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The effect of plant population on growth parameters and seed yield of faba bean

N. Derogar*, M. Mojaddam, T. Saki Nejad

Department of Agronomy, College of Agriculture, Ahwaz branch, Islamic Azad University, Ahwaz, Iran

Key words: Faba bean, density, variety, grain yield, growth indices.

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Abstract

In order to study the effect of density and cultivars on growth physiological indexes affecting grain yield of faba bean, 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 average density of 12 per square meter with 49.478 grams per square meter, grain yield was significantly increased compared with the average barekat76.535 grams per square meter than other cultivars had the highest grain yield. Survey results showed that treatments affected plant growth and physiological parameters were compared. LAI highest number and density of 16 plants m barekat obtained. CGR maximum density of 12 plants per square meter ofleaf area index was more in barekat digits. Maximum net assimilation rate on leaf area due to larger numbers and more barekat and density of 8 per square meter, respectively almost the same trend of relative growth rate of the trend followed.

* **Corresponding Author:** N. Derogar ✉ nazliderogar20@gmail.com

Introduction

Beans, the staple diet of many poor people in the world to make it in the fog of high protein grain cereal products in combination with a combination of bio-food provided worthwhile. Whole grain with 32-18% protein plays an important role in providing the protein needed for human diet (MajnonHoseini, 2008). Desired density to achieve maximum performance of hybrid genetic characteristics, the production and use of water and nutrients depends on But a general rule is that if the number of plants per unit ground for not exploiting the potential advantage of the fact there has not been enough (Mazaheri, 2008).Dentify and analyze the factors affecting the growth and yield components and stability, it is important to determine the amount of dry matter production Traore *et al*., (2003).Peksen *et al*., (2007) and Torabi Jafrodi *et al*., (2010)Reported that increasing the concentration of total dry matter, leaf area index and crop growth rate increased but decreased relative growth rate and net assimilation rate of plants. Madani *et al*., (2008) stated that the maximum LAI is related to a higher density. LAI in the final stages of growth may decline because of the plant's leaves and the old yellow and leaf area index began to decline. Osman *et al*., (2011)expressed with higher levels of growth in all parameters except the relative growth rate and net assimilation rate increased. The maximum RGR and NAR were obtained from the lowest density. Based on the results of this experiment, the maximum yield was obtained with the highest density of plants per hectare.One of the most important factors in determining crop yield optimal compression.Lopez *et al*., (2008) Stated that the use of very high density, photosynthesis and reduce the current dependence on grain yield to vegetative materials stored in the increasing. Malekmelki *et al*., (2012) reported with increasing plant density increased biological yield and seed yield of lentil. Frade and Valenciano (2005) Reported that the yield increase parallel to the increase in density due to the establishment of more plants and increase the number of pods per unit of production. Gozubenli *et al*., (2004) . Reported that the initial surface density increases, the rate of decline in production from the plant by the number of plants per unit area increased compensation and the performan cHowever, excessive congestion reduction plant parts increased so that others are not compensated by the total plant operation decreased.

The aim of this study was to evaluate the effect of density on growth and yield of faba bean cultivars and determine the best and most appropriate number density in the Ahwaz region.

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.

Experiment Soil

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: Fertilization was calculated based on go $kg.ha^{-1}$pure phosphours from ammonium phosphate, as well as 100 $kg.ha^{-1}$ pure nitrogenfrom 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 fertilizerwas 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.

land preparation operation

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

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.

Samples

First samples were collected 66 days after start of planting in order to study growth trend and physiological indices; sampling was repeated every14 days.

Total dry matter (TDM)

To determine the total plant dryweigthat eachsampling, shoots were chopped and located in the oven in the temperature of 72 degreescentigrade for 48 hours.

grain yield

The grain yield started from the three middle lines as long as 2 meter after eliminating the margins.

Crop growth rate (CGR)

Crop growth rate (CGR) was worked out by adopting the formula of Watson [19] and expressed as g m^{-2} day^{-1}.

$$CGR\ (g\ m^{-2}\ day^{-1}) = \frac{W_2 - W_1}{t_2 - t_1} \quad (1)$$

W1 = Total Dry weight (g m-2) at time t1

W2= Total Dry weight (g m-2) at time t2

t2 – t1 = Time interval in days

Relative growth rate (RGR)

Relative growth rate (RGR) is the ratio of increase in dry weight per unit dry weight already present, expressed in g per g dryweight per day. Relative growth rate at various stages was calculated as suggested by Radford [20]:

$$RGR\ (g\ g^{-1}\ day^{-1}) = \frac{LN\ W_2 - LNW_1}{(t_2 - t_1)} \quad (2)$$

W1 = Total Dry weight of plant (g) at time t1

W2= Total Dry weight of plant (g) at time t2

T2- t1 = Time interval in days

Net assimilation rate (NAR)

Net assimilation rate (NAR) was worked out by adopting the formula of Radford (1967) and expressed as g m^{-2} day^{-1}.

$$NAR\ (g\ m^{-2}\ day^{-1}) = \frac{Ln\ (LAI_2) - Ln\ (LAI_1)}{(t_2 - t_1)} \times CGR \quad (3)$$

LAI1= Leaf area index at time t1

LAI2= Leaf area index at time t2

Statistical analysis: Statistical analysis of data was performed using computer software MINITAB and MSTAT-C and comparison of the means was done by Duncan's test at a probability level of 5 percent.

Results and discussion

Total dry matter (TDM)

Dry matter accumulation pattern in faba bean assumes a sigmoid curve and consists of slow-speedgrowth, fast growth and maturation stages. Major part of total dry weight is produced during heading stage onwards and there is a highly positive correlation between amount of dry matter and the grain yield. The maximum dry density of 12 plants per square meter was observed(Fig. 1).Wasfound that the dry weightincreased with increasing plant density andIt seems that at the beginning of the process to increase the use of environmental resources is particularly light,It was during this time small plants, leaf area did not produce enough light to hit the ground does not absorb enough. After this phase, a rapid increase in dry matter accumulation is due to increased leaf area index during this period, radiation is absorbed into the plant community And the absorption of solar radiation is dependent on the accumulation of dry matter and dry matter accumulation when LAIreaches its optimal level, is maximized. And dry to reduce the peak due to the reduction and loss of photosynthetically active plant organs suchas leaves. This finding was in accordance with the results of madani *et al* (2008).Thetotaldry matter accumulation in different varieties and growing at about 94 days after planting to follow a

similar trend. And from this point on dry matter accumulation rate increases and the highest and lowest dry matter, respectively, and the barekat of the local varieties was observed (Fig. 2). Given a positive correlation with dry matter accumulation, leaf area index and leaf area duration is consistent with Gardner's (2007) to appear. Seems to be a barekat compared to the leaf area index and leaf area duration more than able to produce more dry matter than other varieties tested.This finding was in accordance with the results of dahmardeh *et al* (2008).

Table 1. Analysis of variance for grain yield.

Source of variation	d.f	Grian yield
Replication	2	6515
Density	2	32004**
Variety	2	142033**
D*H	4	1946n.s
Error	16	2269
Coefficient of Variation (%)		10.9

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

Table 2. Maen comparison grain yield.

Treatment	Grian yield(g.m-2)
Density	
D1=8 plant.m2	369.69b
D2=12 plant.m2	487.49a
D3=16 plant.m2	444.73a
Variety	
Barecat(V1)	535.76a
Saraziry(V2)	B472.58b
Local varieties Dezfol(V3)	293.57c

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

Leaf area index (LAI)

Leaf area index is a fundamental parameter to show incremental state of crops in agriculture. Leaf area index increases as time elapses, then remains constant for a short duration and assumes a declining trend afterwards depending on cultivars and ambient conditions. Leaf area index variation trend for different treatments and cultivars are illustrated in figures 3 and 4.The results showed that, in the phase first three levels of density changes, but at the same 94 days after planting density of 16 plants per square meter at the flowering stage had the highest LAI. Can be seen at high densities due to the greater number of plants per unit area, the plant has produced more leaf area. The total increase in plant density, leaf area increases, increase the amount of light absorbed and ultimately leads to increased crop growth rate.This finding was in accordance with the results of Habibzadeh *et al* (2002) and Biswas *et al* (2002).Decline in LAI after flowering stage can increase ghosting and yellow leaves on each plant population aging leaves and reducing light penetration to the lower parts of the plant community was concerned.This finding was inaccordance with the results of Madani *et al* (2008) and Daur*et al* (2010) reported thehighest density was highest LAI was consistent. Changes in leaf area index in different varieties and growing at about 94 days after planting, a similar process was followed (Fig. 4). As can be seen in the charts varieties barekat near the end of the growing season had the highest LAI. This suggests that most of the sub-branches, morenumberof plants per unit area and leaf area in this figure is compared with other varieties.This finding was in accordance

with the results of Talji *et al* (2006) and Liu *et al* (2005).

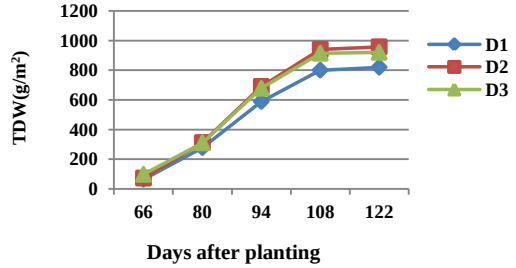

Fig. 1. The trend of changes in TDW affected by different levels of density.

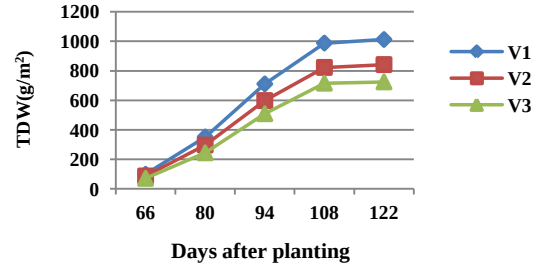

Fig. 2. The trend of changes in TDW affected by different varietis.

Crop Growth Rate (CGR)

Variation trends of crop growth rate in different density treatments represented in (fig.5). As it can be observed,As can be seen the maximum crop growth rate of 12 plants per square meter density of the product is obtained. The fact that most of these treatments is related to LAI.And low-density product growth rate of 8 per square meter of leaf area index of these treatments is low. In fact, at low densities, the percentage of available factors in the growth of the plant is outof thefinding of similar results Fallahi *et al* (2010).At the end of the growing season due to slowdown the aging leaves dry matter accumulation, crop growth rate also decreases, which occurs when The plant to produce new materials, transport of assimilates to the various organs of the seeds This finding was in accordance with the results of Abdol Li *et al* (2011). Note that the density of 12 plants per square meter production growth rate declined less than the density of 8 per square meter that seems The level of radiation absorbed by the vegetation density is actively involved in leading to reduced crop growth rate is lower than the density. This finding was in accordance with the results of Madani *et al* (2008) that Reported that increasing plant density on the growth rate was consistent product is added.Variation trends of crop growth rate in differentvarietiestreatments represented in (fig.6).Bean plants grow rapidly changing data suggest that the early growthperiod up to 94 days after planting Barekat Varetis lot number and crop growth rate thanlocal and shortertime to maximum crop growth rate is reached. In the early stages due to thecomplete lack of vegetation and the low percentage of radiation absorbed by vegetation growth rate is low But over time, the increase in output growth seen since the time of leaf development And the conditions of production and consequent increased asymylat the vegetation growth rate also improved. Crop growth rate at 94 days after planting varieties Barekat for having maximum leaf area and less ghosting than other cultivars were higher. This finding was in accordance with the results of Habibzadeh *et al* (2002) and Ghaeb *et al* (2011).

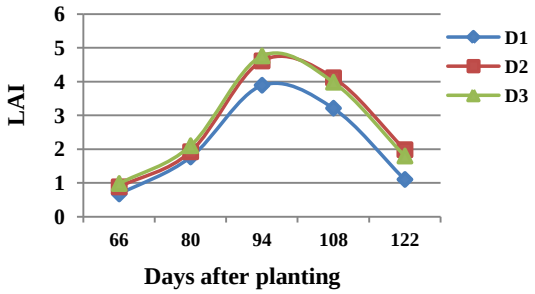

Fig. 3. The trend of changes in LAI affected by different levels of density.

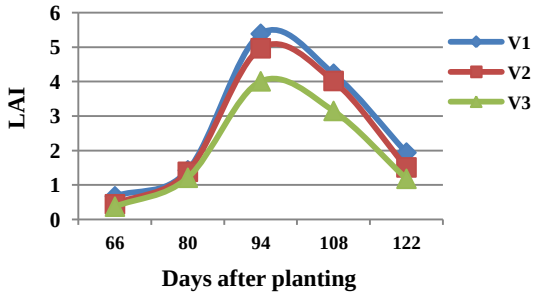

Fig. 4. The trend of changes in LAI affected by different varietis.

Relative growth rate (RGR)

Variation trends of Relative growth rate in different density treatments represented in (fig. 7).According to the figure density of 8 persquare meter during the vegetative growth of the plant and environmental resources and space to develop Different percentage

established by dividing meristematic tissues in non-dividing tissues (movement), more than other densities and This increases the relative dry weight of the plant.This finding was in accordance with the results of Fallahi*et al* (2010) and GhassemiGolezani*et al* (2007).The density of 16 plants per square meter, number of grains per unit area and their competition They produce organs that are involved in determining the weight, but have no role in the production. Over time, the proportion of non-dividing tissue dividing tissues (kinetic) than other densities and relative growth rate decreases.Variation trends of crop growth rate in different varietiestreatments represented in (fig.8).By comparing the changes in the relative growth rate was observed in the number of cultivars have been Barekat with the highest relative growth rate This figure has since been active and growing new tissueand this trend was also seen even when ripe pods Local varieties because it has the lowest relative growth rate growth rate during vegetative growth late in the growing season was even less than other varieties.This finding was in accordance with the results of Bruin *et al* (2008).

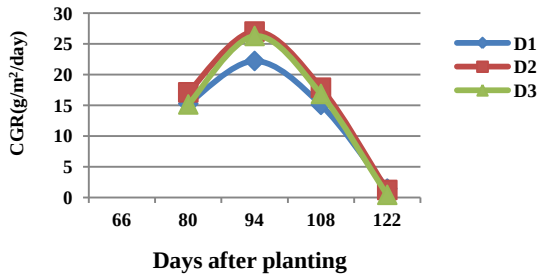

Fig. 5. The trend of changes in CGR affected by different levels of density.

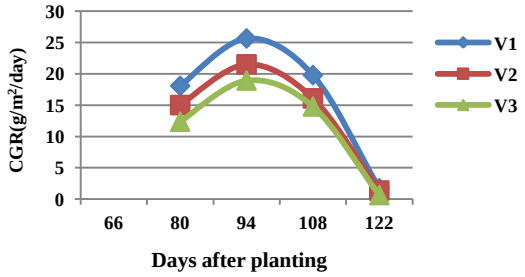

Fig. 6. The trend of changes in CGR affected by different varietis.

Net assimilation rate (NAR)

Net assimilation rate curves exhibited a similar trend for all different density treatments and cultivars. As the trend in figure 9 implies, follows thatthe maximum density of 8 per square meter of pure speed. And after 12 and 16 plants per square meter density were the highest. The NAR began to fall and this decrease continued until the end of the growing season.

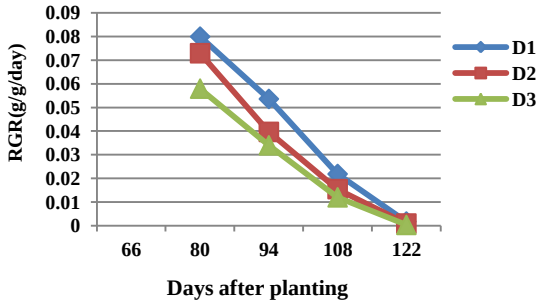

Fig. 7. The trend of changes in RGR affected by different levels of density.

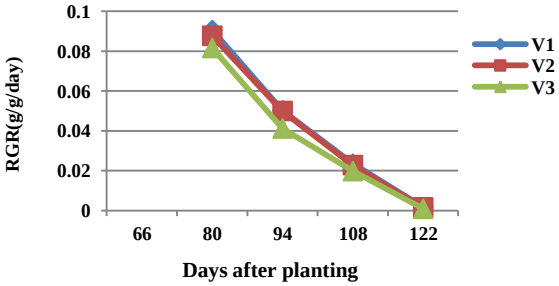

Fig. 8. The trend of changes in RGR affected by different varietis.

Since the density of 8 per square meter with a lesser number of plants per unit area and leaf leaves Less and less ghosting so more light to penetrate. And the rate of accumulation of dry matter in the plant grows the efficiency of plant photosynthesis is greate this finding was in accordance with the results of Osman *et al* (2010). At higher densities due to the frequency of shoot and leaf area index greater photosynthetic efficiency of the plant so ghosting is more or less the NAR is placed on a lower level. This finding was in accordance with the results of Madani *et al* (2008) and Rifaee *et al* (2004).

As the trend in figure 9 implies,NAR charts for all three cultivars, there was a decreasing trend during the period of the maximum NAR was Barekatcultivar growth. were the highest. NAR and then began to fall and this decrease continued until the end of the growing season.Seem to figure Barekat with greater

and greater leaf area, leaf area duration less able to take advantage of environmental opportunities.And dry matter production per squaremeter that the photosynthetic efficiency compared to the other varieties tested increases have caused the net assimilationrate more. This finding was in accordance with the results of Madani *et al* (2008) and Biswas *et al* (2004).

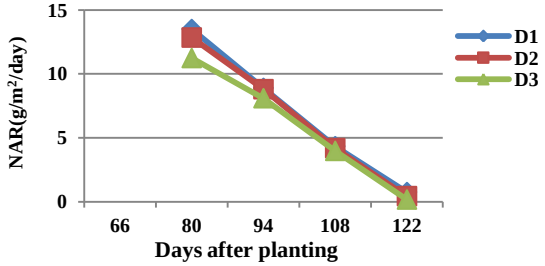

Fig. 9. The trend of changes in NAR affected by different levels of density.

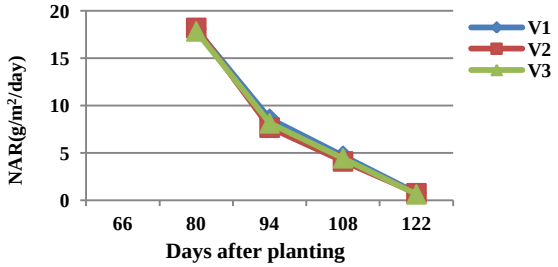

Fig. 10. The trend of changes in NAR affected by different.

Grain yield

The results from analysis of variance for the data showed that the levels of density and varieties have significant difference in 1% probability value on grain yield (Table 1).The maximal and minimal grain yields were obtained for density 12 plants per square meter and density 8 plants per square meter with averages of 487.49 and 369.69 g/m² respectively.And varietiesBarekat and local dezful respectively assumed theaverages of 535.76 and 293.57 g/m² (Table 2). It seemsAsDordas and Lithourgidis (2010) reported a decrease in yield with higher density of 8 per square meter, number of seeds per pod And the numberof pods perplant, poor concentration and lack of efficient use of space is feeding on the plant Habibzadeh *et al* (2002), effect of plant density on yield increase due to increased number of grains per square meter and thus increase the number of pods per per square meter did The study concluded that the results were similar.Bakri *et al* (2011), Reported that the plant more seeds per pod, and this trend moderately reduced in most tributaries of the main branch This review will also increase the number of pods per square meter at high densities relative reduction in pod and seed weight was increased.This finding was in accordance with the results of Gan*et al* (2007).

Conclusions

The results of this study showed that leaf area index, dry matter, crop growth rate, relative growth rate and net assimilation rate were affected by plant density and cultivar With increasing density, leaf area index, dry matter, crop growth rate and net assimilation rate, relative growth rate increased, however, decreased.The density of 12 plants per square meter, these indicators showed the greatest increase. Examined data from physiological indices of growth were different and had the Barekat of the figure.

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