IANR NebGuide

University of Nebraska Lincoln

Published by University of Nebraska–Lincoln Extension, Institute of Agriculture and Natural Resources

G1598

Fertilizer Management for Alfalfa

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Alfalfa is an important crop in Nebraska. It is the only crop that has been planted on more than 1,000 acres in every county of the state. Nebraska consistently ranks as one of the top 10 alfalfa producing states in the country. Adequate soil fertility is necessary for alfalfa production on both dryland and irrigated soils of Nebraska.

Nutrient Needs

Nutrient removal from alfalfa production is high because most of the above ground plant material is harvested and removed several times during the growing season (*Table I*). Therefore, supplying adequate nutrients to the crop is important. As with other crops in Nebraska, we recommend a deficiency correction approach to alfalfa nutrient needs. This means crediting other sources of nutrients before applying specific nutrients.

The nutrient application rate suggestions are based on research in Nebraska, or neighboring states. In Nebraska nitrogen, phosphorus, potassium, sulfur and boron have been shown in research to increase yields in some soils. Lime additions can benefit alfalfa on low pH soils.

Table I. Average Nutrient Removal by Established Alfalfa at Harvest (Based on moisture content common at harvest).

	lbs/ton
N	55.0
P (P_2O_5)	10.0
K (K_2O)	60.0
Ca	30.0
Mg	4.6
S	8.0
Zn	0.006
Cu	0.14
Mn	1.8
Fe	1.8
B	0.02

Collecting soil and irrigation water samples is the first step in determining fertilizer and lime needs for alfalfa. Collect soil samples at any time of the year from a depth of 0 to 8 inches every three to five years to determine soil pH, soil buffer pH and phosphorus and potassium needs. The best time to collect soil samples is at least six months prior to seeding a new crop to allow incorporation during tillage. The irrigation water may contain significant amounts of lime, potassium and sulfur which can reduce the cost of the fertilizer program. Irrigation water normally needs to be analyzed every three to five years.

Lime

The fixation of nitrogen in alfalfa roots by the bacteria *Rhizobium meliloti* is optimized between a soil pH of 6.2 and 7.5. Use lime to establish new alfalfa stands and to ensure high yields the first two years after seeding if the pH of the topsoil is 6.2 or less. Once alfalfa roots penetrate deep enough to reach soil materials with a high pH, there will be decreased to no growth response from applied lime. Many soils in Nebraska have adequate pH in the subsoil. A soil buffer pH analysis from a soil sample can determine if lime is required and the rate of application. The eastern third of Nebraska has a higher chance for the need of lime due to lower soil pH. However, sandy soils in north central and western Nebraska can be acidic and require lime applications.

Lime needs to be incorporated into the soil for maximum benefit for a newly seeded alfalfa crop. Lime applied to the soil surface and not incorporated will only change the soil pH at the soil surface and have minimal benefits to the new alfalfa stand. Incorporation is not needed on no-till land if the lime is applied two or more years before sowing. Soil pH will gradually increase during the first six to 18 months after lime application. Therefore, it is best to lime a year before seeding alfalfa to allow the lime to react in the soil. If the surface pH is below 6.0, have the soil tested to determine lime need. If lime cannot be applied and incorporated in time to increase the pH, an application of 30 to 40 pounds of N may prevent early nitrogen deficiency of alfalfa seedlings.

For information about lime materials, quality, and application refer to the NebGuides, *Estimating Ag Lime Quality* (G84-714), *Management Strategies to Reduce the Rate of Soil Acidification* (G03-1503) and *Lime Use for Soil Acidity Management* (G03-1504).

Nitrogen Recommendations

On established alfalfa stands, nitrogen fertilization is not required because *Rhizobium meliloti* bacteria convert nitrogen gas from the air into a plant usable form of nitrogen. To ensure establishment of these bacteria in the alfalfa roots, alfalfa seed needs to be inoculated with the bacteria prior to planting. Most alfalfa seed currently sold is preinoculated with the appropriate bacteria. For instructions on how to inoculate seed that was not pre-inoculated or seed that has aged beyond the expected lifespan of the bacteria in the pre-inoculation, follow instructions on purchased inoculum packages and the NebGuide *Inoculation of Forage Legumes* (G79-435). Newly seeded alfalfa can benefit from 10 to 15 pounds of nitrogen fertilizer per acre to get it started on many soils, especially sandy or low organic matter sites and with early spring plantings into cold soil. Many farmers and ranchers report that the application of some nitrogen with the drill will increase the probability of obtaining a good stand. Residual nitrogen in the soil may be high enough to supply adequate nitrogen to newly seeded stands. Past fertilizer and cropping history and/or a soil analysis for nitrate in the surface 8 inches will help determine if sufficient nitrogen is available in the soil. If inoculation is not successful, topdressing nitrogen will be necessary.

Excessive nitrogen will reduce the effectiveness of the nodules. When this occurs, the alfalfa uses fertilizer nitrogen for growth and development.

Phosphorus

Phosphorus applications will be needed to achieve top yields on many soils in Nebraska. Suggested rates based on soil analysis are listed in *Table II*. Obtain a soil test to determine phosphorus level because phosphorus levels in soil that are sufficient for other crops like corn are not adequate for optimal alfalfa growth.

When establishing alfalfa apply two or three years worth of phosphorus, preferably before tillage, in order to incorporate the phosphorus. Yearly applications of phosphorus are suggested for irrigated alfalfa and dryland alfalfa with a pH greater than 7.0. On calcareous soils in northeast Nebraska (Crofton and Nora soil types) application ahead of seeding, followed by topdressing every two years, was found to be the most profitable. Knifing phosphorus in bands before planting may be especially effective on higher pH soils since less soil-P contact reduces P fixation.

Alfalfa responds better to incorporated applications than to topdressed applications. When phosphorus is incorporated in the soil, roots can find phosphorus in a greater volume of soil. Under drought conditions surface P may not be available, therefore adequate P deeper in the soil is an important risk management strategy, especially in rainfed production areas. Therefore, when establishing alfalfa, incorporate phosphorus prior to planting and apply phosphorus to the surface in established stands. Phosphorus should be applied early in the spring or in the fall after the last cuttings to get maximum benefit from broadcast applications. Some common forms of phosphorus fertilizer include: triple super phosphate (0-46-0), diammonium phosphate (18-46-0), and monoammonium phosphate (11-52-0).

Potassium

Alfalfa requires large amounts of potassium. Most soils, especially nonsandy soils, in Nebraska have sufficient native potassium levels for alfalfa production and do not require potassium fertilizer additions. However, potassium may be needed for alfalfa production on some course-textured, sandy soils. These soils are usually irrigated.

Suggested rates based on soil analysis are listed in *Table III*. As with phosphorus use, annual broadcast applications are recommended for irrigated alfalfa while large applications sufficient for two to three years applied at seeding are suggested for nonirrigated production. For irrigated alfalfa, the amount of potassium applied in the irrigation water can be subtracted from the application rates. Apply potassium fertilizers after final harvest to prevent damage to the crowns of growing plants and increase winter hardiness of the plants. There are no differences between sources of potassium fertilizers when applied at the same rate. Therefore, use the least expensive source. Potassium chloride (Potash) (0-0-60) is common and usually the least expensive source of potassium.

Table II. Phosphorus fertilizer recommendations for alfalfa in Nebraska based on Bray-1 or Olsen phosphorus tests.

Phosphorus Soil Test			*Irrigated*	*Non-irrigated*	
Bray-1 or Mehlich-3	*Olsen*	*Relative Level*	*Annually*	*Annually*	*Every two years*
(ppm)			*(lb P_2O_5/Acre)*		
0-5	0-3	Very Low	60	40	80
6-15	4-7	Low	40	30	60
16-25	8-14	Medium	30	20	40
> 25	> 14	High	0	0	0

Table III. Potassium fertilizer recommendations for alfalfa in Nebraska based on soil potassium test.

Potassium Soil Test	*Potassium to Apply*
(ppm)	*(lb K_2O/Acre)*
0-40	120
41-74	80
75-125	40
126-150	0
>150	0

Sulfur

As with other Nebraska crops, alfalfa often needs sulfur on sandy, low organic matter soils under irrigated and nonirrigated conditions. In eastern and central Nebraska, a need for sulfur is most likely when the soil is sandy and the organic matter content is less than 1 percent. In western Nebraska, a response to sulfur will most likely occur on sandy soils with an organic matter content of less than 0.6 percent. Sulfur may increase protein content in alfalfa but may not increase yield.

Where needed, annual applications of 30 to 40 pounds of sulfur per acre are suggested for irrigated alfalfa. The use of 100 pounds of sulfur per acre once every three years should provide adequate amounts of this nutrient for dryland alfalfa. Research has shown that fertilizers containing elemental sulfur are as effective for alfalfa production as those containing sulfate-sulfur. Test the irrigation water for sulfur and subtract the amount applied from the total sulfur application rate. Sulfur fertilizer materials include gypsum (16 percent sulfur), ammonium sulfate (24 percent sulfur), ammonium thiosulfate (26 percent sulfur), potassium-magnesium sulfate (22 percent sulfur), and agricultural sulfur (96 percent sulfur). Do not apply ammonium thiosulfate with the seed. It can be mixed with a fertilizer solution such as 10-34-0 but must not be placed with the seed. It can seriously affect germination.

Micronutrients

Except for boron (B), micronutrient deficiencies have not been found in alfalfa in Nebraska. Boron deficiencies are rare. Before applying boron, first take soil samples and observe the crop. Most soil testing labs and extension specialists consider soils testing under 0.5 ppm deficient in boron. When boron is deficient in alfalfa the upper leaves turn bronze to yellow without wilting and leaves are cupped or curled. Top leaves often appear bunched due to shortened internodes. Lower leaves remain a healthy green. Symptoms are similar to potato leafhopper yellowing and drought stress so be certain it is boron deficiency before making an application. It is easy to over-apply boron and it may become toxic to the alfalfa and subsequent crops. If a boron deficiency is indicated, apply 1 pound of boron per acre. Boron fertilizer is often mixed and applied with other fertilizers because of the small amount needed. Do not apply boron near the seed. Test the irrigation water for boron content before its nutrient is applied to irrigated alfalfa.

Things to Consider When Applying Fertilizer for Establishment

Fertilizer required for alfalfa production can be broadcast and incorporated before establishment, applied with a drill at planting time, or applied by a combination of these two methods. When low rates of nutrients are needed, the application of fertilizer with the drill when seeding would be appropriate.

Fertilizer containing high levels of both nitrogen and potassium should not be placed in direct contact with the seed. These nutrients create a salt effect that may reduce germination and stand. Fertilizers containing only phosphorus should not cause problems when placed in direct contact with the seed. The sum of nitrogen and potassium applied with the drill should be limited to less than 20 pounds per acre. If soil is drier than normal, limit application rates to half this amount. If not all the required fertilizer can be placed with the seed, broadcast the balance and incorporate prior to seeding.

Iron Chlorosis

On high pH calcareous soils, new seedlings of alfalfa may be light green or yellow (iron chlorosis) due to a deficiency in iron. This condition is most common in early spring. The Fe chlorosis will usually disappear as temperatures rise and growing conditions improve.

Manure Application to Alfalfa

Producers can apply animal manures to alfalfa as a nutrient source and alfalfa can serve as an accumulator crop for nitrogen in situations where producers have limited land resources available for manure N applications. These situations are common around large animal feeding operations. Research conducted at Concord, Neb., has shown that alfalfa fertilized with swine effluent can remove twice as much N as corn on a per acre basis. Based on *Table I*, an irrigated alfalfa crop that produces 6 to 9 tons per acre will remove 330 to 495 pounds of N per acre. A corn crop that yields 200 bushels per acre will remove approximately 240 pounds of N in harvested grain per acre. Alfalfa also can recover nitrogen in soil to a depth of 12 feet due to its extensive deep root system. To minimize the potential for nitrate leaching, manure application to alfalfa should be limited to 50 percent of predicted removal, and probably should not be applied all at once.

New Seeding

Manures with high salt and ammonia levels such as liquid manure sources can result in reduced germination of alfalfa. Therefore avoid direct contact with manure and seed by mixing manures with soil at least six weeks before plant-

ing. Avoid applying manure after the field has been seeded. Nitrogen removal during the seeding year may be between 24 and 57 percent less than established stands and nitrogen rates need to be adjusted accordingly during the seeding year.

Established Stand

Topdressing manure to established stands can increase the risk of injury due to salts and ammonia in the manure. Do not apply more than 3,000 to 5,000 gallons of liquid or 10 tons of solid manure per acre in a single application. New leaves are susceptible to burning. Apply the manure as soon as possible after harvests when little regrowth of leaves has occurred to minimize damage potential. It is important to uniformly apply the manures to avoid concentrating manure in areas of the field. Applications to older alfalfa stands or poor stands have less chance for injury compared to younger stands. Because production is less for old and poor stands, if salt and ammonia damage occurs, the risks of production losses are less than for productive younger stands. Added nitrogen from manure can stimulate grass growth. If this is a concern apply manure during peak alfalfa growth when alfalfa can compete with grass. Reduced application rates (50 percent of the calculated nitrogen removal rate) during individual applications can reduce chances for salt damage under these conditions.

This is a revision of NebGuide G73-2: Delno Knudsen and George Rehm, *Fertilizer Management for Alfalfa, 1977.*

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