

MU Guide

Managing Manure on Alfalfa Hay

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Alfalfa is a high-quality, high-yielding, cool-season forage that can be profitably marketed as hay. Alfalfa is a desirable crop for manure applications because (1) it requires high phosphorus (P) and potassium (K) fertility, (2) it removes a large amount of nitrogen (N) from the field when harvested as hay, and (3) it has the ability to draw down nitrate levels within its root zone.

Manure can be an excellent source of P, K and boron for alfalfa production and can reduce the need for purchasing other sources of these nutrients. Research in Wisconsin and Minnesota has shown manure can sometimes improve alfalfa yields when compared with other fertilizer sources. However, there are significant challenges in managing manure on alfalfa without damaging the productivity of the stand, particularly with solid manure and manure slurries.

This guide introduces factors producers should consider before applying manure on alfalfa. Other MU publications provide information on establishing, harvesting and maintaining alfalfa stands. A list of these and other related publications is at the end of the guide.

Manure application strategies

Preplant application

Applying manure before planting is an excellent way to use manure for alfalfa production while avoiding many problems associated with surface application on established stands. This method requires incorporation of sufficient manure to meet soil test P or K recommendations for two to three years. After planting, no further applications of manure or commercial fertilizer are needed until the third or fourth year.

Manure applied before planting must be incorporated into the soil either through injection or tillage. The alfalfa seed should not be in direct contact with a manure layer during germination, and the seedling should not grow through a layer of manure at the soil surface.

The preplant application strategy is best suited for producers who have slurry or solid manure systems. Low concentrations of P and K in effluent from unagi-

Soil fertility recommendations for alfalfa

Alfalfa demands an aggressive phosphorus and potassium fertility program to ensure stand persistence. Alfalfa producers should maintain soil test P and K in the "high" test category. Alfalfa is unlikely to persist with soil test P in the "very low" category. Soil test P and K below "medium" may impede persistence. Maintaining soil test P and K in alfalfa hayfields also requires maintenance applications of P, K, and boron because of its high nutrient removal capabilities. Maintenance applications are not usually needed when soil test P and K levels are "very high" to "excessive."

Alfalfa is one of the most sensitive forages to low soil pH and requires a soil pH_s (salt extraction pH) above 6.0 (6.5 in the Ozark region of the state). On low pH soils, apply lime at least one year before planting alfalfa to allow time for it to react with the soil.

Established alfalfa stands require 1 lb/acre of boron each year. Do not apply boron in the seeding year because boron can be toxic to seedling alfalfa.

Alfalfa does not require nitrogen fertilizer for establishment or yields because it can fix atmospheric nitrogen through a symbiosis with microorganisms in the soil. However, initial harvests can yield higher with a 20 to 30 lb application of nitrogen at seeding.

Nutrient removal by alfalfa hay

Alfalfa contains approximately 4.5 lb P/ton (10 lb P₂O₅/ton) when harvested between early and late bloom. Potassium content increases as available soil K increases, ranging from 25 to 60 lb K/ton (30 to 70 lb K₂O/ton). Nitrogen removal ranges from 45 to 60 lb/ton between early and late bloom.

tated lagoons make this approach impractical. To apply three years of P and K in a single application as lagoon effluent would require unmanageably high application rates that would exceed allowable rates of N. Preplant applications of manure do not work well when alfalfa

is seeded with oats as a nurse crop because the high N level that comes from the manure application promotes lodging of oats.

Annual applications

A second strategy of manure application involves annual top-dressing. Manure can be applied to established stands to supply required P and K or as an annual disposal application of manure nitrogen. Annual applications to meet the soil fertility needs of alfalfa are typically based on the most limiting nutrient. For alfalfa, this will be P or K. Disposal applications are based on the N or P removal capability of alfalfa hay. Annual applications are usually surface applied. Care must be taken to avoid practices that may damage the stand (see below).

Concerns associated with manure applications on alfalfa

Damaging the stand

Mismanagement of manure can damage or kill an alfalfa stand. The greatest concerns are surface-applied solid or slurry manure to established alfalfa stands and any form of manure applied during establishment of alfalfa.

Solid or slurry manure are the most concentrated forms of manure and are typically applied with large tractor-pulled spreaders. Alfalfa plants can be damaged by high salt or ammonia concentrations in the manure, physical damage to the crowns from manure application equipment, or water deficits induced by high salt concentrations in the soil from the manure.

When manure slurry or solid manure is applied to established alfalfa stands, the following precautions should be used to minimize potential damage to the stand.

- Make sure application equipment breaks up large lumps of solid manure. The finer the material and the more uniform the spreading pattern, the better. Uniform application patterns are essential for surface-applied manure on alfalfa.
- Limit manure application rates. High rates in a single application will increase the potential for stand damage.
- Apply manure immediately after cutting alfalfa and before any sign of budding on alfalfa crowns. The alfalfa plant is less vulnerable to salt damage when no green leaves are showing. This is particularly important for applications of manure slurries.
- When using a manure source that has a high potential to damage the stand, apply to older stands that have a high grass or weed component. Mistakes with manure applications on these stands are less costly.

Lagoon water from unagitated lagoons is unlikely to damage established alfalfa stands. Swine and dairy

lagoon effluent typically has lower ammonium and salt concentrations than slurry. Salt strength in manure is estimated by measuring electrical conductivity (EC). Effluent from properly functioning anaerobic lagoons usually has an EC less than 15 mmhos/cm. Experience has shown that effluent from these properly functioning lagoons does not damage established crops. Typically, no more than two inches of lagoon water should be applied per year to established alfalfa stands. Do not apply lagoon effluent to seedling stands of alfalfa because it promotes weed competition and because the plants are more sensitive to possible salt effects from the manure.

Alfalfa stands thin each year without necessarily reducing yield. Each crown has the ability to develop additional tillers to fill gaps in the stand. This tillering process compensates for natural crown thinning as well as for some stand reduction that occurs from manure application.

Weeds

Manure has a reputation for increasing weed pressure in alfalfa. Manure can contain weed seed, so manure application may increase weed establishment. In addition, manure contains high levels of N, so manure application can stimulate competitiveness of weeds. Research from Wisconsin and Minnesota suggests weed problems that may occur will be most severe during the seeding year. Producers should be prepared to manage the increased weed pressure with timely harvests or herbicides.

Fate of nitrogen applied to alfalfa

Alfalfa, as a legume, can fulfill most of its nitrogen requirement from a process called symbiotic N fixation. However, the amount of nitrogen fixed by this process is inversely related to the amount of N available to alfalfa from other sources. Therefore, the more manure or fertilizer N applied, the less alfalfa depends on N fixation to meet its N needs. Alfalfa preferentially uses N from the soil and from applied sources such as manure, and uses nitrogen fixation to meet any additional nitrogen need." These characteristics, combined with high yield capability, make alfalfa hay an excellent crop for removing large amounts of nitrogen from the soil.

In the harvested hay, nitrogen taken up from manure will not exceed 70 percent of the total N removed. The rest of the nitrogen will come from organic matter and atmospheric deposition, which together can contribute 30 to 50 lb N/acre/year to the crop. Symbiotic nitrogen fixation will contribute 10 to 25 percent of the N in alfalfa herbage, even at high N application rates.

The potential for leaching nitrate-N below the root zone is lower in alfalfa than in many other crops. Alfalfa has an extended growing season, from mid-March through October. Alfalfa uses large amounts of water, limiting the potential for leaching nitrate-N below the

root zone during the growing season. Producers applying large amounts of preplant manure on sandy soils should apply the manure in the same season of the year as planting to minimize the potential of leaching manure N.

Manure is an unbalanced fertilizer

If application rates of manure are based on one nutrient, other nutrients are likely to be overapplied or underapplied. For example, a 4-ton alfalfa crop will remove 200 lb N/acre in the hay. At the same time, it will remove far less P and K; a 4-ton hay crop will remove only 40 lb P₂O₅/acre (18 lb P/acre) and 180 lb K₂O (150 lb K/acre). Most manure sources contain more P₂O₅ than is removed by the crop at the N removal application rate (Table 1).

If phosphorous is applied at rates higher than crop needs, soil test P will increase (see Figure 1). On soils with low to medium soil test P, buildup applications of P can be desirable. However, too much buildup can raise soil test P to excessive levels (Figure 1). Continued application of P serves no agronomic purpose on these soils. High soil test P soils require careful management to minimize P losses to lakes and streams in runoff and erosion.

Excessive buildup of soil test P can be avoided by rotating fields that receive applications of manure, by applying manure based on soil test recommendations, or by limiting applications to the P removal rate of alfalfa hay. Rotating fields that receive manure allows excessive P applications to be applied in one year and then used in the subsequent year(s) when no manure is applied. Note that K fertilizer may be required in these interim years.

Manure application rates based on the annual P requirements of alfalfa hay will not provide sufficient K. Supplemental applications of K as commercial fertilizers will be necessary unless K is in the “very high” soil test category. Phosphorus-based application rates rarely exceed the nitrogen assimilation rate of alfalfa. Exceptions will be some swine lagoon effluent sources that are injected into the soil.

Table 1. The estimated amount of N, P and K applied when manure application is based on the N removal rate of alfalfa.
(Assume 4 ton/acre yield × 50 lb/acre N removal = 200 lb N/acre removal rate.)

Manure source	Application rate	Nutrients applied in manure		
		N	P ₂ O ₅ ----- lb/acre -----	K ₂ O
Swine lagoon effluent	1.9 acre-inches	200	90	315
Swine slurry	8,200 gal/acre	200	200	200
Dairy lagoon effluent	3.3 acre-inches	200	245	495
Dairy slurry	11,000 gal/acre	200	200	275
Poultry litter	4.5 tons/acre	200	270	160
Annual removal by alfalfa	4 tons/acre yield/year	200	40	180

Note: Available manure N, P₂O₅ and K₂O content was estimated assuming surface application. Actual loading rates for your field should be based on manure testing and nitrogen availability calculations appropriate for your method of application.

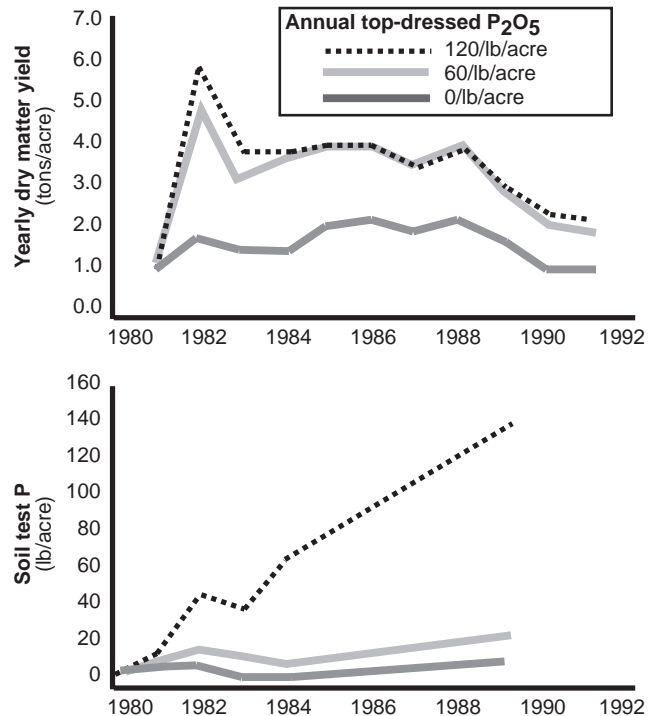


Figure 1: Annual applications of P₂O₅ (phosphate) above that required to attain maximum yield will increase Bray-I soil test P. Fertilizer application of 60 lb P₂O₅ (26 lb P/acre) was sufficient to attain maximum yield (top chart). Overapplication by doubling the P rate increased soil test P above agronomic levels within eight years in the top six inches of soil (bottom chart).

Note: Data provided by Dr. Jerry Nelson, University of Missouri, from a study conducted on test plots in West Plains, Missouri.

Other considerations

Crop rotations

Careful consideration must be given to management strategies for alfalfa. When an old alfalfa stand dies, the field must be rotated to another crop for at least one year before re-establishing alfalfa. This is because of autotoxicity, a process by which alfalfa secretes compounds that are toxic to its own seedlings. In Missouri, these water-soluble compounds will normally leach out of the soil in a 12-month period.

Crops in the year following alfalfa will have a reduced need for nitrogen. Alfalfa is one of the few crops that build up available nitrogen in the soil. In addition, the decomposing alfalfa residue and residual contributions from manure make nitrogen response of crops such as corn unlikely. The nitrogen value of alfalfa to the subsequent crop persists even in stands with a high percentage of grasses. Select a crop such as corn that is capable of using the flush of available N following alfalfa to

minimize the potential for leaching excess nitrogen to groundwater.

Hay palatability

There is no supporting research that the palatability of alfalfa is reduced by the application of manure. However, salt burn from mismanagement of manure may result in palatability problems. To reduce the risk of salt burn, apply manure immediately after cutting alfalfa and before any sign of new growth. This will maximize contact of the manure with the soil and minimize palatability problems.

Pure alfalfa verses alfalfa-grass mixtures

There are advantages of including a grass in an alfalfa stand. Grasses can increase plant density, thereby improving ground cover to curb soil erosion and weed establishment. In addition, alfalfa-grass mixtures can reduce insect infestations. Recent research at the University of Missouri has shown that leafhopper invasions are less likely in alfalfa/orchardgrass mixtures than in pure stands of alfalfa. Mixed swards may be less desirable on fields receiving manure because manure N will accelerate grass competition with the alfalfa.

For further information

- G4550 *Alfalfa*
- G4551 *Alfalfa Diseases in Missouri*
- G9804 *Nitrate in Soils and Plants*
- G9112 *Interpreting Missouri Soil Test Reports*
- G9182 *Managing Manure Phosphorus to Protect Water Quality*
- G9330 *Calculating the Value of Manure as a Fertilizer Source*
- NCR547 *Alfalfa Management Guide*

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