Hindawi Publishing Corporation
International Journal of Agronomy
Volume 2011, Article ID 135097, 9 pages
doi:10.1155/2011/135097

Research Article

Can Leguminous Cover Crops Partially Replace Nitrogen Fertilization in Mississippi Delta Cotton Production?

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Received 26 October 2010; Accepted 13 January 2011

Academic Editor: M. Tejada

Petroleum prices impact cotton nitrogen (N) fertilization cost. A field study was conducted from 2005 to 2007 to assess the interactions of cover crop (none, Austrian winter pea (*Pisum sativum* spp. *arvense*) or hairy vetch (*Vicia villosa* Roth)) and N fertilization (0, 67 or 134 kg N/ha applied at planting) on N availability and cotton yield under reduced-tillage management. Nitrogen content in desiccated residues averaged 49, 220, and 183 kg N/ha, in no cover crop, Austrian winter pea, and hairy vetch, respectively. Seventy percent of N in the above ground cover crop was derived from biological N fixation. In 2005, cover crops decreased cotton yield, while fertilizer N had no effect. In 2006, cover crops did not affect yield, but yield was positively correlated with N rate. In 2007, in no N plots, cotton yields were 65% higher in cover crops than in no cover crop. However, yield from N fertilized cover crop plots were similar to N fertilized no cover plots. These results indicate that leguminous cover crops can provide over 150 kg N/ha, but this N may not be as effective as fertilizer N for lack of synchronization between cotton N requirements and N release from residues.

1. Introduction

Cotton (*Gossypium hirsutum* L.) is a major row crop in the Mississippi Delta region of the southern US, and its production under reduced and no-tillage systems has increased in this region with the introduction of glyphosate-resistant varieties. Sustainable, low-input cropping systems, that is, reduced tillage, no-tillage, and fall seeded leguminous cover crops, are favored by economic pressures including energy, fertilizer, and agrochemical costs. Moreover, crop production systems that combine minimum and (or) reduced tillage with fall seeded cover crops offer environmental advantages such as improved soil tilth, weed suppression, reduced erosion, and off-site agrochemical transport [1].

In some areas of the southern US, high residue cereal cover crops, such as rye, were successfully integrated into cotton cropping systems. Cereal cover crops, however, require additional N for adequate plant residue production which may lead to N immobilization and reduced cotton yield [2]. However, as legumes can provide additional N for the following crop, leguminous cover crops may provide a source of sustainable N input. Mississippi Delta field trials indicate some benefits of a hairy vetch cover crop in corn production [3], as did similar trials in Missouri [4]. Leguminous cover crops provide an additional benefit of N fixation in the fallow period which can supply N to the successive crop [5, 6]. Under these Australian conditions, vetches produced an average of 225 kg N/ha, and replaced over 60% of the N fertilizer requirement for optimum cotton production.

Profitable cotton production will require alteration of N inputs under alternative tillage and cover crop systems [7]. In the sandy soils of the Southeastern coastal plains, a leguminous cover crop was not as cost effective as cereal cover crops [8]. The objective of this 3-year field study conducted from 2005 to 2007 on a Dundee silt loam was to assess the interactions of leguminous cover crops (none, Austrian winter pea (*Pisum sativum* spp. *arvense*) or hairy vetch (*Vicia villosa* Roth)), and N fertilization rate (0, 67 or 134 kg N/ha applied at planting) on N availability and cotton yield under reduced-tillage management.

2. Materials and Methods

2.1. Cover Crop and Cotton Management. A field study was conducted from 2004 through 2007 at the USDA-ARS Crop Production Systems Research farm, Stoneville, MS (33°26′ N, 90°55′ W). The soil was a Dundee silt loam (fine-silty mixed, thermic Aeric Ochraqualf) with pH 6.3, 9.0 g kg^{-1} organic carbon, a CEC of 15 $cmol_c\ kg^{-1}$) soil, and soil textural fractions of 26% sand, 55% silt, and 19% clay. Prior to the present study, the experimental area was under corn production. Field preparation consisted of disking, subsoiling, disking, and bedding in the fall of 2004. The land was not tilled in subsequent years, but the raised seedbeds were refurbished each fall after harvest with no additional tillage operations to maintain a reduced tillage system. The raised seedbeds ensured adequate drainage in early spring, helping to prevent planting delays and enabling furrow irrigation during the growing season.

Cover crop treatments consisted of Austrian winter pea (*Pisum sativum* spp. *arvense*), hairy vetch (*Vicia villosa* Roth), and no cover crop. Cover crops were drilled in 19-cm wide rows using a grain drill (Deere and Co., Moline, IL, USA) at a seed rate of 30 kg/ha in mid-October of 2004, 2005, and 2006. Cover crops were desiccated with paraquat at 1.1 kg ai/ha about 2 wk prior to cotton planting. At desiccation, Austrian winter pea was about 46- to 61-cm tall and hairy vetch was about 30- to 53-cm tall and both were at early flowering stage. No cover crop plots were also treated with paraquat at 1.1 kg ai/ha to kill existing vegetation. Glyphosate-resistant cotton cultivar "DP434RR" was planted on April 25, 2005, April 28, 2006, and April 30, 2007 using a MaxEmerge 2 planter (Deere and Co., Moline, IL, USA) in 102-cm rows at 120,000 seeds/ha directly into desiccated plant residue. Nitrogen fertilizer treatments included 0, 67, and 134 kg N/ha. The commercial liquid formulation of urea and ammonium nitrate (N-SOL 32, Mississippi Chemical Corporation, Yazoo City, MS, USA) was applied at cotton planting.

Cotton was maintained weed-free using only postemergence herbicide programs. Glyphosate at 0.84 kg ae/ha was applied postemergence, over-the-top twice at 4 and 6 wk after planting cotton. A third glyphosate application at 0.84 kg/ha was made as postdirected to base of the crop plant at 9 wk after planting. Glyphosate applications were common to all treatments. Potash application and insect control programs were standard for cotton production [9]. Cotton was furrow irrigated on an as-needed basis: five times in 2005, three times in 2006, and eight times in 2007. Cotton from all eight rows of each plot was harvested once with a spindle picker on September 19, 2005, September 11, 2006, October 10, 2007, and seed cotton yield was reported.

2.2. Experimental Design and Statistical Analysis. The experiment was conducted in a split-plot arrangement of treatments in a randomized complete block design with cover crop (Austrian winter pea, hairy vetch, and no cover crop) as main plot and N level (0, 67, and 134 kg N/ha) as the subplot with four replications. Each treatment consisted of eight rows spaced 102 cm apart and 25.9 m long. The identity of each treatment was maintained by assigning the same treatment to the same plot in all three years. Data were subjected to analysis of variance using PROC GLM (Statistical Analysis Systems, Statistical Analysis Systems Institute, Cary, NC) and treatment means were separated at the 5% level of significance using Fisher's protected LSD test.

2.3. Soil, Cotton, and Cover Crop Residue Sampling. Estimates of plant residues on the soil surface were determined the day before herbicide desiccation and at planting (before N fertilization) in all three years, and 29 and 20 days after planting in 2005 and 2006, respectively. Insufficient residues were present for a postplanting sampling in 2007. Three 0.1-m^2 quadrants were randomly selected from the center four rows of each plot, all vegetation was clipped at the soil surface, combined, oven dried, and weighed. Following removal of surface vegetative residues two 0- to 5-cm soil cores were removed using a 7.5-cm wide probe from each of these three quadrants. Soils were passed through a 2-mm sieve and used fresh for enzymatic activity or air dried for determination of chemical properties. Fully expanded cotton leaves (about 50 per plot) were collected from cotton during early to mid-boll filling for N content determination. Cover crop residues and cotton leaf samples were oven dried at 60°C for 48 to 96 h, depending on the mass of the vegetation collected.

2.4. Plant Analysis. Cover crop and cotton leaf samples were analyzed for N content using a Flash EA 1112 elemental analyzer (CE Elantech, Lakewood, NJ, USA). Prior to analysis, previously dried samples were dried at 60°C overnight and duplicate samples (∼5 to 8 mg) were analyzed for each plot.

Delta ^{15}N abundance was evaluated based on the the ratio of $^{15}N/^{14}N$ ratio [10]. Dried ground samples (1 mg) were analyzed with a Thermo Finnigan Delta Plus Advantage Mass Spectrometer with a Finnigan ConFlo III and Isomass Elemetal Analyzer (Bremen, Germany) that used a Costech ECS4010 using elemental combustion system equipped with an autosampler, using Isodat software version 2.38 to calculate delta values.

The proportion of N in Austrian winter pea and hairy vetch estimated to arise from N fixation (%Ndfa) was calculated based on the equation of Peoples et al. [11] and Rochester and Peoples [5]:

$$\%\text{Ndfa} = 100\frac{(X - Y)}{(X - B)} \quad (1)$$

where X is the ^{15}N content of a non N_2-fixing, nonlegume, Y is the ^{15}N content of the legume, and B is the ^{15}N content of the shoot when totally dependent on N_2 fixation for growth,

(−0.47) from Rochester and Peoples [5]. Total estimates of N_2 fixed were than calculated as follows:

$$\text{Amount of } N_2 \text{ fixed} = (\text{Legume N} \times \%\text{N}) \times (\%\text{Ndfa}). \quad (2)$$

2.5. Soil Chemical Analysis. Chemical analysis was conducted on air-dried soil that was passed through a 2 mm sieve and uniformly milled in a Wiley mill. Soil pH was determined in a 0.01 M $CaCl_2$ soil suspension (2 : 1). Total organic carbon (TOC) and Total N Content (TNC) were determined on duplicate samples using a Flash EA 1112 elemental analyzer (CE Elantech, Lakewood, NJ, USA). For nitrate-N analysis, soil (2 g) was extracted in 10 mL 0.1 M KCl, for 1 h, clarified by centrifugation, and determined colorimetrically [12].

2.6. Soil Enzymatic Activity. Soil hydrolytic activity was evaluated as an indicator of microbial activity, using fluorescein diacetate (FDA). Assays were conducted on freshly collected soil that has been sieved using methodology reported elsewhere [13–15]. Assays were conducted in triplicate corrected for a no substrate control and reported on an oven dry weight equivalent basis.

3. Results and Discussion

3.1. Cover Crop Biomass Production, N Content, ^{15}N Abundance and N Fixation Estimates. Winter vegetation (weed) biomass present in no cover crop plots ranged from 1969 kg/ha to 5062 kg/ha prior to herbicide desiccation (Table 1). Plots seeded with Austrian winter pea and hairy vetch produced a similar biomass in 2005 and 2007 ranging from 7479 and 9025 kg/ha, respectively. However, in 2006, Austrian winter pea yielded about 40% higher than hairy vetch. The highest level of cover crop residues remaining on the surface (6485 and 7286 kg/ha in hairy vetch and Austrian winter pea, resp.) was present at planting in 2005 compared to 2006 or 2007. However, cotton was planted only four days after cover crop desiccation in 2005, compared to 23 days in 2006 and 21 days in 2007 allowing more time for decomposition of crop residues. Both legumes consistently yielded appreciable biomass. As in many field trials conducted elsewhere, the biomass produced by Austrian winter pea and/or hairy vetch yielded over 20% or more biomass than annual weeds under no-tillage [8, 15].

The N content present in Austrian winter pea and hairy vetch residues prior to desiccation was lowest (2.25 and 1.75%) in 2005 with a significantly higher N level in Austrian winter pea compared to hairy vetch. Thereafter, a similar level of N concentration was found in the cover crop residues (2.58 to 3.13%) in 2006, and 2007. Nitrogen content of native vegetation by comparison was 1.04, 0.86 and 1.68% in 2005, 2006, and 2007, respectively. Total N present in natural winter vegetation ranged from 36 to 86 kg ha^{-1} prior to desiccation (Figure 1). In Austrian winter pea residues, the total N present on the soil surface ranged from 170 to 255 kg/ha, and 133 to 225 kg/ha in hairy vetch residues (Figure 1). The total amount of Austrian winter pea and hairy vetch biomass and biomass N produced in these Mississippi field trials is much higher than the 84 and 101 kg N/ha, respectively in field trials conducted in the Southeastern U.S. [8]. The studies conducted by Schomberg et al. [8] were on sandy coastal plains soils of lower fertility than the rich alluvial silt loam soils of the Mississippi Delta and these differences in fertility promoted vigorous cover crop biomass production.

The depletion of N from residues on the soil surface followed the pattern of the degradation of vegetative residues with about 75% of the initial N present in the legume residues at planting in 2005, while 36 to 56% was present in the legume residues at planting in 2006 and 2007 (Figure 1). In 2005, cotton was planted 4 d after cover crop desiccation, while in 2006 and 2007 cotton was planted 23 and 21 d, respectively, following desiccation. Thus, greater biomass N remained on the soil surface initially in 2005. In 2005, 22 to 29% of the N was present in legume residues one month after planting, while less than 5 to 14% was present 20 days after planting in 2006. This indicates a rapid release of the foliar N content. Volatile loss of ammonia has been suggested to occur during the decomposition of a lentil (*Lens culinaris* Medik) green manure with about 8 to 14% loss in 14 days under controlled laboratory conditions [16]. These studies were conducted under reduced-tillage conditions and environmental conditions may have been favorable for volatilization loss. The average maximum air temperatures during April for Stoneville is 24°C [17] with the surface residues prone to rapid drying. It is possible that a significant amount of N in plant residues may have been lost by volatilization. If the cover crop had been incorporated into the soil prior to planting cotton; there may have been more N available for the cotton, however, this would have eliminated the benefits of conservation tillage management.

Over the three-year study, the δN^{15} values in leguminous cover crop residues prior to desiccation (0.64 to 1.33) were similar between Austrian winter pea and hairy vetch, which was significantly lower than native winter vegetation present in no cover crop plots (Table 2). Using the methodology of Rochester and Peoples [5], a 68 to 77% of the shoot N content was derived from N_2 fixation (%Ndfa) in Austrian winter pea and 66 to 69% in hairy vetch (data not shown). Estimates of N fixation in Austrian winter pea ranged from 92 to 178 kg of shoot N/ha and 67 to 165 kg of shoot N/ha in hairy vetch (Table 3). The lowest N fixed was in the initial year of the study, and Austrian winter pea fixed a greater amount of N when compared to hairy vetch in 2005 and 2006. There was no significant effect of N fertilization level on δN^{15} values, % shoot N fixed (TFDA), or total N fixed. These are estimates of N_2 fixation based solely upon shoot N content the contribution of N_2 fixation from below ground roots, nodules and exudation may represent from 10% to 40% of the above ground N_2 fixation estimates [5].

3.2. Effects of Cover Crop Management on Soil Properties. In the first spring (2005) sampling, FDA-hydrolytic activity in nocover crop soils was 25 to 30% higher compared to soil from plots managed with either cover crop (Table 4). However, one month following cover crop desiccation in

Table 1: Effect of cover crop on plant residues remaining on soil surface at various times in 2005, 2006 and 2007.[a]

Cover crop	Plant residue dry weight, kg/ha Sampling date		
	April 15, 2005	April 24, 2005	May 23, 2005
None	3865 b	2584 b	1179 b
Austrian winter pea	7479 a	7286 a	2228 a
Hairy vetch	7532 a	6485 a	2292 a
	April 10, 2006	April 27, 2006	May 16, 2006
None	1969 c	1246 b	Not detectable
Austrian winter pea	5704 a	3737 a	2056 a
Hairy vetch	4070 b	3336 a	751 b
	April 03, 2007	April 30, 2007	
None	5062 b	1474 c	
Austrian winter pea	9025 a	3368 b	
Hairy vetch	8724 a	4193 a	

[a] Means followed by the same letter within a column for the same sampling date do not differ at the 95% confidence level.

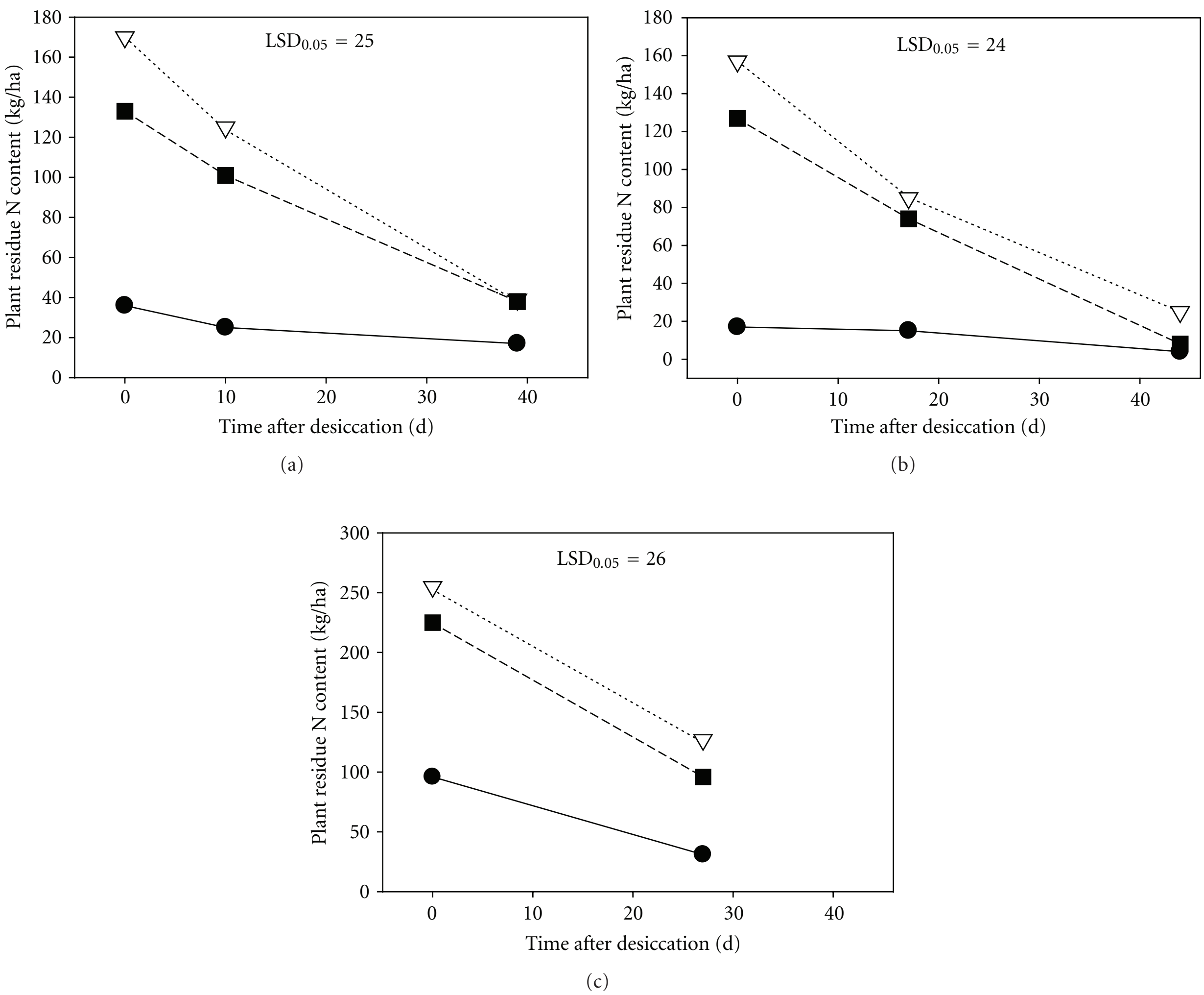

Figure 1: Nitrogen content of plant residues as affected by cover crop, circles no cover crop, triangles Austrian winter pea, squares hairy vetch, (a) = 2005, (b) = 2006, and (c) = 2007.

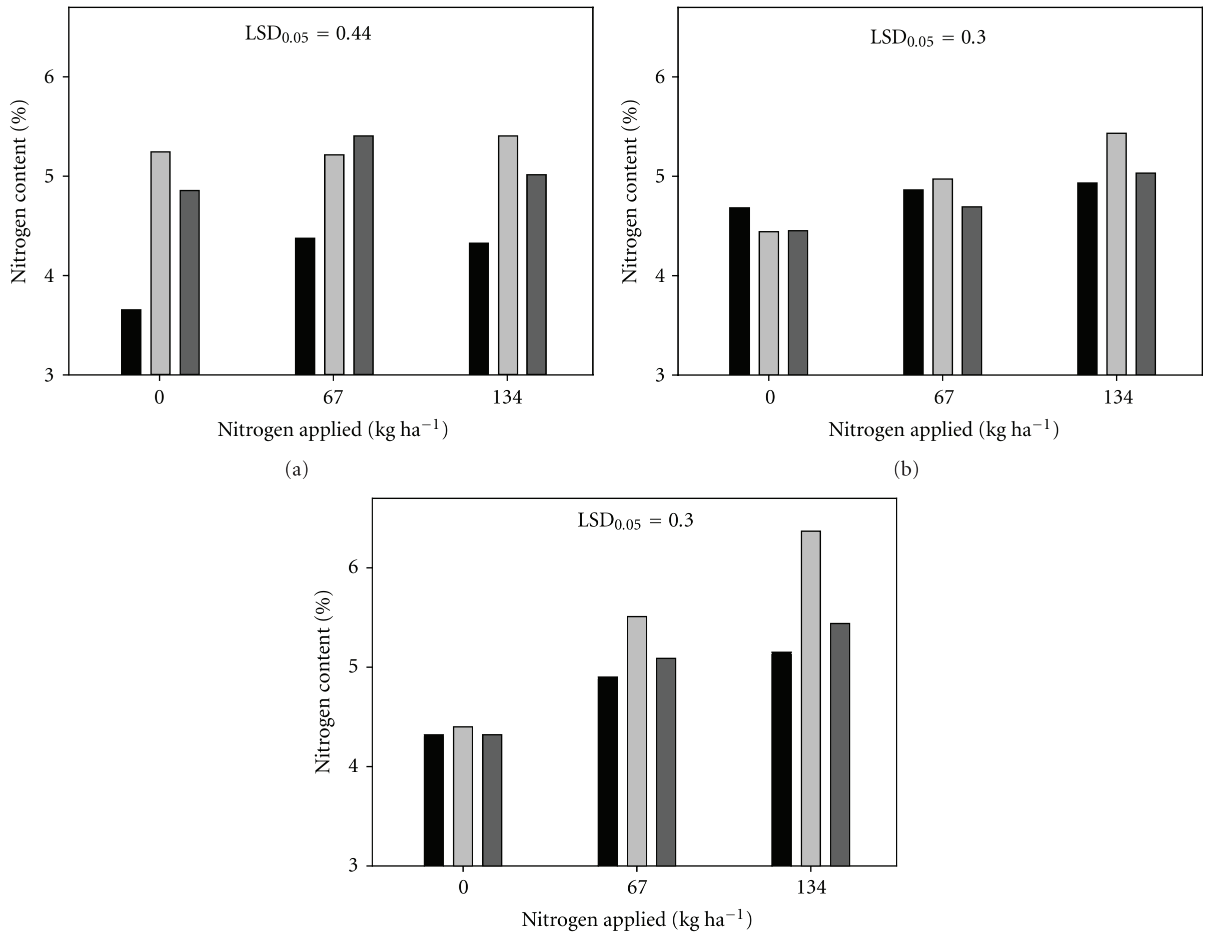

Figure 2: Nitrogen content of cotton leaf at flowering as affected by N rate and cover crop black bars no cover crop, light grey bars Austrian winter pea, dark grey bar hairy vetch, (a) = 2005, (b) = 2006, and (c) = 2007.

Table 2: δN^{15} abundance in plant residues before desiccation in 2005–2007.

Cover crop	δN^{15} abundance		
	2005	2006	2007
None	4.38	5.10	5.00
Austrian winter pea	0.64	0.90	1.44
Hairy vetch	1.05	1.33	1.33
$LSD_{0.05}$ year × cover crop		0.49	

2006 and at planting following the third year of successive cover crop management, FDA was higher in Austrian pea with intermediate N than in plots maintained under hairy vetch. Stimulation of soil heterotrophic activity under cover crop management, especially leguminous cover crops, has been previously documented [15, 18]. Both legumes elicited a reduction of soil pH, with soils managed under Austrian pea initially having the lowest pH (Table 4). A reduction of soil pH under a hairy vetch and crimson clover cover crop has been reported in previous studies [15, 18]. The decrease in pH can be attributable to nitrification of ammonium released from decomposing legume plant tissue.

In all treatments, soil TNC increased during the three year study. Soil from plots seeded with Austrian winter pea had significantly greater TNC compared to the no cover crop soils in all samples, while plots from hairy vetch only had greater TNC compared to no cover crop soils in the 2007 at planting sample. A significant effect of N fertilizer was observed with greater N accumulation in soils receiving the higher N fertilizer rates. In the no cover crop controls there was an overall increase in TNC, most likely due to maintaining crop residues on the soil surface under reduced tillage management. The increases in soil TNC under hairy vetch occurred much slower than that of a study conducted on this site under soybean production [15]. However the magnitude of enhanced TNC accumulation in soil in plots from Austrian winter pea is greater than that attributed to other legumes; in the case of Austrian winter pea there was an additive effect of N fertilization on total soil N pools that was not observed for the no cover crop or hairy vetch plots in 2006 and 2007 (data not shown).

Table 3: Yearly estimates of total biological N fixed in above ground legume cover crop biomass before desiccation in 2005–2007.

Cover crop	Total N_2 fixed, kg//ha		
	2005	2006	2007
Austrian winter pea			
0 N	92	124	146
67 N, kg/ha	149	117	178
134 N, kg/ha	151	114	177
Hairy vetch			
0 N	96	68	165
67 N, kg/ha	103	109	161
134 N, kg/ha	67	85	133
$LSD_{0.05}$ year × cover crop × N		43	

Table 4: Effect of Austrian winter pea and hairy vetch on soil properties in 2005–2007.[a]

Cover crop	04/24/05	05/23/05	04/27/06	05/16/06	04/30/07
	Fluorescein diacetate hydrolytic activity, mmol/kg soil/h				
None	121 a	109 a	68 a	80 c	84 c
Austrian winter pea	79 b	108 a	73 a	133 a	130 a
Hairy vetch	91 b	99 a	75 a	100 b	100 b
	pH				
None	6.35 a	6.22 a	6.35 a	6.22 a	6.04 a
Austrian winter pea	5.82 c	5.91 b	5.85 c	5.91 b	5.60 b
Hairy vetch	6.10 b	6.04 ab	6.12 b	5.96 b	5.66 b
	Total N content, g/kg soil				
None	0.75 b	1.0 b	0.92 b	0.92 b	1.03 c
Austrian winter pea	0.82 a	1.15 a	1.08 a	1.28 a	1.62 a
Hairy vetch	0.73 b	1.07 ab	1.02 ab	1.17 b	1.34 b
	Total organic carbon content, g/kg soil				
None	9.0 a	8.8 a	9.2 b	9.9 c	10.5 c
Austrian winter pea	9.3 a	9.3 a	10.8 a	13.1 a	16.1 a
Hairy vetch	8.5 a	9.4 a	10.2 ab	11.6 b	13.5 b

[a]Means followed by the same letter within a column for the same sampling date do not differ at the 95% confidence level.

Total OC likewise increased in all treatments over time, again in response to reduced tillage as discussed with soil TNC (Table 4). By planting in 2007 the TOC of the upper 5 cm was 56% higher in Austrian winter pea compared to no cover. Total organic carbon accumulation in hairy vetch occurred at a lower rate, with a 30% greater TOC in hairy vetch compared to no cover in 2007. The leguminous cover crops, especially Austrian winter pea, decreased soil pH (Table 4). This effect was observed in the spring of the first year of the study and the same magnitude of acidity maintained thereafter.

Extractable soil nitrate was determined for all years the day of planting and before fertilization (Table 5). In the first year there was no effect of cover crop on extractable soil nitrate-N, and there was minimal decomposition of surface residues (Table 1). However in 2006 and 2007, there was a significant interaction of cover crop and fertilization rate on residual soil nitrate levels at planting (Table 5). The highest nitrate levels were associated with Austrian winter pea plots with incremental gains associated with increasing N application. In the final year, the highest level of fertilization increased extractable soil nitrate by 34 and 47% in no cover and hairy vetch, while the highest N rate elicited a 137% increase in extractable N in Austrian winter pea.

3.3. Cotton Foliar N Content, Yield, and Economics. Foliar N content at mid-flowering stage of cotton is presented in Figure 2. A significant incremental increase in N content in response to N fertilization was observed in 2006 and 2007, while only the two highest N rates increased N content in 2005. The leguminous cover crops increased N content only in 2005 and 2007, with the highest N content associated with Austrian winter pea in three of the four enhanced samples. A significant fertilizer by cover crop interaction was observed in 2006 and 2007, with incremental increases in foliar N content of cotton grown on cover crop plots in response to increasing N rate. The elevated N concentrations found in the leaf samples from all N fertilized cover crop plots may be considered excessive. At this stage of reproductive growth a

Table 5: Interaction of cover crop and N rate on soil nitrate present at planting in 2005, 2006, and 2007.

Year	N applied		Cover crop	
	kg/ha	None	Austrian winter pea	Hairy vetch
			mg NO_3-N/kg soil	
2005	0	20	21	21
	67	21	22	22
	134	21	21	21
2006	0	27	31	27
	67	31	55	39
	134	34	98	51
2007	0	38	45	42
	67	44	63	55
	136	51	107	62
$LSD_{0.05}$ year × cover crop × N			5	

Table 6: Effect of cover crop, and N fertilizer on seed cotton yield in 2005–2007.

		Seed cotton, kg/ha	
Treatments	2005	2006	2007
Cover crop			
None	3597	4019	2624
Austrian winter pea	3095	4407	2976
Hairy vetch	3028	4269	2846
$LSD_{0.05}$	475	ns	ns
N rate, kg/ha			
0	3171	3883	2460
67	3216	4141	2871
134	3331	4671	3114
$LSD_{0.05}$	ns	515	431
Interactions			
None × 0 N	3263	3554	1712
None × 67 N	3704	4060	2659
None × 134 N	3823	4442	3499
Austrian winter pea × 0 N	3198	4006	2827
Austrian winter pea × 67 N	3031	4178	3106
Austrian winter pea × 134 N	3053	5034	2992
Hairy vetch × 0 N	3053	4087	2838
Hairy vetch × 67 N	2913	4184	2846
Hairy vetch × 134 N	3117	4534	2851
$LSD_{0.05}$	525	ns	805

level of sufficient N is 3.0 to 4.5%, and above 4.5% is excessive [19, 20].

In the three years of the study, there was a different yield response to cover crops, and N fertilization (Table 6). Cotton plant population was not affected by cover crop or N rates and averaged 83,000 plants/ha in all three years (data not shown); hence plant density was not a factor affecting yield. In the first year of the study both leguminous cover crops significantly decreased seed cotton yields; however, no response to N fertilization was observed. In the second year, no significant effect of cover crop was observed, but seed cotton yield significantly increased at the highest N rate. Similarly, in the third year of the study, seed cotton yield was increased with increased N rate, but unaffected by cover crops. In 2006 and 2007, there was a significant effect of N fertilization, with the highest rate yielding significantly greater seed cotton compared to no fertilizer. Analysis of variance of seed cotton yield indicated a significant interaction between cover crop and N rate in two (2005 and 2007) of three years. In 2005, N at 67 and 134 kg/ha applied in no cover crop produced higher seed cotton yield than in Austrian winter pea and hairy vetch. In 2007, no N plots in both cover crops yielded higher than no N plots in no cover crop. However, seed cotton yields either at 67 kg/ha N or 134 kg/ha N were similar regardless of cover crops. Essentially, in the no cover crop plots, an incremental yield gain was observed in response to increasing N fertilizer. All Austrian winter pea and hairy vetch plots, regardless of N fertilization, yielded greater than the no cover crop, no N plots. Furthermore, all Austrian winter and hairy vetch plots regardless of N rates were not significantly different than the no cover, 134 kg/ha N.

Excessive N availability can contribute to loss in cotton yield due to a delay in maturity, increased potential for boll rot and regrowth following defoliation. This may have been the case in both legume cover crops. In addition the mineralization of N from cover crop residues may not come in a timely manner to support sustaining higher cotton yields. When cotton follows corn fertilized with a high N rate in Louisiana, the elevated residual soil N can cause an overall loss in cotton productivity unless fertilization rates for cotton are also reduced [21]. Thus, growers seeking to maximize economic returns would find the cost of establishing legume crops unable to offset any possible savings in N fertilizer costs. Application of N accounted for 70 and 140 dollars/ha, while cost of establishment for no cover, Austrian winter pea, and hairy vetch was 43, 215 and 334 dollars/ha in 2007. The seeding rate of 30 kg/ha was similar to that used by Schomberg et al. [8]. To fully assess the contributions of leguminous cover crops on N fertilizer replacement it would be desirable to have additional increments of N fertilization.

The interaction of legume cover crop and N fertilization observed in this Mississippi study differed substantially from studies in Western Tennessee [7], where hairy vetch provided sufficient N to maximize yields with less than half the N fertilization rate, especially under no-tillage conditions. However, the initial depression in cotton yield in response to legume cover crops in these studies is similar to the depression in cotton yield in studies conducted in the sandy soils of South Carolina [22] and Georgia [8]. This was a three-year study with the first year totally unresponsive to N inputs. However, considering the performance of cover crops (Austrian winter pea and hairy vetch) in the last two years of the study, leguminous cover crops offer potential in sustainable low-input production systems for no-till cotton. In terms of developing sustainable land use and improving soil quality components of improved organic carbon and biologically derived N, there are many benefits of a leguminous cover crop system as suggested by others [6]. It is possible to achieve comparable yields to chemical fertilizer; however, there is a degree of uncertainty in achieving a maximum economic advantage using a leguminous cover crop system for cotton production in the Mississippi Delta.

Acknowledgments

The authors thank Efren Ford, Terry Newton, and Albert Tidwell for technical assistance in field work. Mention of trade names or commercial products in this paper is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.

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