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ORIGINAL ARTICLE

Yield and yield Components of Soybean Cultivars as Affected by Planting Date

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ABSTRACT
In order to investigate the effect of planting date on yield and yield components of four soybean cultivars, an experiment was conducted based on split plot in randomized complete block design with four replications in Agricultural Research Station in Ilam province, Iran in 2011-2012 growing season. Factors of experiment consisted of four planting dates (20 June, 30 June, 1 May , 10 May) and cultivars were consisted of four soybean cultivars (M7, M9, L17 and Williams. Result of this experiment showed that the effect of planting data and cultivars on yield and component was significantly effect. Planting date on plant height, seed weight, seed yield, and biological yield had a significant effect, so that the maximum plant height, seed weight, seed yield, biological yield was on 10 May. Cultivars effect was significant for all studied traits. Williams cultivar due to the number of pods per plant, seed weight, seed yield, biological yield was higher than other varieties. Interaction effect between planting date and cultivars on seed yield, 100-seed weight and plant height was significant. The highest seed yield (3107 kg.ha^{-1}) was gained on 10 May with Williams varieties. In general, the results of this study indicated that planting date of 10 July and Williams cultivar were suitable for soybean planting in the Ilam region.
***Key words**: Soybean, Planting date, Cultivar, Yield and yield components.*

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INTRODUCTION

Suitable soybean planting date for maximum yield and its relationship to the problem that each region must be determined during testing. So one of the major needs in crop planning in order to achieve high yield and quality of crops is most suitable planting dates [1]. Planting date is very important in agricultural production management decision, especially at region having environmental restrictions such as sooner and later coldness and severs [2]. The soybean crop, planting date has a significant effect on yield and yield components. Therefore, the proper planting time for optimum utilization of plant climatic factors such as temperature, humidity, and temperature are also consistent with the flowering period. Soybean response not only to the inclement weather that delayed planting date, but also the times when the weather is favorable, it is important [3].

Perez [4] demonstrated that delayed planting reduced yield and yield components of soybean. Also investigate the response characteristics of vegetative and reproductive 14 genotypes of soybean from three maturity group in the northern United States reported that delayed planting from early in May to July reduced line yield of 17 kg.ha^{-1} per day in 2003 year and 43 kg.ha^{-1} the day was observed in 2004 year [5]. Based on the experimental results Pedersen *et al.,* [6] early date of sowing of increase the number of seed pods and harvest index, but compared with late sowing reduced number of seeds per pod.

Bello [7] stated that experiment in the Southern Guinea earlier sowings increase the number of pods per plant, number of branches and ultimately increase yield. Mackinnon and Fettel [8] showed that the effect of planting date, seeding rate, and cultivar on yield and yield losses were significant effect, were followed. Lopez-Billido et al., [9] reported a decrease in yield due to delayed planting. David [10] reported that in the planting of late decrease yield data delayed by more than cultivars of early maturity was. He has recommended that in the late planting of early varieties are used whenever possible. Mackinnon and Fettel [8] with effect of sowing rate showed a significant effect of planting date and cultivar on yield and

yield reduction was caused delays in planting. Therefore the objective of this study was the effect of planting date and cultivar effects on yield and yield components of soybean in Ilam, Iran.

MATERIAL AND METHODS

To investigate the effect of planting date on yield and yield components of four soybean cultivars, an experiment was conducted based on split plot in randomized complete block design with four replications in Agricultural Research Station in Ilam province (with 46º 28' longitude and 33º 37' latitude and 1174 m height sea), Iran in 2011-2012 growing season. Factors of experiment consisted of four planting dates (20 June, 30 June, 1 May, 10 May) and cultivars were consisted of four soybean cultivars (M7, M9, L17 and Williams). The average annual precipitation is 720 mm and means annual precipitation is about 135 mm with climate temperate and area having a mean annual temperature of soil 14 °C and the temperature difference between summer and winter more than 5 °C (Table 1).

Table 1: Monthly mean value of precipitation and temperature in, Ilam station in 2011-2012 growing season

Month	Precipitation (mm)	Abs. min temperature (ºC)	Abs. max temperature (ºC)	Evaporation (mm)	Min temperature (ºC)	Max temperature (ºC)
September	0.4	9.4	37.8	195.4	15.9	33
October	8.1	5.4	33	111.5	9.1	25.2
November	35	0	24	36.5	3.7	18.6
December	57.8	-3.4	16.4	5.9	1	11.9
January	115.7	-5	15.6	0	0.1	9.8
February	29.8	-2.2	25.8	0	3.4	17.1
March	61.4	2.2	28.8	85.8	7.2	21.6
April	76.9	7.4	34.6	139.6	11.9	25.9
May	0	12	41.8	301.6	17.5	36.3
June	0	14	41.5	411.9	18.4	37.1
July	0	14.7	42	413.7	18.9	38.3
August	0	14.5	41.6	355.8	17.6	36.8

Traits which was measured including plant height, number of pods per plant, seeds per pod, seed weight, seed yield, biological yield. To measure seed yield per plant in each part after removal of the bottom margin of 2 square meters and was calculated separately. The data obtained were analyzed using the software MSTATC mean data using Duncan's multiple range tests was performed.

RESULTS AND DISCUSSION

Plant height

The results of the analysis of variance showed that a significant effect of planting date on plant height at 1% probability level (Table 2). planting date of May 10, plant height increased so that the maximum and minimum plant height were obtained from on 31 May and 20 June with an average of 57.17 cm 41.12 cm, respectively, between the planting dates of 22 and 31 May there was not a statistically significant difference and was observed in the same group (Table 3). Effect of planting date on plant height was positive in this experiment. In other word, plant height is product of number of node in length of internodes and investigations showed that foodstuffs and solubility and absorb and suitable achievement of foodstuff, increase number of plant node and water can take away internodes. It appears that planting date in early May, better use of water and nutrients and plant height could be more. With delay in planting date reduced plant growth and plant the proper environmental conditions that are less effective and reduce it to its height. Abel and Dricsoll [11] showed that during a study in the late crop planting to flowering, plant height and less distance is shorter. Therefore we expect that the results of this experiment corresponded to lower yields. Cultivars were positive effects also significantly increased the plant height was at 1% probability level (Table 2). Williams had maximum plant height with an average of 59.17 cm accounted for that was superior to the other varieties. Other cultivars showed no significant difference in plant height was analyzed in the same group. In general, Williams cultivar could use water and foodstuffs better than other cultivar and condition climate of experimental area is more agreeable and also ultimately increase its plant height. Also the results of analysis of variance showed that there was significantly effect regarding to interaction effect between planting date and cultivar on plant height at 5% probability level (Table 2). Interaction effects showed that the highest and lowest plant height belonged to planting date of 31 May and Williams cultivar with average of 72.34 cm and planting date of 20 June and M9 cultivar with average 38.45 cm, respectively (Fig 1).

Number of pod per plant

Result of variance analysis showed that number of pod per plant in view of statistic did not be under effect of the plant date but effect of cultivar on number of pod per plant was significant effect at 1%

probability level (Table 2). Varieties had difference in view of number of pod per plant, so that Williams cultivar with average 42.04 pod and M9 cultivar with 26.37 average pod had maximum and minimum number of pod per plant, respectively (Table 4). Result showed that late on planting date cause to number of pod per plant and it is reason is decreasing growing period special decrease growth vegetative. Different planting dates have very important effect, in view of making special conditions of day, heat degree and other environmentally factors in growth and transport from one phase to another phase of growth and also stability of a growth stage.

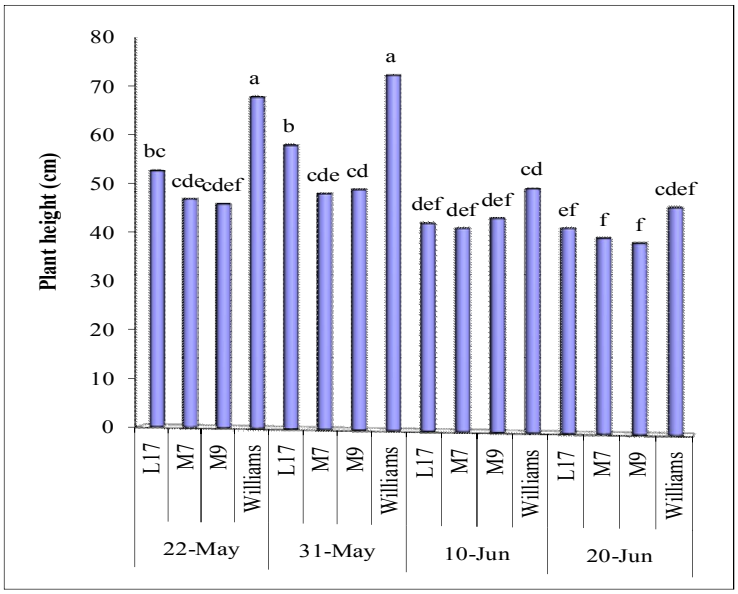

Fig1: Effect of interaction of planting date and cultivar on plant height

Number of seed per pod

Result of variance analysis showed significant effect of cultivar at 1% probability level on number of seed per pod (Table 2) so that M7 cultivar with average 2.4 allocated to number of seed per pod and Williams cultivar with average of 1.32 minimum of number of seed per pod (Table 4). We can say reason of this problem so that number of seed per pod depends to genetic and environmental conditions and M7 cultivar well use of foodstuffs specially water, but in other cultivars because of do not use of water and elements, does not establishment the seed or less establish the seed. Number of seed per pod is an adjective which is depend to genotype and it is independence of environmental factors and just special environmental stress in period of establishment of seed effect on it.

100-seed weight

This trait in view of statistical had been under effect of planting date and cultivar at 1% probability level (Table 2), so that allocated the maximum and minimum of 1000-seed weight on 31 May and 20 June with average of 147 g and 112.56 g, respectively (Table 3). In general, in planting date of 20 June is decreasing weight of 1000-seed weight and this happen because of transport photosynthesis materials to seeds, and decrease of filling of seeds period and environmental temperature inclement and attitude of plant with heat of last season. Also Horn and Burnside [12] showed in an investigation that planting late decrease 100-seed weight, they have stated that reason of this weight decreasing of 100 seeds is low humidity in last of the season.

According to the results of this experiment, among investigated cultivars the number of Williams cultivar was more than other varieties of 1000-seed weight, Williams cultivar with 147.5 g average has the most 1000-seed weight, other cultivars statistically had not significant difference and were placed in a group.

1000-seed weight dependent to amount of carbon stored at the beginning of grain filling on the theory goes that high grain weight in Williams cultivar is because of carbohydrate stored and the impact that has on thousands seed weight. The difference in weight of thousands seed varieties that can be linked to genetics. The results of the analysis of variance of date showed that interaction effect of planting date and varieties on 1000-seed weight was significant at the 1% probability level (Table 2). According to the results, 10 May and Williams cultivar with an average of 174.5 g had highest and the lowest 1000-seed weight belonged to 20 June and M7 cultivar with an average 106.25 g, respectively (Fig 2). So planting date May 10 was with suitable conditions for plant growth. Williams cultivar could better than other

varieties of weather conditions and normally pass their growing during the planting date. Vegetative and reproductive growth of plants was timely and, ultimately, large grains and 1000-seed weight was greater.

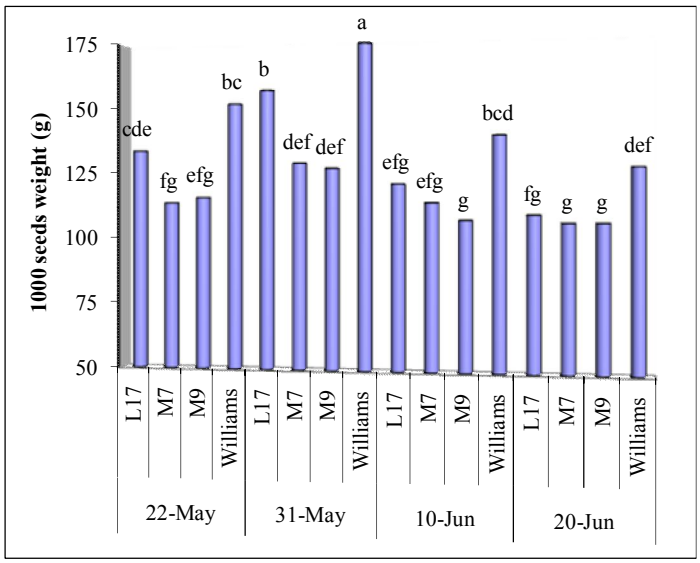

Fig 2: Effect of interaction of planting date and cultivar on thousand seeds weight

Table 2: Variance analysis for studied crop and quality traits in experiment

Source of variances	D.F	Plant height	Number of seed per pod	Number of pod per plant	1000-seeds weight	Seed yield	Biological seed
Replication	3	726.47	2.31	564.87	8574.3	6088825.1	2418009.1
Planting date	3	946.14**	2.28ns	285.9ns	3488.5**	3740001.4**	15792719.4**
Error a	9	36.84	0.53	59.8	380	280478.4	998486
variety	3	778.49**	5.3**	834.3**	3989.1**	2166054.1**	5912802.1**
Error b	9	72.94	0.51	30.79	172.5	62537.8	223841.7
Planting date* variety	36	25.55*	0.25 ns	9.9 ns	145.1*	40225.8*	216493.7 ns
CV	-	10.2	20.2	17.2	9.7	10.8	10.5

ns, * and**:Non- significant and significant at 5% and 1% levels, respectively

Table 3: Mean comparison of effect of planting date on studied crop and quality traits in experiment

Planting date	Plant height (cm)	Number of seed per pod	Number of pod per plant	1000-seeds weight (g)	Seed yield ($kg.ha^{-1}$)	Biological seed ($kg.ha^{-1}$)
22 May	54.21a	2.3a	31.93a	129.37ab	2166ab	4757ab
31 May	57.17a	2.02a	38.12a	147a	2544a	5538a
10 June	44.36b	1.69a	30.37a	120.62ab	1754ab	4104ab
20 June	41.12b	1.44a	28.31a	112.56b	1434a	3196b

Means, in each column, followed by similar letter(s) are not significantly different at the %5 probability level- using Duncan's Multiple Range Test.

Table 4: Mean comparison of effect of varieties on studied crop and quality traits in experiment

Varieties	Plant height (cm)	Number of seed per pod	Number of pod per bush	1000-seeds weight (g)	Seed yield ($kg.ha^{-1}$)	Biological seed ($kg.ha^{-1}$)
L17	48.93 b	1.42 b	33.06 b	130.43 b	2075 b	4505 b
M9	44.37 b	2.32 a	26.37 c	116.12 b	1690 c	3930 b
M7	44.39 b	2.4 a	27.25 c	114.50 b	1681 c	3942 b
Williams	59.17 a	1.32 b	42.06 a	148.50 a	2453 a	5217 a

Means, in each column, followed by similar letter(s) are not significantly different at the %5 probability level- using Duncan's Multiple Range Test.

Seed yield

The results of variance of data analysis indicated significant differences at 1% probability level on seed yield by planting date (Table 2). The planting dates were different in terms of seed yield, planting date of 31 May with the average yield was 2544 $kg.ha^{-1}$ had highest, and seed yield decreased with delay in planting date, so that on planting dates of 10 and 20 June with an average 1754 $kg.ha^{-1}$ and 1434 $kg.ha^{-1}$ the average yield were minimum seed yield (Table 3).

Considering**,** planting date is one of the most effective non-economic factors on the optimal operation of the plant cultivated. In the final planting date because of the crop growing season with shorter days and earlier onset of flowering and reproductive competition with the growing consumption of photosynthesis, amount of yield affected and reduced early planting dates possibly have successful germination, while the performance of late planting due to the growth of unfavorable environmental factors, causes of low yield.
It is concluded that the effect of delayed planting date, soybean growth period will be shorter before the plant can produce maximum foliage, they are entrance to generative phase. As a result, the total amount of assimilates produced in comparison with the number of leaves per plant, will be reduced. In order hand because of the reduction in plant height and number of branches, reduce total number of fertile locations, leading to the lower production number of pods per plant. Also, due to the short duration of grain effecting period, seed reserve amount is also reduced, which will result in reduced 1000-seed weight. In addition, in late planting date, date confronting first step of grain filling to very high temperatures during the days can also lead to the decrease of seed reserve and as a result, in the cases mentioned above are reason for the reduced ultimately seed yield. Other studies researchers stated yield loss due to delay in planting date. Also, Johnson et al., (1995) [13] showed that delayed in planting date leading to decrease seed yield . Reduce the size of the canopy than desirable size, and shorten the growth period of vegetative stated as one of the main reasons for reduced seed yield history of late sowing [14]. Egli and Bruening [15] in their study reported a decrease in yield with delayed sowing. Ozer [16] Reduction in yield of canola seed in late planting history, state as reason for reduced number of pods per plant and decrease of harvest index.
The results of variance of data analysis indicated significant differences at 1% probability level on seed yield by cultivar (Table 2). Williams cultivar with an average seed yield of 2453 kg ha^{-1} compared to other varieties be better and had most seed yield, after Williams cultivars, L17, M9 and M7, respectively, with an average yield of 2075, 1681 and 1690 $kg.ha^{-1}$ had the highest and lowest seed yield and the lowest amount of yield allocated to the M7 cultivar (Table 4). This result may be due to the higher yield of Williams cultivar than other cultivars. Also the interaction of planting date in cultivar had significant effect on seed yield at 5% probability level (Table 2). The highest seed yield found on 10 May and Williams cultivar with an average 3703 $kg.ha^{-1}$ and on May 20 June and M9 cultivar with an average 1254 $kg.ha^{-1}$ had the lowest seed yield, respectively (Fig 3). Seems to be due to a delay in planting date because of facing the plant growth period with increasing temperature causing stress on plant growth and yield is reduced. Williams varieties planted on 10 May that was able to grows very well and be able to had more grain number and had grain with weight more than those with other cultivars that may increase the yield of the cultivars in this variety. Bastidas *et al*., [5] investigated the response characteristics of vegetative and reproductive 14 genotypes of soybean maturity group three in the Northern United States reported that delayed planting from early May to July line reduction yield of 17 $kg.ha^{-1}$ per day in 2003 and 43 $kg.ha^{-1}$ per day in 2004. Elmore [17] conducted a study in Nebraska, in the United States stated that delay in planting date, yield is reduced, but the response of different cultivars to yield, did not the same.

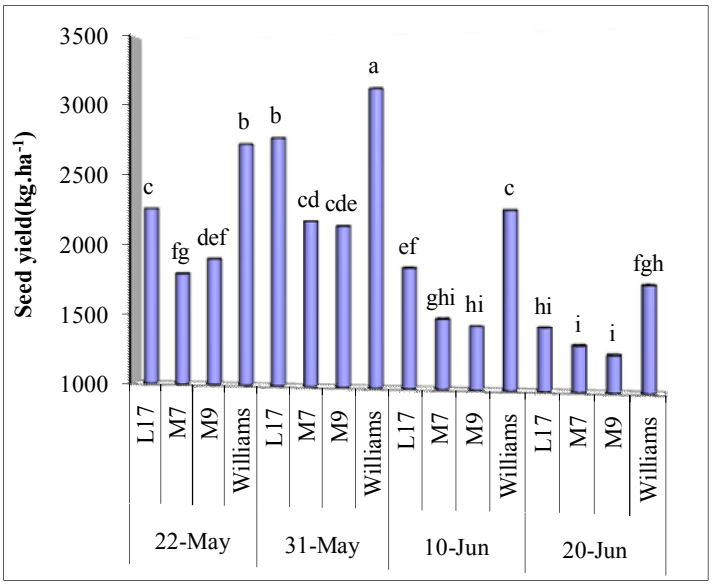

Fig 3: Effect of interaction of planting date and cultivar on seed yield

Biological yield

The results of data analysis variance showed that there was a significant effect of planting date and **cultivar** on biological yield at 1% probability level. However, the interaction effect between planting date and cultivar had a not significant effect on this trait (Table 2). As the table of data average showed, biological yield in planting date of 31 May was more compare to other planting dates so that maximum and minimum of biological yield was on 31 May with average of 5538 $kg.ha^{-1}$ and 20 June with 3196 $kg.ha^{-1}$, respectively (Table 3). Furthermore, it was shown that the late planting date, biological yield decreased because the flowers appear in late summer and produced terminal buds, leaves, new growth and the plant stops. Lopez-Billido et al., [9] reported a reduction in yield due to delayed planting. The results of the analysis of variance indicated that there was a significant effect on biological yield at 1% probability level (Table 2). Williams cultivar with an average of 5217 $kg.ha^{-1}$ had the highest and M9 cultivar with an average of 3930 $kg.ha^{-1}$ had the lowest biological yield, respectively (Table 4).

CONCLUSION

The results of this study showed that planting date had significant positive effect on plant traits such as seed yield. So that the weather conditions of region and the planting date, 30 May had the highest seed yield. Williams cultivar also among the studied varieties was superior to other cultivars and could had yield and yield components, ultimately, it is better each planting date in proper date in region because it could complete vegetative and reproductive growth well and could had better seed yield.

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