NITROGEN RATES AND COVER CROPS FOR NO-TILL COTTON IN THE MISSISSIPPI BROWN LOAM

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INTRODUCTION

A soil resource area east of the Mississippi Delta that runs the entire length of the state and varies in width from 50 to 125 miles is referred to as the Brown Loam soils area of Mississippi. Soils of this area are some of the most erosive soils in the nation. Soils of the Brown Loam are loess soils and have little or no cohesion. When wet the soil particles appear to disperse in water as soils having no structure, making for easy soil erosion. Low organic matter makes these soils susceptible to crusting and sealing following spring rains, which creates conditions conducive to water erosion. In addition, many of the soils have slopes exceeding 10%, which further contributes to erosion. In order to meet the requirements of the 1985 Farm Bill, no-till and minimum tilled practices had to be adopted with the use of cover crops and buffer strips if row crops were to be grown on the Brown Loam. Reducing tillage and growing a cover crop increased surface residue, which helped decrease erosion along with supplying or depleting nitrogen from the soil, depending on type of cover crop.

Wheat, native weeds and grasses deplete nitrogen from the soil whereas clover and vetch add nitrogen to the soil. It was estimated by Stevens et al. (1993) that a wheat cover crop will require 30 additional units of nitrogen during the growing season to compensate for the nitrogen the microbes need to decompose the wheat residue. Brown et al. (1985) estimated that a clover cover crop will add between 30 and 45 lb of nitrogen to the soil and a vetch cover crop will add between 45 and 60 lb of nitrogen to the soil.

A study was started at the North Mississippi Branch Experiment Station in Holly Springs, Mississippi, to determine the nitrogen requirements of no-till grown cotton using wheat, native cover and vetch as the winter cover crops. This information would be useful in helping producers select cover crops and managing no-till grown cotton.

MATERIALS AND METHODS

In 1996 and 1997 nitrogen studies were conducted on fields that were in cotton production the previous year. After cotton harvest the stalks were cut 19 October 1995 using a rotary cutter leaving a plant stubble of approximately 8 in. After stalk shredding, wheat and vetch were planted no-till in the cotton stubble 20 October with a Tye grain and small seed drill in a randomized compete block. Wheat was seeded at 90 lb of seed/acre and vetch was seeded at 45 lb/acre. In the spring of 1996 the wheat, vetch and native cover had Roundup (glyphosate) sprayed over the top at a rate of 2.0 lb ai/acre 8 April l996. A second burndown was made using Gramoxone (paraquat) at 0.5 lb ai/acre 27 April 1996.

The same cover crop management techniques were used in the 1996-97 cover crops except for dates of planting and burndown. In 1996 the cotton stalks were cut 4 November, and cover crops were seeded 5 November. First burndown treatment was sprayed 24 April 1997, and second burndown was sprayed 19 May 1997. A split block design was used with cover crops planted in a randomized complete block and nitrogen levels as subplots randomized within each block. Each plot consisted of eight rows 38 in. wide and 50 ft long. All treatments were replicated four times.

A blend of dry phosphorus and potassium fertilizer was broadcast according to soil test recommendations 27 April 1996 and 7 April 1997 across the entire plot area. All cotton planting was done using a John Deere Max-Emerge Model 7100 planter equipped with bubble coulters to cut through the residue in the no-till systems. Cotton was planted 27 April 1996 and 19 May 1997. At planting Temik (aldicarb) was applied in the drill at 0.75 lb ai/acre. Terrachlor Super X (pentachloronitrobenzene) was applied at planting in the seed drill at the rate of 2.0 lb ai/acre. Cotoran (fluometuron) and Dual (metolachlor) were sprayed broadcast at a rate of 0.75 and 1.0 lb ai/acre. Spray solution was applied at the rate of 18 gallons/acre. Staple (pyrithiobac sodium) was sprayed broadcast over the entire study when the cotton had reached the three- and four-leaf stage. Select (clethodim) at 0.3 lb ai/acre was broadcast over the entire study when the cotton was near first bloom. A lay-by herbicide mixture of Bladex (cyanazine) at 1.0 lb ai/acre and MSMA at 0.75 ai/acre was directed under the cotton and in the middles at approximately eight weeks after planting. Insect control was according to standard recommended practices and thresholds.

Nitrogen fertilizer rates of 0, 30, 60, 90, 120 and 150 lb/acre were evaluated to determine the optimum nitrogen

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rates for each cover crop. Nitrogen was applied using a tractor-mounted Gandy calibrated for each N rate. Ammonium nitrate (34% N) was the source of nitrogen. Nitrogen was placed approximately 1 ft from the drill and 2 in. below the surface. All nitrogen was applied after emergence and before matchhead-sized squares were present.

Chlorophyll fluorescence measurements were made using a Minolta Spad 502 hand-held fluorescent meter on the leaves of 20 plants selected at random within each plot and averaged across the plants for a single plot reading. Leaf readings were taken on the fifth expanded leaf below the terminal of the plant. Chlorophyll fluorescence measurements were made at first bloom, two weeks after first bloom and four weeks after first bloom.

Twenty petioles were collected from the same leaf from which the chlorophyll fluorescence reading was taken, of each plant, of each plot, of each treatment and each replicate for evaluation of nitrate-N status using a Minolta hand-held nitrogen meter. Sampling of petioles was made at first bloom and four weeks after first bloom. Petioles were collected from the fifth fully expanded leaf on the main stem below the plant terminal. Petioles were frozen immediately after collection. Analysis was conducted in an air-conditioned laboratory 24 hours after collection. It was hoped that this would eliminate a variation in the meter reading from exposure to sunlight or temperature variation. Petioles were processed by thawing them under an infrared light for 5 min before the stems were cut into lengths of approximately 1 in. Petiole sap was extracted by placing the cut petiole stems into a garlic press and squeezing out the petiole sap. Approximately 1 ml of sap was squeezed into a test tube from a composite of the 20 petioles of each plot. Two or three drops of sap of each test tube were placed on the calibrated meters. Meter calibration was checked by running a standard at the start of each test period and after every 20 samples.

A defoliant was sprayed over the crop when more than 75% of the bolls were open. Yields were determined by harvesting the two center rows of each eight-row plot. Yields are reported in pounds of seedcotton per acre.

RESULTS AND DISCUSSION

Cotton stands were excellent for both years in all plots. Rainfall was above average in early season of both years. However, the plants suffered severe drought in mid and late season of 1996. Heat units in DD 60's were near normal for northern Mississippi in both years. In 1997, the DD 60's accumulation was extremely slow during the first of the growing season but gained momentum as the season progressed to end with normal DD 60's.

Chlorophyll fluorescence measurements and petiole nitrate-N sap analyses for 1996 are not reported since the techniques that were used varied in accumulating averages for fluorescense and extracting sap from petioles. It was not until the 1997 growing season that a uniform process of collecting, processing and analyzing the petiole sap and chlorophyll fluorescence was worked out.

Chlorophyll fluorescence measurements made in this study in 1997 were not very sensitive to levels of fertilizer nitrogen above 30 lb/acre at the second and fourth week of bloom (Table 1). This was in agreement with studies by Radin et al. (1985) conducted in Arizona on irrigated cotton where leaf conductance was not affected by nitrogen level except in severe N deficits. Only the 90-lb level fluorescence at the first week of bloom had a lower reading than any level above 30 lb, and no logical explanation exists for this low reading. Chlorophyll fluorescence tended to be higher at two weeks and four weeks after bloom for all N levels than at the onset of fruiting. Chlorophyll measurements for cover crops were non-significant at each blooming period (Table 2).

Average petiole nitrate-N sap measurements were significantly lower at first and fourth week of bloom for the 0 N level across all cover crops (Table 3). At first week of bloom, the petiole sap measurement was higher for the 90-lb level than any of the other levels above 30 lb contrasted to fluorescence measurements where the 90-lb level was lower than other levels above 30 lb. Fourth week of bloom, petiole nitrate-N sap levels were non-significant for the N levels of 30 to 150 lb/acre. Petiole sap measurements dropped 53%, 18%, 20%, 31%, 18% and 18% between the first week of bloom and the fourth week of bloom for the 0-, 30-, 60-, 90-, 120- and 150-lb/acre level, respectively. Petiole sap measurements for the wheat and vetch were higher than the native cover crop at first week and fourth week of bloom (Table 4). Petiole sap measurements dropped 12%, 16% and 20% between the first and fourth week of bloom for the wheat, native and vetch cover crops, respectively.

The 1996 yield data were extremely hard to interpret because no pattern was established for nitrogen rates (Table 5). Yields followed the same pattern as the first, second and fourth week of bloom in fluorescence readings in 1997; no difference was noted between cover crop yields. Soil samples were taken after the growing season, and analysis, incomplete at this time, should reflect residual N levels. The 150-lb N/acre level was the only level that yielded higher than the 0-lb N/acre level in 1997. The results presented here are disappointing when expecting a yield response from N levels between the 0 and 150 lb N/acre. Yet this is why the Brown Loam area was an important cotton growing region before commercial fertilizer and has always been an important growing region of Mississippi. The area appears to have a natural fertility of N for cotton. Arnold et al. (unpublished data), working with cotton fertility and N levels for many years at the North Mississippi Branch Station, were able to produce 200 lb lint/acre without the addition of N, P and K for 15 consecutive years.

LITERATURE CITED

Brown, S.M., T. Whitwell, J.T. Touchton and C.H. Burmester. 1985. Conservation tillage systems for cotton production. Soil Sci. Soc. Am. J. 49:1256-1280.

Radin, J.W., J.R. Mauney and G. Guinn. 1985. Effects of N fertility on plant water relations and stomatal responses to water stress in irrigated cotton. Crop Sci. 25:110-114.

Stevens, W.E., J.R. Johnson, J.J. Varco and J. Parkman. 1993. Tillage and winter cover managements effects on fruiting and yield of cotton. J. Prod. Agric. 5:570-575.

Table 1. Chlorophyll fluorescence reading for nitrogen rates averaged across cover crops taken with a hand-held Minolta Spad 502 meter, 1997.

	Blooming Period		
lb N/acre	1st week	2nd week	4th week
0	43.65	42.26	42.69
30	48.81	49.32	52.00
60	49.62	50.90	54.33
90	44.94	49.74	52.70
120	45.98	48.71	54.35
150	51.41	50.35	54.44
LSD (0.05)	1.58	1.85	1.67
CV	3.7	4.2	3.6

Table 2. Chlorophyll fluorescence reading for cover crops averaged across nitrogen rates taken with a hand-held Minolta Spad-502 meter, 1997.

	Blooming Period		
Cover Crop	1st week	2nd week	4th week
Wheat	47.95	48.79	52.42
Native	47.64	49.34	51.48
Vetch	46.60	47.50	51.35
LSD (0.05)	ns	ns	ns
CV	4.1	4.1	5.1

Table 3. Petiole sap analysis of N rates averaged across cover crops using a Minolta hand-held nitrate-N meter (data in ppm x 100), 1997.

	Blooming Period	
N rates (lb N/acre)	1st week	4th week
0	55.00	25.75
30	73.25	59.67
60	77.33	61.83
90	85.42	59.33
120	74.42	60.50
150	74.00	60.59
LSD (0.05)	10.10	11.72
CV	17.10	23.60

Table 4. Petiole sap analysis of cover crops averaged across nitrogen rates using a Minolta hand-held nitrate-N meter (data in ppm x 100), 1997.

	Blooming Period	
Cover Crops	1st week	4th week
Wheat	71.33	62.50
Native	57.33	48.13
Vetch	66.33	53.21
LSD (0.05)	5.45	5.65
CV	11.60	14.70

Table 5. Seed cotton yields of wheat, native cover and vetch cover crops using 0, 30, 60, 90, 120, 150 lb nitrogen/acre, 1996 and 1997.

	Year		
N rates (lb N/acre)	1996	1997	Average
Wheat			
0	620	2822	1721
30	881	2500	1690
60	641	2824	1732
90	1069	3935	2502
120	708	3564	2163
150	968	3390	2179
Native			
0	628	2860	1724
30	814	2697	1756
60	908	3934	2421
90	1215	3465	2340
120	767	3663	2215
150	1301	3762	2531
Vetch			
0	795	2994	1894
30	1014	3118	1894
60	802	3120	1961
90	1088	2275	1681
120	924	2673	1798
150	939	3560	2249
LSD (0.05)	158	304	
CV	16	15	