

Effects of Spring and Fall Treatments of Surface-Applied vs. Incorporated Liquid Dairy Manure on Corn Yields, Nutrient Utilization, and Residue Cover in a No-Till System

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Objective

The objective was two fold: (1) to gain an understanding of the nutrient value of landapplied liquid dairy manure when used with a nitrogen (N) stabilizer through two application methods and two application timings, and (2) to determine the impact of the application timings and methods on the percent residue cover of this no-till farming operation.

Background

Cooperators:	Myron Wehr and Scott Lindsay	Fertilizer:	Liquid dairy manure: 11,800 gal/A
County:	Columbiana	Planting Date:	May 6, 2002
Nearest Town:	New Waterford	Planting Rate:	34,200 seeds/A
Soil type:	Wooster silt loam, 0 to 5% slope	Row Width:	30-inch
Tillage:	No-till	Herbicides:	PRE: Balance Pro 1.9 oz/A, Leadoff 1 qt/A, Roundup 1 pt/A
Previous crop:	Double crop soybeans	Harvest Date:	October 21, 2002
Variety:	Pioneer 34K77		

Methods

Eight treatments were combinations of two application timings (fall and spring) of two application methods (surface applied and incorporated) using two manure types (manure with and without a nitrogen (N) stabilizer). These were compared with two fertilized controls (corn grown with a normal N package (120 lb N/ A as 32% plus Zn and Ca) and the other with the normal N package containing the N stabilizer Guardian®). The 10 treatments were replicated four times in a randomized complete block design. Individual treatment plots were 30 feet wide and 500 feet long. The manure volume remained constant at 11,800 gal/ acre, which was well within the standards set by the Natural Resource Conservation Service (NRCS) for the soil type, slope, etc., at the research site. A 10-foot AerWay® application toolbar pulled behind a 2,600 gal Husky® slurry tank was used to apply all manure.

Four pairs of comparisons, i.e., contrasts, were made to analyze the data collected in this trial: (1) surface applied vs. incorporated, (2) stabilizer present vs. no stabilizer, (3) manure vs. spring-liquid N, and (4) fall manure vs. spring manure.

Results

Monthly rainfall totals were May 3.95"; June 4.00"; July 0.6"; August 1.8"; September 0.9" for a season total of 11.25 inches. Nearly all the rain in May occurred between planting and emergence leading to heavy crusting of the disturbed soil in the newly incorporated plots. The plots then experienced a severe drought receiving only a small amount of rain from July through September.

Table 1. 2002 Corn Yields, Plant Populations, Soil Nitrate N, Plant Tissue N, and Compaction Changes by Treatment.

Compaction Changes by Treatment.								
Trt. code ^a	Corn Yield (bu/A)	Plant Pop. 5/30/02 (plants/A)	Soil NO ₃ -N Change 10/11/01 to 11/15/02 (ppm)	Plant Tissue Analysis 8/6/2002 (%N)	Stalk N 10/26/02 (ppm)	Soil Compaction change at 0-8" (psi)	Soil Compaction change at 8-14" (psi)	Soil Compaction change at 14-20" (psi)
SS	81.3	22,917	7.7	2.6	1,241	18.53	11.2	86.4
FS	77.9	26,583	-0.9	2.9	1,130	87.1	62.1	71.2
FS-G	77.3	28,833	1.1	2.9	1,961	26.04	20.6	83.4
SS-G	77	23,813	4.5	2.6	1,396	31.04	-38.6	-64.2
FI	76.4	28,250	4.4	2.7	2,068	-13.07	-15.1	-32.4
N-G	72.1	28,500	4.7	3	2,492	46.83	-14.5	-46.8
FI-G	72.1	28,250	11	3.1	2,256	-31.8	-10.8	37.6
N	67	28,250	9.7	2.7	2,542	20.23	33.5	17.5
SI-G	49.3	13,792	5.8	2.7	2,898	45.2	-35.2	62.5
SI	44.1	12,438	3.5	2.7	3,281	13.07	14.7	93.8

^aTreatment code

FS = Fall, Surface Applied

SS = Spring, Surface Applied

FI = Fall, Incorporated

SI = Spring, Incorporated

FS-G = Fall, Surface Applied with Guardian®

SS-G = Spring, Surface Applied with Guardian®

FI-G = Fall, Incorporated with Guardian®

SI-G = Spring, Incorporated with Guardian®

N = Nitrogen applied at Planting with no Stabilizer

N-G = Nitrogen applied at Planting with Guardian®

Corn Yields

Yield data showed no significant difference among the treatments with or without the use of the nitrogen stabilizer. There was a highly significant difference ($P > F = 0.0000$) between yields in the surface-applied treatments averaging 78.4 bu/ A compared to incorporated treatment yields averaging 60.5 bu/ A. Also significant ($P > F = 0.004$) was the difference between fall-applied manure treatment yields of 76.0 bu/ A and springapplied manure treatment yields of 62.9 bu/ A.

Yields appeared to be associated with the low emergent plant populations within the different experimental treatments. Average plant population in the fall manure treated plots (27,979 plants per acre) was significantly ($P > F = 0.000$) higher than spring surface-applied average population at 18,240 while spring incorporated plots showed an average population of 13,114 plants per acre.

Nitrogen Utilization

Soil and plant tissue nitrogen data were collected and analyzed to provide an understanding of how much N was available during the critical periods of N uptake by the corn crop. However, the data showed inconclusive results, possibly due to the effects of the climatic conditions experienced. Stalk N tests showed no significant pair-wise difference among the means for the 10 treatment types. Soil tests were collected before fall manure application, at pre side-dress nitrogen timing, and post-harvest. Soil nitrate N data collected at pre side-dress timing showed no significant pair-wise differences among the means of the different treatment types. When comparing change or increase of soil nitrogen from the 10/ 11/ 01 to 11/ 15/ 02, there were no significant differences by the four main contrast comparisons. However, there were significant pairwise differences between individual treatments as noted in Table 2.

Table 2. Change or Increase in Soil Nitrogen from 10-11-01 to 11-15-02 by Treatment.^a

Manure Application Treatment	Soil NO₃-N Change^a 10/11/01 to 11/15/02 (ppm)
Fall, Incorporated with Guardian®	11.0 a
Nitrogen applied at Planting with no Stabilizer	9.7 ab
Spring, Surface Applied	7.7 abc
Spring, Incorporated with Guardian®	5.8 abc
Nitrogen applied at Planting with Guardian®	4.7 abcd
Spring, Surface Applied with Guardian®	4.5 abcd
Fall, Incorporated	4.4 abcd
Spring, Incorporated	3.5 bcd
Fall, Surface Applied with Guardian®	1.1 cd
Fall, Surface Applied	-0.9 d
LSD (0.05)	6.7
F test	2.5

^aMeans followed by the same letter are not significantly different from each other.

Residue Cover

Residue cover was closely monitored to track the impact of the treatments. The cooperating landowner/ operator follows a strict no-till production system. Data were collected and evaluated to determine the best application method and timing to provide the necessary nutrients without disturbing the no-till production system. Average residue cover never dropped below the NRCS standard on no-till operations of 33% residue cover post-planting. The initial cover of 73% was due to wheat stubble followed by double-crop soybeans in the research plot area. Residue counts taken after manure application and planting revealed a residue cover range of 36% to 47% with fall incorporation being the lowest percentage cover (36%) while the plots receiving no manure application showed the highest post-planting percentage cover (47%). Comparison of the four manure application schemes showed no significant difference in residue cover, thus the incorporation method of manure application did not reduce the residue cover below the 33% cover standard set for no-till cropping systems.

Soil Compaction

Soil compaction readings were taken before manure application, at post-application, and at post-planting at depths of 0 to 8", 8 to 14", and 14 to 20". There were no significant differences among soil compaction readings at any depth for the different application timings or methods.

Summary

Yield averages by treatment ranged from a low of 44 bu/ A for the spring-incorporated plots to 81 bu/ A for the spring surface plots. The fall treated plots showed no significant difference between surface and incorporated treatments and averaged 75.9 bu/ A. The manure application rate was calculated to produce a yield of 140 bu/ A corn. We believe these extremely low yields are due to climatic conditions that were beyond our control. The rain in May produced severe crusting of the soil surface, especially on the spring incorporated plots. The AerWay® incorporating tool was run in other (non-plot) areas with no manure applied, and the same low populations and yields resulted. We suspect that manure in the seed germination zone may have contributed to the greater than 50% reduction in plant emergence in the spring-incorporated plots. During July through September, we experienced a severe drought. Excessive spring rain and unseasonably cold weather affected plant populations, causing highly variable yield results. Drought conditions resulted in low overall yields.

However, the cooperating farmers see value in the research and wish to conduct another year of research with slight modifications to the process utilized in 2001-2002. Our results showed that, despite reduced plant populations, the spring surface-manure applications resulted in the highest yields (79.2 bu/ ac). We believe that under "normal" conditions, spring incorporation of manure could result in no-till corn yields comparable to those achieved with chemical fertilizers and the best retention of N for future crops. We need more research to quantify the impact of manure incorporation timing and methods on no-till corn emergence and population. For 2003, we are again conducting research on the utilization of manure N under different application timings and application methods. We will be excluding the use of the nitrogen stabilizer in all manure plot treatments.

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