CROP ROTATION AND TILLAGE SYSTEMS FOR CONSERVATION COMPLIANCE FOR BLACKLAND PRAIRIE

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INTRODUCTION

The Blackbelt Prairie soils (about 2 million acres) are predominately heavy, expanding clays and are highly erosive when pulverized. Topography ranges from level to sloping and is classified as highly erodible by federal law in the 1985 Food Security Act. The Prairie soils are underlined by soft limestone or chalk as the main soil-forming material. This formation causes this land resource region to be one of the nation's most susceptible to productivity losses from soil erosion (USDA 1989, U.S. Corp of Engineers and USDA, SCS, 1990). Previous research (Hairston et al., 1984; Hairston et al., 1987) in the Blackbelt Prairie has shown that a positive correlation existed for higher soybean yield on soils with a greater soil-to-chalk depth. When topsoil is lost to erosion, the unproductive chalk subsoil will render the region unsuited for row crops.

Limited information is available on the rotational influence no-tillage and ridge-tillage corn in rotation with fall tillage wheat followed by double cropped no-till soybean and monocrop soybeans in no-tillage and ridge-tillage systems. The appropriate use of ridge-tillage, no-tillage, cover crop, and rotation systems have potential to be effective practices in minimizing production costs, enhancing productivity, and meeting conservation compliance.

The objectives of this study are to evaluate soybean yield response and residue ground cover and vegetative canopy development by selected tillage and crop rotationltillage systems in the Blackland Prairie Region.

MATERIALS AND METHODS

The experiment was initiated in 1992 at the Prairie Research Unit in Prairie, Mississippi on a Vaiden silty clay (very-fine,montmorillonitic, thermic, Vertic Hapludalfsl with a 1 to 2% slope. The previous crop history on this site was native grass hay meadow.

A randomized complete block design with 14 tillage treatments were evaluated in four replications. Plot size was 20 ft x 70 ft long. P_2O_5 and K_2O fertilizer were applied according to soil test recommendations. Fertilizer was applied broadcast to all plots, prior to establishing tillage sequence. Additional fertilizer will be surface applied broadcast each year according to soil test. Tillage treatments and description of grain crop sequence are presented in Table 1.

The herbicide 2.4-D was applied as an early (mid Feb - mid March) weed control method on all monocrop and wheat-double crop soybean treatments except CT. Two weeks prior to planting soybeans, Gramoxone Extra (0.47 lb ai/ac) was applied to all soybean plots, except RP planted soybean, as a burndown. Soybean plots were planted in 30-inch rows with 9 seedlft of row length. Preemergence application of Dual (1.5 lb ailac) + Canopy (0.28 lb ai/ac) was applied to all soybean plots. All soybean plots received an application of Poast Plus (0.375 lb ailac) over the top to control broadleaf signalgrass grass.

Corn plots were planted in 30-inch rows with 1.5 seedlft of row length. Preemergence Atrazine (2.0 lb ai/ac) + Dual (2.0 lb ailac) + Gramoxone Extra (0.62 lb ailac) + surfactant (0.25% v/v) was applied to all corn plots. Linuron (1.0 lb ai/ac) was applied post-directed to NT and RT corn plots. Nitrogen was applied broadcast over the top to corn plots at the rate of 160 N/ac when corn was approximately 12 to 15 inches tall.

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Table 1. Tillage/Grain Crop Sequence Treatments, MAFES Prairie Research Unit, Prairie, MS.

Seauence	Description
I.	Continuous crops
	A. Corn
	1. No-Tillage (NT)
	2. Ridge-Tillage (RT)
	3. Conventional Tillage (CT), Fall Chisel and Bed
	4. Turf Aerator (TA)
	B. Soybean
	5. NT
	6. RT
	7. CT
	8. TA
II.	Two Year Rotation/Tillage
	A. Corn/Soybean Rotation
	9. RT Corn (92,94,96); Followed by (Fb) RT Beans (93,95,97)
	10. RT Beans (92,94,96); Fb RT Corn (93,95,97)
	B. Corn-Wheat-Double Cropped Soybean Rotation
	11. NT Corn (92,94,96);Fb Fall Disk + Do-all (MT) Wheat and NT Double-Crop Beans (93,95,97).
	12. MT Wheat and NT Double-Crop Beans (92,94,96); Fb NT Corn (93,95,97).
	13. MT Wheat (92,94,96) and Relay Planted (RP) NT Beans (92,94,96); Fall (F) Bed and NT Corn (93,95,97).
	14. F Bed and NT Corn (93,94,96); Fb MT Wheat and RP NT Beans (93,95,97).

Wheat plots were planted in 7.5 inch rows, at 20 seedlft row. Relay planted wheat plots were planted in 7.5 inch rows with 15 inch skips for tractor wheel tracks (2/20 ft planter swath) and every 30 inches for soybean row. Nitrogen was applied broadcast to wheat plots in the spring at 120 N/ac. Harmony-Extra (0.38 lb ai/ac) was applied in mid February for weed control in the wheat.

A 100 pin cam line was used to measure ground residue cover (GRC) and vegetative canopy (VC). This line was drawn diagonal across each plot, approximately in the same location when measurements were made. The pin spacings on the cam line were 8 inches apart. Vegetative and residue counts were made under each pin marking. Measurements were taken periodically during the fall, winter, spring and early summer and after planting each crop. from 3 replications.

Entire wheat plots were harvested for grain yield. The center two rows of corn and soybean plots were harvested for grain yield. Grain yield from each plot was weighed and adjusted to

Table 2. Tillage and grain crop sequence effect on corn plant population and yield, on a silty clay soil in 1993, at the Prairie Research Unit, Prairie, MS.

Crop Sequence/ Tillage Svstem	Pl/ac X 1000	Yield bulac
I. Continuous crops		
A. Corn		
1. NT	20.8	72
2. RT	20.3	100
3. CT	24.7	93
4. TA	17.5	62
B. Sovbean		
5. NT	----	---
6. RT	----	---
7. CT	----	---
8. TA	----	---
II. Two Year Rotation/Tillage		
A. Corn/Soybean Rotation (2 yr)		
9. RT Corn; Fb RT Beans ('931	----	---
10. RT Soybeans; Fb RT Corn ('93)	22.4	109
B. Fall MT Wheat-NT Beans Fb Corn Rotation (2 yr)		
11. NT Corn; Fb MT Wheat-NT Beans ('93)	----	---
12. MT Wheat-NT Beans; Fb NT Corn ('93)	15.9	56
13. MT Wheat-RP Beans; Fb F Bed NT Corn ('93)	22.9	88
14. F Bed NT Corn; Fb MT Wheat-RP Beans ('93)	----	---
LSD 0.05	4.1	18
% CV	15.2	14

bushels per acre. Data was subjected to statistical analysis (SAS, Cary, N.C.) and means were separated by Least Significant Differences (LSD) at the 0.05 probability level.

DISCUSSION

This is the second year of a five year study at the Prairie Research Unit. Data for 1992 is not presented since this was the establishment year of tillage/cropping sequence. The study area had to be smoothed with a disk before tillage treatments were imposed in 1992. Measurements of ground residue cover IGRC) and vegetative canopy IVC) were initiated in the fall of 1992 after harvest of corn and soybeans.

Grain yields in 1993 ranged from 56 to 109 bulac (Table 2). Continuous conventional tillage (CT) and ridge tillage (RT) corn, RT corn following RT soybeans and fall bed with NT corn following minimum tillage (MT) wheat with RP soybeans showed no difference in yield. No-tillage (NT) corn following MT wheat and NT double cropped soybeans, continuous NT corn and continuous corn with turf aerator tillage (TA), however, showed

Table 3. Tillage and grain crop sequence effect on wheat and soybean yield, on a silty clay soil in 1993, at the Prairie Research Unit, Prairie, MS.

Crop Sequence/ Tillage System	---------bu/ac---------- Wheat	Beans
I. Continuous crops		
A. Corn		
1. NT	--	--
2. RT	--	--
3. CT	--	--
4. TA	--	--
B. Soybean		
5. NT	--	41
6. RT	--	29
7. CT	--	41
8. TA	--	41
II. Two Year Rotation/Tillage		
A. Corn-Soybean Rotation (2 yr)		
9. RT Corn; Fb RT Beans ('93)	--	41
10. RT Beans; Fb RT Corn ('93)	--	--
B. Fall MT Wheat-NT Beans Fb Corn Rotation (2 yr)		
11. NT Corn; Fb Wheat-NT Beans ('93)	26	43
12. MT Wheat-NT Beans; Fb NT Corn ('93)	--	--
13. MT Wheat-RP Beans; Fb F Bed NT Corn('93)	--	--
14. F Bed NT Corn Fb; FB MT Wheat-RP Beans ('93)	25	35
LSD 0.05	13	7
% CV	22	12

lower yield than continuous CT corn, continuous RT-corn, RT corn following RT soybeans, fall bed with NT corn following doublecropped soybeans. This yield difference is attributed to the significantly lower corn populations on flat plots as opposed to raised bed treatments (Table 2).

Soybean yields for continuous CT, continuous NT, RT soybeans following RT corn, and NT doublecropped soybeans were not different (Table 3). This is in contrast to previous soybean work on Prairie soils (Buehring et al., 1981; Buehring et al., 1988; Hairston et al., 1984; and Hairston et al., 1990) which showed that NT soybeans produced lower yield than CT. However, additional years of research are needed to determine whether NT yield will be equal or greater than CT. RT continuous and relay planted (RP) soybeans planted into standing wheat had lower yields than CT, NT, and NT doublecropped soybeans. The lower RT yields are attributed to observations of higher infestation levels of stem canker in the RT continuous soybean plots than in RT soybeans following corn, and continuous NT and CT soybeans.

Wheat yields were low in both doublecropping systems (Table 3). due to a March freeze and wet, cloudy conditions. Doublecropped soybeans planted NT in 30-inch rows in wheat stubble in mid-June produced higher yields than soybeans

Table 4. Tillage and grain crop sequence effect on ground cover residue and canopy coverage on a silty clay soil in 1992 and 1993 at the Prairie Research Unit, Prairie, MS.

Crop Sequence/ Tillage System	11/25/92		4112/93		After Planting[3/]	
	GRC[1/]	VC[2/]	GRC	VC	GRC	VC
	%					
I. Continuous crops						
A. Corn						
1. NT	86	3	70	20	59	14
2. RT	78	6	56	25	55	16
3. CT	19	5	25	20	26	14
4. AT	88	5	60	5	56	5
B. Sovbean						
5. NT	79	3	25	67	73	0
6. RT	77	6	17	29	76	1
7. CT	41	5	13	71	12	1
8. At	81	2	24	63	38	41
II. Two Year Rotation/Tillage						
A. Corn-Sovbean Rotation (2 yr)						
9. RT Corn Fb RT Beans ('93)	86	3	53	39	54	40
10. RT Soybeans Fb RT Corn('93)	82	3	30	25	38	--
B. Fall Till Wheat-NT Beans Fb Corn Rotation (2 yr)						
11. Corn Fb Wheat-NT Beans ('93)	21	6	6	86	82	--
12. MT Wheat NT Beans Fb NT Corn ('93)	99	0	64	34	68	25
13. MT Wheat-RP Beans Fb Bd Corn ('93)	28	1	30	23	31	17
14. Bd Corn Fb; MT Wheat-RP Beans ('93)	31	1	25	86	78	12

1/ GRC = ground residue cover

2/ VC = vegetative canopy

3/ After planting of each crop. Corn planting date was 4-12-93, monocrop & RP soybean planting date was 5-31-93 and double cropped soybean planting date was 6-16-94.

relay planted in standing wheat in late May and was not different from continuous CT and NT soybeans. The good double cropped mid June planting yields are attributed to above normal rainfall in September of 1993.

Ground residue cover (GRC) and vegetative canopy IVC) data taken after harvest (November), in April, and after planting each crop are shown in Table 4. Residue decomposition during the fall and winter resulted in lower GRC percent in April. Continuous CT corn showed 26% after planting. All other corn tillage treatments had 31% or more GRC. The percent canopy coverage from 11-25-92 to 4-12-94 increased for all treatments except AT corn. The only corn treatments in which VC

development was more than 30% was corn following soybean in a rotation, (MT wheat and NT soybeans Fb NT corn).

Soybean residue decomposition rate was greater than corn. April data for GRC residue for all treatments had 30% or less GRC, except the corn (92) Fb MT wheat-NT soybeans (93) treatment which had higher GRC due to corn residue. Percent VC was higher for soybean treatments than for corn treatments, which suggest that corn herbicide residue reduced canopy development more than soybean residue herbicides.

After planting, continuous CT corn had 26% GRC, and continuous NT and RT corn treatments had 55% or more GRC. RT corn following RT soybeans had 38% or more GRC. Continuous CT soybeans had 12% GRC in comparison to 70% or more GRC in continuous NT and RT soybeans. Soybeans planted NT into wheat stubble had 68% or more GRC in April.

CONCLUSION

This was the second year of a five year study to evaluate the tillagelcropping sequence effect on yield, ground residue and canopy development. Yields were low for wheat due to early frost and cool wet weather. Corn yields ranged from 56 to 109 bu/ac. CT, RT and MT (Bed) were not different in yield. NT, MT wheat-NT soybeans doublecropped, NT corn and TA corn yields were lower. These yield differences were a result of lower corn populations in the flat than raised bed systems. RT continuous and RP soybeans in standing wheat had lower yields than CT, NT, and NT doublecropped soybeans. Over the fall and winter GRC decreased with an increase in VC. Immediately after planting most treatments showed VC and GRC decreased. VC increased in all wheat plots. Immediately after planting the continuous CT corn and continuous CT soybeans had less than 30% GRC.

REFERENCES

Buehring, N. W., F. D. Whisler. and J. K. Young. 1981. Soybean response to various minimum tillage systems on a silty clay soil. p. 5 In abstr. of Technical Papers, S. Branch of the ASA Meeting.

Buehring. N. W., S. R. Spurlock. N. C. Edwards, D. B. Reginelli, and M. A. Blaine. 1988. Net returns for soybean reduce tillage system on three land resource areas. p. 72-75. Proceedings 1988 Southern Conservation Tillage Conference, Tupelo, MS. Special Bul. 88-1.

Hairston, J. E., J. O. Sanford, J. C. Hayes, and L. L. Reinschmidt. 1984. Crop yield, soil erosion, and net returns from five tillage systems in the Mississippi Blackland Prairie. J. Soil and Water Conservation 39:391-395.

Hairston, J. E.. J. G. Miller, D. L. Lyton, L. K. Marshall and J. O. Sanford. 1987. Effect of soil depths, O. M. and rainfall on soybean yield in the Mississippi Blackbelt. p.8. In Abstr. of Technical Papers, S. Branch of the ASA, Nashville, TN.

Hairston, J. E., W. F. Jones, P. K. McConnaughey, L. K. Marshall, and K. B. Gill. 1990. Tillage and fertilizer management effects on soybean growth and yield on three Mississippi soils. J. Production Agric. 3:317-323.

SAS Institute Inc. 1986. SAS Language Guide for Personal Computers, 6 Edition.

USDA 1989. The second RCA appraisal. Soil, water, and related resources on non-federal land in the US. Analysis of conditions and trends.

US Corp of Engineers and USDA, SCS. 1990. Tombigbee river basin joint study.