Long Term Wheat and Soybean Response to An Intercropping System

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Introduction

Doublecropped soybeans following wheat in the Mid-South commonly produce lower yields than monocropped soybeans. The lower yields are usually associated with straw management problems and delayed planting. The delay in planting is often caused by delayed wheat harvest, straw residue management, and inadequate soil moisture for germinating soybeans. Straw residue management problems are often associated with planting no-till into the straw which was either unevenly distributed or the planter colter was unable to cut through the straw residue which resulted in the straw being pushed into the seed-furrow.

Relay planting or intercropping is an alternate doublecropping system where one crop is planted into another crop before it is harvested. A soybean-wheat intercropping system, where soybeans are planted between wheat rows when the wheat crop is beginning to mature, has the potential not only to insure more optimum soybean planting but also eliminates the wheat straw residue management problems. The relay system removes the potential yield reduction from delayed planting caused by lack of soil moisture for germinating soybeans after wheat harvest. This system also eliminates the need for burning wheat straw residue or the use of a burndown herbicide to kill vegetation when planting soybeans in wheat stubble residue.

Objective

The objective of the study was to evaluate long-term wheat and soybean growth and yield response in a doublecropped wheat-soybean rotation where soybeans were both relay planted into a maturing wheat crop at the medium to soft dough stage of maturity and planted no-till in the wheat stubble in late June.

Materials and Methods

The study was conducted as a randomized complete block design from 1982-89 at the Northeast Branch of the Mississippi Agricultural and Forestry Experiment Station, Verona, MS. Except for 1986, the study was conducted on a Leeper silty clay bottomland soil with about a 0.25% slope. In 1986 the study was conducted on an upland Ora fine sandy loam. The study was planted in a rotation that followed a previous soybean crop of either maturity group IV or V in a monoculture.

Equipment Modifications

In order for the relay planting system to be successful, a few equipment modifications were made before the study was initiated. A 20 ft wide John Deere Soybean Special 3-point hitch planter equipped with bubble colters and heavy duty down-pressure springs was used to plant both wheat and soybeans in 1982-87 and only soybeans in 1988-89. The planter's common rubber tire press wheels were replaced with cast iron press wheels for added weight and good seed-furrow closure in the clay soil. The 4 inch wide planter unit gauge wheels were replaced with 2 inch wide gauge wheels to minimize wheat plants being tracked down during the soybean planting operation. In order to further minimize wheat damage, a 2 ft long v-shaped 0.5-inch diameter rod shield was constructed and mounted in front of each unit so the rod extended in a horizontal plane across the side of each gauge wheel. The rod shielded the wheat plants from the path of the gauge wheel as the planter passed between the wheat rows.

The planter tool-bar row-configuration for planting wheat in 1982-84 was 12 rows arrangcd in 15 inch wide rows with no skips for the tractor wheel. The planter unit hopper boxes rubbed against each other and did not allow each individual unit to flex independently on the tool-bar during the planting operation. The wheat in the tractor wheel track path was also tracked down when the soybeans were relay planted into the wheat in mid-May. In 1985-87 a 16-inch wheat row spacing with two 32 inch wide skips were incorporated on the planter tool-bar to eliminate these problems. The planter configuration consisted of

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4 units spaced 16 inches apart in the center of the tool-bar followed by a 32-inch skip on each side for tractor wheels and 4 additional units spaced 16 inches apart. The monocropped wheat in 7-inch rows were planted with a John Deere grain drill in 1982-87.

In 1988 and 1989 a Great Plains® 20 ft wide grain drill with 7.5-inch row spacings was used to plant the 7.5-inch monocropped wheat rows and 15 inch wide wheat rows for the soybean relay and stubble planted systems. The drill units were arranged with the center unit and every other unit plugged to make a 15-inch row spacing pattern. Two additional units that followed the tractor wheels were plugged in order to leave a skip for the tractor wheels.

In 1982-84 a tractor was used with 15.5 inch wide rear tires spaced on 80-inch centers. In 1985-89 a tractor with 18.4 inch wide rear tires spaced on 72-inch centers was used. The tractor wheel spacings matched the wheel track skips made by the wheat planter in 1985-89. Tractor rate of travel for relay planting soybean in wheat was 2-3 mph in 1982-84 and 5-6 mph in 1985-89.

Wheat and soybeans were harvested with a John Deere 55® combine in 1982-85 and a John Deere 6600® combine in 1986-89. The 55 combine equipped with a sacking unit, straw chopper and 13 ft wide cutter-bar was used to harvest the center 13 ft of a 16 ft wide x 40 ft long plot in 1982-85. The 6600 combine equipped with a 20 ft wide cutter-bar and a straw chopper was used to harvest plots 20 ft wide x 600 ft long. A weigh wagon equipped with electronic scales was used to obtain the harvested seed weights in 1986-89.

Cultural Practices

Fall land preparation was done on all plots and involved the broadcast surface application of about 450 lb/acre of 0-20-20 fertilizer with incorporation by chiseling 6-8 inches deep followed by disking and smoothing with a harrow before planting wheat. Wheat cultivar and row spacings are listed in Table 1. Wheat seeding rates were 45 Ib/acre in 1982-87 and 80 lb/acre in 1988 and 1989. Nitrogen fertilization program was ammonium nitrate applied at 75 lb/acre surface broadcast prior to planting wheat and 250-300 Ib ammonium nitrate applied in mid to late February of each year. Monocropped soybean plots were shallow tilled with a field cultivator at least once or twice in the spring before soybean planting for weed control.

The wheat and soybean row spacings combinations in each system are listed in Table 1. Weeds, insects, and disease pests were controlled in both crops as necessary with appropriate pesticides applied at labeled rates. Wheat and soybean planting and harvest dates are listed in Table 2. Wheat for both doublecropping systems were planted in the same row spacing configuration. 'Centennial' (maturity Group VI) soybean was planted at 9 seeds/ft of row in 32-inch rows in 1985-87 and in 30-inch rows in 1982-84 and 1988-89. The monocrop and relay soybeans were planted about mid to late May when wheat was in the soft to medium dough stage. Soybeans were planted no-till in wheat stubble residue in late June or early July. In one of 8 years (1986), the wheat crop was mature and ready for harvest when soybeans were relay planted into the wheat. The high humidity and previous wet soil conditions allowed soybeans to be relay planted in the early morning with no wheat seed shatter loss. In 1988, howcver, soybean had to be replanted due to mechanical failure of the plantcr.

Table 1. Wheat cultivar and wheat-soybean cropping system row snacine combinations in 1982-1989.

		Wheal-Soybean Cropping System Row Spacing				
				Wheat-SoybeanDoubleCropping*		
	Wheat	Monocrop		Relay and Stubble Planted		
Year	Cultivar	W	SB	W	SB	TWS
				--inches----------		
1982	S. Belle	7	30	15	30	--
1983	S. Belle	7	30	15	30	--
1984	S. Belle	7	30	15	30	--
1985	Coker 916	7	32	16	32	32
1986	F1 302	7	32	16	32	32
1987	F1 302	7	32	16	32	32
1988	Fl 302	7.5	30	15	30	30
1989	F1 302	7.5	30	15	30	30

*W = wheat; SB = soybean; TWS = tractor wheel track skip; the wheat row configuration as indicated included two 30- or 32-inch wide skips (TWS) per 20 ft wide wheat planter swath for the tractor to relay plant soybeans between wheat rows.

Wheat harvest dates ranged from 10 to 27 June and soybean harvest ranged from 27 October to 18 November (Table 2). Wheat stubble cutting height, except for 1989, was about 8-12 inches above the soil surface and 3-4 inches above the soybeans. In 1989, due to a delay in harvest caused by rainy weather, relay planted soybeans were about 15 inches tall and wheat stubble cutting height was adjusted to about 17 inches.

All data were subjected to analysis of variance procedures at the 5% probability level. Least

significant difference (LSD) at the 5% probability level was used to separate data means.

Table 2. Planting and harvest dates for wheat and soybeans in monocropped and doublecropped systems in 1981-1989.

	Planting Dates			Harvest Dates	
		Soybean*			
Year	Wheat	MC & RP	SP	Wheal	Soybean
1981	10/21	--	--	--	--
1982	10/23	5/5	6/26	6/25	10/28
1983	11/2	5/30	7/8	6/20	11/9
1984	11/7	6/2	7/3	6/18	11/14
1985	11/11	5/15	7/7	6/16	11/5
1986	11/4	5/14	6/29	6/16	10/29
1987	11/16	5/29	6/29	6/10	11/3
1988	10/27	5/26	6/26	6/13	11/18
1989	--	5/17	6/28	6/27	10/27

***Soybean monocrop (MC), relay planted (RP) between standing wheat rows, and planted no-till in wheat stubble (SP).**

Results and Discussion

Wheat

1982-84

Since 1982-84 studies were conducted with no skip for tractor wheel tracks in the relay system as was conducted in 1985-89 the results and discussion are reported accordingly. Wheat yields (Table 3) varied widely across years and were very low in 1983 due to excessive spring rains and flooded fields. Although there was no difference 2 of 3 years, the lower yield for the relay planted system was observed to be due to the tractor wheel tracking down wheat in its path during the relay planting operation. The wheat planted in 15-inch rows that were harvested before soybeans were planted (SB stubble) produced yield equal to 7-inch monocropped wheat all 3 years. The lack of difference between the 7-and 15-inch rows is attributed to the study site, which had both poor surface and internal drainage. The data also indicated that to minimize the relay planting effect on yield, a skip for the tractor wheels was necessary so that no wheat was tracked down.

1985-89

Wheat yields (Table 3) varied across years and these data indicated that the system where soybeans were relay planted between maturing wheat in wide rows with skips for the tractor wheels did not reduce yields when compared to 7-inch monocropped wheat 3 of 5 years. Comparing relay planting with stubble planting with the same wheat row configuration, relay planting had no effect on wheat yield in 1985-87 but reduced yields in 1988 and 1989.

In 1988, the significantly lower yield from the relay planting system was caused by seed shatter losses. Drought delayed planting into the wheat until the hard dough stage, and having to replant after mechanical failure of the planter caused wheat seed to shatter. Visual estimates indicated a 15% yield loss from seed shatter was caused by the planter tool-bar (20 inches above the ground) forcing the wheat to bend about 75" from its vertical position and shatter seed as the tool-bar moved across the wheat. In 1989 all yields were low due to the late harvest and spring freezes. However, the relay planted system had lower yield than the stubble system and monocropped wheat system. This difference may be related to early spring freezes that weakened the wheat stems. It was observed after relay planting that about 10 to 15% of the wheat stems were broken off about 4-6 inches below the base of the spiklet. This was the only year that wheat stems were broken off by the relay planting operation.

The 5-year average yield indicated that wheat in the relay planting system produced 44 bu/acre in comparison to 49 bu/acre for the monocrop system. Wheat in the stubble planted system, in the same row configuration as the relay system, produced yields equal to the 7-inch monocropped wheat.

Table 3. Yield of monocropped and doublecropped wheal in 1982-89.

			Douhlecropping System		
			SB	SB	
Year	% CV	LSD 0.05	Relay Planted*	Stubble	7-inch Row PlantedMonocrop
			----------	--Bu/acre	----------
1982	13	11	38	54	53
1983	49	NS	4	6	6
1984	22	NS	35	48	39
		Mean	26	36	33
1985	15	NS	40	40	44
1986	7	NS	45	40	45
1987	9	NS	46	49	49
1988	4	4	60	73	75
1989	9	5	24	30	33
		Mean	44	48	49

***SB = Soybeans.**

Soybean

1982-84

Soybean yields were similar all 3 years (Table 4). However, relay planted soybeans produced a higher yield than those planted no-till in the wheat stubble residue in 1 of 3 years and was equal to the monocropped soybeans all 3 years. The 3 year average indicated that monocrop and relay planted soybean yields were equal and both were 4 bu/acre more than planted in wheat stubble.

1985-89

Monocropped soybeans planted at the same time that soybeans were relay planted into wheat in mid-May, produced significantly higher yields than both relay planted and stubble planted soybeans 4 of 5 years (Table 4). Monocrop yields ranged from 23 bu/acre in 1988 to 48 bu/acre in 1989. Although in 4 of 5 years relay planted soybean yields were lower than monocrop yields, they were significantly higher than those planted into wheat stubble in late June or early July. Our research in other studies has shown that when soybeans were planted in wheat stubble on or before about June 21, little or no differences in yield were measured in comparison to yields from the relay planted system.

Table 4. Soybean yield response in three cropping systems in 1982-89.

Year	%CV	LSD 0.05	Soybean Cropping System Monocrop	RP*	SP*
			Bu/acre		
1982	11	NS	39	36	34
1983	23	NS	31	33	32
1984	10	7	41	42	31
		Mean	37	37	33
1985	12	6	36	40	13
1986	13	4	27	16	6
1987	11	5	41	27	15
1988	17	4	23	9	14
1989	9	4	48	33	15
		Mean	35	25	13

*RP = soybeans relay planted in wheat; SP = soybeans planted in wheat stubble.

The low yield of soybeans relay planted in 1988 was a result of drought conditions until late June before rains began to occur which favored the late June planting. The 5-year average indicated that relay planted soybeans produced 10 bu/acre less than the monocrop system, but was 12 bu/acre more than soybeans planted into wheat stubble in late June or early July.

Summary

Relay planting soybeans between wide wheat rows with no skips for the tractor wheels (1982-84) resulted in reduced wheat yields 1 of 3 years. Wide wheat rows, however, with appropriate skips (1985-89) for the tractor wheels resulted in yields that were equal to yields from 7-inch monocrop rows in 3 of the 5 years. The 5-year average (1985-89) data indicated that the wheat-soybean relay intercropping system with tractor wheel skips and wider than monocropped wheat rows produced about 13% less yield than monocropped wheat.

Soybean yields (1982-84) in the relay planted system were the same as those in the monocropped system and 4 bu/acre (3-yr ave.) more than yields from soybeans planted into wheat stubblc residue in late June. Although relay planted soybeans in 1985-89 produced a 5-year average yield of 25 bu/acre in comparison to 35 bu/acre for the monocrop system, the relay planted system produced 12 bu/acre more than soybeans planted in wheat stubble residue in late June or early July. These results indicate that for successful wheat-soybean intercropping systems the wheat row spacing configuration should match the soybean planter and tractor wheel tracks so that soybeans are planted between the wheat rows and no wheat is tracked down during soybean planting. Soybeans should be neither relay planted nor replanted into wheat when the wheat crop has matured to the hard dough stage and is under dry environmental conditions. However, under wet and high humidity conditions, relay planting can be done in the early morning without causing any wheat seed to shatter. About 13% wheat yield will be sacrificed in the relay system. However, soybean yield can bc increased by 100% in comparison to no-till soybeans planted in wheat stubble residue in late June. Research is currently being conducted to determine whether narrow wheat rows (6, 7, and 15 inches) can be utilized in this system to further minimize the reduction in wheat yield. This system offers an alternative to farmcrs who plant soybeans into wheat stubble in late June.