Soybean-Wheat Intercropping Response and Effect on Estimated Net Returns

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Introduction

Relay planting, or relay intercropping, is a cropping system where one crop is planted into another crop before it is harvested. In our intercropping research, soybeans were relay planted into wheat prior to wheat harvest. Our early research with this system involved row spacings of both wheat and soybeans, and soybean planting dates. Wheat row spacings of 7, 15,and 20 inches with soybeans relay planted in 15-, 20-, and 30-inch rows were evaluated. All the wheat-soybean row-spacing combinations caused varying amounts of wheat to be tracked down by both the planter units and tractor wheels. The 20-inch wheat-soybean row-spacing combinations caused the least amount of wheat to be tracked down by the tractor wheels. The 15-inch row combinations had slightly more wheat tracked down by the tractor wheels, but the planter units rubbed against each other. Therefore, a 16-inch row spacing and 24-inch wide skips for tractor wheels were selected. The 16-inch row spacing allowed a 1-inch clearance between planter units.

In simple terms, with the relay planting system we planted a 20-foot swath of wheat in 16-inch rows with 24-inch wide skips (2 skips per 20-ft planter swath) for tractor wheels. At soybean planting, all units were moved over 8 inches and soybeans were planted between the wheat rows in mid to late May. It was observed, however, that 20-inch wide tractor tires tracked down some wheat with a planter rate of travel of 5 mph.

Therefore, a study was conducted to evaluate the effect of tractor wheel track skip width, soybean planting date, and soybean row spacing on wheat and soybean yield. Economic estimates of net return to land, management, and general farm overhead were made using 3-year average yield data of these doublecropping systems.

Materials and Methods

Field studies were conducted at the Northeast Branch Experiment Station, Verona, MS for 3 years, 1984-86, on a Marietta loam, an Ora fine sandy loam, and a Catalpa silty clay, respectively. The four cropping systems used in the study were monocrop wheat, monocrop soybeans, relay planted soybeans in wheat, and soybeans planted in wheat stubble. To better duplicate farm conditions, large field-size plots were used. We felt that if this system was to be accepted and used by producers, the planter rate of travel would have to be higher than the planter rate of travel in most small plot research. The planter rate of travel in this study was approximately 5 mph.

The wheat-soybean relay cropping system followed a previous crop of monocrop soybeans each year. The study area was chiseled, disked, and smoothed with a do-all (implement equipped with vibratine shanks, rolling cutter bar, and section harrow) twice before planting wheat. In the spring of each year, monocrop soybean plots were tilled with a field cultivator once or twice as needed before planting. Prior to chiseling in the fall of each year, phosphorous and potassium as 0-20-20 were applied as dry fertilizer at 300 and 600 lb/acre for the monocrop and doublecrop systems, respectively. All 16-inch row wheat and 16- and 32-inch row soybeans were planted with a 20-foot wide John Deere soybean special planter equipped with ripple coulters, narrow depth bands (2-inch), cast-iron press wheels, and lift assist wheels. The 7-inch wheat rows were planted with a John Deere grain drill. Preplant nitrogen at 30 lb N/acre were applied each fall as ammonium nitrate. In February of each year, 80 lb N/acre were applied surface broadcast as ammonium nitrate.

Wheat was seeded at 45 lb/acre and soybean seeding rates were 5 and 10 seeds per foot of row in 16- and 32-inch rows, respectively. Wheat varieties used were Coker 916 in 1984, and Florida 302 in 1985 and 1986. Centennial was the variety of soybeans planted.

Wheat was planted all 3 years about November 10. Soybeans were relay planted in wheat about May 15 and May 30, and planted in wheat stubble about June 19 and July 4 of each year. Monocrop soybeans were planted each year about May 15.

Skips (2 per 20-foot planter swath) of 24, 28, and 32 inches (Table 1) for tractor wheel tracks were evaluated. In 1984, only 24-inch wheel tracks and 16-inch soybean rows were used. Wheat row spacings were 7 and 16 inches, with 16-inch rows being utilized for the relay planting system. The 7-inch wheat row was a standard for comparison. In all soybean cropping systems and planting dates, soybeans were planted in 16-inch rows in 1984 and in both 16- and 32-inch rows in 1985-86. Removal of every other planter unit gave us the 32-inch row spacing.

Weeds were controlled in both crops at high levels and weed

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Table 1. Row spacing and tractor wheel track combinations used in relay planting systems at the Northeast Mississippi Branch Experiment Station, 1984-86.

Tractor wheel track spacing (in.)		Wheat row spacing (in.)		Soybean row spacing (in.)
24				16
28*	X	16	X	
32*				32*

*Used only in 1985 and 1986.

management systems varied with the cropping systems. A burndown herbicide (paraquat) was applied to all plots where soybeans were planted in wheat stubble. Postemergence herbicides were used according to label rates for soybean weed control on all plots. Soybean herbicides applied were Basagran®, Blazer®, 2,4-DB, and Fusilade®. The combination of herbicides used varied each year depending on the weed problem. Hoelon® was used each year for ryegrass control in the wheat. Dithane M-45® and Benlate® were applied 2 of the 3 years to wheat for disease control but no fungicides were applied to the soybeans.

Table 2. Weed control management systems used for developing economic analysis hndget of four cropping systems, 1984-1986, MAFES Northeast Branch.

Monocrop Soybeans

16-inch rows
1. PPI — Prowl
2. POT — Basagrao + Blazer
3. POT — Blazer + surfactant

32-inch rows
1. PPI — Prowl
2. Early Cult. + POT hand — Basagran + Blazer
3. Late Cult. + PD hand — Sencor + 2.4-DB

Soybean Relay Planted System

16-inch rows
1. E. POT — Fusilade + crop oil
2. E. POT — Basagran + Blazer
3. L. POT Blazer + surfactant

32-inch rows
1. E. POT — Fusilade
2. Cult. + POT hand — Basagran + Blazer
3. Cult. + PD hand — Sencor + 2.4-DB

Soybeans Planted in Wheat Stubble

16-inch rows
1. Burndown application — Paraquat
2. E. POT Fusilade + crop oil
3. E. POT — Basagran + Blazer
4. L. POT — Blazer + surfactant

Wheat

7-inch row
1. POT - 2,4-D

PPI = Preplant incorporated
POT = Postemergence over-top application
Early cult. = Early cultivation
Late cult. = Late cultivation
PD = Post-directed herbicide application
E. POT = Early postemergence over-lop application
L. POT = Late postemergence over-top application

Economic Analysis

Economic estimates of net returns to land, management, and general farm overhead were based on an estimated practical farming situation. The total expenses did not include a charge for land, management, and general farm overhead. For practical economic comparisons, the weed control systems for soybeans relay planted in wheat and monocrop soybeans were modified as indicated in Table 2. The assumption in the analysis for a practical farm situation was that the modified weed control systems provided the same level of weed control and the cropping systems would produce the same yield as those in the research plots. Budgets were developed for each cropping system. Net returns were based on 3-year average yields obtained from the field studies.

Soybean price used in developing budgets was a 5-year (1981-86) average of $6.21/bu for soybeans and $3.31/bu for wheat received by farmers in Mississippi. Costs of variable inputs and machinery were based on 1986 prices paid by Mississippi farmers. In constructing the budgets, performance rates on all field operations were based on 8-row equipment with associated power units. The hourly wage rate was $4.50/hour. Interest rate on operating capital was computed at 10 percent annual percentage rate

Results and Discussion

Wheat

The first year, 1984, only the 24-inch wheel track spacing was used. The 24-inch wheel tracks with the relay planted treatments produced less yield than the 28- and 32-inch in 1986, but not in 1985 (Table 3). The tractor we used had 20-inch wide tires and the 24-inch wide skip for the tractor wheels allowed only 4 inches for wheel track error in the field planting operation. Wheat yields for the 28- and 32-inch tractor wheel track skips were similar. The wider wheel tracks provided a wider space for tractor wheel track error in doing field operations. Therefore, all data reported are for the 32-inch wide skip (Tables 4 and 5) and averaged over years. Three-year average yields for monocrop wheat planted in the traditional drilled rows (7-inch) averaged 48 buiacre, while the 16-inch wheat rows with soybeans relay planted in mid and late May averaged 44 buiacre (Table 4). This was 92 percent of the 7-inch row monocrop yield. Wheat yields for the two relay planting dates of mid and late May showed little difference between planting dates. Yields for wheat harvested before soybean planting and wheat harvested after soybeans had been relay planted into wheat were very similar. Thus, soybean planting date for a wheat doublecropping system could be extended 2 to 4 weeks using relay planting.

Wheat yields from the late May relay planted soybeans were the same for both soybean row spacings (Table 5).The 16-inch soybean rows had twice as many planter units pass between

Table 3. Effect of relay planting and tractor wheel track width on wheat yield at the Northeast Mississippi Branch Experiment Station, 1984-86.

Systems	Row spacing (in)	Wheel track space (in)	Wheat yield 1984	1985	1986
Monocrop					
Wheat	16	24	53	41	41
Wheat	16	28	—	41	44
Wheat	16	32	—	36	43
Wheat	7	—	53	45	45
Doublecrop					
Relay Planted					
5/14 - 5/15	16	24	50	—	—
5/14 - 5/15	16	28	—	32	44
5/14 - 5/15	16	32	—	40	45
Relay Planted					
5/29 - 6/2	16	24	55	35	42
5/29 - 6/2	16	28	—	38	41
5/29 - 6/2	16	32	—	39	41
Stubble Planted					
7/2 - 7/7	16	24	53	41	41
7/2 7/7	16	28	—	39	45
7/2 7/7	16	32	—	40	41

the wheat rows as the 32-inch soybean rows, but this did not affect wheat yield. Thus, planting between wheat rows in late May had no adverse effect on wheat yield. The mid-May relay planting date for the 16-inch soybean rows produced 5 bu/acre lower wheat yield than the 32-inch soybean rows.

Soybeans

The skip width for the tractor wheel track had no effect on soybean yield. Yield of relay planted soybeans did not differ from monocrop soybeans. Three-year average yield data (Table 4) for 16-inch soybean rows indicated that the relay planting system produced 41 percent (20 bu/acre) more soybeans than those planted in wheat stubble about July 4. Monocrop soybeans in 16-inch rows produced 36 bu/acre. In the relay planting system, 16-inch soybean rows produced 37 and 35 bu/acre for May 15 and May 30 planting dates, respectively. Soybeans planted in wheat stubble about June 19 and July 4 produced 35 bu/acre and 15 bu/acre, respectively. Soybeans planted in wheat stubble about June 19 yielded about as good as monocrop and relay planted beans. The late planting date of about July 4, however, severely reduced yields and indicated no advantage for doublecropping.

Two-year average yields for 16- and 32-inch soybean rows (Table 5), indicated little difference among row spacings. The main advantage for the 32-inch rows is the capability to utilize band application of herbicides and to cultivate. Yields for soybeans planted from May 15 to June 19, regardless of system, ranged from 28 to 35 bu/acre, but declined to 10 bu/acre for the later-than-optimum date (about July 4) for soybeans planted in wheat stubble.

Table 4. Three-year average yields and net returns of four cropping systems at the Northeast Mississippi Branch Experiment Station, 1984-86.

Systems	Row spacing (in)	Net returns ($/acre)*	Avg yield (bu/a)' Wheat	Soybeans
Monocrop				
Soybeans 5/14	16	$ 89	—	36
Wheat	7	$ 18	48	—
Doublecrop				
Relay planted				
5/14 - 5/15	16	$117	42	37
5/29 6/2	16	$117	45	35
Stnhhle planted				
6/17 - 6/21	16	$ 91	41	35
712 - 7/7	16	-$ 14	46	15

1 Average includes 24-inch wheel track space data of 1984 and 32-inch wheel track space data of 1985 and 1986.

2 Net returns per acre do not include a charge for land, management, and general farm overhead.

Economic Analysis

Economic estimates for 16-inch soybean rows (Table 4) indicated monocrop soybeans, relay planted soybeans, and soybeans planted in wheat stubble about June 19 produced higher net returns than monocrop wheat and soybeans planted in wheat stubble about July 4. The highest net return, however, was $117/acre for the relay planting system, $28/acre more than monocrop soybeans. The monocrop soybeans and soybeans planted in wheat stubble produced net returns of $89 and $9l/acre, respectively. A negative return of $14/acre was shown for the soybeans planted in wheat stubble about July 4. The relay cropping system has the most potential to increase net returns for producers who plant soybeans in wheat stubble after June 19 in Northeast Mississippi and similar areas.

Two-year average net returns for 16- and 32-inch rows differed among systems and planting dates (Table 5). The monocrop 16-inch soybean rows showed returns of $8/acre more than 32-inch rows. The May 15 relay planting date showed no difference in returns between 16- and 32-inch rows. However, with the May 29 relay planting date, the 32-inch rows showed net returns of $110/acre compared to $87/acre for 16-inch rows.

Conclusion

Monocrop wheat produced 8 percent more than wheat in 16-inch rows. Relay planting soybeans in wheat had no effect on wheat yield. Tractor wheel track skips (2 per 20-foot planter swath) of 28 and 32 inches showed no wheat yield difference but resulted in higher yields than 24-inch skips 1 of 2 years. The 24-inch wide skip was too narrow for planter operating rates of 5 mph and resulted in some of the wheat being tracked down.

Table 5. Two-year average yields and net returns of four cropping systems at the Northeast Mississippi Branch Experiment Station, 1985-86.

Svstems	Row spacing (in)	Net returns ($/acre)[2]	Avg yield (bu/a)' Wheat	Avg yield (bu/a)' Sovbeans
		Monocrop		
Soybeans 5114	16	$ 78	—	34
	32	$ 70		32
Wheat	7			
		Doublecrop		
Relay planted				
5/14 - 5/15	16	$ 79	38	33
	32	$ 79	43	28
5129 612	16	$ 87	40	33
	32	$110	40	35
Stubble planted				
6/17 - 6121	16	$ 78	42	32
712 - 717	16	-$ 48	41	10

' Average includes 24-inch wheel track space data of 1984 and 32-inch wheel track space data of 1985 and 1986.

[2] Net returns per acre do not include a charge for land, management, and general farm overhead.

Soybean yield (3-year average 16-inch rows) for the relay cropping systems was equal to monocrop soybeans and 20 bu/acre higher than soybeans planted in wheat stubble about July 4. Two-year average yield for relay planted soybean in 16- and 32-inch rows varied with planting date. Monocrop soybeans showed higher yield average with 16-inch rows.

Economic estimates using 3-year average yield data indicated relay planting soybeans into wheat about May 15-30 produced net returns of $117/acre, $28/acre more than monocrop soybeans, and $26/acre more than soybeans planted in wheat stubble about June 19. Two-year average data comparing 16- and 32-inch soybean rows indicated 32-inch rows produced net returns equal to or greater than 16-inch rows.

Relay planting is a doublecropping system that offers producers an opportunity to take advantage of an additional 1 to 4 weeks for planting soybeans and producing yields equal to monocrop soybeans. The approximately 15 to 25 percent soybean yield reduction for the traditional wheat-soybean doublecropping system is due to later planting. Due to the wider rows, wheat yields in 16-inch rows were reduced by 8 percent. But comparing the price of these two commodities, the trade-off of lower wheat yield for higher soybean yield is economically favorable.

The relay cropping system offers several other advantages. Established skips for tractor wheels keep wheat from being tracked down during the soybean relay planting operation. and provide a permanent wheel track for subsequent field operations. The use of the same planter for planting both crops maximizes utilization of equipment. Additional benefits are reduced tillage and reduced erosion potential. The wheat stubble provides excellent soil erosion protection and, with relay planting, soybean land preparation is eliminated.

Relay planting is not the best choice for all situations nor all producers. Because it is a form of reduced tillage, it requires more intensive management and the use of herbicides for weed control. The greatest potential for this cropping system is on bottomland sites where more stored water is available to adequately supply the two crops, and for growers who experience soybean yield reductions from late dates of planting soybeans into wheat stubble.