Fertilizer Placement

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Proper fertilizer placement can be as important as what kind of fertilizer you use. The first step, though, is a soil test to determine phosphorus and potassium needs and the use of realistic yield expectations to determine nitrogen. Once fertilizer needs are determined, fertilizer placement should be assessed.

Starter P (along with N) does not always lead to yield increases, but it can be an effective tool to enhance early season growth and reduce risks of losses associated with billbugs, competitive weeds, and summer droughts (see SoilFacts: Starter Phosphorus Fertilizer and Additives in North Carolina Soils: Use, Placement, and Plant Response, http://www.soil.ncsu.edu/publications/Soilfacts/AG-439-75.pdf). Use of starter fertilizers is more important in no-till since soil warming is delayed, and the cooler temperatures can reduce the rate of crop growth. For fields that already have very high soil test P levels (P-index >100), numerous North Carolina tests have shown there is no advantage to applying additional P in a starter band. Even most mineral soils testing greater than a 50 P-Index generally do not need starter P.

Fertilizer placed in contact with or too close to seeds and young plants can cause salt injury, resulting in poor stands and slow starts. Nonuniform broadcasting of fertilizer with shallow mixing just before planting may give streaks through the field due to delayed germination or seedling injury. Salt injury is most severe in dry weather or following light rains that dissolve the fertilizer salts and leave highly concentrated salt solutions in the root zone. Nitrogen and potassium salts account for most of this injury.

To reduce salt injury risk, a side-band placement of starter fertilizer at planting is generally preferred over application directly in contact with the seed, commonly referred to as “pop-up” placement. Good results are often achieved for seeded crops like corn, cotton, sorghum, and soybeans using a 2 by 2-inch placement, placing the fertilizer 2 inches to the side and 2 inches below the planted seed. The risk of salt injury is also related to the amount of salt applied. Generally, a maximum rate of 80 pounds per acre of nitrogen alone, K_2O alone, or a combination of nitrogen plus K_2O is suggested for 2 x 2 band placement. When a greater rate is necessary, make a split application; broadcast part and apply the remainder in the row at seeding. If side placement is not possible or practical and starter fertilizer is placed directly in the seed furrow, the maximum rate should be much lower; 5 gpa of typical starter solution products contain less than 20 pounds N plus K2O per acre and is the maximum rate that should be used. An alternative method is to broadcast fertilizer prior to planting, with thorough mixing into the soil preferred, except for conservation tillage systems. The lack of soil mixing is an additional reason that banded starters are advantageous with no-till management.

For tobacco, place the band 3 to 5 inches from the transplants. This distance reduces the chance of placing plants in fertilizer bands. If side placement equipment is not available, place the fertilizer deep in the row so it will be 3 to 5 inches below the roots of the transplants.

Seedlings of small grain or plants such as clovers, grasses, and alfalfa respond very early to phosphate; consequently, it can be advantageous to place phosphate close to the seed as is done with the conventional grain drill.

Livestock & Poultry Manure Production Rates and Nutrient Content

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The use of livestock and poultry manure as a fertilizer supplement in crop production has come full circle. Before the advent of inexpensive inorganic fertilizers, farmers routinely used manure to supply essential plant nutrients. Today, because of rising costs of commercial fertilizers and increasing emphasis on good manure management practices to protect water quality renewed interest has been focused on optimizing the nutrient benefits of manures.

Manure production and characteristics are influenced by on-farm management practices. For example, manure from open housing systems or from open storage ponds is diluted by rainfall. Drying and storing solid manures can increase ammonia loss and reduce the nitrogen content and fertilizer value. Microbial digestion in a waste treatment lagoon reduces total nitrogen by 50 to 85% and converts as much as 90% of the phosphorus to forms that settle into the sludge rather than remaining in lagoon liquid. All of the practices ultimately affect the total amount of recoverable nutrients that can be used in crop production.

Manure Production (Volume and Weights)

The total manure produced in volume or weight is related to the animal production system, the number of animals in that system, and the manure collection and treatment system. In liquid systems, the production of manure is often reported in gallons per animal per year or gallons per 1,000 birds capacity per year (Table 4-15). For dry or solid systems, the production is reported in tons per animal per year or tons per 1,000 birds capacity per year (Table 4-15).

Manure Nutrient Content

The manure nutrient content varies with animal age, diet, and waste (manure) management system. Nutrient data reported in Table 4-16 are statewide averages and may not reflect the actual nutrient content on any individual farm. Because of the variability of end products in the numerous different animal production and waste management systems manure must be sampled and analyzed within 60 days of application to land to determine its actual nutrient content. Manure samples can be analyzed for 11 essential plant nutrients for a nominal fee by the N.C. Department of Agriculture and Consumer Services. The Waste/Compost Analysis Laboratory (http://ncagr.gov/agronomi/uyrwaste.htm) provides details on collecting and submitting manure samples for waste analysis).

Plant Availability Coefficients

Two factors are important in the plant availability of nutrients in manure: mineralization potential and application method. Since the nutrients in manure are primarily in organic compounds, they must undergo microbial mineralization in order to become plant available. Once in the plant-available form, some nutrients are at risk of loss to the environment. For example, nitrogen is susceptible to gaseous losses due to volatilization of ammonia (a mineralized form of N). As a result, the availability of nitrogen for plant uptake is dependent on the mineralization potential of the manure. Further, the application method plays an important role in the availability of nutrients. Subsurface placement such as soil incorporation tends to reduce volatile losses whereas surface placement such as irrigation tends to increase volatile losses. Most nutrients including phosphorus and potassium are not subject to volatile losses, meaning the application method has minimal impact on their availability. Plant availability coefficients (Table 4-17) are used to estimate the nutrients that would be available to the first crop, taking into consideration both the mineralization potential and the application method.

Calculating On-Farm Availability of Manure Nutrients

Land application of manures is an integral part of the overall soil-fertility management strategy on many farms. For farm nutrient budgeting, an assessment of the nutrients available for plant utilization must be completed. Using Tables 4-15 through 4-17, the calculation is simple:

$$\textit{Total Plant Available Nutrients} = \frac{\textit{No. of Animals}}{\textit{Year}} \times \frac{\textit{Weight or Volume}}{\textit{Animal}} \times \frac{\textit{Total Nutrients}}{\textit{Weight or Volume}} \times \textit{Availability Coefficient}$$

For example, consider a 900-sow farrow to finish operation where the lagoon effluent is soil incorporated following application but before planting of a grain crop.

$$\textit{Total Plant Available N (PAN)} = \textit{No. of Sows} \times \frac{\textit{gallons}}{\textit{sows/year}} \times \frac{\textit{Total N}}{1,000\ \textit{gal}} \times \frac{\textit{X lbs PAN}}{\textit{lbs Total N}}$$

$$\textit{Total Plant Available N (PAN)} = 900 \times \frac{10,478\ \textit{gallons}}{\textit{sows/year}} \times \frac{3.6\ \textit{Total N}}{1,000\ \textit{gal}} \times \frac{0.6\ \textit{lbs PAN}}{\textit{lbs Total N}}$$

$$\textit{Total Plant Available N (PAN)} = 20,369\ \textit{lbs of N available for the grain crop in the first year}$$

This same calculation can also be performed for other nutrients such as P, Zn, and Cu.

Management Considerations

Always apply manure as close to the period of maximum plant demand for nutrients as possible. Base manure application rates on the available portion of the nutrients and not the total concentration. Do not apply more than the receiver crop needs since excessive amounts not only waste valuable nutrients but may result in surface and/or groundwater pollution. Nutrient management planning guidelines (http://nutrients.soil.ncsu.edu) should be used to determine if application rates should be based on N or P content. Monitoring of Zn and Cu may be needed to avoid accumulation in soils to toxic levels. Use soil testing (http://ncagr.gov/agronomi/sthome.htm) to predict nutrient and lime requirements and proper application rates of the manure. Use plant analysis (http:/ncagr.gov/agronomi/uyrplant.htm) to monitor the crop nutritional status (actual uptake of soil nutrients) and effectiveness of the nutrient management program.

Additional manure management information is available in at http://www.soil.ncsu.edu/publications/extension.htm

Table 4-15. Manure Volume and Weights in Typical North Carolina Animal Production Systems

Animal Production System	NCDA&CS Waste Code	Accumulated Manure
		gallons/animal/year[1]
Anaerobic Lagoon Liquid - Swine	**ALS (except Farrow-to-Wean)**	
Farrow-to-Wean (per sow)	ALF	3,203
Farrow-to-Feeder (per sow)		3,861
Farrow-to-Finish (per sow)		10,478
Wean-to-Feeder (per pig)		191
Wean-to-Finish (per pig)		776
Feeder-to-Finish (per pig)		927
Anaerobic Lagoon Sludge – Swine	**ASS**	
Farrow-to-Wean (per sow)		78
Farrow-to-Feeder (per sow)		94
Farrow-to-Finish (per sow)		382
Wean-to-Feeder (per pig)		6.7
Wean-to-Finish (per pig)		26.3
Feeder-to-Finish (per pig)		33
Dairy – Slurry	**LSD**	
Calf		1,876
Heifer		5,535
Milk Cow		7,749
		gallons/1,000 bird capacity/year[1]
Anaerobic Lagoon Liquid – Poultry	**ALP**	
Pullet (non-laying)		9,110
Pullet (laying)		22,201
Layer		25,373
Anaerobic Lagoon Sludge – Poultry	**ASP**	
Pullet (non-laying)		1,659
Pullet (laying)		4,147
Layer		4,739

Table 4-15. Manure Volume and Weights in Typical North Carolina Animal Production Systems

Animal Production System	NCDA&CS Waste Code	Accumulated Manure
		tons/1,000 bird capacity/year
Poultry Litter – Breeders	**HBB**	**24**
Poultry Litter – Broilers	**HLB**	
Whole House		7.2
Cake		4.0
Poultry Litter – Broiler Pullets	**HBP**	**7.2**
Poultry Litter – Layers	**HLL**	**24**
Poultry Litter – Layer Pullets	**HLP**	**24**
Poultry Litter – Turkeys	**HLT**	
Poult		5.3
Hen		17
Tom		25
Breeder		37
		tons/animal/year
Dairy – Scraped	**SSD**	
Calf		4.1
Heifer		12
Milk Cow		17
Beef – Scraped	**SSB**	
Stocker		1.5
Feeder		2.2
Brood Cow		3.0
Horse – Scraped	**SSH**	**9.1**

[1] To convert gallons to acre-inches, divide gallons by 27,154.

Table 4-16. Total Nitrogen (N), Phosphorus (P AS P_2O_5), and Potassium (K AS K_2O) from Manure Sources

Production System	NCDA&CS Waste Code	N	P_2O_5	K_2O
		pounds of total nutrient per 1,000 gallons[1]		
Anaerobic Lagoon Liquid - Swine	ALS			
Boar		3.6	1.4	8.3
Farrow-to-Wean	ALF	2.4	0.9	4.1
Farrow-to-Feeder		3.6	1.4	8.3
Farrow-to-Finish		3.6	1.4	8.3
Wean-to-Feeder		3.6	1.4	8.3
Wean-to-Finish		3.6	1.4	8.3
Feeder-to-Finish		3.6	1.4	8.3
Anaerobic Lagoon Sludge – Swine	ASS	20.4	30.6	7.5
Anaerobic Lagoon Liquid - Poultry	ALP	3.1	1.0	13.8
Anaerobic Lagoon Sludge - Poultry	ASP	24.4	38.1	10.3
Dairy - Slurry	LSD	16.7	9.1	15.4
		pounds of nutrient per ton		
Dairy - Scraped	SSD	11.2	7.0	9.8
Horse - Scraped	SSH	9.3	7.0	9.8
Beef - Scraped	SSB	13.0	8.3	13.6
Poultry Litter - Breeders	HBB	47.6	44.7	39.5
Poultry Litter - Broilers	HLB	57.8	40.0	48.6
Poultry Litter – Broiler Pullets	HBP	57.8	40.0	48.6
Poultry Litter – Layers	HLL	47.6	44.7	39.5
Poultry Litter – Layer Pullets	HLP	47.6	44.7	39.5
Poultry Litter - Turkeys	HLT	54.0	48.2	33.8

[1] To convert gallons to acre-inches, divide gallons by 27,154.

Table 4-17. First-Year Nutrient Availability Coefficients for Nitrogen (N), Phosphorus (P) and Potassium (K) from Manure Sources

		N		P		K	
Production System	**NCDA&CS Waste Code**	**Broadcast or Irrigated**	**Incorporated or Injected**	**Broadcast or Irrigated**	**Incorporated or Injected**	**Broadcast or Irrigated**	**Incorporated or Injected**
Aanerobic Lagoon Liquids							
Swine	ALS	0.5	0.6	1.0	1.0	1.0	1.0
Swine Farrow to Wean	ALF	0.5	0.6	1.0	1.0	1.0	1.0
Poultry	ALP	0.5	0.6	1.0	1.0	1.0	1.0
Other	ALO	0.5	0.6	1.0	1.0	1.0	1.0
Anaerobic Lagoon Sludges							
Swine	ASS	0.5	0.6	1.0	1.0	1.0	1.0
Poultry	ASP	0.5	0.6	1.0	1.0	1.0	1.0
Other	ASO	0.5	0.6	1.0	1.0	1.0	1.0
Slurries							
Beef	LSB	0.4	0.6	1.0	1.0	1.0	1.0
Dairy	LSD	0.4	0.6	1.0	1.0	1.0	1.0
Swine	LSS	0.4	0.6	1.0	1.0	1.0	1.0
Other	LSO	0.4	0.6	1.0	1.0	1.0	1.0
Scraped or Stockpiled Manure							
Beef	SSB	0.4	0.6	1.0	1.0	1.0	1.0
Dairy	SSD	0.4	0.6	1.0	1.0	1.0	1.0
Horse	SSH	0.4	0.6	1.0	1.0	1.0	1.0
Swine	SSS	0.4	0.6	1.0	1.0	1.0	1.0
Other	SSO	0.4	0.6	1.0	1.0	1.0	1.0
Poultry Litters							
Breeders	HBB	0.5	0.6	1.0	1.0	1.0	1.0
Broilers	HLB	0.5	0.6	1.0	1.0	1.0	1.0
Broiler Pullets	HBP	0.5	0.6	1.0	1.0	1.0	1.0
Layers	HLL	0.5	0.6	1.0	1.0	1.0	1.0
Layer Pullets	HLP	0.5	0.6	1.0	1.0	1.0	1.0
Turkeys	HLT	0.5	0.6	1.0	1.0	1.0	1.0
Other	HLO	0.5	0.6	1.0	1.0	1.0	1.0