Using Dairy Manure Compost for Forage Production

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Dairy Compost Utilization

Forage crops make up a significant part of the total agricultural land in Texas and provide a critical food supply for the livestock industry. Most improved forages, such as the improved bermudagrasses, have been selected for their response to fertilizer inputs. Providing an adequate and balanced nutrient supply to these crops is important to produce high yields of quality forage while optimizing economics. The kind and amount of fertilizer required for forage crops depends on the fertility status of the specific field, the management system, and whether compost or other organic nutrient sources are to be used along with inorganic fertilizer. However, accurate fertilizer recommendations can be made only if soil analysis results are available for each production field.

Livestock manures have been used for centuries in crop production systems as a source of nutrients and organic matter. However, raw manure typically has a high moisture content, which increases transportation costs and can be a significant source of soluble nutrients, viable weed seeds and fecal bacteria that may be conveyed to surface water in runoff. Increasingly, composting is being utilized to improve the characteristics of manure for beneficial reuse in crop production systems.

BENEFITS OF COMPOSTED MANURE

Composting is the biological decomposition of organic materials such as manure to a relatively stable endpoint. Fresh livestock manure is a mixture of urine and feces, varying in chemical and biological composition which is determined by the species of animal and their diet. Because bedding material is consequently harvested with raw manure during traditional collection practices, resulting compost contains additional components such as straw or sand. Biological activity, ventilation and heat generated during the composting process remove much of the moisture in raw manure, reduce odors, and kill most weed seeds and most disease microbes and parasites. In addition, composting reduces the total volume of manure by as much as 50%.

Nutrient concentrations can vary widely from one manure compost to another but their outcomes are beneficial when applied at appropriate rates.

Composted manure can be a significant source of essential plant nutrients including nitrogen, phosphorus, potassium, calcium, magnesium and sulfur, as well as, micronutrients such as zinc, iron, copper and manganese. To determine appropriate compost application rates, it is important to obtain laboratory nutrient analysis of the production field and selected compost product. Table 1 shows the average and range in nutrient concentrations in composts made from different materials. The ratio of nutrient concentrations in a compost product is rarely an exact fit for crop needs. In particular, an application of compost that meets nitrogen requirements will often provide excess phosphorus. As a result, compost application rate should be determined based

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on crop phosphorus requirements and a phosphorus free inorganic fertilizer should be utilized to complete crop nitrogen and/or potassium requirements.

Two of the most important nutrients in compost, nitrogen and phosphorus, typically are in organic forms in compost. Therefore, it is important to account for a slower release rate than is expected for inorganic fertilizer. Research using dairy manure compost in the production of warm-season grasses has indicated that nitrogen release rates are in the range of 30-35% of total N in the first year with decreasing rates the following years. As a result, fast growing, high nutrient demand crops typically require some amount of supplemental inorganic fertilizer to achieve optimum yields.

In addition to serving as a nutrient source, compost supplies stabilized organic matter, which is an important component of soils. Organic matter serves a special role in soils acting in the formation of very small soil clods, called aggregates, which improve soil structure and tilth, and increase water infiltration and water holding capacity. Organic matter also functions similar to clay in soils by increasing the cation exchange capacity, or the nutrient holding potential of a soil. Increasing soil organic matter with compost or other supplements is particular important for maintaining soil quality in cropping systems where most of the above-ground biomass is removed, such as through grazing, silage or hay.

Table 1. Average and range ( ) in nutrient values for various composts (McFarland, 2003; Risse, 2003; Brodie et al., 1996)

Compost Type	Dry Matter	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)
	%		lbs/ton	
Dairy Manure	**70 (58-80)**	**16 (11-23)**	**18 (6-31)**	**21 (8-48)**
Beef Manure	65 (54-72)	10	22	28
Poultry Litter	30 (22-36)	18 (11-25)	31 (11-52)	17 (10-21)
Municipal Solid Waste	40	24	15	6
Yard Trimmings	38	26 (6-84)	9 (2-23)	9 (1-65)

FORAGE NUTRIENT REQUIREMENTS

There are numerous species of forages with varying nutrient requirements, but they can be classified into two main groups: warm-season or cool-season. The most common warm-season grasses are bermudagrass, kleingrass, Old World Bluestems, and bahiagrass while the most common cool-season grasses are oats, rye, ryegrass, wheat, tall fescue, and tall wheatgrass.

The ratio of nutrients required is similar within each group, so yield potential is the primary factor determining differences in total nutrient requirements among the various species within a group. Typically, warm-season forages require 50 lb N, 14 lb P_2O_5, and 42 lb K_2O per ton of forage produced while cool-season forages require 60 lb N, 20 lb P_2O_5, and 32 lb K_2O per ton of forage produced (Table 2). The yield potential will vary slightly for species within a group. The major difference among warm-season grasses is that bermudagrass responds more to higher N rates compared to other grasses. The major factor determining bermudagrass yield potential is the amount of rainfall within a given year. In general, other introduced grasses have a maximum yield potential of approximately 4 ton/A.

Table 2. Estimated nutrient requirements for introduced warm-season and cool-season grasses (Texas A&M University Soil, Water and Forage Testing Laboratory)

Yield	Warm-Season			Yield	Cool-Season		
	N	P_2O_5	K_2O		N	P_2O_5	K_2O
tons DM/A	lbs/A			tons DM/A	lbs/A		
1	50	14	42	1	60	20	32
2	100	28	84	2	120	40	64
4	200	56	168	3	180	60	96
6	300	84	252	4	240	80	128
8	400	112	336				

The average nutrient values of dairy compost (Table 1: 16, 18, and 21 lbs/ton for N, P_2O_5, and K_2O, respectively) have been used along with the estimated nutrient requirements (Table 2) to develop the recommended compost use rates presented in Table 3. Most often, compost rates are calculated based on the phosphorus requirements of the crop and supplemental N is applied to balance the ratio of nutrients that the crop needs. Calculations developed in Table 3 used an estimated 75% phosphorus availability from compost.

This strategy is typically recommended to ensure that phosphorus levels added to the soil are not excessive. Listed rates may be multiplied by 2 or 3 to provide P for multiple years on sites where compost applications are thoroughly incorporated into the soil, or where surface applications have little potential for runoff. However, base application rates on annual crop phosphorus needs in watersheds that are nutrient impaired or on land that is subject to significant surface runoff. In addition, the use of buffer zones or filter strips is recommended where surface applications are made.

An estimated 30% N release was used to calculate the supplemental N rates presented in Table 3. If the carbon to nitrogen (C:N) ratio in compost is greater than 25:1 (or unknown) then supplemental inorganic N rates applied along with the compost may need to be increased accordingly. This is because when C:N ratios are greater than 25:1, soil microbes can tie up N to break down the organic C, which can lead to a N deficiency in the crop. Application of supplemental inorganic N will ensure that adequate N is available to supply the crop and to promote nutrient release from the compost.

Table 3. Estimated rates of compost application for production of warm-season or cool-season grasses based on P requirements and with recommended supplemental N rates

Warm-season Yield	Compost		Fertilizer	Cool-season Yield	Compost		Fertilizer
	Dry	Wet*			Dry	Wet*	
ton/A	ton/A		lbs N/A	ton/A	ton/A		lbs N/A
2	2.1	3.0	90	**1**	1.5	2.1	53
4	4.2	6.0	180	**2**	3.0	4.3	106
6	6.2	8.9	270	**3**	4.5	6.4	158
8	8.3	11.9	360	**4**	6.0	8.6	211

*Based on 30% moisture content in compost. Moisture content of compost may vary and should be determined to develop accurate rate recommendations.

Compost rates ranging from 16 to 32 wet tons/acre with supplemental N applied at rates of 50, 75 and 100 lbs/acre produced forage yields equal to a balanced (N:P:K) application of inorganic fertilizer at recommended rates. These studies indicated that compost supplied sufficient P to provide for the needs of the crop over two growing seasons. On some soils, supplemental K may be needed in the second season to obtain optimum yields. Annual soil testing should be used to determine supplemental inorganic K application rates.

SUMMARY

Manure compost can be a valuable addition to a crop production system by modifying and improving soil physical properties and serving as a source of plant nutrients. Because the ratio of N:P:K in compost is typically not an exact fit for crop needs and because the compost nutrient release rate is slow, supplemental inorganic fertilizer often will be required to produce optimum crop yields. Use soil testing to determine nutrient needs in each field and for each crop based on a realistic yield goal. In addition, test compost prior to use to determine the nutrient composition and predict nutrient supplying potential. Most often, base compost application rates on the phosphorus requirements of the crop, with supplemental inorganic nitrogen applied to meet expected crop demands.

Field studies conducted at the Stephenville Research Center have shown that dairy manure compost applied in combination with supplemental inorganic N can be effective for producing Coastal bermudagrass.