Full Length Research Paper

Effect of plant density and cultivars on growth, yield and yield components of faba bean (*Vicia faba* L.)

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One field experiment was conducted at the Experimental Farm, Faculty of Agriculture at Zabol University during the 2006/2007 season to study the effect of plant density (D) and cultivars (V) on some growth characters of faba bean. The experimental design applied was randomized complete block (RCBD) in factorial arrangement with three replications. Plant density at three levels (12.5, 16.7 and 20 plant m\(^{-2}\)) and cultivars at four levels (Aljazayeri, Barekat, Shami and var. 3514) were used as experimental treatments. The obtained results showed that some characters were markedly affected by plant density, except plant height, height of the lowest pods of soil surface, 100 seeds weight, number of pods per plant and number of seed per pod. Increasing plant density from 12.5 to 20 plant m\(^{-2}\) significantly increased economical yield and biological yield. As such, the cultivars had a significant effect on economical and biological yields. Aljazayeri cultivar surpassed all other cultivars in terms of biological and economical yields, whereas the interaction effect of ‘D x V’ was significant for both biological and economical yields. Increasing plant spacing increased the number of pods per plant, but a decrease in the number of seed/pods consequently gave the highest seed yield. However, cultivars had no significant effect on yield and other investigated characters. Thus, the use of Aljazayeri cultivar at the highest plant density produced the best seed and biological yield in this condition.

Key word: Hundred (100) seeds weight, number of pods, growth characters, economical and biological yield.

INTRODUCTION

Faba bean (*Vicia faba* L.), belonging to pulse crop, is a crop with several benefits. It is important for soil fertility, animal feeding and industry aims (Sharaan et al., 2002). The maximum yield of a legume crop depends upon its yield components, such as the number of branches, pods per plant, seeds per pod and seed weight.

Plant density is an important agent that affects yield and yield components of legumes. The reflex of legume plants to different plant densities was studied by researchers (Ayaz et al., 2004; Tawaha and Turk, 2004).

Plant density is one of the important and effectual factors in the fixation of crop yield and is not stable for one variety in different climate conditions. The studies were conducted by Kakiuchi and Kobata (2004), who concluded that lower plant density increased the pod number per plant and the higher plant density decreased the pod number per plant. Several authors reported that plant height increased with increasing population density up to 33.3 plant/m\(^2\) (Khalil et al., 1993; Abdel-Aziz et al., 1999) or 44.4 plant/m\(^2\) (El-Douby et al., 1996). All of them, in addition to Shahein et al. (1995), Hussein et al. (1999) and Mokhtar (2001), reported that increasing plant density vestige negatively influences numbers of branches and pods per plant. Shams El-Din (1991), El-Douby et al. (1996) and Hassan and Hafiz (1998), indicated that biological yield was improved by increasing plant density. However, non significant effect of plant density was detected on plant height (Shahein et al., 1995). Bruin and Pederson (2008) observed that soybean planted in 38 cm row spacing yielded 248 Kg ha\(^{-1}\) greater than soybean planted in 76 cm rows. Gan et al. (2007) have also shown increase of grain yield at higher plant density in chickpea. Nonetheless, the present work is an attempt to study the effects of different varieties and plant density on the yield

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Table 1. Effect of plant density on mean seed yield (t/ha) and other characters of faba bean during the 2006/07 season.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant height (cm)</td>
<td>43.5</td>
<td>42.8</td>
<td>44.7</td>
<td>43.6&lt;sup&gt;ns&lt;/sup&gt;</td>
</tr>
<tr>
<td>Number of pods/plant</td>
<td>5.4</td>
<td>4.4</td>
<td>4.0</td>
<td>4.6&lt;sup&gt;ns&lt;/sup&gt;</td>
</tr>
<tr>
<td>Number of seed/pod</td>
<td>2.7</td>
<td>2.7</td>
<td>2.9</td>
<td>2.7&lt;sup&gt;ns&lt;/sup&gt;</td>
</tr>
<tr>
<td>Seed weight/plant (g)</td>
<td>28.6</td>
<td>25.1</td>
<td>24.7</td>
<td>26.1&lt;sup&gt;ns&lt;/sup&gt;</td>
</tr>
<tr>
<td>Seed yield /ha (t/ha)</td>
<td>1.8&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.2&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
<tr>
<td>Biological yield (t/ha)</td>
<td>2.8 b</td>
<td>2.9 b</td>
<td>4.3 a</td>
<td>3.3&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Co-variance (C.V) = 17.5%; D1 (12.5 Plant m<sup>-2</sup>), D2 (16.7 Plant m<sup>-2</sup>) and D3 (20 Plant m<sup>-2</sup>); <sup>ns</sup>: Non significant.

Table 2. Effect of cultivars on mean seed yield (t/ha) and other characters of faba bean during the 2006/07 season.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>V1</th>
<th>V2</th>
<th>V3</th>
<th>V4</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant height (cm)</td>
<td>46.8</td>
<td>44.5</td>
<td>43.0</td>
<td>40.4</td>
<td>43.6&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
<tr>
<td>Number of pods/plant</td>
<td>5.7</td>
<td>3.2</td>
<td>4.1</td>
<td>5.3</td>
<td>4.5&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
<tr>
<td>Number of seed/pod</td>
<td>2.6</td>
<td>3.5</td>
<td>2.5</td>
<td>2.8</td>
<td>2.8&lt;sup&gt;ns&lt;/sup&gt;</td>
</tr>
<tr>
<td>Seed weight/plant (g)</td>
<td>29.8</td>
<td>26.7</td>
<td>22.0</td>
<td>26.1</td>
<td>26.1&lt;sup&gt;ns&lt;/sup&gt;</td>
</tr>
<tr>
<td>Seed yield /ha (t/ha)</td>
<td>2.53&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.21&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.06&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>1.91&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.1&lt;sup&gt;ns&lt;/sup&gt;</td>
</tr>
<tr>
<td>Biological yield (t/ha)</td>
<td>3.65 a</td>
<td>3.42 ab</td>
<td>3.39 ab</td>
<td>3.16 b</td>
<td>3.4&lt;sup&gt;ns&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Co-variance (C.V) = 19%; V1 (Algazayeri), V2 (Barekat), V3 (Shami) and V4 (var. 3514); <sup>ns</sup>: Non significant.

and yield components of *V. faba*.

MATERIALS AND METHODS

The field experiment was carried out in the University of Zabol farm, Faculty of Agriculture at University of Zabol, during the 2007/2008 season to study the effect of plant density and varieties on some growth characters of faba bean (*V. faba* L.). The soil of the experimental site was sandy loam in texture with EC of 1.3 mhos/cm and pH of 7.8. The experiment included 12 treatments resulting from the combination of three plant density, that is, 12.5 plant m<sup>-2</sup> (D1), 16.7 plant m<sup>-2</sup> (D2) and 20 plant m<sup>-2</sup> (D3); and four cultivars, that is, Algazayeri (V1), Barekat (V2), Shami (V3) and var. 3514 (V4).

The experimental design applied was randomized complete block in a factorial arrangement, with three replications. The area of each plot was 2 × 4 (8 m<sup>2</sup>), including 4 rows of 4 m length and 50 cm width. Calcium super phosphate ammonium and potassium sulphate (48% K<sub>2</sub>O) were added at the rates of 200 and 100 kg ha<sup>-1</sup>, respectively, during seed bed preparation. Before sowing, the seeds were treated with fungicide (Vetavax) at the rate of 2 g/Kg seeds and seeding was done in holes (two seeds/hole). Thinning was practiced after 25 days from sowing to keep one plant to a hole. Simulative dose of urea (46%) (60 Kg ha<sup>-1</sup>) was added before the first irrigation, while the second split of urea was added after thinning and the third split in the flowering stage. At harvest, five reserved plants were randomly taken from each plot to record the averages of plant height, number of seed per pod, number of pods and seed weight. The biological and economical yield of the two inner rows per plot was determined and used for calculating that of the plot. The data on growth, yield, and other parameters were analyzed by Fisher's analysis of variance technique and Duncan test at 0.05 probability levels to compare the treatment means (Steel and Terrie, 1984). However, data analysis was conducted by SAS Institute (2001) as a factorial experiment 4 × 3 with three replicates.

RESULTS AND DISCUSSION

Plant height (cm)

The data confirmed that changing the plant density had shining influences on plant height, where it was increased by a decreasing space between plants, but the differences were insignificant (Table 1). The highest of plant height was obtained at D3 (20 plant m<sup>-2</sup>) with 44.7 cm and the lowest of plant height was obtained at D2 (16.7 plant m<sup>-2</sup>) with 42.8 cm. This increase in plant height could be justified on the bases of increase in the number of plants per unit area coupled with high plant-to-plant competition. This result was similar to Abdel-Aziz et al., (1999). However, Shahein et al. (1995) reported that plant height was not affected by increasing plant density. The results indicated that var. 3514 was the shortest and Algazayeri was the highest, though plant height did not show significant difference at cultivars (Table 2). Nonetheless, varietals differences in plant heights were frequently recorded by Abdalla et al. (2000).

Number of pods / plant

As shown in Table (1), the number of pods were not affected by plant density, but the highest number of pods...
was obtained at D1 (12.5 plant m$^{-2}$) with 5.4 pods at plant and the lowest number of pods was obtained at D3 (20 plant m$^{-2}$) with 4 pods at plant. Regarding the tested cultivars, the data indicated that Algazayeri cultivar produced the highest number of pods/plant (5.7) (Table 2), whereas Barekat cultivar produced the lowest number of pods/plant (3.2). Such varietals differences in pods number were previously reported by Khalil et al. (1993) and Abdalla et al. (2000).

**Number of seeds per pod**

As shown in Table (1), the seed/pod was not affected by plant density and cultivars. The highest number of seed/pod was obtained at D3 (2.9 seeds/pod) and the lowest number was obtained at D1 (2.7 seeds/pod). However, El-Fieshawy and Fayed (1990) reported that seed/pod was not affected by plant density.

The results showed that cultivars were greatly different in the number of their seeds per pod, but were not significantly affected by plant density and cultivars. Shami cultivar showed the lowest seed/pod and Barekat cultivar showed the highest seed/pod (Table 2). Genotypic differences for this character were also recorded by Abdalla et al. (2000), whereas Ashmawy et al. (1998) found insignificant differences for this character.

**Seed weight per plant (g)**

The data presented in Table 1 showed that seed weight/plant was significantly increased by increasing distances between plants, but was not significantly different at the 5% probability level. The highest number of seed weight/plant was obtained at D1 (28.6 g) and the lowest at D3 (24.7 g). These increases were used in connection with the decreased inter plant competition that leads to increased plant capacity, for utilizing the environmental inputs in building great amount of metabolites to be used in developing new tissues and increasing its yield components. These results are in agreement with those obtained by Mokhtar (2001). Also, they are in agreement with the results of Sutzel and Aufhammer (1992) and Abdel (2008) that seed weight is negatively correlated with the number of seeds and pod in crops’ number. With regard to the cultivars effect, the results showed that Algazayeri cultivar had the heaviest seed weight per plant compared to other cultivars (29.8 g) and Shami cultivar had the lightest seed weight/plant compared to other cultivars (22 g) (Table 2).

**Seed yield /ha (t/ha)**

The results showed that the effect of plant density on seed yield had significant differences ($P < 0.05$). The highest and lowest seed yields were obtained with the highest and lowest plant density, respectively. As such, D3 (20 plants m$^{-2}$) was significantly higher than those of other plant densities. Raising seed yield by increasing plant density was frequently reported by several workers, and amongst them are El-Douby et al. (1996) and Hassan and Hafiz (1998) who established the present findings. However, Shakeel et al. (2005) reported the effects of increasing plant density on yield of rice, though plant density significantly increased on the grain yield of rice.

With regard to cultivars, the results showed that Algazayeri cultivar produced the highest seed yield (2.53 t ha$^{-1}$), because this cultivar had the highest number of pods per plant. These results reflected the importance of number of pods/plant and seed weight/plant as yield contributors (Table 2). D x V interaction effect was significant on seed yield, where the highest yield was obtained from Algazayeri cultivar with the highest plant density (Table 3).

**Biological yield (t/ha)**

The results showed also that the character markedly increased biological yield by increasing plant density from 12.5 to 20 plant m$^{-2}$, due to increased number of plants/unit area (Table 1). These results are confirmed by several faba bean investigators (El-Douby et al., 1996; El-Metwally et al., 2003) and the results showed that Algazayeri cultivar produced the highest values of biological yield (3.65 t ha$^{-1}$) where no significant difference was observed due to Barekat and Shami cultivars. Superiority of this cultivar may be due to their advantages in plant height and number of pods (Table 2). This result reflects the importance of these characters (especially plant height) as biomass contributors. Markedly, varied variation among cultivars detected that these results support those reported by Hassan et al. (1997). The character was significantly affected by (D x V) interaction, where the maximum value resulted from the Algazayeri cultivar under the highest plant density (Table 3). This result is in agreement with those obtained by Leilah et al. (1988) who recorded the largest biological yield from the highest plant density.

**Conclusion**

The present study showed that plant density and cultivars affected yield and yield components of V. faba under arid conditions in the southeast region of Iran. The selection of cultivars and plant density can improve the economic yield and directly influence the yield components. It can reasonably be concluded that the results of this study showed that cultivars of faba bean had significant effect on seed and biological yields.
Table 3. Economic yield (EY) and biological yield (BY) as affected by plant density and faba bean cultivars during the 2006/2007 season.

<table>
<thead>
<tr>
<th>Plant density</th>
<th>Cultivars</th>
<th>EY (t/ha)</th>
<th>BY (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>V1</td>
<td>1.96 bc</td>
<td>2.75 cd</td>
</tr>
<tr>
<td></td>
<td>V2</td>
<td>1.58 c</td>
<td>2.27 d</td>
</tr>
<tr>
<td></td>
<td>V3</td>
<td>1.23 c</td>
<td>2.85 cd</td>
</tr>
<tr>
<td></td>
<td>V4</td>
<td>1.86 bc</td>
<td>3.49 bcd</td>
</tr>
<tr>
<td>D2</td>
<td>V1</td>
<td>1.60 c</td>
<td>2.68 cd</td>
</tr>
<tr>
<td></td>
<td>V2</td>
<td>1.45 c</td>
<td>3.11 cd</td>
</tr>
<tr>
<td></td>
<td>V3</td>
<td>1.93 bc</td>
<td>3.45 bcd</td>
</tr>
<tr>
<td></td>
<td>V4</td>
<td>1.83 bc</td>
<td>2.55 cd</td>
</tr>
<tr>
<td>D3</td>
<td>V1</td>
<td>3.58 a</td>
<td>5.53 a</td>
</tr>
<tr>
<td></td>
<td>V2</td>
<td>2.79 ab</td>
<td>4.88 ab</td>
</tr>
<tr>
<td></td>
<td>V3</td>
<td>2.29 abc</td>
<td>3.86 bc</td>
</tr>
<tr>
<td></td>
<td>V4</td>
<td>1.81 bc</td>
<td>3.10 cd</td>
</tr>
<tr>
<td>Mean</td>
<td>---------</td>
<td>1.99</td>
<td>3.37</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>---------</td>
<td>1.01</td>
<td>1.34</td>
</tr>
<tr>
<td>C.V (%)</td>
<td>---------</td>
<td>21.6</td>
<td>23.5</td>
</tr>
</tbody>
</table>

V1 (Algazayeri), V2 (Barekat), V3 (Shami) and V4 (var. 3514); D1 (12.5 Plant m^{-2}), D2 (16.7 Plant m^{-2}) and D3 (20 Plant m^{-2}); any two means not sharing a common letter differ significantly from each other at 5% probability; C.V, co-variance; LSD, least significant difference.

With the increase in plant density of faba bean, there has been an increase in competition between plants for light reception. This action was caused by an increase in plant height and consumable assimilates for vegetative growth of plant. Nevertheless, probability in high density with a decrease in received light was not due to oxcin rate hormone decomposition, but was caused by an increase in plant height. Thus, low number of pod in plant was due to the most vegetative growth of plant. For compensation, the number of pod in plant decreased and the number of seed in pod increased, but the seed weight decreased because of assimilates division between higher numbers of seed. However, probability in the increased economic yield number of seed was more effective than the seed weight. As a result, more biological yield was obtained for the increased density due to an increase in the number of plant in the unit’s area. For economical and best seed yield, faba bean should be planted in order to obtain density (20 plant m^{-2}) and use Algazayeri cultivar for the best seed and biological yield.

REFERENCES


