Effect of Soybean-Corn Rotation and Tillage on Ground Residue Cover and Canopy Development

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Introduction

Topography in northeastern Mississippi ranges from level to sloping, and the sloping soils are often classified as highly erodible, based on regulations of the 1985 and 1990 Food Security Acts. For row-crop production to meet conservation compliance on these sloping soils, terraces and/or grass strips may be necessary (Argus, 1993). Crop residue and winter vegetation ground cover management have the potential to be effective methods for reducing erosion and thereby meeting compliance standards. Tillage practices directly impact the amount of crop residue and winter vegetation that remain on the soil surface. Therefore, studies were initiated to determine the influence continuous cropping and rotations of corn and soybeans, and corn and wheat with doublecropped soybeans in stale seedbed (no preplant tillage) and conventional tillage systems, have on winter vegetation canopy ground cover and ground residue cover.

Materials and Methods

Studies were conducted as randomized complete block designs with four replications on Vaiden and Leeper silty clay soils at Prairie and Verona, MS, respectively. A 100-pin camline with pins spaced 6 inches apart was used to measure ground residue cover (GRC) and winter vegetation canopy cover (VCC) development in three of four replications. Vegetation and pieces of crop residue under each pin were counted and expressed as a percentage (Sloneker and Moldenhauer, 1977).

The following continuous cropping tillage treatments were evaluated on both sites: (1) no-tillage (NT) corn; (2) ridge-tillage (RT1) corn (planted no-till and cultivated once with a high-clearance cultivator equipped with ridgers); (3) turf aerator (TA) corn, with turf aerator knives operated one month prior to planting at 10° angle from vertical and at a 4 to 6-inch depth at Prairie; (4) conventional raised-bed tillage (CTB) corn (disked, chiselled, bedded, do-alled before planting, and cultivated once); (5) NT soybeans; (6) ridge tillage (RT2) soybeans (planted no-till and cultivated twice with high-clearance cultivator equipped with ridgers); (7) TA soybeans; and (8) conventional smooth seedbed tillage (CT) soybeans (chisel, disk, followed by do-all before planting and cultivated twice during the growing season).

The following tillage/crop rotation treatments were evaluated on both sites: (1) RTl corn followed by RT2 soybeans; (2) RT2 soybeans followed by RT1 corn; (3) NT corn followed by minimum tillage (MT) wheat (disked twice after corn harvest followed by wheat do-alled before planting) with NT doublecrop soybeans; (4) MT wheat with NT doublecrop soybeans followed by NT corn; (5) NT corn followed by MT Bed (MTBd) wheat and NT doublecrop soybeans (Verona site); and (6) MTBd wheat with NT doublecrop soybeans followed by NT corn (Verona site).

Corn stale seedbed systems (TA, NT, and RTl) received a tank mixture of a burndown and preemergence herbicides, after planting corn. CTB corn also received the same preemergence herbicides. Corn was planted at 1.5 seeds/ft row in 30-inch rows with 160 lb N/A applied when corn was 12 to 16 inches tall.

A broadleaf herbicide was applied mid-February to mid-March for weed control on all continuous stale seedbed monocrop soybeans and wheat doublecrop soybean treatments. Two weeks prior to planting soybeans, a burndown herbicide was applied to continuous soybean stale seedbed systems (RT2, TA, and NT) and rotation (RT1 corn followed by RT2 soybeans) treatments. Soybeans were planted in 30-inch rows with 9 seeds/ft of row. Preemergence herbicides were applied to rotation (RT1 corn followed by RT2 soybeans) and continuous CT, RT2, TA, and NT soybeans. All wheat NT doublecrop soybean treatments received a burndown herbicide application at soybean planting. Soybeans, wheat, and corn were harvested with a combine equipped with a chopper that spread the residue across a 20-foot wide plot.

Wheat plots were planted in the fall of 1992 and 1993 in 7.5-inch rows, using 20 seed/ft of row. Nitrogen was applied broadcast to wheat plots in the spring at 120 lb/A. Data were subjected to statistical analysis (SAS, Cary, 1988) and me-

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ans were separated by Least Significant Difference (LSD) at the 0.05 probability level.

Discussion

Corn

Prairie. Winter VCC development was slow from October 1992 and 1993, through March 1993 and 1994, on all treatments (Table 1). Maximum VCC was 20% for RT2 soybeans followed by RT1 corn on March 8, 1993 and 42% VCC on Feb. 18, 1994. Data for GRC indicated stale seedbed treatments TA, NT, and RTl in continuous corn, and RT2 soybeans followed by RT1 corn had *56%* or more GRC on March 8, 1993 and 55% or more GRC on Feb. 18, 1994. The soybean residue in the rotation (RT2 soybeans followed by RT1 corn) had similar GRC as RTl and NT continuous corn in October and November, but was lower than NT corn in February, March, and April. The CTB corn had 26 and 15% GRC after planting in April 1993 and and April 1994. The lower GRC for CTB is a reflection of tillage operations, which destroyed VCC and GRC by mixing and burying both GRC and VCC.

Verona. Winter VCC on the Leeper was similar to the Vaiden site (Table 2). However, the MTBd wheat with doublecrop NT soybeans followed by NT corn in a rotation had 31% VCC on March 11, 1993 and, because of volunteer wheat from the previous wheat crop, had more VCC than all other stale seedbed systems. Stale seedbed corn rotation RT2 soybeans followed by RTl corn indicated that soybean residue disintegrated more rapidly than corn residue resulting in lower GRC for RT2 soybeans than NT corn in March and April 1993, and March 1994.

Stale seedbed (NT, RTl) continuous corn and corn rotation stale seedbed treatment RT2 soybeans followed by RTI corn had similar GRC. Both treatments had 53 and 76% or more GRC after planting corn April 14, 1993 and April 20, 1994,

Table 1. Effect of corn rotation and tillage on winter vegetation canopy cover and ground residue cover on a Vaiden silty clay soil from October 1992 through May 1994 at the MAFES Prairie Unit, Prairie, MS.

	1992 and 1993					
	Fall 1992			Spring 1993		
Corn Rotation/Tillage System[1]	10105	10/23	11/25	3/08	4/12[2]	6/02
	% Ground Residue (Canopy) Cover					
I. CONVENTIONAL TILLAGE (CTB)	94(2)	32(3)	19(5)	20(17)	26(14)	17(44)
11. STALE SEEDBED SYSTEM						
A. **Continuous Corn (C)**						
1. No Tillage (NT)	95(3)	89(7)	***86(3)***	79(9)	59(14)	**30(50)**
2. Ridge Tillage (RTl)	91(2)	***85(5)***	78(6)	67(18)	55(16)	7(45)
3. Turf Aerator (TA)	95(3)	90(8)	**88(5)**	72(4)	56(5)	23(52)
B. Soybean(Bn)-Corn(C) Rotation						
4. RT2-Bn; Fb RT1-C	—	92(0)	82(3)	56(20)	38(-)	4(39)
C. Wheat(W)/Soybean(Bn)-NT-Corn(C) Rotation						
5. MT-W-NT-Bn; Fb NT-C	—	99(0)	99(0)	80(17)	68(25)	15(77)
LSD 0.05	—	5(4)	14(NS)	14(10)	15(12)	15(11)
% CV	—	3(83)	11(95)	13(36)	18(27)	54(33)

	1993 and 1994					
	Fall 1993			Spring 1994		
	9/30	11/02	12/13	2/18	4/14'	5/19
I. CONVENTIONAL TILLAGE (CTB)	97(2)	48(3)	17(0)	25(3)	15(0)	17(16)
11. STALE SEEDBED SYSTEM						
A. **Continuous Corn (C)**						
1. No Tillage (NT)	96(4)	97(1)	96(1)	86(10)	85(13)	77(16)
2. Ridge Tillage (RT1)	95(3)	91(2)	85(6)	69(25)	89(1)	63(18)
3. Turf Aerator (TA)	90(4)	91(5)	94U)	81(14)	46(0)	47(14)
B. Soybean(Bn)-Corn(C) Rotation						
4. RT2-Bn; Fb RT1-C	---(-)	95(2)	68(30)	55(42)	37(0)	74(16)
C. Wheat(W)/Soybean(Bn)-Corn(C) Rotation						
5. MT-W-NT-Bn; Fb NT-C	--(-)	100)	96(3)	83(16)	95(0)	76(17)
LSD 0.05	NS(NS)	5(4)	16(14)	20(19)	31(10)	13(14)
% CV	3(89)	3(97)	12(18)	18(43)	27(40)	12(12)

'Tillage descriptions are listed in materials and method; Fb = followed by.
2Data collected after corn was planted 4/12/93 and 21 days after planting 3/23/94.

respectively. This was in contrast to CTB corn, which had 21% and 20% GRC after planting April 14, 1993 and April 10, 1994.

Soybeans

Prairie Winter VCC development in the soybean treatments was slow and very similar to corn until February, and then increased dramatically from March through April, reaching 67% VCC in continuous NT beans and 86% VCC in MT wheat in April 1993, and 91 and 99% VCC in April 1994, respectively, (Table 3). The RT1 corn followed by RT2 soybeans showed less VCC cover than continuous RT2 and NT soybean March 8, 1993 and April 12, 1993, and Feb. 10, 19994 and April 14, 1994. This may have been because of less corn residue decomposition (higher % GRC), which resulted in more ground shading for the rotation than continuous RT2 and NT soybeans. The soybean stale seedbed TA treatment after planting June 1, 1993 and May 19, 1994 had 42% and 69% GRC, respectively. The continuous NT and RT2 soybeans, after planting June 2, 1993 and May 19, 1994, had 73 and 76% or more GRC compared to 8 and 12% GRC, respectively, for CT soybeans.

Verona The 1993 and 1994 results indicated that stale seedbed soybean rotation system RTl corn followed by RT2 soybean had low VCC development in April in comparison to continuous NT soybeans (Table 4). The NT and RT2 continuous soybean winter VCC for April 19, 1993 and April 20, 1994 was 53 and 24%, and 62 and 64%, respectively. This was in comparison to 11 and 17% VCC for the RTl corn followed by RT2 soybean rotation on April 19, 1993 and April 20, 1994. The rotation RT1 corn followed by RT2 soybeans GRC was higher (less corn residue decomposition) than continuous NT and RT2 soybeans in April of 1993 and 1994,

Table 2. Effect of corn rotation and tillage on winter vegetation canopy cover and ground residue cover on a Leeper silty clay soil from October 1992 through May 1994 at the MAFES Northeast Branch Station, Verona, MS.

	1992 and 1993					
	Fall 1992			Spring 1993		
Corn Rotation Tillage System[1]	10102	10/08	10/26	12/15	3/11	4/14j
	% Ground Residue (Canopy) Cover					
I. CONVENTIONAL TILLAGE (CTB)	89(1)	31[2]	15(0)	19(3)	30(11)	21(3)
II. STALE SEEDBED SYSTEM						
A. **Continuous Corn (C)**						
1. No-Tillage (NT)	92(2)	—	92(7)	84(7)	83(9)	73(8)
2. Ridge Tillage (RT1)	91(0)	—	91(5)	77(7)	73(10)	67(11)
B. Soybean(Bn)-Corn(C) Rotation						
3. RT2-Bn; Fb RT1-C	—	—	88(9)	69(11)	59(14)	53(18)
C. Wheat(W)/Soybean(Bn)-Corn(C) Rotation						
4. MT-W-Drill-Bn; Fb NT-C	—	—	97U)	88(1)	86(9)	78(14)
5. MTBd-W-NT-Bn; Fb NT-C	—	—	85(13)	75(12)	57(31)	42(43)
LSD 0.05	—	—	8(4)	13(9)	14(11)	15(12)
% CV	—	—	6@5)	1l(74)	14(49)	17(46)

	1993 and 1994					
	1993			1994		
	10/01	10/06	11/23	3/07	4/20[3]	5/24
I. CONVENTIONAL TILLAGE (CTB)	84(7)	19[2](1)	14(0)	29(5)	20(2)	1(45)[4]
II. STALE SEEDBED						
A. Continuous Corn (C)						
1. No-Tillage (NT)	9x3)	-(-)	95(3)	82(14)	91(0)	50(41)
2. Ridge Tillage (RT1)	83U)	-(-)	87(8)	67(20)	76(0)	6(45)[4]
B. Soybean(Bn)-Corn(C) Rotation						
3. RT2-Bn; Fb RT1-C	W1)	-(-)	82(2)	58(32)	85(32)	4(32)[4]
C. Wheat(W)/Soybean(Bn)-Corn(C) Rotation						
4. MT-W-Drill-Bn; Fb NT-C	--(-)	-(-)	100(0)	86(12)	87(12)	45(38)
5. MTBd-W-NT-Bn; Fb NT-C		-(-)	88(0)	80(10)	74(10)	26(41)
LSD 0.05	7@")	-(-)	5(2)	22(19)	1l(NS)	12(9)
% CV	3(89)	--(-)	4(61)	18(66)	9(137)	30(13)

[1]Tillage descriptions are listed in materials and method; Fb = followed by.
[2]Disked once 10/06/92 and 10/05/93, chiseled and bedded 10/17/92 and 11/12/93.
[3]Data collected after corn was planted 4/14/93 and 28 days after planting corn 3/23/94.
[4]Ridge-till (T2) and conventional tillage (T3) were cultivated 5/18/94.

but after planting all showed no GRC differences. Continuous soybean stale seedbed systems (RT2 and NT) had 70% or more GRC in comparison to 3% GRC for CT after soybean planting May 31, 1993 and May 24, 1994.

Conclusion

Preliminary 2-year (1993-1994) results indicated that both soils showed similar GRC and VCC development response under the same tillage and crop rotation systems. Soybean residue decomposition in the spring of each year was more rapid than corn residue under the same tillage regime. VCC development was relatively slow during the winter months but increased dramatically in March and April of each year. In the stale seedbed (TA, NT, RT1, and RT2) systems, the existing vegetation was killed with a burndown herbicide, which contributed to the GRC at planting. Conventional tillage (CTB and CT) not only destroyed VCC but also incorporated crop residue, leaving little residue (1 to 20%) on the soil surface at planting. Lower amounts of GRC on the soil surface leaves more of the soil surface area exposed to the energy of the impacting rain drops. This can result in more soil erosion, especially from intense storms, which occur more frequently in Mississippi in the spring of each year (April-July). These preliminary data indicate that NT and RT stale seedbed systems with continuous and rotations of corn and soybeans, and doublecrop MT wheat-soybeans have potential for use in conservation compliance plans.

Further work will concentrate on using these data to determine the "C" factor for each crop tillage system in predicting soil erosion, (USDA, Sci. and Ed. Admin. and Purdue Ag. Exp. Sta., 1978). Early crop stage development will be noted during GRC and VC data collection.

Table 3. Effect of soybean rotation and tillage on winter vegetation canopy cover and ground residue cover on a Vaiden silty clay from October 1992 through May 1994 at the MAFES Prairie Research Unit, Prairie, MS.

	1992 and 1993					
	Fall 1992			Spring 1993		
Sovbean Rotation/Tillage Svstem[1]	10/05	10/23	11/25	3/08	4/12	6/02
	% Ground Residue (Canopy) Cover					
I. CONVENTIONAL TILLAGE (CT)	—	88(0)	41(5)[4]	35(42)	13(29)	12(1)[2]
II. STALE SEEDBED SYSTEMS						
A. Continuous Soybean (Bn)						
1. No Tillage (NT)	—	90(3)	79(3)	52(30)	25(67)	73(22)[2]
2. Ridge Tillage (RT2)	—	92(0)	77(6)	50(40)	29(71)	76(21)[2]
3. Turf Aerator (TA)	—	91(1)	81(2)	50(32)	24(63)	42(32)[2]
B. Corn(C)-Soybean(Bn) Rotation						
4. RT1-C; Fb RT2-Bn	91(2)	88(4)	86(3)	76(20)	53(39)	60(33)[2]
C. Corn(C)-WheatCW)/Soybean(Bn) Doublecrop Rotation						
5. NT-C; Fb MT-W-NT-Bn	28(0)[3]	33(1)	21(16)	317(58)	6(86)	-(-)
LSD 0.05		9(2)	13(4)	13(13)	lO(18)	26(19)
% CV		7(98)	12(29)	17(19)	27(15)	26(73)

	1993 and 1994					
	Fall 1993			Spring 1994		
	9/30	11/02	12/13	2/10	4/14	5/19
I. CONVENTIONAL TILLAGE (CT)	-(-)	95(0)	24(2)	32(16)	12(85)	8(1)[5]
11. STALE SEEDBED SYSTEMS						
A. Continuous Soybean (Bn)						
1. No Tillage (NT)	--(-)		68(31)	50(48)	9(91)	96(1)[5]
2. Ridge Tillage (RT2)	4-)	85(2)	61(33)	41(52)	15(82)	92(2)[5]
3. Turf Aerator (TA)	4-)	92(5)	61(36)	47(45)	90(1)	76(1)[5]
B. Corn(C)-Soybean(Bn) Rotation						
4. RT1-C; Fb RT2-Bn	920)	81(4)	76(17)	69(28)	75(23)	69(3)[5]
C. Corn(C)-Wheat(W)/Soybean(Bn) Doublecrop Rotation						
5. NT-C; Fb MT-W-NT-Bn	91(7)	36(0)	45(3)	46(20)	lO(99)	--(99)
LSD 0.05	NS(11)	11(7)	17(14)	17(11)	28(25)	13(4)
% CV	5(159)	9(133)	17(65)	20(25)	55(24)	13(12)

[1]Tillage descriptions are listed in materials and method; Fb = followed by.
*Data was collected after soybeans had been planted 6/02/93.
[3]Disked twice 10/04/92 and do-alled 10/25/92.
[4]Thiseled 10/29/92, disked 4/10/93, and do-alled 6/01/93.
[5]Data collected after soybeans were planted on 5/19/94.

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Table 4. Effect of soybean rotation and tillage soybean on winter vegetation canopy cover and ground residue cover on a Leeper silty clay soil from October 1992 through May 1994 at the MAFES Northeast Branch Station, Verona, MS.

	1992 and 1993					
	Fall 1992			Spring 1993		
Soybean Rotation Tillage System[1]	10126	12/15	3/11	4/19	5/31	6/17
	% Ground Residue (Canopy) Cover					
I. CONVENTIONAL TILLAGE (CT)3	83(2)	65(7)	56(12)	35(49)	4[2](0)	3(4)
11. STALE SEEDBED SYSTEMS						
A. **Continuous Soybean (Bn)**						
1. No Tillage (NT)	86(13)	65(8)	44(28)	29(53)	81[2](1)	74(10)
2. Ridge Tillage (RT2)	76(2)	56(7)	47(11)	48(24)	7O[2](0)	70(7)
B. Corn(C)-Soybean(Bn)Rotation						
3. RTl-C; Fb RT2-Bn	92(-)	73(2)	690)	73(11)	772(1)	68(9)
C. Corn(C)-Wheat(W)/Soybean(Bn) Doublecrop Rotation						
4. NT-C; Fb MT-W-Drill-Bn	32(2)	24(23)	13(47)	—(85)	—(-)	95[2](1)
5. NT-C; Fb MTBd-W-NT-Bn	16(3)	16(20)	15(37)	12(64)	—(-)	80[2](13)
LSD 0.05	16(9)	19(9)	22(13)	21(22)	17(NS)	15(NS)
% CV	16(116)	21(43)	32(30)	30(25)	15(218)	12(101)

	1993 and 1994					
	Fall 1993			Spring 1994		
	10/01	10/06	11/23	3/07	4/20	5/24
I. CONVENTIONAL TILLAGE (CT)[3]	—	—	9(0)	19(7)	35(42)	34(4)
II. STALE SEEDBED SYSTEMS						
A. **Continuous Soybean (Bn)**						
I. No Tillage (NT)	—	—	90(10)	63(34)	37(62)	76[4](4)
2. Ridge Tillage (RT2)	—	—	63(11)	59(31)	28(64)	70[4](6)
B. Corn(C)-Soybean(Bn) Rotation						
3. RT1-C; Fb RT2-Bn	86(1)	—	74(7)	63(32)	64(17)	61[4](5)
C. Corn(C)-Wheat(W)/Soybean(Bn) Doublecrop Rotation						
4. NTC; Fb MTW-NT 15N36	(12)20	(1)31	(2)31	(24)	—(99)	—(-)
5. NT-C; Fb MTBd-Wh-NT-Bn	95(2)	15(0)	8(4)	12(23)	—(99)	—(-)
LSD 0.05	7(4)	14(NS)	6(6)	16(13)	30(19)	16(3)
% CV	4(51)	35(159)	8(75)	22(32)	40(18)	22(6)

[1]Tillage descriptions are listed in materials and method; Fb = followed by.

[2]Data collected after soybeans were planted 5/31/93 and 6/17/93 (doublecropped beans).

[3]Chiseled 4/29/93; disked and do-alled (2X) 5/29/93.

[4]Data collected 18 days after soybeans were planted 5/06/94.