INFLUENCE OF RELAY INTERCROPPING ON WHEAT AND SOYBEAN YIELD COMPONENTS

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INTRODUCTION

Relay intercropping of wheat (Triticum aestivum L.) and soybean [Glvcine max (L.) Merr.1 is an alternative to conventional sequential doublecropping in which soybean is planted after wheat harvest. The relay intercropping system developed at Clemson University (Hood et al., 1991) involves planting soybean between wheat rows prior to wheat harvest. Both crops are planted with the Clemson Interseeder drill; the most widely used planting pattern places wheat in 13-in. rows with 24-in. traffic lanes between the 3rd and 4th. and between the 8th and 9th. wheat rows in each 11-row planter pass (Fig. 1).

Wheat yields in this planting pattern have been similar to drilled wheat at locations in the SC Coastal Plain and lower Piedmont (Khalilian et al., 1991: Hood et al.. 1991). but 15 to 20% yield reductions have been seen for intercropped wheat at Pendleton, SC, and Griffin, GA (Hood et al., 1991: W. Hargrove, pers. comm.) The objective of this work was to compare growth, yield, and yield components for 3 wheat cultivars followed by one soybean cultivar in both cropping systems.

MATERIALS AND METHODS

Wheat cultivars NK Coker 9766, Pioneer 2555, and Williams were planted on 2 Nov. 1990 and 13 Nov. 1991 at the Simpson Research and Educational Center near Pendleton, SC, in a split-plot design with cultivar as the main plot and cropping system as the subplot. The relay intercropped subplots were planted with the Clemson Interseeder (Fig. 1) whereas the doublecropped subplots were planted with a conventional grain drill in 7-in.-wide rows. Measurements including light interception by the wheat canopy were taken during the season (Bacanamwo, 1992). Wheat was harvested on 3 June 1991 and 16 June 1992 with a combine. Prior to wheat harvest, samples were taken for yield component analysis. In the relay intercropped subplots, separate samples were taken from interior rows and from rows bordering the traffic lanes (Fig. 1).

Intercropped 'Thomas' soybean was planted with the Clemson Interseeder (Fig. 1) on 15 May 1991 and 20 May 1992 (prior to wheat harvest). Doublecropped Thomas soybean was planted in 38-in.-wide rows without tillage on the same day as wheat harvest. Samples for yield component analysis and measurement of other growth parameters (Bacanamwo, 1992) were taken at maturity; separate samples were taken from interior rows and rows bordering traffic lanes in the relay intercropped subplots (Fig. 1). The four (intercroppedl or two (doublecropped) interior rows were harvested with a small plot combine on 7 Nov. 1991 and 18 Nov. 1992 for yield determination.

RESULTS AND DISCUSSION

Wheat yields (Table 11 and test weights (Bacanamwo, 1992) were low in both years of this study, especially in 1991 when Septoria and other diseases were observed in the wheat. Averaged over cultivars and years, intercropping reduced wheat yield by 18% as compared with doublecropped wheat (Table 1).

The reduction in intercropped wheat yield was associated with a reduction in light interception by the intercropped wheat canopy, particularly for the wheat rows bordering the traffic lanes (Bacanamwo, 19921. Number of spikes per area was the yield component most adversely affected by intercropping, with the largest reduction in this yield component in the traffic lane rows (Table 2). Plants bordering the traffic lanes apparently failed to tiller sufficiently to compensate for the additional space available. This may be related to the wide-row planting pattern, but it may also be due to a lower wheat population (plants per area, measured at stand establishment) for the intercropped wheat. The reduced population in the intercropped subplots occurred even though similar seeding rates (about 100 lb/ac) were used in both

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Table 1. Influence of wheat cultivar and cropping system on wheat yields and lodging scores

Wheat Cultivar	Cropping System[†]	1991 Yield	1992 Yield	1992 Lodg.[‡]
		-bu/ac-	-bu/ac-	
NK Coker 9766	I	24.3	45.4	2.2
	D	32.4	56.4	3.0
Pioneer 2555	I	29.4	46.5	1.0
	D	37.1	52.2	1.5
Williams	I	20.2	42.2	1.0
	D	21.9	53.2	1.7
S. V. (from ANOVA)				
Wheat Cultivar		**	NS	**
Cropping System		**	**	**
Cult. x Syst.		**	NS	NS

[†] I = relay intercropped; D = sequentially doublecropped
[‡] Lodging was scored on a scale of 1 [none) to 5 (severe). Wheat lodging scores were not taken in 1991.
**,*,(0.1) = significant at $p < 0.01$, $p < 0.05$ or $p < 0.10$, respectively; NS = not significant ($p < 0.10$)

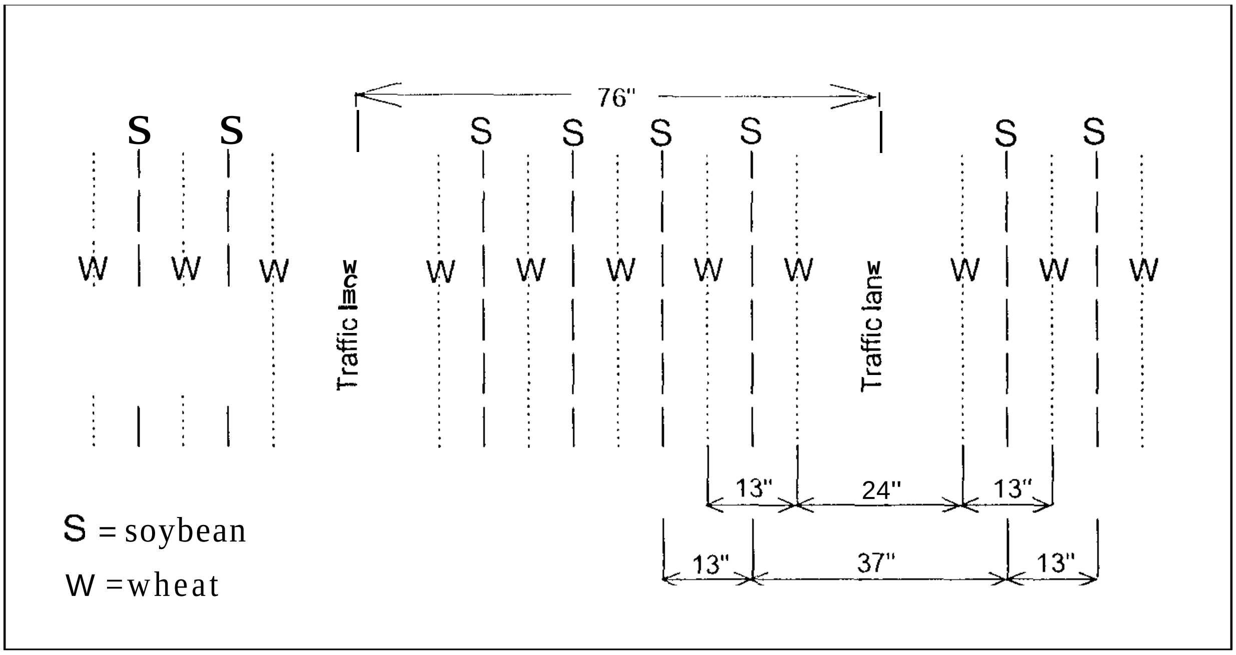

Figure 1. Planting pattern for relay intercropped wheat and soybean.

Table 2. Influence of wheat cultivar and row type on wheat yield components

Year	Wheat Cultivar	Row Type	spikes / m²	grains / spike	ma / grain
1991	NK Coker 9766	I'	687	17.3	19.1
		T	542	17.5	19.4
		D	867	16.1	19.0
	Pioneer 2555	I	501	23.8	23.0
		T	417	23.0	20.8
		D	633	23.8	20.9
	Williams	I	494	20.8	18.3
		T	374	20.8	17.2
		D	593	22.1	18.7
S. V. (from ANOVA)					
	Cultivar		**	**	**
	Row Type		**	NS	*
	Cultivar x Row		*	NS	*
1992	NK Coker 9766	I	650	25.6	28.6
		T	516	27.2	29.3
		D	839	23.2	27.5
	Pioneer 2555	I	502	24.2	33.8
		T	400	29.0	34.2
		D	626	24.6	31.5
	Williams	I	455	30.9	29.8
		T	402	32.7	29.9
		D	638	28.0	28.3
S. V. (from ANOVA)					
	Cultivar		**	**	**
	Row Type		**	**	**
	Cultivar x Row		NS	**	NS

' I = intercropped interior row; T = intercropped row bordering traffic lane; D = doublecropped row
**,* = significant at $p < 0.01$ or $p < 0.05$, respectively; NS = not significant ($p > 0.10$)

systems (Bacanamwo, 1992) and may have been caused by deeper seed placement as compared with the conventionally planted wheat.

In 1991, average weight per grain was somewhat higher for intercropped than doublecropped plants (Table 21, and in 1992, the intercropped treatment had increases in grains per spike and weight per grain. Nonetheless, the small increases in these yield components were not enough to compensate for the reduction in spikes per area (Table 2).

Wheat cultivar and the cultivar by cropping system interaction significantly influenced wheat yield in 1991 but not in 1992 (Table 1). Williams had the lowest yield in both cropping systems in 1991 but also had less yield reduction in the intercropping planting pattern. The poor performance of Williams in 1991 was associated with disease (e.g., Septoria) problems. Lodging scores (taken in 1992 only) showed more wheat lodging in the doublecropped planting pattern, and lodging scores were higher for NK Coker 9766 than for the other cultivars (Table 1).

In 1991. 18 days elapsed between intercropped soybean planting and wheat harvest. In 1992, cool weather slowed wheat development and rain further delayed wheat harvest, so that the period between intercropped soybean planting and wheat harvest was 27 days. This is a longer period of overlap between the two crops than has been suggested (Palmer et al.. 1993). yet intercropped plants did not appear to suffer any major harm from the lengthy shading period, as evidenced by plant growth' characteristics (Bacanamwo, 1992) and yield (Table 3). However, soybean emergence and growth were slow in late May and early June of 1992 because of cool temperatures, and slower growth may have allowed the intercropped plants to avoid some problems, such as excessive soybean height at wheat harvest, which might be expected if too much time elapses between soybean planting and wheat harvest in most years.

Intercropped and doublecropped soybean yields were not detectably different either year (Table 3) although the yield component analysis suggested a potential advantage for intercropping (Table 4). In particular, plants in the interior rows of the intercropping planting pattern had more pods per ground area than those in the intercropped rows bordering the traffic lanes or the doublecropped rows (Table 4). indicating an advantage of the narrow row spacing (Fig. 1). Yield was higher ($P<0.10$) for soybean following Williams wheat than for soybean following Pioneer 2555 in 1992, whereas in 1991 soybean following Williams lodged less ($P< 0.10$) than soybean following NK Coker 9766 (Table 3). but in general previous wheat cultivar had little influence on soybean growth or performance (Bacanamwo. 1992; Tables 3 and 4).

Intercropping resulted in increases in lower internode lengths (Bacanamwo, 1992) as a result of shading of the young soybean seedlings by the wheat canopy. This characteristic of intercropped soybean, which has been reported previously (Wallace et al., 1992). may result in increased lodging as seen in both years of this study (Table 3).

In summary, as compared with a conventional sequential doublecropping system, relay intercropping reduced wheat yield in both years, whereas soybean yield was similar for the two systems. The intercropped wheat yield reduction was associated with reduction in number of spikes per ground area, especially in intercropped rows bordering traffic lanes (Fig. 1). Previous wheat cultivar had an effect (significant at $P<0.10$) on soybean yield only in 1992. Lodging scores were higher for intercropped than for doublecropped soybean; this may be related to increased elongation of lower internodes formed when intercropped soybeans were developing under the wheat canopy before wheat harvest.

Table 3. Influence of wheat cultivar and cropping system on soybean (cv. Thomas) yields and lodging scores

Wheat Cultivar	Cropping System[†]	1991 Yield	1991 Lodg.[‡]	1992 Yield	1992 Lodg.
		-bu/ac-		-bu/ac-	
NK Coker 9766	I	59.6	2.7	42.8	2.0
	D	42.9	2.2	42.3	1.6
Pioneer 2555	I	53.1	2.8	43.2	2.2
	D	43.7	1.8	39.7	1.6
Williams	I	53.1	1.8	44.5	1.9
	D	42.7	1.5	45.6	1.7
S. V. (from ANOVA)					
Wheat Cultivar		NS	(0.1)	(0.1)	NS
Cropping System		NS	*	NS	**
Cult. x Syst.		NS	(0.1)	NS	(0.1)

† I = relay intercropped; D = sequentially doublecropped

‡ Lodging was scored on a scale of 1 (none) to 5 (severe).

**,*,(0. 1) = significant at $p < 0.01$, $p < 0.05$ or $p < 0.10$, respectively; NS = not significant ($p > 0.10$)

Table 4. Influence of wheat cultivar and row type on soybean (cv. Thomas) yield components

Year	Wheat Cultivar	Row Type	pods m2	seeds pod	mg seed
1991	NK Coker 9766	I'	1909	2.07	137
		T	1303	1.63	190
		D	1124	1.89	139
	Pioneer 2555	I	1690	1.91	148
		T	1096	1.63	179
		D	1195	2.02	125
	Williams	I	1775	1.87	144
		T	1149	1.75	152
		D	1129	1.83	143
S. V. (from ANOVA)					
Cultivar			NS	NS	NS
Row Type			**	*	*
Cultivar x Row			NS	NS	NS
1992	NK Coker 9766	I	1821	1.73	149
		T	1054	1.68	149
		D	1132	1.77	153
	Pioneer 2555	I	1563	1.69	155
		T	956	1.64	145
		D	1094	1.80	148
	Williams	I	1640	1.71	158
		T	1090	1.68	151
		D	985	1.76	150
S. V. (from ANOVA)					
Cultivar			NS	NS	NS
Row Type			**	**	**
Cultivar x Row			NS	NS	*

' I = intercropped interior row; T = intercropped row bordering traffic lane: D = doublecropped row
**,* = significant at $p < 0.01$ or $p < 0.05$, respectively; NS = not significant ($p > 0.10$)

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