Wheat Straw Management, Variety Selection, and Row Spacing for Double-cropped Soybean Production

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INTRODUCTION

Growers in Arkansas double-crop almost all the wheat acreage with soybeans. The most accepted practice has been to bum the wheat straw, disk and plant. State laws that were passed in 1990 making a grower liable for automobile accidents caused many growers to begin investigating alternatives to burning wheat straw. Federal clear air standards will make burning of wheat straw illegal if enforced.

In recent years there have been unsubstantiated reports that growing wheat on raised beds results in increased yields. Other research has shown that wheat straw residues can be detrimental to soybean production.

Experiments were initiated in fall of 1989 to evaluate different stubble management and tillage practices used in wheat planted on flat or raised seedbeds.

MATERIALS AND METHODS

Experimental sites were selected at two Arkansas locations: Northeast Research and Extension Center (NEREC), Keiser; and the Cotton Branch Experiment Station (CBES), Marianna. Experimental details are given in Tables 1 and 2. Seedbed preparation consisted of bedded (on 38-in. centers) and flat for wheat and five different stubble management treatments (Table 3) for the double-cropped soybean. The experimental design was a split-split-plot. Rainfall and other weather data were recorded at the local experiment station weather station. Soil moisture measurements were taken at stand establishment for soybean. Soybean canopy development data were taken during late R3 or early R4 growth stages on the soybean.

RESULTS AND DISCUSSION

Wheat was planted in the fall on flat and on raised 38-in.-spaced seedbeds at Keiser and Marianna. The wheat at Marianna died in spots as a result of planting too deep, but the remainder as well as that from replanting generated enough straw for the subsequent stubble management test.

Soybean data were collected at NEREC and the CBES in 1990. Data collected earlier on canopy development showed that narrowing the rows to 19 in. resulted in good canopy closure at maturity on most treatments. For example, at NEREC the gap was 2 and 25 in. between canopies for 19- and 38-in.-row spacings,

Table 1. Soil classification of experimental sites.

Site	Year	Soil Series
CBES	1990	Memphis silt loam
	1991	Calloway-Loring comp1ex
NEREC	1990-91	Sharkey silty clay

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Table 2, Planting and harvest dates, planting rates, and varietal information.

Location	Year	Variety	Planting Date	Harvest Date
CBES	1990	Asgrow 5403	6/17/90	10/30/90
		Lloyd	6/17/90	11/8/90
	1991	Asgrow 5403		
		Lloyd		
NEREC	1990	Asgrow 5403	6/16/90	10/27/90
		Lloyd	6/16/90	11/4/90
	1991	Asgrow 5403	6/19/91	10/23/91
		Lloyd	6/19/91	11/11/91

respectively. Corresponding gaps were 2 and 18 in. at CBES. The canopy developed essentially the same regardless of the soybean variety or the stubble management treatment. It was obvious from observing the plots that differences in soil resulted in areas of lesser canopy development and growth. This nonuniform development suggests that wen closer row spacing could be advantageous to grain yields, especially in a production field.

Soybtan grain yields showed a strong response to either burning or leaving the straw, row spacing and variety. At NEREC (Tables 4 and 5), grain yields ranged from 14 to 42 and 22 to 41 bu/acre in 1990 and 1991, respectively. The best yield was obtained with burned straw, narrow rows and a group V soybean variety. At CBES (Tables 6 and 7), grain yields ranged from 9 to 27 and 11 to 45 bu/acre in 1990 and 1991, respectively. The best yield was obtained by incorporating the straw and planting narrow rows. The only commonality between the two locations for increasing yield was narrow rows.

The straw load at NEREC in 1990 was very large compared to that at CBES. The day after planting there was a rain in excess of 3 in. at CBES. Disking in the straw allowed these CBES plots to store this water instead of it running off as surface drainage. A similar rainfall pattern occurred in 1991 at the CBES.

These results reflect various contributions arising from straw management, seedbed preparation, varietal selection, and row spicing. These data show that the best selection of cultural practices depends to some extent on the soil type being cultivated. These data were subjected to component analysis in an attempt to assign quantitative values to each cultural component. In this manner, the relative importance of the components can be compared. The results of the component analysis are given

Table 3. Stubble management treatments used for double-cropped soybean at NEREC and CBES[1].

	Seedbed preparation		
Straw turning	Bedded	Flat	Flat-disked
	-- Treatment # --		
Yes	1	3	--
No	2	4	5

[1] NEREC = Northeast Research and Extension Center, Keiser, Arkansas; CEES = Cotton Branch Experiment Station, Marianna, Arkansas.

Table 4. Double-cropped soybean yields following different stubble management treatments in 1990 at Keiser, Arkansas.

Straw management	Row spacing	Bedded		Flat		Flat & Inc.		$\bar{x}$
		Asgrow	Lloyd	Asgrow	Lloyd	Asgrow	Lloyd	
	in.	.....		bu/acre----------				
Burned	19	42	25	35	35	---	---	34
	38	24	29	27	24	---	---	26
						Burned Mean		30
Left	19	26	24	20	24	22	20	23
	38	15	15	14	18	15	16	16
						Non-Burned Wean		29
						19-in. Row Spacing Mean		29
						38-in. Row Spacing Mean		21
	$\bar{x}$	27	23	24	25	---	---	
		Bedded Mean		Flat Mean				
		25		25				

Table 5. Double-cropped soybean yields following different stubble management treatments in 1991 at Keiser, Arkansas.

Straw management	Row spacing	Bedded		Flat				$\bar{x}$
		Asgrow	Lloyd	Asgrow	Lloyd	Asgrow	Lloyd	
	in.	.....		bu/acre----------				
Burned	19	34	30	36	33	---	---	33
	38	33	30	36	26	---	---	31
						Burned Mean		32
Left	19	35	28	41	32	37	30	34
	38	28	23	24	22	32	25	26
						Non-Burned Mean		30
						19-in. Row Spacing Mean		34
						38-in. Row Spacing Mean		29
	$\bar{x}$	33	28	34	28	---	---	
		Bedded Mean		Flat Mean				
		31		31				

in Table 8. Note the importance of row spacing in 1991 varied with straw management. Also, the effect of wheat stubble removal is different on the two soil types. The importance of preplant tillage may be exhausted because of the large rainfall events at planting.

Table 6. Double-cropped soybean yields following different stubble management treatments in 1990 at Marianna, Arkansas.

Straw management	Row spacing	Bedded		Flat		Flat & Inc.		$\bar{x}$
		Asgrow	Lloyd	Asgrow	Lloyd	Asgrow	Lloyd	
	in.	bu/acre						
Burned	19	16	22	9	19	---	---	17
	38	14	13	10	14	---	---	13
						Burned Mean		15
Left	19	22	23	15	22	25	27	23
	38	11	11	11	18	15	23	15
						Non-Burned Mean		19
						19-in. Row Spacing Mean		20
						38-in. Row Spacing Mean		14
	$\bar{x}$	16	17	11	18	---	---	
		Bedded Mean 17		Flat Mean 15				

Table 7. Double-cropped soybean yields following different stubble management treatments in 1991 at Marianna, Arkansas.

Straw management	Row spacing	Bedded		Flat		Flat & Inc.		$\bar{x}$
		Asgrow	Lloyd	Asgrow	Lloyd	Asgrow	Lloyd	
	in.	bu/acre						
Burned	19	30	23	40	21	---	---	29
	38	11	11	24	lo	---	---	14
						Burned Mean		22
Left	19	45	18	26	14	28	29	27
	38	32	24	20	14	24	22	23
						Non-Burned Mean		25
						19-in. Row Spacing Mean		28
						38-in. Row Spacing Mean		19
	$\bar{x}$	30	19	28	15	---	---	
		Bedded Mean 25		Flat Mean 22				

Budget analysis for 1991 indicate that at CBESa two-to-ten fold change inprofitability occurs with variety selection. Only about a two-fold change in profitability occurs with straw management and row spacing at NEREC. Variety selection only changed profitability at

Table 8. Yield component analysis for double-cropped soybeans.

	Location			
	CBES		NEREC	
Component	Burn	Leave	Burn	Leave
	bu A^{-1}			
1990				
Base yield	9	9	15	15
Straw management	0	4	11	0
Preplant tillage	0	7	0	0
Variety selection	4(VI)	4(VI)	0	0
Spacing (19 inch)	6	6	8	8
Projected yield	19	30	34	23
Measured yield	22	27	33	26
1991				
Base yield	14	14	24	24
Straw management	0	8	4	0
Preplant tillage	0	0	0	0
Variety selection	9(V)	9(V)	6(V)	6(V)
Spacing (19 inch)	14	4	2	8
Projected yield	38	36	35	37
Measured yield	35	33	35	38

most two fold. The influence of row spacing and straw management were similar to those obtained at CBES.

CONCLUSIONS

As a result of this study it can be concluded that the effect of leaving wheat straw can be detrimental or beneficial on the subsequent soybean crop. Utilizing narrow rows consistently increased profitability of double cropped beans. Selecting the best variety is the most important factor affecting profitability.