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Effect of plant density on seed yield and agronomic characters of faba bean (*Vicia faba* L.) under green house conditions.

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Experiment was conducted to find out the genotypic differences of faba bean in response to different plant densities with the aim to find suitable variety and plant density giving better production under green house condition. Three varieties “Baldy”, “Giza1” and “Syrian” along with three densities i.e. 2, 4 and 6 plants per pot were used. Results showed that for parameters like stem and leaf dry weight, seed dry weight, total dry matter and stem height, highest values were obtained at the highest plant density (06 plants/pot) “Syrian” gave the highest stem and leaf dry mater yield (107.20 g) and total dry weight yield (128.40gm) at this density (06 plants/pot). However, highest main stem height, (58.17 cm/plant) was obtained in variety “Giza1” at this density. Highest stem and leaves dry weight (258.33g) was observed in "Syrian" when values were averaged across the densities. However, other parameters like seed dry weight (106.84g), total dry weight (317.93g) and main stem height (159.17) was highest in the variety “Giza1”. The growth rate was higher at density of 06 plants per pot for all varieties. In case of “Baldy” higher growth rate in term of main stem height (cm) was observed at density of 02 plants/ pot. Highest growth rate was observed in “Baldy” as compared to the “Giza1” and “Syrian”, respectively. In conclusion, highest seed setting and yield was associated with the highest plant density for all varieties however genetic differences also existed. Genotypic differences in the growth rate were also evident.

Key words: ***Vicia faba.*** **L, plant density, stem height, growth, dry weight**

The grain legume faba bean (*Vicia faba. L*) is grown world-wide as a protein source for food and feed. Moreover, faba bean offers ecosystem services such as renewable inputs of nitrogen (N) into crops and soil via biological N_2 fixation, and a diversification of cropping systems (Jensen *et al*. 2010). The faba bean is a very important source of edible protein in the diet with a content of 18-40% for the people of the Middle East and North Africa (Haddad and Thalji, 1988). The increasing need for protein in world has stimulated scientists to research for increased yield and quality in this crop. In Jordan, the crop is mainly grown under irrigation for fresh pod utilization. However, considerable areas of the crops are grown under rainfed conditions for both fresh pod and dry seed production. As a rainfed crop, Faba bean is treated as a winter crop and fit well with cereals in the rotation. The grain yield produced was seriously affected by limited water supply under rainfed conditions. The agronomic traits were also adversely affected by the water stress (Thalji, 2009). The results from the agricultural statistical book have shown that the total area used for both rainfed and under irrigation is (1440 ha), with (963) tons. However, reported yields in Jordan are low in general.

Information regarding the influence of plant density on the growth and yield of the faba bean crop (*Vicia faba* L.) has been reviewed (Lopez-Bellidoa *et al*. 2005). With a longer growing season and under optimum environmental conditions, there is normally no additional response to densities over 20 plants m^{-2}, while in suboptimal conditions; optimum plant density may increase to over

60 plants m^{-2}. Although the faba bean crop displays considerable plasticity in response to variations in plant density, mainly with regard to number of pods per square meter, it is not wholly clear to which component of yield this should really be ascribed. Number of stems per plant appears to be the most influential factor, although further research is required to confirm this (Lopez-Bellidoa *et al*. 2005).

In Jordan faba bean is mainly grown under irrigation for fresh pod utilization. However considerable areas of the crop are grown under rain fed condition for dry seed production (Thalji and Shalaldeh, 2006).

The aim of this study was to point out the genotypic differences in response to different plant densities in order to find suitable variety and plant density giving better production under green house condition.

MATERIALS AND METHODS

The present experiment was carried out in a green house in spilt-plot design with 3 replications where the varieties were the main plot and the plant densities sub-plot. Three varieties used in the experiment were “Baldy”, “Giza1” and “Syrian”. The experimental material was grown during 2007/2008 season in a green house at the University of Jordan, faculty of Agriculture, Jubeiha-Amman. The planting was made during the November which is the normal sowing date in Jordan.

The seed for varieties tested were sown in plastic pots 30cm in diameter. The pots were filled with an equal amount (8.8 kg) of soil that was removed from the field and cleaned by hand from stones. The plants were irrigated daily to field capacity.

Three plant densities used in the experiment were 2, 4 and 6 plants per pot. The varieties and densities were given to each pot at random for each replication. Heights of the main stem, flowering, pollination, number of pods/plant and seed per pod were recorded with one week intervals until the flowering stage. Irrigation of the pots was stopped after 16 weeks of planting and the plants were left in the pots for 3 weeks for drying. After that pots were harvested by hand. The samples were placed in an oven for drying at 100 ^{o}C for 35 hours and then weighed by using a balance. The dry seeds were separated and weighed alone for each pot. Descriptive statistical analysis was carried out for the several characters over three densities and for the three varieties.

RESULTS

Experiment findings showed that for all studied characters there are differences existing among varieties at different plant densities (table 1). For all three varieties included in the study, highest values were obtained at the highest plant density (06 plants/pot) for all the parameters like stem and leaf dry weight, seed dry weight, total dry matter and stem height. “Syrian” gave the highest stem and leaf dry mater yield i.e. 107.20 g and total dry weight yield (128.40gm) at the highest plant density (06 plants/pot). However, for the height of the main stem, the highest height (58.17 cm/plant) was obtained in variety “Giza1” at density of 06 plants/pot.

It is evident from table 2 that the varieties respond positively with the density. As plant density increase per unit for all varieties, all characters also increased. Moreover, it is clear in the table 3 that highest stem and leaves dry weight (258.33g) was observed in variety "Syrian" when values were averaged across the densities. However, other parameters like seed dry weight (106.84g), total dry weight (317.93g) and main stem height (159.17) was highest in the variety “Giza1”.

The data for main stem growth rate is summarized in table 4. The growth rate was higher at density of 06 plants/pot for all varieties. Variety “Giza1” grew at the same rate at different densities. In case of “Baldy” higher growth rate in term of main stem height (cm) was observed at density of 02 plants/ pot. However, “Syrian” showed comparatively higher growth rtes of stem at 02 and 04 plant/pot densities. Mean values of the main stem height at different intervals (one week for each interval) for three varieties averaged across the densities are presented in the table 5. Highest growth rate was observed in “Baldy” variety as compared to the “Giza1” and “Syrian” variety, respectively.

DISCUSSION

Faba bean genotypes prompt variations in optimum plant density, depending on the botanical type (major, equina or minor) and the growth habit (determinate versus indeterminate) of the cultivar selected (Lopez-Bellido, 2005).

Table 1: Variation in the total values for several characters averaged over 3 densities

*Average height of the main stem per plant in cm	Average total wt in gm DM weight	Average seed dry wt in gm	Average stem and leaves dry wt in gm	Variety X density
54.17	95.41	25.23	70.16	V1D1
46.83	100.65	27.06	73.59	V1D2
58.17	121.87	27.55	74.09	V1D3
52.33	97.40	22.81	71.59	V2D1
43.67	81.93	20.29	61.02	V2D2
54.83	122.87	35.76	87.11	V2D3
47.67	75.70	16.99	58.71	V3D1
45.33	104.40	11.43	92.96	V3D2
50.00	128.40	21.21	107.20	V3D3

V1 = Baldy variety D1 = 2 plants / pot
V2 = Giza1 variety D2 = 4 plants / pot
V3 = Syrian variety D3 = 6 plants / pot
* Height of the main stem at flowering stage not at harvesting time. Values are average of three replicates.

Table 2: Mean values of agronomical traits averaged across the different varieties at three densities.

*Height of the main stem in cm	Total dry matter weight in gram	Seeds dry weight in gram	Stem & leaves dry weight in gram	Density Plants / pot
159.17	265.49	65.03	200.46	2
150.83	286.35	58.78	227.57	4
373.14	372.92	84.52	288.40	6

*Height of the main stem at flowering stage not at harvesting time.

Table 3: Mean values of agronomical traits averaged across the different densities for three varieties.

*Height of the main stem in cm	Total dry matter weight in gram	Seeds dry weight in gram	Stem & Leaves dry weight in gram	Variety
159.17	317.93	106.84	237.84	Baldy
149.83	302.20	78.86	219.72	Giza1
143.00	308.50	49.63	258.33	Syrian

*Height of the main stem at flowering stage not at harvesting time.

Table 4: Mean values of main stem height at different time intervals (one week interval) over three densities.

5th date 30-1- 2007/2008	4th date 23-1-2007/2008	3rd date 16-1-2007/2008	2nd date 9-1-2007/2008	1st date 2-1-2007/2008	Variety X Density
54.17	41.83	33.83	25.67	15.00	V1D1
52.23	36.16	28.35	20.50	11.33	V1D2
47.67	34.00	26.83	21.33	15.00	V1D3
46.83	33.67	27.33	20.33	12.00	V2D1
43.67	31.67	24.50	17.83	11.50	V2D2
45.33	34.00	27.50	19.67	13.83	V2D3
58.17	43.83	35.00	25.67	15.33	V3D1
54.83	44.67	36.33	28.00	19.83	V3D2
50.00	36.67	31.00	24.00	17.00	V3D3

V1 = Baldy variety D1 = 2 plants / pot
V2 = Giza1 variety D2 = 4 plants / pot
V3 = Syrian variety D3 = 6 plants / pot

Similarly, in present study all three varieties included in the study, highest values were obtained at the highest plant density (06 plants/pot) for all the parameters like stem and leaf dry weight, seed dry weight, total dry matter and stem height. This clearly shows an increase in the growth of faba bean with increased plant density. Previously, was reported that sowing date also influences optimum seeding rate, which is lower for

Table 5: Mean values of the main stem height at different intervals (one week interval) for three varieties averaged across the densities.

5th date 30-1- 2007/2008	4th date 23-1-2007/2008	3rd date 16-1-2007/2008	2nd date 9-1-2007/2008	1 st date 2-1-2007/2008	Variety
159.17	119.33	96.16	71.67	42.33	Baldy
150.83	112.50	89.33	66.33	42.66	Giza1
143.00	104.67	85.33	65.00	45.83	Syrian

autumn–winter sowing under temperate and Mediterranean conditions and increases as the sowing date is delayed. For the spring-sown crops typical of temperate conditions, optimum plant density will be higher due to the shorter growing season (Lopez-Bellido, 2005). As in the present study, "Syrian" gave the highest stem and leaf dry mater yield and total dry weight yield at the highest plant density (06 plants/pot). This variety may be suitable for shorter growing season. Although the faba bean crop displays considerable plasticity in response to variations in plant density, mainly with regard to number of pods per square meter, it is not wholly clear to which component of yield this should really be ascribed. Number of stems per plant appears to be the most influential factor, although further research is required to confirm this (Lopez-Bellido, 2005).

In the present study, highest values for all the parameters like stem and leaf dry weight, seed dry weight, total dry matter and stem height were obtained at the highest plant density (06 plants/pot) in all genotypes. Theses agronomic characteristics seem to contribute also. Several investigators have studied the effect of plant density on growth and yield of faba bean. They reported that increase in the plant density resulted in the high seed yield of faba bean. As this study was concerned with the problem connected with selection of varieties for the rather specific environment appropriate to Jordan. Variation due to the growth rate was obvious between the densities for one variety and between varieties. The highest growth obtained at the highest densities but at density 4 plants / pot least growth rate was observed.

CONCLUSIONS

This investigation demonstrated good prospects for faba bean improvements under semiarid conditions of Jordan as well as of the Mediterranean zones. The following items can be concluded:

1- The highest seed setting for all varieties was affected by the highest plant density.
2- The highest yield for all varieties was associated with the highest plant density.
3- Genetic differences were existed among varieties.
4- Growth rate differences due to genetics observed clearly.

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