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Full Length Research Paper

Study of effect of planting date on vegetative traits, reproductive traits and grain yield of soybean cultivars in cold region of Ardabil (Iran)

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In order to study the effects of different planting dates on the grain yield of soybean cultivars, an experiment was conducted as factorial in the form of randomized complete blocks design with three replications at the research farm of Ardabil (Iran) in 2009. In this experiment, the first factor of sowing date included four levels (27 May, 5, 15 and 26 June) and the second factor included cultivar Williams and line L_{17}. The results showed that there was not meaningful difference between cultivars under study for all traits, while there was meaningful difference between different sowing dates for all traits being studied except number of seeds per pod. Also, the interaction of planting date and cultivar was not meaningful for all traits under study. Sowing dates of 27 May and 5 June were placed in one group for number of pod in main bough, height of each plant and a weight of 100 seed. Also the mentioned traits had the highest in the expressed sowing dates. Sowing date of 27 May had the highest amount for pods per sub-bough, number of nodes per sub-bough, number of nodes in the main bough and the final yield.

Key words: Sowing date, soybean, vegetative and reproductive traits, yield.

INTRODUCTION

Soybean is the main source of supplying protein and oil in the world. Soybean is a crop which can provide complete protein, containing 8 amino acids essential for human health (Asadi and Faraji, 2009). Sowing date affects significantly on different stages duration of growth as one of the important farming issues and it is one of the important factors in determining harvest of maximum cultivar yield in one region. Appropriate planting date causes optimal utilization of the climate factors such as temperature, humidity, day length and also anthesis time adaptation with proper temperature (Hashemi, 2001). Buehring et al. (2003) in a study conducted in Verona Mississippi reported that all soybean cultivars were obtained more yield from first planting date than two subsequent planting dates. With delay in planting due to high sensitivity of soybean to light period duration and temperature affects yield negatively by reducing the duration of vegetative and reproductive growth and yield components drop (Kazemi et al., 2005). Shafigh et al. (2006) reported that in their experiment, first planting date had the highest number of pods per plant and had meaningful difference with the other two planting dates. Effect of sowing date on yield has been reported by other researchers on the castor (Moghaddam et al., 2008), sunflower (Ashley et al., 2002) and safflower (Heidarizadeh et al., 2008).

Since the Ardabil region is one of the country's cold regions, in this area there has not been much research on soybean, hence this study was conducted to assess

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the best sowing date and cultivar in the region to possibly be in the annual planting pattern in the area which is primarily single-vessel system of wheat and potatoes and causes pests and diseases in the region to increase.

MATERIALS AND METHODS

This experiment was conducted on research farm of Islamic Azad University of Ardabil (Iran) in 2009 (Ardabil West 5 km). The climate is semi-arid and cold, winter temperatures were often below zero degrees. Altitude was 1350 m and latitude and longitude were 38.15 north and 48.2 east, respectively. Average of annual minimum and maximum temperature, and maximum absolute temperature were -1.98, 15.18 and 21.8°C, respectively, and mean annual precipitation have been reported 310.9 mm. The soil of experiment was clay alluvial soils; its acidity varies between 8.2 and 7.8.

The experiment was conducted as factorial in the form of randomized complete blocks design with three replications, the first factor of sowing date included four levels (27 May, 5, 15 and 26 June) and the second factor including cultivar Williams and line L_{17}. Substrate preparation operations included plowing, disk, leveling and preparing the bed. During bed preparation, based on soil test, the amount of 30 kg urea per hectare was used on the farm. Cultivars were prepared from the Research Center of Moghan and after disinfection and inoculation by *Rhizobium Japonicum* bacteria were cultivated on the desired dates. Each plot contains six sowing rows with 4m length and the spacing between sowing rows was 50 cm and the plant distance was considered 8 cm. During the growth period the farm was irrigated each 10 days. During this period, to control weeds, weeding was done three times manually. When maturity of the product, from the effective level of each experimental unit, initially 10 plants were randomly harvested and the number of nodes on main stem and sub-stem, number of seeds per pod, number of pods on main stem and sub-stem, 100 seed weight and plant height were measured. Final harvest of each experimental unit was conducted when the pods were yellow, and its yield, by eliminating two rows of half a meter on the side and remove from the sidelines at the beginning and end of each row, four rows from the middle area of 6 square meters per plot were harvested, and yield based on 14% grain moisture was calculated. Statistical calculations and comparison of averages were performed using SPSS software. To compare means, we used Duncan's multiply range test in probability level of 5%.

RESULTS AND DISCUSSION

Plant height

Results of variance analysis showed that the effect of planting date on plant height is meaningful in probability level of 1% (Table 1) cultivar effect and cultivar interaction with sowing date on this trait had no meaningful effect. Mean comparison of treatments (Table 2) showed that planting dates of 27 May and 5 June had the highest plant height and the lowest is related to 15 and 26 June. Khan et al. (2003) stated that the plants planted in early May, had more height than plants planted in August. In other experiments, which conform to the results of these experiments, they expressed that the highest and lowest soybean height is on 5 May and 20 June, respectively (Salahi et al., 2006). Hamzeh et al. (2004) also expressed that with delay in planting, plant height and height of the first node sheathed surface decreases. Temperature rise during period of growth and reduction of duration causes reduced plant height (Heidarizadeh et al., 2008). Plant height, lodging, pod formation height from the surface of soil and ripeness time will be reduced by the delay in planting and also the three-day delay in planting caused a day delay in maturity (Arshi, 2001).

Number of pods in the main stem and sub stem

The results of variance analysis show that there was meaningful difference between iterations and different planting dates in probability levels of 5 and 1% (Table 1). Considering that the number of pods on the main stem depends on the height of the pod and shows more correlation with it, in this experiment mean comparison of planting dates on this trait showed that the highest number of pods on main stem is related to planting dates in 27 May and 5 June and the lowest of these traits to the 5th of July (Table 2). Number of pod in sub stem depends on the number of sub boughs and shows more correlation with it. Results of data variance analysis for number of pod in sub bough indicate that there was a meaningful difference between different dates of planting in probability level of 1%, but no meaningful difference was observed between remaining effects (Table 1). For data mean comparison, of sowing dates, planting date on 27 May produced highest number of pod in sub-bough and the lowest is related to the fourth planting date, which is 26 June (Table 2). Early planting date creates higher number of seed, pod and harvest index, but less number of seeds per pod than the late planting date is produced (Pedersen and Lauer, 2004). Early planting date of traits like pods in the main stem, number of pods per sub bough, number of pods per plant, number of two seed pod, number of three seed pod and seed yield had the highest amount (Salahi et al., 2006). Number of pod depends on number of nodes per plant and on the other hand, delay in planting during the growing plant and pod formation will be less, followed by a reduced number of pods on the plant production (Azizi et al., 2005).

Number of nodes in main stem and sub stem

Results of different planting dates were meaningful in terms of number of nodes on main stem and sub stem in probability level of 1% (Table 1). Mean comparison showed that the sowing date of 27 May had the highest value and 26 June had the lowest value of these traits (Table 2). Delay in sowing lead to reduced plant height, number of nodes on main stem, number of stem per

Table 1. Analysis of variance for the traits evaluated on different planting cultivar Williams and Line L_{17}.

Source of Variations	df	Mean Square							
		Plant height	Number of pods in the main stem	Number of pods in the sub stem	Number of nodes in main stem	Number of nodes in sub stem	Number of seeds per pod	100 Seed weight (gr)	Yield (kg/ha)
Block	2	411.07^{**}	14.37^{*}	54.30^{ns}	0.74^{ns}	11.83^{ns}	0.02^{ns}	7.4^{*}	$32.58\times10^{4\,**}$
Planting date	3	163.87^{**}	81.61^{**}	573.39^{**}	17.80^{**}	259.12^{**}	0.03^{ns}	19.1^{**}	$66.66\times10^{4\,**}$
Cultivar	1	1.04^{ns}	4.16^{ns}	74.90^{ns}	0.10^{ns}	43.20^{ns}	0.006^{ns}	0.31^{ns}	$30.37\times10^{2\,ns}$
P*c	3	27.07^{ns}	3.17^{ns}	7.08^{ns}	0.34^{ns}	2.58^{ns}	0.03^{ns}	0.94^{ns}	$76.58\times10^{2\,ns}$
Error	14	13.61	2.84	20.57	0.37	9.61	0.02	1.01	42.47×10^{3}
CV (%)		9.26	14.88	25.22	12	24.82	7.28	8.70	11.07

*and ** Significantly at $p < 0.05$ and < 0.01, respectively.

Table 2. Comparison of means traits on different planting cultivar Williams and line L_{17}.

Characters							
Yield	100 Seed weight	Number of nodes in sub stem	Number of nodes in main stem	Number of pods in the sub stem	Number of pods in the main stem	Plant height	planting date
2227^{a}	13.50^{a}	20.33^{a}	7.03^{a}	29.63^{a}	14.87^{a}	42.33^{a}	27-May
1994^{b}	12.36^{a}	15.27^{b}	5.86^{b}	21.93^{b}	13.77^{a}	45.90^{a}	5-Jun
1780^{b}	10.92^{b}	8.60^{c}	4.43^{c}	12.80^{c}	9.86^{b}	36.83^{b}	15-Jun
1443^{c}	9.40^{c}	5.76^{c}	3.06^{d}	7.56^{d}	6.83^{c}	34.37^{b}	26-Jun

Differences between averages of each column which have common characters are not significant at probability level of 5%.

plant, number of pod and seed per plant (Talavaky, 1996). Pope et al. (2002) in an experiment reported that in cultivars with infinite growth with delay in planting from 13 May to 6 July, plant height and number of main stem node is reduced.

Number of seeds per pod

Results of data variance analysis on number of seeds per pod showed that no effects on these traits were meaningful (Table 1). Zynali et al. (2003) expressed that planting date affects significantly number of pods per plant, plant height and 100 seed weight affected but the number of seeds per pod were not affected by planting date. Talavaki (1996) reported the number of seeds per pod, and harvest index were not affected by planting date.

100 seed weight

The results showed that planting date effects in probability level of 1% on this trait are meaningful and on the rest of effects studied on the trait, there were no meaningful differences (Table 1). Mean comparison of data on 100 seed weight traits showed that highest 100 seed weight is related to planting dates of 27 May and 5 June and the lowest value of this trait was awarded on 27 June (Table 2). The test results on 100 seed weight are in accordance with the findings of others (Shafigh et al., 2006). He reported that 1000 seed weight in soybean with delay in planting, showed decrease. The reason for heaviness of the grain weight in the first planting

date in this trial is because of greater growth rate and longer grain filling period. Hamzeh et al. (2004) also reported that 100 seed weight was significantly affected by planting date, so that with delay in sowing, the weight rate of 100 seed decreases.

Yield

According to Table 1, data from the results of this evaluation indicated that there was meaningful difference between different planting date for seed yield in probability level of 1%, so that the comparison of average (Table 2) showed that planting on 27 May, had the highest yield (2227 kg ha) and planting on 26 June, the lowest yield (1443 kg/ ha). Between planting dates of 5 June and 15 June respectively in 1994 and 1780 kg ha there was no significant difference. Plant height, number of pods and seed weight are factors that can affect performance. The present study showed that among the studied cultivars of these traits there was no significant difference. Cultivars with sowing date interaction were also non significant. Proper planting date in different regions, the impact on plant vegetative and reproductive growth increases efficiency of photosynthesis, photo assimilates transport and their storage in the seed and causes increase of performance (Azari and Khajepour, 2003). Rezai-Zadeh (2004) stated that planting date effects on seed yield is significant that is correspondent to the results of this test. Calvin and Brent (2001) expressed that highest soybean yield was 2594 kg/ha in the early planting date, late May. Azizi et al. (2005) reported that planting date was effective on seed yield and delayed planting caused the weakness of performance so that the highest on the first planting and the third seeding date had lowest performance. The experiment that was conducted by Eagly and Bruening (2000) indicates that planting date effects on yield of soybean cultivars and with respect to time delay, reduces the desired yield; considering that soybean is a short day plant, so if exposed to short day length it flowers. Longer day increases the flowering delay with the delay in planting, because, plants exposed to earlier days get a short height, shorter, fewer branches and week growth period before flowering and get a shorter flowering period that all these factors cause the formation of fewer pods and fewer transfer material to the sheath and the photosynthetic performance is reduced (Azizi et al., 2005). General delay in planting resulted in, reduction of potential crop yield, since part of solar radiation is not received by the shadow picture (Jose et al., 2004).

Conclusions

According to the obtained results, it was observed that with delayed planting, due to the loss of suitable time for the growth, the plant does not achieve its potential ability and so this leads to reduced yield. Hence, planting date of 27 May be recommended for sowing soybeans in Ardabil (Iran) cold climate.

For reasons, earlier planting dates than this can't be re commended, because when soybean germinates the temperature of soil is 13°C in depth of 7 cm. If sown earlier, long lasting cold would be one of the probable dangers that may damage the cultivation. Soybean germinates in 8 to 10°C like corn. According to our studies, the low temperatures of 8°C and high temperatures of 38°C are not suitable for soybean (Arshy, 2001). We conducted an experiment in 2008 to study the effects of water pre treatment of seed on the soybean cultivars under the farm condition. In this experiment, we cultivated the seeds in the sowing date of 15th of May, but because of the long lasting cold the seeds did not germinates and we cultivated again on 30th of May (Moosavi et al., 2010). Considering this region as one of the cold climate region of the country, most of the times the long lasting cold of the spring, causes the demolition of the cultivation herbs, as a result we do not recommend the sowing date of earlier than 27th of May in this region.

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