Coupling Manure Application and Cover Crops

J.W. Singer, C.A. Cambardella, T.B. Moorman, J.L. Kovar, and M.D. Tomer
National Laboratory for Agriculture and the Environment, Ames, IA

Background

- Research in Iowa has found that a cereal rye cover crop reduced NO_3-N load by 61% compared to a no cover crop control in a corn-soybean rotation (Kaspar et al., 2007, JEQ).

Table 1. Literature summary of percent reduction in N leaching losses due to cereal rye, ryegrass, or winter wheat cover crops. Adapted in part from Meisinger et al. (1991).

Reference	Location	Cover Crop	% Reduction in N leaching
Morgan et al., 1942	Connecticut, U.S.	Rye	66
Karraker et al., 1950	Kentucky, U.S.	Rye	74
Nielsen & Jensen, 1985	Denmark	Ryegrass	62
Martinez & Guirard, 1990	France	Ryegrass	63
Staver & Brinsfield, 1990	Maryland, U.S.	Rye	77
McCracken et al., 1994	Kentucky, U.S.	Rye	94
Wyland et al., 1996	California, U.S.	Rye	65-70
Brandi-Dohrn et al., 1997	Oregon, U.S.	Rye	32-42
Ritter et al., 1998	Delaware, U.S.	Rye	30
Kladivko et al., 2004	Indiana, U.S.	Wheat+less fert.	61
Jaynes et al., 2004	Iowa, U.S.	Rye	62
Strock et al., 2004	Minnesota, U.S.	Rye	13

Background Con't

- Estimates attribute about 14% of the total nitrate load in the Mississippi River Basin to manure N.
- Coupling manure injection with cover crops may reduce off-site nutrient loss and foster increased nutrient cycling, in addition to other cover crop benefits.

Cover Crops

Cover crops function to reduce soil erosion, increase water infiltration, decrease water runoff, conserve soil water, increase soil organic matter, reduce soil compaction, reduce nitrate leaching, supply nitrogen to subsequent crops, suppress weeds, attract beneficial insects, and other functions.

Experimental Details

- RCBD with four replicates conducted in fall 2005-spring 2006 and 2006-2007.
- Cereal rye(70%)/oat(30%) cover crop (CC).
- Treatments included no CC no manure, CC no manure, manure no CC, and CC with manure at different target rates.
- Target manure N rates 100, 200, and 300 lb/acre.
- Narrow profile knife injected swine slurry about 8 inches.

Field Activities	Dates
Cover crop seeded	8/31/05 and 9/8/06
Manure applied	10/11/05 and 10/25/06
Fall cover crop biomass sampling	11/21/05 and 11/16/06
Spring cover crop biomass sampling	4/17/06 and 4/20/07
Cover crop killed	4/18/06 and 4/20/07
Corn planted	4/26/06 and 5/11/07

Target manure N rate	Fall 2005		Fall 2006	
	N applied	P applied	N applied	P applied
	lb/acre			
100	109	61	105	30
200	189	105	207	60
300	285	158	298	86

Ammonia-N in 2005 55% of total N
Ammonia-N in 2006 67% of total N

Fall Cover Crop Performance

Treatment	Dry Matter	N Uptake	P Uptake	K Uptake
	lb/acre			
CC NM	333	9.0	1.3	6.5
CC M 100	229	7.4	1.1	4.7
CC M 200	247	8.0	1.3	5.4
CC M 300	263	9.0	1.2	5.6
	P > t			
CC NM vs. CC M†	0.0013	0.2831	0.0746	0.0316
CC M 100 vs. CC M 200	0.5327	0.5273	0.1685	0.3809
CC M 200 vs. CC M 300	0.6060	0.3691	0.4647	0.6867
CC M 100 vs. CC M 300	0.2592	0.1326	0.5049	0.2056

†CC M includes the 100, 200, and 300 treatments.

Singer et al., Agronomy J. 2008

The archived presentation is available at:
http://www.extension.org/pages/Manure_Nutrients,_Cover_Crops,_and_Slurry_Seeding

Fall Cover Crop Plant Densities

Treatment	Disturbed	Undisturbed	Mean
		plants/ft^2	
CC NM	-	13.7	13.7
CC M 100	5.5	13.5	9.5
CC M 200	8.4	14.3	11.3
CC M 300	7.2	12.9	10.0
		P > t	
CC NM vs. CC M†	-	0.8469	< 0.0001
CC M 100 vs. CC M 200	0.0102	0.4301	0.0417
CC M 200 vs. CC M 300	0.2567	0.1825	0.1426
CC M 100 vs. CC M 300	0.1045	0.5752	0.5314

†CC M includes the 100, 200, and 300 treatments.

Spring Cover Crop Performance

Treatment	Dry Matter	N Uptake	P Uptake	K Uptake
		lb/acre		
CC NM	1067	31.8	5.9	26.8
CC M 100	1045	41.2	6.3	30.1
CC M 200	1344	57.9	9.2	39.9
CC M 300	1356	61.9	9.2	40.6
		P > t		
CC NM vs. CC M†	0.0923	< 0.0001	0.0150	0.0063
CC M 100 vs. CC M 200	0.0267	0.0028	0.0153	0.0252
CC M 200 vs. CC M 300	0.9273	0.4399	0.9992	0.8655
CC M 100 vs. CC M 300	0.0218	0.0004	0.0153	0.0172

†CC M includes the 100, 200, and 300 treatments.

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Average Sidedress Nitrogen

Treatment	lb N/acre
No CC, No Manure	151
CC, No Manure	151
Manure 200 lb N/ac, no CC	90
CC+manure @100 lb N/ac	90
CC+manure @200 lb N/ac	90
CC+manure @300 lb N/ac	30

Corn Grain Yield

Treatment	Grain yield
	bu/acre
No CC NM	160
CC NM	153
CC M 100	169
No CC M 200	183
CC M 200	176
CC M 300	173
	P > t
NM vs. M†	< 0.0001
No CC NM vs. CC NM	0.1193
No CC M 200 vs. CC M 200	0.1801
CC M 100 vs. CC M 200	0.1873
CC M 200 vs. CC M 300	0.6049
CC M 100 vs. CC M 300	0.4167

†NM includes No CC NM and CC NM and M includes CC M at 100, 200, and 300 and No CC M 200 treatments.

Ongoing Research

- Compare cover crop nutrient uptake in low vs. high disturbance manure injection systems.

- Quantify fate of manure N and the cumulative effect of coupling manure and cover crops on nutrient cycling.

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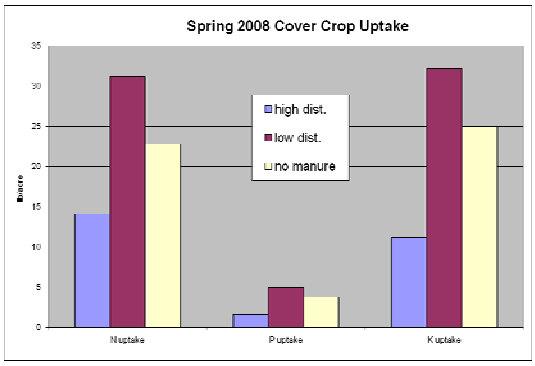
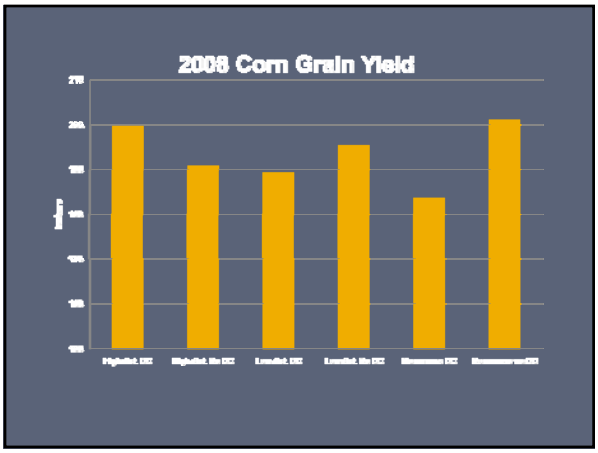
Fall Cover Crop Plant Densities

Treatment	2007	2009
	——plants ft^{-2}——	
High disturbance	6	10
Low disturbance	11	13
No manure	12	15



Target 150 lb manure N/acre, about 6000 gal/acre



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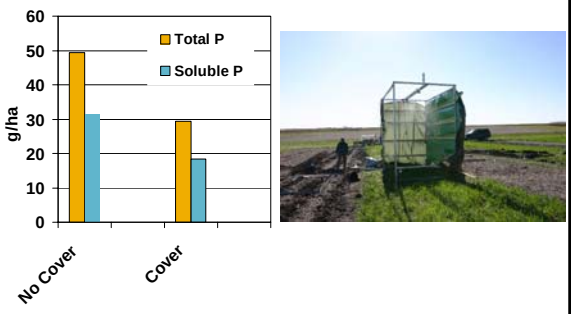
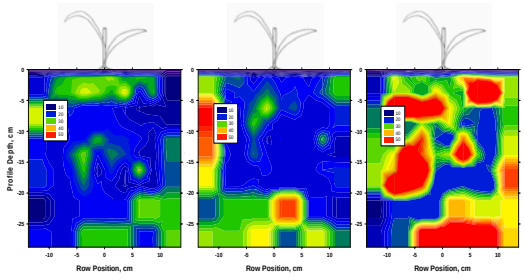
Fall Phosphorus Losses



Profile Distribution of P (µg P cm^{-2} soil) 34 Days after Liquid Swine Manure Application



No manure High disturbance Low disturbance

Conclusions

- Rye cover crop N uptake saturates around 200 lb manure N/acre.
- Low disturbance manure injection cover crop systems lower cover crop mortality and increase the potential for nutrient capture.

What's Next?

- Repeat the manure injection method study.
- Quantify the fate of manure N - plant, soil, water over time using ^{15}N microplots established in the fall of 2007.

Additional Resources

*http://www.sarep.ucdavis.edu/ccrop

*Managing Cover Crops Profitably, 3rd Ed., Sustainable Agriculture Network.

*Crop advisor institute cover Crop module.