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Full Length Research Paper

The effect of planting distance on yield of beans (*Vicia faba L.*) under drip irrigation system

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A study was conducted at the College of Agriculture, Kirkuk University, Iraq to investigate the effect of planting distance on yield of faba beans (*Vicia faba L.*) under drip irrigation. The yield of three different varieties of beans (Spanish, Turkish and Local) at three different planting distances, including 20, 25 and 30 cm was studied. The result indicates that both the interactions between plant distance and different varieties of beans and that of the distance between plants were not significant at 95% level of significance. However there were significant differences (P<0.01) for the varieties of bean based on percentage of growth, plant height, branches plant^{-1}, pod length and number of seed pod^{-1}, with average values of 94.86%, 35.85 cm, 87.50 cm, and 10.39 cm, respectively. Also a significant difference (P<0.05) was found in the number of nodes plant^{-1}. Differences on the number of branches plant^{-1} and weight of pods were not significant.

Key words: Drip irrigation, varieties, bean, pod, plant distance.

INTRODUCTION

Faba beans (*Vicia faba L.*), one of the leguminous crops cultivated widespread in Iraq and other parts of the world, occupies the first place among legumes crops and a source of essential food that in turn contain high proportion of protein (21 to 34%), amino acids, fat and sugar (Aljubouri, 2006; Hansen, 1972). China is ranked first in beans production and consumption, amounting to 2.7 million tons year^{-1} (65%) of world production, followed by Ethiopia (9%) and then Egypt 262 thousand tons year^{-1}. As for Iraq, the rates of production is low, 1.76 t ha^{-1}, of dry seeds and 5.15 t ha^{-1} of pod green on average between 1989 to 2002, (FAO, 2003). This may be due to the cultivation of local varieties and poor methods of field operation (Aljubouri, 2006).

Varieties vary in vegetation according to the nature of growth, which differ in leave sizes, stem, branches, continued to grow after flowering, and thus lead to different forms of plant (Yoshida, 1972). The plant density per cubic meter directly affects the plant height depending on the varieties planted (Abdul and Aziz, 1978); they also found that the branches and plant branches are inversely proportional to each other.

Kambal (1969) found in a study when comparing three varieties of beans that there were no significant differences between varieties in the product of the plant, number of seeds pod^{-1} and the number of branches in the plant. In an experiment conducted by Yassin (1973) for ten varieties of beans in Sudan it was noted that there were significant differences between the mean of factors in a number of Pod of the plant which ranged between 15.10 to 20.70 pod plant^{-1} and the weight of 1000 seeds ranged between 529 to 335 g, while no significant differences were observed in the number of seeds pod^{-1}. Another study conducted by El-Mott (1981) on 18 species for a period of three years in three locations found significant differences for the seeds yield.

Li-Juan (1988) has compared five varieties of *faba* beans in China and the result showed that the plant height

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ranged between 16 and 160 cm and number of pod plant^{-1} 17 and 30. Nanda et al. (1988) found a significant difference in the total of seeds, harvest index, number of seeds per plant and 100 seed weight.

In a study by Taher and Wali (1990) for growth traits and the sum of three varieties of beans (Aguadulce, Italian and Gize) showed superiority in Gize species compared to others in all studied traits like leaf area, plant height and number of branches per plant, weight and number of seeds per plant, while Aguadulce species gave the highest value for 1000-seed weight and seed size. Wali et al. (1990) in a study of three varieties of beans under sprinkler irrigation system study found that Gize species was better than Aguadulce and Italian.

Khidr (1983), also found when he compared four varieties of beans in Hamam alil and Dohuk that Spanish species is better compared to Aquadulce, local and FAO 21 at the site of Dohuk, (during both phases of vegetative growth and flowering, whereas cultivar surpassed the local during the stage of maturity). The study by Almarsomy et al. (1991), for crop beans grown in Central Iraq showed no significant differences between the local and Aquadulce species in pod number/plant and number of seeds/pod and therefore did not differ in the yield. The results of a study in northern Iraq on five varieties of beans under the influence of supplemental irrigation and Abscisic Acid (ABA) by Al-Hamdani (2005) showed superiority (French, Syrian, Teuthah and Babylon unlimited growth) significantly on the species called Energy 375 limited growth.

The increase in plant density and change in the distribution of plants is an important way to improve light interception and use of energy efficiently to get the best production (Issa, 1984). In a study conducted by Tamaki and Noka (1973) using four plant densities 3.8, 7.6, 15.2 and 30.4 plants m^{-1} observed that the effect of plant density started appearing at flowering and high density during elongation of the distance between nodes and reduced the number of branches per plant, pod number and number of seeds per plant.

Shalaby and Mohamed (1978a) found a significant increase in the number of branches to plant at the distance 25 cm when single crops are planted at 25, 20, 15.10 cm between the plants and left 1, 2 and 3 crops are planted. In another study, Mohamed and Shalaby (1978b) found that there was significant increase in the total number of seeds when distance is reduced between plants and increases the number of crop planted. In a study for Abo-El zahab et al (1980), for three inter crop spacing 40, 50 and 60 and 30 cm between plants and leaving two crops are planted, which has given three plant densities, high, medium and low showed no significant effect in any of the components of crops, the number of pod plant^{-1}, number of seed pod^{-1} and 100 seed weight. In Burkhar and Keller (1983), the increase in plant density leads to a significant reduction in the number of branches plant^{-1} and a significant increase in plant height when using the plant density of 80 plants m^{-1}.

Aljubouri (1985) studied using the distances 20, 30.40 cm between plants, which gave plant densities of 2.13 to 5.80 to 6.40 plants m^{-1}, respectively. The increase in the distance between plants led to a decline in seeds and a significant reduction of plant height and 100 seed weight, while increased significantly in number and the number of branches, pod and total of a seed plant^{-1} and increase the number of days from sowing to 50% flowering and until the advent of the first pod.

According to Al-Khafaji (1987) using planting spaces 20, 30 and 40 cm between plants, gave plant densities of 0.4, 8.5 and 13.3 plant m^{-1} respectively. Increase in the distance between plants led to significant increase in the number of branches, pod number, and total seeds of plants, number of seeds pod^{-1} and 100 seed weight, and significantly increased the number of days from planting (50%) flowering, while there were significant decrease in plant height, total seed and total protein (ton ha^{-1}). Also Nasser and Khudair (1990) found when they use the three plant densities 66666, 88888 and 133332 plant ha^{-1} that there was significant effect for plant high density on the yield, 100 seed weight and plant height, while there was significant effect for plant low density on the number of seed pod^{-1} and the number of branches plant^{-1}. This study aimed at finding the effect of plant and rates of productivity in terms of quality and quantity as well as to determine the best distance for agricultural crop beans and the appropriate combination between them and producing the best qualities required.

MATERIALS AND METHOD

Location

A study was conducted at the Faculty of Agriculture, University of Kirkuk, Iraq, during the winter growing season 2009 to 2010. This study was conducted using three varieties of beans (Spanish, Turkish and local) the seeds were planted at the beginning of the month of November using three distances between plants 20, 25, 30 cm, respectively. N.P.K fertilizer added according to recommendations (150 kg ha^{-1}) and urea (20 kg ha^{-1}) and use drip irrigation system according to the needs of the plant (Figure 1).

Soil and weather characteristics of the location

Field experiment was conducted in silty clay soil, the weather characteristics of the Location was warm tends to cold temperature range 18 to 30°C, and day with a short 8 to 10 h.

Experimental design

A randomized complete block design (RCBD) with three replicates was used.

Data were analyzed using ANOVA and the least significant difference LSD calculated at 1 and 5% to estimate the differences between means. Variables recorded were percentage of germination (%), plant height (cm), number of branches per plant, number of leaves per plant, number of nodes for each stem, pod length (cm), number of seeds pod^{-1}, pod weight (g) and grain

Table 1. Analysis of variance (ANOVA).

Source of variation (S.O.V)	d. f	Germination percentage (%)	Plant height (cm)	Number of branches plant^{-1} (No.)	Number of leaves plant^{-1} (No.)	Number of nodes stem^{-1} (No.)	length of pod (cm)	Number of seeds pod-1 (No.)	Pod weight (g plant^{-1})	Seed weight (g)
Duplicates	2									
Transactions	8									
Varieties(v)	2	2998.20	221.33	0.67	5170.23	351.17	14.57	2.76	29.80	18.60
Spaces(d)	2	19.26	5.976	0.15	162.39	67.60	0.74	0.09	76.90	7.82
Overlap between (v, d)	4	94.33	17.86	0.33	122.99	27.30	1.55	0.16	3.27	0.59
Experimental error	16	47.43	23.84	0.31	365.77	69.33	1.142	0.243	35.8	7.07
TOTAL	26									
		L.S.D= 14.526	L.S.D= 10.299	n.s	L.S.D= 40.335	L.S.D= 17.561	L.S.D= 2.253	L.S.D= 1.039	ns	ns

*, Significant at P < 0.05, **, significant at P < 0.01, ns, not significant

weight (g).

RESULTS AND DISCUSSION

Tables 1 and 2 show that all varieties varied significantly for germination (P<0.01). The Turkey variety gave the highest percentage of germination of varieties cultivated rate at 94.86% and lowest in local varieties of 60.65% was motivated by variation in the environmental factors among varieties. No significant differences were found for the distances between plants and the overlapping bilateral between plants spaces and varieties. Highest germination percentage of the distance between the first plants spaces (20 cm) was 83%.

Tables 1 and 3 show that the varieties varied significantly in plant height at P<0.01, the local varieties reached an average 35.85 cm and Spain varieties was the highest with 26.01 cm. The different varieties in plant height may be motivated by variation in the environmental factors among varieties. During growing period, the local variety grows upright and straight while the Spanish and the Turkish varieties are short with sprang branches and several flowers (Pilbeam et al 1990). There results agree with Habib et al (1971); Furgal and Evans (1980); Abbas (1988); Al-Hamdani (2005) and Wierzbicka (1998). It is clear from Tables 1 and 4 on the status of the branches plant^{-1} that there were no significant differences in this study.

The results (Tables 1 and 5) indicate the average number of leaves per plant have a significant difference varieties at P<0.01, the local varieties reached an average 87.50 leaves has reason to adapt the varieties through the nature of the components of the environment and these results agree with the findings of Abbas (1988); Qasim (2002); Wali (1990) and Al-Hamdani (2005), while the differences were not significant for distance between plants and overlap between the varieties and the distance between the plants. Tables 1 and 6 indicate that there were significant differences at P<0.05, for number of nodes stem^{-1} as the local varieties give the highest value amounted to an average 31.37 nodes and the least of which was from Spain variety (19.352 nodes stem^{-1}). The differences in the rate for the nodes stem^{-1} to all varieties included in this study may be due to the nature of the growth of these varieties and to the different structure of genetic. These results agree with the findings of the Al-Hamdani (2005). Table 1 shows the absence of significant differences of the distances between plants and overlap between the varieties and the spaces between plants.

Tables 1 and 7 show that the distances between the plants and overlap between the varieties, and the distances between the plants did not have significant effect on the length of pod (cm). The varieties differ significantly at P<0.01, the Spanish and Turkish varieties had the longest length of pod 10.30 and 9.94 cm respectively, may be due to the disparity between the length of pod to the genetic traits of each type. The result is consistent with Thomson et al. (1997) and Abo-Al-Zahaaby et al. (1981). It is clear from Tables 1 and 8 that the distance between plants and overlap between the varieties and the spaces between the plants did not have significant effects on the number of seeds per pod while the varieties showed significant difference in the Spanish and Turkish over the local variety having

Table 2. Factors influencing the germination percentage.

V	d1	d2	d3	Mean-v
v1	89.95	88.27	88.15	88.78
v2	91.01	98.77	94.81	94.86
v3	68.25	53.70	60.00	60.65
Mean-d	83.06	80.24	80.988	81.43

v=Types of the bean, d= Space or distance between plants.

Figure 1. Experiment field.

Table 3. Varieties influence on plant height (cm).

V	d1	d2	d3	Mean-v
v1	27.72	25.28	27.00	26.66
v2	26.61	30.11	27.33	28.01
v3	36.17	32.72	38.67	35.85
Mean-d	30.16	29.37	31.00	30.17

Table 4. Factors influence on the branches plant^{-1}.

V	d1	d2	d3	Mean-v
v1	3.22	2.89	3.11	3.07
v2	3.67	3.78	3.44	3.63
v3	3.06	2.83	3.72	3.20
Mean-d	3.31	3.16	3.42	3.30

Table 5. Varieties influence on the number of leaves plant^{-1}.

V	d1	d2	d3	Mean-v
v1	35.67	43.89	43.56	41.037
v2	49.72	65.17	47.28	54.056
v3	84.06	85.83	92.61	87.500
Mean-d	56.481	64.963	61.148	60.864

2.80, 3.12 seed pod^{-1}, respectively. It is caused by the relationship of these and genetic factors of the variety.

Table 6. Varieties influence on the number of nodes plant^{-1}.

V	d1	d2	d3	Mean-v
v1	14.17	20.56	23.33	19.35
v2	21.83	23.56	21.83	22.40
v3	28.94	28.94	36.22	31.37
Mean-d	21.64	24.35	27.13	24.37

Table 7. Varieties influence on the number of the length of pod (cm).

V	d1	d2	d3	Mean-v
v1	9.89	10.36	10.94	10.39
v2	10.56	10.01	9.28	9.94
v3	8.89	7.61	7.51	8.00
Mean-d	9.77	9.32	9.24	9.45

These results are consistent with the findings of Abo-El-Zahab et al. (1981), Shafik et al. (1986) and Thomson et al. (1997). They stated that the number of seeds/pod was due to the genetic traits of each category. The result from Tables 1, 9 and 10 show no significant differences of the factors under study in the character of pod weight (g plant^{-1}) and seed weight (g).

Conclusion

Local varieties have better growth parameters compared to Spanish and Turkish varieties. There were no significant differences for the factors of spaces between plants and the overlap between the varieties and the spaces between plants, in all the studied traits.

Drip irrigation reduces the water use and create good environment for the crop. It is recommended that other varieties be tried in other to find the most suitable and productive variety with other variables.

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Table 8. Varieties influence on the number of seeds pod^{-1}.

V	d1	d2	d3	Mean-v
v1	3.39	2.82	3.17	3.12
v2	3.00	2.80	2.61	2.80
v3	1.89	2.06	2.19	2.04
Mean-d	2.75	2.55	2.65	2.65

Table 9. Varieties influence on weight pod^{-1} (g plant^{-1}).

V	d1	d2	d3	Mean-v
v1	21.90	18.83	16.61	19.11
v2	22.07	19.83	14.64	18.84
v3	18.62	15.08	13.81	15.83
Mean-d	20.86	17.91	15.01	17.93

Table 10. Varieties influence on seed weight (g).

V	d1	d2	d3	Mean-v
v1	8.46	8.62	6.58	7.88
v2	7.89	6.86	5.88	6.87
v3	5.97	4.84	4.35	5.05
Mean-d	7.44	6.77	5.60	6.60

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