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Manure as a Fertilizer

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Manure is an excellent fertilizer containing nitrogen, phosphorus, potassium and other nutrients. It also adds organic matter to the soil which may improve soil structure, aeration, soil moisture-holding capacity, and water infiltration.

To determine how much manure is needed, the nutrient content and the rate nitrogen is mineralized (becomes available for plant uptake) needs to be estimated. Actual nutrient content of manures varies depending on source, (the level of protein being fed is more important than even the type of animal - dairy, beef, horse, etc.) moisture content, storage, and handling methods. The following table gives general information of percent moisture, nitrogen (N), phosphorus (P), and potassium (K) content in various manures.

Nutrient Content

The table gives some reported values of nitrogen, phosphorus, and potassium in manures.

	% Moisture	Approximate composition		% Phosphorus
		Nitrogen	Potassium	
Fresh manure with normal quantity of bedding or litter.				
Dairy	86	11	10	0.55
Hog	87	11	9	0.55
Horse	80	13	10	0.65
Sheep	68	15	8	1.00
Steer, feedlot	75	12	11	0.65
Hen	73	22	10	1.10
Turkey	74	26	10	1.30
Dried commercial products:				
Dairy	16	18	31	0.90
Hog	10	45	20	2.25
Horse	8	14	10	0.70
Sheep	9	27	41	1.35
Steer, feedlot	15	41	38	2.05
Poultry (droppings)	8	83	31	4.15
(with litter)	13	41	23	2.05

**Adapted from Western Fertilizer Handbook, 5th Edition and Fresno County grape pomace analysis survey, 1965 and 1966.*

The nutrient content of manure listed in the table should be used as a general guideline when determining rates of application, keeping in mind the wide variability that exists among samples. Also, application rates must take into account mineralization or the rate of release of N as the manure decomposes (see decay series).

Common reasons for the variability of the nitrogen content in manure include type of animal and feed ration, amount of litter, bedding or soil included, and amount of urine concentrated with the manure.

Water content is another major reason for nutrient content variations and should always be considered when buying manure on a per-ton basis. Fresh manures generally contain 70% to 85% water. Air-dried manures will always retain some moisture -- typically around 10% to 15%. As manure dries, the nutrients not only concentrate on a weight basis, but also on a volume basis due to structural changes (settling) of the manure. Volatilization of urine nitrogen can result in considerable loss of nitrogen, up to 50% or more of the total nitrogen.

Generally, dry manure contains 2 to 3 cubic yards per ton; 2.5 cubic yards per ton is a typical figure used for dry poultry and steer manures but must be adjusted with higher moisture contents.

Handling Manure

Handling can greatly alter the value of manure, particularly its nitrogen content. Nitrogen is present in manure in a variety of forms, most of which gradually converts to ammonium and nitrate nitrogen.

The ammonium form can be lost to the air and the nitrates leached by rainfall. Ammonium losses can be minimized by not stockpiling manure while it is moist, minimizing its handling, and discing it under immediately after spreading. Such effects are demonstrated in the following chart.

Manure source	History	Nutrient composition	
		Nitrogen %	Potassium %
Droppings	Prompt drying	4.2	2.5
Center of moist stockpile	Enzyme hydrolysis and volatilization of ammonia	2.1	2.5
Outside of stockpile	Leaching by rain, enzyme hydrolysis, and volatilization of ammonia	1.8	1.6

**From Rackman et al. (1965)*

Some ammonia can be lost to the air each time manure is moved or hauled. Much of the loss is from hydrolysis of the NH_2 groups (enzymatic) and then volatilization of N_20 and NH_3. This loss can be very high when spreading manure, especially during warm, dry weather. Here, at least 50% of the ammonium nitrogen can be lost within 12 hours. Studies have also shown that, by one week after spreading, almost 100% of the ammonium nitrogen can be lost. This loss can represent up to 50% of the total nitrogen available in stockpiled manure.

Thus, the importance if discing in manure **immediately** after spreading is obvious.

Nutrient Availability and Manure Application

Manure is a source of many nutrients including: nitrogen, phosphorus, potassium and man others. However, nitrogen is often the main nutrient of concern for most crops.

Potassium deficiency is usually quite localized within a field and would not be corrected with common rates of manure. However, some improvement might be expected with high rates above 10 tons per acre. The high rates needed to correct a potassium (K) deficiency would supply an excess amount of nitrogen for many crops, and this should be avoided.

Rates of Manure for Nitrogen Needs

The nitrogen compounds in manure are eventually converted to the available nitrate form. Nitrate is soluble and is moved into the root zone with water. It is the same form ultimately available to plants from commercial nitrogen fertilizers.

However, the release of available nitrogen from the complete organic compounds during manure decomposition is very gradual. This slow release of nitrogen is manure's most important asset. It extends nitrogen availability and reduces leaching -- of particular importance in sandy soils.

"Decay series" of nitrogen availability

The nitrogen carry-over from previous years of manuring should always be taken into account in fertilizer programs. This can be done by using a "decay series". This is an estimate of the annual release of nitrogen from manure.

The idea is to first apply enough manure to meet the first year's need of available nitrogen. Decreasing amounts are then applied in following years because of the carry-over organic nitrogen that will be released from previous applications.

If the same rate of manure is applied each year, it is possible for a field originally low in nitrogen to accumulate unnecessarily high levels in successive years.

The calculations of this "decay series" can be complicated and change with year to year variations of soil microbial activity in the field. However, it provides a general idea how to adjust for carry-over nitrogen in manuring.

The nitrogen in poultry manure is in released fastest, as most is the urea or uric acid form, with 90% of nitrogen released in the first year.

Fresh manure which contains both the urine and solid portions and has a large amount of urea or uric acid provides a somewhat slower release rate, with approximately 75% of the total nitrogen released the first year.
An even more gradual nitrogen release can be expected from dry feedlot steer manure, with only 35% of the total nitrogen released the first year.

The following example gives the rates of three manure sources needed to maintain the equivalent rate of 50 lbs nitrogen per acre annually up to 5 years. This is adapted from a "decay series" published by Pratt el al. (1973).

"Decay Series"

Manure Source	Nitrogen Content %	% of Nitrogen released in 1st year	Tons manure/acre required to release 50 lbs of Nitrogen each year Time, years				
			1	2	3	4	5
Chicken (dry)	3.0	90	1.0	0.9	0.9	0.9	0.9
Dairy (fresh)	0.7	75	4.8	4.5	4.4	4.3	4.3
Feedlot, steer (dry)	1.5	35	4.8	3.4	3.0	3.0	2.9

*Based on "decay series" of **chicken** --.90, .10, .05; **dairy** -- .75, .15, .10, .05; and **feedlot** -- .35, .15, .10. 05.*

These figures demonstrate the need to adjust rates with time among the various manure sources, especially feedlot manure with its more gradual nitrogen release.

Other Benefits of Manure

The use of manure helps to maintain the organic matter content of the soil which may improve soil structure and water infiltration. However, manure is quickly decomposed under warm, moist soil conditions. With the manure rates used for most crops, organic matter content in soil is only temporarily increased.

Possible Disadvantages

Weeds... Weed seeds are common in some manures. They may enter the animal with its feed and then pass through the digestive tract, still viable, or they may have come with the litter, or they may have simply blown into the feed yard.

Poultry droppings typically have fewer weed seeds surviving the digestive processes. However, other animal manures may contain numerous viable weed seeds if the original feeds were contaminated. Compositing and stockpiling manures can reduce the number of viable weed seeds.

Salts... Manures commonly contain 4 to 5% soluble salts (dry weight basis) and may run as high as 10%. To illustrate, an application of 5 tons of manure containing 5% salt would add 500 lbs of salt. Normally, irrigation and rain water will sufficiently leach well-drained soils to prevent damaging salt accumulations. However, one should be cautious with poorly drained soils, soils with existing salinity problems, or unusually high application rates, especially when concentrated near young plants.

Induced zinc deficiency... Zinc deficiency can be induced or increased with repeated high rates of manure, especially on sandy soils.

Moderate or infrequent applications do not normally present a zinc problem. However, growers should be aware of the potential problem, especially with soils and varieties or crops of known susceptibility to zinc deficiency.

Summary

The principal value of manure is its extended availability of nitrogen -- of particular value in the more readily leached sandy soils. Manure is also helpful in improving soil fertility in cut areas from land leveling.

Nutrient content and rate of availabilty varies widely, depending mostly on manure source, handling methods, and water content. Fresh manure which includes both liquid and solid fractions with the least handling and then disced in immediately after spreading will retain the most nitrogen. A laboratory analysis of the manure for nitrogen content is useful. Be sure to take an accurate sample of the manure (requires a composite of many samples throughout the pile or lagoon).

Generally, poultry manure is highest in nitrogen content, followed by hog, steer, sheep, dairy, and horse manure. Feedlot, steer manure requires fairly high rates to meet first-year nitrogen requirements because of its lower nitrogen percent and gradual nitrogen release characteristics.
However, this feature provides for more continued nitrogen availability in succeeding years, allowing for progressively lower annual application rates to meet plant requirements.
Faster nitrogen-release sources, such as poultry manure, require more constant and lower annual rates to maintain nitrogen availability.

The possible advantages of organic matter content and disadvantages of weed seed and salt content should be considered in using manure.

References

Azevedo, J. and P. R. Stout. Farm Animal Manures: an Overview of their Role in the Agricultural Environment. Univ. Of CA College of Agriculture Manual 44 (1974).

Bell, D. Chicken Manure as a Fertilizer. Univ. of CA Cooperative Extension, Riverside County bulletin (1971).

California Fertilizer Association. Western Fertilizer Handbook, 5th edition. Sacramento, CA (1975).

Christensen, L.P., A.N. Kasimatis, and F. L. Jensen. Grapevine Nutrition and Fertilization in the San Joaquin Valley. Univ. of CA Div. of Agric. Sciences publication 4087 (1978).
Meyer, R. D. Personal communication.

Pratt, P. F., E. Broadbent, and J. P. Martin. Using Organic Wastes as Nitrogen Fertilizers. California Agriculture, June 1972.

Rackman, R. L., N. C. Welch, and W. D. Shupe. Poultry Manure for Crop Fertilization. Univ. of CA Cooperative Extension, San Bernardino County bulletin (1965).