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Research article

EFFECT OF PLANT DENSITY ON GRAIN YIELDAND YIELD COMPONENTS IN FABA BEAN

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ABSTRACT: In order to investigate the effect of density and cultivar on yield and yield components of faba bean cultivars, field experiment was carried out in the city of Ahwaz field healthy martyr in a factorial randomized complete block design with four replications in crop year of 2011-2012. These factors include density at three levels (8, 12, 16 plants per square meter) and three varieties (Barekat, Saraziri, local varieties dezful), respectively. The results showed that the density of 12 p/m^2 was significantly increased grain yield and yield components and Barekat variety it had the highest degree of yield grain and yield components compared with others varieties. High yield of Barekat cultivar is due to more accumulation of dry matter and greater number of pods and grains per pod in this cultivar rather than other cultivars. As the plant density increased grain yield components including number of pods, number of grains per pod, and 100-grain weight decreased which resulted from the competition among pods to use environment resources that caused the plants to develop less. Cultivars also were different in terms of yield components and Barekat cultivar was superior to the other two ones.
Keywords:faba bean, grain yield, yield components,density, varieties

INTRODUCTION

Legumes make the main diet of many poor people throughout the world since the noticeable amount of good quality protein in grains of such products in combination with grain cereals can make a valuable biological food composition [11]. Legumes grains by having 18-32% protein have an important role in supplying the required protein for human diet [11]. Optimal density to achieve maximum yield depends on genetic characteristics of hybrid, production objective, and also water and nutrients. However, it is a general principle that if appropriate number of plants is not used in the unit of land in fact the available potential has not been used optimally [13]. Determining optimal density is a very important factor of crops yield [2]. [8] Stated that the use of very high densities would decrease current photosynthesis and increase grain yield dependency on assimilates in vegetative parts of plants. [6] Claimed that the increase of grain yield, parallel to increased density, was due to the establishment of more plants and the increase of produced pods per area unit. [15] reported that as the plant density increased, the weight of 100-grain decreased due to insufficient assimilates during grain filling stage.[2]reported that in low density of plant, more pods and heavier grains were obtained compared to high density because of better utilization of nutrition, soil, and light. The decrease of 100-grain weight might be due to non-uniform distribution of plants and decrease of leaf area which leads to decrease of photosynthesis and or decrease of reservoir and assimilates mobilization to the reservoirs.[3]stated that the increase of the number of plants per unit area resulted in higher number of pods and consequently higher number of grains. [4] Stated that the decrease of number of pods in broad bean in different densities was possibly due to plants competition to absorb light and minerals. As the density increases, plants compete more to receive light and thus the number of nodules in main stem decreases; consequently, the number of pods per stem decreases. As the plant grows more in high densities, the space and nutrition for each plant will decrease and thus fewer sub branches are produced. The results of the research conducted by [7] showed that the increase of number of pods in Barekat cultivar in low densities was mainly due to the increase of the number of pods in sub branches, so that as density increased, the number of pods in sub branches decreased. [15] Found that as the density increases, due to the increase of competition the number of grains per pod decreased. In low density, as the rate of photosynthesis increases and assimilated are produced the pods have more potential to produce grains and since the pods are formed in lower heights, environmental tensions will probably have little effect on the number of grains per pod. [5] Stated that as plant density increases the number of grains per pod decreased in mung bean.

MATERIALS AND METHODS

This research was conducted in crop year of 2011-2012 in the farm of martyr healthy located in the city of Ahwaz latitude 31° 36´ north and longitude 48° 53´ east and 51 m above the sea level.The soil of experiment site has clay-loamy texture with 7.7 pH and electrical conductivity of 4.6. The experiment was conducted in the form of factorial and randomized complete block design with four replications. The factors in this experiment included three varieties of (V1=Barekat, V2=Saraziri, V3=Local varieties dezful) and density at three levels (D1= 8, D2=12, D3=16) plants per square meter, respectively.Fertilization was calculated based on go kg.ha^{-1} pure phosphours from ammonium phosphate, as well as 100 kg.ha^{-1} pure nitrogen from urea fertilizer. At the time of final leveling, all the phosphorus fertilizer was distributed uniformly on the farm surface, so fertilizer was thoroughly incorporated in to the soil by means of discs. In addition, urea fertilizer was added to the soil at two stages. One at the beginning of planting and another top dressed at 4-6 leaf stage in the faba bean. In order to carry out the experiment the land preparation operation was done including plowing to the depth of 30 cm, making holes to the depth of 15 cm and flatting. After preparation, the farming land was plotted according to the plan. Every plot contained 5 lines each 5 meters long and 60 cm apart from each other.Sowing operation was done manually on November 22, 2011. The land was irrigated immediately after sowing. The weeding was done manually after the seeds germinated and the stems got strong. The plots were harvested manually. Yield is yield components multiply spacing on planting row. The final harvest was done during thephysiological maturity of the grainsand in order to measure the grain yield, the products of two square meters were harvested while considering the marginal effects of both sides.In order to determine grain yield components during physiologic maturity, 10 plants were chosen randomly from each plot, and then the number of grains per pod and 100 grain weight were assessed. The grain yield started from the three middle lines as longas 2 meter aftereliminatingthe margins. At harvest, ten reserved plants were randomly taken from each plot to record the averages of number of seed per pod. At harvest, ten reserved plants were randomly taken from each plot to record the averages of pods per.

Statistical analysis

Data variance analysis was done bymeans of SAS software the means werecompared by Duncan's multi rangetests at 5% and 1% probability levels.

RESULTS AND DISCUSSION

100-grain Weight

100 Grain weight of faba bean was significantly influenced by the varieties at 5% probability level as well as planting density at 1% probability level. The interaction of varieties and planting density was not significant (Table 1).The mean comparison of the effect of different levels of density on weight of 100-grain showed that the highest weight of 100-grain belonged to the density of 12 plants/m^2 by the average of 111.91 g and the lowest weight of 100-grain belonged to the density of 16 plants/m^2 by 99.67 (Table 2). [2] Reported that in low density of plant, more pods and heavier grains were obtained compared to high density because of better utilization of nutrition, soil, and light. The decrease of 100-grain weight might be due to non-uniform distribution of plants and decrease of leaf area which leads to decrease of photosynthesis and or decrease of reservoir and assimilates mobilization to the reservoirs. [3] Reported that as density increased, the competition among adjacent plants increased and consequently the number of sub branches and pods and grains in each plant would decrease. In low densities, the competition among plants decreases and more assimilated will be allocated to each grain in plant and thus the weight of grain will increase. The mean comparison of the effect of cultivar on weight of 100-grain showed that the highest weight of grain belonged to Barekat cultivar by 113.16 g and the lowest weight of 100-grain was related to the local cultivar by 101.19g (Table 2). This indicates that various cultivars with genetic differences in terms of the number of produced pods and grains per pod are capable of producing grains with different weights. It seems that as [7,4,1] stated Barekat cultivar is superior genetically because it produced the biggest grains in comparison to the other ones.In their research on broad bean, [1] showed that the increase of density led to significant decrease of the number of pods per plant. The increase of density possibly causes the decrease of plant ability to transfer assimilates from the source to the reservoir or perhaps due to shadowing in high densities and the decrease of sub branches the number of pods per plant has decreased.

Number of Pods per Square Meter

Number of pods per square meter of faba bean was significantly influenced by the varieties at 1% probability level as well as planting density at 1% probability level. The interaction of varieties and planting density was not significant (Table 1).The mean comparison of the effect of density on the number of pods/m^2 showed that the highest number of pods per square meter belonged to the density of 16 plants/m^2 by 118.95 and the lowest number of pods belonged to the density of 8 plants/m^2 by 72.11(Table2).

Greater number of pods per area unit in higher density could be due to higher number of plants per area unit. These results are similar to the finding of [8] about pea. [3] Stated that the increase of the number of plants per unit area resulted in higher number of pods and consequently higher number of grains. The meancomparison of the effect of cultivar on number of pods showed that the highest number of pods per square meter belonged to Barekat cultivar by 102.83 and the lowest number of pods per square meter belonged to the local cultivar by 88.03. Genetic potential of Barekat cultivar was so that it could use the radiation and producemore assimilates and also could change more flowers to pods and consequently it increased the number of pods per square meter. The results are consistent with the findings of [7].

Number of Pods per Plant

Number of pods per plant of faba bean was significantly influenced by the varieties at 1% probability level as well as planting density at 1% probability level. The interaction of varieties and planting density was not significant (Table 1).The comparison of the means (Table 2) showed that as density decreased the number of pods per plant increased, so that the lowest number of pods per plant (7.43) belonged to the density of 16 plants per square meter and the highest number of pods per plant (9.01) belonged to the density of 8 plants per square meter. In their research on broad bean, [1] showed that the increase of density led to significant decrease of the number of pods per plant. The increase of density possibly causes the decrease of plant ability to transfer assimilates from the source to the reservoir or perhaps due to shadowing in high densities and the decrease of sub branches the number of pods per plant has decreased. [4] Stated that the decrease of number of pods in broad bean in different densities was possibly due to plants competition to absorb light and minerals. As the density increases, plants compete more to receive light and thus the number of nodules in main stem decreases; consequently, the number of pods per stem decreases. As the plant grows more in high densities, the space and nutrition for each plant will decrease and thus fewer sub branches are produced. It seems like that as [15] stated when the plant density decreases the competition for growth space is reduced and more growth resources such as water, light, and nutrition are available for the plant. In this case, the dominant effect of ending bud is reduced and more sub branches begin to grow and develop in plant; as a result, the plant produces more flowers. This leads to the increase of the number of pods per plant. In high densities, due to the increase of competition for absorbing light and required resources, the height of plants increases which contributes to more allocation of assimilates to vegetative part and consequently, the number of pods per plant decreases. The mean comparison of the effect of cultivar on the number of pods per plant showed that the highest number of pods per plant belonged to Barekat cultivar by 8.74 and the lowest number of pods per plant belonged to local cultivar by 7.52. Genetic potential of Barekat and Saraziri cultivars in utilizing environment resources for changing greater number of flowers to pods has led to the increase of number of pods per plant. The results were consistent with the findings of [5,12]. The results of the research conducted by [7,4] showed that the increase of number of pods in Barekat cultivar in low densities was mainly due to the increase of the number of pods in sub branches, so that as density increased, the number of pods in sub branches decreased. These results were consistent with the findings of the research.

Table-1: Analysis of variance for yield and yield components on the basis of mean square.

Source of variation	d.f	100 Grain Weight (gr)	Number of pods square meter	Number of pods per plant	Number of grain per pod	Grian yield (gr/m^2)
Replication	2	5.31	4.9	0.0492	0.492	6515
Density	2	398.64**	5031.2**	5.7324**	1.8928**	32004**
Variety	2	322.83*	596.7**	4.0408**	4.4164**	142033**
D*H	4	46.81^{ns}	28.3^{ns}	0.0097^{ns}	0.0632^{ns}	1946$^{n.s}$
Error	16	69.21	22.8	0.1467	0.0628	2269
Coefficient of Variation (%)		7.7	4.901	4.62	6	10.9

**And* ns respectively significant at the one percent and five percent level, and no significant difference.

Number of Grains per Pod

Number of Grains per Pod of faba bean was significantly influenced by the varieties at 1% probability level as well as planting density at 1% probability level. The interaction of varieties and planting density was not significant (Table 1).

Table-2: Mean comparison of 100 Grain weight, Number of pods per plant, Number of grain per pod, Grain yield.

Treatment		100 Grain Weight (gr)	Number of pods square meter	Number of pods per plant	Number of grain per pod	Grian yield(gr/m^2)
Density	D1	110.31a	72.11b	9.01a	4.58a	369.69b
	D2	111.91a	101.12a	8.43a	4.23a	487.49a
	D3	99.67b	118.95a	7.43b	3.67b	444.73a
Variety	V1	113.16a	102.83a	8.74a	4.69a	535.76a
	V2	107.54b	101.32a	8.61a	4.42a	472.58b
	V3	101.19c	88.03b	7.52b	3.37b	293.57c

Means with same letters in each column are not significantly different at 5% probability level.

The mean comparison of the effect of plant density on the number of grains per pod showed (Table 2) that the highest number of grains per pod belonged to the density of 8 plants per square meter by 4.58 and the lowest number of grains per pod belonged to the density of 16 plants per square meter by 3.67 which was due to competition among plants to make use of environment resources and caused the plant to develop less and consequently the yield of each plant decreased. [15] Found that as the density increases, due to the increase of competition the number of grains per pod decreased. In low density, as the rate of photosynthesis increases and assimilated are produced the pods have more potential to produce grains and since the pods are formed in lower heights, environmental tensions will probably have little effect on the number of grains per pod. These findings are consistent with the results of the research. The results of the experiments carried out by [7] indicate that the large number of branches leads to the increase of number of flowers and pods and indirectly increases the yield. As density increases, the number of sub branches reduces dramatically and consequently the number of pods and grains per pod decreases, too. In low densities the competition among plants is lessened and more assimilates are allocated to each grain of plant and the weight of grain increases. These findings are consistent with the results of this research. [5] Stated that as plant density increases the number of grains per pod decreased in mung bean. The mean comparison of the effect of cultivar on number of grains showed that the highest number of grains per pod belonged to Barekat cultivar by 4.68 and the lowest number of grains per pod belonged to local cultivar by 3.67 (Table 2). The main reason of the difference between the numbers of grains per pod in various cultivars was related to different size of pods. The pod of local cultivar was naturally smaller than the pod of other cultivars which was followed by fewer numbers of grains per pod. The results were consistent with the findings of [14]. Barekat cultivar, probably due to producing more assimilates than other two cultivars, has been able to produce a lot of pods. Obviously, this cultivar has prevented the infertility of pods by producing more assimilates in similar environmental conditions.

Grain Yield

The results from analysis of variance for the data showed that the levels of density and varieties havesignificant difference in 1% probability value on grain yield (Table 1).The mean comparison of the effect of different levels of density on grain yield showed that the highest rate of grain yield belonged to the density of 12 plants per square meter by 487.49 g/m^2 and the lowest rate of grain yield belonged to the density of 8 plants per square meter by 369.69 g/m^2 (Table 2). It seems that as [1,14] reported, the decrease of grain yield at density of 8 plants/m^2 in spite of the higher number of grains per pod and number also higher number of pods per plant was due to inappropriate density and failure to make optimal use of nutrition space in plant population. [9] Believed that the effect of plant density on the increase of grain yield was due to the increase of number of grains per square meter and consequently the increase of number of pods per square meter. These results are consistent with the findings of this research. [12, 14] reported that the number of grains per pod in higher densities of plants relatively decreased and these changes in sub branches were more than main branch.

In this study, the increase of number pods per square meter in high densities resulted in relative decrease of number of grains per pod and increase of 100-grain weight, as well. These results are consistent with the findings of [5,12]. The mean comparison of the effect of cultivar on grain yield showed that the highest rate of grain yield belonged to Barekat cultivar by 535.76 g/m^2 and the lowest rate of grain yield belonged to local cultivar by 293.57 g/m^2 (Table 2).

High yield of Barekat cultivar is due to more dry matter accumulation in this cultivar rather than other cultivars. Moreover, among the components of grain yield, the number of pods had greater role in the increase of grain yield and this feature in Barekat cultivar was more than other cultivars. These results are consistent with the findings of [12] and Osman et al. (2011).

CONCLUSION

The results of the research showed that yield and yield components were affected by density and cultivar. As density increased, the grain yield increased, too so that the density of 12 plants per square meter due to optimum condition and appropriate light had more grain yield than other cultivars. The highest grain yield belonged to Barekat cultivar. High yield of Barekat cultivar is due to more accumulation of dry matter and greater number of pods and grains per pod in this cultivar rather than other cultivars. At density of 12 plants per square meter the number of pods per area unit was more and the weight of 100-grain increased, but the number of pods per plant and the number of grains per pod increased which resulted from competition among plants to make use of environment resources and caused the plant to develop less.Cultivars also were different in terms of yield components and Barekat cultivar was superior to the other two ones.

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