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Alberta Fertilizer Guide

The purpose of this guide is to provide information on the use of fertilizers under the various cropping and soil-climate conditions throughout the province.

Because the nutrient requirements of crops and the ability of soils to supply nutrients vary widely, fertilizer recommendations are given as a range of application rates typical of a particular crop and soil-climatic area.

Factors to consider when choosing application rates for specific situations are discussed in the guide. Farmers are encouraged to use the fertilizer guide in conjunction with soil tests and their own experience to develop an effective and economic fertilizer program.

Nutrient requirements of crops and the ability of soils to supply nutrients vary widely

Soils, cropping practices and fertilizer use

Nitrogen and phosphorus

These two nutrients are most often responsible for limiting crop yields in Alberta. For crops grown on fallow, phosphorus may be the only nutrient limiting crop yield. Crop-fallow rotations rely heavily on nitrogen released from the mineralization of soil organic matter. As a result of frequent fallowing, soil organic matter levels can decline to a point where nitrogen fertilization is required to maintain yields of crops grown on fallow.

When the frequency of cropping is extended to crop-crop-fallow or approaches continuous cropping, nitrogen becomes an increasingly deficient nutrient. Therefore, when the frequency of cropping is increased, higher rates of nitrogen fertilizer, manure or frequent inclusion of legume crops in the rotation are required to maintain high crop yields. This greater need for nitrogen does not indicate that continuous cropping is more detrimental to the soil than crop-fallow rotations. The additional nitrogen required to maintain yields in continuous cropping systems helps to maintain soil organic matter.

Frequent fallowing of land:

- depletes soil organic matter
- exposes the soil to greater loss by wind and water erosion
- contributes to increased salinity on some soils

From the standpoint of soil conservation, fallowing should only be practised when soil moisture reserves are inadequate for recropping.

Available phosphorus levels in Alberta soils are variable, but are usually in the moderately deficient range. Unlike nitrogen, phosphorus levels do not change quickly as a result of cropping, soil management practices or climate. Application rates of phosphorus fertilizer should reflect the available phosphorus status of individual fields, the requirements of the crop to be grown and the general growing conditions.

The level of available phosphorus in soils can be gradually increased by the application of moderate to high rates of phosphorus fertilizer and manure. Crop rotations that maintain or improve soil organic matter levels can also increase phosphorus availability. Topsoils contain much higher levels of available phosphorus than subsoils. Therefore, management practices that reduce wind and water erosion will help maintain soil phosphorus.

Potassium and sulphur

Deficiencies of potassium and sulphur are not as widespread as nitrogen and phosphorus deficiencies. But deficiencies of potassium and sulphur are common in

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particular areas and soil types. If crop yields are low and responses to nitrogen and phosphorus fertilizers appear small, attempts should be made to determine what other factors are limiting crop yields. Soil testing and field test strips are good methods of determining if potassium and sulphur are deficient.

Micronutrients

Micronutrients are less commonly deficient that macronutrients such as nitrogen and phosphorus, but when deficiencies occur, the effects on crop yield and quality are as detrimental as with macronutrients. In Alberta, some micronutrients are rarely deficient while deficiencies of others, such as copper, are more common. Micronutrient deficiencies tend to be associated with particular soil types, growing conditions and crops such as:

- manganese deficiency in oats under cold, wet soil conditions, boron deficiency in canola and alfalfa on a few Gray Wooded and sandy soils
- copper deficiency on organic and mineral soils in central and northern Alberta
- zinc deficiency, mainly on irrigated field beans in southern Alberta

The general use of micronutrient fertilizers is not recommended. Micronutrients should only be applied in situations where a specific deficiency has been identified.

Cropping and soil management in the major soil groups

A wide range of soil types and climatic conditions exist within the province. Cropping practices and fertilizer use generally reflect the growing conditions in the major soil zones as shown on the soil zone map on the next page.

Brown soils

Brown soils occur in the semi-arid short grass prairie region of the province where the annual precipitation is about 30 cm. There are about five million acres of dryland cultivation and seven million acres of native range within the Brown soil zone. Dryland farming consists mainly of wheat-fallow rotations. Moisture limits crop production the most. Stubble cropping is not recommended unless there is greater than 75 cm of moist soil on medium-textured (loam) soils or 55 cm on fine textured (clay) soils. Minimum or conservation tillage is required to reduce wind erosion and conserve moisture.

Dark Brown soils

Dark Brown soils occur in the prairie region where the average annual precipitation is about 35 cm. There are about eight million acres of Dark Brown soils of which almost five million are cultivated. Cropping practices in this area are similar to those in the Brown soil zone, but improved moisture conditions allow:

- a greater variety of crops
- more frequent cropping of stubble
- higher rates of fertilizer

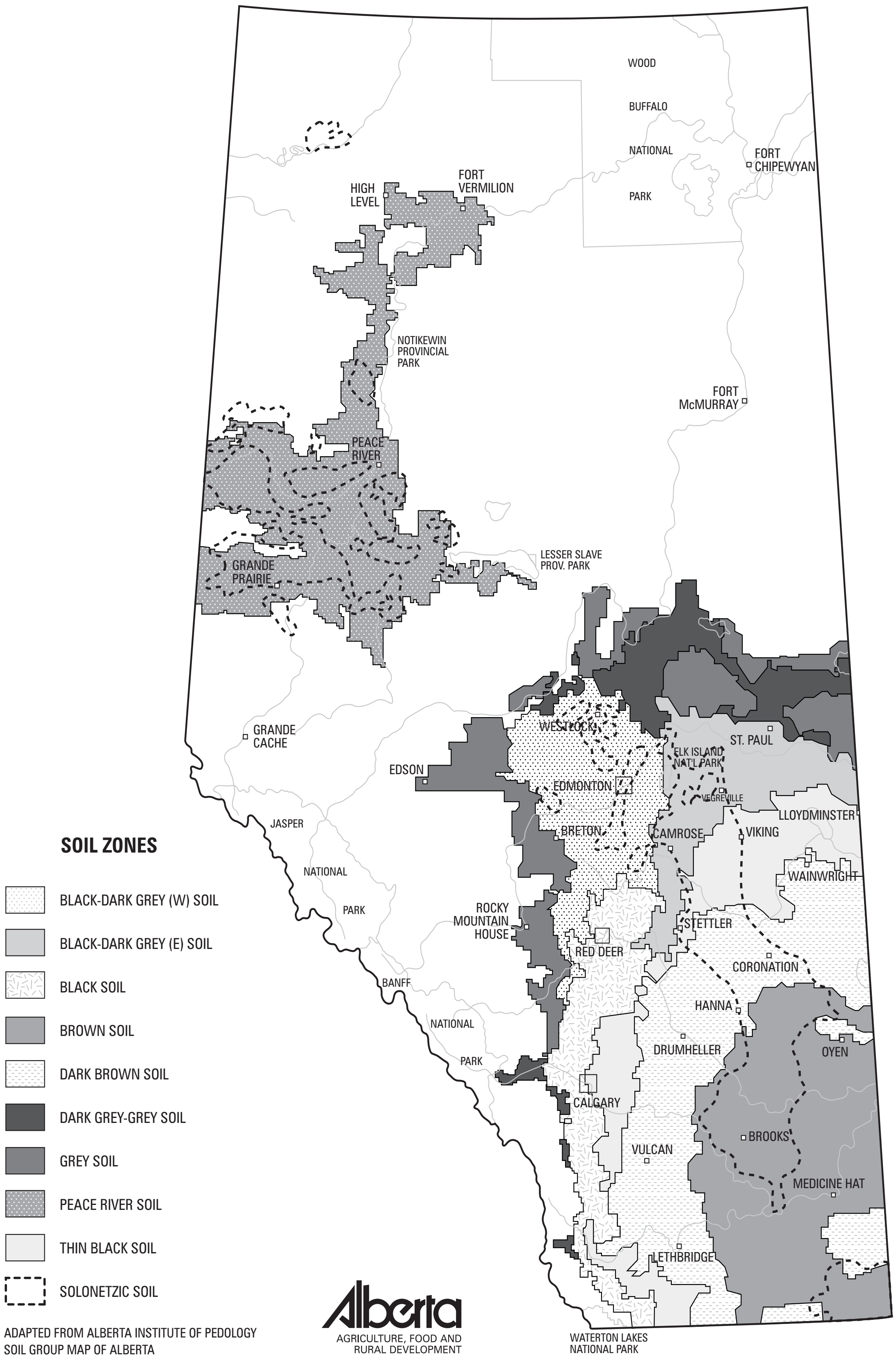
Stubble cropping is not generally recommended unless there is greater than 68 cm of moist soil on medium-textured soils or 50 cm on fine-textured soils. Wind erosion and salinity control may necessitate stubble cropping when moisture levels are less than adequate. Conservation tillage practices are required.

Thin Black soils

Thin Black soils occur as a strip within the Black zone, adjacent to the Dark Brown soils. Soil moisture reserves and summer precipitation have a major influence on yields and fertilizer response. Precipitation is somewhat higher than in the Brown and Dark Brown soil zones. The southern portion of this zone receives more rainfall, but the rate of evaporation is higher than in the northern portion. Rainfall is quite variable in this area. Increased production can be realized from adjusting crop rotations and fertilizer rates to match soil moisture reserves. Soil moisture reserves may be increased with reduced tillage.

Black and Dark Gray Wooded soils of central Alberta

Moisture is less limiting to crop production in this area than in areas to the south and east. There is little need for fallowing to store soil moisture. Good yields can be obtained under continuous cereal cropping systems with adequate fertilization. Rotations that include grasses and legumes and the application of manure are recommended to help maintain soil organic matter and tilth. The higher rates of fertilizer recommended in Table 3 are suggested when previous experience has shown a good response to fertilizer and other management practices are geared to high yields. The relationship between fertilizer costs and crop prices should also provide economic returns that are high enough to offset the higher risk associated with high inputs.



ADAPTED FROM ALBERTA INSTITUTE OF PEDOLOGY
SOIL GROUP MAP OF ALBERTA

Alberta
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Gray Wooded soils of central Alberta

Gray Wooded soils were developed under cool, humid conditions, and the surface layer is leached of clay and plant nutrients. Soil and organic matter is low and crusting often reduces seedling emergence. Crop rotations that include legumes and grasses help to increase soil organic matter, fertility and reduce crusting. Summerfallow and removal of cereal crop residues should be minimized. The application of manure is also very effective for increasing the productivity of Gray Wooded soils.

Moisture is not as limiting as elsewhere in Alberta, but the growing season is shorter. Nitrogen is often the major limiting factor to high crop yields on Gray Wooded soils.

Many Gray Wooded and some Dark Gray Wooded soils are deficient in sulphur. Legume crops will respond to the application of sulphur on one-half to three-quarters of these soils. Cereals and canola may also require additions of sulphur, particularly when nitrogen is added. The use of sulphur-containing fertilizers on cereals and canola is advised where a soil is known to show a sulphur response on legume crops, or a deficiency is indicated by a soil test.

Dark Gray and Gray Wooded soils of the Peace River region and northeastern Alberta

The agricultural soils in the Peace River region range from Black, developed under grassland, to Gray Wooded, which developed under forest vegetation. The Black and Dark Gray soils are relatively productive and respond to good management.

The Gray Wooded soils of this region are similar to those in central Alberta, but generally receive less growing season precipitation. Gray soils in the Peace region often have a high clay content and are particularly difficult to manage. Cultivation operations have to be timed according to soil moisture content. Poor soil moisture at seeding and soil crusting can reduce yields and fertilizer response. Soil-improving practices such as crop rotations with legumes or grass-legume mixtures, incorporation of crop residues and the addition of manure are helpful for improving the physical condition and reducing surface crusting. Because rainfall is often low during the early growing season, it is important to conserve moisture during seedbed preparation.

Irrigated soils

There are about one million acres of irrigated land within the irrigation districts in southern Alberta, plus some private irrigation systems scattered throughout the province. Soil fertility should be maintained at a level that is adequate to ensure an efficient, high level of productivity, which is required to offset the higher production costs associated with irrigation. Soil fertility can be maintained or increased through the use of commercial fertilizers, manure and legume crops.

In addition to maintaining fertility on irrigated soils, cropping practices that prevent the deterioration of soil structure and tilth should be used. Continuous production of row crops such as vegetables, sugarbeets and corn cause the rapid depletion of soil organic matter. The application of manure and crop rotations that include alfalfa, grasses and cereals will help maintain soil organic matter and tilth.

Crops grown in the Brown, Dark Brown and Thin Black soil zones in the irrigated areas of southern Alberta respond to nitrogen and phosphorus. Some irrigated soils have received relatively high applications of phosphate fertilizer for many years and may no longer respond to annual applications. These soils require only maintenance applications.

There have been a few instances of small responses to potassium, but this nutrient is not generally required.

Sulphur fertilization is not generally required on irrigated soils. There is normally a high level of sulphur in the subsoil, and approximately 10 lb/ac of sulphur is added to the soil with each 10 cm application of irrigation water.

Micronutrients are rarely needed on irrigated soils, because the content of micronutrients is sufficient to meet crop requirements. Only zinc deficiencies have been identified and confirmed on some irrigated field beans and occasionally on corn. Zinc, boron and copper deficiencies have been investigated on a number of other crops, but yield increases have either not occurred or have not been consistent.

The recommended rates of fertilizer for a crop vary because of soil type and past management practices. If the fertility of a soil has been built up through the use of manure, legume crops and adequate fertilization, one should use the lower rates of fertilizer in the recommended range. It is possible to get relatively good yields of a crop, such as cereals, for one year without the use of fertilizer where previous management has included the use of manure, legumes and fertilizer. Soil tests should be used to monitor soil nutrient levels.

Problem soils

Solonetzic soils

Solonetzic soils are characterized by a hard-pan layer 5 to 25 cm from the surface. These soils occur in association with normal soils (see soil zone map) and often cause a typical uneven pattern of crop growth. This wavy growth pattern is particularly noticeable in years when moderate to severe moisture stress occurs because the rooting depth of the crop is restricted. Response to fertilizer on Solonetzic soils is also more variable than on associated normal soils because crop yields are decreased more by moisture stress. Therefore, the rate of nitrogen fertilizer should be reduced to 70 to 80 per cent of the rate used on normal soils. Banded applications of nitrogen are often more effective than broadcast applications on Solonetzic soils.

Acid soils

Soil acidity causes reduced yields of acid-sensitive crops such as alfalfa and barley on many fields in central and northern Alberta. Some 5 to 6 million acres are sufficiently acid to cause reduced yields of alfalfa, and 1 million acres are affected for growing barley.

Acid soils are readily identified by a soil test showing a low pH. The soil reaction is alkaline when the pH value is above 7, neutral at 7, and acid below 7. Crops vary greatly in their tolerance to acidity. Yields of alfalfa are reduced at pH 6 and less, and barley at 5.5 and less. Tolerance to acidity in decreasing order for annual crops is as follows: oats> flax>canola>wheat>barley.

Timothy, fescue, red clover and alsike clover are among the most tolerant forage crops, while alfalfa and sweet-clover are very sensitive.

Acid soils occur naturally and as a result of the long-term use of nitrogen fertilizers. The acidifying properties of nitrogen fertilizer are shown in Table 1. The extensive use of ammonium sulphate (21-0-0) is not recommended on acid soils because of its greater acidifying properties compared to other nitrogen fertilizers. Note, however, that some acid soils are deficient in sulphur, so the use of some ammonium sulphate or other sulphur-containing fertilizer may be required.

Table 1. Acidity of nitrogen fertilizers

Fertilizer	Lime ($CaCO_3$) needed to neutralize 1 lb of N
Ammonium sulphate (21-0-0-24S)	5.35 lb
Anhydrous ammonia (82-0-0)	1.80 lb
Urea (46-0-0)	1.80 lb
Ammonium nitrate (34-0-0)	1.80 lb

Liming is a common practice that is used to neutralize acidity caused by natural leaching and the use of nitrogen fertilizers. The productivity of moderately acid soils can also be improved by growing more acid tolerant crops, but the application of lime is the long-term solution to improving these soils.

Choosing the kind and rate of fertilizer

The information needed to determine fertilizer requirements:

- which nutrient or nutrients are deficient and the degree of deficiency
- an estimate of crop response to a given level of fertilizer application
- an assessment of economic returns from fertilizer

The more accurately these three factors can be determined, the greater the potential for profitable returns from fertilizer use. Methods of estimating nutrient requirements and crop response are discussed separately for each of the major nutrients (nitrogen, phosphorus, potassium and sulphur).

Nitrogen

Nitrogen fertilizer requirements for optimum economic returns on crops grown in Alberta cover a very wide range of application rates (Tables 2 and 3). For example, crops grown on fallow will often require little or no additional nitrogen, whereas non-legume crops grown on stubble land can give profitable returns to application rates of 100 lb per ac or more of nitrogen (N). The large range in nitrogen fertilizer requirements result from large differences in the amount of nitrogen supplied by the soil and the amount required by the crop. The yield potential of crops is a major factor affecting nitrogen fertilizer requirements.

Soil nitrogen

Non-legume crops obtain nitrogen from three main sources:

- available nitrogen stored in the soil at planting
- nitrogen released by the soil during the growing season (from soil organic matter, manure and crop residues)
- fertilizer nitrogen

Except for crops grown on fallow, nitrogen stored in the soil, plus that released during the growing season, is normally insufficient to produce high yields. Because of our short growing season, only about one-quarter of the total nitrogen required for high yields of cereal and oilseed crops is supplied from nitrogen released from the soil during the growing season. Therefore, the amount of available nitrogen stored in the soil at planting has a major influence on the amount of nitrogen fertilizer required. A soil test is the most accurate way of determining the available nitrogen status of soils. If soil test results are not available, the cropping history of the field and past experience serve as useful guides.

Fallow fields are not normally considered to be deficient in nitrogen for cereal and oilseed crops, but a significant percentage of samples from fallow fields show a need for additional nitrogen. For example, recommendations based on soil tests indicate that 20 lb/ac or more of nitrogen are required on 30 to 40 per cent of fallow fields. However, the percentage of samples deficient in nitrogen varies widely from year to year.

Stubble fields not recently manured or broken from a legume will usually be low in available nitrogen and require high rates of nitrogen fertilizer to achieve high yields. Stubble fields recently broken from a legume will commonly have an intermediate level of available nitrogen. However, summaries of soil test results indicate large variations can occur from year to year. For example, stubble fields testing low in available nitrogen ranged from 25 to 85 per cent over a 10-year period.

Past experience, cropping history and general recommendations are useful guides to nitrogen fertilizer requirements, but the wide variation in available nitrogen that can occur from year to year provides a strong argument for the use of soil testing to help determine nitrogen fertilizer requirements.

Estimating crop response to nitrogen fertilizer

To assess economic returns from fertilizer, an estimate of the increase in yield from a given rate of application must be made. The following factors will influence crop response to applied nitrogen.

Available nitrogen – The nitrogen available in the soil at planting time is one of the main factors that influences crop response to nitrogen fertilizer. The nitrogen status of a field can be estimated from the previous cropping history, but is more accurately determined by a soil test.

Soil moisture reserves and growing season precipitation – These factors have a major influence on crop yields and the response to nitrogen fertilizer. In the Brown, Dark Brown and Thin Black soil zones, soil moisture reserves should be considered when choosing fertilizer rates. On medium-textured (loam) soils in the Brown and Dark Brown soil zones, moist soil to a depth of 75 cm and 68 cm respectively is considered adequate for cropping stubble land. On fine-textured (clay) soils in the Brown and Dark Brown soil zones, moist soil to a depth of 55 cm and 50 cm respectively is considered adequate for recropping. When soil moisture reserves exceed these levels, higher rates of nitrogen will usually give positive economic returns. If the entire rooting zone (90-120 cm) is moist, rates twice those normally recommended may be profitable.

Weed competition – Weeds lower the yield potential of a crop and compete for nitrogen fertilizer that has been applied. The higher rates of nitrogen recommended will usually not be profitable when weed competition is severe.

Delayed or late seeding – This factor usually decreases the yield response from nitrogen fertilizer. The yield potential of the crop is reduced, and the crop can make greater use of nitrogen released by the soil during the later part of the growing season. There is also greater risk of crop loss from frost and poor harvest conditions.

Crop variety – Varieties with higher yield potential will generally respond to higher rates of nitrogen application better than those with lower yield potential, providing that other factors are not limiting.

The economic returns from nitrogen fertilizer are easily calculated if a reliable estimate of crop response over a range of application rates can be made. Some soil testing laboratories provide predictions of the increase in yield from applied nitrogen based on the test for available nitrogen, soil type, location, the previous crop and crop to be grown. Farmers can then use these yield increase predictions in conjunction with their own past experience, current moisture reserves, fertilizer and crop prices, etc. to determine the rate of fertilizer to apply.

Phosphorus

Soil phosphorus

Unlike nitrogen, available phosphorus (P) levels tend to be characteristic of individual fields or soil types and do not vary widely from year to year owing to previous management. The rate of phosphorus required will depend on several aspects:

- available phosphorus level of the field
- phosphorus requirement of the crop to be grown
- growing conditions

For non-irrigated crops, phosphorus fertilizer requirements are generally higher in central and northern Alberta than in southern Alberta. Cool, wet conditions early in the growing season enhance the response to phosphorus fertilizer. Also, phosphorus fertilizer often results in earlier and more uniform maturity, which is more important in central and northern regions where the growing season is shorter.

Crop response and rates of application

Phosphorus fertilizer requirements can be obtained from the general recommendation tables, but they are more accurately determined by a soil test or field test strips. As

Figure 1 illustrates, crop response to phosphate fertilizer occurs over a narrower range of application rates than for nitrogen. Note that a response is obtained to the initial 10 to 15 lb/ac of phosphate even on soils testing moderately high in available phosphorus, and on soils testing low in phosphorus, most of the response is achieved at 40 to 50 lb/ac. Phosphate application rates therefore range between 10 and 50 lb/ac. In contrast, an economic response to nitrogen is seldom obtained on soils testing high in available nitrogen, but rates of 100 lb/ac or more may be profitable on soils testing low in available nitrogen.

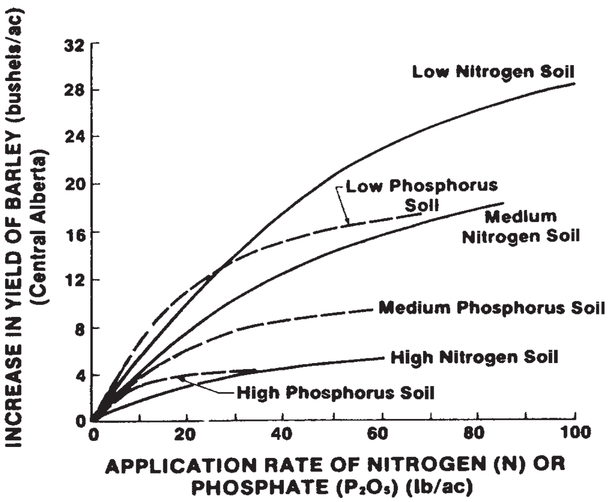


Figure 1. Response comparison to nitrogen and phosphorous on barley.

Adjustments in the rate of application of phosphorus should be based on the same factors related to growing conditions and the fertilizer-crop price relationship as discussed for nitrogen. However, the adjustments should be proportionately smaller (e.g. a 20-30 lb/ac change in the rate of nitrogen warrants only a 10 lb/ac change in the rate of phosphate). On soils that require only maintenance applications of phosphate, the rate of phosphate application does not have to be changed as the rate of nitrogen is increased or decreased (N and P don't have to be applied at a constant ratio). A 10 to 15 lb/ac minimum rate of phosphate should be maintained except when the soil test is very high. On soils that are very deficient in phosphorus, such as eroded hilltops, a single plow-down application of 100 to 200 lb/ac may be beneficial in addition to normal annual applications.

Potassium

Potassium (K) deficient soils are not common throughout Alberta, but do occur quite frequently in certain areas and soil types. Potassium deficiencies tend to occur on sandy, calcareous soils and soils with poor subsurface drainage adjacent to and on organic soils. Soils that test low in available potassium occur most frequently in west-central, northwestern (excluding the Peace region) and northeastern Alberta.

Potassium is a relatively inexpensive fertilizer nutrient and is an important part of an efficient fertilizer program when K is deficient. Barley is somewhat more responsive to potassium than other cereal crops. Potatoes have a very high potassium requirement and therefore may require potassium fertilization on soils containing adequate amounts of potassium for other crops.

Increases in yield from potassium fertilizers are often less visible than for a nitrogen or phosphorus fertilizer. If potassium is tried on a test strip, yields should be measured carefully rather than visually estimated. A comparison of yield with and without potassium should be made where equal and adequate rates of nitrogen and phosphorus are applied.

Crop response to potassium chloride (0-0-60 or 0-0-62) has sometimes been observed on soils that are not deficient in potassium by soil tests. Preliminary research indicates these responses may be due to chloride. The application of chloride has been shown to reduce root and leaf diseases, but insufficient research has been conducted in Alberta to determine whether crop response can be predicted by a soil test. North and South Dakota use a soil test for chloride as a basis for recommending chloride fertilization. Soil testing laboratories in Alberta may use Dakota criteria as a general guide for chloride recommendations. Field trials should be conducted to establish whether or not the application of potassium chloride is beneficial on soils that are not deficient in potassium.

Sulphur

Some Gray Wooded and Dark Gray Wooded soils and well drained Black soils are deficient in sulphur. Sulphur deficiency is not common on Brown and Dark Brown soils. Deficiencies seldom occur in crops grown on fallow, but legume crops, cereal and oilseed crops that have been well-fertilized with nitrogen fertilizer commonly require sulphur fertilization. Sulphur requirements of canola and legumes are greater than those of cereals.

The need for sulphur fertilizer can be determined by a soil test. If a test strip is used to determine responses, the comparison with and without sulphur should be made using equal and adequate rates of nitrogen and phosphorus throughout. Sulphur fertilization is inexpensive owing to the relatively low rate of application required (10-30 lb/ac). Supplying adequate sulphur when it is deficient will usually provide very high returns.

Table 2. General fertilizer recommendations for Alberta (rate in pounds of nutrient per acre)[a]

		Brown [b]		Dark Brown [b]		Thin Black		Black and Gray Wooded				
Crop	**Previous crop**	**Nitrogen (N)**	**Phosphate (P_2O_5)**	**Nitrogen (N)**	**Phosphate (P_2O_5)**	**Nitrogen (N)**	**Phosphate (P_2O_5)**	**Nitrogen (N)**	**Phosphate (P_2O_5)**	**Potassium (K_2O)**	**Sulphur (S)**	**Application and Placement [c]**
Spring wheat	fallow	5 - 20	10 - 20	5 - 20	15 - 35	5 - 25	15 - 35	5 - 35	15 - 40			Phosphate - place in the seed row or band with nitrogen in fall or spring. Under cool, wet conditions and on low phosphorus soils, placing some phosphate (10 - 15 lb/ac P_2O_5) with the seed is usually beneficial. Nitrogen - the relative efficiency of fall and spring, broadcast and band applications are shown in Table 6. Maximum rates that can be safely placed in the seed row are shown in Table 4 and 5.
	stubble	20 - 50	0 - 15	25 - 60	0 - 25	35 - 65	10 - 35	30 - 80	15 - 40			
Malting barley	fallow	–	–	5 - 15	15 - 35	5 - 25	15 - 35	5 - 35	15 - 40			
	stubble	–	–	25 - 50	0 - 25	35 - 65	10 - 35	30 - 80	15 - 40			
Oats and feed barley	fallow	5 - 20	10 - 20	5 - 15	15 - 35	5 - 30	15 - 35	5 - 40	15 - 40			
	stubble	20 - 55	0 - 15	35 - 65	0 - 25	35 - 80	15 - 35	40 - 100	15 - 45			
Fall rye	fallow	–	–	25 - 35	20 - 30	25 - 35	20 - 35	5 - 20	20 - 35			Phosphate - place in the seed row or band before seeding. Nitrogen - broadcast early the following spring.
	stubble	–	–	30 - 55	15 - 25	30 - 60	15 - 30	35 - 70	20 - 35			
Winter wheat	fallow	20 - 30	10 - 25	25 - 35	20 - 40	25 - 45	25 - 45	–				
	stubble	25 - 55	10 - 25	30 - 65	15 - 30	40 - 80	20 - 40	–				
Flax	fallow	–	–	5 - 10	10 - 20	5 - 10	15 - 20	5 - 10	15 - 20			Phosphate - band or place in the seed row. Nitrogen - very sensitive to fertilizer placed in the seed row; N should be banded or broadcast.
	stubble	–	–	20 - 30	0 - 15	20 - 45	0 - 20	20 - 45	15 - 20			
Canola and mustard	fallow	5 - 15	10 - 20	5 - 30	15 - 20	5 - 35	15 - 25	5 - 45	15 - 35	–	0 - 10	Phosphate - a maximum of 25 lb/ac can be placed in the seed row. Band higher rates. Nitrogen - rates higher than 10 lb/ac must be broadcast or banded.
	stubble	20 - 55	10 - 15	35 - 70	15 - 20	30 - 80	15 - 25	40 - 100	15 - 35	–	0 - 20	
Grass	for seed	–	–	30 - 60	0 - 15	30 - 70	0 - 30	45 - 90	0 - 40	–	0 - 10	Broadcast after seed harvest in fall or early spring depending on species. Broadcast fertilizer in late fall or early spring.
	for forage (with <20% legume)	–	–	40 - 90[a]	0 - 15	60 - 110[a]	0 - 30	60 - 120	0 - 40	–	0 - 10	
Grass - Legume	20 - 40% legume	–	–	30 - 65	0 - 20	40 - 80	0 - 35	45 - 90	0 - 35	–	0 - 30	Broadcast fertilizer in late fall or early spring.
	40 - 60% legume	–	–	10 - 30	0 - 35	10 - 30	0 - 45	10 - 30	0 - 50	–	0 - 30	
Legume	(>60%)	–	–	0 - 10	0 - 35	0 - 10	0 - 50	0 - 10	0 - 60	–	0 - 30	A large single application of phosphate (100 - 200 lb/ac) may be beneficial on low P soils.
Potatoes	fallow	–	–	–	–	–	–	25 - 50	45 - 90	30 - 60	0	Fertilizer should be banded 3 to 5 cm away from seed row.
	stubble	–	–	–	–	–	–	70 - 110	55 - 110	50 - 100	0	

a Residual response to the higher rates may persist for two years, particularily when the year of application is dry and production is low. Therefore, annual application may not always be necessary.

b See comments regarding soil moisture reserves and their importance in determining crop rotations and choosing fertilizer rates under Major Soil Groups and Choosing the Kind and Rate of Fertilizer.

c See: Fertilizer Application and Placement.

Note:

i Table 2 should be used in conjunction with the discussion in the text of the publication. Soil tests will provide additional and important information for choosing fertilizer rates.
ii Blanks – indicate that the crop is not commonly grown or recommended in that soil zone.
iii See Table 7 for converting from pounds of nutrient to pounds of fertilizer.

Table 3. General fertilizer recommendations for irrigated crops (pounds of nutrient per acre)					
Crop		**Nitrogen (N)**	**Phosphate (P_2O_5)**	**Potassium (K_2O)**	**Application and Placement** [a]
Wheat	- hard red spring - utility & durum - soft white spring - winter	35 - 110 35 - 110 35 - 110 35 - 80 (spring applied)	20 - 50 20 - 50 20 - 50 20 - 50	0 0 0 0	Broadcast or band N in fall or early spring (see Table 6). Place phosphate in the seed row or band with N at seeding. Broadcast-incorporated P_2O_5 application should be twice the recommended rate at low P soil test levels.
Barley	- feed - malting - silage	40 - 130 35 - 130 50 - 130	20 - 50 35 - 50 35 - 50	0 0 0	
Oats		35 - 80	20 - 50	0	
Fall Rye		30 - 70	20 - 50	0	
Triticale		35 - 90	20 - 50	0	
Canola and Mustard		35 - 140 35 - 110	35 - 60 20 - 50	0	Band or broadcast and incorporate both N and P_2O_5. Maximum amount of P_2O_5 with seed is 20 lb/ac.
Potatoes		90 - 170[b]	90 - 150	0	Broadcast or band N. Sideband P_2O_5 at seeding.
Sugar beets		0 - 140[b]	30 - 65	0	Broadcast N in fall or early spring. Drill in P_2O_5 (side band) at seeding.
Corn	- sweet - silage - grain	70 - 120[b] 80 - 150 80 - 150	35 - 60 45 - 60 30 - 60	0 0 0	Sideband P_2O_5 at seeding. Side dress nitrogen. Broadcast or band N. Sideband P_2O_5 at seeding.
Peas		0 - 40	30 - 40	0	Broadcast or band N. Maximum amount of P_2O_5 with the seed is 25 lb/ac.
Beans		10 - 40[c]	30 - 40	0	Broadcast or band N in fall or early spring. Sideband P_2O_5 at seeding.
Lentils		10 - 30[c]	20 - 40	0	
Sunflowers		70 - 135	20 - 60	0	
Flax		20 - 100	15 - 40	0	Broadcast or band N in fall or early spring. Drill in maximum 15 lb/ac P_2O_5 with seed.
Alfalfa		0 - 20[c]	30 - 60	0	Broadcast in early spring.
Grass	- for hay - for pasture	90 - 150 110 - 200	0 - 60 0 - 60	0 0	Broadcast 50 to 100 lb/ac N in early spring, follow with 50 lb/ac N in mid-July for maximum production.
Grass - legume	- legume (20% - 40%) - legume (40% - 60%)	45 - 90 10 - 35	30 - 60 30 - 60	0	Broadcast fertilizer in early spring. Additional nitrogen (50 lb/ac) may be required in mid-summer to maintain peak production. Broadcast fertilizer in early spring.
Legumes	(>60%)	0 - 10	30 - 60	0	

Remarks: See Irrigated soils, page 4.

a Phosphorus is most effective when drilled with or near the seed. Broadcast-incorporated applications should be twice to four times the drilled-in rate to be equally effective at low P soil test levels. Banded phosphorus will be similiar to or intermediate between drilled-in and broadcast applications (see Phosphate fertilizer).

b Nitrogen requirements open coarse-textured soils (sandy loam and loamy sand) are usually higher than on fine-textured soils (loam, clay loam and clay).

c Fertilizer application rates are based on inoculation with specific rhizobia bacteria to obtain nitrogen fixation.

Fertilizer application and placement

The *Fertilizer Act* requires fertilizers be labelled according to their guaranteed analysis as per cent by weight of nitrogen (N), phosphate (P_2O_5) and potash (K_2O). For example, 100 lb of 11-51-0 contains 11 lb of nitrogen (N), 51 lb of phosphate (P_2O_5) and 0 lb of potash (K_2O). Fertilizer should be purchased on the basis of the price per lb or kg of nutrient, not price per tonne of material. For example:

1. if urea (46-0-0) costs $265.00/tonne, the cost per kilogram or pound of nitrogen (N) is:

   $$1{,}000 \text{ kg} \times \frac{46}{100} = 460 \text{ kg or } 1{,}014 \text{ lb}$$

   $$\frac{\$265.00}{460 \text{ kg}} = \$0.58/\text{kg or } \$\mathbf{0.26}/\text{lb of N}$$

   (1 tonne = 1,000 kg and 1 kg = 2.2 lb)

2. if ammonium nitrate (34-0-0) costs $220/tonne, the cost per kg or lb of nitrogen (N) is:

   $$1{,}000 \text{ kg} \times \frac{34}{100} = 340 \text{ kg or } 749 \text{ lb}$$

   $$\frac{\$220.00}{340 \text{ kg}} = \$0.65/\text{kg or } \$\mathbf{0.29}/\text{lb of N}$$

In this example, urea cost more per tonne ($265.00) than ammonium nitrate ($220.00), but costs less per unit of N ($0.26/lb vs. $0.29).

When determining the amount of fertilizer required to supply a given rate of nutrient, refer to Table 7.

Nitrogen fertilizer

Placement

Nitrogen fertilizers are very soluble and move readily in moist soil. Placement with or very near the seed is not necessary to ensure effective utilization. Placement options that can be considered:

- broadcast
- pre-plant band
- side-band or mid-row band at planting
- seed row placement

The relative efficiencies of the various methods depend on many factors. Broadcast application may be less effective than banded or seed row application under some conditions (see Table 6) Fertilizer placed in the seed row can delay or severely reduce crop emergence. The maximum rate that can be safely placed in the seed row depends on various factors:

- crop type
- soil moisture
- soil type (clay and organic matter content)
- type of fertilizer
- row spacing
- spread of seed and fertilizer (type of opener)

Guidelines for approximate safe rates of seed row nitrogen are shown in Tables 4 and 5.
(Note: all rates are in lb/ac of N. To calculate the rate of urea, divide by 0.46).

Banding

Banding fertilizer (8-15 cm deep) has become a common method of applying nitrogen fertilizers. Under conditions of low rainfall during the early growing season, deeper placement overcomes the problem of nitrogen being stranded in dry surface soil. Under wet soil conditions that can occur in early spring (during and just after spring thaw), fall applied nitrogen fertilizer can be lost by a process called denitrification. Late fall banding of an ammonium form of nitrogen (e.g. 82-0-0 or 46-0-0) will reduce losses.

Time of application

Fall is often an opportune time to apply fertilizers because of the availability of time and price discounts. However, excessively wet conditions in early spring that sometimes occur on fine textured and poorly drained soils in central and northern Alberta can cause significant losses of fall applied nitrogen. Early fall (before mid-October) broadcast applications are most subject to loss. Late fall banded applications of an ammonium form of nitrogen are less subject to loss. Table 6 shows the relative efficiency of fall and spring broadcast and banded applications under various conditions.

Top dressing of nitrogen on cereals after emergence is not generally recommended, but it can be effective up to the shot-blade stage if adequate rainfall is received after application.

Table 4. Maximum rates of nitrogen[a] (as urea-46-0-0) that can be safely placed in the seed row with cereal grains (wheat, barley and oats)

	Width of spread of fertilizer in the row[b]											
	1 inch (Disc or knife)			2 inch (Spoon or hoe)			3 inch (Sweep)			4 inch (Sweep)		
Row spacing	6"	9"	12"	6"	9"	12"	6"	9"	12"	6"	9"	12"
Seed bed utilization (SBU)[c]	17%	11%	8%	33%	22%	17%	50%	33%	25%	67%	44%	33%
Light soil (sandy loam)	20	15	10	30	25	20	40	30	20	50	40	30
Medium soil (loam to clay loam)	30	25	20	40	35	30	50	40	35	60	50	40
Heavy soil (clay to heavy clay)	40	35	30	50	40	35	60	50	40	70	60	50

Table 5. Maximum rates of nitrogen[a] (as urea-46-0-0) that can be safely placed in the seed row with canola and flax

	Width of spread of fertilizer in the row[b]											
	1 inch (Disc or knife)			2 inch (Spoon or hoe)			3 inch (Sweep)			4 inch (Sweep)		
Row spacing	6"	9"	12"	6"	9"	12"	6"	9"	12"	6"	9"	12"
Seed bed utilization (SBU)[c]	17%	11%	8%	33%	22%	17%	50%	33%	25%	67%	44%	33%
Light soil (sandy loam)	10	5	0	20	15	0	30	10	15	40	25	20
Medium soil (loam to clay loam)	15	10	5	30	20	15	40	30	20	50	35	30
Heavy soil (clay to heavy clay)	20	15	10	40	30	20	50	40	30	60	45	40

a The N rates in Tables 4 and 5 are in addition to the N in safe rates of seed row phosphate fertilizer (monoammonium phosphate).

b The width of spread of fertilizer and seed depends on the type of opener, soil type and moisture content, air flow, etc. Some openers give less than 1" spread (e.g. double disc).

c SBU (Seed bed utilization) is the width of spread of fertilizer and seed relative to the row spacing. For example – a 3" spread with a 6" row spacing is a 50% SBU (3/6 x 100 = 50%). If the same rate of fertilizer is applied with a 3" spread and a 12" row spacing, the concentration of fertilizer in the seed row is doubled (3/12 x 100 = 25 % SBU). Some openers spread seed and fertilizer vertically. SBU does not take vertical spread into account. A uniform seeding depth (minimum vertical spread) is conducive to even germination and emergence.

Table 6. The relative effectiveness of methods and time of nitrogen application for increasing crop yield

Method and time of application	Soil-climatic categories			
	1 (Dry)[a]	2 (Medium)	3 (Wet)[b]	4 (Irrigated)
Spring broadcast and incorporated	100	100	100	100
Spring banded	120	110	105	110
Fall broadcast and incorporated[a]	90	75	65	95
Fall banded	120	110	85	110

a Although spring and fall banded nitrogen were equally effective in research trials, fall banding may be more practical under farm conditions. The extra tillage associated with spring banding may dry the seedbed and reduce yields.

b In research trials conducted in the higher rainfall areas, spring broadcast nitrogen was well incorporated, and seeding and packing completed within a short time. Under farm conditions, shallow incorporation or loss of seedbed moisture resulting from deeper incorporation may cause spring broadcasting to be somewhat less effective than shown here.

Table 7. Lb/ac of fertilizer required to supply a given rate of nutrients

Fertilizer formulation	lb/ac of nitrogen (N) required									
	20	30	40	50	60	70	80	100	120	140
	(lb/ac of fertilizer required)									
21-0-0 (24S)	95	143	190	238	286	333	–	–	–	–
20-0-0 (24S)	100	150	200	250	300	350	–	–	–	–
19-3-0 (22S)	105	158	210	263	316	368	–	–	–	–
34-0-0	58	87	116	145	174	203	232	290	348	406
46-0-0	44	65	87	109	133	156	178	217	261	304
82-0-0	24	37	49	61	73	85	98	122	146	171
27-14-0	74	111	148	185	222	259	296	–	–	–
35-15-0	57	86	114	143	171	200	229	286	343	–
23-23-0	87	130	174	217	261	304	–	–	–	–
27-27-0	74	111	148	185	222	259	296	–	–	–
17-20-0 (15S)	118	176	235	294	353	–	–	–	–	–
16-20-0 (14S)	125	188	250	312	375	–	–	–	–	–

Fertilizer formulation	lb/ac of phosphate (P_2O_5) required									
	10	15	20	25	30	35	40	45	50	60
	(lb/ac of fertilizer required)									
11-55-0	18	27	36	45	54	64	73	82	90	109
11-51-0, 12-51-0	20	29	39	49	59	67	78	88	98	118
18-46-0	22	33	43	54	65	76	87	98	109	130
17-34-0	29	44	58	73	88	103	116	131	146	176
8-38-15	26	39	53	66	79	92	105	118	132	158
23-23-0	44	66	87	109	130	152	174	196	217	261
27-27-0	37	56	74	93	111	130	148	167	185	222
16-20-0 (14S), 17-20-0 (15S)	50	75	100	125	150	175	200	225	250	300
27-14-0	71	107	143	179	214					

Fertilizer formulation	lb/ac of potash (K_2O) required							
	10	20	30	40	50	60	80	100
	(lb/ac of fertilizer required)							
0-0-60, 0-0-62	17	33	50	68	85	100	133	167
8-38-15	67	133	200	267	–	–	–	–
8-2-24, 6-24-24	42	83	125	167	208	250	333	417
13-16-10 (11S)	100	200	300	–	–	–	–	–
14-14-7	144	286	–	–	–	–	–	–

Fertilizer formulation	lb/ac of sulphur (S) required						
	5	10	15	20	25	30	40
	(lb/ac of fertilizer required)						
21-0-0 (24S), 20-0-0 (24S)	21	42	62	83	104	125	167
19-3-0 (22S)	23	45	68	91	114	136	182
16-20-0 (14S)	36	71	107	143	180	–	
17-20-0 (15S)	33	67	100	133	167	–	
34-0-0 (11S)	48	95	140	182	–	–	
10-30-10 (5S)	100	200	–	–	–	–	
Gypsum (18S)	27	55	82	110	137	165	
Sulphur bentonite (90S)	–	–	17	22	28	33	44

Other factors affecting 'safe' rate of seed row N

Soil moisture – The 'safe' rates of seed row N given in Tables 4 and 5 are for good to excellent seedbed moisture. If seedbed moisture is below the good to excellent range, the 'safe' rates should be reduced by 25-50 per cent. In addition to soil moisture conditions at planting, rapid drying of the seedbed after planting can result in fertilizer injury. Packing and residue cover will slow moisture loss.

Field variability – Soils on rolling topography often have dry, eroded hill tops. The combined effects of low soil moisture, low organic matter and the presence of free lime make these areas very sensitive to crop injury from seed row N. The 'safe' rate of seed row N on these areas is often less than one-half that of the remainder of the field. The 'safe' rate for a field will be governed by the 'safe' rate for the most sensitive areas.

Nitrogen source – Tables 4 and 5 give 'safe' rates of seed row N for urea (46-0-0). The 'safe' rates of seed row N for cereal grains is about 50 per cent higher if ammonium nitrate (34-0-0) is used in place of urea (assuming that seedbed moisture is good to excellent). For canola, the 'safe' rates of seed row N for canola are the same for ammonium nitrate and urea. There is no information available on the relative 'safety' of ammonium nitrate versus urea on flax.

Crop type – Cereal grains are treated as a group and are more tolerant of seed row N than canola, mustard and flax. Within the cereal group, oat is slightly more tolerant than barley, which is slightly more tolerant than wheat. Canola is slightly more tolerant than flax.

Seeding depth and seed quality – Poor quality seed and an excessive seeding depth makes the crop more vulnerable to injury from seed row N. Using seed with a high percentage germination and vigor while seeding relatively shallow encouraged rapid crop emergence and reduced the potential for damage from seed row N.

Nitrogen fertilizer sources

Ammonium nitrate (34-0-0)

- contains nitrogen in both the ammonium and nitrate form
- less subject to volatilization losses than urea when surface applied without incorporation
- more subject to leaching losses on sandy soils
- used with ammonium phosphate to make the common fertilizer grades 23-23-0 and 26-13-0

Ammonium sulphate (21-0-0-24S; 20-0-0-24S and 19-3-0-22S)

- 22-24 per cent sulphate-sulphur, which is the plant available form
- used for direct application as both a nitrogen and sulphur source
- 20-0-0-24S and 19-3-0-22S are granular products more suitable for blending than 21-0-0-24S
- more acidifying than other nitrogen fertilizers (Table 1) – do not use continuously or at high rates on acid soils
- subject to volatilization losses when not incorporated on high pH soils (pH 7.5 or higher)

Urea (46-0-0)

- highest analysis dry nitrogen fertilizer
- used for direct application or combined with phosphate to make N-P fertilizer such as 27-27-0 and 17-34-0
- more subject to volatilization losses than 34-0-0 when not incorporated into the soil – significant losses can occur when urea is applied under warm dry conditions to sandy soils, forages with a heavy thatch and on alkaline soils (pH 7.5 or higher)

Anhydrous ammonia (82-0-0)

- highest analysis nitrogen fertilizer
- suitable for fall or spring application for annual crops
- must be knifed into the soil to a depth of 8-15 cm
- liquid under pressure; changes immediately to ammonia gas when released into the soil – the soil must be closed behind the applicator shank to prevent the ammonia gas from escaping

  Caution: Anhydrous ammonia is a pressurized gas. Everyone involved in the handling and use of ammonia should be aware of the need for caution.

Urea – ammonium sulphate (34-0-0-11S)

- contains 11 per cent sulphur
- supplies adequate sulphur when used as the nitrogen source on sulphur deficient soil

Urea – ammonium nitrate solutions (28-0-0)

- a water solution of ammonium nitrate (34-0-0) and urea (46-0-0)
- solutions lend themselves to uniform application and ease of handling
- can be applied through sprinkler irrigation systems

Acid nitrogen solutions (24-6-0-4S and 26-0-0-6S)

- contain urea, phosphoric acid and sulphuric acid
- ease of handling and uniform application advantages of solutions
- highly corrosive – corrosion resistant materials are required for storage and application equipment

Phosphate fertilizer

Phosphate fertilizers do not move readily in soil. Placing the band of phosphate near developing seedling roots of annual crops is most effective. Placement below the depth of seeding may improve availability under dry conditions because the fertilizer is in a moist part of the root zone for a longer time than with seed row placement. Broadcast-incorporated applications are less effective than when fertilizer is banded with or near the seed of annual crops. Broadcast application should be two to four times the recommended rates for banding or seed row application.

On established forages, response to broadcast applications may be delayed owing to the slow movement of phosphorus into the root zone. A greater response may occur in the year following application than in the year of application. On soil very deficient in phosphorus, phosphate fertilizer should be banded or incorporated before seeding perennial forages.

Phosphorus fertilizer sources

Monoammonium phosphate (11-51-0, 12-51-0 and 11-55-0)

- the most common phosphate fertilizers available in Alberta
- used for seed row or band application on annual crops, broadcast application on perennial forage or blended with nitrogen fertilizers to give various nitrogen-phosphate fertilizers such as 16-20-0, 23-23-0, 27-27-0 and 26-13-0

Other phosphate fertilizers are used on a limited basis in Alberta. They include diammonium phosphate (18-46-0), monocalcium phosphate or triple super phosphate (0-45-0), ammonium polyphosphate solution (10-34-0), liquid suspensions made from mono-ammonium phosphate (10-30-0) and acid solutions made from phosphoric acid and urea (0-34-0-4S).

Potassium fertilizer

Potassium will move in the soil more readily than phosphorus, but for annual crops, potassium fertilizers are more efficient when drilled with the seed or banded. Broadcast applications can be used at about twice the rate used for drill-in application. The maximum amount that may be safely placed with the seed of cereals is 35 lb/ac. For small-seed crops such as canola or flax, the maximum safe rate with the seed is 15 lb/ac. Broadcast or band applications can be made in either fall or spring.

Potassium fertilizer sources

Muriate of potash (0-0-60 or 0-0-62)

- most commonly used potassium fertilizer in Alberta
- used directly as a broadcast application or in blends with phosphorus and nitrogen fertilizers to make fertilizer grades such as 10-30-10, 8-24-24, 13-13-13, etc.

Sulphur fertilizer

Sulphur in the sulphate form moves readily in moist soils. Therefore, soluble sulphate fertilizers provide an available sulphur source either as broadcast, drill-in or band applications. Elemental sulphur and gypsum can also be used as sulphur fertilizers.

Sulphur fertilizer sources

Ammonium sulphate (21-0-0-24S, 20-0-0-24S and 19-3-0-22S)

- contains 22-24 per cent sulphate sulphur
- used directly as both a nitrogen and sulphur source or combined with ammonium phosphate to produce 16-20-0-14S or with urea to produce 34-0-0-11S

Urea-ammonium sulphate (34-0-0-11S)

- contains 11 per cent sulphur
- not as acidifying as ammonium sulphate and therefore preferable for use on acid soils that are sulphur deficient

Ammonium phosphate-sulphate (16-20-0-14S and 17-20-0-15S)

- made from monoammonium phosphate and ammonium sulphate
- common source of nitrogen, phosphorus and sulphur for broadcast and drill-in application

Sulphur bentonite (90% S)

- elemental sulphur fertilizers containing 10 per cent bentonite clay
- a granular product that can be blended with other fertilizers except ammonium nitrate
- elemental sulphur must be converted to sulphate sulphur before it is available to plants. Conversion to the sulphate form is carried out by soil bacteria and requires several months under warm, moist soil conditions. The rate of conversion is very slow unless fine particles of sulphur are mixed into the soil. Band application or incorporation of intact granules results in slow conversion to sulphate, Allowing the granules on the soil surface to be dispersed by rain or freezing and thawing before incorporation will increase the rate of conversion to sulphate.

Gypsum ($CaSO_4$, $2H_2O$)

- contains 18 per cent sulphur in the sulphate form, but is not as soluble as ammonium sulphate
- supplies both calcium and sulphur

Soil sampling and testing

Soil testing has become an important tool for assessing soil fertility and arriving at proper fertilizer recommendations. It's also a valuable management aid for studying soil changes resulting from cropping practices and for diagnosing specific cropping problems.

Soil testing provides an index for the nutrient availability in soil and is a critical step in nutrient management planning. Soil sampling technique, timing of sampling and type of analysis need to be considered for accurate results. The biggest problem in the effective use of soil testing is proper and representative sampling. Proper soil sampling will provide accurate soil test results and reliable nutrient recommendations.

The following information is offered to answer special questions concerning soil sampling. Further information and guidance can be obtained by contacting your fertilizer dealer, private laboratory or crop advisor.

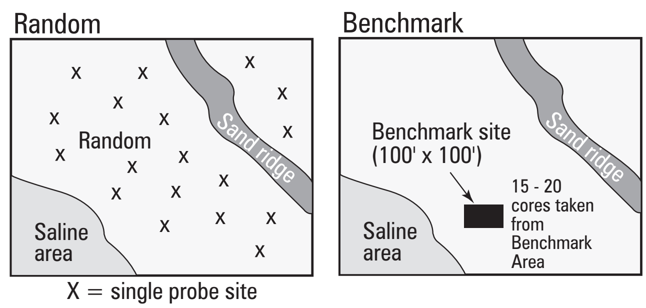
When to sample

Cultivated fields for spring seeding should be sampled after October 1. These fields can also be sampled in the spring, but time may be limited then. Fields for fall-seeded crops should be sampled one month before seeding. Forage fields for seed, pasture or hay may be sampled after September 1. Problem soil areas may be sampled anytime. Frozen and water-logged soils should not be sampled because of the difficulty in obtaining a representative sample.

Where to sample

Soil variability is a major concern when deciding how to collect a representative soil sample. Soil samples submitted for analysis should be representative of the field or portion of a field. Therefore, by sampling from an area of the field where yield is typically average, soil test results should come back with an average representation of the field.

Identifying areas that are representative can be difficult without a first-hand knowledge of the field. If the person taking the soil samples does not take the time or have the knowledge required to take a sample in the appropriate location, the results can come back somewhat unrepresentative.



Source: Westco Fertilizers

Random soil sampling is the traditional approach that works for uniform fields with little variation. The **managed random sampling** technique samples from areas identified as average production areas. This approach is different from random sampling, which provides an average of all cores taken throughout your field. Managed random sampling is recommended if you cannot identify a dominant production area on your field.

Benchmark sampling is recommended for fields with more variability (hills, pot holes, etc.). Benchmark sampling reduces the inherent variability of a field by reducing the area sampled. A small area (generally about ¼ of an acre) representing the majority of the field is sampled the same number of times as in random sampling. This is the reference area from which fertilizer recommendations are made.

The benchmark site should be marked with a global positioning system (GPS) or other means so that one can return there for subsequent years' sampling. Sampling from the same area will reduce sampling variability and create a better picture of year-to-year changes. Creating more than one benchmark is recommended if you cannot identify a dominant production area on your field.

In the first year, analyzing a few separate benchmark areas will reduce the risk of getting a sample not representative of the field. Although there are higher costs for laboratory analysis, this technique helps determine what area to use as a benchmark for future soil sampling.

When picking a benchmark area, use observable features such as soil color and landscape to identify where different soil types occur. Select a site that has characteristics similar to most of the field or the dominant soil type.

Often, the best time to identify different soil characteristics is through crop development. At the beginning of the growing season, differences in crop establishment and vigor can be seen, making a representative location easier to pick out. Other ways of selecting potential benchmark sites include the use productivity, yield, aerial and/or topographic maps.

The benchmark process can be further extended by establishing a couple of benchmark areas in different areas that allow customization of fertilizer rates. By identifying a primary benchmark area, and a secondary benchmark area and perhaps even a tertiary benchmark area, a fine-tuned fertility management strategy can be achieved even without variable rate technology.

Dividing a field into management zones allows for an understanding of different conditions within a field. This approach is particularly effective in rolling and hummocky landscapes. For example, a large depression may be a very productive area, but a separate soil test may indicate it can be optimized with a higher rate of nitrogen than the benchmark is indicating. While most producers do not have variable rate capabilities, rates can often be easily increased through other adjustments.

Each field (with the same crop and management history) must be sampled separately. Size up each field and observe variations in yield and crop growth, texture, color, slope, degree of erosion, drainage and past treatment. Sizable areas of fields where growth is significantly different from the rest of the field should be sampled separately.

Avoid unusual areas such as dead or back furrows, old straw, hay or manure piles, waterways, saline spots, eroded knolls and old fence rows. Select 15 to 20 sampling sites representative of the portion of the field to be tested.

Sample tools and methods

Representative soil samples can best be obtained by using a core sampling tool. The use of a proper sampling tool is essential for sampling to depths below 15 cm. Take soil cores from 0-15 cm at each of the 15 to 20 sampling sites. For improved nitrogen and sulfur evaluation or where problem soils are encountered, separate samples should be taken from the 0-15 cm, 15-30 cm, and 30-60 cm depths at the same 15 to 20 sites.

Place cores in clean pails or bags then mix cores taken from the same depths, crushing lumps in the process. Keep samples taken from individual depths separate from one another. Soil samplers may be available on request from fertilizer dealers, private labs or crop advisors. Many fertilizer dealers offer soil sampling services.

Preparing and submitting samples

How the soil is handled after sampling is just as important as collecting the soil sample. Remove half a kilogram, and air dry to stop nitrate build-up. To air dry, spread a thin layer of soil on a clean piece of paper, plastic sheets or clean, shallow containers (plastic, aluminum, etc.) in a clean room at room temperature. Do not dry with artificial heat. Some laboratories accept moist samples, but these samples must be delivered to the laboratory the same day as they are collected. Samples can also be stored in a refrigerator for a couple of days or frozen if sample delivery is delayed.

Contact your laboratory regarding packing and shipping instructions. Fill the sample containers (boxes, bags, etc.), and label each sample with your name, address, postal code, field and depth from which the sample was taken. Repeat these steps for each uniform field to be sampled. Provide complete information for each soil sample on the sheet supplied. Where unusual problems exist, these should be noted in detail. Keep a completed field plan of the area represented by each sample for your own records.

Laboratory analyses

Consult with your laboratory regarding laboratory analyses of agricultural soils. Research in Alberta indicates that the typical soil analyses package for surface (0-15 or 0-30 cm) agricultural soils should include soil tests for nitrate-nitrogen, available phosphorus, available potassium and extractable sulfur, plus soil pH and salinity (electrical conductivity). If possible, the nitrate and sulfur analysis should be completed for subsurface soil samples (15-30 and 30-60 cm). Additional analyses for micronutrients (Boron, Chlorine, Copper, Iron, Manganese or Zinc), or organic matter for the surface soil samples may be requested. Some laboratories may provide additional analyses as part of the routine analyses package that they may use to improve interpretations and recommendations.

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