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Response of Soybean Varieties to Different Planting Dates

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Abstract: This experiment was conducted at a Research Farm in Shahriar, Iran, to study the effect of planting dates on agronomical and physiological features of some soybean varieties. Experimental design was a split plot in the form of randomized complete block design with four replications. Treatments included four planting dates with intervals of 10 days as main plot (May 20, May 30, June 9 and June 19) and four soybean varieties as subplot (Williams, Zan, L17 and M7). Traits such as the number of kernels and pods, protein and oil content, seed yield and pod yield were measured. Results indicated that the effect of treatments and their interactions significantly affected all traits (at $p \leq 0.01$); the only exception was pod shell weight which showed no response to the interaction of planting date × variety. Overall, results of the experiment showed that the planting date May 20 and the variety Williams yielded better than other treatments.

Key words: *Glycine max* · Variety · Williams · Zan

INTRODUCTION

Soybean (*Glycine max*) is the world's most widely cultivated and economically successful legume. Seeds of this valuable crop are rich in oil (approximately 20%) and protein (approximately 40%). Another major feature of soybean which makes it an attractive crop in many cropping systems is its efficient biological nitrogen fixation in association with microorganisms in the root nodules. How much oil, protein and yield soybean produces, and how much nitrogen soybean fixes is an important question, but it is very difficult to give the correct answer because all these traits are influenced by many factors: (i) climatic factors (water availability, temperature and photoperiod) and (ii) the interaction between environmental factors and the soybean plant, such as the efficiency of soybean varieties [1-3].

Planting date plays an important role in plant growth during the season and the final yield production. This factor is even more important in the regions with harsh climatic variations that weather is the most critical limiting factor for agricultural systems. For example, in tropics or subtropics, planting date is usually delayed until the beginning of rainy season. In such situations, early planting dates with low soil moisture will damage seedlings growth and late planting dates cause drought incidence at the end of growing season, which is important stage in plant growth and directly affects yield. Researchers have represented that late planting date in a soils with enough moisture is always better that early planting date in unfavorable soil conditions [4, 5].

It is well understood that on time planting date allows plant to take advantages of climatic factors such as temperature, moisture and day length. During the past 30 years, breeding programs have developed many soybean varieties for their adaptation to different geographical areas and for improving seed characteristics such as increasing protein and oil concentrations, improving protein quality, reducing antinutritional compounds, etc [6, 7]. In soybean plant, long days postpone flowering and short days accelerate maturation, and as proper day length varies for different soybean varieties, effect of planting dates will not be the same on their growth period [8, 9]. Researchers represented that soybean would have the shortest vegetative growth in early planting dates (short photoperiod) with high temperature (27°C) and the longest vegetative growth in proper planting date (long photoperiod) with low temperature (21°C) [10]. Hashemi [9] also reported that late planting dates would shorten vegetative growth of early soybean varieties and reduce their yield. Other studies concluded that delayed planting dates can accelerate flowering, shorten vegetative and reproductive growth, reduce grain yield and oil content of soybean [11, 12].

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Generally, long growing season allows plants to accumulate more dry matter through more vegetative growth. In an experiment it was concluded that delayed planting date reduces yield through reducing grains number, dry matter content and pods number [13]. Researchers represented that higher temperature in vegetative growth stage and at the time of pods formation increases soybean height [14]. Finally, regarding what stated above, it is clear that proper planting date for different varieties of soybean is of a high importance, so this experiment was conducted to determine the best planting date for different soybean varieties.

MATERIALS AND METHODS

This field experiment was conducted at the Research Farm in Shahriar, Iran. Soil type of the test site was a loam with pH of 7 and EC of 1.8 ds/m. The experimental design was a split plot in the form of randomized complete block design (RCBD) with four replications. Treatments included four planting dates with intervals of 10 days as main factor (May 20, May 29, June 9 and June 19) and four soybean varieties as sub factor (Williams, Zan, L17 and M7).

To prepare the filed for soybean cultivation, moldboard plow, disk and leveler were used at spring. According to prepared map, each plot contained 6 rows, each 6m long and 50cm wide. Before sowing, the field was irrigated to ensure proper germination and after 2 days soybean was planted with 8cm spacing on rows in plots of the first planting date. Other plots were cultivated in other three planting dates according to the prepared map. Irrigation was repeated weekly without any drought stress to plants and weeds were controlled manually during growing season.

All plots were divided into 2 parts, one for sampling during growing season and another for final yield sampling. Sampling was conducted during soybean growth period. To measure final yield production, $1m^2$ and to measure yield components, 10 plants were harvested from each plot. First, pods along with their grains were weighted and then, grains were detached from pods and weighted again. Finally, grains were grinded and analyzed for oil and protein content in laboratory. Obtained data were analyzed using SAS and MSTATC and mean comparison was done by Duncan's multiple range test.

RESULTS AND DISCUSSION

Number of Kernels/m^2: Analysis of variances showed that both planting date and variety significantly affected the number of kernels/m^2 ($p \leq 0.01$; Table 1) and comparison of the mean showed a significant difference between different levels of the two treatments. Among four planting dates, May 20 was the best one with 1542.4 kernels/m^2 (Table 2) and among four varieties, Williams was the best with 1320 kernels/m^2 (Table 2), although it was not significantly different from M7. The interaction of planting date × variety significantly affected this trait ($p \leq 0.01$; Table 1) and mean comparison showed the highest number of kernels/m^2 in May 20 × Williams, with 1681 kernels/m^2, although this treatment had no difference from May 20 × M7 and May 29 × Williams (Table 2). As it was previously mentioned, a wide range of soybean varieties are being cultivated around the world because of the poor adaptive ability of this crop to environmental condition, so four varieties used in this experiment responded quite different to conditions and planting dates. A proper planting date helps plants to take advantages of climatic factors such as temperature, moisture and day length [6].

Number of Pods/m^2: The two treatments of the experiment significantly affected the number of pods/m^2 ($p \leq 0.01$; Table 1). Mean comparison of the four planting dates indicated that the first one (May 20, with 608 pods/m^2) and the last one (June 19, with 322.1 pods/m^2) were the best and the worst treatment, respectively (Table 2). Different varieties had also significant effect on this trait and Williams had the highest number of pods (519.4) and

Table 1: Analysis of variances for measured traits

		Mean Squares (MS)					
SOV	df	Number of kernels/m^2	Number of pods/m^2	Protein content	Oil content	Seed yield	Pod yield
Rep	3	**	**	**	*	**	**
Planting Date	3	**	**	**	**	**	**
Variety	3	**	**	**	**	**	**
A×B	9	**	**	**	**	**	**
CV (%)	-	7.4	6.5	11.6	14	7.7	6.9

NS, nonsignificant; **, significant at 0.01; *, significant at 0.05.

Table 2: Effects of Planting Date (D), Variety (V) and their interactions on measured traits

Treatments	Number of kernels/m^2	Number of pods/m^2	Protein content (g/m^2)	Oil content (g/m^2)	Seed yield (g/m^2)	Pod yield (g/m^2)
May 20	1542.4a	608.0a	88.7a	31.8a	222.4a	329.5a
May 29	1282.4b	493.0b	79.2a	29.3a	195.6b	289.1ab
June 9	1088.7c	430.0b	65.5b	24.1b	163.2c	247.9b
June 19	822.0d	322.1c	48.5c	17.4c	125.8d	197.7c
Zan	1085.0b	422.8b	67.4bc	24.7bc	164.2c	247.5c
L17	1057.0b	413.1b	62.5c	22.3c	164.9c	251.2c
M7	1271.0a	498.2a	71.6b	26.6ab	180.0b	267.0b
Williams	1320.0a	519.4a	80.4a	29.0a	200.0a	297.7a
May 20×Zan	1371.0b	553.5cd	88.0bc	33.0b	206.6bc	303.5bc
May 20×L17	1445.0b	564.3c	80.9cd	28.6bcd	224.0b	329.0ab
May 20×M7	1660.0a	639.5ab	90.5bc	31.6bc	225.0b	330.0ab
May 20×Williams	1681.0a	675.5a	95.6ab	34.2b	244.0a	355.8a
May 29×Zan	1131.0cd	433.0fg	69.5de	25.2de	173.2e	264.7def
May 29×L17	1039.0de	400.3ghi	61.0efg	21.8ef	162.2ef	249.8efg
May 29×M7	1346.0b	518.0de	79.3cd	31.1bcd	194.9cd	285.5cd
May 29×Williams	1614.0a	621.8b	107.3a	40.0a	251.5a	356.3a
June 9×Zan	1057.0cde	412.8gh	63.0ef	22.1ef	157.9ef	239.3fg
June 9×L17	959.0ef	378.0hi	60.7efg	22.2ef	149.0fg	231.0gh
June 9×M7	1185.0c	475.5ef	64.5ef	26.1cde	166.3ef	247.0efg
June 9×Williams	1154.0cd	458.3f	73.7de	25.9cde	179.6de	274.3de
June 19×Zan	770.0g	294.5k	49.3gh	18.4fg	119.3h	182.8i
June 19×L17	786.0g	311.0k	45.4h	16.0g	123.6h	195.4i
June 19×M7	896.0fg	360.3ij	52.1fgh	18.7fg	133.9gh	208.3hi
June 19×Williams	835.0fg	322.8jk	47.4h	17.2g	126.5h	204.5hi

Means in column followed by the same letter are not significantly different at P=0.01.

L17 had the lowest number of pods (413.1). In other study, it was reported that delayed soybean planting date would reduce yield production. They observed that late planting dates decreased plant vegetative growth period, accumulation of dry matter, number of kernels and pods and finally, crop yield [13].

The interaction of planting date × variety also significantly affected the number of pods/m^2 ($p \leq 0.01$; Table 1). According to the results of mean comparison (Table 2), May 20 × Williams (675.5 pods/m^2) and June 19 × Zan (294.5) were the most and the least effective treatments.

Protein Content: Protein content was significantly affected by planting date and variety ($p \leq 0.01$; Table 1). Mean comparison showed the highest protein content in May 20 (88.7 g/m^2) and the lowest in June 19 (48.5 g/m^2). This result proves that delayed planting date reduces plant yield and protein content because of lower growth period. Among four soybean varieties, Williams had the highest protein content with 80.4 g/m^2 (Table 2). The interaction of planting date × variety significantly affected this trait ($p=0.01$) and May 29 × Williams (107.3 g/m^2) and June 19 × L17 (45.4 g/m^2) were the best and the worst treatments, respectively (Table 2). Board and Hall [10] reported that in lower temperature (20°C) and proper planting date (long photoperiod) soybean would have the best growth but higher temperature (28°C) and early planting date (short photoperiod) would eliminate the crop vegetative growth.

Oil Content: Planting date, variety and their interactions significantly affected oil content of the crop ($p \leq 0.01$; Table 1). According to mean comparison (Table 2), the highest oil content occurred in the first planting date (May 20; 31.8 g/m^2) and the lowest occurred in the last date (June 19; 17.4 g/m^2). Tabatabayee [12] also represented that late planning date reduces oil content in soybean grains. Among four varieties, Williams had the highest oil content (29 g/m^2) and the interaction of Williams × May 29 was the best interaction with 40 g/m^2 oil (Table 2).

Seed Yield: Seed yield was also significantly affected by planting date and variety (Table 1); May 20 was the best treatment among planting dates (Table 2).

In varieties, Williams (200 g/m^2) and Zan (164.2 g/m^2) were the best and worst treatment, respectively (Table 2). The interaction of plating date × variety significantly affected this trait ($p \leq 0.01$). Generally, Williams × May 20 and Zan × June 19 were the most and the least effective treatments with 244 and 119.3 g/m^2, respectively (Table 2). These results indicated that late planting dates reduced soybean yield and seed production. Other study, Shafigh *et al* [11] also concluded that delayed soybean planting accelerates flowering, shortens vegetative and reproductive growth period and consequently, decreases grain yield.

Pod yield: Analysis of variances showed significant effect of planting date and variety on pod yield ($p \leq 0.01$) and mean comparison showed the best pod yield in May 20 (329.5) and the worst, in June 19 (197.7 g/m^2), among plating dates (Table 2). The best soybean variety with the highest pod yield was Williams (297.7 g/m^2). Mean comparison of the interaction of plating date × variety showed the highest pod yield in Williams × May 29 (356.3 g/m^2), although had no significant difference from Williams × May 20 (355.8 g/m^2). The lowest pod yield production (182.8 g/m^2) was observed in Zan × June 19 (Table 2). In another experiment anderson and Vasilas [13] concluded that late planting dates accelerate soybean flowering and lower vegetative growth, which means lower accumulation of dry matter and yield production.

CONCLUSION

Overall, results of this experiment indicate that Williams is probably the best variety for areas with climatic conditions as same as Karaj, Iran. Moreover, results represent that earlier planting date gives plants enough time for vegetative growth so higher yield will be obtained in planting dates at the end of May.

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