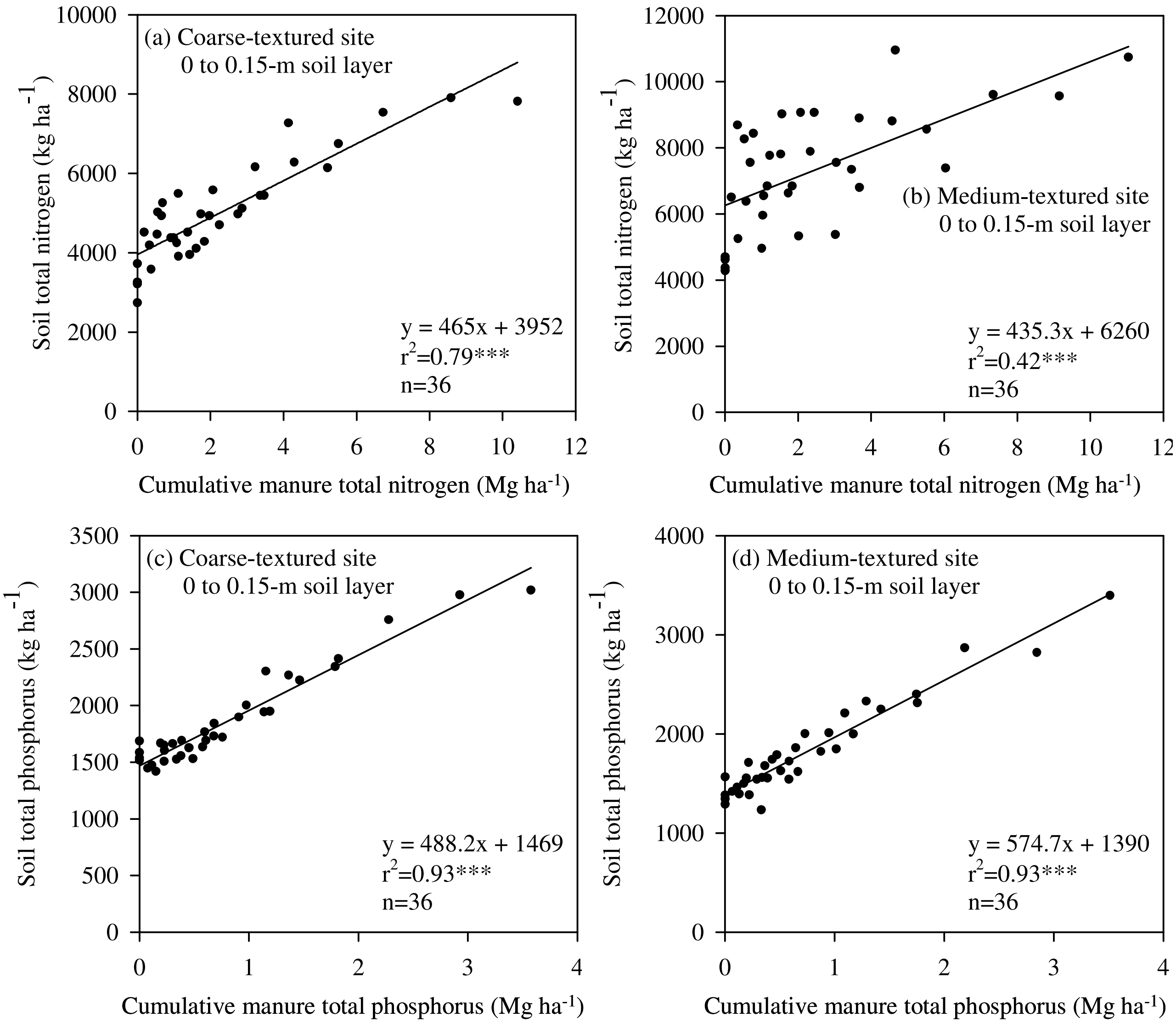


Fig. 27. Total nitrogen content in soil versus added cumulative manure total nitrogen at the (a) coarse- and (b) medium-textured sites, and total phosphorus content in soil versus added cumulative manure total phosphorus at the (c) coarse- and (d) medium-textured sites. Triple asterisks indicates significance at P<0.001.

nitrogen, orthophosphate-P as a percentage of total phosphorus decreased with depth. At the coarse-textured site, the percentage decreased to 8.3 percent in the 0.15 to 0.3-m soil layer, and to 1.4 percent in the 0.3 to 0.6-m soil layer. The percentages were 1.1 percent in the 0.15 to 0.3-m layer and 0.4 percent in the 0.3 to 0.6-m layer at the medium-textured site.

The proportion of extractable nitrate-N and orthophosphate-P relative to total nitrogen and phosphorus changed with manure application during the eight-year study. The nitrate-N:total N and orthophosphate-P:total P ratios increased with manure application (Figs. 28 to 31). The effect was more pronounced as the manure rate increased and generally with time. However, for nitrogen in the 0 to 0.15-m soil layer at the coarse-textured site, the ratio peaked in 1998 and then steadily decreased thereafter (Fig 28a). The main difference between nitrogen and phosphorus is the effect of manure on the ratio intensified with depth for nitrogen (Fig. 28 and 29), whereas the effect was much less apparent with depth for phosphorus, particularly at the medium-textured site (Figs. 29 and 30). This difference may be caused by the greater leachability of nitrate-N and by possible gaseous losses of nitrogen from the soil surface.

Phosphorus and soil aggregate distribution. Surface soil (0 to 0.05 m) was sampled once (October 2000) from the control and four manure-rate plots to determine aggregate-size distribution and phosphorus content in the different aggregate-size fractions. This was after seven annual manure applications. The dominant size fraction was the 0.5 to 0.177 mm fraction at the coarse-textured site (Fig 32a). However, the relative proportion of this size fraction decreased as manure rate increased. A corresponding increase occurred in the >1.0 mm fraction as manure rate increased. The relative proportion of the 1.0 to 0.5 mm fraction also increased with manure application rate, whereas the opposite was true for the <0.177 mm fraction. The application of manure caused a shift from smaller to larger aggregates. Soil organic matter is an important agent in the formation and stability of aggregates (Brady and Weil 2002). The total amount of organic matter added from manure from 1993 to 1999 at the coarse-textured site ranged from 34.8 to 209 Mg ha^{-1}, depending on the application rate.

The >1.0 mm fraction was the dominant size fraction at the medium-textured site, with mean values ranging from 64 to 78 percent among the five manure application rate treatments (Fig. 32b). This indicates the soil at the medium-textured site was more aggregated than the coarse-textured site. There was a significantly higher proportion in the >1.0 mm fraction for the 40, 60, and 120 Mg ha^{-1} manure treatments compared to the control. The proportion in the <0.177 mm fraction was not affected by manure application rate. The proportion of aggregates in the 0.1 to 0.5 mm and 0.5 to 0.177 mm fractions generally was lower for the manure treatments compared to the control. The small increase observed in the >1.0 mm fraction may have been at the expense of the 0.1 to 0.5 mm and 0.5 to 0.177 mm fractions. These results also indicate the promotion of aggregate formation with the application of manure, though the effect was not as extensive as observed at the coarse-textured site.

The wind-erodible fraction is considered to be less than 0.84 mm (Bullock et al. 1999). In our study, a portion of the 1.0 to 0.5 mm fraction can be considered wind-erodible, as well as all of the two smaller fractions. Most of the aggregates at the coarse-textured soil fell within the wind-erodible fraction, whereas most of the aggregates was greater than 0.84 mm at the medium-

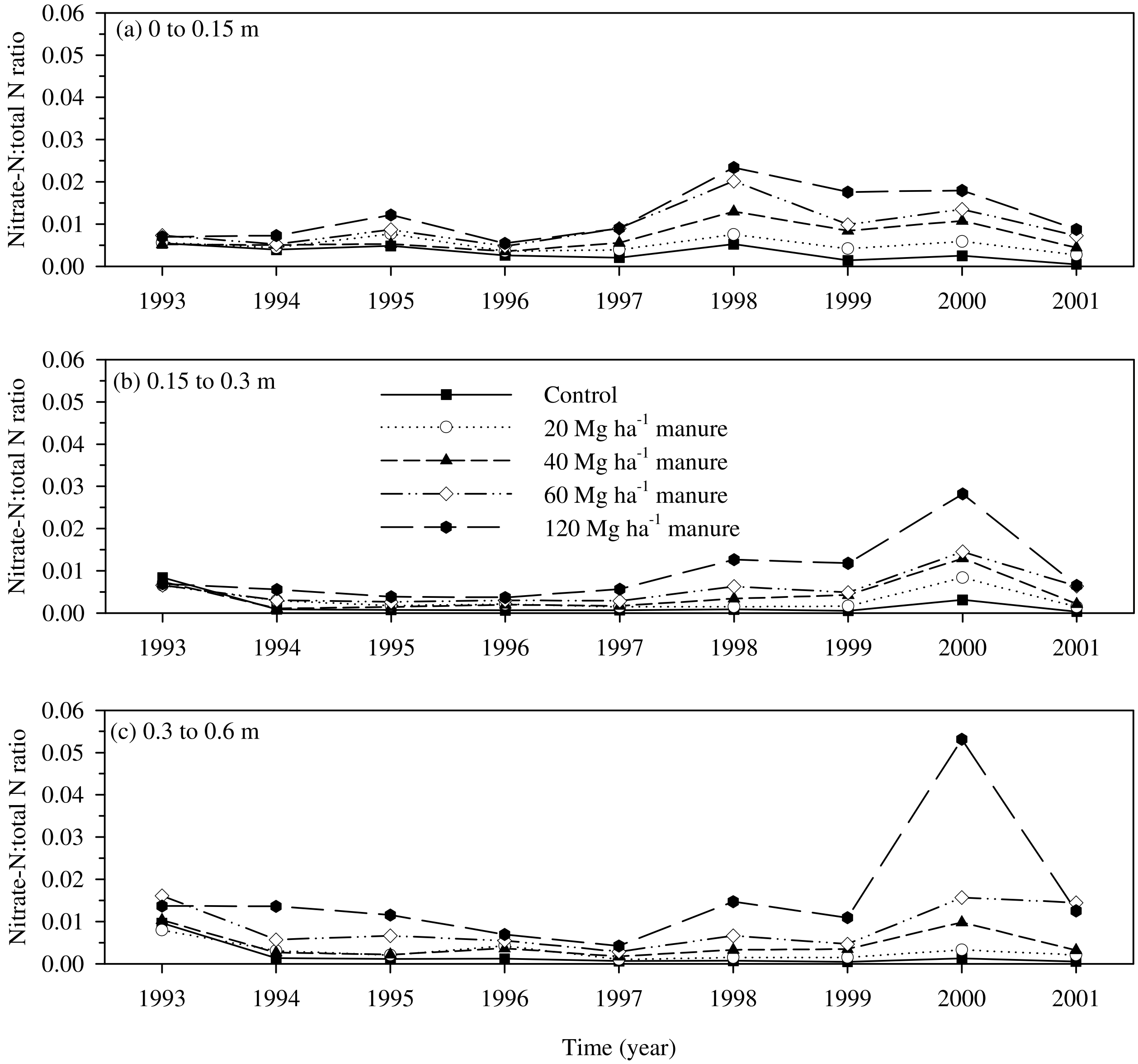


Fig. 28. Nitrate-N:total nitrogen ratios for the five manure rate treatments in the (a) 0 to 0.15-m soil layer, (b) 0.15 to 0.3-m soil layer, and (c) 0.3 to 0.6-m soil layer at the coarse-textured site.

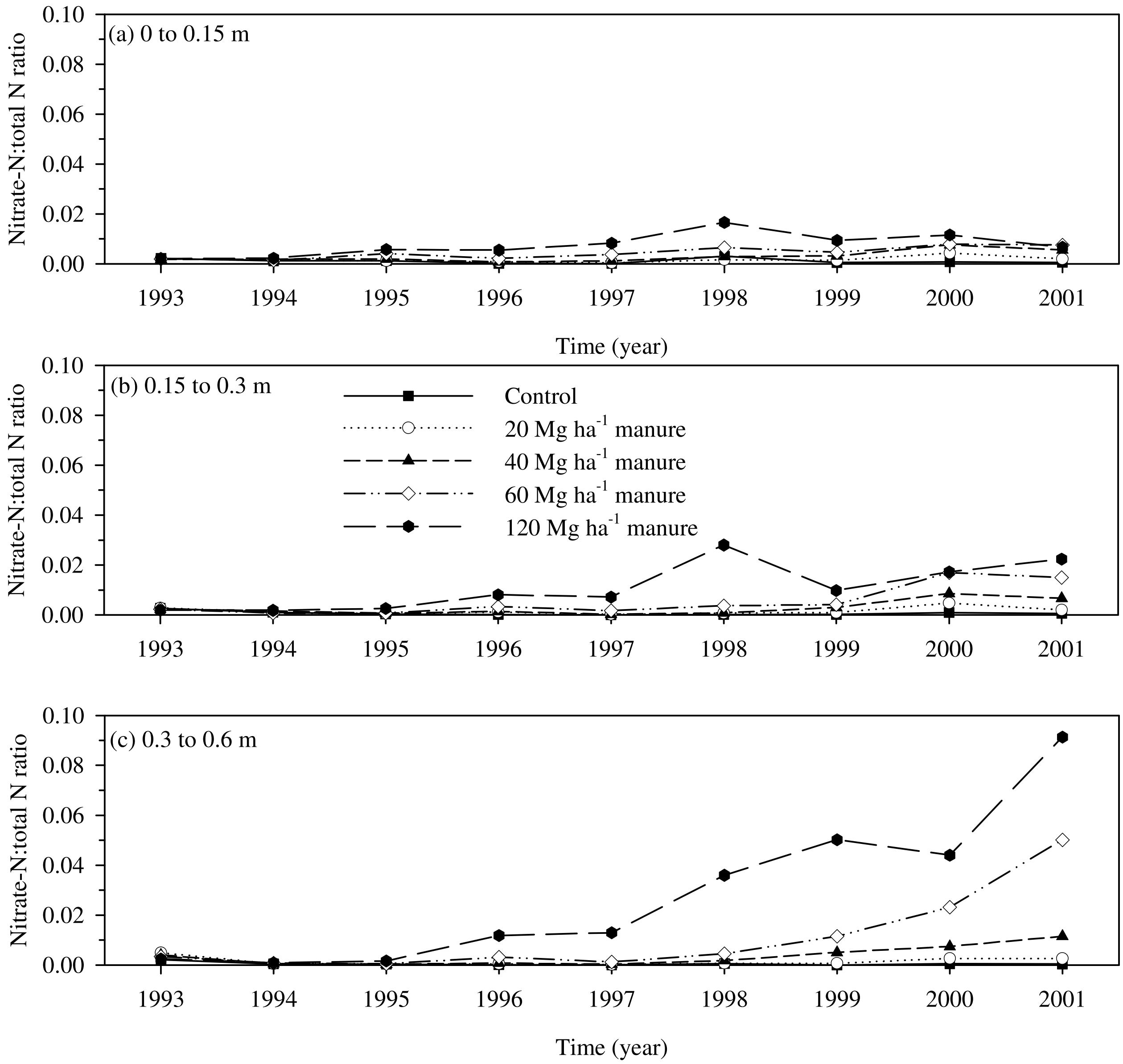


Fig. 29. Nitrate-N:total nitrogen ratios for the five manure rate treatments in the (a) 0 to 0.15-m soil layer, (b) 0.15 to 0.3-m soil layer, and (c) 0.3 to 0.6-m soil layer at the medium-textured site.

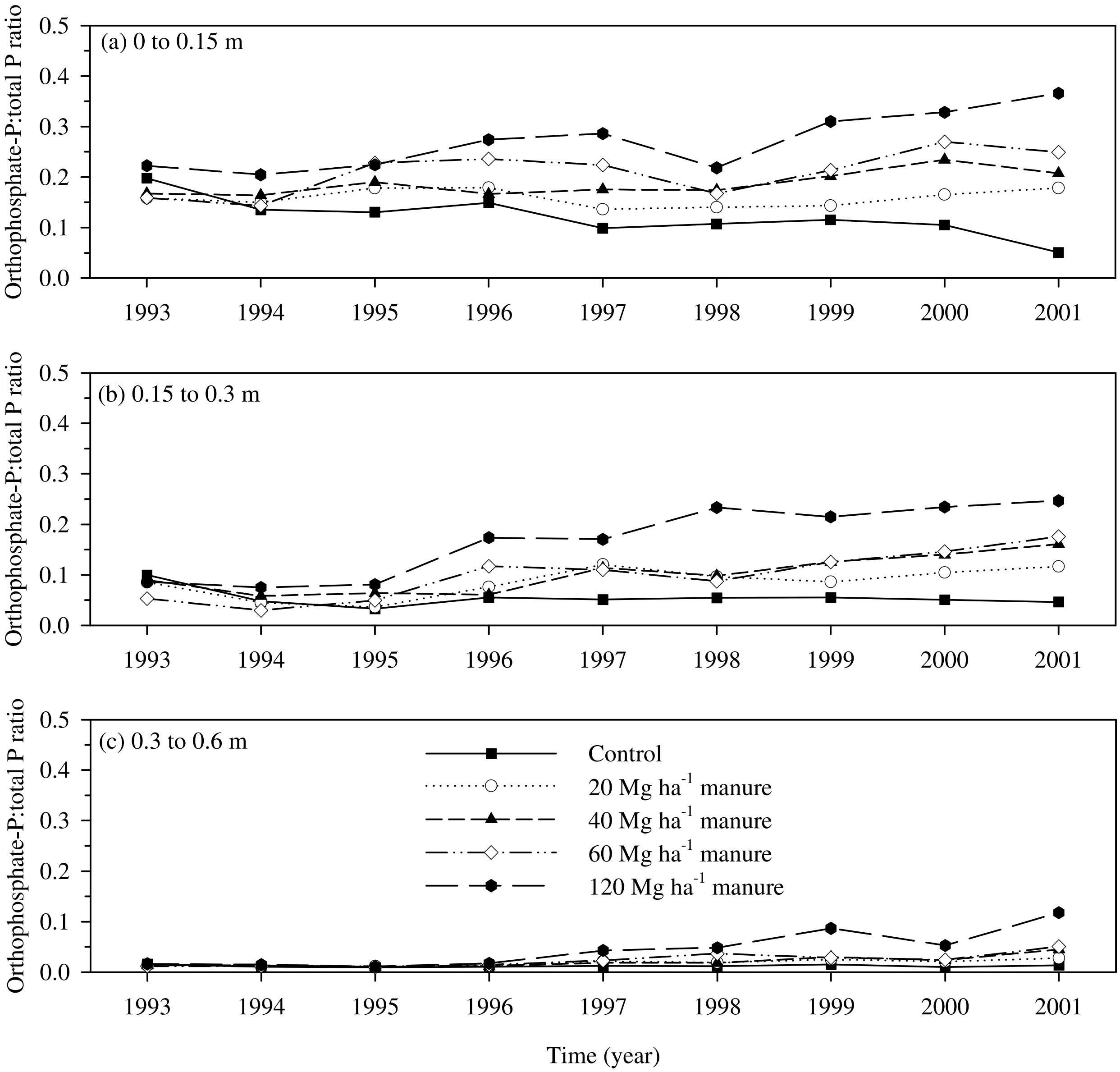


Fig. 30. Orthophosphate-P:total phosphorus ratios for the five manure rate treatments in the (a) 0 to 0.15-m soil layer, (b) 0.15 to 0.3-m soil layer, and (c) 0.3 to 0.6-m soil layer at the coarse-textured site.

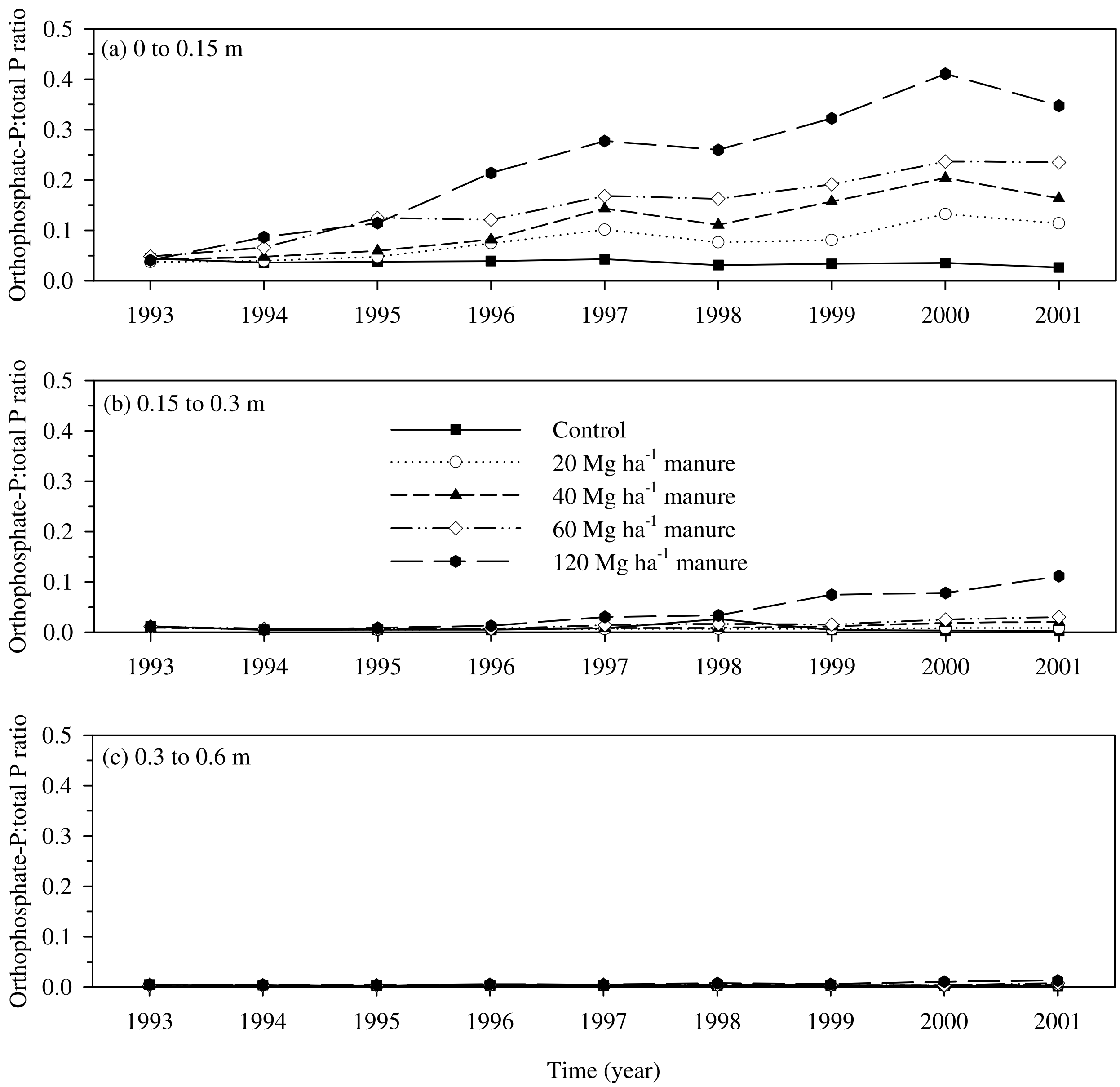


Fig. 31. Orthophosphate-P:total phosphorus ratios for the five manure rate treatments in the (a) 0 to 0.15-m soil layer, (b) 0.15 to 0.3-m soil layer, and (c) 0.3 to 0.6-m soil layer at the medium-textured site.

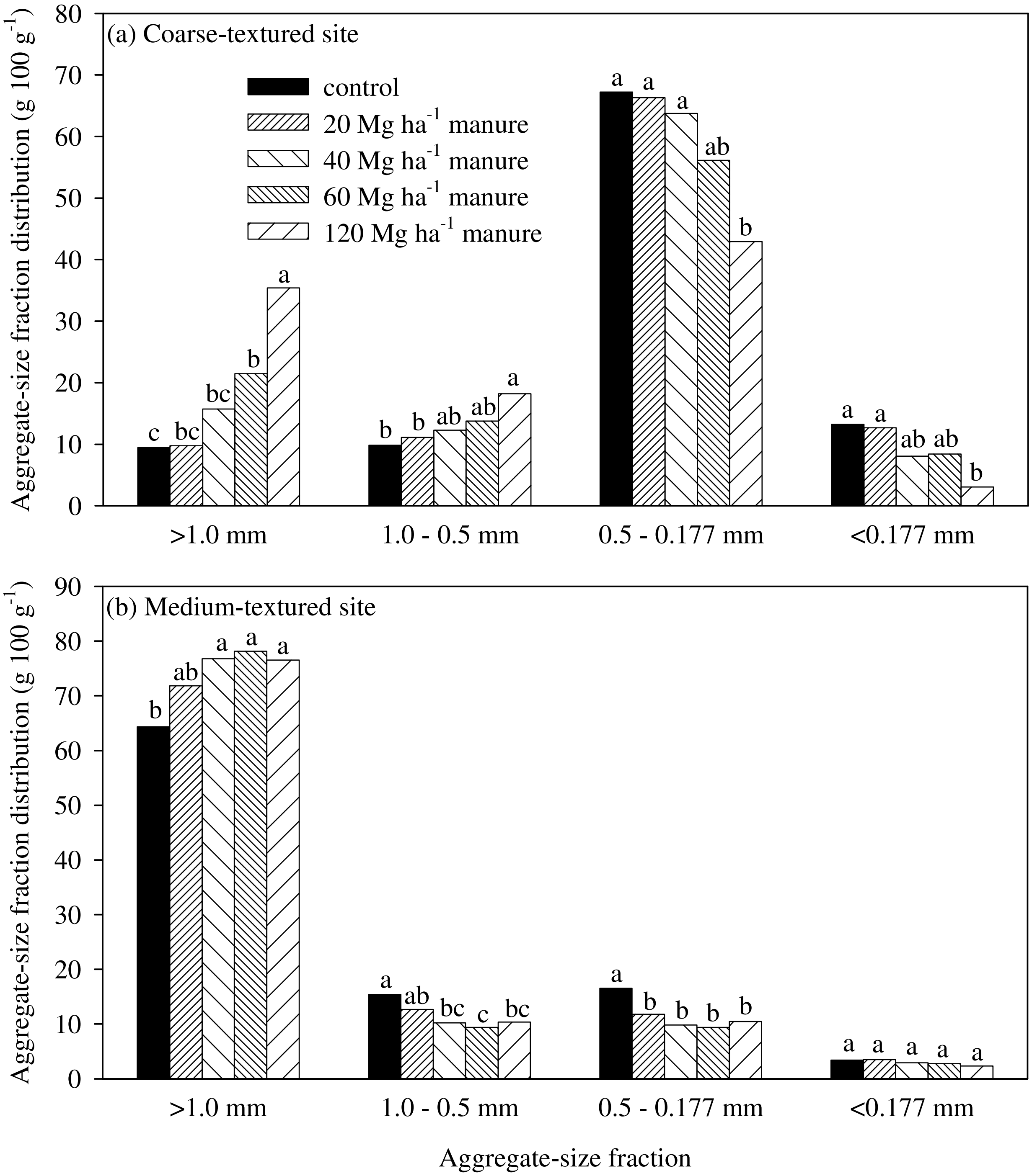


Fig. 32. Aggregate size distribution for the five manure application rate treatments in October 2000 at the (a) coarse-textured site and (b) medium-textured site.

textured site. Not only did the application of manure promote aggregate formation, there was a shift to more aggregates greater than 0.84 mm in size. Therefore, we concluded that application of manure, particularly at the coarse-textured site, may reduce the wind-erodibility of the soil, though this was not tested in this study.

Aoyama et al. (1999) found that 18 years of dairy-cattle manure on a silty loam to loam soil in Québec, Canada, significantly increased the proportion of the third largest size fraction (0.25 to 1.0 mm) and tended to increase the largest size fraction (>1.0 mm). The two smaller size fractions (0.053 to 0.25 mm and <0.035 mm) tended to decrease with manure application. They hypothesized that, "manure-derived organic matter first enters the soil primarily as particulate material, then, during decomposition, is transformed within the aggregate structure into mineral-associated material thereby contributing to aggregate stabilization". In contrast, Whalen and Chang (2002b) reported that 25 years of beef-cattle manure on dryland and irrigated crop land in southern Alberta caused a decrease in larger aggregate-size fractions and an increase in smaller aggregate-size fractions. They suggested that appreciable quantities of monovalent cations (sodium, potassium, and ammonium) and foreign soil in the manure may promote the dispersion of soil aggregates.

Extractable and total phosphorus concentrations were increased as manure rate increased for each of the aggregate-size fractions at both sites (Figs. 33 and 34). The only exception was for the total phosphorus in the >1.0 mm fraction at the coarse-textured site (Fig. 34a). The extractable and total phosphorus values for the >1.0 mm fraction were calculated by subtracting the laboratory values of the other three fractions from the whole-soil values. Negative total phosphorus concentrations were calculated for the >1.0 mm fraction samples at the coarse-textured site, and since negative values can not occur, these negative values may be attributed to analytical error or limited precision in the laboratory method. Even though the >1.0 mm fraction had the largest range among the treatment means (e.g. control versus 20 Mg ha^{-1} manure rate), there were no statistical differences among the treatments, indicating high variability.

In spite of the problem with the total phosphorus results for the >1.0 mm fraction at the coarse-textured site, it appears that the application of manure in this study resulted in a similar increase in extractable and total phosphorus in the four aggregate-size fractions. Phosphorus concentration in the four aggregate-size fractions were similar to the whole soil for the control treatment. The application of manure did not result in an obvious enrichment of phosphorus in any of the aggregate-size fractions. The distribution of phosphorus among the aggregate-size fractions was governed mainly by the distribution of soil mass (Fig. 32) rather than by phosphorus concentration. Most of the extractable (35 to 60 percent) and total (50 to 79 percent) phosphorus was in the 0.5 to 0.177 mm fraction at the coarse-textured site, whereas most of the extractable (65 to 80 percent) and total (64 to 78 percent) phosphorus was in the >1.0 mm fraction at the medium-textured site.

Whalen and Chang (2002b) measured total carbon, nitrogen, and phosphorus in seven aggregate-size fractions (<0.47, 0.47 to 1.2, 1.2 to 2.0, 2.0 to 7.1, 7.1 to 12.7, 12.7 to 38, and >38 mm) from plots that had received annual cattle manure applications for 25 years. They reported that manure caused an increase in total carbon, nitrogen, and phosphorus in the fractions, and

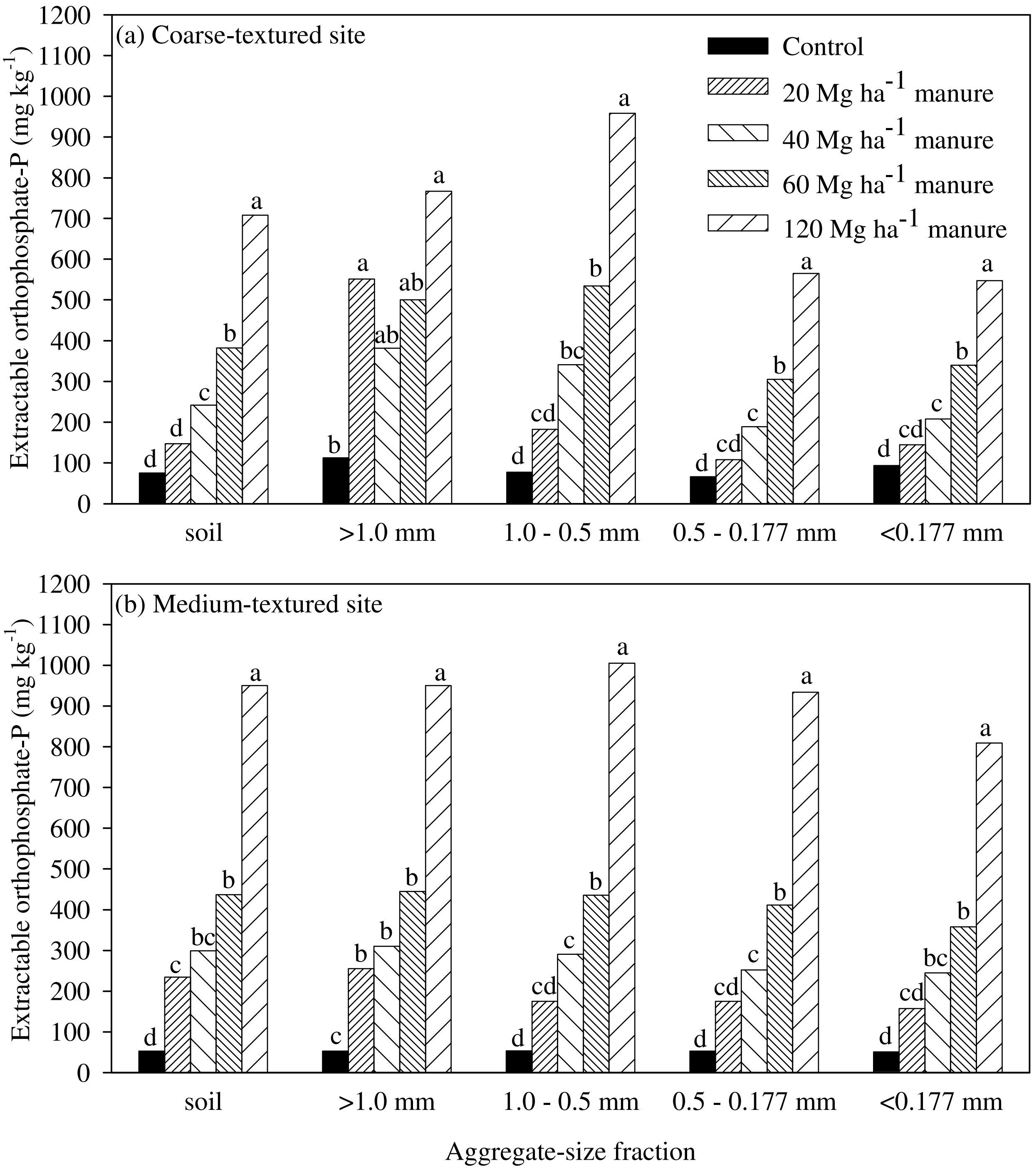


Fig. 33. Extractable orthophosphate-P in the four aggregate size fractions for the five manure application rate treatments in October 2000 at the (a) coarse-textured site and (b) medium-textured site.

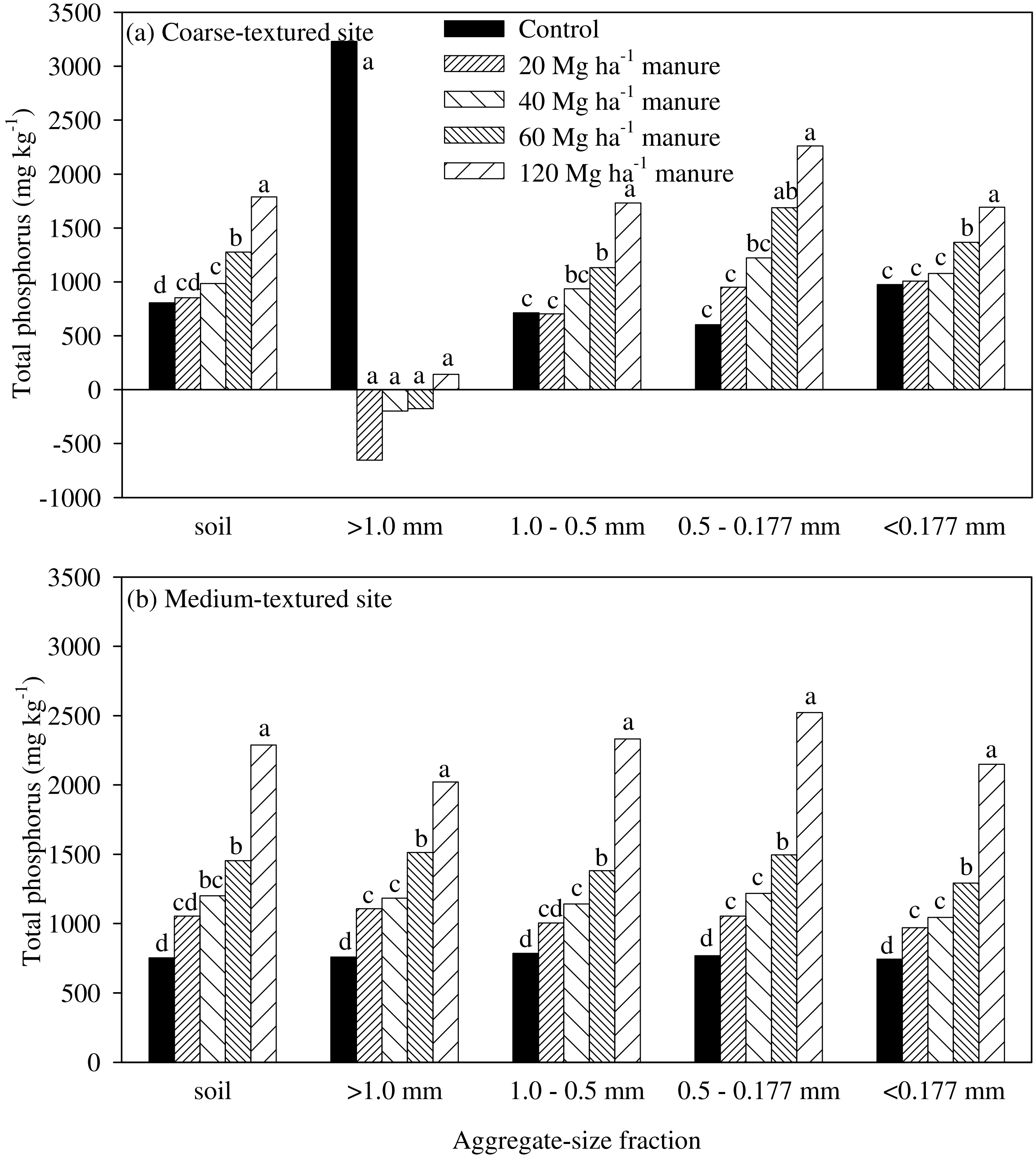


Fig. 34. Total phosphorus in the four aggregate size fractions for the five manure application rate treatments in October 2000 at the (a) coarse-textured site and (b) medium-textured site.

that the 0.47 to 2.0 mm fraction tended to be enriched with total carbon, nitrogen, and phosphorus.

Extractable calcium and magnesium. The content, distribution, and variability of saturated-paste water extractable calcium and magnesium were different between the two sites at the beginning of the study in 1993 (Fig. 35). Calcium and magnesium contents were lower at the coarse-textured site, with a slight increase with depth. At the medium-textured site, calcium and magnesium contents were similar to the coarse-textured site near the soil surface, but increased much more with depth. There was more variability at the medium-textured site for both soil parameters, particularly with depth.

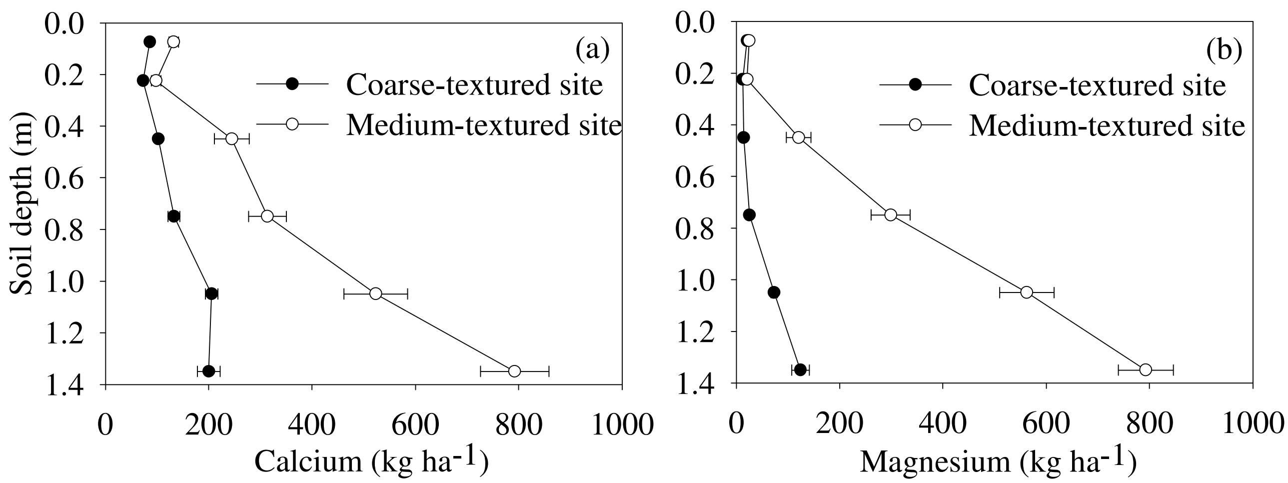


Fig. 35. Baseline (1993) mean values for saturated-paste water extractable (a) calcium and (b) magnesium at the coarse- and medium-textured sites. Horizontal bars are standard errors.

Manure application had minimal effect on soil calcium and magnesium at both sites, and nitrogen fertilizer had no effect on calcium and magnesium. There was no treatment effect on calcium at the medium-textured site. Calcium content increased in the top soil layer as manure rate increased at the coarse-textured site from 1997 to 2000 (Table 17). This trend was observed in 2001, but the treatments were not significantly different. There were no significant differences below the 0 to 0.15-m soil layer from 1997 to 1999. In 2000 and 2001, the manure treatments generally had higher calcium content in the deeper soil layers (Table 17). However, the trend of increasing calcium content with higher manure application rate was not always consistent in the deeper soil layers. For example, the control treatment (0 Mg ha^{-1} manure rate) had nearly as much calcium content in the deepest soil layer as most of the manure treatments. This may be attributed to variation in leaching of calcium and the higher calcium content with depth at the beginning of the study. Warman and Cooper (2000) reported from a three-year study that chicken-manure compost increased calcium content in surface soil under forage production. In contrast, Hao and Chang (2002) found that after 25 years of cattle manure application soluble calcium (saturated-paste extractable) content actually decreased with manure application rate. They proposed that increases in anions, such as HCO_3^-, SO_4^{-2}, and PO_4^{-2}, could reduce calcium

Table 17. Mean extractable calcium (kg ha^{-1}) content in soil at the coarse-textured site in 1997 to 2001.

Layer (m)	0 Mg ha^{-1} y^{-1} manure treatment	20 Mg ha^{-1} y^{-1} manure treatment	40 Mg ha^{-1} y^{-1} manure treatment	60 Mg ha^{-1} y^{-1} manure treatment	120 Mg ha^{-1} y^{-1} manure treatment
			1997		
0-0.15[z]	58 a	65 a	68 a	77 ab	102 b
0.15-0.3	51 a	49 a	46 a	44 a	42 a
0.3-0.6	92 a	94 a	100 a	92 a	93 a
0.6-0.9	76 a	75 a	88 a	66 a	71 a
0.9-1.2	65 a	60 a	77 a	48 a	79 a
1.2-1.5	99 a	49 a	70 a	58 a	83 a
			1998		
0-0.15	75 a	80 ab	102 abc	109 bc	120 c
0.15-0.3	50 a	46 a	52 a	51 a	47 a
0.3-0.6	89 a	99 a	105 a	109 a	143 a
0.6-0.9	78 a	76 a	94 a	88 a	193 a
0.9-1.2	57 a	58 a	142 a	73 a	173 a
1.2-1.5	49 a	47 a	148 a	64 a	114 a
			1999		
0-0.15	63 a	68 a	87 a	90 a	133 b
0.15-0.3	58 a	50 a	54 a	55 a	68 a
0.3-0.6	107 a	103 a	112 a	108 a	130 a
0.6-0.9	91 a	79 a	90 a	107 a	197 a
0.9-1.2	80 a	66 a	83 a	87 a	190 a
1.2-1.5	298 a	57 a	81 a	83 a	336 a
			2000		
0-0.15	57 a	66 ab	81 abc	91 bc	106 c
0.15-0.3	60 a	64 ab	80 abc	85 bc	94 c
0.3-0.6	96 a	119 a	193 ab	236 b	410 c
0.6-0.9	65 a	83 a	143 a	170 ab	291 b
0.9-1.2	225 a	57 a	86 a	96 ab	366 a
1.2-1.5	275 ab	52 a	63 ab	65 ab	360 b
			2001		
0-0.15	58 a	58 a	61 a	77 a	84 a
0.15-0.3	49 a	44 a	46 a	61 a	49 a
0.3-0.6	101 a	121 ab	117 ab	203 b	136 ab
0.6-0.9	81 a	124 a	173 ab	270 b	199 ab
0.9-1.2	61 a	111 ab	145 ab	248 ab	293 b
1.2-1.5	230 a	84 a	102 a	117 a	266 a

[z] Mean values, for each soil layer per site per year, followed by the same letter are not significantly different ($P<0.05$). There were no significant differences prior to 1997 at the coarse-textured site.

concentration in soluble form if calcium is controlled by the solubility of calcium-containing minerals. This phenomenon may be why no treatment effect was observed at the medium-textured site.

Magnesium content in the 0 to 0.15-m layer increased as manure rate increased at both sites (Table 18). This finding is similar to results reported by Hao and Chang (2002) for a field study after 25 years of manure application. Warman and Cooper (2000) found that fresh and composted chicken manure had little effect on surface soil magnesium content. Significant differences among the treatments were restricted to the top soil layer until 1998 at the coarse-textured site. In 1999 to 2001, there were some treatment differences. There were no treatment effects below the top soil layer at the medium-textured site, except in 2001, when the 60 Mg ha^{-1} manure rate was significantly higher than the control. There were no treatment effects below 0.6 m at either site. Even though manure application caused an increase in magnesium content, the cumulation of magnesium, with repeated annual applications of manure, was not extensive or consistent. For example, at the coarse-textured site, the highest magnesium content in the top soil layer for the highest manure rate was 71 kg ha^{-1} in 1999. At the medium-textured site, magnesium content in the top soil layer for the highest manure rate remained relatively consistent after 1996.

During the eight crop years, an average of 38 kg ha^{-1} y^{-1} of calcium was removed by the harvested portion of the test crop. Unfortunately, magnesium content was not measured in crop tissue. Based on the manure analysis summarized in Appendix 10, the average amount of total calcium added from manure ranged from 259 to 1552 kg ha^{-1} y^{-1}, depending on the manure application rate. About 23 percent of manure total calcium was in extractable form. The average amount of total magnesium added from manure ranged from 80 to 483 kg ha^{-1} y^{-1}, and the amount of extractable magnesium added ranged from 21 to 128 kg ha^{-1}y^{-1}. The amounts of calcium and magnesium measured in the soil did not reflect the quantities of calcium and magnesium added to the soil from manure application. This suggests that the saturated-paste method only extracted a small portion of calcium and magnesium from soil.

Extractable sodium. The application of manure clearly increased extractable sodium content in the top soil layer at both sites (Figs. 36 and 37). The effect was greater as the manure rate increased. Sodium content in the 120 Mg ha^{-1} manure treatment was more than four times greater than the control at both sites in 2001 (Table 19). Chang et al. (1991) reported increases in extractable sodium under irrigation in the 0 to 0.3-m soil layer after 11 annual applications of cattle manure. They observed even larger increases in the 0 to 0.3-m layer under nonirrigated conditions. Without the leaching action of irrigation water, sodium in the manure plots tended to remain in the upper soil profile (Chang et al. 1991; Hao and Chang 2002). The largest sodium content occurred at the 0.3 to 1.2-m layer under irrigation, and at the 0 to 0.6-m layer under nonirrigated conditions (Chang et al. 1991).

In a duplicate study (but of shorter duration) carried out in central Alberta, soluble sodium content (saturated-paste analysis) increased from more than three times to nearly six times in the 0 to 0.15-m layer after only two applications of manure at the 120 Mg ha^{-1} rate (Olson et al. 1997).

Table 18. Mean extractable magnesium (kg ha^{-1}) in the 0 to 0.15-m, 0.15 to 0.3-m, 0.3 to 0.6-m soil layers at the coarse- and medium-textured sites.

Layer	Coarse-textured site					Medium-textured site				
(m)	0 [z]	20	40	60	120	0	20	40	60	120
					1993					
0-0.15 [y]	21 a	22 a	18 a	21 a	23 a	21 a	21 a	26 a	32 a	25 a
0.15-0.3	12 a	14 a	12 a	12 a	13 a	13 a	18 a	32 a	19 a	18 a
0.3-0.6	14 a	15 a	15 a	15 a	14 a	45 a	87 a	132 a	95 a	170 a
					1994					
0-0.15 [y]	13 a	15 a	15 a	18 a	19 a	21 a	27 ab	25 ab	31 ab	40 b
0.15-0.3	8.4 a	8.6 a	8.3 a	11 a	14 a	17 a	35 a	32 a	36 a	43 a
0.3-0.6	20 a	14 a	15 a	19 a	25 a	68 a	205 a	146 a	239 a	213 a
					1995					
0-0.15	12 a	19 abc	16 ab	27 bc	32 c	19 a	23 a	24 a	30 a	33 a
0.15-0.3	5.9 a	8.7 ab	6.1 a	18 b	13 ab	15 a	36 a	26 a	44 a	36 a
0.3-0.6	11 a	19 a	19 a	50 b	66 b	94 a	235 a	182 a	268 a	248 a
					1996					
0-0.15	15 a	17 ab	20 ab	21 ab	28 b	21 a	26 ab	29 ab	32 ab	37 b
0.15-0.3	7.7 a	9.1 a	8.5 a	9.7 a	10 a	16 a	25 a	34 a	32 a	29 a
0.3-0.6	15 a	19 a	18 a	25 a	22 a	88 a	257 a	249 a	304 a	352 a
					1997					
0-0.15	13 a	18 ab	20 ab	27 b	44 c	28 a	44 ab	38 ab	52 bc	63 c
0.15-0.3	7.6 a	8.7 a	8.1 a	8.5 a	9.7 a	16 a	28 a	26 a	25 a	23 a
0.3-0.6	13 a	13 a	16 a	16 a	14 a	60 a	144 a	243 a	240 a	273 a
					1998					
0-0.15	17 a	22 a	32 b	36 b	62 c	28 a	33 ab	36 ab	45 b	63 c
0.15-0.3	7.4 a	8.3 a	9.2 a	10 a	13 a	17 a	44 a	35 a	44 a	43 a
0.3-0.6	11 a	13 a	14 a	19 a	21 a	66 a	243 a	211 a	292 a	340 a
					1999					
0-0.15	11 a	18 ab	25 bc	31 c	71 d	23 a	29 abc	42 bc	45 c	63 d
0.15-0.3	7.8 a	8.4 a	10 a	11 a	20 b	13 a	25 a	19 a	25 a	36 a
0.3-0.6	12 a	12 a	16 a	16 a	30 a	42 a	105 a	114 a	187 a	236 a
					2000					
0-0.15	14 a	19 ab	28 bc	39 c	59 d	24 a	35 ab	37 ab	43 b	65 c
0.15-0.3	9.8 a	14 a	16 a	23 b	41 c	12 a	22 a	44 a	33 a	51 a
0.3-0.6	14 a	18 a	27 a	46 b	91 c	36 a	244 a	291 a	264 a	251 a
					2001					
0-0.15	13 a	17 ab	20 ab	30 bc	42 c	21 a	32 ab	31 ab	46 bc	62 c
0.15-0.3	7.3 a	9.2 ab	10 ab	18 b	17 b	14 a	49 ab	32 a	88 b	61 ab
0.3-0.6	14 a	18 a	19 a	40 a	33 a	44 a	239 a	253 a	413 a	305 a

[z] Manure application rates (0, 20, 40, 60, and 120 Mg ha^{-1} y^{-1}) from 1993 to 2000.
[y] Mean values, for each soil layer per site per year, followed by the same letter are not significantly different (P<0.05). There were no significant differences below the 0.6-m soil depth.

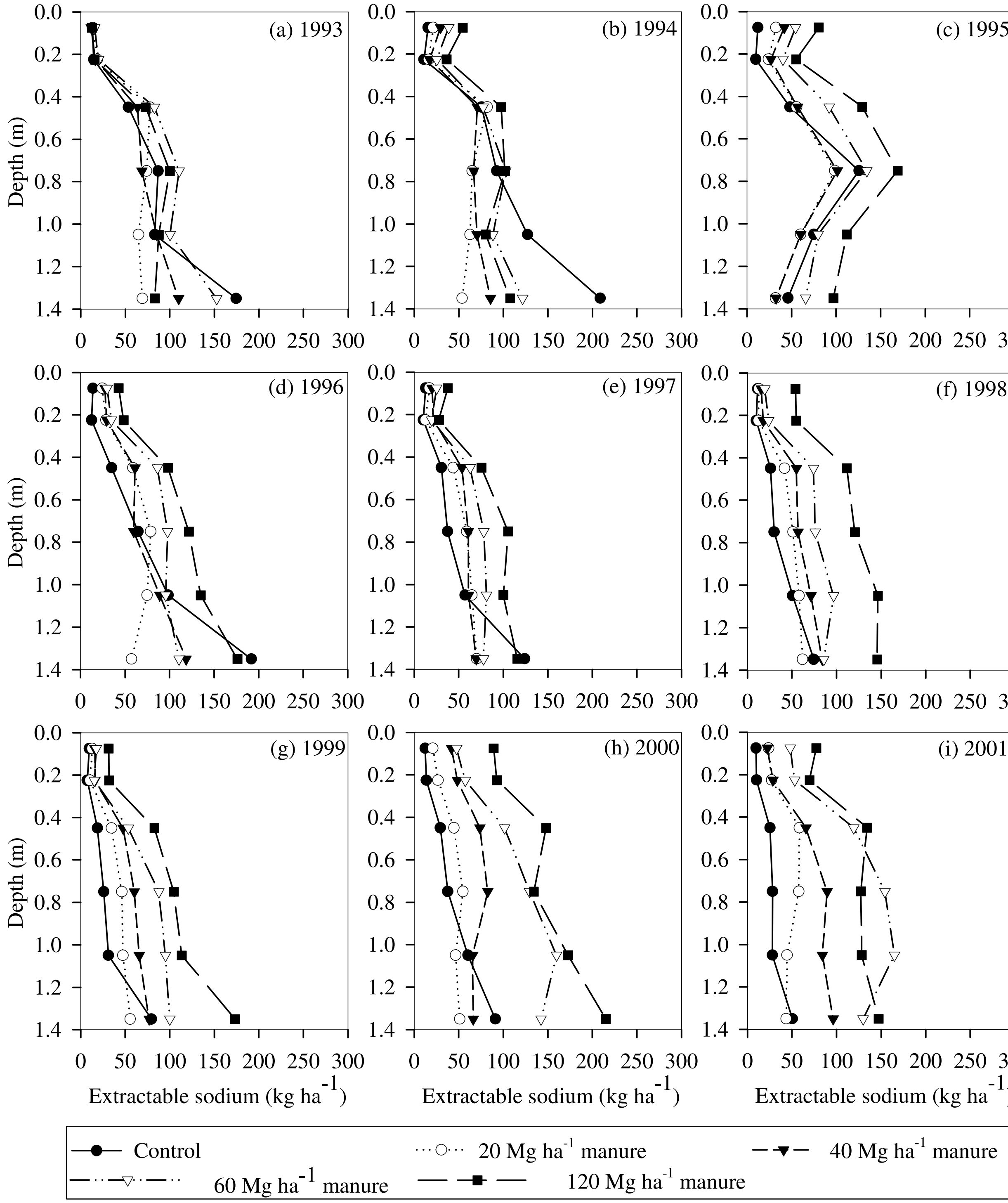


Fig. 36. Soil extractable sodium content of the control and manure treatments at the coarse-textured site.

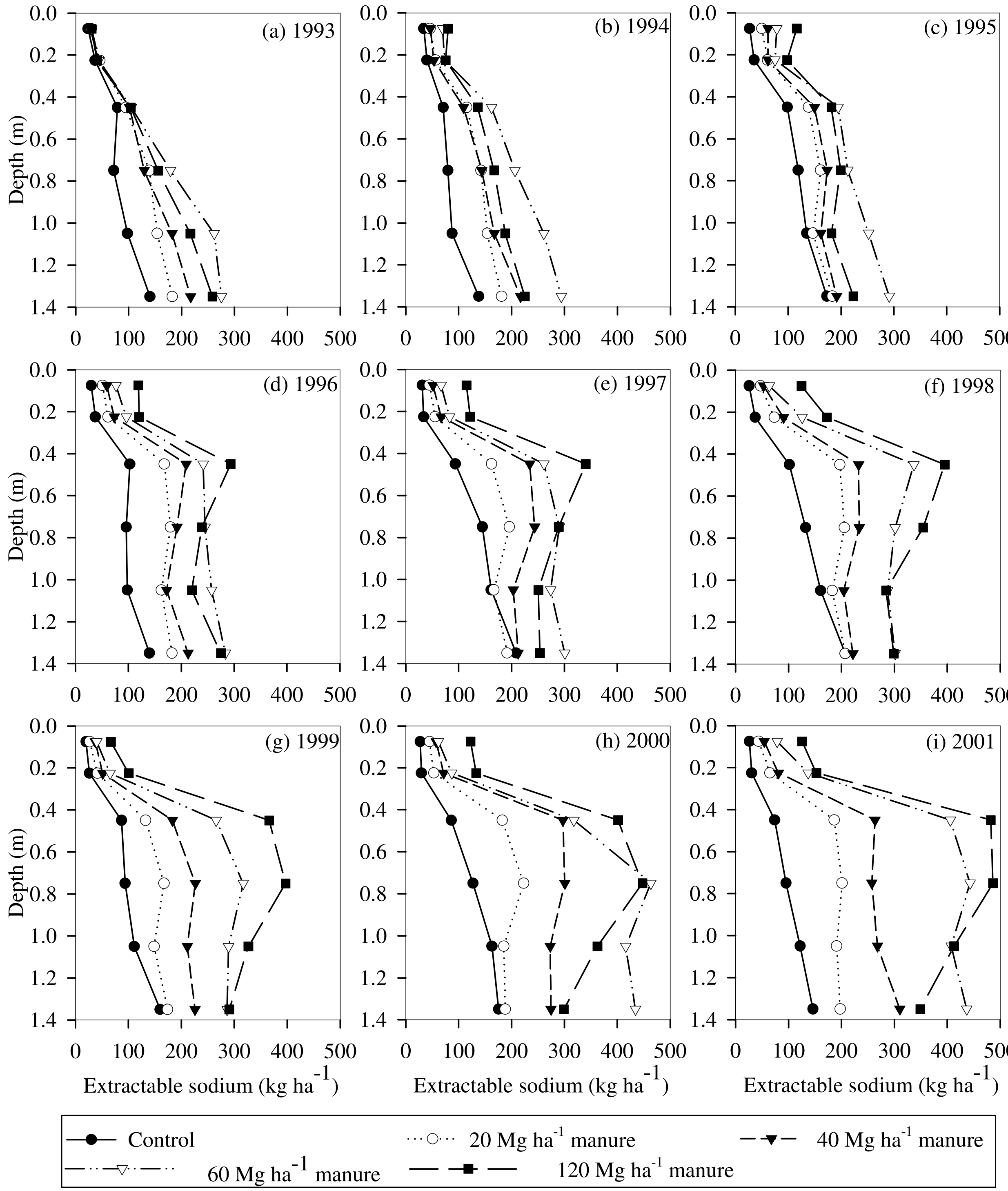


Fig. 37. Soil extractable sodium content of the control and manure treatments at the medium-textured site.

Table 19. Mean extractable sodium content (kg ha^{-1}) in the 0 to 1.5-m soil profile at the coarse- and medium-textured sites in 1993 (baseline) and 2001.

		Fertilizer-N rates (kg ha^{-1})			Manure rates (Mg ha^{-1})			
Year	Control	60	120	180	20	40	60	120
				Coarse-textured site				
1993[z]	426 a	305 a	293 a	303 a	318 a	356 a	482 a	372a
2001	152 a	130 a	132 a	124 a	255 a	387 a	670 b	684 b
				Medium-textured site				
1993	449 a	1026 a	585 a	747 a	646 a	701 a	896 a	806 a
2001	494 a	1188 a	700 a	868 a	885 ab	1235 ab	1909 b	2009 b

[z] Means within the same row followed by the same letter are not significantly different (P<0.05).

The influence of manure on sodium content lower in the soil profile was more difficult to determine in our study because of the initial high soil variability (Figs. 36a and 37a). Through chance by randomization, the plots that received the 60 and 120 Mg ha^{-1} manure treatments also had higher sodium levels in the lower soil profile than the plots that received the 20 and 40 Mg ha^{-1} manure treatments at both sites. However, the sodium content seemed to be higher for the 120 Mg ha^{-1} manure treatment throughout the soil profile at the coarse-textured site in 1998 (Fig. 36f), relative to 1997 (Fig. 36e). Some additional sodium may have cumulated in the lower soil profile at the medium-textured site (Fig. 37).

More sodium cumulated in the soil profile (0 to 1.5 m) at the medium-textured site than at the coarse-textured site (Figs. 36 and 37; Table 19). The amount of total sodium added by the four manure application rates during the eight-year period ranged from 359 to 2155 kg ha^{-1} at the coarse-textured site and from 378 to 2269 kg ha^{-1} at the medium-textured site. Sodium appeared to leach throughout the soil profile (0 to 1.5 m) at both sites. A small portion of the added sodium would have been taken up by the crop. The amount of extractable sodium measured in the soil at the coarse-textured site did not account for all of the total sodium in the applied manure. However, the amount measured in the soil compared to the amount added was reasonable close at the medium-textured site. At the coarse-textured site, much less than half of the added sodium remained in the soil profile by 2001. Therefore, most of the added sodium remained in the 0 to 1.5-m layer at the medium-textured site, whereas a substantial amount of sodium leached below the 1.5-m depth at the coarse-textured site. Sodium is one of the least held metallic ions in soil and is readily leached by water (Tisdale and Nelson 1975).

Cumulation of sodium in soil can lead to sodic conditions, which can result in soil dispersion and degradation of soil structure (Brady and Weil 2002). However, this may not necessarily occur if salt content in the soil is also increased (Tanji 1990). This is discussed further elsewhere in the report (pages 91 to 94).

There was no clear effect of residual manure on extractable sodium content after manure application was stopped. Sodium content decreased or increased with time (from 1999 to 2001), depending on the year and soil layer. This may reflect redistribution of previously cumulated sodium.

Extractable potassium. Manure application significantly increased extractable potassium at both sites (Figs. 38 and 39). Fertilizer-N had no effect on extractable potassium. The increase in potassium was greater as manure rate increased. Potassium from manure was primarily localized in the 0 to 0.15-cm layer at the medium-textured site (Fig. 39). Potassium content for the 120 Mg ha^{-1} manure treatment was significantly higher than the control in the 0.15 to 0.3-m soil layer after 1997. This was also true for the 60 Mg ha^{-1} manure treatment after 1999. The potassium content was 33 times greater than the control by 2001 in the 0 to 0.3-m soil layer at the medium-textured site.

Potassium in the 0 to 1.5-m soil layer increased linearly with the amount of cumulative manure total potassium added at both sites (Fig 40). For every megagram of manure total potassium added per hectare, soil extractable potassium increased by 106 kg ha^{-1} at the coarse-textured site, and by 62.2 kg ha^{-1}at the medium-textured site.

The effects of manure on extractable potassium extended deeper into the soil profile at the coarse-textured site (Fig. 38). The 120 Mg ha^{-1} manure treatment increased potassium content by three to 35 times in the 0 to 0.15-m layer relative to the control, depending on the year. Significant increases were also observed in the 0.15 to 0.3 and 0.3 to 0.6-cm soil layers by the fall of 1997, and in all soil layers down to 1.5 m by the fall of 2001. The different distribution of cumulated potassium reflects the difference in soil texture between the two sites.

Hao and Chang (2002) found that after 25 annual applications of cattle manure, at rates ranging from 30 to 180 Mg ha^{-1}, potassium became the dominant cation, compared to the control, which had calcium as the dominant cation. We observed the same effect with repeated manure application after eight years of annual manure application, particularly for the two highest application rates (Table 20).

The cumulation of sodium, and to a lesser extent, potassium in the soil exchange phase may cause soil degradation such as structure degradation and reduced hydraulic conductivity and infiltration (Hao and Chang 2002). Clay dispersion will increase with electrolyte cation in the order of calcium < magnesium < potassium < sodium (Rengasamy 1983). High levels of soil potassium can also result in high concentration of potassium in forage crops, and when fed to cattle, may cause grass tetany, which is a disorder caused by an imbalance between potassium and magnesium/calcium cations (Ollis 1987).

Extractable chloride. Baseline extractable chloride content was low in the top 0.6 m and then increased with depth at the coarse-textured site in 1993 (Fig. 41a). This supports the nitrate-N and orthophosphate-P data that this site had received manure application prior to the start of the study. Baseline chloride content was low throughout the soil profile at the medium-textured site prior to treatment application in 1993 (Fig. 42a).

Chloride content increased significantly in the upper soil profile (top 0.3 to 0.6 m) at both sites after only the first application of manure (Figs. 41b and 42b; Appendix 12, Tables 12.17 and 12.18). Repeated annual applications of manure continued to increase soil chloride content at the medium-textured site, with the development of a chloride bulge in the 0.3 to 1-m layer (Fig.

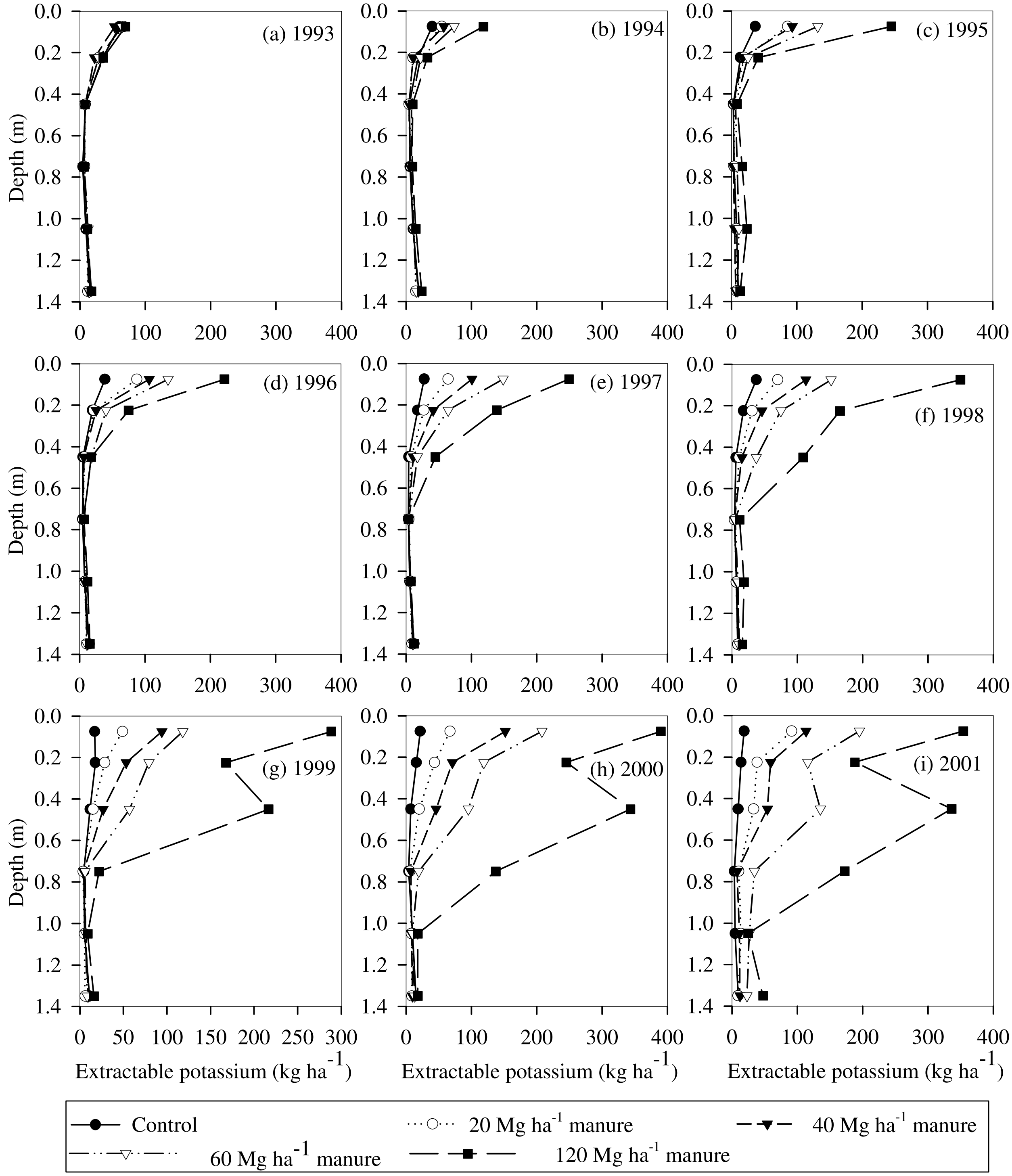


Fig. 38. Soil extractable potassium content of the control and manure treatments at the coarse-textured site.

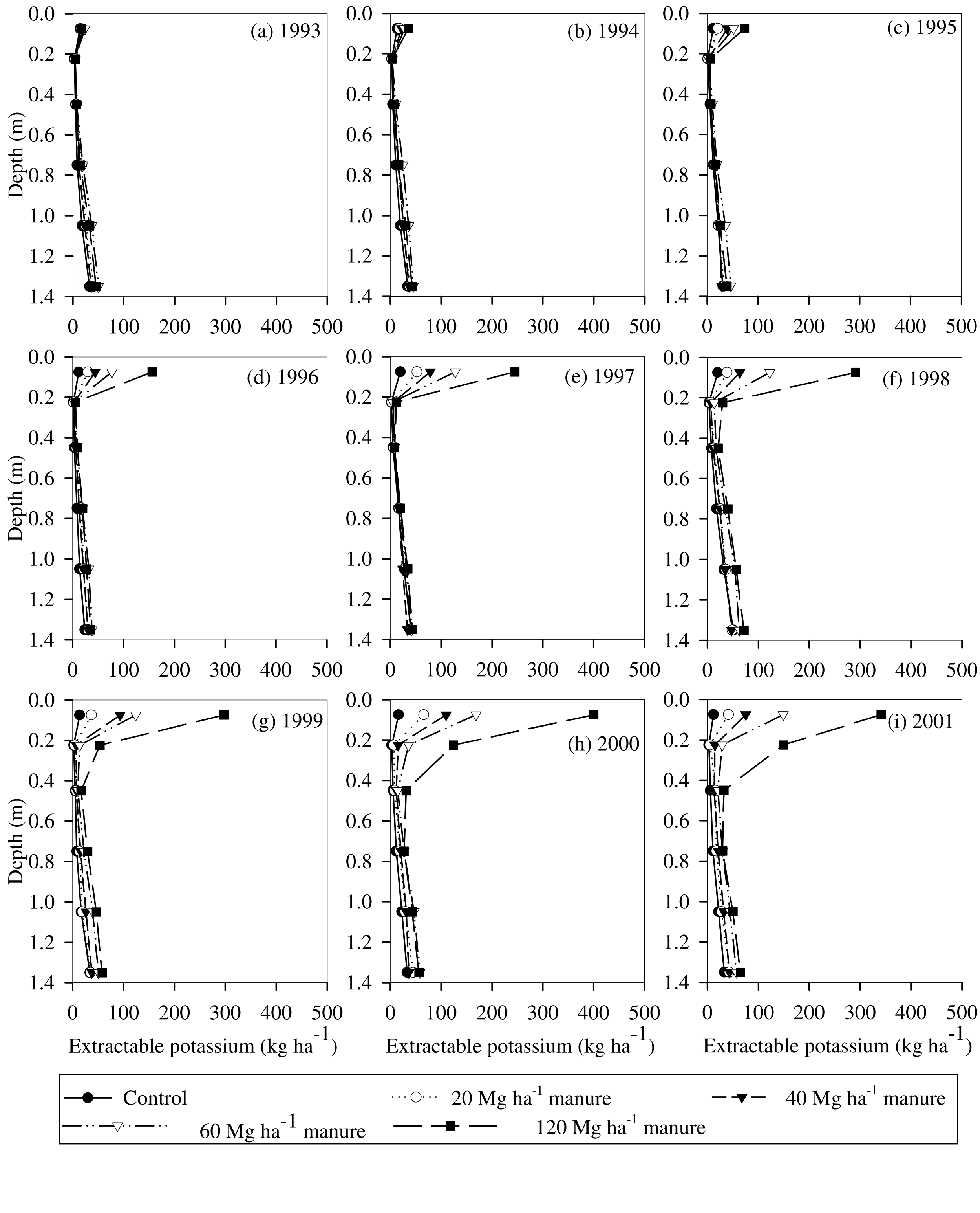


Fig. 39. Soil extractable potassium content of the control and manure treatments at the medium-textured site.

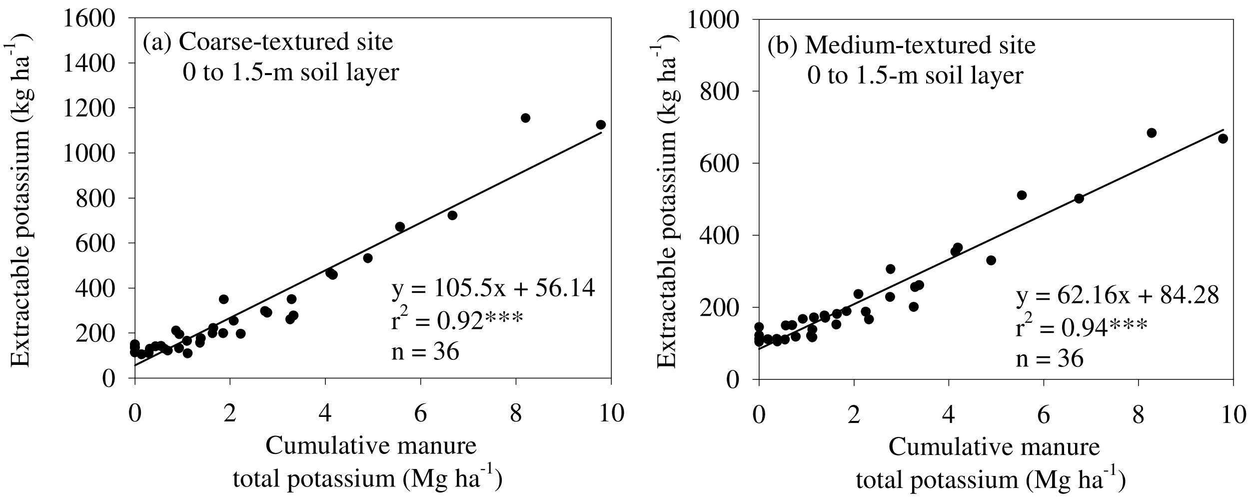


Fig. 40. Extractable potassium content in soil versus added cumulative manure total potassium at the (a) coarse- and (b) medium-textured sites. Triple asterisks indicates significance at P<0.001.

Table 20. Saturated-paste extractable cations in the top soil layer (0 to 0.15 m) after eight years of annual manure application.

Manure rate ($Mg\ ha^{-1}\ y^{-1}$)	Sodium ($kg\ ha^{-1}$)	Potassium ($kg\ ha^{-1}$)	Magnesium ($kg\ ha^{-1}$)	Calcium ($kg\ ha^{-1}$)
		Coarse-textured site		
0	9.6	19	13	58
20	24	92	17	58
40	23	113	20	61
60	48	195	30	77
120	77	354	42	84
		Medium-textured site		
0	26	12	21	115
20	44	41	32	135
40	54	75	31	130
60	78	149	46	146
120	126	341	62	128

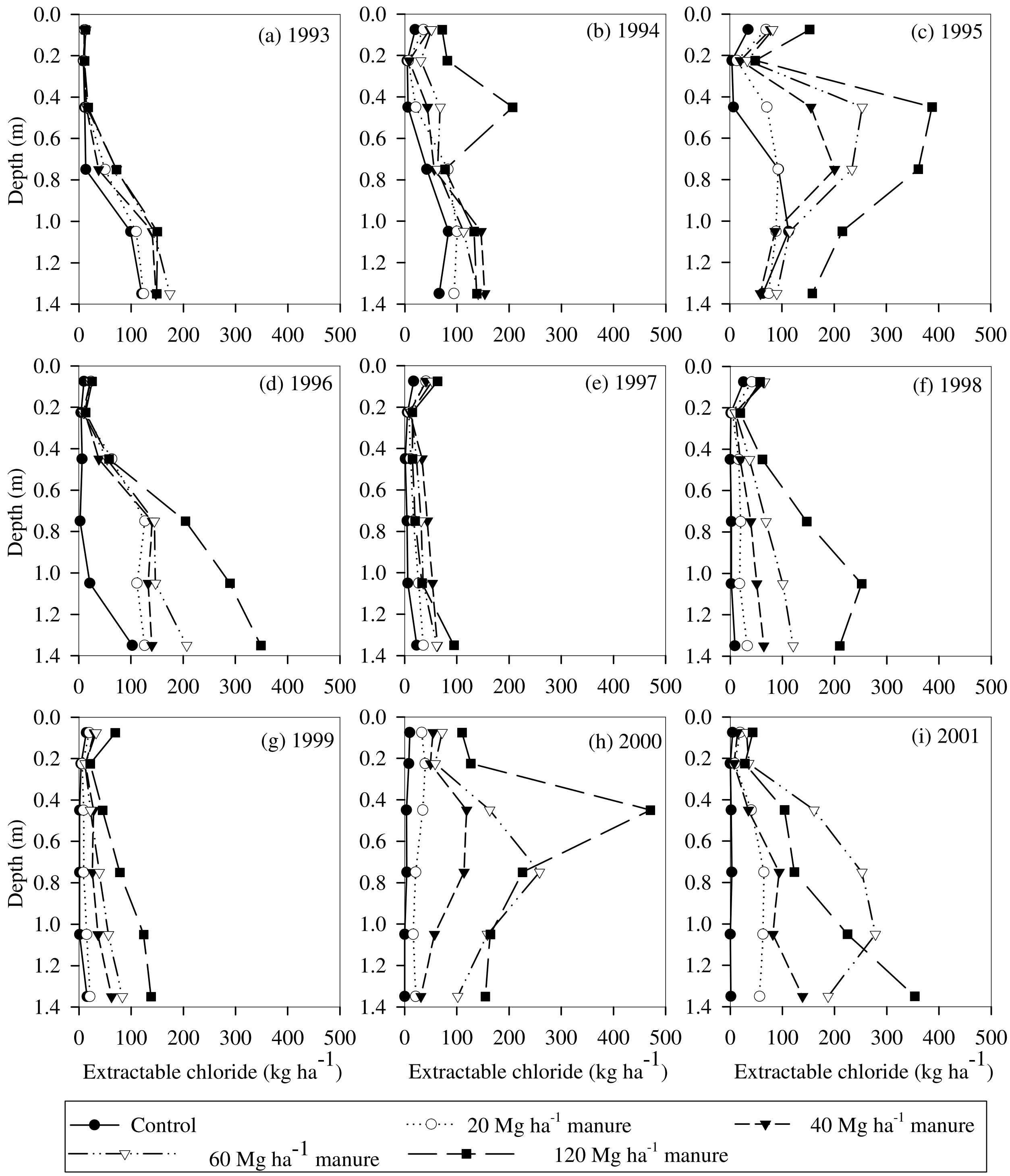


Fig. 41. Soil extractable chloride content of the control and manure treatments at the coarse-textured site.

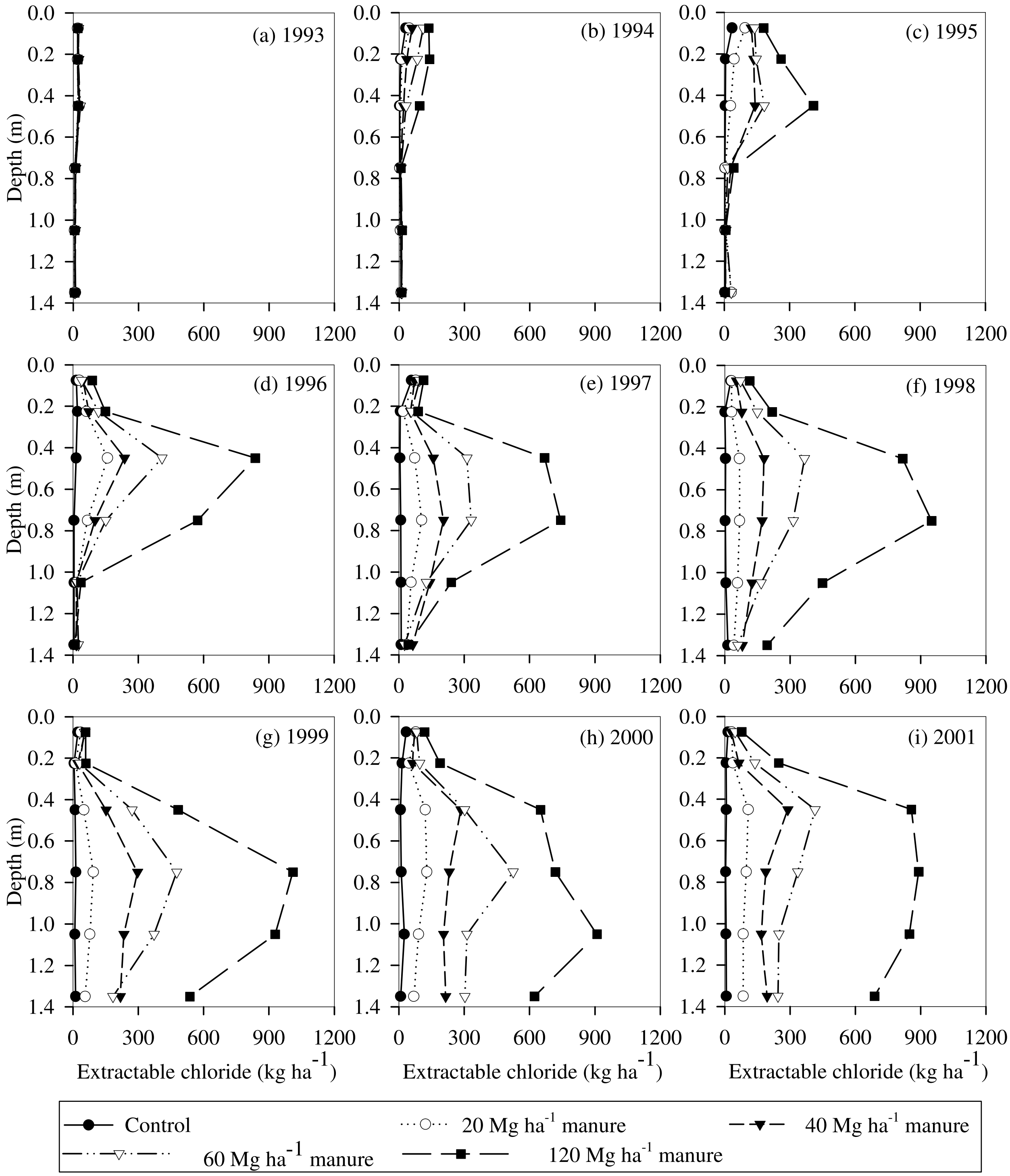


Fig. 42. Soil extractable chloride content of the control and manure treatments at the medium-textured site.

42d-f). The lower leading edge of the chloride bulge moved about 25 to 30 cm per year from 1995 to 1998 (Fig. 42c-f). This is a similar rate observed for nitrate-N under the 120 Mg ha^{-1} manure treatment at this site. The leading edge of the chloride bulge moved below the depth of measurement (1.5 m) by 1999.

Chloride content also continued to increase with repeated applications of manure at the coarse-textured site in 1995 and 1996. However, the movement and distribution of cumulated chloride was different from the medium-textured site. Similar chloride bulges were observed at the coarse-textured site in 1995 (Fig. 41c). Most of the cumulated chloride moved to the lower half of the soil profile (0.5 to 1.5 m) by the fall of 1996 (Fig. 41d), and most of the cumulated chloride had leached below the 1.5-m depth by the fall of 1997. A similar change in the soil nitrate-N distribution was observed at the coarse-textured site (Fig. 10). Then in 1998 to 2001, chloride content increased in the lower soil profile with the application of manure.

The difference in movement and distribution of chloride between the two sites may be explained by soil texture and the application of water. Very little irrigation was carried out at either site in 1995 (Tables 1 and 2). About 350 mm of irrigation water were applied at the coarse-textured site in 1996 and 1997. These irrigation events (plus rainfall) may have readily leached the chloride below 1.5 m in the loamy-sand soil profile. Less irrigation water was generally applied at the medium-textured site. As a result, and because of the loam to clay-loam texture, chloride leached more slowly at the medium-textured site. These data suggest that net leaching occurred below the 1.5-m depth at the coarse-textured site in 1996, 1997, and 1998, but not at the medium-textured site. After 1998, net leaching of chloride below 1.5 m occurred at the medium-textured site (Fig. 42).

Chloride content in the 1.5-m soil layer at both sites from 1993 to 2001 is summarized in Table 21. The fertilizer-N treatments had no effect on soil chloride. Even though the 20 Mg ha^{-1} manure treatment always contained more chloride than the control after 1993, this treatment was not statistically significant from the control. There were treatment-by-year interactions at both sites (Appendix 12, Tables 12.17 and 12.18). For example, there were no significant differences among the treatments in 1997 at the coarse-textured site or in 1994 at the medium-textured site.

Chang et al. (1991) found that after 11 annual manure applications, chloride had moved to at least 1.5 m in the soil profile under nonirrigated and irrigated conditions in southern Alberta. They stated that chloride is not biologically or chemically active in the soil, and chloride from manure can be used as a tracer for net leaching.

After manure application was discontinued, the chloride content in the soil profile generally decreased in the residual-manure subplots at both sites (Table 22). Chloride content was lowest in 2001 and was often significantly lower than the 1999 and/or 2000 values. The chloride content in 1999 and 2000 were not significantly different. There was a significant decrease in chloride content from 1999 to 2001 for the highest manure-rate treatment at both sites. Chloride content was reduced 74 percent at the coarse-textured site and by 33 percent at the medium-textured site, during the two-year period. The greater reduction at the coarse-textured site was probably due to the higher leaching potential.

Table 21. Mean extractable chloride content (kg ha^{-1}) in the 0 to 1.5-m soil profile at the coarse- and medium-textured sites from 1993 to 2001.

		Fertilizer-N rates (kg ha^{-1})			Manure rates (Mg ha^{-1})			
Year	Control	60	120	180	20	40	60	120
				Coarse-textured site				
1993[z]	262a	442a	373a	417a	316a	358a	427a	411a
1994	223a	306a	269a	250a	341ab	456ab	466ab	708b
1995	317ab	323ab	275ab	188a	410ab	601bc	809c	1325d
1996	147abc	124abc	88ab	76a	462bcd	486cd	584de	940e
1997	58a	39a	27a	50a	140a	244a	217a	242a
1998	41ab	11a	16a	15a	133ab	247ab	404bc	747c
1999	37a	14a	27a	24a	80a	195ab	247ab	478b
2000	26a	28a	26a	20a	166ab	425b	812c	1253d
2001	11a	6.2a	19a	12a	252a	371a	877b	947b
				Medium-textured site				
1993	99a	93a	90a	114a	85a	109a	110a	92a
1994	61a	49a	50a	53a	87a	146a	259a	408a
1995	55a	56a	50a	70ab	214ab	446abc	527bc	907c
1996	69a	48a	45a	46a	354ab	493ab	766b	1698c
1997	98a	40a	64a	42a	366ab	694bc	950c	1899d
1998	56a	28a	32a	12a	301ab	694bc	1133c	2746d
1999	72a	61a	28a	26a	326a	981b	1387b	3077c
2000	99a	67a	78a	51a	533a	1072b	1621c	3209d
2001	48a	26a	25a	40a	448a	938b	1432c	3614d

[z] Mean values within the same row not followed by the same letter are significantly different (P<0.05).

Table 22. Changes in soil (0 to 1.5 m) extractable chloride content in the residual-manure subplots after manure application was discontinued.

	Coarse-textured site				Medium-textured site			
Year	20 [z]	40	60	120	20	40	60	120
	-------	-------	-------	------- kg ha^{-1} -------	-------	-------	-------	-------
1999 [y]	100 a	252 ab	252 a	493 b	346 a	1008 b	1341 b	3005 b
2000	177 a	408 b	132 a	334 ab	382 a	817 ab	1372 b	2737 b
2001	64 a	109 a	109 a	126 a	253 a	479 a	755 a	2003 a

[z] Residual-manure subplot treatments, which received annual application (20, 40, 60, and 120 Mg ha^{-1} y^{-1}) from 1993 to 1998. Manure application was discontinued after 1998 (i.e. no manure applied in 1999 and 2000).
[y] Means within the three-year period, for each residual-manure rate and site, followed by the same letter are not significantly different (P<0.05).

Extractable sulphate-S. Baseline (1993) extractable sulphate-S content was generally low in the 0 to 0.15-m soil layer and increased with depth at both sites. The increase in sulphate-S content with depth was much greater at the medium-textured site than at the coarse-textured site. Sulphate-S content increased from 26 kg ha^{-1} (standard error = 2) in the 0 to 0.15-m layer to 131 kg ha^{-1} (S.E. = 35) in the 1.2 to 1.5-m layer at the coarse-textured site. The increase of sulphate-S content with depth at the medium-textured site was from 61 kg ha^{-1} (S.E. = 10) in the top soil layer to 1885 kg ha^{-1} (S.E. = 133) in the bottom soil layer.

Manure and the fertilizer-N treatments had no effect on sulphate-S content at the medium-textured site. Sulphate-S content in the 0 to 0.15-m soil layer for the 120 Mg ha^{-1} manure treatment was significantly higher compared to the control in 1995, 1996, 1997, 1998 and 1999 at the coarse-textured site (Table 23). None of the other manure application rates were significantly different from the control. Differences were also observed in the 0.15 to 0.3-m and 0.3 to 0.6-m layers. The sulphate-S content only increased slightly in the top soil layer under the 120 Mg ha^{-1} manure rate after six annual applications. Sulphate-S content generally decreased with time in the control and the three fertilizer-N treatments (Table 23). There was a significant year effect for the control, 60 kg ha^{-1} fertilizer-N, and 120 Mg ha^{-1}manure treatments (Appendix 12, Table 12.19). Considering the initial sulphate-S in the soil, soil variability, and the lack of significant differences at the medium-textured site, we believe the application of manure in this study had little effect on extractable soil sulphate-S content. Chang et al. (1991) concluded that the effect of repeated annual manure application (11 years) on soluble sulphate in soil was smaller than for other measured parameters. Warman and Cooper (2000) observed few significant differences in soil extractable sulphate-S among treatments, which included the application of fresh and composted chicken manure. Eriksen and Mortensen (1999) also concluded that residual sulphur from long-term annual application of manure did not significantly affect the level of soil extractable sulphate-S.

Soil samples were not analysed for extractable sulphate-S after 1999 because of the minimal treatment effects that were observed and to save on laboratory analytical costs and time.

Table 23. Mean extractable sulphate-S content (kg ha^{-1}) in the 0 to 0.15-m soil profile at the coarse-textured site from 1993 to 1999.

Year	Control	Fertilizer-N rates (kg ha^{-1})			Manure rates (Mg ha^{-1})			
		60	120	180	20	40	60	120
1993^{z}	29 ab	26 ab	19 a	20 a	24 ab	20 a	27 ab	39 b
1994	18 ab	15 a	14 a	11 a	12 a	21 ab	25 ab	34 b
1995	9.2 a	17 a	7.6 a	15 a	16 a	17 a	24 ab	41 b
1996	9.4 a	14 a	12 a	11 a	17 a	20 a	22 a	42 b
1997	20 a	25 a	25 a	24 a	26 a	29 a	35 a	57 b
1998	13 a	12 a	12 a	12 a	15 a	21 a	24 a	67 b
1999	8.8 a	11 a	12 a	14 a	18 a	23 a	25 a	58 b

^{z} Mean values within the same row followed by the same letter are not significantly different ($P<0.05$).

Extractable bicarbonate. Soil samples were analysed for extractable bicarbonate only from 1993 to 1999. Fertilizer-N had no effect on soil bicarbonate content. Bicarbonate content increased with manure rate, and this increase was most apparent in the 0 to 0.15-m soil layer (Table 24). Bicarbonate content in the 120 Mg ha^{-1} manure treatment was 2.8 times greater than the control at the coarse-textured site and 2.5 times greater than the control at the medium-textured site after six annual applications. The 60 Mg ha^{-1} manure treatment in 1996, 1998, and 1999 and the 120 Mg ha^{-1} manure treatment in 1996 to 1999 had significantly higher extractable bicarbonate than the control treatment in the 0.15 to 0.3-m layer at the coarse-textured site. This effect extended to the 0.3 to 0.6-m layer for the 120 Mg ha^{-1} manure treatment in 1999 at the coarse-textured site.

There were some statistically significant differences in soil layers below the 0.15-m depth at the medium-textured site, but results did not make sense in terms of increasing bicarbonate content with increasing manure application rate. For example, in 1997 the bicarbonate content in the 0.3 to 0.6-m soil layer was lowest in the 120 Mg ha^{-1} manure treatment (297 kg ha^{-1} bicarbonate) and highest in the control treatment (426 kg ha^{-1} bicarbonate).

Table 24. Mean extractable bicarbonate content (kg ha^{-1}) in the 0 to 0.15-m soil layer at the coarse- and medium-textured sites from 1993 to 1999.

		Fertilizer-N rates (kg ha^{-1})			Manure rates (Mg ha^{-1})			
Year	Control	60	120	180	20	40	60	120
				Coarse-textured site				
1993^{z}	310 a	340 a	295 a	279 a	305 a	284 a	344 a	316 a
1994	102 a	96 a	102 a	95 a	106 a	116 a	131 a	138 a
1995	202 a	229 ab	227 ab	194 a	251 ab	269 ab	316 bc	402 c
1996	310 ab	283 a	293 ab	287 ab	328 ab	388 bc	432 c	536 d
1997	219 ab	231 ab	201 a	195 a	254 ab	311 bc	390 c	493 d
1998	284 ab	251 a	246 a	242 a	310 ab	355 b	363 b	551 c
1999	214 a	224 a	233 a	246 a	276 ab	363 bc	399 c	608 d
				Medium-textured site				
1993	384 a	359 a	384 a	395 a	379 a	388 a	417 a	415 a
1994	137 a	149 a	136 a	137 a	151 a	149 a	161 a	191 a
1995	283 ab	274 a	332 ab	311 ab	323 ab	373 abc	401 bc	484 c
1996	385 a	388 a	358 a	370 a	460 ab	475 ab	559 b	692 c
1997	464 a	546 ab	514 ab	546 ab	561 ab	628 bc	718 c	924 d
1998	501 a	506 a	448 a	449 a	534 a	558 a	709 b	848 c
1999	339 a	341 a	349 a	333 a	434 ab	552 bc	619 c	835 d

^{z} Mean values within the same row followed by the same letter are not significantly different (P<0.05).

Sodium adsorption ratio. Sodium adsorption ratio (SAR) was lowest in the 0 to 0.15-m soil layer at both sites at the start of the study in 1993. The mean SAR value in the surface soil layer was 0.35 (standard error = 0.02) at the coarse-textured site and 0.58 (S.E. = 0.03) at the medium-textured site. Sodium adsorption ratio increased to 1.6 in the 0.6 to 0.9-m layer and then decreased to 1.1 in the 1.2 to 1.5-m layer at the coarse-textured site. At the medium-textured site, the SAR was near 1.0 in the soil profile below the 0.15-m depth.

The fertilizer-N treatments had no effect on SAR at either site. Sodium adsorption ratio was increased with the addition of manure at both sites (Figs. 43 and 44). After only one manure application, significant increases occurred in the 0 to 0.6-m layer at both sites (Figs. 43b and 44b). The increase in SAR was extended throughout the soil profile at the coarse-textured site by 2000. In 1997 and 1999, there were no treatment differences in the top soil layer at the coarse-textured site. Possibly, the sodium was leached from this soil layer to deeper layers.

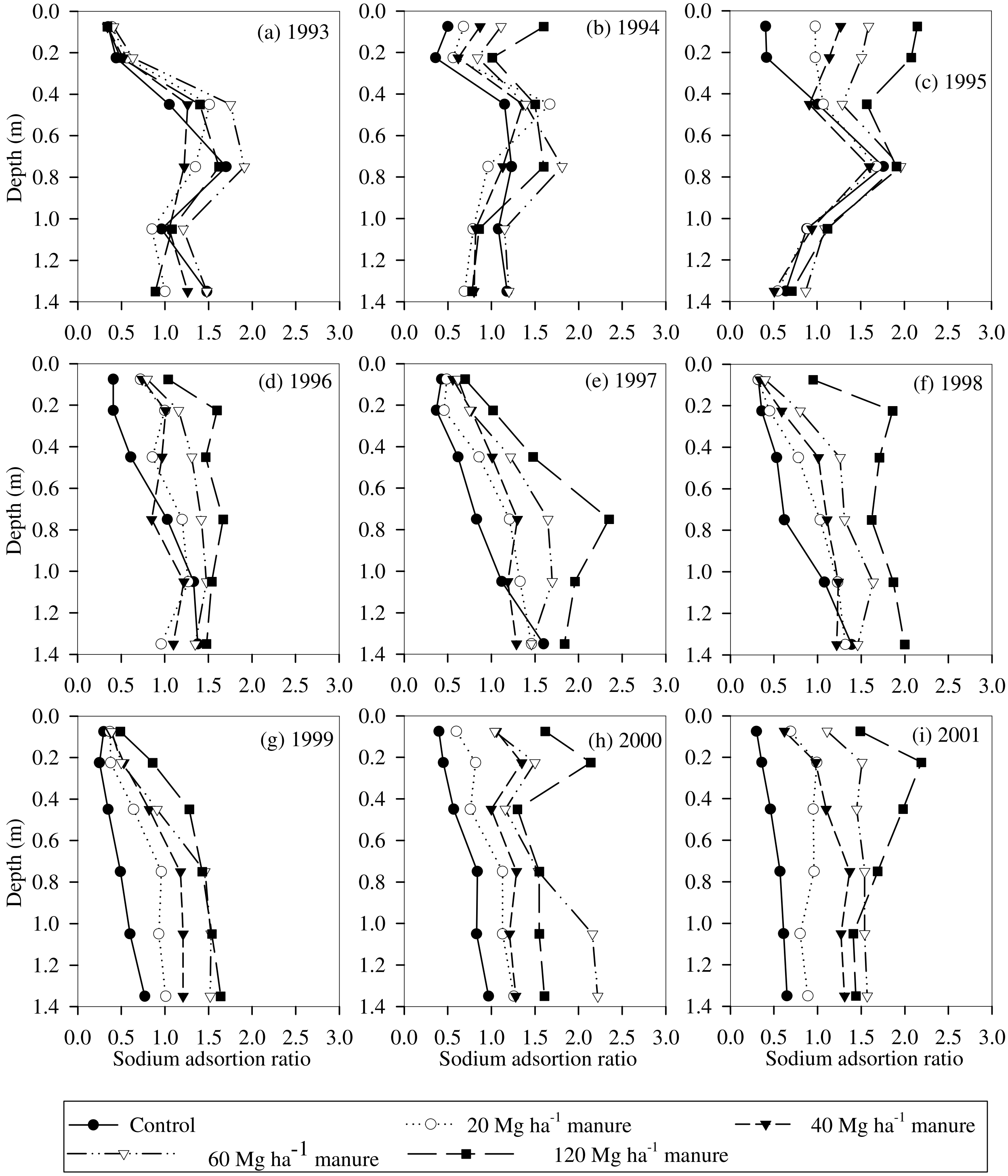


Fig. 43. Soil sodium adsorption ratio for the control and manure treatments at the coarse-textured site.

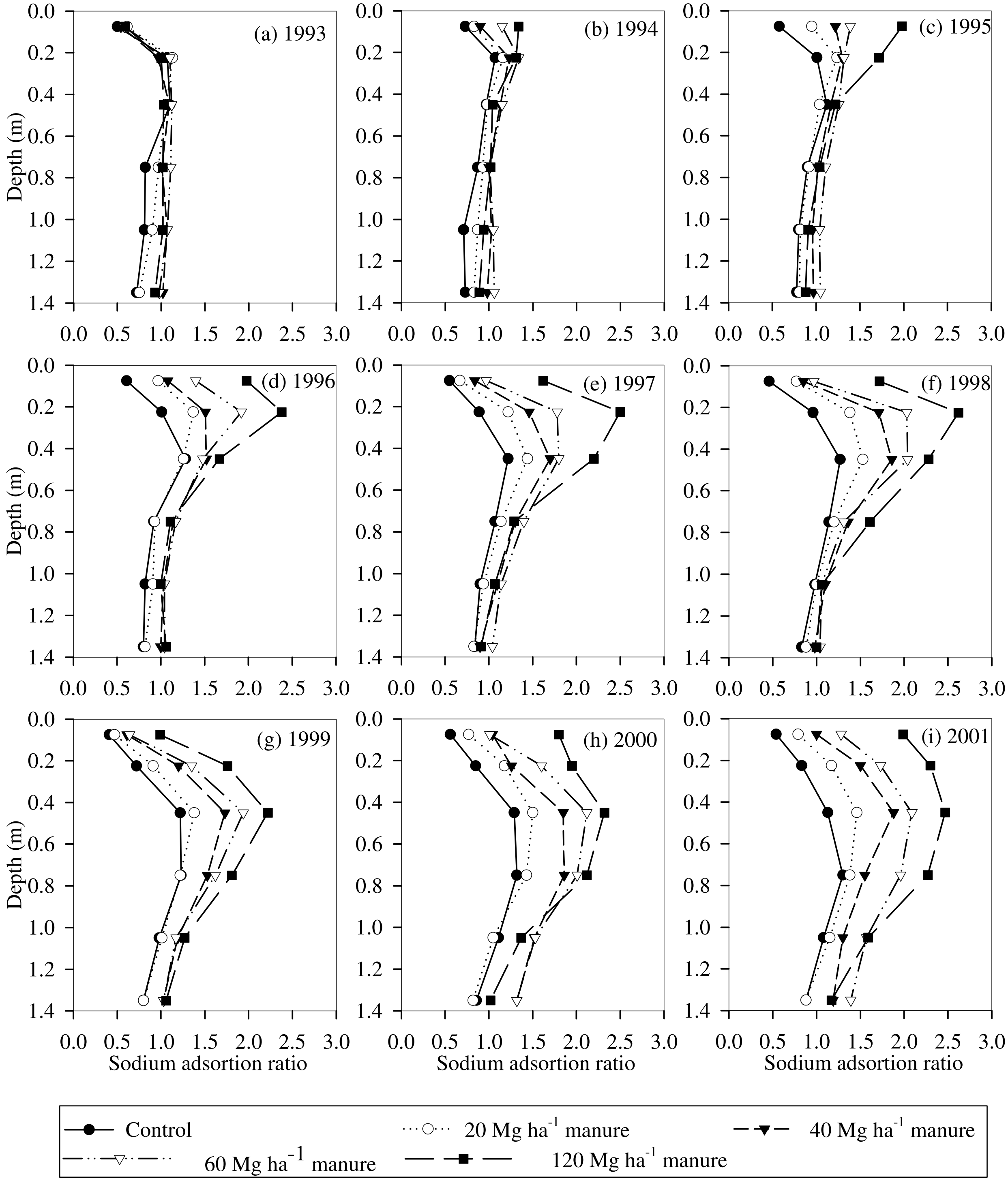


Fig. 44. Soil sodium adsorption ratio for the control and manure treatments at the medium-textured site.

The effect of manure on SAR at the medium-textured site was similar, but did not extend as deep into the soil profile by the end of the study. The maximum SAR values occurred in the 0.15 to 0.3-m layer from 1996 to 1998 (Fig. 44d-f). The maximum values were observed in the 0.3 to 0.6-m layer from 1999 to 2001 (Fig. 44g-i). The leaching action of sodium was slower at the medium-textured site.

The SAR data support the previously discussed results of extractable sodium, calcium, and magnesium. There was minimal effect of manure application on extractable calcium and magnesium content in soil, whereas extractable sodium content was clearly increased with the application of manure. The largest SAR mean value observed during the study was 2.62 for the 120 Mg ha^{-1} treatment, in the 0.15 to 0.3-m soil layer at the medium-textured site. This value was well below an SAR value of 13, which is required for a soil to be classified as either sodic or saline-sodic (Brady and Weil 2002). An increase in soil sodicity by manure application may result in degradation of soil structure. However, this may not necessarily occur if salt content in the soil is also increased (Tanji 1990). Structure stability of soil depends on many factors, including salinity, sodicity, tillage, mineralogy, organic matter, and pH (Tanji 1990).

Sodium adsorption ratio decreased in the 0 to 0.15-m and 0.15 to 0.3-m layers after manure application was discontinued in the residual-manure subplots at both sites. Significant decreases were observed only for the 120 Mg ha^{-1} residual-manure treatment. The surface soil SAR at the coarse-textured site decreased from 0.52 in 1999 to 0.34 in 2001, through the decrease was not statistically significant. However, the surface soil SAR at the medium-textured site was significantly reduced from 1.02 in 1999 to 0.64 in 2001.

Soil pH. The average surface (0 to 0.15-m) soil pH in 1993 was 7.24 at the coarse-textured site and 7.70 at the medium-textured site. Soil pH increased slightly with depth at both sites. The maximum pH measured at the coarse-textured site was 7.80 in the 1.2 to 1.5-m layer. The maximum pH measured at the medium-textured site was 7.96 in the 0.9 to 1.2-m layer.

No significant treatment effect on pH was observed at the coarse-textured site (Appendix 12, Table 12.25). However, manure application at the medium-textured site caused a slight decrease in soil pH. There was little to no significant effect in 1994 to 1999. Often only the 120 Mg ha^{-1} manure treatment was significantly lower than the control and the other three manure rates were not different from the control. The fertilizer-N treatments had no effect on soil pH. Significant differences were observed to a depth of 1.2 m in 2001 (Table 25).

Chang et al. (1991) reported a decrease in soil pH after 11 years of annual manure application in southern Alberta. They attributed the decrease in pH to nitrification of ammonium-N and organic acid production during manure decomposition. Chang et al. (1991) also pointed out that their findings contradicted results reported by Smith et al. (1980) in Texas. Manure has a good buffering capacity, and manure can increase or decrease soil pH, depending on the initial soil pH relative to the manure pH (Chi Chang, personal communication). Zebarth et al. (1999) also suggested that soil pH can either increase or decrease depending on the initial pH of organic amendments. In our study, the baseline (1993) average surface soil pH (0 to 0.15 m) of the coarse- and medium-textured sites was 7.2 and 7.7, respectively. The eight-year (1993 to 2000) average pH of the manure used in the study was 7.7 (Appendix 10). The soil pH in the study by

Table 25. Mean soil pH at the medium-textured site in 2000 and 2001.

Layer		Fertilizer-N rates (kg ha^{-1})			Manure rates (Mg ha^{-1})			
(m)	Control	60	120	180	20	40	60	120
				2000^{z}				
0-0.15	7.36 ab	7.44 b	7.36 ab	7.42 ab	7.24 ab	7.32 ab	7.20 ab	7.16 a
0.15-0.3	7.48 a	7.60 a	7.50 a	7.54 a	7.44 a	7.52 a	7.40 a	7.36 a
0.3-0.6	7.64 b	7.64 b	7.64 b	7.58 b	7.54 ab	7.62 b	7.50 ab	7.32 a
0.6-0.9	7.72 ab	7.80 b	7.72 ab	7.66 ab	7.66 ab	7.74 ab	7.58 ab	7.50 a
0.9-1.2	7.74 a	7.74 a	7.70 a	7.78 a	7.68 a	7.82 a	7.64 a	7.58 a
1.2-1.5	7.66 a	7.72 a	7.58 a	7.74 a	7.54 a	7.80 a	7.62 a	7.64 a
				2001				
0-0.15	7.40 b	7.32 b	7.40 b	7.40 b	7.38 b	7.32 b	7.26 ab	7.04 a
0.15-0.3	7.58 c	7.48 bc	7.52 bc	7.48 bc	7.60 c	7.50 bc	7.32 ab	7.18 a
0.3-0.6	7.72 c	7.46 b	7.58 bc	7.54 bc	7.64 bc	7.48 bc	7.40 ab	7.16 a
0.6-0.9	7.80 b	7.64 ab	7.66 ab	7.62 ab	7.78 b	7.66 ab	7.60 ab	7.38 a
0.9-1.2	7.76 b	7.62 ab	7.64 ab	7.72 ab	7.76 b	7.72 ab	7.66 ab	7.42 a
1.2-1.5	7.62 a	7.58 a	7.60 a	7.64 a	7.70 a	7.68 a	7.60 a	7.42 a

^{z} Means within the same row (soil layer) followed by the same letter are not significantly different ($P<0.05$).

Chang et al. (1991) was about 7.8 for the control, whereas manure pH averaged 7.2. Therefore, we should have expected the pH at the coarse-textured site to have increased slightly, with no change at the medium-textured site. However, this is not what we observed.

King et al. (1985) applied swine lagoon effluent at rates to deliver 335, 670, and 1340 kg ha^{-1} y^{-1} nitrogen for six years and found that the added effluent deceased soil pH. They attributed the decrease in pH to the loss of calcium and magnesium from the top soil layer. In a greenhouse study, Whalen et al. (2002) found that fresh cattle manure can effectively increase the pH of an acidic soil (initial pH = 4.8) and improve the growth of canola and wheat.

Electrical conductivity. Baseline (1993) soil electrical conductivity at the coarse-textured site was 0.90 dS m^{-1} in the top soil layer and decreased to 0.58 dS m^{-1} in the 0.3 to 0.6-m layer, and then increased to 1.58 dS m^{-1} in the bottom layer. Electrical conductivity increased with depth at the medium-textured site from 0.77 dS m^{-1} in the 0 to 0.15-m layer to 3.27 in the 1.2 to 1.5 layer. Soil electrical conductivity was more variable with depth at both sites, and the medium-textured site was more variable than the coarse-textured site.

Soil electrical conductivity was significantly increased in the 0 to 0.15-m layer by eight years of manure application at both sites (Table 26). Even though the 20 and 40 Mg ha^{-1}manure treatments had higher electrical conductivity values than the control and fertilizer-N treatments, they were not significantly different from the control. The fertilizer-N treatments did not affect soil electrical conductivity at either site.

Soil electrical conductivity was also affected by manure application with depth at both sites. After one application of manure, electrical conductivity was significantly increased to the 0.6-m depth at the coarse-textured site (Fig. 45b). The 120 Mg ha^{-1} manure treatment was significantly higher than the control to a depth of 1.2 m in 1995. However, differences were only observed in

Table 26. Mean soil electrical conductivity (dS m^{-1}) at the coarse- and medium-textured sites in 2001, after eight years of manure application.

Layer		Fertilizer-N rates (kg ha^{-1})			Manure rates (Mg ha^{-1})			
(m)	Control	60	120	180	20	40	60	120
				Coarse-textured site [z]				
0-0.15	0.44 ab	0.47 ab	0.39 a	0.45 ab	0.68 ab	0.72 b	1.06 c	1.35 d
0.15-0.3	0.34 a	0.37 a	0.35 a	0.37 a	0.49 a	0.50 a	0.90 b	1.05 b
0.3-0.6	0.37 a	0.38 a	0.39 a	0.45 a	0.55 a	0.59 a	1.13 b	1.23 b
0.6-0.9	0.35 a	0.37 a	0.44 a	0.46 a	0.62 a	0.76 ab	1.49 bc	1.36 c
0.9-1.2	0.37 a	0.43 a	0.45 a	0.52 a	0.62 a	0.86 ab	1.56 b	1.69 b
1.2-1.5	0.97 ab	0.47 a	0.47 a	0.54 a	0.59 a	1.02 ab	1.24 ab	1.97 b
				Medium-textured site				
0-0.15	0.63 a	0.82 a	0.60 a	0.64 a	0.85 ab	0.93 ab	1.21 b	1.65 c
0.15-0.3	0.49 a	0.84 a	0.78 a	0.87 a	1.20 a	1.12 a	2.16 b	2.26 b
0.3-0.6	0.54 a	1.86 abc	1.54 ab	1.60 ab	1.68 ab	2.20 abc	3.15 bc	3.73 c
0.6-0.9	0.73 a	2.30 a	1.77 a	2.04 a	1.77 a	2.18 a	3.22 a	3.65 a
0.9-1.2	1.46 a	2.92 a	2.28 a	2.14 a	2.33 a	2.77 a	3.61 a	4.52 a
1.2-1.5	2.19 a	3.86 a	2.71 a	2.82 a	2.93 a	3.46 a	4.30 a	4.86 a

[z] Means within the same row (soil layer) followed by the same letter are not significantly different ($P<0.05$).

the top two soil layers in 1996 and 1997 (Fig. 45d-e). By 2000 and 2001, there were significant differences throughout the soil profile at the coarse-textured site (Fig. 45h-i; Table 26). Significant increases in electrical conductivity was restricted to the 0 to 0.6-m layer at the medium-textured site (Table 26). Figure 46i shows that as manure rate increased, electrical conductivity increased throughout the soil profile. However, due to greater variability with depth, statistically significant differences were not observed below the 0.6-m depth (Table 26).

Eleven annual manure applications (90 Mg ha^{-1}) increased surface electrical conductivity from about 1 dS m^{-1} to more than 6.4 dS m^{-1} under nonirrigated conditions in a southern Alberta field study by Chang et al. (1991). They found that at a higher manure rate (180 Mg ha^{-1}), but under irrigation, surface electrical conductivity increased from 0.76 dS m^{-1} (control) to less than 2.3 dS m^{-1}. However, electrical conductivity was much higher than the control with depth. They concluded that irrigation provided sufficient leaching to reduce the build-up of salts in the soil surface, but caused the subsoil electrical conductivity to be higher under irrigation than under nonirrigation. A survey study of 41 Colorado irrigated fields, which received manure for several years, showed that none of the fields had electrical conductivity values greater than 4 dS m^{-1} in the top soil layer (0 to 0.2 m), and only four fields had values greater than 2.5 dS m^{-1} (Davis et al. 1997).

The Agricultural Operation Practices Act (AOPA) of Alberta was revised in January 2002 to include regulations for confined feeding operations, including the management and application of manure on agricultural land (Province of Alberta 2001). The standards and administration regulation of the Act states that manure should not be applied in amounts that would increase soil electrical conductivity in the top 0.15 m by more than 1 dS m^{-1}. The Act also states that no manure should be applied to soil that has an electrical conductivity greater than 4 dS m^{-1} in the top 0.15 m. The baseline (1993) electrical conductivity of the surface soil layer was 0.90 dS m^{-1}

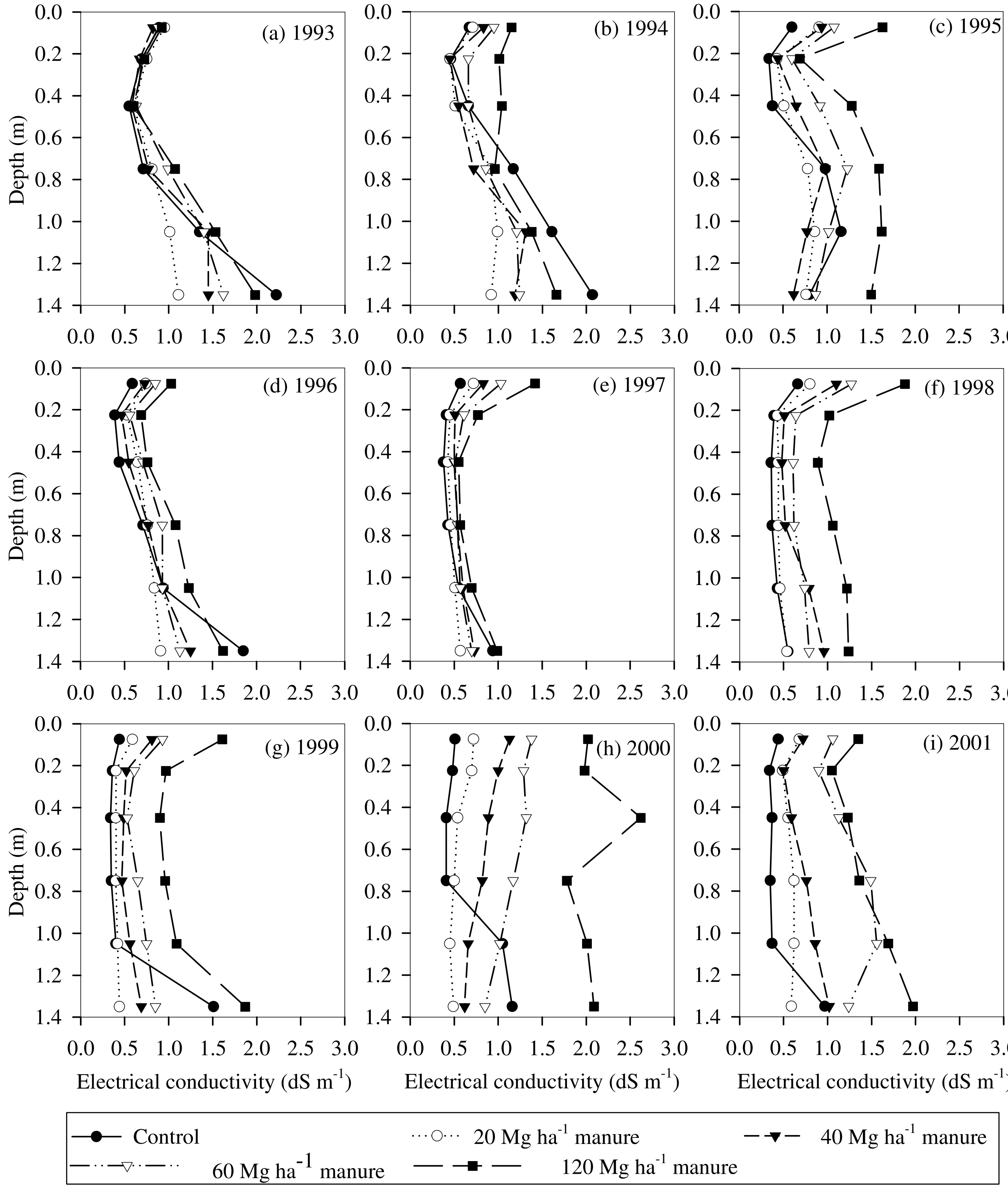


Fig. 45. Soil electrical conductivity of the control and manure treatments at the coarse-textured site.

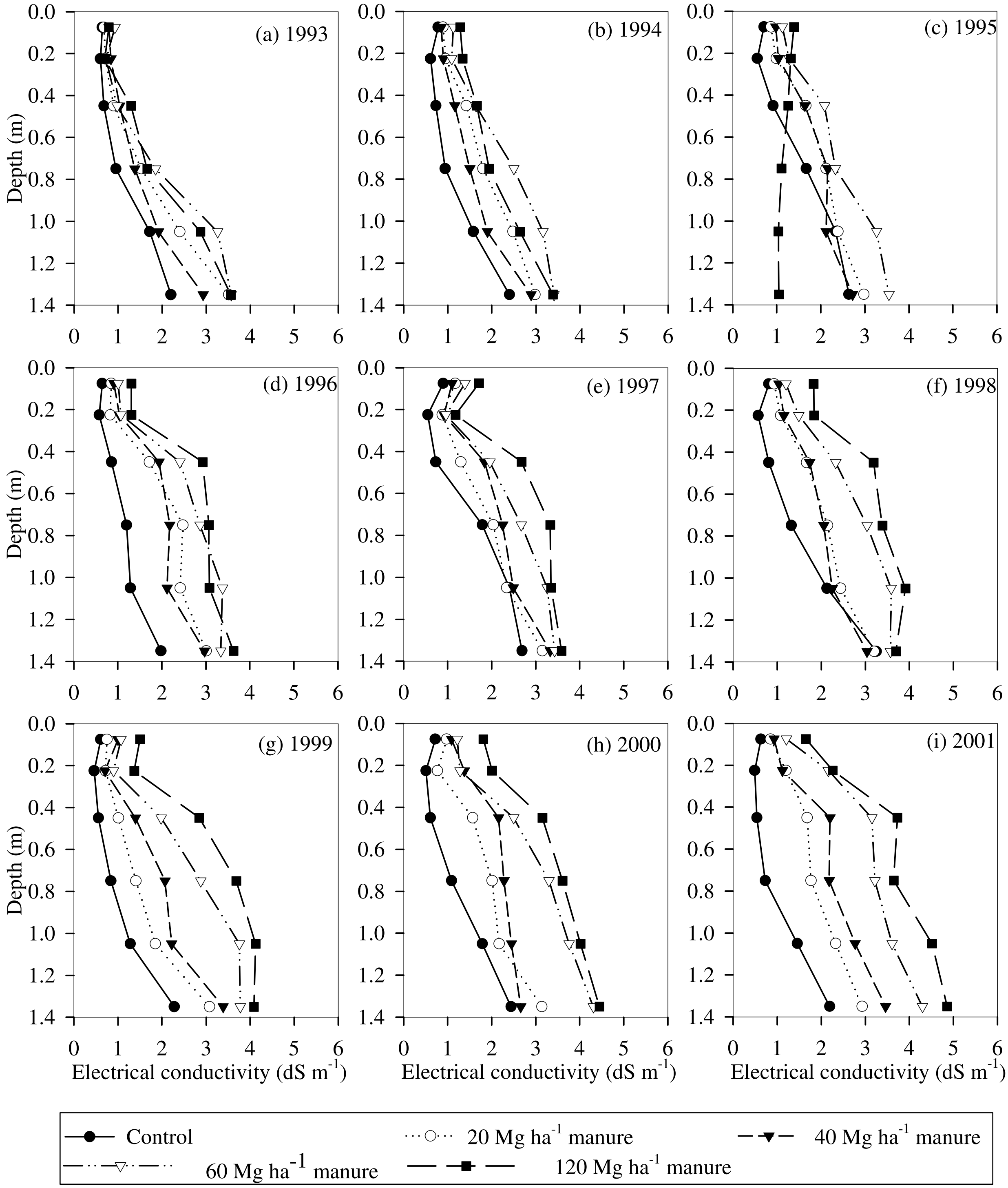


Fig. 46. Soil electrical conductivity of the control and manure treatments at the medium-textured site.

at the coarse-textured site and 0.77 dS m^{-1} at the medium-textured site. After eight annual applications of manure at a rate of 120 Mg ha^{-1}, the surface soil electrical conductivity was 1.35 dS m^{-1} at the coarse-textured site and 1.65 dS m^{-1} at the medium-textured site in 2001. However, in 2000, the electrical conductivity values for the 120 Mg ha^{-1} manure treatment at the two sites were 2.02 and 1.81 dS m^{-1}. Repeated application of manure at the highest rate in this study has caused the surface soil electrical conductivity to increase by nearly 1 dS m^{-1}, and as a result, manure application would have to be discontinued, based on the new AOPA regulations. The example with the highest manure treatment is marginal, regarding the regulations, and the year-to-year variations are probably due to the annual variation in manure salt load and leaching conditions. Also, a substantial amount of cattle manure is required to increase soil electrical conductivity by 1 dS m^{-1}.

Electrical conductivity in the top soil layer decreased in the manure-residual subplots after manure application was discontinued for two years (Table 27). This decrease was more pronounced at the coarse-textured site, probably due to greater leaching potential. The decrease

Table 27. Changes in soil electrical conductivity (dS m^{-1}) in the residual-manure plots from 1999 to 2001.

	Coarse-textured site				Medium-textured site			
Year	20 [z]	40	60	120	20	40	60	120
				0.0 – 0.15 m layer				
1999 [y]	0.59 a	0.84 c	0.83 b	1.85 c	0.73 a	1.07 b	1.06 ab	1.50 b
2000	0.66 a	0.81 b	0.91 b	1.45 b	0.78 a	0.99 ab	1.14 b	1.32 b
2001	0.56 a	0.57 a	0.58 a	0.73 a	0.67 a	0.82 a	0.86 a	1.08 a
				0.15 – 0.3 m layer				
1999	0.40 a	0.56 a	0.57 a	1.05 b	0.53 a	0.81 a	0.84 a	1.20 a
2000	0.69 b	0.84 b	0.83 b	1.29 c	0.59 a	0.83 a	0.95 a	1.34 a
2001	0.39 a	0.44 a	0.49 a	0.67 a	0.71 a	0.65 a	0.92 a	1.58 a

[z] Residual-manure subplot treatments, which received annual application (20, 40, 60, and 120 Mg ha^{-1} y^{-1}) from 1993 to 1998. Manure application was discontinued after 1998 (i.e. no manure applied in 1999 and 2000).
[y] Means within the three-year period, for each residual-manure rate, site and soil layer combination, followed by the same letter are not significantly different ($P<0.05$). There were no significant differences below the 0.3-m depth.

in electrical conductivity was also generally more pronounced as the manure rate increased. For example, at the coarse-textured site, there were no significant differences among the three years for the 20 Mg ha^{-1} residual-manure treatment, whereas by 2001 the electrical conductivity was reduced by 30 percent in the 60 Mg ha^{-1} residual-manure treatment and by 61 percent in the 120 Mg ha^{-1} residual-manure treatment compared to the 1999 values (Table 27). The electrical conductivity in the 0.15 to 0.3-m layer was temporarily increased in 2000 and then decreased in 2001 at the coarse-textured site (Table 27). It would appear that in 2000, salts leached out of the top layer and into the 0.15 to 0.3-m layer. In the subsequent year, this cumulated salt was then leached further into the profile. This was not observed at the medium-textured site in the 0.15 to 0.3-m layer, and no significant redistribution of salts, as measured by electrical conductivity, was observed in the residual-manure subplots below 0.3 m in 2000 and 2001 at either site. Therefore, a modest increase in surface salinity caused by the application of manure can be corrected if enough water is available to the leach cumulated salts. The access to irrigation water would be beneficial for this purpose in more arid regions. Even though the leaching of salts may improve the quality of surface soil, there is the potential for excess salt to leach into shallow groundwater.

Groundwater Chemistry

Coarse-textured site. Groundwater nitrate-N content at the coarse-textured site was generally well above the maximum limit of 10 mg L^{-1} outlined in the Canadian water quality guidelines (CCME 1987) throughout the study period (Fig. 47). Treatment means ranged from 8.0 to 178 mg L^{-1}. Nitrate-N content tended to increase annually during the July to September period. This was particularly true from 1993 to 1997 and in 2001. The annual cycle in nitrate-N concentration followed the annual rise and fall of the water-table elevation (Fig. 6).

Groundwater from the 120 Mg ha^{-1} manure treatment consistently had the greatest concentration of nitrate-N, even prior to the first application of manure (Fig. 47b). The high nitrate-N content in the 120 Mg ha^{-1} manure plots on July 27, 1993, prior to the application of manure, cannot be attributed to one particular replicate. Manure was first applied on October 19, 1993. Groundwater nitrate-N in replicates A, D, and E was much higher (107, 220, and 156 mg L^{-1}, respectively) than in replicates B and C (21 and 8 mg L^{-1}, respectively) on July 27, 1993 (Fig. 48). The former three replicates also contained higher chloride concentrations (50, 442, and 493 mg L^{-1}, respectively) than the latter two replicates (19 and 7 mg L^{-1}, respectively). Nitrate-N content was consistently lower (8 to 11 mg L^{-1}) in replicate C than in the other four replicates from June 1993 to June 1996. A slight increase was then observed from August 1996 to June 1997 (13 to 27 mg L^{-1}). Nitrate-N content increased substantially (118 mg L^{-1}) in August 1997, and remained relatively high (31 to 105 mg L^{-1}) until the end of the study. Chloride content results showed a similar pattern in replicate C for the 120 Mg ha^{-1} manure treatment.

The consistently greater nitrate-N concentrations observed in the 120 Mg ha^{-1} manure treatment, including the period in 1993 before treatment application, can be explained by the soil chemistry. The soil profile throughout the site contained high levels of extractable nitrate-N at the start of the study (Fig. 9). Nitrate-N content in the baseline soil samples (fall, 1993) ranged from 14 to 26 kg ha^{-1} in the 0 to 0.15-m layer, and increased with depth. Nitrate-N concentration ranged from 82 to 177 kg ha^{-1} in the 1.2 to 1.5-m layer. Because of the site variability, and by chance through the randomization procedure, the plots that received the 120 Mg ha^{-1} manure treatment also had, on average, the highest extractable soil nitrate-N contents at the start of the study (Figs. 10a and 11a). This may explain why the groundwater nitrate-N concentration was higher under the 120 Mg ha^{-1} manure treatment plots as compared to the other treatments in late July 1993 (Fig. 47). Extractable nitrate-N values of the soil profile (0 to 1.5 m) for the 120 Mg ha^{-1} treatment plots are shown in Table 28. At the start of the study, replicates B and D had the highest nitrate-N contents, replicates A and E contained about half as much nitrate-N, and replicate C contained the least amount of nitrate-N.

Precipitation was well above normal in 1993, particularly in June and July (Appendix 8), and this may have promoted nitrate-N leaching into the shallow groundwater. The higher soil nitrate-N content in the 120 Mg ha^{-1} manure treatment plots most likely caused the groundwater nitrate-

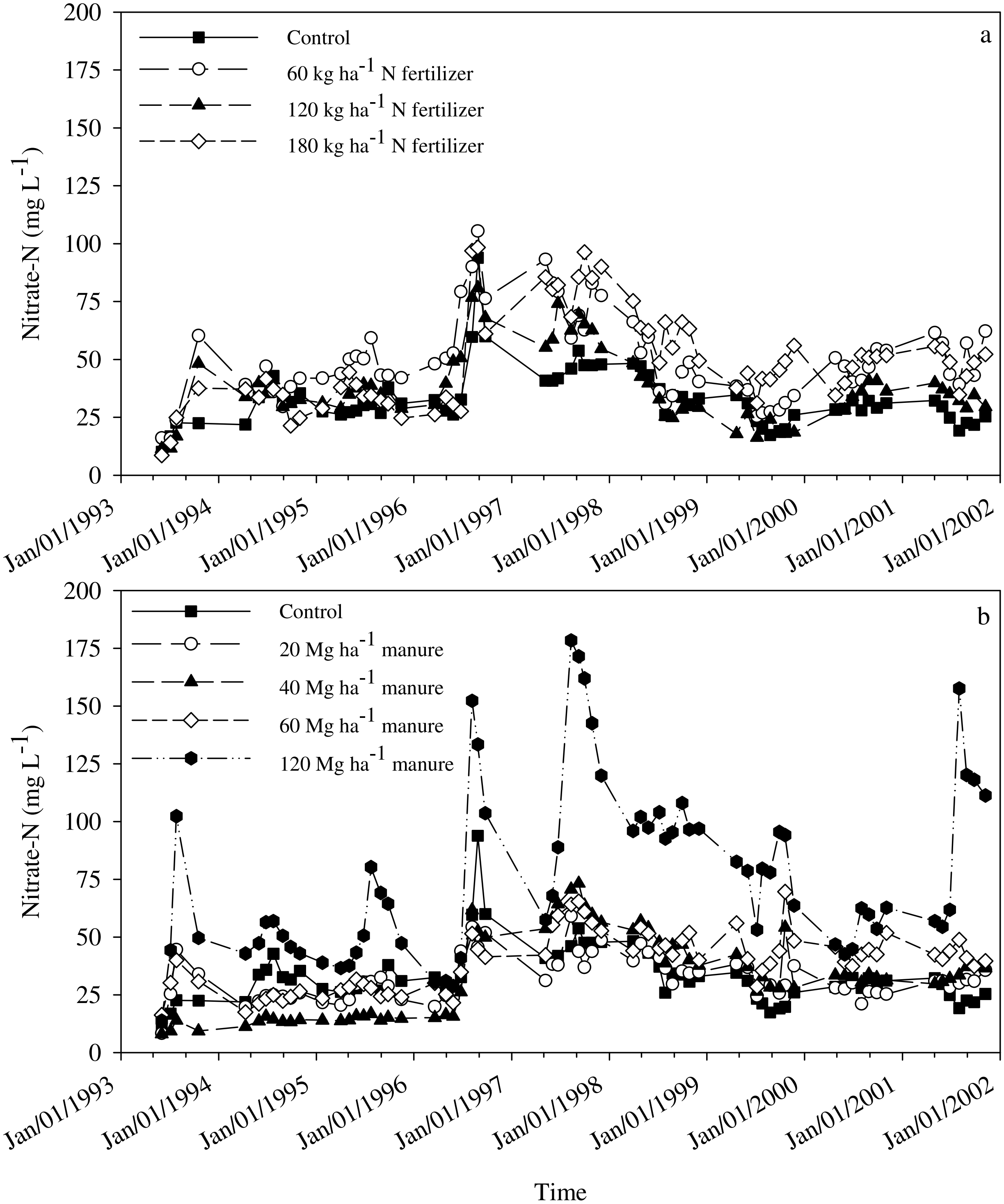


Fig. 47. Mean nitrate-N content in groundwater for the (a) control and fertilizer-N treatments, and (b) control and manure treatments at the coarse-textured site.

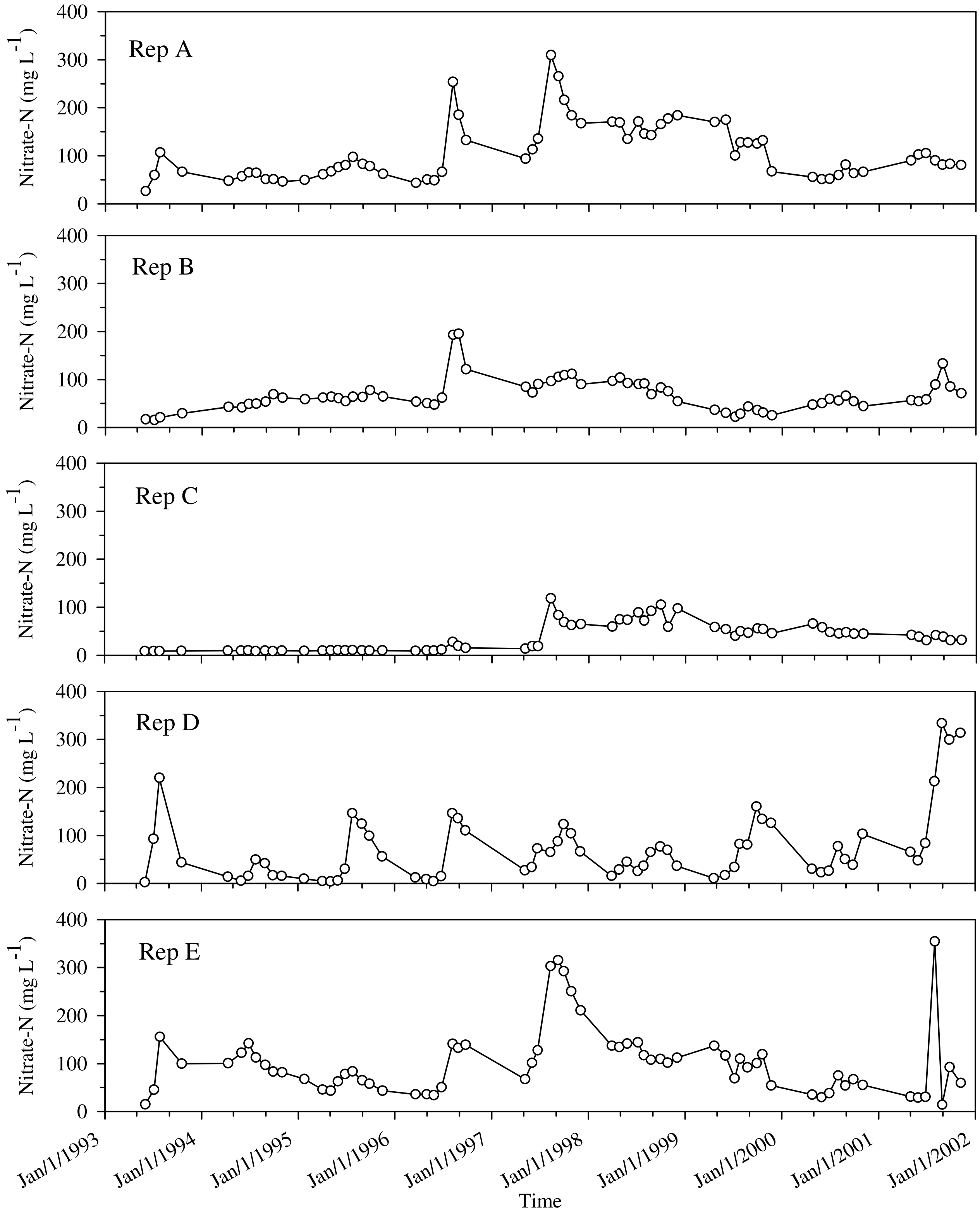


Fig. 48. Nitrate-N content in groundwater below the five replicates for the 120 Mg ha^{-1} manure treatment at the coarse-textured site.

Table 28. Nitrate-N content in the soil profile (0 to 1.5 m) for the 120 Mg ha^{-1} manure treatment for each replicate plot at the coarse-textured site.

	Year								
Replicate	1993[z]	1994	1995	1996	1997	1998	1999	2000	2001
	kg ha^{-1}								
A	347	606	536	190	36	339	393	363	442
B	600	512	310	196	161	369	434	722	674
C	174	247	330	375	206	583	513	970	544
D	791	367	325	296	198	380	561	573	289
E	375	277	457	188	149	558	530	1022	608
Mean	457	402	392	249	150	446	486	730	512

[z] Baseline year, prior to treatment application.

N contents under this treatment to be consistently higher than the other treatments, particularly during the first few years of the study. The initial high content of soil nitrate-N with depth and the site variability most likely confounded or masked any treatment effect on groundwater quality in the first few years of the study (i.e. 1994 to 1997) at the coarse-textured site. The baseline soil chemistry data, particularly the extractable nitrate-N, orthophosphate-P, and chloride data, provide evidence that this site had received significant amounts of manure prior to the start of the study. The variability may be due to uneven application of the manure, and/or temporary storage of manure piles before spreading. The coarse-textured site was managed as a dryland corner in a field with a centre-pivot irrigation system. Subsequently, irrigation during the study may have promoted the downward movement of soil nitrate-N. Also, the increase in crop growth, due to regular irrigation, may have facilitated increased nitrogen uptake. Even though 120 Mg ha^{-1} manure was added annually, the net soil nitrate-N content decreased from 1993 to 1997 at the coarse-textured site (Fig. 11a; Table 28). Soil nitrate-N content actually increased in replicate C with time, whereas a decrease was observed in the other four replicates from 1993 to 1997. There was a large increase in soil-profile nitrate-N in all five replicates in 1998 (Table 28). Soil nitrate-N continued to increase in 1999 and 2000, and then decreased in 2001.

Not only was the groundwater nitrate-N content higher under the 120 Mg ha^{-1} manure treatment than under the other treatments, the annual maximum concentration increased with time until 1997, and the difference between the annual maximum for the highest manure rate and the other treatments became larger (Fig. 47b). This may indicate that excess nitrate-N from the highest manure rate began to influence groundwater nitrate-N as early as 1996. Replicate C of the 120 Mg ha^{-1} treatment seems to support this conclusion (Fig. 48). As stated earlier in this section, groundwater nitrate-N content was low and very consistent in replicate C until about May 1996. Then the groundwater nitrate-N content began to increase in 1996. This increase is most likely due to the added manure. Therefore, the source of nitrate-N leached to groundwater in 1993 to 1997 was probably a combination of the initial nitrate-N present in the soil at the start of the study and the nitrate-N derived from the added manure treatments.

The large amount of nitrate-N initially present in the soil profile was leached out by 1997, with the soil nitrate-N content reasonably uniform below the 0.15-m depth among the treatments (Fig. 10e). The confounding effects of the initially high and variable soil nitrate-N concentrations were no longer present after 1997. Subsequent changes to nitrate-N content in soil and groundwater could be attributed solely to the manure treatments.

As stated above, the annual maximum nitrate-N concentration for the 120 Mg ha^{-1} manure treatment increased from 1994 to 1997 (Fig. 27b). In 1998, the annual maximum concentration decreased, but remained higher than the other three manure rates and control treatments (Fig. 47b). Possibly the amount of nitrate-N leached into the groundwater was less in 1998. The soil chemistry data seems to support this theory since a large amount of nitrate-N cumulated in the soil profile in 1998 under the highest manure rate (Table 28), and leaching out of the soil profile may have been limited due to the very dry conditions that occurred after the last irrigation in late July 1998 and prior to soil sampling in late September. Soil extractable nitrate-N continued to increase in the soil profile in 1999 and 2000 (Table 28), with a corresponding decrease in groundwater nitrate-N content (Fig. 47b) for the 120 Mg ha^{-1} treatment. However, the increase in soil nitrate-N in 1999 was modest compared to 1998 (Table 28), and this may have been because more nitrate-N leached in 1999, resulting in a modest annual maximum concentration of nitrate-N in the groundwater in September 1999 (Fig. 27b). In 2001, there was a large increase in groundwater nitrate-N content and this seems to correspond to a decrease in extractable nitrate-N in the soil profile in the same year (Table 28). Annual variations in the amounts of precipitation and irrigation water may have caused the observed related variations between soil nitrate-N content and groundwater nitrate-N concentration. The last three years (1999 to 2001) were drier than the previous years of the study (Appendix 8). Lower amounts of precipitation may have resulted in reduced nitrate-N leaching. The largest amount of irrigation water applied in a single year occurred in 2001, with the amount nearly double the amounts applied in 1999 and 2000, and almost four times the amount applied in 1998 (Appendix 8). Larger amounts of irrigation water may have facilitated nitrate-N leaching into the shallow groundwater. Plus, irrigated water was applied during the June to July period in most years of the study. The amounts irrigated were usually double the normal precipitation during this period. Therefore, not only the amount, but the intensity of applied water may have influenced nitrate-N leaching into the groundwater.

Groundwater chloride data essentially showed the same results as the nitrate-N data for the manure treatments (Fig. 49b). The control treatment consistently had the least amount of chloride after 1996. The next lowest was the 20 Mg ha^{-1} manure treatment. Groundwater under the 60 Mg ha^{-1} manure treatment generally contained more chloride than the 40 Mg ha^{-1} manure treatment after 1996, but this was not always the case (e.g. in 2000 and 2001). In spite of the high variability in the data, there was a general trend for higher chloride concentration in the groundwater as the manure rate increased. This trend was also observed for the nitrate-N data, particularly late in the study (Fig. 47b), but the chloride data showed the trend more clearly. Perhaps this is because chloride is biologically and physically inert in the soil, except for the small amounts taken up by plants. In contrast, nitrate-N can undergo transformations and be taken up by plants in much larger quantities.

The fertilizer-N treatments did not show any consistent effect on groundwater nitrate-N and chloride concentrations at the coarse-textured site (Figs. 47a and 49a).

There were few significant differences among the treatments at the coarse-textured site prior to 1997. The groundwater nitrate-N content in the 120 Mg ha^{-1} manure treatment was

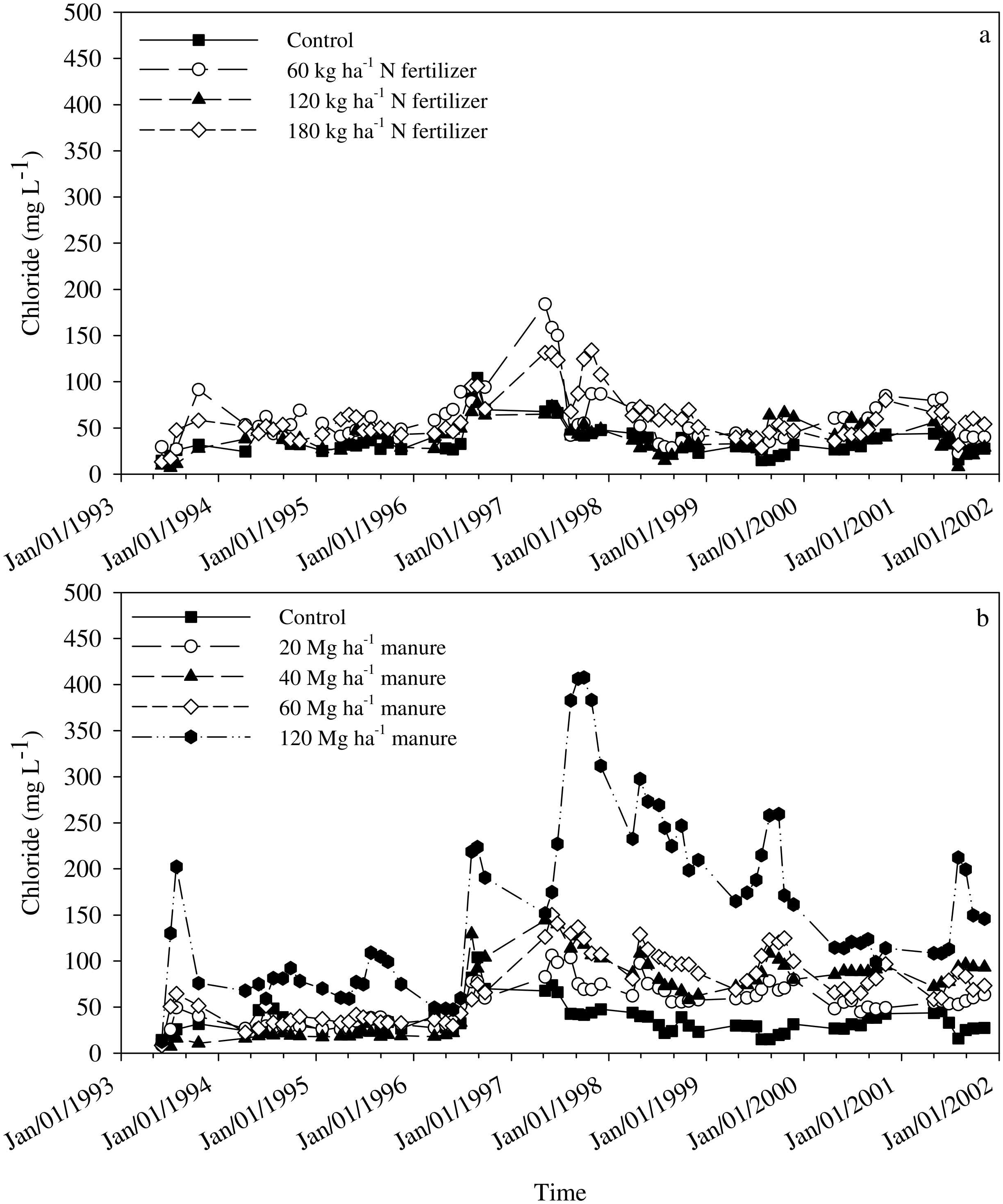


Fig. 49. Mean chloride content in groundwater for the (a) control and fertilizer-N treatments, and (b) control and manure treatments at the coarse-textured site.

significantly higher than the other treatments in the second half of 1997, 1998, and 1999 (Table 29). There were fewer significant differences in 2000 and 2001. The groundwater chloride content in the 120 Mg ha^{-1} manure treatment was significantly higher than the other treatments from about mid-1997 to mid-2000 and in the latter half of 2001 (Table 30). Nitrate-N and chloride contents in the groundwater under the three fertilizer-N treatments and the 20, 40, and 60 Mg ha^{-1} manure treatments did not differ significantly from the control throughout the study.

Groundwater electrical conductivity and pH were measured on a few selected dates from June 1993 to April 2000. The average pH of the groundwater at the site at the start of the study was 7.8±0.02 (±standard error), with a range of 7.4 to 8.1. The fertilizer-N and manure treatments had no significant effect on groundwater pH during the study. Groundwater electrical conductivity at the start of the study averaged 1.00±0.05 dS m^{-1}, with a range of 0.59 to 2.70 dS m^{-1}. From the 15 dates electrical conductivity was measured on groundwater, significant differences were observed on two dates. Groundwater electrical conductivity under the highest manure application rate was significantly higher (2.48 dS m^{-1}) than the other treatments, except for the 60 Mg ha^{-1} treatment, (1.05 to 1.62 dS m^{-1}) on October 27, 1998. On October 20, 1999, the 120 Mg ha^{-1} manure treatment had significantly higher electrical conductivity (2.43 dS m^{-1}) than the other treatments (1.04 to 1.40 dS m^{-1}), except for the 20 Mg ha^{-1} (1.45 dS m^{-1}) and 60 Mg ha^{-1} (1.49 dS m^{-1}) manure treatments.

Orthophosphate-P in groundwater was measured on two dates (July 29, 1998 and October 20, 1999) and total phosphorus in groundwater was measured on one date (October 20, 1999) at the coarse-textured site. Phosphorus content was low in the groundwater (total phosphorus was less than 0.04 mg L^{-1}) and there were no treatment effects.

The above results clearly show that manure application had a significant effect on groundwater nitrate-N and chloride content, and what was observed in the soil profile reflected what was observed in the shallow groundwater. From 1993 to 1997, the initial high levels of nitrate-N and chloride in the soil profile decreased with the addition of irrigation water. During this same period, an increase in groundwater nitrate-N and chloride was observed, particularly under the highest manure application rate. From 1998 to 2000, there was a net build-up of nitrate-N and chloride in the soil profile, along with a corresponding decrease in groundwater nitrate-N and chloride. The reverse was observed in 2001. The dynamic and related changes in nitrate-N and chloride between soil and groundwater can be attributed to the sandy texture of the soil and the shallow depth of the water table. These conditions made the groundwater very sensitive to contamination from excess nutrient application, particularly under irrigation.

Medium-textured site. Groundwater nitrate-N at the medium-textured site was lower than at the coarse-textured site. Treatment means ranged from 0.9 to 33.5 mg L^{-1} during the study period (Fig. 50a). The highest value measured in a single well was 107 mg L^{-1} in plot C10 on May 30, 1995. Significant differences among the treatments were only observed on four out of the 66 dates groundwater samples were taken during the study. These occurred on March 20, 1996, May 6 1997, and May 1 and 29, 2001. In some cases, the significant differences did not follow any expected trend. For example, on March 20, 1996, the 60 Mg ha^{-1} manure treatment had significantly more nitrate-N in the groundwater than the 120 Mg ha^{-1} manure treatment. The 60 Mg ha^{-1} manure treatment tended to have the highest nitrate-N content throughout most of the

Table 29. Mean values of nitrate-N content in groundwater at the coarse-textured site.

		Fertilizer-N rate (kg ha^{-1} y^{-1})			Manure rate (Mg ha^{-1} y^{-1})			
Date	Control	60	120	180	20	40	60	120
	mg L^{-1}							
Jun 2, 1993[z]	10	16	11	9	8	8	16	14
Jul 5, 1993	17	16	12	14	25	9	30	44
Jul 27, 1993	23 ab	24 ab	17 ab	25 ab	44 ab	14 ab	40 b	102 a
Oct 18, 1993	22	60	48	38	34	9	31	50
Apr 11, 1994	22	39	34	37	20	11	17	43
May 31, 1994	34	38	40	34	22	14	21	47
Jun 27, 1994	36	47	41	42	24	16	23	56
Jul 25, 1994	43	36	41	37	25	14	25	57
Aug 29, 1994	33	30	30	35	24	13	22	51
Sep 28, 1994	32	38	31	21	23	13	24	46
Nov 1, 1994	35	42	33	25	26	14	26	43
Jan 24, 1995	27	42	31	29	22	14	23	39
Apr 3, 1995	26	44	29	38	20	14	27	37
May 4, 1995	27	50	35	44	23	14	28	38
May 31, 1995	28	51	38	39	29	16	32	43
Jun 27, 1995	30	50	39	34	30	16	30	51
Jul 25, 1995	31	59	39	34	31	17	28	80
Aug 30, 1995	27	43	35	32	32	14	24	69
Sep 27, 1995	38	43	36	31	29	15	25	64
Nov 15, 1995	31	42	29	25	23	15	24	47
Mar 19, 1996	32	48	30	26	20	15	30	31
Apr 30, 1996	28	50	40	34	25	16	25	31
May 27, 1996	26	53	49	31	24	16	22	29
Jun 25, 1996	33	79	51	28	44	26	35	41
Aug 6, 1996	60	90	77	97	54	62	51	152
Aug 27, 1996	94	105	81	98	46	52	45	133
Sep 24, 1996	60	76	68	61	52	50	41	104
May 7, 1997	41	93	55	86	31	54	42	57
Jun 2, 1997	41	83	59	80	38	58	55	68
Jun 23, 1997	42	79	74	82	38	64	59	89
Aug 11, 1997	46 b	59 b	63 b	68 a	59 b	71 b	64 b	178 a
Sep 8, 1997	54 b	69 b	69 b	86 ab	44 b	73 ab	65 b	172 a
Sep 30, 1997	48 b	63 b	65 b	96 ab	37 b	64 b	61 b	162 a
Oct 28, 1997	47 b	83 ab	63 ab	85 ab	44 b	60 b	56 b	143 a
Dec 2, 1997	48 b	78 ab	55 ab	90 ab	48 b	56 ab	53 ab	120 a
Mar 31, 1998	48	66	48	75	40	53	44	96
Apr 28, 1998	47	53	43	64	47	57	54	102
May 27, 1998	43	60	40	62	43	54	52	97
Jul 7, 1998	37 b	36 b	33 b	49 ab	41 b	48 ab	45 ab	104 a
Jul 29, 1998	26 b	31 b	25 b	66 b	37 b	39 b	47 b	93 a
Aug 25, 1998	34 b	34 b	25 b	55 b	30 b	46 b	42 b	95 a

[Z] Means within the same row (date) followed by the same letter are not significantly different (P<0.05). Means within rows with no letters are not significantly different.

Table 29 continued. Mean values of nitrate-N content in groundwater at the coarse-textured site.

		Fertilizer-N rate (kg ha^{-1} y^{-1})			Manure rate (Mg ha^{-1} y^{-1})			
Date	Control	60	120	180	20	40	60	120
	-------------------------------	-------------------------------	-------------------------------	mg L^{-1}	-------------------------------	-------------------------------	-------------------------------	-------------------------------
Sep 30, 1998[Z]	34 b	45 b	28 b	66 ab	35 b	47 b	49 b	108 a
Oct 27, 1998	31 b	49 ab	30 b	63 ab	34 b	40 b	52 ab	97 a
Dec 2, 1998	33 b	40 b	29 b	49 ab	35 b	38 b	40 b	97 a
Apr 21, 1999	35	38	18	38	38	42	56	83
Jun 2, 1999	31	37	26	44	37	37	41	79
Jul 7, 1999	23 ab	25 ab	16 b	31 ab	24 ab	26 ab	29 ab	53 a
Jul 27, 1999	21 b	27 b	19 b	42 ab	30 b	33 b	36 b	80 a
Aug 25, 1999	17 b	27 b	24 b	41 ab	29 b	28 b	38 b	78 a
Sep 29, 1999	19 b	28 b	18 b	45 b	26 b	28 b	44 b	96 a
Oct 20, 1999	20 ab	31 ab	18 b	49 ab	29 ab	54 ab	70 ab	94 a
Nov 23, 1999	26	34	18	56	37	28	48	64
Apr 25, 2000	28	51	27	35	28	33	46	47
May 30, 2000	29	47	28	40	27	33	39	42
Jun 28, 2000	32	40	34	47	30	33	37	45
Aug 1, 2000	28 bc	41 abc	36 abc	52 ab	21 c	30 bc	42 abc	63 a
Aug 28, 2000	32	47	41	51	26	34	44	60
Sep 27, 2000	29	55	41	51	26	32	42	54
Nov 2, 2000	31	54	36	52	25	31	52	63
May 2, 2001	32	61	40	56	31	30	42	57
May 30, 2001	30	57	37	55	31	31	40	54
Jun 27, 2001	25	44	35	49	28	32	44	62
Aug 1, 2001	19 b	39 b	32 b	35 b	30 b	33 b	49 b	158 a
Aug 29, 2001	23	57	29	43	32	37	41	120
Sep 26, 2001	22 b	43 ab	35 b	49 ab	31 b	37 b	37 b	118 a
Nov 7, 2001	25	62	30	52	36	36	40	111

[Z] Means within the same row (date) followed by the same letter are not significantly different (P<0.05). Means within rows with no letters are not significantly different.

Table 30. Mean values of chloride content in groundwater at the coarse-textured site.

		Fertilizer-N rate (kg ha^{-1} y^{-1})			Manure rate (Mg ha^{-1} y^{-1})			
Date	Control	60	120	180	20	40	60	120
	mg L^{-1}							
Jun 2, 1993[z]	14	29	10	13	9	12	8	13
Jul 5, 1993	20	9	7	17	25	7	51	130
Jul 27, 1993	26	27	11	48	49	16	65	202
Oct 18, 1993	32	91	28	58	40	11	52	76
Apr 11, 1994	24	53	38	52	27	16	23	68
May 31, 1994	47	51	47	44	27	19	27	75
Jun 27, 1994	55	62	51	52	29	21	52	59
Jul 25, 1994	48	44	47	48	28	20	33	81
Aug 29, 1994	39	40	37	53	29	22	31	81
Sep 28, 1994	33	53	36	37	30	19	36	92
Nov 1, 1994	32	69	38	36	29	19	40	78
Jan 24, 1995	25	55	27	43	26	18	37	70
Apr 3, 1995	28	41	26	59	26	18	33	60
May 4, 1995	32	44	31	64	27	18	34	59
May 31, 1995	31	47	47	62	35	21	42	77
Jun 27, 1995	34	56	46	47	38	23	39	75
Jul 25, 1995	37	62	48	47	38	22	38	109
Aug 30, 1995	27	46	42	50	39	18	33	105
Sep 27, 1995	34	44	38	48	34	20	33	99
Nov 15, 1995	27	48	29	43	31	19	33	75
Mar 19, 1996	40	58	27	44	28	18	36	49
Apr 30, 1996	28	65	43	50	30	20	33	48
May 27, 1996	27	70	47	46	34	22	30	47
Jun 25, 1996	33	89	50	56	51	33	43	60
Aug 6, 1996	82 ab	78 ab	67 b	95 ab	78 ab	129 ab	58 b	219 a
Aug 27, 1996	104	95	76	96	78	92	75	224
Sep 24, 1996	70	94	64	71	60	104	66	190
May 7, 1997	68	184	65	131	83	144	126	152
Jun 2, 1997	74	158	73	131	106	149	150	175
Jun 23, 1997	66	150	70	123	98	140	141	227
Aug 11, 1997	43 b	42 b	46 b	68 b	104 b	114 b	130 ab	383 a
Sep 8, 1997	42 b	53 b	43 b	87 ab	75 b	127 ab	137 ab	406 a
Sep 30, 1997	42 b	55 b	54 b	125 b	69 b	118 b	124 b	408 a
Oct 28, 1997	44 b	87 b	44 b	134 ab	69 b	107 b	108 b	383 a
Dec 2, 1997	48 b	87 b	48 b	108 ab	75 b	103 ab	107 ab	312 a
Mar 31, 1998	44 b	71 ab	37 b	63 b	62 b	87 ab	81 ab	233 a
Apr 28, 1998	40 b	52 b	28 b	73 b	97 b	108 b	129 b	298 a
May 27, 1998	40 b	68 b	30 b	64 b	75 b	96 b	113 b	273 a
Jul 7, 1998	31 b	32 b	21 b	59 b	71 b	80 b	105 b	269 a
Jul 29, 1998	22 b	29 b	15 b	68 b	68 b	73 b	102 b	245 a
Aug 25, 1998	24 b	28 b	20 b	61 b	55 b	73 b	97 b	225 a

[z] Means within the same row (date) followed by the same letter are not significantly different (P<0.05). Means within rows with no letters are not significantly different.

Table 30 continued. Mean values of chloride content in groundwater at the coarse-textured site.

		Fertilizer-N rate (kg ha^{-1} y^{-1})			Manure rate (Mg ha^{-1} y^{-1})			
Date	Control	60	120	180	20	40	60	120
	mg L^{-1}							
Sep 30, 1998[Z]	39 b	35 b	27 b	59 b	56 b	67 b	97 b	247 a
Oct 27, 1998	30 b	49 b	34 b	70 b	56 b	58 b	96 b	198 a
Dec 2, 1998	23 b	40 b	32 b	51 b	58 b	63 b	86 b	210 a
Apr 21, 1999	30 b	44 b	33 b	40 b	59 ab	72 ab	69 ab	165 a
Jun 2, 1999	30 b	40 b	41 b	39 b	60 ab	74 ab	79 ab	174 a
Jul 7, 1999	29 b	38 b	29 b	39 b	62 b	79 b	86 b	188 a
Jul 27, 1999	15 b	25 b	25 b	28 b	69 b	87 b	106 b	215 a
Aug 25, 1999	15 b	35 b	64 b	45 b	78 b	108 b	123 ab	258 a
Sep 29, 1999	20 b	43 b	52 b	54 b	68 b	102 b	120 ab	259 a
Oct 20, 1999	21 b	39 b	66 ab	50 b	70 ab	95 ab	125 ab	171 a
Nov 23, 1999	32 b	44 b	61 ab	47 b	80 ab	80 ab	100 ab	161 a
Apr 25, 2000	27 b	60 ab	42 ab	36 b	48 ab	85 ab	66 ab	115 a
May 30, 2000	27 b	61 ab	46 ab	43 ab	55 ab	89 ab	70 ab	114 a
Jun 28, 2000	31 b	55 ab	60 ab	43 ab	57 ab	88 ab	61 ab	121 a
Aug 1, 2000	30 b	48 ab	53 ab	43 b	45 ab	88 ab	65 ab	119 a
Aug 28, 2000	38	60	54	48	50	88	76	124
Sep 27, 2000	38	71	37	60	48	91	81	99
Nov 2, 2000	43	85	40	80	49	95	97	114
May 2, 2001	44	80	56	66	55	72	59	109
May 30, 2001	46	82	30	67	57	76	60	108
Jun 27, 2001	33	51	41	54	54	78	79	113
Aug 1, 2001	16 bc	23 bc	8 c	31 bc	53 bc	93 b	88 b	212 a
Aug 29, 2001	25 b	41 b	20 b	56 b	56 b	96 b	84 b	199 a
Sep 26, 2001	27 b	40 b	21 b	60 b	60 b	93 ab	69 b	150 a
Nov 7, 2001	28 b	40 b	29 b	54 b	63 ab	93 ab	73 ab	146 a

[Z] Means within the same row (date) followed by the same letter are not significantly different (P<0.05). Means within rows with no letters are not significantly different.

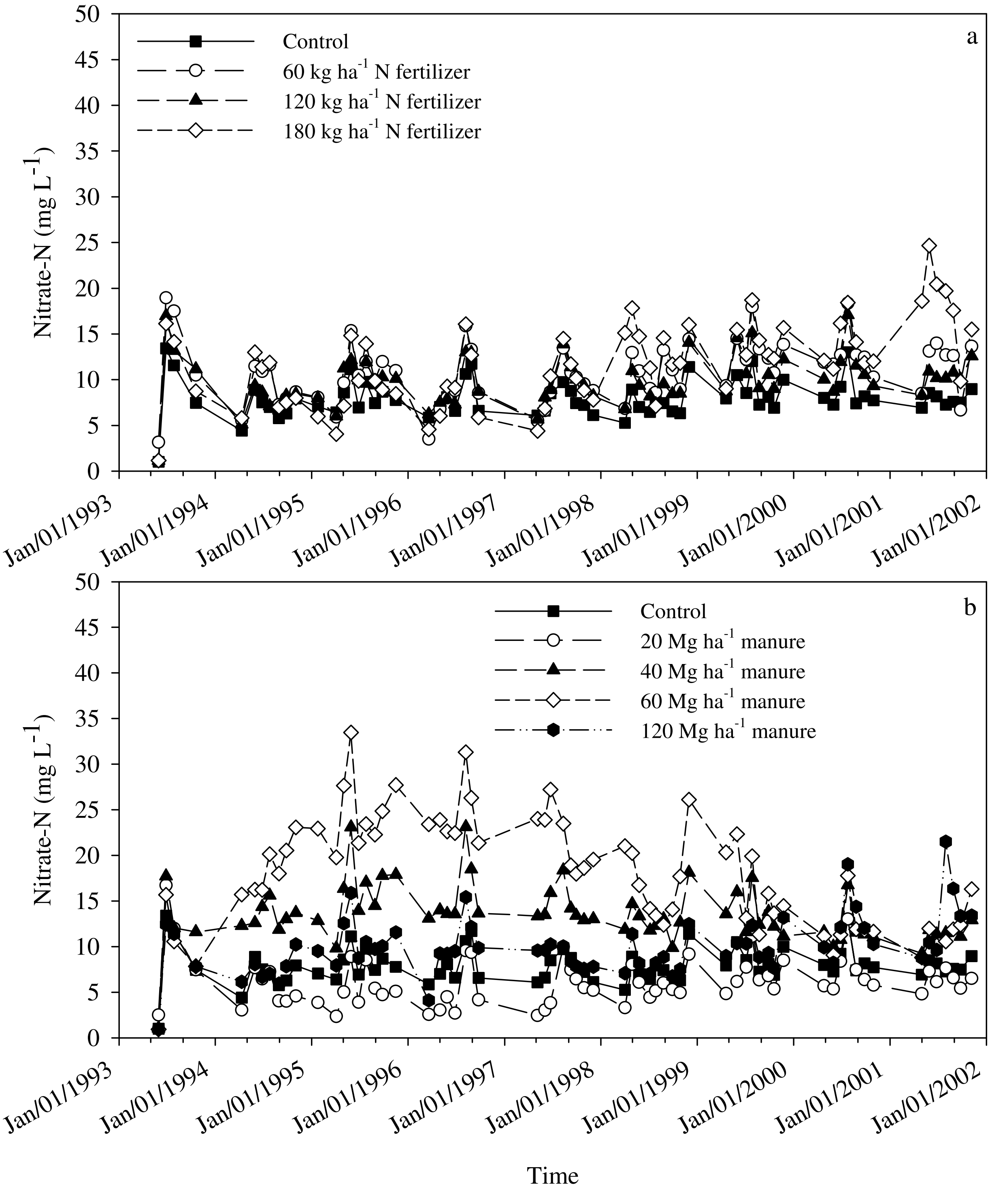


Fig. 50. Mean nitrate-N content in groundwater for the (a) control and fertilizer-N treatments, and (b) control and manure treatments at the medium-textured site.

study, followed by the 40 Mg ha^{-1} manure treatment. The control and 120 Mg ha^{-1} manure treatments were similar and the 20 Mg ha^{-1} manure treatment generally had the lowest nitrate-N concentration in groundwater. If a true treatment effect had occurred, we would have expected increased nitrate-N content in groundwater as manure rate and fertilizer-N rates increased, but this was not the case at the medium-textured site. The chloride data showed the same results (Fig. 51), with few significant differences.

The nitrate-N and chloride content in the soil, and the changes with time as manure and fertilizer-N were applied, can explain the lack of treatment effects in the shallow groundwater. Nitrate and chloride from the added manure and nitrogen from urea fertilizer took several years to leach through the measured soil profile of 1.5 m. The leaching fronts of the cumulated nitrate-N and chloride reached the 1.5-m depth in about 1998 (Figs. 13, 14, and 42). The water table was about 2.66 m, on average, below the soil surface. At the leaching rate that was observed, it would take about another four years to reach the water table (i.e. about the same time the study was ended in 2001). However, towards the end of the study, there may have been some indication that manure and fertilizer applications began to influence groundwater parameters. Starting in June 2000, the 120 Mg ha^{-1} manure treatment began to have the highest nitrate-N and chloride contents compared to the control and the other four manure rates (Figs. 50a and 51a), though the trends were weak and there were no significant differences. The 180 kg ha^{-1} fertilizer-N treatment had the largest increase in groundwater nitrate-N in 2001, with values significantly higher than the control on May 1, and May 29, 2001 (Fig. 50b).

Groundwater pH was similar to the coarse-textured site. The average pH of the groundwater at the start of the study was 7.6±0.02 (±standard error), with a range of 7.3 to 7.9. Electrical conductivity was higher at the medium-textured site compared to the coarse-textured site. Groundwater electrical conductivity at the start of the study averaged 5.61±0.19 dS m^{-1}, with a range of 3.67 to 12.2 dS m^{-1}. The fertilizer-N and manure treatments had no significant effect on groundwater pH and electrical conductivity at the medium-textured site.

Orthophosphate-P in groundwater was measured on two dates (July 28, 1998 and October 19, 1999) and total phosphorus in groundwater was measured on one date (October 19, 1999) at the medium-textured site. Phosphorus content was low in the groundwater (total phosphorus was less than 0.04 mg L^{-1}) and there were no treatment effects.

University of Alberta Hospitals groundwater analyses. Total coliform, faecal coliform, and extensive chemical analyses were performed six times: three times in 1994 (May, July, and September), and three times in 1995 (May, July, and September). There were few significant differences among the treatments at either site. Nitrate-N and chloride content under the 120 Mg ha^{-1} manure treatment at the coarse-textured site tended to be higher than the other treatments (Appendix 12, Tables 12.37 and 12.38). This observation was similar to what was reported for the monthly routine analysis, and was related to the initial variability in the soil chemistry at the site.

The nitrate-N and chloride data from the coarse-textured site, and the chloride data from the medium-textured site were in good agreement with the monthly routine analysis. Correlation coefficients of 0.98 to 0.99 were obtained for the six sampling dates. The 1994 nitrate-N values

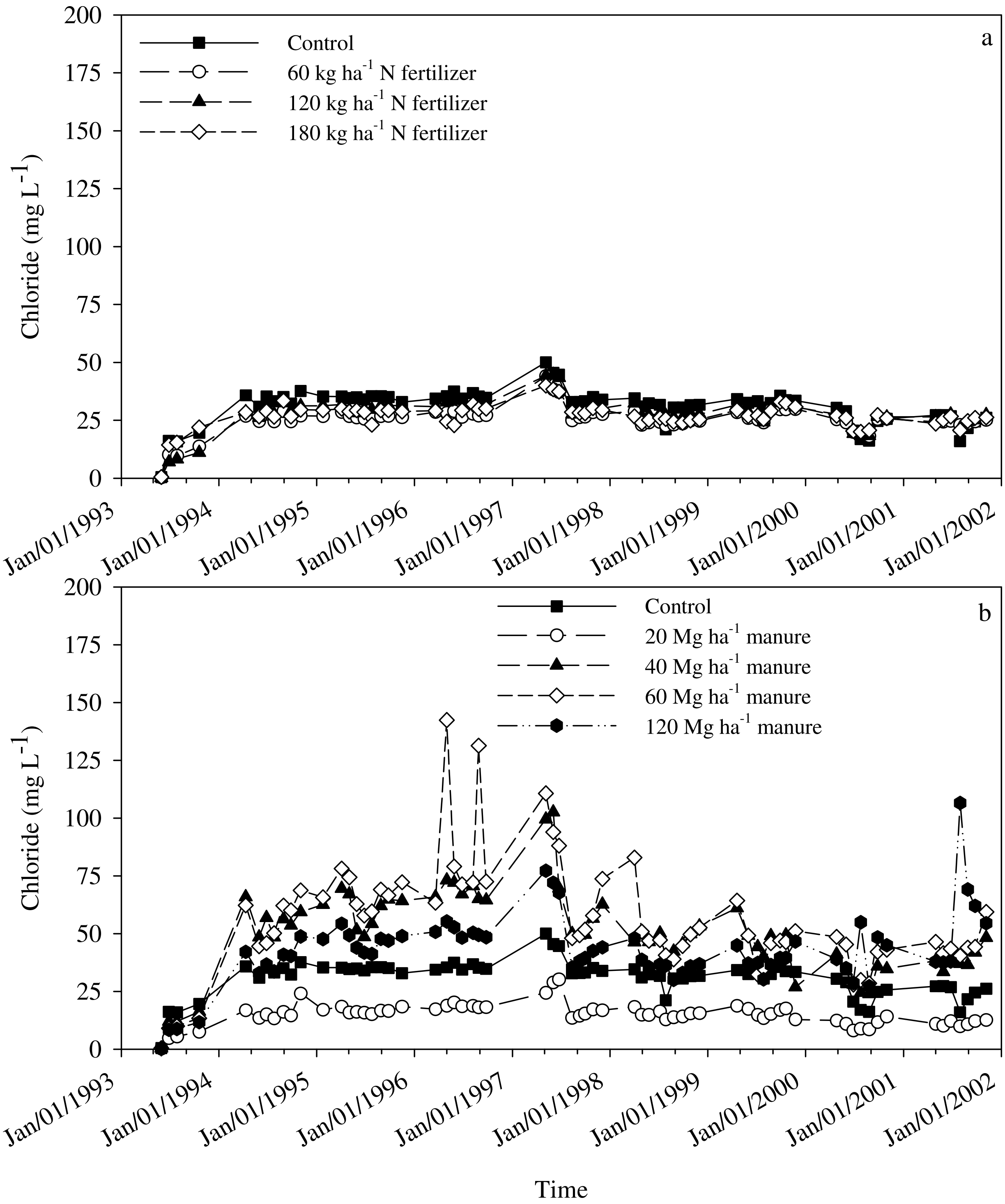


Fig. 51. Mean chloride content in groundwater for the (a) control and fertilizer-N treatments, and (b) control and manure treatments at the medium-textured site.

measured by the University of Alberta Hospitals did not correlate well (r = 0.31) with the monthly routine analysis at the medium-textured site. The values obtained from the University of Alberta Hospitals (Appendix 13, Table 13.39) were generally much lower than the values obtained from the monthly routine analysis in 1994 at the medium-textured site. The reason why the University of Alberta Hospitals 1994 nitrate-N values at the medium-textured site were much lower than the monthly routine values is unknown. Attempts were unsuccessful to determine if an agent was present in the groundwater samples from the medium-textured site that may have interfered with the nitrate-N analysis in 1994. The 1995 nitrate-N data from both sites correlated well (r = 0.97) between the two laboratories.

Crop Data

All of the crop data are summarized in Appendix 14.

Total dry-matter yield. There were no yield differences among the treatments in the first crop year (1994) at the coarse-textured site (Table 31). In 1995, most of the treatments were not significantly different from the control except for the 120 and 180 kg ha^{-1} fertilizer-N treatments, which had greater yields. The lack of differences among the treatments, including the control, in 1994 and 1995 may have been caused by the high levels of nitrate-N initially present with depth at the coarse-textured site (Fig. 9). No yield data were obtained from this site in 1996 because of crop failure due to poor seedling emergence. By 1997, extractable nitrate-N content was relatively low throughout most of the soil profile (Fig. 10e). In 1997, all of the nitrogen source

Table 31. Mean dry-matter yield (Mg ha^{-1}) at the coarse- and medium-textured sites from 1994 to 2001.

		Fertilizer-N rates (kg ha^{-1})			Manure rates (Mg ha^{-1})			
Year	Control	60	120	180	20	40	60	120
				Coarse-textured site				
1994^z	6.9 a	6.7 a	7.3 a	6.8 a	7.1 a	7.2 a	7.1 a	6.9 a
1995	5.5 a	7.1 ab	7.8 b	7.4 b	6.1 ab	6.0 ab	6.2 ab	6.7 ab
1996^y								
1997	6.3 a	8.5 b	8.7 b	9.3 b	8.2 ab	8.4 b	8.8 b	9.1 b
1998	6.4 a	8.0 ab	8.9 b	8.9 b	8.3 b	9.1 b	9.1 b	7.8 ab
1999	5.8 a	7.7 b	8.2 bc	8.7 bc	8.3 bc	9.4 bc	9.8 c	9.7 c
2000	4.6 a	7.2 b	7.3 b	7.3 b	8.0 b	8.8 b	8.3 b	8.6 b
2001	6.5 a	6.4 a	6.9 ab	6.8 ab	8.4 bc	9.2 c	8.8 c	9.2 c
				Medium-textured site				
1994	7.5 a	8.3 a	8.7 a	7.7 a	8.2 a	7.9 a	8.0 a	8.2 a
1995	6.4 a	8.4 bc	8.6 bc	8.6 bc	7.5 ab	7.5 ab	7.8 b	9.3 c
1996	5.6 a	8.5 bc	8.4 bc	8.9 bc	8.0 b	8.8 bc	9.7 c	10.1 c
1997	3.5 a	7.3 cd	7.9 cde	8.4 de	5.6 b	6.8 bc	7.7 cde	9.0 e
1998	6.3 a	8.2 b	7.8 b	7.4 ab	7.8 b	8.4 b	8.0 b	7.4 ab
1999	7.1 a	9.1 b	9.0 b	9.2 b	9.4 b	9.4 b	9.8 b	9.8 b
2000	6.7 a	9.2 b	9.3 b	8.8 b	9.5 b	9.3 b	9.5 b	9.8 b
2001	7.1 a	8.3 ab	8.7 bc	9.1 bcd	10.1 cde	10.5 de	10.9 e	10.0 cde

^{z} Mean values within the same row followed by the same letter are not significantly different (P<0.05).
^{y} No crop in 1996 at the coarse-textured site.

treatments, except for the 20 Mg ha^{-1} manure treatment, yielded significantly higher than the control (Table 31). There were no significant differences among the three fertilizer-N and four manure treatments, though yield tended to increase slightly as the fertilizer and manure rates increased. The 60 kg ha^{-1} fertilizer-N and the 120 Mg ha^{-1} manure treatment did not differ from the control in 1998. This was the only year that the application of manure had a negative effect on the crop. We observed lodging in the crop, and the severity of lodging increased with manure rate. Lodging was also observed for the fertilizer-N treatments. Lodging may have caused the yield for the 120 Mg ha^{-1} manure treatment to be the lowest among the four manure treatments in 1998, though the four rates were not significantly different among themselves. Crop yield from the manure treatment plots was significantly greater than the control in 1999 to 2001. However, the four manure rates did not differ among themselves.

Chang et al. (1993) found that barley production was generally positive to manure application under nonirrigated and irrigated conditions during a 16-year period of annual manure application. However, they also reported that barley yield was negatively affected by manure during dry years without irrigation.

There were no yield differences among the treatments in 1994 at the medium-textured site (Table 31). Crop yield responded to fertilizer-N and manure application earlier in the study at this site compared to the coarse-textured site. This is probably because the soil nitrate-N content at the medium-textured site was relatively low at the beginning of the study. Crop yield increased with manure application rate from 1995 to 1997. After 1997, the four manure rate treatments did not differ among themselves, but consistently yielded higher than the control. For most of the years of the study, the three fertilizer-N treatments did not differ among themselves, but did yield significantly greater than the control.

The results from the medium-textured site showed that after four years of manure application, there were no yield differences between the lowest and highest manure application rates. Under the application regime of our study, the 20 Mg $ha^{-1}y^{-1}$ treatment provided the nutrient requirements of the crop. Higher application rates caused a cumulation of nutrients in the soil profile, such as nitrogen, phosphorus, potassium, magnesium, and chloride.

Manure application was discontinued after 1998 in subplots to study the short-term residual effects of six years of annual manure application. Comparisons with time (1999 to 2001) could not be made within each residual manure rate because triticale was grown in 1999 and 2001 and barley was grown in 2000. Also, since a new crop is grown each year, year-to-year variations due to other factors may have confounded any residual effect from the manure. Comparing yields between residual-manure subplots and manured subplots for each manure rate in 2000 and 2001 showed no significant differences, with one exception. In 2001, the 20 Mg ha^{-1} residual-manure treatment at the medium-textured site yielded significantly less (8.7 Mg ha^{-1}) than the manure treatment (10.1 Mg ha^{-1}), which continued to receive manure at the same rate. The data show that residual manure was able to maintain yields in 2000 and 2001 that were not different from the treatments that continued to receive annual manure application.

Total nitrogen content. The application of fertilizer-N and manure caused an increase in total nitrogen in the crop tissue (Table 32). Total nitrogen content generally increased as the application rate of fertilizer-N and manure increased. The 180 kg ha^{-1} fertilizer-N and 120 Mg ha^{-1} manure treatments consistently had significantly higher total nitrogen content than the control, except in 1995 at the coarse-textured site. The 120 kg ha^{-1} fertilizer-N and 60 Mg ha^{-1} manure treatments were often significantly higher than the control. From 1997 to 2001 at the coarse-textured site and from 1995 to 2001 at the medium-textured site, total nitrogen content in crop tissue in the 120 Mg ha^{-1} manure treatment was 1.24 to 2.24 times greater than the control, and total nitrogen content in the 180 kg ha^{-1} fertilizer-N treatment was 1.23 to 1.84 times greater then the control. Nitrogen content was the lowest in 1998, regardless of the treatment. The control treatments were less than 9 kg Mg^{-1} at both sites in 1998. The reason why total nitrogen content in the crop tissue was lower in 1998 is unkown.

There were no differences between the residual-manure subplots and the manure subplots in 2000 and 2001 at the coarse-textured site. This was essentially true for the medium-textured site, except for the 20 Mg ha^{-1} treatment in 2000 and 2001, when total nitrogen content in the residual-manure subplots were significantly lower than the manure subplots.

Table 32. Mean total nitrogen content (kg Mg^{-1}) of crop tissue at the coarse- and medium-textured sites from 1995 to 2001.

		Fertilizer-N rates (kg ha^{-1})			Manure rates (Mg ha^{-1})			
Year	Control	60	120	180	20	40	60	120
				Coarse-textured site				
1995[z]	24.2 a	25.6 a	2.0 a	27.1 a	24.0 a	24.7 a	25.1 a	25.7 a
1996[y]								
1997	16.7 a	20.4 ab	21.8 bc	23.3 bc	20.5 ab	20.8 b	20.8 b	25.0 c
1998	7.2 a	12.9 bc	12.2 b	13.0 bc	10.2 ab	12.2 b	13.5 bc	16.1 c
1999	14.0 a	15.7 ab	16.5 ab	18.6 b	15.7 ab	16.7 ab	16.8 ab	18.1 b
2000	13.9 a	17.3 ab	18.6 bc	19.5 bc	17.3 ab	17.0 ab	19.9 bc	21.2 c
2001	13.7 a	15.8 ab	16.6 ab	17.6 b	18.6 b	18.8 b	19.5 b	19.1 b
				Medium-textured site				
1995	17.0 a	19.2 ab	23.3 c	22.9 c	16.4 a	17.3 a	19.3 ab	21.1 bc
1996	11.5 a	16.0 bc	18.9 cd	21.2 d	12.8 ab	14.4 ab	15.3 b	21.1 d
1997	14.7 a	18.2 b	21.6 cd	24.1 d	15.5 ab	16.4 ab	18.6 bc	22.6 d
1998	8.9 a	10.7 ab	14.1 bc	16.3 c	9.1 a	12.1 ab	13.7 bc	16.2 c
1999	12.3 a	15.4 abc	16.5 bc	16.2 bc	14.1 ab	16.5 bc	17.0 bc	18.4 c
2000	12.5 a	18.9 bcd	21.4 d	21.7 d	17.2 b	17.8 bc	21.1 cd	19.9 bcd
2001	13.3 a	15.9 ab	15.6 ab	17.6 b	14.9 ab	17.6 b	16.4 ab	18.0 b

[z] Mean values within the same row followed by the same letter are not significantly different ($P<0.05$).
[y] No crop in 1996 at the coarse-textured site.

Total calcium and phosphorus contents. Total calcium content was generally not significantly affected by fertilizer-N and manure at the coarse-textured site, except in 1997 and 2001 (Table 33). The 180 kg ha^{-1} fertilizer-N treatment was significantly higher than the control in 1997 and the 60 Mg ha^{-1} manure treatment was significantly higher than the control in 2001. There were significant differences at the medium-textured site in 1996, 1997, 1998, 2000, and 2001. There was a weak tendency for calcium content in the crop tissue to increase with an increase in fertilizer-N and manure rate at the medium-textured site.

Table 33. Mean total calcium content (kg Mg^{-1}) of crop tissue at the coarse- and medium-textured sites from 1995 to 2001.

		Fertilizer-N rates (kg ha^{-1})			Manure rates (Mg ha^{-1})			
Year	Control	60	120	180	20	40	60	120
				Coarse-textured site				
1995[z]	4.18 a	3.78 a	3.88 a	3.82 a	4.15 a	4.24 a	4.31 a	4.28 a
1996[y]								
1997	3.66 a	3.92 ab	4.32 ab	5.04 b	3.70 a	4.26 ab	4.07 ab	4.61 ab
1998	4.40 a	4.30 a	4.62 a	4.40 a	4.32 a	4.78 a	5.06 a	5.48 a
1999	4.66 a	4.48 a	4.78 a	5.48 a	4.82 a	5.02 a	5.05 a	5.06 a
2000	3.66 a	4.10 a	4.80 a	4.84 a	4.76 a	4.64 a	4.04 a	3.82 a
2001	3.46 a	3.58 ab	3.98 ab	3.92 ab	4.00 ab	4.08 ab	4.70 b	4.46 ab
				Medium-textured site				
1995	3.30 a	3.62 a	3.80 a	3.80 a	3.40 a	3.72 a	3.86 a	3.99 a
1996	4.98 a	5.58 ab	6.12 ab	6.02 ab	5.23 ab	5.56 ab	6.15 ab	6.23 b
1997	4.08 bcd	3.90 abc	4.76 cde	5.20 de	2.82 a	3.48 ab	3.95 abc	5.46 e
1998	4.90 a	5.52 ab	6.42 bc	6.44 bc	5.51 ab	5.47 ab	6.04 abc	6.77 c
1999	5.08 a	5.76 a	5.92 a	5.56 a	5.10 a	6.21 a	6.02 a	6.04 a
2000	4.14 a	5.30 ab	5.68 b	6.08 b	4.98 ab	5.24 ab	5.96 b	5.94 b
2001	3.44 ab	3.82 ab	3.28 a	3.94 ab	4.08 ab	4.20 ab	3.86 ab	4.56 b

[z] Mean values within the same row followed by the same letter are not significantly different ($P<0.05$).
[y] No crop in 1996 at the coarse-textured site.

The application of fertilizer-N had no effect and manure application had a minimal effect on total phosphorus content of crop tissue at the coarse-textured site. The only manure-treatment effects were observed in 2000 and 2001 when total phosphorus increased as manure rate increased (Table 34). Manure application had no effect on total phosphorus content at the medium-textured site, except in 2001 when the 120 Mg ha^{-1} treatment was significantly higher than the control. The other three manure-rate application treatments had larger total phosphorus contents than the control, but were not significantly different from the control.

Chang et al. (1994) reported a decrease in calcium content in barley tissue as manure rate increased after nearly 20 annual manure applications. They attributed this decrease in calcium concentration to an increase in soil salinity associated with long-term manure application. They also reported an increase in phosphorus concentration as manure rate increased. The differences between the results presented by Chang et al. (1994) and our study may be due to the difference in duration of the two studies (i.e. 20 versus eight annual applications).

Table 34. Mean total phosphorus content (kg Mg^{-1}) of crop tissue at the coarse- and medium-textured sites from 1995 to 2001.

Year	Control	Fertilizer-N rates (kg ha^{-1})			Manure rates (Mg ha^{-1})			
		60	120	180	20	40	60	120
				Coarse-textured site				
1995[z]	2.74 a	2.88 a	2.78 a	2.86 a	2.87 a	2.94 a	2.90 a	3.03 a
1996[y]								
1997	2.68 a	2.86 a	2.84 a	2.78 a	2.87 a	2.72 a	2.75 a	2.74 a
1998	1.04 a	1.48 a	1.24 a	1.32 a	1.29 a	1.33 a	1.23 a	1.46 a
1999	1.68 a	1.70 a	1.90 a	2.04 a	1.89 a	1.83 a	1.82 a	2.02 a
2000	1.54 a	1.80 ab	1.62 ab	1.54 a	1.62 ab	1.58 ab	1.98 ab	2.22 b
2001	2.22 a	2.80 ab	2.92 b	2.80 ab	2.88 b	3.00 b	3.10 b	3.24 b
				Medium-textured site				
1995	2.72 a	2.54 a	2.80 a	2.84 a	2.88 a	2.92 a	2.95 a	2.92 a
1996	2.18 a	2.14 a	2.12 a	2.06 a	2.11 a	2.07 a	2.04 a	2.15 a
1997	2.56 a	2.90 ab	3.06 ab	3.10 b	3.05 ab	2.83 ab	2.87 ab	2.90 ab
1998	1.34 a	1.34 a	1.12 a	1.20 a	1.30 a	1.28 a	1.37 a	1.47 a
1999	1.62 a	1.84 a	1.84 a	1.74 a	1.76 a	1.96 a	1.90 a	1.97 a
2000	1.66 a	1.82 a	1.84 a	1.68 a	2.04 a	1.88 a	1.88 a	1.52 a
2001	2.84 ab	2.88 ab	2.86 ab	2.56 a	3.20 bc	2.98 ab	3.16 bc	3.52 c

[z] Mean values within the same row followed by the same letter are not significantly different ($P<0.05$).
[y] No crop in 1996 at the coarse-textured site.

Nitrogen and Phosphorus Budgets

Of all the parameters that were measured during this study, only total phosphorus and total nitrogen were measured in soil (0 to 0.9 m), crop tissue, and manure. These analyses were carried out for the 0, 20, 40, 60, and 120 Mg ha^{-1} manure treatments. The following equations were used to calculate budgets for total phosphorus and nitrogen for the five manure rates.

$$SP_f - (SP_i + MP + FP - CP) = P \text{ balance} \quad (2)$$
$$SN_f - (SN_i + MN + FN - CN) = N \text{ balance} \quad (3)$$

Where:
SP_f and SN_f = Final soil total phosphorus and nitrogen content at the end of the study (2001).
SP_i and SN_i = Initial soil total phosphorus and nitrogen content at the start of the study (1993).
MP and MN = Total phosphorus and nitrogen added from manure.
FP and FN = Total phosphorus and nitrogen added from commercial fertilizer.
CP and CN = Total phosphorus and nitrogen removed in harvested crop material.
P and N balance = If equal to zero, then all pools of N and P are accounted for. If negative or positive, then one or more of the pools are either underestimated or overestimated.
All components are expressed as kg ha^{-1}.

The 1994 crop was not analysed for total phosphorus and nitrogen. These values were estimated for 1994 by using the average values obtained from 1995 to 2001 for each site. Since manure rate had little effect on crop tissue phosphorus content at either site, phosphorus content values were averaged from all treatments from 1995 to 2001 to provide an estimate for 1994. The estimates used were 2.25 kg Mg^{-1} total phosphorus for the coarse-textured site, and 2.27 kg Mg^{-1} total phosphorus for the medium-textured site. Total nitrogen in crop tissue increased with manure application rate. Therefore, mean values for each manure application rate from 1995 to 2001 were used as estimates for the 1994 crop tissue total nitrogen values. The estimates used for the 0, 20, 40, 60, and 120 Mg ha^{-1} manure treatments were 15.0, 17.7, 18.4, 19.3, and 20.9 kg Mg^{-1} total nitrogen, respectively, for the coarse-textured site, and 12.9, 14.3, 16.0, 17.3, and 19.6 kg Mg^{-1} total nitrogen, respectively, for the medium-textured site.

There was not enough sample material for five 1993 soil samples at the coarse-textured site and for one 1993 soil sample at the medium-textured site to be analysed for total phosphorus and nitrogen. Total phosphorus and nitrogen were estimated for these samples by using the 1993 site mean values for the required incremental soil layer. A value was required for each increment soil layer per plot so a summation of total phosphorus and nitrogen could be calculated for the 0 to 0.9-m layer.

Table 35 shows the values for the components of total phosphorus. The amount of fertilizer-P added and amount of phosphorus removed in the harvested crop material were small compared to the amount of phosphorus added from the manure. The crop removed 3.9 to 23.0 percent of the cumulated phosphorus applied. The percent removed decreased with manure application rate. Whalen and Chang (2001) reported a similar range for continuous barley plots that received annual manure applications for 16 years. The variations among the 1993 soil phosphorus values

Table 35. Total phosphorus budget for the five manure-rate treatments at the coarse- and medium-textured sites from 1993 to 2001.

Manure-rate treatment (Mg ha^{-1} y^{-1})	Total manure P added 1993-2000 (kg ha^{-1})	Total fertilizer P added 1994-2001 (kg ha^{-1})	Total crop P removed (kg ha^{-1})	Initial total soil P 0 to 0.9 m 1993 (kg ha^{-1})	Final total soil P 0 to 0.9 m 2001 (kg ha^{-1})	Budget [z] balance (kg ha^{-1})
			Coarse-textured site			
0	0	65	86	6648	6952	325
20	596	65	121	6791	7682	351
40	1192	65	127	6485	7781	166
60	1788	65	132	6679	8784	383
120	3577	65	141	6876	9841	-536
			Medium-textured site			
0	0	78	107	7326	7041	-256
20	586	78	153	7858	7543	-827
40	1171	78	155	7240	7846	-489
60	1751	78	165	7415	8228	-857
120	3513	78	173	7252	9799	-870

[z] Budget balance = final soil P – (initial soil P + manure P + fertilizer P – crop P removal).

were small compared to the 2001 soil phosphorus values. The 2001 soil phosphorus content increased with manure rate. The budget balance was either in excess or deficient, ranging from 383 to –870 kg ha^{-1}, with an average of –261 kg ha^{-1} across the five manure rates and two sites (Table 35). An excess was calculated for all of the manure rates at the coarse-textured site, except for the 120 Mg ha^{-1} treatment. In contrast, deficiencies were calculated for all of the manure rates at the medium-textured site. The calculated excess and deficient phosphorus values are a relative comparison between the 1993 soil phosphorus content and the 2001 soil phosphorus content, after taking into account additions and withdrawals of phosphorus. The calculated excess and deficient phosphorus values may seem large, but they are within a five percent error of the accuracy measured in either the 1993 or 2001 soil samples. Whalen and Chang (2001) found that after 16 years of annual cattle manure application, 7 to 15 percent of total phosphorus applied to irrigated plots could not be accounted for in the soil and crop. This represented about 1,400 kg ha^{-1} of total phosphorus not accounted for in plots that received the highest manure application rate of 180 Mg ha^{-1} y^{-1} for 16 years. This is somewhat comparable to some of the deficient balances calculated for our eight-year study. Whalen and Chang (2001) reported that extractable and total phosphorus had increased throughout the measured soil profile of 1.5 m, and they suggested the phosphorus that could not be accounted for may have leached below the 1.5-m depth. Others have also reported the movement of phosphorus through soil (King et al. 1990; Kingery et al. 1994), including highly calcareous soils (Eghball et al. 1996). In our study, there were no treatment differences below 0.6 m for extractable phosphorus and no treatment differences below 0.3 m for total phosphorus, suggesting that very little, if any, phosphorus had a chance to move below the 0.9-m depth during the eight-year period of the study.

An excess was calculated for total nitrogen for all manure-rate treatments at both sites, except for the 120 Mg ha^{-1} manure treatment at the medium-textured site (Table 36). Mathematically, this means there was more soil total N in 2001 than in 1993, after taking into account the amounts added by manure and removed with the crop. However, we expected that deficiencies were more likely, because of nitrogen losses through leaching below the 0.9-m depth, volatilization of ammonia, and denitrification processes. The nitrate-N data showed that nitrate-N leached quickly through the coarse-textured soil profile, and by 1998, nitrate-N began to leach below the 0.9-m depth at the medium-textured site. No attempt was made to measure gaseous losses of nitrogen in this study. Therefore, we expected not to be able to account for a certain portion of the nitrogen in the system, rather than having too much. One possibility is the accuracy of the total-nitrogen measurements can be questioned. For example, the controls may indicate some inaccuracies in the total nitrogen measurements. In the control treatment at the coarse-textured site, there was 4,396 kg ha^{-1} more total nitrogen in 2001 than in 1993, even though no nitrogen was added and 628 kg ha^{-1} of nitrogen was removed by the crop. The question is where did the extra 5,024 kg ha^{-1} (4,396 + 628) come from? This would represent a gross increase of 628 kg ha^{-1} y^{-1} in the 0 to 0.9-m soil layer that can not be accounted for in the control. This also occurred for the control at the medium-textured site, but not to the same extent. Therefore, the total nitrogen data were of limited use in calculating a nitrogen budget.

Another explanation for a portion of the extra nitrogen is deposition from the atmosphere. Both sites are located in a region with a high density of intensive feeding operations. Livestock production systems are a significant source of atmospheric ammonia-N, and some of this ammonia-N can be deposited on nearby land (Hao et al. 2001). Hao et al. (2001) measured ammonia-N deposition during a 17-week period (October to February) in southern Alberta, and found that the weekly deposition rates ranged from 0.12 to 1.37 kg ha^{-1} y^{-1} of ammonia-N, with a mean of 0.34 kg ha^{-1}. The rate of deposition varied according to proximity to confined feeding operations, operation activities, and weather conditions. They also suggested that higher atmospheric ammonia-N concentrations and higher deposition rates would occur in the summer. These deposition rates would only account for a portion of the extra nitrogen calculated in the nitrogen budget, possibly 50 to 570 kg of nitrogen over the eight-year period of the study. Also, plant leaves have the capability of absorbing some atmospheric ammonia-N (Hutchinson et al. 1972).

The proportion of total nitrogen in manure that was removed by the crop was higher than for phosphorus. The crop removed 11.6 to 54.8 percent of the cumulated nitrogen applied (Table 36). The percent removed by the crop decreased as manure application rate increased.

Table 36. Total nitrogen budget for the five manure-rate treatments at the coarse- and medium-textured sites from 1993 to 2001.

Manure-rate treatment (Mg ha^{-1} y^{-1})	Total manure N added 1993-2000 (kg ha^{-1})	Total fertilizer N added 1994-2001 (kg ha^{-1})	Total crop N removed (kg ha^{-1})	Initial total soil N 0 to 0.9 m 1993 (kg ha^{-1})	Final total soil N 0 to 0.9 m 2001 (kg ha^{-1})	Budget [z] balance (kg ha^{-1})
			Coarse-textured site			
0	0	0	628	9019	13415	5024
20	1735	0	951	9264	16598	6550
40	3470	0	1046	8313	16265	5528
60	5206	0	1101	7260	16771	5406
120	10411	0	1207	8810	18823	809
			Medium-textured site			
0	0	0	643	12004	12064	703
20	1840	0	948	12020	15853	2941
40	3680	0	1100	12276	16770	1914
60	5520	0	1238	11621	18461	2558
120	11040	0	1445	12586	21227	-954

[z] Budget balance = final soil N – (initial soil N + manure N + fertilizer N – crop N removal).

Reliable nitrogen budgets are difficult to construct for manure because of the variable composition of manure, changes that occur in storage, nonuniform application, changes in soil properties, increased soil microbial activity caused by more available carbon, unpredictable nature of gaseous nitrogen losses, and the many factors that vary mineralization (Sharpley et al. 1998). However, manure-nitrogen additions to soil will ultimately appear in the major nitrogen cycle outputs of ammonia volatilization, denitrification, leaching, crop uptake, or cumulation in the soil as organic or mineral nitrogen (Sharpley et al. 1998).

Chang and Janzen (1996) calculated nitrogen balances for a field study after 19 years of cattle manure application (30 to 180 Mg ha^{-1} y^{-1}; wet-weight basis) on nonirrigated and irrigated plots. They were able to account for all of the added manure nitrogen to the nonirrigated plots in terms of crop nitrogen and soil nitrogen. However, they were not able to account for all of the added manure nitrogen to the irrigated plots, and they attributed this to nitrate-N leaching below the depth of measurement in the soil profile and to gaseous losses of nitrogen. Compared to our study, Chang and Janzen (1996) results are based on a much longer time period, 19 years versus eight years.

SUMMARY AND CONCLUSIONS

Eight annual applications of feedlot manure (20, 40, 60, and 120 Mg ha^{-1}; weight-wet basis) and commercial fertilizer-N (60, 120, and 180 kg ha^{-1} nitrogen as urea) were applied to a sandy-loam soil (coarse-textured) and to a loam to clay-loam soil (medium-textured site) under an irrigated cereal silage cropping system. Repeated application of manure resulted in significant changes in soil quality, groundwater quality, and crop yield, with differences between the two soil types.

Effects of Manure Application: Objective 1

Manure application significantly increased nitrate-N, orthophosphate-P, total nitrogen, total phosphorus, sodium, potassium, magnesium, chloride, bicarbonate, sodium adsorption ratio, and electrical conductivity. Extractable soil calcium, sulphate-S, and pH, for the most part, were not affected by manure application. The fertilizer-N treatments essentially had no effect on soil properties or groundwater quality, with the exception of nitrate-N cumulation in the soil profile.

Eight years of application of manure at the 120 Mg ha^{-1} rate caused the electrical conductivity to increase by nearly one unit in the 0 to 0.15-m soil layer. This increase has implications for the confined feeding operations and manure management regulations in the revised Agricultural Operation Practices Act in Alberta. The increase in soil electrical conductivity, and hence soil salinity, was observed under irrigated conditions in our study. The same application of manure would have resulted in higher electrical conductivity values in the top 0.15-m layer under rainfed conditions due to reduced water volume to leach salts. Results showed that a considerable amount of cattle manure would need to be applied to cause a one unit increase in electrical conductivity. The application of cattle manure at agronomic rates (i.e. 15 to 25 Mg ha^{-1} y^{-1}) would result in minimal salt cumulation in the top soil layer in the short term of 10 years or less, particularly under irrigation. The addition of salts from the manure caused a shift in the dominant cation as measured by saturated-paste water extraction. After eight years, extractable cations in the surface soil layer for the control treatment ranked calcium > potassium > magnesium > sodium at the coarse textured site, and calcium > sodium > magnesium > potassium at the medium-textured site. The cations ranked for the 120 Mg ha^{-1} treatment for both sites as potassium >> calcium ≅ sodium > magnesium.

The application of manure caused a shift from divalent to monovalent cations, and increased soil sodicity, which may result in degradation in soil structure. Degradation in soil structure may not necessarily occur if salt content is also increased. A one-time assessment of aggregate-size distribution in the soil surface layer showed that manure application promoted aggregate formation at both sites. This may be a temporary benefit due to the added organic matter, but if sodicity levels are allowed to build-up from heavy manure application, potassium and sodium may cause a net degradation of soil structure in the long term, as suggested by other studies that have been carried out for longer periods. High sodium content will degrade soil structure, and high potassium content can cause high potassium content in forages, which can cause grass tetany in cattle (i.e. an imbalance between potassium and magnesium/calcium cations).

The cumulation and movement of nitrate-N differed between the two sites. Larger amounts of soil nitrate-N cumulated as manure rate increased at the medium-textured site, particularly for the 60 and 120 Mg ha^{-1} y^{-1} manure rates and the 120 and 180 kg ha^{-1} y^{-1} fertilizer-N rates. Regardless of the nitrogen source, when nitrogen was applied in excess of crop requirements, build-up of excess nitrate-N in the soil profile resulted. The largest cumulation initially occurred in the upper soil layers and decreased with depth. The cumulated nitrate-N moved progressively deeper into the soil profile each year. The leaching front of the excess nitrate-N moved downward about 0.3 to 0.35 m per year in the 120 Mg ha^{-1} manure treatment at the medium-textured site. In four to five years, the leaching front had reached the maximum depth of 1.5 m to which soil was sampled. This rate was much slower than the movement of nitrate-N at the coarse-textured site.

Nitrate-N also increased in the top soil layer (0 to 0.15 m) as manure rate increased at the coarse-textured site. A complicating factor at the coarse-textured site was the subsoil contained high levels of extractable nitrate-N at the start of the study. The nitrate-N content in the subsoil decreased during the first four crop years, regardless of treatment. This decrease in subsoil nitrate-N was attributed to removal by leaching and crop uptake. In the last four crop years, there was an increase in soil nitrate-N content caused by the application of fertilizer-N and manure. Unlike the slower downward movement of nitrate-N at the medium-textured site, nitrate-N content in the coarse-textured soil profile changed more dramatically, with changes throughout the profile (0 to 1.5 m) within one year. Sandy soil, at the coarse-textured site, was more vulnerable to rapid leaching of excess nitrate-N from manure application. Extractable chloride, which serves as a good tracer for manure, closely reflected the nitrate-N data.

Manure application resulted in a large build-up of extractable orthophosphate-P. Net cumulation of orthophosphate-P in the 0 to 0.15-m soil layer increased by 64 kg ha^{-1} for the 20 Mg ha^{-1} manure rate and 730 kg ha^{-1} for the 120 Mg ha^{-1} manure rate at the coarse-textured site after eight years of manure application. Corresponding net increases at the medium-textured site were 131 and 1127 kg ha^{-1}, respectively. The extractable orthophosphate-P status in the 0 to 0.15-m soil layer at the end of the study was well above the agronomic requirements for crops, even for the 20 Mg ha^{-1} y^{-1} rate. The vast majority of cumulated orthophosphate-P remained in the 0 to 0.15-m soil layer at the medium-textured site, whereas some orthophosphate-P leached into the 0.15 to 0.6-m layer at the coarse-textured site. Therefore, under the conditions of this study, orthophosphate-P leached into the soil profile, but at a much slower rate than nitrate-N. A large build-up of phosphorus in the surface soil layer and its potential to contaminate surface runoff is of much greater concern than downward movement to groundwater, in the short term.

As with extractable nitrate-N and extractable orthophosphate-P, total nitrogen and total phosphorus also increased with manure application rate. The proportion of extractable nitrate-N and orthophosphate-P relative to total nitrogen and phosphorus changed with manure. The nitrate-N:total N and orthophosphate-P:total P ratios increased with manure application, and the effect was more pronounced as the manure rate increased and generally with time.

Net cumulation rates in soil were calculated for nitrate-N, orthophosphate-P, potassium, total nitrogen, and total phosphorus. For every megagram of total nitrogen, phosphorus, and potassium added from manure, nitrate-N increased 40.1 to 95.1 kg ha^{-1} (0 to 1.5 m soil layer), orthophosphate-P increased 400 to 421 kg ha^{-1} (0 to 0.6 m soil layer), potassium increased 62 to 106 kg ha^{-1} (0 to 0.15 m soil layer), total nitrogen increased 435 to 465 kg ha^{-1} (0 to 0.15 m soil layer), and total phosphorus increased 488 to 575 kg ha^{-1} (0. to 0.15 m soil layer). The ranges reflect variations between the two sites.

Groundwater nitrate-N content was not adversely affected by the manure or fertilizer-N treatments at the medium-textured site. This observation was supported by the soil data, which showed that excess nitrate-N required time to leach through the soil profile. It took about five to six years to leach to the 1.5-m depth. With the water table at an average depth of 2.49 m below the soil surface, another three years may be required before nitrate-N would start to enter the groundwater under the conditions of the experiment. In fact, there was some indication near the end of the study (i.e. during the eighth and last year) that nitrate-N concentration began to increase in the groundwater under the highest manure and fertilizer-N rates. Further monitoring would have been required to confirm this trend.

Groundwater nitrate-N and chloride concentrations at the coarse-textured site were adversely affected by the cumulation of nitrate-N and chloride from manure application and subsequent movement downwards through the soil profile. Results from the first four years were confounded by initially high levels of nitrate and chloride in the soil, presumably from past manure applications by the land owner. However, there was a clear relationship between the build-up and removal of nitrate-N and chloride in the soil and what was observed in the groundwater. As the initially high amounts of the nitrate-N and chloride were leached from the soil profile during the first four years of the study, a corresponding increase was observed in the groundwater. In the subsequent three years, nitrate-N and chloride began to re-cumulate in the soil profile, and as a result, less entered the groundwater. The data showed that a sandy soil over shallow groundwater is very vulnerable to nitrate contamination of groundwater from overapplication of manure, and other nutrient sources, on a yearly basis.

The results from the two sites showed that after a few years of annual manure application there were essentially no crop-yield differences among the three fertilizer-N and four manure rates, but they yielded significantly more than the control. Under the application regime of our study, the 20 Mg $ha^{-1}y^{-1}$ treatment provided the nutrient requirements for the crop within a few years of repeated applications. Higher application rates caused a cumulation of excess nutrients in the soil profile. The only time that a negative effect was observed was in 1998 (i.e. fifth crop year of the study) when manure application caused the crop to lodge, and the extent of lodging increased with application rate. Lodging was also observed in the fertilizer-N treatments in the same year, so the effect was not manure-specific.

The application of manure and fertilizer-N caused an increase in total nitrogen content in crop tissue. For example, from 1997 to 2001 at the coarse-textured site and from 1995 to 2001 at the medium-textured site, total nitrogen content in crop tissue in the 120 Mg ha^{-1} manure treatment was 1.24 to 2.24 times greater than the control, and total nitrogen content in the 180 kg ha^{-1} fertilizer-N treatment was 1.23 to 1.84 times greater then control. Manure and fertilizer-N treatments had minimal effect on total phosphorus and total calcium content in crop tissue.

Discontinuing the application of manure for two years had limited effects on some measured parameters. Soil nitrate-N, orthophosphate-P, chloride, sodium adsorption ratio, and electrical conductivity decreased two years after manure application was discontinued. Residual manure was able to maintain crop yields to the same level for two years compared to treatments that continued to receive manure.

Recommendations for Management Practices: Objective 2

Repeated applications of manure, particularly at high annual rates (60 to 120 Mg ha^{-1} y^{-1}), significantly affected soil and groundwater quality, with a build-up of nutrients in soil and the movement of nitrate and chloride into groundwater. Soil texture affected the distribution and movement of excess nutrients derived from manure. Clearly, manure applied to coarse-textured soils under irrigation poses the greatest risk to shallow groundwater. Prevention of nitrate contamination of shallow groundwater requires avoiding the build-up of excess nitrate in soil. Knowledge of soil type, including texture, and depth to water table is required to assess the vulnerability of a site to nutrient loss.

Based on our study, we recommend that repeated annual rates of manure in the short term (3 to 5 years) should be less than 40 Mg ha^{-1} (based on approximately 50% moisture content), particularly on coarse-textured, irrigated soils over shallow groundwater. However, agronomically, annual applications in the 15 to 25 Mg ha^{-1} range may be sufficient to meet crop requirements and prevent a build-up of excess nitrogen. However, even at these lower rates, the build-up of phosphorus in the surface soil layer will occur and this is a concern for potential surface water contamination by phosphorus through surface runoff. If manure application rates are eventually based on phosphorus, then the risk of excess nitrate build-up would be greatly reduced.

The key for nutrient management is to apply manure and commercial fertilizers at rates that will meet, but not exceed, crop nutrient requirements. Agricultural land should not be used to dispose of excess nutrients. These nutrients could be better distributed to meet crop requirements and prevent nutrient build-up in soil. However, nutrients in organic forms, such as livestock manure, must first be mineralized, and the mineralization rate may not be sufficient for optimum crop yield. A combination of low rates of manure and commercial fertilizer (particularly for nitrogen) may be optimal to avoid environmental problems with land application of manure, and at the same time achieve optimum crop production. Soil and manure testing are essential components of a sustainable manure management program. Land that receives regular applications of manure should be routinely monitored for nutrient build-up. Periodically, soils should be sampled below the sampling depth required for fertilizer recommendations. Sampling to 1.2 to 1.5 m, or deeper, gives an indication on whether nutrients, particularly nitrate-N, are cumulating deeper in the soil profile. Sampling the deeper subsoil is particularly important for more vulnerable sites, such as sandy soils under irrigation or high precipitation.

The animal sector is an important part of Alberta's agricultural industry. Our study, along with other long-term research in southern Alberta, and elsewhere, show that an overall nutrient management strategy for manure utilization is required so that our soil and water resources are not compromised.

REFERENCES

Agriculture and Agri-Food Canada. 1996. Issues and opportunities surrounding ILOs and manure management in western Canada - A discussion paper. PFRA, Agriculture and Agri-food Canada. 51 pp.

Alberta Soil Information Centre. 2001. AGRASID 3.0: Agricultural Region of Alberta Soil Inventory Database (Version 3.0). J.A. Brierley, T.C. Martin, and D.J. Spiess (eds.). Agriculture and Agri-Food Canada, Research Branch; Alberta Agriculture, Food and Rural Development, Conservation Development Branch, Edmonton, Alberta, Canada. (Available online at http://www.agric.gov.ab.ca/agdex/000/agrasid.html) (posted January 29, 2002; accessed July 9, 2002).

Aoyama, M., Angers, D.A., and N'Dayegamiye, A. 1999. Particulate and mineral-associated organic matter in water-stable aggregates as affected by mineral fertilizer and manure applications. Can. J. Soil Sci. **79**: 295-302.

Barnett, G.M. 1991. Deleterious effects of animal manure. Pages 55-84 *in* D.A. Leger, N.K. Patni, and S.K. Ho (eds.) Proceedings of the national workshop on land application of animal manure. Canadian Agricultural Research Council. Ottawa, Ontario, Canada. June 11-12, 1991.

Bennett, D.R. and McCarley, E.L. 1995. Land availability for manure disposal in the LNID portion of the County of Lethbridge. Irrigation Branch, Alberta Agriculture, Food and Rural Development, Lethbridge, Alberta, Canada. 19 pp.

Brady, N.C. and Weil, R.R. 2002. The nature and properties of soils. 13th edition. Prentice Hall, Upper Saddle River, New Jersey, United States. 960 pp.

Breeuwsma, A., Reijerink, J.G.A., and Schoumans, O.F. 1995. Impact of manure on accumulation and leaching of phosphate in areas of intensive livestock farming. Pages 239-249 *in* K. Steele (ed.) Animal waste and the land-water interface. Lewis Publishers-CRC Press, New York, New York, United States.

Bullock, M.S., Larney, F.J., McGinn, S.M., and Izaurralde, R.C. 1999. Freeze-drying processes and wind erodibility of a clay loam soil in southern Alberta. Can. J. Soil Sci. **79**: 127-135.

Caldwell, W.J. 1998. Land-use planning, the environment, and siting intensive livestock facilities in the 21st century. J. Soil Water Cons. **53**: 102-106.

Campbell, K.L. and Edwards, D.R. 2001. Phosphorus and water quality impacts. Pages 91-109 *in* W. F. Ritter and A. Shirmohammadi (eds.). Agricultural nonpoint source pollution: Watershed management and hydrology. Lewis Publishers, Boca Raton, Florida, United States.

Canada-Alberta Environmental Sustainable Agriculture (CAESA). 1998. Agricultural impacts on water quality in Alberta: An initial assessment. CAESA Water Quality Committee. Published by Alberta Agriculture, Food and Rural Development, Edmonton, Alberta, Canada. 95 pp.

Canadian Council of Ministers of the Environment (CCME). 1987 (and updates). Canadian water quality guidelines. Prepared by the Task Force on Water Quality Guidelines of the CCME. Winnipeg, Manitoba, Canada.

Chang, C. 1997. Challenges of manure management. Pages 1-6 *in* Proceedings of the Canadian Society of Soil Science Waste Management Workshop. Lethbridge, Alberta, Canada, July 7, 1996.

Chang C. and Entz T. 1996. Nitrate leaching losses under repeated cattle feedlot manure applications in southern Alberta. J. Environ. Qual. **25**: 145-153.

Chang, C. and Janzen, H.H. 1996. Long-term fate of nitrogen from annual feedlot manure applications. J. Environ. Qual. **25**: 785-790.
Chang, C., Janzen, H.H., and Entz, T. 1994. Long-term manure application effects on nutrient uptake by barley. Can. J. Plant Sci. **74**: 327-330.
Chang, C., Sommerfeldt, T.G., and Entz, T. 1991. Soil chemistry after eleven annual applications of cattle feedlot manure. J. Environ. Qual. **20**: 475-480.
Chang, C., Sommerfeldt, T.G., and Entz, T. 1993. Barley performance under heavy applications of cattle feedlot manure. Agron. J. **85**: 1013-1018.
Chardon, W.J., Oenema, O., del Castilho, P., Vriesema, R., Japenga, J., and Blaauw, D. 1997. Organic phosphorus in solutions and leachates from soils treated with animal slurries. J. Environ. Qual. **26**: 372-378.
Correll, D.L. 1998. The role of phosphorus in the eutrophication of receiving waters: A review. J. Environ. Qual. **27**: 261-266.
Davis, J.G, Young, M., and Ahnstedt, B. 1997. Soil characteristics of cropland fertilized with feedlot manure in the South Platte river basin of Colorado. J. Soil Water Cons. **52**: 327-331.
Daniel, T.C., Sharpley, A.N., Edwards, D.R., Wedepohl, R., and Lemunyon, J.L. 1994. Minimizing surface water eutrophication from agriculture by phosphorus management. J. Soil Water Cons. **49**: 30-38.
Dickson, A. 1996. Issues we face in developing Manitoba's livestock potential. Pages 19-26 *in* Manure management symposium proceedings. Winnipeg, Manitoba, Canada, March 20-21, 1996.
Dormaar, J.F. and Chang, C. 1995. Effect of 20 annual applications of excess feedlot manure on labile soil phosphorus. Can. J. Soil Sci. **75**: 507-512.
Eghball, B., Binford, G.D., and Baltensperger, D.D. 1996. Phosphorus movement and adsorption in a soil receiving long-term manure and fertilizer application. J. Environ. Qual. **25**: 1339-1343.
Environment Canada. 2001. Canadian climate normals: Lethbridge CDA. [Online]. Environment Canada. Available at http://www.mscsmc.ec.gc.ca/climate/climate_normals/results_e.cfm?&RequestTimeout=120&StationName=&SearchType=&Province=ALTA&StnId=29419&autofwd=0 (posted July 9, 2002; accessed August 22, 2002).
Eriksen, J. and Mortensen, J.V. 1999. Soil sulphur status following long-term annual application of animal manure and mineral fertilizers. Biol. Fertil. Soils **28**: 416-421.
Flynn, C.P. and Cho, C.M. 1996. Nitrate distribution in the soil profile from the application of hog manure. Pages 54-61 *in* Papers presented at the 39th annual Manitoba Society of Soil Science meeting. Winnipeg, Manitoba, Canada, January 3-4, 1996.
Gao, G. and Chang, C. 1996. Changes in CEC and particle size distribution of soils associated with long-term annual applications of cattle feedlot manure. Soil Sci. **161**: 115-120.
Gee, G.W. and Bauder, J.W. 1979. Particle size analysis by hydrometer: A simplified method for routine textural analysis and a sensitivity test of measurement parameters. Soil Sci. Soc. Am. J. **43**: 1004-1007.
Geohring, L.D., McHugh, O.V., Walter, M.T., Steenhuis, T.S., Akhtar, M.S., and Walter, M.F. 2001. Phosphorus transport into subsurface drains by macropores after manure applications: Implications for best manure management practices. Soil Sci. **166**: 896-909.
Goss, M.J., Ogilvie, J.R., Beauchamp, E.G., Stonehouse, D.P., Miller, M.H., and Parris, K. 1994. Current state of the art on manure/nutrient management. University of Guelph, Guelph,

Ontario, Canada. Canada-Ontario Environmental Sustainability Accord (COESA) Research Sub-program. COESA Report No. RES/MAN-001/94. 88 pp.
Graetz, D.A., Nair, V.D., Portier, K.M., and Voss, R.L. 1999. Phosphorus accumulation in manure-impacted Spodosols in Florida. Agric. Ecosys. Environ. **75**: 31-40.
Hao, X. and Chang, C. 2003. Does long-term heavy cattle manure application increase salinity of a clay loam soil in semi-arid southern Alberta? Agric. Ecosys. Environ. **94**: 89-103.
Hao, X. and Chang, C. 2002. Effect of 25 annual cattle manure applications on soluble and exchangeable cations in soil. Soil Sci. **167**: 126-134.
Hao, X., Chang, C., Janzen, H., Hill, B., Travis, G., and Ormann, T. 2001. Potential nitrogen enrichment of soil and surface water by atmospheric NH_3 near livestock operations. Pages 204-208 *in* 38th Annual Alberta Soil Science Workshop Proceedings. Lethbridge, Alberta, Canada. February 20-22, 2001.
Hao, X., Chang, C., Travis G.R., and Zhang, F. 2003. Soil carbon and nitrogen response to 25 annual cattle manure applications. J. Plant Nutr. Soil Sci. **166**: 239-245.
Hatfield, J.L. 1997. Environmental implications of livestock production. J. Soil Water Cons. **52**: 312-313.
Haygarth, P.M. and Jarvis, S.C. 1999. Transfer of phosphorus from agricultural soils. Adv. Agron. **66**: 195-249.
Haygarth, P.M., Heathwaite, A.L., Jarvis, S.C., and Harrod, T.R. 2000. Hydrological factors for phosphorus transfer from agricultural soils. Adv. Agron. **69**: 153-178.
Heckrath, G., Brookes, P.C., Poulton, P.R., and Goulding, K.W.T. 1995. Phosphorus leaching from soils containing different phosphorus concentrations in the Broadbalk experiment. J. Environ. Qual. **24**: 904-910.
Hogg, T.J. and Henry J.L. 1984. Comparison of 1:1 and 1:2 suspensions and extracts with the saturation extract in estimating salinity in Saskatchewan soils. Can. J. Soil Sci. **64**: 699-704.
Howard, A.E. 2001. Agronomic thresholds for soil phosphorus in Alberta: A review. Soil Phosphorus Limits Project. Alberta Agriculture, Food and Rural Development, Edmonton, Alberta, Canada. 38 pp.
Hutchinson, G.L., Millington, R.J., and Peters, D.B. 1972. Atmospheric ammonia: Absorption by plant leaves. Science **175:** 771-772.
Intensive Livestock Operations Committee. 1973. Confinement livestock facilities waste management code of practice. Alberta Environment and Alberta Agriculture, Edmonton, Alberta, Canada. Agdex 538/710 6M/73. 31 pp.
James, D.W., Kotuby-Amacher, J., Anderson, G.L., and Huber, D.A. 1996. Phosphorus mobility in calcareous soils under heavy manuring. J. Environ. Qual. **25**: 770-775.
Johnston, A.E., Tunney, H., and Foy, R.H. 1997. Phosphorus loss from agriculture to water: Synthesis and summary. Pages 455-461 *in* H. Tunney, O.T. Carton, P.C. Brookes, and A.E. Johnston (eds.). Phosphorus loss from soil to water. CAB International, Wallingford, Oxon, United Kingdom.
King, L.D., Burns, J.C., and Westerman, P.W. 1990. Long-term swine lagoon effluent applications on 'Coastal' bermudagrass: II. Effect on nutrient accumulation in soil. J. Environ. Qual. **19**: 756-760.
King, L.D., Westerman, P.W., Cummings, G.A., Overcash, M.R., and Burns, J.C. 1985. Swine lagoon effluent applied to 'Coastal' bermudagrass: II. Effect on soil. J. Environ. Qual. **14**: 14-21.

Kingery, W.L., Wood, C.W., Delaney, D.P., Williams, J.C., and Mullins, G.L. 1994. Impact of long-term land application of broiler litter on environmentally related soil properties. J. Environ. Qual. **23**: 139-147.
Larney, F.J. and Janzen, H.H. 1996. Restoration of productivity to a desurfaced soil with livestock manure, crop residue, and fertilizer amendments. Agron. J. **88**: 921-927.
Larney, F.J. and Janzen, H.H. 1997. A simulated erosion approach to assess rates of cattle manure and phosphorus fertilizer for restoring productivity to eroded soils. Agric. Ecosys. Environ. **65**: 113-126.
Larney, F.J., Janzen, H.H., Olson, B.M., and Lindwall, C.W. 2000a. Soil quality and productivity responses to simulated erosion and restorative amendments. Can. J. Soil Sci. **80**: 515-522.
Larney, F.J., Olson, B.M., Janzen, H.H., and Lindwall, C.W. 2000b. Early impact of topsoil removal and soil amendments on crop productivity. Agron. J. **92**: 948-956.
Li, X. 2001. Phosphorus mobility in soil landscape: A site-specific approach. Pages 89-91 *in* Proceedings of the 38th Annual Alberta Soil Science Workshop. Lethbridge, Alberta, Canada. February 20-22, 2001.
Loehr, R.C. 1972. Animal waste management - problems and guidelines for solutions. J. Environ. Qual. **1**: 71-78.
Miller, J.J., Sweetland, N.J., and Chang, C. 2002a. Soil physical properties of a Chernozemic clay loam after 24 years of beef cattle manure application. Can. J. Soil Sci. **82**: 287-296.
Miller, J.J., Sweetland, N.J., and Chang, C. 2002b. Hydrological properties of a clay loam soil after long-term cattle manure application. J. Environ. Qual. **31**: 989-996.
Ollis, G.W. 1987. Disease control calendar for a beef herd. Alberta Agriculture, Edmonton, Alberta, Canada. Agdex 420/662-1. 9 pp.
Olson, B.M., Bennett, D.R., Borg, R., McKenzie, R.H., and Atkins, R.P. 1997. Manure and nutrient management to sustain groundwater quality near feedlots in central Alberta. Prepared for the Water Quality Program of the Canada-Alberta Environmentally Sustainable Agriculture (CAESA) Agreement. 118 pp.
Olson, B.M., Bennett, D.R., McKenzie, R.H., Ormann, T., and Atkins, R.P. 1998. Manure nutrient management to sustain groundwater quality near feedlots. Alberta Agriculture, Food and Rural Development, Lethbridge, Alberta, Canada. Canada-Alberta Environmentally Sustainable Agriculture (CAESA) Agreement, Proposal Based Research Program, project number RES-028-93. 214 pp.
Olson, B.M., Bennett, D.R., McKenzie, R.H., Ormann, T., and Atkins, R.P. 1999. Manure and nutrient management to sustain soil and groundwater quality under irrigated silage barley. Alberta Agriculture, Food and Rural Development, Lethbridge, Alberta, Canada. Alberta Agricultural Research Institute, Farming for the Future Direct Funding Program final report, project number 970786. 86 pp.
Parham, J.A., Deng, S.P., Raun, W.R., and Johnson, G.V. 2002. Long-term cattle manure application in soil. I. Effect on soil phosphorus levels, microbial biomass C, and dehydrogenase and phosphatase activities. Biol. Fertil. Soils **35**: 328-337.
Paterson, B.A. and Lindwall, C.W. 1992. Agricultural impacts on water quality in Alberta. *In* Agricultural impacts on water quality: Canadian perspectives. Proceedings of the National Workshop. Ottawa, Ontario, Canada. April 23-24, 1992.
Pell, A.N. 1997. Manure and microbes: Public and animal health problem? J. Dairy Sci. **80**: 2673-2681.

Power, J.F. and Dick, W.A. 2000. Land application of agricultural, industrial, and municipal by-products. Number 6 in the SSSA book series. Soil Science Society of America, Inc., Madison, Wisconsin, United States. 653 pp.
Power, J.F., Eghball, B., and Lory, J.A. 1994. Utilization of nutrients in beef cattle feedlot manure in the Northern Great Plains. Pages 161-167 *in* D.E. Storm and K.G. Casey (eds.) Great plains animal waste conference on confined animal production and water quality: Balancing animal production and the environment. Proceedings of the 1994 conference. Denver, Colorado, United States, October 19-21, 1994.
Power, J.F. and Schepers, J.S. 1989. Nitrate contamination of groundwater in North America. Agric. Ecosys. Environ. **26**: 165-187.
Pratt, P.F., Broadbent, F.E., and Martin, J.P. 1973. Using organic wastes as nitrogen fertilizers. California Agriculture **27(6)**: 10-13.
Province of Alberta. 2001. Agricultural Operation Practices Act. Alberta Queen's Printer, Edmonton, Alberta, Canada.
Qian, P., Liang, J., and Karamanos, R.E. 1991. Comparison of several extractants for available phosphorus and potassium. Pages 91-100 *in* Soil and Crops Workshop '91, University of Saskatchewan, Saskatoon, Saskatchewan, Canada. February 21-22, 1991.
Rengasamy, P. 1983. Clay dispersion in relation to changes in the electrolyte composition of dialysed red-brown earths. J. Soil Sci. **34**: 723-732.
Riddell, K.M. and Rodvang, S.J. 1992. Soil and groundwater chemistry beneath irrigated land receiving manure applications in southern Alberta. Pages 69-109 *in* Impact of agricultural management practices on water quality. Agriculture Canada and Alberta Agriculture, Lethbridge, Alberta, Canada.
Ryden, J.C., Syers, J.K., and Harris, R.F. 1973. Phosphorus in runoff and streams. Adv. Agron. **25**: 1-45.
SAS Institute Inc. 2000. Copyright 1999-2000. SAS/STAT software, The SAS® System for Windows®, release 8. SAS Institute Inc., Cary, North Carolina, United States.
Sharpley, A.N., Chapra, S.C., Wedepohl, R., Sims, J.T., Daniel, T.C., and Reddy, K.R. 1994. Managing agricultural phosphorus for protection of surface waters: Issues and options. J. Environ. Qual: **23**: 437-451.
Sharpley, A., Foy, B., Withers, P. 2000. Practical and innovative measures for the control of agricultural phosphorus losses to water: An overview. J. Environ. Qual. **29**: 1-9.
Sharpley, A., Meisinger, J.J., Breeuwsma, A., Sims, J.T., Daniel, T.C., and Schepers, J.S. 1998. Impacts of manure management on ground and surface water quality. Pages 173-242 *in* J.L. Hatfield and B.A. Stewart (eds.) Animal Waste Utilization: Effective use of manure as a soil resource. Ann Arbor Press, Chelsea, Michigan, United States.
Sharpley, A.N., Smith, S.J., and Bain, W.R. 1993. Nitrogen and phosphorus fate from long-term poultry litter applications to Oklahoma soils. Soil Sci. Soc. Am. J. **57**: 1131-1137.
Sims, J.T., Simard, R.R., and Joern, B.C. 1998. Phosphorus loss in agricultural drainage: Historical perspective and current research. J. Environ Qual. **27**: 277-293.
Smith, S.J., Mathers, A.C., and Stewart, B.A. 1980. Distribution of nitrogen forms in soil receiving cattle feedlot waste. J. Environ. Qual. **9**: 215-218.
Sommerfeldt, T.G. and Chang, C. 1985. Changes in soil properties under annual applications of feedlot manure and different tillage practices. Soil Sci. Soc. Am. J. **49**: 983-987.
Sommerfeldt, T.G. and Chang, C. 1987. Soil-water properties as affected by twelve annual applications of a cattle feedlot manure. Soil Sci. Soc. Am. J. **51**: 7-9.

Sommerfeldt, T.G., Chang, C., and Entz, T. 1988. Long-term annual manure applications increases soil organic matter and nitrogen, and decrease carbon to nitrogen ratio. Soil Sci. Soc. Am. J. **52**: 1668-1672.

Spalding, R.F. and Exner, M.E. 1991. Nitrate contamination in the contiguous United States. Pages 13-48 *in* I. Bogárdi and R.D. Kuzelka (eds.) Nitrate contamination: Exposure, consequence, and control. NATO Advance Science Institute Series G: Ecological Sciences Vol. 30. Springer-Verlag, Berlin, Germany.

Steele, K. (ed.). 1995. Animal waste and the land-water interface. Lewis Publishers, Boca Raton, Florida, United States. 589 pp.

Sturgul, S.J. and Bundy, L.G. 2002. Understanding soil phosphorus: An overview of phosphorus, water quality, and agricultural management practices. Publication A3771. Nutrient and Pest Management Program, University of Wisconsin, Madison, Wisconsin, United States. 32 pp.

Tanji, K.K. (ed.). 1990. Agricultural salinity assessment and management. ASCE Manuals and Report on Engineering Practice No. 71. American Society of Civil Engineers, New York, New York, United States. 619 pp.

Technicon Industrial Systems. 1986. Nitrate. Technicon TrAAcs 800™ Industrial Method No. 782-86T. Technicon Industrial Systems, Tarrytown, New York, United States.

Technicon Industrial Systems. 1987a. Ammonia in water and wastewater. Technicon TrAAcs 800™ Industrial Method No. 780-86T. Technicon Industrial Systems, Tarrytown, New York, United States.

Technicon Industrial Systems. 1987b. Chloride. Technicon TrAAcs 800™ Industrial Method No. 783-86T. Technicon Industrial Systems, Tarrytown, New York, United States.

Technicon Industrial Systems. 1987c. Ortho phosphorus. Technicon TrAAcs 800™ Industrial Method No. 781-86T. Technicon Industrial Systems, Tarrytown, New York, United States.

Tisdale, S.L. and Nelson, W.L. 1975. Soil fertility and fertilizers, 3rd edition. Macmillian Publishing Co., Inc., New York, New York, United States. 694 pp.

Warman, P.R. and Cooper, J.M. 2000. Fertilization of a mixed forage crop with fresh and composted chicken manure and NPK fertilizer: Effects on soil and tissue Ca, Mg, S, B, Cu, Fe, Mn, and Zn. Can. J. Soil Sci. **80**: 345-352.

Whalen, J.K. and Chang, C. 2001. Phosphorus accumulation in cultivated soils from long-term annual applications of cattle feedlot manure. J. Environ. Qual. **30**: 229-237.

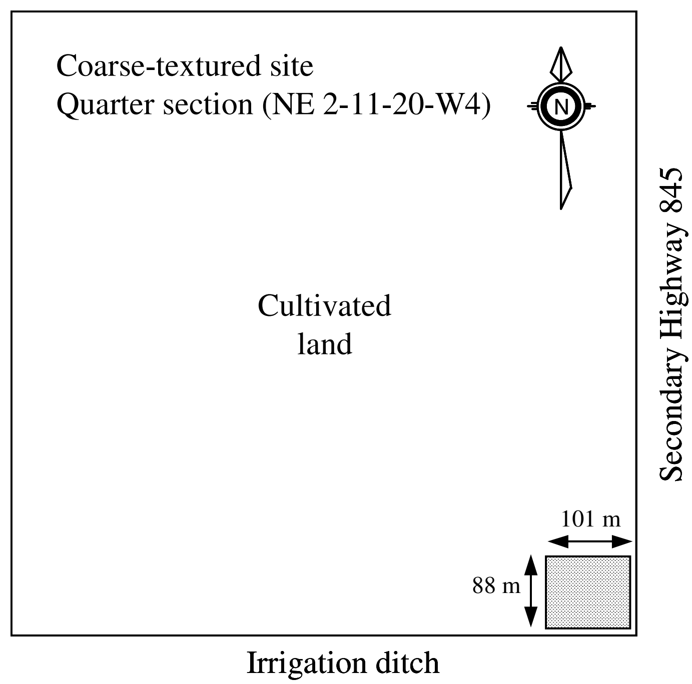
Whalen, J.K. and Chang, C. 2002a. Phosphorus sorption capacities of calcareous soils receiving cattle manure applications for 25 years. Comm. Soil Sci. Plant Anal. **33**: 1011-1026.

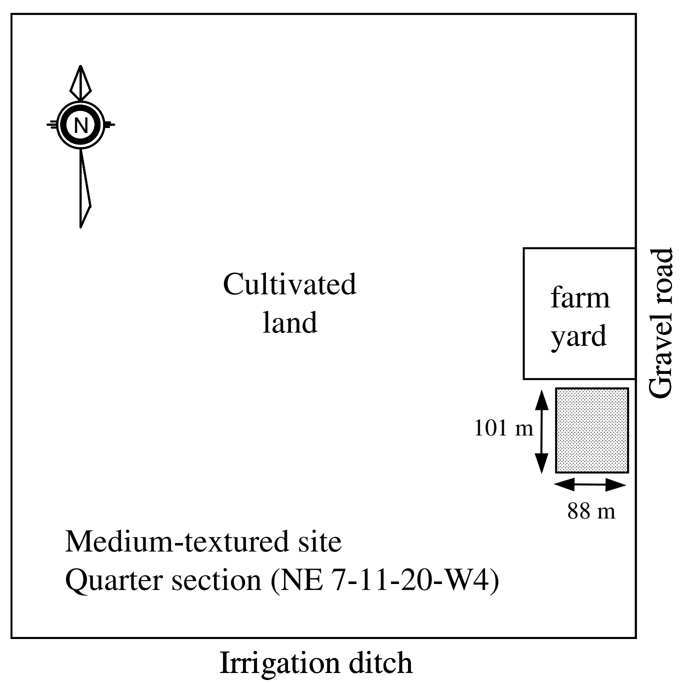
Whalen, J.K. and Chang, C. 2002b. Macroaggregate characteristics in cultivated soils after 25 annual manure applications. Soil Sci. Soc. Am. J. **66**: 1637-1647.

Whalen, J.K., Chang C., and Clayton, G.W. 2002. Cattle manure and lime amendments to improve crop production of acidic soils in northern Alberta. Can. J. Soil Sci. **82**: 227-238.

Zebarth, B.J., Neilsen, G.H., Hogue, E., and Neilsen, D. 1999. Influence of organic waste amendments on selected soil physical and chemical properties. Can. J. Soil Sci. **79**: 501-504.

Appendix 1. Location of the coarse-textured and medium-textured sites within their respective quarter sections.





Appendix 2. Procedure and results for determining nitrogen fertilizer requirements for the BMP-manure subplots, based on spring soil-extractable nitrogen and estimates of mineralizable nitrogen from added manure.

Table 2.1. Extractable soil nitrogen content (kg ha^{-1}) in the BMP-manure subplots at the coarse- and medium-textured site in spring 1994 to 1998 (n = 5).

Soil depth (m)	Coarse-textured site				Medium-textured site			
	20 [z]	40	60	120	20	40	60	120
	Spring 1994							
0 - 0.15	17	22	22	48	17	17	15	7.9
0.15 - 0.3	14	13	20	22	11	10	8.5	8.3
0.3 - 0.6	18	17	21	28	25	15	4.8	3.5
0.6 - 0.9	25	22	34	59	4.0	3.7	5.6	0.0
0.9 - 1.2	42	50	33	134	9.9	1.9	6.0	0.0
(0 – 0.6)	**49**	**52**	**63**	**98**	**53**	**42**	**28**	**20**
	Spring 1995							
0 - 0.15	26	31	41	92	35	35	38	32
0.15 - 0.3	19	21	23	37	15	25	25	18
0.3 - 0.6	52	45	74	104	9.0	12	6.1	5.0
0.6 - 0.9	60	69	103	81	1.5	2.0	3.5	1.9
0.9 - 1.2	54	58	43	144	3.6	2.4	3.5	2.2
(0 – 0.6)	**97**	**97**	**138**	**233**	**59**	**72**	**69**	**55**
	Spring 1996							
0 - 0.15	28	35	47	64	39	64	47	78
0.15 - 0.3	34	31	43	48	39	40	43	68
0.3 - 0.6	57	52	67	95	29	31	31	37
(0 – 0.6)	**119**	**118**	**157**	**207**	**107**	**135**	**121**	**183**
	Spring 1997							
0 - 0.15	41	35	47	67	20	23	52	83
0.15 - 0.3	17	17	20	32	6.1	6.3	13	29
0.3 - 0.6	19	23	28	44	5.8	8.5	9.8	49
(0 – 0.6)	**77**	**75**	**95**	**143**	**32**	**38**	**75**	**161**
	Spring 1998							
0 - 0.15	13	46	59	127	28	46	101	178
0.15 - 0.3	11	25	46	36	14	20	28	45
0.3 - 0.6	19	26	33	44	14	17	31	85
(0 – 0.6)	**43**	**97**	**138**	**207**	**56**	**83**	**160**	**308**

[z] Mg ha^{-1} manure on a wet-weight basis.

Table 2.2. Total nitrogen and moisture content of applied manure.										
	Coarse-textured site					Medium-textured site				
	1993[z]	1994	1995	1996	1997	1993	1994	1995	1996	1997
% total N[y]	2.30	1.76	2.58	1.45	1.45	2.26	2.23	4.59	2.71	1.75
% moisture[x]	59.5	59.5	59.6	47.8	32.2	60.9	62.4	74.6	63.1	34.6

[z] Year of manure application.
[y] Expressed on a dry-weight basis.
[x] Expressed on a wet-weight basis.

Estimating the amount of total nitrogen mineralized from applied manure. Example calculation:

The decay series of 0.40, 0.25, 0.06, 0.03 was used for manure with higher total nitrogen content (2.23 to 4.59 %), and the decay series 0.35, 0.15, 0.10, 0.075, 0.05, 0.04 was used for manure with lower total nitrogen content (1.76 and 1.45 %) (Pratt et al. 1973).

Coarse-textured site 1994 crop year, 20 Mg ha^{-1} rate:

20 Mg ha^{-1} x 1000 kg Mg^{-1} = 20,000 kg ha^{-1} wet manure
20,000 kg ha^{-1} x (1 - (59.5/100)) = 8,100 kg ha^{-1} dry manure
8,100 kg ha^{-1} x 0.0230 = 186.3 kg total N ha^{-1}
186.3 kg ha^{-1} x 0.40 = **74.5 kg ha^{-1} of mineralized manure-N in 1994 crop year**
186.3 kg ha^{-1} - 74.5 kg ha^{-1} = 111.8 kg ha^{-1} residue N carried over to 1995

Coarse-textured site 1995 crop year, 20 Mg ha^{-1} rate:

20 Mg ha^{-1} x 1000 kg Mg^{-1} = 20,000 kg ha^{-1} wet manure
20,000 kg ha^{-1} x (1 - (59.5/100)) = 8,100 kg ha^{-1} dry manure
8,100 kg ha^{-1} x 0.0176 = 142.6 kg total N ha^{-1}
142.6 kg ha^{-1} x 0.35 = 49.9 kg N ha^{-1} mineralized from manure applied in fall, 1994
142.6 kg ha^{-1} - 49.9 kg ha^{-1} = 92.7 kg ha^{-1} residue N carried over to 1996

111.8 kg ha^{-1} x 0.25 = 28.0 kg N ha^{-1} mineralized from manure applied in fall, 1993
186.3 kg ha^{-1} - 74.5 kg ha-1 - 28.0 kg ha^{-1} = 83.8 kg ha^{-1} residue N carried over to 1996

49.9 kg ha^{-1} + 28.0 kg ha^{-1} = **77.9 kg ha^{-1} of mineralized manure-N in 1995 crop year**

Coarse-textured site 1996 crop year, 20 Mg ha^{-1} rate:

20 Mg ha^{-1} x 1000 kg Mg^{-1} = 20,000 kg ha^{-1} wet manure
20,000 kg ha^{-1} x (1 - (59.6/100)) = 8,080 kg ha^{-1} dry manure
8,080 kg ha^{-1} x 0.0258 = 208.5 kg total N ha^{-1}
208.5 kg ha^{-1} x 0.40 = 83.4 kg N ha^{-1} mineralized from manure applied in fall, 1995
208.5 kg ha^{-1} - 83.4 kg ha^{-1} = 125.1 kg ha^{-1} residue N carried over to 1997

92.7 kg ha^{-1} x 0.15 = 13.9 kg N ha^{-1} mineralized from manure applied in fall, 1994
142.6 kg ha^{-1} - 49.9 kg ha^{-1} - 13.9 kg ha^{-1} = 78.8 kg ha^{-1} residue N carried over to 1997

83.8 kg ha^{-1} x 0.06 = 5.0 kg N ha^{-1} mineralized from manure applied in fall, 1993
186.3 - 74.5 - 28.0 - 5.0 = 78.8 kg ha^{-1} residue N carried over to 1997

83.4 + 13.9 + 5.0 = **102.3 kg ha^{-1} of mineralized manure-N in 1996 crop year**

Coarse-textured site 1997 crop year, 20 Mg ha^{-1} rate:

20 Mg ha^{-1} x 1000 kg Mg^{-1} = 20,000 kg ha^{-1} wet manure
20,000 kg ha^{-1} x (1 - (47.8/100)) = 10,440 kg ha^{-1} dry manure
10,440 kg ha^{-1} x 0.0145 = 151.4 kg total N ha^{-1}
151.4 kg ha^{-1} x 0.35 = 53.0 kg N ha^{-1} mineralized from manure applied in fall, 1996
151.4 kg ha^{-1} - 53.0 kg ha^{-1} = 98.4 kg ha^{-1} residue N carried over to 1998

125.1 kg ha^{-1} x 0.25 = 31.3 kg N ha^{-1} mineralized from manure applied in fall, 1995
208.5 kg ha^{-1} - 83.4 kg ha^{-1} - 31.3 kg N ha^{-1} = 93.8 kg ha^{-1} residue N carried over to 1998

78.8 kg ha^{-1} x 0.10 = 7.9 kg N ha^{-1} mineralized from manure applied in fall, 1994
142.6 - 49.9 - 13.9 - 7.9 = 70.9 kg ha^{-1} residue N carried over to 1998

78.8 kg ha^{-1} x 0.03 = 2.4 kg N ha^{-1} mineralized from manure applied in fall, 1993
186.3 - 74.5 - 28.0 - 5.0 - 2.4 = 76.4 kg ha^{-1} residue N carried over to 1998

53.0 + 31.3 + 7.9 + 2.4 = **94.6 kg ha^{-1} of mineralized manure-N in 1997 crop year**

Coarse-textured site 1998 crop year, 20 Mg ha^{-1} rate:

20 Mg ha^{-1} x 1000 kg Mg^{-1} = 20,000 kg ha^{-1} wet manure
20,000 kg ha^{-1} x (1 - (32.2/100)) = 13,560 kg ha^{-1} dry manure
13,560 kg ha^{-1} x 0.0145 = 196.6 kg total N ha^{-1}
196.6 kg ha^{-1} x 0.35 = 68.8 kg N ha^{-1} mineralized from manure applied in fall, 1997
196.6 kg ha^{-1} - 68.8 kg ha^{-1} = 127.8 kg ha^{-1} residue N carried over to 1999

98.4 kg ha^{-1} x 0.15 = 14.8 kg N ha^{-1} mineralized from manure applied in fall, 1996
151.4 kg ha^{-1} - 53.0 kg ha^{-1} - 14.8 kg N ha^{-1} = 83.6 kg ha^{-1} residue N carried over to 1999

93.8 kg ha^{-1} x 0.06 = 5.6 kg N ha^{-1} mineralized from manure applied in fall, 1995
208.5 - 83.4 - 31.3 - 5.6 = 88.2 kg ha^{-1} residue N carried over to 1999

70.9 kg ha^{-1} x 0.075 = 5.3 kg N ha^{-1} mineralized from manure applied in fall, 1994
142.6 - 49.9 - 13.9 - 7.9 - 5.3 = 65.6 kg ha^{-1} residue N carried over to 1999

76.4 kg ha^{-1} x 0.03 = 2.3 kg N ha^{-1} mineralized from manure applied in fall, 1993
186.3 - 74.5 - 28.0 - 5.0 - 2.4 - 2.3 = 74.1 kg ha^{-1} residue N carried over to 1999

68.8 + 14.8 + 5.6 + 5.3 + 2.3 = **91.5 kg ha^{-1} of mineralized manure-N in 1998 crop year**

We assumed, for a best management practice (BMP), that 180 kg ha^{-1} of nitrogen in the 0 to 0.6-m soil depth is the optimum level for cereal-barley production under irrigation in southern Alberta. The BMP-manure subplots were sampled in the spring to measure available nitrogen. In addition, an estimate of nitrogen mineralized from added manure was calculated based on decay series reported by Pratt et al. (1973). The purpose of the BMP-manure treatments was to add supplemental nitrogen fertilizer if the measured soil-available nitrogen in the spring plus the estimated nitrogen mineralized from added manure was less than 180 kg ha^{-1} nitrogen. This was only carried out for the 20 Mg ha^{-1} BMP-manure subplots in 1994 at both sites. The spring 1994 soil test nitrogen plus estimated mineralized nitrogen from the manure was about 124 kg ha^{-1} nitrogen (Table 2.3). Sixty kilograms per hectare of nitrogen, as commercial urea fertilizer, were added to the 20 Mg ha^{-1} BMP-manure subplots in 1994.

The summary of results in Table 2.3 show that estimated available nitrogen was about 25 kg ha^{-1} below the target BMP level (180 kg ha^{-1}) in the 20 Mg ha^{-1} manure subplots at the medium-textured site in 1995 and 1997, and about 55 kg ha^{-1} below the target BMP level in the 20 Mg ha^{-1} manure subplots at the coarse-textured site in 1998. Earlier calculations gave higher values because we assumed the manure moisture content values were reported on a dry-weight basis. However, it was later revealed that the moisture contents were reported on a wet-weight basis. Lower estimates of manure-mineralized nitrogen were obtained when the manure moisture values were reported on a wet-weight basis. At no time did the 40, 60, and 120 Mg ha^{-1} BMP-manure subplots require the addition of nitrogen fertilizer. Therefore, the BMP-manure treatments were essentially not implemented in the study.

Table 2.3. Available nitrogen based on spring soil test and estimated mineralized from fall-applied manure.

Nitrogen source [z,y]	Coarse-texture site 20 [x]	40	60	120	Medium-texture site 20	40	60	120
	kg N ha^{-1}				kg N ha^{-1}			
1994 crop year								
Spring 1994 soil test	49	52	63	98	53	42	28	20
1993 applied manure	75	150	225	450	71	142	213	426
Total available N	124	202	288	548	124	184	241	446
1995 crop year								
Spring 1995 soil test	97	97	138	233	59	72	69	55
1994 applied manure	50	100	150	300	67	134	201	402
1993 applied manure	28	56	84	168	27	54	81	162
Total available N	175	253	372	701	153	260	351	619
1996 crop year								
Spring 1996 soil test	119	118	157	207	107	135	121	183
1995 applied manure	83	166	249	498	93	186	279	558
1994 applied manure	14	28	42	84	25	50	75	150
1993 applied manure	5	10	15	30	5	10	15	30
Total available N	221	322	463	819	230	381	490	921
1997 crop year								
Spring 1997 soil test	77	75	95	143	32	38	75	161
1996 applied manure	53	106	159	318	80	160	240	480
1995 applied manure	31	62	93	186	35	70	105	210
1994 applied manure	8	16	24	48	5	10	15	30
1993 applied manure	2	4	6	12	2	4	6	12
Total available N	171	263	377	707	154	282	441	893
1998 crop year								
Spring 1998 soil test	43	97	138	207	56	83	160	308
1997 applied manure	69	138	207	414	80	160	240	480
1996 applied manure	15	30	45	90	30	60	90	180
1995 applied manure	6	12	18	36	6	12	18	36
1994 applied manure	5	10	15	30	2	4	6	12
1993 applied manure	2	4	6	12	2	4	6	12
Total available N	125	291	429	789	176	323	520	1028

[z] Spring soil test from 0 to 0.6 m soil layer.
[y] Manure applied in the fall of the application years (1993, 1994, 1995, 1996, and 1997).
[x] Manure rate treatment (Mg ha^{-1}, wet-weight basis).

Appendix 3. Soil-log notes recorded during the installation of water-table wells in 1993.

Table 3.1. Soil log-notes recorded during the installation of the water-table wells at the coarse-textured site.

Plot	Layer interval (m)	Soil horizon	Soil moisture	Soil texture[z]	Parent material	Remarks
A1	0.00-0.20	Apk	Moist	L-SL	Fluv.	
A1	0.20-1.00	I Ck	Moist	SL-LS		
A1	1.00-1.50	II Ck	V. Moist	LS-S		
A1	1.50-2.25	III Ck	Sat.	SCL		coal flakes, lots of dark material
A1	2.25-2.90	IV Ck		SL		(clay layer)
A2	0.00-0.20	Apk	Moist	SL	Fluv.	
A2	0.20-1.10	I Ck	Moist	SL-LS		
A2	1.10-1.70	II Ck	M.- VM.	C	Fluv.	
A2	1.70-2.90	III Ck	Sat.	C		lots of gypsum, iron staining and pebbles
A3	0.00-0.21	Apk	Moist	SL		
A3	0.21-0.90	I Ck	Moist	SL-LS		
A3	0.90-1.30	II Ck	Moist	LS-S		
A3	1.30-1.50	III Ck	V. Moist	SiCL		lots of coal
A3	1.50-2.90	IV Ck	Sat.	S		
A4	0.00-0.22	Apk	Moist	SL	Fluv.	
A4	0.22-1.50	I Ck	Moist-VM.	SL-LS-S		alternating layers
A4	1.50-2.50	II Ck	Sat.	fSL-fSCL		
A4	2.50-2.90	III Ck	Sat.	SCL		coal, alternating bands of dark material
A5	0.00-0.22	Apk		SL	Fluv.	
A5	0.22-1.70	I Ck		SL-LS		alternating texture
A5	1.70-2.90	II Ck		C		chunks of bedrock or dry clay lots of iron staining and odd cluster of gypsum crystals
A6	0.00-0.26	Apk	Moist	SL-L		
A6	0.26-1.50	I Ck	VM.- Sat.	SL-LS		
A6	1.50-2.90	II Ck	Sat.	fSL-fSCL		
A7	0.00-0.25	Apk	Moist	SL-LCS		
A7	0.25-0.75	I Ck	Moist	SL		
A7	0.75-1.10	II Ck	V. Moist	SCL		
A7	1.10-2.40	III Ck		LS-S		coal or something black in bands
A8	0.00-0.25	Apk	Moist	L-SL		
A8	0.25-1.40	I Ck	Moist-VM.	SL-LS		
A8	1.40-2.90	II Ck		C		lots of iron staining, pebbles and gypsum
A9	0.00 - 0.25	Apk	Moist	SL		
A9	0.25 - 1.10	I Ck	V. Moist	SL-LS		

[z] Soil texture determined by hand.

Table 3.1. Continued.						
Plot	Layer interval (m)	Soil horizon	Soil moisture	Soil texture[z]	Parent material	Remarks
A9	1.10 - 1.50	II Ck	Moist	S		
A9	1.50 - 2.00	III Ck	VM.-Sat.	S		
A9	2.00 - 2.90	IV Ck		C		pebbles, coal flecks and some iron staining
A10	0.00 - 0.25	Apk	Moist	SL		
A10	0.90 - 1.90	I Ck	VM.-Sat.	SL-LS-S		
A10	1.90 - 2.60	II Ck	Sat.	C		coal, pebbles & gypsum
A10	2.60 - 2.90	III Ck	Sat.	SL-LS		
A11	0.00 - 0.25	Apk		SCL		
A11	0.25 - 2.90	Ck	Sat.at 1.70	LS-S		no clay
A12	0.00 - 0.28	Apk	Moist	L-SL		
A12	0.28 - 0.65	Bmk	Moist	SL-LS		
A12	0.65 - 1.00	BCk	Moist	LS		
A12	1.00 - 2.00	I Ck	V. Moist	S		
A12	2.00 - 2.90	II Ck	Sat.	LS		some clay
B1	0.00 - 0.50		Moist	SL-SCL	Fluv.	
B1	0.50 - 1.50		Moist	LS-SL		
B1	1.20 - 2.50		Sat.	SL-SCL		
B1	2.50 - 3.00		Moist	vfSCL		interbedded clays and sands, oxid
B2	0.00 - 1.00		Moist	SL	Fluv.	
B2	1.00 - 1.50		Moist-VM.	LS		
B2	1.50 - 2.25		Sat.	LS		
B2	2.25 - 3.00		Moist	CL-SiC		oxid
B3	0.00 - 0.70		Moist	SL	Fluv.	
B3	0.70 - 1.50		V. Moist	LS		
B3	1.50 - 1.80		Sat.	LS		
B3	1.80 - 2.00		Moist	C		coal, oxid
B3	2.00 - 2.80		V. Moist	vfSCL		
B3	2.80 - 3.00		Sat.	LS-S		
B4	0.00 - 1.20		Moist	SL-LS	Fluv.	
B4	1.20 - 1.50		Moist	LS-S		
B4	1.50 - 2.00		Sat.	LS		
B4	2.00 - 2.25		Moist	C		coal, oxid, may have sand lenses
B4	2.25 - 2.70		Moist	vfSCL		
B4	2.70 - 3.00		Sat.	LS-S		
B5	0.00 - 0.70		Moist	SL	Fluv.	
B5	0.70 - 1.20		Moist	LS		

[z] Soil texture determined by hand.

Table 3.1. Continued.						
Plot	Layer interval (m)	Soil horizon	Soil moisture	Soil texture[z]	Parent material	Remarks
B5	1.20 - 1.60		Moist	LS-S		
B5	1.60 - 2.30		Moist	C		coal, dark chips, oxid mottled
B5	2.30 - 3.00		Sat.	LS-S		
B6	0.00 - 0.75		Sm.-Moist	SL	Fluv.	
B6	0.50 - 1.50		Sm.-Moist	LS-S		
B6	1.50 - 2.50		VM-Sat.	LS-S		
B6	2.50 - 3.00		Sat.	S-LS		
B7	0.00 - 1.50		M.-Sat	SL	Fluv.	saturated at 1.20-1.50
B7	1.50 - 2.50		Sat.	SL		
B7	2.50 - 3.00		Sat.	LS-SL		
B8	0.00 - 0.70		Moist	SL	Fluv.	
B8	0.70 - 1.50		Moist	LS		
B8	1.50 - 3.00		VM-Sat.	SL		saturated at 2.00-3.00
B9	0.00 - 0.70		Moist	SL	Fluv.	saturated at 1.20-1.50
B9	0.70 - 1.50		Moist	LS		
B9	1.50 - 3.00		VM-Sat.	SL		
B10	0.00 - 0.70		S. Moist	SL		
B10	0.70 - 1.00		S. Moist	CL		thin layer of till, coal, pebbles, rock chips, oxid
B10	1.00 - 1.50		Moist	LS		
B10	1.50 - 3.00		VM-Sat.	LS-SL		saturated at 2.00-3.00
B11	0.00 - 0.90		S. Moist	SL	Fluv.	
B11	0.90 - 1.50		S. Moist	LS		
B11	1.50 - 2.50		VM-Sat.	fSCL		
B11	2.50 - 3.00		Sat.	LS		
B12	0.00 - 0.75		Moist	SL	Fluv.	
B12	0.75 - 1.50		Moist	LS		
B12	1.50 - 2.00		Moist	fSCL		
B12	2.00 - 3.00		Moist	C		layered silts and clays
C1	0.00 - 0.24	Apk	Moist	L		
C1	0.24 - 0.50	Bmk	Moist	SL		
C1	0.50 - 0.80	I Ck	V. Moist	LS		
C1	0.80 - 1.50	II Ck	V. Moist	S		
C1	1.50 - 3.00	III Ck	Sat.	Coarse S		
C2	0.00 - 0.25	Apk	Moist	L		
C2	0.25 - 0.60	Bmk	Moist	SL		

[z] Soil texture determined by hand.

Table 3.1. Continued.

Plot	Layer interval (m)	Soil horizon	Soil moisture	Soil texture[z]	Parent material	Remarks
C2	0.60 - 1.00	I Ck	Moist	LS		
C2	1.00 - 1.50	II Ck	V. Moist	S		
C2	1.50 - 2.90	III Ck	Sat.	Coarse S		water in hole right away
C3	0.00 - 0.24	Apk	Moist	SL		
C3	0.24 - 0.60	Bmk	Moist	SL		
C3	0.60 - 0.90	I Ck	V. Moist	LS		
C3	0.90 - 1.50	II Ck	V. Moist	S		
C3	1.50 - 2.90	III Ck	Sat.	Coarse S		
C4	0.00 - 0.20	Apk	Moist	L		
C4	0.20 - 0.40	Bmk	Moist	L-SL		
C4	0.40 - 1.50	I Ck	Moist	LS-S		
C4	1.50 - 2.90	II Ck	Sat.	Coarse S		
C5	0.00 - 0.20	Apk		L		
C5	0.20 - 0.60	Bmk		L-S		
C5	0.60 - 2.40	I Ck		LS-S		
C5	2.40 - 2.90	II Ckg		C		lots of mottles
C6	0.00 - 0.13	Apk	Moist			
C6	0.13 - 0.38	Bmk	Moist			
C6	0.38 - 1.00	I Ck	Moist	LS		
C6	1.00 - 1.90	II Ck	VM-Sat.	S		
C6	1.90 - 2.90	III Ckg		C		very heavy, occasional pebbles, iron staining
C7	0.00 - 0.25	Apk		L		
C7	0.25 - 0.70	Bmk		SL		
C7	0.70 - 1.40	I Ck		LS-S		
C7	1.40 - 1.90	II Ckg		C		prominent mottling, pebbles and chunks of bedrock or dry clay
C7	1.90 - 2.10	III Ckg		LS		
C7	2.10 - 2.90	IV Ckg		C		prominent mottling
C8	0.00 - 0.26	Apk	Moist	L-SL		
C8	0.26 - 0.60	Bmk	Moist	SL		
C8	0.60 - 2.40	I Ck	VM-Sat.	LS-SL		
C8	2.40 - 2.90	II Ckg		C		lots of iron staining & black streaks
C9	0.00 - 0.25	Apk		L-SL		
C9	0.25 - 0.60	Bmk		SL-LS		
C9	0.60 - 1.40	Ck		LS-S		
C9	1.40 - 1.90	I Ckg		SCL		mottling and black streaks
C9	1.90 - 2.00	II Ck		LS		
C9	2.00 - 2.90	III Ckg		SCL		mottling and black streaks

[z] Soil texture determined by hand.

Table 3.1. Continued.

Plot	Layer interval (m)	Soil horizon	Soil moisture	Soil texture[z]	Parent material	Remarks
C10	0.00 - 0.25	Apk	Moist	L-SL		
C10	0.25 - 0.60	Bmk	Moist	SL		
C10	0.60 - 1.50	Ck	Moist	fS		some clay in it
C10	1.50 - 2.30	I Ckg		SCL		mottling and black streaks (coal)
C10	2.30 - 2.60	II Ckg		LS		mottling and black streaks (coal)
C10	2.60 - 2.90	III Ckg		SCL		
C11	0.00 - 0.25	Apk	Moist	L		
C11	0.25 - 0.60	Bmk	Moist	L-SL		
C11	0.60 - 1.50	Ck	Moist	SL-LS		
C11	1.50 - 2.90	Ckg	V. Moist	SCL		prominent mottling, lots of black streaks (coal), shells and occasional pebble
C12	0.00 - 0.24	Apk		L		
C12	0.24 - 0.50	Bmk		L-SL		
C12	0.50 - 1.30	Ck		LS-S		
C12	1.30 - 1.50	Ckg		fS		lots of prominent mottling
C12	1.50 - 2.90	Ckg		SCL		lots of mottling and coal layers
D1	0.00 - 0.60		Moist	SL	Fluv.	
D1	0.60 - 1.50		Moist	LS		
D1	1.50 - 1.70		Sat.	LS		
D1	1.70 - 3.00		Moist	C		
D2	0.00 - 0.50		Moist	SL	Fluv.	
D2	0.50 - 1.50		Moist	LS		
D2	1.50 - 2.00		Sat.	LS		
D2	2.00 - 3.00		Moist	C		
D3	0.00 - 0.50		Moist	SL	Fluv.	
D3	0.50 - 1.50		Moist-VM.	LS		1.40-1.50 dark, may have organics
D3	1.50 - 1.70		Sat.	LS		
D3	1.70 - 3.00		Moist	C		
D4	0.00 - 0.50		Moist	SL	Fluv.	
D4	0.50 - 0.70		Moist	C-fSC		
D4	0.70 - 1.50		V. Moist	LS		
D4	1.50 - 1.60		VM.-Sat	LS		
D4	1.60 - 3.00		Moist	C		
D5	0.00 - 0.50		Moist	SL	Fluv.	
D5	0.50 - 0.80		Moist	C		silts and fine sand in clay
D5	0.80 - 1.50		Moist-VM.	LS		
D5	1.50 - 1.70		Sat.	LS		
D5	1.70 - 3.00		Moist	C		

[z] Soil texture determined by hand.

Table 3.1. Continued.

Plot	Layer interval (m)	Soil horizon	Soil moisture	Soil texture^z	Parent material	Remarks
D6	0.00 - 0.70		Moist	SL	Fluv.	
D6	0.70 - 1.50		VM-Moist	LS		
D6	1.50 - 1.70		Sat.	LS		
D6	1.70 - 3.00		Moist	C		
D7	0.00 - 0.50		Moist	SL		
D7	0.50 - 1.50		VM-Moist	LS		
D7	1.50 - 1.80		Sat.	LS		
D7	1.80 - 3.00		Moist	C		
D8	0.00 - 0.50		Moist	SL	Fluv.	
D8	0.50 - 1.50		V. Moist	LS		
D8	1.50 - 2.40		Sat.	LS		
D8	2.40 - 3.00		Moist	C		
D9	0.00 - 0.50		Moist	SL	Fluv.	
D9	0.50 - 1.50		Moist	LS		
D9	1.50 - 3.00		Moist	C		
D10	0.00 - 0.70		Moist	SL	Fluv.	
D10	0.70 - 0.90		Moist	SL-LS		- dark brown to black, possible organics
D10	0.90 - 1.50		Moist	LS		
D10	1.50 - 2.00		VM-Moist	fSCL		
D10	2.00 - 3.00		Moist	C		
D11	0.00 - 0.75		Moist	fSL	Fluv.	
D11	0.75 - 1.50		VM-Moist	fSCL-fSL		
D11	1.50 - 3.00		VM-Sat.	LS		
D12	0.00 - 1.50		VM-Moist	fSCL-fSL	Fluv.	
D12	1.50 - 3.00		VM-Sat.	SL-LS		
E1	0.00 - 0.18	Ap	Moist	SL		
E1	0.18 - 0.40	Bm	Moist	SL		
E1	0.40 - 0.80	Ck	Moist	LS		
E1	0.80 - 1.10		V. Moist	disturbed dark layer		
E1	1.10 - 2.00	Ck	VM-Sat.	CS		
E1	2.00 - 2.90	Ckg	VM-Sat.	C		iron staining
E2	0.00 - 0.20	Ap	Moist	SL		
E2	0.20 - 0.60	Bm	Moist	SL		
E2	0.60 - 1.80	I Ck	VM-Moist	LS-S		pebbles, coal, iron stone and lots of iron staining (much like till)
E2	1.80 - 2.90	II Ck		C		

^{z} Soil texture determined by hand.

Table 3.1. Continued.

Plot	Layer interval (m)	Soil horizon	Soil moisture	Soil texture[z]	Parent material	Remarks
E3	0.00 - 0.20	Ap		SL		
E3	0.20 - 0.45	Bm		LS		
E3	0.45 - 0.90	I Ck		S		
E3	0.90 - 2.90	II Ck		C		coal, iron stone and lots of iron staining (like till but layered like lacustrine)
E4	0.00 - 0.20	Ap	Moist	L-SL		
E4	0.20 - 0.40	Bm	Moist	SL		
E4	0.40 - 0.60	I Ck	Moist	LS		
E4	0.60 - 1.30	II Ck	V. Moist	Coarse Sand		
E4	1.30 - 1.50	III Ck	V. Moist	C		
E4	1.50 - 2.90	IV Ck	Sat.	LS		
E5	0.00 - 0.24	Ap	Moist	L-SL		
E5	0.24 - 0.40	Bm	Moist	SL		
E5	0.40 - 0.75	I Ck	Moist	LS		
E5	0.75 - 2.90	II Ck	VM-Sat.	LS-S		Vm.-sat. at 1.50
E6	0.00 - 0.25	Ap	Moist	L		
E6	0.25 - 0.70	Bm	Moist	SL		
E6	0.70 - 1.50	I Ck	VM-Moist	LS-S		
E6	1.50 - 2.90	II Ck	Sat.	S		
E7	0.00 - 0.60		Moist	SL	Fluv.	
E7	0.60 - 1.50		Moist	LS		
E7	1.50 - 2.25		Sat.	LS		
E7	2.25 - 3.00		Moist	C		
E8	0.00 - 0.70		Moist	SL	Fluv.	
E8	0.70 - 1.50		Moist	LS		
E8	1.50 - 2.25		Sat.	LS		
E8	2.25 - 3.00		Moist	C		
E9	0.00 - 1.00		Moist	SL	Fluv.	
E9	1.00 - 1.25		Moist	C		salts
E9	1.25 - 1.50		Moist	C		
E9	1.50 - 2.50		VM-Sat.	fSCL-fSC		saturated sand lens
E9	2.50 - 3.00		Moist	C		
E10	0.00 - 0.70		Moist	SL	Fluv.	
E10	0.70 - 1.50		V. Moist	LS		
E10	1.50 - 3.00		Sat.	fSCL		
E11	0.00 - 0.70		Moist	SL	Fluv.	
E11	0.70 - 1.50		Moist	LS		

[z] Soil texture determined by hand.

Table 3.1. Continued.						
Plot	Layer interval (m)	Soil horizon	Soil moisture	Soil texture[z]	Parent material	Remarks
E11	1.50 - 3.00		Sat.	SCL		
E12	0.00 - 0.15	Apk	Moist	SL	Fluv.	
E12	0.15 - 0.75	Cca1	Moist	SL		
E12	0.75 - 1.50	Cca2	Moist	LS		
E12	1.50 - 2.25		VM.-Sat.	LS		
E12	2.25 - 3.00		Moist	C		

[z] Soil texture determined by hand.

Abbreviations in Table 3.1

Soil horizon:

A	A horizon
B	B horizon
C	C horizon
c	cemented horizon
ca	secondary carbonate enrichment
g	gray colour with or without mottling
k	carbonates
m	change in structure or colour or both
p	cultivated layer
s	salts
sa	secondary salt enrichment

Soil moisture:

M.	moist
S. Moist or SM.	slightly moist
Sat.	saturated
V. Moist or VM.	very moist

Soil texture:

C	clay
L	loam
LS	loamy sand
S	sand
SC	sandy clay
SCL	sandy clay loam
SiCL	silty clay loam
SL	sandy loam
f	fine
vf	very fine

Parent material:

Fluv.	fluvial

Table 3.2. Soil log-notes recorded during the installation of the water-table wells at the medium-textured site.

Plot	Layer interval (m)	Soil horizon	Soil moisture	Soil texture[z]	Parent material	Remarks
A1	0.00 - 0.25	Apk	Moist	SiCL		varied (dark black layers)
A1	0.25 - 0.80	Ck	Moist	SiCL		lots of iron staining and gleying below 1.50
A1	0.80 - 1.20	II Ck	Moist	LS-S		
A1	1.20 - 1.40		V. Moist	SL		
A1	1.40 - 1.50		V. Moist	SiCL-SiL		
A1	1.50 - 2.80		VM.- Sat.	SiCL-SiL		
A2	0.00 - 0.25	Apk	Moist	SiCL		lots of gypsum crystals with some
A2	0.25 - 1.20	Ck	Moist	SiCL-SiC		round pebbles and iron staining
A2	1.20 - 2.20	Cks	VM.- Sat.	SiCL-SiCL		
A2	2.20 - 2.90		VM.- Sat.	SiC-C		very hard, good varving with dark layers
A3	0.00 - 0.25	Apk	Moist	SiCL	Fluv.-Lac.	
A3	0.25 - 0.90	I Ck	Moist	SiCL		
A3	0.90 - 1.40	II Ck	VM.- Sat.	SL-LS		sand lens
A3	1.40 - 2.10	III Ck	Sat.	SiCL-SiC		
A3	2.10 - 2.90	IV Ck	Sat.	SiC-C		iron stone and pebbles
A4	0.00 - 0.25	Apk	Moist	SiCL	Fluv.-Lac.	
A4	0.25 - 0.90	I Ck	V. Moist	SiCL		
A4	0.90 - 1.45	II Ck	VM.- Sat.	SL-LS		
A4	1.45 - 2.20	III Ck		SiCL-SiC		
A4	2.20 - 2.90	IV Ck		SiC-C		pebbles, iron staining, coal very hard
A5	0.00 - 0.25	Apk	Moist	SiCL		
A5	0.25 - 1.35	I Ck	V. Moist	SiCL		
A5	1.35 - 1.75	II Ck	Sat.	SL-LS		
A5	1.75 - 2.25	III Ck	Sat.	FSCL		
A5	2.25 - 2.90		Sat.	SiC-C		very hard
A6	0.00 - 0.25	Apk	Moist	SiCL		
A6	0.25 - 0.90	I Ck	Moist	SiCL		
A6	0.90 - 1.30	II Ck	Sat.	SL-LS		
A6	1.30 - 1.60	III Ck	Sat.	FSCL		
A6	1.60 - 2.10	IV Ck	V. Moist	SiCL		
A6	2.10 - 2.90	IV Ck		SiC-C		gypsum crystals, pebbles, very hard iron stone and staining
A7	0.00 - 0.24	Apk	Moist	SiCL	Fluv.-Lac.	
A7	0.24 - 0.95	I Ck	Moist	SiCL		
A7	0.95 - 1.35	II Ck	VM.- Sat.	SL-LS		
A7	1.35 - 2.20	III Ck		SiCL-SiC		

[z] Soil texture determined by hand.

Plot	Layer interval (m)	Soil horizon	Soil moisture	Soil texture[z]	Parent material	Remarks
A7	2.20 - 2.90	IV Ck		SiC-C		very hard, gypsum crystals, dark varving
A8	0.00 - 0.25	Apk		SiCL	Fluv.-Lac.	
A8	0.25 - 1.20	I Ck		SiCL		
A8	1.20 - 1.70	II Ck		vfSCL		
A8	1.70 - 2.60	III Ck		SiCL-SiC		
A8	2.60 - 2.90	IV Ck		SiC-C		very hard
A9	0.00 - 0.25	Apk	Moist	SiCL	Fluv.-Lac.	
A9	0.25 - 0.90	I Ck	Moist	vfSCL		
A9	0.90 - 1.40	II Ck	Sat.	SL		
A9	1.40 - 2.90	III Ck	V. Moist	SiCL-SiC		
A10	0.00 - 0.25	Apk	Moist	SiCL		
A10	0.25 - 0.90	I Ck	Moist	SiCL-fSCLM		
A10	0.90 - 1.40	II Ck	Sat.	SL		
A10	1.40 - 1.90	III Ck	Sat.	SiCL		
A10	1.90 - 2.90	IV Ck	V. Moist	SiC-C		very hard, lots of gypsum crystals and the odd pebble
A11	0.00 - 0.25	Apk	Moist	SiCL	Fluv.-Lac.	
A11	0.25 - 1.05	I Ck	V. Moist	SiCL		lighter colored
A11	1.05 - 1.35	II Ck	Sat.	vfSL-SL		
A11	1.35 - 2.10	III Ck	Sat.	SiCL		
A11	2.10 - 2.90	IV Ck	V. Moist	SiC-C		very hard, lots of gypsum crystals
A12	0.00 - 0.20	Apk		SiCL		
A12	0.20 - 0.33	Bmk		SiCL		
A12	0.33 - 0.60	Cca		SiCL		
A12	0.60 - 1.30	Ccag		SiCL-SiL		
A12	1.30 - 1.80	Ck		SiCL		
A12	1.80 - 2.90	Cks		SiC-C		very hard, lots of gypsum crystals
B2	0.00 - 0.90		Moist	SiCL-CL	Fluv.-Lac.	
B2	0.90 - 1.20		Moist	SL-LS		
B2	1.20 - 1.50		VM.- Sat.	SL		
B2	1.50 - 2.75		Moist	CL-SiCL		
B2	2.75 - 3.00		Moist	C		rock chips, oxid
B3	0.00 - 0.75		Moist	SiCL-CL	Fluv.-Lac.	
B3	0.75 - 1.20		M-VM.	SL		
B3	1.20 - 1.50		Moist	CL-SiCL		

Table 3.2. Continued.

[z] Soil texture determined by hand.

Table 3.2. Continued.

Plot	Layer interval (m)	Soil horizon	Soil moisture	Soil texture[z]	Parent material	Remarks
B3	1.50 - 3.00		Moist	C		
B4	0.00 - 0.50		Moist	CL-SiCL	Fluv.-Lac.	
B4	0.50 - 0.75		Moist	SL-SCL		
B4	0.75 - 1.20		VM-Sat.	SL-SCL		
B4	1.20 - 1.50		Moist	CL		gypsum salts
B4	1.50 - 3.00		Moist	C		some gypsum, oxid, rock chips
B5	0.00 - 0.75		Moist	vfSCL-SiCL	Fluv.-Lac.	
B5	0.75 - 1.20		VM-Sat.	SL		
B5	1.20 - 1.50		Moist	CL		
B5	1.50 - 3.00		Moist	C		oxid, rock chips
B6	0.00 - 0.75		Moist	SL	Fluv.-Lac.	
B6	0.75 - 1.20		Sat.	SL		
B6	1.20 - 1.50		Moist	CL-SCL		
B6	1.50 - 3.00		Moist	C		oxid
B7	0.00 - 0.50		Moist	vfSCL-SiCL	Fluv.-Lac.	
B7	0.50 - 1.00		VM-Sat.	fSL		
B7	1.00 - 1.30		Moist	fSCL		
B7	1.30 - 1.50		Moist	CL		oxid
B7	1.50 - 3.00		Moist	C		oxid
B8	0.00 - 0.75		Moist	SiCL-vfSCL	Fluv.-Lac.	
B8	0.75 - 1.30		V. Moist	SL		
B8	1.30 - 1.50		Moist	CL		oxid
B8	1.50 - 1.80		Moist	CL		
B8	1.80 - 3.00		Moist	C		
B9	0.00 - 0.50		Moist	SiCL-vfSCL	Fluv.-Lac.	
B9	0.50 - 0.75		Moist	CL-C		
B9	0.75 - 1.20		V. Moist	SL		
B9	1.20 - 1.50		Moist	SCL		
B9	1.50 - 3.00		Moist	C		oxid
B10	0.00 - 0.70		Moist	SiCL	Fluv.-Lac.	
B10	0.70 - 1.20		V. Moist	SL		
B10	1.20 - 1.50		Moist	SCL		
B10	1.50 - 2.25		Moist	SiCL-SiC		
B10	2.25 - 3.00		Moist	C		

[z] Soil texture determined by hand.

Table 3.2. Continued.

Plot	Layer interval (m)	Soil horizon	Soil moisture	Soil texture[z]	Parent material	Remarks
B11	0.00 - 0.70		Moist	SiCL	Fluv.-Lac.	
B11	0.70 - 1.20		Moist	vfSCL-SiCL		
B11	1.20 - 3.00		Moist	SiCL-SiC		
B12	0.00 - 0.70		Moist	SiC-SiCL	Fluv.-Lac.	
B12	0.70 - 1.10		Moist	vfSCL-SiCL		
B12	1.10 - 1.60		Moist	vfSC		
B12	1.60 - 3.00		Moist	C		gypsum
C1	0.00 - 0.25	Apk	V. Moist	SiCL		
C1	0.25 - 1.60	Ckg	VM-Sat.	SiCL		lots of gleying
C1	1.60 - 2.50	Cks	VM-Sat.	SiC-C		very hard, dark varving
C1	2.50 - 2.90	Ck	VM-Sat.	SiC-C		very hard, lots of iron staining
C2	0.00 - 0.25	Apk	Moist	SiCL	Fluv.-Lac.	
C2	0.25 - 1.00	Ck	V. Moist	SiCL		
C2	1.00 - 2.10	Cksa	VM-Sat.	SiC-C		very hard, lots of gypsum crystals
C2	2.10 - 2.60	Ck		SiCL		softer with no gypsum or ironstone
C2	2.60 - 2.90	Ck		SiC-C		hard, lots of iron staining & ironstone
C3	0.00 - 0.25	Apk	Moist	SiCL		
C3	0.25 - 0.65	Ck	Moist	SiCL		
C3	0.65 - 1.10	Cca	V. Moist	SiCL		
C3	1.10 - 1.40	Cksa	VM-Sat.	SiCL		lots of gypsum
C3	1.40 - 2.10	Cksa	VM-Sat.	SiC-C		very hard, lots of gypsum, black varing
C3	2.10 - 2.90	Ck	VM-Sat.	SiC-C		very hard, lots of ironstone and occasional pebble, black varing
C4	0.00 - 0.25	Apk	Moist	SiCL		
C4	0.25 - 1.10	Ck	V. Moist	SiCL		
C4	1.10 - 1.30	Cks	Sat.	SiCL		gypsum crystals
C4	1.30 - 1.80	Cksa	Sat.	SiC-C		very hard, lots of gypsum crystals
C4	1.80 - 2.90	Ckg	Sat.	SiC-C		lots of iron staining, occasional pebble and large chunk of ironstone
C5	0.00 - 0.24	Apk	Moist	SiCL		
C5	0.24 - 0.52	Ck	V. Moist	SiCL		
C5	0.52 - 0.85	Ckg	V. Moist	SiCL		prominent mottling
C5	0.85 - 1.20	Cksg	Sat.	SiCL		occasional gypsum crystals and iron staining
C5	1.20 - 1.70	Ck	Sat.	SiCL		
C5	1.70 - 2.90	Cks	Sat.	SiC-C		very hard, large chunks of ironstone, cluster of gypsum crystals, varving
C6	0.00 - 0.25	Apk	Moist	SiCL		

[z] Soil texture determined by hand.

Plot	Layer interval (m)	Soil horizon	Soil moisture	Soil texture[z]	Parent material	Remarks
C6	0.25 - 0.50	I Ck	Moist	SiCL		
C6	0.50 - 0.80	II Ck	V. Moist	SL		
C6	0.80 - 1.20	III Ck	Sat.	SiCL		
C6	1.20 - 1.80	IV Ck		SiCL		
C6	1.80 - 2.90	V Ck		SiC-C		very hard, pebbles, iron staining, and varving
C7	0.00 - 0.24	Apk		SiCL		
C7	0.24 - 0.60	I Ck		SL-LS		
C7	0.60 - 1.20	II Ck		fSCL		
C7	1.20 - 1.75	III Ckg		SiCL		iron staining
C7	1.75 - 2.25	IV Cks		SiC-C		very hard, gypsum crystals
C7	2.25 - 2.90	V Ck		SiCL		
C8	0.00 - 0.24	Apk	Moist	SiCL	Fluv.-Lac.	
C8	0.24 - 0.48	I Ck	Moist	SiCL		
C8	0.48 - 0.80	II Ck	V. Moist	SL-LS		
C8	0.80 - 1.35	III Ck	V. Moist	SiCL		
C8	1.35 - 1.90	IV Ckg	Sat.	SiCL		lots of iron staining
C8	1.90 - 2.60	V Cks	Sat.	SiC-C		very hard, with gypsum crystals
C8	2.65 - 2.90	VI Ck	Sat.	SiCL		
C9	0.00 - 0.24	Apk	Moist	SiCL	Fluv.-Lac.	
C9	0.24 - 0.95	Ck	Moist	SiCL		
C9	0.95 - 1.90	Cks	V. Moist	SiC-C		lots of gypsum, black varving
C9	1.90 - 2.50	II Ck	Sat.	SiCL		lots of iron staining
C9	2.50 - 2.90	III Ck	V. Moist	SiC-C		lots of ironstone
C10	0.00 - 0.24	Apk	Moist	SiCL		
C10	0.24 - 0.85	I Ck	Moist	SiCL		
C10	0.85 - 3.00	II Cks	Sat.	SiC-C		very hard, gypsum crystals, black varving, lots of ironstone and iron staining
C11	0.00 - 0.22	Apk		SiCL		
C11	0.22 - 1.50			SiCL-SiC		
C11	1.50 - 3.00			SiC-C		gypsum, pebbles, very hard
C12	0.00 - 0.22	Apk	Moist	SiCL	Fluv.-Lac.	
C12	0.22 - 1.50		Moist	SiCL-SiC		
C12	1.50 - 3.00		V. Moist	SiC-C		very hard, lots of gypsum crystals
D1	0.00 - 0.90		Moist	SiC	Fluv.-Lac.	
D1	0.90 - 1.50		Moist	C-SiC		

Table 3.2. Continued.

[z] Soil texture determined by hand.

Table 3.2. Continued.

Plot	Layer interval (m)	Soil horizon	Soil moisture	Soil texture[z]	Parent material	Remarks
D1	1.50 - 2.50		V. Moist	SiC		
D1	2.50 - 3.00		Moist	C		
D2	0.00 - 1.00		Moist	SiC	Fluv.-Lac.	
D2	1.00 - 1.20		Moist	SiC		some sand lens
D2	1.20 - 1.50		Moist	C-SiC		
D2	1.50 - 2.25		Moist	C-SiC		
D2	2.25 - 3.00		VM-sat.	SiC		
D3	0.00 - 1.00		Moist	SiC-SiCL	Fluv.-Lac.	
D3	1.00 - 1.50		Moist	C-SiC		oxid
D3	1.50 - 3.00		Moist	C		oxid silt layers
D4	0.00 - 0.75		Moist	SiC	Fluv.-Lac.	
D4	0.75 - 1.00		Moist	fSCL-fSC		
D4	1.00 - 1.50		Moist	SiC-SiCL		
D4	1.50 - 3.00		Moist	C-SiC		oxid
D5	0.00 - 0.70		Moist	SiC	Fluv.-Lac.	
D5	0.70 - 1.10		Moist	fSCL-fSCL		
D5	1.10 - 1.50		Moist	SiC-SiCL		
D5	1.50 - 3.00		Moist	SiC-C		layered silt and clay
D6	0.00 - 0.75		Moist	SiC	Fluv.-Lac.	
D6	0.75 - 1.20		Moist	SiCL-SiC		sand lens
D6	1.20 - 1.50		Moist	SiC		
D6	1.50 - 3.00		Moist	C-SiC		gypsum, layered clays and silts
D7	0.00 - 0.70		Moist	SiC	Fluv.-Lac.	
D7	0.70 - 1.00		VM-Moist	vfSCL		
D7	1.00 - 1.50		Moist	vfSC-SiC		gypsum
D7	1.50 - 1.80		Moist	SiC		
D7	1.80 - 2.25		Sat.	SiC-vfSC		sand lens
D7	2.25 - 3.00		Moist	SiC-vfSC		
D8	0.00 - 0.75		Moist	SiC	Fluv.-Lac.	
D8	0.75 - 1.20		V. Moist	vfSCL		
D8	1.20 - 1.60		Moist	SiC-vfSC		
D8	1.60 - 3.00		Moist	C		oxid
D9	0.00 - 0.70		Moist	SiC	Fluv.-Lac.	

[z] Soil texture determined by hand.

Table 3.2. Continued.

Plot	Layer interval (m)	Soil horizon	Soil moisture	Soil texture[z]	Parent material	Remarks
D9	0.70 - 0.90		V. Moist	SL-SCL		
D9	0.90 - 1.30		Sat.	vfSCL		
D9	1.30 - 1.50		Moist	vfSCL		
D9	1.50 - 3.00		Moist	C		oxid
D10	0.00 - 0.90		Moist	SiC-SiCL	Fluv.-Lac.	
D10	0.90 - 1.10		Moist	SL-SCL		
D10	1.00 - 1.30		Moist	vfSC-vfSCL		
D10	1.30 - 1.60		Sat.	vfSCL		
D10	1.60 - 3.00		Moist	C		
D11	0.00 - 1.00		Moist	SiC-SiCL	Fluv.-Lac.	
D11	1.10 - 1.20		V. Moist	SCL-SL		
D11	1.20 - 1.40		Moist	vfSC-vfSCL		
D11	1.40 - 1.50		Sat.	vfSCL		
D11	1.50 - 2.00		Moist	vfSC		oxid
D11	2.00 - 3.00		Moist	C		
D12	0.00 - 0.40		Moist	C-CL	Fluv.-Lac.	
D12	0.40 - 0.65		Moist	SiC-SiCL		
D12	0.65 - 0.80		Moist	SCL		
D12	0.80 - 1.50		Moist	vfSC		
D12	1.50 - 1.90		Moist	SiC		oxid
D12	1.90 - 3.00		Moist	C		oxid
E1	0.00 - 0.24	Apk	Moist	SiCL		
E1	0.24 - 0.95	Ckg	V. Moist	SiCL		
E1	0.95 - 1.20	Cks		SiCL-SiC		some gypsum crystals
E1	1.20 - 2.90	Ck		SiC-C		very hard, varved, not a lot of iron staining
E2	0.00 - 0.25	Apk	Moist	SiCL	Fluv.-Lac.	
E2	0.25 - 1.20	Ck	V. Moist	SiCL-SiC		
E2	1.20 - 2.90	Cks	VM-Sat.	SiC		occasional cluster of gypsum crystals not hard, no dark varving
E3	0.00 - 0.24	Apk	Moist	SiCL	Fluv.-Lac.	
E3	0.24 - 1.00	Ck	V. Moist	SiCL-SiC		
E3	1.00 - 2.90	Cks	VM-Sat.	SiCL-SiC		occasional gypsum crystals, no iron staining, no dark varves, not very hard, good moisture to depth

[z] Soil texture determined by hand.

Table 3.2. Continued.

Plot	Layer interval (m)	Soil horizon	Soil moisture	Soil texture[z]	Parent material	Remarks
E4	0.00 - 0.24	Apk	Moist	SiCL	Fluv.-Lac.	
E4	0.24 - 1.10	Ck	V. Moist	SiCL-SiC		pebbles
E4	1.10 - 1.50	Cks	V. Moist	SiCL-SiC		gypsum crystals, pebbles
E4	1.50 - 2.90	Cks		SiC-C		scattered gypsum crystals, pebbles, varving
E5	0.00 - 0.25	Apk	Moist	SiCL	Fluv.-Lac.	
E5	0.25 - 1.10	Ck	V. Moist	SiCL-SiC		
E5	1.10 - 1.50	Cks	VM-Sat.	SiCL-SiC		gypsum crystals
E5	1.50 - 2.90	Cks		SiC-C		gypsum crystals, pebbles, varved, very hard
E6	0.00 - 0.24	Apk	Moist	SiCL	Fluv.-Lac.	
E6	0.24 - 1.10	Ck	V. Moist	SiCL-SiC		
E6	1.10 - 1.60	Cks	VM-Sat.	SiCL-SiC		gypsum crystals
E6	1.60 - 2.90	Cks	VM-Sat.	SiC-C		odd gypsum crystals, very hard
E7	0.00 - 0.24	Apk	Moist	SiCL	Fluv.-Lac.	
E7	0.24 - 0.80	Ck	V. Moist	SiCL-SiC		
E7	0.80 - 1.60	Cksa	VM-Sat.	SiCL-SiC		lots of gypsum crystals
E7	1.60 - 2.40	Cks		SiC-C		lots of iron staining & odd gypsum crystals
E7	2.40 - 2.90	Ck		C		varved, fractures, very hard
E8	0.00 - 0.25	Apk	V. Moist	SiCL	Fluv.-Lac.	
E8	0.25 - 0.90	Ck	V. Moist	SiCL-SiC		
E8	0.90 - 1.60	Cksa	V. Moist	SiC		gypsum crystals, very hard
E8	1.60 - 2.10	Ckg		SiC-C		lots of iron staining
E8	2.10 - 2.90	Ck		C		lots of iron staining, very hard
E9	0.00 - 0.24	Ap	Moist	SiCL	Fluv.-Lac.	
E9	0.24 - 1.20	Ck	V. Moist	SiCL-SiC		
E9	1.20 - 1.60	Cksa	VM-Sat.	SiCL-SiC		
E9	1.60 - 2.90	Ck		SiC-C		soft (1.6 - 2.4), hard (2.4 - 2.9)
E10	0.00 - 0.25	Apk	Moist	SiCL	Fluv.-Lac.	
E10	0.25 - 1.35	Ck	V. Moist	SiCL-SiC		
E10	1.35 - 1.50	Cksa	VM-Sat.	SiCL-SiC		
E10	1.50 - 2.90	Ck	VM-Sat.	SiC-C		hard, no gypsum or iron staining

[z] Soil texture determined by hand.

Table 3.2. Continued.

Plot	Layer interval (m)	Soil horizon	Soil moisture	Soil texture[z]	Parent material	Remarks
E11	0.00 - 0.25	Apk	Moist	SiCL	Fluv.-Lac.	
E11	0.25 - 1.40	Ck	V. Moist	SiCL-SiC		
E11	1.40 - 2.90	Cksa	VM-Sat.	SiCL-SiC		gypsum crystals
E12	0.00 - 0.24	Apk		SiCL	Fluv.-Lac.	
E12	0.45 - 1.50	Ck		SiC-SiCL		
E12	1.50 - 2.90	Cksa		SiCL-C		gypsum crystals, very hard

[z] Soil texture determined by hand.

Abbreviations in Table 3.2

Soil horizon:

A	A horizon
B	B horizon
C	C horizon
ca	secondary carbonate enrichment
g	gray colour with or without mottling
k	carbonates
m	change in structure or colour or both
p	cultivated layer
s	salts
sa	secondary salt enrichment

Soil moisture:

M.	moist
S. Moist or SM.	slightly moist
Sat.	saturated
V. Moist or VM.	very moist

Soil texture:

C	clay
CL	clay loam
LS	loamy sand
S	sand
SC	sandy clay
SiC	silty clay
SiCL	silty clay loam
SiL	silty loam
SL	sandy loam
f	fine
vf	very fine

Parent material:

Fluv.-Lac.	fluvial-lacustrine

Appendix 4. Soil bulk density values determined from field samples collected October 30, 1997 (coarse-textured site) and November 5, 1997 (medium-textured site).

Core number	Incremental layer (m)	Coarse-textured site bulk density (Mg m^{-1})	Medium-textured site bulk density (Mg m^{-1})
1	0 - 0.15	na [z]	1.50
1	0.15 - 0.3	1.60	1.29
1	0.3 - 0.6	1.52	1.19
1	0.6 - 0.9	1.55	1.57
1	0.9 - 1.2	1.63	1.52
1	1.2 - 1.5	1.60	1.59
2	0 - 0.15	na	1.41
2	0.15 - 0.3	1.67	1.27
2	0.3 - 0.6	1.51	1.19
2	0.6 - 0.9	1.58	1.33
2	0.9 - 1.2	1.62	1.47
2	1.2 - 1.5	1.49	1.40
3	0 - 0.15	1.41	1.41
3	0.15 - 0.3	1.68	1.28
3	0.3 - 0.6	1.58	1.20
3	0.6 - 0.9	1.55	1.29
3	0.9 - 1.2	1.56	1.40
3	1.2 - 1.5	1.63	1.47
4	0 - 0.15	1.63	1.44
4	0.15 - 0.3	1.54	1.28
4	0.3 - 0.6	1.48	1.26
4	0.6 - 0.9	1.55	1.33
4	0.9 - 1.2	1.44	1.39
4	1.2 - 1.5	1.46	1.48
5	0 - 0.15	1.48	1.37
5	0.15 - 0.3	1.57	1.26
5	0.3 - 0.6	1.53	1.32
5	0.6 - 0.9	1.56	1.66
5	0.9 - 1.2	1.76	1.46
5	1.2 - 1.5	1.60	1.42
6	0 - 0.15	1.47	1.48
6	0.15 - 0.3	1.68	1.33
6	0.3 - 0.6	1.57	1.54
6	0.6 - 0.9	1.55	1.74
6	0.9 - 1.2	1.51	1.79
6	1.2 - 1.5	1.64	1.56

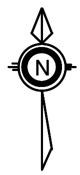
[z] na = not available or missing sample.

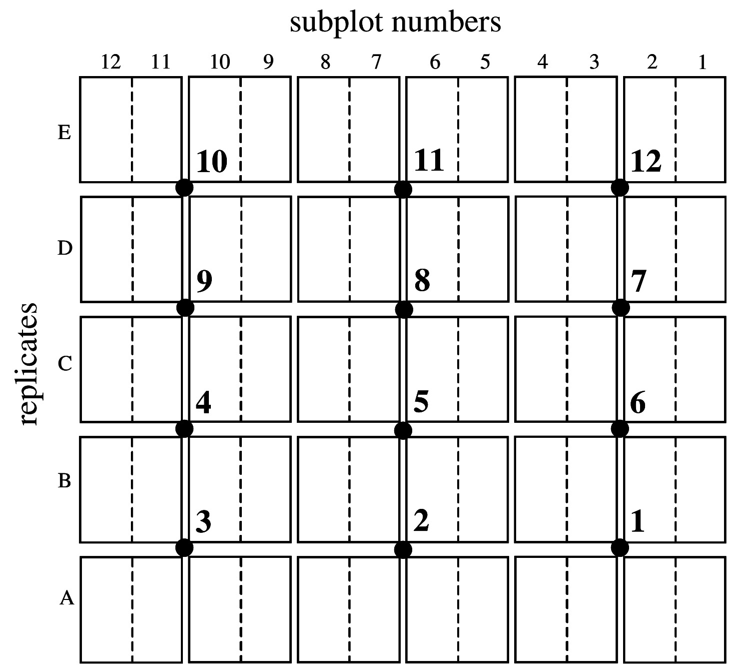
Core number	Incremental layer (m)	Coarse-textured site bulk density ($Mg\ m^{-1}$)	Medium-textured site bulk density ($Mg\ m^{-1}$)
7	0 - 0.15	1.56	1.41
7	0.15 - 0.3	1.62	1.35
7	0.3 - 0.6	1.56	1.31
7	0.6 - 0.9	1.80	1.37
7	0.9 - 1.2	1.78	1.25
7	1.2 - 1.5	1.62	1.43
8	0 - 0.15	1.55	1.43
8	0.15 - 0.3	1.54	1.25
8	0.3 - 0.6	1.61	1.35
8	0.6 - 0.9	1.56	1.43
8	0.9 - 1.2	1.61	1.38
8	1.2 - 1.5	1.63	1.44
9	0 - 0.15	1.72	1.42
9	0.15 - 0.3	1.60	1.22
9	0.3 - 0.6	1.51	1.24
9	0.6 - 0.9	1.38	1.38
9	0.9 - 1.2	1.50	1.41
9	1.2 - 1.5	1.49	1.39
10	0 - 0.15	1.65	1.37
10	0.15 - 0.3	1.65	1.23
10	0.3 - 0.6	1.54	1.27
10	0.6 - 0.9	1.55	1.29
10	0.9 - 1.2	1.45	1.33
10	1.2 - 1.5	1.41	1.41
11	0 - 0.15	1.59	1.24
11	0.15 - 0.3	1.63	1.32
11	0.3 - 0.6	1.64	1.21
11	0.6 - 0.9	1.55	1.33
11	0.9 - 1.2	1.59	1.40
11	1.2 - 1.5	1.64	1.38
12	0 - 0.15	1.44	1.31
12	0.15 - 0.3	1.64	1.23
12	0.3 - 0.6	1.50	1.15
12	0.6 - 0.9	1.78	1.32
12	0.9 - 1.2	1.74	1.43
12	1.2 - 1.5	1.51	1.44

[z] na = not available or missing sample.

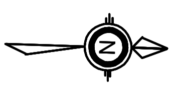
Location of the bulk-density soil sample cores at the coarse-textured and medium-textured sites. Core numbers 1 to 10 correspond to the core numbers in the previous table.

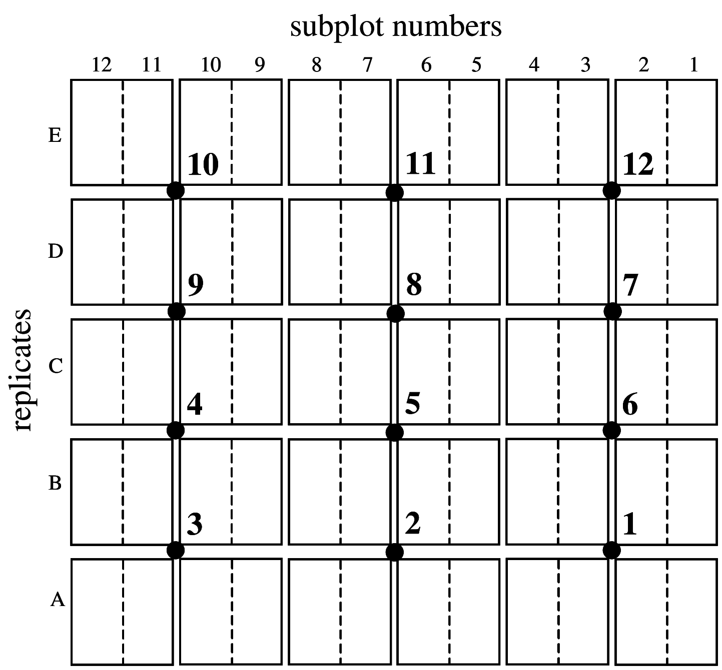
Coarse-textured site





Medium-textured site





Appendix 5. Dates of irrigation events and the amount of water applied at the coarse- and medium-textured sites.

1994		1995		1996		1997	
Date	mm	Date	mm	Date	mm	Date	mm
Coarse-textured site							
(records lost)		July 18	60	June 7	42	June 23	16
				June 10	32	June 24	47
				June 18	18	June 30	40
				July 5	17	July 3	49
				July 8	38	July 9	46
				July 12	36	July 10	22
				July 15	39	July 15	44
				July 17	16	July 11	45
				July 27	20	July 22	46
				Aug. 2	25		
				Aug. 9	27		
				Aug. 16	14		
				Aug. 23	21		
				Aug. 27	12		
			(60)		**(357)**		**(355)**
Medium-textured site							
(records lost)		July 21	64	June 11	16	June 25	40
				June 12	32	June 27	21
				July 9	59	July 4	64
				July 18	17	July 8	24
				July 22	23	July 17	74
				July 23	53		
			(64)		**(200)**		**(223)**

1998		1999		2000		2001	
Date	mm	Date	mm	Date	mm	Date	mm
Coarse-textured site							
June 22	62	June 24	22	June 19	not recorded	May 22	28
July 22	17	July 9	62	June 20	27	May 31	58
July 23	31	July 14	60	July 5	46	June 21	58
July 27	62	July 29	44	July 14	55	July 6	34
		Aug. 6	69	July 19	65	July 11	95
				July 28	34	July 19	69
						July 25	89
	(172)		**(257)**		**(227)**		**(431)**
Medium-textured site							
July 20	35	June 22	38	June 21	54	May 25	26
July 21	70	July 6	46	July 7	57	June 27	66
		July 7	30	July 13	43	June 29	16
		July 22	20	July 20	39	July 3	48
		July 23	31	July 23	51	July 5	47
		Aug. 4	69			July 13	95
						July 26	115
	(105)		**(234)**		**(244)**		**(413)**

Appendix 6. Soil particle-size distribution results for selected soil samples collected during groundwater-well installation in 1993 at the coarse- and medium-textured sites.

Table 6.1. Particle-size analysis for soil samples collected during the groundwater-well installation in 1993 at the coarse-textured site.

Subplot	Layer (m)	% Sand	% Silt	% Clay	Texture [z]
A1	0 – 0.15	81.0	11.0	8.0	LS
A1	0.3 – 0.6	82.0	9.0	9.0	LS
A1	0.9 – 1.2	84.0	8.0	8.0	LS
A1	1.5 – 2.0	77.0	15.0	8.0	SL-LS
A1	2.5 – 3.0	75.0	17.0	8.0	SL
A6	0 – 0.15	78.0	13.0	9.0	SL-LS
A6	0.3 – 0.6	80.0	10.0	10.0	LS-SL
A6	0.9 – 1.2	85.0	9.0	6.0	LS
A12	0 – 0.15	82.0	10.0	8.0	LS
A12	0.3 – 0.6	80.0	12.0	8.0	LS
A12	0.9 – 1.2	86.0	5.0	9.0	LS
A12	1.5 – 2.0	92.0	4.0	4.0	S
A12	2.5 – 3.0	82.0	11.0	7.0	LS
C1	0 – 0.15	81.0	11.0	8.0	LS
C1	0.3 – 0.6	86.0	7.0	7.0	LS
C1	0.9 – 1.2	89.0	4.0	7.0	S-LS
C6	0 – 0.15	76.0	15.0	9.0	SL
C6	0.3 – 0.6	84.0	7.0	9.0	LS
C6	0.9 – 1.2	95.0	1.0	4.0	S
C12	0 – 0.15	75.0	18.0	7.0	SL
C12	0.3 – 0.6	78.0	13.0	9.0	SL-LS
C12	0.9 – 1.2	73.0	17.0	10.0	SL
C12	1.5 – 2.0	45.0	43.0	12.0	L
C12	2.5 – 3.0	52.0	40.0	8.0	SL-L
E1	0 – 0.15	75.0	15.0	10.0	SL
E1	0.3 – 0.6	82.0	8.0	10.0	LS
E1	0.9 – 1.2	78.0	10.0	12.0	SL
E1	1.5 – 2.0	88.0	7.0	5.0	S-LS
E1	2.5 – 3.0	26.0	45.0	29.0	CL
E6	0 – 0.15	72.0	19.0	9.0	SL
E6	0.3 – 0.6	80.0	11.0	9.0	LS-SL
E6	0.9 – 1.2	84.0	8.0	8.0	LS
E6	1.5 – 2.0	89.0	7.0	4.0	S
E6	2.5 – 3.0	89.0	8.0	3.0	S
E12	0 – 0.15	80.0	12.0	8.0	LS
E12	0.3 – 0.6	80.0	12.0	8.0	LS
E12	0.9 – 1.2	88.0	7.0	5.0	S-LS
E12	1.5 – 2.0	94.0	5.0	1.0	S
E12	2.5 – 3.0	34.0	54.0	12.0	SiL

[z] LS = Loamy sand; SL = sandy loam; S = sand; L = loam; CL = clay loam; SiL = silty loam

Table 6.2. Particle-size analysis for soil samples collected during the groundwater-well installation in 1993 at the medium-textured site.

Subplot	Layer (m)	% Sand	% Silt	% Clay	Texture [z]
A1	0 – 0.15	35.0	39.0	26.0	L-CL
A1	0.3 – 0.6	24.0	48.0	28.0	CL-C
A1	0.9 – 1.2	88.0	7.0	5.0	S-LS
A1	1.5 – 2.0	22.0	53.0	25.0	SiL
A1	2.5 – 3.0	20.0	53.0	27.0	SiL-SiCL-CL
A6	0 – 0.15	37.0	39.0	24.0	L
A6	0.3 – 0.6	41.0	36.0	23.0	L
A6	0.9 – 1.2	63.0	25.0	12.0	SL
A12	0 – 0.15	34.0	39.0	27.0	L-CL
A12	0.3 – 0.6	27.0	43.0	30.0	CL
A12	0.9 – 1.2	38.0	43.0	19.0	L
C1	0 – 0.15	28.0	45.0	27.0	L-CL
C1	0.3 – 0.6	24.0	47.0	29.0	CL
C1	0.9 – 1.2	24.0	53.0	23.0	SiL
C1	1.5 – 2.0	22.0	49.0	29.0	CL
C1	2.5 – 3.0	20.0	54.0	26.0	SiL-SiCL-CL
C6	0 – 0.15	36.0	39.0	25.0	L
C6	0.3 – 0.6	34.0	40.0	26.0	L-CL
C6	0.9 – 1.2	26.0	51.0	23.0	SiL-L
C12	0 – 0.15	30.0	43.0	27.0	L-CL
C12	0.3 – 0.6	32.0	48.0	20.0	L
C12	0.9 – 1.2	20.0	54.0	26.0	SiL-SiCL-CL
E1	0 – 0.15	30.0	43.0	27.0	L-CL
E1	0.3 – 0.6	25.0	51.0	24.0	SiL-L
E1	0.9 – 1.2	18.0	56.0	26.0	Sil-SiCL
E6	0 – 0.15	26.0	47.0	27.0	L-CL
E6	0.3 – 0.6	24.0	48.0	28.0	CL-C
E6	0.9 – 1.2	18.0	52.0	30.0	SiCL
E6	1.5 – 2.0	20.0	49.0	31.0	CL-SiCL
E6	2.5 – 3.0	16.0	52.0	32.0	SiCL
E12	0 – 0.15	24.0	48.0	28.0	CL-C
E12	0.3 – 0.6	23.0	49.0	28.0	CL-L-SiL
E12	0.9 – 1.2	26.0	52.0	22.0	SiL
E12	1.5 – 2.0	18.0	57.0	25.0	SiL
E12	2.5 – 3.0	16.0	54.0	30.0	SiCL

[z] L = Loam; CL = clay loam; C = clay; LS = loamy sand; SiL = silty loam; SiCL = silty clay loam; SL = sandy loam

Appendix 7. Ground-surface elevations at the coarse- and medium-textured sites.

Rep and plot number	Coarse-textured site (m)	Medium-textured site (m)
A1	866.580	870.266
A2	866.575	870.276
A3	866.605	870.291
A4	866.692	870.307
A5	866.617	870.323
A6	866.480	870.328
A7	866.416	870.387
A8	866.355	870.391
A9	866.341	870.379
A10	866.298	870.377
A11	866.313	870.384
A12	866.246	870.367
B1	866.430	870.218
B2	866.418	870.260
B3	866.483	870.219
B4	866.482	870.267
B5	866.488	870.298
B6	866.408	870.335
B7	866.339	870.358
B8	866.466	870.372
B9	866.540	870.381
B10	866.565	870.381
B11	866.489	870.361
B12	866.403	870.372
C1	866.368	870.183
C2	866.230	870.169
C3	866.319	870.182
C4	866.402	870.157
C5	866.426	870.186
C6	866.396	870.232
C7	866.414	870.291
C8	866.526	870.329
C9	866.667	870.358
C10	866.692	870.369
C11	866.752	870.377
C12	866.670	870.372

Rep and plot number	Coarse-textured site (m)	Medium-textured site (m)
D1	866.290	870.162
D2	866.229	870.162
D3	866.273	870.173
D4	866.398	870.177
D5	866.496	870.133
D6	866.453	870.177
D7	866.415	870.199
D8	866.504	870.208
D9	866.632	870.263
D10	866.713	870.311
D11	866.772	870.352
D12	866.590	870.374
E1	866.475	870.154
E2	866.461	870.187
E3	866.442	870.204
E4	866.378	870.195
E5	866.530	870.207
E6	866.473	870.214
E7	866.462	870.208
E8	866.553	870.229
E9	866.668	870.277
E10	866.720	870.311
E11	866.712	870.339
E12	866.466	870.358

Appendix 8. Mean monthly temperature, monthly precipitation, and monthly evaporation in 1993 to 2001 at the Agriculture and Agri-Food Canada Lethbridge Research Centre. The climate data collection station is located on the border between the northwest and northeast quarter sections of section 34, township 8, range 21, west of the fourth (49^{o} 42’ north, 122^{o} 47’ west, 899 m elevation).

	Year									
	1993	1994	1995	1996	1997	1998	1999	2000	2001	Norm.[z]
					Mean temperature (C^{o}) [y]					
Jan.	-10.5	-7.1	-6.2	-14.5	-10.2	-10.3	-5.1	-7.7	-0.1	-7.8
Feb.	-6.7	-12.4	-2.7	-3.7	0.0	0.3	1.8	-4.0	-9.3	-4.6
Mar.	2.1	4.1	-0.3	-3.9	-0.7	-2.2	2.1	2.5	2.3	-0.2
Apr.	6.7	7.1	4.3	7.4	3.9	8.0	6.1	6.6	6.0	6.0
May	12.9	12.0	10.1	8.8	11.3	13.7	10.3	12.2	14.0	11.3
Jun.	13.8	14.9	14.6	15.7	16.0	14.4	14.6	15.4	15.5	15.5
Jul.	14.4	18.8	17.3	18.5	18.2	20.3	16.4	19.8	19.6	18.0
Aug.	14.9	17.8	15.8	19.6	18.6	20.2	18.8	18.7	21.0	17.7
Sep.	11.3	15.6	12.5	11.1	15.9	16.0	12.9	13.1	15.4	12.6
Oct.	7.5	6.5	6.0	6.3	7.7	9.0	8.4	7.6	7.2	7.0
Nov.	-1.7	-1.6	-1.1	-7.1	0.0	0.6	4.5	-1.5	3.1	-1.5
Dec.	-0.8	-3.0	-8.9	-10.8	-0.6	-6.0	2.2	-8.7	-4.9	-6.1
Year	5.3	6.1	5.1	4.0	6.7	7.0	7.8	6.2	7.5	5.7
					Precipitation (mm) [y]					
Jan.	6.4	26.3	3.8	32.3	16.7	14.0	10.2	28.6	13.4	17.6
Feb.	18.0	18.7	3.2	6.0	9.2	0.0	7.0	15.8	12.5	11.6
Mar.	15.2	0.8	9.6	44.7	33.1	73.6	6.4	38.5	16.3	24.0
Apr.	27.4	14.1	38.4	21.0	14.2	41.9	41.5	34.5	43.8	31.3
May	44.8	82.4	105.8	21.7	95.7	53.4	58.3	11.2	10.0	54.2
Jun.	117.4	78.4	137.8	53.5	100.6	148.4	65.1	44.6	42.9	63.0
Jul.	126.0	24.7	65.5	18.1	31.8	57.4	64.2	5.5	10.2	47.5
Aug.	64.5	25.4	43.5	4.8	32.8	36.2	39.3	27.3	0.0	45.8
Sep.	70.5	10.8	18.8	70.0	7.6	13.7	10.8	41.9	7.1	39.6
Oct.	16.8	58.4	32.5	6.3	10.0	8.6	23.0	7.9	8.3	18.9
Nov.	14.0	20.0	14.9	26.5	4.6	14.9	11.6	5.0	9.7	16.9
Dec.	9.2	12.5	19.8	24.4	9.9	19.6	3.9	14.7	2.0	16.7
Year	530.2	372.5	493.6	329.3	366.2	481.7	341.3	275.5	176.2	387.0

[z] Thirty-year normal values from 1971 to 2000 for Lethbridge A (Environment Canada 2001).
[y] Monthly data from January 1993 to December 2001 were obtained from the Agriculture and Agri-Food Canada Research Centre in Lethbridge.

	Year									
	1993	1994	1995	1996	1997	1998	1999	2000	2001	Ave.[z]
					Evaporation (mm) [y]					
Jan.	na [x]	na	na	na	na	na	na	na	na	na
Feb.	na	na	na	na	na	na	na	na	na	na
Mar.	na	na	na	na	na	na	na	na	na	na
Apr.	129.0	187.7	167.9	202.9	200.2	0.0	181.3	116.5	138.8	121.3
May	218.1	218.1	189.4	187.7	232.4	213.2	249.4	300.7	348.8	190.6
Jun.	188.4	246.6	211.8	320.9	244.7	190.5	264.4	262.0	283.5	237.6
Jul.	166.9	272.0	233.5	331.4	288.4	319.6	305.7	357.7	327.4	228.4
Aug.	146.2	235.1	235.9	189.1	250.0	309.5	264.6	313.0	358.0	199.7
Sep.	135.9	221.7	167.7	152.2	241.5	225.4	217.5	141.7	230.0	150.9
Oct.	150.1	153.0	157.4	200.0	207.0	157.4	192.0	163.2	180.8	92.5
Nov.	na	na	na	na	na	na	na	na	na	na
Dec.	na	na	na	na	na	na	na	na	na	na
Year	1135	1534	1364	1584	1664	1416	1675	1655	1867	1221

[z] Long-term average (1909 to 2001).
[y] Monthly data from January 1993 to December 2001 were obtained from the Agriculture and Agri-Food Canada Research Centre in Lethbridge.
[x] Not available.

Appendix 9. Water-table elevation and depth below ground surface at the coarse- and medium-textured sites.

Table 9.1. Water-table elevation (m) at the coarse-textured site (page 1 of 16).

Rep/ plot no.	21 May 1993	26 May 1993	2 Jun. 1993	14 Jun. 1993	22 Jun. 1993	5 Jul. 1993	15 Jul. 1993	21 Jul. 1993	27 Jul. 1993	11 Aug. 1993	23 Aug. 1993
A1	864.36	864.36	864.38	864.50	864.61	864.59	864.69	864.68	864.65	864.55	864.56
A2	864.17	864.25	864.32	864.42	864.64	864.58	864.68	864.65	864.61	864.52	864.50
A3	864.31	864.35	864.37	864.46	864.63	864.57	864.65	864.63	864.59	864.49	864.46
A4	864.32	864.35	864.37	864.47	864.62	864.55	864.63	864.61	864.57	864.47	864.45
A5	864.31	864.35	864.38	864.46	864.61	864.55	864.62	864.61	864.56	864.47	864.44
A6	864.30	864.36	864.38	864.53	864.58	864.52	864.58	864.55	864.51	864.41	864.40
A7	864.31	864.36	864.39	864.53	864.58	864.52	864.57	864.55	864.51	864.42	864.40
A8	864.29	864.35	864.38	864.53	864.57	864.50	864.56	864.53	864.49	864.40	864.38
A9	864.20	864.27	864.31	864.46	864.54	864.47	864.51	864.47	864.43	864.36	864.33
A10	864.22	864.28	864.32	864.47	864.52	864.46	864.50	864.46	864.42	864.34	864.32
A11	864.21	864.27	864.30	864.46	864.50	864.44	864.49	864.45	864.41	864.33	864.31
A12	864.20	864.26	864.29	864.45	864.50	864.43	864.49	864.45	864.41	864.32	864.31
B1	864.37	864.37	864.38	864.53	864.60	864.58	864.68	864.68	864.65	864.55	864.56
B2	864.38	864.37	864.38	864.53	864.60	864.58	864.68	864.68	864.64	864.54	864.55
B3	864.37	864.37	864.38	864.52	864.59	864.56	864.66	864.65	864.62	864.52	864.52
B4	864.37	864.37	864.38	864.52	864.59	864.55	864.66	864.64	864.60	864.50	864.50
B5	864.38	864.38	864.39	864.52	864.61	864.54	864.64	864.63	864.59	864.49	864.48
B6	864.37	864.38	864.39	864.53	864.59	864.53	864.63	864.61	864.57	864.47	864.47
B7	864.36	864.38	864.40	864.53	864.59	864.52	864.62	864.60	864.56	864.45	864.44
B8	864.37	864.38	864.40	864.54	864.59	864.53	864.62	864.60	864.55	864.45	864.43
B9	864.34	864.35	864.37	864.51	864.58	864.50	864.60	864.57	864.52	864.41	864.40
B10	864.31	864.33	864.36	864.49	864.57	864.48	864.58	864.55	864.50	864.40	864.38
B11	864.27	864.31	864.33	864.48	864.55	864.46	864.55	864.52	864.47	864.37	864.35
B12	864.25	864.28	864.31	864.45	864.53	864.45	864.54	864.51	864.45	864.36	864.33
C1	864.40	864.39	864.40	864.57	864.60	864.59	864.71	864.71	864.69	864.58	864.60
C2	864.40	864.40	864.40	864.57	864.60	864.59	864.70	864.70	864.68	864.56	864.59
C3	864.42	864.41	864.41	864.57	864.61	864.58	864.69	864.70	864.67	864.56	864.58
C4	864.43	864.42	864.42	864.56	864.61	864.57	864.69	864.69	864.66	864.55	864.57
C5	864.45	864.44	864.45	864.57	864.62	864.57	864.69	864.69	864.66	864.56	864.57
C6	864.36	864.36	864.38	864.50	864.61	864.59	864.69	864.68	864.65	864.55	864.56

Table 9.1. Water-table elevation (m) at the coarse-textured site (page 2 of 16).

Rep/ plot no.	21 May 1993	26 May 1993	2 Jun. 1993	14 Jun. 1993	22 Jun. 1993	5 Jul. 1993	15 Jul. 1993	21 Jul. 1993	27 Jul. 1993	11 Aug. 1993	23 Aug. 1993
C7	864.47	864.46	864.46	864.58	864.63	864.57	864.68	864.69	864.65	864.54	864.56
C8	864.40	864.40	864.41	864.59	864.60	864.52	864.64	864.63	864.59	864.47	864.46
C9	864.40	864.41	864.41	864.59	864.61	864.53	864.64	864.63	864.58	864.46	864.45
C10	864.41	864.42	864.42	864.59	864.62	864.53	864.65	864.63	864.60	864.46	864.45
C11	864.43	864.42	864.43	864.59	864.61	864.52	864.65	864.63	864.59	864.45	864.45
C12	864.43	864.42	864.43	864.60	864.62	864.52	864.64	864.64	864.59	864.45	864.45
D1	864.44	864.43	864.43	864.60	864.62	864.53	864.65	864.64	864.59	864.45	864.45
D2	864.41	864.40	864.40	864.58	864.61	864.61	864.72	864.71	864.72	864.59	864.62
D3	864.42	864.41	864.41	864.57	864.61	864.59	864.71	864.70	864.71	864.58	864.61
D4	864.44	864.43	864.42	864.57	864.61	864.59	864.71	864.71	864.69	864.57	864.59
D5	864.45	864.45	864.44	864.59	864.63	864.59	864.70	864.71	864.69	864.57	864.59
D6	864.51	864.51	864.50	864.63	864.67	864.61	864.74	864.73	864.71	864.60	864.61
D7	864.53	864.53	864.52	864.65	864.67	864.60	864.72	864.73	864.71	864.59	864.60
D8	864.54	864.52	864.52	864.63	864.66	864.59	864.70	864.71	864.70	864.58	864.59
D9	864.53	864.52	864.52	864.62	864.67	864.58	864.69	864.71	864.69	864.58	864.57
D10	864.53	864.51	864.52	864.58	864.70	864.60	864.69	864.70	864.68	864.58	864.53
D11	864.47	864.44	864.45	864.62	864.65	864.54	864.65	864.65	864.61	864.47	864.45
D12	864.45	864.44	864.44	864.60	864.62	864.53	864.66	864.65	864.61	864.47	864.46
E1	864.45	864.45	864.44	864.60	864.62	864.54	864.66	864.65	864.61	864.46	864.46
E2	864.44	864.42	864.42	864.59	864.63	864.60	864.71	864.72	864.70	864.60	864.62
E3	864.15	864.30	864.39	864.58	864.64	864.60	864.72	864.72	864.70	864.60	864.62
E4	864.39	864.51	864.55	864.67	864.73	864.68	864.77	864.78	864.76	864.68	864.67
E5	864.57	864.57	864.56	864.71	864.73	864.68	864.78	864.79	864.77	864.67	864.67
E6	864.58	864.58	864.57	864.72	864.74	864.67	864.78	864.78	864.76	864.66	864.66
E7	864.57	864.56	864.56	864.69	864.72	864.64	864.75	864.76	864.73	864.64	864.64
E8	864.57	864.57	864.56	864.68	864.72	864.64	864.74	864.75	864.73	864.63	864.62
E9	864.58	864.57	864.56	864.67	864.73	864.63	864.74	864.75	864.72	864.63	864.61
E10	864.50	864.49	864.49	864.63	864.68	864.57	864.69	864.69	864.64	864.52	864.49
E11	864.47	864.47	864.47	864.59	864.66	864.55	864.68	864.67	864.62	864.49	864.48
E12	864.47	864.47	864.47	864.59	864.66	864.55	864.68	864.67	864.62	864.49	864.47

Table 9.1. Water-table elevation (m) at the coarse-textured site (page 3 of 16).

Rep/ plot no.	16 Sep. 1993	27 Sep. 1993	12 Oct. 1993	15 Nov. 1993	21 Jan 1994	14 Feb. 1994	14 Mar. 1994	23 Mar. 1994	11 Apr. 1994	3 May 1994	24 May 1994
A1	864.47	864.53	864.53	864.44	864.31	864.25	864.21	864.22	864.26	864.23	864.38
A2	864.45	864.50	864.52	864.42	864.28	864.22	864.17	864.15	864.14	864.21	864.34
A3	864.42	864.49	864.49	864.38	864.22	864.17	864.10	864.09	864.16	864.19	864.34
A4	864.41	864.47	864.47	864.38	864.24	864.16	864.12	864.11	864.17	864.17	864.35
A5	864.36	864.45	864.50	864.36	864.22	864.17	864.09	864.08	864.07	864.17	864.32
A6	864.38	864.48	864.54	864.33	864.19	864.13	864.06	864.08	864.15	864.19	864.41
A7	864.38	864.46	864.47	864.34	864.19	864.12	864.06	864.08	864.15	864.19	864.41
A8	864.35	864.45	864.42	864.33	864.16	864.13	864.05	864.07	864.14	864.17	864.39
A9	864.31	864.40	864.39	864.28	864.11	864.08	863.98	864.00	864.06	864.11	864.31
A10	864.30	864.39	864.39	864.27	864.10	864.04	863.96	863.97	864.06	864.11	864.33
A11	864.29	864.39	864.38	864.26	864.10	864.03	863.96	863.96	863.85	864.09	864.31
A12	864.29	864.39	864.38	864.26	864.08	863.03	863.95	863.95	864.05	864.09	864.31
B1	864.47	864.54	864.53	864.45	864.33	864.28	864.23	864.22	864.29	864.26	864.40
B2	864.47	864.54	864.54	864.45	864.33	863.17	864.23	864.22	864.30	864.26	864.41
B3	864.45	864.53	864.53	864.44	864.30	864.25	864.20	864.19	864.28	864.22	864.40
B4	864.44	864.51	864.52	864.44	864.27	864.25	864.19	864.17	864.27	864.25	864.40
B5	864.42	864.50	864.52	864.42	864.29	864.23	864.17	864.17	864.26	864.25	864.40
B6	864.41	864.50	864.52	864.42	864.27	864.22	864.43	864.16	864.25	864.35	864.53
B7	864.40	864.48	864.50	864.40	864.25	864.21	864.14	864.12	864.24	864.22	864.41
B8	864.40	864.49	864.51	864.41	864.27	864.20	864.14	864.15	864.25	864.25	864.42
B9	864.36	864.45	864.48	864.38	864.22	864.17	864.10	864.10	864.21	864.22	864.38
B10	864.35	864.44	864.46	864.36	864.20	864.14	864.07	864.08	864.18	864.19	864.37
B11	864.32	864.42	864.43	864.41	864.16	864.12	864.04	864.04	864.14	864.16	864.35
B12	864.32	864.43	864.44	864.24	864.15	864.12	864.04	864.03	864.14	864.15	864.35
C1	864.52	864.56	864.56	864.49	864.37	864.33	864.28	864.27	864.34	864.30	864.43
C2	864.49	864.53	864.51	864.46	864.34	864.30	864.25	864.25	864.31	864.27	864.40
C3	864.49	864.55	864.54	864.48	864.35	864.29	864.27	864.24	864.34	864.29	864.43
C4	864.50	864.55	864.56	864.48	864.37	864.32	864.28	864.26	864.37	864.32	864.45
C5	864.51	864.58	864.57	864.51	864.38	864.31	864.30	864.29	864.39	864.33	864.47
C6	864.51	864.58	864.56	864.51	864.37	864.34	864.29	864.27	864.40	864.33	864.47

Table 9.1. Water-table elevation (m) at the coarse-textured site (page 4 of 16).

Rep/ plot no.	16 Sep. 1993	27 Sep. 1993	12 Oct. 1993	15 Nov. 1993	21 Jan 1994	14 Feb. 1994	14 Mar. 1994	23 Mar. 1994	11 Apr. 1994	3 May 1994	24 May 1994
C7	864.41	864.50	864.49	864.44	864.28	864.23	864.18	864.16	864.28	864.26	864.43
C8	864.40	864.50	864.50	864.43	864.28	864.22	864.16	864.16	864.28	864.25	864.42
C9	864.42	864.52	864.53	864.45	864.28	864.23	864.19	864.18	864.30	864.27	864.44
C10	864.41	864.50	864.51	864.44	864.27	864.24	864.18	864.17	864.30	864.28	864.44
C11	864.41	864.52	864.54	864.45	864.25	864.23	864.17	864.16	864.30	864.30	864.44
C12	864.40	864.48	864.50	864.43	864.26	864.23	864.16	864.16	864.31	864.28	864.44
D1	864.51	864.56	864.55	864.14	864.37	864.32	864.31	864.28	864.34	864.30	864.42
D2	864.52	864.57	864.56	863.91	864.35	864.32	864.34	864.28	864.36	864.31	864.44
D3	864.52	864.59	864.58	864.02	864.35	864.33	864.32	864.30	864.38	864.33	864.46
D4	864.52	864.58	864.59	864.39	864.39	864.35	864.31	864.29	864.40	864.33	864.48
D5	864.55	864.62	864.62	864.51	864.43	864.39	864.36	864.33	864.45	864.39	864.51
D6	864.55	864.62	864.63	864.58	864.46	864.39	864.38	864.38	864.48	864.42	864.54
D7	864.54	864.61	864.63	864.55	864.44	864.41	864.36	864.35	864.48	864.42	864.53
D8	864.53	864.62	864.62	864.61	864.43	864.30	864.35	864.35	864.47	864.41	864.52
D9	864.50	864.55	864.60	864.68	864.39	864.35	864.31	864.30	864.42	864.38	864.47
D10	864.41	864.60	864.55	864.95	864.30	864.25	864.20	864.19	864.32	864.30	864.44
D11	864.42	864.51	864.55	865.05	864.31	864.24	864.20	864.19	864.40	864.32	864.45
D12	864.42	864.51	864.45	864.82	864.30	864.25	864.20	864.20	864.33	864.31	864.45
E1	864.52	864.55	864.55	864.49	864.39	864.34	864.37	864.30	864.37	864.33	864.43
E2	864.53	864.58	864.58	864.52	864.40	864.37	864.34	864.33	864.30	864.35	864.44
E3	864.63	864.65	864.68	864.63	864.52	864.47	864.45	864.43	864.34	864.48	864.56
E4	864.59	864.62	864.64	864.58	864.47	864.43	864.41	864.39	864.37	864.44	864.54
E5	864.62	864.66	864.67	864.64	864.50	864.48	864.45	864.42	864.52	864.47	864.59
E6	864.59	864.64	864.65	864.61	864.49	864.45	864.42	864.41	864.50	864.45	864.56
E7	864.58	864.63	864.64	864.59	864.49	864.46	864.41	864.39	864.51	864.46	864.56
E8	864.57	864.62	864.66	864.59	864.46	864.44	864.40	864.39	864.50	864.45	864.54
E9	864.45	864.52	864.57	864.51	864.32	864.29	864.24	864.24	864.37	864.36	864.46
E10	864.43	864.52	864.57	864.49	864.31	864.26	864.22	864.21	864.34	864.33	864.45
E11	864.43	864.51	864.56	864.50	864.27	864.27	864.22	864.21	864.34	864.32	864.45
E12	864.43	864.52	864.56	864.47	864.21	864.26	864.21	864.19	864.34	864.31	864.45

Table 9.1. Water-table elevation (m) at the coarse-textured site (page 5 of 16).

Rep/ plot no.	27 May 1994	31 May 1994	10 Jun. 1994	27 Jun. 1994	11 Jul. 1994	22 Jul. 1994	29 Aug. 1994	26 Sep. 1994	31 Oct. 1994	23 Jan. 1995	23 Feb. 1995
A1	864.40	864.43	864.47	864.44	864.43	864.43	864.38	864.40	864.43	864.26	864.22
A2	864.37	864.38	864.48	864.48	864.44	864.43	864.28	864.36	864.38	864.23	864.18
A3	864.37	864.43	864.47	864.46	864.41	864.40	864.32	864.32	864.34	864.18	864.13
A4	864.39	864.43	864.47	864.45	864.39	864.38	864.29	864.30	864.34	864.18	864.13
A5	864.36	864.34	864.44	864.45	864.40	864.38	864.20	864.28	864.31	864.17	864.13
A6	864.41	864.44	864.46	864.45	864.37	864.37	864.27	864.27	864.30	864.16	864.11
A7	864.43	864.45	864.46	864.45	864.37	864.36	864.27	864.27	864.30	864.15	864.10
A8	864.42	864.43	864.45	864.43	864.35	864.34	864.25	864.25	864.29	864.13	864.06
A9	864.34	864.38	864.42	864.42	864.33	864.31	864.21	864.21	864.21	864.09	864.02
A10	864.35	864.38	864.41	864.40	864.31	864.29	864.09	864.19	864.20	864.07	864.02
A11	864.35	864.37	864.40	864.38	864.29	864.26	864.17	864.18	864.20	864.05	864.00
A12	864.32	864.37	864.40	864.36	864.28	864.25	864.16	864.17	864.20	864.06	864.00
B1	864.42	864.44	864.48	864.45	864.42	864.43	864.38	864.39	864.52	864.28	864.24
B2	864.44	864.45	864.48	864.45	864.43	864.42	864.37	864.37	864.43	864.26	864.23
B3	864.43	864.45	864.48	864.44	864.40	864.40	864.35	864.35	864.41	864.25	864.22
B4	864.43	864.46	864.48	864.44	864.39	864.39	864.33	864.33	864.39	864.24	864.20
B5	864.44	864.46	864.49	864.43	864.39	864.39	864.32	864.33	864.39	864.23	864.19
B6	864.55	864.58	864.60	864.55	864.50	864.49	864.43	864.42	864.49	864.33	864.30
B7	864.44	864.46	864.48	864.43	864.37	864.37	864.27	864.29	864.36	864.21	864.16
B8	864.43	864.48	864.49	864.43	864.37	864.37	864.29	864.30	864.36	864.21	864.16
B9	864.41	864.45	864.47	864.40	864.33	864.32	864.26	864.26	864.34	864.18	864.13
B10	864.41	864.43	864.46	864.39	864.32	864.31	864.24	864.23	864.31	864.17	864.12
B11	864.38	864.41	864.44	864.37	864.30	864.28	864.41	864.22	864.28	864.13	864.07
B12	864.39	864.42	864.45	864.38	864.31	864.28	864.21	864.21	864.26	864.12	864.07
C1	864.44	864.46	864.49	864.46	864.44	864.45	864.29	864.42	864.46	864.32	864.28
C2	864.41	864.43	864.46	864.43	864.40	864.42	864.37	864.38	864.43	864.29	864.25
C3	864.44	864.46	864.48	864.44	864.42	864.43	864.38	864.38	864.43	864.29	864.26
C4	864.47	864.49	864.50	864.45	864.42	864.43	864.37	864.38	864.46	864.32	864.28
C5	864.49	864.51	864.52	864.46	864.43	864.44	864.37	864.39	864.48	864.33	864.29
C6	864.50	864.51	864.53	864.46	864.42	864.43	864.38	864.39	864.46	864.33	864.29

Table 9.1. Water-table elevation (m) at the coarse-textured site (page 6 of 16).

Rep/ plot no.	27 May 1994	31 May 1994	10 Jun. 1994	27 Jun. 1994	11 Jul. 1994	22 Jul. 1994	29 Aug. 1994	26 Sep. 1994	31 Oct. 1994	23 Jan. 1995	23 Feb. 1995
C7	864.46	864.48	864.50	864.42	864.36	864.37	864.31	864.29	864.39	864.25	864.19
C8	864.45	864.47	864.49	864.41	864.35	864.34	864.29	864.29	864.48	864.24	864.19
C9	864.46	864.49	864.51	864.42	864.36	864.35	864.31	864.30	864.41	864.26	864.20
C10	864.46	864.49	864.51	864.41	864.35	864.34	864.30	864.29	864.41	864.26	864.21
C11	864.47	864.49	864.51	864.41	864.34	864.34	864.30	864.28	864.43	864.27	864.21
C12	864.46	864.48	864.51	864.40	864.33	864.32	864.29	864.28	864.41	864.26	864.20
D1	864.43	864.43	864.48	864.45	864.43	864.44	864.39	864.41	864.44	864.33	864.28
D2	864.44	864.46	864.49	864.45	864.44	864.44	864.38	864.40	864.43	864.31	864.29
D3	864.48	864.49	864.51	864.47	864.44	864.45	864.39	864.41	864.47	864.32	864.29
D4	864.49	864.50	864.52	864.46	864.43	864.45	864.40	864.40	864.47	864.34	864.29
D5	864.53	864.54	864.56	864.50	864.45	864.47	864.42	864.42	864.51	864.39	864.34
D6	864.55	864.56	864.58	864.51	864.46	864.46	864.42	864.41	864.52	864.40	864.36
D7	864.55	864.56	864.58	864.50	864.45	864.46	864.40	864.40	864.50	864.36	864.33
D8	864.54	864.55	864.57	864.50	864.43	864.45	864.39	864.39	864.49	864.37	864.34
D9	864.52	864.56	864.59	864.50	864.41	864.41	864.26	864.35	864.46	864.34	864.30
D10	864.48	864.50	864.54	864.43	864.35	864.34	864.30	864.29	864.38	864.27	864.23
D11	864.48	864.50	864.54	864.42	864.35	864.34	864.46	864.31	864.45	864.28	864.24
D12	864.48	864.50	864.53	864.42	864.35	864.34	864.30	864.29	864.44	864.28	864.23
E1	864.45	864.48	864.50	864.47	864.44	864.46	864.39	864.42	864.41	864.34	864.30
E2	864.46	864.50	864.52	864.48	864.45	864.47	864.39	864.43	864.46	864.35	864.33
E3	864.60	864.57	864.64	864.60	864.55	864.54	864.31	864.49	864.56	864.47	864.43
E4	864.55	864.56	864.60	864.54	864.50	864.51	864.44	864.45	864.53	864.43	864.40
E5	864.60	864.62	864.64	864.58	864.52	864.53	864.48	864.47	864.57	864.47	864.43
E6	864.57	864.58	864.61	864.55	864.50	864.50	864.43	864.45	864.55	864.43	864.40
E7	864.58	864.59	864.61	864.55	864.49	864.50	864.45	864.45	864.54	864.44	864.40
E8	864.58	864.60	864.62	864.55	864.49	864.49	864.44	864.44	864.51	864.43	864.39
E9	864.50	864.54	864.57	864.46	864.39	864.40	864.34	864.33	864.48	864.33	864.27
E10	864.49	864.51	864.56	864.44	864.37	864.36	864.32	864.32	864.46	864.30	864.25
E11	864.49	864.52	864.55	864.44	864.37	864.35	864.32	864.31	864.46	864.30	864.25
E12	864.49	864.52	864.56	864.44	864.39	864.35	864.31	864.31	864.46	864.30	864.25

Table 9.1. Water-table elevation (m) at the coarse-textured site (page 7 of 16).

Rep/ plot no.	31 Mar. 1995	2 May 1995	29 May 1995	26 Jun. 1995	24 Jul. 1995	28 Aug. 1995	25 Sep. 1995	3 Nov. 1995	18 Mar. 1996	29 Apr. 1996	24 May 1996
A1	864.20	864.26	864.47	864.49	864.53	864.38	864.36	864.31	864.15	864.29	864.31
A2	864.17	864.24	864.49	864.51	864.54	864.35	864.34	864.28	864.09	864.24	864.30
A3	864.11	864.23	864.47	864.50	864.52	864.34	864.30	864.24	864.02	864.20	864.28
A4	864.11	864.24	864.47	864.51	864.52	864.30	864.29	864.23	864.02	864.21	864.29
A5	864.10	864.23	864.47	864.49	864.51	864.31	864.28	864.23	863.99	864.18	864.29
A6	864.10	864.27	864.47	864.50	864.52	864.30	864.27	864.20	863.98	864.20	864.33
A7	864.10	864.26	864.47	864.49	864.51	864.31	864.26	864.20	863.98	864.20	864.32
A8	864.09	864.25	864.46	864.48	864.49	864.28	864.23	864.19	863.97	864.19	864.31
A9	864.02	864.18	864.42	864.46	864.47	864.25	864.21	864.15	863.91	864.09	864.26
A10	864.01	864.18	864.41	864.45	864.44	864.23	864.20	864.12	863.90	864.10	864.27
A11	864.00	864.18	864.40	864.43	864.42	864.21	864.18	864.12	863.89	864.10	864.25
A12	864.00	864.17	864.39	864.42	864.40	864.20	864.18	864.12	863.89	864.10	864.24
B1	864.23	864.29	864.48	864.50	864.53	864.37	864.36	864.31	864.16	864.30	864.31
B2	864.23	864.29	864.48	864.50	864.53	864.37	864.36	864.31	864.16	864.30	864.32
B3	864.21	864.29	864.49	864.50	864.51	864.35	864.33	864.29	864.12	864.29	864.30
B4	864.20	864.29	864.49	864.50	864.51	864.33	864.31	864.28	864.09	864.28	864.30
B5	864.20	864.29	864.50	864.50	864.52	864.33	864.30	864.27	864.08	864.28	864.31
B6	864.30	864.41	864.62	864.60	864.62	864.44	864.42	864.37	864.17	864.38	864.44
B7	864.17	864.29	864.50	864.50	864.49	864.30	864.27	864.24	864.04	864.25	864.32
B8	864.18	864.30	864.51	864.51	864.50	864.30	864.27	864.25	864.04	864.26	864.32
B9	864.14	864.27	864.50	864.48	864.45	864.25	864.25	864.21	864.00	864.23	864.29
B10	864.13	864.26	864.48	864.46	864.45	864.25	864.23	864.20	863.98	864.21	864.27
B11	864.09	864.22	864.45	864.45	864.42	864.22	864.21	864.17	863.94	864.17	864.26
B12	864.07	864.22	864.46	864.45	864.43	864.23	864.21	864.17	863.94	864.17	864.27
C1	864.28	864.31	864.49	864.50	864.54	864.39	864.38	864.34	864.23	864.33	864.32
C2	864.25	864.29	864.47	864.42	864.50	864.36	864.35	864.31	864.19	864.31	864.31
C3	864.27	864.31	864.48	864.48	864.52	864.36	864.35	864.32	864.20	864.34	864.33
C4	864.29	864.33	864.43	864.45	864.53	864.37	864.37	864.33	864.21	864.36	866.35
C5	864.30	864.35	864.51	864.59	864.56	864.38	864.36	864.34	864.21	864.38	864.36
C6	864.31	864.36	864.54	864.51	864.54	864.37	864.36	864.34	864.20	864.39	864.37

Table 9.1. Water-table elevation (m) at the coarse-textured site (page 8 of 16).

Rep/ plot no.	31 Mar. 1995	2 May 1995	29 May 1995	26 Jun. 1995	24 Jul. 1995	28 Aug. 1995	25 Sep. 1995	3 Nov. 1995	18 Mar. 1996	29 Apr. 1996	24 May 1996
C7	864.22	864.31	864.53	864.38	864.49	864.28	864.28	864.26	864.05	864.29	864.32
C8	864.22	864.30	864.51	864.40	864.47	864.28	864.27	864.25	864.05	864.28	864.31
C9	864.23	864.33	864.54	864.51	864.48	864.29	864.28	864.27	864.05	864.31	864.32
C10	864.24	864.33	864.54	864.46	864.47	864.28	864.27	864.26	864.05	864.30	864.32
C11	864.24	864.34	864.55	864.58	864.47	864.27	864.27	864.26	864.05	864.31	864.33
C12	864.24	864.34	864.54	864.68	864.46	864.26	864.25	864.25	864.04	864.31	864.32
D1	864.27	864.31	864.48	864.49	864.51	864.37	864.37	864.33	864.24	864.33	864.31
D2	864.29	864.33	864.49	864.50	864.53	864.39	864.36	864.33	864.24	864.35	864.34
D3	864.31	864.35	864.51	na [z]	na	na	864.39	864.36	864.25	864.38	864.36
D4	864.31	864.35	864.51	864.54	864.56	864.38	864.36	864.34	864.22	864.38	864.35
D5	864.36	864.41	864.56	864.57	864.57	864.41	864.40	864.37	864.27	864.21	864.39
D6	864.38	864.43	864.57	864.58	864.58	864.41	864.39	864.38	864.26	864.44	864.42
D7	864.37	864.42	864.59	864.58	864.57	864.41	864.37	864.37	864.25	864.44	864.42
D8	864.36	864.41	864.59	864.58	864.55	864.40	864.36	864.36	864.21	864.44	864.41
D9	864.33	864.40	864.60	864.59	864.54	864.36	864.33	864.34	864.16	864.39	864.39
D10	864.25	864.35	864.57	864.54	864.49	864.28	864.26	864.28	864.06	864.32	864.34
D11	864.27	864.36	864.56	864.53	864.46	864.28	864.28	864.32	864.10	864.36	864.38
D12	864.27	864.36	864.56	864.54	864.36	864.26	864.27	864.27	864.05	864.32	864.32
E1	864.29	864.33	864.50	864.50	864.52	864.39	864.38	864.34	864.25	864.34	864.34
E2	864.31	864.36	864.52	864.52	864.53	864.41	864.39	864.36	864.27	864.37	864.36
E3	864.43	864.48	864.65	864.65	864.62	864.48	864.47	864.44	864.32	864.47	864.45
E4	864.40	864.44	864.58	864.60	864.58	864.44	864.39	864.39	864.30	864.43	864.41
E5	864.44	864.48	864.64	864.64	864.61	864.48	864.45	864.42	864.33	864.47	864.45
E6	864.42	864.46	864.61	864.61	864.58	864.44	864.43	864.40	864.29	864.45	864.42
E7	864.42	864.47	864.62	864.62	864.59	864.43	864.42	864.40	864.30	864.46	864.44
E8	864.39	864.46	864.62	864.62	864.57	864.44	864.41	864.39	864.27	864.44	864.44
E9	864.29	864.39	864.59	864.57	864.50	864.31	864.29	864.30	864.10	864.35	864.54
E10	864.28	864.38	864.57	864.56	864.49	864.28	864.27	864.28	864.07	864.33	864.34
E11	864.27	864.37	864.58	864.56	864.49	864.28	864.27	864.28	864.06	864.32	864.35
E12	864.29	864.38	864.58	864.56	864.49	864.24	864.27	864.28	864.07	864.33	864.34

[z] Not available.

Table 9.1. Water-table elevation (m) at the coarse-textured site (page 9 of 16).

Rep/ plot no.	20 Jun. 1996	2 Aug. 1996	23 Aug. 1996	23 Sep. 1996	5 May 1997	29 May 1997	20 Jun. 1997	8 Aug. 1997	5 Sep. 1997	26 Sep. 1997	27 Oct. 1997
A1	864.45	864.63	864.54	864.57	864.30	864.44	864.54	864.76	864.60	864.53	864.42
A2	864.44	864.68	864.55	864.49	864.28	864.39	864.56	864.80	864.62	864.53	864.41
A3	864.44	864.65	864.51	864.42	864.23	864.39	864.51	864.77	864.58	864.49	864.36
A4	864.44	864.64	864.49	864.41	864.24	864.41	864.49	864.74	864.57	864.48	864.35
A5	864.42	864.64	864.48	864.39	864.23	864.34	864.49	864.73	864.57	864.47	864.34
A6	864.49	864.59	864.43	864.36	864.22	864.42	864.46	864.66	864.51	864.42	864.31
A7	864.50	864.57	864.43	864.35	864.22	864.42	864.46	864.65	864.50	864.41	864.31
A8	864.48	864.56	864.40	864.33	864.21	864.42	864.44	864.62	864.48	864.40	864.29
A9	864.46	864.50	864.37	864.26	864.14	864.32	864.40	864.55	864.42	864.33	864.23
A10	864.44	864.47	864.34	864.25	864.14	864.34	864.39	864.51	864.40	864.32	864.21
A11	864.40	864.45	864.32	864.24	864.13	864.33	864.38	864.48	864.38	864.30	864.20
A12	864.38	864.43	864.30	864.24	864.13	864.32	864.37	864.45	864.37	864.30	864.20
B1	864.46	864.62	864.52	864.56	864.32	864.46	864.54	864.74	864.60	864.53	864.42
B2	864.47	864.62	864.52	864.54	864.32	864.47	864.53	864.75	864.61	864.53	864.42
B3	864.48	864.62	864.50	864.50	864.31	864.46	864.52	864.74	864.59	864.51	864.40
B4	864.47	864.62	864.49	864.47	864.30	864.46	864.51	864.73	864.59	864.50	864.39
B5	864.47	864.61	864.47	864.44	864.29	864.46	864.50	864.72	864.59	864.49	864.38
B6	864.59	864.72	864.57	864.53	864.40	864.57	864.61	864.82	864.68	864.59	864.48
B7	864.48	864.59	864.43	864.38	864.28	864.45	864.48	864.68	864.54	864.46	864.35
B8	864.49	864.60	864.43	864.37	864.28	864.46	864.49	864.68	864.55	864.46	864.36
B9	864.44	864.55	864.38	864.32	864.24	864.43	864.46	864.62	864.50	864.43	864.32
B10	864.42	864.52	864.36	864.31	864.23	864.41	864.45	864.58	864.48	864.40	864.30
B11	864.40	864.48	864.33	864.27	864.19	864.38	864.42	864.53	864.44	864.36	864.26
B12	864.38	864.48	864.33	864.27	864.20	864.38	864.43	864.51	864.44	864.36	864.26
C1	864.45	864.61	864.54	864.59	864.35	864.48	864.55	864.74	864.61	864.54	864.45
C2	864.44	864.59	864.51	864.54	864.33	864.46	864.52	864.71	864.59	864.52	864.42
C3	864.46	864.62	864.52	864.54	864.36	864.48	864.53	864.74	864.61	864.53	864.43
C4	864.48	864.64	864.53	864.54	864.38	864.50	864.53	864.76	864.63	864.55	864.45
C5	864.49	864.65	864.54	864.53	864.40	864.51	864.54	864.78	864.65	864.56	864.46
C6	864.50	864.67	864.55	864.52	864.41	864.52	864.54	864.79	864.65	864.56	864.47

Table 9.1. Water-table elevation (m) at the coarse-textured site (page 10 of 16).

Rep/ plot no.	20 Jun. 1996	2 Aug. 1996	23 Aug. 1996	23 Sep. 1996	5 May 1997	29 May 1997	20 Jun. 1997	8 Aug. 1997	5 Sep. 1997	26 Sep. 1997	27 Oct. 1997
C7	864.51	864.60	864.43	864.39	864.31	864.49	864.50	864.72	864.57	864.48	864.38
C8	864.46	864.56	864.39	864.36	864.29	864.46	864.49	864.66	864.54	864.46	864.36
C9	864.48	864.56	864.40	864.36	864.31	864.48	864.52	864.66	864.55	864.47	864.38
C10	864.44	864.55	864.37	864.35	864.31	864.47	864.51	864.64	864.54	864.46	864.36
C11	864.44	864.52	864.36	864.34	864.31	864.47	864.51	864.62	864.53	864.46	864.37
C12	864.40	864.50	864.34	864.31	864.31	864.46	864.50	864.59	864.52	864.45	864.36
D1	864.44	864.59	864.52	864.58	864.34	864.47	864.53	864.71	864.60	864.53	864.43
D2	864.46	864.62	864.53	864.57	864.37	864.49	864.54	864.74	864.62	864.54	864.45
D3	864.49	864.65	864.56	864.59	864.41	864.54	864.57	864.79	864.66	864.59	864.48
D4	864.49	864.66	864.55	864.55	864.40	864.53	864.55	864.78	864.65	864.57	864.47
D5	864.49	864.67	864.56	864.54	864.44	864.56	864.57	864.80	864.67	864.59	864.50
D6	864.54	864.69	864.55	864.52	864.46	864.56	864.59	864.87	864.68	864.59	864.51
D7	864.57	864.70	864.56	864.52	864.46	864.55	864.58	864.83	864.70	864.60	864.51
D8	864.58	864.71	864.56	864.52	864.46	864.54	864.58	864.84	864.70	864.60	864.51
D9	864.55	864.73	864.53	864.44	864.42	864.52	864.59	864.85	864.71	864.61	864.48
D10	864.49	864.57	864.38	864.34	864.33	864.49	864.54	864.70	864.57	864.48	864.39
D11	864.47	864.57	864.40	864.39	864.37	864.52	864.57	864.67	864.58	864.52	864.43
D12	864.41	864.50	864.34	864.34	864.32	864.47	864.52	864.61	864.53	864.46	864.38
E1	864.43	864.61	864.53	864.57	864.37	864.49	864.55	864.74	864.62	864.55	864.45
E2	864.45	864.62	864.54	864.57	864.40	864.50	864.56	864.76	864.64	864.57	864.47
E3	864.52	864.69	864.58	864.54	864.48	864.60	864.66	864.81	864.70	864.64	864.56
E4	864.49	864.63	864.53	864.50	864.44	864.57	864.61	864.75	864.65	864.59	864.50
E5	864.53	864.69	864.57	864.53	864.49	864.61	864.64	864.81	864.71	864.64	864.55
E6	864.53	864.68	864.55	864.50	864.47	864.58	864.61	864.80	864.69	864.61	864.53
E7	864.55	864.70	864.56	864.51	864.48	864.57	864.62	864.83	864.71	864.62	864.54
E8	864.55	864.70	864.56	864.50	864.47	864.54	864.62	864.84	864.71	864.62	864.53
E9	864.49	864.58	864.40	864.37	864.36	864.49	864.57	864.71	864.59	864.51	864.42
E10	864.43	864.54	864.36	864.34	864.33	864.46	864.55	864.64	864.55	864.48	864.40
E11	864.43	864.53	864.36	864.34	864.33	864.46	864.55	864.64	864.57	864.48	864.40
E12	864.41	864.52	864.36	864.34	864.33	864.47	864.55	864.63	864.55	864.48	864.40

Table 9.1. Water-table elevation (m) at the coarse-textured site (page 11 of 16).

Rep/ plot no.	1 Dec. 1997	30 Mar. 1998	27 Apr. 1998	25 May 1998	26 Jun. 1998	27 Jul. 1998	24 Aug. 1998	28 Sep. 1998	26 Oct. 1998	30 Nov. 1998	19 Apr. 1999
A1	864.33	864.24	864.45	864.52	864.70	864.68	864.62	864.50	864.47	864.41	864.22
A2	864.31	864.17	864.47	864.54	864.80	864.67	864.65	864.51	864.46	864.39	864.20
A3	864.26	864.14	864.43	864.53	864.72	864.63	864.61	864.47	864.41	864.32	864.15
A4	864.25	864.15	864.42	864.52	864.72	864.61	864.59	864.45	864.40	864.33	864.15
A5	864.24	864.10	864.41	864.52	864.72	864.60	864.58	864.44	864.39	864.32	864.14
A6	864.22	864.18	864.41	864.57	864.71	864.56	864.54	864.42	864.37	864.30	864.13
A7	864.21	864.17	864.42	864.57	864.71	864.56	864.54	864.42	864.36	864.30	864.13
A8	864.20	864.15	864.42	864.54	864.71	864.53	864.52	864.40	864.35	864.28	864.12
A9	864.13	864.03	864.37	864.52	864.68	864.50	864.46	864.35	864.28	864.22	864.05
A10	864.12	864.05	864.26	864.52	864.63	864.48	864.44	864.34	864.28	864.22	864.04
A11	864.11	864.04	864.34	864.48	864.59	864.45	864.42	864.33	864.27	864.19	864.03
A12	864.11	864.04	864.33	864.46	864.57	864.44	864.41	864.32	864.27	864.20	864.03
B1	864.34	864.27	864.46	864.51	864.69	864.66	864.61	864.50	864.48	864.42	864.25
B2	864.34	864.26	864.46	864.51	864.71	864.65	864.61	864.50	864.47	864.41	864.24
B3	864.32	864.25	864.46	864.51	864.72	864.63	864.60	864.48	864.46	864.40	864.23
B4	864.31	864.24	864.46	864.51	864.72	864.62	864.59	864.47	864.45	864.39	864.22
B5	864.30	864.24	864.47	864.52	864.73	864.61	864.58	864.46	864.44	864.39	864.22
B6	864.40	864.35	864.57	864.65	864.85	864.72	864.70	864.58	864.55	864.48	864.33
B7	864.27	864.23	864.46	864.53	864.72	864.57	864.56	864.44	864.41	864.37	864.20
B8	864.28	864.23	864.47	864.54	864.73	864.58	864.57	864.45	864.42	864.37	864.21
B9	864.24	864.19	864.47	864.51	864.70	864.53	864.52	864.42	864.39	864.33	864.18
B10	864.22	864.17	864.43	864.50	864.67	864.51	864.50	864.39	864.37	864.31	864.16
B11	864.18	864.12	864.41	864.48	864.63	864.48	864.47	864.38	864.34	864.26	864.11
B12	864.18	864.12	864.41	864.48	864.61	864.48	864.47	864.37	864.33	864.26	864.10
C1	864.37	864.31	864.47	864.53	864.68	864.67	864.62	864.51	864.49	864.44	864.28
C2	864.35	864.29	864.43	864.49	864.67	864.64	864.59	864.48	864.47	864.41	864.26
C3	864.36	864.32	864.46	864.52	864.70	864.65	864.61	864.50	864.48	864.43	864.28
C4	864.38	864.34	864.49	864.52	864.73	864.66	864.63	864.51	864.48	864.44	864.30
C5	864.39	864.35	864.51	864.53	864.76	864.67	864.65	864.52	864.50	864.46	864.31
C6	864.40	864.37	864.52	864.54	864.76	864.66	864.65	864.53	864.51	864.46	864.32

Table 9.1. Water-table elevation (m) at the coarse-textured site (page 12 of 16).

Rep/ plot no.	1 Dec. 1997	30 Mar. 1998	27 Apr. 1998	25 May 1998	26 Jun. 1998	27 Jul. 1998	24 Aug. 1998	28 Sep. 1998	26 Oct. 1998	30 Nov. 1998	19 Apr. 1999
C7	864.29	864.27	864.48	864.51	864.72	864.58	864.58	864.46	864.44	864.39	864.23
C8	864.28	864.25	864.47	864.51	864.69	864.55	864.55	864.44	864.43	864.58	864.22
C9	864.30	864.27	864.49	864.54	864.70	864.57	864.57	864.47	864.45	864.40	864.25
C10	864.30	864.27	864.50	864.53	864.68	864.55	864.55	864.45	864.45	864.39	864.25
C11	864.30	864.27	864.50	864.52	864.66	864.54	864.55	864.45	864.45	864.40	864.25
C12	864.29	864.27	864.49	864.52	864.63	864.52	864.53	864.44	864.45	864.39	864.25
D1	864.36	864.30	864.45	864.51	864.65	864.66	864.15	864.49	864.48	864.43	864.28
D2	864.38	864.33	864.47	864.52	864.69	864.66	864.33	864.51	864.50	864.45	864.29
D3	864.41	864.38	864.51	864.55	864.75	864.69	864.58	864.55	864.53	864.49	864.33
D4	864.40	864.36	864.50	864.54	864.75	864.67	864.84	864.53	864.51	864.46	864.32
D5	864.43	864.41	864.54	864.56	864.77	864.68	864.84	864.56	864.54	864.49	864.37
D6	864.45	864.44	864.56	864.57	864.77	864.68	864.62	864.56	864.54	864.52	864.39
D7	864.45	864.43	864.55	864.56	864.77	864.68	864.64	864.56	864.54	864.52	864.38
D8	864.44	864.41	864.56	864.56	864.77	864.68	864.75	864.56	864.54	864.51	864.38
D9	864.41	864.34	864.60	864.57	864.79	864.68	864.90	864.54	864.52	864.48	864.35
D10	864.32	864.27	864.53	864.54	864.70	864.59	864.91	864.47	864.48	864.42	864.28
D11	864.36	864.33	864.55	864.58	864.70	864.61	864.60	864.51	864.52	864.46	864.32
D12	864.30	864.29	864.50	864.54	864.64	864.53	864.55	864.46	864.47	864.41	864.27
E1	864.39	864.31	864.48	864.52	864.72	864.67	864.63	864.52	864.50	864.46	864.31
E2	864.41	864.31	864.50	864.54	864.75	864.68	864.64	864.53	864.52	864.48	864.34
E3	864.50	864.42	864.60	864.62	864.78	864.73	864.72	864.62	864.62	864.58	864.45
E4	864.45	864.42	864.55	864.58	864.73	864.68	864.68	864.57	864.57	864.54	864.41
E5	864.49	864.47	864.60	864.62	864.79	864.71	864.72	864.61	864.60	864.58	864.45
E6	864.47	864.45	864.58	864.58	864.77	864.69	864.70	864.58	864.57	864.55	864.43
E7	864.48	864.44	864.59	864.60	864.78	864.70	864.71	864.59	864.58	864.55	864.43
E8	864.47	864.40	864.60	864.59	864.79	864.70	864.71	864.58	864.56	864.54	864.42
E9	864.35	864.30	864.56	864.57	864.73	864.60	864.61	864.50	864.51	864.46	864.32
E10	864.33	864.28	864.53	864.56	864.68	864.56	864.56	864.57	864.49	864.43	864.30
E11	864.33	864.29	864.53	864.55	864.66	864.55	864.56	864.47	864.49	864.44	864.29
E12	864.33	864.29	864.54	864.55	864.65	864.56	864.56	864.47	864.49	864.44	864.29

Table 9.1. Water-table elevation (m) at the coarse-textured site (page 13 of 16).

Rep/ plot no.	31 May 1999	5 Jul. 1999	26 Jul. 1999	23 Aug. 1999	29 Sep. 1999	18 Oct. 1999	22 Nov. 1999	20 Apr. 2000	29 May 2000	26 Jun. 2000	31 Jul. 2000
A1	864.50	864.66	864.73	864.77	864.56	864.50	864.41	864.50	864.37	864.46	864.60
A2	864.49	864.68	864.80	864.78	864.55	864.49	864.39	864.20	864.36	864.45	864.57
A3	864.45	864.65	864.77	864.73	864.51	864.44	864.34	864.15	864.33	864.44	864.53
A4	864.43	864.64	864.72	864.71	864.49	864.43	864.34	864.15	864.33	864.43	864.50
A5	864.42	864.63	864.71	864.70	864.49	864.42	864.33	864.14	864.32	864.42	864.49
A6	864.44	864.62	864.65	864.62	864.45	864.39	864.30	864.15	864.37	864.46	864.47
A7	864.44	864.62	864.64	864.61	864.44	864.38	864.29	864.16	864.37	864.46	864.47
A8	864.42	864.60	864.63	864.59	864.42	864.36	864.28	864.14	864.34	864.43	864.45
A9	864.36	864.55	864.57	864.51	864.36	864.30	864.20	864.06	864.31	864.41	864.39
A10	864.36	864.53	864.54	864.48	864.34	864.28	864.19	864.06	864.30	864.39	864.35
A11	864.34	864.50	864.51	864.45	864.32	864.27	864.17	864.05	864.27	864.34	864.31
A12	864.33	864.48	864.48	864.43	864.32	864.26	864.17	864.05	864.25	864.32	864.28
B1	864.52	864.65	864.72	864.76	864.56	864.51	864.43	864.24	864.37	864.44	864.60
B2	864.51	864.66	864.72	864.76	864.56	864.51	864.43	864.24	864.36	864.43	864.59
B3	864.50	864.64	864.72	864.74	864.54	864.49	864.40	864.22	864.34	864.42	864.55
B4	864.48	864.64	864.71	864.73	864.53	864.47	864.39	864.23	864.33	864.41	864.53
B5	864.48	864.63	864.70	864.71	864.52	864.46	864.38	864.22	864.32	864.40	864.51
B6	864.59	864.75	864.82	864.81	864.63	864.57	864.49	864.34	864.44	864.52	864.61
B7	864.46	864.61	864.67	864.67	864.49	864.43	864.35	864.21	864.31	864.39	864.45
B8	864.47	864.62	864.68	864.67	864.49	864.43	864.36	864.22	864.32	864.40	864.46
B9	864.43	864.57	864.64	864.56	864.45	864.39	864.31	864.18	864.27	864.34	864.39
B10	864.41	864.56	864.61	864.58	864.42	864.37	864.29	864.16	864.26	864.33	864.36
B11	864.38	864.53	864.56	864.53	864.38	864.33	864.25	864.11	864.24	864.31	864.32
B12	864.38	864.52	864.55	864.51	864.38	864.33	864.24	864.11	864.25	864.31	864.29
C1	864.54	864.66	864.72	864.77	864.58	864.53	864.46	864.28	864.39	864.44	864.63
C2	864.51	864.63	864.70	864.75	864.56	864.51	864.42	864.25	864.36	864.41	864.59
C3	864.52	864.65	864.72	864.76	864.57	864.52	864.45	864.28	864.36	864.43	864.60
C4	864.53	864.66	864.74	864.77	864.59	864.54	864.47	864.30	864.37	864.44	864.59
C5	864.55	864.68	864.76	864.79	864.61	864.56	864.49	864.32	864.38	864.45	864.59
C6	864.55	864.68	864.76	864.78	864.61	864.56	864.49	864.33	864.37	864.44	864.58

Table 9.1. Water-table elevation (m) at the coarse-textured site (page 14 of 16).

Rep/ plot no.	31 May 1999	5 Jul. 1999	26 Jul. 1999	23 Aug. 1999	29 Sep. 1999	18 Oct. 1999	22 Nov. 1999	20 Apr. 2000	29 May 2000	26 Jun. 2000	31 Jul. 2000
C7	864.48	864.62	864.70	864.71	864.52	864.46	864.38	864.24	864.29	864.36	864.44
C8	864.47	864.60	864.67	864.67	864.49	864.43	864.36	864.23	864.27	864.33	864.39
C9	864.49	864.61	864.68	864.68	864.50	864.45	864.38	864.26	864.28	864.33	864.38
C10	864.48	864.60	864.67	864.67	864.49	864.44	864.38	864.26	864.26	864.31	864.34
C11	864.48	864.59	864.67	864.66	864.49	864.44	864.37	864.26	864.25	864.29	864.31
C12	864.47	864.58	864.64	864.65	864.48	864.42	864.37	864.26	864.23	864.27	864.27
D1	864.53	864.65	864.70	864.76	864.57	864.52	864.45	864.27	864.38	864.42	864.62
D2	864.54	864.66	864.72	864.78	864.59	864.54	864.47	864.28	864.38	864.43	864.62
D3	864.56	864.71	864.77	864.80	864.63	864.58	864.51	864.33	864.41	864.46	864.63
D4	864.55	864.69	864.76	864.79	864.62	864.56	864.49	864.32	864.38	864.44	864.59
D5	864.58	864.71	864.78	864.80	864.64	864.59	864.53	864.38	864.40	864.44	864.59
D6	864.59	864.71	864.79	864.81	864.65	864.60	864.54	864.39	864.39	864.44	864.59
D7	864.58	864.71	864.81	864.82	864.65	864.60	864.53	864.39	864.38	864.43	864.60
D8	864.58	864.71	864.81	864.83	864.66	864.60	864.54	864.39	864.37	864.44	864.61
D9	864.57	864.71	864.82	864.83	864.64	864.57	864.50	864.36	864.34	864.40	864.60
D10	864.50	864.63	864.71	864.72	864.52	864.46	864.39	864.28	864.25	864.29	864.35
D11	864.54	864.65	864.71	864.72	864.55	864.49	864.43	864.33	864.29	864.32	864.33
D12	864.50	864.59	864.65	864.67	864.49	864.44	864.38	864.28	864.23	864.26	864.27
E1	864.56	864.67	864.73	864.79	864.60	864.55	864.48	864.30	864.40	864.43	864.62
E2	864.56	864.68	864.75	864.79	864.61	864.56	864.50	864.32	864.41	864.44	864.61
E3	864.65	864.77	864.83	864.84	864.69	864.64	864.60	864.44	864.45	864.45	864.57
E4	864.60	864.72	864.77	864.79	864.64	864.59	864.54	864.39	864.40	864.41	864.52
E5	864.64	864.76	864.82	864.84	864.68	864.64	864.59	864.44	864.43	864.45	864.56
E6	864.61	864.73	864.80	864.82	864.66	864.61	864.56	864.41	864.41	864.43	864.55
E7	864.61	864.74	864.82	864.83	864.68	864.62	864.57	864.42	864.41	864.44	864.56
E8	864.60	864.74	864.82	864.84	864.67	864.62	864.57	864.42	864.40	864.48	864.54
E9	864.53	864.66	864.74	864.74	864.56	864.50	864.44	864.32	864.27	864.30	864.32
E10	864.50	864.62	864.69	864.70	864.52	864.46	864.41	864.29	864.24	864.26	864.27
E11	864.51	864.62	864.68	864.69	864.51	864.46	864.40	864.29	864.24	864.26	864.27
E12	864.51	864.62	864.68	864.69	864.52	864.46	864.41	864.29	864.24	864.27	864.27

Table 9.1. Water-table elevation (m) at the coarse-textured site (page 15 of 16).

Rep/ plot no.	24 Aug. 2000	25 Sep. 2000	30 Oct. 2000	30 Apr. 2001	28 May 2001	25 Jun. 2001	30 Jul. 2001	27 Aug. 2001	24 Sep. 2001	5 Nov. 2001
A1	864.52	864.43	864.35	864.17	864.25	864.52	864.48	864.33	864.37	864.21
A2	864.50	864.40	864.33	864.15	864.24	864.37	864.43	864.38	864.29	864.20
A3	864.45	864.37	864.28	864.11	864.21	864.36	864.51	864.37	864.27	864.16
A4	864.42	864.33	864.27	864.12	864.20	864.34	864.53	864.34	864.25	864.13
A5	864.40	864.32	864.25	864.10	864.18	864.32	864.52	864.33	864.24	864.12
A6	864.36	864.28	864.21	864.10	864.21	864.33	864.54	864.35	864.22	864.09
A7	864.34	864.28	864.20	864.10	864.21	864.33	864.54	864.35	864.22	864.09
A8	864.32	864.26	864.18	864.09	864.18	864.29	864.52	864.41	864.14	864.02
A9	864.28	864.19	864.13	864.03	864.18	864.25	864.44	864.31	864.18	864.04
A10	864.26	864.17	864.11	864.02	864.13	864.23	864.43	864.30	864.17	864.01
A11	864.20	864.13	864.10	864.01	864.10	864.18	864.39	864.26	864.14	864.00
A12	864.20	864.14	864.09	864.01	864.08	864.15	864.35	864.25	864.12	864.00
B1	864.44	864.42	864.34	864.19	864.23	864.31	864.48	864.30	864.24	864.20
B2	864.38	864.41	864.34	864.18	864.23	864.18	864.50	864.30	864.24	864.19
B3	864.45	864.37	864.31	864.17	864.21	864.37	864.52	864.29	864.23	864.17
B4	864.42	864.36	864.29	864.17	864.20	864.30	864.53	864.29	864.22	864.15
B5	864.40	864.32	864.28	864.16	864.19	864.29	864.54	864.28	864.20	864.14
B6	864.50	864.42	864.38	864.28	864.31	864.41	864.66	864.40	864.32	864.25
B7	864.36	864.28	864.23	864.15	864.18	864.28	864.53	864.28	864.18	864.11
B8	864.35	864.29	864.23	864.16	864.18	864.28	864.54	864.28	864.19	864.11
B9	864.29	864.23	864.19	864.13	864.14	864.23	864.49	864.23	864.14	864.07
B10	864.27	864.21	864.17	864.11	864.13	864.22	864.46	864.22	864.13	864.06
B11	864.24	864.18	864.14	864.07	864.10	864.18	864.41	864.22	864.12	864.03
B12	864.24	864.17	864.14	864.07	864.10	864.16	864.40	864.23	864.12	864.04
C1	864.50	864.32	864.36	864.22	864.25	864.28	864.45	864.29	864.24	864.22
C2	864.51	864.40	864.33	864.19	864.22	864.29	864.45	864.26	864.22	864.19
C3	864.48	864.40	864.34	864.21	864.23	864.31	864.51	864.29	864.23	864.20
C4	864.49	864.40	864.35	864.23	864.25	864.34	864.56	864.31	864.25	864.21
C5	864.49	864.41	864.36	864.25	864.26	864.37	864.61	864.32	864.26	864.22
C6	864.49	864.42	864.35	864.25	864.26	864.39	864.63	864.32	864.25	864.21

Table 9.1. Water-table elevation (m) at the coarse-textured site (page 16 of 16).

Rep/ plot no.	24 Aug. 2000	25 Sep. 2000	30 Oct. 2000	30 Apr. 2001	28 May 2001	25 Jun. 2001	30 Jul. 2001	27 Aug. 2001	24 Sep. 2001	5 Nov. 2001
C7	864.35	864.29	864.25	864.17	864.17	864.26	864.55	864.24	864.16	864.11
C8	864.31	864.26	864.22	864.16	864.14	864.21	864.49	864.21	864.13	864.09
C9	864.31	864.27	864.23	864.18	864.15	864.22	864.49	864.21	864.13	864.10
C10	864.29	864.24	864.22	864.18	864.13	864.18	864.45	864.19	864.11	864.09
C11	864.26	864.23	864.21	864.18	864.12	864.15	864.43	864.17	864.09	864.08
C12	864.24	864.21	864.20	864.17	864.10	864.12	864.38	864.15	864.07	864.07
D1	864.49	864.42	864.34	864.20	864.23	864.26	864.40	864.25	864.20	864.20
D2	864.51	864.43	864.36	864.22	864.24	864.21	864.47	864.28	864.23	864.21
D3	864.51	864.46	864.38	864.25	864.27	864.36	864.56	864.33	864.27	864.24
D4	864.49	864.43	864.37	864.24	864.25	864.34	864.58	864.31	864.25	864.22
D5	864.49	864.43	864.38	864.30	864.27	864.34	864.59	864.31	864.23	864.23
D6	864.47	864.41	864.38	864.29	864.27	864.37	864.62	864.31	864.24	864.21
D7	864.48	864.43	864.37	864.29	864.27	864.36	864.66	864.32	864.25	864.21
D8	864.49	864.41	864.37	864.29	864.27	864.39	864.70	864.34	864.25	864.20
D9	864.42	864.36	864.32	864.26	864.23	864.36	864.78	864.30	864.19	864.16
D10	864.26	864.24	864.23	864.20	864.13	864.17	864.58	864.17	864.09	864.09
D11	864.30	864.28	864.27	864.24	864.16	864.18	864.45	864.21	864.12	864.13
D12	864.19	864.21	864.21	864.19	864.10	864.11	864.37	864.15	864.06	864.07
E1	864.50	864.42	864.36	864.22	864.24	864.30	864.54	864.29	864.23	864.22
E2	864.51	864.44	864.38	864.25	864.25	864.30	864.57	864.29	864.24	864.23
E3	864.50	864.45	864.43	864.33	864.28	864.30	864.51	864.29	864.22	864.26
E4	864.44	864.40	864.37	864.28	864.23	864.24	864.44	864.24	864.17	864.21
E5	864.48	864.43	864.41	864.33	864.27	864.30	864.53	864.28	864.21	864.24
E6	864.46	864.42	864.38	864.31	864.26	864.29	864.55	864.27	864.20	864.22
E7	864.48	864.44	864.40	864.32	864.27	864.33	864.61	864.30	864.21	864.23
E8	864.46	864.42	864.38	864.31	864.26	864.35	864.66	864.30	864.21	864.21
E9	864.28	864.25	864.25	864.22	864.13	864.18	864.50	864.17	864.08	864.11
E10	864.25	864.21	864.22	864.20	864.11	864.12	864.40	864.15	864.07	864.09
E11	864.24	864.22	864.22	864.20	864.10	864.11	864.39	864.15	864.06	864.08
E12	864.24	864.22	864.23	864.20	864.11	864.10	864.38	864.15	864.06	864.09

Table 9.2. Water-table elevation (m) at the medium-textured site (page 1 of 14).

Rep/ plot no.	21 May 1993	26 May 1993	31 May 1993	11 Jun. 1993	14 Jun. 1993	22 Jun. 1993	28 Jun. 1993	15 Jul. 1993	21 Jul. 1993	27 Jul. 1993	11 Aug. 1993	23 Aug. 1993
A1	868.65	868.61	868.56	868.39	868.91	868.60	868.40	868.65	868.62	868.61	868.21	868.25
A2	868.63	868.62	868.58	868.40	868.95	868.61	868.40	868.67	868.63	868.62	868.19	868.25
A3	868.64	868.64	868.59	868.43	868.95	868.64	868.45	868.69	868.65	868.65	868.24	868.31
A4	868.67	868.67	868.63	868.47	869.01	868.67	868.49	868.73	868.69	868.70	868.28	868.36
A5	868.69	868.69	868.65	868.50	869.05	868.69	868.51	868.77	868.71	868.73	868.31	868.38
A6	868.71	868.72	868.67	868.52	869.04	868.74	868.53	868.78	868.74	868.73	868.29	868.36
A7	868.73	868.73	868.68	868.52	869.15	868.75	868.51	868.78	868.75	868.73	868.26	868.31
A8	868.71	868.73	868.67	868.51	869.25	868.77	868.49	868.78	868.76	868.75	868.28	868.32
A9	868.71	868.72	868.67	868.51	869.22	868.75	868.51	868.80	868.75	868.76	868.30	868.32
A10	868.71	868.72	868.67	868.51	869.13	868.76	868.53	868.77	868.75	868.73	868.27	868.30
A11	868.73	868.74	868.69	868.52	869.25	868.79	868.52	868.77	868.74	868.72	868.22	868.25
A12	868.74	868.74	868.68	868.51	869.25	868.78	868.50	868.75	868.73	868.70	868.18	868.19
B1	868.50	868.50	868.46	868.31	868.67	868.48	868.31	868.47	868.48	868.44	868.11	868.07
B2	868.53	868.53	868.50	868.34	868.72	868.53	868.34	868.52	868.53	868.48	868.13	868.10
B3	868.57	868.57	868.53	868.34	868.85	868.57	868.33	868.59	868.58	868.55	868.10	868.14
B4	868.61	868.62	868.57	868.38	869.00	868.62	868.34	868.71	868.64	868.64	868.08	868.22
B5	868.61	868.63	868.58	868.39	868.92	868.63	868.38	868.72	868.66	868.65	868.12	868.23
B6	868.63	868.65	868.60	868.42	868.95	868.67	868.41	868.69	868.67	868.64	868.13	868.20
B7	868.63	868.66	868.60	868.44	868.99	868.69	868.43	868.72	868.68	868.67	868.15	868.19
B8	868.61	868.62	868.58	868.43	868.95	868.69	868.44	868.70	868.68	868.66	868.16	868.20
B9	868.56	868.58	868.56	868.40	868.90	868.67	868.43	868.67	868.66	868.64	868.13	868.18
B10	868.55	868.57	868.54	868.40	868.92	868.67	868.43	868.67	868.65	868.63	868.01	868.15
B11	868.51	868.54	868.49	868.33	868.99	868.63	868.35	868.58	868.58	868.54	868.01	868.02
B12	868.45	868.47	868.42	868.27	868.82	868.53	868.27	868.47	868.50	868.45	867.94	867.92
C1	868.47	868.46	868.40	868.21	868.89	868.45	868.16	868.38	868.36	868.33	867.86	867.86
C2	868.53	868.52	868.47	868.27	869.05	868.60	868.24	868.42	868.45	868.37	867.85	867.78
C3	868.54	868.54	868.49	868.30	869.07	868.66	868.30	868.50	868.52	868.46	867.89	867.79
C4	868.52	868.53	868.48	868.29	869.04	868.63	868.29	868.55	868.54	868.52	867.93	867.88
C5	868.50	868.51	868.46	868.24	868.94	868.56	868.25	868.62	868.57	868.57	867.93	868.01
C6	868.51	868.52	868.47	868.27	868.87	868.59	868.30	868.57	868.57	868.55	867.97	868.00

Table 9.2. Water-table elevation (m) at the medium-textured site (page 2 of 14).

Rep/ plot no.	21 May 1993	26 May 1993	31 May 1993	11 Jun. 1993	14 Jun. 1993	22 Jun. 1993	28 Jun. 1993	15 Jul. 1993	21 Jul. 1993	27 Jul. 1993	11 Aug. 1993	23 Aug. 1993
C7	868.53	868.53	868.48	868.28	868.91	868.61	868.31	868.53	868.56	868.51	867.96	867.90
C8	868.53	868.52	868.48	868.31	868.97	868.67	868.36	868.53	868.57	868.50	867.98	867.89
C9	868.52	868.52	868.47	868.29	869.04	868.68	868.35	868.48	868.55	868.43	867.99	867.84
C10	868.52	868.51	868.45	868.26	868.90	868.66	868.35	868.41	868.51	868.37	868.02	867.86
C11	868.46	868.46	868.41	868.25	868.69	868.60	868.32	868.33	868.44	868.28	867.95	867.79
C12	868.37	868.38	868.35	868.20	868.42	868.54	868.24	868.30	868.37	868.22	867.86	867.70
D1	868.49	868.47	868.42	868.24	868.98	868.62	868.27	868.27	868.35	868.20	867.75	867.53
D2	868.48	868.48	868.43	868.25	869.01	868.65	868.29	868.40	868.43	868.34	867.84	867.62
D3	868.44	868.46	868.41	868.23	868.99	868.63	868.28	868.44	868.47	868.41	867.84	867.69
D4	868.41	868.43	868.40	868.21	868.94	868.62	868.29	868.51	868.49	868.46	867.85	867.74
D5	868.38	868.39	868.36	868.21	868.92	868.59	868.29	868.51	868.49	868.47	867.89	867.79
D6	868.45	868.39	868.35	868.19	868.88	868.58	868.26	868.51	868.49	868.47	867.88	867.84
D7	868.38	868.39	868.34	868.15	868.81	868.52	868.21	868.47	868.47	868.46	867.85	867.85
D8	868.35	868.37	868.32	868.14	868.75	868.50	868.22	868.44	868.47	868.45	867.89	867.90
D9	868.30	868.31	868.27	868.11	868.57	868.41	868.17	868.35	868.42	868.36	867.85	867.81
D10	868.26	868.26	868.24	868.08	868.61	868.40	868.14	868.32	868.37	868.29	867.80	867.72
D11	868.21	868.23	868.20	868.06	868.59	868.39	868.10	868.28	868.33	868.23	867.73	867.61
D12	868.17	868.18	868.16	868.04	868.54	868.37	868.09	868.23	868.28	868.15	867.65	867.53
E1	868.40	868.39	868.34	868.14	868.86	868.53	868.15	868.25	868.28	868.19	867.64	867.44
E2	868.42	868.43	868.39	868.21	868.98	868.61	868.28	868.35	868.40	868.30	867.80	867.57
E3	868.46	868.46	868.42	868.25	868.99	868.67	868.36	868.44	868.48	868.39	867.86	867.62
E4	868.47	868.47	868.44	868.26	869.03	868.72	868.39	868.49	868.53	868.43	867.87	867.63
E5	868.47	868.47	868.43	868.25	869.05	868.74	868.40	868.53	868.56	868.47	867.87	867.67
E6	868.46	868.47	868.42	868.23	869.04	868.72	868.37	868.53	868.54	868.47	867.80	867.63
E7	868.49	868.48	868.43	868.24	869.09	868.74	868.39	868.48	868.55	868.40	867.84	867.59
E8	868.45	868.43	868.40	868.22	869.02	868.69	868.37	868.45	868.53	868.40	867.90	867.67
E9	868.36	868.37	868.34	868.19	868.92	868.64	868.32	868.39	868.46	868.34	867.92	867.75
E10	868.31	868.30	868.29	868.17	868.75	868.61	868.33	868.35	868.42	868.28	867.88	867.70
E11	868.23	868.24	868.23	868.12	868.59	868.54	868.27	868.27	868.34	868.21	867.80	867.60
E12	868.11	868.14	868.16	868.19	868.31	868.51	868.23	868.16	868.25	868.11	867.77	867.56

Table 9.2. Water-table elevation (m) at the medium-textured site (page 3 of 14).

Rep/ plot no.	15 Nov. 1993	21 Jan. 1994	8 Apr. 1994	12 Apr. 1994	3 May 1994	24 May 1994	27 May 1994	30 May 1994	10 Jun. 1994	28 Jun. 1994	11 Jul. 1994	29 Jul. 1994
A1	868.32	867.97	868.10	868.20	868.29	868.57	868.53	868.45	868.32	868.03	867.83	867.75
A2	868.32	867.94	867.95	868.01	868.23	868.51	868.48	868.40	868.29	868.00	867.83	867.76
A3	868.34	867.97	867.95	868.00	868.26	868.52	868.49	868.40	868.32	868.01	867.86	867.82
A4	868.43	868.03	867.88	867.88	868.33	868.52	868.48	868.48	868.38	868.09	867.93	867.91
A5	868.41	868.02	868.04	868.09	868.34	868.60	868.59	868.53	868.45	868.13	867.96	867.94
A6	868.44	868.03	867.99	868.09	868.39	868.65	868.62	868.55	868.46	868.10	867.89	867.83
A7	868.45	867.99	868.01	868.06	868.33	868.71	868.66	868.59	868.50	868.11	867.84	867.84
A8	868.42	868.00	868.02	868.11	868.36	868.70	868.66	868.60	868.51	868.15	867.85	867.82
A9	868.42	867.99	867.93	867.99	868.35	868.62	868.60	868.54	868.46	868.09	867.80	867.77
A10	868.39	867.94	867.90	868.00	868.40	868.67	868.63	868.58	868.50	868.10	867.81	867.79
A11	868.36	867.92	867.89	867.99	868.33	868.72	868.70	868.62	868.54	868.08	867.78	867.73
A12	868.33	867.88	867.93	867.98	868.37	868.75	868.72	868.66	868.57	868.09	867.83	867.69
B1	868.14	867.84	867.80	867.86	867.87	868.34	868.35	868.30	868.19	867.91	867.70	867.58
B2	868.18	867.85	867.77	867.82	867.80	868.40	868.38	868.36	868.24	867.93	867.71	867.61
B3	868.24	867.82	866.82	866.48	867.87	868.38	868.32	868.22	868.25	867.91	867.70	867.63
B4	868.32	867.77	866.99	866.85	868.02	868.40	868.43	868.27	868.26	867.87	867.64	867.66
B5	868.34	867.81	867.53	867.51	868.02	868.49	868.48	868.42	868.33	867.88	867.68	867.83
B6	868.32	867.85	867.48	867.53	868.19	868.48	868.44	868.43	868.36	867.95	867.85	868.03
B7	868.35	867.89	867.60	867.64	868.19	868.51	868.50	868.45	868.39	867.93	867.74	867.85
B8	868.34	867.86	867.61	867.65	868.21	868.53	868.53	868.48	868.41	867.96	867.72	867.73
B9	868.29	867.81	867.59	867.63	868.20	868.53	868.53	868.48	868.40	867.96	867.72	867.69
B10	868.26	867.77	867.43	867.44	868.22	868.44	868.45	868.40	868.32	867.88	867.64	867.54
B11	868.15	867.67	866.92	866.91	868.18	868.42	868.45	868.40	868.30	867.85	867.62	867.52
B12	868.11	867.64	867.35	867.36	868.17	868.38	868.40	868.34	868.26	867.84	867.68	867.50
C1	867.93	867.59	867.61	867.67	867.97	868.36	868.33	868.26	868.10	867.68	867.45	867.30
C2	867.96	867.56	867.31	867.30	867.74	868.40	868.39	868.32	868.11	867.67	867.43	867.33
C3	868.00	867.54	866.87	866.84	867.67	868.22	868.36	868.29	868.13	867.68	867.40	867.46
C4	868.10	867.56	866.89	866.91	867.72	868.27	868.31	868.25	868.12	867.67	867.44	867.68
C5	868.16	867.56	866.80	866.87	867.90	868.31	868.35	868.29	868.20	867.70	867.69	868.10
C6	868.17	867.62	867.21	867.26	867.90	868.29	868.33	868.27	868.18	867.70	868.31	868.47

Table 9.2. Water-table elevation (m) at the medium-textured site (page 4 of 14).

Rep/ plot no.	15 Nov. 1993	21 Jan. 1994	8 Apr. 1994	12 Apr. 1994	3 May 1994	24 May 1994	27 May 1994	30 May 1994	10 Jun. 1994	28 Jun. 1994	11 Jul. 1994	29 Jul. 1994
C7	868.16	867.67	867.03	867.03	867.83	868.24	868.35	868.30	868.19	867.75	868.27	868.36
C8	868.11	867.67	866.74	866.73	867.73	868.16	868.37	868.35	868.23	867.83	867.75	867.93
C9	868.07	867.63	866.66	867.59	867.50	868.09	868.37	868.36	868.24	867.84	867.61	867.63
C10	868.01	867.66	866.72	866.66	867.31	867.63	867.98	867.93	867.79	867.69	867.63	867.54
C11	867.92	867.58	866.69	866.62	867.21	867.54	867.80	868.10	868.20	867.87	867.63	867.46
C12	867.80	867.49	866.58	866.51	867.17	867.49	867.59	867.64	867.94	867.76	867.58	867.39
D1	867.61	867.34	867.02	867.13	867.50	867.93	868.13	868.15	867.99	867.55	867.23	867.00
D2	867.71	867.40	866.79	866.95	867.33	867.69	868.02	868.12	868.03	867.64	867.34	867.14
D3	867.82	867.42	866.76	866.84	867.25	867.72	868.01	868.06	867.98	867.60	867.34	867.25
D4	867.90	867.41	866.76	866.84	867.28	867.86	868.06	868.07	868.01	867.60	867.35	867.49
D5	867.95	867.44	866.68	866.82	867.27	867.83	868.03	868.05	867.97	867.58	867.62	868.01
D6	867.99	867.43	866.80	866.87	867.38	867.93	868.06	868.06	867.98	867.56	867.46	868.24
D7	868.00	867.50	866.91	866.94	867.32	867.93	868.11	868.09	868.03	867.63	867.68	867.94
D8	867.97	867.48	866.94	866.97	867.28	867.85	868.04	868.04	867.99	867.62	867.45	867.57
D9	867.92	867.48	866.82	866.94	867.22	867.71	867.93	867.97	867.93	867.60	867.37	867.26
D10	867.85	867.41	866.89	866.93	867.21	867.67	867.90	867.97	867.93	867.58	867.34	867.27
D11	867.77	867.34	866.85	866.86	867.17	867.62	867.82	867.90	867.91	867.55	867.29	867.14
D12	867.66	867.23	866.70	866.77	867.08	867.50	867.68	867.77	867.82	867.47	867.23	867.06
E1	867.45	867.15	866.52	866.72	867.10	867.46	867.73	867.84	867.81	867.43	867.16	866.95
E2	867.61	867.25	866.63	866.71	867.00	867.39	867.71	867.91	867.88	867.53	867.28	867.09
E3	867.74	867.34	866.42	866.66	867.06	867.62	868.01	868.08	868.05	867.60	867.29	867.09
E4	867.78	867.36	866.26	866.61	866.95	867.67	868.02	868.11	868.07	867.59	867.26	867.13
E5	867.81	867.38	866.28	866.67	866.99	867.74	868.12	868.15	868.09	867.63	867.38	867.51
E6	867.77	867.38	867.19	866.48	867.16	867.79	868.07	868.10	868.00	867.54	867.39	867.69
E7	867.75	867.37	866.52	866.79	866.95	867.59	868.05	868.09	867.99	867.58	867.32	867.42
E8	867.75	867.34	866.66	866.82	866.88	867.28	867.78	867.96	867.99	867.65	867.40	867.34
E9	867.75	867.39	866.40	866.70	866.87	867.21	867.56	867.71	867.97	867.70	867.49	867.38
E10	867.70	867.35	866.45	866.72	866.85	867.26	867.59	867.82	867.96	867.66	867.46	867.28
E11	867.61	867.33	866.75	866.82	866.90	867.29	867.51	867.70	867.88	867.59	867.35	867.18
E12	867.50	867.24	866.26	866.44	866.77	867.11	867.19	867.10	867.63	867.54	867.34	867.17

Table 9.2. Water-table elevation (m) at the medium-textured site (page 5 of 14).

Rep/ plot no.	30 Aug. 1994	26 Sep. 1994	31 Oct. 1994	23 Jan. 1995	23 Feb. 1995	31 Mar. 1995	2 May 1995	29 May 1995	26 Jun. 1995	24 Jul. 1995	28 Aug. 1995	25 Sep. 1995
A1	867.60	867.50	867.59	867.49	867.45	867.50	867.75	868.05	867.82	867.55	867.37	867.32
A2	867.54	867.56	867.59	867.45	867.40	867.44	867.69	868.01	867.81	867.58	867.38	867.12
A3	867.61	867.61	867.64	867.46	867.40	867.42	867.72	868.07	867.84	867.68	867.42	867.17
A4	867.58	867.63	867.73	867.54	867.48	867.50	867.78	868.14	867.95	867.72	867.52	867.47
A5	867.64	867.64	867.80	867.59	867.55	867.54	867.87	868.24	867.98	867.77	867.56	867.46
A6	867.64	867.59	867.78	867.52	867.46	867.49	867.91	868.29	868.01	867.72	867.46	867.44
A7	867.58	867.53	867.79	867.48	867.42	867.46	867.98	868.33	868.02	867.69	867.40	867.38
A8	867.54	867.49	867.79	867.49	867.41	867.45	867.98	868.33	868.02	867.69	867.40	867.38
A9	867.49	867.44	867.71	867.41	867.31	867.38	867.90	868.26	867.97	867.67	867.37	867.34
A10	867.47	867.43	867.71	867.41	867.32	867.36	867.91	868.30	868.00	867.67	867.43	867.41
A11	867.43	867.44	867.69	867.46	867.36	867.42	867.97	868.37	868.13	867.70	867.57	867.53
A12	867.39	867.57	867.79	867.50	867.40	867.45	868.02	868.40	868.08	868.04	867.93	867.81
B1	867.36	867.27	867.32	867.19	867.12	867.12	867.35	867.69	867.67	867.38	867.17	867.07
B2	867.38	867.02	867.39	867.22	867.15	867.13	867.39	867.78	867.74	867.41	867.19	867.13
B3	866.45	867.30	867.40	867.16	867.06	867.02	867.39	867.92	867.76	867.43	867.15	867.08
B4	866.59	867.30	867.47	867.17	867.05	867.01	867.50	868.01	868.13	867.44	867.12	867.04
B5	867.24	867.35	867.58	867.25	867.13	867.09	867.56	868.12	867.90	867.43	867.13	867.06
B6	867.37	867.36	867.62	867.30	867.16	867.11	867.49	868.16	867.95	867.49	867.18	867.11
B7	867.33	867.30	867.50	867.19	867.07	867.01	867.50	868.14	867.80	867.45	867.11	867.02
B8	867.37	867.26	867.43	867.17	867.05	866.98	867.42	868.06	867.88	867.49	867.17	867.11
B9	867.28	867.27	867.38	867.19	867.05	866.99	867.35	868.01	867.73	867.53	867.25	867.19
B10	867.26	867.16	867.27	867.07	866.94	866.86	867.21	867.92	867.77	867.44	867.23	867.18
B11	867.04	867.04	867.26	867.03	866.89	866.82	867.19	867.92	867.72	867.45	867.40	867.39
B12	867.05	867.09	867.29	867.06	866.91	866.84	867.21	867.94	867.75	867.63	867.71	867.75
C1	866.89	866.82	866.90	866.76	866.68	866.65	867.05	867.59	867.35	867.09	866.90	866.75
C2	866.85	866.86	866.93	866.75	866.65	866.59	866.89	867.61	867.44	867.10	866.86	866.73
C3	866.94	866.95	866.99	866.77	866.63	866.55	866.77	867.59	867.58	867.17	866.84	866.68
C4	867.01	867.05	867.22	866.89	866.74	866.61	866.80	867.84	867.65	867.23	866.88	866.68
C5	867.15	867.23	867.58	867.03	866.86	866.75	867.17	868.06	867.72	867.28	866.90	866.75
C6	867.58	867.34	867.76	867.06	866.86	866.74	867.23	868.10	867.75	867.28	866.88	866.71

Table 9.2. Water-table elevation (m) at the medium-textured site (page 6 of 14).

Rep/ plot no.	30 Aug. 1994	26 Sep. 1994	31 Oct. 1994	23 Jan. 1995	23 Feb. 1995	31 Mar. 1995	2 May 1995	29 May 1995	26 Jun. 1995	24 Jul. 1995	28 Aug. 1995	25 Sep. 1995
C7	867.54	867.33	867.55	867.07	866.86	866.75	866.97	868.02	867.78	867.33	866.96	866.78
C8	867.08	867.27	867.28	867.01	866.85	866.77	866.82	867.73	867.82	867.38	867.02	866.84
C9	867.10	867.19	867.12	866.96	866.83	866.76	866.76	867.24	867.64	867.31	867.05	866.94
C10	866.99	867.17	867.11	866.95	866.84	866.77	866.76	866.95	867.37	867.28	867.09	867.03
C11	866.76	867.18	867.03	866.86	866.79	866.68	866.68	866.91	867.34	867.26	867.17	867.12
C12	866.68	867.00	866.96	866.79	866.68	866.59	866.60	866.90	867.34	867.35	867.55	867.39
D1	866.61	866.57	866.55	866.43	866.36	866.31	866.42	866.75	866.98	866.79	866.71	866.63
D2	866.61	866.58	866.49	866.39	866.28	866.19	866.32	866.77	867.15	866.91	866.63	866.53
D3	866.78	866.56	866.59	866.44	866.29	866.15	866.30	866.93	867.31	867.12	866.65	866.48
D4	866.93	866.66	866.86	866.59	866.40	866.25	866.47	867.45	867.46	867.12	866.70	866.50
D5	867.14	866.71	867.24	866.73	866.51	866.33	866.67	867.76	867.59	867.12	866.70	866.47
D6	867.34	867.12	867.47	866.81	866.57	866.43	866.86	867.88	867.59	867.13	866.71	866.50
D7	867.25	867.06	867.27	866.84	866.62	866.51	866.75	867.66	867.60	867.19	866.79	866.60
D8	866.13	866.97	867.01	866.78	866.63	866.53	866.59	867.20	867.46	867.18	866.83	866.65
D9	866.97	866.88	866.85	866.67	866.55	866.47	866.46	866.85	867.29	867.08	866.82	866.69
D10	866.90	866.85	866.79	866.63	866.51	866.44	866.44	866.80	867.22	867.06	866.82	866.76
D11	866.79	866.82	866.75	866.59	866.46	866.38	866.38	866.75	867.18	866.98	866.83	866.81
D12	866.65	866.91	866.77	866.55	866.42	866.34	866.35	866.73	867.15	866.97	867.01	866.96
E1	866.39	866.38	866.30	866.17	866.05	866.00	866.09	866.43	866.77	866.90	867.11	867.14
E2	866.59	866.60	866.60	866.41	866.29	866.20	866.24	866.56	866.95	866.98	867.17	867.23
E3	866.55	866.73	866.89	866.51	866.35	866.23	866.32	866.94	867.31	867.24	867.20	867.28
E4	866.52	866.85	867.10	866.66	866.50	866.35	866.35	867.39	867.51	867.23	867.17	867.23
E5	866.71	867.02	867.13	866.90	866.70	866.55	866.54	867.91	867.71	867.30	867.17	867.20
E6	866.58	867.04	867.13	866.89	866.70	866.54	866.62	868.01	867.68	867.24	867.06	867.06
E7	866.90	867.00	867.04	866.85	866.68	866.55	866.60	867.77	867.63	867.23	867.01	867.01
E8	866.86	867.01	866.92	866.84	866.69	866.57	866.52	867.06	867.51	867.26	866.99	867.12
E9	866.62	867.00	866.85	866.79	866.64	866.51	866.46	866.80	867.46	867.31	867.16	867.13
E10	866.66	866.86	866.81	866.71	866.57	866.45	866.39	866.68	867.32	867.29	867.08	867.07
E11	866.76	866.85	866.83	866.71	866.58	866.48	866.44	866.76	867.28	867.15	867.06	867.10
E12	866.46	866.80	866.81	866.67	866.56	866.43	866.41	866.63	867.14	867.10	866.96	867.16

Table 9.2. Water-table elevation (m) at the medium-textured site (page 7 of 14).

Rep/ plot no.	3 Nov. 1995	18 Mar. 1996	29 Apr. 1996	24 May 1996	20 Jun. 1996	2 Aug. 1996	23 Aug 1996	23 Sep 1996	5 May 1997	29 May 1997	20 Jun. 1997	8 Aug. 1997
A1	867.27	867.20	867.52	867.62	867.60	867.43	867.27	867.08	867.48	867.64	867.82	868.01
A2	867.26	867.18	867.48	867.56	867.61	867.51	867.35	867.18	867.38	867.55	867.74	867.99
A3	867.29	867.20	867.52	867.60	867.63	867.63	867.46	867.29	867.40	867.60	867.71	868.03
A4	867.38	867.32	867.61	867.69	867.73	867.73	867.56	867.38	867.49	867.66	867.83	868.10
A5	867.43	867.43	867.71	867.80	867.83	867.74	867.58	867.43	867.62	867.77	867.94	868.11
A6	867.38	867.25	867.59	867.77	867.82	867.67	867.50	867.38	867.59	867.78	867.94	868.12
A7	867.37	867.13	867.47	867.78	867.83	867.62	867.46	867.36	867.62	867.84	867.95	868.20
A8	867.39	867.08	867.46	867.76	867.83	867.64	867.46	867.35	867.62	867.84	867.97	868.27
A9	867.35	866.99	867.28	867.68	867.76	867.66	867.45	867.29	867.51	867.73	867.91	868.31
A10	867.43	867.04	867.32	867.80	867.87	867.74	867.49	867.27	867.62	867.89	868.00	868.34
A11	867.60	867.16	867.47	868.03	868.03	867.74	867.44	867.23	867.85	868.21	868.15	868.28
A12	867.83	867.23	867.53	868.15	868.02	867.59	867.36	867.18	867.78	868.16	868.14	868.20
B1	867.01	866.85	867.06	867.23	867.31	867.15	867.05	866.88	867.09	867.22	867.47	867.86
B2	867.03	866.90	867.10	867.27	867.38	867.24	867.15	866.96	867.06	867.21	867.52	868.00
B3	866.98	866.83	867.03	867.26	867.39	867.30	867.22	867.05	867.00	867.15	867.53	868.05
B4	866.94	866.75	866.99	867.23	867.36	867.29	867.22	867.05	866.95	867.12	867.52	868.02
B5	866.97	866.75	867.02	867.22	867.36	867.24	867.16	867.04	866.92	867.11	867.54	868.02
B6	866.99	866.71	866.92	867.12	867.30	867.20	867.15	867.05	866.84	867.04	867.54	868.02
B7	866.92	866.65	866.88	867.15	867.35	867.22	867.12	866.99	866.90	867.10	867.63	868.02
B8	866.99	866.69	866.86	867.16	867.39	867.33	867.22	867.05	866.88	867.10	867.61	868.07
B9	867.09	866.79	866.90	867.21	867.43	867.41	867.30	867.10	866.87	867.09	867.56	868.18
B10	867.12	866.77	866.87	867.24	867.43	867.38	867.23	867.03	866.85	867.05	867.53	868.20
B11	867.39	866.90	867.03	867.48	867.59	867.42	867.19	867.01	866.80	866.96	867.47	868.02
B12	867.71	866.98	867.17	867.74	867.69	867.42	867.18	866.97	866.80	866.99	867.47	867.91
C1	866.64	866.95	867.10	867.32	867.22	867.00	866.86	866.64	866.99	867.10	867.40	867.70
C2	866.59	867.69	867.16	867.32	867.31	867.06	866.94	866.73	866.92	867.06	867.59	867.97
C3	866.52	867.61	867.07	867.24	867.36	867.12	866.99	866.77	866.78	866.94	867.62	868.27
C4	866.54	867.40	866.82	867.05	867.20	867.09	867.02	866.81	866.59	866.75	867.43	868.38
C5	866.60	866.51	866.63	866.86	867.05	867.10	867.04	866.85	866.51	866.68	867.22	868.35
C6	866.54	866.27	866.43	866.65	866.87	866.96	866.94	866.77	866.37	866.54	866.97	868.17

Table 9.2. Water-table elevation (m) at the medium-textured site (page 8 of 14).

Rep/ plot no.	3 Nov. 1995	18 Mar. 1996	29 Apr. 1996	24 May 1996	20 Jun. 1996	2 Aug. 1996	23 Aug 1996	23 Sep 1996	5 May 1997	29 May 1997	20 Jun. 1997	8 Aug. 1997
C7	866.58	866.24	866.32	866.48	866.72	866.94	866.93	866.78	866.28	866.44	866.78	868.07
C8	866.66	866.34	866.36	866.49	866.70	866.93	866.93	866.81	866.29	866.44	866.69	868.00
C9	866.78	866.53	866.52	866.59	866.75	866.90	866.92	866.88	866.33	866.46	866.64	867.92
C10	866.91	866.66	866.65	866.69	866.83	866.95	866.93	866.91	866.44	866.53	866.68	867.42
C11	867.00	866.67	866.64	866.75	866.99	867.04	866.95	866.89	866.43	866.52	866.69	867.86
C12	867.20	866.68	866.66	866.87	867.24	867.17	866.98	866.84	866.41	866.52	866.70	867.78
D1	866.53	867.27	867.05	867.26	867.30	866.89	866.74	866.56	866.63	866.77	867.33	867.81
D2	866.40	na[z]	866.88	867.14	867.25	866.88	866.76	866.61	866.58	866.74	867.38	868.04
D3	866.31	867.12	866.78	867.05	867.18	866.83	866.73	866.48	866.45	866.62	867.19	868.27
D4	866.31	867.16	866.73	866.99	867.12	866.83	866.73	866.48	866.36	866.53	867.01	868.45
D5	866.29	866.41	866.40	866.72	866.91	866.74	866.68	866.43	866.19	866.37	866.79	868.46
D6	866.33	866.08	866.24	866.58	866.78	866.73	866.69	866.44	866.18	866.36	866.77	868.41
D7	866.42	866.05	866.19	866.41	866.64	866.81	866.76	866.52	866.14	866.32	866.66	868.14
D8	866.49	866.12	866.18	866.34	866.55	866.76	866.72	866.51	866.08	866.23	866.50	867.92
D9	866.54	866.20	866.19	866.31	866.53	866.70	866.65	866.53	866.01	866.13	866.33	867.80
D10	866.60	866.24	866.25	866.37	866.64	866.73	866.63	866.50	866.01	863.16	866.38	867.75
D11	866.70	866.28	866.32	866.50	866.77	866.77	866.63	866.46	866.02	866.17	866.42	867.66
D12	866.85	866.36	866.37	866.68	866.94	866.83	866.64	866.45	866.05	866.16	866.41	867.51
E1	867.06	867.78	867.26	867.72	867.52	866.95	866.73	866.44	866.77	866.93	867.38	867.50
E2	867.15	na	866.85	867.43	867.46	867.05	866.85	866.64	866.42	866.60	867.11	867.64
E3	867.23	866.50	866.69	867.29	867.47	867.06	866.83	866.60	866.21	866.41	866.97	867.83
E4	867.22	866.48	866.52	867.13	867.42	866.97	866.81	866.61	867.03	866.18	866.52	868.07
E5	867.18	866.55	866.42	866.95	867.34	867.01	866.89	866.73	866.09	866.18	866.35	868.33
E6	867.07	866.49	866.47	866.89	867.22	866.90	866.79	866.64	866.08	866.18	866.38	868.37
E7	866.98	866.45	866.42	866.65	866.95	866.85	866.75	866.59	866.05	866.14	866.34	868.19
E8	867.03	866.49	866.44	866.55	866.84	866.91	866.81	866.66	866.04	866.13	866.27	868.06
E9	867.03	866.48	866.40	866.53	866.83	866.92	866.82	866.68	866.02	866.09	866.24	868.10
E10	866.97	866.47	866.40	866.52	866.84	866.89	866.78	866.65	866.00	866.08	866.24	868.09
E11	867.02	866.56	866.51	866.66	866.95	866.92	866.82	866.72	866.09	866.16	866.33	867.97
E12	867.08	866.60	866.54	866.67	866.98	866.97	866.85	866.74	866.10	866.12	866.25	867.86

[z] Not available.

Table 9.2. Water-table elevation (m) at the medium-textured site (page 9 of 14).

Rep/ plot no.	5 Sep. 1997	26 Sep. 1997	27 Oct. 1997	1 Dec. 1997	30 Mar. 1998	27 Apr. 1998	25 May 1998	25 Jun. 1998	27 Jul. 1998	24 Aug. 1998	28 Sep. 1998	26 Oct. 1998
A1	867.78	867.62	867.47	867.35	867.33	867.97	867.88	867.75	868.03	867.80	867.49	867.41
A2	867.84	867.71	867.55	867.40	867.34	867.96	867.90	867.78	868.05	867.98	867.64	867.54
A3	867.91	867.78	867.62	867.50	867.45	867.99	867.97	867.84	868.31	868.17	867.81	867.70
A4	867.98	867.87	867.72	867.58	867.53	868.05	868.03	867.94	868.53	868.28	867.92	867.81
A5	868.02	867.89	867.76	867.64	867.65	868.16	868.11	868.01	868.52	868.32	867.95	867.85
A6	868.03	867.88	867.75	867.63	867.67	868.22	868.13	868.02	868.34	868.25	867.88	867.79
A7	868.10	867.92	867.78	867.67	867.71	868.28	868.22	868.05	868.30	868.23	867.85	867.77
A8	868.16	867.96	867.81	867.70	867.76	868.29	868.24	868.08	868.32	868.23	867.84	867.75
A9	868.14	867.92	867.77	867.67	867.77	868.28	868.20	868.05	868.34	868.19	867.77	867.69
A10	868.15	867.93	867.80	867.70	867.78	868.34	868.27	868.12	868.44	868.25	867.78	867.68
A11	868.13	867.95	867.85	867.76	867.90	868.45	868.34	868.15	868.49	868.28	867.75	867.64
A12	868.03	868.14	868.03	867.88	868.26	868.55	868.46	868.14	868.29	868.17	867.73	867.62
B1	867.66	867.52	867.34	867.21	867.07	867.67	867.70	867.62	867.82	867.74	867.41	867.30
B2	867.78	867.63	867.44	867.29	867.13	867.80	867.80	867.72	868.04	867.96	867.55	867.42
B3	867.83	867.66	867.49	867.34	867.13	867.93	867.89	867.81	868.48	868.20	867.71	867.57
B4	867.90	867.71	867.54	867.39	867.22	868.05	868.01	867.89	868.78	868.43	867.91	867.77
B5	867.93	867.76	867.60	867.44	867.30	868.15	868.07	867.92	868.70	868.46	867.95	867.82
B6	867.93	867.79	867.62	867.46	867.27	868.14	868.07	867.96	868.36	868.37	867.90	867.78
B7	867.96	867.78	867.61	867.47	867.38	868.18	868.12	867.99	868.26	868.33	867.82	867.69
B8	868.00	867.80	867.62	867.48	867.39	868.19	868.12	868.01	868.32	868.28	867.76	867.63
B9	868.02	867.80	867.63	867.50	867.46	868.19	868.16	868.04	868.39	868.23	867.74	867.63
B10	868.00	867.75	867.62	867.51	867.43	868.24	868.20	868.05	868.39	868.20	867.73	867.60
B11	867.89	867.72	867.67	867.55	867.84	868.34	868.31	868.05	868.34	868.12	867.67	867.54
B12	867.81	867.86	867.86	867.72	868.33	868.50	868.43	868.07	868.10	868.00	867.65	867.51
C1	867.48	867.23	867.04	866.90	866.91	867.77	867.61	867.50	867.96	867.63	867.16	867.03
C2	867.73	867.42	867.16	867.00	867.31	868.08	867.83	867.68	867.30	868.01	867.39	867.19
C3	867.99	867.61	867.31	867.09	867.29	868.23	868.06	867.87	868.82	868.44	867.66	867.44
C4	868.02	867.67	867.39	867.18	867.39	868.24	868.11	867.92	868.95	868.47	867.76	867.57
C5	868.09	867.75	867.50	867.31	867.22	868.22	868.14	867.91	868.74	868.52	867.89	867.73
C6	867.99	867.69	867.45	867.26	866.97	868.10	868.04	867.83	868.32	868.34	867.80	867.63

Table 9.2. Water-table elevation (m) at the medium-textured site (page 10 of 14).

Rep/ plot no.	5 Sep. 1997	26 Sep. 1997	27 Oct. 1997	1 Dec. 1997	30 Mar. 1998	27 Apr. 1998	25 May 1998	25 Jun. 1998	27 Jul. 1998	24 Aug. 1998	28 Sep. 1998	26 Oct. 1998
C7	867.89	867.66	867.43	867.23	866.89	868.01	867.95	867.82	868.20	868.20	867.73	867.57
C8	867.80	867.64	867.42	867.21	866.91	867.85	867.92	867.84	868.15	868.15	867.71	867.54
C9	867.70	867.58	867.38	867.21	866.94	867.64	867.84	867.82	868.06	868.15	867.70	867.53
C10	867.37	867.41	867.32	867.19	866.96	867.30	867.49	867.61	867.64	867.87	867.64	867.51
C11	867.56	867.49	867.39	867.24	866.97	867.95	868.04	867.87	868.25	868.26	867.73	867.52
C12	867.51	867.55	867.56	867.37	867.22	868.09	868.13	867.98	867.96	868.03	867.66	867.45
D1	867.50	867.22	866.96	866.78	866.53	867.90	867.72	867.59	868.27	867.95	867.29	867.04
D2	867.80	867.45	867.08	866.85	866.57	868.12	867.94	867.81	868.31	868.22	867.51	867.20
D3	867.95	867.57	867.20	866.95	866.68	868.13	868.00	867.84	868.38	868.29	867.59	867.32
D4	868.09	867.65	867.29	867.07	866.81	868.18	868.05	867.88	868.53	868.37	867.64	867.40
D5	868.04	867.62	867.29	867.09	867.50	868.10	868.00	867.85	868.38	868.23	867.57	867.38
D6	868.01	867.61	867.31	867.10	867.09	868.07	867.99	867.81	868.21	868.16	867.58	867.43
D7	867.96	867.63	867.32	867.11	867.06	868.02	867.97	867.82	868.16	868.15	867.64	867.46
D8	867.78	867.54	867.28	867.07	866.86	867.87	867.90	867.75	868.11	868.09	867.62	867.44
D9	867.63	867.44	867.22	867.02	866.74	867.70	867.82	867.71	868.02	868.02	867.59	867.40
D10	867.54	867.38	867.19	867.02	866.80	867.73	867.84	867.74	868.09	868.01	867.56	867.39
D11	867.47	867.34	867.18	867.03	867.00	867.86	867.93	867.79	868.12	868.04	867.52	867.36
D12	867.30	867.31	867.26	867.12	867.77	868.03	868.00	867.76	867.97	867.90	867.42	867.26
E1	867.23	867.12	866.94	866.76	866.59	867.94	867.95	867.77	868.28	867.99	867.39	867.10
E2	867.39	867.28	867.11	866.93	866.63	868.08	868.04	867.90	868.34	868.16	867.56	867.29
E3	867.60	867.44	867.24	867.04	866.66	868.22	868.12	867.99	868.35	868.33	867.60	867.34
E4	867.78	867.53	867.27	867.07	866.69	868.20	868.07	867.94	868.41	868.27	867.52	867.27
E5	867.91	867.56	867.31	867.12	866.78	868.21	868.07	867.92	868.45	868.22	867.53	867.32
E6	867.87	867.47	867.21	867.04	866.69	868.16	867.97	867.83	868.36	868.16	867.47	867.28
E7	867.81	867.45	867.17	866.98	866.68	868.08	867.90	867.79	868.39	868.17	867.51	867.29
E8	867.74	867.47	867.20	866.99	866.69	867.98	867.90	867.79	868.39	868.18	867.56	867.32
E9	867.75	867.50	867.25	867.05	866.71	867.96	867.94	867.84	868.46	868.18	867.62	867.38
E10	867.72	867.47	867.24	867.07	866.74	868.03	867.97	867.86	868.33	868.15	867.61	867.37
E11	867.68	867.45	867.28	867.13	866.84	868.18	868.11	867.94	868.31	868.10	867.60	867.37
E12	867.55	867.41	867.29	867.17	866.83	868.24	868.11	867.95	868.07	867.91	867.51	867.32

Table 9.2. Water-table elevation (m) at the medium-textured site (page 11 of 14).

Rep/ plot no.	30 Nov. 1998	19 Apr. 1999	31 May 1999	5 Jul. 1999	26 Jul. 1999	23 Aug. 1999	27 Sep. 1999	18 Oct. 1999	22 Nov. 1999	20 Apr. 2000	29 May 2000	26 Jun. 2000
A1	867.35	867.40	867.73	867.90	868.36	868.36	867.93	867.84	867.78	867.84	867.99	868.26
A2	867.44	867.42	867.83	867.97	868.47	868.53	868.15	868.05	867.97	867.97	868.10	868.41
A3	867.59	867.53	867.96	868.08	868.60	868.64	868.33	868.24	868.15	868.13	868.22	868.50
A4	867.68	867.64	868.08	868.16	868.62	868.70	868.41	868.32	868.24	868.23	868.29	868.54
A5	867.75	867.73	868.18	868.23	868.69	868.76	868.49	868.41	868.33	868.35	868.42	868.63
A6	867.70	867.74	868.21	868.25	868.72	868.82	868.53	868.44	868.36	868.39	868.47	868.70
A7	867.68	867.78	868.22	868.28	868.86	868.93	868.57	868.48	868.40	868.42	868.50	868.77
A8	867.68	867.79	868.19	868.29	868.94	868.97	868.58	868.50	868.42	868.41	868.51	868.79
A9	867.61	867.71	868.12	868.26	868.94	868.96	868.56	868.47	868.38	868.36	868.45	868.74
A10	867.60	867.67	868.14	868.30	868.95	869.02	868.58	868.48	868.39	868.36	868.46	868.81
A11	867.55	867.66	868.16	868.29	868.88	868.96	868.48	868.36	868.25	868.27	868.42	868.89
A12	867.51	867.65	868.17	868.28	868.75	868.85	868.42	868.28	868.17	868.22	868.51	868.95
B1	867.19	867.09	867.43	867.77	868.23	868.30	867.99	867.90	867.83	867.71	867.87	868.17
B2	867.30	867.18	867.58	867.95	868.52	868.56	868.19	868.08	867.98	867.85	868.01	868.38
B3	867.44	867.28	867.83	868.05	868.62	868.71	868.32	868.22	868.13	868.01	868.14	868.53
B4	867.61	867.52	868.08	868.15	868.77	868.82	868.47	868.38	868.30	868.27	868.34	868.67
B5	867.68	867.57	868.18	868.24	868.83	868.92	868.61	868.52	868.44	868.41	868.50	868.79
B6	867.65	867.54	868.18	868.26	868.82	868.98	868.66	868.57	868.48	868.45	868.52	868.75
B7	867.56	867.54	868.14	868.26	868.87	869.04	868.69	868.59	868.51	868.46	868.54	868.83
B8	867.52	867.49	868.09	868.28	868.90	869.07	868.70	868.60	868.51	868.46	868.55	868.84
B9	867.50	867.47	868.08	868.31	869.03	869.11	868.73	868.63	868.54	868.49	868.58	868.89
B10	867.48	867.41	868.05	868.30	869.03	869.10	868.70	868.60	868.50	868.44	868.56	868.91
B11	867.40	867.31	868.02	868.22	868.99	869.02	868.59	868.48	868.37	868.32	868.51	869.01
B12	867.37	867.25	867.98	868.13	868.82	868.90	868.49	868.37	868.25	868.22	868.47	868.99
C1	866.94	866.81	867.41	867.69	868.22	868.27	867.87	867.77	867.72	867.74	867.81	868.21
C2	867.06	866.84	867.73	868.01	868.55	868.72	868.22	868.10	868.03	868.05	868.15	868.68
C3	867.27	866.96	868.05	868.22	868.86	868.98	868.50	868.40	868.33	868.33	868.44	868.91
C4	867.42	867.09	868.12	868.23	869.05	869.05	868.61	868.52	868.45	868.44	868.51	869.02
C5	867.55	867.33	868.15	868.25	869.20	869.09	868.71	868.63	868.55	868.51	868.59	869.07
C6	867.46	867.23	868.08	868.20	868.97	869.07	868.70	868.63	868.55	868.50	868.57	868.98

Table 9.2. Water-table elevation (m) at the medium-textured site (page 12 of 14).

Rep/ plot no.	30 Nov. 1998	19 Apr. 1999	31 May 1999	5 Jul. 1999	26 Jul. 1999	23 Aug. 1999	27 Sep. 1999	18 Oct. 1999	22 Nov. 1999	20 Apr. 2000	29 May 2000	26 Jun. 2000
C7	867.43	867.10	867.99	868.22	868.94	869.10	868.74	868.66	868.57	868.54	868.61	868.96
C8	867.41	867.05	867.87	868.26	868.95	869.14	868.78	868.70	868.61	868.58	868.64	869.01
C9	867.38	867.01	867.73	868.28	868.85	869.12	868.74	868.66	868.58	868.56	868.67	869.04
C10	867.38	866.94	867.39	867.85	868.28	868.65	868.37	868.32	868.29	868.06	868.23	868.64
C11	867.35	866.89	867.44	868.26	868.83	869.05	868.61	868.50	868.40	868.29	868.48	869.05
C12	867.27	866.80	867.40	868.08	868.36	868.82	868.41	868.28	868.20	868.02	868.26	868.89
D1	866.85	866.51	867.14	867.91	868.45	868.54	868.07	867.95	867.88	867.70	867.90	868.49
D2	867.00	866.62	867.58	868.17	868.80	868.93	868.47	868.37	868.27	868.15	868.27	868.88
D3	867.12	866.74	867.78	868.19	868.95	869.04	868.60	868.51	868.41	868.30	868.39	868.94
D4	867.23	866.86	867.89	868.20	869.01	869.12	868.70	868.63	868.53	868.40	868.48	869.05
D5	867.24	866.91	867.88	868.14	868.94	869.11	868.72	868.64	868.55	868.41	868.50	869.06
D6	867.28	866.99	867.92	868.13	868.87	869.10	868.74	868.69	868.60	868.45	868.55	869.08
D7	867.30	866.92	867.91	868.13	868.90	869.09	868.77	868.72	868.62	868.48	868.57	869.05
D8	867.26	866.84	867.83	868.10	868.89	869.06	868.76	868.70	868.60	868.49	868.59	869.03
D9	867.23	866.77	867.71	868.05	868.80	868.99	868.71	868.64	868.55	868.44	868.54	868.99
D10	867.23	866.79	867.66	868.06	868.80	868.98	868.69	868.62	868.52	868.39	868.52	869.01
D11	867.20	866.79	867.64	868.01	868.65	868.92	868.61	868.52	868.43	868.29	868.46	869.01
D12	867.11	866.73	867.53	867.86	868.30	868.75	868.44	868.34	868.25	868.17	868.32	868.92
E1	866.85	866.39	867.26	867.81	868.56	868.56	868.40	868.20	868.01	867.71	867.90	868.47
E2	867.04	866.48	867.36	868.05	868.80	868.87	868.66	868.47	868.27	867.96	868.13	868.80
E3	867.12	866.62	867.65	868.29	868.99	869.09	868.85	868.67	868.48	868.19	868.33	869.03
E4	867.08	866.56	867.53	868.27	869.06	869.13	868.90	868.72	868.53	868.24	868.40	869.15
E5	867.16	866.67	867.46	868.21	869.13	869.18	869.01	868.84	868.65	868.41	868.56	869.30
E6	867.13	866.69	867.60	868.14	869.03	869.14	869.00	868.83	868.63	868.39	868.57	869.27
E7	867.11	866.65	867.47	868.16	869.03	869.12	869.03	868.85	868.64	868.43	868.62	869.25
E8	867.13	866.62	867.23	868.19	869.04	869.13	869.03	868.85	868.65	868.43	868.62	869.25
E9	867.18	866.59	867.23	868.21	869.04	869.12	869.04	868.85	868.65	868.45	868.65	869.24
E10	867.15	866.57	867.34	868.19	868.93	869.05	868.95	868.77	868.58	868.33	868.55	869.20
E11	867.18	866.63	867.30	868.10	868.76	868.97	868.85	868.68	868.50	868.21	868.44	869.19
E12	867.13	866.54	866.92	867.90	868.19	868.81	868.67	868.49	868.31	867.96	868.42	869.21

Table 9.2. Water-table elevation (m) at the medium-textured site (page 13 of 14).

Rep/ plot no.	24 Jul. 2000	24 Aug. 2000	25 Sep. 2000	30 Oct. 2000	30 Apr. 2001	28 May 2001	25 Jun. 2001	30 Jul. 2001	27 Aug. 2001	24 Sep. 2001	5 Nov. 2001
A1	868.13	867.74	867.62	867.49	867.68	867.78	867.80	868.50	867.71	867.43	867.17
A2	868.35	867.93	867.82	867.66	867.79	867.89	867.86	868.64	867.86	867.61	867.32
A3	868.48	868.09	868.00	867.86	867.90	868.00	868.10	868.68	868.01	867.77	867.51
A4	868.58	868.19	868.12	867.98	867.99	868.08	868.12	868.69	868.08	867.87	867.62
A5	868.65	868.28	868.22	868.08	868.11	868.17	868.14	868.78	868.13	867.91	867.67
A6	868.67	868.27	868.26	868.10	868.16	868.21	868.15	868.94	868.12	867.90	867.66
A7	868.71	868.27	868.30	868.14	868.21	868.25	868.18	869.13	868.16	867.93	867.69
A8	868.72	868.29	868.32	868.16	868.19	868.24	868.18	869.19	868.20	867.97	867.72
A9	868.72	868.30	868.29	868.13	868.13	868.20	868.14	869.19	868.20	867.96	867.68
A10	868.82	868.37	868.32	868.13	868.14	868.22	868.20	869.29	868.22	867.97	867.70
A11	868.84	868.28	868.22	868.00	868.11	868.16	868.25	869.37	868.15	867.89	867.60
A12	868.78	868.18	868.10	867.89	868.02	868.10	868.41	869.36	868.19	867.92	867.63
B1	868.05	867.71	867.58	867.49	867.53	867.68	867.77	868.12	867.64	867.38	867.16
B2	868.34	867.87	867.75	867.61	867.66	867.80	867.86	868.43	867.80	867.52	867.26
B3	868.54	868.00	867.90	867.74	867.88	867.93	867.92	868.64	867.86	867.61	867.33
B4	868.68	868.20	868.18	867.98	868.14	868.13	868.02	868.79	867.92	867.72	867.49
B5	868.77	868.33	868.33	868.14	868.25	868.25	868.12	868.83	867.98	867.78	867.54
B6	868.79	868.39	868.39	868.20	868.30	868.29	868.18	868.89	868.05	867.85	867.60
B7	868.81	868.40	868.43	868.23	868.28	868.27	868.21	868.99	868.11	867.89	867.63
B8	868.84	868.41	868.43	868.24	868.24	868.27	868.21	869.00	868.14	867.92	867.65
B9	868.91	868.46	868.45	868.26	868.25	868.31	868.18	869.07	868.19	867.96	867.69
B10	868.95	868.42	868.41	868.21	868.19	868.27	868.17	869.11	868.16	867.94	867.67
B11	869.00	868.32	868.31	868.07	868.02	868.18	868.19	869.15	868.08	867.89	867.66
B12	868.89	868.21	868.18	867.96	867.88	868.07	868.23	869.07	868.11	867.92	867.70
C1	867.93	867.45	867.46	867.34	867.74	867.70	867.71	868.24	867.29	867.04	866.82
C2	868.53	867.74	867.75	867.54	868.00	867.93	867.88	868.47	867.46	867.19	866.94
C3	868.81	868.12	868.12	867.88	868.16	868.16	868.06	868.79	867.70	867.40	867.12
C4	868.92	868.27	868.23	868.02	868.26	868.23	868.05	868.93	867.82	867.54	867.23
C5	868.95	868.40	868.40	868.19	868.32	868.32	868.13	868.99	867.93	867.68	867.40
C6	868.88	868.39	868.42	868.20	868.33	868.30	868.11	868.98	867.93	867.70	867.41

Table 9.2. Water-table elevation (m) at the medium-textured site (page 14 of 14).

Rep/ plot no.	24 Jul. 2000	24 Aug. 2000	25 Sep. 2000	30 Oct. 2000	30 Apr. 2001	28 May 2001	25 Jun. 2001	30 Jul. 2001	27 Aug. 2001	24 Sep. 2001	5 Nov. 2001
C7	868.89	868.41	868.48	868.25	868.39	868.34	868.13	868.98	867.99	867.75	867.48
C8	868.92	868.44	868.54	868.31	868.42	868.39	868.25	869.01	868.04	867.81	867.54
C9	868.95	868.42	868.55	868.30	868.45	868.40	868.27	869.05	868.02	867.79	867.54
C10	868.71	868.29	868.37	868.13	867.96	868.04	868.07	868.64	867.91	867.72	867.52
C11	869.08	868.44	868.50	868.19	868.01	868.29	868.33	869.06	867.92	867.69	867.47
C12	868.87	868.30	868.28	868.02	867.58	868.05	868.37	868.77	867.89	867.67	867.45
D1	868.17	867.54	867.59	867.34	867.41	867.72	868.02	868.66	867.36	866.94	866.63
D2	868.72	868.31	868.05	867.73	867.90	868.05	868.08	868.96	867.63	867.21	866.79
D3	868.85	868.43	868.20	868.01	868.07	868.20	868.07	869.05	867.74	867.38	866.96
D4	868.97	868.48	868.33	868.06	868.12	868.23	868.10	869.18	867.86	867.51	867.12
D5	869.01	868.03	868.39	868.14	868.10	868.24	868.07	869.34	867.95	867.62	867.25
D6	869.03	868.23	868.46	868.23	868.18	868.29	868.07	869.52	868.09	867.77	867.40
D7	869.01	868.46	868.51	868.26	868.17	868.27	868.05	869.56	868.10	867.80	867.45
D8	869.05	868.52	868.56	868.30	868.16	868.31	868.11	869.53	868.16	867.84	867.50
D9	869.05	868.53	868.52	868.28	868.09	868.26	868.08	869.45	868.15	867.82	867.49
D10	869.10	868.55	868.50	868.26	868.11	868.24	868.13	869.36	868.12	867.81	867.49
D11	869.08	868.52	868.46	868.21	868.05	868.17	868.21	869.17	868.04	867.76	867.47
D12	868.89	868.34	868.25	868.04	867.94	868.04	868.29	868.88	867.89	867.65	867.39
E1	868.00	867.40	867.38	867.14	866.80	867.39	867.60	868.52	867.29	866.85	866.39
E2	868.49	868.00	867.83	867.49	867.16	867.72	867.83	868.94	867.54	867.13	866.72
E3	868.90	868.22	868.22	867.84	867.84	867.97	868.04	869.04	867.67	867.29	866.89
E4	869.09	868.37	868.30	867.93	867.86	868.01	868.13	869.10	867.71	867.35	866.98
E5	869.25	868.49	868.42	868.07	868.05	868.20	868.13	869.36	867.87	867.53	867.19
E6	869.26	868.49	868.44	868.07	868.09	868.20	868.09	869.50	867.94	867.59	867.24
E7	869.26	868.48	868.47	868.08	868.04	868.16	868.09	869.61	867.97	867.62	867.27
E8	869.33	868.50	868.49	868.12	867.88	868.16	868.15	869.65	868.14	867.68	867.32
E9	869.35	868.55	868.53	868.19	867.80	868.21	868.14	869.64	868.14	867.78	867.40
E10	869.29	868.55	868.51	868.18	867.62	868.15	868.15	869.51	868.09	867.77	867.41
E11	869.24	868.50	868.44	868.13	867.44	868.03	868.15	869.29	868.00	867.72	867.40
E12	869.13	868.35	868.24	867.95	867.25	867.81	868.18	869.07	867.92	867.65	867.36

Table 9.3. Water-table depth (m) below ground surface at the coarse-textured site (page 1 of 16).

Rep/ plot no.	21 May 1993	26 May 1993	2 Jun. 1993	14 Jun. 1993	22 Jun. 1993	5 Jul. 1993	15 Jul. 1993	21 Jul. 1993	27 Jul. 1993	11 Aug. 1993	23 Aug. 1993
A1	2.22	2.22	2.20	2.08	1.97	1.99	1.89	1.90	1.93	2.03	2.02
A2	2.40	2.32	2.25	2.15	1.93	1.99	1.89	1.92	1.96	2.05	2.07
A3	2.29	2.25	2.23	2.14	1.97	2.03	1.95	1.97	2.01	2.11	2.14
A4	2.37	2.34	2.32	2.22	2.07	2.14	2.06	2.08	2.12	2.22	2.24
A5	2.31	2.27	2.24	2.16	2.01	2.07	2.00	2.01	2.06	2.15	2.18
A6	2.18	2.12	2.10	1.95	1.90	1.96	1.90	1.93	1.97	2.07	2.08
A7	2.11	2.06	2.03	1.89	1.84	1.90	1.85	1.87	1.91	2.00	2.02
A8	2.06	2.00	1.97	1.82	1.78	1.85	1.79	1.82	1.86	1.95	1.97
A9	2.14	2.07	2.03	1.88	1.80	1.87	1.83	1.87	1.91	1.98	2.01
A10	2.08	2.02	1.98	1.83	1.78	1.84	1.80	1.84	1.88	1.96	1.98
A11	2.10	2.04	2.01	1.85	1.81	1.87	1.82	1.86	1.90	1.98	2.00
A12	2.05	1.99	1.96	1.80	1.75	1.82	1.76	1.80	1.84	1.93	1.94
B1	2.06	2.06	2.05	1.90	1.83	1.85	1.75	1.75	1.78	1.88	1.87
B2	2.04	2.05	2.04	1.89	1.82	1.84	1.74	1.74	1.78	1.88	1.87
B3	2.11	2.11	2.10	1.96	1.89	1.92	1.82	1.83	1.86	1.96	1.96
B4	2.11	2.11	2.10	1.96	1.89	1.93	1.82	1.84	1.88	1.98	1.98
B5	2.11	2.11	2.10	1.97	1.88	1.95	1.85	1.86	1.90	2.00	2.01
B6	2.04	2.03	2.02	1.88	1.82	1.88	1.78	1.80	1.84	1.94	1.94
B7	1.98	1.96	1.94	1.81	1.75	1.82	1.72	1.74	1.78	1.89	1.90
B8	2.10	2.09	2.07	1.93	1.88	1.94	1.85	1.87	1.92	2.02	2.04
B9	2.20	2.19	2.17	2.03	1.96	2.04	1.94	1.97	2.02	2.13	2.14
B10	2.25	2.23	2.20	2.07	1.99	2.08	1.98	2.01	2.06	2.16	2.18
B11	2.22	2.18	2.16	2.01	1.94	2.03	1.94	1.97	2.02	2.12	2.14
B12	2.15	2.12	2.09	1.95	1.87	1.95	1.86	1.89	1.95	2.04	2.07
C1	1.97	1.98	1.97	1.80	1.77	1.78	1.66	1.66	1.68	1.79	1.77
C2	1.83	1.83	1.83	1.66	1.63	1.64	1.53	1.53	1.55	1.67	1.64
C3	1.90	1.91	1.91	1.75	1.71	1.74	1.63	1.62	1.65	1.76	1.74
C4	1.97	1.98	1.98	1.84	1.79	1.83	1.71	1.71	1.74	1.85	1.83
C5	1.98	1.99	1.98	1.86	1.81	1.86	1.74	1.74	1.77	1.87	1.86
C6	1.93	1.94	1.94	1.82	1.77	1.83	1.72	1.71	1.75	1.86	1.84

Table 9.3. Water-table depth (m) below ground surface at the coarse-textured site (page 2 of 16).

Rep/ plot no.	21 May 1993	26 May 1993	2 Jun. 1993	14 Jun. 1993	22 Jun. 1993	5 Jul. 1993	15 Jul. 1993	21 Jul. 1993	27 Jul. 1993	11 Aug. 1993	23 Aug. 1993
C7	2.01	2.01	2.00	1.82	1.81	1.89	1.77	1.78	1.82	1.94	1.95
C8	2.13	2.12	2.12	1.94	1.92	2.00	1.89	1.90	1.95	2.07	2.08
C9	2.26	2.25	2.25	2.08	2.05	2.14	2.02	2.04	2.07	2.21	2.22
C10	2.26	2.27	2.26	2.10	2.08	2.17	2.04	2.06	2.10	2.24	2.24
C11	2.32	2.33	2.32	2.15	2.13	2.23	2.11	2.11	2.16	2.30	2.30
C12	2.23	2.24	2.24	2.07	2.05	2.14	2.02	2.03	2.08	2.22	2.22
D1	1.88	1.89	1.89	1.71	1.68	1.68	1.57	1.58	1.57	1.70	1.67
D2	1.81	1.82	1.82	1.66	1.62	1.64	1.52	1.53	1.52	1.65	1.62
D3	1.83	1.84	1.85	1.70	1.66	1.68	1.56	1.56	1.58	1.70	1.68
D4	1.95	1.95	1.96	1.81	1.77	1.81	1.70	1.69	1.71	1.83	1.81
D5	1.99	1.99	2.00	1.87	1.83	1.89	1.76	1.77	1.79	1.90	1.89
D6	1.92	1.92	1.93	1.80	1.78	1.85	1.73	1.72	1.74	1.86	1.85
D7	1.87	1.89	1.89	1.78	1.75	1.82	1.71	1.70	1.71	1.83	1.82
D8	1.97	1.98	1.98	1.88	1.83	1.92	1.81	1.79	1.81	1.92	1.93
D9	2.10	2.12	2.11	2.05	1.93	2.03	1.94	1.93	1.95	2.05	2.10
D10	2.24	2.27	2.26	2.09	2.06	2.17	2.06	2.06	2.10	2.24	2.26
D11	2.32	2.33	2.33	2.17	2.15	2.24	2.11	2.12	2.16	2.30	2.31
D12	2.14	2.14	2.15	1.99	1.97	2.05	1.93	1.94	1.98	2.13	2.13
E1	2.03	2.05	2.05	1.88	1.84	1.87	1.76	1.75	1.77	1.87	1.85
E2	2.31	2.16	2.07	1.88	1.82	1.86	1.74	1.74	1.76	1.86	1.84
E3	2.05	1.93	1.89	1.77	1.71	1.76	1.67	1.66	1.68	1.76	1.77
E4	1.81	1.81	1.82	1.67	1.65	1.70	1.60	1.59	1.61	1.71	1.71
E5	1.95	1.95	1.96	1.81	1.79	1.86	1.75	1.75	1.77	1.87	1.87
E6	1.90	1.91	1.91	1.78	1.75	1.83	1.72	1.71	1.74	1.83	1.83
E7	1.89	1.89	1.90	1.78	1.74	1.82	1.72	1.71	1.73	1.83	1.84
E8	1.97	1.98	1.99	1.88	1.82	1.92	1.81	1.80	1.83	1.92	1.94
E9	2.17	2.18	2.18	2.04	1.99	2.10	1.98	1.98	2.03	2.15	2.18
E10	2.25	2.25	2.25	2.13	2.06	2.17	2.04	2.05	2.10	2.23	2.24
E11	2.24	2.24	2.24	2.12	2.05	2.16	2.03	2.04	2.09	2.22	2.24
E12	2.00	2.00	2.00	1.88	1.81	1.92	1.80	1.80	1.85	1.98	2.00

Table 9.3. Water-table depth (m) below ground surface at the coarse-textured site (page 3 of 16).

Rep/ plot no.	16 Sep. 1993	27 Sep. 1993	12 Oct. 1993	15 Nov. 1993	21 Jan 1994	14 Feb. 1994	14 Mar. 1994	23 Mar. 1994	11 Apr. 1994	3 May 1994	24 May 1994
A1	2.11	2.05	2.05	2.14	2.27	2.33	2.37	2.36	2.32	2.35	2.20
A2	2.12	2.07	2.05	2.15	2.29	2.35	2.40	2.42	2.43	2.36	2.23
A3	2.18	2.11	2.11	2.22	2.38	2.43	2.50	2.51	2.44	2.41	2.26
A4	2.28	2.22	2.22	2.31	2.45	2.53	2.57	2.58	2.52	2.52	2.34
A5	2.26	2.17	2.12	2.26	2.40	2.45	2.53	2.54	2.55	2.45	2.30
A6	2.10	2.00	1.94	2.15	2.29	2.35	2.42	2.40	2.33	2.29	2.07
A7	2.04	1.96	1.95	2.08	2.23	2.30	2.36	2.34	2.27	2.23	2.01
A8	2.00	1.90	1.93	2.02	2.19	2.22	2.30	2.28	2.21	2.18	1.96
A9	2.03	1.94	1.95	2.06	2.23	2.26	2.36	2.34	2.28	2.23	2.03
A10	2.00	1.91	1.91	2.03	2.20	2.26	2.34	2.33	2.24	2.19	1.97
A11	2.02	1.92	1.93	2.05	2.21	2.28	2.35	2.35	2.46	2.22	2.00
A12	1.96	1.86	1.87	1.99	2.17	3.22	2.30	2.30	2.20	2.16	1.94
B1	1.96	1.89	1.90	1.98	2.10	2.15	2.20	2.21	2.14	2.17	2.03
B2	1.95	1.88	1.88	1.97	2.09	3.25	2.19	2.20	2.12	2.16	2.01
B3	2.03	1.95	1.95	2.04	2.18	2.23	2.28	2.29	2.20	2.26	2.08
B4	2.04	1.97	1.96	2.04	2.21	2.23	2.29	2.31	2.21	2.23	2.08
B5	2.07	1.99	1.97	2.07	2.20	2.26	2.32	2.32	2.23	2.24	2.09
B6	2.00	1.91	1.89	1.99	2.14	2.19	1.98	2.25	2.16	2.06	1.88
B7	1.94	1.86	1.84	1.94	2.09	2.13	2.20	2.22	2.10	2.12	1.93
B8	2.07	1.98	1.96	2.06	2.20	2.27	2.33	2.32	2.22	2.22	2.05
B9	2.18	2.09	2.06	2.16	2.32	2.37	2.44	2.44	2.33	2.32	2.16
B10	2.21	2.12	2.10	2.20	2.36	2.42	2.49	2.48	2.38	2.37	2.19
B11	2.17	2.07	2.06	2.08	2.33	2.37	2.45	2.45	2.35	2.33	2.14
B12	2.08	1.97	1.96	2.16	2.25	2.28	2.36	2.37	2.26	2.25	2.05
C1	1.85	1.81	1.81	1.88	2.00	2.04	2.09	2.10	2.03	2.07	1.94
C2	1.74	1.70	1.72	1.77	1.89	1.93	1.98	1.98	1.92	1.96	1.83
C3	1.83	1.77	1.78	1.84	1.97	2.03	2.05	2.08	1.98	2.03	1.89
C4	1.90	1.85	1.84	1.92	2.03	2.08	2.12	2.14	2.03	2.08	1.95
C5	1.92	1.85	1.86	1.92	2.05	2.12	2.13	2.14	2.04	2.10	1.96
C6	1.89	1.82	1.84	1.89	2.03	2.06	2.11	2.13	2.00	2.07	1.93

Table 9.3. Water-table depth (m) below ground surface at the coarse-textured site (page 4 of 16).

Rep/ plot no.	16 Sep. 1993	27 Sep. 1993	12 Oct. 1993	15 Nov. 1993	21 Jan 1994	14 Feb. 1994	14 Mar. 1994	23 Mar. 1994	11 Apr. 1994	3 May 1994	24 May 1994
C7	2.00	1.91	1.92	1.97	2.13	2.18	2.23	2.25	2.13	2.15	1.98
C8	2.13	2.03	2.03	2.10	2.25	2.31	2.37	2.37	2.25	2.28	2.11
C9	2.25	2.15	2.14	2.22	2.39	2.44	2.48	2.49	2.37	2.40	2.23
C10	2.28	2.19	2.18	2.25	2.42	2.45	2.51	2.52	2.39	2.41	2.25
C11	2.34	2.23	2.21	2.30	2.50	2.52	2.58	2.59	2.45	2.45	2.31
C12	2.27	2.19	2.17	2.24	2.41	2.44	2.51	2.51	2.36	2.39	2.23
D1	1.78	1.73	1.74	2.15	1.92	1.97	1.98	2.01	1.95	1.99	1.87
D2	1.71	1.66	1.67	2.32	1.88	1.91	1.89	1.95	1.87	1.92	1.79
D3	1.75	1.68	1.69	2.25	1.92	1.94	1.95	1.97	1.89	1.94	1.81
D4	1.88	1.82	1.81	2.01	2.01	2.05	2.09	2.11	2.00	2.07	1.92
D5	1.95	1.88	1.88	1.99	2.07	2.11	2.14	2.17	2.05	2.11	1.99
D6	1.90	1.83	1.82	1.87	1.99	2.06	2.07	2.07	1.97	2.03	1.91
D7	1.87	1.80	1.78	1.86	1.97	2.00	2.05	2.06	1.93	1.99	1.88
D8	1.97	1.88	1.88	1.89	2.07	2.20	2.15	2.15	2.03	2.09	1.98
D9	2.13	2.08	2.03	1.95	2.24	2.28	2.32	2.33	2.21	2.25	2.16
D10	2.30	2.11	2.16	1.76	2.41	2.46	2.51	2.52	2.39	2.41	2.27
D11	2.35	2.26	2.22	1.72	2.46	2.53	2.57	2.58	2.37	2.45	2.32
D12	2.17	2.08	2.14	1.77	2.29	2.34	2.39	2.39	2.26	2.28	2.14
E1	1.95	1.92	1.92	1.98	2.08	2.13	2.10	2.17	2.10	2.14	2.04
E2	1.93	1.88	1.88	1.94	2.06	2.09	2.12	2.13	2.16	2.11	2.02
E3	1.81	1.79	1.76	1.81	1.92	1.97	1.99	2.01	2.10	1.96	1.88
E4	1.79	1.76	1.74	1.80	1.91	1.95	1.97	1.99	2.01	1.94	1.84
E5	1.91	1.87	1.86	1.89	2.03	2.05	2.08	2.11	2.01	2.06	1.94
E6	1.88	1.83	1.82	1.86	1.98	2.02	2.05	2.06	1.97	2.02	1.91
E7	1.88	1.83	1.82	1.87	1.97	2.00	2.05	2.07	1.95	2.00	1.90
E8	1.98	1.93	1.89	1.96	2.09	2.11	2.15	2.16	2.05	2.10	2.01
E9	2.22	2.15	2.10	2.16	2.35	2.38	2.43	2.43	2.30	2.31	2.21
E10	2.29	2.20	2.15	2.23	2.41	2.46	2.50	2.51	2.38	2.39	2.27
E11	2.28	2.20	2.15	2.21	2.44	2.44	2.49	2.50	2.37	2.39	2.26
E12	2.04	1.95	1.91	2.00	2.26	2.21	2.26	2.28	2.13	2.16	2.02

Table 9.3. Water-table depth (m) below ground surface at the coarse-textured site (page 5 of 16).

Rep/ plot no.	27 May 1994	31 May 1994	10 Jun. 1994	27 Jun. 1994	11 Jul. 1994	22 Jul. 1994	29 Aug. 1994	26 Sep. 1994	31 Oct. 1994	23 Jan. 1995	23 Feb. 1995
A1	2.18	2.15	2.11	2.14	2.15	2.15	2.20	2.18	2.15	2.32	2.36
A2	2.20	2.19	2.09	2.09	2.13	2.14	2.29	2.21	2.19	2.34	2.39
A3	2.23	2.17	2.13	2.14	2.19	2.20	2.28	2.28	2.26	2.42	2.47
A4	2.30	2.26	2.22	2.24	2.30	2.31	2.40	2.39	2.35	2.51	2.56
A5	2.26	2.28	2.18	2.17	2.22	2.24	2.42	2.34	2.31	2.45	2.49
A6	2.07	2.04	2.02	2.03	2.11	2.11	2.21	2.21	2.18	2.32	2.37
A7	1.99	1.97	1.96	1.97	2.05	2.06	2.15	2.15	2.12	2.27	2.32
A8	1.93	1.92	1.90	1.92	2.00	2.01	2.10	2.10	2.06	2.22	2.29
A9	2.00	1.96	1.92	1.92	2.01	2.03	2.13	2.13	2.13	2.25	2.32
A10	1.95	1.92	1.89	1.90	1.99	2.01	2.21	2.11	2.10	2.23	2.28
A11	1.96	1.94	1.91	1.93	2.02	2.05	2.14	2.13	2.11	2.26	2.31
A12	1.93	1.88	1.85	1.89	1.97	2.00	2.09	2.08	2.05	2.19	2.25
B1	2.01	1.99	1.95	1.98	2.01	2.00	2.05	2.04	1.91	2.15	2.19
B2	1.98	1.97	1.94	1.97	1.99	2.00	2.05	2.05	1.99	2.16	2.19
B3	2.05	2.03	2.00	2.04	2.08	2.08	2.13	2.13	2.07	2.23	2.26
B4	2.05	2.02	2.00	2.04	2.09	2.09	2.15	2.15	2.09	2.24	2.28
B5	2.05	2.03	2.00	2.06	2.10	2.10	2.17	2.16	2.10	2.26	2.30
B6	1.86	1.83	1.81	1.86	1.91	1.92	1.98	1.99	1.92	2.08	2.11
B7	1.90	1.88	1.86	1.91	1.97	1.97	2.07	2.05	1.98	2.13	2.18
B8	2.04	1.99	1.98	2.04	2.10	2.10	2.18	2.17	2.11	2.26	2.31
B9	2.13	2.09	2.07	2.14	2.21	2.22	2.28	2.28	2.20	2.36	2.41
B10	2.15	2.13	2.10	2.17	2.24	2.25	2.32	2.33	2.25	2.39	2.44
B11	2.11	2.08	2.05	2.12	2.19	2.21	2.08	2.27	2.21	2.36	2.42
B12	2.01	1.98	1.95	2.02	2.09	2.12	2.19	2.19	2.14	2.28	2.33
C1	1.93	1.91	1.88	1.91	1.93	1.92	2.08	1.95	1.91	2.05	2.09
C2	1.82	1.80	1.77	1.80	1.83	1.81	1.86	1.85	1.80	1.94	1.98
C3	1.88	1.86	1.84	1.88	1.90	1.89	1.94	1.94	1.89	2.03	2.06
C4	1.93	1.91	1.90	1.95	1.98	1.97	2.03	2.02	1.94	2.08	2.12
C5	1.94	1.92	1.91	1.97	2.00	1.99	2.06	2.04	1.95	2.10	2.14
C6	1.90	1.89	1.87	1.94	1.98	1.97	2.02	2.01	1.94	2.07	2.11

Table 9.3. Water-table depth (m) below ground surface at the coarse-textured site (page 6 of 16).

Rep/ plot no.	27 May 1994	31 May 1994	10 Jun. 1994	27 Jun. 1994	11 Jul. 1994	22 Jul. 1994	29 Aug. 1994	26 Sep. 1994	31 Oct. 1994	23 Jan. 1995	23 Feb. 1995
C7	1.95	1.93	1.91	1.99	2.05	2.04	2.10	2.12	2.02	2.16	2.22
C8	2.08	2.06	2.04	2.12	2.18	2.19	2.24	2.24	2.05	2.29	2.34
C9	2.21	2.18	2.16	2.25	2.31	2.32	2.36	2.37	2.26	2.41	2.47
C10	2.23	2.20	2.18	2.28	2.34	2.35	2.39	2.40	2.28	2.43	2.48
C11	2.28	2.26	2.24	2.34	2.41	2.41	2.45	2.47	2.32	2.48	2.54
C12	2.21	2.19	2.16	2.27	2.34	2.35	2.38	2.39	2.26	2.41	2.47
D1	1.86	1.86	1.81	1.84	1.86	1.85	1.90	1.88	1.85	1.96	2.01
D2	1.79	1.77	1.74	1.78	1.79	1.79	1.85	1.83	1.80	1.92	1.94
D3	1.79	1.78	1.76	1.80	1.83	1.82	1.88	1.86	1.80	1.95	1.98
D4	1.91	1.90	1.88	1.94	1.97	1.95	2.00	2.00	1.93	2.06	2.11
D5	1.97	1.96	1.94	2.00	2.05	2.03	2.08	2.08	1.99	2.11	2.16
D6	1.90	1.89	1.87	1.94	1.99	1.99	2.03	2.04	1.93	2.05	2.09
D7	1.86	1.85	1.83	1.91	1.96	1.95	2.01	2.01	1.91	2.05	2.08
D8	1.96	1.95	1.93	2.00	2.07	2.05	2.11	2.11	2.01	2.13	2.16
D9	2.11	2.07	2.04	2.13	2.22	2.22	2.37	2.28	2.17	2.29	2.33
D10	2.23	2.21	2.17	2.28	2.36	2.37	2.41	2.42	2.33	2.44	2.48
D11	2.29	2.27	2.23	2.35	2.42	2.43	2.31	2.46	2.32	2.49	2.53
D12	2.11	2.09	2.06	2.17	2.24	2.25	2.29	2.30	2.15	2.31	2.36
E1	2.02	1.99	1.97	2.00	2.03	2.01	2.08	2.05	2.06	2.13	2.17
E2	2.00	1.96	1.94	1.98	2.01	1.99	2.07	2.03	2.00	2.11	2.13
E3	1.84	1.87	1.80	1.84	1.89	1.90	2.13	1.95	1.88	1.97	2.01
E4	1.83	1.82	1.78	1.84	1.88	1.87	1.94	1.93	1.85	1.95	1.98
E5	1.93	1.91	1.89	1.95	2.01	2.00	2.05	2.06	1.96	2.06	2.10
E6	1.90	1.89	1.86	1.92	1.97	1.97	2.04	2.02	1.92	2.04	2.07
E7	1.88	1.87	1.85	1.91	1.97	1.96	2.01	2.01	1.92	2.02	2.06
E8	1.97	1.95	1.93	2.00	2.06	2.06	2.11	2.11	2.04	2.12	2.16
E9	2.17	2.13	2.10	2.21	2.28	2.27	2.33	2.34	2.19	2.34	2.40
E10	2.23	2.21	2.16	2.28	2.35	2.36	2.40	2.40	2.26	2.42	2.47
E11	2.22	2.19	2.16	2.27	2.34	2.36	2.39	2.40	2.25	2.41	2.46
E12	1.98	1.95	1.91	2.03	2.08	2.12	2.16	2.16	2.01	2.17	2.22

Table 9.3. Water-table depth (m) below ground surface at the coarse-textured site (page 7 of 16).

Rep/ plot no.	31 Mar. 1995	2 May 1995	29 May 1995	26 Jun. 1995	24 Jul. 1995	28 Aug. 1995	25 Sep. 1995	3 Nov. 1995	18 Mar. 1996	29 Apr. 1996	24 May 1996
A1	2.38	2.32	2.11	2.09	2.05	2.20	2.22	2.27	2.43	2.29	2.27
A2	2.40	2.33	2.08	2.06	2.03	2.22	2.23	2.29	2.48	2.33	2.27
A3	2.49	2.37	2.13	2.10	2.08	2.26	2.30	2.36	2.58	2.40	2.32
A4	2.58	2.45	2.22	2.18	2.17	2.39	2.40	2.46	2.67	2.48	2.40
A5	2.52	2.39	2.15	2.13	2.11	2.31	2.34	2.39	2.63	2.44	2.33
A6	2.38	2.21	2.01	1.98	1.96	2.18	2.21	2.28	2.50	2.28	2.15
A7	2.32	2.16	1.95	1.93	1.91	2.11	2.16	2.22	2.44	2.22	2.10
A8	2.26	2.10	1.89	1.87	1.86	2.07	2.12	2.16	2.38	2.16	2.04
A9	2.32	2.16	1.92	1.88	1.87	2.09	2.13	2.19	2.43	2.25	2.08
A10	2.29	2.12	1.89	1.85	1.86	2.07	2.10	2.18	2.40	2.20	2.03
A11	2.31	2.13	1.91	1.88	1.89	2.10	2.13	2.19	2.42	2.21	2.06
A12	2.25	2.08	1.86	1.83	1.85	2.05	2.07	2.13	2.36	2.15	2.01
B1	2.20	2.14	1.95	1.93	1.90	2.06	2.07	2.12	2.27	2.13	2.12
B2	2.19	2.13	1.94	1.92	1.89	2.05	2.06	2.11	2.26	2.12	2.10
B3	2.27	2.19	1.99	1.98	1.97	2.13	2.15	2.19	2.36	2.19	2.18
B4	2.28	2.19	1.99	1.98	1.97	2.15	2.17	2.20	2.39	2.20	2.18
B5	2.29	2.20	1.99	1.99	1.97	2.16	2.19	2.22	2.41	2.21	2.18
B6	2.11	2.00	1.79	1.81	1.79	1.97	1.99	2.04	2.24	2.03	1.97
B7	2.17	2.05	1.84	1.84	1.85	2.04	2.07	2.10	2.30	2.09	2.02
B8	2.29	2.17	1.96	1.96	1.97	2.17	2.20	2.22	2.43	2.21	2.15
B9	2.40	2.27	2.04	2.06	2.09	2.29	2.29	2.33	2.54	2.31	2.25
B10	2.43	2.30	2.08	2.10	2.11	2.31	2.33	2.36	2.58	2.35	2.29
B11	2.40	2.27	2.04	2.04	2.07	2.27	2.28	2.32	2.55	2.32	2.23
B12	2.33	2.18	1.94	1.95	1.97	2.17	2.19	2.23	2.46	2.23	2.13
C1	2.09	2.06	1.88	1.87	1.83	1.98	1.99	2.03	2.14	2.04	2.05
C2	1.98	1.94	1.76	1.81	1.73	1.87	1.88	1.92	2.04	1.92	1.92
C3	2.05	2.01	1.84	1.84	1.80	1.96	1.97	2.00	2.12	1.98	1.99
C4	2.11	2.07	1.97	1.95	1.87	2.03	2.03	2.07	2.19	2.04	0.05
C5	2.13	2.08	1.92	1.84	1.87	2.05	2.07	2.09	2.22	2.05	2.07
C6	2.09	2.04	1.86	1.89	1.86	2.03	2.04	2.06	2.20	2.01	2.03

Table 9.3. Water-table depth (m) below ground surface at the coarse-textured site (page 8 of 16).

Rep/ plot no.	31 Mar. 1995	2 May 1995	29 May 1995	26 Jun. 1995	24 Jul. 1995	28 Aug. 1995	25 Sep. 1995	3 Nov. 1995	18 Mar. 1996	29 Apr. 1996	24 May 1996
C7	2.19	2.10	1.88	2.03	1.92	2.13	2.13	2.15	2.36	2.12	2.09
C8	2.31	2.23	2.02	2.13	2.06	2.25	2.26	2.28	2.48	2.25	2.22
C9	2.44	2.34	2.13	2.16	2.19	2.38	2.39	2.40	2.62	2.36	2.35
C10	2.45	2.36	2.15	2.23	2.22	2.41	2.42	2.43	2.64	2.39	2.37
C11	2.51	2.41	2.20	2.17	2.28	2.48	2.48	2.49	2.70	2.44	2.42
C12	2.43	2.33	2.13	1.99	2.21	2.41	2.42	2.42	2.63	2.36	2.35
D1	2.02	1.98	1.81	1.80	1.78	1.92	1.92	1.96	2.05	1.96	1.98
D2	1.94	1.90	1.74	1.73	1.70	1.84	1.87	1.90	1.99	1.88	1.89
D3	1.96	1.92	1.76	na[z]	na	na	1.88	1.91	2.02	1.89	1.91
D4	2.09	2.05	1.89	1.86	1.84	2.02	2.04	2.06	2.18	2.02	2.05
D5	2.14	2.09	1.94	1.93	1.93	2.09	2.10	2.13	2.23	2.29	2.11
D6	2.07	2.02	1.88	1.87	1.87	2.04	2.06	2.07	2.19	2.01	2.03
D7	2.04	1.99	1.82	1.83	1.84	2.00	2.04	2.04	2.16	1.97	1.99
D8	2.14	2.09	1.91	1.92	1.95	2.10	2.14	2.14	2.29	2.06	2.09
D9	2.30	2.23	2.03	2.04	2.09	2.27	2.30	2.29	2.47	2.24	2.24
D10	2.46	2.36	2.14	2.17	2.22	2.43	2.45	2.43	2.65	2.39	2.37
D11	2.50	2.41	2.21	2.24	2.31	2.49	2.49	2.45	2.67	2.41	2.39
D12	2.32	2.23	2.03	2.05	2.23	2.33	2.32	2.32	2.54	2.27	2.27
E1	2.18	2.14	1.97	1.97	1.95	2.08	2.09	2.13	2.22	2.13	2.13
E2	2.15	2.10	1.94	1.94	1.93	2.05	2.07	2.10	2.19	2.09	2.10
E3	2.01	1.96	1.79	1.79	1.82	1.96	1.97	2.00	2.12	1.97	1.99
E4	1.98	1.94	1.80	1.78	1.80	1.94	1.99	1.99	2.08	1.95	1.97
E5	2.09	2.05	1.89	1.89	1.92	2.05	2.08	2.11	2.20	2.06	2.08
E6	2.05	2.01	1.86	1.86	1.89	2.03	2.04	2.07	2.18	2.02	2.05
E7	2.04	1.99	1.84	1.84	1.87	2.03	2.04	2.06	2.16	2.00	2.02
E8	2.16	2.09	1.93	1.93	1.98	2.11	2.14	2.16	2.28	2.11	2.11
E9	2.38	2.28	2.08	2.10	2.17	2.36	2.38	2.37	2.57	2.32	2.13
E10	2.44	2.34	2.15	2.16	2.23	2.44	2.45	2.44	2.65	2.39	2.38
E11	2.44	2.34	2.13	2.15	2.22	2.43	2.44	2.43	2.65	2.39	2.36
E12	2.18	2.09	1.89	1.91	1.98	2.23	2.20	2.19	2.40	2.14	2.13

[z] Not available.

Table 9.3. Water-table depth (m) below ground surface at the coarse-textured site (page 9 of 16).

Rep/ plot no.	20 Jun. 1996	2 Aug. 1996	23 Aug. 1996	23 Sep. 1996	5 May 1997	29 May 1997	20 Jun. 1997	8 Aug. 1997	5 Sep. 1997	26 Sep. 1997	27 Oct. 1997
A1	2.13	1.95	2.04	2.01	2.28	2.14	2.04	1.82	1.98	2.05	2.16
A2	2.13	1.89	2.02	2.08	2.29	2.18	2.01	1.77	1.95	2.04	2.16
A3	2.16	1.95	2.09	2.18	2.37	2.21	2.09	1.83	2.02	2.11	2.24
A4	2.25	2.05	2.20	2.28	2.45	2.28	2.20	1.95	2.12	2.21	2.34
A5	2.20	1.98	2.14	2.23	2.39	2.28	2.13	1.89	2.05	2.15	2.28
A6	1.99	1.89	2.05	2.12	2.26	2.06	2.02	1.82	1.97	2.06	2.17
A7	1.92	1.85	1.99	2.07	2.20	2.00	1.96	1.77	1.92	2.01	2.11
A8	1.87	1.79	1.95	2.02	2.14	1.93	1.91	1.73	1.87	1.95	2.06
A9	1.88	1.84	1.97	2.08	2.20	2.02	1.94	1.79	1.92	2.01	2.11
A10	1.86	1.83	1.96	2.05	2.16	1.96	1.91	1.79	1.90	1.98	2.09
A11	1.91	1.86	1.99	2.07	2.18	1.98	1.93	1.83	1.93	2.01	2.11
A12	1.87	1.82	1.95	2.01	2.12	1.93	1.88	1.80	1.88	1.95	2.05
B1	1.97	1.81	1.91	1.87	2.11	1.97	1.89	1.69	1.83	1.90	2.01
B2	1.95	1.80	1.90	1.88	2.10	1.95	1.89	1.67	1.81	1.89	2.00
B3	2.00	1.86	1.98	1.98	2.17	2.02	1.96	1.74	1.89	1.97	2.08
B4	2.01	1.86	1.99	2.01	2.18	2.02	1.97	1.75	1.89	1.98	2.09
B5	2.02	1.88	2.02	2.05	2.20	2.03	1.99	1.77	1.90	2.00	2.11
B6	1.82	1.69	1.84	1.88	2.01	1.84	1.80	1.59	1.73	1.82	1.93
B7	1.86	1.75	1.91	1.96	2.06	1.89	1.86	1.66	1.80	1.88	1.99
B8	1.98	1.87	2.04	2.10	2.19	2.01	1.98	1.79	1.92	2.01	2.11
B9	2.10	1.99	2.16	2.22	2.30	2.11	2.08	1.92	2.04	2.11	2.22
B10	2.14	2.04	2.20	2.25	2.33	2.15	2.11	1.98	2.08	2.16	2.26
B11	2.09	2.01	2.16	2.22	2.30	2.11	2.07	1.96	2.05	2.13	2.23
B12	2.02	1.92	2.07	2.13	2.20	2.02	1.97	1.89	1.96	2.04	2.14
C1	1.92	1.76	1.83	1.78	2.02	1.89	1.82	1.63	1.76	1.83	1.92
C2	1.79	1.64	1.72	1.69	1.90	1.77	1.71	1.52	1.64	1.71	1.81
C3	1.86	1.70	1.80	1.78	1.96	1.84	1.79	1.58	1.71	1.79	1.89
C4	1.92	1.76	1.87	1.86	2.02	1.90	1.87	1.64	1.77	1.85	1.95
C5	1.94	1.78	1.89	1.90	2.03	1.92	1.89	1.65	1.78	1.87	1.97
C6	1.90	1.73	1.85	1.88	1.99	1.88	1.86	1.61	1.75	1.84	1.93

Table 9.3. Water-table depth (m) below ground surface at the coarse-textured site (page 10 of 16).

Rep/ plot no.	20 Jun. 1996	2 Aug. 1996	23 Aug. 1996	23 Sep. 1996	5 May 1997	29 May 1997	20 Jun. 1997	8 Aug. 1997	5 Sep. 1997	26 Sep. 1997	27 Oct. 1997
C7	1.90	1.81	1.98	2.02	2.10	1.92	1.91	1.69	1.84	1.93	2.03
C8	2.07	1.97	2.14	2.17	2.24	2.07	2.04	1.87	1.99	2.07	2.17
C9	2.19	2.11	2.27	2.31	2.36	2.19	2.15	2.01	2.12	2.20	2.29
C10	2.25	2.14	2.32	2.34	2.38	2.22	2.18	2.05	2.15	2.23	2.33
C11	2.31	2.23	2.39	2.41	2.44	2.28	2.24	2.13	2.22	2.29	2.38
C12	2.27	2.17	2.33	2.36	2.36	2.21	2.17	2.08	2.15	2.22	2.31
D1	1.85	1.70	1.77	1.71	1.95	1.82	1.76	1.58	1.69	1.76	1.86
D2	1.77	1.61	1.70	1.66	1.86	1.74	1.69	1.49	1.61	1.69	1.78
D3	1.78	1.62	1.71	1.68	1.86	1.73	1.70	1.48	1.61	1.68	1.79
D4	1.91	1.74	1.85	1.85	2.00	1.87	1.85	1.62	1.75	1.83	1.93
D5	2.01	1.83	1.94	1.96	2.06	1.94	1.93	1.70	1.83	1.91	2.00
D6	1.91	1.76	1.90	1.93	1.99	1.89	1.86	1.58	1.77	1.86	1.94
D7	1.84	1.71	1.85	1.89	1.95	1.86	1.83	1.58	1.71	1.81	1.90
D8	1.92	1.79	1.94	1.98	2.04	1.96	1.92	1.66	1.80	1.90	1.99
D9	2.08	1.90	2.10	2.19	2.21	2.11	2.04	1.78	1.92	2.02	2.15
D10	2.22	2.14	2.33	2.37	2.38	2.22	2.17	2.01	2.14	2.23	2.32
D11	2.30	2.20	2.37	2.38	2.40	2.25	2.20	2.10	2.19	2.25	2.34
D12	2.18	2.09	2.25	2.25	2.27	2.12	2.07	1.98	2.06	2.13	2.21
E1	2.04	1.86	1.94	1.90	2.10	1.98	1.92	1.73	1.85	1.92	2.02
E2	2.01	1.84	1.92	1.89	2.06	1.96	1.90	1.70	1.82	1.89	1.99
E3	1.92	1.75	1.86	1.90	1.96	1.84	1.78	1.63	1.74	1.80	1.88
E4	1.89	1.75	1.85	1.88	1.94	1.81	1.77	1.63	1.73	1.79	1.88
E5	2.00	1.84	1.96	2.00	2.04	1.92	1.89	1.72	1.82	1.89	1.98
E6	1.94	1.79	1.92	1.97	2.00	1.89	1.86	1.67	1.78	1.86	1.94
E7	1.91	1.76	1.90	1.95	1.98	1.89	1.84	1.63	1.75	1.84	1.92
E8	2.00	1.85	1.99	2.05	2.08	2.01	1.93	1.71	1.84	1.93	2.02
E9	2.18	2.09	2.27	2.30	2.31	2.18	2.10	1.96	2.08	2.16	2.25
E10	2.29	2.18	2.36	2.38	2.39	2.26	2.17	2.08	2.17	2.24	2.32
E11	2.28	2.18	2.35	2.37	2.38	2.25	2.16	2.07	2.14	2.23	2.31
E12	2.06	1.95	2.11	2.13	2.14	2.00	1.92	1.84	1.92	1.99	2.07

Table 9.3. Water-table depth (m) below ground surface at the coarse-textured site (page 11 of 16).

Rep/ plot no.	1 Dec. 1997	30 Mar. 1998	27 Apr. 1998	25 May 1998	26 Jun. 1998	27 Jul. 1998	24 Aug. 1998	28 Sep. 1998	26 Oct. 1998	30 Nov. 1998	19 Apr. 1999
A1	2.25	2.34	2.13	2.06	1.88	1.90	1.96	2.08	2.11	2.17	2.36
A2	2.26	2.40	2.10	2.03	1.77	1.90	1.92	2.06	2.11	2.18	2.37
A3	2.34	2.46	2.17	2.07	1.88	1.97	1.99	2.13	2.19	2.28	2.45
A4	2.44	2.54	2.27	2.17	1.97	2.08	2.10	2.24	2.29	2.36	2.54
A5	2.38	2.52	2.21	2.10	1.90	2.02	2.04	2.18	2.23	2.30	2.48
A6	2.26	2.30	2.07	1.91	1.77	1.92	1.94	2.06	2.11	2.18	2.35
A7	2.21	2.25	2.00	1.85	1.71	1.86	1.88	2.00	2.06	2.12	2.29
A8	2.15	2.20	1.93	1.81	1.64	1.82	1.83	1.95	2.00	2.07	2.23
A9	2.21	2.31	1.97	1.82	1.66	1.84	1.88	1.99	2.06	2.12	2.29
A10	2.18	2.25	2.04	1.78	1.67	1.82	1.86	1.96	2.02	2.08	2.26
A11	2.20	2.27	1.97	1.83	1.72	1.86	1.89	1.98	2.04	2.12	2.28
A12	2.14	2.21	1.92	1.79	1.68	1.81	1.84	1.93	1.98	2.05	2.22
B1	2.09	2.16	1.97	1.92	1.74	1.77	1.82	1.93	1.95	2.01	2.18
B2	2.08	2.16	1.96	1.91	1.71	1.77	1.81	1.92	1.95	2.01	2.18
B3	2.16	2.23	2.02	1.97	1.76	1.85	1.88	2.00	2.02	2.08	2.25
B4	2.17	2.24	2.02	1.97	1.76	1.86	1.89	2.01	2.03	2.09	2.26
B5	2.19	2.25	2.02	1.97	1.76	1.88	1.91	2.03	2.05	2.10	2.27
B6	2.01	2.06	1.84	1.76	1.56	1.69	1.71	1.83	1.86	1.93	2.08
B7	2.07	2.11	1.88	1.81	1.62	1.77	1.78	1.90	1.93	1.97	2.14
B8	2.19	2.24	2.00	1.93	1.74	1.89	1.90	2.02	2.05	2.10	2.26
B9	2.30	2.35	2.07	2.03	1.84	2.01	2.02	2.12	2.15	2.21	2.36
B10	2.34	2.39	2.13	2.06	1.89	2.05	2.06	2.17	2.19	2.25	2.40
B11	2.31	2.37	2.08	2.01	1.86	2.01	2.02	2.11	2.15	2.23	2.38
B12	2.22	2.28	1.99	1.92	1.79	1.92	1.93	2.03	2.07	2.14	2.30
C1	2.00	2.06	1.90	1.84	1.69	1.70	1.75	1.86	1.88	1.93	2.09
C2	1.88	1.94	1.80	1.74	1.56	1.59	1.64	1.75	1.76	1.82	1.97
C3	1.96	2.00	1.86	1.80	1.62	1.67	1.71	1.82	1.84	1.89	2.04
C4	2.02	2.06	1.91	1.88	1.67	1.74	1.77	1.89	1.92	1.96	2.10
C5	2.04	2.08	1.92	1.90	1.67	1.76	1.78	1.91	1.93	1.97	2.12
C6	2.00	2.03	1.88	1.86	1.64	1.74	1.75	1.87	1.89	1.94	2.08

Table 9.3. Water-table depth (m) below ground surface at the coarse-textured site (page 12 of 16).

Rep/ plot no.	1 Dec. 1997	30 Mar. 1998	27 Apr. 1998	25 May 1998	26 Jun. 1998	27 Jul. 1998	24 Aug. 1998	28 Sep. 1998	26 Oct. 1998	30 Nov. 1998	19 Apr. 1999
C7	2.12	2.14	1.93	1.90	1.69	1.83	1.83	1.95	1.97	2.02	2.18
C8	2.25	2.28	2.06	2.02	1.84	1.98	1.98	2.09	2.10	1.95	2.31
C9	2.37	2.40	2.18	2.13	1.97	2.10	2.10	2.20	2.22	2.27	2.42
C10	2.39	2.42	2.19	2.16	2.01	2.14	2.14	2.24	2.24	2.30	2.44
C11	2.45	2.48	2.25	2.23	2.09	2.21	2.20	2.30	2.30	2.35	2.50
C12	2.38	2.40	2.18	2.15	2.04	2.15	2.14	2.23	2.22	2.28	2.42
D1	1.93	1.99	1.84	1.78	1.64	1.63	2.14	1.80	1.81	1.86	2.01
D2	1.85	1.90	1.76	1.71	1.54	1.57	1.90	1.72	1.73	1.78	1.94
D3	1.86	1.89	1.76	1.72	1.52	1.58	1.69	1.72	1.74	1.78	1.94
D4	2.00	2.04	1.90	1.86	1.65	1.73	1.56	1.87	1.89	1.94	2.08
D5	2.07	2.09	1.96	1.94	1.73	1.82	1.66	1.94	1.96	2.01	2.13
D6	2.00	2.01	1.89	1.88	1.68	1.77	1.83	1.89	1.91	1.93	2.06
D7	1.96	1.98	1.86	1.85	1.64	1.73	1.77	1.85	1.87	1.89	2.03
D8	2.06	2.09	1.94	1.94	1.73	1.82	1.75	1.94	1.96	1.99	2.12
D9	2.22	2.29	2.03	2.06	1.84	1.95	1.73	2.09	2.11	2.15	2.28
D10	2.39	2.44	2.18	2.17	2.01	2.12	1.80	2.24	2.23	2.29	2.43
D11	2.41	2.44	2.22	2.19	2.07	2.16	2.17	2.26	2.25	2.31	2.45
D12	2.29	2.30	2.09	2.05	1.95	2.06	2.04	2.13	2.12	2.18	2.32
E1	2.08	2.16	1.99	1.95	1.75	1.80	1.84	1.95	1.97	2.01	2.16
E2	2.05	2.15	1.96	1.92	1.71	1.78	1.82	1.93	1.94	1.98	2.12
E3	1.94	2.02	1.84	1.82	1.66	1.71	1.72	1.82	1.82	1.86	1.99
E4	1.93	1.96	1.83	1.80	1.65	1.70	1.70	1.81	1.81	1.84	1.97
E5	2.04	2.06	1.93	1.91	1.74	1.82	1.81	1.92	1.93	1.95	2.08
E6	2.00	2.02	1.89	1.89	1.70	1.78	1.77	1.89	1.90	1.92	2.04
E7	1.98	2.02	1.87	1.86	1.68	1.76	1.75	1.87	1.88	1.91	2.03
E8	2.08	2.15	1.95	1.96	1.76	1.85	1.84	1.97	1.99	2.01	2.13
E9	2.32	2.37	2.11	2.10	1.94	2.07	2.06	2.17	2.16	2.21	2.35
E10	2.39	2.44	2.19	2.16	2.04	2.16	2.16	2.15	2.23	2.29	2.42
E11	2.38	2.42	2.18	2.16	2.05	2.16	2.15	2.24	2.22	2.27	2.42
E12	2.14	2.18	1.93	1.92	1.82	1.91	1.91	2.00	1.98	2.03	2.18

Table 9.3. Water-table depth (m) below ground surface at the coarse-textured site (page 13 of 16).

Rep/ plot no.	31 May 1999	5 Jul. 1999	26 Jul. 1999	23 Aug. 1999	29 Sep. 1999	18 Oct. 1999	22 Nov. 1999	20 Apr. 2000	29 May 2000	26 Jun. 2000	31 Jul. 2000
A1	2.08	1.92	1.85	1.81	2.02	2.08	2.17	2.08	2.21	2.12	1.98
A2	2.08	1.89	1.77	1.79	2.02	2.08	2.18	2.37	2.21	2.12	2.00
A3	2.15	1.95	1.83	1.87	2.09	2.16	2.26	2.45	2.27	2.16	2.07
A4	2.26	2.05	1.97	1.98	2.20	2.26	2.35	2.54	2.36	2.26	2.19
A5	2.20	1.99	1.91	1.92	2.13	2.20	2.29	2.48	2.30	2.20	2.13
A6	2.04	1.86	1.83	1.86	2.03	2.09	2.18	2.33	2.11	2.02	2.01
A7	1.98	1.80	1.78	1.81	1.98	2.04	2.13	2.26	2.05	1.96	1.95
A8	1.93	1.75	1.72	1.76	1.93	1.99	2.07	2.21	2.01	1.92	1.90
A9	1.98	1.79	1.77	1.83	1.98	2.04	2.14	2.28	2.03	1.93	1.95
A10	1.94	1.77	1.76	1.82	1.96	2.02	2.11	2.24	2.00	1.91	1.95
A11	1.97	1.81	1.80	1.86	1.99	2.04	2.14	2.26	2.04	1.97	2.00
A12	1.92	1.77	1.77	1.82	1.93	1.99	2.08	2.20	2.00	1.93	1.97
B1	1.91	1.78	1.71	1.67	1.87	1.92	2.00	2.19	2.06	1.99	1.83
B2	1.91	1.76	1.70	1.66	1.86	1.91	1.99	2.18	2.06	1.99	1.83
B3	1.98	1.84	1.76	1.74	1.94	1.99	2.08	2.26	2.14	2.06	1.93
B4	2.00	1.84	1.77	1.75	1.95	2.01	2.09	2.25	2.15	2.07	1.95
B5	2.01	1.86	1.79	1.78	1.97	2.03	2.11	2.27	2.17	2.09	1.98
B6	1.82	1.66	1.59	1.60	1.78	1.84	1.92	2.07	1.97	1.89	1.80
B7	1.88	1.73	1.67	1.67	1.85	1.91	1.99	2.13	2.03	1.95	1.89
B8	2.00	1.85	1.79	1.80	1.98	2.04	2.11	2.25	2.15	2.07	2.01
B9	2.11	1.97	1.90	1.98	2.09	2.15	2.23	2.36	2.27	2.20	2.15
B10	2.15	2.00	1.95	1.98	2.14	2.19	2.27	2.40	2.30	2.23	2.20
B11	2.11	1.96	1.93	1.96	2.11	2.16	2.24	2.38	2.25	2.18	2.17
B12	2.02	1.88	1.85	1.89	2.02	2.07	2.16	2.29	2.15	2.09	2.11
C1	1.83	1.71	1.65	1.60	1.79	1.84	1.91	2.09	1.98	1.93	1.74
C2	1.72	1.60	1.53	1.48	1.67	1.72	1.81	1.98	1.87	1.82	1.64
C3	1.80	1.67	1.60	1.56	1.75	1.80	1.87	2.04	1.96	1.89	1.72
C4	1.87	1.74	1.66	1.63	1.81	1.86	1.93	2.10	2.03	1.96	1.81
C5	1.88	1.75	1.67	1.64	1.82	1.87	1.94	2.11	2.05	1.98	1.84
C6	1.85	1.72	1.64	1.62	1.79	1.84	1.91	2.07	2.03	1.96	1.82

Table 9.3. Water-table depth (m) below ground surface at the coarse-textured site (page 14 of 16).

Rep/ plot no.	31 May 1999	5 Jul. 1999	26 Jul. 1999	23 Aug. 1999	29 Sep. 1999	18 Oct. 1999	22 Nov. 1999	20 Apr. 2000	29 May 2000	26 Jun. 2000	31 Jul. 2000
C7	1.93	1.79	1.71	1.70	1.89	1.95	2.03	2.17	2.12	2.05	1.97
C8	2.06	1.93	1.86	1.86	2.04	2.10	2.17	2.30	2.26	2.20	2.14
C9	2.18	2.06	1.99	1.99	2.17	2.22	2.29	2.41	2.39	2.34	2.29
C10	2.21	2.09	2.02	2.02	2.20	2.25	2.31	2.43	2.43	2.38	2.35
C11	2.27	2.16	2.08	2.09	2.26	2.31	2.38	2.49	2.50	2.46	2.44
C12	2.20	2.09	2.03	2.02	2.19	2.25	2.30	2.41	2.44	2.40	2.40
D1	1.76	1.64	1.59	1.53	1.72	1.77	1.84	2.02	1.91	1.87	1.67
D2	1.69	1.57	1.51	1.45	1.64	1.69	1.76	1.95	1.85	1.80	1.61
D3	1.71	1.56	1.50	1.47	1.64	1.69	1.76	1.94	1.86	1.81	1.64
D4	1.85	1.71	1.64	1.61	1.78	1.84	1.91	2.08	2.02	1.96	1.81
D5	1.92	1.79	1.72	1.70	1.86	1.91	1.97	2.12	2.10	2.06	1.91
D6	1.86	1.74	1.66	1.64	1.80	1.85	1.91	2.06	2.06	2.01	1.86
D7	1.83	1.70	1.60	1.59	1.76	1.81	1.88	2.02	2.03	1.98	1.81
D8	1.92	1.79	1.69	1.67	1.84	1.90	1.96	2.11	2.13	2.06	1.89
D9	2.06	1.92	1.81	1.80	1.99	2.06	2.13	2.27	2.29	2.23	2.03
D10	2.21	2.08	2.00	1.99	2.19	2.25	2.32	2.43	2.46	2.42	2.36
D11	2.23	2.12	2.06	2.05	2.22	2.28	2.34	2.44	2.48	2.45	2.44
D12	2.09	2.00	1.94	1.92	2.10	2.15	2.21	2.31	2.36	2.33	2.32
E1	1.91	1.80	1.74	1.68	1.87	1.92	1.99	2.17	2.07	2.04	1.85
E2	1.90	1.78	1.71	1.67	1.85	1.90	1.96	2.14	2.05	2.02	1.85
E3	1.79	1.67	1.61	1.60	1.75	1.80	1.84	2.00	1.99	1.99	1.87
E4	1.78	1.66	1.61	1.59	1.74	1.79	1.84	1.99	1.98	1.97	1.86
E5	1.89	1.77	1.71	1.69	1.85	1.89	1.94	2.09	2.10	2.08	1.97
E6	1.86	1.74	1.67	1.65	1.81	1.86	1.91	2.06	2.06	2.04	1.92
E7	1.85	1.72	1.64	1.63	1.78	1.84	1.89	2.04	2.05	2.02	1.90
E8	1.95	1.81	1.73	1.71	1.88	1.93	1.98	2.13	2.15	2.07	2.01
E9	2.14	2.01	1.93	1.93	2.11	2.17	2.23	2.35	2.40	2.37	2.35
E10	2.22	2.10	2.03	2.02	2.20	2.26	2.31	2.43	2.48	2.46	2.45
E11	2.20	2.09	2.03	2.02	2.20	2.25	2.31	2.42	2.47	2.45	2.44
E12	1.96	1.85	1.79	1.78	1.95	2.01	2.06	2.18	2.23	2.20	2.20

Table 9.3. Water-table depth (m) below ground surface at the coarse-textured site (page 15 of 16).

Rep/ plot no.	24 Aug. 2000	25 Sep. 2000	30 Oct. 2000	30 Apr. 2001	28 May 2001	25 Jun. 2001	30 Jul. 2001	27 Aug. 2001	24 Sep. 2001	5 Nov. 2001
A1	2.06	2.15	2.23	2.41	2.33	2.06	2.10	2.25	2.21	2.37
A2	2.07	2.17	2.24	2.42	2.33	2.20	2.14	2.19	2.28	2.37
A3	2.15	2.23	2.32	2.49	2.39	2.24	2.09	2.23	2.33	2.44
A4	2.27	2.36	2.42	2.57	2.49	2.35	2.16	2.35	2.44	2.56
A5	2.22	2.30	2.37	2.52	2.44	2.30	2.10	2.29	2.38	2.50
A6	2.12	2.20	2.27	2.38	2.27	2.15	1.94	2.13	2.26	2.39
A7	2.08	2.14	2.22	2.32	2.21	2.09	1.88	2.07	2.20	2.33
A8	2.03	2.09	2.17	2.26	2.17	2.06	1.83	1.94	2.21	2.33
A9	2.06	2.15	2.21	2.31	2.16	2.09	1.90	2.03	2.16	2.30
A10	2.04	2.13	2.19	2.28	2.17	2.07	1.87	2.00	2.13	2.29
A11	2.11	2.18	2.21	2.30	2.21	2.13	1.92	2.05	2.17	2.31
A12	2.05	2.11	2.16	2.24	2.17	2.10	1.90	2.00	2.13	2.25
B1	1.99	2.01	2.09	2.24	2.20	2.12	1.95	2.13	2.19	2.23
B2	2.04	2.01	2.08	2.24	2.19	2.24	1.92	2.12	2.18	2.23
B3	2.03	2.11	2.17	2.31	2.27	2.11	1.96	2.19	2.25	2.31
B4	2.06	2.12	2.19	2.31	2.28	2.18	1.95	2.19	2.26	2.33
B5	2.09	2.17	2.21	2.33	2.30	2.20	1.95	2.21	2.29	2.35
B6	1.91	1.99	2.03	2.13	2.10	2.00	1.75	2.01	2.09	2.16
B7	1.98	2.06	2.11	2.19	2.16	2.06	1.81	2.06	2.16	2.23
B8	2.12	2.18	2.24	2.31	2.29	2.19	1.93	2.19	2.28	2.36
B9	2.25	2.31	2.35	2.41	2.40	2.31	2.05	2.31	2.40	2.47
B10	2.29	2.35	2.39	2.45	2.43	2.34	2.10	2.34	2.43	2.50
B11	2.25	2.31	2.35	2.42	2.39	2.31	2.08	2.27	2.37	2.46
B12	2.16	2.23	2.26	2.33	2.30	2.24	2.00	2.17	2.28	2.36
C1	1.87	2.05	2.01	2.15	2.12	2.09	1.92	2.08	2.13	2.15
C2	1.72	1.83	1.90	2.04	2.01	1.94	1.78	1.97	2.01	2.04
C3	1.84	1.92	1.98	2.11	2.09	2.01	1.81	2.03	2.09	2.12
C4	1.91	2.00	2.05	2.17	2.15	2.06	1.84	2.09	2.15	2.19
C5	1.94	2.02	2.07	2.18	2.17	2.06	1.82	2.11	2.17	2.21
C6	1.91	1.98	2.05	2.15	2.14	2.01	1.77	2.08	2.15	2.19

Table 9.3. Water-table depth (m) below ground surface at the coarse-textured site (page 16 of 16).

Rep/ plot no.	24 Aug. 2000	25 Sep. 2000	30 Oct. 2000	30 Apr. 2001	28 May 2001	25 Jun. 2001	30 Jul. 2001	27 Aug. 2001	24 Sep. 2001	5 Nov. 2001
C7	2.06	2.12	2.16	2.24	2.24	2.15	1.86	2.17	2.25	2.30
C8	2.22	2.27	2.31	2.37	2.39	2.32	2.04	2.32	2.40	2.44
C9	2.36	2.40	2.44	2.49	2.52	2.45	2.18	2.46	2.54	2.57
C10	2.40	2.45	2.47	2.51	2.56	2.51	2.24	2.50	2.58	2.60
C11	2.49	2.52	2.54	2.57	2.63	2.60	2.32	2.58	2.66	2.67
C12	2.43	2.46	2.47	2.50	2.57	2.55	2.29	2.52	2.60	2.60
D1	1.80	1.87	1.95	2.09	2.06	2.03	1.89	2.04	2.09	2.09
D2	1.72	1.80	1.87	2.01	1.99	2.02	1.76	1.95	2.00	2.02
D3	1.76	1.81	1.89	2.02	2.00	1.91	1.71	1.94	2.00	2.03
D4	1.91	1.97	2.03	2.16	2.15	2.06	1.82	2.09	2.15	2.18
D5	2.01	2.07	2.12	2.20	2.23	2.16	1.91	2.19	2.27	2.27
D6	1.98	2.04	2.07	2.16	2.18	2.08	1.83	2.14	2.21	2.24
D7	1.93	1.98	2.04	2.12	2.14	2.05	1.75	2.09	2.16	2.20
D8	2.01	2.09	2.13	2.21	2.23	2.11	1.80	2.16	2.25	2.30
D9	2.21	2.27	2.31	2.37	2.40	2.27	1.85	2.33	2.44	2.47
D10	2.45	2.47	2.48	2.51	2.58	2.54	2.13	2.54	2.62	2.62
D11	2.47	2.49	2.50	2.53	2.61	2.59	2.32	2.56	2.65	2.64
D12	2.40	2.38	2.38	2.40	2.49	2.48	2.22	2.44	2.53	2.52
E1	1.97	2.05	2.11	2.25	2.23	2.17	1.93	2.18	2.24	2.25
E2	1.95	2.02	2.08	2.21	2.21	2.16	1.89	2.17	2.22	2.23
E3	1.94	1.99	2.01	2.11	2.16	2.14	1.93	2.15	2.22	2.18
E4	1.94	1.98	2.01	2.10	2.15	2.14	1.94	2.14	2.21	2.17
E5	2.05	2.10	2.12	2.20	2.26	2.23	2.00	2.25	2.32	2.29
E6	2.01	2.05	2.09	2.16	2.21	2.18	1.92	2.20	2.27	2.25
E7	1.98	2.02	2.06	2.14	2.19	2.13	1.85	2.16	2.25	2.23
E8	2.09	2.13	2.17	2.24	2.29	2.20	1.89	2.25	2.34	2.34
E9	2.39	2.42	2.42	2.45	2.54	2.49	2.17	2.50	2.59	2.56
E10	2.47	2.51	2.50	2.52	2.61	2.60	2.32	2.57	2.65	2.63
E11	2.47	2.49	2.49	2.51	2.61	2.60	2.32	2.56	2.65	2.63
E12	2.23	2.25	2.24	2.27	2.36	2.37	2.09	2.32	2.41	2.38

Table 9.4. Water-table depth (m) below ground surface at the medium-textured site (page 1 of 14).

Rep/ plot no.	21 May 1993	26 May 1993	31 May 1993	11 Jun. 1993	14 Jun. 1993	22 Jun. 1993	28 Jun. 1993	15 Jul. 1993	21 Jul. 1993	27 Jul. 1993	11 Aug. 1993	23 Aug. 1993
A1	1.62	1.66	1.71	1.88	1.36	1.67	1.87	1.62	1.65	1.66	2.06	2.02
A2	1.65	1.66	1.70	1.88	1.33	1.67	1.88	1.61	1.65	1.66	2.09	2.03
A3	1.65	1.65	1.70	1.86	1.34	1.65	1.84	1.60	1.64	1.64	2.05	1.98
A4	1.64	1.64	1.68	1.84	1.30	1.64	1.82	1.58	1.62	1.61	2.03	1.95
A5	1.63	1.63	1.67	1.82	1.27	1.63	1.81	1.55	1.61	1.59	2.01	1.94
A6	1.62	1.61	1.66	1.81	1.29	1.59	1.80	1.55	1.59	1.60	2.04	1.97
A7	1.66	1.66	1.71	1.87	1.24	1.64	1.88	1.61	1.64	1.66	2.13	2.08
A8	1.68	1.66	1.72	1.88	1.14	1.62	1.90	1.61	1.63	1.64	2.11	2.07
A9	1.67	1.66	1.71	1.87	1.16	1.63	1.87	1.58	1.63	1.62	2.08	2.06
A10	1.67	1.66	1.71	1.87	1.25	1.62	1.85	1.61	1.63	1.65	2.11	2.08
A11	1.65	1.64	1.69	1.86	1.13	1.59	1.86	1.61	1.64	1.66	2.16	2.13
A12	1.63	1.63	1.69	1.86	1.12	1.59	1.87	1.62	1.64	1.67	2.19	2.18
B1	1.72	1.72	1.76	1.91	1.55	1.74	1.91	1.75	1.74	1.78	2.11	2.15
B2	1.73	1.73	1.76	1.92	1.54	1.73	1.92	1.74	1.73	1.78	2.13	2.16
B3	1.65	1.65	1.69	1.88	1.37	1.65	1.89	1.63	1.64	1.67	2.12	2.08
B4	1.66	1.65	1.70	1.89	1.27	1.65	1.93	1.56	1.63	1.63	2.19	2.05
B5	1.69	1.67	1.72	1.91	1.38	1.67	1.92	1.58	1.64	1.65	2.18	2.07
B6	1.70	1.68	1.73	1.91	1.38	1.66	1.92	1.64	1.66	1.69	2.20	2.13
B7	1.73	1.70	1.76	1.92	1.37	1.67	1.93	1.64	1.68	1.69	2.21	2.17
B8	1.76	1.75	1.79	1.94	1.42	1.68	1.93	1.67	1.69	1.71	2.21	2.17
B9	1.82	1.80	1.82	1.98	1.48	1.71	1.95	1.71	1.72	1.74	2.25	2.20
B10	1.83	1.81	1.84	1.98	1.46	1.71	1.95	1.71	1.73	1.75	2.37	2.23
B11	1.85	1.82	1.87	2.03	1.37	1.73	2.01	1.78	1.78	1.82	2.35	2.34
B12	1.92	1.90	1.95	2.10	1.55	1.84	2.10	1.90	1.87	1.92	2.43	2.45
C1	1.71	1.72	1.78	1.97	1.29	1.73	2.02	1.80	1.82	1.85	2.32	2.32
C2	1.64	1.65	1.70	1.90	1.12	1.57	1.93	1.75	1.72	1.80	2.32	2.39
C3	1.64	1.64	1.69	1.88	1.11	1.52	1.88	1.68	1.66	1.72	2.29	2.39
C4	1.64	1.63	1.68	1.87	1.12	1.53	1.87	1.61	1.62	1.64	2.23	2.28
C5	1.69	1.68	1.73	1.95	1.25	1.63	1.94	1.57	1.62	1.62	2.26	2.18
C6	1.72	1.71	1.76	1.96	1.36	1.64	1.93	1.66	1.66	1.68	2.26	2.23

Table 9.4. Water-table depth (m) below ground surface at the medium-textured site (page 2 of 14).

Rep/ plot no.	21 May 1993	26 May 1993	31 May 1993	11 Jun. 1993	14 Jun. 1993	22 Jun. 1993	28 Jun. 1993	15 Jul. 1993	21 Jul. 1993	27 Jul. 1993	11 Aug. 1993	23 Aug. 1993
C7	1.76	1.76	1.81	2.01	1.38	1.68	1.98	1.76	1.73	1.78	2.33	2.39
C8	1.80	1.81	1.85	2.02	1.36	1.66	1.97	1.80	1.76	1.83	2.35	2.44
C9	1.84	1.84	1.89	2.07	1.32	1.68	2.01	1.88	1.81	1.93	2.37	2.52
C10	1.85	1.86	1.92	2.11	1.47	1.71	2.02	1.96	1.86	2.00	2.35	2.51
C11	1.92	1.92	1.97	2.13	1.69	1.78	2.06	2.05	1.94	2.10	2.43	2.59
C12	2.00	1.99	2.02	2.17	1.95	1.83	2.13	2.07	2.00	2.15	2.51	2.67
D1	1.67	1.69	1.74	1.92	1.18	1.54	1.89	1.89	1.81	1.96	2.41	2.63
D2	1.68	1.68	1.73	1.91	1.15	1.51	1.87	1.76	1.73	1.82	2.32	2.54
D3	1.73	1.71	1.76	1.94	1.18	1.54	1.89	1.73	1.70	1.76	2.33	2.48
D4	1.77	1.75	1.78	1.97	1.24	1.56	1.89	1.67	1.69	1.72	2.33	2.44
D5	1.75	1.74	1.77	1.92	1.21	1.54	1.84	1.62	1.64	1.66	2.24	2.34
D6	1.73	1.79	1.83	1.99	1.30	1.60	1.92	1.67	1.69	1.71	2.30	2.34
D7	1.82	1.81	1.86	2.05	1.39	1.68	1.99	1.73	1.73	1.74	2.35	2.35
D8	1.86	1.84	1.89	2.07	1.46	1.71	1.99	1.77	1.74	1.76	2.32	2.31
D9	1.96	1.95	1.99	2.15	1.69	1.85	2.09	1.91	1.84	1.90	2.41	2.45
D10	2.05	2.05	2.07	2.23	1.70	1.91	2.17	1.99	1.94	2.02	2.51	2.59
D11	2.14	2.12	2.15	2.29	1.76	1.96	2.25	2.07	2.02	2.12	2.62	2.74
D12	2.20	2.19	2.21	2.33	1.83	2.00	2.28	2.14	2.09	2.22	2.72	2.84
E1	1.75	1.76	1.81	2.01	1.29	1.62	2.00	1.90	1.87	1.96	2.51	2.71
E2	1.77	1.76	1.80	1.98	1.21	1.58	1.91	1.84	1.79	1.89	2.39	2.62
E3	1.74	1.74	1.78	1.95	1.21	1.53	1.84	1.76	1.72	1.81	2.34	2.58
E4	1.72	1.72	1.75	1.93	1.16	1.47	1.80	1.70	1.66	1.76	2.32	2.56
E5	1.74	1.74	1.78	1.96	1.16	1.47	1.81	1.68	1.65	1.74	2.34	2.54
E6	1.75	1.74	1.79	1.98	1.17	1.49	1.84	1.68	1.67	1.74	2.41	2.58
E7	1.72	1.73	1.78	1.97	1.12	1.47	1.82	1.73	1.66	1.81	2.37	2.62
E8	1.78	1.80	1.83	2.01	1.21	1.54	1.86	1.78	1.70	1.83	2.33	2.56
E9	1.92	1.91	1.94	2.09	1.36	1.64	1.96	1.89	1.82	1.94	2.36	2.53
E10	2.00	2.01	2.02	2.14	1.56	1.70	1.98	1.96	1.89	2.03	2.43	2.61
E11	2.11	2.10	2.11	2.22	1.75	1.80	2.07	2.07	2.00	2.13	2.54	2.74
E12	2.25	2.22	2.20	2.17	2.05	1.85	2.13	2.20	2.11	2.25	2.59	2.80

Table 9.4. Water-table depth (m) below ground surface at the medium-textured site (page 3 of 14).

Rep/ plot no.	15 Nov. 1993	21 Jan. 1994	8 Apr. 1994	12 Apr. 1994	3 May 1994	24 May 1994	27 May 1994	30 May 1994	10 Jun. 1994	28 Jun. 1994	11 Jul. 1994	29 Jul. 1994
A1	1.95	2.30	2.17	2.07	1.98	1.70	1.74	1.82	1.95	2.24	2.44	2.52
A2	1.96	2.34	2.33	2.27	2.05	1.77	1.80	1.88	1.99	2.28	2.45	2.52
A3	1.95	2.32	2.34	2.29	2.03	1.77	1.80	1.89	1.97	2.28	2.43	2.47
A4	1.88	2.28	2.43	2.43	1.98	1.79	1.83	1.83	1.93	2.22	2.38	2.40
A5	1.91	2.30	2.28	2.23	1.98	1.72	1.73	1.79	1.87	2.19	2.36	2.38
A6	1.89	2.30	2.34	2.24	1.94	1.68	1.71	1.78	1.87	2.23	2.44	2.50
A7	1.94	2.40	2.38	2.33	2.06	1.68	1.73	1.80	1.89	2.28	2.55	2.55
A8	1.97	2.39	2.37	2.28	2.03	1.69	1.73	1.79	1.88	2.24	2.54	2.57
A9	1.96	2.39	2.45	2.39	2.03	1.76	1.78	1.84	1.92	2.29	2.58	2.61
A10	1.99	2.44	2.48	2.38	1.98	1.71	1.75	1.80	1.88	2.28	2.57	2.59
A11	2.02	2.46	2.49	2.39	2.05	1.66	1.68	1.76	1.84	2.30	2.60	2.65
A12	2.04	2.49	2.44	2.39	2.00	1.62	1.65	1.71	1.80	2.28	2.54	2.68
B1	2.08	2.38	2.42	2.36	2.35	1.88	1.87	1.92	2.03	2.31	2.52	2.64
B2	2.08	2.41	2.49	2.44	2.46	1.86	1.88	1.90	2.02	2.33	2.55	2.65
B3	1.98	2.40	3.40	3.74	2.35	1.84	1.90	2.00	1.97	2.31	2.52	2.59
B4	1.95	2.50	3.28	3.42	2.25	1.87	1.84	2.00	2.01	2.40	2.63	2.61
B5	1.96	2.49	2.77	2.79	2.28	1.81	1.82	1.88	1.97	2.42	2.62	2.47
B6	2.01	2.48	2.85	2.80	2.14	1.85	1.89	1.90	1.97	2.38	2.48	2.30
B7	2.01	2.47	2.76	2.72	2.17	1.85	1.86	1.91	1.97	2.43	2.62	2.51
B8	2.03	2.51	2.76	2.72	2.16	1.84	1.84	1.89	1.96	2.41	2.65	2.64
B9	2.09	2.57	2.79	2.75	2.18	1.85	1.85	1.90	1.98	2.42	2.66	2.69
B10	2.12	2.61	2.95	2.94	2.16	1.94	1.93	1.98	2.06	2.50	2.74	2.84
B11	2.21	2.69	3.44	3.45	2.18	1.94	1.91	1.96	2.06	2.51	2.74	2.84
B12	2.26	2.73	3.02	3.01	2.20	1.99	1.97	2.03	2.11	2.53	2.69	2.87
C1	2.25	2.59	2.57	2.51	2.21	1.82	1.85	1.92	2.08	2.50	2.73	2.88
C2	2.21	2.61	2.86	2.87	2.43	1.77	1.78	1.85	2.06	2.50	2.74	2.84
C3	2.18	2.64	3.31	3.34	2.51	1.96	1.82	1.89	2.05	2.50	2.78	2.72
C4	2.06	2.60	3.27	3.25	2.44	1.89	1.85	1.91	2.04	2.49	2.72	2.48
C5	2.03	2.63	3.39	3.32	2.29	1.88	1.84	1.90	1.99	2.49	2.50	2.09
C6	2.06	2.61	3.02	2.97	2.33	1.94	1.90	1.96	2.05	2.53	1.92	1.76

Table 9.4. Water-table depth (m) below ground surface at the medium-textured site (page 4 of 14).

Rep/ plot no.	15 Nov. 1993	21 Jan. 1994	8 Apr. 1994	12 Apr. 1994	3 May 1994	24 May 1994	27 May 1994	30 May 1994	10 Jun. 1994	28 Jun. 1994	11 Jul. 1994	29 Jul. 1994
C7	2.13	2.62	3.26	3.26	2.46	2.05	1.94	1.99	2.10	2.54	2.02	1.93
C8	2.22	2.66	3.59	3.60	2.60	2.17	1.96	1.98	2.10	2.50	2.58	2.40
C9	2.29	2.73	3.70	2.77	2.86	2.27	1.99	2.00	2.12	2.52	2.75	2.73
C10	2.36	2.71	3.65	3.71	3.06	2.74	2.39	2.44	2.58	2.68	2.74	2.83
C11	2.46	2.80	3.69	3.76	3.17	2.84	2.58	2.28	2.18	2.51	2.75	2.92
C12	2.57	2.88	3.79	3.86	3.20	2.88	2.78	2.73	2.43	2.61	2.79	2.98
D1	2.55	2.82	3.14	3.03	2.66	2.23	2.03	2.01	2.17	2.61	2.93	3.16
D2	2.45	2.76	3.37	3.21	2.83	2.47	2.14	2.04	2.13	2.52	2.82	3.02
D3	2.35	2.75	3.41	3.33	2.92	2.45	2.16	2.11	2.19	2.57	2.83	2.92
D4	2.28	2.77	3.42	3.34	2.90	2.32	2.12	2.11	2.17	2.58	2.83	2.69
D5	2.18	2.69	3.45	3.31	2.86	2.30	2.10	2.08	2.16	2.55	2.51	2.12
D6	2.19	2.75	3.38	3.31	2.80	2.25	2.12	2.12	2.20	2.62	2.72	1.94
D7	2.20	2.70	3.29	3.26	2.88	2.27	2.09	2.11	2.17	2.57	2.52	2.26
D8	2.24	2.73	3.27	3.24	2.93	2.36	2.17	2.17	2.22	2.59	2.76	2.64
D9	2.34	2.78	3.44	3.32	3.04	2.55	2.33	2.29	2.33	2.66	2.89	3.00
D10	2.46	2.90	3.42	3.38	3.10	2.64	2.41	2.34	2.38	2.73	2.97	3.04
D11	2.58	3.01	3.50	3.49	3.18	2.73	2.53	2.45	2.44	2.80	3.06	3.21
D12	2.71	3.14	3.67	3.60	3.29	2.87	2.69	2.60	2.55	2.90	3.14	3.31
E1	2.70	3.00	3.63	3.43	3.05	2.69	2.42	2.31	2.34	2.72	2.99	3.20
E2	2.58	2.94	3.56	3.48	3.19	2.80	2.48	2.28	2.31	2.66	2.91	3.10
E3	2.46	2.86	3.78	3.54	3.14	2.58	2.19	2.12	2.15	2.60	2.91	3.11
E4	2.41	2.83	3.93	3.58	3.24	2.52	2.17	2.08	2.12	2.60	2.93	3.06
E5	2.40	2.83	3.93	3.54	3.22	2.47	2.09	2.06	2.12	2.58	2.83	2.70
E6	2.44	2.83	3.02	3.73	3.05	2.42	2.14	2.11	2.21	2.67	2.82	2.52
E7	2.46	2.84	3.69	3.42	3.26	2.62	2.16	2.12	2.22	2.63	2.89	2.79
E8	2.48	2.89	3.57	3.41	3.35	2.95	2.45	2.27	2.24	2.58	2.83	2.89
E9	2.53	2.89	3.88	3.58	3.41	3.07	2.72	2.57	2.31	2.58	2.79	2.90
E10	2.61	2.96	3.86	3.59	3.46	3.05	2.72	2.49	2.35	2.65	2.85	3.03
E11	2.73	3.01	3.59	3.52	3.44	3.05	2.83	2.64	2.46	2.75	2.99	3.16
E12	2.86	3.12	4.10	3.92	3.59	3.25	3.17	3.26	2.73	2.82	3.02	3.19

Table 9.4. Water-table depth (m) below ground surface at the medium-textured site (page 5 of 14).

Rep/ plot no.	30 Aug. 1994	26 Sep. 1994	31 Oct. 1994	23 Jan. 1995	23 Feb. 1995	31 Mar. 1995	2 May 1995	29 May 1995	26 Jun. 1995	24 Jul. 1995	28 Aug. 1995	25 Sep. 1995
A1	2.67	2.77	2.68	2.78	2.82	2.77	2.52	2.22	2.45	2.72	2.90	2.95
A2	2.74	2.72	2.69	2.83	2.88	2.84	2.59	2.27	2.47	2.70	2.90	3.16
A3	2.68	2.68	2.65	2.83	2.89	2.87	2.57	2.22	2.45	2.61	2.87	3.12
A4	2.73	2.68	2.58	2.77	2.83	2.81	2.53	2.17	2.36	2.59	2.79	2.84
A5	2.68	2.68	2.52	2.73	2.77	2.78	2.45	2.08	2.34	2.55	2.76	2.86
A6	2.69	2.74	2.55	2.81	2.87	2.84	2.42	2.04	2.32	2.61	2.87	2.89
A7	2.81	2.86	2.60	2.91	2.97	2.93	2.41	2.06	2.37	2.70	2.99	3.01
A8	2.85	2.90	2.60	2.90	2.98	2.94	2.41	2.06	2.37	2.70	2.99	3.01
A9	2.89	2.94	2.67	2.97	3.07	3.00	2.48	2.12	2.41	2.71	3.01	3.04
A10	2.91	2.95	2.67	2.97	3.06	3.02	2.47	2.08	2.38	2.71	2.95	2.97
A11	2.95	2.94	2.69	2.92	3.02	2.96	2.41	2.01	2.25	2.68	2.81	2.85
A12	2.98	2.80	2.58	2.87	2.97	2.92	2.35	1.97	2.29	2.33	2.44	2.56
B1	2.86	2.95	2.90	3.03	3.10	3.10	2.87	2.53	2.55	2.84	3.05	3.15
B2	2.88	3.24	2.87	3.04	3.11	3.13	2.87	2.48	2.52	2.85	3.07	3.13
B3	3.77	2.92	2.82	3.06	3.16	3.20	2.83	2.30	2.46	2.79	3.07	3.14
B4	3.68	2.97	2.80	3.10	3.22	3.26	2.77	2.26	2.14	2.83	3.15	3.23
B5	3.06	2.95	2.72	3.05	3.17	3.21	2.74	2.18	2.40	2.87	3.17	3.24
B6	2.96	2.97	2.71	3.03	3.17	3.22	2.84	2.17	2.38	2.84	3.15	3.22
B7	3.03	3.06	2.86	3.17	3.29	3.35	2.86	2.22	2.56	2.91	3.25	3.34
B8	3.00	3.11	2.94	3.20	3.32	3.39	2.95	2.31	2.49	2.88	3.20	3.26
B9	3.10	3.11	3.00	3.19	3.33	3.39	3.03	2.37	2.65	2.85	3.13	3.19
B10	3.12	3.22	3.11	3.31	3.44	3.52	3.17	2.46	2.61	2.94	3.15	3.20
B11	3.32	3.32	3.10	3.33	3.47	3.54	3.17	2.44	2.64	2.91	2.96	2.97
B12	3.32	3.28	3.08	3.31	3.46	3.53	3.16	2.43	2.62	2.74	2.66	2.62
C1	3.29	3.36	3.28	3.42	3.50	3.53	3.13	2.59	2.83	3.09	3.28	3.43
C2	3.32	3.31	3.24	3.42	3.52	3.58	3.28	2.56	2.73	3.07	3.31	3.44
C3	3.24	3.23	3.19	3.41	3.55	3.63	3.41	2.59	2.60	3.01	3.34	3.50
C4	3.15	3.11	2.94	3.27	3.42	3.55	3.36	2.32	2.51	2.93	3.28	3.48
C5	3.04	2.96	2.61	3.16	3.33	3.44	3.02	2.13	2.47	2.91	3.29	3.44
C6	2.65	2.89	2.47	3.17	3.37	3.49	3.00	2.13	2.48	2.95	3.35	3.52

Table 9.4. Water-table depth (m) below ground surface at the medium-textured site (page 6 of 14).

Rep/ plot no.	30 Aug. 1994	26 Sep. 1994	31 Oct. 1994	23 Jan. 1995	23 Feb. 1995	31 Mar. 1995	2 May 1995	29 May 1995	26 Jun. 1995	24 Jul. 1995	28 Aug. 1995	25 Sep. 1995
C7	2.75	2.96	2.74	3.22	3.43	3.54	3.32	2.27	2.51	2.96	3.33	3.51
C8	3.25	3.06	3.05	3.32	3.48	3.56	3.51	2.60	2.51	2.95	3.31	3.49
C9	3.26	3.17	3.24	3.40	3.53	3.60	3.60	3.12	2.72	3.05	3.31	3.42
C10	3.38	3.20	3.26	3.42	3.53	3.60	3.61	3.42	3.00	3.09	3.28	3.34
C11	3.62	3.20	3.35	3.52	3.59	3.70	3.70	3.47	3.04	3.12	3.21	3.26
C12	3.69	3.37	3.41	3.58	3.69	3.78	3.77	3.47	3.03	3.02	2.82	2.98
D1	3.55	3.59	3.61	3.73	3.80	3.85	3.74	3.41	3.18	3.37	3.45	3.53
D2	3.55	3.58	3.67	3.77	3.88	3.97	3.84	3.39	3.01	3.25	3.53	3.63
D3	3.39	3.61	3.58	3.73	3.88	4.02	3.87	3.24	2.86	3.05	3.52	3.69
D4	3.25	3.52	3.32	3.59	3.78	3.93	3.71	2.73	2.72	3.06	3.48	3.68
D5	2.99	3.42	2.89	3.40	3.62	3.80	3.46	2.37	2.54	3.01	3.43	3.66
D6	2.84	3.06	2.71	3.37	3.61	3.75	3.32	2.30	2.59	3.05	3.47	3.68
D7	2.95	3.14	2.93	3.36	3.58	3.69	3.45	2.54	2.60	3.01	3.41	3.60
D8	4.08	3.24	3.20	3.43	3.58	3.68	3.62	3.01	2.75	3.03	3.38	3.56
D9	3.29	3.38	3.41	3.59	3.71	3.79	3.80	3.41	2.97	3.18	3.44	3.57
D10	3.41	3.46	3.52	3.68	3.80	3.87	3.87	3.51	3.09	3.25	3.49	3.55
D11	3.56	3.53	3.60	3.76	3.89	3.97	3.97	3.60	3.17	3.37	3.52	3.54
D12	3.72	3.46	3.60	3.82	3.95	4.03	4.02	3.64	3.22	3.40	3.36	3.41
E1	3.76	3.77	3.85	3.98	4.10	4.15	4.06	3.72	3.38	3.25	3.04	3.01
E2	3.60	3.59	3.59	3.78	3.90	3.99	3.95	3.63	3.24	3.21	3.02	2.96
E3	3.65	3.47	3.31	3.69	3.85	3.97	3.88	3.26	2.89	2.96	3.00	2.92
E4	3.67	3.34	3.09	3.53	3.69	3.84	3.84	2.80	2.68	2.96	3.02	2.96
E5	3.50	3.19	3.08	3.31	3.51	3.66	3.67	2.30	2.50	2.91	3.04	3.01
E6	3.63	3.17	3.08	3.32	3.51	3.67	3.59	2.20	2.53	2.97	3.15	3.15
E7	3.31	3.21	3.17	3.36	3.53	3.66	3.61	2.44	2.58	2.98	3.20	3.20
E8	3.37	3.22	3.31	3.39	3.54	3.66	3.71	3.17	2.72	2.97	3.24	3.11
E9	3.66	3.28	3.43	3.49	3.64	3.77	3.82	3.48	2.82	2.97	3.12	3.15
E10	3.65	3.45	3.50	3.60	3.74	3.86	3.92	3.63	2.99	3.02	3.23	3.24
E11	3.58	3.49	3.51	3.63	3.76	3.86	3.90	3.58	3.06	3.19	3.28	3.24
E12	3.90	3.56	3.55	3.69	3.80	3.93	3.95	3.73	3.22	3.26	3.40	3.20

Table 9.4. Water-table depth (m) below ground surface at the medium-textured site (page 7 of 14).

Rep/ plot no.	3 Nov. 1995	18 Mar. 1996	29 Apr. 1996	24 May 1996	20 Jun. 1996	2 Aug. 1996	23 Aug 1996	23 Sep 1996	5 May 1997	29 May 1997	20 Jun. 1997	8 Aug. 1997
A1	3.00	3.07	2.75	2.65	2.67	2.84	3.00	3.19	2.79	2.63	2.45	2.26
A2	3.02	3.10	2.80	2.72	2.67	2.77	2.93	3.10	2.90	2.73	2.54	2.29
A3	3.00	3.09	2.77	2.69	2.66	2.66	2.83	3.00	2.89	2.69	2.58	2.26
A4	2.93	2.99	2.70	2.62	2.58	2.58	2.75	2.93	2.82	2.65	2.48	2.21
A5	2.89	2.89	2.61	2.52	2.49	2.58	2.74	2.89	2.70	2.55	2.38	2.21
A6	2.95	3.08	2.74	2.56	2.51	2.66	2.83	2.95	2.74	2.55	2.39	2.21
A7	3.02	3.26	2.92	2.61	2.56	2.77	2.93	3.03	2.77	2.55	2.44	2.19
A8	3.00	3.31	2.93	2.63	2.56	2.75	2.93	3.04	2.77	2.55	2.42	2.12
A9	3.03	3.39	3.10	2.70	2.62	2.72	2.93	3.09	2.87	2.65	2.47	2.07
A10	2.95	3.34	3.06	2.58	2.51	2.64	2.89	3.11	2.76	2.49	2.38	2.04
A11	2.78	3.22	2.91	2.35	2.35	2.64	2.94	3.15	2.53	2.17	2.23	2.10
A12	2.54	3.14	2.84	2.22	2.35	2.78	3.01	3.19	2.59	2.21	2.23	2.17
B1	3.21	3.37	3.16	2.99	2.91	3.07	3.17	3.34	3.13	3.00	2.75	2.36
B2	3.23	3.36	3.16	2.99	2.88	3.02	3.11	3.30	3.20	3.05	2.74	2.26
B3	3.24	3.39	3.19	2.96	2.83	2.92	3.00	3.17	3.22	3.07	2.69	2.17
B4	3.33	3.52	3.28	3.04	2.91	2.98	3.05	3.22	3.32	3.15	2.75	2.25
B5	3.33	3.55	3.28	3.08	2.94	3.06	3.14	3.26	3.38	3.19	2.76	2.28
B6	3.34	3.62	3.41	3.21	3.03	3.13	3.18	3.28	3.49	3.29	2.79	2.31
B7	3.44	3.71	3.48	3.21	3.01	3.14	3.24	3.37	3.46	3.26	2.73	2.34
B8	3.38	3.68	3.51	3.21	2.98	3.04	3.15	3.32	3.49	3.27	2.76	2.30
B9	3.29	3.59	3.48	3.17	2.95	2.97	3.08	3.28	3.51	3.29	2.82	2.20
B10	3.26	3.61	3.51	3.14	2.95	3.00	3.15	3.35	3.53	3.33	2.85	2.18
B11	2.97	3.46	3.33	2.88	2.77	2.94	3.17	3.35	3.56	3.40	2.89	2.34
B12	2.66	3.39	3.20	2.63	2.68	2.95	3.19	3.40	3.57	3.38	2.90	2.46
C1	3.54	3.23	3.08	2.86	2.96	3.18	3.32	3.54	3.19	3.08	2.78	2.48
C2	3.58	2.48	3.01	2.85	2.86	3.11	3.23	3.44	3.25	3.11	2.58	2.20
C3	3.66	2.57	3.11	2.94	2.82	3.06	3.19	3.41	3.40	3.24	2.56	1.91
C4	3.62	2.76	3.34	3.11	2.96	3.07	3.14	3.35	3.57	3.41	2.73	1.78
C5	3.59	3.68	3.56	3.33	3.14	3.09	3.15	3.34	3.68	3.51	2.97	1.84
C6	3.69	3.96	3.80	3.58	3.36	3.27	3.29	3.46	3.86	3.69	3.26	2.06

Table 9.4. Water-table depth (m) below ground surface at the medium-textured site (page 8 of 14).

Rep/ plot no.	3 Nov. 1995	18 Mar. 1996	29 Apr. 1996	24 May 1996	20 Jun. 1996	2 Aug. 1996	23 Aug 1996	23 Sep 1996	5 May 1997	29 May 1997	20 Jun. 1997	8 Aug. 1997
C7	3.71	4.05	3.97	3.81	3.57	3.35	3.36	3.51	4.01	3.85	3.51	2.22
C8	3.67	3.99	3.97	3.84	3.63	3.40	3.40	3.52	4.04	3.89	3.64	2.33
C9	3.58	3.83	3.84	3.77	3.61	3.46	3.44	3.48	4.03	3.90	3.72	2.44
C10	3.46	3.71	3.72	3.68	3.54	3.42	3.44	3.46	3.93	3.84	3.69	2.95
C11	3.38	3.71	3.74	3.63	3.39	3.34	3.43	3.49	3.95	3.86	3.69	2.52
C12	3.17	3.69	3.71	3.50	3.13	3.20	3.39	3.53	3.96	3.85	3.67	2.59
D1	3.63	2.89	3.11	2.90	2.86	3.27	3.42	3.60	3.53	3.39	2.83	2.35
D2	3.76	na[z]	3.28	3.02	2.91	3.28	3.40	3.55	3.58	3.42	2.78	2.12
D3	3.86	3.05	3.39	3.12	2.99	3.34	3.44	3.69	3.72	3.55	2.98	1.90
D4	3.87	3.02	3.45	3.19	3.06	3.35	3.45	3.70	3.82	3.65	3.17	1.73
D5	3.84	3.72	3.73	3.41	3.22	3.39	3.45	3.70	3.94	3.76	3.34	1.67
D6	3.85	4.10	3.94	3.60	3.40	3.45	3.49	3.74	4.00	3.82	3.41	1.77
D7	3.78	4.15	4.01	3.79	3.56	3.39	3.44	3.68	4.06	3.88	3.54	2.06
D8	3.72	4.09	4.03	3.87	3.66	3.45	3.49	3.70	4.13	3.98	3.71	2.29
D9	3.72	4.06	4.07	3.95	3.73	3.56	3.61	3.73	4.25	4.13	3.93	2.46
D10	3.71	4.07	4.06	3.94	3.67	3.58	3.68	3.81	4.30	7.15	3.93	2.56
D11	3.65	4.07	4.03	3.85	3.58	3.58	3.72	3.89	4.33	4.18	3.93	2.69
D12	3.52	4.01	4.00	3.69	3.43	3.54	3.73	3.92	4.32	4.21	3.96	2.86
E1	3.09	2.37	2.89	2.43	2.63	3.20	3.42	3.71	3.38	3.22	2.77	2.65
E2	3.04	na	3.34	2.76	2.73	3.14	3.34	3.55	3.77	3.59	3.08	2.55
E3	2.97	3.70	3.51	2.91	2.73	3.14	3.37	3.60	3.99	3.79	3.23	2.37
E4	2.97	3.71	3.67	3.06	2.77	3.22	3.38	3.58	3.16	4.01	3.67	2.12
E5	3.03	3.66	3.79	3.26	2.87	3.20	3.32	3.48	4.12	4.03	3.86	1.88
E6	3.14	3.72	3.74	3.32	2.99	3.31	3.42	3.57	4.13	4.03	3.83	1.84
E7	3.23	3.76	3.79	3.56	3.26	3.36	3.46	3.62	4.16	4.07	3.87	2.02
E8	3.20	3.74	3.79	3.68	3.39	3.32	3.42	3.57	4.19	4.10	3.96	2.17
E9	3.25	3.80	3.88	3.75	3.45	3.36	3.46	3.60	4.26	4.19	4.04	2.18
E10	3.34	3.84	3.91	3.79	3.47	3.42	3.53	3.66	4.31	4.23	4.07	2.22
E11	3.32	3.78	3.83	3.68	3.39	3.42	3.52	3.62	4.25	4.18	4.01	2.37
E12	3.28	3.76	3.82	3.69	3.38	3.39	3.51	3.62	4.26	4.24	4.11	2.50

[z] Not available.

Table 9.4. Water-table depth (m) below ground surface at the medium-textured site (page 9 of 14).

Rep/ plot no.	5 Sep. 1997	26 Sep. 1997	27 Oct. 1997	1 Dec. 1997	30 Mar. 1998	27 Apr. 1998	25 May 1998	25 Jun. 1998	27 Jul. 1998	24 Aug. 1998	28 Sep. 1998	26 Oct. 1998
A1	2.49	2.65	2.80	2.92	2.94	2.30	2.39	2.52	2.24	2.47	2.78	2.86
A2	2.44	2.57	2.73	2.88	2.94	2.32	2.38	2.50	2.23	2.30	2.64	2.74
A3	2.38	2.51	2.67	2.79	2.84	2.30	2.32	2.45	1.98	2.12	2.48	2.59
A4	2.33	2.44	2.59	2.73	2.78	2.26	2.28	2.37	1.78	2.03	2.39	2.50
A5	2.30	2.43	2.56	2.68	2.67	2.16	2.21	2.31	1.80	2.00	2.37	2.47
A6	2.30	2.45	2.58	2.70	2.66	2.11	2.20	2.31	1.99	2.08	2.45	2.54
A7	2.29	2.47	2.61	2.72	2.68	2.11	2.17	2.34	2.09	2.16	2.54	2.62
A8	2.23	2.43	2.58	2.69	2.63	2.10	2.15	2.31	2.07	2.16	2.55	2.64
A9	2.24	2.46	2.61	2.71	2.61	2.10	2.18	2.33	2.04	2.19	2.61	2.69
A10	2.23	2.45	2.58	2.68	2.60	2.04	2.11	2.26	1.94	2.13	2.60	2.70
A11	2.25	2.43	2.53	2.62	2.48	1.93	2.04	2.23	1.89	2.10	2.63	2.74
A12	2.34	2.23	2.34	2.49	2.11	1.82	1.91	2.23	2.08	2.20	2.64	2.75
B1	2.56	2.70	2.88	3.01	3.15	2.55	2.52	2.60	2.40	2.48	2.81	2.92
B2	2.48	2.63	2.82	2.97	3.13	2.46	2.46	2.54	2.22	2.30	2.71	2.84
B3	2.39	2.56	2.73	2.88	3.09	2.29	2.33	2.41	1.74	2.02	2.51	2.65
B4	2.37	2.56	2.73	2.88	3.05	2.22	2.26	2.38	1.49	1.84	2.36	2.50
B5	2.37	2.54	2.70	2.86	3.00	2.15	2.23	2.38	1.60	1.84	2.35	2.48
B6	2.40	2.54	2.71	2.87	3.06	2.19	2.26	2.37	1.97	1.96	2.43	2.55
B7	2.40	2.58	2.75	2.89	2.98	2.18	2.24	2.37	2.10	2.03	2.54	2.67
B8	2.37	2.57	2.75	2.89	2.98	2.18	2.25	2.36	2.05	2.09	2.61	2.74
B9	2.36	2.58	2.75	2.88	2.92	2.19	2.22	2.34	1.99	2.15	2.64	2.75
B10	2.38	2.63	2.76	2.87	2.95	2.14	2.18	2.33	1.99	2.18	2.65	2.78
B11	2.47	2.64	2.69	2.81	2.52	2.02	2.05	2.31	2.02	2.24	2.69	2.82
B12	2.56	2.51	2.51	2.65	2.04	1.87	1.94	2.30	2.27	2.37	2.72	2.86
C1	2.70	2.95	3.14	3.28	3.27	2.41	2.57	2.68	2.22	2.55	3.02	3.15
C2	2.44	2.75	3.01	3.17	2.86	2.09	2.34	2.49	2.87	2.16	2.78	2.98
C3	2.19	2.57	2.87	3.09	2.89	1.95	2.12	2.31	1.36	1.74	2.52	2.74
C4	2.14	2.49	2.77	2.98	2.77	1.92	2.05	2.24	1.21	1.69	2.40	2.59
C5	2.10	2.44	2.69	2.88	2.97	1.97	2.05	2.28	1.45	1.67	2.30	2.46
C6	2.24	2.54	2.78	2.97	3.26	2.13	2.19	2.40	1.91	1.89	2.43	2.60

Table 9.4. Water-table depth (m) below ground surface at the medium-textured site (page 10 of 14).

Rep/ plot no.	5 Sep. 1997	26 Sep. 1997	27 Oct. 1997	1 Dec. 1997	30 Mar. 1998	27 Apr. 1998	25 May 1998	25 Jun. 1998	27 Jul. 1998	24 Aug. 1998	28 Sep. 1998	26 Oct. 1998
C7	2.40	2.63	2.86	3.06	3.40	2.28	2.34	2.47	2.09	2.09	2.56	2.72
C8	2.53	2.69	2.91	3.12	3.42	2.48	2.41	2.49	2.18	2.18	2.62	2.79
C9	2.66	2.78	2.98	3.15	3.42	2.72	2.52	2.54	2.30	2.21	2.66	2.83
C10	3.00	2.96	3.05	3.18	3.41	3.07	2.88	2.76	2.73	2.50	2.73	2.86
C11	2.82	2.89	2.99	3.14	3.41	2.43	2.34	2.51	2.13	2.12	2.65	2.86
C12	2.86	2.82	2.81	3.00	3.15	2.28	2.24	2.39	2.41	2.34	2.71	2.92
D1	2.66	2.94	3.20	3.38	3.63	2.26	2.44	2.57	1.89	2.21	2.87	3.12
D2	2.36	2.71	3.08	3.31	3.59	2.04	2.22	2.35	1.85	1.94	2.65	2.96
D3	2.22	2.60	2.97	3.22	3.49	2.04	2.17	2.33	1.79	1.88	2.58	2.85
D4	2.09	2.53	2.89	3.11	3.37	2.00	2.13	2.30	1.65	1.81	2.54	2.78
D5	2.09	2.51	2.84	3.04	2.63	2.03	2.13	2.28	1.75	1.90	2.56	2.75
D6	2.17	2.57	2.87	3.08	3.09	2.11	2.19	2.37	1.97	2.02	2.60	2.75
D7	2.24	2.57	2.88	3.09	3.14	2.18	2.23	2.38	2.04	2.05	2.56	2.74
D8	2.43	2.67	2.93	3.14	3.35	2.34	2.31	2.46	2.10	2.12	2.59	2.77
D9	2.63	2.82	3.04	3.24	3.52	2.56	2.44	2.55	2.24	2.24	2.67	2.86
D10	2.77	2.93	3.12	3.29	3.51	2.58	2.47	2.57	2.22	2.30	2.75	2.92
D11	2.88	3.01	3.17	3.32	3.35	2.49	2.42	2.56	2.23	2.31	2.83	2.99
D12	3.07	3.06	3.11	3.25	2.60	2.34	2.37	2.61	2.40	2.47	2.95	3.11
E1	2.92	3.03	3.21	3.39	3.56	2.21	2.20	2.38	1.87	2.16	2.76	3.05
E2	2.80	2.91	3.08	3.26	3.56	2.11	2.15	2.29	1.85	2.03	2.63	2.90
E3	2.60	2.76	2.96	3.16	3.54	1.98	2.08	2.21	1.85	1.87	2.60	2.86
E4	2.41	2.66	2.92	3.12	3.50	1.99	2.12	2.25	1.78	1.92	2.67	2.92
E5	2.30	2.65	2.90	3.09	3.43	2.00	2.14	2.29	1.76	1.99	2.68	2.89
E6	2.34	2.74	3.00	3.17	3.52	2.05	2.24	2.38	1.85	2.05	2.74	2.93
E7	2.40	2.76	3.04	3.23	3.53	2.13	2.31	2.42	1.82	2.04	2.70	2.92
E8	2.49	2.76	3.03	3.24	3.54	2.25	2.33	2.44	1.84	2.05	2.67	2.91
E9	2.53	2.78	3.03	3.23	3.57	2.32	2.34	2.44	1.82	2.10	2.66	2.90
E10	2.59	2.84	3.07	3.24	3.57	2.28	2.34	2.45	1.98	2.16	2.70	2.94
E11	2.66	2.89	3.06	3.21	3.50	2.16	2.23	2.40	2.03	2.24	2.74	2.97
E12	2.81	2.95	3.07	3.19	3.53	2.12	2.25	2.41	2.29	2.45	2.85	3.04

Table 9.4. Water-table depth (m) below ground surface at the medium-textured site (page 11 of 14).

Rep/ plot no.	30 Nov. 1998	19 Apr. 1999	31 May 1999	5 Jul. 1999	26 Jul. 1999	23 Aug. 1999	27 Sep. 1999	18 Oct. 1999	22 Nov. 1999	20 Apr. 2000	29 May 2000	26 Jun. 2000
A1	2.92	2.87	2.54	2.37	1.91	1.91	2.34	2.43	2.49	2.43	2.28	2.01
A2	2.84	2.86	2.45	2.31	1.81	1.75	2.13	2.23	2.31	2.31	2.18	1.87
A3	2.70	2.76	2.33	2.21	1.69	1.65	1.96	2.05	2.14	2.16	2.07	1.79
A4	2.63	2.67	2.23	2.15	1.69	1.61	1.90	1.99	2.07	2.08	2.02	1.77
A5	2.57	2.59	2.14	2.09	1.63	1.56	1.83	1.91	1.99	1.97	1.90	1.69
A6	2.63	2.59	2.12	2.08	1.61	1.51	1.80	1.89	1.97	1.94	1.86	1.63
A7	2.71	2.61	2.17	2.11	1.53	1.46	1.82	1.91	1.99	1.97	1.89	1.62
A8	2.71	2.60	2.20	2.10	1.45	1.42	1.81	1.89	1.97	1.98	1.88	1.60
A9	2.77	2.67	2.26	2.12	1.44	1.42	1.82	1.91	2.00	2.02	1.93	1.64
A10	2.78	2.71	2.24	2.08	1.43	1.36	1.80	1.90	1.99	2.02	1.92	1.57
A11	2.83	2.72	2.22	2.09	1.50	1.42	1.90	2.02	2.13	2.11	1.96	1.49
A12	2.86	2.72	2.20	2.09	1.62	1.52	1.95	2.09	2.20	2.15	1.86	1.42
B1	3.03	3.13	2.79	2.45	1.99	1.92	2.23	2.32	2.39	2.51	2.35	2.05
B2	2.96	3.08	2.68	2.31	1.74	1.70	2.07	2.18	2.28	2.41	2.25	1.88
B3	2.78	2.94	2.39	2.17	1.60	1.51	1.90	2.00	2.09	2.21	2.08	1.69
B4	2.66	2.75	2.19	2.12	1.50	1.45	1.80	1.89	1.97	2.00	1.93	1.60
B5	2.62	2.73	2.12	2.06	1.47	1.38	1.69	1.78	1.86	1.89	1.80	1.51
B6	2.68	2.79	2.15	2.07	1.51	1.35	1.67	1.76	1.85	1.88	1.81	1.58
B7	2.80	2.82	2.22	2.10	1.49	1.32	1.67	1.77	1.85	1.90	1.82	1.53
B8	2.85	2.88	2.28	2.09	1.47	1.30	1.67	1.77	1.86	1.91	1.82	1.53
B9	2.88	2.91	2.30	2.07	1.35	1.27	1.65	1.75	1.84	1.89	1.80	1.49
B10	2.90	2.97	2.33	2.08	1.35	1.28	1.68	1.78	1.88	1.94	1.82	1.47
B11	2.96	3.05	2.34	2.14	1.37	1.34	1.77	1.88	1.99	2.04	1.85	1.35
B12	3.00	3.12	2.39	2.24	1.55	1.47	1.88	2.00	2.12	2.15	1.90	1.38
C1	3.24	3.37	2.77	2.49	1.96	1.91	2.31	2.41	2.46	2.44	2.37	1.97
C2	3.11	3.33	2.44	2.16	1.62	1.45	1.95	2.07	2.14	2.12	2.02	1.49
C3	2.91	3.22	2.13	1.96	1.32	1.20	1.68	1.78	1.85	1.85	1.74	1.27
C4	2.74	3.07	2.04	1.93	1.11	1.11	1.55	1.64	1.71	1.72	1.65	1.14
C5	2.64	2.86	2.04	1.94	0.99	1.10	1.48	1.56	1.64	1.68	1.60	1.12
C6	2.77	3.00	2.15	2.03	1.26	1.16	1.53	1.60	1.68	1.73	1.66	1.25

Table 9.4. Water-table depth (m) below ground surface at the medium-textured site (page 12 of 14).

Rep/ plot no.	30 Nov. 1998	19 Apr. 1999	31 May 1999	5 Jul. 1999	26 Jul. 1999	23 Aug. 1999	27 Sep. 1999	18 Oct. 1999	22 Nov. 1999	20 Apr. 2000	29 May 2000	26 Jun. 2000
C7	2.86	3.19	2.30	2.07	1.35	1.19	1.55	1.63	1.72	1.75	1.68	1.33
C8	2.92	3.28	2.46	2.07	1.38	1.19	1.55	1.63	1.72	1.75	1.69	1.32
C9	2.98	3.35	2.63	2.08	1.51	1.24	1.62	1.70	1.78	1.80	1.69	1.32
C10	2.99	3.43	2.98	2.52	2.09	1.72	2.00	2.05	2.08	2.31	2.14	1.73
C11	3.03	3.49	2.94	2.12	1.55	1.33	1.77	1.88	1.98	2.09	1.90	1.33
C12	3.10	3.57	2.97	2.29	2.01	1.55	1.96	2.09	2.17	2.35	2.11	1.48
D1	3.31	3.65	3.02	2.25	1.71	1.62	2.09	2.21	2.28	2.46	2.26	1.67
D2	3.16	3.54	2.58	1.99	1.36	1.23	1.69	1.79	1.89	2.01	1.89	1.28
D3	3.05	3.43	2.39	1.98	1.22	1.13	1.57	1.66	1.76	1.87	1.78	1.23
D4	2.95	3.32	2.29	1.98	1.17	1.06	1.48	1.55	1.65	1.78	1.70	1.13
D5	2.89	3.22	2.25	1.99	1.19	1.02	1.41	1.49	1.58	1.72	1.63	1.07
D6	2.90	3.19	2.26	2.05	1.31	1.08	1.44	1.49	1.58	1.73	1.63	1.10
D7	2.90	3.28	2.29	2.07	1.30	1.11	1.43	1.48	1.58	1.72	1.63	1.15
D8	2.95	3.37	2.38	2.11	1.32	1.15	1.45	1.51	1.61	1.72	1.62	1.18
D9	3.03	3.49	2.55	2.21	1.46	1.27	1.55	1.62	1.71	1.82	1.72	1.27
D10	3.08	3.52	2.65	2.25	1.51	1.33	1.62	1.69	1.79	1.92	1.79	1.30
D11	3.15	3.56	2.71	2.34	1.70	1.43	1.74	1.83	1.92	2.06	1.89	1.34
D12	3.26	3.64	2.84	2.51	2.07	1.62	1.93	2.03	2.12	2.20	2.05	1.45
E1	3.30	3.76	2.89	2.34	1.59	1.59	1.75	1.95	2.14	2.44	2.25	1.68
E2	3.15	3.71	2.83	2.14	1.39	1.32	1.53	1.72	1.92	2.23	2.06	1.39
E3	3.08	3.58	2.55	1.91	1.21	1.11	1.35	1.53	1.72	2.01	1.87	1.17
E4	3.11	3.63	2.66	1.92	1.13	1.06	1.29	1.47	1.66	1.95	1.79	1.04
E5	3.05	3.54	2.75	2.00	1.08	1.03	1.20	1.37	1.56	1.80	1.65	0.91
E6	3.08	3.52	2.61	2.07	1.18	1.07	1.21	1.38	1.58	1.82	1.64	0.94
E7	3.10	3.56	2.74	2.05	1.18	1.09	1.18	1.36	1.57	1.78	1.59	0.96
E8	3.10	3.61	3.00	2.04	1.19	1.10	1.20	1.38	1.58	1.80	1.61	0.98
E9	3.10	3.69	3.05	2.07	1.24	1.16	1.24	1.43	1.63	1.83	1.63	1.04
E10	3.16	3.74	2.97	2.12	1.38	1.26	1.36	1.54	1.73	1.98	1.76	1.11
E11	3.16	3.71	3.04	2.24	1.58	1.37	1.49	1.66	1.84	2.13	1.90	1.15
E12	3.23	3.82	3.44	2.46	2.17	1.55	1.69	1.87	2.05	2.40	1.94	1.15

Table 9.4. Water-table depth (m) below ground surface at the medium-textured site (page 13 of 14).

Rep/ plot no.	24 Jul. 2000	24 Aug. 2000	25 Sep. 2000	30 Oct. 2000	30 Apr. 2001	28 May 2001	25 Jun. 2001	30 Jul. 2001	27 Aug. 2001	24 Sep. 2001	5 Nov. 2001
A1	2.14	2.53	2.65	2.78	2.59	2.49	2.47	1.77	2.56	2.84	3.10
A2	1.93	2.35	2.46	2.62	2.49	2.39	2.42	1.64	2.42	2.67	2.96
A3	1.81	2.20	2.29	2.43	2.39	2.29	2.19	1.61	2.28	2.52	2.78
A4	1.73	2.12	2.19	2.33	2.32	2.23	2.19	1.62	2.23	2.44	2.69
A5	1.67	2.04	2.10	2.24	2.21	2.15	2.18	1.54	2.19	2.41	2.65
A6	1.66	2.06	2.07	2.23	2.17	2.12	2.18	1.39	2.21	2.43	2.67
A7	1.68	2.12	2.09	2.25	2.18	2.14	2.21	1.26	2.23	2.46	2.70
A8	1.67	2.10	2.07	2.23	2.20	2.15	2.21	1.20	2.19	2.42	2.67
A9	1.66	2.08	2.09	2.25	2.25	2.18	2.24	1.19	2.18	2.42	2.70
A10	1.56	2.01	2.06	2.25	2.24	2.16	2.18	1.09	2.16	2.41	2.68
A11	1.54	2.10	2.16	2.38	2.27	2.22	2.13	1.01	2.23	2.49	2.78
A12	1.59	2.19	2.27	2.48	2.35	2.27	1.96	1.01	2.18	2.45	2.74
B1	2.17	2.51	2.64	2.73	2.69	2.54	2.45	2.10	2.58	2.84	3.06
B2	1.92	2.39	2.51	2.65	2.60	2.46	2.40	1.83	2.46	2.74	3.00
B3	1.68	2.22	2.32	2.48	2.34	2.29	2.30	1.58	2.36	2.61	2.89
B4	1.59	2.07	2.09	2.29	2.13	2.14	2.25	1.48	2.35	2.55	2.78
B5	1.53	1.97	1.97	2.16	2.05	2.05	2.18	1.47	2.32	2.52	2.76
B6	1.54	1.94	1.94	2.13	2.03	2.04	2.15	1.44	2.28	2.48	2.73
B7	1.55	1.96	1.93	2.13	2.08	2.09	2.15	1.37	2.25	2.47	2.73
B8	1.53	1.96	1.94	2.13	2.13	2.10	2.16	1.37	2.23	2.45	2.72
B9	1.47	1.92	1.93	2.12	2.13	2.07	2.20	1.31	2.19	2.42	2.69
B10	1.43	1.96	1.97	2.17	2.19	2.11	2.21	1.27	2.22	2.44	2.71
B11	1.36	2.04	2.05	2.29	2.34	2.18	2.17	1.21	2.28	2.47	2.70
B12	1.48	2.16	2.19	2.41	2.49	2.30	2.14	1.30	2.26	2.45	2.67
C1	2.25	2.73	2.72	2.84	2.44	2.48	2.47	1.94	2.89	3.14	3.36
C2	1.64	2.43	2.42	2.63	2.17	2.24	2.29	1.70	2.71	2.98	3.23
C3	1.37	2.06	2.06	2.30	2.02	2.02	2.12	1.39	2.48	2.78	3.06
C4	1.24	1.89	1.93	2.14	1.90	1.93	2.11	1.23	2.34	2.62	2.93
C5	1.24	1.79	1.79	2.00	1.87	1.87	2.06	1.20	2.26	2.51	2.79
C6	1.35	1.84	1.81	2.03	1.90	1.93	2.12	1.25	2.30	2.53	2.82

Table 9.4. Water-table depth (m) below ground surface at the medium-textured site (page 14 of 14).

Rep/ plot no.	24 Jul. 2000	24 Aug. 2000	25 Sep. 2000	30 Oct. 2000	30 Apr. 2001	28 May 2001	25 Jun. 2001	30 Jul. 2001	27 Aug. 2001	24 Sep. 2001	5 Nov. 2001
C7	1.40	1.88	1.81	2.04	1.90	1.95	2.16	1.31	2.30	2.54	2.81
C8	1.41	1.89	1.79	2.02	1.91	1.94	2.08	1.32	2.29	2.52	2.79
C9	1.41	1.94	1.81	2.06	1.91	1.96	2.09	1.31	2.34	2.57	2.82
C10	1.66	2.08	2.00	2.24	2.41	2.33	2.30	1.73	2.46	2.65	2.85
C11	1.30	1.94	1.88	2.19	2.37	2.09	2.05	1.32	2.46	2.69	2.91
C12	1.50	2.07	2.09	2.35	2.79	2.32	2.00	1.60	2.48	2.70	2.92
D1	1.99	2.62	2.57	2.82	2.75	2.44	2.14	1.50	2.80	3.22	3.53
D2	1.44	1.85	2.11	2.43	2.26	2.11	2.08	1.20	2.53	2.95	3.37
D3	1.32	1.74	1.97	2.16	2.10	1.97	2.10	1.12	2.43	2.79	3.21
D4	1.21	1.70	1.85	2.12	2.06	1.95	2.08	1.00	2.32	2.67	3.06
D5	1.12	2.10	1.74	1.99	2.03	1.89	2.06	0.79	2.18	2.51	2.88
D6	1.15	1.95	1.72	1.95	2.00	1.89	2.11	0.66	2.09	2.41	2.78
D7	1.19	1.74	1.69	1.94	2.03	1.93	2.15	0.64	2.10	2.40	2.75
D8	1.16	1.69	1.65	1.91	2.05	1.90	2.10	0.68	2.05	2.37	2.71
D9	1.21	1.73	1.74	1.98	2.17	2.00	2.18	0.81	2.11	2.44	2.77
D10	1.21	1.76	1.81	2.05	2.20	2.07	2.18	0.95	2.19	2.50	2.82
D11	1.27	1.83	1.89	2.14	2.30	2.18	2.14	1.18	2.31	2.59	2.88
D12	1.48	2.03	2.12	2.33	2.43	2.33	2.08	1.49	2.48	2.72	2.98
E1	2.15	2.75	2.77	3.01	3.35	2.76	2.55	1.63	2.86	3.30	3.76
E2	1.70	2.19	2.36	2.70	3.03	2.47	2.36	1.25	2.65	3.06	3.47
E3	1.30	1.98	1.98	2.36	2.36	2.23	2.16	1.16	2.53	2.91	3.31
E4	1.10	1.82	1.89	2.26	2.33	2.18	2.06	1.09	2.48	2.84	3.21
E5	0.96	1.72	1.79	2.14	2.16	2.01	2.08	0.85	2.34	2.68	3.02
E6	0.95	1.72	1.77	2.14	2.12	2.01	2.12	0.71	2.27	2.62	2.97
E7	0.95	1.73	1.74	2.13	2.17	2.05	2.12	0.60	2.24	2.59	2.94
E8	0.90	1.73	1.74	2.11	2.35	2.07	2.08	0.58	2.09	2.55	2.91
E9	0.93	1.73	1.75	2.09	2.48	2.07	2.14	0.64	2.14	2.50	2.88
E10	1.02	1.76	1.80	2.13	2.69	2.16	2.16	0.80	2.22	2.54	2.90
E11	1.10	1.84	1.90	2.21	2.90	2.31	2.19	1.05	2.34	2.62	2.94
E12	1.23	2.01	2.12	2.41	3.11	2.55	2.18	1.29	2.44	2.71	3.00

Appendix 10. Chemical analysis of manure samples.

Table 10.1. Chemical and moisture analysis of manure samples from the coarse-textured site (Page 1 of 2).

	Yearly mean (n = 5)								
	1993 [z]	1994	1995	1996	1997	1998	1999	2000	Eight-year mean
Feedlot	A	A	A	A	A	B	C	C	
Moisture (%) [y]	59.5	59.5	59.6	47.8	32.2	24.6	44.6	50.4	47.3
Extractable nutrients (mg kg^{-1}) [x]									
NH_4-N [w]	2906	1490	1755	1309	1525	2435	3375	5938	2592
NO_3-N [v]	1.2	11	144	10	4.4	5.4	0.0	1.0	22
PO_4-P [v]	1457	993	1777	1306	1654	3241	5135	6068	2704
Na [u]	1855	4460	5302	3241	3067	1674	6052	9104	4344
K [u]	6704	12758	25450	11514	15176	1994	17170	30965	15216
Ca [u]	na [t]	3041	2044	2958	na	4328	7880	14589	5807
Mg [u]	na	1040	1389	1528	na	1772	2376	4813	2153
Zn [s]	33	85	101	53	75	65	127	186	91
Cu [s]	3.6	22	20	7.2	14	10	31	27	17
Mn [s]	29	48	38	39	41	45	74	86	50
Fe [s]	156	186	152	288	322	103	141	101	181
B [r]	1.35	na	na	na	2.97	3.38	4.67	1.90	2.90
Cl [q]	na	na	na	na	na	3308	9838	7.2	4384
Saturated-paste water extractable ($mmol_c$ L^{-1})									
Ca	3.33	5.43	4.02	10.2	7.29	11.4	13.1	14.5	8.70
Mg	18.6	14.6	6.52	33.8	34.0	74.5	63.7	73.7	39.9
Na	48.2	54.7	73.4	46.9	57.6	37.2	77.2	77.9	59.1
K	101	123	329	93.4	143	142	149	164	156
SAR	14.7	16.8	32.1	11.7	12.7	5.7	12.5	11.9	14.8
pH [q]	7.3	8.4	8.1	8.1	7.6	8.0	6.7	6.7	7.6
EC (dS m^{-1}) [q]	17.9	10.2	22.4	8.3	8.9	10.0	9.3	14.4	12.7
Total Kjeldahl N (%) [x]	2.30	1.76	2.58	1.45	1.69	1.35	2.80	3.06	2.12
Organic matter (%) [x]	57.4	42.8	54.4	36.9	39.7	34.6	70.7	75.0	51.4

Table 10.1. Chemical and moisture analysis of manure samples from the coarse-textured site (Page 2 of 2).

	Yearly mean (n = 5)								
	1993 [z]	1994	1995	1996	1997	1998	1999	2000	Eight-year mean
Feedlot	A	A	A	A	A	B	C	C	
Total elemental analysis, ICP (mg kg^{-1}) [x]									
Fe	7620	14406	7007	18397	23088	10724	2149	1355	10593
Cu	61.2	60.8	59.5	31.5	36.4	37.3	72.1	730	54.0
Mn	320	374	372	246	296	242	225	228	288
Zn	257	211	273	151	165	156	287	312	227
Mg	7976	7977	10524	5991	8558	7287	7272	7351	7867
K	17754	20672	29400	13790	17346	12180	23120	26560	20103
Na	4561	4336	5829	2834	3149	1530	5648	6192	4260
Al	10923	10810	na	na	10013	8481	2773	1458	7410
B	19.2	20.8	12.8	6.21	21.2	12.3	8.80	12.2	14.2
S	5320	3790	7040	3225	4505	3590	5729	7237	5055
P	9241	4720	9830	3299	5604	5060	9776	10944	7309
Ca	23655	23382	28682	23106	na	21390	26956	27186	24908

[z] Year of manure application.
[y] Moisture content expressed on a wet-weight basis.
[x] Expressed on a dry-weight basis. To convert the values to a wet-weight basis, multiply by:
[1 - (% moisture ÷ 100)]
[w] KCl extractable.
[v] Miller-Axley 5:1 $NH_4F-H_2SO_4$ extractable.
[u] NH_4-acetate extractable.
[t] Not analysed.
[s] DTPA (diethylene triamine pentaacetic acid) extractable.
[r] 5:1 hot water extractable
[q] 2:1 water extract

Table 10.2. Chemical and moisture analysis of manure samples from the medium-textured site (Page 1 of 2).

	Yearly mean (n = 5)								
	1993 [z]	1994	1995	1996	1997	1998	1999	2000	Eight-year
Feedlot	A	A	A	A	A	B	C	C	mean
Moisture (%) [y]	60.9	62.4	74.6	63.1	34.6	21.5	40.6	46.4	50.5
Extractable nutrients (mg kg^{-1}) [x]									
NH_4-N [w]	2681	986	3932	4005	1756	1991	2373	4455	2772
NO_3-N [v]	2	19	47	5	12	40	0	1	16
PO_4-P [v]	1372	1350	2356	3460	1742	2497	4664	5612	2882
Na [u]	2010	5248	5730	4396	3268	1416	5577	9150	4599
K [u]	8137	14400	29963	15280	16324	2670	15376	29324	16434
Ca [u]	na [t]	3334	1868	2725	na	4330	6999	15231	5748
Mg [u]	na	1130	1352	1106	na	1498	2211	4837	2022
Zn [s]	39	110	146	106	80	63	139	165	106
Cu [s]	4.3	26	24	17	16	6.1	35	30	20
Mn [s]	25	50	43	44	41	51	75	81	51
Fe [s]	142	151	181	265	501	113	122	117	199
B [r]	1.8	na	na	na	3.1	3.0	5.6	1.9	3.1
Cl [q]	na	na	na	na	na	3010	9450	7.2	4156
Saturated-paste water extractable ($mmol_c$ L^{-1})									
Ca	3.36	3.47	3.61	3.91	6.62	8.72	10.1	14.2	6.70
Mg	12.6	12.9	6.81	14.1	35.5	53.8	53.4	76.4	33.2
Na	50.8	43.5	81.9	42.9	54.6	34.1	75.2	83.7	58.3
K	114	103	421	100	134	131	134	162	162
SAR	18.6	15.4	36.6	14.4	12.0	6.1	13.3	12.4	16.1
pH [q]	7.6	8.6	8.0	8.0	7.6	8.0	6.9	7.8	7.8
EC (dS m^{-1}) [q]	19.4	10.2	25.7	9.40	9.40	9.10	9.00	14.0	13.3
Total Kjeldahl N (%) [x]	2.26	2.23	4.59	2.71	1.75	1.38	2.54	2.94	2.55
Organic matter (%) [x]	59.4	54.3	61.8	55.8	43.3	30.3	68.8	72.0	55.7

Table 10.2. Chemical and moisture analysis of manure samples from the medium-textured site (Page 2 of 2).

	Yearly mean (n = 5)								
	1993 [z]	1994	1995	1996	1997	1998	1999	2000	Eight-year mean
Feedlot	A	A	A	A	A	B	C	C	
Total elemental analysis, ICP (mg kg^{-1}) [x]									
Fe	6176	7832	5300	8249	21996	10744	1935	1728	7995
Cu	57.4	76.1	63	49.4	38.2	24.6	70.5	72.6	56.5
Mn	309	353	366	246	293	255	219	234	284
Zn	245	264	305	223	174	153	281	314	245
Mg	7465	7950	11108	6406	8646	7387	6942	7223	7891
K	24008	26420	31790	20478	17194	12809	21468	23340	22188
Na	5004	5792	6495	4404	3507	1508	5638	5849	4775
Al	8487	3210	na	na	9508	10189	2486	1866	5958
B	17.7	21.9	17.8	10.0	20.4	13.4	8.50	13.0	15.3
S	3576	4616	8042	4223	4747	3893	5638	6409	5143
P	8290	6117	11519	6167	5849	4655	9251	10376	7778
Ca	25578	29476	29758	20442	na	20950	25572	28270	25721

[z] Year of manure application.
[y] Moisture content expressed on a wet-weight basis.
[x] Expressed on a dry-weight basis. To convert the values to a wet-weight basis, multiply by:
[1 - (% moisture ÷ 100)]
[w] KCl extractable.
[v] Miller-Axley 5:1 NH_4F-H_2SO_4 extractable.
[u] NH_4-acetate extractable.
[t] Not analysed.
[s] DTPA (diethylene triamine pentaacetic acid) extractable.
[r] 5:1 hot water extractable
[q] 2:1 water extract

Appendix 11. Soil analytical data for the coarse- and medium-textured sites.

Table 11.1. Soil chemistry mean values (n=5) for the coarse-textured site, fall 1993 (1 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		---- kg ha^{-1} ----														
Control	0-0.15	19.0	md[w]	342.1	86	20.6	13.1	60.4	29.5	11.6	310	3487	1732	7.2	0.89	0.35
	0.15-0.3	13.3	md	113.0	72	12.0	14.7	34.8	19.1	8.0	222	1578	1135	7.3	0.69	0.44
	0.3-0.6	25.9	md	31.2	104	14.2	53.6	8.2	21.1	10.8	370	2690	1939	7.6	0.55	1.05
	0.6-0.9	45.7	md	na[w]	105	17.7	86.9	4.4	42.9	13.0	275	1232	1866	7.7	0.71	1.70
	0.9-1.2	63.7	md	na	244	87.5	83.0	9.1	205.9	98.7	208	na	na	7.6	1.35	0.96
	1.2-1.5	92.4	md	na	264	223.2	174.5	16.1	404.8	120.0	191	na	na	7.8	2.22	1.48
60 F[v]	0-0.15	21.5	md	na	91	24.2	12.6	74.7	25.7	13.1	340	na	na	7.2	0.92	0.31
	0.15-0.3	12.5	md	na	74	12.5	15.0	37.2	13.9	8.6	222	na	na	7.4	0.70	0.46
	0.3-0.6	18.0	md	na	94	12.6	80.8	8.4	25.6	14.5	407	na	na	7.8	0.57	1.66
	0.6-0.9	46.2	md	na	112	18.3	92.2	4.0	45.9	26.3	292	na	na	7.8	0.76	1.90
	0.9-1.2	129.5	md	na	239	62.4	58.5	9.5	56.3	184.9	188	na	na	7.7	1.37	0.74
	1.2-1.5	140.0	md	na	231	77.2	45.7	14.6	34.4	194.6	188	na	na	7.7	1.47	0.57
120 F[v]	0-0.15	14.1	md	na	79	17.7	11.5	50.8	18.8	11.0	295	na	na	7.2	0.83	0.33
	0.15-0.3	12.7	md	na	74	13.2	12.6	27.7	13.3	8.1	201	na	na	7.3	0.72	0.39
	0.3-0.6	20.9	md	na	108	12.9	49.2	6.7	23.4	11.0	372	na	na	7.6	0.53	0.96
	0.6-0.9	49.6	md	na	144	28.1	65.9	5.0	43.7	56.9	280	na	na	7.6	0.82	1.19
	0.9-1.2	89.8	md	na	200	62.7	43.0	7.3	52.9	132.5	196	na	na	7.6	1.17	0.58
	1.2-1.5	146.6	md	na	208	54.9	110.7	11.7	43.3	153.9	166	na	na	7.6	1.45	1.44
180 F[v]	0-0.15	18.3	md	na	85	21.0	10.1	64.4	20.2	10.7	279	na	na	7.2	0.94	0.28
	0.15-0.3	14.5	md	na	67	12.1	14.3	37.0	12.5	9.4	200	na	na	7.3	0.68	0.45
	0.3-0.6	20.5	md	na	99	12.3	78.2	8.3	26.2	14.3	400	na	na	7.8	0.57	1.62
	0.6-0.9	43.0	md	na	109	16.4	94.9	3.9	43.7	30.9	281	na	na	7.8	0.72	1.83
	0.9-1.2	101.3	md	na	232	47.2	57.4	9.6	69.3	141.0	199	na	na	7.6	1.26	0.75
	1.2-1.5	126.7	md	na	252	78.9	47.7	14.1	43.4	211.2	200	na	na	7.6	1.44	0.54

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] md = missing data; na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.1. Soil chemistry mean values (n=5) for the coarse-textured site, fall 1993 (2 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 M[w]	0-0.15	18.3	md[v]	250.9	89	22.1	13.8	67.5	23.8	10.4	305	3255	1586	7.2	0.95	0.39
	0.15-0.3	13.1	md	98.7	78	13.9	18.6	28.9	17.8	9.0	216	2002	1159	7.4	0.75	0.56
	0.3-0.6	21.4	md	26.1	105	15.1	77.7	7.9	29.6	13.4	400	2690	2022	7.8	0.60	1.51
	0.6-0.9	52.0	md	na[v]	131	22.8	73.8	6.9	49.3	49.9	286	1326	2027	7.7	0.81	1.35
	0.9-1.2	81.5	md	na	163	53.8	64.8	10.7	62.7	109.4	241	na	na	7.8	1.01	0.85
	1.2-1.5	82.2	md	na	134	76.8	69.3	12.0	57.6	123.8	256	na	na	7.9	1.11	1.00
40 M[w]	0-0.15	16.6	md	253.1	79	18.2	11.9	53.2	19.7	9.9	284	3208	1516	7.3	0.82	0.34
	0.15-0.3	13.0	md	93.2	71	11.6	16.5	22.4	15.0	9.2	199	1747	1044	7.4	0.67	0.52
	0.3-0.6	25.8	md	28.2	106	14.9	63.7	8.1	24.1	14.4	371	2505	2069	7.7	0.58	1.26
	0.6-0.9	43.7	md	na	125	23.9	68.7	5.2	54.3	37.4	248	853	1857	7.7	0.77	1.22
	0.9-1.2	109.0	md	na	202	83.8	85.3	10.0	96.3	140.2	191	na	na	7.7	1.45	1.05
	1.2-1.5	113.2	md	na	144	120.7	109.9	13.9	93.0	147.3	253	na	na	7.8	1.45	1.26
60 M[w]	0-0.15	20.0	md	243.7	88	21.1	15.8	64.5	26.9	13.0	344	2732	1534	7.2	0.88	0.41
	0.15-0.3	13.1	md	60.0	73	11.9	20.2	28.6	17.5	9.2	231	1990	1136	7.4	0.70	0.63
	0.3-0.6	25.3	md	23.1	96	14.8	82.8	7.6	33.0	15.2	356	1577	1929	7.7	0.63	1.75
	0.6-0.9	54.9	md	na	137	34.3	110.4	7.1	58.2	71.8	281	853	2065	7.8	0.99	1.91
	0.9-1.2	85.3	md	na	180	93.8	100.3	12.5	114.0	143.8	259	na	na	7.8	1.40	1.21
	1.2-1.5	123.3	md	na	180	144.9	152.6	14.7	152.9	174.0	271	na	na	7.9	1.62	1.48
120 M[w]	0-0.15	26.0	md	374.5	89	22.9	12.6	69.6	38.5	12.2	316	3720	1686	7.2	0.92	0.34
	0.15-0.3	16.5	md	105.8	72	12.7	15.8	35.9	21.1	10.6	208	2378	1233	7.4	0.72	0.49
	0.3-0.6	26.7	md	32.9	107	14.5	72.8	7.9	32.7	17.5	347	1948	2013	7.7	0.60	1.40
	0.6-0.9	86.8	md	na	169	31.9	100.0	6.3	62.1	71.7	252	853	1961	7.7	1.07	1.62
	0.9-1.2	124.8	md	na	231	79.0	87.5	11.4	112.5	149.9	204	na	na	7.7	1.53	1.08
	1.2-1.5	176.8	md	na	266	186.0	83.0	17.6	222.1	148.7	217	na	na	7.8	1.98	0.89

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] md = missing data; na = not analysed.

Table 11.2. Soil chemistry mean values (n=5) for the coarse-textured site, fall 1994 (1 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
Control	0-0.15	14.8	1.2	193.9	66	13.2	15.5	39.9	18.2	20.0	102	3766	1432	7.2	0.67	0.50
	0.15-0.3	2.9	0.6	51.5	60	8.4	10.9	18.2	13.8	4.6	80	3349	1087	7.4	0.46	0.36
	0.3-0.6	4.9	1.0	22.8	163	20.0	75.6	5.0	94.9	6.2	146	3710	2143	7.6	0.66	1.15
	0.6-0.9	19.8	1.0	na[w]	240	70.9	92.5	6.2	242.1	42.3	100	2368	2132	7.6	1.17	1.23
	0.9-1.2	47.7	0.7	na	216	155.0	127.1	10.8	362.5	83.7	80	na	na	7.6	1.61	1.08
	1.2-1.5	50.7	0.9	na	306	322.8	208.8	19.4	797.8	65.9	88	na	na	7.7	2.07	1.18
60 F[v]	0-0.15	18.4	1.7	na	59	12.9	14.7	51.4	15.4	13.7	96	na	na	7.1	0.62	0.49
	0.15-0.3	5.0	1.3	na	55	8.1	14.2	15.5	11.3	3.2	75	na	na	7.5	0.43	0.50
	0.3-0.6	22.1	2.4	na	88	12.2	97.0	4.3	34.2	20.0	136	na	na	7.5	0.58	2.02
	0.6-0.9	42.9	2.5	na	142	28.9	76.6	7.3	61.2	75.7	106	na	na	7.5	0.87	1.33
	0.9-1.2	59.4	2.3	na	162	43.8	33.7	9.5	54.0	99.0	84	na	na	7.5	0.97	0.52
	1.2-1.5	62.1	2.6	na	133	52.6	26.0	15.7	28.6	94.5	83	na	na	7.5	0.97	0.42
120 F[v]	0-0.15	17.0	0.8	na	65	12.8	12.2	34.9	13.8	12.4	102	na	na	7.2	0.61	0.39
	0.15-0.3	5.8	0.7	na	59	8.1	10.0	10.2	11.9	3.9	75	na	na	7.4	0.42	0.34
	0.3-0.6	31.7	1.2	na	127	17.1	63.9	5.6	27.8	18.1	149	na	na	7.6	0.57	1.11
	0.6-0.9	73.7	1.2	na	161	44.6	56.3	8.6	46.9	76.1	123	na	na	7.5	0.80	0.87
	0.9-1.2	51.5	1.0	na	156	48.0	39.5	9.8	54.1	72.0	85	na	na	7.5	0.89	0.54
	1.2-1.5	64.5	0.8	na	145	69.6	31.0	14.1	50.5	86.9	80	na	na	7.6	1.04	0.42
180 F[v]	0-0.15	15.2	1.3	na	56	12.3	13.2	43.0	10.9	10.6	95	na	na	7.1	0.57	0.45
	0.15-0.3	3.7	1.4	na	52	7.7	9.9	15.1	7.2	2.0	75	na	na	7.4	0.40	0.36
	0.3-0.6	20.3	1.3	na	91	12.5	80.0	3.6	33.4	8.1	137	na	na	7.6	0.51	1.69
	0.6-0.9	33.7	1.3	na	129	20.6	77.7	5.0	56.7	63.2	94	na	na	7.6	0.77	1.50
	0.9-1.2	55.7	3.0	na	163	36.2	43.4	10.0	51.9	86.0	80	na	na	7.5	0.93	0.70
	1.2-1.5	61.4	2.4	na	139	45.0	31.7	16.0	34.8	80.3	89	na	na	7.5	0.90	0.50

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.2. Soil chemistry mean values (n=5) for the coarse-textured site, fall 1994 (2 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 M[w]	0-0.15	20.0	1.4	216.1	65	14.6	21.3	54.7	12.4	35.9	106	4510	1446	7.1	0.71	0.68
	0.15-0.3	9.5	1.5	49.4	60	8.6	16.3	10.6	11.4	7.0	77	3252	1102	7.4	0.45	0.56
	0.3-0.6	10.6	1.2	25.3	96	13.9	81.9	4.6	30.5	21.3	149	3432	2180	7.6	0.51	1.67
	0.6-0.9	43.6	1.4	na[v]	156	43.3	65.0	7.3	82.7	82.9	105	2274	2103	7.5	0.92	0.96
	0.9-1.2	57.5	1.7	na	139	68.6	62.7	12.4	74.7	100.2	101	na	na	7.6	0.99	0.79
	1.2-1.5	49.7	1.5	na	102	74.3	53.8	14.8	44.7	94.3	101	na	na	7.6	0.92	0.69
40 M[w]	0-0.15	18.0	1.6	232.3	74	15.2	29.5	57.9	21.4	47.7	116	3580	1418	7.1	0.83	0.87
	0.15-0.3	3.3	0.2	62.8	55	8.3	17.3	11.0	13.3	8.3	71	3107	1078	7.3	0.45	0.62
	0.3-0.6	8.8	0.9	27.5	104	15.4	70.9	4.6	38.5	43.6	135	3339	2143	7.5	0.55	1.36
	0.6-0.9	26.2	0.6	na	134	26.5	66.7	6.3	57.3	56.5	112	2084	2046	7.5	0.72	1.13
	0.9-1.2	64.2	0.5	na	185	98.4	70.4	11.1	100.8	146.4	100	na	na	7.5	1.31	0.82
	1.2-1.5	69.7	0.4	na	138	121.6	85.5	18.5	107.4	153.4	111	na	na	7.6	1.19	0.80
60 M[w]	0-0.15	26.1	3.1	236.3	78	18.0	38.6	73.6	25.3	51.0	131	5022	1651	7.2	0.95	1.11
	0.15-0.3	8.3	1.7	33.8	69	10.7	25.4	22.1	22.0	30.8	75	2767	1146	7.4	0.66	0.84
	0.3-0.6	19.0	1.6	26.3	123	19.0	77.4	8.2	44.8	68.0	134	3339	2245	7.5	0.66	1.39
	0.6-0.9	36.4	1.7	na	125	38.3	102.8	8.1	80.7	63.0	107	1895	2217	7.6	0.86	1.81
	0.9-1.2	76.0	1.5	na	155	96.8	88.2	11.5	112.2	112.7	95	na	na	7.6	1.21	1.15
	1.2-1.5	101.3	1.2	na	124	118.1	121.6	15.7	102.3	140.9	102	na	na	7.7	1.24	1.20
120 M[w]	0-0.15	39.8	3.1	332.6	73	19.5	54.5	118.3	33.7	71.4	138	5487	1627	7.2	1.15	1.60
	0.15-0.3	15.7	0.9	87.0	97	14.3	36.3	32.6	42.9	81.7	69	2815	1160	7.3	1.01	1.01
	0.3-0.6	44.1	1.7	30.7	186	25.2	97.5	10.0	48.0	206.6	115	3247	2124	7.4	1.04	1.50
	0.6-0.9	63.2	1.7	na	153	35.8	101.7	9.5	73.7	77.1	103	2084	2084	7.5	0.96	1.60
	0.9-1.2	117.0	1.6	na	203	124.7	80.2	15.0	127.1	132.9	95	na	na	7.6	1.38	0.86
	1.2-1.5	121.9	2.6	na	218	228.2	107.6	23.7	251.5	138.2	101	na	na	7.6	1.66	0.78

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] na = not analysed.

Table 11.3. Soil chemistry mean values (n=5) for the coarse-textured site, fall 1995 (1 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
Control	0-0.15	18.2	0.3	175.4	62	12.4	12.4	36.7	9.2	35.2	202	3766	1344	7.5	0.60	0.41
	0.15-0.3	2.5	0.4	36.4	39	5.9	9.9	13.8	3.4	4.4	153	3301	1107	7.9	0.34	0.42
	0.3-0.6	3.9	0.0	20.3	82	10.9	48.2	2.9	29.6	7.4	272	3432	2124	8.1	0.38	1.01
	0.6-0.9	32.3	0.0	na[w]	153	41.9	125.8	3.9	118.0	93.6	186	2179	1980	8.1	0.98	1.76
	0.9-1.2	70.5	0.0	na	159	101.3	75.1	8.1	108.2	113.1	158	na	na	8.1	1.16	0.88
	1.2-1.5	46.4	0.0	na	80	73.2	46.2	10.2	65.3	63.5	160	na	na	8.3	0.80	0.64
60 F[v]	0-0.15	39.5	0.0	na	75	17.7	15.3	49.9	16.8	31.0	229	na	na	7.4	0.77	0.43
	0.15-0.3	6.8	0.0	na	42	6.4	10.9	23.1	7.1	4.0	147	na	na	7.7	0.39	0.44
	0.3-0.6	50.9	0.0	na	141	17.6	63.7	4.1	26.2	31.6	248	na	na	8.1	0.64	0.97
	0.6-0.9	68.9	0.0	na	180	37.3	94.0	3.2	72.1	117.1	187	na	na	8.1	1.00	1.72
	0.9-1.2	48.9	0.0	na	133	34.0	33.1	4.8	42.9	83.8	156	na	na	8.1	0.71	0.58
	1.2-1.5	33.1	0.0	na	100	30.5	18.4	7.0	28.9	55.0	142	na	na	8.2	0.60	0.33
120 F[v]	0-0.15	36.8	0.0	na	75	15.5	15.6	37.7	7.6	33.0	227	na	na	7.5	0.74	0.47
	0.15-0.3	12.0	0.0	na	49	7.2	11.1	18.4	6.4	5.1	150	na	na	7.8	0.42	0.41
	0.3-0.6	58.6	0.0	na	134	18.0	60.2	4.1	20.5	16.5	250	na	na	8.0	0.65	0.97
	0.6-0.9	125.9	0.0	na	175	46.3	109.4	3.9	44.2	62.1	199	na	na	8.1	1.03	1.52
	0.9-1.2	80.0	0.0	na	151	53.1	51.3	5.8	53.0	74.9	157	na	na	8.1	0.86	0.67
	1.2-1.5	71.0	0.0	na	122	62.6	27.7	6.8	31.8	83.0	142	na	na	8.2	0.83	0.41
180 F[v]	0-0.15	39.6	0.4	na	73	17.9	11.2	43.9	14.7	21.2	194	na	na	7.4	0.75	0.33
	0.15-0.3	21.5	0.0	na	58	10.5	8.8	25.3	10.1	10.4	126	na	na	7.8	0.54	0.32
	0.3-0.6	83.4	0.0	na	154	18.3	43.2	29.1	18.2	7.1	208	na	na	7.9	0.72	0.61
	0.6-0.9	89.9	0.6	na	141	20.4	114.5	4.6	39.2	31.8	172	na	na	8.0	0.88	1.88
	0.9-1.2	84.4	1.0	na	150	30.3	77.7	6.1	43.6	57.2	151	na	na	8.1	0.87	1.23
	1.2-1.5	62.8	0.0	na	121	39.6	29.4	7.2	38.3	60.4	127	na	na	8.2	0.74	0.47

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.3. Soil chemistry mean values (n=5) for the coarse-textured site, fall 1995 (2 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 M[w]	0-0.15	32.1	0.4	262.4	62	19.5	32.7	85.9	16.1	69.4	251	4185	1474	7.5	0.91	0.98
	0.15-0.3	4.6	0.3	39.5	37	8.7	24.1	19.5	12.3	13.9	148	2621	1092	7.8	0.43	0.98
	0.3-0.6	8.6	0.6	27.3	95	18.9	55.8	4.0	25.8	71.3	270	4267	2365	8.1	0.51	1.07
	0.6-0.9	25.4	0.0	na[v]	117	29.7	98.5	4.5	70.7	92.6	197	2463	2103	8.1	0.78	1.68
	0.9-1.2	45.6	0.3	na	100	64.5	60.4	7.4	72.6	88.6	162	na	na	8.2	0.86	0.89
	1.2-1.5	47.6	0.0	na	72	65.5	32.0	7.9	40.8	74.8	148	na	na	8.3	0.76	0.55
40 M[w]	0-0.15	26.1	0.2	285.6	65	15.6	41.8	93.1	17.4	78.1	269	4929	1507	7.5	0.94	1.27
	0.15-0.3	4.5	0.0	69.2	39	6.1	27.0	17.2	10.0	20.3	147	3155	1087	7.8	0.44	1.14
	0.3-0.6	7.9	0.0	22.0	136	19.1	56.9	3.3	32.9	155.8	222	3618	2096	8.0	0.65	0.91
	0.6-0.9	29.1	0.0	na	171	34.3	101.6	3.3	65.1	201.1	198	2274	2122	8.1	0.98	1.60
	0.9-1.2	33.3	0.0	na	109	52.3	60.3	5.2	55.0	86.6	185	na	na	8.2	0.77	0.94
	1.2-1.5	36.8	0.0	na	79	54.2	32.6	6.7	36.9	58.8	203	na	na	8.3	0.62	0.51
60 M[w]	0-0.15	37.8	0.3	347.9	52	26.7	54.5	132.2	24.0	82.4	316	4371	1525	7.6	1.08	1.59
	0.15-0.3	9.4	0.1	63.5	34	17.8	40.5	25.4	17.6	33.7	166	3592	1291	7.9	0.60	1.51
	0.3-0.6	22.0	0.3	20.5	142	49.8	92.4	6.3	47.2	253.7	208	3339	2152	8.0	0.92	1.29
	0.6-0.9	62.8	0.2	na	185	54.5	134.6	8.8	77.2	234.1	188	3695	2113	8.1	1.23	1.96
	0.9-1.2	65.3	0.1	na	135	72.4	79.8	11.7	81.8	115.0	171	na	na	8.1	1.02	1.09
	1.2-1.5	60.5	0.2	na	84	80.6	65.9	9.0	64.8	90.1	174	na	na	8.3	0.87	0.87
120 M[w]	0-0.15	59.9	2.2	387.6	64	31.6	80.6	244.7	40.7	153.2	402	4929	1730	7.5	1.63	2.15
	0.15-0.3	10.3	0.2	91.4	38	13.3	55.3	41.2	20.5	49.0	171	2670	1131	7.9	0.69	2.08
	0.3-0.6	38.5	0.2	23.0	189	65.7	129.5	8.7	48.8	387.5	203	3339	2124	7.9	1.28	1.57
	0.6-0.9	88.3	0.0	na	186	107.7	169.2	16.6	97.1	361.1	158	2842	2075	7.9	1.59	1.91
	0.9-1.2	91.5	0.0	na	213	187.5	112.0	23.7	237.1	215.9	165	na	na	8.1	1.62	1.12
	1.2-1.5	103.2	0.0	na	218	266.0	97.1	13.5	340.9	158.2	158	na	na	8.2	1.50	0.71

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] na = not analysed.

Table 11.4. Soil chemistry mean values (n=5) for the coarse-textured site, fall 1996 (1 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
Control	0-0.15	9.5	3.0	203.1	71	15.2	14.2	38.7	9.4	9.8	310	3627	1362	7.4	0.59	0.41
	0.15-0.3	1.9	0.9	65.7	57	7.7	12.5	19.6	9.1	4.3	205	2912	1195	7.5	0.39	0.41
	0.3-0.6	4.7	1.2	22.6	117	15.2	35.1	5.0	29.7	6.4	351	3896	2069	7.6	0.44	0.61
	0.6-0.9	9.0	1.1	na[w]	152	35.7	64.7	4.7	113.3	2.4	310	2274	2046	7.7	0.71	1.03
	0.9-1.2	13.9	1.1	na	125	82.4	98.5	8.1	178.8	21.1	257	na	na	7.8	0.94	1.33
	1.2-1.5	36.8	1.1	na	278	306.5	191.8	14.7	642.4	102.5	196	na	na	7.9	1.85	1.38
60 F[v]	0-0.15	11.0	3.6	na	68	15.2	16.8	38.9	14.5	7.8	283	na	na	7.2	0.58	0.49
	0.15-0.3	3.8	1.2	na	57	9.8	13.4	20.3	11.7	4.7	184	na	na	7.3	0.44	0.45
	0.3-0.6	6.8	1.4	na	130	16.0	26.5	7.0	36.0	3.7	332	na	na	7.6	0.46	0.44
	0.6-0.9	15.8	1.4	na	100	18.1	53.5	3.1	40.0	9.0	275	na	na	7.7	0.53	1.02
	0.9-1.2	39.8	1.1	na	118	28.7	72.6	5.3	42.4	47.2	229	na	na	7.7	0.75	1.45
	1.2-1.5	37.1	1.4	na	117	29.4	45.1	8.7	39.4	51.3	195	na	na	7.8	0.73	0.90
120 F[v]	0-0.15	9.9	3.2	na	66	14.5	17.0	43.2	11.7	8.6	293	na	na	7.3	0.56	0.50
	0.15-0.3	2.3	0.9	na	54	9.1	14.4	21.4	9.2	2.9	202	na	na	7.5	0.40	0.47
	0.3-0.6	8.0	1.5	na	131	16.1	35.8	7.8	34.7	5.5	362	na	na	7.6	0.47	0.57
	0.6-0.9	26.1	1.4	na	117	19.9	59.5	4.0	36.1	6.7	315	na	na	7.7	0.54	0.94
	0.9-1.2	34.7	1.8	na	95	28.0	66.3	6.2	45.8	15.8	244	na	na	7.8	0.61	1.23
	1.2-1.5	55.7	1.4	na	110	38.1	47.7	8.1	37.5	48.2	176	na	na	7.8	0.74	0.92
180 F[v]	0-0.15	13.4	2.1	na	66	14.7	15.7	39.7	11.1	9.4	287	na	na	7.2	0.57	0.47
	0.15-0.3	3.1	0.9	na	55	9.3	11.4	20.4	10.6	3.9	184	na	na	7.4	0.40	0.39
	0.3-0.6	9.0	1.1	na	135	16.7	27.1	6.9	34.3	4.9	338	na	na	7.6	0.47	0.44
	0.6-0.9	30.6	1.2	na	111	17.6	43.7	3.6	27.6	1.6	283	na	na	7.7	0.50	0.79
	0.9-1.2	30.2	0.8	na	96	19.2	55.0	4.9	27.1	12.0	269	na	na	7.7	0.56	1.07
	1.2-1.5	65.0	1.2	na	125	44.7	55.3	9.1	36.8	44.4	203	na	na	7.7	0.81	0.95

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.4. Soil chemistry mean values (n=5) for the coarse-textured site, fall 1996 (2 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 M[w]	0-0.15	15.8	1.7	298.4	62	17.0	24.6	87.6	17.4	23.5	328	4464	1669	7.4	0.74	0.72
	0.15-0.3	6.3	0.8	86.1	53	9.1	28.7	21.8	13.1	10.4	192	3034	1135	7.5	0.53	1.00
	0.3-0.6	19.8	1.2	28.7	150	18.9	58.9	7.4	45.3	63.5	313	4731	2273	7.7	0.65	0.86
	0.6-0.9	24.2	0.9	na[v]	145	25.9	78.8	5.0	43.9	127.0	276	2463	2236	7.7	0.76	1.20
	0.9-1.2	32.4	1.1	na	119	42.7	74.8	8.1	55.1	111.4	239	na	na	7.8	0.84	1.27
	1.2-1.5	30.6	0.9	na	104	60.6	57.3	10.9	48.7	126.4	207	na	na	7.9	0.91	0.96
40 M[w]	0-0.15	14.9	2.0	281.6	69	20.3	27.7	106.5	19.7	21.8	388	4243	1691	7.4	0.73	0.74
	0.15-0.3	5.5	0.5	69.4	52	8.5	29.5	25.2	12.0	11.7	205	2815	1150	7.5	0.47	1.01
	0.3-0.6	14.9	1.1	24.7	134	18.3	61.2	6.4	41.1	38.7	351	4081	2096	7.7	0.55	0.97
	0.6-0.9	25.6	1.0	na	170	31.5	59.8	5.8	54.4	140.8	275	2653	2065	7.6	0.77	0.85
	0.9-1.2	28.4	0.9	na	164	63.3	89.1	7.8	116.1	133.0	249	na	na	7.8	0.94	1.22
	1.2-1.5	39.4	0.9	na	187	144.8	118.7	12.5	258.7	139.9	256	na	na	7.9	1.25	1.10
60 M[w]	0-0.15	19.5	2.8	385.4	71	21.1	30.0	135.5	22.2	22.5	432	4107	1635	7.4	0.85	0.80
	0.15-0.3	7.2	0.8	123.1	54	9.7	34.7	40.3	16.8	8.7	229	2427	1052	7.6	0.56	1.16
	0.3-0.6	22.7	1.3	32.5	144	25.3	86.4	18.2	56.6	54.5	354	4174	2291	7.7	0.71	1.31
	0.6-0.9	34.8	1.3	na	153	41.9	97.8	5.8	61.5	144.9	275	2463	2103	7.7	0.93	1.42
	0.9-1.2	36.9	1.1	na	107	59.5	95.7	10.2	58.3	147.0	249	na	na	7.9	0.93	1.48
	1.2-1.5	56.8	1.2	na	100	100.0	110.7	10.7	68.8	206.9	218	na	na	8.0	1.13	1.35
120 M[w]	0-0.15	33.2	1.9	630.4	67	28.3	42.9	221.6	41.8	25.5	536	6161	2302	7.3	1.03	1.04
	0.15-0.3	11.7	0.9	220.7	55	10.4	48.5	75.0	29.1	13.3	241	3155	1272	7.5	0.69	1.60
	0.3-0.6	29.6	1.2	39.2	158	22.3	98.4	17.9	58.9	58.1	367	4267	2282	7.6	0.76	1.47
	0.6-0.9	46.4	1.3	na	189	41.8	121.9	6.8	64.0	204.6	259	2653	2141	7.6	1.08	1.67
	0.9-1.2	56.5	1.2	na	155	103.2	135.1	12.2	83.2	289.5	272	na	na	7.7	1.23	1.54
	1.2-1.5	71.6	0.9	na	164	197.5	176.2	15.8	221.1	348.7	231	na	na	7.9	1.62	1.48

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] na = not analysed.

Table 11.5. Soil chemistry mean values (n=5) for the coarse-textured site, fall 1997 (1 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
Control	0-0.15	8.2	1.0	155.3	58	12.9	13.1	28.0	19.5	17.4	219	4045	1576	7.3	0.57	0.43
	0.15-0.3	2.1	1.0	58.9	51	7.6	10.4	18.0	10.8	5.4	173	3107	1155	7.4	0.41	0.37
	0.3-0.6	2.4	2.0	24.4	92	13.2	30.7	4.4	27.3	1.3	313	3803	2031	7.7	0.38	0.62
	0.6-0.9	2.4	2.0	na[w]	76	17.4	37.5	3.9	41.0	4.6	269	2179	1781	7.7	0.43	0.83
	0.9-1.2	3.2	2.1	na	65	34.7	57.2	5.7	75.6	6.2	253	na	na	7.9	0.55	1.12
	1.2-1.5	6.1	1.8	na	99	121.0	124.2	12.5	251.0	23.4	266	na	na	8.0	0.94	1.60
60 F[v]	0-0.15	16.9	1.2	na	64	14.4	16.4	38.4	24.9	14.4	231	na	na	7.1	0.60	0.49
	0.15-0.3	3.7	1.2	na	45	8.2	9.6	19.8	9.3	3.3	154	na	na	7.1	0.39	0.35
	0.3-0.6	4.3	2.0	na	91	12.4	26.8	6.7	26.7	3.7	303	na	na	7.5	0.39	0.53
	0.6-0.9	3.6	1.8	na	78	14.6	27.6	3.0	28.3	4.7	272	na	na	7.6	0.37	0.58
	0.9-1.2	4.4	2.2	na	58	14.7	51.9	4.3	29.7	4.6	262	na	na	7.7	0.40	1.25
	1.2-1.5	9.7	1.9	na	59	17.7	54.4	6.6	37.2	8.1	239	na	na	7.8	0.49	1.36
120 F[v]	0-0.15	19.7	1.1	na	64	13.9	14.7	24.0	24.6	12.8	201	na	na	7.2	0.61	0.46
	0.15-0.3	4.8	0.9	na	52	8.6	9.8	16.7	13.3	2.6	161	na	na	7.4	0.43	0.35
	0.3-0.6	5.2	1.5	na	100	13.4	26.0	5.1	29.8	1.3	322	na	na	7.6	0.40	0.50
	0.6-0.9	5.6	1.7	na	85	15.4	31.2	3.7	31.6	2.4	287	na	na	7.7	0.39	0.61
	0.9-1.2	6.3	1.9	na	62	19.0	41.0	3.9	32.3	3.5	256	na	na	7.8	0.41	0.90
	1.2-1.5	11.1	1.4	na	59	26.3	46.9	8.1	42.9	4.2	247	na	na	7.8	0.49	1.04
180 F[v]	0-0.15	18.9	1.3	na	61	14.0	13.7	29.7	23.7	14.6	195	na	na	7.0	0.58	0.42
	0.15-0.3	4.7	1.3	na	50	9.7	10.8	19.3	12.8	4.7	162	na	na	7.2	0.43	0.38
	0.3-0.6	6.4	2.3	na	99	13.4	27.1	7.0	31.0	2.5	305	na	na	7.5	0.40	0.51
	0.6-0.9	12.9	1.7	na	84	14.0	24.2	3.8	28.3	4.4	252	na	na	7.6	0.41	0.50
	0.9-1.2	23.6	2.2	na	86	17.0	41.1	5.6	32.0	5.7	242	na	na	7.6	0.46	0.82
	1.2-1.5	36.3	2.2	na	82	21.4	49.8	8.6	35.5	17.6	204	na	na	7.7	0.58	1.04

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.5. Soil chemistry mean values (n=5) for the coarse-textured site, fall 1997 (2 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 M[w]	0-0.15	20.4	1.4	218.0	65	17.6	17.1	64.5	25.7	40.8	254	5254	1604	7.1	0.72	0.49
	0.15-0.3	4.6	1.0	140.6	49	8.7	12.9	27.3	12.5	8.4	175	3252	1170	7.3	0.45	0.46
	0.3-0.6	4.4	1.9	45.6	94	13.3	44.0	8.1	31.0	11.4	332	4452	2133	7.5	0.43	0.86
	0.6-0.9	3.9	2.0	na[v]	75	19.8	59.1	4.6	39.0	17.2	314	2463	1933	7.7	0.46	1.21
	0.9-1.2	5.9	2.0	na	60	27.7	64.9	7.0	43.3	26.8	274	na	na	7.8	0.51	1.33
	1.2-1.5	10.0	1.4	na	49	38.4	70.3	9.1	48.9	35.6	264	na	na	7.8	0.57	1.46
40 M[w]	0-0.15	24.9	1.2	285.3	68	20.1	20.2	101.1	29.2	40.9	311	4510	1627	7.3	0.83	0.56
	0.15-0.3	5.0	1.2	128.6	46	8.1	21.8	41.9	16.8	10.1	181	3058	1131	7.5	0.51	0.77
	0.3-0.6	6.3	2.4	36.6	100	15.8	53.8	11.3	38.2	33.3	321	3710	2004	7.7	0.50	1.01
	0.6-0.9	8.7	1.9	na	88	17.9	60.9	4.2	41.6	43.8	275	2368	1971	7.7	0.54	1.30
	0.9-1.2	11.6	1.7	na	77	36.3	61.3	6.5	52.6	53.4	261	na	na	7.8	0.60	1.19
	1.2-1.5	17.6	2.1	na	70	52.8	69.7	10.5	66.0	62.7	259	na	na	7.9	0.73	1.29
60 M[w]	0-0.15	50.0	1.6	411.9	77	26.5	25.4	148.8	35.2	52.9	390	5580	1841	7.1	1.03	0.62
	0.15-0.3	9.1	0.9	141.7	44	8.5	19.8	64.9	14.5	12.6	195	3155	1291	7.4	0.61	0.75
	0.3-0.6	9.3	1.4	47.4	92	15.6	63.0	17.7	39.5	22.9	342	3247	2087	7.6	0.51	1.22
	0.6-0.9	9.7	1.4	na	66	24.3	78.2	4.5	43.9	31.4	300	1990	2084	7.7	0.54	1.65
	0.9-1.2	8.2	1.8	na	48	36.4	81.3	6.0	48.4	35.6	280	na	na	7.8	0.57	1.70
	1.2-1.5	14.8	1.7	na	58	52.4	78.0	10.9	60.8	61.5	263	na	na	7.8	0.70	1.46
120 M[w]	0-0.15	65.1	2.4	647.9	102	44.3	37.8	249.7	56.9	63.2	493	7266	2267	7.0	1.42	0.70
	0.15-0.3	17.0	1.0	241.3	42	9.7	27.9	139.1	27.8	15.1	227	3009	1417	7.3	0.77	1.02
	0.3-0.6	15.2	2.1	90.8	93	14.1	75.6	45.1	37.8	15.2	373	3618	2124	7.5	0.55	1.48
	0.6-0.9	14.3	2.2	na	71	12.8	105.6	4.0	52.9	20.2	307	2274	1838	7.6	0.57	2.35
	0.9-1.2	11.6	2.1	na	79	28.5	100.1	7.5	74.1	33.3	273	na	na	7.7	0.70	1.96
	1.2-1.5	26.9	1.6	na	83	70.0	115.8	12.5	118.8	94.6	239	na	na	7.7	0.99	1.84

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] na = not analysed.

Table 11.6. Soil chemistry mean values (n=5) for the coarse-textured site, fall 1998 (1 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
Control	0-0.15	18.8	1.9	156.0	75	16.6	11.5	37.4	12.9	25.6	284	3580	1455	7.2	0.66	0.32
	0.15-0.3	2.1	1.0	60.9	50	7.4	10.0	17.6	7.0	1.3	186	2573	1121	7.4	0.39	0.36
	0.3-0.6	2.5	1.2	25.3	89	11.1	26.0	6.3	17.0	0.0	302	3525	2133	7.7	0.36	0.53
	0.6-0.9	2.5	1.6	na[w]	78	15.6	29.9	4.1	30.8	2.4	271	2274	2103	7.8	0.37	0.62
	0.9-1.2	3.7	1.0	na	57	27.0	50.8	6.7	41.3	2.3	269	na	na	7.9	0.43	1.08
	1.2-1.5	6.8	1.8	na	49	41.5	74.3	9.0	70.1	9.1	274	na	na	8.0	0.55	1.39
60 F[v]	0-0.15	23.3	1.5	na	68	15.7	10.3	27.9	11.8	9.6	251	na	na	7.2	0.54	0.29
	0.15-0.3	3.8	1.1	na	49	9.0	8.9	17.0	6.8	0.0	180	na	na	7.4	0.38	0.30
	0.3-0.6	5.1	1.8	na	92	15.2	27.1	7.4	18.4	0.0	317	na	na	7.6	0.37	0.51
	0.6-0.9	4.0	2.2	na	80	14.5	27.2	3.9	27.5	0.0	275	na	na	7.8	0.36	0.56
	0.9-1.2	5.6	2.1	na	66	14.9	35.7	4.9	29.6	0.0	247	na	na	7.8	0.37	0.78
	1.2-1.5	10.3	1.9	na	57	16.6	47.9	6.5	27.6	1.2	241	na	na	7.9	0.41	1.15
120 F[v]	0-0.15	35.7	1.2	na	82	16.4	10.3	27.6	11.7	7.3	246	na	na	7.2	0.70	0.28
	0.15-0.3	8.6	0.8	na	53	7.8	9.4	13.5	5.0	1.3	166	na	na	7.5	0.40	0.32
	0.3-0.6	10.9	1.1	na	109	13.6	28.2	5.0	25.2	1.2	315	na	na	7.7	0.42	0.50
	0.6-0.9	14.6	1.0	na	90	15.7	29.9	3.3	26.1	2.8	276	na	na	7.7	0.39	0.56
	0.9-1.2	5.9	1.2	na	62	16.0	31.9	4.6	25.8	0.0	228	na	na	7.9	0.36	0.74
	1.2-1.5	17.0	1.7	na	60	19.4	41.4	7.3	28.4	3.2	205	na	na	7.9	0.45	1.00
180 F[v]	0-0.15	41.8	1.7	na	83	19.9	12.1	32.7	11.7	9.5	242	na	na	7.1	0.70	0.31
	0.15-0.3	7.6	1.6	na	52	9.8	9.5	14.5	6.5	0.7	173	na	na	7.4	0.42	0.32
	0.3-0.6	13.3	1.0	na	109	14.2	31.6	8.5	23.8	0.0	307	na	na	7.6	0.43	0.57
	0.6-0.9	14.2	1.0	na	91	13.0	30.7	3.6	27.7	0.0	264	na	na	7.8	0.40	0.61
	0.9-1.2	20.3	1.8	na	88	16.6	36.6	6.1	30.0	0.0	245	na	na	7.8	0.44	0.72
	1.2-1.5	31.8	1.6	na	81	26.2	45.6	9.3	34.3	4.6	246	na	na	7.8	0.52	0.86

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.6. Soil chemistry mean values (n=5) for the coarse-textured site, fall 1998 (2 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 M[w]	0-0.15	32.9	2.3	232.9	80	22.3	12.9	70.3	15.2	41.6	310	4371	1665	7.1	0.80	0.32
	0.15-0.3	5.0	1.9	125.5	46	8.3	12.5	30.9	7.8	4.3	182	3398	1301	7.4	0.43	0.45
	0.3-0.6	6.1	3.1	44.2	99	13.3	41.6	11.2	23.0	16.3	333	4174	2356	7.7	0.44	0.78
	0.6-0.9	5.1	3.4	na[v]	76	19.2	51.1	4.0	36.3	20.2	287	2368	2170	7.8	0.44	1.03
	0.9-1.2	5.8	3.4	na	58	24.2	58.1	6.7	35.2	17.8	277	na	na	7.9	0.46	1.23
	1.2-1.5	9.5	3.1	na	47	35.2	61.8	8.8	41.8	32.8	247	na	na	8.0	0.54	1.32
40 M[w]	0-0.15	55.3	1.4	294.1	102	31.7	15.5	113.2	20.9	63.4	355	4278	1693	7.1	1.10	0.34
	0.15-0.3	11.3	0.7	131.4	52	9.2	17.9	45.9	10.8	9.2	192	3349	1340	7.4	0.51	0.59
	0.3-0.6	13.7	2.6	41.4	105	14.0	55.0	15.2	29.6	19.4	351	4174	2300	7.7	0.48	1.01
	0.6-0.9	9.8	1.9	na	94	17.5	56.7	4.2	44.9	39.5	266	2368	2103	7.8	0.52	1.11
	0.9-1.2	10.1	2.0	na	142	51.0	71.4	8.0	143.0	51.1	250	na	na	7.9	0.79	1.24
	1.2-1.5	16.3	1.3	na	148	101.1	84.0	11.9	219.7	64.3	248	na	na	7.9	0.96	1.22
60 M[w]	0-0.15	100.4	2.2	317.8	109	36.3	19.4	151.7	24.0	66.2	363	4975	1897	7.1	1.27	0.40
	0.15-0.3	16.4	1.7	123.7	51	10.1	23.8	75.1	9.9	10.0	228	2621	1417	7.5	0.64	0.80
	0.3-0.6	22.1	2.8	83.5	109	19.5	74.2	37.4	46.9	37.3	354	3339	2291	7.8	0.61	1.26
	0.6-0.9	16.6	2.6	na	88	33.5	76.1	5.1	55.1	68.7	272	1990	2141	7.8	0.62	1.31
	0.9-1.2	21.7	2.4	na	73	49.7	96.8	9.2	58.0	100.8	289	na	na	7.9	0.74	1.64
	1.2-1.5	23.1	1.8	na	64	58.2	85.7	10.5	53.4	120.7	234	na	na	8.0	0.79	1.46
120 M[w]	0-0.15	157.7	3.9	526.2	120	62.0	54.0	349.7	66.5	57.4	551	6742	2413	7.1	1.88	0.95
	0.15-0.3	34.3	1.5	340.7	47	12.6	54.8	165.6	31.4	19.5	252	2718	1461	7.5	1.02	1.86
	0.3-0.6	51.8	2.9	108.0	143	21.2	111.6	109.0	82.4	61.9	377	3525	2245	7.7	0.89	1.71
	0.6-0.9	63.6	3.3	na	193	36.2	120.6	11.9	90.7	146.7	255	2368	2170	7.6	1.06	1.62
	0.9-1.2	77.8	2.5	na	173	59.9	146.6	18.6	66.3	251.8	249	na	na	7.7	1.22	1.87
	1.2-1.5	60.6	2.0	na	114	90.8	145.7	16.3	93.9	210.2	240	na	na	7.8	1.24	2.00

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] na = not analysed.

Table 11.7. Soil chemistry mean values (n=5) for the coarse-textured site, fall 1999 (1 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
Control	0-0.15	4.7	0.6	134.1	63	11.2	9.6	17.2	8.8	14.0	214	3348	1162	7.2	0.44	0.30
	0.15-0.3	1.6	0.8	62.1	58	7.8	7.6	17.9	7.4	4.1	180	2864	1131	7.3	0.36	0.25
	0.3-0.6	1.7	0.8	32.0	107	12.3	19.0	11.8	20.1	1.2	320	3618	2143	7.5	0.34	0.35
	0.6-0.9	1.5	4.2	17.3	91	15.5	26.1	4.6	30.7	1.3	284	2463	2046	7.6	0.35	0.49
	0.9-1.2	1.7	0.9	14.7	80	24.8	31.2	5.6	37.5	1.3	266	na[w]	na	7.7	0.40	0.60
	1.2-1.5	2.4	0.6	6.3	298	218.5	79.6	11.2	540.2	15.5	189	na	na	7.7	1.51	0.77
60 F[v]	0-0.15	10.8	1.5	na	64	13.1	11.1	20.5	11.1	6.9	224	na	na	7.1	0.46	0.34
	0.15-0.3	2.9	1.1	na	53	8.5	8.6	16.7	8.6	2.8	160	na	na	7.3	0.34	0.30
	0.3-0.6	4.7	3.1	na	106	11.5	21.2	13.5	20.4	2.5	311	na	na	7.6	0.35	0.39
	0.6-0.9	4.2	1.6	na	86	11.8	25.4	3.8	24.2	1.2	258	na	na	7.7	0.34	0.53
	0.9-1.2	5.5	1.5	na	75	13.8	28.4	5.1	24.6	0.0	265	na	na	7.7	0.36	0.62
	1.2-1.5	13.5	0.8	na	74	16.8	38.4	6.4	36.7	1.1	215	na	na	7.7	0.44	0.82
120 F[v]	0-0.15	8.7	1.2	na	64	13.3	10.1	19.9	12.3	10.2	233	na	na	7.1	0.50	0.32
	0.15-0.3	3.2	0.4	na	53	8.7	8.6	14.1	8.1	2.0	166	na	na	7.3	0.36	0.29
	0.3-0.6	5.9	1.1	na	107	13.6	22.3	9.5	21.2	3.9	327	na	na	7.5	0.36	0.41
	0.6-0.9	9.6	0.5	na	96	16.2	31.7	5.8	29.4	2.6	287	na	na	7.5	0.39	0.59
	0.9-1.2	9.8	0.6	na	70	14.9	35.6	7.2	26.6	2.3	231	na	na	7.7	0.38	0.79
	1.2-1.5	16.1	0.3	na	77	21.7	32.7	5.8	34.2	5.9	219	na	na	7.7	0.44	0.66
180 F[v]	0-0.15	23.1	0.8	na	77	15.3	12.4	26.2	13.7	8.0	246	na	na	7.1	0.56	0.35
	0.15-0.3	6.4	0.5	na	56	9.3	8.3	15.9	7.1	2.1	159	na	na	7.3	0.38	0.28
	0.3-0.6	19.6	1.2	na	120	13.9	22.0	18.6	23.3	2.6	313	na	na	7.6	0.41	0.37
	0.6-0.9	13.6	0.8	na	91	12.5	27.4	6.5	23.7	2.4	253	na	na	7.5	0.39	0.55
	0.9-1.2	22.9	1.6	na	94	15.0	34.7	6.6	27.8	2.4	233	na	na	7.6	0.44	0.68
	1.2-1.5	40.8	1.9	na	90	22.4	35.8	19.7	28.5	6.6	204	na	na	7.6	0.54	0.69

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.7. Soil chemistry mean values (n=5) for the coarse-textured site, fall 1999 (2 of 2 pages).

Treatment	Layer m	NO_3-N^z	NH_4-N^z	PO_4-P^y	Ca^x	Mg^x	Na^x	K^x	SO_4-S^x	Cl^x	HCO_3^{x}	Total N	Total P	pH^x	EC^x dS m^{-1}	SAR^x
		kg ha^{-1}														
20 M^w	0-0.15	16.4	0.8	222.7	68	17.5	13.1	49.2	17.8	20.0	276	3906	1558	7.1	0.59	0.37
	0.15-0.3	4.6	0.6	107.7	50	8.4	10.6	28.7	9.5	6.3	170	2864	1252	7.3	0.40	0.38
	0.3-0.6	6.2	1.0	56.4	103	11.9	34.8	15.4	25.8	9.0	350	4174	2254	7.5	0.40	0.64
	0.6-0.9	4.6	1.1	20.7	79	16.7	46.3	3.8	36.3	8.9	278	2653	2151	7.3	0.40	0.96
	0.9-1.2	5.5	1.1	15.3	66	25.6	47.6	5.4	36.3	15.1	263	na^v	na	7.5	0.42	0.93
	1.2-1.5	8.7	0.7	7.2	57	36.5	55.7	6.1	39.8	21.1	260	na	na	7.9	0.44	1.01
40 M^w	0-0.15	39.4	1.6	347.3	87	25.3	16.1	94.2	23.4	29.5	363	4696	1720	7.0	0.81	0.38
	0.15-0.3	11.8	0.7	150.7	54	10.0	16.0	53.2	11.6	12.5	183	2767	1199	7.2	0.52	0.53
	0.3-0.6	14.9	2.4	66.5	112	16.4	47.7	26.8	36.8	28.0	367	4267	2236	7.5	0.49	0.82
	0.6-0.9	9.4	1.0	21.4	90	17.6	60.4	4.6	44.4	26.0	282	2558	2065	7.6	0.47	1.18
	0.9-1.2	14.0	1.1	18.7	83	33.5	65.9	6.9	57.9	36.6	268	na	na	7.7	0.56	1.21
	1.2-1.5	15.3	1.9	11.7	81	59.6	77.1	9.6	77.3	62.6	276	na	na	7.7	0.69	1.21
60 M^w	0-0.15	53.7	1.8	414.8	90	30.8	17.6	118.3	24.8	33.1	399	5440	1944	7.0	0.93	0.39
	0.15-0.3	14.5	1.6	180.5	55	11.2	15.4	79.3	13.3	12.1	211	2961	1442	7.3	0.61	0.50
	0.3-0.6	18.6	3.8	66.4	108	16.2	53.5	57.0	37.8	22.1	370	3989	2347	7.5	0.53	0.91
	0.6-0.9	27.1	2.8	17.3	107	35.0	87.9	6.1	60.9	39.3	272	1990	2075	7.6	0.65	1.46
	0.9-1.2	26.0	2.8	13.9	87	57.0	95.3	6.8	64.0	56.6	269	na	na	7.6	0.75	1.53
	1.2-1.5	29.8	2.3	8.4	83	67.3	100.1	8.5	71.7	83.3	241	na	na	7.7	0.85	1.52
120 M^w	0-0.15	132.6	2.8	854.9	133	71.1	31.6	288.6	58.2	69.9	608	7533	2757	6.9	1.61	0.49
	0.15-0.3	33.7	1.1	349.1	68	20.5	32.0	167.9	39.8	21.9	262	2864	1626	7.2	0.97	0.86
	0.3-0.6	46.6	1.6	200.6	130	30.4	82.9	216.8	66.6	45.4	466	4267	2319	7.5	0.90	1.28
	0.6-0.9	69.5	1.0	30.2	197	28.0	104.6	22.1	85.6	78.5	256	2558	2179	7.5	0.96	1.43
	0.9-1.2	78.3	5.8	18.1	190	42.2	113.6	9.1	66.8	124.3	209	na	na	7.5	1.09	1.54
	1.2-1.5	125.5	1.2	12.2	336	179.2	173.4	16.3	366.6	138.4	179	na	na	7.5	1.87	1.64

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] na = not analysed.

Table 11.8. Soil chemistry mean values (n=5) for the coarse-textured site, fall 2000 (1 of 3 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
Control	0-0.15	7.9	2.0	140.8	57	13.7	12.3	21.9	na[w]	10.0	na	3208	1339	7.1	0.51	0.40
	0.15-0.3	6.8	1.4	53.2	60	9.8	13.7	16.0	na	8.1	na	2184	1053	7.3	0.48	0.45
	0.3-0.6	4.4	2.2	20.4	96	14.0	29.5	7.4	na	3.4	na	3432	2004	7.5	0.41	0.57
	0.6-0.9	3.3	2.4	13.3	65	20.3	37.7	4.3	na	4.4	na	1895	1999	7.6	0.41	0.84
	0.9-1.2	2.6	1.4	7.8	225	161.5	60.6	10.3	na	0.0	na	na	na	7.6	1.05	0.83
	1.2-1.5	3.0	2.7	10.0	275	253.5	91.3	15.3	na	0.0	na	na	na	7.7	1.16	0.97
60 F[v]	0-0.15	14.1	1.8	na	69	15.3	13.7	21.5	na	9.4	na	na	na	7.1	0.55	0.41
	0.15-0.3	13.3	1.4	na	65	11.8	14.2	13.3	na	8.2	na	na	na	7.2	0.54	0.45
	0.3-0.6	9.2	2.6	na	108	15.5	28.4	7.6	na	4.5	na	na	na	7.4	0.45	0.53
	0.6-0.9	4.8	2.8	na	76	16.0	33.7	4.3	na	2.1	na	na	na	7.6	0.40	0.74
	0.9-1.2	6.6	3.9	na	65	16.3	34.6	7.2	na	2.1	na	na	na	7.6	0.39	0.82
	1.2-1.5	10.5	2.1	na	56	18.5	39.8	7.8	na	2.0	na	na	na	7.7	0.42	1.05
120 F[v]	0-0.15	16.3	1.0	na	59	12.9	12.2	21.2	na	6.5	na	na	na	7.0	0.49	0.39
	0.15-0.3	22.0	1.2	na	73	13.2	14.2	11.2	na	8.0	na	na	na	7.2	0.59	0.42
	0.3-0.6	33.9	2.2	na	132	19.3	30.0	7.5	na	5.0	na	na	na	7.4	0.55	0.50
	0.6-0.9	27.0	1.7	na	103	20.8	41.0	5.1	na	2.4	na	na	na	7.4	0.52	0.74
	0.9-1.2	18.5	2.5	na	89	29.5	38.5	6.2	na	2.2	na	na	na	7.5	0.52	0.73
	1.2-1.5	20.3	1.0	na	78	35.3	39.5	8.1	na	2.1	na	na	na	7.6	0.55	0.76
180 F[v]	0-0.15	18.8	2.5	na	63	14.6	14.2	25.8	na	7.3	na	na	na	6.8	0.53	0.43
	0.15-0.3	29.2	1.3	na	81	15.2	14.6	13.0	na	6.6	na	na	na	7.1	0.64	0.41
	0.3-0.6	30.2	2.5	na	128	17.9	25.6	11.0	na	3.5	na	na	na	7.3	0.53	0.43
	0.6-0.9	37.3	2.6	na	112	18.8	32.7	5.1	na	0.0	na	na	na	7.4	0.54	0.60
	0.9-1.2	37.5	2.9	na	98	21.0	39.1	6.6	na	1.1	na	na	na	7.5	0.56	0.77
	1.2-1.5	35.4	4.2	na	81	24.9	36.3	9.9	na	2.0	na	na	na	7.6	0.56	0.76

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.8. Soil chemistry mean values (n=5) for the coarse-textured site, fall 2000 (2 of 3 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		------ kg ha^{-1} ------														
20 M[w]	0-0.15	23.1	2.5	252.5	66	19.4	21.0	67.6	na[v]	32.7	na	3952	1530	7.0	0.72	0.60
	0.15-0.3	19.1	2.3	121.6	64	14.0	26.7	43.8	na	39.6	na	2281	1165	7.2	0.70	0.82
	0.3-0.6	10.3	2.5	45.2	119	18.1	44.7	20.6	na	34.8	na	3154	2161	7.5	0.54	0.76
	0.6-0.9	6.2	2.0	19.1	83	19.5	54.9	6.1	na	21.1	na	1611	1942	7.6	0.50	1.13
	0.9-1.2	6.0	2.9	17.4	57	21.5	46.6	8.3	na	16.3	na	na	na	7.7	0.45	1.13
	1.2-1.5	11.9	2.4	13.0	52	22.4	51.3	9.2	na	21.3	na	na	na	7.8	0.49	1.26
40 M[w]	0-0.15	54.9	1.5	469.7	81	27.7	42.1	152.1	na	54.3	na	5115	2004	7.0	1.13	1.06
	0.15-0.3	36.4	0.8	169.9	80	16.3	48.6	71.2	na	49.7	na	2815	1213	7.2	1.00	1.35
	0.3-0.6	32.7	1.0	50.2	193	27.1	73.9	46.0	na	119.0	na	3339	2152	7.4	0.89	1.00
	0.6-0.9	25.8	1.2	19.0	143	32.8	82.8	7.6	na	113.9	na	1990	2084	7.5	0.82	1.29
	0.9-1.2	18.0	0.9	17.9	86	37.9	65.9	9.0	na	57.2	na	na	na	7.6	0.66	1.21
	1.2-1.5	13.3	1.4	10.9	63	41.6	66.3	10.1	na	31.2	na	na	na	7.7	0.62	1.28
60 M[w]	0-0.15	84.8	0.7	599.3	91	38.7	47.8	208.2	na	71.7	na	6277	2223	6.9	1.38	1.04
	0.15-0.3	52.8	0.4	200.1	85	22.6	57.5	119.2	na	58.6	na	3640	1374	7.3	1.29	1.50
	0.3-0.6	85.6	0.4	50.7	236	45.8	101.6	95.7	na	163.1	na	5473	2115	7.4	1.32	1.16
	0.6-0.9	62.5	0.8	15.0	170	72.6	129.7	19.6	na	258.3	na	1800	2113	7.5	1.17	1.54
	0.9-1.2	55.2	0.9	11.0	96	84.8	159.9	9.8	na	158.6	na	na	na	7.7	1.02	2.16
	1.2-1.5	33.4	2.0	11.3	65	60.1	142.5	13.1	na	101.8	na	na	na	7.8	0.85	2.22
120 M[w]	0-0.15	142.0	2.6	976.2	106	59.3	89.3	390.1	na	110.1	na	7905	2976	6.9	2.02	1.62
	0.15-0.3	83.5	1.5	375.1	94	40.6	93.1	245.7	na	126.9	na	2961	1602	7.1	1.98	2.14
	0.3-0.6	182.4	2.3	123.8	410	91.3	148.2	343.8	na	470.7	na	3432	2347	7.2	2.62	1.30
	0.6-0.9	130.1	2.0	43.7	291	49.1	134.5	137.5	na	225.9	na	1990	1990	7.4	1.78	1.55
	0.9-1.2	104.9	9.7	16.2	366	211.5	172.8	18.4	na	164.2	na	na	na	7.5	2.01	1.55
	1.2-1.5	87.2	11.9	7.0	360	320.6	215.1	18.1	na	154.8	na	na	na	7.6	2.09	1.61

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] na = not analysed.

Table 11.8. Soil chemistry mean values (n=5) for the coarse-textured site, fall 2000 (3 of 3 pages).

Treatment	Layer	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x]	SAR[x]
	m	kg ha^{-1}													dS m^{-1}	
20 MR[w]	0-0.15	19.1	2.1	233.7	66	19.8	16.6	58.9	na[v]	23.5	na	na	na	7.0	0.66	0.46
	0.15-0.3	17.4	1.6	101.0	70	14.0	21.1	34.9	na	28.5	na	na	na	7.3	0.69	0.62
	0.3-0.6	14.9	1.6	22.2	102	21.7	69.0	7.7	na	37.6	na	na	na	7.6	0.59	1.27
	0.6-0.9	11.5	1.7	17.6	84	29.3	92.8	6.5	na	31.0	na	na	na	7.6	0.64	1.67
	0.9-1.2	11.4	1.8	12.1	51	37.8	115.3	7.9	na	32.0	na	na	na	7.8	0.65	2.14
	1.2-1.5	11.0	1.2	17.3	65	57.3	85.2	12.9	na	24.4	na	na	na	7.8	0.64	1.31
40 MR[w]	0-0.15	28.4	1.3	333.7	75	23.1	16.2	81.6	na	25.5	na	na	na	7.0	0.81	0.43
	0.15-0.3	31.8	0.7	134.8	82	15.9	26.0	58.5	na	34.8	na	na	na	7.2	0.84	0.70
	0.3-0.6	30.1	1.2	38.0	137	19.7	85.9	24.3	na	32.7	na	na	na	7.4	0.70	1.37
	0.6-0.9	29.5	1.1	16.9	148	50.7	103.9	5.4	na	138.4	na	na	na	7.5	0.92	1.49
	0.9-1.2	20.4	1.0	21.3	97	62.6	72.4	8.8	na	103.2	na	na	na	7.5	0.76	1.14
	1.2-1.5	18.0	1.1	14.0	72	66.2	56.4	10.5	na	73.4	na	na	na	7.7	0.66	1.00
60 MR[w]	0-0.15	45.4	1.0	385.1	91	30.7	17.0	95.9	na	25.5	na	na	na	6.9	0.91	0.39
	0.15-0.3	27.2	0.6	159.0	71	16.1	16.2	85.3	na	17.2	na	na	na	7.2	0.83	0.47
	0.3-0.6	22.8	1.0	35.2	108	24.1	55.0	69.5	na	13.3	na	na	na	7.5	0.61	0.94
	0.6-0.9	14.5	0.5	14.2	77	28.4	71.3	10.8	na	11.1	na	na	na	7.6	0.56	1.38
	0.9-1.2	17.5	0.6	12.0	60	42.9	77.9	8.4	na	25.8	na	na	na	7.7	0.61	1.48
	1.2-1.5	24.4	0.8	8.5	57	46.3	73.6	10.4	na	38.8	na	na	na	7.8	0.64	1.40
120 MR[w]	0-0.15	118.0	2.0	796.5	112	62.7	21.1	222.0	na	42.3	na	na	na	6.8	1.45	0.37
	0.15-0.3	61.7	1.3	344.5	61	22.8	26.6	218.0	na	21.2	na	na	na	7.2	1.29	0.76
	0.3-0.6	111.4	2.4	96.6	150	28.4	95.9	227.9	na	20.4	na	na	na	7.5	1.18	1.45
	0.6-0.9	83.1	2.0	24.9	177	32.3	133.7	18.7	na	47.3	na	na	na	7.4	1.10	1.88
	0.9-1.2	105.6	2.0	23.3	163	67.0	123.7	16.3	na	86.9	na	na	na	7.4	1.26	1.65
	1.2-1.5	97.5	1.4	11.5	109	95.3	110.8	19.0	na	116.4	na	na	na	7.6	1.21	1.52

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure. Residual manure treatment. Annual manure application was discontinued after 1998.
[v] na = not analysed.

Table 11.9. Soil chemistry mean values (n=5) for the coarse-textured site, fall 2001 (1 of 3 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
Control	0-0.15	1.7	2.8	68.1	58	12.8	9.6	18.9	na[w]	4.5	na	3627	1348	7.0	0.44	0.30
	0.15-0.3	1.1	1.0	53.7	49	7.3	10.3	14.0	na	0.0	na	2961	1170	7.2	0.34	0.36
	0.3-0.6	2.4	1.6	30.4	101	13.8	25.4	9.7	na	1.9	na	4174	2226	7.4	0.37	0.46
	0.6-0.9	2.4	2.4	22.1	81	14.1	28.2	4.0	na	3.0	na	2653	2207	7.5	0.35	0.57
	0.9-1.2	2.2	1.6	15.3	61	21.4	28.0	5.2	na	0.0	na	na	na	7.6	0.37	0.61
	1.2-1.5	1.6	1.0	7.0	230	113.5	50.4	9.6	na	1.2	na	na	na	7.6	0.97	0.65
60 F[v]	0-0.15	5.8	2.5	na	63	14.5	8.8	22.3	na	1.8	na	na	na	7.0	0.47	0.26
	0.15-0.3	2.5	0.8	na	52	10.3	9.4	10.4	na	1.1	na	na	na	7.2	0.37	0.32
	0.3-0.6	4.2	1.5	na	102	15.1	23.6	14.1	na	1.9	na	na	na	7.4	0.38	0.42
	0.6-0.9	5.4	2.4	na	87	15.7	25.1	4.8	na	0.0	na	na	na	7.5	0.37	0.48
	0.9-1.2	17.8	2.9	na	84	19.4	33.0	6.0	na	0.0	na	na	na	7.5	0.43	0.63
	1.2-1.5	24.0	1.8	na	78	23.7	30.0	8.8	na	1.3	na	na	na	7.5	0.47	0.61
120 F[v]	0-0.15	4.4	1.7	na	51	9.7	9.0	14.9	na	3.3	na	na	na	6.9	0.39	0.31
	0.15-0.3	2.4	0.7	na	51	8.6	10.0	7.5	na	1.9	na	na	na	7.1	0.35	0.34
	0.3-0.6	7.2	0.8	na	108	14.3	24.0	6.6	na	1.6	na	na	na	7.3	0.39	0.42
	0.6-0.9	21.3	1.1	na	103	18.7	31.2	4.5	na	5.7	na	na	na	7.4	0.44	0.53
	0.9-1.2	19.8	1.3	na	78	21.9	30.0	4.6	na	4.0	na	na	na	7.5	0.45	0.59
	1.2-1.5	26.5	1.5	na	78	23.9	27.6	6.7	na	2.7	na	na	na	7.5	0.47	0.55
180 F[v]	0-0.15	6.4	3.8	na	59	13.2	9.4	22.9	na	3.2	na	na	na	6.9	0.45	0.30
	0.15-0.3	2.9	0.7	na	54	10.0	9.4	9.5	na	0.8	na	na	na	7.2	0.37	0.31
	0.3-0.6	17.0	1.4	na	122	17.0	23.0	8.2	na	1.7	na	na	na	7.4	0.45	0.38
	0.6-0.9	22.9	1.1	na	106	17.7	24.9	5.3	na	2.4	na	na	na	7.4	0.46	0.46
	0.9-1.2	30.7	1.7	na	104	19.7	28.9	5.2	na	0.0	na	na	na	7.4	0.52	0.54
	1.2-1.5	35.2	1.6	na	95	22.1	28.2	8.5	na	4.2	na	na	na	7.4	0.54	0.54

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.9. Soil chemistry mean values (n=5) for the coarse-textured site, fall 2001 (2 of 3 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 M[w]	0-0.15	13.4	4.7	314.5	58	17.4	23.8	91.6	na[v]	19.0	na	4975	1767	7.0	0.68	0.69
	0.15-0.3	4.9	1.3	152.0	44	9.2	27.1	38.5	na	8.6	na	3495	1306	7.2	0.49	0.99
	0.3-0.6	11.2	1.1	67.9	121	17.9	58.3	33.3	na	40.4	na	5380	2449	7.3	0.55	0.95
	0.6-0.9	18.0	2.5	39.0	124	22.5	57.6	10.6	na	64.7	na	2747	2160	7.4	0.62	0.96
	0.9-1.2	23.6	2.3	33.2	111	25.1	44.6	14.1	na	62.9	na	na	na	7.4	0.62	0.80
	1.2-1.5	16.8	1.1	8.1	84	26.0	43.5	9.7	na	56.3	na	na	na	7.5	0.59	0.89
40 M[w]	0-0.15	24.1	4.9	403.5	61	19.6	22.5	113.3	na	14.1	na	5440	1948	6.9	0.72	0.62
	0.15-0.3	6.6	0.7	214.6	46	10.2	28.7	59.4	na	7.7	na	3155	1335	7.1	0.50	0.98
	0.3-0.6	14.7	2.5	104.5	117	18.9	65.7	54.3	na	35.0	na	4638	2338	7.3	0.59	1.10
	0.6-0.9	20.5	2.7	31.8	173	25.2	89.5	8.1	na	93.8	na	3032	2160	7.4	0.76	1.37
	0.9-1.2	44.4	2.7	31.7	145	41.1	84.1	11.5	na	82.0	na	na	na	7.3	0.86	1.27
	1.2-1.5	106.4	1.8	19.2	102	94.6	96.2	12.4	na	138.9	na	na	na	7.5	1.02	1.31
60 M[w]	0-0.15	44.2	6.1	583.5	77	30.4	48.1	195.1	na	31.5	na	6138	2344	7.0	1.06	1.11
	0.15-0.3	20.1	1.7	278.8	61	17.5	53.1	115.9	na	35.7	na	3155	1587	7.3	0.90	1.51
	0.3-0.6	68.3	3.8	128.8	203	39.6	119.3	135.5	na	160.8	na	4731	2551	7.4	1.13	1.45
	0.6-0.9	107.6	3.5	53.9	270	80.3	154.3	34.5	na	252.6	na	2747	2302	7.3	1.49	1.54
	0.9-1.2	140.6	2.2	32.1	248	131.0	165.1	26.7	na	278.4	na	na	na	7.4	1.56	1.54
	1.2-1.5	91.5	3.1	21.5	117	103.2	129.8	23.2	na	187.7	na	na	na	7.5	1.24	1.57
120 M[w]	0-0.15	68.4	7.5	1104.0	84	42.4	77.3	353.8	na	43.0	na	7812	3018	7.0	1.35	1.49
	0.15-0.3	21.2	0.9	425.9	49	17.0	69.7	188.3	na	28.4	na	3252	1728	7.3	1.05	2.19
	0.3-0.6	61.5	2.4	326.1	136	33.2	134.2	336.1	na	104.2	na	4916	2774	7.5	1.23	1.98
	0.6-0.9	92.1	2.6	81.7	199	33.5	127.3	172.6	na	123.0	na	2842	2321	7.4	1.36	1.69
	0.9-1.2	108.2	3.4	49.0	293	68.5	128.4	25.0	na	225.0	na	na	na	7.3	1.69	1.41
	1.2-1.5	160.0	4.0	38.9	266	138.0	147.3	47.7	na	353.7	na	na	na	7.3	1.97	1.44

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] na = not analysed.

Table 11.9. Soil chemistry mean values (n=5) for the coarse-textured site, fall 2001 (3 of 3 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 MR[w]	0-0.15	6.5	3.3	208.6	65	18.0	10.9	39.2	na[v]	6.3	na	na	na	7.0	0.56	0.31
	0.15-0.3	2.2	0.6	109.8	46	9.5	10.8	25.7	na	3.9	na	na	na	7.2	0.39	0.38
	0.3-0.6	4.7	1.4	42.5	100	17.8	39.5	13.7	na	10.6	na	na	na	7.5	0.41	0.71
	0.6-0.9	4.3	1.4	26.5	89	23.9	62.5	6.0	na	16.6	na	na	na	7.5	0.51	1.15
	0.9-1.2	3.7	1.7	14.1	61	28.2	68.9	6.4	na	11.2	na	na	na	7.7	0.49	1.34
	1.2-1.5	5.7	1.3	5.9	46	31.9	65.8	7.9	na	15.3	na	na	na	7.7	0.51	1.42
40 MR[w]	0-0.15	12.1	3.7	305.6	68	19.4	12.2	51.5	na	8.2	na	na	na	6.9	0.57	0.32
	0.15-0.3	4.7	1.1	158.9	50	10.6	12.8	41.5	na	4.5	na	na	na	7.1	0.44	0.42
	0.3-0.6	11.2	2.1	74.2	110	17.2	35.8	39.0	na	8.7	na	na	na	7.4	0.45	0.60
	0.6-0.9	16.4	2.8	42.9	102	21.5	58.9	8.2	na	18.3	na	na	na	7.4	0.49	1.01
	0.9-1.2	27.2	2.7	27.7	109	36.5	78.1	9.2	na	46.0	na	na	na	7.5	0.65	1.28
	1.2-1.5	29.2	1.9	16.3	71	53.4	61.7	8.5	na	23.2	na	na	na	7.6	0.63	1.06
60 MR[w]	0-0.15	8.8	3.2	336.6	65	20.5	10.9	57.0	na	8.5	na	na	na	7.0	0.58	0.30
	0.15-0.3	4.0	1.2	197.0	51	12.4	11.0	58.2	na	6.2	na	na	na	7.3	0.49	0.36
	0.3-0.6	12.3	2.0	85.6	112	21.0	34.2	80.5	na	9.4	na	na	na	7.4	0.53	0.53
	0.6-0.9	22.9	3.1	32.1	103	31.9	66.1	14.0	na	27.7	na	na	na	7.5	0.61	1.05
	0.9-1.2	17.2	2.4	21.4	78	48.5	83.1	9.0	na	28.8	na	na	na	7.6	0.65	1.39
	1.2-1.5	35.2	1.9	8.7	65	56.0	79.3	11.2	na	28.5	na	na	na	7.7	0.71	1.35
120 MR[w]	0-0.15	21.9	4.1	660.6	75	30.3	14.4	115.1	na	13.7	na	na	na	6.8	0.73	0.34
	0.15-0.3	7.2	1.1	345.8	45	15.3	16.2	136.1	na	8.4	na	na	na	7.2	0.67	0.54
	0.3-0.6	56.3	2.9	132.4	120	24.7	59.1	288.9	na	23.1	na	na	na	7.5	0.95	0.91
	0.6-0.9	152.3	2.2	54.3	266	45.5	133.8	49.4	na	38.9	na	na	na	7.3	1.33	1.48
	0.9-1.2	110.2	2.5	40.6	186	52.5	123.6	13.8	na	19.8	na	na	na	7.4	1.14	1.57
	1.2-1.5	163.5	2.8	15.0	354	216.7	159.4	20.0	na	22.3	na	na	na	7.5	1.60	1.51

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure. Residual manure treatment. Annual manure application was discontinued after 1998.
[v] na = not analysed.

Table 11.10. Soil chemistry mean values (n=5) for the medium-textured site, fall 1993 (1 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
Control	0-0.15	9.3	md[w]	64.7	109	20.6	23.3	14.2	30.9	23.1	384	4354	1469	7.6	0.64	0.50
	0.15-0.3	7.6	md	13.5	70	13.5	36.7	3.0	36.4	21.4	222	2871	1133	7.8	0.60	1.07
	0.3-0.6	7.9	md	11.9	131	44.5	79.0	5.2	125.2	28.0	350	3734	2515	7.9	0.68	1.10
	0.6-0.9	2.6	md	na[w]	154	112.8	71.7	8.5	261.8	7.8	305	1022	2222	8.0	0.95	0.82
	0.9-1.2	1.6	md	na	389	309.1	97.9	18.3	744.3	7.5	295	na	na	8.0	1.72	0.81
	1.2-1.5	4.1	md	na	555	512.5	140.2	33.1	1186.0	11.1	359	na	na	8.0	2.20	0.72
60 F[v]	0-0.15	7.4	md	na	117	21.9	28.0	15.6	54.7	17.3	359	na	na	7.7	0.72	0.59
	0.15-0.3	5.2	md	na	87	19.0	45.1	3.5	66.3	19.2	238	na	na	7.9	0.69	1.12
	0.3-0.6	5.3	md	na	372	158.1	98.3	7.2	520.0	23.9	329	na	na	7.8	1.42	0.94
	0.6-0.9	3.1	md	na	552	445.0	174.9	16.0	1155.3	11.8	308	na	na	7.8	2.41	0.96
	0.9-1.2	1.2	md	na	657	697.2	278.8	29.9	1688.2	10.9	329	na	na	7.9	3.13	1.24
	1.2-1.5	2.0	md	na	940	960.9	400.7	45.6	2383.9	9.6	315	na	na	7.8	4.15	1.52
120 F[v]	0-0.15	7.3	md	na	114	23.5	32.5	13.8	44.4	24.9	384	na	na	7.7	0.71	0.68
	0.15-0.3	5.7	md	na	124	26.0	40.4	3.8	105.0	21.3	222	na	na	7.8	0.87	0.93
	0.3-0.6	6.0	md	na	246	170.5	93.5	10.3	418.1	21.7	375	na	na	7.9	1.14	1.00
	0.6-0.9	9.2	md	na	367	334.2	116.9	15.4	791.0	9.4	319	na	na	7.9	1.77	0.73
	0.9-1.2	1.1	md	na	594	489.9	151.5	26.2	1220.0	5.9	332	na	na	8.0	2.36	0.82
	1.2-1.5	0.0	md	na	592	452.4	150.3	30.8	1184.0	6.6	341	na	na	7.9	2.49	0.81
180 F[v]	0-0.15	10.7	md	na	125	22.7	29.2	16.3	55.5	23.9	395	na	na	7.7	0.76	0.58
	0.15-0.3	10.0	md	na	95	17.4	44.4	4.1	57.8	23.8	243	na	na	7.8	0.71	1.10
	0.3-0.6	20.8	md	na	270	110.7	102.2	5.4	354.5	27.0	309	na	na	7.7	1.20	1.09
	0.6-0.9	16.7	md	na	309	349.7	156.5	12.5	746.9	16.5	358	na	na	7.9	1.73	0.99
	0.9-1.2	7.6	md	na	347	511.3	195.3	21.7	1043.7	13.6	408	na	na	8.0	2.32	1.04
	1.2-1.5	2.8	md	na	730	856.7	219.8	40.4	1890.2	9.7	351	na	na	7.9	3.31	0.88

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] md = missing data; na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.10. Soil chemistry mean values (n=5) for the medium-textured site, fall 1993 (2 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 M[w]	0-0.15	8.4	md[v]	58.4	113	21.5	29.4	16.3	44.7	20.5	379	4281	1565	7.7	0.68	0.61
	0.15-0.3	8.1	md	10.6	92	18.5	45.9	4.6	65.8	20.3	234	2948	1110	7.8	0.71	1.13
	0.3-0.6	16.5	md	10.0	215	86.8	94.9	6.9	260.2	23.0	336	3429	2560	7.8	0.90	1.06
	0.6-0.9	7.2	md	na[v]	285	267.2	139.0	17.3	614.7	8.3	337	1362	2622	7.8	1.53	0.97
	0.9-1.2	1.5	md	na	418	480.6	154.3	25.5	1050.4	6.1	290	na	na	7.9	2.40	0.90
	1.2-1.5	1.5	md	na	904	827.8	182.7	41.1	1984.3	6.7	283	na	na	7.8	3.51	0.75
40 M[w]	0-0.15	7.9	md	55.9	137	25.8	27.8	20.1	63.6	23.1	388	4617	1343	7.7	0.79	0.54
	0.15-0.3	6.7	md	10.7	123	31.9	42.6	4.3	108.8	25.7	237	2833	1187	7.8	0.84	0.97
	0.3-0.6	12.5	md	11.5	227	131.6	101.6	6.7	339.7	29.4	355	3124	2446	7.9	1.04	1.09
	0.6-0.9	3.6	md	na	234	244.4	129.7	12.3	552.4	12.2	351	1703	2265	8.0	1.38	1.01
	0.9-1.2	0.9	md	na	345	426.0	182.4	23.9	945.4	10.1	370	na	na	8.0	1.92	1.07
	1.2-1.5	0.0	md	na	631	689.1	217.3	36.3	1586.5	8.3	331	na	na	8.0	2.93	1.02
60 M[w]	0-0.15	9.3	md	66.2	177	32.5	30.5	23.9	107.3	25.5	417	4701	1381	7.7	0.93	0.58
	0.15-0.3	6.5	md	13.5	93	18.7	43.7	4.8	65.2	23.0	232	2833	1225	7.7	0.73	1.10
	0.3-0.6	9.7	md	8.7	191	94.9	105.4	8.0	261.9	33.3	339	2896	2476	7.8	0.98	1.12
	0.6-0.9	5.1	md	na	372	364.3	179.1	19.6	880.4	11.2	353	1192	2333	7.9	1.85	1.11
	0.9-1.2	0.9	md	na	785	761.9	261.6	37.6	1858.7	8.2	305	na	na	7.9	3.26	1.07
	1.2-1.5	0.7	md	na	932	914.1	275.3	50.6	2254.9	8.9	311	na	na	7.9	3.57	0.98
120 M[w]	0-0.15	8.7	md	52.4	133	25.2	30.2	16.2	59.4	21.1	415	4365	1288	7.7	0.79	0.59
	0.15-0.3	6.0	md	14.3	93	18.0	40.5	5.0	56.1	21.2	263	3139	1286	7.8	0.70	1.00
	0.3-0.6	7.7	md	11.0	326	169.7	104.5	7.4	497.9	24.0	342	3124	2370	7.8	1.30	1.03
	0.6-0.9	2.9	md	na	301	298.0	155.9	14.8	690.2	10.7	364	1958	2307	7.9	1.66	1.02
	0.9-1.2	1.1	md	na	600	702.9	216.8	32.9	1588.7	7.6	342	na	na	7.9	2.87	1.02
	1.2-1.5	0.0	md	na	879	934.5	258.3	45.5	2161.9	7.6	338	na	na	7.9	3.56	0.93

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] md = missing data; na = not analysed.

Table 11.11. Soil chemistry mean values (n=5) for the medium-textured site, fall 1994 (1 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		---------- kg ha^{-1} ----------														
Control	0-0.15	6.7	2.0	49.8	117	20.6	33.8	13.5	55.1	30.4	137	5613	1390	7.4	0.78	0.73
	0.15-0.3	2.4	2.0	5.4	77	17.2	39.7	2.7	60.3	7.2	81	2201	1201	7.6	0.61	1.07
	0.3-0.6	1.3	2.7	8.0	122	68.1	70.7	5.0	155.3	2.2	123	2972	2286	7.7	0.73	0.97
	0.6-0.9	1.0	3.4	na[w]	143	136.5	79.6	11.0	246.1	4.2	128	1533	2205	7.8	0.94	0.87
	0.9-1.2	1.5	3.1	na	340	296.4	87.6	19.8	628.1	8.0	117	na	na	7.8	1.58	0.71
	1.2-1.5	2.1	4.4	na	711	551.6	137.9	33.9	1336.9	8.6	126	na	na	7.7	2.40	0.73
60 F[v]	0-0.15	9.2	2.8	na	180	33.8	43.6	18.3	105.5	22.0	149	na	na	7.4	1.04	0.74
	0.15-0.3	2.3	2.0	na	203	47.8	64.8	3.6	192.0	9.3	75	na	na	7.5	1.32	1.13
	0.3-0.6	2.2	4.5	na	551	302.7	152.2	11.6	810.1	3.9	101	na	na	7.6	2.20	1.02
	0.6-0.9	2.4	4.3	na	494	533.8	221.3	19.1	1224.6	3.2	114	na	na	7.7	2.66	1.12
	0.9-1.2	0.3	4.2	na	570	667.9	261.2	30.9	1451.2	5.6	111	na	na	7.8	3.20	1.32
	1.2-1.5	2.0	5.6	na	961	958.9	399.4	46.3	2279.7	4.8	115	na	na	7.7	4.04	1.48
120 F[v]	0-0.15	6.8	2.0	na	197	35.9	45.4	15.0	136.0	30.3	136	na	na	7.4	1.09	0.78
	0.15-0.3	2.0	1.7	na	102	34.4	50.8	2.6	103.8	2.7	73	na	na	7.6	0.89	1.17
	0.3-0.6	1.3	2.6	na	305	228.1	106.1	9.2	501.4	3.9	112	na	na	7.7	1.53	0.93
	0.6-0.9	1.3	3.5	na	341	353.9	136.3	17.0	742.9	1.8	124	na	na	7.8	1.86	0.91
	0.9-1.2	0.6	3.7	na	549	429.6	135.6	24.7	1053.8	3.1	114	na	na	7.7	2.27	0.84
	1.2-1.5	1.6	3.7	na	836	627.1	165.0	38.3	1562.7	8.3	113	na	na	7.6	3.03	0.75
180 F[v]	0-0.15	15.5	2.8	na	180	31.2	40.5	12.1	105.9	28.0	137	na	na	7.4	0.98	0.76
	0.15-0.3	4.6	2.9	na	101	23.6	53.1	2.4	93.9	6.5	78	na	na	7.6	0.81	1.27
	0.3-0.6	4.8	5.4	na	362	211.0	182.6	9.2	577.8	2.7	116	na	na	7.6	1.60	1.83
	0.6-0.9	1.5	4.7	na	270	377.9	176.0	15.0	715.6	4.2	126	na	na	7.8	1.87	1.09
	0.9-1.2	2.1	4.2	na	346	528.8	195.7	25.1	994.2	6.6	129	na	na	7.9	2.32	1.00
	1.2-1.5	2.3	5.2	na	876	804.5	196.6	40.2	1899.4	5.5	111	na	na	7.7	3.48	0.86

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.11. Soil chemistry mean values (n=5) for the medium-textured site, fall 1994 (2 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 M[w]	0-0.15	9.3	3.2	55.5	147	26.9	45.7	18.0	76.3	47.5	151	6505	1419	7.4	0.89	0.83
	0.15-0.3	2.6	2.6	6.4	135	34.8	56.4	3.2	133.4	11.8	79	2182	1179	7.6	0.95	1.16
	0.3-0.6	1.8	4.3	7.3	319	205.4	115.0	8.6	493.8	8.0	111	3277	2294	7.6	1.42	0.98
	0.6-0.9	0.6	3.9	na[v]	281	332.3	142.1	16.3	659.7	3.4	117	2384	2409	7.8	1.80	0.93
	0.9-1.2	0.5	4.5	na	481	511.0	154.1	26.5	1092.2	5.3	113	na	na	7.7	2.48	0.87
	1.2-1.5	0.8	5.2	na	741	662.6	181.1	38.1	1534.3	10.6	103	na	na	7.6	2.98	0.83
40 M[w]	0-0.15	9.5	3.1	65.5	131	25.2	46.4	22.2	70.0	59.7	149	5246	1393	7.4	0.85	0.90
	0.15-0.3	3.5	2.7	8.0	122	32.1	53.1	3.9	112.7	35.9	80	2249	1225	7.5	0.90	1.23
	0.3-0.6	1.6	5.0	8.8	231	145.8	109.1	6.6	367.5	21.1	116	3048	2256	7.7	1.16	1.13
	0.6-0.9	1.6	5.0	na	230	285.9	143.4	15.8	552.9	7.1	127	1958	2154	7.8	1.50	1.00
	0.9-1.2	1.3	4.6	na	260	405.3	167.3	25.9	759.7	12.5	131	na	na	7.8	1.90	1.03
	1.2-1.5	1.4	5.1	na	675	678.6	217.0	37.0	1562.2	10.2	118	na	na	7.7	2.89	0.98
60 M[w]	0-0.15	11.0	2.4	101.7	176	30.6	69.5	27.9	99.7	110.4	161	8268	1553	7.4	1.13	1.15
	0.15-0.3	2.6	1.9	8.4	149	35.6	73.8	4.0	123.1	83.9	76	3445	1202	7.5	1.09	1.34
	0.3-0.6	1.8	3.3	7.3	347	239.0	162.1	10.4	563.8	32.0	117	2438	2210	7.7	1.64	1.15
	0.6-0.9	1.7	3.6	na	560	523.8	206.4	25.1	1189.5	9.4	125	2214	2231	7.7	2.50	1.01
	0.9-1.2	1.8	4.4	na	732	736.4	260.7	36.3	1683.0	10.0	115	na	na	7.7	3.16	1.05
	1.2-1.5	6.0	5.1	na	865	840.6	294.1	45.5	1949.3	13.0	114	na	na	7.7	3.41	1.06
120 M[w]	0-0.15	14.6	2.6	134.6	176	39.8	79.8	35.7	94.8	137.0	191	6547	1553	7.3	1.28	1.34
	0.15-0.3	4.6	2.6	6.1	184	43.3	75.4	3.8	137.7	140.5	78	2526	1217	7.4	1.34	1.31
	0.3-0.6	2.4	4.2	9.9	386	212.9	136.1	7.9	536.7	94.9	112	2667	2248	7.6	1.66	1.04
	0.6-0.9	1.8	4.9	na	286	380.6	166.8	16.6	713.2	9.2	126	2214	2461	7.8	1.94	1.02
	0.9-1.2	1.7	5.1	na	501	630.9	187.8	30.6	1305.4	14.6	126	na	na	7.8	2.64	0.94
	1.2-1.5	3.0	6.2	na	806	846.7	225.0	42.9	1864.0	11.8	120	na	na	7.7	3.39	0.89

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] na = not analysed.

Table 11.12. Soil chemistry mean values (n=5) for the medium-textured site, fall 1995 (1 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
Control	0-0.15	8.7	0.0	52.9	118	19.5	27.5	11.9	47.3	36.4	283	6841	1410	7.7	0.71	0.58
	0.15-0.3	1.7	0.4	6.6	71	14.7	35.9	1.4	42.2	5.8	175	4632	1248	7.9	0.56	1.01
	0.3-0.6	1.1	0.5	6.2	185	94.3	98.8	5.7	253.2	4.5	263	3277	2164	8.0	0.92	1.12
	0.6-0.9	0.9	0.0	na[w]	284	288.2	119.2	12.4	630.2	2.9	229	1618	2052	8.0	1.67	0.90
	0.9-1.2	0.4	0.0	na	491	490.6	135.2	22.0	1121.3	3.0	225	na	na	8.0	2.34	0.80
	1.2-1.5	1.2	0.0	na	650	601.8	173.2	31.0	1382.7	2.2	224	na	na	7.9	2.64	0.78
60 F[v]	0-0.15	13.5	0.0	na	157	25.1	42.9	12.5	85.9	48.6	274	na	na	7.7	0.93	0.78
	0.15-0.3	2.7	0.0	na	256	69.5	85.4	2.4	300.8	4.1	148	na	na	7.8	1.65	1.19
	0.3-0.6	1.4	0.0	na	509	336.9	241.0	7.6	957.3	1.6	221	na	na	7.9	2.38	1.40
	0.6-0.9	0.9	0.0	na	410	440.6	277.5	14.2	1081.5	0.0	231	na	na	8.0	2.51	1.52
	0.9-1.2	0.8	0.0	na	525	653.2	307.6	26.2	1493.5	1.8	238	na	na	8.0	3.08	1.56
	1.2-1.5	1.8	0.0	na	804	750.8	295.4	35.7	1887.2	0.0	215	na	na	7.9	3.54	1.40
120 F[v]	0-0.15	46.8	0.4	na	161	24.7	32.6	13.8	50.6	41.9	332	na	na	7.6	0.92	0.58
	0.15-0.3	17.1	0.3	na	140	35.3	54.3	2.3	124.9	2.2	163	na	na	7.7	1.00	1.02
	0.3-0.6	13.9	0.0	na	349	244.1	125.2	8.0	567.0	0.0	243	na	na	7.8	1.63	0.92
	0.6-0.9	3.0	0.0	na	282	364.1	135.2	15.1	713.5	1.6	258	na	na	8.0	1.72	0.80
	0.9-1.2	3.1	0.0	na	577	507.0	137.1	24.5	1210.6	2.8	231	na	na	7.9	2.51	0.72
	1.2-1.5	2.5	0.0	na	776	564.0	139.9	31.0	1464.2	1.4	204	na	na	7.9	2.85	0.71
180 F[v]	0-0.15	58.5	0.4	na	172	25.8	33.7	16.0	58.5	49.7	311	na	na	7.6	1.00	0.58
	0.15-0.3	57.3	0.4	na	180	36.4	49.8	2.7	117.0	6.1	147	na	na	7.7	1.24	0.89
	0.3-0.6	63.9	0.5	na	440	250.0	154.0	6.3	678.2	9.0	205	na	na	7.8	1.96	1.10
	0.6-0.9	15.0	0.0	na	398	429.9	177.7	13.7	961.2	0.0	237	na	na	8.0	2.26	1.05
	0.9-1.2	4.6	0.0	na	287	475.1	167.1	20.2	919.6	0.0	251	na	na	8.1	2.15	0.98
	1.2-1.5	5.1	0.0	na	654	668.0	184.6	33.1	1554.0	4.8	232	na	na	7.9	2.92	0.92

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.12. Soil chemistry mean values (n=5) for the medium-textured site, fall 1995 (2 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 M[w]	0-0.15	9.6	0.7	69.0	135	23.2	50.5	21.7	43.9	95.8	323	8688	1461	7.6	0.87	0.95
	0.15-0.3	2.2	0.2	5.7	140	36.3	61.1	2.2	125.3	45.6	170	4364	1233	7.8	0.99	1.24
	0.3-0.6	1.3	0.5	6.5	385	234.5	138.8	7.1	642.9	29.2	238	3505	2355	7.9	1.66	1.04
	0.6-0.9	0.4	1.0	na[v]	459	417.6	161.7	16.4	999.8	4.7	253	2384	2409	7.9	2.12	0.92
	0.9-1.2	3.1	0.4	na	547	481.3	147.0	22.7	1132.4	5.2	225	na	na	7.9	2.39	0.82
	1.2-1.5	1.4	0.5	na	785	628.8	183.5	34.1	1600.6	33.4	210	na	na	7.8	2.98	0.81
40 M[w]	0-0.15	14.0	0.3	81.7	129	23.7	62.2	39.7	31.5	124.7	373	7555	1385	7.6	0.98	1.22
	0.15-0.3	2.5	0.1	6.5	130	26.4	62.0	3.2	75.3	135.9	160	3751	957	7.7	1.04	1.30
	0.3-0.6	1.1	2.2	7.1	346	182.3	149.9	6.5	520.9	141.6	230	3277	2217	7.9	1.64	1.17
	0.6-0.9	0.7	0.0	na	448	412.2	173.9	15.6	993.1	30.7	245	1958	2265	8.0	2.16	1.02
	0.9-1.2	1.1	0.4	na	357	446.8	162.3	23.7	964.0	6.1	255	na	na	8.0	2.12	0.96
	1.2-1.5	1.9	0.0	na	531	575.8	192.1	28.9	1304.2	6.9	223	na	na	7.9	2.72	0.97
60 M[w]	0-0.15	24.5	0.5	153.6	151	29.7	78.6	52.0	58.0	139.5	401	5960	1234	7.5	1.13	1.39
	0.15-0.3	3.0	0.7	8.2	159	44.0	75.4	6.8	125.3	147.3	176	4173	1198	7.7	1.28	1.32
	0.3-0.6	1.5	0.2	6.9	429	267.6	194.8	10.5	709.0	183.4	246	3505	2134	7.7	2.09	1.26
	0.6-0.9	0.9	0.7	na	404	466.6	213.2	19.3	1036.7	15.9	248	1958	2171	7.9	2.33	1.11
	0.9-1.2	1.0	0.4	na	743	762.1	252.1	36.3	1752.6	8.2	229	na	na	7.8	3.27	1.04
	1.2-1.5	2.6	0.6	na	866	881.5	291.4	46.7	2077.7	33.1	231	na	na	7.8	3.55	1.05
120 M[w]	0-0.15	51.8	0.5	185.0	163	32.7	116.5	73.7	58.2	181.0	484	9066	1620	7.6	1.35	1.98
	0.15-0.3	9.8	0.1	10.8	180	35.5	98.3	3.5	96.7	261.4	162	3751	1244	7.6	1.50	1.72
	0.3-0.6	5.6	0.0	9.4	480	247.7	182.0	7.7	618.2	409.5	207	3429	2240	7.7	2.23	1.22
	0.6-0.9	1.6	0.3	na	400	459.6	199.6	16.1	990.7	43.9	247	2128	2350	7.9	2.38	1.04
	0.9-1.2	1.5	0.5	na	579	665.5	181.9	26.3	1513.7	6.8	226	na	na	7.9	3.05	0.91
	1.2-1.5	2.8	0.7	na	807	792.5	223.4	39.1	1888.0	4.6	228	na	na	7.9	3.40	0.88

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] na = not analysed.

Table 11.13. Soil chemistry mean values (n=5) for the medium-textured site, fall 1996 (1 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
Control	0-0.15	1.2	0.8	58.3	117	21.1	30.1	12.4	36.2	15.8	385	6295	1503	7.3	0.65	0.61
	0.15-0.3	0.4	0.4	5.9	71	16.3	37.7	1.5	39.5	21.2	206	3024	1187	7.5	0.58	1.01
	0.3-0.6	0.4	0.9	6.9	159	87.8	102.8	3.7	212.4	15.5	308	2972	2278	7.6	0.86	1.28
	0.6-0.9	0.2	0.9	na[w]	200	165.8	96.1	8.6	360.2	5.0	283	1447	2146	7.7	1.20	0.92
	0.9-1.2	0.2	1.0	na	187	235.7	98.1	14.1	457.8	5.8	267	na	na	7.8	1.29	0.82
	1.2-1.5	0.9	8.9	na	510	419.6	140.1	24.2	1010.1	5.5	256	na	na	7.7	1.98	0.80
60 F[v]	0-0.15	3.6	0.6	na	148	25.8	36.6	15.8	68.2	13.4	388	na	na	7.2	0.80	0.68
	0.15-0.3	6.2	0.5	na	167	42.4	57.0	2.4	158.9	21.4	178	na	na	7.3	1.10	1.04
	0.3-0.6	3.3	0.7	na	621	399.7	261.3	8.5	1152.5	11.8	250	na	na	7.5	2.60	1.38
	0.6-0.9	5.1	0.6	na	631	643.8	351.4	17.8	1571.1	0.0	240	na	na	7.6	3.25	1.47
	0.9-1.2	0.2	0.7	na	658	752.1	307.7	29.1	1754.6	1.2	222	na	na	7.6	3.43	1.41
	1.2-1.5	1.2	0.9	na	1167	1057.7	412.5	42.0	2702.2	0.0	230	na	na	7.6	4.26	1.44
120 F[v]	0-0.15	5.6	0.7	na	106	18.5	31.5	12.4	33.9	8.7	358	na	na	7.4	0.59	0.67
	0.15-0.3	13.0	0.4	na	76	20.8	37.0	1.5	37.5	19.1	188	na	na	7.5	0.63	0.93
	0.3-0.6	23.9	0.6	na	297	218.9	137.1	6.3	514.6	11.8	276	na	na	7.6	1.46	1.10
	0.6-0.9	1.3	0.7	na	316	352.6	140.5	12.4	743.0	0.0	264	na	na	7.7	1.86	0.88
	0.9-1.2	0.7	0.7	na	407	457.1	142.8	19.6	951.6	0.0	251	na	na	7.8	2.25	0.84
	1.2-1.5	3.1	1.3	na	767	651.2	189.5	29.7	1596.4	5.7	249	na	na	7.7	2.77	0.77
180 F[v]	0-0.15	9.3	0.4	na	108	17.8	34.2	10.5	34.2	11.2	370	na	na	7.3	0.61	0.73
	0.15-0.3	25.6	0.3	na	151	36.4	51.9	2.0	113.6	23.8	173	na	na	7.3	1.06	0.97
	0.3-0.6	48.5	0.7	na	530	384.5	232.9	6.2	964.8	11.1	247	na	na	7.5	2.52	1.34
	0.6-0.9	32.7	0.5	na	440	545.1	249.9	13.0	1152.7	0.0	260	na	na	7.7	2.61	1.24
	0.9-1.2	2.8	0.6	na	471	652.8	221.5	23.2	1337.2	0.0	284	na	na	7.7	2.72	1.02
	1.2-1.5	3.0	1.0	na	753	698.9	208.8	30.1	1625.3	0.0	236	na	na	7.6	3.11	0.96

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.13. Soil chemistry mean values (n=5) for the medium-textured site, fall 1996 (2 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 M[w]	0-0.15	4.8	1.5	111.1	134	25.7	51.5	30.4	57.5	30.0	460	6379	1498	7.4	0.85	0.97
	0.15-0.3	3.9	0.7	8.2	100	25.4	61.8	2.5	74.6	63.2	206	3397	1268	7.6	0.83	1.37
	0.3-0.6	1.4	1.0	7.5	354	257.3	168.2	7.2	627.5	159.5	266	2972	2256	7.7	1.72	1.26
	0.6-0.9	0.4	1.0	na[v]	440	510.8	179.7	16.9	1099.4	67.3	258	1958	2409	7.7	2.48	0.93
	0.9-1.2	0.6	0.8	na	419	496.5	162.4	21.9	1058.3	16.8	243	na	na	7.8	2.42	0.91
	1.2-1.5	0.9	0.9	na	843	653.1	182.5	31.0	1655.6	16.9	202	na	na	7.7	3.01	0.82
40 M[w]	0-0.15	5.5	0.8	127.7	144	29.2	59.3	44.7	63.8	47.0	475	6841	1561	7.3	0.91	1.08
	0.15-0.3	4.1	0.5	7.9	137	34.0	73.6	3.0	115.8	73.9	210	3024	1171	7.5	1.04	1.51
	0.3-0.6	2.0	0.6	10.4	419	248.9	209.3	6.4	642.6	238.0	285	2743	2271	7.6	1.94	1.52
	0.6-0.9	0.6	0.7	na	354	423.2	192.2	13.5	896.6	102.0	267	1958	1950	7.8	2.18	1.14
	0.9-1.2	0.5	0.7	na	345	466.8	172.6	21.9	973.0	16.1	276	na	na	7.9	2.12	1.03
	1.2-1.5	3.3	0.6	na	697	677.0	213.1	30.8	1601.5	15.8	255	na	na	7.8	2.97	1.00
60 M[w]	0-0.15	14.2	1.0	196.7	136	32.0	77.0	77.4	72.1	40.6	559	6631	1628	7.2	1.01	1.40
	0.15-0.3	9.7	0.6	8.0	112	32.0	96.3	3.5	83.8	118.2	216	2909	1183	7.4	1.07	1.92
	0.3-0.6	8.4	0.8	9.2	468	304.4	241.6	9.1	696.3	410.1	248	2667	2118	7.4	2.41	1.48
	0.6-0.9	1.1	0.9	na	506	581.7	245.0	20.0	1243.7	152.1	262	1873	2120	7.6	2.87	1.17
	0.9-1.2	0.8	1.0	na	856	774.5	257.5	32.5	1917.7	19.7	240	na	na	7.6	3.38	1.04
	1.2-1.5	2.5	1.1	na	877	788.7	283.5	38.3	1979.3	25.6	234	na	na	7.6	3.34	1.04
120 M[w]	0-0.15	40.0	1.1	394.6	150	36.6	119.2	156.6	94.8	89.5	692	7345	1847	7.2	1.31	1.98
	0.15-0.3	27.1	0.7	15.3	136	29.1	120.6	5.7	79.4	149.6	220	3369	1194	7.3	1.31	2.38
	0.3-0.6	38.7	0.8	12.6	681	352.4	293.7	9.7	785.6	838.2	234	3277	2256	7.3	2.93	1.67
	0.6-0.9	8.1	1.0	na	554	620.7	238.8	19.8	1172.0	573.5	244	2214	2426	7.6	3.07	1.11
	0.9-1.2	3.1	0.8	na	610	697.5	220.2	28.1	1541.8	37.5	257	na	na	7.7	3.08	1.00
	1.2-1.5	3.2	0.8	na	960	738.2	274.9	35.7	1988.7	9.4	225	na	na	7.6	3.63	1.06

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] na = not analysed.

Table 11.14. Soil chemistry mean values (n=5) for the medium-textured site, fall 1997 (1 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
Control	0-0.15	0.8	0.6	60.2	159	28.3	31.5	20.4	48.9	58.2	464	6547	1410	7.4	0.90	0.55
	0.15-0.3	0.1	0.5	9.8	75	15.9	34.0	2.6	33.5	6.3	282	3254	1206	7.7	0.55	0.89
	0.3-0.6	0.2	0.8	7.5	139	59.9	93.9	5.8	158.0	4.9	426	2972	2240	7.8	0.73	1.22
	0.6-0.9	0.0	0.8	na[w]	367	293.3	145.0	16.8	731.2	8.7	337	1533	2137	7.9	1.79	1.07
	0.9-1.2	0.0	0.4	na	571	500.7	161.7	27.7	1204.0	9.5	302	na	na	7.9	2.40	0.90
	1.2-1.5	0.2	0.5	na	731	663.2	208.6	40.7	1652.4	10.4	315	na	na	7.9	2.69	0.84
60 F[v]	0-0.15	4.1	0.8	na	193	33.4	38.8	20.4	79.5	27.2	546	na	na	7.4	1.01	0.61
	0.15-0.3	0.4	0.7	na	121	28.4	45.0	2.7	92.8	2.5	276	na	na	7.6	0.79	0.88
	0.3-0.6	0.7	1.1	na	375	205.9	203.2	6.6	610.0	2.5	377	na	na	7.8	1.56	1.42
	0.6-0.9	0.5	0.9	na	375	386.9	321.6	16.9	936.8	2.8	337	na	na	7.9	2.17	1.70
	0.9-1.2	0.2	1.4	na	538	609.4	305.1	33.7	1424.2	0.0	323	na	na	7.9	2.78	1.56
	1.2-1.5	1.0	0.9	na	1082	939.8	358.0	52.4	2477.0	4.8	308	na	na	7.8	3.96	1.39
120 F[v]	0-0.15	17.9	0.6	na	199	35.6	44.1	18.8	94.4	46.7	514	na	na	7.4	1.09	0.67
	0.15-0.3	9.0	0.5	na	188	84.1	60.9	14.1	241.2	2.8	245	na	na	7.6	1.32	0.88
	0.3-0.6	12.9	0.8	na	341	291.3	153.1	10.3	674.4	1.9	365	na	na	7.8	1.78	1.09
	0.6-0.9	3.3	0.9	na	238	349.4	150.4	18.9	705.0	1.8	357	na	na	7.9	1.75	1.01
	0.9-1.2	2.2	0.7	na	470	492.4	156.3	30.8	1086.3	5.0	322	na	na	7.9	2.24	0.86
	1.2-1.5	2.6	0.9	na	903	765.4	184.3	46.2	1884.9	6.3	275	na	na	7.8	3.11	0.71
180 F[v]	0-0.15	26.9	0.9	na	166	26.1	36.6	19.2	46.4	26.2	546	na	na	7.5	0.90	0.62
	0.15-0.3	20.6	0.5	na	166	34.3	41.3	3.1	110.5	2.5	260	na	na	7.6	0.98	0.73
	0.3-0.6	74.0	0.9	na	515	349.8	163.8	11.6	828.0	2.4	298	na	na	7.7	2.30	1.04
	0.6-0.9	62.8	1.2	na	447	516.7	241.7	18.6	1114.2	0.0	315	na	na	7.9	2.52	1.28
	0.9-1.2	17.4	1.0	na	360	528.7	217.7	30.1	1095.2	2.4	344	na	na	8.0	2.28	1.12
	1.2-1.5	8.3	1.2	na	668	645.8	208.9	39.4	1538.5	8.2	308	na	na	7.9	2.81	0.92

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.14. Soil chemistry mean values (n=5) for the medium-textured site, fall 1997 (2 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 M[w]	0-0.15	2.9	0.8	173.6	202	43.9	45.1	52.9	69.0	77.4	561	8436	1712	7.3	1.17	0.67
	0.15-0.3	0.6	0.7	7.9	130	28.4	55.8	3.5	109.3	19.5	296	3637	1221	7.6	0.88	1.22
	0.3-0.6	0.4	1.0	8.5	282	144.3	162.5	7.5	417.4	72.7	401	3124	2332	7.7	1.30	1.44
	0.6-0.9	0.3	1.0	na[v]	367	383.1	195.9	17.7	837.6	105.0	333	1958	2324	7.8	2.04	1.14
	0.9-1.2	0.3	0.8	na	435	467.5	167.0	27.9	1033.5	55.7	293	na	na	7.8	2.34	0.94
	1.2-1.5	0.7	1.0	na	799	678.1	191.8	40.1	1687.8	35.8	254	na	na	7.8	3.15	0.83
40 M[w]	0-0.15	10.0	0.8	249.6	168	37.6	51.7	79.0	58.7	71.9	628	9024	1742	7.4	1.10	0.84
	0.15-0.3	0.8	0.5	9.9	109	25.6	67.2	6.6	87.9	53.4	255	2833	1175	7.7	0.92	1.46
	0.3-0.6	0.8	0.7	10.7	419	243.0	234.4	8.0	693.4	158.3	360	2591	2347	7.8	1.84	1.70
	0.6-0.9	0.8	0.8	na	368	443.3	244.0	17.2	938.2	205.3	310	1447	2239	7.9	2.25	1.30
	0.9-1.2	0.6	0.9	na	465	541.1	203.3	24.6	1138.7	141.6	308	na	na	7.9	2.49	1.10
	1.2-1.5	1.1	0.9	na	732	784.8	212.4	34.3	1814.1	63.8	261	na	na	7.8	3.33	0.90
60 M[w]	0-0.15	29.6	1.4	312.7	194	52.1	67.2	128.2	95.5	94.9	718	7890	1859	7.4	1.39	0.97
	0.15-0.3	6.3	1.0	16.7	110	24.8	83.2	5.5	94.5	57.4	278	3675	1183	7.7	0.96	1.78
	0.3-0.6	3.6	1.1	9.2	415	239.8	261.3	8.8	626.2	312.7	338	2972	2164	7.7	1.96	1.80
	0.6-0.9	1.6	1.2	na	454	540.3	290.5	19.1	1079.7	332.0	313	1703	2137	7.8	2.67	1.40
	0.9-1.2	1.2	2.1	na	614	751.3	274.0	32.4	1661.1	126.3	280	na	na	7.8	3.26	1.14
	1.2-1.5	2.6	1.6	na	901	885.1	300.7	42.5	2142.1	26.3	278	na	na	7.8	3.43	1.04
120 M[w]	0-0.15	90.5	1.2	646.5	187	63.3	115.0	245.2	109.2	113.7	924	10954	2329	7.3	1.71	1.62
	0.15-0.3	24.1	0.7	38.7	124	22.7	122.3	12.3	91.1	88.8	306	3369	1279	7.6	1.18	2.50
	0.3-0.6	37.5	1.0	11.0	558	272.6	340.6	8.8	687.5	669.2	297	2896	2263	7.5	2.68	2.20
	0.6-0.9	18.9	1.1	na	587	649.8	289.2	20.6	1187.4	743.5	284	2299	2375	7.7	3.33	1.29
	0.9-1.2	7.8	1.3	na	648	825.7	250.8	34.4	1691.9	240.4	308	na	na	7.8	3.35	1.07
	1.2-1.5	4.3	0.9	na	853	922.9	253.9	43.9	2105.7	42.9	285	na	na	7.8	3.59	0.91

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] na = not analysed.

Table 11.15. Soil chemistry mean values (n=5) for the medium-textured site, fall 1998 (1 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
Control	0-0.15	12.4	3.4	44.0	150	27.6	25.7	20.0	38.9	28.0	501	4071	1410	7.4	0.81	0.46
	0.15-0.3	0.3	0.9	29.3	77	17.0	37.3	3.2	41.4	1.2	271	2526	1118	7.6	0.57	0.96
	0.3-0.6	1.6	1.5	6.9	147	66.3	101.7	7.8	182.2	3.9	397	2743	2042	7.6	0.81	1.27
	0.6-0.9	1.7	1.8	na[w]	198	196.8	132.2	18.0	439.1	2.4	369	1533	2018	7.8	1.32	1.14
	0.9-1.2	1.3	1.3	na	427	412.9	160.8	32.3	1000.2	5.2	339	na	na	7.9	2.13	0.98
	1.2-1.5	2.3	2.2	na	868	769.9	207.3	50.8	1923.3	14.8	333	na	na	7.7	3.25	0.83
60 F[v]	0-0.15	26.3	1.1	na	152	26.1	31.9	17.3	94.9	12.6	506	na	na	7.4	0.80	0.55
	0.15-0.3	6.4	1.0	na	133	32.2	58.6	3.7	124.0	2.2	255	na	na	7.6	0.92	1.09
	0.3-0.6	6.3	1.4	na	493	264.3	248.1	11.1	879.4	1.6	347	na	na	7.6	2.01	1.59
	0.6-0.9	5.0	1.4	na	508	500.9	364.1	36.2	1319.7	2.0	351	na	na	7.8	2.60	1.67
	0.9-1.2	4.1	0.6	na	526	618.2	302.9	43.0	1457.6	2.9	356	na	na	7.8	2.78	1.55
	1.2-1.5	4.5	1.1	na	1064	938.2	379.6	60.1	2413.6	6.3	298	na	na	7.7	4.02	1.44
120 F[v]	0-0.15	28.6	1.0	na	147	27.2	29.8	13.3	47.1	10.0	448	na	na	7.4	0.81	0.53
	0.15-0.3	15.1	1.0	na	109	31.6	39.2	3.8	81.9	3.6	248	na	na	7.5	0.81	0.80
	0.3-0.6	29.6	1.3	na	298	231.8	137.0	14.4	546.5	2.2	366	na	na	7.6	1.52	1.10
	0.6-0.9	15.0	0.9	na	321	396.3	166.9	26.0	849.8	5.1	381	na	na	7.8	1.91	1.02
	0.9-1.2	12.7	1.7	na	579	538.6	158.7	36.7	1300.0	3.3	325	na	na	7.8	2.47	0.86
	1.2-1.5	12.6	1.6	na	947	760.1	196.2	51.6	2001.5	8.3	319	na	na	7.7	3.20	0.76
180 F[v]	0-0.15	40.4	0.9	na	150	23.8	31.3	12.6	24.5	7.9	449	na	na	7.4	0.83	0.56
	0.15-0.3	37.5	0.9	na	165	42.2	56.2	3.7	137.5	0.0	211	na	na	7.5	1.14	1.03
	0.3-0.6	63.6	2.7	na	362	262.4	185.5	11.0	627.8	0.0	321	na	na	7.7	1.91	1.38
	0.6-0.9	25.9	1.6	na	375	488.1	236.0	24.8	1047.8	0.0	373	na	na	7.8	2.36	1.24
	0.9-1.2	16.0	2.4	na	447	622.1	216.1	38.0	1345.5	0.0	343	na	na	7.8	2.85	1.00
	1.2-1.5	15.4	1.3	na	632	579.1	205.7	45.2	1408.8	4.2	325	na	na	7.8	2.76	0.96

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.15. Soil chemistry mean values (n=5) for the medium-textured site, fall 1998 (2 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 M[w]	0-0.15	8.1	15.4	116.7	160	32.6	47.1	38.6	67.4	31.4	534	4952	1540	7.5	0.93	0.77
	0.15-0.3	1.5	1.8	8.3	152	44.2	73.2	5.5	168.4	31.4	263	2029	1164	7.6	1.08	1.38
	0.3-0.6	1.9	1.5	7.5	327	243.3	197.2	12.6	676.9	67.8	356	2743	2134	7.7	1.67	1.53
	0.6-0.9	2.2	1.5	na[v]	368	417.3	205.8	25.7	968.2	68.5	369	1788	2163	7.8	2.14	1.20
	0.9-1.2	2.7	1.5	na	484	488.3	182.6	35.9	1146.5	59.4	316	na	na	7.8	2.44	1.00
	1.2-1.5	2.9	1.2	na	824	671.4	207.3	48.6	1742.3	42.6	288	na	na	7.8	3.20	0.88
40 M[w]	0-0.15	15.4	1.8	170.8	163	36.4	52.8	63.5	76.2	54.7	558	5330	1540	7.4	1.04	0.85
	0.15-0.3	1.7	1.5	9.8	149	34.7	90.9	6.7	140.0	78.8	266	2144	1125	7.6	1.15	1.71
	0.3-0.6	5.3	1.6	9.3	329	211.0	232.6	11.4	561.6	180.7	360	2972	2172	7.7	1.74	1.86
	0.6-0.9	3.1	2.1	na	337	398.1	233.6	24.5	872.8	172.5	366	2043	2154	7.8	2.06	1.36
	0.9-1.2	3.3	1.8	na	388	476.5	204.6	34.8	1014.7	125.5	348	na	na	7.9	2.25	1.10
	1.2-1.5	5.7	1.9	na	674	681.1	221.7	47.6	1605.2	81.3	299	na	na	7.8	3.04	0.98
60 M[w]	0-0.15	34.7	1.2	296.2	171	45.3	63.7	122.4	66.4	73.0	709	5372	1821	7.4	1.20	0.97
	0.15-0.3	9.6	0.8	17.7	184	43.8	125.8	13.6	167.6	150.6	278	2641	1072	7.5	1.49	2.03
	0.3-0.6	13.1	1.1	9.2	487	292.1	337.0	17.1	810.9	366.5	346	2896	2042	7.6	2.33	2.04
	0.6-0.9	9.4	1.9	na	613	617.5	301.3	35.0	1433.4	315.2	335	2469	2120	7.7	3.04	1.31
	0.9-1.2	5.0	2.0	na	854	867.8	287.2	54.2	2047.2	167.4	307	na	na	7.8	3.59	1.06
	1.2-1.5	7.9	1.6	na	924	869.5	301.3	62.7	2188.2	60.6	303	na	na	7.8	3.57	1.04
120 M[w]	0-0.15	122.1	1.4	623.2	185	63.5	124.7	290.7	116.6	114.9	848	7387	2401	7.3	1.83	1.72
	0.15-0.3	64.3	0.8	38.4	201	43.4	172.4	29.7	131.0	218.4	282	2297	1145	7.4	1.84	2.62
	0.3-0.6	114.9	1.1	16.4	647	340.2	395.4	21.3	730.5	817.8	304	3200	2134	7.4	3.19	2.28
	0.6-0.9	84.9	1.5	na	590	596.4	354.4	40.1	993.8	950.7	330	3320	2350	7.5	3.39	1.61
	0.9-1.2	27.4	1.7	na	846	986.9	284.5	56.8	2038.4	449.6	318	na	na	7.7	3.91	1.06
	1.2-1.5	22.9	2.6	na	926	987.2	299.0	71.9	2278.0	194.9	354	na	na	7.7	3.70	1.00

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] na = not analysed.

Table 11.16. Soil chemistry mean values (n=5) for the medium-textured site, fall 1999 (1 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		---- kg ha^{-1} ----														
Control	0-0.15	3.3	1.5	49.4	124	22.8	20.0	13.7	25.9	22.6	339	6254	1486	7.4	0.61	0.41
	0.15-0.3	0.5	0.8	5.5	77	13.4	26.2	2.2	28.6	5.1	200	2948	1164	7.6	0.46	0.72
	0.3-0.6	0.0	2.0	6.9	130	42.5	86.8	5.1	97.0	9.9	336	3200	2301	7.7	0.56	1.22
	0.6-0.9	0.0	1.7	6.8	128	83.1	93.7	8.1	172.6	13.3	317	1703	2103	7.8	0.84	1.23
	0.9-1.2	0.0	2.2	4.0	180	199.4	110.8	16.6	376.4	8.7	300	na[w]	na	7.8	1.28	0.98
	1.2-1.5	0.0	2.5	3.7	581	525.3	159.7	33.7	1196.0	12.7	284	na	na	7.7	2.28	0.80
60 F[v]	0-0.15	10.8	2.2	na	128	25.5	22.5	14.4	37.6	21.3	341	na	na	7.5	0.63	0.44
	0.15-0.3	4.2	1.7	na	82	15.1	27.1	2.5	38.6	5.3	192	na	na	7.7	0.51	0.71
	0.3-0.6	7.2	2.1	na	337	106.5	113.9	6.3	376.2	10.3	292	na	na	7.7	1.15	1.13
	0.6-0.9	3.4	2.4	na	455	310.0	207.0	15.0	835.9	6.0	280	na	na	7.8	1.92	1.27
	0.9-1.2	0.5	2.8	na	637	601.9	287.3	31.2	1397.9	6.8	290	na	na	7.7	2.78	1.34
	1.2-1.5	1.2	2.8	na	984	854.6	349.2	44.2	2154.8	11.6	265	na	na	7.6	3.68	1.41
120 F[v]	0-0.15	11.8	1.3	na	125	22.6	21.1	11.7	31.0	13.2	349	na	na	7.4	0.61	0.42
	0.15-0.3	3.7	0.8	na	79	17.3	24.2	2.1	32.7	2.1	196	na	na	7.6	0.48	0.63
	0.3-0.6	29.1	1.3	na	187	72.4	88.3	6.0	151.3	2.4	306	na	na	7.7	0.78	0.98
	0.6-0.9	37.9	1.9	na	294	227.7	143.7	14.4	462.7	2.1	307	na	na	7.7	1.36	1.07
	0.9-1.2	10.3	1.1	na	459	462.2	146.4	23.9	980.9	4.2	283	na	na	7.8	2.22	0.86
	1.2-1.5	4.6	1.7	na	997	877.1	196.5	42.9	2087.0	4.0	247	na	na	7.6	3.46	0.72
180 F[v]	0-0.15	14.3	1.3	na	187	31.0	26.4	11.9	84.1	13.0	333	na	na	7.5	0.78	0.45
	0.15-0.3	6.7	1.1	na	115	19.1	28.1	2.1	66.2	1.9	179	na	na	7.6	0.62	0.63
	0.3-0.6	31.6	1.9	na	359	122.9	107.7	6.6	378.1	1.9	257	na	na	7.6	1.30	1.03
	0.6-0.9	103.8	2.8	na	472	352.0	209.4	15.7	757.7	3.7	272	na	na	7.6	2.13	1.28
	0.9-1.2	62.4	4.4	na	507	645.3	231.0	27.8	1250.2	3.6	293	na	na	7.7	2.73	1.09
	1.2-1.5	21.3	4.4	na	756	885.1	237.8	41.0	1860.1	2.2	282	na	na	7.7	3.27	0.94

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.16. Soil chemistry mean values (n=5) for the medium-textured site, fall 1999 (2 of 2 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 M[w]	0-0.15	10.3	1.7	135.2	158	29.4	26.8	36.9	37.8	35.6	434	7764	1679	7.4	0.75	0.47
	0.15-0.3	3.4	1.2	7.9	132	25.3	41.6	4.1	85.9	11.9	203	3713	1198	7.6	0.72	0.91
	0.3-0.6	2.0	2.3	7.7	261	104.8	132.5	7.1	290.5	50.3	315	3124	2225	7.7	1.01	1.38
	0.6-0.9	0.2	2.7	6.0	282	241.5	167.3	13.7	508.7	93.7	328	2384	2690	7.7	1.41	1.22
	0.9-1.2	0.2	2.5	4.6	308	323.8	148.6	19.2	780.2	77.9	280	na[v]	na	7.7	1.85	1.01
	1.2-1.5	0.6	2.0	4.4	821	635.5	174.0	35.1	1497.6	56.4	230	na	na	7.7	3.08	0.80
40 M[w]	0-0.15	28.0	2.2	314.0	164	41.8	37.4	93.3	57.6	56.1	552	9066	2002	7.2	1.00	0.61
	0.15-0.3	10.2	1.6	13.7	102	19.1	51.4	7.0	63.8	22.5	206	3445	1194	7.5	0.71	1.20
	0.3-0.6	17.7	3.5	8.9	334	114.2	183.2	7.6	362.7	152.7	266	3505	2362	7.6	1.40	1.73
	0.6-0.9	16.0	4.3	6.3	370	311.1	226.4	15.6	637.3	297.1	277	1958	2307	7.7	2.07	1.53
	0.9-1.2	7.6	4.9	6.5	341	434.8	211.3	26.3	803.9	234.2	293	na	na	7.7	2.22	1.19
	1.2-1.5	5.3	4.5	5.5	688	738.7	225.9	37.8	1599.4	218.2	239	na	na	7.7	3.39	1.03
60 M[w]	0-0.15	40.4	2.1	421.7	164	44.8	40.1	124.1	121.7	52.1	619	8898	2208	7.3	1.07	0.64
	0.15-0.3	14.0	1.7	18.0	125	25.5	65.2	13.9	95.0	30.6	211	3407	1171	7.6	0.90	1.35
	0.3-0.6	35.1	2.2	8.6	428	186.8	265.8	10.4	538.8	271.1	250	3048	2103	7.5	1.98	1.94
	0.6-0.9	38.0	3.1	6.2	557	485.6	317.0	22.3	967.2	476.8	252	2043	2188	7.6	2.88	1.62
	0.9-1.2	17.5	3.2	6.0	861	824.0	289.3	39.4	1805.1	372.7	252	na	na	7.6	3.76	1.17
	1.2-1.5	7.3	2.9	4.4	971	927.0	286.7	50.6	2111.4	184.0	245	na	na	7.6	3.78	1.03
120 M[w]	0-0.15	89.9	2.3	923.8	165	63.2	66.9	296.9	89.6	57.8	835	9611	2867	7.3	1.50	0.99
	0.15-0.3	33.7	1.3	97.2	174	36.1	100.7	53.4	137.9	59.5	285	3445	1305	7.4	1.37	1.76
	0.3-0.6	172.2	1.9	13.6	698	235.7	366.0	16.7	586.4	483.1	226	3429	2271	7.4	2.85	2.22
	0.6-0.9	245.9	1.9	8.5	745	612.3	397.2	29.6	981.9	1010.9	226	2724	2563	7.5	3.69	1.81
	0.9-1.2	108.6	1.7	9.9	773	904.7	326.9	46.6	1454.3	928.7	263	na	na	7.6	4.13	1.27
	1.2-1.5	45.7	2.1	15.8	924	954.3	290.8	58.0	1897.3	536.9	278	na	na	7.6	4.09	1.06

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] na = not analysed.

Table 11.17. Soil chemistry mean values (n=5) for the medium-textured site, fall 2000 (1 of 3 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
Control	0-0.15	5.3	1.5	51.2	113	24.3	27.6	16.3	na[w]	33.9	na	6799	1456	7.4	0.72	0.56
	0.15-0.3	2.5	1.6	4.0	68	11.8	29.9	3.0	na	14.3	na	2756	1210	7.5	0.51	0.85
	0.3-0.6	1.6	2.8	5.0	107	36.2	86.4	5.9	na	7.7	na	3048	2256	7.6	0.61	1.29
	0.6-0.9	0.7	2.9	6.0	182	144.7	127.2	12.0	na	11.0	na	3065	2163	7.7	1.09	1.32
	0.9-1.2	0.5	2.1	2.8	430	371.2	163.0	23.1	na	24.3	na	na	na	7.7	1.79	1.11
	1.2-1.5	0.5	2.6	3.6	524	620.3	175.9	33.3	na	8.1	na	na	na	7.7	2.44	0.86
60 F[v]	0-0.15	17.6	1.1	na	87	25.3	28.6	14.1	na	19.6	na	na	na	7.4	0.62	0.62
	0.15-0.3	11.1	0.7	na	71	12.4	31.6	3.2	na	9.1	na	na	na	7.6	0.54	0.85
	0.3-0.6	4.4	1.7	na	309	131.0	136.8	7.7	na	5.1	na	na	na	7.6	1.18	1.33
	0.6-0.9	0.9	1.2	na	360	311.7	278.1	17.0	na	4.2	na	na	na	7.8	1.92	1.73
	0.9-1.2	1.3	1.8	na	598	539.5	292.6	30.0	na	12.5	na	na	na	7.7	2.68	1.60
	1.2-1.5	1.1	1.5	na	996	952.8	353.6	45.2	na	16.7	na	na	na	7.7	3.75	1.44
120 F[v]	0-0.15	33.9	1.4	na	114	19.6	33.6	15.3	na	19.2	na	na	na	7.4	0.70	0.68
	0.15-0.3	26.3	1.2	na	88	18.2	31.6	3.1	na	12.6	na	na	na	7.5	0.64	0.73
	0.3-0.6	40.5	2.6	na	182	78.0	97.5	7.4	na	6.7	na	na	na	7.6	0.81	1.06
	0.6-0.9	38.4	2.9	na	207	232.9	159.9	17.1	na	2.9	na	na	na	7.7	1.31	1.25
	0.9-1.2	18.6	2.2	na	433	429.9	158.9	28.6	na	18.2	na	na	na	7.7	2.16	0.98
	1.2-1.5	9.1	2.6	na	918	773.7	183.3	43.6	na	18.7	na	na	na	7.6	2.90	0.74
180 F[v]	0-0.15	41.8	1.1	na	119	22.4	34.6	16.3	na	25.1	na	na	na	7.4	0.75	0.67
	0.15-0.3	46.5	1.1	na	179	37.8	37.9	3.5	na	8.3	na	na	na	7.5	1.00	0.69
	0.3-0.6	131.2	2.2	na	467	274.0	136.5	8.7	na	0.0	na	na	na	7.6	1.73	0.98
	0.6-0.9	173.8	1.6	na	428	386.7	230.3	18.8	na	4.7	na	na	na	7.7	2.12	1.38
	0.9-1.2	117.0	1.5	na	369	448.5	226.2	26.4	na	4.8	na	na	na	7.8	2.24	1.24
	1.2-1.5	58.2	1.7	na	554	628.6	234.7	38.0	na	8.4	na	na	na	7.7	2.68	1.10

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.17. Soil chemistry mean values (n=5) for the medium-textured site, fall 2000 (2 of 3 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 M[w]	0-0.15	33.4	0.9	236.3	139	35.1	45.4	66.2	na[v]	77.8	na	7806	1788	7.2	0.98	0.77
	0.15-0.3	19.0	0.7	10.2	97	21.7	53.3	7.3	na	46.3	na	4019	1248	7.4	0.77	1.18
	0.3-0.6	9.6	1.5	5.7	430	244.0	182.6	9.0	na	121.1	na	3658	2195	7.5	1.57	1.50
	0.6-0.9	2.1	1.2	7.0	382	407.1	223.1	18.9	na	128.1	na	2895	2324	7.7	2.01	1.43
	0.9-1.2	1.1	1.1	5.1	446	470.1	185.6	29.9	na	90.7	na	na	na	7.7	2.17	1.05
	1.2-1.5	1.2	1.4	5.6	740	791.9	188.1	45.6	na	68.9	na	na	na	7.5	3.14	0.82
40 M[w]	0-0.15	57.5	2.1	409.3	122	37.0	57.7	110.1	na	72.8	na	7555	2010	7.3	1.09	1.04
	0.15-0.3	32.2	0.7	22.1	199	44.3	71.7	15.7	na	63.1	na	3790	1194	7.5	1.38	1.26
	0.3-0.6	27.8	2.1	8.5	603	291.3	297.1	12.2	na	284.7	na	3734	2141	7.6	2.16	1.85
	0.6-0.9	14.3	1.8	6.9	400	430.0	300.7	21.3	na	231.6	na	2469	2214	7.7	2.28	1.86
	0.9-1.2	10.9	2.0	6.2	363	499.6	273.2	31.9	na	205.1	na	na	na	7.8	2.45	1.52
	1.2-1.5	10.5	1.9	5.0	373	594.3	274.8	36.9	na	214.8	na	na	na	7.8	2.66	1.32
60 M[w]	0-0.15	69.0	1.7	532.4	146	42.7	62.0	168.7	na	81.7	na	8814	2250	7.2	1.22	1.01
	0.15-0.3	52.7	1.1	28.6	143	32.6	87.3	36.2	na	95.5	na	3101	1133	7.4	1.28	1.60
	0.3-0.6	88.2	2.6	7.5	614	263.9	317.9	15.1	na	302.4	na	3810	2164	7.5	2.50	2.12
	0.6-0.9	70.7	2.1	5.7	749	668.2	463.3	27.3	na	525.3	na	4598	2128	7.6	3.30	2.01
	0.9-1.2	32.9	2.5	6.5	838	893.4	416.0	47.3	na	312.2	na	na	na	7.6	3.76	1.53
	1.2-1.5	19.0	2.6	6.2	1120	1107.3	434.5	58.5	na	303.5	na	na	na	7.6	4.31	1.32
120 M[w]	0-0.15	110.3	1.4	1158.0	140	65.1	122.9	400.2	na	117.4	na	9569	2820	7.2	1.81	1.80
	0.15-0.3	89.6	0.6	133.6	227	50.6	133.3	124.2	na	188.9	na	5206	1711	7.4	2.01	1.95
	0.3-0.6	248.0	1.6	25.6	831	250.7	401.6	31.4	na	650.8	na	5639	2454	7.3	3.15	2.32
	0.6-0.9	254.6	1.6	12.1	763	606.8	447.8	27.4	na	719.2	na	3320	2409	7.5	3.61	2.12
	0.9-1.2	171.2	2.6	8.2	766	917.0	362.4	43.7	na	910.3	na	na	na	7.6	4.02	1.37
	1.2-1.5	71.2	1.4	5.8	1047	1127.7	299.1	56.7	na	622.8	na	na	na	7.6	4.45	1.02

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] na = not analysed.

Table 11.17. Soil chemistry mean values (n=5) for the medium-textured site, fall 2000 (3 of 3 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 MR[w]	0-0.15	16.9	0.8	136.6	131	24.6	33.4	40.3	na[v]	57.2	na	na	na	7.3	0.78	0.61
	0.15-0.3	9.7	0.8	7.3	78	15.7	41.0	5.7	na	32.2	na	na	na	7.5	0.59	1.04
	0.3-0.6	5.0	1.1	6.6	225	77.9	151.2	8.5	na	31.5	na	na	na	7.6	0.98	1.55
	0.6-0.9	1.3	1.5	6.9	388	351.3	226.1	21.9	na	76.9	na	na	na	7.7	1.85	1.45
	0.9-1.2	0.7	1.0	6.2	288	348.8	191.9	23.4	na	103.2	na	na	na	7.7	2.03	1.26
	1.2-1.5	0.7	0.9	4.4	685	604.4	222.5	38.4	na	80.9	na	na	na	7.6	2.66	1.06
40 MR[w]	0-0.15	45.9	1.9	325.0	116	30.5	40.6	95.4	na	75.1	na	na	na	7.3	0.99	0.76
	0.15-0.3	27.4	1.3	14.6	93	14.6	51.9	14.2	na	45.1	na	na	na	7.5	0.83	1.26
	0.3-0.6	19.0	2.7	8.7	238	76.8	188.4	8.9	na	131.3	na	na	na	7.6	1.24	2.03
	0.6-0.9	11.2	2.4	5.4	325	271.7	222.9	17.3	na	249.3	na	na	na	7.7	1.82	1.68
	0.9-1.2	7.5	2.9	5.5	460	450.1	199.7	30.8	na	203.7	na	na	na	7.8	2.16	1.23
	1.2-1.5	5.8	2.1	4.7	718	520.8	185.0	40.8	na	112.6	na	na	na	7.7	2.72	1.01
60 MR[w]	0-0.15	69.1	1.4	491.0	133	41.0	42.8	149.6	na	74.6	na	na	na	7.3	1.14	0.72
	0.15-0.3	39.8	1.3	40.2	106	20.1	64.2	24.1	na	42.2	na	na	na	7.4	0.95	1.42
	0.3-0.6	70.2	3.6	9.4	356	132.1	248.0	11.8	na	199.2	na	na	na	7.5	1.72	2.10
	0.6-0.9	52.6	2.8	4.9	636	501.6	293.2	25.5	na	446.8	na	na	na	7.6	2.77	1.43
	0.9-1.2	43.1	3.3	4.6	907	825.8	245.9	42.4	na	351.4	na	na	na	7.6	3.31	1.03
	1.2-1.5	32.5	2.7	5.2	1048	906.7	252.7	55.5	na	258.0	na	na	na	7.6	3.60	0.92
120 MR[w]	0-0.15	95.3	1.2	849.2	130	52.6	50.4	265.8	na	72.2	na	na	na	7.2	1.32	0.80
	0.15-0.3	65.8	0.9	120.2	145	31.5	90.4	80.1	na	37.3	na	na	na	7.4	1.34	1.64
	0.3-0.6	283.0	1.1	13.7	672	206.0	390.6	21.0	na	321.7	na	na	na	7.4	2.73	2.34
	0.6-0.9	264.7	1.2	7.1	535	447.5	384.4	26.6	na	782.8	na	na	na	7.6	3.03	2.00
	0.9-1.2	111.0	1.1	9.4	672	835.2	293.4	42.6	na	834.9	na	na	na	7.6	3.60	1.25
	1.2-1.5	58.9	1.6	5.8	887	979.4	304.1	52.7	na	687.7	na	na	na	7.6	3.93	1.08

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure. Residual manure treatment. Annual manure application was discontinued after 1998.
[v] na = not analysed.

Table 11.18. Soil chemistry mean values (n=5) for the medium-textured site, fall 2001 (1 of 3 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
Control	0-0.15	2.8	1.5	37.5	115	20.8	26.3	12.1	na[w]	15.6	na	4994	1423	7.4	0.63	0.54
	0.15-0.3	1.5	1.0	3.4	68	14.5	30.4	2.8	na	6.7	na	2641	1236	7.6	0.49	0.83
	0.3-0.6	1.0	2.2	4.0	95	44.2	73.9	5.7	na	7.4	na	2896	2271	7.7	0.54	1.13
	0.6-0.9	0.8	2.2	3.7	104	85.0	95.2	10.8	na	4.9	na	1533	2111	7.8	0.73	1.30
	0.9-1.2	0.7	2.5	1.9	363	274.4	121.8	22.1	na	5.9	na	na	na	7.8	1.46	1.08
	1.2-1.5	0.7	1.9	1.3	680	466.0	146.2	32.9	na	7.8	na	na	na	7.6	2.19	0.88
60 F[v]	0-0.15	10.8	1.0	na	149	25.8	37.5	10.2	na	8.7	na	na	na	7.3	0.82	0.68
	0.15-0.3	3.1	0.8	na	118	31.2	43.3	3.1	na	3.4	na	na	na	7.5	0.84	0.90
	0.3-0.6	4.8	1.1	na	504	251.7	150.0	61.4	na	1.6	na	na	na	7.5	1.86	1.11
	0.6-0.9	4.9	1.5	na	422	458.6	240.8	20.7	na	1.8	na	na	na	7.6	2.30	1.32
	0.9-1.2	4.8	0.8	na	574	608.2	281.1	34.8	na	5.5	na	na	na	7.6	2.92	1.40
	1.2-1.5	5.5	0.5	na	917	922.1	435.5	47.2	na	4.9	na	na	na	7.6	3.86	1.71
120 F[v]	0-0.15	19.6	2.0	na	109	18.7	27.5	7.4	na	7.4	na	na	na	7.4	0.60	0.58
	0.15-0.3	14.2	0.7	na	110	31.4	39.6	3.0	na	3.1	na	na	na	7.5	0.78	0.82
	0.3-0.6	32.6	2.3	na	384	253.6	130.0	11.2	na	0.0	na	na	na	7.6	1.54	1.09
	0.6-0.9	30.0	2.0	na	434	382.4	163.2	21.4	na	1.7	na	na	na	7.7	1.77	1.09
	0.9-1.2	21.0	2.9	na	636	485.3	156.4	29.6	na	3.1	na	na	na	7.6	2.28	0.90
	1.2-1.5	23.9	1.9	na	753	687.9	183.5	42.0	na	10.0	na	na	na	7.6	2.71	0.82
180 F[v]	0-0.15	20.9	1.1	na	123	20.8	30.1	10.4	na	10.8	na	na	na	7.4	0.64	0.60
	0.15-0.3	25.4	0.9	na	130	28.8	39.5	2.9	na	4.5	na	na	na	7.5	0.87	0.77
	0.3-0.6	82.6	0.9	na	396	195.4	145.1	8.4	na	3.0	na	na	na	7.5	1.60	1.15
	0.6-0.9	46.3	0.3	na	375	431.3	212.6	19.2	na	4.3	na	na	na	7.6	2.04	1.19
	0.9-1.2	49.6	0.6	na	359	454.1	206.3	25.9	na	6.3	na	na	na	7.7	2.14	1.17
	1.2-1.5	42.2	1.0	na	621	675.0	234.2	40.6	na	10.8	na	na	na	7.6	2.82	1.10

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] na = not analysed.
[v] 60, 120, and 180 kg ha^{-1} nitrogen fertilizer.

Table 11.18. Soil chemistry mean values (n=5) for the medium-textured site, fall 2001 (2 of 3 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		kg ha^{-1}														
20 M[w]	0-0.15	13.5	1.8	196.0	135	31.7	43.8	41.4	na[v]	31.7	na	6841	1725	7.4	0.85	0.79
	0.15-0.3	6.7	1.2	10.1	192	49.5	64.9	5.3	na	38.0	na	3445	1187	7.6	1.20	1.17
	0.3-0.6	8.7	2.1	9.9	392	239.3	186.4	15.8	na	108.7	na	3353	2256	7.6	1.68	1.46
	0.6-0.9	6.2	2.5	10.2	304	323.3	201.2	17.7	na	99.0	na	2214	2375	7.8	1.77	1.38
	0.9-1.2	5.7	1.8	7.6	492	474.3	191.0	28.3	na	85.0	na	na	na	7.8	2.33	1.15
	1.2-1.5	6.1	2.3	6.1	825	675.2	197.6	43.0	na	85.3	na	na	na	7.7	2.93	0.88
40 M[w]	0-0.15	37.3	1.9	326.1	130	31.0	54.1	75.4	na	30.1	na	6799	1998	7.3	0.93	1.00
	0.15-0.3	20.6	1.5	25.3	151	32.0	81.0	14.8	na	65.8	na	3101	1217	7.5	1.12	1.50
	0.3-0.6	36.0	2.5	12.3	469	252.7	263.5	13.5	na	290.7	na	3124	2332	7.5	2.20	1.88
	0.6-0.9	14.9	2.4	8.3	348	411.9	257.5	21.3	na	188.8	na	3746	2299	7.7	2.18	1.55
	0.9-1.2	10.4	2.4	4.7	512	683.8	268.3	32.2	na	168.1	na	na	na	7.7	2.77	1.30
	1.2-1.5	11.5	2.4	4.4	730	873.0	310.3	43.5	na	194.9	na	na	na	7.7	3.46	1.19
60 M[w]	0-0.15	64.1	2.5	543.4	146	46.2	78.5	148.8	na	48.1	na	8562	2313	7.3	1.21	1.28
	0.15-0.3	58.0	1.9	38.3	306	88.5	137.0	28.8	na	138.8	na	3866	1275	7.3	2.16	1.73
	0.3-0.6	187.1	4.3	18.1	654	413.1	405.9	21.0	na	415.1	na	3734	2316	7.4	3.15	2.09
	0.6-0.9	70.5	3.1	11.2	545	657.8	443.2	29.6	na	335.8	na	2299	2324	7.6	3.22	1.96
	0.9-1.2	37.7	3.4	5.2	714	893.1	407.6	44.7	na	249.1	na	na	na	7.7	3.61	1.57
	1.2-1.5	33.7	3.4	3.7	979	1140.5	436.7	57.1	na	244.7	na	na	na	7.6	4.30	1.39
120 M[w]	0-0.15	71.1	2.1	1179.1	128	61.9	125.6	341.5	na	78.6	na	10744	3395	7.0	1.65	1.99
	0.15-0.3	101.1	0.7	180.5	200	61.1	152.7	149.3	na	248.3	na	4517	1615	7.2	2.26	2.30
	0.3-0.6	327.1	1.5	29.5	886	305.2	482.3	32.3	na	857.6	na	3581	2294	7.2	3.73	2.47
	0.6-0.9	282.1	1.1	14.3	657	563.8	486.5	29.7	na	891.9	na	2384	2495	7.4	3.65	2.27
	0.9-1.2	218.2	1.6	12.3	919	989.2	413.1	49.8	na	848.7	na	na	na	7.4	4.52	1.59
	1.2-1.5	135.0	2.6	9.8	1163	1204.2	349.1	64.9	na	688.4	na	na	na	7.4	4.86	1.17

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure.
[v] na = not analysed.

Table 11.18. Soil chemistry mean values (n=5) for the medium-textured site, fall 2001 (3 of 3 pages).

Treatment	Layer m	NO_3-N[z]	NH_4-N[z]	PO_4-P[y]	Ca[x]	Mg[x]	Na[x]	K[x]	SO_4-S[x]	Cl[x]	HCO_3[x]	Total N	Total P	pH[x]	EC[x] dS m^{-1}	SAR[x]
		---------- kg ha^{-1} ----------														
20 MR[w]	0-0.15	7.0	1.9	96.0	112	22.6	27.6	26.5	na[v]	17.1	na	na	na	7.4	0.67	0.56
	0.15-0.3	1.7	1.3	6.9	97	23.7	42.4	4.4	na	12.3	na	na	na	7.6	0.71	0.96
	0.3-0.6	1.5	1.9	8.5	182	94.2	145.5	8.1	na	26.6	na	na	na	7.7	0.96	1.55
	0.6-0.9	2.4	2.3	6.9	217	200.4	178.4	14.2	na	53.8	na	na	na	7.8	1.36	1.50
	0.9-1.2	2.1	1.9	8.3	516	473.9	218.5	26.4	na	73.1	na	na	na	7.7	2.32	1.21
	1.2-1.5	1.7	3.2	5.0	848	626.5	229.6	37.7	na	70.2	na	na	na	7.7	3.02	1.07
40 MR[w]	0-0.15	14.6	1.7	211.4	142	31.0	29.1	51.1	na	16.5	na	na	na	7.3	0.82	0.52
	0.15-0.3	4.5	0.8	13.1	88	17.6	45.2	6.8	na	11.3	na	na	na	7.6	0.65	1.12
	0.3-0.6	5.8	2.3	11.1	166	61.5	151.6	8.0	na	36.6	na	na	na	7.7	0.94	1.90
	0.6-0.9	5.2	1.7	6.5	191	190.2	184.6	17.2	na	128.0	na	na	na	7.8	1.34	1.65
	0.9-1.2	4.8	2.3	4.9	345	409.1	170.7	28.5	na	145.0	na	na	na	7.7	1.86	1.15
	1.2-1.5	5.0	1.8	6.8	802	634.4	191.6	44.7	na	142.0	na	na	na	7.6	2.88	0.91
60 MR[w]	0-0.15	28.5	2.0	331.3	129	31.5	51.1	78.9	na	29.9	na	na	na	7.3	0.86	0.90
	0.15-0.3	16.9	1.5	25.6	121	26.2	66.7	17.2	na	34.5	na	na	na	7.5	0.92	1.35
	0.3-0.6	41.7	2.6	10.1	274	144.5	230.4	13.5	na	97.8	na	na	na	7.6	1.43	1.96
	0.6-0.9	36.2	2.7	7.6	585	490.2	263.1	25.4	na	187.7	na	na	na	7.6	2.51	1.45
	0.9-1.2	34.0	4.8	7.1	780	669.9	232.5	42.6	na	207.1	na	na	na	7.6	3.14	1.07
	1.2-1.5	24.4	3.4	3.9	972	818.8	244.0	50.6	na	198.3	na	na	na	7.6	3.50	1.01
120 MR[w]	0-0.15	36.3	1.3	708.0	131	47.9	37.1	167.4	na	19.7	na	na	na	7.2	1.08	0.64
	0.15-0.3	49.7	0.6	115.1	157	81.6	92.1	63.3	na	105.0	na	na	na	7.4	1.58	1.44
	0.3-0.6	233.4	0.5	22.2	676	220.5	377.5	19.8	na	333.5	na	na	na	7.3	2.81	2.29
	0.6-0.9	232.6	0.9	18.1	510	354.4	331.3	38.7	na	372.9	na	na	na	7.5	2.54	1.85
	0.9-1.2	171.0	1.0	9.9	642	737.2	312.3	41.0	na	664.2	na	na	na	7.5	3.45	1.39
	1.2-1.5	123.9	1.0	4.9	1014	933.7	321.5	52.5	na	507.8	na	na	na	7.5	4.12	1.16

[z] Potassium chloride extractable procedure used.
[y] Modified Kelowna extraction procedure used.
[x] Determined from saturated-paste extracts.
[w] 20, 40, 60, and 120 Mg ha^{-1} wet manure. Residual manure treatment. Annual manure application was discontinued after 1998.
[v] na = not analysed.

Table 11.19. Mean values of extractable nitrate-N and orthophosphate-P content in the monthly soil samples from June 1999 to June 2000 at the coarse-textured site.

	Soil	15 June 1999		13 July 1999		24 August 1999		20 October 1999	
	layer	Nitrate-N	PO_4-P	Nitrate-N	PO_4-P	Nitrate-N	PO_4-P	Nitrate-N	PO_4-P
Treatment	m	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}
Control	0-0.15	8.6	na	3.7	na	1.8	na	19.5	na
	0.15-0.3	na	na	na	na	na	na	na	na
20 M	0-0.15	18.6	na	6.8	na	6.1	na	43.4	na
	0.15-0.3	na	na	na	na	na	na	na	na
40 M	0-0.15	37.1	na	13.2	na	18.6	na	86.6	na
	0.15-0.3	na	na	na	na	na	na	na	na
60 M	0-0.15	76.2	na	12.5	na	30.4	na	110.9	na
	0.15-0.3	na	na	na	na	na	na	na	na
120 F	0-0.15	259.2	na	47.4	na	62.6	na	200.7	na
	0.15-0.3	na	na	na	na	na	na	na	na
		29 November 1999		25 April 2000		23 May 2000		19 June 2000	
		Nitrate-N kg ha^{-1}	PO_4-P kg ha^{-1}	Nitrate-N kg ha^{-1}	PO_4-P kg ha^{-1}	Nitrate-N kg ha^{-1}	PO_4-P kg ha^{-1}	Nitrate-N kg ha^{-1}	PO_4-P kg ha^{-1}
Control	0-0.15	19.4	na	11.8	153.5	17.6	138.4	10.2	172.2
	0.15-0.3	na	na	15.6	64.7	17.5	101.6	11.9	81.5
20 M	0-0.15	42.9	na	21.2	256.3	44.2	316.8	34.6	295.8
	0.15-0.3	na	na	31.1	127.9	39.4	149.8	43.5	169.9
40 M	0-0.15	78.4	na	46.7	413.9	114.8	529.2	111.4	459.1
	0.15-0.3	na	na	56.9	180.6	61.2	209.6	72.7	215.1
60 M	0-0.15	111.4	na	157.2	599.9	187.4	668.2	220.6	695.4
	0.15-0.3	na	na	83.4	239.1	84.7	248.6	112.6	331.0
120 M	0-0.15	190.0	na	173.1	965.9	267.6	1275.0	337.6	1119.7
	0.15-0.3	na	na	101.8	428.6	114.8	417.5	147.2	549.5

na = not analysed.

Table 11.20. Mean values of extractable nitrate-N and orthophosphate-P content in the monthly soil samples from July 2000 to August 2001 at the coarse-textured site.

Treatment	Soil layer m	17 July 2000 Nitrate-N $kg\ ha^{-1}$	17 July 2000 PO_4-P $kg\ ha^{-1}$	21 August 2000 Nitrate-N $kg\ ha^{-1}$	21 August 2000 PO_4-P $kg\ ha^{-1}$	11 October 2000 Nitrate-N $kg\ ha^{-1}$	11 October 2000 PO_4-P $kg\ ha^{-1}$	17 April 2001 Nitrate-N $kg\ ha^{-1}$	17 April 2001 PO_4-P $kg\ ha^{-1}$
Control	0-0.15	6.1	176.2	6.1	175.0	11.6	177.4	8.5	142.0
	0.15-0.3	5.1	90.1	3.2	92.4	7.1	77.8	13.1	68.6
20 M	0-0.15	10.3	317.3	22.0	335.2	31.7	310.0	30.3	195.1
	0.15-0.3	7.4	149.4	11.7	183.8	23.9	164.6	35.8	233.7
40 M	0-0.15	12.2	348.5	49.8	539.7	56.8	418.5	63.3	477.6
	0.15-0.3	9.5	174.3	19.2	233.7	31.4	203.5	49.2	229.3
60 M	0-0.15	34.3	539.4	65.1	855.3	107.0	653.8	103.6	574.2
	0.15-0.3	32.3	276.8	67.8	344.8	51.2	248.7	86.7	353.9
120 F	0-0.15	40.8	911.4	107.4	1230.6	168.1	1077.3	240.8	1150.1
	0.15-0.3	94.1	452.8	74.2	623.4	84.5	519.3	148.7	524.7

Treatment	Soil layer m	14 May 2001 Nitrate-N $kg\ ha^{-1}$	14 May 2001 PO_4-P $kg\ ha^{-1}$	11 June 2001 Nitrate-N $kg\ ha^{-1}$	11 June 2001 PO_4-P $kg\ ha^{-1}$	9 July 2001 Nitrate-N $kg\ ha^{-1}$	9 July 2001 PO_4-P $kg\ ha^{-1}$	21 August 2001 Nitrate-N $kg\ ha^{-1}$	21 August 2001 PO_4-P $kg\ ha^{-1}$
Control	0-0.15	18.5	144.5	3.1	143.1	5.6	155.6	1.3	133.7
	0.15-0.3	17.3	69.9	4.3	62.4	2.8	70.7	0.9	61.0
20 M	0-0.15	57.6	274.3	11.6	264.5	11.2	363.1	7.3	274.5
	0.15-0.3	44.0	153.7	11.0	191.8	7.8	182.1	2.9	155.7
40 M	0-0.15	79.1	425.1	14.9	468.5	25.6	598.5	14.8	378.5
	0.15-0.3	56.4	217.4	20.8	226.6	14.7	248.2	4.3	206.1
60 M	0-0.15	143.7	603.2	27.6	602.6	52.4	804.6	14.1	589.4
	0.15-0.3	84.3	252.6	42.9	321.4	58.6	356.9	8.3	251.6
120 M	0-0.15	222.5	992.6	61.7	1223.2	109.9	1415.5	56.3	978.6
	0.15-0.3	123.0	473.6	82.5	519.5	85.6	563.7	16.4	468.0

Table 11.21. Mean values of extractable nitrate-N and orthophosphate-P content in the monthly soil samples from June 1999 to June 2000 at the medium-textured site.

Treatment	Soil layer m	15 June 1999 Nitrate-N kg ha^{-1}	15 June 1999 PO_4-P kg ha^{-1}	13 July 1999 Nitrate-N kg ha^{-1}	13 July 1999 PO_4-P kg ha^{-1}	24 August 1999 Nitrate-N kg ha^{-1}	24 August 1999 PO_4-P kg ha^{-1}	20 October 1999 Nitrate-N kg ha^{-1}	20 October 1999 PO_4-P kg ha^{-1}
Control	0-0.15	13.7	na	3.0	na	0.8	na	10.3	na
	0.15-0.3	na	na	na	na	na	na	na	na
20 M	0-0.15	20.6	na	6.4	na	7.6	na	33.9	na
	0.15-0.3	na	na	na	na	na	na	na	na
40 M	0-0.15	40.6	na	8.5	na	16.1	na	66.9	na
	0.15-0.3	na	na	na	na	na	na	na	na
60 M	0-0.15	69.3	na	12.0	na	27.4	na	103.5	na
	0.15-0.3	na	na	na	na	na	na	na	na
120 F	0-0.15	207.3	na	30.8	na	75.3	na	180.6	na
	0.15-0.3	na	na	na	na	na	na	na	na

Treatment	Soil layer m	29 November 1999 Nitrate-N kg ha^{-1}	29 November 1999 PO_4-P kg ha^{-1}	25 April 2000 Nitrate-N kg ha^{-1}	25 April 2000 PO_4-P kg ha^{-1}	23 May 2000 Nitrate-N kg ha^{-1}	23 May 2000 PO_4-P kg ha^{-1}	19 June 2000 Nitrate-N kg ha^{-1}	19 June 2000 PO_4-P kg ha^{-1}
Control	0-0.15	8.5	na	16.9	52.5	21.1	54.6	7.6	67.2
	0.15-0.3	na	na	6.9	7.8	6.0	8.7	10.5	12.2
20 M	0-0.15	23.4	na	46.3	148.3	37.0	303.4	23.1	205.5
	0.15-0.3	na	na	15.8	12.4	15.6	14.7	38.1	21.6
40 M	0-0.15	49.2	na	88.1	308.1	92.1	278.0	51.2	371.5
	0.15-0.3	na	na	28.1	19.1	25.6	28.2	63.8	42.8
60 M	0-0.15	76.9	na	123.8	446.7	141.4	386.5	70.8	564.1
	0.15-0.3	na	na	49.6	31.7	51.2	40.7	97.9	55.8
120 M	0-0.15	134.8	na	185.8	1050.6	224.5	876.1	97.1	1036.4
	0.15-0.3	na	na	111.8	117.6	111.6	124.6	140.6	173.4

na = not analysed.

Table 11.22. Mean values of extractable nitrate-N and orthophosphate-P content in the monthly soil samples from July 2000 to August 2001 at the medium-textured site.

	Soil	17 July 2000		21 August 2000		11 October 2000		17 April 2001	
	layer	Nitrate-N	PO_4-P	Nitrate-N	PO_4-P	Nitrate-N	PO_4-P	Nitrate-N	PO_4-P
Treatment	m	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}
Control	0-0.15	6.2	82.1	6.3	54.4	5.9	64.9	27.9	81.4
	0.15-0.3	4.0	19.0	2.5	8.2	3.6	9.2	11.4	12.5
20 M	0-0.15	9.1	184.1	26.6	200.2	22.5	206.6	65.8	358.5
	0.15-0.3	4.8	25.1	6.0	11.9	12.5	18.8	34.8	41.9
40 M	0-0.15	20.0	369.1	42.3	314.0	69.1	388.9	145.4	513.1
	0.15-0.3	13.5	48.7	13.1	17.1	31.5	33.8	69.5	66.2
60 M	0-0.15	25.0	560.8	69.3	483.0	111.2	658.1	170.0	781.0
	0.15-0.3	22.2	74.8	45.2	18.0	65.7	84.6	91.0	102.8
120 F	0-0.15	39.1	967.9	88.2	1012.9	151.4	1062.8	222.3	1452.4
	0.15-0.3	41.2	184.9	74.0	60.5	92.3	211.4	134.6	301.2

		14 May 2001		11 June 2001		9 July 2001		20 August 2001	
		Nitrate-N	PO_4-P	Nitrate-N	PO_4-P	Nitrate-N	PO_4-P	Nitrate-N	PO_4-P
		kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}
Control	0-0.15	14.0	49.8	11.3	60.9	21.1	64.9	2.5	54.1
	0.15-0.3	7.6	6.3	10.4	7.1	5.3	6.7	1.5	8.4
20 M	0-0.15	67.8	190.2	58.1	230.8	55.8	298.7	17.0	271.0
	0.15-0.3	22.7	15.4	31.1	15.4	31.9	23.5	9.5	20.4
40 M	0-0.15	127.0	367.3	116.3	445.8	33.5	424.5	42.4	476.1
	0.15-0.3	57.0	28.8	86.1	33.2	77.1	31.4	43.2	48.5
60 M	0-0.15	174.9	589.6	156.8	718.4	84.7	904.5	46.1	672.1
	0.15-0.3	84.7	37.7	115.5	46.0	128.5	64.7	60.0	76.3
120 M	0-0.15	240.2	1262.2	231.9	1568.6	106.2	1457.0	65.7	998.6
	0.15-0.3	121.0	144.7	170.8	318.4	196.3	238.9	84.5	205.5

Appendix 12. Summary of statistical analysis of the soil and crop data.

Table 12.1. Statistical analysis results of the soil extractable nitrate-N data for the coarse-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-1.5 (m)
treatment	***	***	***	***	***	***	***
year	***	***	***	***	***	***	***
treatment x year	***	***	***	***	***	ns	***
Cont-treat	-	-	-	-	-	-2.7**	-
Cont-treat: 1993	ns	ns	ns	ns	-39*	-	ns
Cont-treat: 1994	ns	ns	ns	ns	ns	-	-101*
Cont-treat: 1995	-21**	-7.4*	-35**	-38*	ns	-	-107*
Cont-treat: 1996	ns	ns	ns	ns	ns	-	ns
Cont-treat: 1997	-23***	ns	ns	ns	ns	-	ns
Cont-treat: 1998	-45***	-10**	ns	ns	ns	-	-121*
Cont-treat: 1999	-36***	-9.4**	ns	ns	ns	-	-133**
Cont-treat: 2000	-43***	-30***	-51***	-39*	ns	-	-222***
Cont-treat: 2001	-14**	-4.8*	ns	-25*	-34**	-	-209***

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	*	*
year x treat		1994	ns	ns	ns	ns	ns	ns	**
year x treat		1995	***	**	***	***	ns	ns	***
year x treat		1996	ns	ns	ns	ns	ns	ns	ns
year x treat		1997	***	*	ns	ns	ns	ns	ns
year x treat		1998	***	***	ns	ns	*	ns	***
year x treat		1999	***	***	ns	*	*	***	***
year x treat		2000	***	***	***	***	***	ns	***
year x treat		2001	***	***	***	***	***	***	***
year x treat	cont[y]		ns	ns	ns	ns	**	**	***
year x treat	fert 60		**	ns	ns	**	***	***	***
year x treat	fert 120		***	***	**	***	***	***	***
year x treat	fert 180		***	***	***	**	***	**	***
year x treat	man 20		ns	**	ns	ns	**	ns	***
year x treat	man 40		***	***	ns	ns	***	***	***
year x treat	man 60		***	***	***	***	***	***	***
year x treat	man 120		***	***	***	***	***	***	***

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.2. Statistical analysis results of the soil extractable nitrate-N data for the medium-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-1.5 (m)
treatment	***	***	***	***	***	***	***
year	***	***	***	***	***	***	***
treatment x year	***	***	***	***	***	***	***
Cont-treat	-	-	-	-	-	-	-
Cont-treat: 1993	ns	ns	ns	ns	ns	ns	ns
Cont-treat: 1994	ns	ns	ns	ns	ns	ns	ns
Cont-treat: 1995	-23***	-12*	ns	ns	ns	ns	ns
Cont-treat: 1996	ns	-12*	ns	ns	ns	ns	ns
Cont-treat: 1997	-25***	ns	ns	ns	ns	ns	ns
Cont-treat: 1998	-27***	-19*	ns	ns	ns	ns	-114**
Cont-treat: 1999	-26***	ns	-42*	-64***	-30***	ns	-184***
Cont-treat: 2000	-47***	-37***	-77***	-79***	-50***	-24**	-313***
Cont-treat: 2001	-20***	-20***	-61***	-41***	-31***	-23***	-308***

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	ns	ns
year x treat		1994	ns	ns	ns	ns	ns	ns	ns
year x treat		1995	***	***	ns	ns	ns	ns	**
year x treat		1996	***	***	ns	ns	ns	ns	ns
year x treat		1997	***	**	*	***	ns	ns	***
year x treat		1998	***	***	***	***	ns	ns	***
year x treat		1999	***	***	***	***	***	***	***
year x treat		2000	***	***	***	***	***	***	***
year x treat		2001	***	***	***	***	***	***	***
year x treat	cont[y]		ns	ns	ns	ns	ns	ns	ns
year x treat	fert 60		ns	ns	ns	ns	ns	ns	ns
year x treat	fert 120		***	*	ns	*	ns	ns	*
year x treat	fert 180		***	***	***	***	***	***	***
year x treat	man 20		*	ns	ns	ns	ns	ns	ns
year x treat	man 40		***	***	ns	ns	ns	ns	*
year x treat	man 60		***	***	***	***	***	***	***
year x treat	man 120		***	***	***	***	***	***	***

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.3. Statistical analysis results of the soil extractable orthophosphate-P data for the coarse-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-0.6 (m)
treatment	***	***	***	*	ns	ns	***
year	***	***	***	***	***	**	***
treatment x year	***	***	***	ns	ns	*	***
Cont-treat	-	-	-	-15*	-10*	-	-
Cont-treat: 1993	ns	ns	ns	-	-	-	ns
Cont-treat: 1994	ns	ns	ns	-	-	-	ns
Cont-treat: 1995	-145**	ns	ns	-	-	-	-178*
Cont-treat: 1996	-192***	ns	ns	-	-	-	-218**
Cont-treat: 1997	-236***	-104**	ns	-	-	-	-370***
Cont-treat: 1998	-181***	-126***	ns	-	-	-	-378***
Cont-treat: 1999	-326***	-135***	-65*	-	-	ns	-526***
Cont-treat: 2000	-434***	-163***	ns	-	-	ns	-644***
Cont-treat: 2001	-533***	-214***	-126***	-	-	-15**	-874***

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-0.6 (m)
year x treat		1993	ns	ns	ns				ns
year x treat		1994	ns	ns	ns				ns
year x treat		1995	**	ns	ns				ns
year x treat		1996	ns	***	ns				***
year x treat		1997	***	***	ns				***
year x treat		1998	***	***	ns				***
year x treat		1999	***	***	***	ns	ns	ns	***
year x treat		2000	***	***	*	ns	ns	ns	***
year x treat		2001	***	***	***	***	**	***	***
year x treat	cont[y]		*	ns	ns	ns	ns	ns	*
year x treat	fert 60		-	-	-	-	-	-	-
year x treat	fert 120		-	-	-	-	-	-	-
year x treat	fert 180		-	-	-	-	-	-	-
year x treat	man 20		ns	***	ns	ns	*	ns	ns
year x treat	man 40		***	***	ns	ns	ns	ns	***
year x treat	man 60		***	***	***	**	*	ns	***
year x treat	man 120		***	***	***	***	***	***	***

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.4. Statistical analysis results of the soil extractable orthophosphate-P data for the medium-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-0.6 (m)
treatment	***	***	***	*	**	ns	***
year	***	***	**	*	ns	ns	***
treatment x year	***	***	***	ns	ns	ns	***
Cont-treat	-	-	-	-3.1*	-4.0**	-	-
Cont-treat: 1993	ns	ns	ns	-	-	-	ns
Cont-treat: 1994	ns	ns	ns	-	-	-	ns
Cont-treat: 1995	ns	ns	ns	-	-	-	ns
Cont-treat: 1996	-149***	ns	ns	-	-	-	156***
Cont-treat: 1997	-285***	ns	ns	-	-	-	-296***
Cont-treat: 1998	-252***	ns	ns	-	-	-	-289***
Cont-treat: 1999	-399***	-19**	ns	-	-	-	-431***
Cont-treat: 2000	-533***	-45***	-6.9**	-	-	-	-584***
Cont-treat: 2001	-524***	-60***	-13***	-	-	-	-597***

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-0.6 (m)
year x treat		1993	ns	ns	ns				ns
year x treat		1994	ns	ns	ns				ns
year x treat		1995	*	ns	ns				*
year x treat		1996	***	ns	ns				***
year x treat		1997	***	ns	ns				***
year x treat		1998	***	ns	**				***
year x treat		1999	***	***	ns	ns	*	**	***
year x treat		2000	***	***	***	*	ns	ns	***
year x treat		2001	***	***	***	***	***	ns	***
year x treat	cont[y]		ns	ns	ns	ns	ns	ns	ns
year x treat	fert 60		-	-	-	-	-	-	
year x treat	fert 120		-	-	-	-	-	-	
year x treat	fert 180		-	-	-	-	-	-	
year x treat	man 20		**	ns	ns	ns	ns	ns	**
year x treat	man 40		***	ns	ns	ns	ns	ns	***
year x treat	man 60		***	ns	***	*	ns	ns	***
year x treat	man 120		***	***	***	*	ns	**	***

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.5. Statistical analysis results of the soil total nitrogen data for the coarse-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	***	ns	ns	ns		
year	***	***	**	*		
treatment x year	***	ns	ns	ns		
Cont-treat	-	ns	ns	ns		
Cont-treat: 1993	ns	-	-	-		
Cont-treat: 1994	ns	-	-	-		
Cont-treat: 1995	ns	-	-	-		
Cont-treat: 1996	ns	-	-	-		
Cont-treat: 1997	-1.64**	-	-	-		
Cont-treat: 1998	-1.51**	-	-	-		
Cont-treat: 1999	-2.05***	-	-	-		
Cont-treat: 2000	-2.60***	-	-	-		
Cont-treat: 2001	-2.46***	-	-	-		

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	ns	ns	ns	ns		
year x treat		1994	*	ns	ns	ns		
year x treat		1995	ns	ns	ns	*		
year x treat		1996	ns	ns	ns	ns		
year x treat		1997	***	ns	ns	ns		
year x treat		1998	***	ns	ns	ns		
year x treat		1999	***	ns	ns	ns		
year x treat		2000	***	*	*	ns		
year x treat		2001	***	ns	ns	ns		
year x treat	cont[y]		ns	*	ns	ns		
year x treat	fert 60		-	-	-	-		
year x treat	fert 120		-	-	-	-		
year x treat	fert 180		-	-	-	-		
year x treat	man 20		*	*	**	*		
year x treat	man 40		**	ns	ns	**		
year x treat	man 60		***	*	***	***		
year x treat	man 120		***	ns	**	**		

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.6. Statistical analysis results of the soil total nitrogen data for the medium-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	***	ns	ns	ns		
year	***	***	***	***		
treatment x year	*	ns	ns	ns		
Cont-treat	-	ns	ns	ns		
Cont-treat: 1993	ns	-	-	-		
Cont-treat: 1994	ns	-	-	-		
Cont-treat: 1995	ns	-	-	-		
Cont-treat: 1996	ns	-	-	-		
Cont-treat: 1997	-2.53**	-	-	-		
Cont-treat: 1998	-1.69*	-	-	-		
Cont-treat: 1999	-2.58**	-	-	-		
Cont-treat: 2000	-1.64*	-	-	-		
Cont-treat: 2001	-3.24***	-	-	-		

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	ns	ns	ns	ns		
year x treat		1994	*	ns	ns	ns		
year x treat		1995	*	ns	ns	*		
year x treat		1996	ns	ns	ns	ns		
year x treat		1997	***	ns	ns	ns		
year x treat		1998	*	ns	ns	ns		
year x treat		1999	**	ns	ns	ns		
year x treat		2000	ns	**	***	*		
year x treat		2001	***	*	ns	*		
year x treat	cont[y]		*	**	ns	ns		
year x treat	fert 60		-	-	-	-		
year x treat	fert 120		-	-	-	-		
year x treat	fert 180		-	-	-	-		
year x treat	man 20		***	***	ns	ns		
year x treat	man 40		***	ns	ns	*		
year x treat	man 60		***	ns	ns	***		
year x treat	man 120		***	***	***	ns		

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.7. Statistical analysis results of the soil total phosphorus data for the coarse-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	***	***	ns	ns		
year	***	***	***	***		
treatment x year	***	***	ns	ns		
Cont-treat	-	ns	ns	ns		
Cont-treat: 1993	ns	ns	-	-		
Cont-treat: 1994	ns	ns	-	-		
Cont-treat: 1995	ns	ns	-	-		
Cont-treat: 1996	-0.44***	ns	-	-		
Cont-treat: 1997	-0.26*	ns	-	-		
Cont-treat: 1998	-0.46***	-0.26***	-	-		
Cont-treat: 1999	-0.83***	-0.25**	-	-		
Cont-treat: 2000	-0.84***	-0.29***	-	-		
Cont-treat: 2001	-0.92***	-0.32***	-	-		

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	ns	ns	ns	ns		
year x treat		1994	ns	ns	ns	ns		
year x treat		1995	ns	ns	ns	ns		
year x treat		1996	***	ns	ns	ns		
year x treat		1997	***	*	ns	ns		
year x treat		1998	***	**	ns	ns		
year x treat		1999	***	***	ns	ns		
year x treat		2000	***	***	ns	ns		
year x treat		2001	***	***	***	ns		
year x treat	cont[y]		**	ns	ns	*		
year x treat	fert 60		-	-	-	-		
year x treat	fert 120		-	-	-	-		
year x treat	fert 180		-	-	-	-		
year x treat	man 20		ns	ns	*	ns		
year x treat	man 40		***	**	ns	ns		
year x treat	man 60		***	***	***	ns		
year x treat	man 120		***	***	***	**		

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.8. Statistical analysis results of the soil total phosphorus data for the medium-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	***	***	ns	ns		
year	***	***	***	***		
treatment x year	***	***	ns	ns		
Cont-treat			ns	ns		
Cont-treat: 1993	ns	ns	-	-		
Cont-treat: 1994	ns	ns	-	-		
Cont-treat: 1995	ns	ns	-	-		
Cont-treat: 1996	ns	ns	-	-		
Cont-treat: 1997	-0.50**	ns	-	-		
Cont-treat: 1998	-0.42*	ns	-	-		
Cont-treat: 1999	-0.70**	ns	-	-		
Cont-treat: 2000	-0.76*	ns	-	-		
Cont-treat: 2001	-0.94***	ns	-	-		

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	ns	ns	ns	ns		
year x treat		1994	ns	ns	ns	ns		
year x treat		1995	ns	*	ns	ns		
year x treat		1996	ns	ns	ns	ns		
year x treat		1997	***	ns	ns	ns		
year x treat		1998	***	ns	ns	ns		
year x treat		1999	***	ns	ns	ns		
year x treat		2000	***	***	ns	ns		
year x treat		2001	***	***	ns	ns		
year x treat	cont[y]		ns	ns	*	ns		
year x treat	fert 60		-	-	-	-		
year x treat	fert 120		-	-	-	-		
year x treat	fert 180		-	-	-	-		
year x treat	man 20		ns	ns	*	**		
year x treat	man 40		***	ns	ns	ns		
year x treat	man 60		***	ns	*	ns		
year x treat	man 120		***	***	ns	ns		

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.9. Statistical analysis results of the soil extractable calcium data for the coarse-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	***	*	***	*	**	ns
year	***	***	***	***	***	***
treatment x year	***	**	***	*	ns	ns
Cont-treat					ns	89.4*
Cont-treat: 1993	ns	ns	ns	ns	-	-
Cont-treat: 1994	ns	ns	46.8*	97.2**	-	-
Cont-treat: 1995	ns	ns	-59.7**	ns	-	-
Cont-treat: 1996	ns	ns	-23.1**	ns	-	-
Cont-treat: 1997	ns	ns	ns	ns	-	-
Cont-treat: 1998	-16.6*	ns	ns	ns	-	-
Cont-treat: 1999	-20.9**	ns	ns	ns	-	-
Cont-treat: 2000	-19.1*	-17.4**	-93.6***	-74.7*	-	-
Cont-treat: 2001	ns	ns	ns	-45.1*	-	-

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	ns
year x treat		1994	ns	***	**	ns	ns	ns
year x treat		1995	ns	*	*	ns	ns	ns
year x treat		1996	ns	ns	ns	ns	ns	ns
year x treat		1997	***	ns	ns	ns	ns	ns
year x treat		1998	***	ns	ns	ns	ns	ns
year x treat		1999	***	ns	ns	ns	ns	**
year x treat		2000	***	***	***	***	***	**
year x treat		2001	*	ns	*	***	***	ns
year x treat	cont[y]		ns	**	ns	***	**	**
year x treat	fert 60		ns	***	ns	ns	*	ns
year x treat	fert 120		ns	**	ns	ns	ns	ns
year x treat	fert 180		*	**	ns	ns	ns	ns
year x treat	man 20		ns	***	ns	ns	ns	ns
year x treat	man 40		**	***	*	ns	ns	ns
year x treat	man 60		***	***	***	***	*	ns
year x treat	man 120		***	***	***	***	***	**

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.10. Statistical analysis results of the soil extractable calcium data for the medium-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	ns	ns	ns	ns	ns	ns
year	***	***	***	*	ns	ns
treatment x year	ns	**	*	**	ns	ns
Cont-treat	-24.2*				ns	ns
Cont-treat: 1993	-	ns	ns	ns	-	-
Cont-treat: 1994	-	ns	ns	ns	-	-
Cont-treat: 1995	-	-98*	ns	ns	-	-
Cont-treat: 1996	-	ns	-322*	ns	-	-
Cont-treat: 1997	-	ns	ns	ns	-	-
Cont-treat: 1998	-	-79.1*	ns	ns	-	-
Cont-treat: 1999	-	ns	ns	-326*	-	-
Cont-treat: 2000	-	ns	-384**	-288*	-	-
Cont-treat: 2001	-	-66.4**	-275**	-214*	-	-

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	ns
year x treat		1994	*	ns	ns	ns	ns	ns
year x treat		1995	ns	ns	ns	ns	ns	ns
year x treat		1996	ns	ns	ns	ns	ns	ns
year x treat		1997	ns	ns	ns	ns	ns	ns
year x treat		1998	ns	ns	ns	ns	ns	ns
year x treat		1999	ns	ns	ns	*	ns	ns
year x treat		2000	ns	**	**	**	ns	ns
year x treat		2001	ns	***	**	ns	ns	ns
year x treat	cont[y]		ns	ns	ns	ns	ns	ns
year x treat	fert 60		**	***	*	ns	ns	ns
year x treat	fert 120		***	ns	ns	ns	ns	ns
year x treat	fert 180		**	ns	ns	ns	ns	ns
year x treat	man 20		*	ns	ns	ns	ns	ns
year x treat	man 40		ns	ns	*	ns	ns	ns
year x treat	man 60		ns	***	**	*	ns	ns
year x treat	man 120		ns	*	***	***	ns	ns

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^1 N fertilizer ; fert 120 = 120 kg ha^{-1} yr^1 N fertilizer ; fert 180 = 180 kg ha^{-1} yr^1 N fertilizer ; man 20 = 20 Mg ha^{-1} yr^1 manure; man 40 = 40 Mg ha^{-1} yr^1 manure; man 60 = 60 Mg ha^{-1} yr^1 manure; man 120 = 120 Mg ha^{-1} yr^1 manure.

Table 12.11. Statistical analysis results of the soil extractable magnesium data for the coarse-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	***	***	***	ns	*	ns
year	***	***	***	***	***	*
treatment x year	***	***	***	ns	ns	ns
Cont-treat				ns	ns	112*
Cont-treat: 1993	ns	ns	ns	-	-	-
Cont-treat: 1994	ns	ns	ns	-	-	-
Cont-treat: 1995	-8.2**	ns	-18.7**	-	-	-
Cont-treat: 1996	ns	ns	ns	-	-	-
Cont-treat: 1997	-8.6**	ns	ns	-	-	-
Cont-treat: 1998	-12.6***	ns	ns	-	-	-
Cont-treat: 1999	-15.4***	ns	ns	-	-	-
Cont-treat: 2000	-13.1***	-9.3***	-19.5**	-	-	-
Cont-treat: 2001	-5.2*	-2.9*	ns	-	-	-

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	ns
year x treat		1994	ns	ns	ns	ns	ns	*
year x treat		1995	***	***	***	***	*	ns
year x treat		1996	*	ns	ns	ns	ns	*
year x treat		1997	***	ns	ns	ns	ns	ns
year x treat		1998	***	ns	ns	ns	ns	ns
year x treat		1999	***	***	ns	ns	ns	ns
year x treat		2000	***	***	***	*	***	**
year x treat		2001	***	***	*	**	ns	ns
year x treat	cont[y]		ns	ns	ns	**	***	***
year x treat	fert 60		ns	ns	ns	ns	ns	ns
year x treat	fert 120		ns	ns	ns	ns	ns	ns
year x treat	fert 180		ns	ns	ns	ns	ns	ns
year x treat	man 20		ns	ns	ns	ns	ns	ns
year x treat	man 40		***	*	ns	ns	ns	ns
year x treat	man 60		***	***	***	**	ns	ns
year x treat	man 120		***	***	***	***	***	*

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.12. Statistical analysis results of the soil extractable magnesium data for the medium-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	***	ns	ns	ns	ns	ns
year	***	***	***	***	ns	**
treatment x year	***	**	ns	ns	ns	**
Cont-treat			-168*	-265*	ns	
Cont-treat: 1993	ns	ns	-	-	-	ns
Cont-treat: 1994	-11.3**	ns	-	-	-	ns
Cont-treat: 1995	ns	-26*	-	-	-	ns
Cont-treat: 1996	ns	ns	-	-	-	-332*
Cont-treat: 1997	-13.4**	ns	-	-	-	ns
Cont-treat: 1998	-8.8*	ns	-	-	-	ns
Cont-treat: 1999	-14.1**	ns	-	-	-	-314*
Cont-treat: 2000	-11.0*	ns	-	-	-	ns
Cont-treat: 2001	-8.3**	-20.1*	-	-	-	-265**

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	ns
year x treat		1994	*	ns	ns	ns	ns	ns
year x treat		1995	ns	ns	ns	ns	ns	ns
year x treat		1996	**	ns	ns	ns	ns	ns
year x treat		1997	***	**	ns	ns	ns	ns
year x treat		1998	***	ns	ns	ns	ns	ns
year x treat		1999	***	ns	ns	ns	*	ns
year x treat		2000	***	ns	ns	ns	ns	*
year x treat		2001	***	**	ns	ns	*	**
year x treat	cont[y]		ns	ns	ns	ns	*	ns
year x treat	fert 60		ns	**	**	*	ns	ns
year x treat	fert 120		**	***	*	ns	ns	**
year x treat	fert 180		ns	ns	**	ns	ns	ns
year x treat	man 20		***	ns	ns	ns	ns	ns
year x treat	man 40		**	ns	ns	ns	ns	ns
year x treat	man 60		***	***	**	*	ns	*
year x treat	man 120		***	ns	ns	**	***	***

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.13. Statistical analysis results of the soil extractable sodium data for the coarse-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-1.5 (m)
treatment	***	***	***	***	***	ns	***
year	***	***	***	***	*	**	***
treatment x year	***	***	***	***	***	ns	***
Cont-treat						ns	
Cont-treat: 1993	ns	ns	ns	ns	ns	-	ns
Cont-treat: 1994	-11**	-7.6*	ns	ns	67**	-	201*
Cont-treat: 1995	-24***	-16***	-23*	ns	ns	-	ns
Cont-treat: 1996	-11**	-13***	ns	ns	ns	-	ns
Cont-treat: 1997	ns	ns	ns	ns	ns	-	ns
Cont-treat: 1998	ns	-9.5**	-27*	ns	ns	-	ns
Cont-treat: 1999	ns	ns	ns	-29*	ns	-	ns
Cont-treat: 2000	-22***	-25***	-35**	-35*	ns	-	-129*
Cont-treat: 2001	-12***	-12***	-25**	-28**	-29*	-	-188**

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	ns	ns
year x treat		1994	***	***	ns	ns	*	**	**
year x treat		1995	***	***	***	**	ns	ns	***
year x treat		1996	***	***	***	**	ns	*	***
year x treat		1997	***	***	**	***	ns	ns	*
year x treat		1998	***	***	***	***	***	ns	***
year x treat		1999	***	***	***	***	*	ns	***
year x treat		2000	***	***	***	***	***	**	***
year x treat		2001	***	***	***	***	***	ns	***
year x treat	cont[y]		ns	ns	***	***	***	***	***
year x treat	fert 60		ns	ns	***	***	ns	ns	ns
year x treat	fert 120		ns	ns	**	***	ns	ns	ns
year x treat	fert 180		ns	ns	***	***	ns	ns	ns
year x treat	man 20		**	***	**	*	ns	ns	ns
year x treat	man 40		***	***	ns	*	ns	ns	ns
year x treat	man 60		***	***	***	***	***	ns	***
year x treat	man 120		***	***	***	***	**	**	***

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.14. Statistical analysis results of the soil extractable sodium data for the medium-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-1.5 (m)
treatment	***	***	***	ns	ns	ns	*
year	***	***	***	***	***	***	***
treatment x year	***	***	***	***	***	*	***
Cont-treat							
Cont-treat: 1993	ns	ns	ns	ns	ns	ns	ns
Cont-treat: 1994	-19***	-21*	ns	ns	ns	ns	ns
Cont-treat: 1995	-32***	-34**	ns	ns	ns	ns	ns
Cont-treat: 1996	-28***	-34**	-118**	-132*	ns	ns	-538*
Cont-treat: 1997	-25***	-34***	-123**	ns	ns	ns	ns
Cont-treat: 1998	-29***	-51***	-146***	-134*	ns	ns	-483*
Cont-treat: 1999	-14**	-22*	-93*	-145*	124*	ns	-489*
Cont-treat: 2000	-27***	-34***	-138**	-173**	ns	ns	-588**
Cont-treat: 2001	-19***	-31***	-113***	-122**	-97*	-102*	-762***

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	ns	ns
year x treat		1994	***	ns	ns	ns	ns	ns	ns
year x treat		1995	***	***	ns	ns	ns	ns	ns
year x treat		1996	***	***	*	ns	ns	ns	*
year x treat		1997	***	***	**	ns	ns	ns	ns
year x treat		1998	***	***	***	ns	ns	ns	*
year x treat		1999	***	***	***	*	ns	ns	*
year x treat		2000	***	***	***	***	*	ns	***
year x treat		2001	***	***	***	***	**	**	***
year x treat	cont[y]		ns	ns	ns	ns	ns	ns	ns
year x treat	fert 60		*	***	***	***	ns	**	**
year x treat	fert 120		**	ns	ns	ns	ns	ns	ns
year x treat	fert 180		ns	ns	ns	ns	ns	ns	ns
year x treat	man 20		***	ns	ns	ns	ns	ns	ns
year x treat	man 40		***	***	***	**	**	*	***
year x treat	man 60		***	***	***	***	***	***	***
year x treat	man 120		***	***	***	***	***	**	***

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.15. Statistical analysis results of the soil extractable potassium data for the coarse-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-1.5 (m)
treatment	***	***	***	***	**	**	***
year	***	***	***	***	***	***	***
treatment x year	***	***	***	***	**	***	***
Cont-treat							
Cont-treat: 1993	ns	ns	ns	ns	ns	ns	ns
Cont-treat: 1994	ns	ns	ns	ns	ns	ns	ns
Cont-treat: 1995	-61***	ns	ns	ns	ns	ns	-79*
Cont-treat: 1996	-57**	ns	ns	ns	ns	ns	-71*
Cont-treat: 1997	-66***	-29**	ns	ns	ns	ns	-102**
Cont-treat: 1998	-73***	-34***	ns	ns	ns	ns	-132***
Cont-treat: 1999	-71***	-36***	-39*	ns	ns	ns	-149***
Cont-treat: 2000	-105***	-58***	-69***	ns	ns	ns	-248***
Cont-treat: 2001	-62***	-30***	-47***	-19*	-5.2*	ns	-265***

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	ns	ns
year x treat		1994	***	ns	ns	ns	ns	ns	ns
year x treat		1995	***	ns	ns	ns	***	ns	***
year x treat		1996	***	***	ns	ns	ns	ns	***
year x treat		1997	***	***	ns	ns	ns	ns	***
year x treat		1998	***	***	***	ns	*	ns	***
year x treat		1999	***	***	***	ns	ns	*	***
year x treat		2000	***	***	***	***	ns	ns	***
year x treat		2001	***	***	***	***	***	***	***
year x treat	cont[y]		ns	ns	ns	ns	***	***	ns
year x treat	fert 60		*	ns	ns	ns	ns	ns	ns
year x treat	fert 120		ns	ns	ns	ns	ns	ns	ns
year x treat	fert 180		ns	ns	ns	ns	ns	ns	ns
year x treat	man 20		ns	ns	ns	ns	ns	ns	ns
year x treat	man 40		***	***	ns	ns	ns	ns	***
year x treat	man 60		***	***	***	ns	***	*	***
year x treat	man 120		***	***	***	***	***	***	***

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.16. Statistical analysis results of the soil extractable potassium data for the medium-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-0.3 (m)
treatment	***	***	*	ns	**	*	***
year	***	***	***	***	***	***	***
treatment x year	***	***	ns	ns	ns	ns	***
Cont-treat			-5.5*	-7.7*	-9.4*	ns	
Cont-treat: 1993	ns	ns	-	-	-	-	ns
Cont-treat: 1994	ns	ns	-	-	-	-	ns
Cont-treat: 1995	ns	ns	-	-	-	-	ns
Cont-treat: 1996	-37**	ns	-	-	-	-	-39*
Cont-treat: 1997	-60***	ns	-	-	-	-	-64***
Cont-treat: 1998	-60***	ns	-	-	-	-	-66***
Cont-treat: 1999	-70***	-10*	-	-	-	-	-80***
Cont-treat: 2000	-97***	-25***	-	-	-	-	-121***
Cont-treat: 2001	-50***	-17***	-	-	-	-	-105***

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	ns	ns
year x treat		1994	ns	ns	ns	ns	ns	ns	ns
year x treat		1995	***	ns	ns	ns	ns	ns	**
year x treat		1996	***	ns	ns	ns	ns	ns	***
year x treat		1997	***	ns	ns	ns	ns	ns	***
year x treat		1998	***	***	ns	***	***	**	***
year x treat		1999	***	***	ns	**	***	*	***
year x treat		2000	***	***	ns	ns	**	**	***
year x treat		2001	***	***	***	**	***	**	***
year x treat	cont[y]		ns	ns	ns	ns	**	***	ns
year x treat	fert 60		ns	ns	***	***	*	**	ns
year x treat	fert 120		ns	ns	ns	*	*	***	ns
year x treat	fert 180		ns	ns	ns	*	**	ns	ns
year x treat	man 20		**	ns	ns	ns	*	*	*
year x treat	man 40		***	ns	ns	*	*	*	***
year x treat	man 60		***	***	ns	***	***	***	***
year x treat	man 120		***	***	**	***	***	***	***

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.

[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.17. Statistical analysis results of the soil extractable chloride data for the coarse-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-1.5 (m)
treatment	***	***	***	***	***	***	***
year	***	***	***	***	***	***	***
treatment x year	***	***	***	***	***	***	***
Cont-treat							
Cont-treat: 1993	ns	ns	ns	ns	ns	ns	ns
Cont-treat: 1994	-15*	-15*	-49*	ns	ns	ns	ns
Cont-treat: 1995	-32***	-15*	-125***	ns	ns	ns	-244***
Cont-treat: 1996	ns	ns	ns	-88*	-87*	ns	-248**
Cont-treat: 1997	-17**	ns	ns	ns	ns	ns	ns
Cont-treat: 1998	ns	ns	ns	ns	ns	ns	-184*
Cont-treat: 1999	ns	ns	ns	ns	ns	ns	ns
Cont-treat: 2000	-32***	-34***	-111***	-85*	ns	ns	-364***
Cont-treat: 2001	-7.6***	ns	-30*	-47*	-59*	-67**	-344***

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	ns	ns
year x treat		1994	***	***	***	ns	ns	ns	**
year x treat		1995	***	***	***	***	*	ns	***
year x treat		1996	ns	ns	ns	***	***	***	***
year x treat		1997	***	ns	ns	ns	ns	ns	ns
year x treat		1998	***	ns	ns	*	***	***	***
year x treat		1999	***	ns	ns	ns	ns	*	**
year x treat		2000	***	***	***	***	***	***	***
year x treat		2001	***	***	***	***	***	***	***
year x treat	cont[y]		**	ns	ns	ns	*	**	*
year x treat	fert 60		*	ns	ns	ns	***	***	***
year x treat	fert 120		**	ns	ns	ns	*	***	***
year x treat	fert 180		ns	ns	ns	ns	**	***	***
year x treat	man 20		***	**	ns	ns	*	*	**
year x treat	man 40		***	***	***	***	*	**	**
year x treat	man 60		***	***	***	***	***	***	***
year x treat	man 120		***	***	***	***	***	***	***

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.18. Statistical analysis results of the soil extractable chloride data for the medium-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-1.5 (m)
treatment	***	***	***	***	***	***	***
year	***	***	***	***	***	***	***
treatment x year	***	***	***	***	***	***	***
Cont-treat							
Cont-treat: 1993	ns	ns	ns	ns	ns	ns	ns
Cont-treat: 1994	-32***	-34*	ns	ns	ns	ns	ns
Cont-treat: 1995	-61***	-80***	-106*	ns	ns	ns	-269*
Cont-treat: 1996	-19*	-46**	-225***	-123**	ns	ns	-423***
Cont-treat: 1997	ns	ns	-169***	-190***	-72**	ns	-481***
Cont-treat: 1998	ns	-68***	-201***	-214***	-110***	ns	-651***
Cont-treat: 1999	ns	ns	-129**	-257***	-224***	-132***	-769***
Cont-treat: 2000	-25**	-46**	-188***	-220***	-198***	-171***	-848***
Cont-treat: 2001	ns	-41***	-148***	-135***	-120***	-108***	-883***

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)	0-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	ns	ns
year x treat		1994	***	***	ns	ns	ns	ns	ns
year x treat		1995	***	***	***	ns	ns	ns	***
year x treat		1996	***	***	***	***	ns	ns	***
year x treat		1997	***	***	***	***	***	ns	***
year x treat		1998	***	***	***	***	***	***	***
year x treat		1999	***	ns	***	***	***	***	***
year x treat		2000	***	***	***	***	***	***	***
year x treat		2001	***	***	***	***	***	***	***
year x treat	cont[y]		*	ns	ns	ns	ns	ns	ns
year x treat	fert 60		ns	ns	ns	ns	ns	ns	ns
year x treat	fert 120		**	ns	ns	ns	ns	ns	ns
year x treat	fert 180		*	ns	ns	ns	ns	ns	ns
year x treat	man 20		***	ns	ns	ns	*	ns	*
year x treat	man 40		***	***	***	***	***	***	***
year x treat	man 60		***	***	***	***	***	***	***
year x treat	man 120		***	***	***	***	***	***	***

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.19. Statistical analysis results of the soil extractable sulphate-S data for the coarse-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	***	***	***	ns	*	ns
year	***	***	**	***	**	ns
treatment x year	**	***	*	ns	ns	ns
Cont-treat					80**	
Cont-treat: 1993	ns	ns	ns	-	-	-
Cont-treat: 1994	ns	ns	58***	-	-	-
Cont-treat: 1995	-10*	-8.6**	ns	-	-	-
Cont-treat: 1996	-10*	ns	ns	-	-	-
Cont-treat: 1997	-12**	ns	ns	-	-	-
Cont-treat: 1998	-10*	ns	ns	-	-	-
Cont-treat: 1999	-14*	-6.6 *	ns	-	-	-
Cont-treat: 2000	-	-	-	-	-	-
Cont-treat: 2001	-	-	-	-	-	-

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	*	ns	ns	ns	ns	ns
year x treat		1994	***	***	***	***	***	**
year x treat		1995	***	***	ns	ns	ns	ns
year x treat		1996	***	***	ns	ns	ns	ns
year x treat		1997	***	***	ns	ns	ns	ns
year x treat		1998	***	***	***	ns	ns	ns
year x treat		1999	***	***	*	ns	ns	ns
year x treat		2000	-	-	-	-	-	-
year x treat		2001	-	-	-	-	-	-
year x treat	cont[y]		**	**	***	***	***	***
year x treat	fert 60		*	ns	ns	ns	ns	ns
year x treat	fert 120		ns	ns	ns	ns	ns	ns
year x treat	fert 180		ns	ns	ns	ns	ns	ns
year x treat	man 20		ns	ns	ns	ns	ns	ns
year x treat	man 40		ns	ns	ns	ns	ns	ns
year x treat	man 60		ns	ns	ns	ns	ns	ns
year x treat	man 120		***	***	**	ns	ns	ns

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.20. Statistical analysis results of the soil extractable sulphate-S data for the medium-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	ns	ns	ns	ns	ns	ns
year	**	***	***	***	**	*
treatment x year	ns	*	ns	ns	ns	ns
Cont-treat	-30*		-415*	ns	ns	ns
Cont-treat: 1993	-	ns	-	-	-	-
Cont-treat: 1994	-	ns	-	-	-	-
Cont-treat: 1995	-	ns	-	-	-	-
Cont-treat: 1996	-	ns	-	-	-	-
Cont-treat: 1997	-	ns	-	-	-	-
Cont-treat: 1998	-	ns	-	-	-	-
Cont-treat: 1999	-	ns	-	-	-	-
Cont-treat: 2000	-	-	-	-	-	-
Cont-treat: 2001	-	-	-	-	-	-

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	ns
year x treat		1994	ns	ns	ns	ns	ns	ns
year x treat		1995	ns	**	ns	ns	ns	ns
year x treat		1996	ns	ns	ns	ns	ns	ns
year x treat		1997	ns	ns	ns	ns	ns	ns
year x treat		1998	ns	ns	ns	ns	ns	ns
year x treat		1999	ns	ns	ns	ns	ns	ns
year x treat		2000	-	-	-	-	-	-
year x treat		2001	-	-	-	-	-	-
year x treat	cont[y]		ns	ns	ns	*	**	*
year x treat	fert 60		ns	***	***	**	ns	ns
year x treat	fert 120		**	**	ns	ns	ns	*
year x treat	fert 180		ns	ns	**	ns	ns	ns
year x treat	man 20		ns	ns	*	*	ns	ns
year x treat	man 40		ns	ns	ns	ns	ns	ns
year x treat	man 60		ns	ns	*	ns	ns	ns
year x treat	man 120		ns	ns	ns	ns	ns	ns

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.21. Statistical analysis results of the soil extractable bicarbonate data for the coarse-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	***	***	ns	ns	ns	ns
year	***	***	***	***	***	***
treatment x year	***	***	***	ns	ns	ns
Cont-treat						
Cont-treat: 1993	ns	ns	ns	-	-	-
Cont-treat: 1994	ns	ns	ns	-	-	-
Cont-treat: 1995	-68**	ns	-42*	-	-	-
Cont-treat: 1996	-54*	ns	ns	-	-	-
Cont-treat: 1997	-77**	ns	ns	-	-	-
Cont-treat: 1998	ns	ns	ns	-	-	-
Cont-treat: 1999	-122***	ns	-38*	-	-	-
Cont-treat: 2000	-	-	-	-	-	-
Cont-treat: 2001	-	-	-	-	-	-

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	ns
year x treat		1994	ns	ns	ns	ns	ns	ns
year x treat		1995	***	ns	**	ns	ns	ns
year x treat		1996	***	***	ns	ns	ns	ns
year x treat		1997	***	***	ns	ns	ns	ns
year x treat		1998	***	***	*	ns	ns	ns
year x treat		1999	***	***	***	ns	ns	ns
year x treat		2000	-	-	-	-	-	-
year x treat		2001	-	-	-	-	-	-
year x treat	cont[y]		***	***	***	***	***	***
year x treat	fert 60		***	***	***	***	***	***
year x treat	fert 120		***	***	***	***	***	***
year x treat	fert 180		***	***	***	***	***	***
year x treat	man 20		***	***	***	***	***	***
year x treat	man 40		***	***	***	***	***	***
year x treat	man 60		***	***	***	***	***	***
year x treat	man 120		***	***	***	***	***	***

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.22. Statistical analysis results of the soil extractable bicarbonate data for the medium-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	***	**	ns	ns	ns	ns
year	***	***	***	***	***	***
treatment x year	***	ns	ns	*	ns	ns
Cont-treat						
Cont-treat: 1993	ns	ns	43*		ns	ns
Cont-treat: 1994	ns	-	-	ns	-	-
Cont-treat: 1995	-74*	-	-	ns	-	-
Cont-treat: 1996	-86**	-	-	ns	-	-
Cont-treat: 1997	-170***	-	-	ns	-	-
Cont-treat: 1998	-78**	-	-	ns	-	-
Cont-treat: 1999	-155***	-	-	ns	-	-
Cont-treat: 2000	-	-	-	-	-	-
Cont-treat: 2001	-	-	-	-	-	-

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	ns	ns	ns	ns	***	ns
year x treat		1994	ns	ns	ns	ns	ns	ns
year x treat		1995	***	ns	ns	ns	ns	ns
year x treat		1996	***	ns	ns	ns	ns	ns
year x treat		1997	***	*	***	ns	ns	ns
year x treat		1998	***	**	ns	ns	ns	ns
year x treat		1999	***	***	*	**	ns	ns
year x treat		2000	-	-	-	-	-	-
year x treat		2001	-	-	-	-	-	-
year x treat	cont [y]		***	***	***	***	***	***
year x treat	fert 60		***	***	***	***	***	***
year x treat	fert 120		***	***	***	***	***	***
year x treat	fert 180		***	***	***	***	***	***
year x treat	man 20		***	***	***	***	***	***
year x treat	man 40		***	***	***	***	***	***
year x treat	man 60		***	***	***	***	***	***
year x treat	man 120		***	***	***	***	***	***

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.23. Statistical analysis results of the soil sodium adsorption ratio data for the coarse-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	***	***	***	***	***	*
year	***	***	***	***	***	***
treatment x year	***	***	***	***	*	ns
Cont-treat						
Cont-treat: 1993	ns	ns	-0.4*	ns	ns	ns
Cont-treat: 1994	-0.3***	-0.2**	-0.4*	ns	ns	-
Cont-treat: 1995	-0.6***	-0.6***	ns	ns	ns	-
Cont-treat: 1996	-0.3**	-0.5***	ns	ns	ns	-
Cont-treat: 1997	ns	-0.2*	ns	ns	ns	-
Cont-treat: 1998	ns	-0.3***	-0.4*	ns	ns	-
Cont-treat: 1999	ns	-0.2*	-0.3*	-0.5*	-0.4*	-
Cont-treat: 2000	-0.4***	-0.6***	ns	ns	ns	-
Cont-treat: 2001	-0.2***	-0.4***	-0.3**	-0.3*	ns	-

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	ns	ns	***	**	ns	*
year x treat		1994	***	***	***	**	ns	ns
year x treat		1995	***	***	***	ns	ns	ns
year x treat		1996	***	***	***	**	ns	ns
year x treat		1997	ns	***	***	***	***	ns
year x treat		1998	***	***	***	***	***	ns
year x treat		1999	ns	***	***	***	***	ns
year x treat		2000	***	***	***	***	***	**
year x treat		2001	***	***	***	***	***	*
year x treat	cont[y]		ns	ns	***	***	*	**
year x treat	fert 60		ns	ns	***	***	***	**
year x treat	fert 120		ns	ns	***	***	ns	**
year x treat	fert 180		ns	ns	***	***	ns	ns
year x treat	man 20		***	***	***	*	ns	*
year x treat	man 40		***	***	ns	ns	ns	ns
year x treat	man 60		***	***	**	ns	***	**
year x treat	man 120		***	***	*	**	***	***

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.24. Statistical analysis results of the soil sodium adsorption ratio data for the medium-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	***	***	***	ns	ns	ns
year	***	***	***	***	***	***
treatment x year	***	***	***	***	ns	ns
Cont-treat						
Cont-treat: 1993	ns	ns	ns	ns	-	-
Cont-treat: 1994	-0.2*	ns	ns	ns	-	-
Cont-treat: 1995	-0.5***	-0.2*	ns	ns	-	-
Cont-treat: 1996	-0.5***	-0.4***	ns	ns	-	-
Cont-treat: 1997	-0.3***	-0.5***	ns	ns	-	-
Cont-treat: 1998	-0.4***	-0.6***	-0.4*	ns	-	-
Cont-treat: 1999	-0.2*	-0.3**	ns	ns	-	-
Cont-treat: 2000	-0.4***	-0.3***	ns	*	-	-
Cont-treat: 2001	-0.3***	-0.3***	-0.3**	ns	-	-

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	ns
year x treat		1994	***	ns	**	ns	ns	ns
year x treat		1995	***	***	ns	ns	ns	ns
year x treat		1996	***	***	ns	ns	ns	ns
year x treat		1997	***	***	***	ns	ns	ns
year x treat		1998	***	***	***	ns	ns	ns
year x treat		1999	***	***	***	*	ns	ns
year x treat		2000	***	***	***	***	ns	ns
year x treat		2001	***	***	***	***	ns	ns
year x treat	cont[y]		ns	*	ns	**	*	ns
year x treat	fert 60		ns	***	*	***	*	*
year x treat	fert 120		ns	***	ns	*	ns	ns
year x treat	fert 180		ns	***	**	ns	ns	ns
year x treat	man 20		***	**	*	**	ns	ns
year x treat	man 40		***	***	***	***	***	***
year x treat	man 60		***	***	***	***	***	***
year x treat	man 120		***	***	***	***	***	*

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.25. Statistical analysis results of the soil pH data for the coarse-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	ns	ns	ns	ns	ns	ns
year	***	***	***	***	***	***
treatment x year	*	ns	*	ns	ns	ns
Cont-treat		-		-	-	-
Cont-treat: 1993	ns	-	-0.1*	-	-	-
Cont-treat: 1994	ns	-	ns	-	-	-
Cont-treat: 1995	ns	-	0.1*	-	-	-
Cont-treat: 1996	ns	-	ns	-	-	-
Cont-treat: 1997	0.2*	-	0.1*	-	-	-
Cont-treat: 1998	ns	-	ns	-	-	-
Cont-treat: 1999	ns	-	ns	-	-	-
Cont-treat: 2000	0.2*	-	ns	-	-	-
Cont-treat: 2001	ns	-	ns	-	-	-

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	*
year x treat		1994	ns	ns	ns	ns	ns	ns
year x treat		1995	ns	ns	**	ns	ns	ns
year x treat		1996	ns	ns	ns	ns	ns	ns
year x treat		1997	*	*	*	ns	ns	ns
year x treat		1998	ns	ns	ns	ns	ns	ns
year x treat		1999	ns	ns	ns	**	ns	ns
year x treat		2000	ns	ns	*	ns	ns	ns
year x treat		2001	ns	ns	ns	ns	ns	ns
year x treat	cont[y]		***	***	***	***	***	***
year x treat	fert 60		***	***	***	***	***	***
year x treat	fert 120		***	***	***	***	***	***
year x treat	fert 180		***	***	***	***	***	***
year x treat	man 20		***	***	***	***	***	***
year x treat	man 40		***	***	***	***	***	***
year x treat	man 60		***	***	***	***	***	***
year x treat	man 120		***	***	***	***	***	***

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.26. Statistical analysis results of the soil pH data for the medium-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	**	**	***	*	ns	ns
year	***	***	***	***	***	***
treatment x year	ns	*	**	ns	ns	ns
Cont-treat	ns			ns	-	-
Cont-treat: 1993	-	ns	ns	-	-	-
Cont-treat: 1994	-	ns	ns	-	-	-
Cont-treat: 1995	-	0.2**	0.2**	-	-	-
Cont-treat: 1996	-	ns	ns	-	-	-
Cont-treat: 1997	-	ns	ns	-	-	-
Cont-treat: 1998	-	ns	ns	-	-	-
Cont-treat: 1999	-	ns	0.1*	-	-	-
Cont-treat: 2000	-	ns	ns	-	-	-
Cont-treat: 2001	-	0.1*	0.2***	-	-	-

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	ns
year x treat		1994	ns	ns	ns	ns	ns	ns
year x treat		1995	ns	**	*	ns	ns	ns
year x treat		1996	ns	**	***	ns	ns	ns
year x treat		1997	ns	ns	ns	ns	ns	ns
year x treat		1998	ns	ns	ns	*	ns	ns
year x treat		1999	ns	ns	**	*	ns	ns
year x treat		2000	*	ns	***	*	ns	ns
year x treat		2001	***	***	***	***	*	ns
year x treat	cont[y]		***	***	***	***	***	***
year x treat	fert 60		***	***	***	***	***	***
year x treat	fert 120		***	***	***	***	***	***
year x treat	fert 180		***	***	***	***	***	***
year x treat	man 20		***	***	***	ns	*	**
year x treat	man 40		***	***	***	***	***	***
year x treat	man 60		***	***	***	***	***	***
year x treat	man 120		***	***	***	***	***	***

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.27. Statistical analysis results of the soil electrical conductivity data for the coarse-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	***	***	***	***	***	*
year	***	***	***	***	***	***
treatment x year	***	***	***	***	ns	ns
Cont-treat					ns	ns
Cont-treat: 1993	ns	ns	ns	ns	-	-
Cont-treat: 1994	ns	ns	ns	0.3*	-	-
Cont-treat: 1995	-0.4***	-0.2*	-0.4***	ns	-	-
Cont-treat: 1996	-0.1*	ns	ns	ns	-	-
Cont-treat: 1997	-0.3***	ns	ns	ns	-	-
Cont-treat: 1998	-0.3***	-0.2*	ns	ns	-	-
Cont-treat: 1999	-0.3***	-0.1*	ns	ns	-	-
Cont-treat: 2000	-0.5***	-0.5***	-0.6***	-0.4**	-	-
Cont-treat: 2001	-0.2***	-0.1***	-0.2***	-0.3**	-	-

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	ns
year x treat		1994	***	***	***	ns	ns	ns
year x treat		1995	***	***	***	**	*	ns
year x treat		1996	***	**	*	*	ns	ns
year x treat		1997	***	***	ns	ns	ns	ns
year x treat		1998	***	***	***	**	*	ns
year x treat		1999	***	***	***	*	ns	**
year x treat		2000	***	***	***	***	***	**
year x treat		2001	***	***	***	***	***	**
year x treat	cont[y]		***	**	ns	***	***	***
year x treat	fert 60		***	**	ns	***	***	*
year x treat	fert 120		***	***	ns	**	*	*
year x treat	fert 180		***	**	ns	ns	*	ns
year x treat	man 20		***	***	ns	*	ns	ns
year x treat	man 40		***	***	*	ns	**	ns
year x treat	man 60		***	***	***	***	**	ns
year x treat	man 120		***	***	***	***	***	*

[z]Level of significance: *(P<0.05), ** (P<0.01), and *** (P<0.001). ns = not significant.
[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Table 12.28. Statistical analysis results of the soil electrical conductivity data for the medium-textured site.[z]

	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
treatment	***	**	*	ns	ns	ns
year	***	***	***	***	ns	ns
treatment x year	***	***	***	***	**	*
Cont-treat						
Cont-treat: 1993	ns	ns	ns	ns	ns	-1.2*
Cont-treat: 1994	-0.3**	ns	ns	-1.1*	ns	ns
Cont-treat: 1995	-0.3***	-0.7**	-1.0*	ns	ns	ns
Cont-treat: 1996	-0.2*	ns	-1.4**	-1.4**	-1.5**	-1.3*
Cont-treat: 1997	-0.3**	-0.4*	-1.2*	ns	ns	ns
Cont-treat: 1998	-0.2**	-0.6**	-1.2**	-1.2*	ns	ns
Cont-treat: 1999	-0.3**	ns	-0.9*	-1.4**	-1.5**	-1.3*
Cont-treat: 2000	-0.3**	-0.6**	-1.3**	-1.3**	ns	ns
Cont-treat: 2001	-0.2***	-0.5***	-1.1***	-1.1***	-0.9**	-0.9*

Effect	Treatment	Year	0-0.15 (m)	0.15-0.3 (m)	0.3-0.6 (m)	0.6-0.9 (m)	0.9-1.2 (m)	1.2-1.5 (m)
year x treat		1993	ns	ns	ns	ns	ns	ns
year x treat		1994	***	ns	ns	ns	ns	ns
year x treat		1995	***	*	ns	ns	ns	ns
year x treat		1996	***	ns	*	*	ns	ns
year x treat		1997	***	ns	ns	ns	ns	ns
year x treat		1998	***	***	*	*	ns	ns
year x treat		1999	***	*	**	***	**	ns
year x treat		2000	***	***	***	**	*	*
year x treat		2001	***	***	***	**	**	**
year x treat	cont [y]		ns	ns	ns	*	*	ns
year x treat	fert 60		**	***	***	**	ns	ns
year x treat	fert 120		***	*	ns	ns	ns	ns
year x treat	fert 180		**	ns	**	ns	ns	ns
year x treat	man 20		**	ns	ns	ns	ns	ns
year x treat	man 40		ns	ns	*	ns	ns	ns
year x treat	man 60		**	***	***	***	ns	ns
year x treat	man 120		***	***	***	***	***	***

[z]Level of significance: *($P<0.05$), ** ($P<0.01$), and *** ($P<0.001$). ns = not significant.

[y] Cont = control; fert 60 = 60 kg ha^{-1} yr^{1} N fertilizer ; fert 120 = 120 kg ha^{-1} yr^{1} N fertilizer ; fert 180 = 180 kg ha^{-1} yr^{1} N fertilizer ; man 20 = 20 Mg ha^{-1} yr^{1} manure; man 40 = 40 Mg ha^{-1} yr^{1} manure; man 60 = 60 Mg ha^{-1} yr^{1} manure; man 120 = 120 Mg ha^{-1} yr^{1} manure.

Appendix 13. Chemical analysis data of groundwater samples from the coarse- and medium-textured sites.

Table 13.1. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, June to October, 1993.

		2 June 1993		5 July 1993		27 July 1993		18 October 1993	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	6.10	20.70	7.77	6.50	20.60	18.40	14.50	12.20
	B	11.10	9.00	12.15	8.00	11.62	8.60	9.55	7.10
	C	20.71	27.20	40.38	71.50	25.70	46.20	42.00	74.20
	D	4.54	7.01	9.22	2.90	17.62	27.00	9.92	15.50
	E	7.93	8.51	14.59	9.90	37.40	30.10	36.21	49.70
	mean	10.08	14.48	16.82	19.76	22.59	26.06	22.44	31.74
60 F	A	21.34	104.00	20.67	9.80	26.70	13.50	122.40	106.57
	B	11.15	7.00	10.01	5.40	10.60	6.00	12.03	7.50
	C	20.00	12.40	18.80	13.20	33.50	53.80	56.76	139.70
	D	22.96	17.70	24.26	15.20	39.30	57.90	97.58	192.00
	E	4.70	5.60	5.86	3.70	8.06	4.00	12.40	10.80
	mean	16.03	29.34	15.92	9.46	23.63	27.04	60.23	91.31
120 F	A	13.14	13.20	13.31	4.60	44.50	25.70	198.10	106.20
	B	4.29	10.50	4.50	9.00	4.55	9.60	1.99	9.10
	C	19.23	9.50	19.00	13.00	14.20	9.40	24.40	12.00
	D	0.36	8.20	0.32	2.70	0.00	5.80	0.02	6.10
	E	19.88	6.50	20.90	5.80	20.49	5.90	16.77	5.20
	mean	11.38	9.58	11.61	7.02	16.75	11.28	48.26	27.72
180 F	A	4.44	33.40	6.36	9.50	42.80	58.60	73.50	93.10
	B	9.07	6.90	9.94	6.70	9.95	6.80	28.07	19.10
	C	1.31	5.96	27.70	49.70	23.20	50.30	28.75	49.10
	D	16.02	14.80	14.21	15.50	35.60	117.70	16.80	28.50
	E	12.24	5.35	11.89	4.10	12.98	4.60	40.40	100.70
	mean	8.62	13.28	14.02	17.10	24.91	47.60	37.50	58.10
20 M	A	9.23	7.21	56.25	45.95	123.05	122.60	146.05	155.70
	B	4.12	3.95	4.38	2.45	4.21	2.65	4.91	2.50
	C	3.10	6.09	38.55	54.35	65.22	93.45	3.01	6.30
	D	12.95	18.42	15.13	17.50	15.93	18.70	13.57	18.10
	E	11.92	7.73	12.34	7.10	13.99	8.25	2.37	17.20
	mean	8.27	8.68	25.33	25.47	44.48	49.13	33.98	39.96
40 M	A	4.33	30.75	3.99	8.50	6.49	8.50	6.88	8.30
	B	9.11	9.75	12.22	11.55	10.62	10.10	9.27	6.15
	C	8.29	4.75	7.89	2.75	7.57	2.95	8.24	2.90
	D	3.50	6.70	6.49	7.90	28.19	51.80	8.14	28.55
	E	14.85	7.11	15.81	6.35	16.83	6.85	14.03	6.95
	mean	8.02	11.81	9.28	7.41	13.94	16.04	9.32	10.57
60 M	A	11.11	8.35	12.00	5.70	12.55	6.20	25.60	21.45
	B	41.61	10.25	80.45	145.85	116.30	166.50	67.70	133.85
	C	3.00	7.79	3.64	6.20	6.59	10.75	25.05	43.05
	D	19.47	7.65	21.15	6.75	19.05	7.20	22.19	7.45
	E	6.28	7.96	33.73	89.25	45.58	131.95	13.37	51.90
	mean	16.29	8.40	30.20	50.75	40.01	64.52	30.78	51.54
120 M	A	26.33	9.85	59.40	34.15	106.75	49.90	66.45	40.55
	B	16.74	7.15	15.19	13.65	21.00	19.00	29.42	36.30
	C	8.56	8.37	8.55	6.60	8.43	7.00	8.95	6.85
	D	2.60	8.03	92.88	115.75	219.80	442.25	43.70	78.80
	E	14.92	29.70	45.25	480.60	155.55	493.30	99.55	217.50
	mean	13.83	12.62	44.26	130.15	102.31	202.29	49.62	76.00

Table 13.2. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, April to July, 1994.

		11 April 1994		31 May 1994		27 June 1994		25 July 1994	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	13.27	12.58	19.91	14.20	29.50	24.10	21.70	17.60
	B	7.44	7.06	10.24	7.90	11.42	10.40	18.20	20.90
	C	27.57	35.07	76.63	140.50	86.00	166.00	115.20	145.60
	D	7.65	21.18	13.40	27.32	13.08	36.80	7.60	22.10
	E	53.47	46.55	48.48	43.65	39.24	38.70	51.40	36.20
	mean	21.88	24.49	33.73	46.71	35.85	55.20	42.82	48.48
60 F	A	34.45	18.23	54.13	31.14	56.95	38.90	48.80	31.60
	B	27.04	27.13	56.58	81.70	70.06	95.00	53.60	80.60
	C	71.86	118.70	11.56	23.20	43.25	68.00	23.30	45.80
	D	50.78	95.75	51.85	101.00	48.80	84.80	41.40	41.30
	E	11.26	6.70	15.56	19.70	15.88	23.30	13.30	19.60
	mean	39.08	53.30	37.94	51.35	46.99	62.00	36.08	43.78
120 F	A	116.30	104.80	128.00	105.40	126.30	111.80	133.00	97.90
	B	2.91	9.76	2.81	9.50	2.87	10.60	2.20	9.10
	C	33.86	63.82	49.71	108.00	50.60	124.00	52.40	117.70
	D	0.00	6.17	0.12	5.95	0.09	4.80	0.10	5.60
	E	16.31	4.58	18.67	4.82	22.99	5.50	17.60	6.20
	mean	33.88	37.83	39.86	46.73	40.57	51.34	41.06	47.30
180 F	A	86.55	99.40	91.01	98.99	138.50	159.00	91.00	93.30
	B	15.02	6.85	14.05	7.70	14.01	7.50	13.90	7.80
	C	5.91	13.68	11.99	27.20	7.03	17.50	14.60	31.60
	D	68.50	129.70	40.61	80.40	37.05	71.70	58.00	104.90
	E	9.60	8.15	10.26	6.49	11.31	3.00	8.50	3.30
	mean	37.12	51.56	33.58	44.16	41.58	51.74	37.20	48.18
20 M	A	57.80	69.47	36.54	41.05	27.08	32.30	58.10	55.25
	B	4.60	3.35	7.12	2.97	7.01	0.70	5.65	2.70
	C	2.88	9.75	4.81	12.61	6.49	16.35	4.90	14.30
	D	15.69	25.79	38.57	41.64	49.85	54.35	33.15	41.80
	E	17.85	24.94	23.88	34.89	31.98	43.05	22.95	24.60
	mean	19.77	26.66	22.18	26.64	24.48	29.35	24.95	27.73
40 M	A	5.66	8.75	7.44	8.35	7.07	7.55	5.70	8.55
	B	8.31	6.96	11.94	12.10	11.56	14.00	7.30	8.10
	C	8.42	3.09	9.59	2.56	9.67	0.00	9.30	2.80
	D	12.29	44.27	14.58	52.86	20.99	56.25	20.45	51.35
	E	21.48	17.49	24.55	17.59	28.75	26.20	29.45	26.95
	mean	11.23	16.11	13.62	18.69	15.61	20.80	14.44	19.55
60 M	A	11.00	11.77	12.99	11.25	14.47	107.90	11.55	10.75
	B	28.30	49.01	34.32	56.85	36.54	70.15	36.95	60.95
	C	19.12	30.72	20.02	29.25	21.24	35.30	34.70	45.10
	D	22.49	5.96	26.51	7.83	29.85	9.70	25.20	8.25
	E	6.38	15.04	11.95	29.44	14.47	34.80	16.60	41.90
	mean	17.46	22.50	21.16	26.93	23.31	51.57	25.00	33.39
120 M	A	47.52	29.02	56.98	31.66	65.05	42.85	64.05	33.90
	B	42.82	70.02	41.72	82.00	49.08	97.75	49.50	82.20
	C	9.40	6.30	9.50	6.12	9.97	4.80	8.55	5.75
	D	13.86	27.48	5.74	11.69	15.79	24.60	49.75	62.05
	E	100.61	205.75	122.36	243.15	142.20	125.15	112.70	222.80
	mean	42.84	67.71	47.26	74.92	56.42	59.03	56.91	81.34

Table 13.3. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, August, 1994 to January, 1995.

		29 August 1994		28 September 1994		1 November 1994		24 January 1995	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	14.16	14.16	19.34	15.42	21.60	17.10	22.60	16.70
	B	33.40	39.97	5.58	8.05	4.27	6.70	4.04	6.90
	C	52.79	85.36	54.92	76.92	54.91	70.80	61.54	61.10
	D	4.89	14.65	3.62	12.14	5.31	10.50	9.58	13.10
	E	57.91	41.33	74.53	49.99	90.58	57.10	39.74	27.90
	mean	32.63	39.09	31.60	32.50	35.33	32.44	27.50	25.14
60 F	A	32.91	32.91	54.66	31.95	45.24	28.50	69.08	45.10
	B	40.90	59.10	47.59	81.98	43.06	83.50	50.47	85.60
	C	30.24	72.10	31.02	83.20	54.51	143.90	46.01	103.70
	D	33.95	29.53	45.08	54.56	53.50	75.80	35.83	31.90
	E	10.06	4.51	12.70	14.99	12.70	12.90	8.04	6.30
	mean	29.61	39.63	38.21	53.34	41.80	68.92	41.89	54.52
120 F	A	97.93	97.93	102.22	92.16	103.10	95.00	126.10	102.40
	B	3.70	9.39	3.56	9.40	3.39	9.40	2.47	10.40
	C	28.04	67.07	31.33	65.64	35.39	75.20	8.37	10.30
	D	0.14	5.79	0.10	6.07	0.00	5.60	0.11	6.20
	E	18.09	5.80	17.34	6.66	20.88	7.30	18.40	6.70
	mean	29.58	37.20	30.91	35.99	32.55	38.50	31.09	27.20
180 F	A	62.49	62.49	25.69	28.20	41.71	43.90	15.91	14.60
	B	11.16	5.10	13.49	8.24	21.69	23.60	43.89	57.30
	C	25.40	52.10	12.01	26.11	6.43	15.60	15.30	34.20
	D	65.93	143.60	47.98	120.43	45.22	90.00	60.15	99.00
	E	8.64	3.58	7.82	3.91	8.72	4.70	9.16	12.30
	mean	34.72	53.37	21.40	37.38	24.75	35.56	28.88	43.48
20 M	A	60.99	60.99	49.92	51.04	48.66	49.15	35.26	34.80
	B	4.80	2.94	4.57	2.90	4.44	0.00	4.99	0.00
	C	7.18	22.12	11.51	31.11	9.34	18.15	6.71	23.60
	D	28.68	41.16	29.06	42.32	42.17	54.80	36.33	51.95
	E	19.85	19.75	22.25	21.19	24.28	23.30	24.82	20.90
	mean	24.30	29.39	23.46	29.71	25.78	29.08	21.62	26.25
40 M	A	7.66	10.39	8.49	10.48	11.04	12.55	6.14	7.85
	B	7.20	7.15	9.40	12.34	6.70	7.25	5.92	8.10
	C	10.36	3.33	11.04	3.58	12.50	3.80	13.74	2.60
	D	10.73	53.81	6.17	31.55	6.84	31.25	10.22	24.20
	E	30.58	34.79	30.70	38.69	33.54	38.90	33.85	45.15
	mean	13.31	21.90	13.16	19.33	14.13	18.75	13.98	17.58
60 M	A	9.88	9.88	10.26	11.84	15.02	14.60	8.17	9.25
	B	33.66	57.02	46.33	74.79	48.70	78.10	44.48	66.00
	C	31.64	46.51	26.59	39.15	24.67	37.25	19.90	32.35
	D	21.71	7.90	21.18	7.74	23.24	6.85	19.88	6.45
	E	14.96	35.91	16.20	45.86	20.74	61.50	24.90	71.25
	mean	22.37	31.45	24.11	35.88	26.48	39.66	23.47	37.06
120 M	A	50.90	33.40	50.95	32.69	45.98	33.55	49.46	46.50
	B	53.54	116.75	69.36	239.97	61.76	161.30	58.67	155.05
	C	9.37	6.33	8.60	6.80	9.31	6.10	8.76	6.05
	D	41.89	60.35	16.74	25.79	15.69	26.60	9.87	20.55
	E	97.13	188.65	83.05	155.95	81.79	163.75	67.78	122.90
	mean	50.57	81.10	45.74	92.24	42.91	78.26	38.91	70.21

Table 13.4. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, April to June, 1995.

		3 April 1995		4 May 1995		31 May 1995		27 June 1995	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	22.89	16.65	27.70	20.90	35.61	28.10	39.90	34.50
	B	6.18	6.85	7.29	7.90	10.78	11.00	8.32	9.00
	C	74.69	95.60	79.30	106.50	56.58	84.10	55.80	86.90
	D	5.66	8.90	6.05	9.30	15.71	14.60	13.46	14.50
	E	21.60	12.36	15.86	13.70	20.64	16.40	34.20	24.90
	mean	26.20	28.07	27.24	31.66	27.86	30.84	30.34	33.96
60 F	A	108.40	73.12	126.90	87.90	112.70	81.20	98.50	83.50
	B	65.96	99.47	40.20	61.50	76.87	91.90	74.40	97.40
	C	1.24	7.41	35.90	44.00	17.91	23.30	22.90	43.60
	D	31.63	13.60	36.30	17.10	34.29	26.10	34.80	26.80
	E	11.67	10.40	11.27	8.80	14.92	14.20	20.67	30.00
	mean	43.78	40.80	50.11	43.86	51.34	47.34	50.25	56.26
120 F	A	95.19	56.46	108.20	57.30	102.90	59.20	93.90	62.40
	B	1.43	9.98	1.30	11.00	3.72	12.60	1.73	10.60
	C	29.13	49.30	39.90	73.80	48.61	138.30	51.80	125.80
	D	0.00	5.60	0.08	5.90	1.24	8.50	0.09	5.90
	E	18.70	6.50	24.60	8.30	31.44	15.70	48.70	25.90
	mean	28.89	25.57	34.82	31.26	37.58	46.86	39.24	46.12
180 F	A	30.03	25.48	68.90	53.70	76.73	59.90	73.30	66.70
	B	44.11	53.59	51.60	68.00	34.37	49.30	32.50	47.90
	C	19.31	28.37	0.30	5.60	4.57	13.10	2.75	9.20
	D	80.11	167.40	83.80	171.10	59.15	162.10	36.50	79.50
	E	16.19	21.71	17.74	23.70	20.90	24.50	25.20	30.80
	mean	37.95	59.31	44.47	64.42	39.14	61.78	34.05	46.82
20 M	A	31.33	28.23	26.65	23.20	22.55	19.70	20.89	19.90
	B	4.14	0.00	5.31	0.00	8.94	6.80	6.15	3.35
	C	8.25	38.50	7.60	31.70	12.80	44.65	11.90	54.40
	D	31.35	43.85	48.35	64.30	77.18	85.15	85.80	96.60
	E	27.26	18.38	26.23	14.80	25.84	18.10	27.59	16.15
	mean	20.47	25.79	22.83	26.80	29.46	34.88	30.47	38.08
40 M	A	6.61	9.79	5.42	9.40	5.88	10.25	5.07	7.30
	B	4.71	7.08	4.44	7.00	7.58	11.90	6.47	10.40
	C	13.25	2.47	13.90	2.65	15.17	6.65	12.67	3.60
	D	9.89	31.00	10.84	29.75	13.49	35.35	14.01	41.05
	E	34.37	41.15	35.75	43.65	37.07	39.30	40.85	50.25
	mean	13.77	18.30	14.07	18.49	15.84	20.69	15.81	22.52
60 M	A	6.52	6.77	7.59	7.65	14.27	12.95	12.77	11.45
	B	59.92	54.02	61.75	61.00	52.40	55.85	52.15	62.05
	C	18.21	28.64	18.32	27.80	33.33	44.85	28.54	42.20
	D	22.09	6.10	23.47	6.60	23.09	9.80	19.12	7.00
	E	28.41	70.80	30.87	68.75	35.21	85.95	35.42	72.45
	mean	27.03	33.27	28.40	34.36	31.66	41.88	29.60	39.03
120 M	A	61.15	60.61	67.05	63.40	76.04	77.85	80.25	70.85
	B	62.06	135.05	63.95	133.00	60.85	165.35	54.65	121.00
	C	9.35	3.85	9.82	4.25	10.71	8.75	9.90	6.20
	D	4.90	12.26	3.76	10.25	6.15	13.15	30.40	34.00
	E	45.58	89.18	43.55	84.45	62.67	120.55	78.05	141.70
	mean	36.61	60.19	37.63	59.07	43.29	77.13	50.65	74.75

Table 13.5. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, July to November, 1995.

		25 July 1995		30 August 1995		27 September 1995		15 November 1995	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	41.81	37.83	40.41	34.86	45.79	36.70	43.26	39.90
	B	7.37	9.62	8.22	9.70	6.61	7.90	6.35	7.10
	C	58.86	98.73	38.30	54.43	50.70	67.60	31.33	34.10
	D	11.30	10.70	5.78	6.51	4.84	6.20	5.88	6.20
	E	34.15	25.77	41.72	30.11	81.30	50.90	68.02	47.30
	mean	30.70	36.53	26.89	27.12	37.85	33.86	30.97	26.92
60 F	A	104.63	86.58	94.92	81.43	96.74	78.00	77.32	70.80
	B	114.15	136.80	50.98	74.81	46.10	75.70	58.85	90.00
	C	24.55	36.85	19.55	29.16	12.78	19.60	19.04	27.80
	D	36.64	29.84	32.86	24.49	36.31	24.20	33.24	24.60
	E	16.38	18.75	17.09	19.43	23.10	24.70	21.63	29.10
	mean	59.27	61.76	43.08	45.86	43.01	44.44	42.02	48.46
120 F	A	98.02	64.03	90.22	61.01	96.64	59.00	78.80	54.30
	B	2.62	11.06	3.61	9.85	5.49	9.40	6.41	8.20
	C	48.50	136.70	39.37	112.00	39.90	95.80	25.12	58.70
	D	0.83	5.52	0.52	5.31	1.33	5.10	0.33	5.10
	E	43.26	24.06	41.04	22.71	38.40	18.30	33.16	17.60
	mean	38.65	48.27	34.95	42.18	36.35	37.52	28.76	28.78
180 F	A	66.13	58.82	36.97	33.87	36.60	31.00	29.90	28.60
	B	34.69	53.17	37.43	60.41	36.44	52.40	29.76	47.80
	C	15.55	25.70	23.24	35.68	10.20	19.70	1.02	5.40
	D	29.41	65.08	43.23	97.30	52.10	116.40	44.90	114.30
	E	26.42	33.46	20.36	22.64	19.32	21.00	17.59	18.90
	mean	34.44	47.25	32.25	49.98	30.93	48.10	24.63	43.00
20 M	A	35.41	30.24	70.59	68.81	52.37	45.45	34.94	32.45
	B	5.30	0.00	4.45	0.00	4.75	0.00	4.86	0.00
	C	11.51	51.00	9.16	40.68	9.89	46.55	9.44	45.95
	D	73.34	91.88	51.57	72.11	47.40	65.60	38.34	63.00
	E	27.61	17.82	26.60	13.17	29.40	13.70	26.97	14.55
	mean	30.63	38.19	32.48	38.95	28.76	34.26	22.91	31.19
40 M	A	7.18	8.60	5.98	8.29	6.68	8.55	9.36	8.60
	B	8.21	12.06	4.59	7.62	4.26	6.90	6.33	8.00
	C	14.03	2.63	13.55	2.52	14.17	2.75	14.73	2.95
	D	15.31	39.56	9.34	26.17	13.70	37.15	11.40	31.50
	E	39.09	49.62	36.21	46.00	36.95	44.60	31.88	43.15
	mean	16.77	22.49	13.94	18.12	15.15	19.99	14.74	18.84
60 M	A	12.49	11.21	10.09	9.68	9.14	9.20	10.07	9.20
	B	51.16	60.31	46.62	53.41	56.97	56.85	50.57	55.55
	C	23.36	36.21	17.72	29.90	15.09	29.95	19.95	33.95
	D	18.05	5.69	15.61	6.85	13.99	6.35	15.17	6.90
	E	34.80	74.70	31.44	67.23	31.15	63.50	24.51	57.45
	mean	27.97	37.62	24.30	33.42	25.27	33.17	24.06	32.61
120 M	A	97.03	90.28	82.78	78.41	77.90	73.20	62.25	67.85
	B	64.10	139.20	63.22	176.00	77.65	190.05	64.74	132.80
	C	10.56	4.46	9.83	3.74	9.54	3.60	9.68	3.50
	D	146.34	149.00	124.50	130.70	99.15	116.25	56.29	75.80
	E	83.45	162.05	65.18	135.45	57.85	112.30	43.48	94.25
	mean	80.30	109.00	69.10	104.86	64.42	99.08	47.29	74.84

Table 13.6. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, March to June, 1996.

		19 March 1996		30 April 1996		27 May 1996		25 June 1996	
Treatment	Rep	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}
Control	A	59.25	56.40	57.91	64.49	66.70	67.66	74.96	75.60
	B	1.36	6.80	3.27	7.20	3.38	8.60	5.11	8.90
	C	77.64	115.70	51.71	43.37	38.07	31.20	43.60	44.40
	D	1.96	5.90	3.65	7.09	2.80	7.90	5.26	9.40
	E	22.12	17.00	23.11	17.04	19.89	18.10	34.37	24.90
	mean	32.47	40.36	27.93	27.84	26.17	26.69	32.66	32.64
60 F	A	98.41	91.70	103.80	103.20	110.20	111.00	120.62	123.30
	B	66.65	112.90	59.02	112.40	56.06	109.10	147.14	163.10
	C	12.42	25.80	21.21	45.64	32.82	58.40	42.29	58.90
	D	38.55	26.90	42.77	32.80	39.80	34.30	58.98	65.90
	E	24.42	32.70	25.56	31.53	24.26	35.80	27.02	33.00
	mean	48.09	58.00	50.47	65.11	52.63	69.72	79.21	88.84
120 F	A	85.76	57.60	101.30	67.79	107.00	66.80	111.72	66.39
	B	2.54	7.70	2.47	8.06	2.19	9.80	2.16	8.40
	C	32.11	51.60	57.97	115.90	97.52	129.80	94.04	144.60
	D	0.00	5.00	0.08	5.32	0.00	6.60	0.10	6.10
	E	31.68	15.20	35.90	19.70	39.10	23.10	45.08	22.60
	mean	30.42	27.42	39.54	43.35	49.16	47.22	50.62	49.62
180 F	A	28.06	29.20	47.53	44.02	55.46	51.52	57.61	50.87
	B	md[z]	md	20.81	38.56	21.03	37.80	35.59	52.50
	C	5.91	12.90	23.15	29.06	4.64	10.30	3.41	9.00
	D	55.70	115.80	57.31	117.40	52.24	108.90	10.52	136.60
	E	15.19	17.90	19.11	20.76	19.39	22.10	30.72	30.40
	mean	26.21	43.95	33.58	49.96	30.55	46.12	27.57	55.87
20 M	A	28.47	25.65	28.55	23.35	20.10	20.40	48.23	40.00
	B	4.31	0.00	4.87	0.00	5.04	4.15	5.25	0.00
	C	7.29	42.85	5.88	29.46	7.70	41.75	9.68	39.50
	D	29.09	50.95	52.52	75.47	55.76	79.10	120.94	145.95
	E	30.00	18.60	31.79	23.15	29.38	24.80	35.04	30.55
	mean	19.83	27.61	24.73	30.29	23.60	34.04	43.83	51.20
40 M	A	7.56	7.50	4.91	6.70	6.65	9.75	15.94	14.45
	B	6.45	9.90	9.34	12.78	6.29	11.90	16.76	23.70
	C	15.59	4.15	14.66	3.42	14.36	6.15	16.84	3.80
	D	12.32	28.20	17.80	33.63	16.98	38.25	30.34	68.05
	E	33.74	41.00	34.89	42.98	33.49	44.10	50.98	56.60
	mean	15.13	18.15	16.32	19.90	15.55	22.03	26.17	33.32
60 M	A	8.11	10.95	9.11	12.51	11.15	14.80	15.58	15.10
	B	66.81	80.45	55.45	57.45	40.74	39.85	45.33	41.50
	C	14.57	32.30	15.89	34.98	15.02	34.15	61.84	93.95
	D	11.84	4.30	19.10	5.86	15.97	5.80	20.63	5.25
	E	49.27	54.45	26.30	55.39	25.17	54.30	31.12	59.90
	mean	30.12	36.49	25.17	33.24	21.61	29.78	34.90	43.14
120 M	A	43.16	51.95	50.07	59.28	48.81	63.31	66.02	72.05
	B	53.33	88.30	50.35	83.72	47.34	77.85	61.75	101.20
	C	8.69	3.10	9.63	3.20	9.51	3.95	11.28	4.75
	D	12.25	26.65	8.73	20.23	4.54	13.60	14.89	29.75
	E	35.73	77.15	35.85	74.56	33.83	78.00	50.55	90.50
	mean	30.63	49.43	30.93	48.20	28.81	47.34	40.90	59.65

[z] md = missing data.

Table 13.7. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, August, 1996 to May, 1997.

		6 August 1996		27 August 1996		24 September 1996		7 May 1997	
Treatment	Rep	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}
Control	A	74.32	77.90	73.59	71.50	71.40	70.40	59.98	84.17
	B	84.15	103.40	263.20	269.40	97.14	118.60	20.17	65.02
	C	79.13	146.90	75.56	111.90	80.70	100.30	60.13	97.11
	D	16.91	52.69	10.31	38.50	10.39	39.90	16.33	55.84
	E	43.85	28.66	46.70	29.40	40.15	19.90	47.78	36.57
	mean	59.67	81.91	93.87	104.14	59.96	69.82	40.88	67.74
60 F	A	123.70	97.91	171.90	115.60	125.54	125.00	135.00	241.00
	B	121.90	84.30	159.90	100.50	100.10	148.60	118.50	279.50
	C	52.30	10.32	62.05	108.60	49.23	91.60	45.25	88.91
	D	122.00	118.60	106.72	95.20	84.44	77.90	129.00	224.80
	E	30.10	79.56	26.62	55.70	22.21	26.50	37.93	85.43
	mean	90.00	78.14	105.44	95.12	76.30	93.92	93.14	183.93
120 F	A	123.30	81.20	117.80	71.60	93.60	52.80	52.74	58.05
	B	12.59	11.80	20.77	25.10	10.26	14.40	19.19	10.09
	C	52.02	86.16	71.31	97.10	64.99	107.80	63.80	98.12
	D	22.77	45.26	16.08	39.50	4.80	21.50	0.38	9.29
	E	172.80	111.80	178.46	146.90	166.06	122.20	139.60	148.30
	mean	76.70	67.24	80.88	76.04	67.94	63.74	55.14	64.77
180 F	A	54.42	49.48	56.52	57.00	47.85	51.20	104.30	65.93
	B	226.30	140.00	154.34	124.90	109.84	109.80	74.07	215.70
	C	27.59	33.44	115.50	73.20	40.42	42.20	101.90	85.48
	D	115.80	148.20	106.70	135.70	68.38	110.00	111.90	246.00
	E	60.43	106.20	58.55	87.70	38.75	39.50	35.44	42.93
	mean	96.91	95.46	98.32	95.70	61.05	70.54	85.52	131.21
20 M	A	54.45	50.59	41.84	41.00	40.89	41.35	27.74	55.07
	B	12.06	21.43	8.71	11.55	79.00	4.50	8.22	6.62
	C	56.15	58.30	41.34	101.15	35.10	96.55	17.37	128.91
	D	110.95	210.45	102.54	189.45	72.35	123.15	75.52	186.00
	E	38.00	46.87	33.44	45.75	31.56	33.35	26.92	36.64
	mean	54.33	77.53	45.58	77.78	51.78	59.78	31.16	82.65
40 M	A	22.50	20.28	18.29	19.15	13.58	15.45	42.54	44.03
	B	68.37	99.29	69.57	84.40	34.53	50.55	57.99	125.20
	C	15.69	5.41	15.23	6.20	16.16	7.55	12.64	7.36
	D	88.16	337.65	55.94	194.25	83.73	281.90	77.96	345.00
	E	113.35	184.20	103.01	156.85	101.50	165.05	77.04	199.55
	mean	61.62	129.37	52.41	92.17	49.90	104.10	53.64	144.23
60 M	A	24.69	25.12	20.49	21.90	17.83	17.70	16.24	29.85
	B	50.83	77.97	75.44	122.75	83.17	134.65	63.27	136.08
	C	98.75	14.21	60.47	104.90	44.15	85.85	78.15	294.05
	D	21.45	23.26	18.44	15.65	19.06	12.30	16.28	9.95
	E	61.58	150.23	48.66	110.30	42.47	78.75	36.78	161.37
	mean	51.46	58.16	44.70	75.10	41.34	65.85	42.15	126.26
120 M	A	253.45	150.88	184.85	124.10	132.34	88.35	93.82	126.55
	B	192.95	250.80	195.11	326.45	121.17	203.80	84.88	287.40
	C	27.81	43.26	19.38	25.45	14.88	22.05	13.38	26.41
	D	146.35	383.95	135.45	371.25	110.52	342.20	27.27	87.82
	E	140.97	265.30	132.31	270.35	139.04	295.95	67.48	230.00
	mean	152.31	218.84	133.42	223.52	103.59	190.47	57.37	151.64

Table 13.8. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, June to September, 1997.

		2 June 1997		23 June 1997		11 August 1997		8 September 1997	
Treatment	Rep	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}
Control	A	65.39	103.10	66.44	86.65	55.25	56.25	50.27	50.16
	B	17.00	57.90	28.10	77.27	34.86	18.24	38.97	15.20
	C	51.73	103.10	32.95	45.70	37.36	16.60	57.32	18.25
	D	22.30	69.20	30.49	86.40	31.48	102.00	44.40	104.50
	E	47.35	36.40	51.20	35.40	71.26	20.95	77.94	23.78
	mean	40.75	73.94	41.84	66.28	46.04	42.81	53.78	42.38
60 F	A	113.70	205.30	107.80	177.60	36.48	17.58	56.27	28.18
	B	112.50	247.20	101.60	274.70	25.97	6.22	25.25	0.00
	C	39.31	82.50	45.07	100.40	55.22	50.83	70.04	107.00
	D	105.70	156.90	93.60	100.80	80.35	28.54	75.34	33.29
	E	43.12	100.30	48.47	95.80	97.59	107.10	117.90	97.74
	mean	82.87	158.44	79.31	149.86	59.12	42.05	68.96	53.24
120 F	A	57.85	63.60	70.77	72.96	147.10	83.08	179.90	107.20
	B	9.52	14.70	8.85	11.22	19.52	36.18	21.73	27.34
	C	72.38	116.70	96.65	87.87	44.32	44.22	77.10	48.22
	D	0.21	9.50	0.34	7.30	55.18	60.28	13.52	17.59
	E	153.10	159.20	193.60	171.50	46.47	8.02	54.81	14.31
	mean	58.61	72.74	74.04	70.17	62.52	46.36	69.41	42.93
180 F	A	94.90	72.00	76.66	71.29	77.56	52.09	120.00	15.98
	B	73.15	187.30	75.18	159.00	104.70	116.30	111.10	124.10
	C	90.37	132.60	79.15	131.50	49.70	64.54	58.02	74.33
	D	107.20	220.20	140.20	207.40	35.29	71.84	50.95	170.70
	E	35.81	43.30	39.56	47.38	74.54	33.74	87.97	50.42
	mean	80.29	131.08	82.15	123.31	68.36	67.70	85.61	87.11
20 M	A	28.42	61.50	28.62	60.71	34.45	81.59	23.81	58.47
	B	10.95	18.55	9.40	11.75	24.97	40.19	29.03	49.11
	C	24.48	169.25	27.15	178.10	41.04	144.80	40.83	118.05
	D	90.52	221.55	98.74	210.10	66.06	90.66	83.62	103.09
	E	36.36	59.60	25.63	31.16	128.48	161.60	41.82	45.66
	mean	38.15	106.09	37.91	98.37	59.00	103.77	43.83	74.88
40 M	A	40.07	45.75	49.44	52.65	73.11	56.33	72.96	125.93
	B	67.80	151.65	76.54	131.04	85.89	131.80	91.66	123.01
	C	13.26	9.15	14.31	7.65	30.54	33.00	24.24	24.49
	D	81.34	330.35	69.92	267.80	86.43	198.50	84.97	198.25
	E	88.30	207.35	111.00	241.30	77.03	148.94	92.30	164.11
	mean	58.15	148.85	64.25	140.09	70.60	113.71	73.23	127.16
60 M	A	31.97	50.75	42.02	58.05	57.76	86.14	50.48	65.29
	B	65.57	124.25	64.91	107.78	55.60	119.40	58.60	129.35
	C	118.23	362.70	123.76	340.30	89.10	145.05	96.21	177.60
	D	15.10	25.90	16.21	24.75	11.96	56.73	18.83	96.00
	E	45.47	186.65	49.82	171.85	105.98	242.50	103.00	216.15
	mean	55.27	150.05	59.35	140.55	64.08	129.96	65.43	136.88
120 M	A	112.95	139.90	135.17	151.63	309.25	194.25	265.50	175.35
	B	72.75	251.95	90.21	293.80	96.41	225.50	105.55	247.60
	C	18.61	38.80	18.78	35.01	118.34	338.80	83.51	236.25
	D	33.77	140.30	72.99	299.20	65.23	176.95	87.88	218.45
	E	101.35	302.10	127.39	356.00	302.80	978.85	315.25	1154.25
	mean	67.89	174.61	88.91	227.13	178.41	382.87	171.54	406.38

Table 13.9. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, September, 1997 to March, 1998.

		30 September 1997		28 October 1997		2 December 1997		31 March 1998	
Treatment	Rep	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}
Control	A	54.06	58.02	56.49	60.80	58.01	66.70	59.10	67.98
	B	18.79	9.43	15.22	18.20	26.17	29.32	8.51	18.67
	C	48.31	21.72	41.86	32.20	40.48	34.12	61.39	20.81
	D	41.30	94.59	42.82	85.50	38.59	75.60	37.96	63.50
	E	75.26	24.17	81.00	23.60	75.89	32.90	74.07	49.45
	mean	47.54	41.59	47.48	44.06	47.83	47.73	48.21	44.08
60 F	A	78.87	55.46	94.79	76.70	99.91	69.70	87.69	45.23
	B	17.06	4.83	67.12	92.10	59.95	110.90	65.40	112.00
	C	49.20	93.50	55.55	109.90	39.72	78.78	40.38	61.97
	D	82.78	37.57	86.17	62.30	98.22	80.40	83.54	66.29
	E	85.44	83.73	110.50	93.40	89.87	93.40	53.63	68.65
	mean	62.67	55.02	82.83	86.88	77.53	86.64	66.13	70.83
120 F	A	168.50	105.40	147.90	99.60	108.50	71.60	51.72	21.12
	B	26.39	73.66	9.87	17.20	18.01	40.75	9.72	11.46
	C	59.77	57.28	67.70	64.80	55.35	84.39	72.00	87.06
	D	5.12	11.50	2.55	8.80	1.09	6.60	0.12	6.40
	E	66.30	21.25	84.97	31.60	90.07	37.50	108.40	56.49
	mean	65.22	53.82	62.60	44.40	54.60	48.17	48.39	36.51
180 F	A	160.00	14.88	114.70	34.00	131.10	25.00	121.10	21.00
	B	79.16	130.30	87.10	152.10	91.97	175.20	77.97	88.78
	C	65.99	66.46	52.97	81.50	51.55	101.90	48.22	61.68
	D	94.08	353.20	96.46	353.00	87.74	190.80	51.41	85.30
	E	82.09	58.23	74.85	49.60	87.68	46.48	77.32	60.26
	mean	96.26	124.61	85.22	134.04	90.01	107.88	75.20	63.40
20 M	A	18.40	35.07	15.96	30.85	25.05	36.33	24.12	35.69
	B	16.53	77.70	12.33	18.05	12.45	18.02	12.05	17.80
	C	39.76	113.75	46.08	130.20	52.06	123.96	28.37	69.64
	D	84.23	95.53	89.39	105.45	88.69	117.60	82.44	117.60
	E	25.50	24.05	55.08	59.75	64.22	77.55	51.31	69.63
	mean	36.89	69.22	43.77	68.86	48.50	74.69	39.66	62.07
40 M	A	43.09	96.59	24.83	30.65	29.44	24.91	25.64	38.90
	B	86.19	119.93	83.93	134.25	65.23	99.80	59.88	61.68
	C	17.80	17.67	14.35	13.15	13.70	11.45	14.46	13.19
	D	79.72	196.90	82.22	199.75	83.21	223.60	73.87	163.20
	E	91.62	158.94	93.61	155.15	90.08	155.75	91.37	157.28
	mean	63.69	118.01	59.79	106.59	56.33	103.10	53.05	86.85
60 M	A	57.87	79.98	31.01	39.45	28.01	40.30	40.92	77.14
	B	57.94	91.74	76.74	104.05	64.87	123.16	46.17	26.10
	C	88.74	180.20	82.77	171.40	81.47	172.45	61.32	123.00
	D	12.84	56.60	11.74	33.60	11.68	15.60	14.39	9.31
	E	87.48	212.06	78.83	192.95	77.30	183.90	57.57	167.90
	mean	60.98	124.12	56.22	108.29	52.67	107.08	44.08	80.69
120 M	A	216.20	157.00	183.82	141.00	167.56	133.05	170.67	161.50
	B	109.20	313.65	111.35	295.40	90.13	224.50	96.95	189.10
	C	68.65	182.80	62.77	155.50	64.46	182.85	59.55	163.75
	D	123.59	383.75	104.41	418.60	66.52	229.25	15.50	54.36
	E	292.30	1001.15	250.38	905.55	210.95	789.95	137.10	594.50
	mean	161.99	407.67	142.55	383.21	119.92	311.92	95.96	232.64

Table 13.10. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, April to July, 1998.

		28 April 1998		27 May 1998		7 July 1998		29 July 1998	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	55.02	59.70	47.94	54.10	42.77	47.88	30.73	29.90
	B	12.12	19.00	8.87	17.20	3.76	0.00	7.03	8.86
	C	47.62	19.40	48.17	17.30	36.01	18.33	10.05	0.00
	D	43.86	66.30	35.91	70.00	20.84	43.96	20.73	41.92
	E	76.97	37.50	75.24	39.40	82.44	42.51	61.28	29.06
	mean	47.12	40.38	43.23	39.60	37.16	30.54	25.96	21.95
60 F	A	66.04	30.20	62.40	28.90	41.67	17.46	20.29	7.20
	B	31.75	48.60	68.83	114.80	19.68	27.03	19.41	27.26
	C	36.68	65.00	35.50	62.60	33.82	46.63	24.26	30.07
	D	68.00	49.10	69.41	69.40	39.10	20.25	34.55	20.04
	E	61.66	66.20	61.65	62.80	46.18	50.05	56.14	62.82
	mean	52.83	51.82	59.56	67.70	36.09	32.28	30.93	29.48
120 F	A	59.24	21.80	48.64	18.90	51.83	18.60	51.49	17.00
	B	12.41	15.10	10.03	12.80	12.63	19.63	11.43	16.94
	C	63.57	65.90	59.40	76.00	56.76	36.55	40.51	22.27
	D	0.57	6.30	0.23	6.10	25.41	23.58	6.48	12.33
	E	76.89	31.50	80.42	35.80	17.36	5.10	16.64	5.24
	mean	42.54	28.12	39.74	29.92	32.80	20.69	25.31	14.76
180 F	A	99.55	21.90	105.10	28.60	94.67	36.20	101.30	31.22
	B	74.15	114.10	79.86	76.80	72.59	69.37	72.27	75.61
	C	24.33	50.40	13.40	37.30	26.12	60.52	36.99	74.27
	D	43.45	120.20	41.20	102.90	43.67	92.73	44.25	84.16
	E	76.73	56.90	72.13	74.70	5.64	35.95	75.70	75.85
	mean	63.64	72.70	62.34	64.06	48.54	58.95	66.10	68.22
20 M	A	32.63	65.50	34.81	47.80	21.00	35.35	20.35	41.16
	B	30.96	106.00	20.91	55.30	27.25	77.82	20.06	53.57
	C	26.07	85.15	27.69	76.10	31.50	82.48	41.28	93.89
	D	97.48	152.30	86.33	132.55	79.37	111.38	56.49	87.46
	E	48.63	77.95	47.18	64.85	46.06	46.35	44.49	62.98
	mean	47.16	97.38	43.39	75.32	41.04	70.68	36.54	67.81
40 M	A	27.08	45.15	29.94	35.45	37.66	30.35	33.78	31.47
	B	56.35	78.00	51.98	71.30	39.20	57.61	31.48	54.53
	C	19.03	22.40	16.80	20.25	25.36	46.34	19.74	33.84
	D	79.52	213.05	76.47	178.80	63.73	131.05	43.07	123.55
	E	102.51	183.05	94.46	174.80	72.42	134.07	65.31	120.89
	mean	56.90	108.33	53.93	96.12	47.68	79.89	38.68	72.86
60 M	A	60.81	145.85	58.32	104.85	63.16	110.30	61.86	105.96
	B	43.21	18.95	36.76	19.00	33.24	22.36	30.41	20.47
	C	71.38	175.00	75.54	156.90	36.57	86.98	53.93	107.20
	D	14.72	44.90	14.68	51.95	21.65	91.79	19.31	81.97
	E	80.14	260.25	72.48	231.35	70.39	211.35	67.00	194.70
	mean	54.05	128.99	51.56	112.81	45.01	104.56	46.50	102.06
120 M	A	168.95	221.25	134.55	184.95	170.85	158.85	145.79	123.75
	B	103.57	241.45	92.41	199.25	90.28	203.25	91.67	184.55
	C	74.44	258.50	73.64	264.50	88.90	248.25	72.09	218.00
	D	28.74	165.95	45.01	192.45	26.00	186.45	36.39	219.10
	E	134.38	600.80	141.54	524.15	143.96	549.85	117.31	477.15
	mean	102.02	297.59	97.43	273.06	104.00	269.33	92.65	244.51

Table 13.11. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, August to December, 1998.

		25 August 1998		30 September 1998		27 October 1998		2 December 1998	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	27.84	27.00	37.28	36.56	34.91	38.90	35.90	39.52
	B	9.83	15.10	12.29	19.41	10.17	16.90	11.38	15.06
	C	30.85	22.30	39.80	90.88	30.78	11.60	36.60	12.76
	D	15.14	30.70	17.63	27.41	17.08	22.60	20.35	17.56
	E	87.42	25.70	61.85	21.66	60.19	60.20	61.12	30.19
	mean	34.22	24.16	33.77	39.18	30.63	30.04	33.07	23.02
60 F	A	24.04	10.40	42.76	14.81	41.97	15.50	39.29	15.28
	B	6.84	5.00	25.13	30.67	63.08	108.90	32.57	45.06
	C	41.88	45.70	40.09	43.77	30.39	30.80	42.28	43.40
	D	43.01	17.40	47.41	22.51	48.01	31.90	34.53	20.83
	E	55.34	62.40	67.43	63.91	59.77	59.80	53.27	77.10
	mean	34.22	28.18	44.56	35.13	48.64	49.38	40.39	40.33
120 F	A	55.19	17.60	61.15	16.39	62.95	15.70	52.10	11.08
	B	12.24	19.80	16.73	28.82	18.21	37.50	18.59	40.25
	C	30.98	41.50	37.10	77.16	32.08	78.90	39.27	89.44
	D	5.52	12.80	0.81	6.18	0.52	6.10	0.15	6.18
	E	19.77	7.80	26.22	6.85	33.76	33.80	35.77	12.89
	mean	24.74	19.90	28.40	27.08	29.50	34.40	29.18	31.97
180 F	A	79.62	27.60	95.17	27.13	75.78	55.50	53.28	21.22
	B	73.93	78.50	86.72	80.13	79.14	97.90	82.91	88.25
	C	37.94	97.60	31.91	79.92	27.96	66.20	19.14	35.98
	D	20.68	46.10	24.11	46.34	46.82	42.40	24.18	47.64
	E	63.31	56.70	92.37	63.53	86.56	86.60	67.42	61.54
	mean	55.10	61.30	66.06	59.41	63.25	69.72	49.39	50.93
20 M	A	16.93	31.25	17.40	32.60	19.37	34.95	26.96	33.93
	B	14.48	31.40	13.45	19.07	11.38	15.65	13.28	12.57
	C	42.25	104.45	44.27	101.53	38.82	102.50	37.70	98.44
	D	32.28	47.10	50.77	64.95	55.73	83.00	59.66	92.08
	E	42.17	63.00	50.22	59.87	46.06	46.10	36.59	51.82
	mean	29.62	55.44	35.22	55.61	34.27	56.44	34.84	57.77
40 M	A	40.56	38.60	38.62	38.48	29.79	30.95	27.67	26.14
	B	52.02	62.55	56.97	60.36	46.05	62.60	41.60	72.89
	C	22.32	37.15	21.18	30.83	19.49	30.50	21.97	32.22
	D	53.11	119.95	50.49	98.21	41.82	102.55	33.19	82.35
	E	64.41	108.60	66.30	108.71	63.30	63.30	63.95	99.25
	mean	46.49	73.37	46.71	67.32	40.09	57.98	37.68	62.57
60 M	A	59.66	100.75	61.91	92.75	58.72	95.15	55.04	95.15
	B	20.80	21.20	30.28	22.60	29.39	22.85	22.01	16.92
	C	48.21	99.10	57.64	112.84	89.09	229.75	48.74	104.09
	D	23.96	86.25	21.29	68.80	19.81	72.30	19.98	53.11
	E	58.93	178.50	71.89	185.85	62.14	62.15	54.12	162.30
	mean	42.31	97.16	48.60	96.57	51.83	96.44	39.98	86.31
120 M	A	142.67	119.30	165.68	141.65	177.30	172.90	183.95	177.70
	B	69.26	151.90	83.11	155.75	75.23	143.05	54.40	108.35
	C	92.17	249.30	105.27	281.25	59.17	150.95	97.59	263.40
	D	65.17	227.90	76.76	290.00	69.44	260.55	36.52	122.39
	E	107.55	375.80	109.50	365.65	101.66	264.10	112.04	376.50
	mean	95.37	224.84	108.06	246.86	96.56	198.31	96.90	209.67

Table 13.12. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, April to July, 1999.

		21 April 1999		2 June 1999		7 July 1999		27 July 1999	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	66.46	34.39	30.47	29.07	20.96	21.94	16.04	12.57
	B	11.22	26.52	10.63	22.76	9.63	23.80	11.31	15.21
	C	51.04	30.16	36.73	36.53	29.58	36.04	32.33	21.34
	D	2.06	17.04	19.96	14.76	19.43	15.62	15.18	8.02
	E	42.22	42.22	57.53	45.21	37.25	47.75	31.59	18.29
	mean	34.60	30.07	31.06	29.67	23.37	29.03	21.29	15.09
60 F	A	21.31	17.34	22.34	26.96	19.06	24.26	17.44	16.01
	B	34.80	42.14	35.19	30.84	23.14	34.87	20.96	9.24
	C	49.81	66.00	36.36	50.10	24.04	47.19	42.69	71.47
	D	39.13	48.22	46.79	54.89	27.39	36.64	28.70	14.12
	E	46.79	46.79	43.32	39.54	33.56	45.44	24.34	15.04
	mean	38.37	44.10	36.80	40.47	25.44	37.68	26.83	25.18
120 F	A	11.49	0.00	12.52	0.00	12.12	0.00	11.94	0.00
	B	7.01	10.09	7.98	10.75	8.91	17.26	18.80	36.44
	C	49.93	127.60	65.51	173.50	40.00	116.40	30.83	67.47
	D	0.59	5.76	1.11	5.78	0.48	6.47	19.36	19.76
	E	19.99	19.99	44.92	14.75	19.70	6.84	15.85	0.00
	mean	17.80	32.69	26.41	40.96	16.24	29.39	19.36	24.73
180 F	A	31.68	19.05	50.38	34.61	36.41	38.53	73.40	22.06
	B	65.01	50.65	69.48	53.10	44.55	47.35	64.23	42.16
	C	22.92	36.50	15.86	24.36	11.21	22.31	21.27	28.18
	D	26.31	49.43	31.51	37.84	22.14	42.43	18.52	32.50
	E	42.39	42.39	53.15	42.73	41.21	44.38	30.98	16.93
	mean	37.66	39.60	44.08	38.53	31.10	39.00	41.68	28.37
20 M	A	29.29	38.47	29.69	38.12	26.18	49.60	28.38	53.44
	B	10.58	11.60	13.61	15.88	11.51	22.42	15.30	39.68
	C	43.59	103.10	38.62	105.10	30.42	106.99	41.10	112.34
	D	71.79	106.17	71.90	103.29	32.81	87.29	34.74	90.57
	E	36.09	36.09	30.13	37.48	21.41	46.14	32.36	49.28
	mean	38.27	59.09	36.79	59.98	24.47	62.49	30.38	69.06
40 M	A	16.41	34.03	16.17	37.72	13.63	42.21	15.32	39.41
	B	57.93	118.81	54.43	115.38	35.51	104.63	36.97	103.06
	C	15.35	21.59	17.96	27.08	18.00	35.98	22.69	40.63
	D	39.06	102.78	38.84	98.82	27.79	99.58	31.60	73.69
	E	83.23	83.23	58.23	92.17	37.22	114.29	56.45	179.30
	mean	42.40	72.09	37.13	74.23	26.43	79.34	32.61	87.22
60 M	A	57.38	74.18	59.35	81.66	38.09	84.36	47.75	86.22
	B	22.92	18.85	24.24	23.51	20.47	55.06	34.50	137.91
	C	54.47	109.40	55.35	116.96	39.11	109.30	38.41	115.75
	D	19.72	15.88	27.74	50.48	21.74	72.64	26.89	67.16
	E	125.50	125.50	35.82	120.15	23.14	111.05	30.27	121.01
	mean	56.00	68.76	40.50	78.55	28.51	86.48	35.57	105.61
120 M	A	170.10	236.50	174.45	235.65	100.35	206.75	127.41	192.85
	B	36.84	49.93	30.57	50.32	22.07	60.90	28.42	84.19
	C	58.26	183.50	54.16	156.55	40.00	159.75	49.58	131.95
	D	10.77	39.15	17.15	59.09	33.89	191.50	82.31	262.25
	E	137.10	315.80	116.78	369.25	69.39	321.15	110.20	403.50
	mean	82.62	164.98	78.62	174.17	53.14	188.01	79.59	214.95

Table 13.13. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, August to October, 1999.

		25 August 1999		29 September 1999		20 October 1999			
Treatment	Rep	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}
Control	A	15.31	16.92	16.69	19.90	16.94	18.20		
	B	8.04	17.31	9.52	23.84	5.76	18.84		
	C	39.44	31.27	30.32	24.55	38.69	25.91		
	D	7.13	7.23	14.30	17.73	25.33	30.57		
	E	16.94	3.27	24.54	12.32	12.37	12.37		
	mean	17.37	15.20	19.07	19.67	19.82	21.18		
60 F	A	14.24	11.40	19.33	42.20	19.03	43.10		
	B	24.47	40.67	25.05	44.59	25.66	48.63		
	C	49.04	84.95	46.52	81.42	44.61	54.61		
	D	28.67	11.41	27.62	11.73	31.35	13.90		
	E	19.99	27.45	22.01	36.75	35.25	35.25		
	mean	27.28	35.18	28.11	43.34	31.18	39.10		
120 F	A	9.04	0.00	9.50	0.00	10.66	4.08		
	B	44.26	202.80	41.06	173.10	54.53	249.41		
	C	24.55	80.87	19.94	70.66	18.56	64.27		
	D	24.78	30.00	2.45	10.37	1.04	8.65		
	E	17.64	4.16	16.81	4.63	4.95	4.95		
	mean	24.05	63.57	17.95	51.75	17.95	66.27		
180 F	A	67.82	63.22	72.67	69.10	81.01	58.40		
	B	64.55	54.42	68.34	63.49	74.05	61.58		
	C	22.15	40.73	19.51	32.06	20.61	28.38		
	D	18.71	45.45	17.59	51.58	18.64	48.06		
	E	33.77	21.92	49.22	52.68	51.79	51.79		
	mean	41.40	45.15	45.47	53.78	49.22	49.64		
20 M	A	29.16	65.31	28.84	61.36	30.44	69.50		
	B	12.92	36.32	13.65	41.01	12.91	36.72		
	C	39.75	128.75	28.97	97.03	29.86	91.49		
	D	29.86	94.60	28.25	84.47	34.58	87.12		
	E	34.06	65.54	29.07	57.36	37.48	67.43		
	mean	29.15	78.11	25.76	68.25	29.06	70.45		
40 M	A	14.53	54.74	14.32	67.52	12.38	54.65		
	B	37.19	114.90	36.38	96.33	38.24	94.71		
	C	22.67	54.23	19.72	52.66	20.22	50.64		
	D	28.36	125.70	31.45	123.00	34.97	111.73		
	E	38.71	191.80	37.48	169.05	164.61	164.60		
	mean	28.29	108.28	27.87	101.71	54.09	95.27		
60 M	A	49.89	106.00	52.29	100.48	56.78	95.98		
	B	39.41	81.16	61.39	156.84	54.71	157.20		
	C	39.85	144.25	42.97	121.05	30.95	139.00		
	D	25.89	78.57	25.82	54.91	27.53	53.12		
	E	37.39	204.55	37.17	168.45	178.11	178.11		
	mean	38.49	122.91	43.93	120.35	69.62	124.69		
120 M	A	127.27	253.65	124.96	226.55	131.94	224.10		
	B	43.61	231.85	36.14	130.03	31.19	99.36		
	C	46.52	122.55	55.62	188.65	54.22	191.35		
	D	80.69	171.85	160.45	201.65	134.25	196.65		
	E	91.71	510.40	100.45	550.15	119.22	144.81		
	mean	77.96	258.06	95.53	259.41	94.17	171.25		

Table 13.14. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, November, 1999 to June, 2000. (1 of 2 pages)

		23 November 1999		25 April 2000		30 May 2000		28 June 2000	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	20.30	21.00	21.56	20.30	19.62	20.43	24.46	27.20
	B	13.90	47.10	27.21	62.80	23.87	57.70	24.66	58.10
	C	29.10	25.40	33.60	14.80	43.00	17.96	49.09	30.20
	D	34.80	50.30	28.95	28.10	27.43	28.94	31.59	33.60
	E	32.00	13.80	31.02	7.90	29.30	8.10	32.07	7.80
	mean	26.02	31.52	28.47	26.78	28.64	26.63	32.37	31.38
60 F	A	23.70	56.50	29.24	71.10	28.14	61.75	28.16	60.10
	B	33.20	68.10	36.56	63.10	42.97	82.87	32.31	27.00
	C	22.30	45.70	65.21	46.70	69.84	64.90	44.59	98.30
	D	67.80	15.50	85.92	76.70	66.34	77.80	66.81	72.10
	E	24.50	35.60	35.91	43.50	27.97	17.61	29.49	18.10
	mean	34.30	44.28	50.57	60.22	47.05	60.99	40.27	55.12
120 F	A	11.90	4.50	24.95	4.70	25.50	6.85	27.77	7.60
	B	43.50	210.60	43.13	139.36	41.78	132.70	61.64	188.70
	C	17.20	77.50	40.97	49.90	45.19	75.05	45.97	87.30
	D	0.90	8.20	0.44	5.90	0.00	6.32	0.51	6.20
	E	18.90	6.70	27.78	8.10	28.15	9.49	32.89	10.10
	mean	18.48	61.50	27.45	41.59	28.12	46.08	33.76	59.98
180 F	A	109.90	43.40	56.48	18.30	61.33	37.60	66.31	46.70
	B	77.00	60.70	32.70	63.70	29.71	54.87	38.90	42.30
	C	16.70	22.30	16.14	19.40	23.93	20.15	26.35	21.80
	D	30.10	54.80	42.98	66.60	48.66	55.29	63.51	62.30
	E	46.00	54.80	24.46	10.60	35.05	47.74	37.68	40.10
	mean	55.94	47.20	34.55	35.72	39.74	43.13	46.55	42.64
20 M	A	30.80	43.50	25.51	30.90	26.37	37.51	29.12	53.80
	B	16.00	58.40	18.08	43.80	20.69	63.07	18.58	58.80
	C	13.60	46.30	26.96	44.70	23.52	58.63	25.07	49.50
	D	38.60	97.70	48.10	85.50	46.67	83.80	46.94	83.00
	E	88.20	152.30	21.40	36.10	20.21	32.51	31.01	39.80
	mean	37.44	79.64	28.01	48.20	27.49	55.10	30.14	56.98
40 M	A	8.40	10.90	34.37	77.30	29.59	82.15	19.38	98.80
	B	36.80	110.80	46.60	109.20	49.76	112.60	51.72	103.30
	C	26.80	85.10	23.17	67.80	21.43	69.14	23.72	72.40
	D	25.60	73.80	28.17	74.90	30.49	79.96	30.17	64.20
	E	41.90	118.70	35.12	97.40	34.91	100.50	38.89	102.80
	mean	27.90	79.86	33.49	85.32	33.24	88.87	32.78	88.30
60 M	A	56.20	52.90	32.67	61.20	32.61	72.40	34.16	65.80
	B	72.10	91.10	56.61	14.90	25.43	16.39	27.62	14.70
	C	39.90	127.60	59.74	128.10	58.05	135.60	47.31	110.70
	D	26.90	13.60	35.77	14.20	38.25	15.36	25.61	11.80
	E	46.80	213.60	44.17	111.00	41.67	108.80	52.37	102.40
	mean	48.38	99.76	45.79	65.88	39.20	69.71	37.41	61.08
120 M	A	67.02	200.10	55.71	122.60	50.87	134.00	51.98	153.60
	B	25.20	70.60	47.55	91.90	50.79	97.86	59.35	170.80
	C	45.70	167.20	65.40	183.90	58.21	181.20	47.85	120.90
	D	125.90	205.70	30.27	79.10	23.01	64.53	26.31	68.50
	E	54.50	163.10	35.25	95.90	29.61	92.14	38.25	90.10
	mean	63.66	161.34	46.84	114.68	42.50	113.95	44.75	120.78

Table 13.14. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, November, 1999 to June, 2000. (2 of 2 pages)

		23 November 1999		25 April 2000		30 May 2000		28 June 2000	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
20 MR	A	43.80	69.60	34.38	48.10	37.63	54.48	25.16	47.80
	B	10.90	14.70	11.67	10.50	10.98	11.07	9.31	9.40
	C	20.10	97.60	34.29	87.60	39.15	82.73	48.76	84.80
	D	40.50	95.70	54.08	83.80	51.42	84.31	27.25	18.00
	E	31.80	52.90	30.13	39.90	28.01	40.56	25.17	38.00
	mean	29.42	66.10	32.91	53.98	33.44	54.63	27.13	39.60
40 MR	A	19.30	96.10	18.59	45.80	19.62	56.18	25.93	80.10
	B	37.40	93.10	25.41	49.80	30.57	67.18	34.69	83.20
	C	14.60	19.20	16.24	31.90	14.77	33.27	15.22	31.10
	D	39.10	155.90	36.48	111.00	39.46	129.90	42.53	141.30
	E	24.20	175.40	21.87	103.40	20.70	97.19	20.57	96.20
	mean	26.92	107.94	23.72	68.38	25.02	76.74	27.79	86.38
60 MR	A	56.00	121.20	42.39	81.70	35.84	78.94	41.33	81.60
	B	52.10	220.60	50.52	10.70	48.78	8.71	39.46	12.20
	C	55.80	147.80	50.34	122.90	45.49	124.50	49.01	117.10
	D	32.10	92.90	24.08	13.10	24.73	143.64	55.01	81.90
	E	32.20	111.50	23.93	62.60	26.41	72.10	31.45	75.90
	mean	45.64	138.80	38.25	58.20	36.25	85.58	43.25	73.74
120 MR	A	197.30	214.20	182.80	177.90	160.90	179.40	17.97	180.20
	B	35.30	102.20	45.95	125.30	36.98	98.70	69.44	159.20
	C	61.60	209.40	55.70	187.50	49.30	190.70	47.07	160.40
	D	48.70	94.90	12.04	25.10	11.52	27.19	11.41	25.10
	E	410.60	1007.10	197.70	443.20	161.91	424.40	17.54	429.90
	mean	150.70	325.56	98.84	191.80	84.12	184.08	32.69	190.96

Table 13.15. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, August, 2000 to November, 2000. (1 of 2 pages)

		1 August 2000		28 August 2000		27 September 2000		2 November 2000	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	23.57	26.90	22.78	27.30	22.43	36.30	26.71	40.65
	B	26.49	70.50	24.07	79.30	27.75	76.10	28.32	89.11
	C	36.23	18.10	55.05	43.70	39.34	39.60	46.30	43.35
	D	27.21	28.40	28.82	32.80	29.81	33.20	30.09	32.26
	E	26.61	7.10	29.93	9.20	26.18	7.10	24.15	9.24
	mean	28.02	30.20	32.13	38.46	29.10	38.46	31.11	42.92
60 F	A	28.95	70.50	36.15	83.50	34.74	75.80	35.75	80.94
	B	27.31	12.60	37.04	64.40	59.56	131.40	65.81	158.40
	C	56.11	69.20	64.76	70.20	75.61	75.80	62.33	101.91
	D	66.11	71.30	67.97	67.70	70.32	56.10	70.09	61.07
	E	26.25	18.10	27.27	15.80	32.41	18.10	35.17	20.92
	mean	40.95	48.34	46.64	60.32	54.53	71.44	53.83	84.65
120 F	A	27.56	9.80	28.36	9.70	27.35	10.40	27.44	10.17
	B	55.56	149.10	57.43	163.10	50.15	114.60	44.49	122.31
	C	61.58	84.80	85.77	75.10	90.58	41.40	80.38	46.85
	D	7.39	10.60	6.85	10.70	6.91	10.50	2.39	9.01
	E	28.78	9.90	25.42	9.10	28.55	8.90	26.07	10.62
	mean	36.17	52.84	40.77	53.54	40.71	37.16	36.15	39.79
180 F	A	67.17	40.30	75.05	63.10	57.68	82.40	56.79	97.14
	B	44.47	68.10	37.94	62.60	40.45	67.40	39.08	76.25
	C	35.77	25.30	33.81	28.80	50.55	39.60	52.59	66.38
	D	78.31	42.40	75.44	61.30	74.67	78.60	76.34	124.79
	E	34.07	38.30	31.56	24.40	33.45	29.90	33.79	35.95
	mean	51.96	42.88	50.76	48.04	51.36	59.58	51.72	80.10
20 M	A	29.19	55.90	30.53	47.60	31.52	50.70	30.96	55.16
	B	17.87	56.20	11.93	35.40	14.46	46.80	18.01	55.76
	C	21.96	30.80	21.81	41.30	20.92	29.40	15.72	23.57
	D	9.57	33.90	33.54	67.30	32.49	60.40	35.58	71.27
	E	26.51	46.80	33.81	57.60	30.47	51.90	26.15	40.11
	mean	21.02	44.72	26.32	49.84	25.97	47.84	25.28	49.17
40 M	A	26.07	44.90	32.34	48.80	28.11	56.20	25.93	60.65
	B	35.59	84.40	43.93	92.30	37.48	86.40	34.77	91.92
	C	24.63	76.80	23.89	74.10	24.23	76.70	24.46	99.59
	D	28.26	133.60	30.59	112.50	30.62	124.30	29.53	81.26
	E	37.42	101.70	38.17	113.60	40.85	113.20	41.91	140.11
	mean	30.39	88.28	33.78	88.26	32.26	91.36	31.32	94.71
60 M	A	31.12	62.70	37.29	65.40	34.01	76.10	32.65	71.16
	B	37.71	40.80	45.60	47.40	38.18	32.50	45.42	51.43
	C	44.41	103.10	45.15	109.50	34.65	87.30	33.16	80.45
	D	56.44	32.10	57.16	63.70	66.55	122.40	73.46	175.71
	E	42.51	87.10	37.23	94.10	38.71	86.70	74.42	104.51
	mean	42.44	65.16	44.49	76.02	42.42	81.00	51.82	96.65
120 M	A	59.28	187.20	81.06	237.40	63.31	208.00	66.14	201.10
	B	55.88	97.50	66.13	82.90	54.24	45.70	44.39	39.68
	C	45.11	139.90	47.52	147.50	44.38	101.20	44.51	108.31
	D	77.15	63.60	50.26	55.10	38.71	41.60	102.91	106.11
	E	75.21	108.80	53.99	95.40	67.18	97.30	55.45	114.41
	mean	62.53	119.40	59.79	123.66	53.56	98.76	62.68	113.92

Table 13.15. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, August, 2000 to November, 2000. (2 of 2 pages)

		1 August 2000		28 August 2000		27 September 2000		2 November 2000	
Treatment	Rep	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}
20 MR	A	39.61	88.50	36.66	73.90	34.21	63.60	28.84	52.62
	B	10.21	12.40	9.18	13.60	9.29	13.20	9.33	15.61
	C	37.76	91.50	42.55	90.40	43.39	72.30	39.43	75.68
	D	29.63	60.50	36.18	65.40	45.79	69.50	51.78	97.08
	E	28.11	43.10	27.28	42.30	27.39	30.60	1.92	42.25
	mean	29.06	59.20	30.37	57.12	32.01	49.84	26.26	56.65
40 MR	A	20.39	29.50	16.64	28.50	15.53	21.80	15.06	16.43
	B	27.53	58.10	29.08	55.80	42.98	56.90	37.97	54.13
	C	1.67	36.70	14.62	38.20	17.49	51.90	18.65	47.78
	D	33.91	109.50	35.91	113.50	34.95	105.40	37.01	130.91
	E	23.11	107.80	19.51	104.20	19.42	92.70	1.87	115.31
	mean	21.32	68.32	23.15	68.04	26.07	65.74	22.11	72.91
60 MR	A	37.93	76.90	37.93	75.90	33.49	64.80	31.53	66.78
	B	27.64	14.60	31.25	17.20	34.64	22.80	40.94	30.94
	C	47.56	119.10	46.17	115.80	42.57	99.10	41.81	109.51
	D	28.09	46.80	28.31	81.30	23.01	72.50	20.27	92.42
	E	32.27	89.50	22.49	63.50	28.36	72.90	29.42	77.54
	mean	34.70	69.38	33.23	70.74	32.41	66.42	32.79	75.44
120 MR	A	192.30	180.20	178.40	186.40	166.80	180.30	155.81	185.80
	B	98.13	181.10	42.32	85.60	53.74	101.20	56.85	66.16
	C	39.71	140.10	40.59	152.90	39.16	163.90	42.38	176.81
	D	54.42	81.80	69.71	82.70	117.90	119.80	225.41	204.71
	E	173.71	439.70	152.81	455.80	147.50	429.90	141.21	419.91
	mean	111.65	204.58	96.77	192.68	105.02	199.02	124.33	210.68

Table 13.16. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, May to August, 2001. (1 of 2 pages)

		2 May 2001		30 May 2001		27 June 2001		1 August 2001	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	36.64	58.90	35.28	68.59	32.00	59.30	22.75	43.60
	B	35.87	90.80	32.32	87.48	17.58	47.50	11.60	6.40
	C	37.53	32.20	31.92	32.20	29.54	24.10	14.49	0.00
	D	29.93	31.60	29.27	33.22	26.75	29.50	28.81	23.60
	E	21.00	5.20	19.51	6.18	18.40	5.00	18.45	5.80
	mean	32.19	43.74	29.66	45.53	24.85	33.08	19.22	15.88
60 F	A	49.21	65.80	52.45	79.06	46.26	70.20	47.37	57.10
	B	77.07	138.10	76.90	149.20	15.88	12.80	32.95	4.60
	C	82.48	124.10	70.73	115.90	76.08	139.30	74.64	39.60
	D	58.14	53.50	57.12	57.44	60.80	26.90	17.90	7.20
	E	40.36	16.10	27.61	7.67	18.59	4.80	22.95	5.00
	mean	61.45	79.52	56.96	81.85	43.52	50.80	39.16	22.70
120 F	A	34.77	8.50	37.54	9.64	33.13	7.70	38.96	7.80
	B	76.27	239.90	71.31	104.50	60.50	167.30	25.82	13.30
	C	60.14	18.10	50.10	20.16	51.09	18.30	41.78	7.90
	D	0.33	6.10	0.41	6.84	7.83	7.20	31.63	4.50
	E	27.72	8.10	26.07	8.08	22.71	6.40	22.36	5.70
	mean	39.85	56.14	37.09	29.84	35.05	41.38	32.11	7.84
180 F	A	52.78	79.80	47.78	83.11	49.46	80.50	46.36	86.60
	B	57.15	50.90	59.49	56.70	52.80	51.60	49.71	17.70
	C	50.50	36.90	47.55	37.02	32.49	21.90	30.96	12.30
	D	81.80	127.60	84.35	126.00	86.26	101.40	19.09	34.70
	E	36.25	36.90	33.69	32.72	23.52	13.60	27.52	5.30
	mean	55.70	66.42	54.57	67.11	48.91	53.80	34.73	31.32
20 M	A	31.92	54.10	33.75	61.71	33.62	62.80	32.64	72.70
	B	15.08	49.50	18.05	61.48	19.87	56.00	20.70	29.50
	C	22.69	31.20	21.15	21.02	21.42	28.40	17.54	25.20
	D	39.78	75.70	37.96	75.18	27.49	59.60	25.19	52.70
	E	45.05	63.70	43.89	63.58	37.73	61.00	53.67	83.40
	mean	30.90	54.84	30.96	56.59	28.03	53.56	29.95	52.70
40 M	A	21.88	30.30	28.66	42.06	30.83	66.30	40.80	88.50
	B	27.90	61.30	30.15	69.02	29.46	71.10	26.65	57.90
	C	22.28	86.50	21.79	93.00	22.34	82.40	13.68	99.60
	D	29.11	60.60	29.18	57.50	29.29	55.40	41.63	94.90
	E	47.41	121.30	43.21	117.30	47.75	112.80	44.42	125.40
	mean	29.72	72.00	30.60	75.78	31.93	77.60	33.44	93.26
60 M	A	32.99	67.00	31.77	77.36	31.92	85.70	31.71	86.10
	B	43.96	32.70	45.81	33.81	44.34	31.80	43.23	38.90
	C	37.68	76.10	35.22	81.73	40.81	90.60	77.01	145.60
	D	56.55	42.00	52.55	36.48	66.26	120.50	45.48	100.70
	E	40.70	75.90	36.97	70.82	36.36	65.90	46.41	70.10
	mean	42.38	58.74	40.46	60.04	43.94	78.90	48.77	88.28
120 M	A	89.97	234.20	102.50	237.60	105.30	247.40	89.96	230.20
	B	56.54	47.60	54.39	49.74	58.18	69.20	89.39	115.10
	C	41.88	88.70	38.37	97.29	30.94	79.30	41.59	124.40
	D	65.50	98.40	47.94	85.71	83.92	98.70	212.80	267.50
	E	30.76	73.70	29.03	71.05	30.62	69.80	354.40	324.50
	mean	56.93	108.52	54.45	108.28	61.79	112.88	157.63	212.34

Table 13.16. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, May to August, 2001. (2 of 2 pages)

		2 May 2001		30 May 2001		27 June 2001		1 August 2001	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
20 MR	A	30.28	49.70	29.56	50.45	28.09	45.60	28.96	60.10
	B	10.20	13.10	11.02	14.89	12.83	20.40	12.46	31.30
	C	24.32	43.70	24.28	46.56	23.07	54.10	59.24	43.10
	D	55.24	82.20	50.34	79.46	20.02	35.60	18.23	15.70
	E	25.19	41.40	25.35	40.25	26.71	39.50	24.87	39.70
	mean	29.05	46.02	28.11	46.32	22.14	39.04	28.75	37.98
40 MR	A	14.11	36.40	14.95	35.22	19.97	38.50	23.53	34.10
	B	43.88	50.40	46.55	44.07	48.24	42.80	47.37	28.40
	C	15.36	53.50	16.65	50.40	23.51	60.90	29.90	102.90
	D	39.29	128.10	37.80	125.80	33.74	96.70	30.58	47.10
	E	17.19	91.50	18.59	95.67	19.92	96.70	19.24	35.20
	mean	25.97	71.98	26.91	70.23	29.08	67.12	30.12	49.54
60 MR	A	27.19	49.10	26.28	57.14	29.49	66.60	31.84	78.80
	B	22.30	10.70	22.43	11.04	22.60	13.20	38.08	21.50
	C	39.71	88.90	38.23	92.95	37.55	87.60	70.41	64.60
	D	22.11	88.90	25.93	82.44	16.88	98.90	15.47	81.70
	E	23.08	61.90	26.02	64.87	34.93	59.60	81.13	33.10
	mean	26.88	59.90	27.78	61.69	28.29	65.18	47.39	55.94
120 MR	A	133.60	185.40	135.00	185.20	137.00	185.40	13.69	181.60
	B	76.74	78.70	62.11	70.94	63.68	79.20	10.63	71.80
	C	42.27	135.10	41.18	124.90	37.84	137.00	40.46	301.80
	D	45.58	42.90	44.30	44.33	45.23	49.10	203.20	20.10
	E	119.80	344.90	116.40	332.70	176.60	270.50	325.40	186.60
	mean	83.60	157.40	79.80	151.61	92.07	144.24	118.68	152.38

Table 13.17. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, August to November, 2001. (1 of 2 pages)

		29 August 2001		26 September 2001		7 November 2001			
Treatment	Rep	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}
Control	A	29.62	54.10	37.92	65.94	37.19	69.96		
	B	11.83	31.70	9.70	26.39	10.59	26.01		
	C	25.59	5.20	18.38	5.09	31.50	7.28		
	D	29.46	30.10	24.24	30.71	28.15	28.42		
	E	16.33	4.20	18.84	5.93	19.64	6.03		
	mean	22.57	25.06	21.82	26.81	25.41	27.54		
60 F	A	46.28	55.10	47.25	58.40	47.68	59.21		
	B	56.12	82.70	45.39	60.89	62.57	49.95		
	C	61.63	26.80	53.75	32.11	107.50	20.80		
	D	37.78	13.50	32.32	13.19	48.12	23.76		
	E	83.17	25.30	36.41	32.92	44.80	45.97		
	mean	57.00	40.68	43.02	39.50	62.13	39.94		
120 F	A	39.00	8.80	38.14	9.73	33.88	8.86		
	B	25.45	53.90	49.25	38.12	27.07	61.60		
	C	29.47	26.60	39.38	41.56	51.81	62.00		
	D	28.26	5.50	25.80	7.62	17.30	6.30		
	E	22.57	4.90	20.48	5.62	17.75	4.75		
	mean	28.95	19.94	34.61	20.53	29.56	28.70		
180 F	A	57.36	113.90	62.29	127.60	58.94	117.30		
	B	46.18	73.30	48.73	71.22	41.17	66.60		
	C	23.51	19.10	23.06	21.68	39.95	17.25		
	D	37.03	66.60	41.30	72.56	39.05	68.53		
	E	49.70	5.70	68.01	6.34	81.88	0.00		
	mean	42.76	55.72	48.68	59.88	52.20	53.94		
20 M	A	31.37	67.90	31.40	65.02	34.23	66.22		
	B	31.31	49.70	27.11	58.18	33.19	56.34		
	C	22.75	52.20	23.11	59.90	35.73	67.72		
	D	33.90	69.90	34.81	71.63	35.68	69.57		
	E	38.38	42.80	37.91	45.35	39.21	57.33		
	mean	31.54	56.50	30.87	60.02	35.61	63.44		
40 M	A	32.42	74.60	36.30	77.09	37.25	76.09		
	B	45.95	75.10	39.46	64.92	36.76	64.84		
	C	19.50	93.50	22.68	93.54	25.08	95.26		
	D	40.24	118.00	40.48	119.10	38.84	113.70		
	E	47.05	120.20	46.56	112.70	44.48	115.70		
	mean	37.03	96.28	37.10	93.47	36.48	93.12		
60 M	A	34.46	99.60	32.62	78.41	33.26	73.21		
	B	47.84	42.50	56.92	54.42	59.61	78.80		
	C	42.19	90.60	35.89	79.66	39.50	76.61		
	D	35.45	102.60	19.96	45.46	19.16	47.90		
	E	44.68	83.20	41.44	85.99	46.36	89.52		
	mean	40.92	83.70	37.37	68.79	39.58	73.21		
120 M	A	81.26	215.60	82.87	186.10	80.50	160.60		
	B	133.40	143.40	84.95	91.95	70.97	78.76		
	C	38.19	98.70	31.04	90.86	31.57	89.87		
	D	333.80	388.00	299.40	270.10	313.80	311.60		
	E	14.13	151.40	92.35	108.70	59.59	88.97		
	mean	120.16	199.42	118.12	149.54	111.29	145.96		

Table 13.17. Nitrate-N and chloride content in groundwater samples at the coarse-textured site, August to November, 2001. (2 of 2 pages)

		29 August 2001		26 September 2001		7 November 2001			
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
20 MR	A	23.04	48.50	24.55	49.51	28.11	51.95		
	B	11.30	22.20	11.27	21.75	11.57	17.95		
	C	74.88	50.70	52.06	41.73	34.70	29.60		
	D	28.90	36.90	33.53	51.91	40.44	60.77		
	E	28.35	39.60	26.51	43.37	27.09	39.92		
	mean	33.29	39.58	29.58	41.65	28.38	40.04		
40 MR	A	29.16	58.60	31.36	66.46	37.33	75.74		
	B	37.51	38.90	35.93	33.81	38.89	39.10		
	C	38.12	94.80	42.13	97.53	44.54	91.05		
	D	23.57	55.70	64.39	50.17	38.18	74.91		
	E	21.60	59.30	21.56	73.96	18.61	76.08		
	mean	29.99	61.46	39.07	64.39	35.51	71.38		
60 MR	A	31.46	75.90	30.20	69.03	29.72	65.78		
	B	33.28	21.70	59.28	34.30	68.95	69.73		
	C	44.62	91.80	38.84	92.08	40.01	93.86		
	D	10.77	63.40	7.52	43.70	8.44	32.32		
	E	28.44	28.90	46.21	49.18	49.42	55.06		
	mean	29.71	56.34	36.41	57.66	39.31	63.35		
120 MR	A	135.90	183.20	146.40	183.00	127.30	186.60		
	B	146.30	72.20	175.10	181.60	115.30	173.20		
	C	46.25	186.20	54.67	188.80	65.28	186.50		
	D	204.60	22.70	204.75	31.46	218.20	29.96		
	E	274.20	94.20	257.50	134.70	239.80	183.60		
	mean	161.45	111.70	167.68	143.91	153.18	151.97		

Table 13.18. Nitrate-N and chloride content in groundwater samples at the medium-textured site, May to October, 1993.

		31 May 1993		28 June 1993		28 July 1993		19 October 1993	
Treatment	Rep	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}
Control	A	0.57	0.19	2.23	5.15	2.21	5.05	0.72	5.39
	B	0.59	0.17	4.39	4.90	3.31	4.00	1.25	3.91
	C	1.01	0.52	18.00	15.66	8.76	15.30	14.91	18.13
	D	1.41	1.47	27.90	47.55	27.66	46.70	18.62	41.40
	E	1.50	0.34	14.53	7.50	15.82	8.70	1.82	29.20
	mean	1.02	0.54	13.41	16.15	11.55	15.95	7.46	19.61
60 F	A	0.39	0.31	2.07	9.00	1.43	8.90	0.32	10.54
	B	0.36	0.25	6.29	5.90	2.86	4.10	0.52	6.57
	C	0.98	0.39	12.94	11.79	6.66	9.90	1.65	13.17
	D	1.81	0.84	28.59	20.04	30.69	21.10	33.67	24.99
	E	12.17	0.19	44.79	4.20	45.82	4.40	16.29	13.30
	mean	3.14	0.40	18.94	10.19	17.49	9.68	10.49	13.71
120 F	A	0.23	0.18	0.33	4.71	1.36	4.90	0.33	5.10
	B	0.73	0.16	6.00	4.10	3.92	3.40	1.38	3.02
	C	1.27	0.24	21.15	6.33	10.36	6.70	19.33	7.66
	D	1.74	0.54	31.01	15.20	29.20	21.00	33.22	16.90
	E	1.73	0.21	26.34	4.83	20.97	5.20	1.60	22.80
	mean	1.14	0.27	16.97	7.03	13.16	8.24	11.17	11.10
180 F	A	0.41	0.33	2.86	9.40	1.81	8.90	0.62	9.56
	B	0.49	0.15	2.68	0.00	2.28	3.50	0.46	3.30
	C	1.37	1.17	15.65	29.94	9.47	31.40	15.23	39.87
	D	1.74	0.97	31.81	29.50	28.67	29.90	18.58	35.40
	E	1.73	0.16	27.61	3.26	28.50	3.50	md[z]	md
	mean	1.15	0.56	16.12	14.42	14.15	15.44	8.72	22.03
20 M	A	0.43	0.23	9.03	7.06	3.46	6.35	0.66	6.60
	B	0.76	0.32	3.65	7.79	3.00	7.40	0.97	7.63
	C	0.92	0.13	7.95	2.55	3.43	4.05	0.85	10.30
	D	9.03	0.18	27.79	2.90	25.53	3.90	17.73	4.16
	E	1.36	0.22	35.16	3.35	24.53	5.70	17.09	9.00
	mean	2.50	0.22	16.72	4.73	11.99	5.48	7.46	7.54
40 M	A	0.53	0.37	2.29	10.26	1.82	9.40	0.50	10.57
	B	0.42	0.22	1.93	6.25	1.60	6.05	0.57	5.77
	C	1.53	1.15	25.71	28.16	15.43	29.75	36.33	44.39
	D	1.21	0.34	15.98	8.81	10.93	8.00	1.66	10.69
	E	1.51	0.26	42.67	6.70	30.32	6.35	18.97	9.79
	mean	1.04	0.47	17.72	12.04	12.02	11.91	11.61	16.24
60 M	A	0.63	0.26	3.01	7.15	2.71	7.30	2.35	8.38
	B	0.47	0.19	3.39	4.60	2.87	5.10	0.79	4.17
	C	1.07	0.71	21.95	19.32	11.35	19.70	8.32	28.83
	D	1.16	0.27	29.88	4.32	17.99	6.45	17.32	9.41
	E	1.40	0.34	20.14	9.94	17.86	11.35	10.50	16.10
	mean	0.95	0.35	15.68	9.07	10.56	9.98	7.86	13.38
120 M	A	0.40	0.28	2.84	10.50	2.06	10.20	0.52	12.11
	B	0.49	0.32	4.28	9.49	3.12	8.00	0.76	8.72
	C	0.87	0.46	9.64	10.60	7.14	12.45	1.56	15.82
	D	1.29	0.26	14.12	5.30	13.12	6.90	10.25	13.30
	E	1.65	0.26	31.23	5.80	31.51	6.15	26.08	8.47
	mean	0.94	0.32	12.42	8.34	11.39	8.74	7.83	11.68

[z] md = missing data

Table 13.19. Nitrate-N and chloride content in groundwater samples at the medium-textured site, April to July, 1994.

		11 April 1994		31 May 1994		28 June 1994		26 July 1994	
Treatment	Rep	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}
Control	A	0.00	17.30	2.76	5.15	0.00	20.00	0.00	16.90
	B	0.00	9.60	0.04	8.59	0.00	8.10	0.00	8.40
	C	4.82	28.44	7.04	26.94	5.67	31.70	0.80	26.40
	D	3.53	91.74	10.30	87.22	9.94	87.50	7.91	89.10
	E	13.72	32.16	24.28	26.70	22.04	29.30	26.40	25.20
	mean	4.41	35.85	8.88	30.92	7.53	35.32	7.02	33.20
60 F	A	0.00	20.80	1.00	20.21	0.00	26.90	0.00	21.70
	B	0.00	18.68	0.04	18.15	0.00	21.00	0.00	16.30
	C	2.99	23.63	1.28	22.49	0.11	26.40	0.33	21.30
	D	12.00	50.97	27.18	49.20	21.14	54.50	30.90	48.60
	E	12.59	20.48	27.81	13.10	33.10	10.40	26.70	14.80
	mean	5.52	26.91	11.46	24.63	10.87	27.84	11.59	24.54
120 F	A	0.00	13.50	2.43	5.18	0.00	16.70	0.00	14.60
	B	1.64	19.98	2.92	18.38	0.22	24.40	0.00	21.50
	C	5.57	44.17	8.24	45.82	6.17	52.20	0.84	45.80
	D	8.99	39.49	20.10	38.40	20.79	44.00	18.21	37.60
	E	9.41	25.98	13.05	23.10	15.90	19.50	16.46	19.40
	mean	5.12	28.62	9.35	26.18	8.62	31.36	7.10	27.78
180 F	A	0.00	14.00	0.04	13.63	0.00	15.50	0.00	13.50
	B	1.11	5.68	0.08	5.19	0.07	2.70	0.14	4.90
	C	7.74	52.80	1.14	51.09	9.08	56.90	1.24	51.70
	D	8.90	58.10	26.92	56.60	18.10	61.80	25.50	54.50
	E	11.17	11.57	36.71	7.15	29.71	7.70	32.40	8.30
	mean	5.78	28.43	12.98	26.73	11.39	28.92	11.86	26.58
20 M	A	0.00	10.75	1.19	6.82	0.00	9.85	0.00	9.65
	B	0.28	22.95	0.67	22.70	0.13	25.85	0.06	21.10
	C	5.70	11.36	4.85	11.26	3.09	12.90	0.44	10.65
	D	5.25	12.40	16.33	9.15	10.95	11.10	18.82	9.75
	E	4.02	26.43	15.37	17.64	18.10	15.35	16.95	15.00
	mean	3.05	16.78	7.68	13.51	6.46	15.01	7.26	13.23
40 M	A	0.00	13.95	0.04	13.57	0.00	15.20	0.00	13.20
	B	0.07	7.83	0.04	7.52	0.00	6.40	0.00	7.35
	C	44.41	224.30	21.85	171.45	39.32	196.95	40.85	163.30
	D	6.26	32.87	15.79	22.23	12.75	29.70	11.88	27.20
	E	10.68	50.69	25.31	27.55	19.76	35.90	25.35	31.15
	mean	12.28	65.93	12.61	48.47	14.37	56.83	15.62	48.44
60 M	A	0.03	9.75	0.13	8.46	0.05	7.90	0.06	7.85
	B	0.00	42.89	0.58	29.32	0.00	36.95	0.00	32.80
	C	35.44	136.06	24.88	92.41	26.28	80.40	37.65	103.70
	D	28.89	53.28	29.75	38.76	29.69	46.20	35.61	50.65
	E	14.19	68.96	25.90	53.90	25.12	58.00	27.33	55.75
	mean	15.71	62.19	16.25	44.57	16.23	45.89	20.13	50.15
120 M	A	2.27	14.35	2.02	19.16	0.43	23.75	0.11	16.70
	B	0.79	22.60	0.72	29.66	0.05	44.35	0.06	32.10
	C	20.60	91.27	16.91	55.04	14.05	46.00	18.58	52.50
	D	1.10	40.99	3.51	36.80	3.45	40.30	2.68	37.80
	E	5.99	41.45	17.22	24.00	15.50	28.80	13.73	29.15
	mean	6.15	42.13	8.08	32.93	6.70	36.64	7.04	33.65

Table 13.20. Nitrate-N and chloride content in groundwater samples at the medium-textured site, August, 1994 to January, 1995.

		30 August 1994		27 September 1994		2 November 1994		25 January 1995	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	0.00	18.87	0.00	17.25	0.00	22.14	0.00	17.80
	B	0.00	7.13	0.00	8.46	0.00	8.60	0.00	8.50
	C	5.28	30.33	6.31	25.22	7.14	27.20	6.13	27.40
	D	5.72	89.99	5.18	88.14	5.58	93.10	3.45	93.30
	E	17.98	29.12	19.99	22.49	26.99	37.50	25.70	29.80
	mean	5.80	35.09	6.30	32.31	7.94	37.71	7.06	35.36
60 F	A	0.00	23.43	0.00	20.64	0.00	24.59	0.53	21.30
	B	0.17	24.61	0.00	15.67	0.00	16.70	0.00	16.10
	C	2.02	24.64	2.53	20.42	4.11	21.80	2.01	22.00
	D	17.98	51.50	19.24	46.41	20.48	49.80	19.81	51.30
	E	16.07	20.50	17.84	19.49	18.66	21.90	17.95	23.30
	mean	7.25	28.94	7.92	24.53	8.65	26.96	8.06	26.80
120 F	A	0.00	17.88	0.00	15.86	0.00	18.47	0.00	16.10
	B	0.07	25.95	0.13	22.27	2.00	23.32	0.97	24.10
	C	6.69	53.16	3.69	45.12	8.41	51.50	8.45	52.10
	D	13.02	40.20	13.40	35.83	13.43	38.10	11.57	39.40
	E	13.41	25.14	24.12	26.58	18.36	25.00	18.95	25.10
	mean	6.64	32.47	8.27	29.13	8.44	31.28	7.99	31.36
180 F	A	0.00	14.76	0.00	13.20	0.00	16.62	0.00	13.70
	B	0.36	22.85	0.00	4.73	1.03	4.90	0.00	4.90
	C	10.13	57.09	11.07	50.39	12.69	53.70	8.58	53.60
	D	14.06	58.79	14.26	53.93	15.99	58.90	14.10	59.20
	E	10.44	13.89	12.12	11.41	10.24	13.80	7.15	15.50
	mean	7.00	33.48	7.49	26.73	7.99	29.58	5.97	29.38
20 M	A	0.00	10.28	0.00	9.53	0.08	48.39	0.00	10.05
	B	0.00	22.20	0.02	21.11	0.00	23.70	0.32	22.70
	C	1.70	13.35	1.56	11.11	2.97	12.95	2.10	13.80
	D	9.96	11.21	11.03	9.80	10.72	11.50	9.70	12.35
	E	8.61	23.63	7.49	21.23	9.08	23.90	7.21	26.00
	mean	4.06	16.14	4.02	14.56	4.57	24.09	3.87	16.98
40 M	A	0.06	17.47	0.00	13.03	0.00	17.75	0.00	13.65
	B	0.00	8.09	0.00	7.14	0.00	7.56	0.00	7.45
	C	35.97	179.60	39.40	178.20	40.60	193.65	37.72	207.30
	D	7.74	35.57	8.14	31.98	8.59	37.85	7.78	37.70
	E	15.54	40.84	17.59	37.92	19.39	39.90	18.74	46.60
	mean	11.86	56.32	13.03	53.66	13.72	59.34	12.85	62.54
60 M	A	0.00	8.58	0.08	7.69	0.13	9.22	0.33	7.75
	B	0.00	45.97	0.00	45.83	0.00	47.00	0.00	15.10
	C	34.17	116.89	43.51	117.94	47.11	137.95	49.35	150.05
	D	31.69	75.82	33.67	69.55	36.80	84.55	34.98	86.75
	E	24.21	63.25	25.41	59.36	31.32	64.65	30.05	69.00
	mean	18.01	62.10	20.54	60.08	23.07	68.67	22.94	65.73
120 M	A	0.00	11.82	0.24	16.81	2.74	34.37	2.31	20.40
	B	0.00	41.93	0.03	32.87	0.56	37.97	0.43	34.40
	C	18.18	69.79	25.94	77.26	31.15	91.15	31.98	97.70
	D	1.47	41.70	2.01	37.81	2.17	40.75	1.28	42.80
	E	10.14	39.20	11.01	36.77	14.57	39.75	11.60	42.70
	mean	5.96	40.89	7.85	40.30	10.24	48.80	9.52	47.60

Table 13.21. Nitrate-N and chloride content in groundwater samples at the medium-textured site, April to June, 1995.

		4 April 1995		3 May 1995		30 May 1995		28 June 1995	
Treatment	Rep	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}
Control	A	0.00	16.34	0.00	13.60	2.10	15.70	0.00	15.33
	B	0.00	8.60	0.00	7.10	2.01	8.60	0.00	8.38
	C	4.30	27.33	7.11	25.20	14.88	26.60	5.10	26.88
	D	2.45	93.02	4.16	96.40	7.76	93.00	5.05	93.05
	E	25.29	31.06	31.70	31.00	28.90	30.90	24.55	26.65
	mean	6.41	35.27	8.59	34.66	11.13	34.96	6.94	34.06
60 F	A	0.00	25.21	0.00	20.30	2.37	20.58	0.00	23.69
	B	0.00	16.36	0.00	14.50	2.32	16.60	0.00	15.83
	C	1.17	21.52	4.03	19.90	9.71	21.30	3.71	20.88
	D	13.93	51.52	20.60	50.10	34.60	49.10	27.24	48.82
	E	14.36	28.28	23.50	28.90	27.60	23.50	21.33	19.09
	mean	5.89	28.58	9.63	26.74	15.32	26.22	10.46	25.66
120 F	A	0.00	16.16	0.00	13.60	2.02	12.70	0.00	14.75
	B	0.00	24.86	2.80	20.20	5.32	18.33	1.86	20.11
	C	5.57	52.25	9.66	48.50	14.62	47.00	5.28	51.39
	D	8.43	39.13	15.28	38.90	14.41	37.10	20.63	40.37
	E	15.96	26.64	28.40	25.90	24.40	26.00	21.89	22.60
	mean	5.99	31.81	11.23	29.42	12.15	28.23	9.93	29.84
180 F	A	0.00	14.22	0.00	12.30	1.70	13.30	0.00	14.42
	B	0.00	4.88	0.00	3.40	5.34	5.70	0.56	4.27
	C	6.25	52.96	12.03	54.40	19.94	54.70	9.09	54.21
	D	8.52	61.66	14.52	60.40	28.30	59.00	23.05	58.00
	E	5.46	16.49	9.13	13.70	18.80	14.00	16.70	11.90
	mean	4.05	30.04	7.14	28.84	14.82	29.34	9.88	28.56
20 M	A	0.00	9.73	0.00	8.25	2.06	9.36	0.00	9.14
	B	0.00	26.98	0.00	23.35	2.31	23.00	0.00	23.77
	C	1.59	14.30	4.06	11.60	9.05	11.30	2.51	11.47
	D	5.24	13.36	10.11	10.65	18.80	11.65	12.10	11.62
	E	4.91	27.49	10.92	25.55	12.20	25.35	4.82	22.99
	mean	2.35	18.37	5.02	15.88	8.89	16.13	3.89	15.80
40 M	A	0.00	14.26	0.00	12.15	2.19	13.35	0.00	14.12
	B	0.00	7.61	0.00	6.05	1.87	7.40	0.00	7.71
	C	29.16	224.45	46.55	219.65	62.79	171.40	38.59	159.85
	D	4.11	47.52	7.49	43.00	19.67	37.25	7.15	32.36
	E	15.86	53.80	27.75	54.65	28.90	28.45	23.93	28.90
	mean	9.83	69.53	16.36	67.10	23.08	51.57	13.93	48.59
60 M	A	0.00	7.73	0.00	6.35	1.91	7.80	0.00	7.71
	B	0.00	55.56	0.00	40.45	3.37	24.75	0.59	28.90
	C	41.07	159.23	61.00	162.00	73.55	145.05	40.83	126.30
	D	31.82	92.35	40.70	87.05	55.15	74.80	36.89	71.59
	E	26.02	75.96	36.50	76.10	33.40	61.65	28.43	54.44
	mean	19.78	78.17	27.64	74.39	33.48	62.81	21.35	57.79
120 M	A	2.39	24.68	3.76	18.35	3.59	14.85	2.54	20.72
	B	0.00	50.96	0.00	36.80	3.14	27.80	0.51	32.90
	C	28.14	106.19	39.35	103.75	50.50	98.65	26.38	82.11
	D	0.76	43.68	1.79	43.25	3.98	40.60	1.37	39.48
	E	8.40	46.22	17.85	44.60	18.15	37.85	12.99	33.76
	mean	7.94	54.35	12.55	49.35	15.87	43.95	8.76	41.79

Table 13.22. Nitrate-N and chloride content in groundwater samples at the medium-textured site, July to November, 1995.

		26 July 1995		29 August 1995		26 September 1995		16 November 1995	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	0.00	17.06	0.00	18.37	0.00	18.80	0.00	17.50
	B	0.00	8.40	0.00	8.12	0.00	7.60	0.00	7.80
	C	8.83	27.83	6.53	27.78	7.31	27.90	6.26	25.60
	D	11.91	97.27	5.35	96.13	5.78	94.40	4.16	89.70
	E	28.05	26.98	25.32	27.07	30.25	26.80	28.50	24.00
	mean	9.76	35.51	7.44	35.49	8.67	35.10	7.78	32.92
60 F	A	0.64	23.35	0.00	24.46	0.00	22.50	0.00	25.10
	B	0.00	16.37	0.00	16.66	0.00	16.00	0.00	15.40
	C	4.97	22.10	3.43	21.80	3.72	21.60	2.79	20.40
	D	29.25	51.78	24.41	51.97	28.90	52.90	25.69	50.20
	E	24.87	19.47	21.90	18.98	27.20	21.40	26.34	20.20
	mean	11.95	26.61	9.95	26.77	11.96	26.88	10.96	26.26
120 F	A	0.00	15.44	0.00	15.37	0.00	15.90	0.00	15.80
	B	2.61	21.34	1.34	23.36	1.60	23.80	0.00	24.10
	C	10.29	46.90	7.01	54.27	8.40	53.20	8.62	54.90
	D	21.60	41.13	15.91	39.91	13.42	40.30	16.23	38.30
	E	25.12	23.28	22.71	23.92	28.01	24.20	25.69	23.30
	mean	11.92	29.62	9.39	31.37	10.29	31.48	10.11	31.28
180 F	A	0.00	14.01	0.00	13.50	0.00	13.30	0.00	13.00
	B	1.80	5.37	0.76	4.72	1.30	4.40	0.00	0.00
	C	12.09	27.14	8.90	55.65	9.18	55.60	7.63	54.90
	D	26.01	59.61	19.38	61.45	14.41	62.40	18.28	62.20
	E	29.67	9.19	20.34	11.46	19.66	11.20	16.23	13.80
	mean	13.91	23.06	9.88	29.36	8.91	29.38	8.43	28.78
20 M	A	0.00	9.46	0.00	9.32	0.00	8.10	0.00	9.10
	B	0.67	24.65	0.00	25.36	0.00	25.40	0.00	27.20
	C	5.29	11.45	2.96	12.78	3.43	12.70	2.51	16.10
	D	17.33	10.67	10.28	12.40	9.65	12.55	11.94	14.30
	E	19.34	19.77	13.92	23.40	10.53	23.90	10.95	25.35
	mean	8.53	15.20	5.43	16.65	4.72	16.53	5.08	18.41
40 M	A	0.00	13.90	0.00	13.47	0.00	13.10	0.00	12.90
	B	0.00	7.41	0.00	7.35	0.00	6.70	0.00	6.85
	C	41.59	184.00	41.25	209.75	52.80	221.90	49.92	209.40
	D	16.89	30.53	7.30	40.24	8.52	41.50	12.47	49.75
	E	26.73	35.48	23.84	39.38	27.60	40.85	27.05	41.90
	mean	17.04	54.26	14.48	62.04	17.78	64.81	17.89	64.16
60 M	A	0.00	7.61	0.00	7.41	0.00	10.20	0.00	5.10
	B	0.71	38.99	0.00	49.68	0.00	54.20	0.00	60.70
	C	43.42	124.71	45.52	139.24	54.51	142.70	59.90	144.05
	D	40.64	67.78	35.71	85.52	38.29	60.69	47.35	86.45
	E	32.37	58.88	30.14	63.43	31.40	65.00	31.33	65.00
	mean	23.43	59.59	22.27	69.06	24.84	66.56	27.72	72.26
120 M	A	3.29	18.41	2.61	19.44	3.31	20.40	4.95	24.60
	B	0.86	33.78	0.00	43.86	0.64	40.15	0.00	52.60
	C	28.93	77.20	27.36	91.53	30.75	91.95	36.61	88.70
	D	0.00	41.11	1.45	46.05	1.99	44.05	1.36	40.45
	E	19.47	35.29	17.32	37.96	13.58	38.25	14.91	38.35
	mean	10.51	41.16	9.75	47.77	10.06	46.96	11.57	48.94

Table 13.23. Nitrate-N and chloride content in groundwater samples at the medium-textured site, March to June, 1996.

		20 March 1996		1 May 1996		28 May 1996		27 June 1996	
Treatment	Rep	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}
Control	A	0.00	15.50	0.00	15.61	0.00	16.89	0.00	15.60
	B	0.00	7.50	0.00	8.32	0.00	8.89	0.00	8.30
	C	5.60	25.10	6.52	27.07	5.51	29.80	6.02	27.50
	D	1.91	94.90	2.15	95.42	2.15	99.50	3.25	92.90
	E	21.82	29.10	26.40	30.84	32.81	32.10	23.68	28.00
	mean	5.87	34.42	7.01	35.45	8.09	37.44	6.59	34.46
60 F	A	0.00	22.30	0.00	25.70	0.00	25.70	0.15	24.70
	B	0.00	14.10	0.00	15.86	0.00	18.20	0.00	16.60
	C	1.68	19.50	2.36	21.28	2.84	23.40	3.15	21.90
	D	12.29	58.40	15.00	57.20	17.44	58.20	18.99	52.60
	E	md[z]	md	16.46	21.11	19.67	19.30	21.68	16.60
	mean	3.49	28.57	6.76	28.23	7.99	28.96	8.79	26.48
120 F	A	0.00	14.20	0.00	15.50	0.00	15.70	0.00	15.10
	B	0.00	24.10	0.70	24.86	1.19	23.53	1.66	21.00
	C	5.81	48.90	6.73	52.52	10.59	55.90	6.32	51.80
	D	6.53	42.80	7.67	45.31	7.22	44.02	7.28	39.80
	E	18.80	24.70	22.41	26.13	20.33	28.50	21.28	25.00
	mean	6.23	30.94	7.50	32.86	7.87	33.53	7.31	30.54
180 F	A	0.00	12.00	0.00	13.61	0.00	14.60	0.00	14.00
	B	0.00	4.20	0.00	4.92	0.00	6.02	0.00	5.20
	C	4.07	49.70	5.31	54.86	5.52	55.70	5.48	55.30
	D	7.57	68.20	9.44	37.93	11.59	30.40	13.37	63.30
	E	11.11	11.80	15.42	11.01	29.12	8.00	26.77	8.80
	mean	4.55	29.18	6.03	24.47	9.25	22.94	9.12	29.32
20 M	A	0.00	8.75	0.00	9.36	0.00	10.29	0.00	9.65
	B	0.00	24.30	0.00	27.23	0.00	29.51	0.00	27.35
	C	3.10	11.30	2.96	12.52	7.42	14.14	2.51	13.30
	D	4.79	13.35	5.36	14.53	5.81	16.05	5.16	14.70
	E	4.93	28.60	6.90	30.25	9.15	31.15	5.85	27.45
	mean	2.56	17.26	3.04	18.78	4.48	20.23	2.70	18.49
40 M	A	0.00	12.35	0.00	13.64	0.00	14.68	0.00	14.10
	B	0.00	6.45	0.00	7.24	0.00	8.13	0.00	7.80
	C	35.47	231.55	39.65	252.45	38.05	255.75	37.98	237.65
	D	13.47	23.50	9.95	33.46	10.69	33.45	8.92	36.65
	E	16.52	55.55	20.42	58.75	19.23	48.68	20.86	39.05
	mean	13.09	65.88	14.01	73.11	13.60	72.14	13.55	67.05
60 M	A	0.00	4.80	0.00	5.30	0.00	8.20	0.00	7.80
	B	0.00	63.40	0.00	61.96	0.00	55.18	0.00	46.00
	C	46.91	157.40	55.08	493.44	51.45	178.85	50.12	163.45
	D	41.41	9.50	32.50	67.88	31.94	73.25	32.98	72.95
	E	28.75	81.95	31.85	83.60	29.74	79.75	29.15	66.10
	mean	23.41	63.41	23.89	142.44	22.63	79.05	22.45	71.26
120 M	A	2.45	21.70	3.04	25.54	2.80	25.81	2.99	24.70
	B	0.00	44.30	0.00	53.98	0.00	52.63	0.00	45.00
	C	10.03	100.10	32.51	107.33	29.87	106.00	28.41	95.90
	D	0.00	42.65	0.50	44.75	0.00	41.60	0.54	40.75
	E	8.10	45.05	10.24	44.70	13.42	37.67	15.55	34.80
	mean	4.12	50.76	9.26	55.26	9.22	52.74	9.50	48.23

[z] md = missing data.

Table 13.24. Nitrate-N and chloride content in groundwater samples at the medium-textured site, August, 1996 to May, 1997.

		7 August 1996		28 August 1996		25 September 1996		6 May 1997	
Treatment	Rep	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}
Control	A	1.81	17.80	1.11	18.70	0.00	18.30	0.00	23.45
	B	1.85	9.09	0.00	8.80	0.00	8.40	0.00	11.53
	C	9.38	27.62	15.60	27.60	5.33	27.50	4.17	37.81
	D	6.23	99.44	10.76	92.40	3.56	91.00	1.26	131.90
	E	33.82	29.84	31.17	28.80	23.99	28.60	25.00	45.47
	mean	10.62	36.76	11.73	35.26	6.58	34.76	6.09	50.03
60 F	A	2.04	25.35	0.00	23.80	0.00	21.70	0.00	33.21
	B	0.00	16.94	0.00	16.60	0.00	16.60	0.00	49.60
	C	14.94	22.22	12.55	21.80	3.45	22.40	1.82	29.13
	D	31.21	53.80	27.21	51.50	19.64	52.60	10.99	75.05
	E	31.21	20.69	26.62	21.00	19.50	22.77	14.60	33.25
	mean	15.88	27.80	13.28	26.94	8.52	27.21	5.48	44.05
120 F	A	1.58	15.99	0.00	14.70	0.00	15.10	0.00	19.37
	B	3.39	23.04	1.97	22.70	1.24	22.60	0.00	32.54
	C	8.88	55.63	16.91	49.40	10.49	51.30	5.69	66.04
	D	20.32	41.12	16.92	39.90	9.91	45.10	6.48	62.80
	E	30.85	26.06	28.92	25.50	21.78	25.28	16.14	40.45
	mean	13.00	32.37	12.94	30.44	8.68	31.88	5.66	44.24
180 F	A	1.68	14.28	0.00	13.80	0.00	13.20	0.00	18.54
	B	1.73	5.70	0.00	5.30	0.00	5.40	0.00	6.75
	C	20.57	58.65	15.30	56.90	6.78	56.60	3.65	70.71
	D	25.92	68.23	21.73	62.50	13.06	61.70	7.29	87.08
	E	30.39	12.80	26.46	11.40	9.57	13.73	11.02	17.07
	mean	16.06	31.93	12.70	29.98	5.88	30.13	4.39	40.03
20 M	A	1.74	10.71	0.00	10.45	0.00	9.77	0.00	13.44
	B	1.50	27.10	3.44	26.40	0.35	26.25	0.00	25.17
	C	4.67	13.92	11.00	12.95	2.37	13.80	2.41	17.64
	D	20.42	13.88	15.47	13.55	7.41	13.45	4.32	19.69
	E	19.45	27.83	16.79	27.00	10.71	27.67	5.51	45.84
	mean	9.56	18.69	9.34	18.07	4.17	18.19	2.45	24.36
40 M	A	1.73	14.47	0.00	14.05	0.00	13.30	0.00	18.68
	B	1.65	8.14	0.00	7.90	0.00	7.50	0.35	10.73
	C	55.66	221.00	47.30	222.00	37.70	211.95	39.16	327.65
	D	25.55	62.57	17.47	35.40	9.82	39.65	7.53	56.44
	E	31.05	47.30	27.66	45.80	20.78	50.01	19.66	84.09
	mean	23.13	70.70	18.49	65.03	13.66	64.48	13.34	99.52
60 M	A	1.65	8.53	0.00	8.10	0.00	7.30	0.00	10.36
	B	1.61	53.83	0.00	56.25	0.00	56.25	0.00	84.43
	C	62.16	156.98	50.51	446.70	38.91	147.90	49.15	236.95
	D	51.19	69.08	43.27	76.69	36.27	78.10	35.00	83.43
	E	39.92	72.43	37.67	69.10	31.67	72.91	35.93	138.35
	mean	31.31	72.17	26.29	131.37	21.37	72.49	24.02	110.71
120 M	A	4.91	21.10	3.44	24.60	2.95	21.95	2.97	31.92
	B	1.53	44.54	0.00	44.20	1.34	43.75	0.00	69.61
	C	43.21	103.30	37.20	96.60	29.75	92.25	35.73	153.60
	D	2.58	42.08	0.00	41.55	0.84	42.50	0.00	61.76
	E	24.84	40.86	20.05	40.30	14.45	41.78	9.13	69.32
	mean	15.42	50.38	12.14	49.45	9.87	48.45	9.57	77.24

Table 13.25. Nitrate-N and chloride content in groundwater samples at the medium-textured site, June to September, 1997.

		3 June 1997		24 June 1997		12 August 1997		9 September 1997	
Treatment	Rep	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}
Control	A	0.00	24.60	0.05	23.35	0.00	15.95	0.00	16.53
	B	0.00	12.76	0.00	12.20	0.00	8.05	0.00	8.26
	C	4.97	40.30	6.71	40.55	11.37	26.92	10.94	27.63
	D	1.46	101.50	2.49	99.92	5.38	89.62	9.18	88.06
	E	26.60	48.35	33.22	47.30	31.89	23.93	23.75	24.45
	mean	6.61	45.50	8.49	44.66	9.73	32.89	8.77	32.99
60 F	A	0.00	36.28	0.14	34.64	0.15	23.85	0.00	25.22
	B	0.00	24.67	0.00	25.51	0.00	16.26	0.00	16.91
	C	2.33	32.40	3.69	32.51	5.11	21.18	5.60	22.15
	D	13.65	66.20	16.79	66.06	27.71	50.26	25.44	50.58
	E	17.03	32.29	22.50	27.02	34.16	13.16	22.77	16.75
	mean	6.60	38.37	8.62	37.15	13.43	24.94	10.76	26.32
120 F	A	0.00	22.94	0.00	22.80	0.00	15.28	0.00	14.62
	B	1.18	33.22	1.98	30.57	1.89	19.39	1.94	20.67
	C	10.08	65.95	7.64	64.01	12.23	49.39	11.43	47.92
	D	6.83	58.50	8.13	57.23	23.64	38.71	21.18	38.57
	E	22.20	43.16	26.72	42.57	31.71	15.32	22.40	16.94
	mean	8.06	44.75	8.89	43.44	13.89	27.62	11.39	27.74
180 F	A	0.00	21.43	0.00	19.60	0.00	13.46	0.00	13.92
	B	0.00	6.81	0.00	6.50	0.00	5.25	0.00	5.26
	C	4.37	68.33	5.96	71.52	14.79	53.68	14.05	55.31
	D	9.69	80.28	13.96	77.80	23.12	62.24	22.08	56.54
	E	20.20	15.00	32.03	11.34	34.45	8.09	22.31	10.29
	mean	6.85	38.37	10.39	37.35	14.47	28.54	11.69	28.26
20 M	A	0.00	15.12	0.00	28.92	0.00	9.99	0.00	10.29
	B	0.00	40.26	0.00	38.48	0.11	24.10	0.37	25.51
	C	2.42	20.84	3.53	18.79	3.09	11.82	3.31	12.44
	D	5.96	22.11	6.91	20.19	16.39	10.22	12.66	10.26
	E	6.75	46.06	8.68	44.46	30.27	11.58	20.96	13.43
	mean	3.03	28.88	3.82	30.17	9.98	13.54	7.46	14.39
40 M	A	0.00	21.05	0.00	20.11	0.02	13.95	0.00	14.14
	B	0.00	11.35	0.00	11.17	0.00	7.49	0.00	7.51
	C	37.95	344.65	42.71	194.00	45.11	172.95	37.36	164.00
	D	7.95	54.69	12.22	44.61	16.71	25.47	11.92	29.59
	E	21.60	80.90	24.53	78.01	30.02	29.95	21.76	30.97
	mean	13.50	102.53	15.89	69.58	18.38	49.96	14.21	49.24
60 M	A	0.00	10.75	0.00	10.35	0.00	7.62	0.00	7.64
	B	0.00	65.17	0.30	48.32	0.00	28.65	0.37	31.19
	C	51.21	229.20	59.73	229.82	40.69	109.67	33.35	106.18
	D	33.77	62.96	35.90	52.85	38.15	33.48	32.55	43.97
	E	34.50	101.46	40.14	99.13	38.56	60.79	28.30	57.65
	mean	23.90	93.91	27.21	88.10	23.48	48.04	18.91	49.33
120 M	A	2.81	32.58	3.31	33.43	2.59	21.24	3.08	22.84
	B	0.00	59.18	0.30	53.54	0.00	34.64	0.30	38.71
	C	34.41	147.65	35.66	140.72	23.19	50.84	19.49	54.24
	D	0.00	58.76	0.98	54.99	1.07	41.16	1.37	41.44
	E	10.85	62.15	10.88	56.17	23.28	28.80	17.68	33.13
	mean	9.62	72.07	10.23	67.77	10.03	35.34	8.39	38.07

Table 13.26. Nitrate-N and chloride content in groundwater samples at the medium-textured site, September, 1997 to April, 1998.

		29 September 1997		29 October 1997		3 December 1997		2 April 1998	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	0.00	16.37	0.00	19.70	0.14	16.60	0.00	17.58
	B	0.00	8.71	0.00	9.00	0.00	8.70	0.00	8.89
	C	9.01	28.09	9.02	29.80	5.24	28.80	5.77	29.08
	D	7.15	88.47	5.66	90.80	4.46	89.00	4.52	92.86
	E	20.94	24.62	21.38	26.30	20.73	26.40	16.02	24.36
	mean	7.42	33.25	7.21	35.12	6.11	33.90	5.26	34.55
60 F	A	0.00	24.51	0.00	26.80	0.00	25.80	0.00	26.12
	B	0.00	16.63	0.00	17.50	0.00	16.50	0.00	16.36
	C	5.58	22.11	5.90	23.50	3.68	22.30	3.49	22.59
	D	24.60	51.34	23.06	53.70	21.36	53.00	15.48	55.54
	E	21.02	18.15	18.64	20.70	18.81	21.10	15.17	23.40
	mean	10.24	26.55	9.52	28.44	8.77	27.74	6.83	28.80
120 F	A	0.00	14.65	0.00	14.90	0.00	14.60	0.00	12.89
	B	1.52	20.71	1.28	23.22	1.27	22.50	0.00	23.24
	C	9.57	51.91	9.01	53.90	5.33	50.20	5.27	52.39
	D	19.35	39.41	17.52	41.80	14.98	40.70	10.71	43.25
	E	19.68	19.69	18.72	23.90	19.43	23.20	17.97	30.21
	mean	10.02	29.27	9.31	31.54	8.20	30.24	6.79	32.40
180 F	A	0.00	14.00	0.00	15.00	0.00	14.30	0.00	14.47
	B	0.00	5.65	0.00	5.70	0.00	5.50	0.00	5.78
	C	12.03	52.78	11.36	55.90	7.60	54.00	6.69	56.36
	D	18.72	56.57	18.49	60.80	16.48	60.50	60.50	40.99
	E	19.94	11.20	14.34	13.70	14.83	13.30	8.34	15.85
	mean	10.14	28.04	8.84	30.22	7.78	29.52	15.11	26.69
20 M	A	0.00	10.17	0.00	11.25	0.00	10.75	0.00	10.58
	B	0.29	25.62	0.21	27.50	0.22	26.55	0.00	27.50
	C	3.21	12.73	3.42	14.00	2.29	13.20	1.99	13.91
	D	11.81	10.98	10.18	12.07	9.70	11.55	6.72	13.11
	E	16.91	17.42	13.57	21.25	13.78	22.15	7.80	26.48
	mean	6.45	15.39	5.48	17.21	5.20	16.84	3.30	18.32
40 M	A	0.00	14.19	0.00	15.25	0.00	14.40	0.00	14.72
	B	0.00	7.60	0.00	8.15	0.00	8.10	0.00	8.27
	C	35.01	165.05	35.76	184.60	35.63	215.00	37.10	112.71
	D	12.02	29.06	10.46	35.95	10.83	34.15	6.47	43.01
	E	19.89	32.04	18.46	38.50	18.67	41.55	15.82	52.65
	mean	13.38	49.59	12.94	56.49	13.03	62.64	11.88	46.28
60 M	A	0.00	7.49	0.00	8.05	0.00	7.90	0.00	57.28
	B	0.00	34.64	0.00	42.77	0.00	46.25	0.00	48.34
	C	32.29	107.76	36.01	119.25	38.69	157.85	43.83	148.11
	D	30.01	48.77	31.81	54.96	32.12	89.35	31.20	82.24
	E	27.56	59.96	25.28	63.95	26.94	66.90	30.06	78.39
	mean	17.97	51.73	18.62	57.80	19.55	73.65	21.02	82.87
120 M	A	2.66	21.88	2.60	22.75	2.45	21.75	3.68	30.67
	B	0.00	39.15	0.00	39.79	0.00	42.20	0.00	40.28
	C	19.04	57.97	20.71	66.25	21.90	73.55	19.99	82.36
	D	0.96	42.47	0.55	43.55	0.82	41.95	1.87	40.74
	E	16.56	35.80	14.05	40.15	13.85	41.10	9.88	45.92
	mean	7.85	39.46	7.58	42.50	7.81	44.11	7.09	48.00

Table 13.27. Nitrate-N and chloride content in groundwater samples at the medium-textured site, April to July, 1998.

		29 April 1998		26 May 1998		6 July 1998		28 July 1998	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	0.00	15.10	0.00	15.90	0.00	15.92	0.00	14.17
	B	0.00	8.10	0.00	8.40	0.92	8.45	0.00	7.62
	C	7.00	26.70	8.33	27.90	7.22	27.04	7.07	25.41
	D	13.42	83.20	7.92	86.90	7.09	84.20	16.18	37.34
	E	24.10	22.10	18.75	22.90	17.00	23.06	16.42	21.20
	mean	8.90	31.04	7.00	32.40	6.45	31.73	7.93	21.15
60 F	A	0.00	24.60	0.48	24.80	0.00	25.73	0.00	23.24
	B	0.56	15.00	0.00	15.90	0.00	15.27	0.00	14.60
	C	5.61	20.50	6.13	22.10	5.16	21.60	5.85	20.68
	D	29.43	47.40	19.79	51.20	17.93	50.71	16.97	48.03
	E	29.12	7.80	28.22	6.60	21.95	7.97	20.08	6.98
	mean	12.94	23.06	10.92	24.12	9.01	24.26	8.58	22.71
120 F	A	0.00	10.80	0.00	11.80	0.00	12.32	0.00	11.45
	B	2.11	17.70	2.32	18.60	1.26	21.00	2.59	14.59
	C	5.01	48.40	6.05	49.90	5.24	48.52	5.86	47.14
	D	25.62	38.30	19.04	40.10	17.29	39.74	12.70	50.24
	E	22.05	18.80	19.31	15.80	17.15	17.85	15.52	11.95
	mean	10.96	26.80	9.34	27.24	8.19	27.89	7.33	27.07
180 F	A	0.00	13.60	0.00	15.20	0.00	14.58	0.00	12.90
	B	0.46	5.30	0.98	5.80	0.47	5.30	0.57	5.33
	C	10.58	47.80	11.90	49.90	10.26	49.95	10.14	45.94
	D	44.84	45.90	38.18	47.10	25.73	51.24	22.46	45.92
	E	33.22	6.80	22.50	7.90	19.87	8.87	2.33	18.06
	mean	17.82	23.88	14.71	25.18	11.27	25.99	7.10	25.63
20 M	A	0.00	9.80	0.00	10.20	0.00	10.37	0.00	9.37
	B	0.00	24.95	0.03	26.90	0.00	27.16	0.31	24.20
	C	3.11	11.50	3.30	12.50	2.49	13.05	3.41	10.87
	D	17.02	10.50	10.68	11.30	9.11	12.28	9.31	9.10
	E	20.06	17.85	16.38	13.25	10.60	18.67	12.69	10.83
	mean	8.04	14.92	6.08	14.83	4.44	16.31	5.15	12.88
40 M	A	0.00	14.00	0.23	14.60	0.58	14.11	0.00	13.36
	B	0.00	7.40	0.00	7.80	0.94	7.70	0.00	7.10
	C	33.36	165.10	35.37	152.80	30.91	162.75	37.67	134.10
	D	15.43	31.10	10.85	31.25	8.73	34.24	10.07	25.74
	E	24.62	29.15	20.33	25.65	17.74	32.13	13.68	19.25
	mean	14.68	49.35	13.36	46.42	11.78	50.19	12.29	39.91
60 M	A	0.00	7.65	0.00	7.80	0.00	7.54	0.00	6.91
	B	0.25	25.30	0.39	25.35	0.00	29.11	0.30	21.96
	C	36.14	121.50	29.73	104.60	24.56	96.77	26.85	93.08
	D	34.81	43.50	28.02	41.80	26.02	43.98	21.06	39.46
	E	30.06	56.45	25.58	54.80	20.08	59.21	18.78	41.93
	mean	20.25	50.88	16.74	46.87	14.13	47.32	13.40	40.67
120 M	A	8.44	50.10	7.31	44.30	6.22	37.72	5.34	36.53
	B	0.00	35.85	0.38	33.70	0.00	39.01	0.41	29.43
	C	17.73	47.05	12.38	37.20	12.01	37.52	11.57	33.40
	D	7.33	36.95	2.40	38.05	2.34	37.19	5.34	64.50
	E	23.36	23.40	18.39	24.30	14.69	31.66	18.37	17.22
	mean	11.37	38.67	8.17	35.51	7.05	36.62	8.21	36.22

Table 13.28. Nitrate-N and chloride content in groundwater samples at the medium-textured site, August to December, 1998.

		26 August 1998		29 September 1998		28 October 1998		1 December 1998	
Treatment	Rep	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}
Control	A	0.00	15.70	0.00	16.05	0.00	17.10	1.09	16.75
	B	0.00	8.40	0.00	8.31	0.00	8.40	1.24	8.36
	C	8.11	26.10	5.96	26.09	7.16	27.10	13.62	26.72
	D	9.06	81.40	8.17	80.08	7.18	82.30	12.73	82.77
	E	19.99	21.20	18.44	22.29	17.26	23.10	28.26	24.08
	mean	7.43	30.56	6.51	30.56	6.32	31.60	11.39	31.74
60 F	A	0.00	23.90	0.00	24.91	0.32	24.90	1.67	22.99
	B	0.00	15.30	0.00	14.92	0.00	14.90	1.45	14.61
	C	6.76	21.40	4.49	20.87	5.35	21.10	10.02	20.79
	D	26.38	49.10	23.69	48.16	18.61	50.50	29.71	50.23
	E	32.93	6.10	27.02	9.06	20.51	12.90	29.31	15.18
	mean	13.21	23.16	11.04	23.58	8.96	24.86	14.43	24.76
120 F	A	0.00	13.70	0.00	13.01	0.00	13.90	1.24	13.93
	B	2.18	18.20	1.47	19.36	1.56	20.30	3.15	19.52
	C	6.01	48.60	5.38	46.71	7.26	49.30	13.87	47.86
	D	19.95	38.60	18.31	37.39	16.67	38.90	24.93	38.96
	E	19.45	12.70	17.03	14.23	16.99	17.20	26.99	17.72
	mean	9.52	26.36	8.44	26.14	8.50	27.92	14.04	27.60
180 F	A	0.00	14.10	0.00	13.76	0.00	13.60	1.26	13.53
	B	0.45	5.50	0.19	5.27	0.49	5.30	2.01	5.32
	C	11.91	46.20	8.43	45.62	9.95	46.40	17.27	46.87
	D	31.81	48.40	26.47	49.49	29.72	50.50	34.08	51.31
	E	28.63	7.70	23.25	5.37	18.89	8.90	25.37	10.05
	mean	14.56	24.38	11.67	23.90	11.81	24.94	16.00	25.42
20 M	A	0.00	10.25	0.00	9.89	0.00	10.05	1.20	10.11
	B	0.30	25.55	0.02	24.91	0.37	25.85	1.72	25.30
	C	3.19	12.15	2.68	11.89	2.96	12.65	5.94	12.08
	D	11.88	9.15	11.21	10.17	9.46	10.20	16.69	10.17
	E	14.69	11.95	12.55	13.95	11.96	18.35	20.28	20.27
	mean	6.01	13.81	5.29	14.16	4.95	15.42	9.17	15.59
40 M	A	0.00	14.10	0.00	13.89	0.00	13.65	1.48	13.57
	B	0.00	7.80	0.00	7.60	0.00	7.60	1.19	7.57
	C	35.56	139.15	26.26	150.50	36.51	165.95	43.60	175.15
	D	12.60	25.85	8.06	27.22	10.39	29.40	18.34	30.40
	E	17.02	25.00	15.07	28.22	16.34	32.70	25.90	39.35
	mean	13.04	42.38	9.88	45.49	12.65	49.86	18.10	53.21
60 M	A	0.00	7.70	0.00	7.37	0.00	7.49	1.20	7.31
	B	0.29	24.90	0.23	30.29	0.23	31.95	1.41	35.71
	C	9.99	80.20	23.44	91.61	32.44	102.05	39.74	109.21
	D	27.65	32.40	24.52	41.38	30.21	49.10	55.15	49.04
	E	23.96	49.45	22.15	52.74	25.65	57.75	33.05	61.44
	mean	12.38	38.93	14.07	44.68	17.71	49.67	26.11	52.54
120 M	A	4.96	33.30	3.75	32.35	4.22	31.35	6.21	29.09
	B	0.38	33.50	0.24	35.96	0.40	35.90	2.13	32.72
	C	11.54	32.00	9.40	38.43	14.76	46.15	25.55	52.93
	D	5.77	30.10	4.58	31.77	3.49	34.10	6.05	35.94
	E	21.59	21.30	15.69	26.38	14.67	32.15	22.41	33.42
	mean	8.85	30.04	6.73	32.98	7.51	35.93	12.47	36.82

Table 13.29. Nitrate-N and chloride content in groundwater samples at the medium-textured site, April to July, 1999.

		20 April 1999		1 June 1999		6 July 1999		28 July 1999	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	0.00	17.16	0.89	16.27	0.00	17.71	0.00	15.82
	B	0.00	9.05	1.04	8.66	0.00	9.08	0.00	8.96
	C	6.42	28.82	10.96	27.82	10.25	28.69	14.89	25.88
	D	8.52	86.75	10.06	82.31	11.42	85.38	16.94	80.33
	E	24.74	29.28	29.59	27.76	20.96	25.71	28.26	21.95
	mean	7.94	34.21	10.51	32.56	8.53	33.31	12.02	30.59
60 F	A	0.00	25.87	1.24	24.81	1.11	25.15	1.52	23.84
	B	0.00	15.93	0.77	15.63	0.00	16.60	1.19	15.92
	C	4.85	22.63	8.38	21.81	8.07	22.71	10.85	22.68
	D	21.71	55.38	32.43	52.08	22.49	54.97	35.38	51.91
	E	19.96	23.00	29.58	15.36	29.31	7.23	40.83	6.09
	mean	9.30	28.56	14.48	25.94	12.20	25.33	17.95	24.09
120 F	A	0.00	14.96	0.87	13.00	0.00	13.73	0.00	10.94
	B	1.42	23.05	4.36	16.44	3.94	17.37	4.42	17.47
	C	6.86	53.69	8.65	50.18	9.29	46.37	12.49	34.07
	D	13.89	42.96	30.39	41.79	19.05	45.24	30.47	44.93
	E	21.55	23.72	28.49	21.84	20.81	14.27	28.12	13.61
	mean	8.74	31.68	14.55	28.65	10.62	27.40	15.10	24.20
180 F	A	0.00	14.06	0.96	14.16	0.00	14.95	0.00	14.01
	B	0.00	5.61	1.51	5.47	1.56	5.91	2.29	5.84
	C	10.08	51.32	13.56	46.64	13.02	47.64	16.69	46.48
	D	21.25	62.07	29.65	59.39	23.18	58.96	36.65	53.55
	E	13.72	14.04	31.56	8.86	25.81	7.86	37.88	7.44
	mean	9.01	29.42	15.45	26.90	12.71	27.06	18.70	25.46
20 M	A	0.00	10.68	0.96	10.35	0.00	11.03	0.70	10.20
	B	0.00	27.26	1.19	26.69	0.74	26.43	1.62	26.20
	C	2.54	14.69	4.34	13.44	5.08	12.30	7.30	11.34
	D	10.33	14.12	12.33	12.00	13.48	11.30	17.02	10.16
	E	11.35	26.87	12.01	24.55	19.43	13.13	28.99	9.37
	mean	4.85	18.73	6.17	17.41	7.75	14.84	11.13	13.46
40 M	A	0.00	14.52	1.07	14.30	0.52	15.04	0.78	14.90
	B	0.00	8.25	0.98	7.95	0.00	8.12	0.00	8.04
	C	36.59	190.30	40.01	156.81	21.97	133.65	40.28	122.90
	D	10.13	41.36	12.82	34.30	14.62	30.70	18.64	28.86
	E	21.12	51.38	25.01	32.18	20.85	33.50	28.01	25.47
	mean	13.57	61.16	15.98	49.11	11.59	44.20	17.54	40.03
60 M	A	0.00	7.69	0.91	7.79	0.00	8.27	0.00	7.88
	B	0.00	32.47	1.43	21.25	0.84	21.56	1.19	19.41
	C	38.18	126.61	40.21	107.71	15.41	33.30	30.92	73.02
	D	34.19	78.77	34.11	45.97	24.73	40.57	35.63	22.24
	E	29.24	75.89	34.92	63.20	24.64	57.46	31.73	52.08
	mean	20.32	64.29	22.32	49.19	13.13	32.23	19.89	34.93
120 M	A	3.94	30.64	5.74	29.80	4.90	26.57	6.53	28.75
	B	0.00	42.93	1.70	31.43	0.98	28.24	2.35	31.16
	C	22.45	68.62	21.78	54.32	20.49	71.68	17.15	30.30
	D	3.78	40.18	4.06	37.78	4.88	38.16	5.31	39.02
	E	14.59	41.99	18.54	31.79	20.45	21.97	30.40	22.12
	mean	8.95	44.88	10.37	37.03	10.34	37.33	12.35	30.27

Table 13.30. Nitrate-N and chloride content in groundwater samples at the medium-textured site, August to October, 1999.

		24 August 1999		28 September 1999		19 October 1999			
Treatment	Rep	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}
Control	A	0.59	20.64	0.00	21.46	0.00	19.01		
	B	0.00	10.98	0.00	10.93	0.00	11.01		
	C	7.73	32.63	6.46	32.84	7.60	33.31		
	D	14.21	83.51	14.35	90.34	11.92	87.19		
	E	13.70	14.59	19.72	22.47	15.04	18.11		
	mean	7.25	32.47	8.11	35.61	6.91	33.73		
60 F	A	0.00	30.96	0.00	31.78	0.00	30.51		
	B	0.00	20.53	0.00	19.58	0.00	20.29		
	C	6.42	28.31	5.82	27.08	6.61	27.14		
	D	28.25	61.71	26.41	63.64	19.32	63.26		
	E	32.12	6.33	29.39	6.29	27.78	7.44		
	mean	13.36	29.57	12.32	29.67	10.74	29.73		
120 F	A	0.00	15.59	0.00	16.40	0.00	15.17		
	B	2.51	20.86	1.53	23.18	2.01	23.13		
	C	6.62	51.77	6.33	59.07	6.75	59.69		
	D	19.95	54.61	24.61	52.25	20.64	51.13		
	E	16.25	8.48	20.24	11.63	15.54	10.57		
	mean	9.07	30.26	10.54	32.51	8.99	31.94		
180 F	A	0.00	18.47	0.00	18.22	0.00	17.96		
	B	0.00	7.61	0.74	7.22	0.43	7.74		
	C	10.57	58.18	9.53	57.36	11.09	56.82		
	D	27.21	52.23	21.80	72.49	16.89	69.72		
	E	33.73	8.93	31.48	9.36	33.01	9.67		
	mean	14.30	29.08	12.71	32.93	12.28	32.38		
20 M	A	0.00	12.94	0.00	13.37	0.02	12.67		
	B	0.00	32.74	0.00	33.10	0.00	33.32		
	C	3.82	13.44	3.23	14.67	3.17	15.65		
	D	14.39	9.18	11.63	13.25	10.10	15.05		
	E	13.53	7.92	19.12	10.33	13.48	11.45		
	mean	6.35	15.25	6.80	16.95	5.35	17.63		
40 M	A	0.00	18.66	0.00	18.43	0.00	18.13		
	B	0.00	9.90	0.00	10.05	0.00	10.18		
	C	33.94	157.65	34.17	134.35	33.91	147.95		
	D	13.47	30.13	13.99	37.49	11.53	36.10		
	E	14.69	28.53	20.88	32.83	15.55	34.51		
	mean	12.42	48.98	13.81	46.63	12.20	49.38		
60 M	A	0.00	10.02	0.00	10.65	0.00	10.16		
	B	0.32	25.57	0.55	27.20	0.34	30.77		
	C	15.49	102.51	24.73	83.78	17.84	70.09		
	D	25.24	29.27	29.10	45.28	28.00	44.65		
	E	15.55	62.27	24.75	68.15	22.04	76.43		
	mean	11.32	45.93	15.83	47.01	13.65	46.42		
120 M	A	4.09	41.09	4.74	44.32	4.42	40.42		
	B	0.47	39.78	0.66	41.40	0.56	41.80		
	C	9.33	38.13	14.10	39.33	10.44	42.22		
	D	7.96	35.66	4.06	42.68	4.55	42.91		
	E	22.30	27.72	22.95	29.97	18.30	30.61		
	mean	8.83	36.48	9.30	39.54	7.66	39.59		

Table 13.31. Nitrate-N and chloride content in groundwater samples at the medium-textured site, November, 1999l to June, 2000. (1 of 2 pages)

		24 November 1999		26 April 2000		31 May 2000		27 June 2000	
Treatment	Rep	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}
Control	A	0.00	19.10	0.00	14.50	0.00	14.55	0.00	13.09
	B	0.00	11.10	0.40	8.50	0.00	8.39	0.00	7.57
	C	10.40	32.20	8.19	27.70	7.09	27.33	10.40	21.99
	D	18.10	84.20	10.90	78.90	10.99	73.24	19.09	48.01
	E	21.40	20.80	20.52	22.50	18.26	21.20	16.60	12.31
	mean	9.98	33.48	8.00	30.42	7.27	28.94	9.22	20.59
60 F	A	0.00	31.30	0.00	25.90	0.00	23.77	0.00	20.58
	B	0.00	19.30	0.00	15.80	0.00	16.07	0.00	12.74
	C	7.80	27.40	6.78	21.30	5.79	21.47	7.72	19.33
	D	28.50	63.70	20.83	55.60	17.49	52.85	30.37	40.70
	E	32.90	7.70	31.81	8.90	35.11	6.38	25.33	6.71
	mean	13.84	29.88	11.88	25.50	11.68	24.11	12.68	20.01
120 F	A	0.00	15.10	0.00	8.80	0.00	9.11	0.00	8.08
	B	2.40	23.80	1.99	20.20	1.45	19.16	2.85	13.89
	C	10.10	52.10	7.64	51.20	6.11	48.61	9.55	28.42
	D	27.30	51.80	21.64	46.20	18.94	44.89	28.06	36.13
	E	21.40	10.50	18.89	11.90	16.92	11.07	19.27	9.76
	mean	12.24	30.66	10.03	27.66	8.68	26.57	11.95	19.26
180 F	A	0.00	17.80	0.00	13.90	0.00	13.91	0.00	13.19
	B	1.00	7.50	0.00	5.70	0.00	6.18	1.65	5.43
	C	13.00	59.10	12.35	46.90	10.27	47.03	13.42	38.85
	D	26.90	61.40	19.69	60.20	16.91	55.20	26.54	39.31
	E	37.40	8.40	28.46	8.30	28.66	7.75	39.10	5.36
	mean	15.66	30.84	12.10	27.00	11.17	26.01	16.14	20.43
20 M	A	0.00	7.80	0.00	6.10	0.00	6.01	0.00	5.50
	B	0.70	23.40	0.51	20.40	0.00	18.77	0.52	17.37
	C	6.40	14.80	4.88	14.20	4.15	12.91	7.26	7.61
	D	12.90	9.70	7.30	13.40	6.98	10.34	8.93	5.33
	E	22.40	8.60	15.84	7.70	15.56	6.62	25.15	4.47
	mean	8.48	12.86	5.71	12.36	5.34	10.93	8.37	8.06
40 M	A	0.50	11.90	0.00	9.60	0.00	9.60	0.54	8.31
	B	0.00	9.60	0.00	7.20	0.00	7.67	0.00	4.02
	C	22.60	44.60	31.34	120.50	26.87	96.89	29.62	66.81
	D	17.20	37.50	10.30	36.30	9.42	30.97	13.55	21.13
	E	15.40	30.50	16.39	31.80	13.83	23.32	10.11	39.84
	mean	11.14	26.82	11.61	41.08	10.02	33.69	10.76	28.02
60 M	A	0.00	13.50	0.00	10.40	0.00	10.37	0.00	9.41
	B	0.00	20.90	0.00	21.20	0.00	18.96	0.00	11.80
	C	28.90	112.40	21.58	96.70	16.15	86.45	24.49	57.62
	D	20.80	46.40	16.15	60.40	14.81	59.47	14.81	25.60
	E	22.60	62.40	18.04	54.30	14.39	51.32	17.24	35.42
	mean	14.46	51.12	11.15	48.60	9.07	45.31	11.31	27.97
120 M	A	6.70	53.50	6.65	41.10	4.53	37.89	6.09	36.82
	B	2.00	29.80	1.01	39.40	0.10	29.96	1.83	23.36
	C	20.50	52.60	14.66	39.70	11.31	37.90	12.02	25.62
	D	10.20	61.80	8.03	49.60	7.36	46.55	12.97	28.77
	E	26.50	35.50	19.31	25.20	17.88	23.08	27.64	28.91
	mean	13.18	46.64	9.93	39.00	8.24	35.08	12.11	28.70

Table 13.31. Nitrate-N and chloride content in groundwater samples at the medium-textured site, November, 1999 to June, 2000. (2 of 2 pages)

		24 November 1999		26 April 2000		31 May 2000		27 June 2000	
Treatment	Rep	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}	Nitrate-N mg L^{-1}	Cl mg L^{-1}
20 MR	A	0.60	16.80	0.42	13.80	0.00	13.86	0.49	12.70
	B	0.00	40.70	0.00	34.40	0.00	33.24	0.00	28.94
	C	2.70	14.10	1.53	11.90	1.27	14.43	3.41	8.53
	D	23.00	12.10	14.07	11.20	13.26	10.11	24.44	7.38
	E	16.10	16.80	13.68	16.70	12.41	13.56	14.48	8.21
	mean	8.48	20.10	5.94	17.60	5.39	17.04	8.56	13.15
40 MR	A	0.00	23.60	0.00	18.30	0.00	18.57	0.00	17.78
	B	0.50	10.60	0.45	8.50	0.00	7.94	0.68	7.02
	C	40.70	164.80	40.27	133.50	37.51	126.20	40.30	84.26
	D	20.40	29.50	11.69	36.70	13.54	25.93	18.36	13.41
	E	27.50	35.10	24.72	32.90	19.75	30.60	26.88	19.01
	mean	17.82	52.72	15.43	45.98	14.16	41.85	17.24	28.30
60 MR	A	0.00	6.10	0.00	4.50	0.00	4.49	0.00	4.42
	B	1.10	35.40	1.15	30.10	0.60	27.21	1.65	14.12
	C	32.20	137.60	18.98	37.50	17.52	34.74	21.45	27.32
	D	45.00	14.30	40.94	12.20	38.39	11.52	40.74	8.96
	E	30.40	88.80	33.16	68.50	31.35	60.27	26.02	65.40
	mean	21.74	56.44	18.85	30.56	17.57	27.65	17.97	24.04
120 MR	A	3.50	26.70	3.25	25.10	2.30	22.47	3.31	20.88
	B	0.00	44.80	0.00	37.80	0.00	37.36	0.00	30.42
	C	14.40	37.30	9.72	27.90	7.49	26.79	9.05	20.93
	D	8.30	21.80	2.85	20.90	2.81	19.18	8.80	10.49
	E	25.40	23.10	20.02	24.40	19.72	20.24	24.92	21.28
	mean	10.32	30.74	7.17	27.22	6.46	25.21	9.22	20.80

Table 13.32. Nitrate-N and chloride content in groundwater samples at the medium-textured site, July, 2000 to October, 2000. (1 of 2 pages)

		25 July 2000		25 August 2000		26 September 2000		30 October 2000	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	1.18	12.80	0.00	12.60	0.00	15.40	0.00	15.24
	B	1.46	7.80	0.00	7.40	0.54	8.80	0.38	8.89
	C	17.56	18.30	9.31	19.30	9.04	27.40	8.41	26.75
	D	25.14	37.60	15.28	32.70	13.42	55.60	12.55	59.61
	E	19.62	8.40	12.42	9.10	17.88	16.60	17.31	17.81
	mean	12.99	16.98	7.40	16.22	8.18	24.76	7.73	25.66
60 F	A	1.35	19.70	0.00	19.20	0.48	24.10	0.00	25.67
	B	0.96	11.90	0.00	11.30	0.00	15.80	0.00	15.63
	C	14.85	17.70	7.20	16.90	7.30	22.00	7.09	21.55
	D	35.18	39.10	24.01	37.20	25.51	52.80	20.62	52.35
	E	39.34	7.40	32.28	6.10	28.94	12.90	23.61	13.31
	mean	18.34	19.16	12.70	18.14	12.45	25.52	10.26	25.70
120 F	A	1.50	7.90	0.00	7.90	0.52	9.60	0.00	9.78
	B	4.42	13.30	2.06	15.70	2.03	20.30	1.59	20.38
	C	17.91	27.90	9.62	25.60	8.84	48.60	7.12	49.52
	D	34.53	32.80	25.97	33.70	23.06	42.10	20.42	40.71
	E	27.02	9.70	20.09	8.90	18.14	12.40	17.43	11.63
	mean	17.08	18.32	11.55	18.36	10.52	26.60	9.31	26.40
180 F	A	1.13	13.10	0.00	12.60	0.00	14.30	0.00	14.18
	B	2.31	5.50	1.68	5.30	0.70	6.70	0.42	6.51
	C	19.57	37.20	11.43	34.40	12.21	46.00	11.82	44.74
	D	32.51	37.80	24.75	38.30	20.38	58.10	19.06	56.12
	E	36.61	6.70	32.66	13.10	25.94	11.10	28.79	8.29
	mean	18.43	20.06	14.10	20.74	11.85	27.24	12.02	25.97
20 M	A	1.16	5.70	0.00	5.60	0.00	6.40	0.00	6.56
	B	1.67	17.10	0.00	16.20	0.61	20.40	0.00	32.29
	C	15.42	8.10	5.98	9.00	5.79	13.70	4.76	14.33
	D	17.91	7.70	9.15	7.50	8.67	10.20	8.25	10.09
	E	28.94	5.60	22.14	4.60	16.85	7.80	15.81	7.55
	mean	13.02	8.84	7.45	8.58	6.38	11.70	5.76	14.16
40 M	A	1.48	8.40	0.60	7.70	0.71	9.80	0.00	10.14
	B	1.24	7.20	0.00	6.90	0.00	8.20	0.00	7.87
	C	38.01	49.60	30.10	57.70	28.37	95.50	30.14	96.41
	D	22.21	23.20	13.82	14.90	12.70	29.50	11.14	29.51
	E	20.84	33.90	13.24	32.50	14.99	36.50	13.98	29.89
	mean	16.76	24.46	11.55	23.94	11.35	35.90	11.05	34.76
60 M	A	1.18	9.40	0.00	9.10	0.00	10.70	0.00	11.00
	B	1.37	14.40	0.00	13.50	0.45	18.70	0.00	19.75
	C	31.61	53.30	26.56	57.90	22.38	76.10	27.11	81.88
	D	26.51	34.90	15.89	26.10	17.89	50.30	15.04	50.68
	E	28.24	37.60	17.11	35.60	18.31	54.70	16.12	52.02
	mean	17.78	29.92	11.91	28.44	11.81	42.10	11.65	43.07
120 M	A	7.45	34.60	5.44	30.00	5.26	36.30	4.79	34.69
	B	3.36	20.30	2.09	19.50	1.61	34.10	1.19	37.19
	C	24.71	29.40	13.81	29.10	14.92	41.10	14.47	41.04
	D	30.14	170.30	25.41	32.20	15.48	102.40	11.29	86.33
	E	29.42	20.20	25.16	25.20	22.94	28.10	19.68	25.53
	mean	19.02	54.96	14.38	27.20	12.04	48.40	10.28	44.96

Table 13.32. Nitrate-N and chloride content in groundwater samples at the medium-textured site, July, 2000 to October, 2000. (2 of 2 pages)

		25 July 2000		25 August 2000		26 September 2000		30 October 2000	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
20 MR	A	1.60	12.80	0.50	12.90	0.50	14.60	0.00	14.64
	B	1.23	27.10	0.00	27.20	0.00	33.70	0.49	18.86
	C	3.88	9.40	2.69	8.20	2.23	12.40	1.68	11.61
	D	27.86	8.50	21.64	7.50	17.08	10.30	15.23	10.27
	E	20.78	8.70	11.78	10.50	13.14	16.50	12.73	16.42
	mean	11.07	13.30	7.32	13.26	6.59	17.50	6.03	14.36
40 MR	A	1.17	17.20	0.00	16.60	0.00	18.70	0.00	18.41
	B	1.56	4.80	0.72	6.70	0.70	8.80	0.55	7.73
	C	44.57	79.70	39.74	80.10	38.65	106.90	39.74	110.30
	D	25.27	18.20	16.96	14.90	16.11	24.40	13.31	25.36
	E	32.81	23.50	25.13	19.10	24.48	30.20	25.29	29.33
	mean	21.08	28.68	16.51	27.48	15.99	37.80	15.78	38.23
60 MR	A	1.13	4.80	0.00	4.50	0.00	5.00	0.00	4.66
	B	2.81	18.30	1.36	20.10	1.42	27.10	0.98	30.11
	C	30.04	25.50	21.04	25.30	19.93	36.40	21.62	35.32
	D	49.46	8.90	40.71	8.60	38.34	12.80	39.46	12.77
	E	36.82	65.80	29.36	63.40	29.95	74.60	31.76	65.84
	mean	24.05	24.66	18.49	24.38	17.93	31.18	18.76	29.74
120 MR	A	4.79	20.90	3.60	19.70	3.34	24.80	2.96	25.75
	B	1.35	30.80	0.00	30.20	0.46	36.50	0.00	35.92
	C	25.44	84.90	13.12	61.20	12.14	62.40	11.35	56.09
	D	17.55	12.70	8.77	209.60	4.74	21.40	2.54	21.23
	E	29.00	23.70	23.37	20.30	22.17	27.70	19.92	23.65
	mean	15.63	34.60	9.77	68.20	8.57	34.56	7.35	32.53

Table 13.33. Nitrate-N and chloride content in groundwater samples at the medium-textured site, May to July, 2001. (1 of 2 pages)

		1 May 2001		29 May 2001		26 June 2001		31 July 2001	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	0.00	13.80	0.00	14.38	0.00	14.80	0.00	13.40
	B	0.00	9.30	0.00	9.29	0.00	8.90	0.00	8.90
	C	7.08	25.20	9.16	27.17	8.65	26.80	10.11	22.30
	D	10.96	66.20	14.57	65.56	13.85	63.80	16.04	28.70
	E	16.61	21.70	18.88	20.09	18.32	20.00	10.20	6.80
	mean	6.93	27.24	8.52	27.30	8.16	26.86	7.27	16.02
60 F	A	0.00	20.40	0.00	21.69	0.00	22.90	0.00	20.30
	B	0.00	14.80	0.00	15.00	0.00	16.20	0.00	14.80
	C	5.69	19.90	7.03	21.68	6.55	22.40	7.34	21.40
	D	18.03	51.90	27.95	51.85	27.43	53.60	25.14	52.00
	E	18.58	14.10	30.53	11.92	35.81	8.70	30.92	6.30
	mean	8.46	24.22	13.10	24.43	13.96	24.76	12.68	22.96
120 F	A	0.07	7.90	0.48	8.90	0.09	9.10	3.47	8.30
	B	1.73	18.40	2.31	16.85	1.68	19.10	2.31	15.90
	C	6.59	41.50	8.24	42.34	7.47	48.20	7.52	44.30
	D	17.74	46.30	24.96	48.17	23.41	48.90	21.48	35.30
	E	15.28	18.50	18.49	14.10	18.28	12.80	15.85	4.50
	mean	8.28	26.52	10.90	26.07	10.19	27.62	10.13	21.66
180 F	A	0.00	13.10	0.00	13.62	0.00	14.00	0.00	13.50
	B	0.81	7.70	1.37	7.37	1.12	7.10	1.68	7.30
	C	30.59	44.70	44.46	47.31	36.66	48.10	29.80	46.10
	D	32.94	44.90	36.46	51.37	30.34	56.20	28.76	31.90
	E	28.63	7.80	40.94	6.32	34.08	8.20	38.21	5.10
	mean	18.59	23.64	24.65	25.20	20.44	26.72	19.69	20.78
20 M	A	0.00	5.80	0.00	6.52	0.00	6.50	0.00	6.20
	B	0.62	17.90	0.74	18.18	0.00	20.40	0.00	18.80
	C	4.45	14.10	6.77	11.81	5.54	13.70	6.63	11.80
	D	8.22	7.70	10.45	7.45	6.82	13.10	10.73	6.10
	E	10.78	9.10	18.55	6.81	18.35	7.00	20.85	6.50
	mean	4.81	10.92	7.30	10.15	6.14	12.14	7.64	9.88
40 M	A	0.40	9.10	0.46	10.08	0.00	10.00	0.00	9.70
	B	0.00	7.70	0.00	8.41	0.00	8.00	0.00	8.60
	C	21.69	121.80	29.81	98.72	29.78	117.70	26.30	92.20
	D	10.19	23.90	12.91	24.57	11.43	28.40	16.98	38.50
	E	13.85	28.90	16.00	25.59	15.61	27.00	14.20	36.10
	mean	9.23	38.28	11.84	33.47	11.36	38.22	11.50	37.02
60 M	A	0.00	10.00	0.00	10.64	0.00	10.60	0.00	10.00
	B	0.00	14.50	0.00	15.62	0.00	18.20	0.00	14.70
	C	17.81	107.00	26.99	88.71	18.65	85.40	18.43	80.60
	D	13.17	47.70	16.53	41.61	16.30	52.20	17.08	33.30
	E	13.07	52.90	16.45	51.25	15.74	51.10	17.40	63.50
	mean	8.81	46.42	11.99	41.57	10.14	43.50	10.58	40.42
120 M	A	3.86	31.50	4.60	31.29	4.81	33.90	7.70	49.00
	B	1.87	23.30	1.86	27.63	1.51	31.00	2.02	29.60
	C	13.69	45.70	15.26	41.88	13.11	38.70	13.22	35.10
	D	8.97	67.70	10.70	65.70	10.31	63.80	55.47	321.90
	E	15.34	21.10	19.91	21.23	18.50	22.30	29.09	97.00
	mean	8.75	37.86	10.47	37.55	9.65	37.94	21.50	106.52

Table 13.33. Nitrate-N and chloride content in groundwater samples at the medium-textured site, May to July, 2001. (2 of 2 pages)

		1 May 2001		29 May 2001		26 June 2001		31 July 2001	
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
20 MR	A	0.00	13.80	0.00	14.30	0.05	14.40	0.00	13.20
	B	0.00	31.70	0.00	31.73	0.00	32.90	0.00	32.00
	C	3.14	10.10	4.33	9.48	2.12	11.30	3.99	9.10
	D	14.35	9.10	17.82	10.03	14.86	10.50	21.24	9.30
	E	9.89	21.30	16.00	15.18	15.38	15.90	11.89	10.40
	mean	5.48	17.20	7.63	16.14	6.48	17.00	7.42	14.80
40 MR	A	0.00	17.50	0.00	18.36	0.00	18.90	0.00	18.80
	B	0.52	8.30	0.51	7.38	0.00	8.10	0.00	7.60
	C	21.37	135.30	39.91	129.40	39.53	132.40	36.42	109.00
	D	12.45	19.90	15.53	19.26	14.02	26.80	16.02	18.20
	E	17.71	29.20	26.29	26.55	24.89	31.10	23.68	23.80
	mean	10.41	42.04	16.45	40.19	15.69	43.46	15.22	35.48
60 MR	A	0.00	4.50	0.00	5.05	0.00	5.10	0.00	5.20
	B	1.08	28.30	1.47	24.45	1.13	25.90	1.71	17.90
	C	15.44	36.40	18.47	35.87	18.65	35.30	18.56	37.20
	D	26.63	12.30	37.87	12.55	38.87	13.40	29.58	16.70
	E	21.01	59.20	33.66	55.62	34.20	59.10	27.94	93.80
	mean	12.83	28.14	18.29	26.71	18.57	27.76	15.56	34.16
120 MR	A	2.66	20.70	3.09	21.88	2.99	23.60	3.16	23.50
	B	0.00	33.80	0.00	35.17	0.00	36.70	0.00	33.30
	C	9.43	49.90	10.96	42.18	9.93	41.20	13.03	64.90
	D	5.19	16.10	6.87	15.42	4.84	18.40	11.77	30.30
	E	15.64	25.10	24.90	18.84	24.06	20.20	60.97	101.60
	mean	6.58	29.12	9.16	26.70	8.36	28.02	17.79	50.72

Table 13.34. Nitrate-N and chloride content in groundwater samples at the medium-textured site, August to November, 2001. (1 of 2 pages)

		28 August 2001		25 September 2001		6 November 2001			
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Control	A	0.00	13.20	0.00	14.32	0.00	14.74		
	B	0.00	7.80	0.00	9.11	0.00	8.98		
	C	9.14	25.00	8.16	27.68	9.95	26.75		
	D	14.24	50.10	13.22	55.51	14.17	61.84		
	E	14.47	12.30	16.12	16.06	20.69	18.61		
	mean	7.57	21.68	7.50	24.54	8.96	26.18		
60 F	A	0.00	20.80	0.00	21.89	0.00	24.00		
	B	0.00	13.50	0.00	14.96	0.00	14.78		
	C	7.16	20.60	6.42	21.42	7.11	20.86		
	D	25.68	53.50	24.13	51.88	29.19	51.10		
	E	30.19	10.30	2.80	12.62	31.75	15.13		
	mean	12.61	23.74	6.67	24.55	13.61	25.17		
120 F	A	2.70	8.30	1.07	8.91	1.20	9.25		
	B	1.89	17.50	1.25	19.43	1.83	21.29		
	C	8.22	46.80	8.56	42.14	10.00	48.70		
	D	22.76	38.70	20.76	39.34	25.13	39.75		
	E	18.32	10.30	18.37	15.91	24.63	18.17		
	mean	10.78	24.32	10.00	25.15	12.56	27.43		
180 F	A	0.00	12.40	0.00	13.78	0.00	13.60		
	B	1.32	6.10	1.86	7.44	1.20	6.09		
	C	25.70	47.70	20.73	48.42	22.64	49.21		
	D	25.43	51.00	23.51	51.50	28.48	50.94		
	E	35.37	6.50	2.88	9.17	25.07	11.61		
	mean	17.56	24.74	9.80	26.06	15.48	26.29		
20 M	A	0.00	5.80	0.00	6.30	0.00	6.35		
	B	0.00	18.20	0.00	17.94	0.00	19.80		
	C	6.08	12.70	4.96	15.44	6.18	14.93		
	D	9.91	9.20	7.87	12.21	8.27	13.03		
	E	16.87	8.30	14.32	8.85	18.05	8.71		
	mean	6.57	10.84	5.43	12.15	6.50	12.56		
40 M	A	0.51	8.60	0.00	9.57	0.00	9.53		
	B	0.00	6.80	0.00	8.25	0.00	7.75		
	C	28.40	99.40	27.94	125.90	33.26	153.50		
	D	14.58	32.90	11.98	33.57	11.65	36.25		
	E	15.46	35.30	15.51	31.98	19.72	34.34		
	mean	11.79	36.60	11.09	41.85	12.93	48.27		
60 M	A	0.00	9.50	0.00	10.38	0.00	10.36		
	B	0.00	14.30	0.00	15.07	0.00	19.38		
	C	26.28	88.90	28.41	97.43	36.75	121.50		
	D	16.72	50.40	17.01	44.35	20.34	90.37		
	E	16.56	56.60	16.51	54.35	24.47	55.34		
	mean	11.91	43.94	12.39	44.32	16.31	59.39		
120 M	A	7.17	43.10	5.60	38.47	6.81	38.33		
	B	2.19	27.20	1.85	27.71	1.41	44.31		
	C	15.76	41.10	16.75	45.83	24.34	52.03		
	D	29.37	160.80	20.23	118.40	19.76	100.40		
	E	27.28	73.40	22.34	79.80	14.70	37.68		
	mean	16.35	69.12	13.35	62.04	13.40	54.55		

Table 13.34. Nitrate-N and chloride content in groundwater samples at the medium-textured site, August to November, 2001. (2 of 2 pages)

		28 August 2001		25 September 2001		6 November 2001			
		Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl	Nitrate-N	Cl
Treatment	Rep	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
20 MR	A	0.55	13.30	0.00	14.12	0.00	14.18		
	B	0.00	31.20	0.00	29.45	0.00	33.96		
	C	2.66	9.40	1.89	10.73	2.13	10.77		
	D	17.69	10.70	14.14	10.17	17.64	9.93		
	E	13.02	15.80	13.22	22.26	15.16	24.99		
	mean	6.78	16.08	5.85	17.35	6.99	18.77		
40 MR	A	0.00	17.10	0.00	17.86	0.00	18.03		
	B	0.50	6.60	0.00	8.48	0.00	7.93		
	C	38.31	129.50	37.65	130.70	43.96	155.40		
	D	15.43	22.00	12.66	31.46	13.87	33.29		
	E	24.60	27.20	22.26	31.46	26.09	37.23		
	mean	15.77	40.48	14.51	43.99	16.78	50.38		
60 MR	A	0.00	4.50	0.00	4.75	0.00	4.60		
	B	1.24	25.00	0.73	32.90	1.05	44.08		
	C	18.79	36.60	19.93	40.66	23.56	39.42		
	D	34.81	16.30	36.65	15.95	50.43	15.32		
	E	30.66	76.70	29.91	67.89	38.37	69.73		
	mean	17.10	31.82	17.44	32.43	22.68	34.63		
120 MR	A	3.37	21.40	2.97	23.75	3.87	25.26		
	B	0.42	31.40	0.00	32.21	0.00	37.26		
	C	13.71	61.70	12.87	55.03	15.01	51.23		
	D	5.48	25.10	4.83	27.92	3.35	21.38		
	E	26.96	73.00	19.97	47.79	14.37	45.09		
	mean	9.99	42.52	8.13	37.34	7.32	36.04		

Table 13.35. Mean (n=5) groundwater pH and electrical conductivity at the coarse-textured site.								
		N fertilizer rates (kg ha^{-1} y^{-1})			Manure rates (Mg ha^{-1} y^{-1})[z]			
Date	Control	60	120	180	20	40	60	120
					pH			
5 July 1993	7.8	7.8	7.8	7.8	7.8	7.9	7.8	7.8
27 July 1993	7.7	7.7	7.7	7.7	7.8	7.8	7.7	7.7
18 Oct. 1993	8.1	8.0	8.0	8.0	8.1	8.1	8.1	8.0
11 April 1994	8.0	7.9	7.9	7.9	8.0	8.0	8.0	7.9
3 April 1995	8.3	8.1	8.1	8.1	8.2	8.3	8.2	8.2
24 Sep. 1996	7.8	7.7	7.7	7.7	7.8	7.8	7.8	7.6
7 May 1997	8.1	7.9	8.0	7.9	8.1	8.1	8.0	7.9
31 Mar. 1998	7.9	7.8	7.9	7.8	7.9	7.9	7.9	7.8
27 Oct. 1998	8.1	8.2	8.2	8.1	8.2	8.2	8.1	8.1
21 April 1999	8.1	8.0	8.1	8.0	8.1	8.1	8.1	8.0
2 June 1999	8.0	7.9	7.9	7.9	8.0	7.9	8.0	7.9
20 Oct. 1999	8.3	8.2	8.3	8.2	8.3	8.3	8.3	8.2
25 April 2000	8.1	8.0	8.1	8.1	8.1	8.1	8.1	8.1
				Electrical conductivity (dS m^{-1})				
2 June 1993	0.9	0.8	0.9	0.8	1.1	0.9	1.0	1.3
5 July 1993	0.9	0.7	0.8	0.8	1.3	1.1	1.2	1.9
27 July 1993	1.0	0.8	0.9	1.0	1.5	1.1	1.9	2.3
18 Oct. 1993	1.0	1.3	1.2	1.2	1.5	1.0	1.1	1.6
11 April 1994	0.9	1.0	1.0	1.1	1.3	0.9	0.9	1.5
24 Jan. 1995	1.0	1.1	1.0	1.1	1.3	0.9	1.1	1.5
3 April 1995	1.0	1.0	1.0	1.2	1.2	0.9	1.1	1.5
24 Sep. 1996	1.5	1.3	1.3	1.3	1.4	1.6	1.3	2.3
7 May 1997	1.2	1.6	1.2	1.6	1.4	1.5	1.4	1.8
31 Mar. 1998	1.2	1.4	1.2	1.6	1.5	1.6	1.4	2.6
27 Oct. 1998	1.1	1.2	1.1	1.5	1.5	1.5	1.6	2.5
21 April 1999	1.2	1.3	1.1	1.3	1.6	1.5	1.5	2.3
2 June 1999	1.1	1.2	1.2	1.3	1.5	1.5	1.5	2.3
20 Oct. 1999	1.0	1.0	1.1	1.2	1.5	1.4	1.5	2.4
25 April 2000	1.1	1.3	1.0	1.1	1.4	1.4	1.3	1.8

[z] Manure rates are on a wet-weight basis.

Table 13.36. Mean (n=5) groundwater pH and electrical conductivity at the medium-textured site.

		N fertilizer rates (kg ha^{-1} y^{-1})			Manure rates (Mg ha^{-1} y^{-1})^{z}			
Date	Control	60	120	180	20	40	60	120
				pH				
28 June 1993	7.6	7.5	7.5	7.6	7.5	7.6	7.7	7.5
28 July 1993	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
19 Oct. 1993	7.8	7.8	7.8	7.9	7.8	7.8	7.9	7.9
11 April 1994	7.8	7.7	7.7	7.7	7.7	7.7	7.7	7.7
4 April 1995	7.8	7.7	7.8	7.8	7.8	7.7	7.7	7.7
25 Sep. 1996	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6
6 May 1997	7.9	7.9	7.9	7.8	7.9	7.8	7.8	7.9
2 April 1998	7.5	7.5	7.5	7.5	7.5	7.5	7.4	7.5
28 Oct. 1998	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.4
20 April 1999	7.7	7.7	7.7	7.7	7.7	7.6	7.7	7.7
1 June 1999	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
19 Oct. 1999	8.0	8.1	8.0	8.1	8.1	8.1	8.0	8.1
26 April 2000	7.7	7.8	7.7	7.7	7.7	7.7	7.7	7.7
				Electrical conductivity (dS m^{-1})				
31 May 1993	5.3	6.0	5.1	5.0	5.1	5.8	6.3	5.8
28 June 1993	5.3	5.7	5.0	4.9	4.8	5.5	5.9	5.6
28 July 1993	5.2	5.7	5.1	4.9	5.0	5.5	6.0	5.7
19 Oct. 1993	5.3	6.1	5.5	5.2	5.6	6.0	6.5	6.0
11 April 1994	6.6	7.3	7.3	6.9	7.3	7.3	7.8	7.1
25 Jan. 1995	6.6	7.3	7.5	7.1	7.4	7.5	7.7	7.2
4 April 1995	6.6	7.3	7.4	7.4	7.4	7.4	7.5	7.2
25 Sep. 1996	6.7	7.5	7.7	7.2	7.7	7.6	7.9	7.5
6 May 1997	6.1	6.7	7.2	6.7	7.4	7.0	7.0	6.9
2 April 1998	6.8	7.2	7.2	6.1	7.3	7.4	7.6	7.3
28 Oct. 1998	6.7	7.3	7.4	6.7	7.1	7.4	7.9	7.2
20 April 1999	7.0	7.7	7.9	7.3	7.7	7.9	8.2	7.7
1 June 1999	7.1	7.7	7.8	7.1	7.6	7.9	8.3	7.7
19 Oct. 1999	6.6	6.5	6.2	6.7	6.7	7.3	7.5	7.0
26 April 2000	6.7	7.2	7.2	6.8	6.8	7.6	8.2	7.2

^{z} Manure rates are on a wet-weight basis.

Table 13.37. Mean values (n=5) for the groundwater chemical analysis for the coarse-textured site in 1994. Analysis was carried out by the University of Alberta Hospitals. F = nitrogen fertilizer rate (kg ha^{-1} y^{-1}); M = manure rate (Mg ha^{-1} y^{-1}). (1 of 3 pages)

Date	Treatment	Total coliforms counts 100 mL^{-1}	Faecal coliforms counts 100 mL^{-1}	pH	Electrical conductivity dS m^{-1}	Na mg L^{-1}	K mg L^{-1}	Ca mg L^{-1}	Mg mg L^{-1}	Hardness total Ca CO_3 mg L^{-1}	Fe mg L^{-1}	Total alkalinity (Ca CO_3) mg L^{-1}
31 May	Control	7	1	8.22	0.99	35	5.3	76	71	481	4.12	280
31 May	60 F	7	4	8.14	0.96	17	7.6	83	68	489	2.96	251
31 May	120 F	4	1	8.16	1.06	31	2.7	98	71	535	4.49	270
31 May	180 F	4	4	8.16	0.96	32	4.4	94	57	469	2.92	247
31 May	20 M	8	3	8.20	1.12	89	3.2	66	75	474	3.44	289
31 May	40 M	2	1	8.23	0.95	48	2.6	52	83	473	3.96	294
31 May	60 M	4	2	8.21	0.92	45	4.1	60	68	430	3.61	283
31 May	120 M	7	2	8.21	1.50	69	4.1	109	132	816	2.98	320
25 July	Control	13	1	8.01	1.10	41	5.0	92	78	551	0.53	279
25 July	60 F	10	1	7.98	0.97	19	6.3	88	69	506	0.22	250
25 July	120 F	12	1	7.86	1.08	34	2.5	105	69	545	0.57	257
25 July	180 F	10	1	7.93	1.00	34	4.3	104	60	506	0.20	248
25 July	20 M	13	1	7.91	1.29	105	3.3	94	88	538	0.45	278
25 July	40 M	15	1	8.06	0.93	46	2.4	55	80	467	0.50	287
25 July	60 M	14	1	8.00	0.99	49	3.8	71	73	479	0.46	277
25 July	120 M	14	1	8.01	1.59	70	3.9	116	132	833	0.38	305
28 Sept.	Control	4	1	8.14	0.96	38	5.5	72	75	487	1.87	299
28 Sept.	60 F	9	1	8.07	0.98	19	8.0	84	70	499	0.90	256
28 Sept.	120 F	8	1	8.08	0.97	33	2.8	91	66	498	1.44	274
28 Sept.	180 F	4	1	7.98	0.92	33	4.8	94	55	461	0.84	269
28 Sept.	20 M	6	1	8.09	1.35	108	3.7	88	91	595	1.45	283
28 Sept.	40 M	5	1	8.14	0.88	42	2.7	458	77	440	1.19	301
28 Sept.	60 M	4	1	8.09	0.99	48	4.4	70	75	483	1.34	281
28 Sept.	120 M	9	1	8.15	1.49	65	4.6	105	125	778	1.81	316

Table 13.37. Mean values (n=5) for the groundwater chemical analysis for the coarse-textured site in 1994. Analysis was carried out by the University of Alberta Hospitals. F = nitrogen fertilizer rate (kg ha^{-1} y^{-1}); M = manure rate (Mg ha^{-1} y^{-1}). (2 of 3 pages)

Date	Treatment	CO_3 mg L^{-1}	HCO_3 mg L^{-1}	OH mg L^{-1}	Cl mg L^{-1}	F mg L^{-1}	NO_3-N + NO_2-N mg L^{-1}	SO_4 mg L^{-1}	Total dissolved solids mg L^{-1}	Al µg L^{-1}	Sb µg L^{-1}	As µg L^{-1}	Ba µg L^{-1}	Be µg L^{-1}
31 May	Control	2	337	0	50.6	0.47	32.4	107	660	1	1	1	184	1
31 May	60 F	0	306	0	55.6	0.34	38.0	71	624	1	1	1	325	1
31 May	120 F	0	328	0	52.0	0.33	38.1	127	717	178	1	1	237	1
31 May	180 F	0	302	0	48.2	0.27	35.4	106	650	2	1	1	231	1
31 May	20 M	0	352	0	27.2	0.45	20.7	273	802	93	1	1	161	1
31 May	40 M	0	359	0	19.6	0.50	12.9	205	648	50	1	1	133	1
31 May	60 M	0	344	0	27.1	0.54	19.1	151	614	67	1	1	139	1
31 May	120 M	2	386	0	80.1	0.51	46.9	363	1160	54	1	1	140	1
25 July	Control	0	340	0	52.7	0.46	39.4	124	735	1	2	1	205	1
25 July	60 F	0	304	0	48.2	0.35	38.1	73	623	29	1	1	305	1
25 July	120 F	0	314	0	53.0	0.32	38.1	131	717	1	2	1	216	1
25 July	180 F	0	302	0	48.1	0.25	33.9	117	666	1	1	1	273	1
25 July	20 M	0	339	0	28.1	0.40	21.9	381	964	2	1	1	152	1
25 July	40 M	0	349	0	22.0	0.46	14.4	182	624	27	1	1	132	1
25 July	60 M	0	337	0	35.3	0.48	23.8	157	638	5	1	1	145	1
25 July	120 M	0	372	0	81.8	0.49	52.1	332	1150	1	2	1	177	1
28 Sept.	Control	0	364	0	32.4	0.51	29.7	120	655	2	4	1	205	1
28 Sept.	60 F	0	312	0	57.5	0.35	38.1	79	641	3	1	1	301	1
28 Sept.	120 F	0	334	0	37.2	0.37	30.3	133	664	1	2	1	188	1
28 Sept.	180 F	0	328	0	36.5	0.26	22.4	136	621	3	3	1	267	1
28 Sept.	20 M	0	345	0	31.5	0.43	23.2	399	996	94	2	1	153	1
28 Sept.	40 M	0	367	0	20.0	0.47	13.5	151	584	21	2	1	118	1
28 Sept.	60 M	0	341	0	36.0	0.50	22.7	168	671	94	3	1	153	1
28 Sept.	120 M	1	384	0	80.9	0.50	43.6	300	1064	79	4	1	187	1

Table 13.37. Mean values (n=5) for the groundwater chemical analysis for the coarse-textured site in 1994. Analysis was carried out by the University of Alberta Hospitals. F = nitrogen fertilizer rate (kg ha^{-1} y^{-1}); M = manure rate (Mg ha^{-1} y^{-1}). (3 of 3 pages)

Date	Treatment	B $\mu g\ L^{-1}$	Cd $\mu g\ L^{-1}$	Cr $\mu g\ L^{-1}$	Co $\mu g\ L^{-1}$	Cu $\mu g\ L^{-1}$	Pb $\mu g\ L^{-1}$	Mn $\mu g\ L^{-1}$	Mo $\mu g\ L^{-1}$	Ni $\mu g\ L^{-1}$	Se $\mu g\ L^{-1}$	Ag $\mu g\ L^{-1}$	Tl $\mu g\ L^{-1}$	Ti $\mu g\ L^{-1}$	V $\mu g\ L^{-1}$	Zn $\mu g\ L^{-1}$
31 May	Control	76	1	4	1	1	1	1	2	1	3	1	1	1	1	1
31 May	60 F	39	1	3	1	1	1	1	1	1	1	1	1	1	1	1
31 May	120 F	58	1	3	1	1	1	56	2	1	2	1	1	3	1	3
31 May	180 F	52	1	3	1	1	1	1	1	1	2	1	1	1	1	1
31 May	20 M	141	1	4	1	2	1	12	2	1	5	1	1	3	1	13
31 May	40 M	86	1	4	1	2	1	8	2	1	2	1	1	1	1	2
31 May	60 M	95	1	4	1	1	1	9	3	1	3	1	1	2	1	2
31 May	120 M	87	1	4	1	2	7	9	2	1	8	1	1	2	1	5
25 July	Control	114	1	8	1	3	1	1	1	1	3	1	1	1	1	6
25 July	60 F	51	1	8	1	4	1	11	1	1	1	1	1	1	1	5
25 July	120 F	68	1	7	1	3	1	17	1	1	2	1	1	1	1	6
25 July	180 F	59	1	7	1	3	1	3	1	1	2	1	1	1	1	6
25 July	20 M	167	1	8	1	4	1	1	1	1	7	1	6	1	1	8
25 July	40 M	104	1	8	1	6	1	7	1	1	2	1	1	1	1	6
25 July	60 M	120	1	8	1	3	1	1	3	1	3	1	1	1	1	6
25 July	120 M	112	1	9	1	4	1	3	1	1	6	1	1	1	1	9
28 Sept.	Control	131	1	6	1	2	1	1	2	1	2	1	1	1	1	5
28 Sept.	60 F	58	1	4	1	2	6	1	1	1	2	1	11	1	1	5
28 Sept.	120 F	76	1	5	1	2	1	20	1	1	1	1	4	1	1	5
28 Sept.	180 F	65	1	5	1	2	1	3	1	1	2	1	1	1	1	9
28 Sept.	20 M	192	1	5	1	3	1	1	3	1	6	1	2	1	1	8
28 Sept.	40 M	110	1	5	1	2	1	8	2	1	1	1	3	1	1	6
28 Sept.	60 M	118	1	5	1	3	1	10	2	1	3	1	1	4	1	11
28 Sept.	120 M	114	1	6	1	3	2	55	2	1	4	1	4	3	1	10

Table 13.38. Mean values (n=5) for the groundwater chemical analysis for the coarse-textured site in 1995. Analysis was carried out by the University of Alberta Hospitals. F = nitrogen fertilizer rate (kg ha^{-1} y^{-1}); M = manure rate (Mg ha^{-1} y^{-1}). (1 of 3 pages)

Date	Treatment	Total coliforms counts 100 mL^{-1}	Faecal coliforms counts 100 mL^{-1}	pH	Electrical conductivity dS m^{-1}	Na mg L^{-1}	K mg L^{-1}	Ca mg L^{-1}	Mg mg L^{-1}	Hardness total Ca CO_3 mg L^{-1}	Fe mg L^{-1}	Total alkalinity (Ca CO_3) mg L^{-1}
31 May	Control	1	1	8.12	0.94	35	4.7	66	71	458	0.08	285
31 May	60 F	1	1	7.97	1.01	16	7.8	81	71	495	0.14	233
31 May	120 F	1	1	7.96	1.06	31	2.6	95	68	518	0.12	264
31 May	180 F	1	1	7.93	1.12	36	4.6	102	67	530	0.07	249
31 May	20 M	1	1	8.06	2.72	82	3.1	69	76	485	0.20	266
31 May	40 M	1	1	8.05	0.92	49	2.7	54	85	485	0.08	285
31 May	60 M	1	1	8.01	2.02	49	4.0	70	77	490	0.11	265
31 May	120 M	1	1	8.07	1.57	67	3.7	95	130	771	0.25	289
25 July	Control	15	1	7.95	0.98	34	5.5	74	71	479	0.95	279
25 July	60 F	9	1	7.98	1.14	16	9.0	94	77	553	0.89	239
25 July	120 F	8	1	7.83	1.08	30	2.9	101	68	531	0.28	263
25 July	180 F	11	1	7.98	1.04	34	5.0	99	58	488	0.74	246
25 July	20 M	8	1	7.98	1.26	89	3.5	79	79	521	0.84	277
25 July	40 M	8	1	8.08	1.02	48	2.9	60	83	491	1.41	282
25 July	60 M	11	2	7.99	1.07	50	4.2	72	75	486	0.90	260
25 July	120 M	10	3	7.94	1.92	72	4.5	133	144	924	0.99	287
27 Sept.	Control	10	1	8.09	1.04	39	5.4	74	76	497	0.07	292
27 Sept.	60 F	6	1	8.16	0.98	17	8.2	83	77	523	0.04	259
27 Sept.	120 F	10	1	8.09	1.04	31	2.6	93	71	524	0.10	267
27 Sept.	180 F	9	1	8.06	1.05	36	4.8	105	63	520	0.06	273
27 Sept.	20 M	10	1	8.18	1.40	106	3.4	90	89	592	0.13	282
27 Sept.	40 M	10	1	8.13	0.97	43	2.8	56	84	487	0.06	305
27 Sept.	60 M	8	1	8.19	1.03	48	4.0	70	77	492	0.07	281
27 Sept.	120 M	14	3	8.06	1.75	70	4.6	121	135	858	0.08	308

Table 13.38. Mean values (n=5) for the groundwater chemical analysis for the coarse-textured site in 1995. Analysis was carried out by the University of Alberta Hospitals. F = nitrogen fertilizer rate (kg ha^{-1} y^{-1}); M = manure rate (Mg ha^{-1} y^{-1}). (2 of 3 pages)

Date	Treatment	CO_3 mg L^{-1}	HCO_3 mg L^{-1}	OH mg L^{-1}	Cl mg L^{-1}	F mg L^{-1}	NO_3-N + NO_2-N mg L^{-1}	SO_4 mg L^{-1}	Total dissolved solids mg L^{-1}	Al µg L^{-1}	Sb µg L^{-1}	As µg L^{-1}	Ba µg L^{-1}	Be µg L^{-1}
31 May	Control	2	343	0	31.4	0.45	25.6	116	609	1	1	1	148	1
31 May	60 F	0	284	0	48.0	0.30	45.2	73	637	1	1	1	278	1
31 May	120 F	0	322	0	45.9	0.29	36.5	128	691	2	1	1	178	1
31 May	180 F	0	304	0	61.5	0.22	39.7	139	736	2	1	1	285	1
31 May	20 M	0	324	0	37.5	0.44	28.2	229	781	1	1	1	141	1
31 May	40 M	0	347	0	20.3	0.46	15.7	217	669	2	1	1	125	1
31 May	60 M	0	609	0	40.8	0.49	30.1	159	692	10	1	1	130	1
31 May	120 M	0	352	0	75.6	0.47	43.4	352	1088	3	1	1	152	1
25 July	Control	0	340	0	35.1	0.47	29.6	111	631	3	1	2	161	1
25 July	60 F	0	292	0	62.7	0.34	58.2	72	733	14	1	1	293	1
25 July	120 F	0	321	0	48.1	0.32	37.5	127	701	1	1	1	196	1
25 July	180 F	0	300	0	47.6	0.29	34.1	135	678	1	1	2	301	1
25 July	20 M	0	345	0	39.7	0.48	30.2	260	850	30	1	2	161	1
25 July	40 M	0	344	0	23.3	0.48	15.9	205	663	4	1	1	126	1
25 July	60 M	0	317	0	38.4	0.55	26.9	168	683	2	1	1	131	1
25 July	120 M	0	349	0	109.9	0.51	79.6	348	1337	4	1	2	192	1
27 Sept.	Control	0	357	0	35.7	0.50	37.9	119	692	1	1	1	202	1
27 Sept.	60 F	0	315	0	46.0	0.34	42.0	74	646	1	1	1	270	1
27 Sept.	120 F	0	325	0	39.5	0.37	35.6	128	684	1	1	1	192	1
27 Sept.	180 F	0	333	0	48.7	0.27	30.8	149	707	1	1	1	292	1
27 Sept.	20 M	2	340	0	37.1	0.44	28.6	373	995	2	1	1	158	1
27 Sept.	40 M	0	371	0	21.9	0.46	16.1	183	645	1	1	1	123	1
27 Sept.	60 M	0	342	0	35.8	0.53	25.9	174	692	2	1	1	135	1
27 Sept.	120 M	0	376	0	99.1	0.50	61.7	345	1232	1	1	1	210	1

Table 13.38. Mean values (n=5) for the groundwater chemical analysis for the coarse-textured site in 1995. Analysis was carried out by the University of Alberta Hospitals. F = nitrogen fertilizer rate (kg ha^{-1} y^{-1}); M = manure rate (Mg ha^{-1} y^{-1}). (3 of 3 pages)

Date	Treatment	B $\mu g\ L^{-1}$	Cd $\mu g\ L^{-1}$	Cr $\mu g\ L^{-1}$	Co $\mu g\ L^{-1}$	Cu $\mu g\ L^{-1}$	Pb $\mu g\ L^{-1}$	Mn $\mu g\ L^{-1}$	Mo $\mu g\ L^{-1}$	Ni $\mu g\ L^{-1}$	Se $\mu g\ L^{-1}$	Ag $\mu g\ L^{-1}$	Tl $\mu g\ L^{-1}$	Ti $\mu g\ L^{-1}$	V $\mu g\ L^{-1}$	Zn $\mu g\ L^{-1}$
31 May	Control	87	1	3	1	6	1	1	2	1	3	1	1	1	1	6
31 May	60 F	44	1	3	1	5	1	1	1	1	2	1	1	1	1	6
31 May	120 F	57	1	3	1	5	1	3	1	1	2	1	1	1	1	6
31 May	180 F	63	1	2	1	6	1	1	1	1	2	1	1	1	1	7
31 May	20 M	136	1	3	1	6	1	1	3	1	5	1	1	1	1	9
31 May	40 M	101	1	3	1	6	1	1	2	1	3	1	1	1	1	9
31 May	60 M	100	1	2	1	6	1	1	3	1	3	1	1	1	1	7
31 May	120 M	88	1	3	1	6	1	1	2	1	4	1	1	1	1	10
25 July	Control	98	1	3	1	5	1	1	2	1	4	1	1	1	1	6
25 July	60 F	53	1	4	1	5	1	2	1	1	2	1	1	1	1	6
25 July	120 F	69	1	3	1	5	1	12	1	1	2	1	1	1	1	7
25 July	180 F	65	1	3	1	5	1	2	1	1	3	1	1	1	1	5
25 July	20 M	161	1	5	1	6	1	3	3	1	6	1	1	1	1	8
25 July	40 M	105	1	3	1	6	1	1	2	1	3	1	1	1	1	7
25 July	60 M	114	1	4	1	5	1	1	3	1	4	1	1	1	1	7
25 July	120 M	105	1	4	1	6	1	1	2	1	6	1	1	1	1	10
27 Sept.	Control	129	1	2	1	5	1	1	2	1	2	1	1	1	1	5
27 Sept.	60 F	63	1	2	1	5	1	1	1	1	1	1	1	1	1	5
27 Sept.	120 F	80	1	3	1	5	1	8	1	1	2	1	1	1	1	5
27 Sept.	180 F	83	1	2	1	6	1	2	1	1	3	1	1	1	1	5
27 Sept.	20 M	193	1	3	1	7	1	1	2	1	6	1	1	1	1	8
27 Sept.	40 M	115	1	3	1	7	1	1	2	1	2	1	1	1	1	6
27 Sept.	60 M	129	1	3	1	7	1	1	3	1	3	1	1	1	1	6
27 Sept.	120 M	118	1	3	1	7	1	2	2	1	4	1	1	1	1	9

Table 13.39. Mean values (n=5) for the groundwater chemical analysis for the medium-textured site in 1994. Analysis was carried out by the University of Alberta Hospitals. F = nitrogen fertilizer rate (kg ha^{-1} y^{-1}); M = manure rate (Mg ha^{-1} y^{-1}). (1 of 3 pages)

Date	Treatment	Total coliforms counts 100 mL^{-1}	Faecal coliforms counts 100 mL^{-1}	pH	Electrical conductivity dS m^{-1}	Na mg L^{-1}	K mg L^{-1}	Ca mg L^{-1}	Mg mg L^{-1}	Hardness total Ca CO_3 mg L^{-1}	Fe mg L^{-1}	Total alkalinity (Ca CO_3) mg L^{-1}
31 May	Control	8	3	7.73	7.66	541	9.0	421	678	3843	3.08	501
31 May	60 F	6	2	7.75	8.89	692	10.8	413	803	4338	1.95	504
31 May	120 F	6	1	7.79	8.85	623	10.3	443	801	4405	3.11	515
31 May	180 F	6	1	7.69	8.03	489	7.4	429	757	4191	2.48	507
31 May	20 M	16	2	7.82	8.49	566	9.2	414	778	4237	3.04	502
31 May	40 M	51	2	7.71	8.96	665	9.0	441	797	4382	1.70	534
31 May	60 M	8	2	7.74	9.66	730	11.5	433	933	4923	1.88	542
31 May	120 M	6	2	7.65	8.73	594	10.1	419	829	4461	2.28	503
26 July	Control	4	1	7.74	9.30	622	9.4	432	694	3937	0.07	525
26 July	60 F	2	1	7.74	10.28	676	9.8	408	836	4461	0.09	438
26 July	120 F	8	2	7.70	10.47	674	10.2	420	881	4676	0.09	497
26 July	180 F	7	1	7.74	9.53	538	7.5	420	788	4295	0.10	497
26 July	20 M	3	1	7.79	9.61	592	8.6	412	786	4266	0.07	498
26 July	40 M	7	1	7.67	10.50	689	9.1	432	844	4555	0.10	521
26 July	60 M	10	1	7.77	11.20	653	10.5	434	953	5009	0.08	516
26 July	120 M	4	1	7.76	10.17	626	9.7	418	832	4472	0.09	491
27 Sept.	Control	1	1	8.00	8.97	628	10.2	442	675	3882	3.17	511
27 Sept.	60 F	1	1	7.93	9.85	688	10.4	402	827	4408	8.28	482
27 Sept.	120 F	1	1	7.88	9.99	702	11.2	424	852	4567	2.65	502
27 Sept.	180 F	1	1	7.95	9.34	630	8.6	414	810	4368	3.29	516
27 Sept.	20 M	2	1	7.92	9.90	627	10.0	414	846	4516	2.45	515
27 Sept.	40 M	2	1	7.95	10.21	731	9.9	443	821	4489	3.93	516
27 Sept.	60 M	1	1	7.89	10.90	760	11.6	438	913	4853	3.55	524
27 Sept.	120 M	2	1	7.88	10.01	666	10.8	421	831	4473	2.71	488

Table 13.39. Mean values (n=5) for the groundwater chemical analysis for the medium-textured site in 1994. Analysis was carried out by the University of Alberta Hospitals. F = nitrogen fertilizer rate (kg ha^{-1} y^{-1}); M = manure rate (Mg ha^{-1} y^{-1}). (2 of 3 pages)

Date	Treatment	CO_3 mg L^{-1}	HCO_3 mg L^{-1}	OH mg L^{-1}	Cl mg L^{-1}	F mg L^{-1}	NO_3-N + NO_2-N mg L^{-1}	SO_4 mg L^{-1}	Total dissolved solids mg L^{-1}	Al μg L^{-1}	Sb μg L^{-1}	As μg L^{-1}	Ba μg L^{-1}	Be μg L^{-1}
31 May	Control	0	635	0	31.3	0.25	3.1	4224	6222	3	1	2	21	1
31 May	60 F	0	614	0	24.7	0.13	0.6	4990	7241	178	1	2	32	1
31 May	120 F	0	628	0	25.1	0.24	3.4	4974	7203	1	1	2	27	1
31 May	180 F	0	618	0	27.0	0.13	1.8	4500	6525	1	1	3	26	1
31 May	20 M	0	612	0	13.1	0.18	0.7	4705	6792	4	1	1	24	1
31 May	40 M	0	650	0	51.6	0.15	7.8	5013	7333	2	1	5	26	1
31 May	60 M	0	661	0	45.5	0.12	2.6	5737	8229	16	1	4	27	1
31 May	120 M	0	614	0	31.2	0.13	0.5	4898	7089	136	1	2	29	1
26 July	Control	0	640	0	35.0	0.12	0.7	4868	6799	39	2	1	25	1
26 July	60 F	0	607	0	26.1	0.12	0.9	5312	7535	77	2	1	22	1
26 July	120 F	0	605	0	29.0	0.10	0.6	5576	7891	1	2	1	22	1
26 July	180 F	0	606	0	27.4	0.12	0.8	4864	6947	1	2	1	22	1
26 July	20 M	0	608	0	14.7	0.13	0.6	5040	7155	30	2	1	23	1
26 July	40 M	0	636	0	50.5	0.14	6.7	5366	7734	1	2	2	23	1
26 July	60 M	0	629	0	50.4	0.16	0.7	5900	8404	2	1	3	23	1
26 July	120 M	0	599	0	34.9	0.12	0.6	5240	7458	3	2	1	23	1
27 Sept.	Control	0	623	0	36.4	0.15	5.2	4266	6391	3	1	2	23	1
27 Sept.	60 F	0	588	0	27.0	0.14	2.3	5016	7278	4	1	1	24	1
27 Sept.	120 F	0	613	0	31.4	0.13	0.9	5240	7569	32	1	3	22	1
27 Sept.	180 F	0	629	0	29.5	0.16	0.5	4776	6983	2	1	3	22	1
27 Sept.	20 M	0	627	0	16.1	0.15	0.4	4967	7193	1	1	1	23	1
27 Sept.	40 M	0	629	0	57.2	0.17	0.6	5011	7390	3	1	5	24	1
27 Sept.	60 M	0	638	0	64.6	0.14	0.7	5315	7824	4	1	2	24	1
27 Sept.	120 M	0	595	0	44.2	0.15	0.5	4946	7217	2	1	2	23	1

Table 13.39. Mean values (n=5) for the groundwater chemical analysis for the medium-textured site in 1994. Analysis was carried out by the University of Alberta Hospitals. F = nitrogen fertilizer rate (kg ha^{-1} y^{-1}); M = manure rate (Mg ha^{-1} y^{-1}). (3 of 3 pages)

Date	Treatment	B $\mu g\ L^{-1}$	Cd $\mu g\ L^{-1}$	Cr $\mu g\ L^{-1}$	Co $\mu g\ L^{-1}$	Cu $\mu g\ L^{-1}$	Pb $\mu g\ L^{-1}$	Mn $\mu g\ L^{-1}$	Mo $\mu g\ L^{-1}$	Ni $\mu g\ L^{-1}$	Se $\mu g\ L^{-1}$	Ag $\mu g\ L^{-1}$	Tl $\mu g\ L^{-1}$	Ti $\mu g\ L^{-1}$	V $\mu g\ L^{-1}$	Zn $\mu g\ L^{-1}$
31 May	Control	168	1	6	1	17	1	84	1	1	104	1	1	2	1	48
31 May	60 F	198	1	7	5	15	1	1708	10	3	109	1	1	10	1	60
31 May	120 F	150	1	6	1	16	1	174	3	1	121	1	1	2	1	57
31 May	180 F	246	1	8	3	15	1	881	2	3	192	1	1	2	1	55
31 May	20 M	195	1	8	2	17	2	625	5	1	69	1	1	2	1	62
31 May	40 M	193	1	7	2	17	1	718	7	1	337	1	1	2	3	61
31 May	60 M	162	1	7	2	19	1	553	3	1	231	1	1	3	1	69
31 May	120 M	148	1	8	2	18	1	665	2	1	106	1	1	8	1	62
26 July	Control	152	1	6	1	17	1	540	3	10	140	1	1	4	1	76
26 July	60 F	192	1	4	4	13	1	1879	9	13	113	1	1	2	1	75
26 July	120 F	142	1	6	2	17	1	419	3	7	114	1	1	2	1	72
26 July	180 F	254	1	5	1	16	1	691	3	3	175	1	1	2	1	68
26 July	20 M	192	1	6	2	14	1	869	4	9	74	1	1	3	1	67
26 July	40 M	195	1	4	2	16	1	850	4	6	296	1	1	2	1	72
26 July	60 M	151	1	3	1	43	2	545	3	5	227	1	1	3	1	94
26 July	120 M	147	1	5	2	16	1	755	4	7	94	1	1	3	1	71
27 Sept.	Control	138	1	6	1	18	1	607	3	11	96	1	1	3	1	60
27 Sept.	60 F	211	1	5	2	16	1	1301	3	13	95	1	1	3	1	62
27 Sept.	120 F	143	1	6	1	20	1	301	3	9	111	1	1	3	1	67
27 Sept.	180 F	208	1	5	1	19	1	433	5	6	108	1	1	3	1	69
27 Sept.	20 M	196	1	5	1	16	1	705	3	11	42	1	1	3	1	69
27 Sept.	40 M	193	1	6	1	18	1	588	3	10	332	1	1	3	1	67
27 Sept.	60 M	153	1	6	1	19	1	314	2	11	256	1	3	3	1	84
27 Sept.	120 M	153	1	5	1	18	1	447	3	7	100	1	1	3	1	66

Table 13.40. Mean values (n=5) for the groundwater chemical analysis for the medium-textured site in 1995. Analysis was carried out by the University of Alberta Hospitals. F = nitrogen fertilizer rate (kg ha^{-1} y^{-1}); M = manure rate (Mg ha^{-1} y^{-1}). (1 of 3 pages)

Date	Treatment	Total coliforms counts 100 mL^{-1}	Faecal coliforms counts 100 mL^{-1}	pH	Electrical conductivity dS m^{-1}	Na mg L^{-1}	K mg L^{-1}	Ca mg L^{-1}	Mg mg L^{-1}	Hardness total Ca CO_3 mg L^{-1}	Fe mg L^{-1}	Total alkalinity (Ca CO_3) mg L^{-1}
30 May	Control	2	1	7.76	7.44	649	9.7	430	745	4141	0.16	547
30 May	60 F	1	1	7.73	10.79	683	9.5	415	891	4704	0.26	518
30 May	120 F	2	1	7.92	10.68	709	11.3	420	845	4527	0.25	481
30 May	180 F	1	1	7.70	10.10	608	8.0	412	816	4389	0.35	496
30 May	20 M	2	1	7.82	10.35	612	9.6	414	854	4552	0.27	507
30 May	40 M	1	1	7.70	10.65	689	8.8	428	854	4584	0.40	501
30 May	60 M	1	1	7.74	11.05	724	11.0	434	903	4801	0.25	500
30 May	120 M	1	1	7.72	10.25	641	10.5	418	806	4363	0.37	464
26 July	Control	9	3	7.69	8.13	610	10.5	468	699	4050	0.34	518
26 July	60 F	9	1	7.69	8.78	628	10.1	433	835	4520	0.34	489
26 July	120 F	8	4	7.65	9.19	674	11.4	450	859	4660	0.28	481
26 July	180 F	9	2	7.73	8.20	541	8.1	434	781	4298	0.30	481
26 July	20 M	7	1	7.68	8.74	567	9.5	436	824	4483	0.27	498
26 July	40 M	8	1	7.69	9.03	679	9.4	451	830	4545	0.25	506
26 July	60 M	4	1	7.66	9.72	710	11.5	463	920	4945	0.26	507
26 July	120 M	9	4	7.67	8.80	623	10.8	443	831	4526	0.29	477
27 Sept.	Control	15	1	7.76	9.41	613	10.8	443	674	3882	0.37	518
27 Sept.	60 F	11	1	7.69	10.36	645	10.7	423	832	4482	0.33	492
27 Sept.	120 F	12	1	7.73	10.70	685	11.9	429	854	4587	0.75	481
27 Sept.	180 F	15	1	7.73	9.69	568	8.9	416	762	4176	0.38	491
27 Sept.	20 M	13	1	7.75	10.57	627	10.5	423	884	4698	0.46	515
27 Sept.	40 M	13	1	7.80	10.61	722	10.2	444	814	4463	0.33	514
27 Sept.	60 M	14	1	7.68	11.14	719	11.7	442	900	4810	0.44	510
27 Sept.	120 M	10	1	7.71	10.47	646	10.9	423	820	4431	0.33	487

Table 13.40. Mean values (n=5) for the groundwater chemical analysis for the medium-textured site in 1995. Analysis was carried out by the University of Alberta Hospitals. F = nitrogen fertilizer rate (kg ha^{-1} y^{-1}); M = manure rate (Mg ha^{-1} y^{-1}). (2 of 3 pages)

Date	Treatment	CO_3 mg L^{-1}	HCO_3 mg L^{-1}	OH mg L^{-1}	Cl mg L^{-1}	F mg L^{-1}	NO_3-N + NO_2-N mg L^{-1}	SO_4 mg L^{-1}	Total dissolved solids mg L^{-1}	Al µg L^{-1}	Sb µg L^{-1}	As µg L^{-1}	Ba µg L^{-1}	Be µg L^{-1}
30 May	Control	0	667	0	37.6	0.09	4.5	4700	6919	29	1	1	21	1
30 May	60 F	0	632	0	29.0	0.08	7.8	5245	7617	1	1	1	19	1
30 May	120 F	0	586	0	30.4	0.08	9.3	5368	7713	164	1	1	20	1
30 May	180 F	0	605	0	30.4	0.09	11.5	4708	6931	15	1	2	21	1
30 May	20 M	0	617	0	17.1	0.09	6.4	4978	7218	1	1	1	19	1
30 May	40 M	0	611	0	50.1	0.10	15.2	4978	7376	1	1	2	21	1
30 May	60 M	0	610	0	64.4	0.08	24.3	5210	7754	1	1	3	20	1
30 May	120 M	0	565	0	47.4	0.08	10.7	4736	6985	15	1	1	20	1
26 July	Control	0	631	0	35.8	0.08	9.4	4426	6603	64	1	1	20	1
26 July	60 F	0	596	0	26.8	0.07	11.5	4942	7219	109	1	1	24	1
26 July	120 F	0	586	0	29.8	0.07	11.5	5174	7537	34	1	2	20	1
26 July	180 F	0	587	0	28.9	0.08	14.2	4598	6743	9	1	2	22	1
26 July	20 M	0	607	0	14.6	0.09	8.5	4873	7061	71	1	1	21	1
26 July	40 M	0	617	0	54.5	0.09	16.0	5073	7472	5	1	4	22	1
26 July	60 M	0	618	0	56.3	0.08	21.4	5511	8071	34	1	3	20	1
26 July	120 M	0	582	0	40.2	0.08	10.3	5015	7294	3	1	2	21	1
27 Sept.	Control	0	631	0	36.3	0.09	8.0	4270	6393	1	1	2	19	1
27 Sept.	60 F	0	600	0	27.3	0.08	10.2	4972	7251	1	1	2	23	1
27 Sept.	120 F	0	586	0	32.1	0.07	9.5	5026	7369	14	1	1	19	1
27 Sept.	180 F	0	598	0	30.0	0.08	11.2	4538	6667	6	1	2	16	1
27 Sept.	20 M	0	625	0	17.1	0.08	6.0	5169	7467	16	1	1	20	1
27 Sept.	40 M	0	627	0	65.7	0.09	14.9	5003	7434	6	1	5	21	1
27 Sept.	60 M	0	621	0	57.3	0.08	23.5	5302	7842	1	1	2	19	1
27 Sept.	120 M	0	594	0	46.1	0.07	10.0	4943	7225	1	1	1	19	1

Table 13.40. Mean values (n=5) for the groundwater chemical analysis for the medium-textured site in 1995. Analysis was carried out by the University of Alberta Hospitals. F = nitrogen fertilizer rate (kg ha^{-1} y^{-1}); M = manure rate (Mg ha^{-1} y^{-1}). (3 of 3 pages)

Date	Treatment	B $\mu g\ L^{-1}$	Cd $\mu g\ L^{-1}$	Cr $\mu g\ L^{-1}$	Co $\mu g\ L^{-1}$	Cu $\mu g\ L^{-1}$	Pb $\mu g\ L^{-1}$	Mn $\mu g\ L^{-1}$	Mo $\mu g\ L^{-1}$	Ni $\mu g\ L^{-1}$	Se $\mu g\ L^{-1}$	Ag $\mu g\ L^{-1}$	Tl $\mu g\ L^{-1}$	Ti $\mu g\ L^{-1}$	V $\mu g\ L^{-1}$	Zn $\mu g\ L^{-1}$
30 May	Control	143	1	5	1	20	1	262	2	2	131	1	1	3	1	74
30 May	60 F	192	1	5	1	19	1	241	3	5	92	1	1	3	1	86
30 May	120 F	146	1	6	1	20	1	96	2	1	62	1	1	11	1	85
30 May	180 F	226	1	5	1	18	1	103	2	1	123	1	1	3	1	81
30 May	20 M	181	1	6	1	18	1	174	3	3	47	1	1	3	1	88
30 May	40 M	195	1	6	1	19	1	138	2	1	304	1	1	3	1	86
30 May	60 M	152	1	6	1	21	1	65	2	2	247	1	1	3	1	91
30 May	120 M	145	1	6	1	20	1	96	2	1	107	1	1	3	1	80
26 July	Control	145	1	6	1	24	1	280	1	6	145	1	1	5	1	63
26 July	60 F	182	1	6	1	18	1	371	3	3	106	1	1	8	1	73
26 July	120 F	137	1	6	1	21	1	180	2	3	104	1	1	3	1	73
26 July	180 F	221	1	5	1	19	1	292	2	3	166	1	1	2	1	67
26 July	20 M	175	1	7	1	18	1	330	2	4	55	1	1	4	1	71
26 July	40 M	188	1	6	1	20	1	259	2	1	330	1	1	2	1	70
26 July	60 M	153	1	7	1	21	1	124	2	1	244	1	1	3	1	77
26 July	120 M	141	1	5	1	21	1	229	2	2	103	1	1	2	1	70
27 Sept.	Control	140	1	4	1	24	1	253	1	12	119	1	1	2	1	69
27 Sept.	60 F	218	1	4	1	23	1	374	3	13	77	1	1	2	1	85
27 Sept.	120 F	134	1	4	1	22	1	207	1	9	75	1	1	3	1	79
27 Sept.	180 F	162	1	3	1	19	1	329	2	4	98	1	1	2	1	68
27 Sept.	20 M	168	1	4	1	22	1	392	2	10	33	1	1	3	1	82
27 Sept.	40 M	177	1	4	1	23	1	314	2	8	329	1	1	2	1	78
27 Sept.	60 M	149	1	4	1	23	1	179	2	8	237	1	1	2	1	83
27 Sept.	120 M	141	1	4	1	24	1	292	1	8	98	1	1	2	1	80

Appendix 14. Moisture content, dry-matter yield, crop height, and nitrogen, calcium, and phosphorus contents of plant tissue at the coarse- and medium-textured sites.

Table 14.1. Crop data for the coarse-textured site in 1994.

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
Control	A	59.1	4.95	nm[x]	nm	nm	nm
	B	63.9	7.24	nm	nm	nm	nm
	C	58.8	6.98	nm	nm	nm	nm
	D	69.3	7.31	nm	nm	nm	nm
	E	57.1	7.78	nm	nm	nm	nm
	mean	61.7	6.85	nm	nm	nm	nm
60 F	A	62.4	6.19	nm	nm	nm	nm
	B	65.7	6.60	nm	nm	nm	nm
	C	69.5	6.77	nm	nm	nm	nm
	D	62.2	7.87	nm	nm	nm	nm
	E	70.4	5.89	nm	nm	nm	nm
	mean	66.1	6.66	nm	nm	nm	nm
120 F	A	69.6	6.25	nm	nm	nm	nm
	B	68.1	7.09	nm	nm	nm	nm
	C	69.4	7.65	nm	nm	nm	nm
	D	67.0	7.23	nm	nm	nm	nm
	E	69.6	8.52	nm	nm	nm	nm
	mean	68.7	7.35	nm	nm	nm	nm
180 F	A	71.0	4.66	nm	nm	nm	nm
	B	69.7	6.34	nm	nm	nm	nm
	C	69.5	8.66	nm	nm	nm	nm
	D	69.5	7.76	nm	nm	nm	nm
	E	68.9	6.67	nm	nm	nm	nm
	mean	69.7	6.82	nm	nm	nm	nm
20 M	A	62.6	7.29	nm	nm	nm	nm
	B	63.7	6.36	nm	nm	nm	nm
	C	69.1	7.23	nm	nm	nm	nm
	D	67.4	7.62	nm	nm	nm	nm
	E	72.7	7.03	nm	nm	nm	nm
	mean	67.1	7.11	nm	nm	nm	nm
40 M	A	52.4	8.13	nm	nm	nm	nm
	B	65.1	6.29	nm	nm	nm	nm
	C	63.0	6.99	nm	nm	nm	nm
	D	69.0	7.65	nm	nm	nm	nm
	E	67.6	7.01	nm	nm	nm	nm
	mean	63.4	7.22	nm	nm	nm	nm
60 M	A	66.8	7.06	nm	nm	nm	nm
	B	63.9	5.62	nm	nm	nm	nm
	C	67.2	7.17	nm	nm	nm	nm
	D	71.7	8.16	nm	nm	nm	nm
	E	67.8	7.41	nm	nm	nm	nm
	mean	67.5	7.08	nm	nm	nm	nm
120 M	A	58.3	5.85	nm	nm	nm	nm
	B	72.4	6.82	nm	nm	nm	nm
	C	70.3	6.70	nm	nm	nm	nm
	D	68.4	8.65	nm	nm	nm	nm
	E	73.0	6.72	nm	nm	nm	nm
	mean	68.5	6.95	nm	nm	nm	nm

[z] wet-weight basis; [y] dry-weight basis; [x] nm = not measured.

Table 14.2. Crop data for the coarse-textured site in 1995.

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
Control	A	66.6	5.76	72	24.1	4.2	2.7
	B	70.7	5.80	76	25.7	4.4	2.8
	C	69.1	5.52	77	25.3	4.4	2.7
	D	74.3	5.44	79	26.4	4.3	3.1
	E	61.3	4.74	62	19.7	3.6	2.4
	mean	68.4	5.45	73	24.2	4.2	2.7
60 F	A	67.1	6.88	74	22.2	3.0	2.7
	B	68.8	6.50	78	25.3	4.1	2.8
	C	70.3	7.41	82	24.6	3.6	2.7
	D	70.6	7.21	81	28.0	4.0	3.0
	E	71.6	7.71	84	28.0	4.2	3.2
	mean	69.7	7.14	80	25.6	3.8	2.9
120 F	A	68.0	8.51	76	26.3	3.6	3.1
	B	70.5	7.92	83	22.0	3.0	2.6
	C	71.6	6.53	81	27.0	4.0	2.8
	D	71.5	8.02	73	25.7	4.4	3.0
	E	66.3	7.83	74	24.1	4.4	2.4
	mean	69.6	7.76	77	25.0	3.9	2.8
180 F	A	69.8	7.05	76	26.4	3.5	2.7
	B	70.7	6.58	80	26.8	4.0	2.9
	C	71.9	7.35	85	28.7	3.4	3.1
	D	73.8	7.51	77	26.3	3.8	2.6
	E	71.5	8.27	88	27.4	4.4	3.0
	mean	71.5	7.35	81	27.1	3.8	2.9
20 M	A	65.4	5.94	71	22.4	3.8	2.9
	B	69.9	5.91	75	24.2	4.3	2.9
	C	68.8	6.08	73	24.6	4.3	2.8
	D	67.2	5.11	77	23.5	4.1	2.7
	E	70.0	7.47	78	25.1	4.1	3.0
	mean	68.3	6.10	75	24.0	4.1	2.9
40 M	A	68.9	5.71	74	25.1	4.1	2.9
	B	67.4	7.09	75	25.1	4.2	3.0
	C	68.7	5.92	78	24.3	4.4	2.7
	D	73.6	5.19	85	25.5	4.3	3.1
	E	67.5	5.94	70	23.6	4.1	2.8
	mean	69.2	5.97	76	24.7	4.2	2.9
60 M	A	67.5	7.33	74	24.4	4.2	3.0
	B	67.8	5.00	68	25.1	4.5	2.7
	C	70.1	5.48	72	25.5	4.4	2.8
	D	67.7	6.20	86	24.6	4.1	2.9
	E	69.1	7.23	78	25.8	4.3	2.9
	mean	68.4	6.25	76	25.1	4.3	2.9
120 M	A	68.1	6.36	64	26.6	4.2	3.0
	B	67.2	6.64	69	26.4	4.3	3.0
	C	71.5	6.52	78	25.7	4.5	3.0
	D	70.0	6.95	70	25.5	4.0	3.1
	E	67.2	7.08	72	24.4	4.3	3.0
	mean	68.8	6.71	70	25.7	4.3	3.0

[z] wet-weight basis; [y] dry-weight basis.

Table 14.3. Crop data for the coarse-textured site in 1997.

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
Control	A	55.4	5.27	65	13.0	3.9	2.1
	B	58.2	6.92	67	18.5	3.4	3.0
	C	61.4	5.59	64	17.2	1.8	3.5
	D	60.1	8.77	73	20.7	4.6	2.9
	E	57.4	5.19	64	14.3	4.6	1.9
	mean	58.5	6.35	67	16.7	3.7	2.7
60 F	A	62.8	7.52	68	19.2	3.9	3.0
	B	60.2	8.00	71	19.1	4.5	2.4
	C	64.7	7.47	72	16.4	4.5	2.8
	D	64.8	9.32	73	25.7	4.5	2.7
	E	60.4	10.19	76	21.7	2.2	3.4
	mean	62.6	8.50	72	20.4	3.9	2.9
120 F	A	65.4	9.04	76	22.5	3.7	3.5
	B	69.1	8.49	76	21.8	4.4	3.1
	C	63.6	8.05	71	19.8	3.8	2.5
	D	67.2	9.84	81	23.0	4.2	2.5
	E	64.2	8.11	75	21.8	5.5	2.6
	mean	65.9	8.71	76	21.8	4.3	2.8
180 F	A	66.4	9.07	75	20.7	5.1	2.7
	B	66.9	8.67	76	22.1	4.3	2.8
	C	66.9	9.52	78	23.1	5.9	2.4
	D	68.2	10.03	81	27.4	5.0	3.3
	E	66.1	9.39	82	23.2	4.9	2.7
	mean	66.9	9.34	78	23.3	5.0	2.8
20 M	A	61.6	7.89	70	16.1	3.4	2.5
	B	68.0	7.35	73	24.8	5.7	3.0
	C	61.2	8.34	70	20.1	2.0	3.2
	D	55.9	7.96	69	21.1	4.0	2.8
	E	61.9	9.40	75	20.4	3.3	2.7
	mean	61.7	8.19	71	20.5	3.7	2.9
40 M	A	66.0	8.25	73	17.7	3.6	2.6
	B	65.4	7.95	70	20.8	5.1	2.4
	C	67.5	8.58	73	23.0	4.5	2.6
	D	61.9	8.94	72	22.3	4.5	2.8
	E	57.9	8.30	67	19.9	3.5	3.1
	mean	63.7	8.41	71	20.8	4.3	2.7
60 M	A	65.6	9.17	74	19.0	3.5	2.8
	B	63.3	7.47	68	21.9	3.9	2.7
	C	65.3	8.82	71	20.3	3.5	2.8
	D	63.0	9.71	74	24.1	4.5	2.8
	E	62.4	9.04	74	18.6	4.8	2.4
	mean	63.9	8.84	72	20.8	4.1	2.7
120 M	A	65.6	8.07	68	22.2	4.8	2.3
	B	67.6	8.32	71	25.7	4.4	3.0
	C	68.4	8.93	73	25.0	4.2	3.0
	D	68.7	9.71	78	26.5	4.7	2.8
	E	66.1	10.69	78	25.6	4.8	2.5
	mean	67.3	9.15	73	25.0	4.6	2.7

[z] wet-weight basis; [y] dry-weight basis.

Table 14.4. Crop data for the coarse-textured site in 1998.

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
Control	A	27.4	5.31	57	5.0	4.5	0.6
	B	28.4	7.26	69	9.9	4.4	1.3
	C	16.8	6.56	60	7.3	4.4	1.2
	D	23.5	7.31	71	5.4	4.3	0.7
	E	20.3	5.46	53	8.5	4.4	1.4
	mean	23.3	6.38	62	7.2	4.4	1.0
60 F	A	19.7	7.91	73	10.9	4.5	1.3
	B	27.1	7.63	79	11.8	5.1	1.2
	C	19.1	8.66	78	13.3	4.3	1.5
	D	22.0	7.65	76	14.2	4.3	1.6
	E	23.8	7.91	81	14.2	3.3	1.8
	mean	22.3	7.95	77	12.9	4.3	1.5
120 F	A	25.7	9.66	85	14.0	5.0	1.2
	B	29.4	9.10	76	12.6	4.4	1.4
	C	21.6	9.35	76	11.5	4.4	1.3
	D	24.1	8.45	81	13.1	5.0	1.1
	E	30.7	8.15	80	9.9	4.3	1.2
	mean	26.3	8.94	79	12.2	4.6	1.2
180 F	A	29.6	9.11	79	12.2	4.0	1.3
	B	33.7	9.35	80	14.9	4.2	1.6
	C	28.1	10.24	75	15.4	3.7	1.4
	D	30.0	7.12	78	12.8	5.0	1.0
	E	29.3	8.65	83	9.4	5.1	1.3
	mean	30.1	8.89	79	13.0	4.4	1.3
20 M	A	21.6	7.36	71	8.0	4.5	1.1
	B	29.6	8.97	71	10.8	4.9	1.2
	C	28.1	9.38	70	9.7	4.8	1.1
	D	24.4	7.64	69	10.7	3.4	1.6
	E	31.1	8.10	78	11.9	3.8	1.4
	mean	26.9	8.29	72	10.2	4.3	1.3
40 M	A	34.0	9.11	74	11.5	4.4	1.2
	B	36.5	9.33	72	12.3	4.1	1.3
	C	36.2	9.73	74	14.6	5.4	1.4
	D	29.3	8.24	73	10.0	5.1	1.1
	E	28.5	8.89	76	12.6	4.7	1.5
	mean	32.9	9.06	74	12.2	4.8	1.3
60 M	A	30.5	9.26	76	14.9	4.4	1.3
	B	30.5	8.66	77	14.2	4.0	1.4
	C	37.4	8.75	77	12.4	5.6	1.1
	D	34.6	8.65	78	14.5	5.2	1.1
	E	24.5	10.21	76	11.4	6.1	1.2
	mean	31.5	9.11	77	13.5	5.1	1.2
120 M	A	38.0	8.12	76	16.2	5.1	1.5
	B	43.4	8.34	77	16.0	5.7	1.3
	C	38.0	8.05	76	17.1	5.4	1.5
	D	29.9	7.25	78	16.1	6.4	1.2
	E	33.7	7.41	77	15.1	4.7	1.6
	mean	36.6	7.83	77	16.1	5.5	1.5

[z] wet-weight basis; [y] dry-weight basis.

Table 14.5. Crop data for the coarse-textured site in 1999.

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
Control	A	66.1	4.81	nm[x]	13.4	4.2	1.8
	B	66.9	6.28	nm	17.2	4.9	2.1
	C	65.0	5.00	nm	15.2	5.3	1.5
	D	64.4	7.61	nm	14.3	4.6	1.6
	E	61.8	5.20	nm	10.2	4.3	1.4
	mean	64.9	5.78	nm	14.0	4.7	1.7
60 F	A	68.8	8.41	nm	17.2	5.1	1.9
	B	67.3	7.85	nm	16.6	4.8	1.7
	C	66.6	6.76	nm	14.5	4.2	1.6
	D	64.1	6.84	nm	14.9	4.5	1.7
	E	65.7	8.56	nm	15.1	4.8	1.6
	mean	66.5	7.68	nm	15.7	4.7	1.7
120 F	A	68.8	8.81	nm	18.3	4.8	1.9
	B	69.2	8.86	nm	17.6	4.4	2.1
	C	66.9	6.73	nm	15.8	4.9	1.9
	D	68.3	8.44	nm	16.0	4.8	1.9
	E	66.5	8.38	nm	14.6	5.0	1.7
	mean	68.0	8.25	nm	16.5	4.8	1.9
180 F	A	69.6	7.88	nm	19.3	4.6	1.9
	B	68.7	9.09	nm	19.3	5.7	2.3
	C	68.5	8.63	nm	19.0	5.6	2.3
	D	68.0	8.37	nm	15.9	5.0	1.8
	E	69.4	9.49	nm	19.6	6.5	1.9
	mean	68.9	8.69	nm	18.6	5.5	2.0
20 M	A	68.4	8.12	nm	16.6	5.0	1.9
	B	67.4	8.95	nm	17.2	5.0	2.2
	C	65.8	8.41	nm	16.7	4.7	2.0
	D	65.1	7.59	nm	12.6	4.2	1.5
	E	67.1	8.62	nm	15.7	5.1	1.8
	mean	66.8	8.34	nm	15.7	4.8	1.9
40 M	A	69.6	9.03	nm	17.4	5.3	2.0
	B	68.4	9.79	nm	19.5	5.0	2.2
	C	67.0	9.76	nm	16.9	5.3	1.8
	D	66.9	9.17	nm	14.6	4.4	1.5
	E	65.3	9.05	nm	15.2	5.0	1.5
	mean	67.4	9.36	nm	16.7	5.0	1.8
60 M	A	70.5	10.74	nm	17.7	5.3	2.0
	B	67.5	8.79	nm	17.9	4.4	1.8
	C	67.2	9.97	nm	17.5	4.9	1.9
	D	67.0	9.60	nm	15.2	5.3	1.6
	E	68.4	9.68	nm	15.8	5.2	1.7
	mean	68.1	9.76	nm	16.8	5.0	1.8
120 M	A	70.5	9.50	nm	20.0	5.5	2.2
	B	69.7	10.07	nm	19.2	5.2	2.2
	C	69.6	9.99	nm	17.3	5.4	1.9
	D	69.8	9.44	nm	16.8	4.4	1.7
	E	69.1	9.70	nm	17.4	4.6	1.9
	mean	69.8	9.74	nm	18.1	5.1	2.0

[z] wet-weight basis; [y] dry-weight basis; [x] nm = not measured.

Table 14.6. Crop data for the coarse-textured site in 2000. (page 1 of 2)

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
Control	A	55.1	3.61	nm[x]	13.3	3.1	1.6
	B	61.9	4.99	nm	12.6	3.1	1.7
	C	57.0	4.07	nm	15.8	3.7	1.5
	D	59.4	5.35	nm	15.2	4.1	1.8
	E	57.2	5.00	nm	12.3	4.3	1.1
	mean	58.1	4.61	nm	13.9	3.7	1.5
60 F	A	58.2	6.56	nm	21.0	3.9	2.4
	B	60.0	7.74	nm	15.4	4.3	1.8
	C	60.4	6.71	nm	15.7	4.2	1.5
	D	58.6	6.68	nm	16.3	4.0	1.7
	E	58.6	8.21	nm	18.1	4.1	1.6
	mean	59.2	7.18	nm	17.3	4.1	1.8
120 F	A	57.7	7.34	nm	19.0	4.3	1.9
	B	64.0	7.51	nm	18.4	5.7	1.3
	C	59.6	5.99	nm	16.8	4.7	1.4
	D	57.6	8.23	nm	19.8	3.7	2.2
	E	57.9	7.48	nm	18.7	5.6	1.3
	mean	59.3	7.31	nm	18.6	4.8	1.6
180 F	A	57.9	6.36	nm	17.9	3.7	1.5
	B	58.6	7.45	nm	19.7	5.9	1.3
	C	60.6	7.36	nm	21.0	4.3	2.1
	D	58.1	7.02	nm	20.6	4.9	1.6
	E	56.4	8.45	nm	18.1	5.4	1.2
	mean	58.3	7.33	nm	19.5	4.8	1.5
20 M	A	60.7	8.26	nm	16.0	4.3	1.7
	B	62.6	7.50	nm	15.0	4.5	1.7
	C	59.9	8.07	nm	19.5	4.3	1.9
	D	57.8	7.72	nm	17.9	6.3	1.1
	E	61.2	8.66	nm	17.9	4.4	1.7
	mean	60.5	8.04	nm	17.3	4.8	1.6
40 M	A	63.8	9.11	nm	14.2	5.3	1.0
	B	62.0	8.50	nm	17.1	4.2	1.8
	C	59.9	9.47	nm	17.3	4.3	1.8
	D	60.3	8.56	nm	16.5	5.2	1.3
	E	57.0	8.59	nm	19.7	4.2	2.0
	mean	60.6	8.84	nm	17.0	4.6	1.6
60 M	A	63.3	8.10	nm	18.2	5.3	1.3
	B	61.4	6.93	nm	18.6	5.0	1.5
	C	58.1	9.36	nm	17.9	2.9	2.1
	D	60.3	8.11	nm	23.7	3.3	2.8
	E	57.3	9.06	nm	21.1	3.7	2.2
	mean	60.1	8.31	nm	19.9	4.0	2.0
120 M	A	66.1	7.09	nm	21.0	4.3	1.8
	B	63.2	9.16	nm	20.3	3.3	2.3
	C	63.0	8.76	nm	22.1	4.3	2.2
	D	62.5	8.87	nm	22.2	2.9	2.8
	E	63.2	9.36	nm	20.5	4.3	2.0
	mean	63.6	8.65	nm	21.2	3.8	2.2

[z] wet-weight basis; [y] dry-weight basis; [x] nm = not measured.

Table 14.6. Crop data for the coarse-textured site in 2000. (page 2 of 2)

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
20 MR	A	61.8	7.23	nm[x]	12.8	3.9	1.5
	B	58.8	7.70	nm	17.4	5.5	1.3
	C	58.8	8.24	nm	20.5	3.0	2.8
	D	61.2	6.74	nm	12.8	2.5	1.9
	E	60.9	7.95	nm	17.9	5.5	1.8
	mean	60.3	7.57	nm	16.3	4.1	1.9
40 MR	A	61.2	7.42	nm	20.0	3.0	2.4
	B	59.2	8.34	nm	19.2	4.7	1.5
	C	59.2	8.96	nm	19.5	5.7	1.4
	D	61.7	7.34	nm	15.8	3.3	2.0
	E	57.0	8.40	nm	17.8	4.4	1.5
	mean	59.7	8.09	nm	18.5	4.2	1.8
60 MR	A	60.3	7.54	nm	18.4	4.3	1.6
	B	63.9	6.72	nm	15.5	4.4	1.2
	C	59.7	7.65	nm	19.4	5.3	1.4
	D	59.9	7.65	nm	17.9	4.2	1.7
	E	58.3	8.54	nm	17.9	5.3	1.3
	mean	60.4	7.62	nm	17.8	4.7	1.4
120 MR	A	66.2	6.52	nm	23.7	6.4	1.6
	B	63.6	7.77	nm	20.3	5.6	1.4
	C	57.6	9.10	nm	18.2	4.7	1.5
	D	55.1	10.15	nm	20.2	4.5	1.6
	E	57.1	7.98	nm	20.0	4.9	1.6
	mean	59.9	8.30	nm	20.5	5.2	1.5

[z] wet-weight basis; [y] dry-weight basis; [x] nm = not measured.

Table 14.7. Crop data for the coarse-textured site in 2001. (page 1 of 2)

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
Control	A	55.1	5.61	nm[x]	11.8	3.4	2.2
	B	57.5	6.24	nm	15.0	3.2	3.1
	C	54.7	4.83	nm	10.2	3.4	1.5
	D	56.5	8.91	nm	15.2	4.0	2.3
	E	57.0	6.74	nm	16.3	3.3	2.0
	mean	56.2	6.46	nm	13.7	3.5	2.2
60 F	A	59.4	5.55	nm	14.6	3.3	2.7
	B	58.9	7.06	nm	15.7	3.6	2.8
	C	57.3	4.44	nm	12.5	3.0	2.6
	D	57.9	5.95	nm	16.5	3.4	2.6
	E	60.9	8.85	nm	20.0	4.6	3.3
	mean	58.9	6.37	nm	15.8	3.6	2.8
120 F	A	61.1	7.69	nm	18.2	4.2	3.2
	B	60.6	6.09	nm	15.2	3.8	2.9
	C	54.2	4.38	nm	13.9	4.1	2.5
	D	60.0	8.32	nm	17.4	4.1	2.9
	E	57.7	8.18	nm	18.4	3.7	3.1
	mean	58.7	6.93	nm	16.6	4.0	2.9
180 F	A	60.3	5.89	nm	17.6	3.7	2.9
	B	57.8	7.09	nm	17.0	3.5	2.3
	C	59.9	6.41	nm	16.6	4.1	2.4
	D	61.1	6.58	nm	18.6	4.1	2.9
	E	60.6	7.91	nm	18.2	4.2	3.5
	mean	59.9	6.78	nm	17.6	3.9	2.8
20 M	A	56.4	8.61	nm	16.5	4.5	3.0
	B	61.3	8.91	nm	17.9	4.0	3.3
	C	56.8	7.09	nm	20.3	3.7	2.5
	D	58.8	9.22	nm	20.0	4.1	2.5
	E	60.3	8.06	nm	18.1	3.7	3.1
	mean	58.7	8.38	nm	18.6	4.0	2.9
40 M	A	60.8	8.63	nm	17.0	3.7	3.4
	B	59.1	9.66	nm	23.5	5.4	2.8
	C	59.1	9.42	nm	18.2	4.3	2.8
	D	59.0	8.91	nm	17.3	3.6	2.8
	E	58.6	9.24	nm	18.1	3.4	3.2
	mean	59.4	9.17	nm	18.8	4.1	3.0
60 M	A	62.1	7.49	nm	20.2	4.6	3.9
	B	58.3	6.67	nm	17.3	4.0	2.9
	C	51.5	11.76	nm	18.9	5.3	3.5
	D	62.0	8.47	nm	21.3	5.1	2.4
	E	59.3	9.67	nm	19.8	4.5	2.8
	mean	58.6	8.81	nm	19.5	4.7	3.1
120 M	A	57.7	6.33	nm	18.1	3.7	3.5
	B	59.0	8.20	nm	22.1	5.8	3.1
	C	59.8	12.59	nm	17.1	3.6	3.4
	D	55.6	10.25	nm	19.0	4.5	3.7
	E	58.0	8.67	nm	19.0	4.7	2.5
	mean	58.0	9.21	nm	19.1	4.5	3.2

[z] wet-weight basis; [y] dry-weight basis; [x] nm = not measured.

Table 14.7. Crop data for the coarse-textured site in 2001. (page 2 of 2)

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
20 MR	A	57.7	7.93	nm[x]	13.9	4.2	2.4
	B	59.5	7.25	nm	17.0	4.1	2.9
	C	57.1	7.97	nm	17.1	3.8	2.1
	D	56.2	9.24	nm	16.3	3.6	2.9
	E	57.7	8.77	nm	18.1	4.0	3.0
	mean	57.6	8.23	nm	16.5	3.9	2.7
40 MR	A	61.2	6.37	nm	17.9	3.8	3.3
	B	61.1	7.76	nm	17.0	4.0	3.4
	C	61.6	9.30	nm	18.2	4.2	3.4
	D	58.3	8.87	nm	18.1	3.2	3.2
	E	57.0	9.57	nm	19.7	3.8	2.6
	mean	59.8	8.37	nm	18.2	3.8	3.2
60 MR	A	61.8	7.27	nm	18.9	4.6	2.4
	B	58.4	7.17	nm	19.7	4.5	2.9
	C	58.6	8.09	nm	15.2	3.4	3.0
	D	56.7	9.32	nm	15.2	3.0	3.0
	E	57.5	9.87	nm	16.5	3.1	2.9
	mean	58.6	8.34	nm	17.1	3.7	2.8
120 MR	A	63.4	6.75	nm	23.2	5.7	3.5
	B	57.6	8.18	nm	16.6	3.9	2.9
	C	61.0	10.15	nm	18.6	4.1	3.4
	D	58.1	9.79	nm	18.1	4.0	3.0
	E	58.8	8.49	nm	14.7	3.7	3.3
	mean	59.8	8.67	nm	18.2	4.3	3.2

[z] wet-weight basis; [y] dry-weight basis; [x] nm = not measured.

Table 14.8. Crop data for the medium-textured site in 1994.

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
Control	A	64.0	8.34	nm[x]	nm	nm	nm
	B	57.3	7.57	nm	nm	nm	nm
	C	62.0	7.81	nm	nm	nm	nm
	D	68.7	6.48	nm	nm	nm	nm
	E	60.1	7.24	nm	nm	nm	nm
	mean	62.4	7.49	nm	nm	nm	nm
60 F	A	65.8	9.98	nm	nm	nm	nm
	B	67.1	8.04	nm	nm	nm	nm
	C	68.8	8.68	nm	nm	nm	nm
	D	69.5	7.58	nm	nm	nm	nm
	E	69.7	7.04	nm	nm	nm	nm
	mean	68.2	8.26	nm	nm	nm	nm
120 F	A	70.5	10.65	nm	nm	nm	nm
	B	68.0	7.44	nm	nm	nm	nm
	C	70.3	9.03	nm	nm	nm	nm
	D	67.3	8.13	nm	nm	nm	nm
	E	66.3	8.20	nm	nm	nm	nm
	mean	68.5	8.69	nm	nm	nm	nm
180 F	A	69.9	9.64	nm	nm	nm	nm
	B	70.1	7.59	nm	nm	nm	nm
	C	71.6	8.43	nm	nm	nm	nm
	D	70.0	6.76	nm	nm	nm	nm
	E	68.4	6.26	nm	nm	nm	nm
	mean	70.0	7.74	nm	nm	nm	nm
20 M	A	68.6	9.03	nm	nm	nm	nm
	B	67.4	7.05	nm	nm	nm	nm
	C	68.6	10.11	nm	nm	nm	nm
	D	67.0	7.28	nm	nm	nm	nm
	E	67.1	7.69	nm	nm	nm	nm
	mean	67.7	8.23	nm	nm	nm	nm
40 M	A	65.0	8.17	nm	nm	nm	nm
	B	64.7	8.67	nm	nm	nm	nm
	C	63.5	8.87	nm	nm	nm	nm
	D	68.5	7.21	nm	nm	nm	nm
	E	71.7	6.41	nm	nm	nm	nm
	mean	66.7	7.87	nm	nm	nm	nm
60 M	A	67.5	8.74	nm	nm	nm	nm
	B	67.0	7.61	nm	nm	nm	nm
	C	64.6	8.52	nm	nm	nm	nm
	D	66.8	8.31	nm	nm	nm	nm
	E	70.7	6.92	nm	nm	nm	nm
	mean	67.3	8.02	nm	nm	nm	nm
120 M	A	68.9	9.41	nm	nm	nm	nm
	B	68.6	7.43	nm	nm	nm	nm
	C	71.1	8.88	nm	nm	nm	nm
	D	69.5	7.99	nm	nm	nm	nm
	E	67.3	7.31	nm	nm	nm	nm
	mean	69.1	8.20	nm	nm	nm	nm

[z] wet-weight basis; [y] dry-weight basis; [x] nm = not measured.

Table 14.9. Crop data for the medium-textured site in 1995.

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
Control	A	62.7	6.31	69	14.3	2.8	2.7
	B	64.1	5.90	72	14.4	3.3	2.5
	C	65.5	6.25	74	27.0	4.2	2.9
	D	65.4	6.24	67	14.3	3.5	2.8
	E	63.2	7.34	74	15.0	2.7	2.7
	mean	64.2	6.41	71	17.0	3.3	2.7
60 F	A	68.2	8.70	92	20.0	3.2	2.6
	B	66.9	8.03	84	16.3	3.1	2.2
	C	68.7	8.42	90	19.3	3.8	2.4
	D	68.2	7.70	86	20.3	4.1	2.9
	E	66.2	9.17	85	19.8	3.9	2.6
	mean	67.7	8.41	87	19.2	3.6	2.5
120 F	A	68.8	8.89	88	24.5	3.9	3.1
	B	70.9	8.07	91	24.7	3.6	2.6
	C	69.9	8.57	94	22.9	3.6	2.8
	D	69.4	8.68	89	23.5	4.0	3.0
	E	69.7	8.63	92	21.1	3.9	2.5
	mean	69.7	8.57	91	23.3	3.8	2.8
180 F	A	72.2	8.66	90	25.8	4.3	2.8
	B	73.0	7.97	94	24.4	3.6	2.7
	C	71.8	8.95	94	13.5	3.7	2.8
	D	72.5	8.44	89	25.2	3.5	2.8
	E	70.3	9.11	90	25.8	3.9	3.1
	mean	72.0	8.63	91	22.9	3.8	2.8
20 M	A	65.6	8.06	78	15.2	3.6	2.7
	B	65.8	7.05	78	16.4	3.5	2.9
	C	63.7	7.94	81	18.1	3.2	3.1
	D	66.9	6.95	78	17.0	3.3	2.8
	E	65.1	7.61	80	15.4	3.3	2.8
	mean	65.4	7.52	79	16.4	3.4	2.9
40 M	A	66.3	7.67	75	18.1	3.6	2.8
	B	64.7	7.04	76	17.0	3.7	3.0
	C	68.4	7.79	79	18.1	3.6	3.0
	D	67.3	7.40	83	16.3	3.6	2.9
	E	67.6	7.54	79	16.9	4.0	2.8
	mean	66.9	7.49	78	17.3	3.7	2.9
60 M	A	68.5	8.20	82	18.1	3.5	2.6
	B	68.7	7.86	81	19.4	4.4	2.9
	C	68.4	7.73	81	19.5	3.3	3.0
	D	67.2	8.60	82	20.6	3.9	3.1
	E	72.3	6.66	83	18.7	4.1	3.0
	mean	69.0	7.81	81	19.3	3.9	2.9
120 M	A	69.7	9.60	87	21.9	4.3	2.9
	B	68.2	8.63	85	19.7	3.8	2.8
	C	68.9	9.63	87	21.8	3.9	3.1
	D	67.8	9.58	85	20.5	4.0	2.9
	E	70.9	8.83	87	21.6	3.9	2.8
	mean	69.1	9.25	86	21.1	4.0	2.9

[z] wet-weight basis; [y] dry-weight basis.

Table 14.10. Crop data for the medium-textured site in 1996.

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
Control	A	57.4	5.29	63	10.1	5.9	1.8
	B	56.2	5.88	62	11.5	4.9	2.3
	C	59.0	5.14	58	11.8	4.9	2.4
	D	60.2	5.66	64	11.4	5.4	2.1
	E	60.3	5.79	66	12.6	3.8	2.3
	mean	58.6	5.55	62	11.5	5.0	2.2
60 F	A	65.0	9.08	74	15.5	6.2	2.0
	B	64.9	8.64	75	14.9	5.0	1.9
	C	65.3	7.43	74	16.5	6.1	2.0
	D	66.1	7.84	73	16.5	5.3	2.3
	E	65.0	9.53	76	16.6	5.3	2.5
	mean	65.3	8.50	74	16.0	5.6	2.1
120 F	A	64.5	8.72	69	19.2	6.4	2.2
	B	66.3	8.59	75	21.0	6.4	2.3
	C	69.9	8.52	82	17.9	6.6	2.0
	D	69.4	7.65	73	18.2	5.7	2.1
	E	67.0	8.74	76	18.1	5.5	2.0
	mean	67.4	8.44	75	18.9	6.1	2.1
180 F	A	68.3	9.16	74	20.8	5.5	2.2
	B	68.5	9.37	79	20.6	6.9	2.3
	C	69.7	8.30	73	21.6	5.4	2.2
	D	72.1	7.95	80	22.6	6.6	1.8
	E	69.1	9.92	85	20.3	5.7	1.8
	mean	69.5	8.94	78	21.2	6.0	2.1
20 M	A	60.8	7.75	69	13.2	4.9	2.0
	B	62.0	8.69	69	13.8	5.4	2.3
	C	61.3	8.46	72	11.0	5.4	1.8
	D	61.4	7.51	71	11.8	5.6	1.8
	E	63.1	7.61	69	14.5	4.7	2.5
	mean	61.7	8.00	70	12.8	5.2	2.1
40 M	A	66.4	9.13	73	16.1	5.6	2.2
	B	58.9	8.92	65	13.2	5.5	1.9
	C	63.3	8.88	69	13.7	5.5	2.2
	D	64.1	8.54	76	13.6	5.1	1.9
	E	65.5	8.57	78	15.4	5.9	2.0
	mean	63.6	8.81	72	14.4	5.6	2.1
60 M	A	66.1	9.63	72	14.0	5.5	2.1
	B	64.2	9.81	71	18.1	6.7	2.1
	C	64.9	9.42	73	13.9	6.3	2.0
	D	66.7	10.16	77	14.9	6.3	2.0
	E	67.8	9.65	78	15.5	5.8	1.9
	mean	65.9	9.73	74	15.3	6.1	2.0
120 M	A	70.6	10.13	79	20.6	6.0	1.9
	B	69.2	10.00	77	20.2	6.3	1.9
	C	68.4	10.53	76	22.7	6.2	2.3
	D	69.4	9.76	74	20.0	6.2	2.1
	E	72.0	9.86	81	21.8	6.4	2.4
	mean	69.9	10.06	77	21.1	6.2	2.1

[z] wet-weight basis; [y] dry-weight basis.

Table 14.11. Crop data for the medium-textured site in 1997.

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
Control	A	60.1	3.50	67	11.2	3.4	1.9
	B	62.1	3.52	67	15.4	4.1	2.6
	C	62.8	2.86	66	14.9	4.2	2.8
	D	61.0	3.94	70	13.8	3.8	3.0
	E	65.7	3.78	71	18.1	4.9	2.5
	mean	62.4	3.52	68	14.7	4.1	2.6
60 F	A	64.9	7.38	83	20.7	3.5	3.3
	B	64.8	7.09	86	19.3	3.1	3.1
	C	65.0	6.42	80	16.4	4.2	2.5
	D	63.8	7.01	80	16.4	4.8	2.5
	E	64.4	8.40	80	18.0	3.9	3.1
	mean	64.6	7.26	82	18.2	3.9	2.9
120 F	A	67.2	7.84	87	20.8	5.1	2.8
	B	68.5	7.24	83	23.1	4.9	3.3
	C	69.1	8.18	82	22.1	4.2	3.3
	D	67.8	7.96	80	21.5	4.7	3.1
	E	65.5	8.40	85	20.5	4.9	2.8
	mean	67.7	7.92	83	21.6	4.8	3.1
180 F	A	71.8	7.68	82	22.4	5.9	2.9
	B	73.4	7.60	86	24.3	6.0	2.6
	C	71.2	7.88	85	23.7	4.4	4.0
	D	67.4	8.98	85	25.7	6.0	3.1
	E	67.5	9.90	89	24.6	5.0	2.9
	mean	70.2	8.41	85	24.1	5.5	3.1
20 M	A	61.7	5.74	76	16.1	2.1	3.4
	B	62.5	6.48	78	16.6	2.6	3.3
	C	61.0	5.95	74	13.7	3.8	2.4
	D	61.6	4.65	69	14.9	3.5	2.8
	E	60.9	5.12	70	16.2	2.0	3.2
	mean	61.5	5.59	73	15.5	2.8	3.0
40 M	A	63.1	6.63	78	15.5	4.0	2.3
	B	63.2	7.17	79	15.7	2.4	3.0
	C	64.3	7.12	78	19.5	3.2	3.4
	D	60.0	7.80	76	16.2	4.0	2.6
	E	62.3	5.13	71	15.1	3.7	2.7
	mean	62.6	6.77	76	16.4	3.5	2.8
60 M	A	68.4	7.37	82	18.3	5.3	2.4
	B	69.9	7.94	83	19.4	4.9	2.7
	C	67.4	7.34	82	19.6	3.0	3.2
	D	64.7	9.07	81	18.6	3.5	3.0
	E	63.7	6.79	77	17.2	2.9	3.0
	mean	66.8	7.70	81	18.6	3.9	2.9
120 M	A	71.3	8.18	85	23.2	4.7	3.0
	B	70.3	9.27	87	20.0	5.5	2.5
	C	70.4	9.22	85	23.3	5.3	3.1
	D	72.3	8.35	85	22.8	4.9	3.2
	E	66.5	9.75	84	23.6	5.4	2.6
	mean	70.1	8.95	85	22.6	5.2	2.9

[z] wet-weight basis; [y] dry-weight basis.

Table 14.12. Crop data for the medium-textured site in 1998.

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
Control	A	39.6	5.73	70	7.4	4.5	1.3
	B	37.1	6.03	70	7.9	4.5	1.4
	C	39.9	5.74	71	8.1	5.0	1.3
	D	40.9	6.17	73	11.3	4.8	1.6
	E	34.9	7.59	72	9.9	5.7	1.1
	mean	38.5	6.25	71	8.9	4.9	1.3
60 F	A	38.3	7.69	81	9.7	5.3	1.0
	B	34.4	8.01	84	9.4	5.9	1.2
	C	34.5	8.40	82	9.0	5.1	1.4
	D	36.7	8.33	85	13.5	5.3	1.7
	E	39.7	8.55	80	11.8	6.0	1.4
	mean	36.7	8.20	82	10.7	5.5	1.3
120 F	A	33.6	8.48	80	14.6	6.5	1.5
	B	36.1	6.74	84	15.7	6.1	1.0
	C	39.2	7.80	81	15.3	7.5	1.2
	D	38.4	7.42	83	13.2	5.8	1.0
	E	33.8	8.76	83	11.6	6.2	0.9
	mean	36.2	7.84	82	14.1	6.4	1.1
180 F	A	36.8	6.58	81	17.4	6.6	1.5
	B	37.1	7.31	85	15.8	6.0	1.1
	C	34.1	7.62	81	14.7	7.1	1.0
	D	35.8	7.68	81	17.5	6.1	1.5
	E	34.4	7.97	84	16.3	6.4	0.9
	mean	35.6	7.43	82	16.3	6.4	1.2
20 M	A	41.2	8.06	76	9.1	4.5	1.4
	B	41.6	7.90	80	7.2	5.4	1.0
	C	45.5	7.64	77	10.0	5.9	1.4
	D	41.4	8.03	79	9.6	5.5	1.4
	E	33.7	7.61	77	9.8	6.1	1.2
	mean	40.7	7.85	78	9.1	5.5	1.3
40 M	A	39.5	8.18	77	11.8	5.2	1.5
	B	42.1	8.12	78	12.2	5.6	1.1
	C	37.4	8.73	79	12.6	5.1	1.2
	D	41.2	8.26	77	11.7	5.6	1.3
	E	39.2	8.53	77	12.4	5.8	1.2
	mean	39.9	8.37	78	12.1	5.5	1.3
60 M	A	41.7	7.96	81	14.2	6.0	1.3
	B	40.2	7.70	83	15.7	6.0	1.4
	C	39.8	7.67	79	13.9	6.0	1.4
	D	38.1	8.49	77	12.2	5.8	1.5
	E	39.0	8.42	81	12.5	6.3	1.1
	mean	39.7	8.05	80	13.7	6.0	1.4
120 M	A	38.6	7.17	78	16.2	6.2	1.7
	B	39.3	7.27	81	15.8	6.8	1.4
	C	35.9	7.35	79	16.4	6.9	1.3
	D	35.6	7.45	79	17.8	6.9	1.5
	E	39.2	7.65	80	15.1	6.9	1.3
	mean	37.7	7.38	79	16.2	6.8	1.5

[z] wet-weight basis; [y] dry-weight basis.

Table 14.13. Crop data for the medium-textured site in 1999.

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
Control	A	64.6	6.55	nm[x]	12.4	5.8	1.9
	B	63.7	6.44	nm	12.6	5.0	1.5
	C	64.0	7.04	nm	13.0	5.2	1.5
	D	65.9	7.52	nm	11.5	4.7	1.5
	E	65.5	8.09	nm	12.0	4.7	1.7
	mean	64.7	7.13	nm	12.3	5.1	1.6
60 F	A	66.7	9.23	nm	14.4	4.8	1.8
	B	66.7	8.98	nm	14.3	5.7	1.5
	C	67.0	9.13	nm	14.4	5.2	1.6
	D	68.1	9.07	nm	14.5	6.7	2.0
	E	68.4	9.18	nm	19.5	6.4	2.3
	mean	67.4	9.12	nm	15.4	5.8	1.8
120 F	A	69.4	8.84	nm	16.9	5.2	1.9
	B	67.7	9.50	nm	14.5	5.1	1.6
	C	68.9	8.88	nm	18.9	8.1	2.2
	D	67.5	9.64	nm	15.4	5.6	1.7
	E	69.5	8.34	nm	16.7	5.6	1.8
	mean	68.6	9.04	nm	16.5	5.9	1.8
180 F	A	68.3	8.85	nm	16.0	5.6	1.8
	B	67.7	9.43	nm	16.0	5.3	1.6
	C	69.1	9.03	nm	16.0	5.8	1.8
	D	69.1	9.44	nm	16.7	5.6	1.6
	E	70.7	9.46	nm	16.5	5.5	1.9
	mean	69.0	9.24	nm	16.2	5.6	1.7
20 M	A	67.5	8.72	nm	13.9	4.9	1.8
	B	66.8	9.25	nm	15.1	5.3	1.8
	C	65.2	9.63	nm	13.8	4.6	1.6
	D	66.5	9.96	nm	13.5	5.4	1.8
	E	66.8	9.45	nm	14.1	5.1	1.7
	mean	66.6	9.40	nm	14.1	5.1	1.8
40 M	A	67.5	9.66	nm	17.1	6.2	2.1
	B	71.0	8.44	nm	17.1	6.9	2.1
	C	68.6	9.57	nm	15.1	5.4	1.7
	D	69.5	9.54	nm	16.6	5.6	2.0
	E	68.3	10.00	nm	16.7	6.8	1.8
	mean	69.0	9.44	nm	16.5	6.2	2.0
60 M	A	68.9	9.16	nm	14.6	4.9	1.6
	B	68.9	10.00	nm	19.8	6.6	2.1
	C	71.1	9.46	nm	17.7	6.3	2.1
	D	68.2	10.64	nm	16.9	6.6	1.8
	E	67.2	9.72	nm	16.2	5.5	1.8
	mean	68.9	9.80	nm	17.0	6.0	1.9
120 M	A	69.6	9.44	nm	16.4	5.3	1.8
	B	68.5	10.29	nm	19.2	6.3	1.9
	C	69.6	10.08	nm	15.7	4.9	1.7
	D	69.5	9.67	nm	20.6	7.1	2.2
	E	68.1	9.30	nm	20.2	6.5	2.1
	mean	69.1	9.76	nm	18.4	6.0	2.0

[z] wet-weight basis; [y] dry-weight basis; [x] nm = not measured.

Table 14.14. Crop data for the medium-textured site in 2000. (page 1 of 2)

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
Control	A	66.1	6.05	nm[x]	16.6	4.6	1.9
	B	60.9	6.30	nm	11.8	3.5	1.7
	C	63.1	6.28	nm	10.7	4.2	1.4
	D	63.3	7.85	nm	11.4	4.0	1.7
	E	65.5	7.11	nm	12.2	4.4	1.6
	mean	63.8	6.72	nm	12.5	4.1	1.7
60 F	A	66.8	9.11	nm	21.3	6.2	1.9
	B	65.9	9.07	nm	16.3	4.5	1.6
	C	65.5	8.54	nm	20.2	5.9	1.8
	D	65.9	9.66	nm	17.4	4.1	2.0
	E	68.6	9.44	nm	19.2	5.8	1.8
	mean	66.5	9.17	nm	18.9	5.3	1.8
120 F	A	66.4	9.80	nm	22.1	5.2	2.4
	B	69.2	8.84	nm	21.6	6.5	1.7
	C	68.4	8.53	nm	21.6	5.4	1.9
	D	67.1	9.67	nm	21.3	5.8	1.3
	E	68.2	9.78	nm	20.3	5.5	1.9
	mean	67.9	9.32	nm	21.4	5.7	1.8
180 F	A	72.4	8.32	nm	21.0	6.4	1.6
	B	68.8	9.20	nm	21.3	5.7	1.7
	C	67.4	9.06	nm	21.3	5.2	1.8
	D	70.7	8.65	nm	19.5	6.4	1.4
	E	70.5	8.66	nm	25.4	6.7	1.9
	mean	70.0	8.78	nm	21.7	6.1	1.7
20 M	A	67.0	9.38	nm	18.2	3.6	2.6
	B	68.3	9.38	nm	17.6	6.8	1.8
	C	67.6	9.33	nm	15.5	4.9	1.7
	D	66.8	9.85	nm	18.4	3.7	2.5
	E	68.0	9.66	nm	16.2	5.9	1.6
	mean	67.5	9.52	nm	17.2	5.0	2.0
40 M	A	68.3	8.72	nm	17.8	5.8	1.7
	B	68.2	9.45	nm	15.8	4.6	1.8
	C	71.7	9.15	nm	20.8	6.4	1.9
	D	66.8	9.78	nm	16.3	5.2	1.7
	E	71.5	9.31	nm	18.1	4.2	2.3
	mean	69.3	9.28	nm	17.8	5.2	1.9
60 M	A	67.7	9.63	nm	19.4	5.4	2.0
	B	67.8	9.15	nm	19.7	6.8	1.5
	C	68.9	8.94	nm	20.0	5.5	1.9
	D	69.5	8.94	nm	24.3	6.7	1.9
	E	68.2	10.95	nm	21.9	5.4	2.1
	mean	68.4	9.52	nm	21.1	6.0	1.9
120 M	A	64.3	9.80	nm	19.0	4.8	1.7
	B	66.1	9.41	nm	21.4	6.3	1.6
	C	65.9	9.55	nm	19.5	5.8	1.5
	D	67.7	9.68	nm	18.7	6.5	1.3
	E	63.8	10.51	nm	20.6	6.3	1.5
	mean	65.6	9.79	nm	19.9	5.9	1.5

[z] wet-weight basis; [y] dry-weight basis; [x] nm = not measured.

Table 14.14. Crop data for the medium-textured site in 2000. (page 2 of 2)

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
20 MR	A	67.2	8.21	nm[x]	11.7	3.5	1.8
	B	64.7	9.83	nm	10.7	4.4	1.4
	C	67.7	7.80	nm	14.2	4.8	1.7
	D	66.0	9.64	nm	15.0	5.4	1.8
	E	67.9	9.59	nm	13.1	4.2	1.7
	mean	66.7	9.01	nm	13.0	4.5	1.7
40 MR	A	67.3	9.84	nm	19.4	5.6	2.0
	B	66.0	9.62	nm	14.1	5.9	1.3
	C	67.5	9.85	nm	17.3	5.8	1.7
	D	66.9	9.80	nm	14.6	4.3	2.1
	E	67.6	10.21	nm	19.4	5.0	2.2
	mean	67.1	9.86	nm	16.9	5.3	1.9
60 MR	A	70.0	8.97	nm	23.2	6.8	2.1
	B	66.5	10.39	nm	19.7	5.9	2.0
	C	68.5	9.83	nm	19.2	5.4	1.9
	D	72.1	7.77	nm	19.0	4.8	2.2
	E	69.7	9.67	nm	20.2	5.1	2.1
	mean	69.3	9.33	nm	20.3	5.6	2.1
120 MR	A	68.2	8.83	nm	20.2	6.1	1.7
	B	68.2	9.16	nm	21.1	7.1	1.3
	C	64.4	10.19	nm	24.0	8.2	1.6
	D	66.8	10.82	nm	20.6	5.4	1.8
	E	70.2	9.03	nm	20.3	5.7	1.7
	mean	67.6	9.61	nm	21.2	6.5	1.6

[z] wet-weight basis; [y] dry-weight basis; [x] nm = not measured.

Table 14.15. Crop data for the medium-textured site in 2001. (page 1 of 2)

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
Control	A	59.1	7.20	nm[x]	13.6	3.5	3.3
	B	57.8	6.71	nm	14.2	3.8	2.3
	C	57.4	6.48	nm	11.4	3.3	2.5
	D	62.1	8.04	nm	14.1	3.3	3.3
	E	58.5	7.14	nm	13.1	3.3	2.8
	mean	59.0	7.11	nm	13.3	3.4	2.8
60 F	A	61.8	8.45	nm	16.2	3.7	3.0
	B	63.5	9.08	nm	14.7	3.5	3.0
	C	62.7	7.28	nm	16.5	3.8	3.1
	D	62.6	8.37	nm	16.0	3.5	3.0
	E	62.9	8.26	nm	16.3	4.6	2.3
	mean	62.7	8.29	nm	15.9	3.8	2.9
120 F	A	61.7	8.70	nm	17.0	3.9	3.0
	B	64.9	8.18	nm	16.2	3.7	2.8
	C	63.4	8.29	nm	15.2	3.3	3.0
	D	61.6	8.63	nm	13.8	2.2	2.7
	E	62.7	9.90	nm	15.8	3.3	2.8
	mean	62.8	8.74	nm	15.6	3.3	2.9
180 F	A	62.9	8.80	nm	18.4	4.2	2.6
	B	63.0	9.22	nm	17.1	3.0	2.5
	C	63.8	9.28	nm	17.3	3.9	2.3
	D	64.3	8.95	nm	17.9	4.2	2.7
	E	63.7	9.34	nm	17.1	4.4	2.7
	mean	63.5	9.12	nm	17.6	3.9	2.6
20 M	A	57.3	10.56	nm	13.0	4.0	3.1
	B	63.5	9.34	nm	15.0	4.3	3.2
	C	60.9	9.73	nm	15.0	3.4	3.6
	D	64.0	10.29	nm	15.2	3.9	3.4
	E	63.0	10.36	nm	16.3	4.8	2.7
	mean	61.7	10.06	nm	14.9	4.1	3.2
40 M	A	62.7	9.46	nm	17.6	4.8	2.3
	B	65.0	9.17	nm	17.1	3.6	3.1
	C	60.3	12.12	nm	17.8	3.9	3.6
	D	63.8	10.85	nm	17.9	4.1	2.7
	E	65.1	10.70	nm	17.4	4.6	3.2
	mean	63.4	10.46	nm	17.6	4.2	3.0
60 M	A	64.8	9.47	nm	17.0	3.8	3.0
	B	63.3	10.54	nm	15.4	3.7	3.4
	C	63.8	11.52	nm	17.4	4.0	3.5
	D	66.2	9.95	nm	17.3	3.9	2.6
	E	60.6	12.77	nm	15.0	3.9	3.3
	mean	63.8	10.85	nm	16.4	3.9	3.2
120 M	A	64.0	9.10	nm	17.3	5.1	3.3
	B	64.8	10.41	nm	18.2	4.5	3.6
	C	66.8	9.80	nm	18.9	4.5	3.6
	D	63.7	9.97	nm	17.4	4.9	3.6
	E	62.4	10.80	nm	18.2	3.8	3.5
	mean	64.3	10.02	nm	18.0	4.6	3.5

[z] wet-weight basis; [y] dry-weight basis; [x] nm = not measured.

Table 14.15. Crop data for the medium-textured site in 2001. (page 2 of 2)

Treatment	Rep	Tissue moisture [z] %	Dry-matter yield Mg ha^{-1}	Crop height cm	Total N [y] kg Mg^{-1}	Total Ca [y] kg Mg^{-1}	Total P [y] kg Mg^{-1}
20 MR	A	57.1	8.94	nm[x]	11.0	3.3	2.5
	B	61.5	8.19	nm	14.9	3.2	3.2
	C	61.0	8.92	nm	12.8	3.5	2.8
	D	58.1	9.33	nm	11.5	2.6	3.2
	E	62.5	8.37	nm	13.8	3.6	3.3
	mean	60.0	8.75	nm	12.8	3.2	3.0
40 MR	A	59.1	10.52	nm	13.6	3.1	3.0
	B	59.2	9.97	nm	13.6	2.7	3.3
	C	64.6	9.85	nm	17.9	4.1	3.5
	D	65.5	8.73	nm	16.3	3.6	3.2
	E	60.9	10.14	nm	16.5	3.9	3.5
	mean	61.9	9.84	nm	15.6	3.5	3.3
60 MR	A	62.6	9.89	nm	14.6	2.4	2.6
	B	63.5	11.09	nm	16.0	4.7	2.6
	C	65.3	11.14	nm	17.0	3.7	3.6
	D	63.1	10.13	nm	17.4	3.9	3.5
	E	63.3	11.73	nm	17.4	4.2	2.8
	mean	63.6	10.80	nm	16.5	3.8	3.0
120 MR	A	63.3	10.48	nm	17.3	3.4	3.3
	B	64.8	10.47	nm	17.0	4.6	2.8
	C	65.9	10.93	nm	17.8	4.6	2.8
	D	64.7	10.18	nm	17.6	4.0	2.3
	E	62.1	10.49	nm	16.0	3.6	3.4
	mean	64.2	10.51	nm	17.1	4.0	2.9

[z] wet-weight basis; [y] dry-weight basis; [x] nm = not measured.