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Sowing Date and Row Spacing Effects on Soybean Cultivars Grown After Wheat in the Central Region of Saudi Arabia

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Abstract. Wheat is the dominant field crop grown in Saudi Arabia. Several summer leguminous crops were tried as relay crops for wheat and soybean was found to be the most productive one. The present investigation was conducted to identify the optimum sowing date and row spacing for growing soybean as a relay crop after wheat in the Central Region of Saudi Arabia. The four sowing dates (through June 20 – August 13) and the two row spacings; i.e. '25 and 50 cm' were studied for five previously selected soybean cultivars grown in the summer seasons of 1987 and 1988.

The response of cultivars to sowing date was different. R-315 was the top yielding cultivar in the late June planting of 1987. In 1988, the sowing date by cultivar interaciton was not significant.

Sowing date x row spacing interaction was also not significant in both years. The 25 cm row spacing showed a slight advantage in seed yield over the 50 cm rows only in the late sowing dates. According to the present study, it is possible to grow a soybean cultivar, as R-315' in the Central Region as a relay crop after wheat around mid June at a row spacing of 50 cm to obtain a good yield of soybean.

Introduction

Soybean (*Glycine max*) is an important oil and feed crop that could be grown in the summer season. In Saudi Arabia, wheat is the dominant crop occupying around 75% of the total cultivated area. The land is usually left fallow during the summer season which extends from late May up to mid November. Several attempts were made to evaluate different leguminous summer crops (i.e. cowpea, soybean, peanut) as relay crops that could successfully be grown after wheat. The preliminary results [1, 2] showed that soybean was the most productive crop among these summer legume crops.

Several investigators tried to introduce soybean cultivation in Saudi Arabia. Among them were Anonymous [3] and Sayed *et al.* [2] who obtained low yield with an average of 2.0 and 1.0 t/ha, respectively. However, Sayed *et al.* [2] evaluated several cultivars of soybean during later summer seasons of 1984 to 1986 in the Central

Region of Saudi Arabia and they recommended the cultivation of Cabrillo and Rillito as the highest yielding cultivars in this region.

The effect of planting date between 1 March to 1 June was investigated by Sayed *et al.* [1] who found that delaying planting date decreased seed yield. Moreover, the average yield for their experiment was very low (1.23 t/ha).

In the USA, the recommended row spacing for growing soybean changed from 100 to 50 cm rows [4]. Taylor [5] found that 25 cm rows outyielded 100 cm ones under adequate moisture conditions, while at the dry conditions this superiority disappeared. Beatty *et al.* [6] obtained an insignificant yield increase from planting in 18-48 versus 96 cm rows under irrigation. Heatherly [7] and Taylor *et al.* [8] reported a significant yield increase when row spacing decreased. Boerma and Ashley [9] found that 51 cm rows outyielded 91 cm ones by 11% in late June or early July planting. Heatherly [7] studied the effect of row spacing on seed yield from early or mid May versus late June planting of soybean. The 53 cm rows significantly outyielded the 102 cm rows by 100 kg/ha. The results also showed that delaying planting decreased seed yield. Boquet [10] showed that the 50 m rows were higher in yield than the 100 cm rows for June and July planting dates.

The objective of the present investigation was to study the effects of four sowing dates in June, July and August and two row spacings and their interactions on five soybean cultivars in order to identify the optimum sowing date and row spacing for growing soybean as a relay crop after wheat in the Central Region of Saudi Arabia.

Materials and Methods

Two field experiments were conducted at the College of Agriculture Experimental Research Station at Deirab near Riyadh (24 52 N, 46 44 E, Alt. 600 m) in 1987 and 1988 summer seasons. The site of experimentation was a non-saline sandy loam soil.

A split-split plot design, with three replications, was used in both years. The main plots were allocated to four dates (June 20, July 7, July 26 and August 13 in 1987; June 19, July 3, July 17 and August 31 in 1988). The sub-plots were assigned to five soybean cultivars (Cabrillo, Rillito, CM, Duocrop and R-315). The two row spacings, narrow (25 cm) and wide (50 cm), were allocated to the sub-sub-plots. In all treatments, plants were spaced at 10 cm within rows. The sub-sub-plot size was 2.5 $\times$ 5.0 m and contained either five or ten rows, corresponding to 50 and 25 cm row spacings, respectively. Due to the failure of bacterial *(Rhizobium japonicum)* inoculation, nitrogenous fertilizer (in the form of urea, 48% N) was applied at a rate of 150 kg/ha, in three equal increments; at planting and 3 and 5 weeks after sowing. Phos-

phorus (in the form of calcium superphosphate, 16% P_2O_5) was added prior to planting. Chelated iron was added twice at the rate of 1 kg/ha, as a soil application during seedbed preparation and at blooming time. Plots were irrigated with treated municipal water whenever needed throughout the growing season. Harvest was carried out when about 75% of pods matured.

Above ground biomass or biological yield, (BY) and seed yield (SY) were taken from the central four and two rows within each sub-sub-plot for 25 and 50 cm spacings, respectively. Plant number per m2 (PNO) was counted from a central area of one square meter in each plot. The number of days to flowering (DFL) and maturity (DM) were recorded during the growing season. Plant height (PH) was taken prior to harvest as an average of five random central plants per plot. Data for the two years were statistically analyzed according to Snedecor and Cochran [11].

Results and Discussion

The combined analysis of variance for 1987 and 1988 data, shown in Table 1, revealed that the year effect was highly significant for all characters, except for PNO and SWT. Sowing date was only significantly influenced by years in case of DM and PH. The year effect on cultivars was highly significant only for DFL and DM, whereas row spacing was not significantly affected by years for all traits, except for DM, PNO and BY.

Data in Table 1 also indicate that all interactions were insignificant for most characters. However, year by sowing date interaction was either significant or highly significant for all traits, except for BY and SWT.

Data in Table 2 show the error variance and indicate that their values were heterogeneous for all the studied characters, except for SWT, and were greatly different in 1987 and 1988, especially in the case of BY. For this reason, data of both years were treated separately in the manuscript.

The analysis of variance for 1987 and 1988 data, shown in Table 3, reveals that the effects of cultivars were either significant or highly significant for all the studied characters in the two seasons, except for plant number (PNO) in 1987 and seed weight (SWT) in 1988 season. Significant or highly significant differences were also obtained among planting dates for all characters, except for biological yield (BY) in 1987 and 1988, and seed weight (SWT) in 1988. Moreover, row spacings showed significant or highly significant values for all traits, except for days to flowering (DFL) and seed weight (SWT), in both seasons, and days to maturity (DM) in 1988, (Table 3). The sowing date X cultivar interaction was highly significant in several cases, but insignificant for PNO (in both seasons), DFL, PH, BY, SY and SWT in 1988. For the

Table 1. Combined analysis of variance for soybean variables over sowing dates, cultivars and row spacings in 1987 and 1988

S.O.V.	df	DFL"1"	DM	Ph	PNO	BY	SY	SWT
Years (Y)	1	**	**	**	NS	**	**	NS
Dates (D)	3	NS	*	**	NS	NS	NS	NS
D X Y	3	**	**	*	**	NS	**	NS
Cultivars (CV)	4	**	**	NS	NS	NS	NS	NS
CV X Y	4	NS	**	NS	NS	NS	*	*
CV X D	12	NS	NS	NS	NS	NS	NS	NS
CV X D X Y	12	*	**	NS	NS	**	NS	NS
Spacing (S)	1	NS	**	NS	**	**	NS	NS
S X Y	1	NS	NS	**	NS	NS	NS	NS
S X D	3	NS	NS	NS	NS	NS	**	NS
S X CV	4	NS	NS	NS	NS	NS	NS	NS
S X D X Y	3	NS	NS	NS	**	NS	NS	NS
S X CV X Y	4	NS	**	NS	NS	NS	NS	NS
S X D X CV	12	NS	NS	NS	NS	NS	NS	NS
S X D X CV X Y	12	NS	**	**	NS	NS	**	NS

*, **, NS = Significant at 0.05 and 0.01 levels of probability and not significant, respectively.

"1" DFL = Number of days to flowering; DM = Number of days to maturity
PH = Plant height (cm); PNO = Plant number /m^2;
BY = Biological yield (t/ha); SY = Seed yield (t/ha);
SWT = 100-seed weight (g).

Table 2. Error variance values for soybean variables in 1987 and 1988

Variables	1987	1988
Number of days to flowering (DFL)	0.9917	0.2250
Number of days to maturity (DM)	0.4667	1.1417
Plant height (PH)	48.4083	26.6750
Plant number /m2 (PNO)	40.5750	80.8000
Biological yield (BY)	13,163.8917	9,114.9250
Seed yield (SY)	1,478.2667	1,376.6667
100-seed weight (SWT)	2.1867	3.3153

sowing date X row spacing interaction, insignificant differences were obtained for PH and SWT in both seasons, and for DM and BY in 1988. Moreover, insignificant values were observed in the interaction between cultivars and row spacings for all characters in both seasons, except for DM. Finally, the 3-factor interaction was significant only for PH in both seasons, and for DM, PNO, and SY in 1987 (Table 3).

Table 3. Analyses of variance for soybean variables over sowing dates, cultivars and row spacings in 1987 and 1988

S.O.V.	df	DFL[1]		DM		PH		PNO		BY		SY		SWT	
		87	88	87	88	87	88	87	88	87	88	87	88	87	88
Dates (D)	3	**	**	**	**	**	**	**	*	NS	*	**	*	*	NS
Cultivars (CV)	4	*	**	**	**	**	*	NS	*	**	*	**	*	**	NS
D X CV	12	**	NS	**	**	*	NS	NS	NS	**	NS	**	NS	*	NS
Spacings (S)	1	NS	NS	**	NS	*	**	**	**	**	**	**	**	NS	NS
D X S	3	NS	*	**	NS	NS	NS	**	*	**	NS	**	**	NS	NS
CV X S	4	NS	NS	**	*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
D X CV X S	12	NS	NS	**	NS	*	*	*	NS	NS	NS	**	NS	NS	NS

*, **, NS = Significant at 0.05 and 0.01 levels of probability and not significant, respectively.

(1) DFL = Number of days to flowering; DM = Number of days to maturity; PH = Plant height (cm);
PNO = Plant number/m^2;
BY = Biological yield (t/ha); SY = Seed yield (t/ha);
SWT = 100 – seed weight (g).

Accordingly, the significant interactions obtained in this study indicated that soybean cultivars responded differently to various sowing dates in the two seasons, especially in the cases of biomass and seed yield. Hence, the stability of soybean cultivars is expected to vary in different environments. Such results coincided with those reported by Sayed *et al.* [1].

Sowing dates

Delaying of soybean planting from June 20 till August 13 in 1987 or from June 19 to July 31 in 1988 caused a significant earliness in flowering and maturity by about 24 and 16 days, in 1987, and 6 and 12 days, in 1988, respectively (Tables 4 and 5). The effect of late sowing on August 13 was more pronounced on early flowering in 1987. Such effect on earliness could be attributed, as was previously observed [1], to the relatively higher monthly average temperature in July and August than in June during the two years (Fig. 1).

A similar effect was observed on plant height in both seasons (Tables 4 and 5), where soybean plants were shorter at the late sowing dates. This was true in the two years, however, the plants were shorter in 1988 than in 1987. This means that planting of soybeans on late July or early August did not favor its vegetative growth (in terms of plant height), but in the meantime, accelerated its flowering and fruiting, as stated earlier.

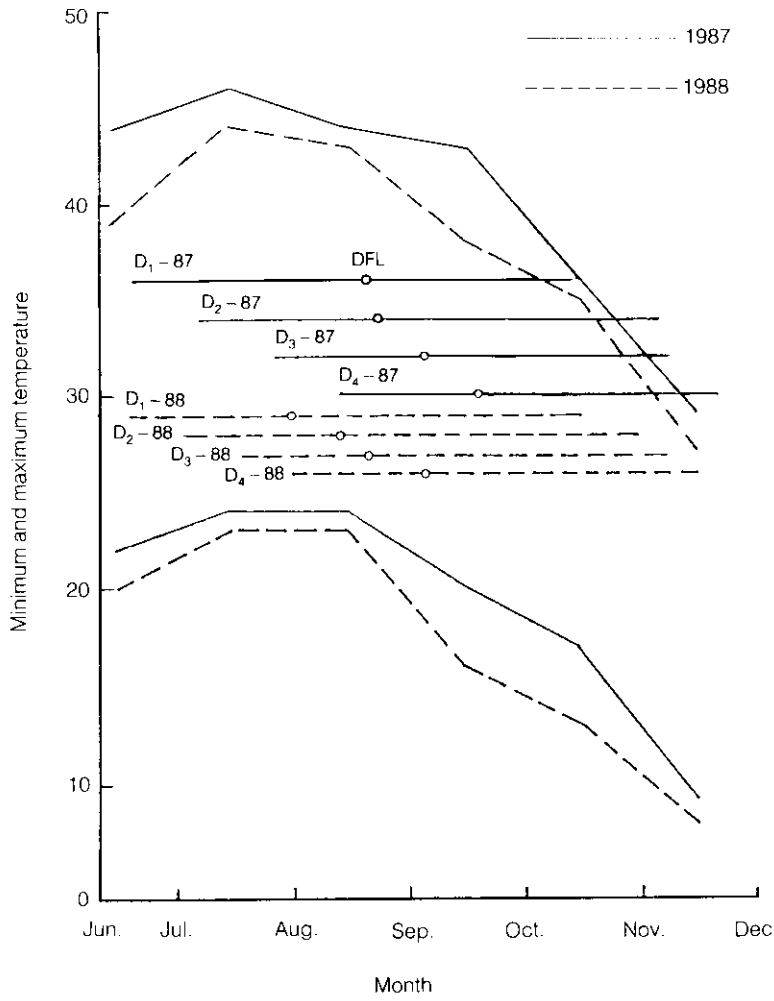

Fig. 1. Average monthly minimum and maximum temperatures and growth period for the sowing date (D) during the growing seasons of 1987 and 1988.

Moreover, data in Tables 4 and 5 show that PNO reacted differently in the two seasons. In 1988, both June 19 and July 31 plantings had significantly larger PNO means than those for July 3 and 17 plantings. On the other hand, in 1987 such PNO significantly increased from about 31 to 42, with delayed planting from June 20 to July 7. Such different results might be due to the various climatic conditions (Fig. 1) and sites of experimentation in the two seasons.

Table 4. Means for studied characters as influenced by different treatments in 1987

Treatment	DFL	DM	PH	PNO	BY	SY	SWT
Planting dates							
20/6	60.7a	118.0b	69.8a	30.6b	8.4a	3.71b	12.5b
7/7	46.9b	122.6a	56.4b	41.8a	9.7a	4.46a	13.8a
26/7	40.6c	106.0c	50.7c	47.7a	8.4a	2.99c	13.5ab
13/8	37.4d	102.2d	48.3c	47.3a	8.4a	2.49d	13.3ab
LSD .05	1.1	0.6	4.8	6.2	NS	0.22	1.1
Cultivars							
Cabrillo	46.1b	112.0b	53.9b	42.0a	7.9bc	3.61a	13.5b
Rillito	46.3ab	110.0c	53.6b	41.2a	7.7c	3.40a	13.3bc
CM	45.7b	114.4a	58.1ab	42.1a	9.5ab	3.38a	14.3a
Duocrop	47.0a	110.5c	54.8b	42.0a	8.2bc	3.10b	12.8c
R–315	46.9a	114.2a	61.1a	42.0a	10.5a	3.57a	12.7c
LSD .05	0.8	0.6	5.5	NS	1.6	0.27	0.7
Row spacings							
50 cm	46.3a	111.9b	54.8b	27.5b	8.2b	3.31b	13.5a
25 cm	46.5a	112.5a	57.8a	56.3a	9.4a	3.51a	13.2a
LSD .05	NS	0.3	2.6	2.4	0.4	0.14	NS

(1) Means followed by a common letter are not significant at the 0.05 level of probability. NS = Not significant.
DFL = Number of days to flowering; DM = Number of days to maturity; PH = Plant height (cm); PNO = Plant number/m^2; BY = Biological yield (t/ha); SY = Seed yield (t/ha); SWT = 100 – seed weight (g).

Biomass (BY) was slightly affected by sowing dates (Tables 4 and 5). In 1987, the differences were not significant among the sowing dates. On the other hand, in 1988, June and July 3 and 17 plantings produced similar BY values, however, July 17 BY (6.6 t/ha) significantly outyielded that of July 31 (5.7 t/ha), (Table 5). Besides, the overall mean of planting dates showed that sowing in late July or early August would produce the lowest BY, while early dates would encourage vegetative growth. Such findings agreed with those of Sayed *et al.* [1], Bonari *et al.* [12], Singh *et al.* [13], and Anderson and Vasilas [14]. The mean values of seed yield (SY) in 1987 were relatively higher than those of 1988 and this might be attributed to the heavy infestation of the plants with white fly observed visually in 1988, (Tables 4 and 5) and/or the year effect (Table 1). In 1987, the highest significant SY (4.46 t/ha) was attained at the second date (July 7), while in 1988, the three dates in July were similar in seed yield (averaged 2.36 t/ha) and that of July 3 and 17 significantly outyielded June SY. Con -

Table 5. Means for studied characters as influenced by different treatments in 1988

Treatment	DFL	DM	PH	PNO	BY	SY	SWT
Planting dates							
19/6[1]	52.5a	118.8b	69.1a	48.8a	6.3ab	1.77b	11.8a
3/7	50.7b	120.1a	53.7b	31.4b	6.1ab	2.32a	12.6a
17/7	47.3c	115.6c	39.9c	38.5b	6.6a	2.54a	13.6a
31/7	46.3d	107.1d	39.7c	46.3a	5.7b	2.21ab	13.2a
LSD .05	0.5	0.8	6.0	9.5	0.7	0.51	NS
Cultivars							
Cabrillo	48.5c	114.2d	49.0b	44.0a	5.6b	2.32a	13.3a
Rillito	49.3b	114.9c	50.3ab	40.3ab	5.9b	2.31a	13.3a
CM	48.1c	116.4b	47.1b	35.9b	6.3ab	2.23ab	12.4a
Duocrop	49.6b	114.4cd	49.8ab	42.6a	6.0ab	2.23ab	13.0a
R–315	50.5a	117.2a	56.8a	43.3a	7.1a	1.96b	12.1a
LSD .05	0.6	0.7	7.2	5.5	0.9	0.35	NS
Row spacings							
50 cm	49.2a	115.2b	47.0b	28.5b	5.7b	2.02b	12.7a
25 cm	49.2a	115.6a	54.2a	54.0a	6.7a	2.40a	13.0a
LSD .05	NS	NS	1.9	3.3	0.4	0.14	NS

(1) Means followed by a common letter are not significant at the 0.05 level of probability. NS = Not significant.
DFL = Number of days to flowering; DM = Number of days to maturity; PH = Plant height (cm); PNO = Plant number/m^2; BY = Biological yield (t/ha); SY = Seed yield (t/ha); SWT = 100 – seed weight (g).

sequently, as an average of the two years and the five cultivars, sowing soybean in early July could be an optimum sowing date (Fig. 2). Anderson and Vasilas [14] and Sayed *et al.* [1] reached similar results.

The effect of sowing dates on SWT was different in the two years (Tables 4 and 5). In 1987, the heaviest significant SWT (13.8 g) was produced from the July 7 planting, while in 1988, the differences in SWT were not significant.

Cultivars

Soybean cultivars significantly varied in DFL and DM in both seasons (Table 3). However, the range in DM was small, being four days in 1987 and three days in 1988 (Tables 4 and 5). In 1987, Duocrop and R-315 flowered later than the other cultivars. Meanwhile, R-315 was the latest in 1988. It was observed that DFL and DM mean

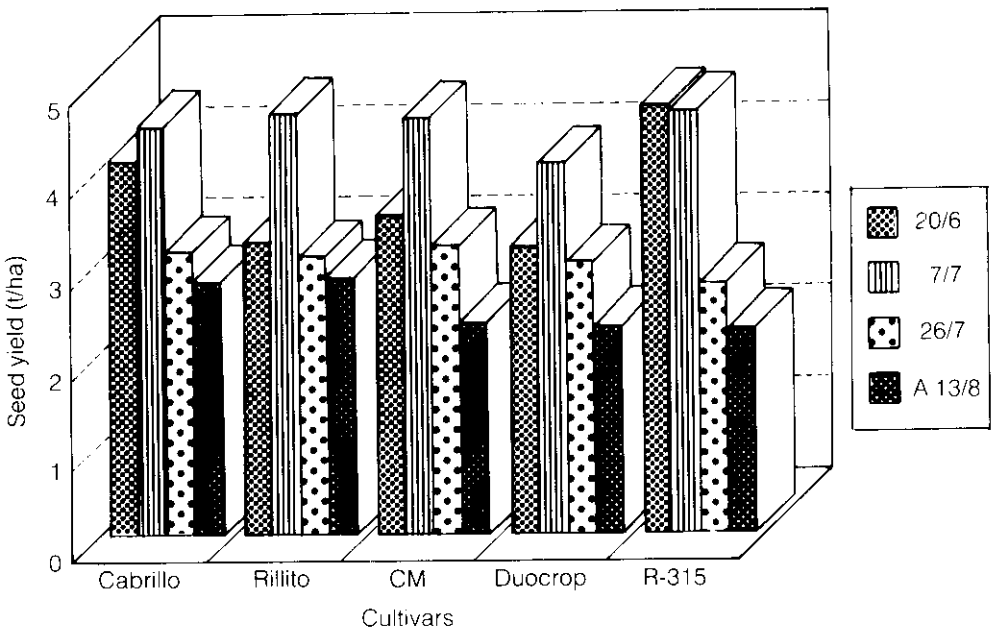

Fig. 2. Response of soybean cultivars to different sowing date in 1987.

values were relatively lower in 1987 than in 1988 and this may probably be due to the differences in air temperature that prevailed during the two growing seasons (Fig. 1).

The soybean cultivars significantly differed in PH in both seasons (Tabls 4 and 5). R-315 was consistently the tallest, while Rillito in 1987 and CM in 1988 were the shortest. In general, plants were relatively taller in 1987 than in 1988 and this might be due to the year effect (Table 1) and/or the white fly infestation. The differences among cultivars in PNO were significant only in 1988 (Tables 4 and 5), where CM has significantly lower PNO (36) than the other cultivars (averaged 43). Such differences in PNO might be due to the observed early infestation with the white fly which resulted in the loss of about 10% of the plants.

There were significant cultivar differences in BY in both years (Table 3). R-315 and CM were the top yielding cultivars in 1987, while R-315 surpassed the other cultivars, especially Cabrillo and Rillito in 1988, (Tables 4 and 5). As an average of the two years, R-315 would be a suitable cultivar with respect to BY, since no significant cultivar by year interaction was detected (Table 1).

Concerning the most important character for cultivar evaluation, i.e. SY, the differences among cultivars were small, but significant in both years (Tables 4 and 5). In general, the overall mean value for SY in 1987 was higher than in 1988 and this might be due to the white fly damage and the significant cultivar by year interaction

(Table 1), (being 3.41 t/ha in 1987 and 2.21 t/ha in 1988). In 1987, only Duocrop was significantly lower (3.10 t/ha) than the other tested cultivars (averaged 3.49 t/ha), while in 1988, R-315 cultivar produced significantly lower SY than Cabrillo and Rillito cultivars.

The differences in SWT among cultivars were highly significant in 1987 only. CM cultivar had the heaviest significant seed weight (14.30 g), while both Duocrop and R-315 were the lightest in SWT.

Row spacing

In both years, DFL was similar in the two row spacings under study (Tables 4 and 5). The differences in DM was significant in 1987 only. This was confirmed by data in Table 1. The 50 cm row spacing was one day earlier than the 25 cm one (Table 4). PH and PNO were significantly affected by row spacing in both years (Table 3). The 25 cm rows gave significantly taller and larger PNO than the 50 cm ones (Tables 4 and 5). The 25 cm row spacing was significantly higher in SY and BY than the 50 cm one in both years (Tables 4 and 5). However, the percent of increase in SY was about 6% in 1987 and 19% in 1988. Consequently, it might be stated that the close spacing would increase SY due to the increase in number of plants (Tables 4 and 5). Board *et al.* [15] showed that narrow rows increased light interception and total dry matter duration. They showed that the advantage of narrow rows was more pronounced at the late planting. Taylor *et al.* [8] came to the same conclusion.

Duncan [4] concluded that, in the narrow rows, greater biomass accumulation contributed to seed yield increment. However, this increase in yield was opposed by higher water consumption [7].

Sowing date × cultivar

Several significant interactions were detected among the three factors under study (Table 3). Because BY and SY determine the yielding ability of cultivars, only those interactions concerned with these two yield estimates will be discussed.

Sowing significant interactions was highly significant in 1987 only (Table 3). The cultivar means under the four sowing dates (Table 6) were used to calculate the response curves of SY for the different cultivars with regard to different sowing dates and they are shown in Fig. 2. The response curves for Cabrillo and R-315 were similar as delaying sowing date would steadily decrease SY. Therefore, the optimum date for planting either of these cultivars would be June 20. On the other hand, for CM, Duocrop and Rillito cultivars, delaying sowing date would increase SY up to mid July and, then, it would drastically drop after that (Table 6 and Fig. 2). R-315 was the top

Table 6. Means of seed yield (t/ha) as influenced by sowing date x cultivar interaction in 1987

Cultivars	Sowing dates			
	20/6	7/7	26/7	13/8
Cabrillo	4.09 b	4.47 a	3.09 a	2.78 a
Rillito	3.19 c	4.60 a	3.03 a	2.82 a
CM	3.48 c	4.55 a	3.15 a	2.34 a
Duocrop	3.14 c	4.05 a	2.96 a	2.27 a
R-315	4.68 a	4.62 a	2.74 a	2.25 a

LSD (0.05) for spacing each cultivar = 0.53.
Means, within each column, followed by a common letter are not significant at the 0.05 level of probability.

yielding cultivar during June planting in 1987. The differences among cultivars were large under that date, while the cultivars behaved similarly in the other dates (Table 6 and Fig. 2). According to these results, R-315 cultivar would be the best choice among the tested cultivars and the most suitable date for its planting might be June 20.

On the other hand, the sowing date x cultivar interaction was not significant for SY in 1988 (Table 3), suggesting that the five cultivars behaved similarly to the change in sowing date. The average response of the five cultivars is presented in Fig. 2. Accordingly, an optimum date for soybean planting would be around mid-July.

The contradiction between the two years might be due to the variable severity of infestation with while fly. In 1988, infestation was heavy and its effect was clear on the early sowing dates. The damage due to white fly was less on the late sowing date. Therefore, this damage had a significant effect on the response of the different cultivars to sowing dates.

The interaction between sowing date x cultivar for BY was different from that of SY (Table 7). R-315 behaved differently to the change in sowing date in 1987. The response was linear as shown in Fig. 3. Delaying planting would reduce both the total biomass and seed yield. In 1988, the change in sowing date did not effect the total biomass. This is also attributed to the white fly damage.

Sowing date x spacing

This interaction was highly significant for SY in both years (Table 3). Means of SY for sowing date x spacing combinations are given in Table 8. In 1987, the early sowing date in June would favor wider spacing, while the reverse was true in late planting in August (Table 8).

Table 7. Means of biomass (t/ha) as influenced by sowing date x cultivar interaction in 1987

Cultivars	Sowing dates			
	20/6	7/7	26/7	13/8
Cabrillo	7.20 b	9.92 a	6.15 b	8.35 a
Rillito	6.25 b	10.48 a	6.07 b	7.93 a
CM	6.68 b	8.42 a	11.92 a	9.05 a
Duocrop	6.10 b	9.61 a	8.76 a	8.19 a
R-315	14.00 a	10.17 a	9.22 a	8.45 a

LSD (0.05) for spacing each cultivar = 3.2 t/ha.
Means, within each column, followed by a common letter are not significant at the 0.05 level of probability.

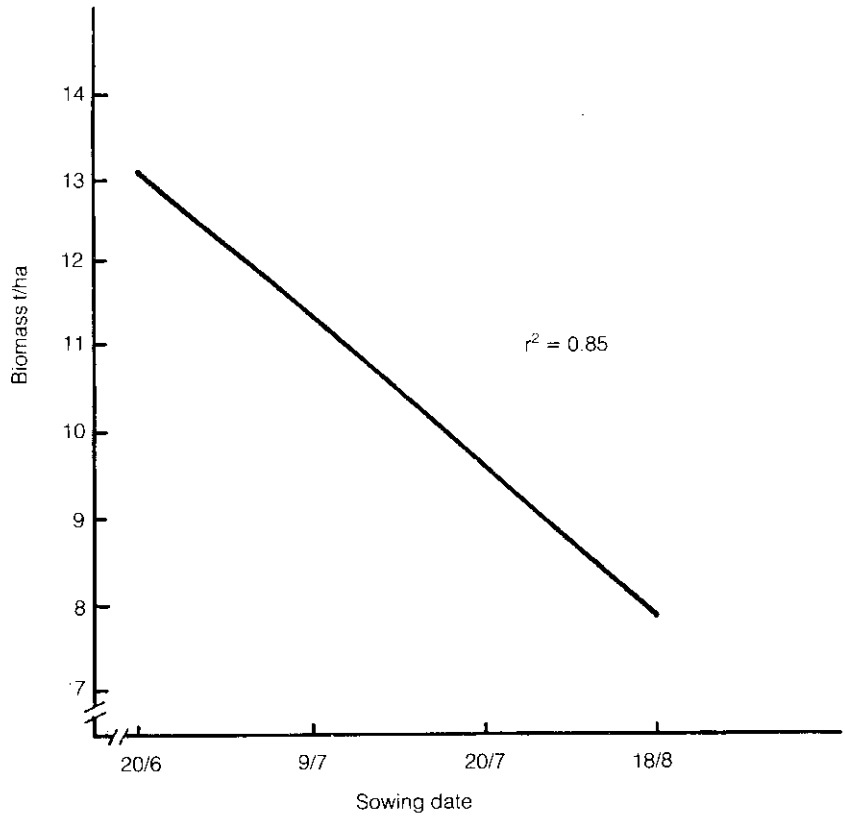

Fig. 3. Response of biomass (t/ha) of soybean cultures to sowing date in 1987.

Table 8. Means of seed yield (t/ha) as influenced by sowing date x row spacing interaction in 1987

	Sowing dates							
	20/6	**19/6**	**7/7**	**3/7**	**26/7**	**17/7**	**13/8**	**31/7**
Row spacings	**87**	**88**	**87**	**88**	**87**	**88**	**87**	**88**
50 cm[1]	3.86 a	1.77 a	4.32 a	2.17 b	2.89 a	2.35 b	2.18 b	1.81 b
25 cm	3.56 b	1.77 a	4.60 a	2.47 a	3.10 a	2.73 a	2.81 a	2.61 a

(1) LSD (0.05) for spacing each date = 0.29 (1987), 0.28 (1988).
Means, within each column, followed by a common letter are not significant at the 0.05 level of probability.

In 1988, there was no advantage of narrow rows in the early sowing date in June, but the advantage appeared on later sowing dates in July. These results are similar to those obtained by Board *et al.* [15] who reported that yield enhancement of narrow rows was greater with delayed planting. Johnson [16] showed that late planting date and early cultivars tended to have great yield response to narrow rows.

Based on the previous results, a practice to obtain a good yield of soybean under the prevailing high temperature conditions of the Central Region of Saudi Arabia might be planting a soybean cultivar, like R-315, around mid June at a row spacing of 50 cm. This sowing date would be feasible for wheat growers as they would be able to harvest the wheat crop and prepare the land for the soybean crop. Effective means to control white fly should be investigated.

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تأثيرات ميعاد ومسافات الزراعة على أصناف فول الصويا المنزرعة عقب محصول القمح في المنطقة الوسطى بالمملكة العربية السعودية

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ملخص البحث. القمح هو المحصول الرئيسي بالمملكة العربية السعودية. وقد جربت زراعة بضعة محاصيل بقولية صيفية كمحاصيل لاحقة للقمح، ووجد أن محصول فول الصويا أفضلها إنتاجًا. وقد أجرى هذا البحث بغرض تحديد أنسب ميعاد للزراعة وأنسب مسافة لتخطيط زراعة فول الصويا كمحصول لاحق للقمح في المنطقة الوسطى بالمملكة العربية السعودية. وقد تمت دراسة تأثير أربعة مواعيد للزراعة (خلال الفترة من ٢٠ يونيو وحتى ٣ أغسطس) ومسافتان للتخطيط وهما ٢٥، ٥٠سم على إنتاجية خمسة أصناف سبق انتخابها لفول الصويا، وذلك في الموسم الصيفي لعامي ١٩٨٧، ١٩٨٨م.

وقد استخدم في البحث التصميم التجريبي «القطع المنشقة مرتين» في أربعة مكررات، حيث احتلت مواعيد الزراعة القطع الرئيسة والأصناف القطع الفرعية ومسافتا التخطيط القطع تحت الفرعية. وقد أظهر تحليل التباين المجمع لعامي الدراسة اختلاف قيم تباين الخطأ التجريبي بشكل ملحوظ لجميع الصفات التي تمت دراستها. ولهذا السبب تم تحليل النتائج المتحصل عليها في كل عام على حدة.

وبصفة عامة كان لمواعيد الزراعة تأثير معنوي على جميع الصفات المدروسة في الموسمين فيما عدا المحصول البيولوجي في عام ١٩٨٧م ووزن المائة بذرة في عام ١٩٨٨م. كما تأثرت معنويًا جميع الصفات المقاسة بالأصناف في موسمي الزراعة فيما عدا عدد النباتات بالمتر المربع في عام ١٩٨٧م ووزن المائة بذرة

في عام ١٩٨٨م . أما مسافتا التخطيط فكان لهما تأثير معنوي على جميع الصفات في الموسمين فيما عدا عدد الأيام للتزهير ووزن المائة بذرة في العامين، وعدد الأيام للنضج في عام ١٩٨٨م .

وقد كانت استجابة الأصناف مختلفة لميعاد الزراعة، وكان الصنف "R-315" أعلى الأصناف إنتاجية عند زراعته في أواخر شهر يونيو عام ١٩٨٧م . وفي عام ١٩٨٨م كان التفاعل غير معنوي بين ميعاد الزراعة والأصناف لصفة محصول البذور. كما كان التفاعل غير معنوي بين ميعاد الزراعة ومسافة التخطيط لصفة محصول البذور في العامين . وقد أظهرت مسافة التخطيط «٢٥» تفوقًا طفيفًا في محصول البذور على المسافة «٥٠» في المواعيد المتأخرة للزراعة فقط .

وطبقًا لهذه الدراسة فأنه يمكن زراعة صنف من فول الصويا ـ كالصنف المسمى R-315 بالمنطقة الوسطى كمحصول لاحق عقب القمح في حوالي منتصف شهر يونيو وعلى مسافة ٥٠سم بين الخطوط للحصول على إنتاج جيد .