Field Changes after 10 Years of Continuous No-till Soybeans.

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INTRODUCTION

Little is known about the long-term changes continuous no-till production will have on a field in Brown Loamsoils of Mississippi. Producers have questions concerning changes in soil properties, weed species shifts, and consistency of yields. McGregor et al. (1973) found that no-till soybean plots increased surface residue from 2.5 T/A to 4.0 T/A and reduced field soil loss 6.7 T/A annually in some of the early work on Brown Loam soils.

Mutchler et al. (1984) reported average annual soil losses were reduced from 7.9 t/A to 0.6 T/A by continuous no-till soybean during a 9-year study in Brown Loam soils. Accumulated residue after harvest averaged 1.7 T/A for conventional to 3.9 T/A for continuous no-till. During the last 5 years of an 8-year study on Brown Loam soils, McGregor et al. reported no-till soybean yields averaged 44% more than conventionally tilled soybean. Johnson et al. (1985) reported lower yields from no-till over a 3-year period in the same soils but cultivation, however, did improve yields of no-till soybean. Stevens et al. (1987) also reported a significant yield increase from no-till planting followed by cultivation in Brown Loam soils.

The objective of this study was to determine the effects continuous no-till soybean production had on soil properties, weed ecology, and grain yields in Brown Loam soils.

MATERIALS AND METHODS

This study was started in the spring of 1981 at the North Mississippi Branch Experiment Station in Holly Springs, MS on an eroded Grenada silt loam soil with a 2-5% slope. Depth to fragipan varied from 9 to 17 inches across the test area. Five years previous to the study, the site had been used for a soybean variety test area. Weeds were not allowed to produce seed in the study area. The study area soil pH in 1981 was 6.2 and organic matter was 0.82% in the 0-to 6-inch soil depth.

The experimental design was a split-plot with herbicide management system as main plots and cultivation as sub-plot treatment. Main plots consisted of eight rows, 40 inches wide and 30 feet long, and each sub-plot consisted of four rows. Plots were replicated four times. A conventionally tilled plot (disk, chisel, disk, and do-all) was used as a check. Fertilizer was drilled 2 inches to the side of row and 2 inches deep at planting. A standard rate of 300 lb of 0-20-20 was used on all plots since soil test results of drilled fertilizer can be quite variable.

At the onset of the study, the decision was made not to test the efficacy of herbicides. Herbicides were to be changed to superior herbicides when they became available. Not changing herbicides would have allowed definitive statements on herbicide efficacy, but the results might have shown that it is not possible to maintain weed control in no-till soybeans when, in fact, farmers could do so by using new herbicides as they were released. Since evaluating herbicide efficacy was secondary to the broader objective of determining whether weed control can be maintained, herbicides were changed as warranted. The best available herbicide treatments for control of annual grasses and weeds were used for the duration of the study in comparison to a standard program (Lasso*, Dual*, Lexone*). This same decision applied to johnsongrass and burndown herbicides. All herbicides were used according to the labels for best results. The time and manner of application

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Table 1. Preplant, preemergence, and postemergence herbicide programs in main plot treatments.

Trt. No.			PPI or PRE		
			Annual Grasses	Annual Weeds	Postemergence
1	None	Non-selective	Excellent	Excellent	dir w/contact
2	None	Contact	Excellent	Poor	dir w/residual
3	None	Contact	Excellent	Excellent	O.T.w/str. grass
4.	None	Contact	Excellent	Excellent'	O.T.w/weak grass
5.	None	Contact	Excellent	Excellent'	O.T.w/str. grass
6.	Tilled	None	Excellent	Excellent	O.T.when needed

[1]At low rate (1/2 rate)
[2]At high rate (1 1/4 rate)

were according to MCES recommendations.

Table 1 lists herbicide systems that were applied preplant to foliage (PPF), preplant incorporated (PPI), preemergence (PRE), over-the-top (OT), and postdirected sprayed (dir). Treatments 1-5 were no-till planted and Treatment *6* was a conventionally tilled control. Conventional tilled plots were chiseled and disked 2 weeks before applying PPI herbicides. Incorporation was performed with a finishing harrow immediately before planting.

In the no-till plots preplant burndown herbicides (PPF) were sprayed at planting at the onset of the study. After 5 years into the study, it was decided to apply burndown herbicides 2 weeks prior to planting. Preemergence (PRE) herbicides were sprayed immediately after planting. Postdirected (dir) sprays were applied when soybeans were about 8 inches tall. Cultivation was done 3 to 5 weeks after emergence followed by a second cultivation approximately 2 weeks later.

Plots were visually rated for percent annual weeds and grasses in March and July. Perennial weeds and grasses were mapped in October. Soil samples to a 6-inch depth were taken after removing residue from soil surface. All chemical soil analyses were conducted at the MCES soil testing laboratory. Soybean was harvested from two center rows of each plot. Planting dates for the 10 years ranged from May 9, 1986 to June 25, 1985.

RESULTS AND DISCUSSION

Annual grasses and weeds were not a problem during the soybean growing season in any treatment during the 10-year study. The preemergence herbicides either gave satisfactory control of the weeds or the weed seed were not present in the plots to germinate. Table 2 lists weeds found in test area for 1984, 1987, and 1990 before burndown and preemergence applications. In the no-till plots, henbit became more abundant after 10 years, Virginia pepperweed decreased, while annual bluegrass, little barley, and mousetail ramained the same. Rhizome johnsongrass (perennial), however, became a problem in the postdirected treatments (Treatments 1 and 2) within the first 5 years. Post-directed treatments suppressed the johnsongrass in the early season, but did not prevent growth of johnsongrass later in the season. Johnsongrass, however, was scattered in all treatments after 10 years. Perennial grasses and weeds listed in Table 3 began to show up randomly in the no-till study area. Horsenettle was the only broadleaf perennial that was widespread throughout all no-till plots at the end of the growing season in 1990, since other perennial broadleaf plants found in plots were

Table 2. Distribution of winter weeds 3, 7, and 10 years after initiation of study.

	Distribution'		
Weed name	3/15/84	4/30/87	3/23/90
Little barley	VA	VA	VA
Annual bluegrass	VA	VA	VA
Mousetail	VA	VA	VA
Horseweed	VA	VS	M
Carolina geranium	VA	M	M
Bittercress	VA	M	M
Henbit	A	VA	VA
Virginia pepperweed	A	S	M
Shepherdspurse	M	VS	VS
Mouseear chickweed	M	M	VA
Wild garlic	M	S	VA
Buttercup	M	S	--
Cutleaf eveningprimrose	S	M	VA
Hop clover	S	M	VS
Narowleaf vetch	S	M–VA	VA
Common chickweed	VS	S	VS
Whitlowort	VS	--	--
Wild lettuce	--	S	VS
Curly dock	--	S	VS
Chervil	--	S	--
Bracted plantain	--	VS	VS
Red sorrel	--	VS	VS
Wild oats	--	VS	--

'Infestation was uniform over the entire no-till area. Visual estimate distributions were described as very abundant (VA), abundant (A), moderate (M), scattered (S), or very scattered (VS).

dormant in October.

Preemergence and over-the-top (OT) herbicides at the rates used did not kill perennial broadleaf plants such as pokeweed, horsenettle, curly dock, and maypop passion flower. For the first 5 years number and magnitude of these plants were not evident until near the end of the growing season, yet the few pokeweed plants present did cause discoloration of the soybean when harvested. Systems, including contact burndown herbicides such as Gramoxone® (paraquat) that destroyed vegetation within a day or two after spraying, did not produce any better kill than Roundup® (glyphosate), which was slower acting and more effective on weeds such as horseweed. None of the materials used in this study controlled all the vegetation when applied

Table 3. Weeds that were present in the no-till plots either in the spring or fall of 1990.

General weed name	Weeds present and Treatment No.		Present in All Reps	Present in Tilled Plots
	Cult.	No Cult.		
Broomsedge		1	NO	No
Johnsongrass	1,2,3,4,5	1,2,3,4,5	Yes	Yes
Bennudagrass	1,2	1,2	NO	NO
Pokeweeds	1,2,3	1,2,3	NO	NO
Horsenettle	1,2,3,4,5	1,2,3,4,5	Yes	No
Wild Garlic	1,2,3,4,5	1,2,3,4,5	Yes	Yes
Maypop Passion Flower		2,4	No	NO
Broadleaf Plantain	1,2,3,4,5	1,2,3,4,5	Yes	No
Curly Dock	1,2,3,4,5	1,2,3,4,5	Yes	NO
Red Sorrel	1,2,3,4,5	1,2,3,4,5	Yes	NO
Dandelion	1,2,3,4,5	1,2,3,4,5	Yes	NO

Table 4. The effects of tillage for soybean on soil bulk density following 10 years of tillage.

Postemergence cultivation	Tillage treatment		
	Tilled	No-tilled	
within the seed drill			
	gm cm^{-3}		
Yes	1.38	1.38	n.s.
No	1.38	1.39	n.s.
	n.s.	n.s.	
within the traffic row			
	gm cm^{-3}		
Yes	1.47	1.48	n.s.
No	1.49	1.47	n.s.
	n.s.	n.s.	
	n.s.	n.s.	
the non-traffic row			
	gm cm^{-3}		
Yes	1.43	1.45	n.s.
NO	1.43	1.46	n.s.
	n.s.	n.s.	

Table 5. Effects of herbicides and cultivation on soybean yields, 1981-90.

Trt.	Cultivated	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	10-yr. Avg.
		bu A^{-1}										
1	Yes	28.4	32.1	13.9	24.2	29.9	21.4	18.2	24.6	14.8	12.6	22.0
	No	29.7	36.8	12.6	17.9	26.6	19.3	14.5	16.9	12.9	9.8	19.7
2	Yes	33.0	38.4	14.7	19.4	22.5	25.4	20.3	3.8	18.9	9.3	20.6
	NO	31.4	36.8	13.0	8.9	20.2	26.1	19.7	6.5	19.1	18.1	20.0
3	Yes	35.3	35.7	14.7	18.5	31.6	25.0	14.8	7.4	14.6	16.8	21.4
	NO	30.9	35.1	11.1	11.8	25.5	16.5	5.0	4.8	16.8	11.8	16.9
4	Yes	35.4	38.2	15.9	18.3	34.5	32.0	21.9	19.1	7.7	14.3	23.7
	NO	36.7	37.9	12.1	10.1	29.6	25.1	22.9	18.6	8.9	15.1	20.2
5	Yes	37.3	32.1	17.3	14.5	37.3	30.1	25.1	30.5	16.5	14.4	25.5
	NO	34.9	36.5	14.5	14.9	30.8	26.6	21.6	23.8	14.8	10.6	22.9
6	Yes	33.0	35.5	13.5	26.5	46.8	30.5	24.7	36.1	12.5	17.1	27.6
	NO	33.7	38.5	12.1	24.8	39.5	27.0	20.7	20.0	9.1	13.4	24.0
LSD $_{0.05}$[1]		ns	ns	ns	4.0	8.7	4.3	4.8	8.9	4.3	4.5	
LSD $_{0.05}$[2]		ns	ns	ns	2.0	3.4	2.3	2.2	2.3	ns	ns	
CV (%)		20.8	13.9	20.7	21.5	22.0	15.6	23.6	46.9	29.3	42.7	

[1] LSD 0.05 values for comparing two herbicide means. Statistical analyses of 1984, 1989, and 1990 yields showed a cultivation x herbicide interaction. NS = not significant.

LSD 0.05 values for comparing cultivated and not cultivated means.

alone at rates used, making combinations with other herbicides necessary.

Field organic matter at the 6-inch depth was 0.82% at the beginning of the study. The organic matter content of the plots after 10 years was not consistent within tillage or post-plant cultivation. No significant differences in bulk densities were found between the tilled and no-tilled plots, and the no-tilled values were combined Table 4). It is apparent that soil compaction was no greater in the spring prior to conventional tillage following 10 years of no-tillage on Brown Loam soils than when conventional tillage was used.

Average grain yield of soybean was not significantly different for the first 3 years of the study for either the main plot treatment (herbicide management) or subplots (postemergence cultivation), Table 5. Generally, the yields were closely associated with rains that came during the growing season, especially from July through mid-September. Cultivation produced a significant yield increase 5 of 10 years. The 10-year average favored cultivation in all the main plots.

In summary, bermudagrass was present after 10 years in the treatments where an OT grass herbicide was not used. Scattered johnsongrass plants were found in all plots after 10 years. Horsenettle was abundant in all no-till

plots at the end of the soybean growing season. Perennial weeds such as curly dock, dandelion, and wild garlic were dormant during most of the soybean growing season.

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