Table 5. Effect of tillage and cover crops on soil (0 to 5 cm depth) nitrate concentration at planting and midseason (seven weeks after planting), 2002 to 2005, Stoneville, Mississippi

Sample	Treatment	2002	2003	2004	2005
		Nitrate (mg kg^{-1})			
At planting	Conventional tillage	48	30	39	23
	No-tillage	57	36	71	43
	LSD 0.01 [a]	NS [b]	NS	13	16
Midseason	Conventional tillage	117	30	91	96
	No-tillage	132	20	73	61
	LSD 0.01	NS	NS	NS	19
At planting	No cover	37	19	44	30
	Rye	39	19	38	25
	Hairy Vetch	83	61	85	45
	LSD 0.01	17	8	15	7
Midseason	No cover	78	20	63	67
	Rye	88	14	63	68
	Hairy Vetch	207	42	120	100
	LSD 0.01	46	18	18	24
		P values for the analysis of variance components for nitrate concentration			
At planting	Tillage (Til)	0.232	0.103	<0.001	0.006
	Cover crop (CC)	<0.001	<0.001	<0.001	<0.001
	Til x CC	0.456	0.420	0.655	0.114
	Herbicide	0.086	0.312	0.505	0.308
Midseason	Til	0.310	0.188	0.261	<0.001
	CC	<0.001	<0.001	<0.001	<0.001
	Til x CC	0.002	0.427	0.535	0.734
	Herbicide	0.940	0.481	0.296	0.140

[a] Fisher's least significant difference [b] NS = Not significant.

The contribution of hairy vetch cover crop to nitrogen requirement in corn has been well documented (Koger and Reddy 2005; Teasdale 1996; Fortuna et al. 2008). No consistent effect of tillage or cover crop was observed on other anions e.g., sulfate and phosphate (data not shown).

Electrical conductivity was significantly increased by NT compared to CT in three of the four years regardless of cover crop or glyphosate use (Table 6), as has been previously reported at this site (Reddy et al., 2003). However, cover crop, specifically hairy vetch, had the greatest effect on EC. Soils maintained under hairy vetch had from 49 to 109% greater EC compared to no cover crop, with the lowest response in 2005, when hairy vetch failed to establish. By comparison rye plots had 20 to 44% greater EC compared to control plots in 2002 to 2004, but similar EC levels in 2005. Pooled across tillage and cover crops, plots receiving glyphosate had about 8% greater EC compared to non-glyphosate plots at mid season in 2004 and 2005. This may be partially explained by the liberation of organic acids from decaying weeds.

The increased EC observed under NT and a legume cover crop is consistent with that previously reported for these experimental plots (Reddy et al., 2003) when crimson clover was used instead of hairy vetch. Studies in a tropical Brazilian soil indicated no difference in EC in no-till compared to mouldboard plowing (Roldań et al., 2005). Electrical conductivity is a parameter being used to assess spatial variability of soil properties (Johnson et al., 2001) and define site-specific management practices for reduced chemical input systems such as efficient nitrogen use (Khosla et al. 2002). The increased nitrate levels in hairy vetch plots correlates with the highest EC values in these soils.

Table 6. Effect of tillage and cover crops on soil (0 to 5 cm depth) electrical conductivity at planting and midseason (seven weeks after planting), 2002 to 2005, Stoneville, Mississippi

Sample	Treatment	2002	2003	2004	2005
		Electrical conductivity (μS cm^{-1})			
At planting	Conventional tillage	67	77	88	129
	No-tillage	99	109	116	172
	LSD 0.01 [a]	NS [b]	22	22	26
Midseason	Conventional tillage	115	109	134	133
	No-tillage	131	71	111	110
	LSD 0.01	NS	11	14	17
At planting	No cover	55	64	110	110
	Rye	78	82	113	117
	Hairy Vetch	115	117	148	144
	LSD 0.01	26	26	17	22
Midseason	No cover	84	64	104	104
	Rye	111	82	113	116
	Hairy Vetch	174	117	148	144
	LSD 0.01	35	26	16	23
		P values for the analysis of variance components for total organic carbon			
At planting	Tillage (Til)	0.032	<0.001	0.001	0.018
	Cover crop (CC)	<0.001	<0.001	<0.001	<0.001
	Til x CC	0.525	0.765	0.947	0.011
	Herbicide	0.086	0.248	0.677	0.283
Midseason	Til	0.148	<0.001	<0.001	0.002
	CC	<0.001	<0.001	<0.001	<0.001
	Til x CC	0.289	0.844	0.361	0.223
	Herbicide	0.6147	0.429	0.018	0.013

[a] Fisher's least significant difference [b] NS = Not significant.

Fluorescein Diacetate Hydrolytic Activity

The hydrolysis of FDA was chosen as a model substrate to characterize total heterotrophic activity of the soil microbial community in response to crop management regimes as FDA is a generic substrate for a wide range of hydrolytic enzymes such as esterases, lipases and certain proteases (Zablotowicz et al., 2000b). In all years, mean FDA hydrolytic activity was 55 to 120% greater in NT compared to CT soil regardless of cover crop or glyphosate use (Table 7).

Table 7. Effect of tillage and cover crops on soil (0 to 5 cm depth) fluorescein diacetate hydrolytic activity at planting and midseason (seven weeks after planting), 2002 to 2005, Stoneville, Mississippi

Sample	Treatment	2002	2003	2004	2005
		Fluorescein formed (nmol $g^{-1} h^{-1}$)			
At planting	Conventional tillage	98	104	143	79
	No-tillage	215	162	294	175
	LSD 0.01 [a]	80	36	22	19
Midseason	Conventional tillage	111	109	121	248
	No-tillage	204	164	234	330
	LSD 0.01	12	18	30	39
At planting	No cover	119	106	174	96
	Rye	164	159	224	133
	Hairy Vetch	187	140	258	152
	LSD 0.01	39	25	35	23
Midseason	No cover	125	122	148	248
	Rye	183	158	198	320
	Hairy Vetch	163	130	187	254
	LSD 0.01	53	22	37	39
		P values for the analysis of variance components for FDA-hydrolytic activity			
At planting	Tillage (Til)	0.0023	<0.0001	<0.0001	<0.001
	Cover crop (CC)	<0.0001	0.0001	<0.0001	<0.001
	Til x CC	0.0619	0.3722	0.6064	<0.001
	Herbicide	0.1207	0.7072	0.1076	0.1243
Midseason	Til	0.016	<0.001	<0.001	<0.001
	CC	0.016	<0.001	0.002	<0.001
	Til x CC	0.245	0.179	0.247	<0.001
	Herbicide	0.316	0.615	0.648	0.001

[a] Fisher's least significant difference.

Likewise in all years soil from cover crop plots had 28 to 58% greater FDA hydrolytic activity compared to no cover crop, regardless of tillage or glyphosate use. The effects of rye and hairy vetch on FDA hydrolytic activity were similar in all years at planting, while at mid season soil from rye plots had greater FDA activity compared to hairy vetch plots in 2003 and 2005.

These results are in agreement with other studies (Wagner et al., 1995; Bandick and Dick, 1999; Mendes et al., 1999; Reddy et al., 2003; Zablotowicz et al; 1998, 2007b) where increased FDA activity has been associated with various cover crop management practices. However, studies by Gaston et al. (2003) found elevated FDA hydrolytic activity in a silt loam under NT compared to CT in Louisiana, while either a hairy vetch or wheat cover crop had no effect on FDA hydrolytic activity. The increased activity of FDA may be due to either increased populations of soil microflora, or elevated levels of available carbon sources that serve as substrates for the hydrolytic enzymes associated with NT or cover crop management.

Soil Microbial Populations

Estimates of culturable microorganisms (total fungi, and total and gram-negative bacteria) were enumerated during 2002-2004. Total bacteria CFU were similar at planting and mid season under NT and CT in 2002 and slightly higher under NT in 2003 and 2004 for both planting and midseason averaged across all cover crop and herbicide regimes (Table 8). The greatest enrichment of total bacterial CFU was found in relation to cover crop with a significant increase in total bacteria associated with cover crops in all samples except mid season 2002. A significant tillage by cover crop interaction was observed in two of the six sampling dates, in that a greater enrichment of total bacteria due to cover crop was observed when rye was incorporated by tillage compared to no cover CT.

Tillage had a minor effect on gram-negative bacteria at planting (NT significantly greater than CT only in 2003) pooled across cover crop and herbicide regimes. In the mid season sample, there was a greater abundance of gram-negative bacteria CFU in NT compared to CT all three years pooled across cover crops and glyphosate use. These results are not as easy to interpret because a significant tillage by cover crop interaction was observed in all at planting samples and one mid season sample (2004). The effects of cover crop with significantly higher gram negative CFU in rye plots compared to no cover crop for all sample dates. Gram negative bacteria are typically higher under moist conditions and the higher CFU under rye cover crops may be due to both increased carbon substrate and moisture. Gram-negative bacteria especially *Pseudomonas* spp. are associated with plant growth promoting activity as well as antagonism to phytopathogenic bacteria and may contribute to soil health under cover crop management (Kloepper et al., 1989).

Estimates of total soil fungal populations were consistently greater under NT compared to CT soils, regardless of cover crop or glyphosate use (Table 10). The greatest increase in soil fungi CFU was associated with cover crop with the highest populations associated with hairy vetch in 2002 and 2003 ($P > 0.01$), while fungal CFU had similar densities under rye and hairy vetch in 2004. Similar responses of increased soil fungi have been observed in soybeans grown under hairy vetch, rye, or ryegrass cover crop management in other studies (Wagner et al. 1995; Zablotowicz et al., 1998; Reddy et al., 2003; Zablotowicz et al., 2007b). Studies by Reeleder et al. (2006) found no significant effect of either tillage or a rye cover crop on total soil fungal CFU. However, that study indicated that one pathogenic group of fungi, *Pythium* was greater under CT plots, especially under a rye cover crop. Specific antagonism or stimulation of beneficial and phytopathogenic fungi by cover crops (Rothrock and Hargrove, 1983) and their relationship to soil bacterial microflora is an area worthy of further investigation. The study by Reeleder et al. (2006) also evaluated fungal populations in soil sampled to 10 cm, while the previously cited studies observed greater increase in fungal populations when soil was sampled at a shallower depth (2 or 5 cm deep).

Table 8. Effect of tillage and cover crops on soil (0 to 5 cm depth) total bacterial colony forming units at planting and midseason (seven weeks after planting), 2002 to 2004 Stoneville, Mississippi

Sample	Treatment	2002	2003	2004
		Total bacteria (log (10) CFU g^{-1})		
At planting	Conventional tillage	8.13	8.09	8.21
	No-tillage	8.11	8.15	8.33
	LSD 0.05 [a]	NS [b]	0.03	0.05
Midseason	Conventional tillage	7.90	7.68	7.78
	No-tillage	7.87	7.81	8.07
	LSD 0.01	NS	0.12	0.25
At planting	No cover	7.91	7.93	8.09
	Rye	8.13	8.20	8.34
	Hairy Vetch	8.31	8.24	8.46
	LSD 0.01	0.17	0.06	0.08
Midseason	No cover	7.85	7.69	7.61
	Rye	7.99	7.77	8.11
	Hairy Vetch	7.82	7.78	8.05
	LSD 0.01	NS	0.08	0.17
Planting	Non-glyphosate	7.92	7.74	8.30
	Glyphosate	7.92	7.76	8.29
	LSD 0.05	NS	NS	NS
Midseason	Non-glyphosate	7.92	7.74	8.04
	Glyphosate	7.92	7.76	7.81
	LSD 0.05	NS	NS	0.04
		P values for the analysis of variance components for total bacteria		
At planting	Tillage (Til)	0.5653	0.017	0.0401
	Cover crop (CC)	<0.0001	<0.0001	<0.0001
	Til x CC	0.0347	<0.0001	0.0512
	Herbicide	0.9108	0.5974	0.9421
Midseason	Til	0.683	<0.001	0.0392
	CC	0.887	0.003	<0.001
	Til x CC	0.707	0.093	0.004
	Herbicide	0.390	0.289	0.006

[a] Fisher's least significant difference [b] NS = Not significant.

At time of planting there was no significant effect of herbicide on any of the general groups of microorganisms studied. However, at mid season a significant effect of herbicide regime on soil fungi was observed in that soils under glyphosate management had lower fungal CFU compared to conventional herbicide programs in 2003 and 2004. Greater populations of total bacteria and gram-negative bacteria were observed under a non-glyphosate herbicide program compared to glyphosate only in 2004.

Table 9. Effect of tillage and cover crops on soil (0 to 5 cm depth) gram-negative bacterial colony forming units, at planting and midseason (seven weeks after planting), 2002 to 2004, Stoneville, MS

Sample	Treatment	2002	2003	2004
		Gram negative bacteria (log (10) CFU g^{-1})		
At planting	Conventional tillage	6.80	6.46	6.37
	No-tillage	6.70	6.81	6.43
	LSD 0.01 [a]	NS [b]	0.30	NS
Midseason	Conventional tillage	5.43	5.83	6.37
	No-tillage	5.73	6.03	6.73
	LSD 0.05	0.22	0.16	0.11
At planting	No cover	5.53	6.68	5.18
	Rye	5.75	6.70	5.24
	Hairy Vetch	5.47	6.89	5.32
	LSD 0.01	0.20	0.12	0.12
Midseason	No cover	5.53	5.88	6.38
	Rye	5.75	6.02	6.62
	Hairy Vetch	5.47	5.89	6.58
	LSD 0.01	0.20	0.12	0.11
		P values for the analysis of variance components for gram-negative bacteria		
At planting	Tillage (Til)	0.169	0.002	0.153
	Cover crop (CC)	<0.001	0.001	<0.001
	Til x CC	<0.001	0.013	<0.001
	Herbicide	0.007	0.065	0.431
Midseason	Til	0.014	0.037	<0.001
	CC	0.028	0.047	<0.001
	Til x CC	0.225	0.112	0.001
	Herbicide	0.264	0.225	0.006

[a] Fisher's least significant difference [b] NS = Not significant.

Table 10. Effect of tillage and cover crops on soil (0 to 5 cm depth) total fungal colony forming units at planting and midseason (seven weeks after planting), 2002 to 2004, Stoneville, Mississippi

Sample	Treatment	2002	2003	2004
At planting	Conventional tillage	5.57	5.36	5.50
	No-tillage	5.74	5.52	5.61
	LSD 0.01 [a]	0.12	0.09	0.05
Midseason	Conventional tillage	5.30	5.20	5.13
	No-tillage	5.63	5.43	5.44
	LSD 0.01	0.13	0.16	0.06

Table 10. (Continued)

Sample	Treatment	2002	2003	2004
At planting	No cover	5.44	5.22	5.35
	Rye	5.59	5.48	5.61
	Hairy Vetch	5.94	5.61	5.71
	LSD 0.01	0.15	0.10	0.08
Midseason	No cover	5.47	5.22	5.18
	Rye	5.50	5.44	5.34
	Hairy Vetch	5.42	5.26	5.31
	LSD 0.01	NS[b]	0.15	0.06
		P values for the analysis of variance components for total fungi		
At planting	Non-glyphosate	5.68	5.45	5.57
	Glyphosate	5.64	5.43	5.55
		NS	NS	NS
Midseason	Non-glyphosate	5.53	5.40	5.36
	Glyphosate	5.40	5.26	5.25
	LSD 0.01	0.13	0.07	0.04
At planting	Tillage (Til)	0.044	0.011	<0.001
	Cover crop (CC)	<0.001	<0.001	<0.001
	Til x CC	<0.001	0.135	0.003
	Herbicide	0.121	0.326	0.432
Midseason	Til	0.017	0.003	<0.001
	CC	0.413	0.033	<0.001
	Til x CC	0.320	0.276	<0.002
	Herbicide	0.001	<0.001	<0.001

[a] Fisher's least significant difference [b] NS = Not significant.

More effective weed control was observed under the glyphosate system and a greater abundance of weeds in the conventional herbicide program may have stimulated soil fungi through rhizosphere enrichment. The lower fungal and or bacterial CFU associated with the glyphosate management program is in contrast to results conducted on a Brazilian soil (Arújo et al., 2003) where increased fungal and actinomycete propagules were associated with glyphosate under *in vitro* conditions.

Soil Microbial Community Structure

The soil microbial community structure based on total FAMEs, assessed using principal component analysis is summarized in Figure 1, 2, and Table 11 . These results indicated a unique and dynamic microbial composition in each year of the study and even at sample time. For example, at planting in 2002, higher chain length unsaturated FAMEs 18:0 and 22:0, and the gram-positive branched fames 15:0iso and 17:0iso were among the factors in PC1, while in 2005 the low chain length saturated FAMES 15:0 and 14:0 and gram-negative hydroxylated FAME's 18:1wtOH, 17:1wtOH and 16:1 2OH had the greatest contribution to PC1.

Table 11. Analysis of variance of principal components of soil (0 to 5 cm depth) microbial community structure based on total fatty acid methyl esters, at planting and midseason (seven weeks after planting), 2002 to 2005, Stoneville, Mississippi

Principal component	Source	2002	2003	2004	2005
At planting					
PC1	Eigen value	32.2	34.3	31.8	32.6
	Tillage	0.045	0.367	0.202	<0.001
	Cover crop	<0.001	0.482	0.017	0.001
	Tillage * cover crop	<0.001	0.031	0.080	0.001
	Herbicide	0.408	0.477	0.097	0.041
PC2	Eigen value	18.5	19.8	21.0	
	Tillage	0.859	0.124	0.215	0.887
	Cover crop	0.779	0.019	0.352	0.885
	Tillage * cover crop	0.762	0.644	0.006	0.668
	Herbicide	0.990	0.485	0.934	0.973
Midseason					
PC1	Eigen value	42.6	43.6	36.3	39.8
	Tillage	0.528	0.419	<0.001	0.003
	Cover crop	0.248	0.192	0.268	0.161
	Tillage * cover crop	0.567	0.512	0.921	0.329
	Herbicide	0.577	0.512	0.921	0.309
PC2	Eigen value	18.3	18.4	14.7	15.0
	Tillage	0.032	0.042	0.535	0.075
	Cover crop	0.453	0.391	0.049	0.053
	Tillage * cover crop	0.091	0.054	0.050	0.091
	Herbicide	0.133	0.126	0.185	0.884

At planting, the microbial community structure was associated with crop management in that cover crop, tillage or the interaction of tillage and cover crop contributing to principal component 1 (PC1) in all four years (Table 11). Principal component 2 was less affected by management practices as cover crop only significantly contributed to principal component 2 (PC2) in 2003, and the interaction of cover crop and tillage contributed to PC2 only in 2004. Considering the correlation of soil properties with the two major principal components FDA hydrolytic activity and total fungi were the major biological properties correlating with PC1 or PC2 in 2003, while nitrate, EC, or SOM were major chemical properties correlating to PC1 or PC2 in 2003.

At the midseason sample tillage significantly contributed to PC1 in 2004 and 2005, and PC2 in 2002 and 2003. There was no significant contribution of cover crop to either PC1 or PC2 at mid season . At midseason, FDA hydrolysis was the dominant biological parameter correlated with microbial community structure, and TOC, TNC, EC, and nitrate were the chemical properties that had contributed to community structure.

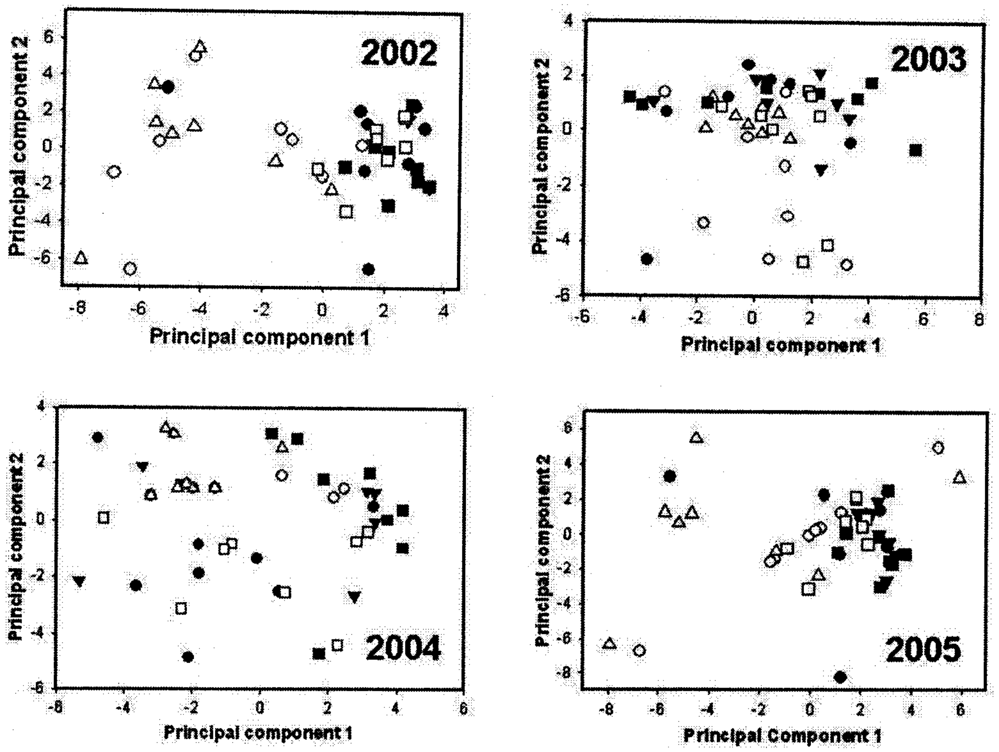

Figure 1. Principal component analysis of soil (0 to 5 cm depth) microbial community structure based on total fatty acid methyl esters, at planting 2002 to 2005, Stoneville, MS. Symbols for conventional till plots are unfilled and no-till plots are filled with no cover (●), rye (▼), and hairy vetch (■).

Studies by Schutter et al., 2001 and Schutter and Dick (2002) indicated that specific changes in microbial communities in response to cover crops changed over time and these changes were driven by total carbon and nitrogen and biological activities such as microbial biomass and respiration. Studies on the microbial community structure of a silt loam maintained under continuous NT or CT cotton production in Alabama (Feng et al., 2001) indicated that the greatest effects of reduced tillage are observed prior to planting. During the fallow period prior to planting, the bacterial community has a greater role in contributing to the total microbial community. However, later in the growing season environmental conditions associated with higher temperature and crop competition for moisture have a greater effect on the soil microbial community.

In contrast to this study, FAME-based microbial community structure was assessed in a cotton-corn rotation or monoculture managed under conventional or glyphosate resistant cropping system (Locke et al., 2008). Following five years of glyphosate management, the greatest differences in microbial communities were associated with soils planted with glyphosate-resistant crops compared to conventional corn and cotton, while the crop species had less of an effect. Other studies evaluating the short-term effects of glyphosate on soil microbial community structure on a similar Dundee silt loam found no effect of glyphosate application also using total FAME analysis (Weaver et al., 2007).

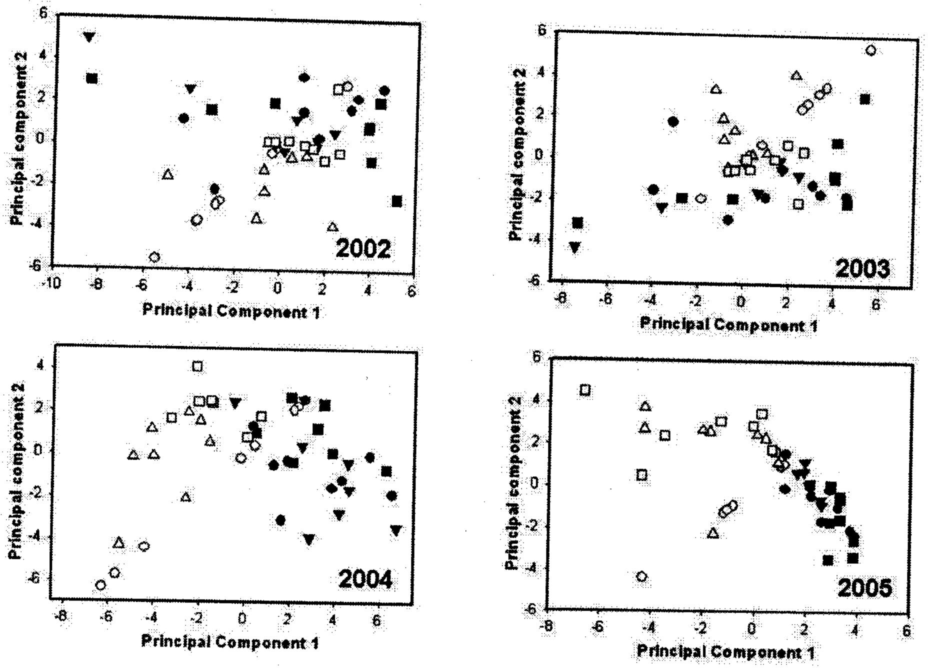

Figure 2. Principal component analysis of microbial community structure based on soil (0 to 5 cm depth) total fatty acid methyl esters, midseason (seven weeks after planting) 2002 to 2005, Stoneville, MS. Symbols for conventional till plots are unfilled and no-till plots are filled with no cover (●), rye (▼), and hairy vetch (■).

Soybean Yield

A summary of the effects of tillage, cover crops and glyphosate on soybean yield is presented in Table 12. Tillage had no effect on soybean yield with cover crops and herbicide having the greatest effect on yield. In all four years of the study rye significantly reduced yield compared to no cover crop by 15 to 33%. Similar yields were attained under hairy vetch cover crop compared to no cover crop. Although hairy vetch can provide additional nutritional stimulation associated with an increase in the nitrate mineralized from hairy vetch residue, this had little effect on yield potential of soybean. The consistent increase in soybean productivity was associated with the use of a glyphosate herbicide regime as glyphosate-managed soybeans yielded 6.6 to 25.7% greater compared to soybean managed under a conventional herbicide regime. Several factors may be associated with a loss of soybean productivity under the rye cover crop system. The resilience of rye straw can interfere with stand establishment and slow early soybean development. Secondly, rye produces a composite of allelopathic compounds (Barnes and Putnam, 1986). These allelopathic compounds may directly restrict soybean growth or indirectly by affecting the microbial community in a manner to affect pathogenic or growth promoting microorganisms. Previous studies on these plots (Reddy et al., 2003) indicated that rye had no effect on soybean yield, while the legume crimson clover significantly reduced yields although there was a significant herbicide by cover crop interactions affecting soybean yield.

Table 12. Pearson correlations of soil biological and chemical properties contributing to principal components of microbial community structure based on total fatty acid methyl esters, at planting and midseason (seven weeks after planting), 2002 to 2005, Stoneville, Mississippi

Principal Component	2002	2003	2004	2005
At planting				
PC1	FDA* <0.0001	None	FDA 0.0232	FDA 0.0005
	Fungi <0.0001		Fungi 0.033	Nitrate < 0.0001
	TOC <0.0001		Nitrate 0.007	TOC < 0.0001
	Nitrate < 0.0001		pH 0.0127	Moisture 0.009
	EC < 0.0001			
PC2	None	Fungi 0.018	None	None
		FDA 0.008		
		EC 0.004		
		TOC 0.018		
MidSeason				
PC1	TOC <0.001	None	FDA <0.001	FDA <0.001
			EC <0.001	TOC <0.001
			TOC < 0.001	TNC <0.001
			TNC <0.001	Nitrate 0.002
PC2	FDA 0.005	FDA 0.001	EC 0.002	None
	Moisture 0.001	TBac 0.034	Nitrate 0.002	
	EC 0.007	EC 0.001		
	TOC 0.013	TOC 0.007		

* FDA = fluorescein diacetate hydrolytic activity; EC = electrical conductivity, TOC = total organic carbon, TNC total nitrogen content, TBAC = total bacteria.

The use of cover crops may affect the symbiotic relations of soybean with *Bradyrhizobium japonicum*, as nitrogen released from the degradation of hairy vetch residues may inhibit nitrogen fixation. Symbiotic characteristics, nodulation and acetylene reduction activity (ARA) were determined in 2004.

Early nodulation was greatest under NT plots or CT and NT plots under rye cover crop management, with the lowest nodulation observed in soybean from hairy vetch plots (data not shown). Nitrogen fixation as estimated by ARA was initially the highest in NT plots without cover crops during the initial two samples.

These results suggest that a delay in establishment of nitrogen fixation may be associated with soybean grown under soils previously cultivated to a hairy vetch cover crop. Nodulation is sensitive to available soil nitrogen and the high nitrate availability could inhibit initial establishment of the symbiosis (Streeter, 1988.).

Table 13. Effect of tillage, cover crop, and glyphosate on soybean yield in 2002 to 2005, Stoneville, Mississippi

Treatment	2002	2003	2004	2005
	Soybean yield (kg ha^{-1})			
Tillage				
Conventional tillage	2537	3392	2415	2707
No-tillage	2237	3308	2146	2778
LSD 0.05[a]	NS[b]	NS	NS	NS
Cover crop				
No cover	2623	3492	2365	3024
Rye	1774	2981	1983	2100
Hairy Vetch	2765	3575	2493	3103
LSD 0.05	308	154	196	201
Herbicide				
Non-glyphosate	2262	3191	2207	2430
Glyphosate	2513	3508	2354	3055
LSD 0.05	214	125	90	164
Tillage (T)	0.158	0.630	0.168	0.385
Cover crop (CC)	<0.001	<0.001	0.001	<0.001
T * CC	0.403	0.035	0.581	0.002
Herbicide (H)	0.024	<0.001	0.003	<0.001
T * H	0.725	0.546	0.002	<0.001
CC * H	0.658	0.738	0.456	0.358
T * CC * H	0.642	0.359	0.431	0.739

No preemergence herbicides were used. Glyphosate-based treatment received two postemergence applications of glyphosate. Non-glyphosate treatment received postemergence applications of acifluorfen, bentazon, chlorimuron, and clethodim or fluazifop-P.

[a] Fisher's least significant difference [b] NS = Not significant.

CONCLUSIONS

Tillage and cover crops show beneficial effects on several parameters of soil quality. The consistently reduced soybean yield under rye cover crop illustrates a negative effect on soybean productivity, thus a rye cover crop is not recommended for soybean production in Mississippi.

Hairy vetch had no deleterious effects on soybean productivity, however considering the costs associated with establishment of this cover crop, there is no economic benefit to the producer. Although soybean yield was not affected by NT practices, this management was facilitated by the use of a glyphosate based management system and does offer a clear economic benefit for the grower.

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