Using Dairy Manure Compost for Corn Silage

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INTRODUCTION

The dairy industry represents a significant component of the southern agricultural economy, having total sales in excess of $24.8 million (USDA, 2001). Erath County contains over 200 dairy cattle operations, each with an estimated 150,000 to 200,000 cows. With approximately 200,000 cattle in confined animal feeding operations (CAFOs) an estimated 1.8 million metric tons/yr of manure is created (Brazos River Authority, 1993). The USEPA, in a compilation of state reports, has identified agricultural runoff as the cause of impairment of 55% of surveyed river lengths and 58% of surveyed lake areas (USEPA, 1990). There are few options for disposing of waste thus fueling a controversy over the contamination of drinking water. The Upper North Bosque River watershed, located in Erath county, is a small, 160 km long ephemeral river that flows from north of Stephenville south to Lake Waco, and is the sole source of drinking water for about 150,000 people (Siebert, 2002).

Elevated levels of nitrogen (N) and phosphorus (P) concentrations have been reported in several reservoir and stream sites in the Upper North Bosque River watershed (McFarland and Hauck, 1999). As the concentrations of these nutrients increase, there is the potential for eutrophication, a condition where a body of water ceases to sustain a diverse ecosystem due to the concentrations of these nutrients. This promotes algal blooms and reduces dissolved oxygen causing “smelly water” or fish kills as well as human infections from pathogens in animal fecal material. Although many factors contribute to the eutrophication process, economically feasible controls relate to the supply of N and P (Stumm and Morgan, 1981). With potential health threats and an increasing concern about the environment, composting dairy cow manure has become an attractive option to turn problem materials and waste into a valuable product, which can then be returned to the land.

The objectives of this study were to 1) determine the optimal composted manure rate on corn silage and 2) evaluate two manure compost sources with varying levels of organic matter.

Materials and Methods

The field experiment was conducted in 2003, 2004, and 2005 at the Texas A&M Research and Extension Center at Stephenville, TX [32° 13', 38" N, 98° 12', 9" W and, 401 m elevation]. The experiment was arranged in a split-plot design with four replications arranged in randomized complete blocks (Hoshmand, 1994). The main plots consisted of varying rates of compost, while subplots consisted of varying rates of N.

In each year, plots consisted of four 9.14 m rows of corn with 0.91 m between rows and 1.52 m alleys between blocks. In 2003, the main plots consisted of four levels (0, 45, 90, and 135 Mg ha^{-1}) of a commercial source of composted dairy manure from Producers Compost, Stephenville, TX. In 2003 (Study I), Compost analysis averaged 15% OM, 78.2% dry matter (DM), 0.72% N, 0.39% P, and 1.57% K, which contained 5.11 kg N, 6.29 kg P_2O_5 , and 13.43 kg K_2O per wet Mg. Subplots consisted of two nitrogen levels (224 kg ha^{-1} and 336 kg ha^{-1}) applied as a 50/50 blend of ammonium sulfate and urea. These treatments were compared to a commercial fertilizer (336-224-112 kg ha^{-1} of N-P_2O_5-K_2O respectively) standard and a true standard (0-0-0). Nitrogen was applied as a blend of ammonium sulfate and urea 33.5-0-0-12, P was applied as triple super phosphate 0-46-0 and K was applied as muriate of potash 0-0-60.

In 2004 (Study II) main plots consisted of four levels (0, 45, 90, and 135 Mg ha^{-1}) of a commercial source of high quality composted dairy manure (HQC) from Organic Residual Reclamation, Dublin, TX, and three levels (0, 45, and 90 Mg ha^{-1}) of low quality composted dairy manure (LQC) from Producers Compost, Stephenville, TX. The HQC Compost analysis averaged 57% OM, 41.3% DM, 2.40% N, 0.45% P, and 1.36% K, which contained 8.99 kg N, 3.88 kg P_2O_5, and 6.13 kg K_2O per wet Mg. The LQC analysis averaged 17% OM, 74.1% DM, 1.13% N, 0.40% P, and 2.02% K, equivalent to 7.60 kg N, 6.14 kg P_2O_5, and 16.34 kg K_2O per wet Mg. The subplot treatments in 2004 consisted of 112, 224, 336 Kg ha^{-1} N. These treatments were compared to a commercial fertilizer check (336-224-112, 168-112-100 and 0-0-0 Kg ha^{-1} of N-P_2O_5-K_2O respectively). Compost was disked to incorporate into the top 15 cm soil approximately two months before planting along with a commercial application of $P_2O_5$and K_2O as recommended by the soil test. Half of the N fertilizer was applied the day of planting and the other half was surface applied one month after planting as NH_4NO_3.

Corn variety Triumph 2011RR was seeded (23,000 seeds/acre) in March each year, with a John Deere MaxEmerge 2 planter. After seeding corn in each year, weeds were controlled with a pre-emergent application of atrazine (2-chloro-4-ethylamino-6-isopropylamino-s-triazine) at 1.12 Kg ai ha^{-1}. Herbicide applications were applied at 262 kPa with a tractor-mounted sprayer equipped with flat fan nozzles (Teejet 8003 flat fan nozzle, Spraying Systems, Co., Wheaton, IL) at 140 L ha^{-1}. Weeds were also controlled with a post-emergent application of glyphosate [N(phosphonomethyl)glycine] at 1.54 kg ai ha^{-1}. Herbicides were applied at 207 kPa with a CO_2 backpack sprayer equipped with 4 flat-fan nozzles spaced 48.26 cm apart (Teejet 8002 flat fan nozzle, Spraying Systems Co., Wheaton, IL) at 140 L ha^{-1}.

At harvest, a 3.05 m section of the inner two rows in each subplot were hand-harvested at a 5.08-7.62 cm stubble height when kernels reached one-half milkline. A representative sample of three plants was ground through a three-way Chipper Shredder (MTD Products, Inc., Cleveland, OH.) and a representative sub-sample was collected. Each sample was oven dried at 55°C for three days. Yields were calculated on a DM basis and then converted to Mg ha^{-1} at 35% DM.

Dependent variables corn silage yield and nutritive values were submitted to analysis of variance where compost rate, N rate and year were considered fixed effects. A *P* value of 0.05 was used to determine significance. Where appropriate, multiple means were separated using $LSD_{0.05}$.

Results and Discussion

Compost Rate - Study I

Year X compost rate and year X N rate interactions were measured; therefore means are reported by year. Compost rate X N rate interaction and N rate effect were not apparent, thus means are pooled across main effects. In 2003 (growing season following compost application), corn silage yields increased as compost rate increased, when N was not limiting (Table 1). The low (45 Mg ha^{-1}) compost rate increased corn silage yield by 27% when compared to the no-compost control, which did not differ from the moderate (90 Mg ha^{-1}) compost rate. The high (135 Mg ha^{-1}) compost rate increased corn silage yields by 44% when compared to no compost application and 11% over the moderate (90

Mg ha^{-1}) compost rate. The moderate (39.7 Mg ha^{-1}) and high (135 Mg ha^{-1}) levels of compost were similar to the high, 336-224, 112, commercial fertilizer rate (40.1 Mg ha-1).

In 2004, (in the second growing season after application), the low, moderate, and high compost rates increased corn silage yields by 58-75% compared to the no compost rate (Table 1), however these three compost rates did not differ from each other. The two N rates evaluated (224 and 336 kg ha^{-1}) did not differ. Only the moderate (90 Mg ha^{-1}) compost rate was similar to the high, 336-224-112, commercial fertilizer rate.

In 2005, (in the third growing season after application), the low, moderate, and high compost rates increased corn silage yields by 39-69% compared to no compost application (Table 1), however these yields were 17-42% lower than the high commercial fertilizer rate. The two N rates evaluated did not differ from each other. Based on the results of this study, the optimal compost rate was 90 Mg ha-1, which was equivalent to the high commercial fertilizer treatment in the first and second growing season, however by the third growing season it yielded less than the commercial fertilizer, which indicates that compost would need to be reapplied after two seasons of corn silage.

Compost Quality by Rate - Study II

Interactions were observed between year and compost quality, thus data are reported by year. In 2004, (the first growing season after application), corn silage yields in the HQC plots yielded 7-18% higher than plots treated with LQC (Table 2). In 2004, the optimal LQC and HQC was measured when the compost rate was 45 Mg ha^{-1} for, a rate that yielded 38% more corn silage than when compost was not applied. The optimal

N rate for both LQC and HQC was 224 kg N ha^{-1}, which did not differ from 336 kg N ha^{-1}. The high commercial fertilizer rate (336-224-112) yielded 15% more corn silage than the LQC, but did not differ from the HQC in 2004.

In 2005, (the second season after application), the moderate and high rates of LQC yielded 9 and 15%, respectively, more corn silage than the same rates of HQC, which is the reverse of the previous year (Table II). The HQC apparently had greater nutrient release rates compared to the LQC in the first season, however these nutrients were not available the second growing season. In 2005, the optimal N rate was 224 kg N ha^{-1}, which did not differ from 336 kg N ha^{-1}. In 2005, only the moderate compost rate (90 Mg ha^{-1}) yielded equal corn silage to the high commercial fertilizer rate (336-224-112). The LQC averaged 43.4, 59.3, and 61.0 Mg ha^{-1} for no compost, low rate (45 Mg), and moderate rate (90 Mg ha^{-1}), respectively compared to the same rates of HQC which averaged 44.4, 59.6, and 62.7, respectively. When averaged across years, effect of compost on corn nutritive value did not differ (data not shown).

Table 1. Effect of dairy manure compost on corn silage during the 2003, 2004, and 2005 growing seasons, at Stephenvlille, TX.

	Growing Season		
Study I	2003	2004	2005
	Mg ha^{-1} @ 35% DM		
Compost Rate[a]			
135 Mg ha^{-1}	44.1 a[b]	65.2 a	56.4 a
90 Mg ha^{-1}	39.7 b	72.4 a	53.5 a
45 Mg ha^{-1}	39.0 b	67.6 a	46.5 b
0 Mg ha^{-1}	30.7 c	41.4 b	33.4 c
N rate			
224 kg N ha^{-1}	38.8 a	61.4 a	47.3 a
336 kg N ha^{-1}	38.0 a	62.0 a	48.4 a
Fertilizer[c]			
336-224-112	40.1 a	75.3 a	66.3 a
0-0-0	23.3 b	26.6 b	21.5 b

a Compost Applied in 2003

b Means within column and main effect followed by the same letter do not differ at the 0.05 significance level

c Commercial fertilizer applied kg N, P_2O_5, K_2O ha^{-1}

Table 2. Effect of compost quality on corn silage yields during the 2004 and 2005 growing seasons, at Stephenvlille, TX.

Study II	Growing Season 2004[a] LQC[c]	HQC	2005[b] LQC	HQC
Compost Rate	Mg ha^{-1} @ 35% DM			
135 Mg ha^{-1}	.	70.3 a[d]	.	52.4 a
90 Mg ha^{-1}	61.2 a B	72.4 a A[e]	60.7 a A	53.0 a B
45 Mg ha^{-1}	64.5 a B	69.6 a A	54.0 b A	49.5 b B
0 Mg ha^{-1}	47.1 b A	50.5 b A	39.6 c A	38.4 c A
N rate				
112 kg N ha^{-1}	.	63.0 b	.	45.0 b
224 kg N ha^{-1}	59.2 a B	67.6 a A	62.0 a A	50.0 a B
336 kg N ha^{-1}	56.0 a B	66.5 a A	61.9 a A	49.9 a B
Fertilizer[f]				
300-200-100	73.9 a	70.3 a	60.0 a	62.0 a
150-100-50	60.7 b	62.0 b	49.1 b	49.1 b
0-0-0	21.5 c	24.9 c	20.7 c	19.9 c

a First season after application
b Second season after application
c LQC, low quality compost; HQC, high quality compost
d means within column followed by the same lower case letter do not differ at the 0.05 significance level
e Means within year and row followed by the same upper case letter do not differ at the 0.05 significance level
f Commercial fertilizer applied kg N, P_2O_5, K_2O ha^{-1}

REFERENCES