Residual Effects of Cover Crops and Fertilizer N in a No-Tillage Corn System

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Introduction

Cover crops provide several advantages such as soil erosion control, improved soil water conservation and greater soil organic matter content (Mannering and Meyer 1963; Meyer, et al. 1970; Phillips 1984, and Hargrove 1986). Moreover, legume cover crops can supply a considerable amount of biologically fixed N to the summer row crops.

Estimates of N fertilizer equivalence of legume cover crops vary considerably (Smith et al. 1987). Ladd et al. (1981) concluded that the main benefit of legumes was in maintenance of soil organic N. McCracken et al. (1989) evaluated the residual effects of long-term cover cropping and fertilizer N addition on N availability in a no-tillage corn system. They observed that a history of hairy vetch increased N uptake by 25 Ib/acre, while the average residual effect of fertilizer N was 18 Ib/acre. Little effort has been put forth in determining the cumulative residual effects of cover crops and fertilizer N in no-tillage corn production. The objective of this study was to determine the cumulative residual effect of cover crops and fertilizer N on N uptake by no-tillage corn.

Materials and Methods

This experiment was conducted at the Northeast branch experiment station, Verona, Mississippi. The soil at this site was a Prentiss fine sandy loam (coarse-loamy, siliceous, thermic, glossic fragiudult) with 4% slope. A randomized complete block design with four replications was used in this study. Management practices prior to studying residual effects included broadcasted fertilizer N as NH_4NO_3 at rates of 0, 58, 116 and 174 Ib N/acre within a week of corn planting and cover cropping with hairy vetch *(Vicia villosa* Roth.) and ryegrass *(Lolium multiflorum* Lam.) in 1987 and hairy vetch and wheat *(Triticum sativum* L.) in 1988. Residual years are designated as residual year-1 and residual year-2. These terms describe the number of years that the factorial combinations of cover crop and fertilizer N treatments were imposed on those plots. For example, residual year-2 plots were studied the residual year after discontinuing treatments which were previously imposed on the plots for two growing seasons, while for residual year-1, treatments were imposed on plots only one growing season.

At physiological maturity, a 3.3 foot length of whole corn plants was harvested. Also, two rows, each 25 feet long, were harvested using a combine with corn headers. Grain yield was adjusted to 15.5% moisture content. Corn stover and grain samples were dried and ground separately in preparation for total N analysis. Plant samples were digested by the micro-Kjeldahl method described by Nelson and Sommers (1973). Ammonium-N in the digests was measured colorimetrically (Catalodo et al., 1974). Statistical analyses included ANOVA and regression using SAS (SAS/STAT 1988).

Results and Discussion

Corn Yield and N Uptake

There were no residual effects of cover crops on corn yield in residual year-I (Table 1). This is likely due to the extreme drought stress which occurred during tasseling and silking in 1988 (Table 5). Residual effects of cover crops on corn yield were observed in residual year-2. Averaged over N rates, hairy vetch increased corn stover yield by 1.6 ton/acre and corn grain yield by 0.5 ton/acre compared to a grass cover crop. Residual effects of fertilizer N on corn yield are shown in Table 2. In residual year-I, corn stover yield increased linearly as N rates increased. No effect of N rates on grain yield was observed. No residual effect of fertilizer N was observed for either stover or grain yield in residual year-2. This was probably due to NO; leaching as well as denitrification as a result of above normal precipitation received during the fallow period (Table 6).

The effects of cover crops on corn N uptake are presented in Table 3. When hairy vetch was used as a cover crop, corn stover and total N uptake were

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Table 1. Residual effect of cover crops on corn yield.

Residual Year	Cover Crop	Stover Yield	Grain+ Yield
		ton/acre	
Year-1 (1988)	Grass	3.8	1.9
	Vetch	3.5	2.0
Year-2 (1989)	Grass	5.2	1.9
	Vetch	6.8*	2.4*

+ Adjusted to 15.5% Moisture
* Means significantly different at p = 0.05

Table 2 Residual fertilizer N effects on corn yield

	Year-1 (1988)		Year-2 (1989)	
Fertilizer N lb./acre	Stover Yield	Grain+ Yield	Stover Yield	Grain Yield
	lb/acre			
0	3.2	1.9	6.4	2.2
58	3.4	1.7	6.1	2.3
116	3.6	2.1	5.4	1.8
174	4.4	2.3	6.1	2.2
Effect of:				
Fertilizer N	•	NS	NS	NS

+ Adjusted lo 15.5% Moisture
• Linear effect significant p = 0.05
NS = Not significant

Table 3. Residual cover crop effects on N uptake by corn.

	Corn N Content					
	Year-1 (1988)			Year-2 (1989)		
Cover Crop	Stover	Grain	Total	Stover	Grain	Total
	lb/acre					
Grass	53	42	95	62	29	91
Vetch	70*	45	115*	78*	34	112*

* Means significantly different at p = 0.05

Table 4. Residual effects offertilizer N on corn N uptake.

	Corn N Conient					
Fertilizer N	Year-1 (1988)			Year-2 (1989)		
lb/acre	Stover	Grain	Total	Stover	Grain	Total
	lb/acre					
0	41	41	82	71	33	104
58	60	37	97	74	31	105
116	69	44	113	64	28	92
174	76	51	127	72	33	105
Effect of:						
Fertilizer N	*	NS		NS	NS	NS

• Linear effect significant p = 0.05 NS = Not significant

Table 5. Precipitation each growing season at Verona

	Year									
	1988					1989				
	Apr	May	Jun	Jul	Aug	Apr	May	Jun	Jul	Aug
Duration	Precipitation									
	inch									
1st half of the month	2.3	1.1	0.3	1.4	2.1	2.3	3.4	7.8	4.2	2.2
2nd half of the month	2.3	0.9	---	0.3	0.8	0.6	1.3	2.1	1.8	1.5
Total	4.6	2.0	0.3	1.7	2.9	2.9	5.0	9.9	6.0	3.7
30-year average	5.3	4.0	3.5	4.5	3.1	5.3	4.0	3.5	4.5	3.1

Table 6. Precipitation each fallow period at Verona

Year	1st half of the month	2nd half of the month	Total	30-Yr Average
	inch			
Year-1				
Sept. 87	2.05	0.12	2.17	3.39
Oct.	---	1.38	1.38	2.60
Nov.	0.04	3.39	3.43	4.49
Dec.	0.31	3.70	4.01	5.44
Jan. 88	4.02	1.62	5.64	5.44
Feb.	2.84	0.51	3.35	5.36
Mar.	2.09	1.69	3.78	6.34
Total	11.35	12.41	23.76	33.06
Year-2				
Sept. 88	0.75	8.43	9.18	3.39
Oct.	2.17	3.07	5.24	2.60
Nov.	1.77	3.31	5.08	4.49
Dec.	0.16	3.31	3.47	5.44
Jan. 89	6.93	0.55	7.48	5.44
Feb.	2.09	7.21	9.30	5.36
Mar.	3.82	1.62	5.44	6.34
Total	17.69	27.50	45.19	33.06

increased in both residual year-1 and year-2. Although stover and total corn N uptake were increased, no effect on grain N content was observed. The effect was consistent in that with vetch N in stover was 17 lb/acre year-1 and 16 lb/acre year-2 and total N was 20 lb/acre year-1 and 21 lb/acre year-2 more than with a grass cover. A residual effect of fertilizer N on corn N uptake was observed in residual year-1 (Table 4). Corn stover and total N uptake increased linearly with increasing N rates, although no effect on grain N uptake was observed in residual year-1. No residual effect of fertilizer N rates on corn N uptake was observed in residual year-2.

Summary

The residual effect of fertilizer N on no-tillage corn yield was not consistent. Although, stover yield and N content increased linearly with increasing N rates in residual year-I, fertilizer N did not influence corn stover yield or N content in year-2. No residual effects of fertilizer N on grain yield were observed either year. Grain and stover yield were not influenced by cover treatments in residual year-1 but were greatest with vetch in residual year-2. Hairy vetch increased stover N content both years compared to a grass cover crop.

References

Catalodo, D. A., L. E. Schrader, and V. L. Youngs. 1974. Analysis by digestion and colorimetric essay of total nitrogen in plant tissue high in nitrate. Crop Science. 14:854-856.

Hargrove, W. L. 1986. Winter legume as a nitrogen source for no-till grain sorghum. Agro. J. 78:70-74.

Ladd, J. N., J. M. Oades and M. Amato. 1981. Distribution and recovery of nitrogen from legume residues decomposing in soil sown to wheat in the field. Soil Biol. Biochem. 13:251-256.

Mannering, J. V., and L. D. Meyer. 1963. The effects of various rates of surface mulch on infiltration and erosion. Soil Sci. Soc.Am. Proc. 27:84-86.

McCracken, D. V., S. J. Corak, M. S. Smith, W. W. Frye, and R. L. Blevins. 1989. Residual effects of nitrogen fertilization and winter cover cropping on nitrogen availability. Soil Sci. Soc.Am. J. 53:1459-1464.

Meyer, L. D., W. H. Wischmeier, and G. R. Folster. 1970. Mulch rates required for erosion control on steep slopes. Soil Sci. Soc.Am. Proc. 34:24-86.

Nelson, D. W. , and L. E. Sommers. 1973. Determination of total nitrogen in plant material. Agron. J. 65109-111.

Phillips, R. E. 1984. Soil Moisture. In: R. E. Phillips and S. H. Phillips (eds.), No-Tillage Agriculture: Principles and Practice. Van Nostrand Reinhold Co., New York.

SAS/STAT User's Guide, Release 6.03 Edition, 1989. SAS Institute Inc., Cary, NC.

Smith, M. S., W. W. Frye, and J. J. Varco. 1987. Legume winter cover crops. pp. 96-139. Advances in Soil Science, Vol. 7. Springer-Verlag New York, Inc.