Summary of Cotton Response to Nitrogen in Conventional Tillage and No-Till Vetch Cover Crop System

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Abstract: On highly erodible land. cover crops may be necessary to meet conservation compliance with the 1990 Food Security Act. Cotton growth and yield response to tillage, nitrogen rates, and winter cover crops were evaluated on an Ora fine sandy loam soil. The average vetch winter cover crop dry matter biomass yield was 1816 lbiacre (1989-1994) producing a N content equivalent to 94 lb of N/acre. Soil organic matter at the 0 - 2 in. depth in 1992 was the only depth the no-tillage cotton cover crop had more organic matter than conventional tillage (no vetch). Stand failures in no-tillage (1989-1991) may have been due to soil compaction caused by the planter cast-iron seed slit closing wheels and the soil surface containing more moisture under the vetch mulch. Changing the cast-iron closing wheels to small inverted disk and flat press wheels resulted in good stands with the first planting. All treatments at harvest had adequate populations for good seedcotton yield and there was no tillage by year interaction for yield. The 7-yr (1989-1995) average seedcotton yield for no-tillage + 40 lb of N/acre and no-tillage + 80 lb of N/acre were not different but both produced more seedcotton than no-tillage + no N. conventional tillage (no vetch) + 40 lb of N/acre and conventional tillage + 80 lb of N/acre. Plant mapping data indicated first fruiting branch node and percent bolls in first and second position on the fruiting branches were not influenced by tillage and N rate. No-tillage + 80 lb of N/acre plants had more nodes than conventional tillage + 80 ob of N/acre and was taller than all other treatments. No-tillage + no N had fewer harvestable bolls/plant than all conventional tillage treatments.

Introduction

Cotton farmers may need to change production practices to meet the 1990 Food Security Act conservation compliance mandates for highly erodible soils. Research on highly erodible soils indicated that no-tillage and reduced tillage were effective in reducing soil erosion to within tolerance levels only when winter cover crops were included in the production system (Mutchler and McDowell, 1990). Winter cover crops have been shown to increase subsequent cotton yields without additional N. Several reports indicated that winter legumes, especially vetch provided sufficient N for good cotton yield (Buehring and Reginelli, 1993; Millhollon and Melville, 1991; Hoskinson et al., 1988; Brown et al., 1985; Touchton et al., 1984; and Varco, 1993). The purpose of this study was to evaluate the influence of vetch as a cover crop on soil organic matter, and no-till cotton growth and yield response to fertilizer N management.

Materials and Methods

The field study was conducted over a 7-yr period (1989-1995) on an ora fine sandy loam soil which had been double-cropped with cool season and warm season forages since 1960 at the Northeast Branch of the Mississippi Agriculture and Forestry Experiment Station, Verona, MS. The study was conducted as a randomized complete block design with 6 replications. Plots were 4 rows (38 in.) by 40 ft long and were located on the same site each year. Selected N rates (0, 40, and 80 lb of N/acre) were applied to 2 cotton tillage systems [no-tillage (cotton planted no-till in killed vetch sod) and conventional tillage (subsoil + disk + harrow with no vetch)].

Hairy vetch was planted (30 lb seed/acre) no-till in mowed cotton stubble in early November each year. Vetch biomass samples were harvested in mid-April from the no-tillage cotton (0 lb of N/acre) prior to the burndown herbicide application. Composite samples of each treatment were dried at 140° F for 72 hours and analyzed for N content by the Kjeldahl procedure. Soil samples were taken from the conventional tillage + 80 lb of Nacre and the no-tillage cotton + 80 lb of N/acre plots from 4 replications in the fall of 1989 and 1992. Sampledepth was 0-2, 2-6, 6-12, 12-18, and 18-24 inches, Soil samples were analyzed for organic matter content by the Debolt procedure.

Plot management cultural practices are listed in (Table I). Cotton was planted (5 seed/ft row) no-till in killed hairy vetch and in conventional tillage with a four row planter equipped with colters and cast-iron seed-slit closing wheels in 1989-1991. Due to cotton stand failures, conventional tillage and no-tillage plots were replanted in 1989, 1990, 1991, and 1995. In 1992, the planter seed slit closing wheels were changed to an inverted disk with a flat closing wheel. Appropriate N rates were surface broadcast as ammonium nitrate within 3 weeks after cotton seedling emergence.

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Table I. Plot management cultural practices and dates performed in 1989-95 in a tillage cotton cover crop study on an ora fine sandy loam soil at the MAFES Northeast Branch Station, Verona, MS

Operations performed	1989	1990	1991	1992	1993	1994	1995
Plant no-till cover crop	Nov	Nov	Nov	Nov	Nov	Oct	Nov
Subsoil[1]	March	March	March	March	February	April	April
Disk	April	April	April	April	April	April	April
Harrow	May 2	April 24	May 24	June 5	May 10	May 10	May 10
Vetch burndown herbicide application	April 14	April 12	April 16	April 6	April 14	April 15	April 17
Cotton variety	DES 119	DES 119	DP 50	DES 119	DES 119	SG 501	SG 501
Planted cotton	May 2	April 24	May 24	June 5	May 10	May 10	May 10
Replanted cotton	May 17	May 8	June 4				
N application	June 16	May 30	June 12	June 15	May 20	June 2	June 8
Defoliation date	Oct. 18	Sept. 12	Sept. 30	Oct. 9	Sept. 28	Oct. 1	Sept. 26
Harvest date	Oct. 30	Sept. 23	Oct. 18	Nov. 6	Oct. 20	Nov. 17	Oct. 15

[1] Subsoil 12-14 inches deep with shanks spaced 30 inches apart

Table 2. Vetch dry matter yield and N content at the MAFES Northeast Branch Station, Verona, MS, 1989-94.

Year	----Vetch dry matter---- lb/ac	lb N/ac
1989	2849	131
1990	1675	**92**
1991	1409	73
1992	2524	121
1993	1165	62
1994	1273	85
Mean	1816	94

Recommended herbicide and insecticide applications were used to control weeds and insects. None of the cotton plots were cultivated during any of the 7-yr growing seasons.

Five plants were selected at random from each of the 2 center rows of 3 replications and mapped about 7 days prior to harvest. Plants were mapped for height, harvestable bolls/plant, nodes/plant. first fruit position node, and percent of harvestable bolls in first and second position. The 2 center rows of each 4-row plot were harvested with a 2-row cotton picker (modified for plot harvest) and weighed for seedcotton vield. Analysis of variance and Least Significant Difference (LSD) at the 5% probability level were used to separate treatment means (SAS, Cary, NC, 1988).

Results and Discussion

Vetch Dry Matter-N Content

The dry matter yield of hairy vetch ranged from 2849 Ib/acre in 1989 to 1165 lb/acre in 1993 (Table 2). Dry matter production and lb of N/acre in the dry matter in 1989 and 1992 were similar but higher than 1990, 1991, and 1993. The year to year yield variation was related to weather conditions during the cover crop emergence and growing season. Since vetch N content was relatively constant, yield of N/acre would be proportional to dry matter yield. The N yield ranged from 62 to 131 lb of N/acre with a 6-yr (1989-94) average of 94 Ib.

Soil Organic Matter

Soil organic matter comparisons (Table 3) at all depths for no-tillage and conventional tillage in 1989 were not different (P>.05). Initial organic matter content in 1989 for conventional tillage was I.24, 1.I I, 0.56, and 0.40% at 0-2. 2-6, 6-12, and 12-18 in. depths, respectfully. Both no-tillage and conventional tillage treatments in 1992 showed less organic matter at the 0-2 and 2-6 in. depth than in 1989. However, no-tillage had more organic matter than conventional tillage at the 0-2 in. depth with no difference between conventional tillage and no-tillage at all other depths.

Stand Problems

Plantings the first 3 yr (1989-91) into no-tillage (killed vetch sod) plots resultedin poor cotton stands while acceptable stands were achieved in conventional tillage plots. The stand failure seem to be due to a more moist soil surface than conventional tillage and compaction from the planter cast-iron seed-slit closing wheels. The seed-slit closing wheels were changed in 1992 to small inverted disk with a flat rubber press wheels. This change resulted in good stands with the first planting in both no-tillage (vetch) and conventional tillage (1992-1994). However, due to heavy rains after planting in 1995, the first planting resulted in poor stands in both no- tillage and conventional tillage plots. Harvest plant population were adequate all years for good cotton yields in both no-tillage and conventional tillage plots.

Seedcotton yield

Cotton planted in no-tillage and in conventional tillage plots showed variable yield response to additional N (Table 4). Since there was no year by tillage interaction, 7-yr treatment mean comparisons were made. Seedcotton yield for no-tillage + no added N was equal to conventional tillage + 80 lb of N/acre. These results are similar to reports (Buehringand Reginelli, 1993 and Varco, 1993) showing no-tillage cotton following a vetch winter cover crop produced

Table 3. Influence of tillage system on organic matter in an Ora fine sandy loam soil at the MAFES Northeast Branch Station, Verona, MS.

Soil depth (in.)	1989 Conv.tillage[1]	1989 No-tillage[2]	1992 Conv.tillage[1]	1992 No-tillage[2]
	% organic matter			
0-2	1.24	1.30	0.97	1.19
2-6	1.11	1.10	0.90	1.02
6-12	0.56	0.75	0.79	0.70
12-18	0.40	0.52	0.63	0.56
18-24	0.34	0.52	0.46	0.60
LSD.05 tillage w/depth	NS		0.21	
LSD.05 depth w/tillage	NS		0.06	
% CV	15.3		2.95	

[1] Conventional tillage (no-vetch) cotton.
[2] No-tillage cotton with a vetch winter cover crop.

Table 4 Cotton yield response to tillage and N rate at the MAFES Northeast Branch Station, Verona. MS, 1989-95

Cotton tillage system	N lb/ac	Seedcotton yield lb/ac 1989	1990	1991	1992	1993	1994	1995	Mean
No-tillage (vetch cover crop)	0	2023	1657	2541	2547	1936	2042	1967	2099
	40	1977	1662	2596	2837	2369	2799	2083	2334
	80	2447	1720	2940	2765	2080	2430	1842	2297
Conventional tillage (no-vetch)	40	1892	1688	21 19	2654	1435	2201	1498	1943
	80	2085	1588	2239	2535	1620	2218	1529	1970
	LSD.05	NS	NS	717	NS	302	453	290	159
	% CV	17	23	19	10	12	13	11	15

Table 5. Six-year (1989-94) average cotton plant variables as influenced by tillage system and N rate **MAFES** Northeast Branch Station. Verona. MS.

Tillage system	N lb/ac	Height at maturity (in)	Bolls/ plant[1]	Nodes/ plant	First F.B. node[2]	% Bolls first and second position[3]
No-tillage	0	42.3	7.6	17.0	6.1	70.9
(vetch cover crop)	40	42.3	8.9	16.7	6.0	71.5
	80	48.0	8.4	18.5	6.3	71.2
Conventional tillage	40	38.8	9.4	16.6	5.9	73.5
(no [illegible])	80	38.9	9.4	16.4	6.1	73.5
	Mean	42.1	8.7	17.0	6.1	72.1
	LSD.05	5.3	1.6	1.9	NS	NS
	% CV	9.7	11.2	7.8	7.4	7.6

[1] Harvestable bolls/plant.
[2] First fruiting branch node.
[3] Percent of bolls in the first and second position.

yield equal to no-tillage cotton + 70 and 80 lb of N/acre. These results also are in agreement with other reports (Millhollon and Melville, 1991; Hoskinson et al., 1988; Brown et al., 1985; and Touchton et al., 1984) which showed vetch provide sufficient N for the cotton crop. However, our results indicated no-tillage + 40 lb of N/acre and no-tillage + 80 lb of N/acre had similar yield but both produced more seedcotton than no-tillage + no N, conventional tillage + 40 lb of N/acre, and conventional tillage + 80 lb of N/acre.

Plant Mapping

Plant mapping data averaged over years (1989-1994) indicated first fruiting branch node, and percent of bolls in first and second position on the fruiting branch were not influenced by tillage or N rate (Table 5). No-tillage + 80 lb of N/acre had more nodes/plant than conventional tillage + 80 lb of N/acre and was taller than all other treatments. The other treatments showed no difference in plant height and nodes/plant. Harvestable bolls/plant for no-tillage + 40 lb of N/acre and no-tillage + 80 lb of N/acre were not different from conventional tillage + 40 lb of N/acre and conventional tillage + 80 lb of N/acre. However, no-tillage + no N had fewer harvestable bolls/plant than conventional tillage + 40 lb of N/acre and conventional tillage + 80 lb of N/acre.

References

- Brown, S. M., T. Whitwell, J. T. Touchton, and G. H. Burnmeister. 1985. Conservation tillage systems for cotton production. J. Amer. Soil Sci. Soc. 49(5): 1256-1260.
- Hoskinson, P. E., D. D. Tyler, and R. M. Hayes. 1988. Long-term no-till cotton yields as affected by nitrogen. p. 584. Beltwide Cotton Prod. Res. Conf. Proc. p. 584.
- Millhollon, E. P. and D. R. Melville. 1991. The long-term effects of winter cover crops on cotton production in Northwest Louisiana. Louisiana Agric. Exp. Sta., Bull. 30.
- Mutchler, C. K. and L. L. McDowell. 1990. Soil loss from cotton with winter cover crops. Transactions of the ASAE 33(2): 432-436.

SAS Institute Inc. SAS Language Guides for Personal Computers. Release 6.03 Edition. Cary, NC: SAS Institute, 1988. 588p.

- Touchton, J. T., D. H. Ricker, R. H. Walker, and C. E. Snipes. 1984. Winter legumes as anitrogen source for no-tillage cotton. Soils and Tillage Res. 4:391-401.
- Varco, Jac J. 1993. Fertilizer, nitrogen, and cover crop management for no-tillage cotton production. Conservation Tillage Systems for Cotton. Arkansas Agric. Exp. Sta. Spec. Rep. 160:63-64.