Effects of Spring Incorporated Liquid Dairy Manure Versus Spring Surface Applications and the Role of Starter Fertilizer on Nitrogen Utilization, Residue Management and No-Till Corn Yields in Northeast Ohio.

Ernest F. Oelker, Extension Educator, Agriculture and Natural Resources, Ohio State University Extension, Columbiana County, Ohio
Gary W. Graham, Extension Specialist, Natural Resources, Ohio State University Extension Center at Wooster, Wooster, Ohio

Objectives:

Objectives were; (1) To measure the effects of two manure application methods on nutrient utilization and corn yield, (2) To measure the effects of application methods and timings on the percent residue cover of this no-till farming system, (3) To measure the effects of starter fertilizer on nutrient utilization and corn yield.

Background:

Manure nutrient recycling and utilization is extremely important to Columbiana County and Ohio. Ohio has approximately 265,000 mature dairy cows that produce more than 4,000,000 gallons of liquid dairy manure per day, not including milk house, silage, replacement cattle or other waste streams from the dairies. Previous studies in Columbiana County and other locations suggest that farmers could improve utilization of nutrients in liquid manure while reducing crop input costs by incorporating manure instead of surface spreading. Yet it appears most liquid manure is still surface applied in Ohio.

This is the third year of applied research on this farm located in Fairfield Township of Columbiana County.
Year 1: The 2002 crop year effects of fall and spring manure applications, incorporated and surface-applied, on surface residue, plant population, soil nitrogen, plant tissue composition and yield of no-till corn were measured. An Aerway® manure distributor, pulled behind a 2,600 gallon Husky® tank was used to apply 11,800 gallons of liquid dairy manure per acre. Extremely dry weather in 2002 limited yields to an average of 69 bu/acre. Due to extremely heavy spring rains, the spring incorporated manure plots resulted in severely reduced final plant populations averaging 13,115 plants per acre, compared to an average of 26,924 plants per acre for the other treatments.

Year 2: For the 2003 crop year the Aerway® manure distributor was again utilized and a Balzer® 6,350 gallon tank with four shank injector was added to apply 11,800 gallons of liquid dairy manure per acre in both late-fall and spring applications, incorporated and surface spread. Yields for the 2003 crop year averaged 160 bu/acre over all plots. Yields from incorporated manure plots were significantly higher than yields from surface applications. Yields from spring-incorporated plots were not significantly different from fall-incorporated plots. There was no significant difference between plots treated with the Aerway® tool and the Balzer® tool.

Cooperators: Myron Wehr and Scott Lindsay
County: Columbiana
Nearest Town: New Waterford
Soil Type: Canfield Silt Loam, 0-5% Slope
Tillage: No-till
Soil Test Values: pH 6.22 – 6.73
P 21 – 73 PPM **K** 69 – 167 PPM

Previous Crop: Wheat
Corn Variety: Pioneer 36M28
Planting Date: May 6, 2004
Planting Rate: 34,000 seeds /ac
Row Width: 30 inches
Harvest Date: October 4, 2004

Herbicide: PRE: 1qt. Glyphosate , 1 qt Atrazine, 1.88 oz. Balance Pro, .11 gal
Fertilizer: Starter Plots: 6 gal/ac 9-18-9 liquid in the row
Liquid Dairy Manure: 9,111 gal/ac (125 lb/ac available N)
Non-Manure Plots: 6 gal/ac 9-18-9 liquid in the row + 125 lb/ac actual N applied at planting as liquid 32%

Methods:

Year 3: In 2004, all manure applications were made on April 19. A Balzer® 6,350 gallon tank with four-shank injector was used to make 2 manure application treatments consisting of: (1) surface-applied with the Balzer® sweeps discharging on top of the ground, and (2) incorporated with the Balzer® sweeps 6 to 8" below the surface. There were 6 treatments each replicated four times in a randomized complete block design for a total of 24 plots including the control plots. Each individual treatment plot was 30 feet wide by 540 feet long. The 6 different treatment types were possible because half of the manure plots received liquid starter fertilizer. These manure treatments were compared to each other as well as to two 32% liquid N fertilized controls; (Control-1) corn grown with the cooperator's normal N package (125 lb N/ac as 32% liquid N applied at planting), and, (Control-2) corn grown with the normal N package plus the N stabilizer Guardian®.

Manure applications remained constant at 9,111 gal/ac, providing approximately 125 lb/ac actual N, which is within guidelines set by the Natural Resources Conservation Service (NRCS) and the Ohio Department of Agriculture Livestock Environmental Permitting Program for the soil type, slope, etc. at the research site (can be found in Appendix A,- Land Application Restrictions – of rule 901:10-2-14 of the Ohio Administrative Code and Table 2 Appendix E of the rule). Analysis for agitated liquid dairy manure was as follows: 8.04 total percent solids; 4.81 total percent N; and 25,591.6 ppm ammonia N. Manure application rates were calculated based on the following assumptions; (a) 50% of manure ammonia N is available to the crop in the year applied, (b) 33% of manure organic N is available to the crop in the year applied, and (c) the cooperator's well-proven nitrogen management program of 125 lb N/ac from 32% liquid N at planting.

Data were collected and comparisons were made (standard *t* test) to analyze the effects of; (1) surface applied manure vs. incorporated manure, (2) manure vs. liquid N, and (3) liquid N with stabilizer vs. no stabilizer on the following parameters: no-till corn yield, plant population, plant tissue percent nitrogen, soil nitrate and ammonium-nitrogen, and percent crop residue cover. These same parameters have been tracked all three years of the research project.

<u>2004 Research Results:</u>

Rainfall:

In year 1 (2002) heavy rains occurred in May and June, followed by severe drought conditions for the remainder of the growing season. Year 2 (2003) saw rains at times heavy throughout the growing season, and rainfall totaled 33.1 inches from May 1 through September 30. Year 3 (2004) brought heavy rains much like the 2002 season except the rains remained heavy (1" to 2" per event) all season. Despite several extremely heavy (greater than 4" within several hours) rainfall events no surface runoff of manure was observed from the plots. Rainfall totaled 36.8 inches from May 1 to September 30 in 2004.

Corn Yields:

Corn yields averaged 148 bu/acre over all treatments. Moisture content of the harvested plots ranged from 23.0 – 26.4%. Corn from surface manure treated plots was significantly higher in moisture than corn from liquid nitrogen plots (25.2 vs. 24.1 percent), (p=0.0015). Corn from incorporated manure plots was also significantly higher in moisture than corn from liquid nitrogen plots (24.9 vs. 24.1percent), (p=0.061). Yields from conventional N plots (169 bu/ac) were higher than those from incorporated manure applications (156 bu/ac) , (p = 0.0347), which were higher than yields from surface manure applications (118 bu/ac), (p = <0.0001). Starter fertilizer had no significant affect on corn yields, either in manure or conventional fertilizer plots.

Nitrogen Utilization:

Soil and plant tissue nitrogen data were analyzed to gain an understanding of how much nitrogen was available during the critical periods of N uptake by the corn crop. Manure applications had no significant affect on soil nitrate N content as shown by before-and-after application comparisons (Table 1).

Pre-side dress soil nitrate N and total soil inorganic N were significantly lower where manure was surface applied, compared to incorporated manure (p = 0.0174) plots and conventional nitrogen (p = 0.0173) plots in 2002 and 2003. However, this relationship did not hold true in 2004. Corn yield was highly correlated with plant tissue percent N. Corn yield was not highly correlated with pre-side dress soil ammonium N, pre-side dress soil nitrate N and total inorganic soil N (Table 1), although these correlations were high in 2004..

Stalk nitrate N values from all manure treated plots (incorporated and surface spread) were significantly higher (p = < 0.0001) than stalk nitrate N values from conventional N plots.

Table 1: 2004 Data Summary: Effect of Liquid Dairy Manure Applications, with or without Starter Fertilizer on No-Till Corn Yields, and associated parameters including Tests of Significance[1]

		Treatment Code[2,3]						
		SSNS	**SSS**	**SINS**	**SIS**	**LN**	**LNG**	*Overall Average*
Corn Yield *10-4-04*	*bu/ac*	117.58_{a}	121.30_{a}	158.41_{bc}	156.09_{b}	170.25_{c}	166.58_{c}	*148.37*
Soil NO_3 Change *11-03 to 11-04*	*ppm*	$+2.99_{a}$	$+0.61_{a}$	$+0.42_{a}$	$+0.65_{a}$	$+0.64_{a}$	$+2.35_{a}$	*+1.28*
Crop[4] Residue *5-16-04*	*% Cover*	67.25_{a}	61.8_{a}	51.0_{bc}	51.0_{bc}	62.5_{ac}	63.5_{a}	*58.37*
Plant Population *6-11-04*	*#/ac*	$27{,}250_{a}$	$25{,}500_{a}$	$23{,}375_{a}$	$25{,}125_{a}$	$27{,}000_{a}$	$25{,}500_{a}$	*25,625*
Pre-Side Dress Soil Nitrate N *6-24-04*	*ppm*	12.46_{a}	13.78_{a}	17.18_{a}	13.94_{a}	15.91a	16.46a	*14.95*
Pre-Side Dress Soil Ammonia *6-24-04*	*ppm*	.24a	.28a	.29a	.28a	.26a	.27a	*.27*
Pre-Side Dress Soil Total Inorganic N *6-24-04*	*ppm*	12.70_{a}	14.05_{a}	17.47_{a}	14.34_{a}	17.17_{a}	16.84_{a}	*15.43*
Plant Tissue *7-20-04*	*ppm*	1.65_{a}	1.64_{a}	2.35_{b}	2.28_{b}	2.43_{b}	2.20_{b}	*2.08*
Stalk NO_3N *9-29-04*	*ppm*	218.3_{a}	215_{a}	220.9_{a}	202.8_{a}	134.2_{b}	149.5_{b}	*194.2*
Corn Percent Moisture *10-04-04*		25.3_{a}	25.18_{ac}	25.22_{ac}	24.62_{ab}	23.72_{b}	24.42_{bc}	24.7

[1]Means in the same row followed by the same letter are not significantly different from each other. LSD (0.05)

[2] Treatment Code

- **SSNS** = Spring, Surface Manure Application, Balzer® Implement, No Starter Fertilizer
- **SSS** = Spring, Surface Manure Application, Balzer® Implement, 6 gal/acre 9-18-9 Starter Fertilizer
- **SINS** = Spring, Incorporated Manure Application, Balzer® Implement, No Starter Fertilizer
- **SIS** = Spring, Incorporated Manure Application, Balzer® Implement, 6 gal/acre 9-18-9 Starter Fertilizer
- **LN** = Liquid 28% Nitrogen, Applied at Planting with No Stabilizer, 6 gal/acre 9-18-9 Starter Fertilizer
- **LNG** = Liquid 28% Nitrogen, Applied at Planting with Guardian® Stabilizer, 6 gal/acre 9-18-9 Starter Fertilizer

[3] All manure application treatments applied 4-19-04 at 9,111 gal/ac (125lb/ac available N)

[4] Crop residue cover post-planting, (All plots averaged 64% residue cover before manure application)

Crop Residue Cover:

Crop residue cover on all plots remained above the NRCS standard on no-till operations of 20% residue cover post-planting (Table 1) as measured by the NRCS guidelines. The initial residue cover average of 64% consisted of wheat stubble. Incorporated residue counts averaged 51.0% residue cover, while surface applied averages were 64.5% residue cover. The lowest post planting residue cover was recorded within the spring incorporated manure plots (51.0%), compared to 63.0% average residue cover post-planting for the non-manure-treated plots).

Conclusions:

Based upon our three years of research, we conclude that equipment and application methods are available to effectively incorporate liquid dairy manure on no-till fields while maintaining adequate residue for the no-till system. There was no significant interaction between method of application and season of application in effect of manure applications on subsequent corn population. However, raw data suggest that growers may want to consider increasing seeding rates and using fungicide-treated seed in planting situations closely following spring manure applications. Yields from non-incorporated manure applications were significantly lower than those achieved with incorporated manure.

Corn yields comparable with those achievable with chemical nitrogen fertilizer can be produced with liquid dairy manure as the only nitrogen source provided the manure is incorporated at application. In 2004, manure application rates were reduced to 9,111 gal/ac to better equate to the cooperators standard liquid N package providing 125 lbs of actual N per acre. The reduced application rate produced significantly lower yields (10 – 14 bu/ac) for 2004. However, corn yields from incorporated manure applications of 11,800 gal/ac in 2003 research plots were 8 bushels per acre higher than corn yields resulting from the cooperator’s proven chemical nitrogen fertilizer package.

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For more information, contact:

Ernest Oelker
Ohio State University Extension,
Columbiana County
7876B Lincole Place
Lisbon, Ohio 44432
330-424-7291
oelker.2@osu.edu

Gary Graham
Ohio State University Extension
Center at Wooster
OARDC Old Administration Bldg.
1680 Madison Avenue
Wooster Ohio 44691
330-263-3799
graham.124@osu.edu

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Appendix A,- Land Application Restrictions – of rule 901:10-2-14 of the Ohio Administrative Code and Table 2 Appendix E of the rule.

USDA-NRCS Ohio (August, 1999) Revised Universal Soil Loss Equation (RUSLE), Technical Guide, Section I, Erosion Control.