Using Dairy Manure Compost for Corn Production

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Dairy Compost Utilization

Corn is an important grain crop in Central Texas and the preferred silage crop due to its high yield and high-energy content. Corn silage can yield 20-25 tons of forage per acre based on 35% dry matter content. The kind and amount of fertilizer required for corn grain or silage will depend on the fertility status of the specific field, the cropping program, and whether compost or other organic nutrient sources will be used along with inorganic fertilizer. However, accurate fertilizer recommendations can be made only if soil test 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%.

Composted manure can be a significant source of essential plant nutrients, including nitrogen, phosphorus, potassium, calcium, magnesium and sulfur, as well as micronutrients as zinc, iron, copper and manganese. However, nutrient concentrations can vary widely from one manure compost to another. To determine appropriate compost application rates, obtain a 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 rates should be determined based 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, may be predominantly in organic forms in compost. Therefore, it is important to account for a slower release rate than is

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expected from 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 such as corn 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 particularly important for maintaining soil quality in cropping systems where most of the above-ground biomass is removed, such as corn 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)

CORN NUTRIENT REQUIREMENTS

Corn has a high demand for nitrogen (N), phosphorous (P_2O_5), and potassium (K_2O), because of its high yield potential and the amount of dry matter produced. Obtain regular soil tests to predict the amount and type of fertilizer needed. Corn yields are often limited by inadequate supplies of nitrogen because it is commonly the single most deficient nutrient in soils and is required in the greatest amounts. Corn extracts less than 15 percent of its seasonal nitrogen uptake before rapid vegetative growth begins, with maximum nitrogen use occurring just before pollination. Thus, split application of nitrogen fertilizer is often recommended to improve nitrogen use efficiency.

Typically, one third of the total N and all of the P & K are applied at planting and the remaining two thirds of the N is applied at the V5 to V8 growth stage (5 to 8 emerged leaves with collars present), which occurs about 25 to 35 days after emergence. Corn requires 1.2 lbs N per bushel when yields exceed 150 bushels; 1.1 lbs N per bushel for yields of 100 to 150 bushels; and 1 lb N per bushel for yields less than 100 bushels per acre.

Table 2 provides average nutrient requirements for corn grain and silage based on yield goal. For example, if corn is producing 150 bushels per acre, 165 lbs of N, 95 lbs of P_2O_5, and 140 lbs of K_2O are needed per acre. Likewise, a 25-ton yield of corn silage requires approximately 250 lbs of N, 100 lbs of P_2O_5, and 140 lbs of K_2O per acre. Continuous corn silage production may require an increase in N, P, and K fertilizer rates compared to conventional grain production due to removal of the whole plant and all the nutrients contained therein.

Average nutrient values for dairy compost from Table 1 (16, 18, and 21 lbs/ton for N, P_2O_5, and K_2O, respectively) can be used along with the estimated nutrient requirements for corn in Table 2 to develop the proposed compost use rates presented in Table 3. An estimated 35% N release rate for compost was used for the calculations. It is important to note that because compost nutrient concentrations vary, estimated rates listed in Table 3 should be adjusted based on nutrient analysis of compost and application site. If the C:N ratio of the compost is greater than 25:1 (or unknown) then supplemental N should be applied along with the compost. When the C:N ratio is greater than 25:1, soil microbes will tie up the N to break down organic matter, which can result in a N deficiency.

Table 2. Estimated nutrient requirements for corn grain and silage (Texas A&M University Soil, Water and Forage Testing Laboratory)

Grain Yield	N	P_2O_5	K_2O	Silage Yield*	N	P_2O_5	K_2O
bu/A		lbs/A		ton/A		lbs/A	
70	70	65	80	**5**	50	45	55
90	95	75	90	**10**	100	65	75
110	120	85	110	**15**	150	85	100
125	145	90	130	**20**	200	95	120
150	165	95	140	**25**	250	100	140
190	210	100	150	**30**	300	105	160

*Based on 35% dry matter content.

Based on the rates used in Table 3, a single application of compost typically will provide enough P & K for three or more growing seasons. However, the nitrogen based loading rate should only be used on soils testing very low or low in plant available phosphorus and with composts having a low salt index. Accumulation of soluble salts near seed can reduce germination and/or kill young seedlings.

Table 3. Estimated rates of compost application for production of corn grain or silage based on crop N requirements and assuming a 35% N release rate from compost

Grain Yield	Compost Rate		Silage Yield	Compost Rate	
	Dry	Wet*		Dry	Wet*
bu/A	tons/A		ton/A	tons/A	
70	12.5	17.9	**10**	17.9	25.5
110	21.4	30.6	**20**	35.7	51.0
150	29.5	42.1	**25**	44.6	63.8
190	37.5	53.6	**30**	53.6	76.5

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

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 4 are based on an estimated 75% phosphorus availability rate from compost.

It is recommended to use this strategy when nitrogen release rates of compost are not known, or when the soil test indicates that phosphorus levels are moderate or higher. Listed rates may be multiplied by 2 or 3 to provide P for multiple years from one single application on sites where compost will be applied and thoroughly incorporated into the soil. However, compost application rates should always be based on annual crop phosphorus requirements in watersheds of streams or lakes that are nutrient impaired or on land that is subject to significant surface runoff. Also, select a fertilizer with a low phosphorus value to provide the indicated supplemental N.

Table 4. Estimated rates of compost application for production of corn grain or silage based on P & K requirements and with recommended supplemental N fertilizer rates

Grain Yield	Compost Rate		Fertilizer	Silage Yield	Compost Rate		Fertilizer
	Dry	Wet*			Dry	Wet*	
bu/A	tons/A		lbs N/A	ton/A	tons/A		lbs N/A
70	4.8	6.9	43	**10**	4.8	6.9	73
110	6.3	9.0	85	**20**	7.0	10.0	161
150	7.0	10.0	126	**25**	7.4	10.6	209
190	7.4	10.5	169	**30**	7.8	11.1	256

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

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 crops such as corn and corn silage have a high nutrient demand, supplemental nitrogen in the form of 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 salt index. Compost application rates are most often based on the phosphorus requirements of the crop, with supplemental inorganic nitrogen applied to meet expected crop demands. Finally, avoid over application of nutrients such as hosphorus, whether from organic or inorganic sources, particularly in sensitive or impaired watersheds.