



Revised April 2001

Agdex 561-18

Fertilizer Requirements of Irrigated Alfalfa

Ensuring soil fertility levels are adequate is a major factor to consider when growing irrigated alfalfa in southern Alberta.

Irrigated alfalfa will produce 5 to 6 tons of dry matter per acre if it receives sufficient amounts of water and nutrients. Climate, soil type and management will all affect the yield a producer can expect from an alfalfa crop.

Alfalfa has a high demand for nutrients compared to other crops. Table 1 gives the approximate amount of each nutrient removed per ton of dry matter alfalfa.

Table 1. Nutrient removal per ton of dry matter alfalfa

Nutrient	Amount Removed (lbs/ac)
Phosphorus (P)	4 - 6
Phosphate (P_2O_5)	10 - 15
Potassium (K)	40 - 55
Potash (K_2O)	50 - 65
Calcium (Ca)	30
Magnesium (Mg)	5 - 7
Sulphur (S)	5 - 7
Boron (B)	0.08
Copper (Cu)	0.01
Iron (Fe)	0.3
Manganese (Mn)	0.1
Molybdenum (Mo)	0.002
Zinc (Zn)	0.05

Soil testing

Soil testing is the most reliable way to both identify which nutrients may be deficient in a soil and to assist a producer in developing a balanced fertilizer program. A field should be soil sampled (see *Micronutrient Requirements of Crops in Alberta* Agdex 531-1) and tested for the levels of plant-available nutrients before an alfalfa crop is seeded. Eroded

knolls or fields that have been machine levelled recently should be sampled separately because they may require higher applications of some nutrients.

Soil fertility levels should be monitored throughout the life of an alfalfa stand to ensure the alfalfa remains productive.

Nitrogen

Alfalfa is a legume that can “fix” its own nitrogen (N) with the help of *Rhizobium meliloti*, a bacteria that lives in association with alfalfa roots. The bacteria converts nitrogen gas (N_2) in the air into a form that plants can use. A 5 ton/ac alfalfa crop will fix up to 250 lb/ac of nitrogen per year.

Since the soils in southern Alberta are low in N-fixing bacteria, alfalfa seed must be inoculated with the *R. meliloti*. Alfalfa seed is often pre-inoculated before sale. Store inoculated seed in a dark, cool place to ensure the live bacteria survive until seeding time.

Poor N-fixation can be the result of improper inoculation. In some cases, N-fixation declines after a stand is four or five years old. Poor stands should be broken and seeded to an annual crop for several years before being reseeded with a recommended variety of alfalfa.

Phosphorus

Alfalfa has a high requirement for phosphorus (P). A 5 ton/ac crop requires approximately 50 lb/ac of P_2O_5 .

Soils in southern Alberta are naturally low in plant available phosphorus. Residual P levels vary in irrigated soils of southern Alberta because many fields have received phosphate fertilizer or manure regularly for years, so a soil test should be done before applying phosphorus.

A large batch application of phosphate fertilizer or the application of manure or compost before establishing alfalfa is the most effective way to add P. An application of 200 lb/ac of P₂O₅ will meet crop requirements for four to five years. Phosphate fertilizer can be either banded or broadcast-incorporated prior to seeding alfalfa.

In an Alberta Agriculture survey of 100 alfalfa fields, 70 per cent tested low in soil P, while only 44 per cent tested low in tissue P. Further research is needed to accurately determine when alfalfa will respond to added P fertilizer.

Potassium

Alfalfa has a high requirement for potassium (K). Most southern Alberta soils have adequate amounts of available K (>300 lb/ac of ammonium acetate extractable K). Potassium is normally only deficient on very sandy soils and a soil test will help to determine if K levels are deficient.

The Alberta Agriculture survey of alfalfa fields also showed that no fields tested low in K, while 79 per cent tested low in tissue K. In soils testing low in soil K, a large batch application (100-200 lb K₂O/ac) of K₂O fertilizer may be necessary and may need to be coupled with annual applications. Further research is needed to accurately determine when alfalfa might respond to added K fertilizer.

Sulphur

Alfalfa has a high requirement for sulphur (S), but irrigated soils are rarely deficient in S. Irrigation water naturally contains dissolved sulphate-sulphur (SO₄-S), which is the form required by plants. For every 12 inches of irrigation water applied, approximately 30 lb/ac of SO₄-S is also added, which meets crop requirements.

Micronutrients

No responses to micronutrient fertilizers have been observed in alfalfa in southern Alberta. Boron (B) is the only micronutrient that may become a problem. Boron deficiencies first appear on sandy, low organic matter soils. Extreme care is required when using boron because a 5 lb/ac application can be toxic to alfalfa as well as other crops. A soil specialist should be consulted before using costly micronutrient fertilizers.

Fertilizing established alfalfa

Nitrogen

Nitrogen fertilizer can provide a small increase in the yield of alfalfa stands when N-fixation is inadequate. However, no research has been done to determine if applying N fertilizer on alfalfa is economical. It is not clear how much of this increase is due to increased growth of grass. Application of N fertilizer favors the growth of grasses, which may eventually dominate the stand. Applying nitrogen fertilizer on healthy alfalfa stands is not recommended.

Phosphorus

If phosphate was not applied before seeding or is limiting production, a grower may consider an annual maintenance application of 50 lb/ac of P₂O₅ to meet crop removal rates. This may not be as effective as pre-plant incorporated P because P is immobile and moves very slowly into soil. However, irrigated alfalfa has feeder roots near the soil surface that can take up P with reasonable efficiency.

Broadcasting is presently the only practical method of in-crop fertilizer application and should be done very early in the spring. Table 2 provides general phosphate fertilizer recommendations. Compost is also an excellent source of both phosphorus and potassium.

Table 2. Annual phosphate fertilizer recommendations for irrigated alfalfa.

Soil Test Phosphorus (P) (0-15 cm depth) (lb/ac)	Phosphate (P ₂ O ₅) Recommendation (lb/ac)
0 - 10	60
10 - 20	50
20 - 30	45
30 - 40	40
40 - 50	35
50 - 60	30
60 - 70	20
70 - 80	10
>80	0

Note: Based on the Kelowna soil P test method.

Potassium

In fields testing deficient in potassium, annual applications of potash (K₂O) fertilizer may be necessary, and the soil test recommendation should be followed (Table 3). Occasionally, fields that have sufficient K soil levels will respond to a 50 lb/ac application of K₂O fertilizer in early spring if conditions are unseasonably wet and cool. Under these conditions, soil K is less available and less mobile in the soil.

However, responses to K_2O fertilizer in Alberta research trials is uncommon. Applications should first be tried in carefully marked test strips to determine if a response actually occurs.

Table 3. Potash fertilizer recommendations for irrigated alfalfa.

Soil Test Potassium (K) (0-15 cm depth) (lb/ac) ppm	Potash (K_2O) Recommendation (lb/ac)
0 - 50	240 - 260
50 - 100	165 - 180
100 - 150	115 - 125
150 - 175	75
175 - 200	50
200 - 225	25
225	0

Note: Based on the ammonium acetate soil K test method.

Manure and compost

Manure and compost supply relatively large amounts of phosphorus and potassium. When manure is used as a fertilizer on established alfalfa fields, it can burn leaves, which in turn reduces the yield and quality of alfalfa. Manure application equipment may reduce yields by compacting soil and damaging alfalfa crowns. Generally, it is best to apply manure before establishing alfalfa or during the cereal part of an alfalfa – cereal crop rotation.

Nitrogen in manure may stimulate grass and even weed growth in alfalfa stands; therefore, manure is better used on non-legume crops. If no other land is available, spread the manure on the oldest alfalfa stand or the one with the most grass in it.

Solid manure should be well broken up and applied at a rate no higher than 10 tons/acre. Apply it immediately after a cut, so the manure contacts the soil rather than the crop. To reduce soil compaction, the manure should be applied on relatively firm, dry soil. Irrigation after a manure application will minimize crop damage and reduce nitrogen loss.

Plant tissue analysis

Plant tissue analysis will provide additional information on soil fertility and the nutritional health of the crop. At the bud-stage, healthy alfalfa plants contain a minimum of 3.0 per cent nitrogen, 0.2 per cent phosphorus, 1.7 per cent potassium and 0.2 per cent sulphur. Table 4 shows the levels of each nutrient in the top 15 cm of plant tissue at 5 per cent bloom.

Table 4. Levels of nutrients in the top 15 cm of alfalfa tissue at 5 per cent bloom.

Nutrient	Low	Sufficient	
		Per cent (%)	High
Nitrogen	<3.0	3.0 - 5.0	>5.0
Phosphorus	<0.20	0.20 - 0.70	>0.70
Potassium	<1.70	1.70 - 3.80	>3.80
Calcium	<0.25	0.25 - 3.0	>3.0
Magnesium	<0.20	0.20 - 1.0	>1.0
Sulphur	<0.20	0.20 - 0.50	>0.50
Parts per million (ppm)			
Boron	<20	20 - 80	>80
Copper	<5	5 - 30	>30
Iron	<20	20 - 250	>250
Manganese	<20	20 - 200	>200
Molybdenum	<0.5	0.5 - 5.0	>5.0
Zinc	<20	20 - 70	>70

Tissue analysis can help in determining when nutrient deficiencies are present before visual symptoms appear. Coupled with soil tests, tissue analysis allows producers to establish a more comprehensive fertilizer management program for alfalfa.

For additional information on fertilizing irrigated alfalfa, contact:

- the nearest district office of Alberta Agriculture, Food and Rural Development (AAFRD)
- Crop or Forage Specialist – AAFRD Taber, 223-7907
- Soil Fertility Specialist – AAFRD Lethbridge, 381-5842

Prepared by:

Dr. Ross H. McKenzie
Research Scientist – Soil Fertility/Crop Nutrition
AAFRD
Lethbridge, Alberta
(403) 381-5842

Dr. R. Colin McKenzie
Research Scientist – Soil and Water
AAFRD
Brooks, Alberta
(403) 362-1347

References:

Alfalfa Management Guide. Undersander, D., Martin, N.,
Cosgrove, D., Kelling, K., Schmitt, M., Wedburg, J., Becker, R.,
Grau, C., Doll, J., and Rice, M.E. 1994. Pub. By American
Society Of Agronomy 51 pp.

Canadian Fertilizer Institute. 1998. Nutrient Uptake and
Removal by Field Crops.

McKenzie, R.C., McKenzie, R.H. and Kryzanowski, L. 1999.
Fertilizer requirement of irrigated alfalfa. Alberta Agricultural
Research Institute. Project 94M626. 60 pp.