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Research Article

INVESTIGATION OF CULTIVAR, PLANTING DATE, PLANT DENSITY AND ON GRAIN YIELD, BIOLOGICAL YIELD AND HARVEST INDEX OF BEAN (*VIGNA SINENSIS* L.) IN DIFFERENT REGION OF KHUZESTAN STATE, IRAN

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ABSTRACT
In order to evaluation of planting date, plant density and cultivar on yield and yield component phonological stages and growth trends of bean (Vigna sinensise L.) an factorial stripe block experiment was carried out based on completely randomized block design in for replication in summer 2011 in safi-abad region. Treatments were planting date at 3 levels (T1=June 8, T2= June 22 and T3= July 7), as stripe blocks. Plant density (D1= 10, D2= 13.3, D3= 20 and D4= 40 plant m-2) and two cultivars (V1= Kamran and V2= Mashhad) as factorial sub plat. Traits were: grain yield, yield components, biological yield, harvest index. Results showed that except growth trends, type of cultivar had not significant effects on traits. In other hand, kamran and mashhad cultivars had the same growth and production. Plant density had significant effects on pod per plant, seed weight and grain yield. The highest the highest grain yield (1745 kg.ha) was obtained from 10 and 20 plant m2. Planting date only had significant effect on grain yield and biological yield. The highest grain yield (1800 kg.ha) and biological yield (9191 kg.ha) was obtained from June 8. Triple interaction had significant effect on grain yield. In safi-abad region the kamran and mashhad cultivars are recommended to planting in June 8 and plant density of 20 plant m-2 for highest use efficiency of inputs, duration growth period and highest grain yield production.

Keywords: *Bean, Planting Date, Plant Density, Grain Yield, Yield Components, Phonological*

INTRODUCTION
Cowpea is cultivated in tropical and subtropical countries especially in Asia، Africa and South America (Singh *et al.,* 1997). Cowpea (*vina sinensis* L) is considered as the most important، adaptable، the most versatile and the most tonic legume family of plants that is cultivated in level of over 7 million hectare in tropical regions of the world (Majnon, 2008). In Iran bean acreage is about 93 thousand hectare، with a total production of over 209 thousand tons and an average yield of 1365 kg per hectare (Binam, 2010). Cowpea cultivation in Khuzestan province is about 12 thousand hectare with total production of 21 thousand tons and average yield of 1772 kg ha (Binam, 2010). One of the most important factors for determining the performance of cowpea is determining suitable planting date. The best cultivation date for any plants is date that environmental conditions for germination، emergence and plant establishment were provided by cultivating at that time and risk of unfavorable environmental conditions such as heat، cold and drought is the least. In this case، the highest level of performance is achieved than other cultivated dates. Generally climatic factors such as temperature، rainfall، day length، intensity and timing of non-climatic factors such as wind direction and other pests, diseases ’weeds birds’ production economics and so on are effective for selecting appropriate planting date (Mazaheri and Majnon Hoseini, 2005).
Proper density is that in that the maximum seed yield is obtained by producing less dry matter (Nour-Mohammadi *et al.,* 2006). Way of distribution and plant density on farm effected on absorption and utilization from effective environmental factors on growth and competition between plants، finally، it is determinant factors of yield (Azari and Khajehpour, 1382; Khajehpour, 2008; Gardiner *et al.,* 2001). Determining optimal density is one of the important factors for achieving to the maximum yield

according to the climatic conditions in each region and features of cultivated cultivars (Nourmohammadi *et al.,* 2006). By considering an appropriate density، mutual ghosting reaches to minimum value and receiving light and therefore photosynthesis reaches to its maximum value (Sarmadiyan and Kochaki, 1997). Increasing density causes to reduce light passing through the low parts of the plant community and most plants compete for receiving light causes to reach faster aging and to fall. This includes a reduction in leaf area (Talebian, 1993). At high densities، the total received sun radiation has risen by canopy and finally causes to increase yield (Hashemi and Katwal, 1993). Density is other determinant factors of yield. Planting density is depended to several factors such as the features of crop plant and its growth period length the time and method of planting soil fertility status, purpose of planting management practices on farm and harvesting methods (Mazaheri and Majnon, 2005). Delay in planting caused to short stem height to form smaller number of nods as result makes to fewer locations to create the appearance of pods and reduces number of pods per stem. Delay in planting date shorten the growth period and reduce yield. Reduction in yield due to late planting of vegetative growth can deal with the intense season heat and attribute to reduction during the growth period produce less vegetative organs assimilatory reduction، early flowering increased flower abscission and failure to reduce grain yield (Sreelatha *et al.,* 1997). Afshar Manesh in a two-year field experiment on cowpea plants in Jiroft declared that the highest seed yield (2.94 tons per ha) is obtained since July 20 of planting date and the lowest seed yield (1.78 tons per ha) is obtained since August 19 of planting date. Effect of planting date on yield occurs through its effect on the response to photoperiod and temperature. Reduction length of growth periods or dealing with critical periods of plant growth with adverse conditions of temperature can cause to decrease vegetative growth and yield components and even death (Khajehpour, 1998).

Taherkhani and associates (2008) by evaluating the effect of planting date on yield of two type of bean in Abhar and Khoramdareh areas in the EASt Azarbaijan province showed that delay in planting date decreases the yield. In their study, the highest seed yield was obtained by 15 May planning date. Mathews *et al.,* (2008) believe that density plant is the determinant factor in plant growth and dry matter accumulation. In conducted research on bean، it is observed that light penetration into the canopy is inadequate and inappropriate by increasing density intense and thus making photoassimilate in each plant is dropped and the number of filled seed per plant decreases which may result in reducing yield. However، the low number of plants per unit area results not to use maximum as producing potential and causes to decrease crop growth rate. The reviews of different research results is inferred that the components of yield are independent of each other and increasing one part often cause to decrease in one of the other components. In general, the number of reproductive units per each plant is decreased by increasing number of plants per unit area. Weight of each plant is reduced by increasing the number of seeds per reproductive unit. This means that to achieve a desired yield، all independent components compared to each other must be well balanced. Yield components were not independent of each other and changes in one، will follow compensatory effects of other components. Therefore، understanding the relationship between yield components in crop plants and outcome in relation to the yield of the final product is so sensitive and it has great important. Yield of bean seed is function of different physiological activities and the highest yield is achieved when yield components such as: number of pods per plant، number of seeds per pod and seed weight are at the maximum level but due to competition correlations between some of the yield components are negative.

Shirtlif and Johnston (2002) and Rosalind *et al.,* (2000) respectively reported about beans and soya beans that weight of hundred seed did not change by changing planting density. But Hayat and colleagues in 2003 reported that weight of hundred seed in soybean and mungbean is affected by planting density. Talei and colleagues (2000) reported a lack effects on different densities of planting on seed number per pod during the research on wax bean. However, during studies on mungbean and other legumes, Hayat and colleagues (2003) and Ayaz and colleagues (2001) reported that the number of seed per pod is changed by changing the density of planting and increasing density is caused to reduce the number of seeds per pod. According to Zaffaroni and Schneiter (1991) increasing competition in high densities relatively effects the seed yield more than biological yield and harvest index decreased. Elahiyari (1998) in a two-year field

study in a Ardebil on cowpea stated the highest seed yield (2.85 tons per hecatre) on space of 15 cm row in compared with other intervals (10,20,25 cm) is obtained 29005. The bean of Iran has high genetic diversity in term of qualitative and quantitative traits. Given the importance of genetic diversity in reforming of plants and expanding the cultivation and production of beans، understanding the genetic potential of this plant is very important. The use of improved cultivars causes to increase crop yields or to increase yield per unit area. Choose appropriate cultivar adapted to climatic conditions in each region and determine the appropriate density is important factors in achieving high yield. Bean genotypes affected by environmental conditions for one part of yield may be different. The amount of dry matter accumulation in seed is affected by planting date, genotype and their interactions. By delay in planting because of change in photoperiod، moisture stress and competition and competition، plant size are changed. Singh in 1999 stated that the bean yield is decreased 72 kg per hectare for each reduction in growing period day in length of maturity and increasing number of days for maturity cause to increase that yield. Farahmandrad *et al.,* (1999) in a study on the effect of planting date and planting density on cowpea stated the 29005 in Karaj that planting on 14 and 24 June and increasing density to 15 plants per square meter are increased seed yield، so that the maximum yield is obtained on 14 June planting date with 15 plants density per square meter. Mousavi *et al.,* (2005) also showed in study the effect of different planting dates and density of different planting on yield and yield components of normal bean in Khuzestan conditions and the maximum seed yield of seed cultivation is obtained on 18 May planting date and by using 10 cm space on rows. Also the Moser *et al.,* (2006) stated that the maximum yield is obtained on 10 May planting date and 5 cm space of row by reviews of effect of planting date and density on cowpea density in Ghaem Shahr. Thus the choice of suitable cultivars and compatible with climate،determine the plant density and appropriate planting date are important factors for achieving to high yield. Generally and according to the top reviews, density and genotype has important effect on yield of cowpea، but there is not enough information about their interaction on yield and yield components of cowpea in area conditions. Due to the growing season cowpea in Khuzestan between wheat harvest to planting it in next crop year therefore، in this period of time could be introduced the plant to the farmers that economic income is followed for them and even lead to more fertile land and it is important that their next wheat harvest that usually due to harvest of corn is delayed، timely is done. Determining the suitable planting date of cowpea is very important. Due to the importance of this issue and the lack of information، the present study for reviewing the effects of planting date, plant density and number on yield and yield components of this plant was conducted at Agriculture Research Center of Safi Abad.

MATERIALS AND METHODS

This study was conducted in the summer of 2011 at the Agriculture Research Center of Safi Abad which is located at 18 km from south of the Dezfoul city for one year. Safi Abad Research Center was located at a distance of 120 km from north of Ahvaz with a height of 82 meters above sea level and latitude 32 degrees and 24 minutes north. Generally all the lands of south coasts which have their height are less than 100 meters، has desert climate. Annual average of rainfall in this region is very low amounts and it is very erratic too. Almost all of the rainfall is occurred in winter and seven months of the year is without rainfall. In order to determine physical and chemical features of soil, after selecting the place of yield testing، soil test part before any land preparation by Agar from the depth of 0-30 cm as 10 points randomly are sampled and physical and chemical features of soil were determined. Experiment in term of Streep block in the form of randomized complete block design with four replications in which the planting date as the main factor (bar) at three levels (17 June and 1 and 16 July, respectively T1, T2 and T3) the figure in two levels (Kamran and Mashhad respectively V1 and V2) colore of Kanmran cowpea seeds is cream and cord of seeds are brown. This cultivar is premature and has friendly market. The amount of its yield is approximately 1 to 1.5 tons per hectare in the provinces of North Khorasan, Golestan, East and West Azarbaijan. Mashhad cowpea cultivars are white and quick cooking. Hilum color of seeds of this cultivar is black. Its yield in Golestan province, Markazi and Khorasan is approximately 1.5 ton per hectare. Density at four levels (10, 13.3, 20 and 40 plants per square meter respectively D1, D2, D3 and D4) were

considered. Cultivars and plant spacing of 5,10,15 and 20 cm on rows respectively D1,D2,D3 and D4 high densities equivalent were considered as a factorial and randomized subplots within each main plot (planting date). Each subplot included 8 lines with 6 m length and 50 cm spaces. Lines 1,3,6 and 8 were as margins lines 4 and 5 were as final harvest. In all 0.5 meter lines were regarded as margin from top and down. Between subplots were located a Nekasht row and between main bands were located a 2 meter space. Final harvest is done after physiological maturity of lines 4 and 5 for each plot after removing 0.5 meter margins from top and down with 5 meter length which is equal with 5 square meter. Flesh weight of all plants was measured in the field. To determine the total dry weight (biological function) randomly 15 plants were selected and were fragmented by clipper. Then a sample of 150gr was isolated and then was kept in oven at 75˚C for about 72 hours and sample dry weight was obtained. Finally, biological function per square meter was obtained by using the following equation.

$TDM = [(BWY \times SDW) .SWW] \div 5$

To determine the seed yield and yield components، 15 remaining plants were selected and its yield and yield components were measured. Seed yield and weight of single seed were determined after drying seeds in an oven with a temperature of 75 ˚C for about 72 hours. Raw data was analyzed by SAS statistical program and mean comparisons were made by Duncan method.

RESULTS AND DISCUSSION

Table 1: Analysis of variance (mean squares) for yield, Biological yield and Harvest Index

S. O. V.	*df*	*yield*	*Biological yield*	*Harvest Index*
Region	1	43395.19027^{ns}	845.246425^{ns}	030769.45^{ns}
Error a	6	23375.7342	971.334894	883405.276
Planting date	2	84550.8329**	410.201327*	249318.11^{ns}
Planting date × Region	2	00292.851^{ns}	525.456^{ns}	840676.51^{ns}
Error b	12	08020.1104	305.123415	805776.164
Cultivars	1	22487.61778**	517.321449*	688037.529**
Density	3	45307.19983**	785.51614^{ns}	689209.212*
Density× Cultivars	3	03874.20188**	732.32277^{ns}	235829.434**
Region× Cultivars	1	36977.47001**	910.728^{ns}	669880.860**
Density× Region	3	17888.10630**	040.117^{ns}	140525.177^{ns}
Cultivars×Region ×Density	3	68972.6027**	192.73^{ns}	382154.101^{ns}
Error c	42	60420.916	524.76616	651335.76
Planting date× Density	6	03172.746 ^{n}s	976.73937^{ns}	908080.50^{ns}
Planting date× Cultivars	2	58178.2364**	175.32069^{ns}	169672.65^{ns}
Planting date× Cultivars ×Density	6	78678.10921**	954.193505**	565995.240**
Region×Planting date× Density	6	53440.323 ^{ns}	660.167^{ns}	357474.14^{ns}
Region× Planting date× Cultivars× Density	6	10484.3531**	789.438^{ns}	541634.99^{ns}
Region× Planting date × Cultivars	2	00797.106^{ns}	719.72^{ns}	485046.1^{ns}
Region	84	61900.584	980.56885	738630.57
Error a	-	63.16	70.31	81.35

ns: non significant, ,** : respectively significant (p≤0.05) and highly significant (p≤0.01)*

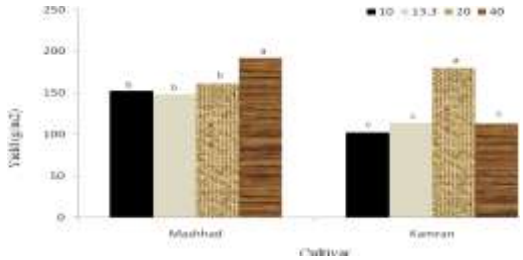

Figure 1: Effect of Density and Cultivars in The yield

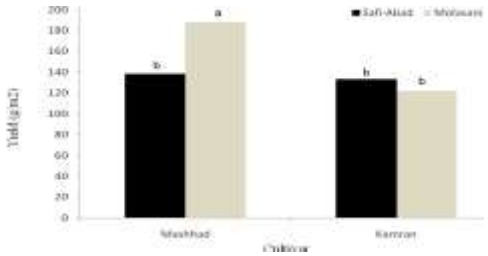

Figure 2: Effect of Cultivars and Region in The yield

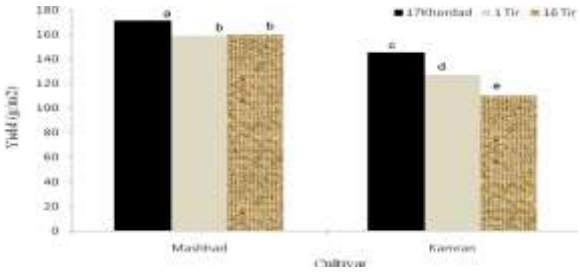

Figure 3: Effect of Cultivars and Planting date in The yield

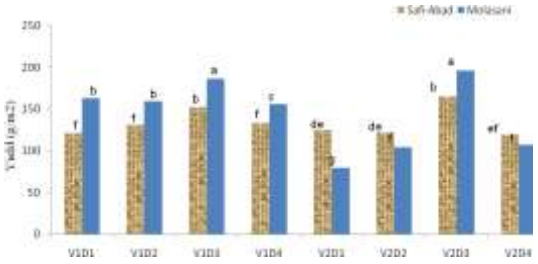

Figure 4: Effect of Density, Cultivars and Region in The yield

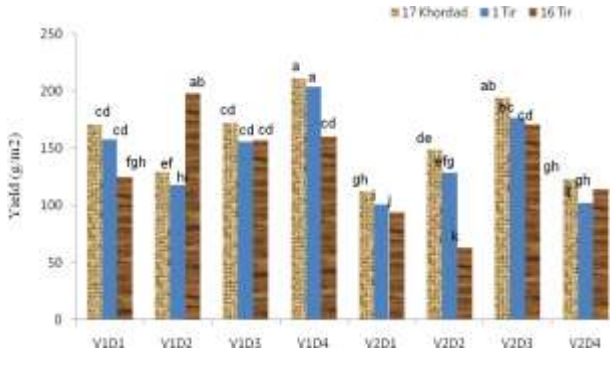

Figure 5: Effect of Density, Cultivars and Planting date in The yield

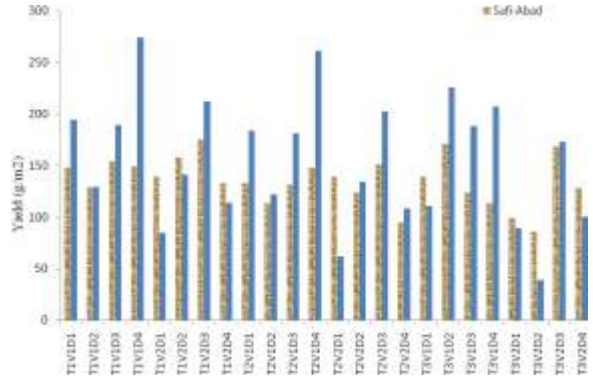

Figure 6: Effect of Density, Cultivars, Region and Planting date in The yield

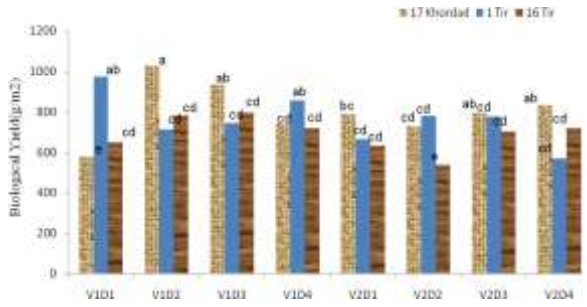

Figure 7: Effect of Density, Cultivars and Planting date in The Biological yield

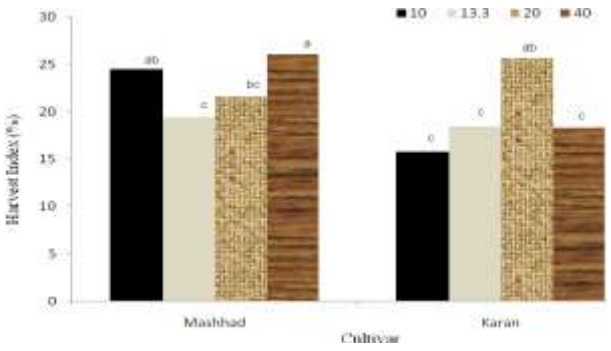

Figure 8: Effect of Cultivars and Density in The Harvest index

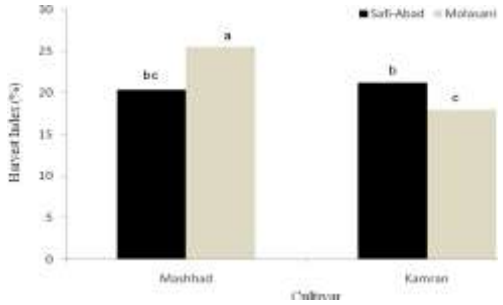

Figure 9: Effect of Cultivars and Region in The Harvest index

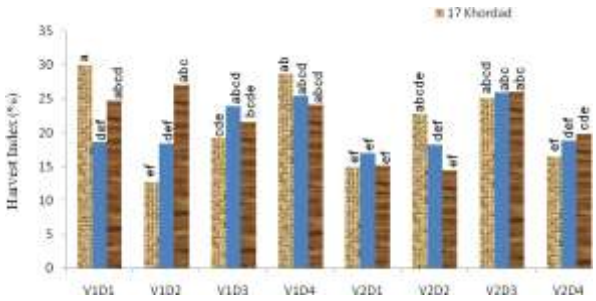

Figure 10: Effect of Cultivars, Planting date and density in The Harvest index

Results

Yield

Planting date, cultivar and plant density had significant effects on economical performance. The maximum economical performance (158gr per square meter) was obtained on June seventeenth. Economical performance reached to 135gr per square meter with 14.5% reduction by one-month delay in planting. Mashhad cultivar in comparison with Kamran cultivar had high economical performance. Economical performance at first reduced and then increased by increasing plant density from 10 to 40plants per square meter and the maximum economical performance (171ge per square meter) was obtained from 20plants density per square meter.

Interactions of Cultivar and Plant Density on Economical Performance

Economical performance in 1%probability level was affected by interactions of cultivar and plant density. According to Figure 4-22 it is observed that economical performance increases by increasing plant density and for Kamran cultivar, performance increased until 20 plants per square meter and then reduced. It probably indicates that changes intensity of economical performance by changes of plant density and also optimal density for achieving to maximum performance of seed is depended to morphological and physiological features of cultivars.

Interactions of Region and Cultivar on Economical Performance

Interactions of region and cultivar had more significant effects on economical performance. Mashhad cultivar in comparison with Kamran cultivar had high performance in Masalani condition. While Kamran cultivar had almost similar performances in Safi Abad and Masalani conditions. In other words, Mashhad cultivar had ability to use more from environmental conditions of Masalani in comparison with Kamran cultivar and had high economical performance.

Interactions of Planting Date and Cultivar on Economical Performance

Interactions of planting date and cultivar on economical performance were more significant. Mashhad cultivar produced less economical performance by delay in planting. Kamran cultivar also had reduction in performance by delay in planting with the difference that reduction intense of performance was higher than Mashhad cultivar. The results indicate that economical performance of Mashhad cultivar in comparison with Kamran cultivar had more stable by delay in planting. It can be related to differences of cultivars.

Interactions of Region, Cultivar and Plant Density on Economical Performance

Interactions of region, cultivar and plant density had significant effects on economical performance. Kamran cultivar in comparison with Mashhad cultivar in both Safi Abad and Masalani conditions had more intense of changes in related to economical performance in comparison with changes of plant density. The results indicate that the compressibility of Mashhad cultivar is more than Kamran cultivar.

Interactions of Planting Date, Cultivar and Plant Density on Economical Performance

Economical performance was affected by interactions of planting date, cultivar and plant density. Dwyer and colleagues (1991) stated that optimal cultivar and compatibility of climate, determining plant density and optimal planting date are important factors in achieving to high economical performance.

Interactions of region, planting date, cultivar and plant density on economical performance.
Quad interactions had significant effects on economical performance. Difference of performance indifferent densities in both Safi Abad and Masalani regions was less by delay in planting.

Biological Yield

Biological performance was affected by planting date and type of cultivar significantly. The maximum biological performance (804gr per square meter) was obtained in planting date of June seventeenth and reduction of 13.8% reached to 693gr per square meter by one-month delay in planting. Comparisons of cultivars indicated that Mashhad cultivar was higher than Kamran cultivar by biological performance of 793gr per square meter.
Interactions of planting date, cultivar and plant density on biological performance.
Interactions of planting date, cultivar and plant density had more significant effects on biological performance.

Harvest Index

Harvest index was affected by type of cultivar and plant density respectively more significant and significant. Mashhad cultivar in comparison with Kamran cultivar had more harvest index. The maximum harvest index was obtained in density of 20plants per square meter about 23.64%.

Interactions of Cultivar and Plant Density on Harvest Index

Interactions of cultivar and plant density affected harvest index significantly. The maximum amount of harvest index was obtained for Mashhad cultivar in first and last densities; but the maximum harvest index was obtained for Kamran cultivar in density of 20 plants per square meter.

Interactions of Region and Cultivar on Harvest Index

Interaction of region and cultivar was significant on harvest index. In Masalani condition, Mashhad cultivar had maximum harvest index, while Kamran cultivar had more harvest index in Safi Abad condition.

Interactions of Planting Date, Cultivar and Plant Density on Harvest Index

Interactions of planting date, cultivar and plant density on harvest index was significant on harvest index.

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