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Research Article

THE EFFECT OF PLANTING DATE ON YIELD AND YIELD COMPONENTS OF TWO RED BEAN CULTIVARS IN AZNA WEATHER CONDITIONS

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ABSTRACT
In order to investigate the effect of different planting dates on yield and yield components of two red bean cultivars (Local and Sayad), a research was carried out in a research field in Azna in 2013. The experiment was conducted as split plots in the form of randomized complete block design with three replications. The main plot included four planting dates (May 20, May 31, June 10, June 20) and the sub plot included two red bean cultivars (Local and Sayad). The ANOVA results showed that delay in planting date decreased the yield and yield components (number of pods per plant, number of grains per pod, 1000-grain weight), so that the highest rate of yield and yield components belonged to the planting date of May 20 and the lowest rate belonged to June 20. Comparison of two cultivars (Local and Sayad) showed that the local cultivar had lower rate of yield and yield components than the Sayad cultivar. According to the research results, Sayad cultivar planted on May 20 had a good yield.

***Keywords*:** *Red Bean, Planting Date, Cultivar, Yield, Yield Components*

INTRODUCTION
One of the major requirements in crop planning is to determine the best planting time in order to obtain maximum and quality yield. Planting date is an important factor that influences vegetative and reproductive growth period and the balance between them. It also affects other production factors, harvest quality, and ultimately crop yield and quality (Lampung *et al.*, 1988). Sowing date controls crop phenological stages and total biomass production and influences the efficiency of biomass conversion into performance (Kichar and Novas, 2006).
Changing climatic factors and sowing date can affect both the quantity of production and the quality of dry matter distribution. Proper planting date leads to taking optimal advantages of climatic factors such as temperature, humidity, day length, and also adaptation of flowering time with appropriate temperature (Hashemi, 2001). Kouchaki *et al.*, (1997), Nezami (1994) investigated the effect of planting date and density on yield and yield components of soybean and found that appropriate planting date which is affected by cultivar, region, density, and environmental conditions would provide an opportunity to prevent yield reduction and to take better advantages of early season conditions in certain regions. Mousavi (2004) stated that delay in planting beans reduced the crop growth period which resulted in the decrease of number of pods, number of grains per pod, 100-grain weight, and finally the decrease of grain yield. Kamra (1981) stated that the most appropriate planting date depends on the variety, region conditions, and especially the latitude.
Aliloo *et al.*, (2003) stated that one of the most important factors affecting the yield is the selection of suitable cultivar. Usually for all crops the desired cultivar should be selected in such a way that it can pass its growing season in the best conditions; otherwise, its yield will be reduced. In this regard, the selection of premature or post-mature cultivars is different and depends on climate and non-climate factors of the region which affect the yield. Usually, the yield of premature cultivars is less than the post-mature ones. If the premature cultivar is recommended instead of the post-mature cultivar without any special reason, the rate of economic yield will reduce. Therefore, if planting is delayed for any reason, it is recommended to use premature cultivars instead of post-mature ones. Khajehpoor (2000) reported that the use of improved seeds, good bed preparation, selection of appropriate planting date, rate of seeds, crop rotation, etc would increase crop yield or yield per area unit. Shipvi (1981) stated that farmers could increase qualitative and

quantitative yield of crops by selecting appropriate farming parameters such as rotation, sowing date, plant density, etc. even though the yield reduction of second crop products is inevitable, their quick planting can decrease the loss. The strategies for early planting of summer crops are selecting the premature cultivar of winter crop and earlier harvest of the crop which might make the earlier planting of summer crop possible about 3 to 5 days (Borlin, 2001).

Cetino *et al.*, (2007) did an experiment and concluded that temperature and photoperiod had a significant effect on the soybean phenology and the interactive effect of cultivar and planting date would develop the soybean growth and yield. Salehi (2007) conducted an experiment entitled "The effect of different planting dates on yield and yield components of three red bean cultivars" and showed that the effect of cultivar and planting date on all the measured traits was significant. The interactive effect of cultivar and planting date on traits such as plant height, number of pods per plant, 100-grain weight, biological yield, number of grains per pod, and grain yield was significant.

MATERIALS AND METHODS

Experimental Location

The experiment was carried out in 2013 in the surrounded and controlled farm of Ordugah (camp) located in Azna at latitude 33°N and longitude 49°E, in Lorestan Province. The land was prepared through spring plowing and disk operations. 20 to 30 tons per hectare manure along with chemical fertilizers as 150 kg/ha ammonium phosphate and 100 kg/ha urea were used. The farm area was determined with regard to the kind of experimental plan and the required number of plots. In each replication 8 plots were used and the distance between plots was two non-planting lines (1 m) and the distance between replications was 2 m. Planting was down in rows and the distance between rows was 50 cm. Furrows were created in experimental plots using a furrower and according to the sowing plan, so that in each plot five planting lines were created. Optimal density was considered to be 40plants/m^2. Siphon irrigation took place immediately after planting according to the plants need. Hand weeding was done in the farm during the growth period in order to control the weed grass. The required urea was calculated and added to the experimental plots with regard to the time differences between planting dates after weeding and thinning at 2-to-6-leaf stages along with the second irrigation (after cutting water in streams). After physiological maturity and browning of more than 75% of the pods in all plots, the side rows of each plot were eliminated as the marginal effect, and also 1 meter from the top and bottom of each plot was omitted in three middle plots. The research was conducted as a split plot experiment in the form of randomized complete block design with three replications. The main plot included four planting dates (D1, D2, D3, D4) (May 20, May 31, June 10, June 20) and the sub plot included two red bean cultivars (Local and Sayad). After the full maturity, 10 plants were selected from each sub plot with considering the margin and the following traits were identified in them: number of pods per plant, number of grains per pod, 100-grain weight. In order to measure the final grain yield, the plants in three middle rows of each sub plot as long as 3 m were selecting while observing the margin. The date was analyzed and the means-in case of the significant effect of the experimental treatment- were compared using Duncan's multi range test at 1% probability level. To do the above calculations, SAS 9.2 software was used and to draw the diagrams Excel 2007 was used.

RESULTS AND DISCUSSION

100-Grain Weight

The ANOVA results showed that the effect of planting date, cultivar, and the interactive effect of planting date and cultivar on 100-grain weight were significant at 1% level. Other studies have shown that delay in planting since the mid May to the late June had led to the reduction of 100-grain weight (Farahmand, 1997; Mahlooji *et al.*, 2000). The highest weight of 100-grain belonged to Sayad cultivar in the first sowing date by 42.22 g. lower photosynthetic level and little opportunity for grain filling could contribute to the reduction of 100-grain weight in delayed planting. It seems that late sowing makes the plant unable to make use of environmental conditions sufficiently for photosynthesis and sufficient assimilate

production. Moreover the grain filling occurs when the environment temperature is very high and overheating prevents grain filling process and consequently the rate of stored metabolic materials will decrease as the respiration increases. As a result, they produce small pods with little weight of 1000-grain (Angadi, 2000).

Number of Pods per Plant

The ANOVA results showed that the number of pods per plant was significantly affected by planting date, cultivar and the interactive effect of planting date and cultivar at 1% level. The results of the experiment showed that Sayad cultivar had the highest number of pods per plant by 10 pods and local cultivar had the lowest number of pods per plant by 4.94 pods. The planting date of May 20 had the highest number of pods per plant by 9.12 pods and the planting date of June 20 had the lowest number of pods per plant by 4.25 pods. Delay in planting since May 20 to June 20 caused the reduction of number of pods per plant in both cultivars. This is the most important factor reducing the grain yield. Producing less number of pods with delayed planting due to the loss of flowers and other factors were influenced by high temperature during the flowering stage (Tasdik, 1995). Shahsavari (1989) has stated that the number of pods per plant is one of the most important yield components in beans. Jafari *et al.*, (2002) have reported that the number of pods per plant highly contributes to the production of fruitful cultivars. Generally, it seems that Sayad cultivar is genetically superior to local cultivar in terms of pod formation potential. Since the number of pods per plant depends on the total number of nodes per plant and also the stem height, and as delay in planting causes the decrease of height and consequently the decrease of number of pods per plant (Salehi, 2001), the accuracy of these findings can be well realized.

Number of Grains per Pod

The ANOVA results showed that the number of grains per pod was significantly affected by planting date, cultivar and the interactive effect of planting date and cultivar at 1% level.

The results of the experiment showed that Sayad cultivar had the highest number of grains per pod by 6.10 grains and local cultivar had the lowest number of grains per pod by 4.34 grains. Delay in planting led to the reduction of number of grains per pod, so that the planting date of May 20 had the highest number of grains per pod by 6.36 grains and the planting date of June 20 had the lowest number of grains per pod by 3.52 grains.

Shahsavari (1989) reported that delay in planting caused the graining period to coincide with the warm weather and thus the number of grains per pod decreased. The number of grains per pod depends on genotype and is largely independent of biological factors and only certain environmental stresses during the formation of grain can affect it. Moreover, such stresses cause the loss of flowers and pods and consequently the decrease of number of pods per plant more than the reduction of number of grains per pod, and if this occurs during the grain filling stage, the grain weigh will reduce, as well (Hanway, 1984).

Grain Yield

The results showed that the effect of cultivar and planting date on grain yield was significant at 1% level, but the interactive effect of cultivar and planting date on grain yield was not significant. Comparison of the means via Duncan method showed that the highest grain yield by 5032 kg belonged to the first planting date and delay in planting reduced the grain yield. Mousavi (2005) has stated that delay in planting the bean reduced the growth period of crop which led to the decrease of number of pods, number of grains per pod, 100-grain weight, and finally the decrease of grain yield. Ghanbari and Taheri (2008) carried out an experiment on beans and observed that delay in planting decreased the crop height and the highest grain yield belonged to the early planting date (May 5). It seems that earlier establishment and growth at the beginning of growing season have led to better use of proper environmental conditions and on the other hand, the yield components of the plant have been less affected by water and heat stress at the end of growing season (Shahsavari, 1989). Some researchers (Mousavi *et al.*, 2009) believe that the decrease of grain yield in delayed planting is due to the decrease of plant height and the decrease of number of nodes in pods. Pop *et al.*, (2002) reported the grain yield of soybean in unlimited growth cultivars significantly decreased in delayed planting dates after May in proportion to the rate of delay. The highest grain yield belonged to Sayad cultivar by 5007 kg/ha and the lowest grain yield belonged to

local cultivar by 4123 kg/ha. Post-maturity of the cultivar, high weigh of grain, number of pods per plant, and total biomass are the factors which have caused the increase of grain yield in Sayad cultivar.

Biological Yield

The ANOVA results showed that the simple effect of planting date and cultivar on biological yield was significant at 1% level, but the interactive effect of planting date and cultivar on biological yield was not significant.

Table 1: The ANOVA of yield and yield components of red bean at different levels of planting date in two cultivars

Mean of squares						
Biological yield	**Grain yield**	**Number of grains per pod**	**Number of pods per plant**	**100-grain weight**	**Degree of freedom**	**Sources of variations**
1605177	81897	0.41	2.03	15.45	3	Block
2207129 *	1248691 **	11.89 **	38.95 **	207.42 **	3	Planting date
409996	86405	0.29	1.06	7.09	9	Error (a)
41393626 **	2658818 **	25.12 **	205.03 **	207.11 **	1	Cultivar
2907214 ns	35438 **	7.22 **	63.61 **	80.72 **	3	Planting date cultivar×
1359922	28698	0.28	2.47	10.36	12	Error (b)
11.86	13.59	10.06	19.03	9.98		Coefficient of variations (CV)

*ns, *, ** indicate non-significant difference and significant difference at 5% and 1% levels, respectively.*

Table 2: Mean comparison of the simple effects of different levels of planting date and cultivar on the yield and yield components of red bean

Mean of traits					Treatments
Biological yield (kg/ha)	**Grain yield (kg/ha)**	***Number* of grains per pod**	**Number of pods per plant**	**100-grain weight**	**Planting date**
10374 a	5032 a	6.36 a	9.12 a	37.17 a	*May 20*
10002 a	4957 a	5.74 b	8.62 ab	32.02 b	*May 31*
9827 ab	4532 bc	5.30 b	7.87 b	30.97 b	*June 10*
9122 b	4159 c	3.52 c	4.25 c	24.76 c	*June 20*
					cultivar
8694 b	4123 b	4.34 b	4.94 b	28.69 b	*Local*
10969 a	5007 a	6.11 a	10.00 a	33.78 a	*Sayad*

According to Duncan's multi range test, the mean of treatments with similar letters are not significantly different from each other at 5% level.

The highest biological yield belonged to the first planting date by 10375 kg/ha and the lowest biological yield belonged to the fourth planting date by 9122 kg/ha. In the research conducted by Nezami (2004), further increase of biological yield in the first planting resulted from the growth of plant and side

branches. Sowing dates are different from each other in terms of providing essential conditions for growth period of different cultivars which has caused some differences among the biological yields. In this research, the first planting date could produce suitable biomass with regard to providing necessary opportunity for plant to produce appropriate canopy, using maximum assimilates, and producing maximum dry matter. In the next planting dates, with regard to the decrease of temperature the production of stored assimilates has decreased and consequently the biological yield has decreased, as well.

Biological yield of Sayad cultivar by 10969 kg/ha was more than that of Local cultivar by 8694 kg/ha. Biological yield results from the efficiency of a plant population in terms of using production potential and environmental conditions particularly the available parameters in growing season. Each cultivar with regard to its adjustment to environmental conditions has certain production potential. Therefore, the cultivar which has adjusted itself more to the existing conditions has been able to have the highest biological yield. Biological yield is different in various cultivars. It can be influenced by genetic, environmental conditions or water stress. Delay in planting affects both vegetative and reproductive growths in peas and consequently, the rate of biological yield decreases. In late planting, the height of plants and the growth of vegetative organs will decrease and the interval between planting and flowering will shorten; therefore, the grain yield and biological yield are expected to reduce. Other researchers have achieved similar conclusion about the soybean and other crops (Raymar *et al.*, 1988).

Conclusion

According to the results of the measurement of red bean traits it was identified that the improved cultivar (Sayad) had the highest grain yield by 5007 kg/ha. Moreover, the best planting date was May 20. In addition the interactive effect of cultivar and planting date was investigated, so that the highest grain yield by 5373 kg/ha belonged to the treatment with Sayad cultivar and planting date of May 20. Other traits were also evaluated and the results were analyzed. In summary, the best cultivar in this experiment was Sayad cultivar and the best planting date was May 20.

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