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Effect of planting pattern and plant density on some quantitative traits spotted bean cos16 line

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Abstract

This study was conducted to evaluate the effect of planting density on some quantitative traits bean cos 16 line. The experiment was carried out split plot base on randomized complete block design with three replications at the Agricultural Research Station Borujerd in crop year 2009-2010. In this study the main plots was row spacing including 25, 50 and 75 cm with signs of A1, A2 and A3 and subplots included three densities of 30, 40 and 50 plants per square meter marks B1, B2 and B3. Each plot consisted of 7 lines with length 6 m. and between each two plot one line was considered as the no planting line. After soil testing, land plowed and on the tenth of May, disk operations and ground leveling, planting was performed. The fertilizer was applied based on soil test. In addition to weed control herbicide Terflan (2 liters per hectare) was used. During the growth period combat pests was done. At harvesting time, number of branches, pod length, number of seeds per pod, seed weight, biological yield and grain yield were measured. Experimental results showed that the grain yield per hectare at spacing between rows, and different densities were significant at the 5% level. Maximum production per unit area was obtained in the maximum distance between the rows and the highest density.

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Introduction

Density and planting pattern are two important factors for increasing performance in beans. Desired plant density, is resulting of all the environmental factors: Water, light, nutrients and soil completely used, and yet competition inside plant and outside plant be minimum to achieve maximum performance (Khajehpour, 2000). Also, the arrangement of plants within a specific density is important, so that the desired density of healthy plants in the appropriate of the pattern plant it's based on successful producing system. Arrangement or geometric status of plants can be changed within rows and between plants on the row changed (Ghanbari and Taheri Mazandarani, 2004). According to previous studies, combining proteins of legumes and grains can solve malnutrition and deficiencies amino acids. On the other hand consider to the ability to fix nitrogen in these plants, if put them in a crop rotation leads to the sustainability of agricultural systems (Bagheri *et al*., 2001). Spotted bean with scientific name: *Phaseou* (*vulgaris* var.) in English is called spotted bean or pinto bean and it's most important in legume family. Because of the high percentage of protein and other desirable agronomic characteristics, most of the cultivated area is devoted to the legume (Torabi Jafroudi *et al*., 2007). According to previous studies, proper suitable mix of legumes and grains can solve malnutrition and lack of amino acids. On the other hand consider to the ability to fix nitrogen in these plants, if put them in a crop rotation leads to the sustainability of agricultural systems (Khajehpour, 2000). Increased agricultural production is possible in two ways: increasing the area under cultivation and increase yield. Due to limitations cultivable and fertile lands and unsuitable climatic conditions, inevitably need to increase the grain yield per acre that is main goal of agronomy.

Falah (2007) with investigate the effect of date and density planting on properties of Chickpea concluded that the lowest number of pods per plant was obtained in the highest plant density. So that the, with increasing plant density from 18 to 36 plants per square meter, number of seeds per pod reached from 1.24 to 1.16. It also concluded that the effects of plant density on grain weight were significant at 1%; the lowest seed weight had the highest density. Buttery (1996) reported that one reason for the reduced number of pods per plant was high density and increasing number of branches without pod. Ghanbari and Taheri Mazandarani (2003) in the National Bean Research Station Khomeini with investigate and determine the most suitable planting date and plant density in the bean concluded that between the different density in terms of number pods per plant, number of seeds per plant, seed weight and seed yield were difference significant. The highest number of pods and seeds per plant and seed weight were obtained from the density of 20 plants per square meter.

Shahsavari *et al*., (1994) by study yield components of beans concluded that 100 grain weight, number of pods per plant and seeds per pod were an important factor in increasing the performance of beans, and these traits had negative correlation.

Herbert *et al*., (1983) reported that number of pods and seed number per pod had the most important role in yield of cowpea and with increasing plant density significantly their number decreases. Seed yield depends on the yield components such as number of pods per plant, number of seeds per pod and seed weight. The highest performance is obtained when the multiplied of these parameters will have a maximum amount. Ability to compensate of yield components due to inside competition for nutrients and metabolic function avoids from high changes of yield (Yestern *et al*., 1997). Mousavi *et al*., (2005) indicated that increasing density from 20 to 40 per plant, grain weight due to the increased number of plants per unit area was increased also grain yield and biological yield were increased.

The main objective from this study was to investigate the effect planting density on yield and yield components COS16 bean line in Agriculture and Natural Resources Research Station Borujerd. Also, findings of this study using for achieved the optimal planting density in this area.

Materials and methods

Site description

This research was carried out at field of Agriculture Research Station Borujerd in 18 km east of Borujerd city with 34 north latitude degrees, 48.5 eastern longitude degrees and 1476 elevation in May 2009. Average annual rainfall is 500 ml and a maximum 24-hour rainfall for the 10-years was 83 mm and for a period of 5 years was 91 mm.

Replications at the Agricultural Research Station Borujerd in crop year 2009-10. For 6 months on the two factors the distance between rows and plant density was conducted. In this study, densities 30, 40 and 50 plants per square meter and the distance between rows 25, 50 and 75 cm were used, to determine the best spacing between the rows also be identified density. In this design, the distances between the rows in the main plots and sub-plots were plant densities, 3 treatments between rows were shown with signs A1, A2 and A3 and three treatment of plant density with signs B1, B2, and B3. Each experimental plot includes 7 lines in 6 m length and between each two plot one line was considered as the no planting line. A fertilizer recommendation includes (50 kg urea, 100 kg and 100 kg ha-ha superphosphate and potassium sulfate, respectively) that broadcasted before disk harrow and leveler actions of cultivated land. Irrigation date until seedling establishment, once every 4 days and after seedling establishment, on average, once every 8 days were done. Fight against weeds based on farm by mechanical manpower and chemical control was done. In addition to weed control herbicide Terflan with amount of 2 liters per hectare (before disk) were used. Beside to pest control grow over time also using diazinon with amount of 1.5 liter per thousand liters of water in two stages, and danitol was once insecticide spraying. For take samples from each plot that has 7 cultivation lines, the lateral line was removed as margins and from 5 center line, 0.5 meters from the edge of the line (top and bottom) deleted, then from 1 x 1 m plots were sampled considering to cultivating spacing onto row and between rows. Usually sampling were occurs from the middle line because of the lower effect of marginal. Samples were taken every 5 or 10 plants and measurements necessary to be done on it. Traits measured include: number of branches, number of nodes per stem, pod length, number of seeds per pod, biological yield and grain yield per hectare. In order to statistical analysis of the data were used SAS software version 9.1, and to draw charts and graphs using Excel 2007 software. Also mean comparison was carried out by Duncan multiple range in % 0.05 level.

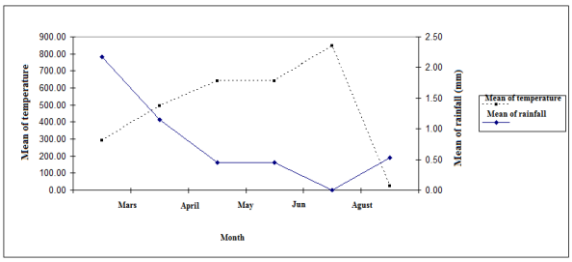

Fig. 1. Diagram ombrotérmic weather in Borujerd in crop year 2009-2010.

Soils testing from 0-30 cm depth of field the samples taken and analyzed soil samples were done at soil laboratory of Borujerd city. The results are shown in Table 1.

Table 1. Chemical composition and nutritional value of beans (Majnoon Hosseini, 1993).

Type of Seed	Water (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Fiber (%)	Ashes (%)
Green seed	66.5	7.5	0.8	22	1.5	1.7
Dry seed	11	22	1.6	8.57	0.4	3.6

Results and discussion

Number of branches per plant

Results of variance analysis (Table 3) and mean comparison (Table 4) showed that row spacing had no significant effect on the number of branches. Also, the density had no significant effect on the number of branches. The results showed that the interaction between row spacing and density had no significant

effect on the number of branches. Reduction of row spacing and plant spacing was reduced the production of pods per plant and number of branches. Beside, increasing density by reducing the distance between rows and between plants, lead to that light no reaching to the lower parts of plant also this reduces the number of fertile pods per plant.

Table 2. Results of soil test from soil laboratory of Borujerd city.

Electrical conductivity (EC)	PH	Total dissolved material extracts	Soil composition (%)			Soil texture
Ds/m	--	Mg/L	Clay	Silt	Sand	Silt-loam
0.34	8.15	217.6	24	50	26	

Electrical conductivity	PH	Total dissolved material extracts	Cations and anions (meq per liter)							SAR	Total hardness of water	Classification
Umohs/com	--	Mg/L	Carbonate	Bicarbonate	Cl	Na	Ca+Mg	SO_4	Ca	Mg			
547.33	8.02	350.290	0.0	0.7	2.3	0.57	4.4	0.0	2.7	1.7	0.384	218.83	Semirigid

Pod length

The results of the variance analysis table (Table 3) and mean comparison (Table 4) showed that the effect of row spacing on pod was significance at 5% level. The maximum pod length was in distance between rows (A3) with 10.67 cm and the lowest pod length was in distance between rows (A2) with 10.16 cm. Density had no significant effect on pod length. The results showed that the interaction between row spacing and plant density on pod length had significant effect at level of 1%. So that maximum pod length was related to the distance between rows (A1) and density (B3) with 10.88 cm and the lowest pod length related to the distance between rows (A2) density (B2) with 9.67 cm.

Seed number per pod

The results of the variance analysis (Table 3) and mean comparison (Table 4) showed that the effect of row spacing and plant density on number of grain per pod was not significant. The interaction between row spacing and plant density on seed number per pod was not significant. If number of seeds per pods in cereals such as beans was changed can quickly increase or decrease the amount of grain production. But mostly in this product the seed number per pod was less affected by environmental conditions. Because the low density can be expressed in the early stages, there is no competition. Therefore many flower-producing cells arise and simultaneously, with increase growth, the competition gradually was increased. So in seed filling stage supply photosynthetic materials was not enough and this leads to a lot of these flowers were aborted. So, in low density of grain number and grain weight will decline. But at desired density, because number of grains was based on previous competition, plants were able to supply photosynthetic materials. Findings with the results Ghanbari and Taheri Mazandarani (2009) and Hashemi Dezfuli *et al.*, (1995) Was in accordance. They had expressed that the seed number per pod does not affected by planting and this trait was under genetic control.

Table 3. Analysis of variance for the traits.

SOV	df	Biological yield per hectare	Grain yield per hectare	Hundred grain weight	Seed number per pod	Pod length	Number of branches per plant
Block	2	1347194.02	48.197	7.362	0.254	1.241	0.029
Row spacing(a)	2	370478.26	3325161.9*	13.91 n.s	0.25 n.s	0.59*	0.31 n.s
Error (a)	4	91785.77	3346574.2	24.04	0.97	0.12	2.42
Density (b)	2	16885308	8963275*	28.8*	0.12 n.s	0.51 n.s	1.46 n.s
a*b	4	373120	3452397**	3.18*	0.65 n.s	0.43**	0.4 n.s
CV		10.99	13.98	8.88	29.81	4.35	20.21

Table 4. Results of mean comparing for the traits

Biological yield per hectare	grain yield per hectare	Hundred grain weight	Seed number per pod	Pod length	Number of branches per plant	
9033/8 a	5551/3 b	38/13 a	3/66 a	10/42 ab	4/11 a	A1
8739/4 a	5664/1 ab	35/75 a	3/53 a	10/16 b	4/00 a	A2
8726/1 a	6535/1 a	36/23 a	3/33 a	10/67 a	4/36 a	A3
7753/7 b	4981 b	36/99 ab	3/44 a	10/60 a	4/33 a	B1
8504/1 b	6121/7 a	38/38 a	3/44 a	10/14 a	3/69 a	B2
10336/6 a	6667/6 a	34/83 b	3/64 a	10/50 a	4/44 a	B3
8989 bc	5948 bdc	39/71 a	3/33 a	10/34 ab	4/33 a	A1B1
9200 bc	6234/5 bc	39/05 a	3/33 a	10/04 ab	4 a	A1B2
8913 bc	3271/5 E	35/64 a	4/33 a	10/88 a	4 a	A1B3
7752 bc	4319/7 de	35/03 a	3/33 a	10/67 a	4/33 a	A2B1
6950 c	5550 dc	37/86 a	3/66 a	9/67 b	3/33 a	A2B2
12010 a	7795 ab	34/36 a	3/61 a	10/12 ab	4/33 a	A2B3
6932 c	4997/7 edc	36/25 a	3/66 a	10/79 a	4/33 a	A3B1
9076 bc	6427/7 abc	38/24 a	3/33 a	10/72 a	3/76 a	A3B2
10170 ab	8180 a	34/49 a	3 a	10/49 a	5 a	A3B3

Hundred grain weight

The results of the variance analysis (Table 2) and mean comparison (Table 3) showed that the effects of row spacing on hundred seed weight was not significant and the effect of plant density on hundred seed weight was significant at the 5% level. So the most weight related to density (B2) with 38.38 g, and the minimum related to density on 100 grain weight was not significant. Plants for the absorb air and soil resources in the environment were competing and competition for light begins. This cases in where the shadow of mutual leads to leaf system no performance, reduced levels of photosynthesis in leaves under the umbrella act. Thus, the selection and arrangement of plant to crops due to competition for light was important. Whatever move towards higher concentration of hundred seed weight decreased. At higher densities the less amount of food, share of the single plant that affected on hundred seed weight. Results, Bagrmn and Herbert, (1983), Cernet *et al.*, (1997), Astvtvzl and Tamr, (1991) and Fallah, (1386), were confirmed this result. Khraryan, (2002) concluded that competition between plants was reduced at low densities. The seed of the plant was allocated to more photosynthesis and a grain yield increase that was contradicts with the present results. Because it can be expressed at inappropriate densities created competition between plants and due to intense competition plant faced with resource limitations the plant and was not able to assimilate

supply to resource. This results in less weight loss and producing seeds. This results cause to product with loss and less weight. Therefore, the competition for assimilates between vegetative and reproductive organs, vegetative organs due to the competitive excellence and drawn photosynthetic materials to itself lead to reduce yield and 1000 seed weight.

Biological yield per hectare

The results of the variance analysis (Table 3) and mean comparison (Table 4) indicated that the biological effects of row spacing on yield per hectare were not significant. The effect of density on biological yield was significant at the 5% level. Most Biological yield of density were (B3) with 10336.6 kg and the lowest yield biologically were related to density (B1) with 7753.6 kg. With increasing density, the biological was affected of farm management, genotypes and environment. With increasing plant density, biological yield was increased. If creation of limitations such as lack of food and lack of space for growth, ghosting and bushes on each other, the performance will also gradually be reduced. The interaction between row spacing and plant density on biological yield per hectare was significant at the 1% level. The most biological yield was related to the distance between rows (A2) and density (B3) with 12010, and the lowest biological yield was related to the distance between rows (A3) and density (B1) with 6932 kg. The total dry matter production resulting of efficiency of solar radiation was during the growing season. In this relationship the plant needs enough leaf area that was uniformly distributed and completely covered the ground. The purpose of changing the plant density and adequate was distribution of plants on the ground. So one of the main tasks of farm management is selected adequate plant density for maximum solar radiation absorbed. Solar radiation, humidity and soil fertility are environmental factors that affect the optimum plant density for performance. If the density was too low to produce the full potential was not being fully used, and if it was too high, too much competition of plants especially due to severe moisture stress, the efficiency of the entire product was reduced. Thus, we can conclude with increased density lead to increase biological yield. With the increasing density in vegetative parts, competition on access to food and light requirements was increased. Then the volume plant reproductive organs were increased. Also, with the increasing volume of vegetative and reproductive organs, so called chaff and grain, biological yield plant goes up. In evaluation weight of single plant was observed that with increasing plant density reduced weight. This was due to competition and less access to food. But due to increase in the number of plants per unit area, which increases the weight of the plants. Results of Abdi (2008) and Ibrahim Amini (2000), Zhou (1998) and Danjal (2001) were confirmed this result.

Grain yield per hectare

The results of the variance analysis (Table 3) and mean comparison (Table 4) showed that the effect of row spacing on seed yields was significant at 5% level. The most weight was related to the distance between rows (A3) with 6535.1 kg and the lowest grain yield was related to (A1) with 5551.3 kg. Effect of plant density on seed yield was significant at the 5% level related to the maximum weight density (B3) with 6667.6 kg and a minimum weight density related to (B1) with 4981 kg. The interaction between row spacing and plant density on seed yield was significant in the 1% level. The maximum grain yield was related to spacing between rows (A3) and density (B3) with 8180 kg. The lowest grain yield was related to spacing between rows (A1) and density (B3) with 3271.5 kg. Solar radiation, humidity, soil fertility were environmental factors that effect on optimum plants density affects the performance. If the density was too low, the full production potential was not fully used, and if it was too high. Too much competition of plants due to extreme moisture stress, particularly, reduces the efficiency of the product. Yield components had compensation relationship with each other. This means that we could not imagine the situation that all yield components were maximum of performance, but also on how to manage of the agricultural one or more yield components has increased, but others were less. Seed yield indicated that in row with less

spaced compared with long distance, plant earlier the soil volume fully searchable for water and had absorbed more water available in the soil during growth and for reproductive growth, remains little water. These restrictions on reproductive development in less spaced rows, when it was important that their density was highest. Grain yield increased with increasing distance between rows, Of course, to a certain range of that number of plants per unit area was not very less, since the number of plants per unit area is one of the yield components. Grain yield increased with increasing density because with increased density per unit area was increased photosynthetic surface and photosynthetic materials percent absorption by plants increased, as a result, yield total rises. As with the characters specified, with increased distance between the rows of pods per plant that is one of the yield components was increased that could be one reason for the increased grain yield. Hashemi Jezi and Danesh, (2003) Concluded that grain yield increases with increasing distance between rows that were in accordance with results of the present study. They also concluded that with increasing plant density, grain yield be reduced that present results were conflict. Kahrarian, (2002) in his research on soybean and beans concluded that increasing density, intensity of light penetration into the canopy was inadequate and as a result of photosynthetic material per plant, the number of unfilled grains wad increased which lead to decreased yield that result of present study was conflict.

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