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Forages

NITROGEN FERTILIZER: What Should I Use

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Nitrogen (N) is typically the most costly fertilizer input used in grass production. Although a sound fertility plan that considers optional methods of providing N to the forage system should be the norm, producers often wait until N fertilizer prices escalate before examining alternatives.

Fertilizer should generally be purchased based on the price per pound of nutrient. Table 1 indicates the differences in N cost for different types of N fertilizer. Although certain sources of N fertilizer, when priced by the ton, may be more appealing than others, consider the analysis and the actual cost per pound of N. Many times higher-priced fertilizer on a per-ton basis is actually a better purchase. For example, urea that is $5 more expensive per ton than ammonium nitrate actually has a lower cost per pound of N when compared with ammonium nitrate. In the case of ammonium sulfate, although it is generally the most expensive form of N due to its low analysis for N, if sulfur is required based on soil test recommendation, it may be a sound investment for the pasture fertility program.

One aspect of considerable interest in East Texas is the use of broiler litter instead of inorganic fertilizer. Information contained in Tables 2 through 4 indicates the various fertilizer nutrients contained in broiler litter. The range indicates the variability of the litter, but provides information that can help producers estimate the level of nutrients being applied per ton of litter.

Broiler litter can be a good source of nutrients for several reasons. Besides providing the primary nutrients N-P_2O_5-K_2O, there also are appreciable amounts of Ca, Mg, Cu,

Table 1. Nitrogen content and cost per pound of nitrogen of various nitrogen-containing fertilizers.

Fertilizer Source	Fertilizer Analysis	N Content (lbs/ton)	Fertilizer Cost[1] ($/ton)	N Cost ($/ton)
Anhydrous Ammonia	82-0-0	1640	360	0.21
Urea	46-0-0	920	283	0.31
Ammonium nitrate	34-0-0	680	233	0.34
Urea-ammonium nitrate	32-0-0	640	180	0.28
Ammonium sulfate	21-0-0-24	420	185	0.44[2]

[1] Fertilizer prices current for spring 2001 in East Texas.
[2] If sulfur is required, credit the per-ton price of ammonium sulfate with $52.80, reducing the per-pound cost of N to $0.32.

Table 2. Nutrient composition of litter from 147 broiler houses sampled in Alabama, 1977 - 1987[1].

	Average Analysis Dry-Weight Basis (%)	Range (%)	Average Nutrient Content As-Is Basis[2] (lbs/ton)
Moisture	19.7	15.0 - 39.0	---
Nitrogen (N)	3.9	2.1 - 6.0	62
Phosphate (P_2O_5)	3.7	1.4 - 8.9	59
Potassium (K_2O)	2.5	0.8 - 6.2	40
Calcium (Ca)	2.2	0.8 - 6.1	35
Magnesium (Mg)	0.5	0.2 - 2.1	8
Sulfur (S)	0.4	0.01 - 0.8	6

[1] Ball et. al., 1998.
[2] Average as-is or wet-weight values assume a moisture content of 19.7%

Table 3. Total elemental concentrations for various manures from Texas and literature.[1]

	Total Elemental Concentrations										
	N	P	K	Ca	Mg	Na	Zn	Fe	Cu	Mn	S
Animal	%						Mg/kg				
Dairy[2]	1.35	0.54	1.37	3.69	0.60	0.24	129	4430	36	195	3778
Beef[3]	1.36	0.53	1.54	1.43	0.49	0.67	91	2582	18	251	5026
Poultry[4]	3.15	2.41	2.61	2.98	0.61	0.76	602	2668	465	579	7661
Biosolids[5]	5.00	1.53	0.52	2.87	0.26	0.22	1340	2278	473	357	---

[1] Feagley and Dollar, 2002.
[2] Texas data – 161 sample average, except for N (n = 160) and S and B (53 mg/kg), 13 sample average.
[3] Texas data – 29 sample average, except for Cu, Mn, S, and B (40 mg/kg), 6 sample average; 23 of the 29 samples from Mathis et al., 1973.
[4] Texas data – 30 sample average, except for S (8); B (79 mg/kg), 8 samples; Ca, 29 samples; and As (13 mg/kg), 6 samples.
[5] Texas data – 49 sample average, except for Ca, Mg, N, Fe, and Mn have 3 samples and metals listed here have 48 samples; metals listed in mg/kg – As = 5.58; Cd = 2.85; Cr = 26.6; Pb = 48; Hg = 1.30 (46 sample average); Mo = 12.6; Ni = 18.0; Se = 5.95.

and B (Table 3) brought into the pasture in the broiler litter. Yearly applications of litter may also raise soil pH over time. This can be critical for the production of certain forage species and serves to reduce overall input costs associated with limestone application. Also provided by the litter is organic matter that helps to improve soil tilth and nutrient and moisture holding capability. Although some producers are interested in organic agriculture, those using broiler litter should realize that like all organic sources of fertilizer nutrients, organic materials must undergo a transformation from the organic state to the inorganic state before nutrients will be available for plant uptake. Thus, organic fertilizer nutrients actually are transformed to inorganic fertilizer nutrients by soil microbes in a process known as mineralization. This transformation period can be prolonged by environmental factors such as extreme heat, cold, or drought. Other factors such as low soil pH can also impede mineralization. There is, therefore, some lag time in broiler litter application and when the nutrients will actually be available. Because of this lag time in nutrient availability, producers may wish to apply broiler litter at least one month prior to forage green-up. Users of broiler litter should also realize that approximately 10-15% of the N is not available in the application year, but will be available the following year. Most of the P and K, however, are available the first year. There may be an approximate 20-25% loss of N contained in the broiler litter as ammonia gas. If, however, the litter is incorporated into the soil, or if the litter if rained on within a few days, much lower amounts of N will be lost to the atmosphere.

Data contained in Tables 2 and 3 indicate the primary problem associated with exclusive use of broiler litter as a nutrient source for pasture forages. The approximately 1:1:1 (N-P_2O_5-K_2O) ratio illustrated in Table 2 shows that more P_2O_5 will be added as will N and K_2O. Warm-season perennial forage grasses, such as bermudagrass, take up these nutrients in a ratio that more closely approximates 4:1:4 (N-P_2O_5-K_2O). Therefore, over time, P will accumulate at the site simply because more P is being applied than can be used by the forage grass. This effect can be offset if only enough litter is applied to meet the P requirement each year for the soil and the remaining N and K are applied as inorganic fertilizers. An alternative is to apply the litter at the required N rate every four years and use supplemental inorganic N and K_2O, if needed during the other three years of the rotation. Note that if the litter is applied at the N rate yearly, P soil buildup has been linked to P runoff and surface water quality issues such as eutrophication.

When comparing the cost of broiler litter versus inorganic fertilizer several aspects must be considered. First is the cost of the litter. If the distance to the broiler houses is not too great, litter can be a good buy when only the cost of the N is considered. Even if the distance and thus the freight charge is greater, broiler litter may still be a good buy when other nutrients are considered. Examine the following example where it is assumed there are 60 lbs of N per ton of litter and a 20% loss due to volatilization:

Litter cost = $25/ton
60 lbs N/ac - 20% = 48 lbs N/ton available
$25/48 lbs N/ton = **$0.52/lb N**

Is $0.52/lb of N a good buy? It is not when compared to other N sources and prices contained in Table 1. If the value of P_2O_5 and K_2O are considered, however, the price for N drops significantly. Consider the following example where some values for P_2O_5 ($0.24/lb, 60 lbs/ton of litter) and K_2O ($0.15/lb, 40 lbs/ton of litter) are used in the equation.

Table 4. Nutrient concentration of broiler litter and amount contained per ton[1].

Nutrient	Concentration (%)		Nutrient per ton (lbs)	
	1992	1993	1992	1993
N	3.57	2.08	71.4	41.6
P_2O_5 (P)	5.75	3.77	115 (50)	75.4 (33)
K_2O	3.83	3.13	76.6	62.6
Ca	2.80	1.58	56.0	31.6
Mg	0.68	0.49	13.6	9.8
Na	0.88	0.65	17.6	13.0
	Concentration (ppm)		**Nutrient per ton (lbs)**	
	1992	**1993**	**1992**	**1993**
Zn	560	485	1.13	0.98
Fe	2013	1634	4.03	3.28
Cu	739	302	1.48	0.6
Mn	627	446	1.25	0.9

[1] Evers, 1998.

Litter cost = $25/ton
60 lbs N/ac – 20% = 48 lbs N/ton litter available
60 lbs P_2O_5 x $0.24 = $14.40 value/ton of litter for P
40 K_2O x $0.15 = $6.00 value/ton of litter for K
$25/ton litter cost – ($14.40 + $6.00) = $4.60 remaining cost of litter after the values for P & K are subtracted $4.60/48 lbs available N/ton = **$0.08/lb N**

Is the N a good buy at $0.08/lb? You bet! But there are still some aspects to consider. For example, 60 lbs of P_2O_5 is enough for approximately 4 tons of bermudagrass hay production. Unless you plan to harvest more than 4 tons of hay, you cannot value the additional P_2O_5 that is applied beyond the 1 ton considered in the above example except for its value in increasing soil test phosphorus levels. Thus, for the second ton of litter applied, only the K_2O should be credited, which makes the cost of a pound of N in the second ton approximately $0.40/lb. Averaged across two tons of broiler litter, N would cost approximately $0.24/lb, still a bargain in today's fertilizer market. Even if the liming value and organic matter content are not considered, broiler litter can be a competitive source of fertilizer nutrients.

To help reduce fertilizer input costs, some consideration should be given to using forage legumes such as clover and vetch in the pasture system as a source for N. Where adapted, clovers and vetch can provide up to 100 lbs or more of N per acre per year. Besides lengthening the grazing season and enhancing the nutritive value of the forage base, the N input from forage legumes can reduce fertilizer costs.

Finally, when purchasing N fertilizer, thought should be given to the rate at which the applied N will decrease soil pH. All ammonium-containing fertilizers release hydrogen ions into the soil solution as part of the conversion by soil microbes of ammonium to nitrate. Some N fertilizers, however, have a higher acidifying potential than others (Fig. 1).

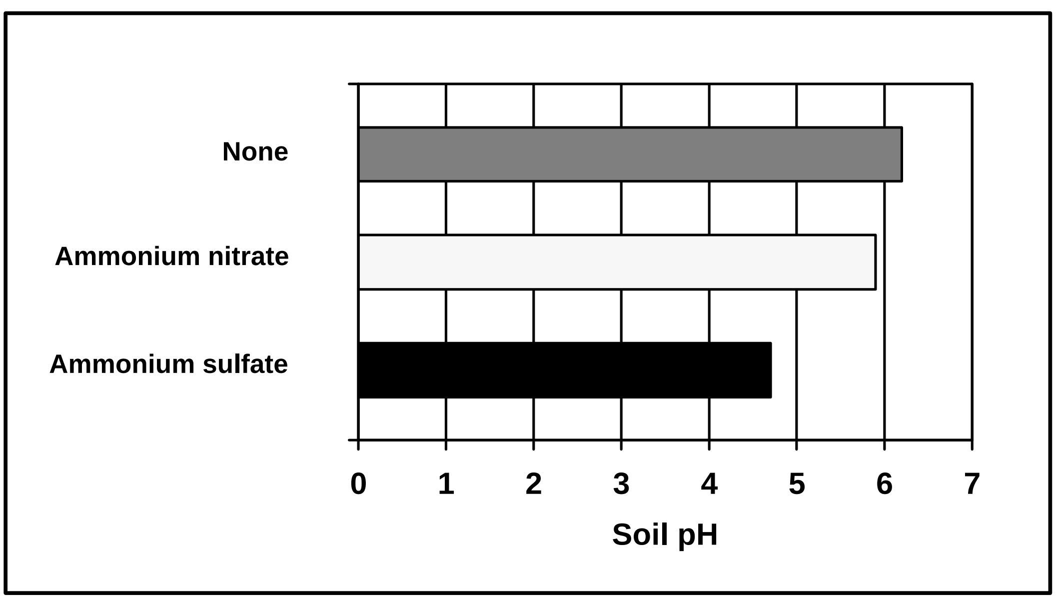

Figure 1. Effect on soil pH of different N fertilizer sources after three years. TAMU-Overton

From the data contained in Figure 1, it is apparent ammonium sulfate has a much higher acidifying effect on soil pH. In fact, among soil scientists, there is general agreement that ammonium sulfate has three times the acidifying effect on soil pH compared with ammonium nitrate, urea, or urea ammonium nitrate solution. Therefore, the increased level of limestone (e.g., limestone required more often) that may be required for the pasture system may affect the source of N fertilizer used.

Purchasing N fertilizer can be similar to purchasing a new automobile. While there are many makes and models around, they all provide transportation. Some automobiles, however, can provide transportation at better cost than others. Nitrogen fertilizer is no different. They all provide an essential plant nutrient for growth. Some N sources, however, may provide a little better value.

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