Research Article

Bioscience Research, 6(1): 35-39, 2009
www.isisn.org

Growth and yield of faba bean (*Vicia faba* .L) under rain fed and irrigated conditions in Jordan.

Talal Thalji*

Seed technology unit, Department of Horticulture and Crop science, Faculty of Agriculture, University of Jordan, P.O. Box: {13176} Amman {11942} **Jordan**.
***Corresponding author**

Experiments were conducted to access the effect of rain fed and irrigated conditions on yield and some agronomical traits in five faba bean cultivars. Studies were conducted during two successive growing seasons (2005-06 and 2006-07) at Jordan University Research Station under irrigated condition and Jubeiha Research Station under rain fed conditions. The results showed that, the effect of water stress under rain fed condition was very clear on bud and flower initiation. The more frequently the plants were watered, the more flowers were produced and therefore more pods were set. The pollen grains were affected only slightly by frequency of watering. Plant height and weight showed a high significant positive association with grain yield, pod number, plant height and nodule number at two locations during both growing seasons. Present study demonstrated good prospects for Faba bean improvement under semi-arid conditions. Moreover, it revealed the importance of leguminous crops in nitrogen fixation which is entirely reflected on the performance of the crop and on ecology.

Key words: Faba Bean, Irrigated condition Mediterranean region, Seed yield

Faba bean is one of the major winter-sown legume crops grown in the Mediterranean region, and has considerable importance as a low-cost food rich in proteins and carbohydrates (Theib *et al*., 2005). Faba bean (*Vicia faba* L.) yields are highly sensitive to variations of water availability (De-Costa *et al*., 1997). The period during which the crop's evaporative demand is high coincides with the end of the rainy season; thus, faba bean experiences considerable soil moisture stress during the reproductive growth stage and often produces poor yields (Theib *et al*., 2005). Faba bean was thought unsuitable for commercial dryland production in short-season Mediterranean-type environments because of its susceptibility to moisture and high temperature stresses (Lossa and Siddique 1997). Faba bean (*Vicia faba* L.) was considered poorly adapted to the low-rainfall environments of south Western Australia because of its susceptibility to moisture and heat stresses (Lossa *et al*., 1997). Moreover, for indeterminate faba bean, high levels of water could promote excessive vegetative growth at the expense of pod growth (De-Costa *et al*., 1997).

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). As a rainfed crop, Faba bean is treated as a winter crop and fit well with cereals in the rotation. The results from the Agricultural Statistical book 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. The crop plays an important role in improving the productivity of the cereal crops in the rainfed farming systems in the mediterranean region through improvement in physical, chemical and biological properties of the soil. Yields of rainfed cereal crops following faba bean have been higher than those in a continuous cereal rotation (Saxena, 1991). The moisture supply seems to play a dominant role in determining the productivity in these regions. The genotypes adapted to specific environments, when grown with appropriate husbandry and care, show an impressive yield potential which is several times higher than the average yields

obtained in the Mediterranean basin (Saxena, 1991).

In this study, several aspects of yield and yield components were studied in *Vicia faba* L, under irrigated and limited water supply under rain fed conditions. The objective was to find the effect of water deficit on faba bean production, agronomic traits and yield losses under rain fed conditions.

MATERIALS AND METHODS

Five local indeterminate (*Vicia faba* L.) cultivars were used to study variation in production and some agronomic traits under irrigated and rainfed conditions in Jordan. The experiments were conducted during the 2005-06 and 2006-07 growing seasons at two different locations, namely Jordan University Research Station under irrigated condition and Jubeiha Research Station under rainfed conditions. Jordan University Research Station lies on a latitude of 32º:12 and longitude of 35º:37 with an altitude of about 300 meters below sea level. The area is characterized by a relatively warm winter with mean monthly temperatures ranging from 14-22 ^{o}C during the growing season. The soil in this experiment site was deep, Sandy Loam with average water holiday capacity of 130mm/m in the top 90 cm .Apparent specific gravity was 1.52, pH 8 and EC ranged between 1.5ds/m, at the surface to 2.4 ds/m at 1.0m depth. Jubeiha Research Station is located in central Jordan in the high rainfall zone, with an average annual rainfall of about 500 mm.

The sites were prepared for planting by standard procedures. Triple super phosphate was broadcasted at rate 80kg P/ ha and potassium chloride and urea were banded at rates 60kg/ha and 40kg N/ha respectively. These rates were determined by soil tests, and recommendations by the university farm for optimal conditions. At the second site i.e. Jubeiha Research Station selected for rainfed conditions the rainfall during the two growing seasons (2005-06 and 2006-07) was 478 and 585mm respectively. The soil class was clay with a pH of 7.7. The total soil Nitrogen percentage was 0.118. The seeding rates were 80 kg/ha for both experimental cites. Each experiment was completely randomized in a split-plot design, with the varieties as a main plot and four replications.

The planting dates were 18-December 2005 and 22-November 2006. Every main plot consisted of six rows (5 meter long) with row to row distance 50 cm and 25-30 cm distance between plants within a row. Seeds for each row were calculated according to the respective seeding rate (80 Kg/ha) and planted by hand in well- prepared soil. The plots were hand weeded when necessary. Ten plants were randomly selected from each sub-plot before harvest. These plants were pulled and used to record plant height and various yield components. At maturity, the four central rows were shorted to three meters length, and then harvested. The harvest from each plot was bundle, weight and threshed by hand. Data were recorded for different traits from the whole plot referred to as bulk, and for the ten randomly selected plants mentioned.

RESULTS

Yield and agronomic traits were studied in faba bean cultivars under irrigated and rain fed conditions during two consecutive years (2005-06 and 2006-07). Plant height was promptly affected under rain fed condition as compared to that under irrigated condition during both years (table 1). Plant height was less under rain fed condition as compared to irrigated condition in all cultivars.

Similarly, total biomass yield was also considerably reduced under rain fed condition as compared to irrigated condition during both years (table 2). Most sever reduction in total biomass yield under rain fed condition was observed in Syria-1 during both experimental years. Total no of branches in different faba bean cultivars were also affected under irrigated and rain fed conditions. Total number of branches was comparatively higher under irrigated conditions as under rain fed conditions (table 3). Under irrigated conditions highest number of branches was observed in Syria-1 while under rain fed conditions number was maximum in Cyprus.

Total no of pods in different faba bean cultivars also varied under irrigated and rain fed conditions. Total number of pods was relatively higher under irrigated conditions as compared to that under rain fed conditions (table 4). Under irrigated conditions highest number of pods was observed in Balady and 4 while under rain fed conditions number was maximum in Cyprus. This showed clear differences in pod per plant under limited water supply in faba bean.

Total no of seeds per pod varied under irrigated and rain fed conditions in some of faba bean cultivars. Total number of seeds per pod was relatively higher under irrigated

Table: 1. Plant height of different faba bean cultivars under irrigated and rain fed conditions.

Cultivars	Rain fed conditions (Jubeiha Research Station)				Irrigated conditions (Jordan University Research Station)			
	Season 2005-06		Season 2006-07		Season 2005-06		Season 2006-07	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Balady	107.50	3.79	103.25	6.99	133.00	5.29	132.50	5.26
Giza	100.00	9.09	99.25	7.89	120.50	14.75	120.00	14.51
Syria-1	101.50	4.43	100.25	7.41	138.25	1.71	138.00	2.83
Cyprus	106.50	6.19	100.00	6.32	139.25	2.50	130.00	3.65
Hudebia	118.00	3.65	113.75	3.50	131.25	4.86	133.25	2.75

Table: 2. Total biomass yield (g) of different faba bean cultivars under irrigated and rain fed conditions.

Cultivars	Rain fed conditions (Jubeiha Research Station)				Irrigated conditions (Jordan University Research Station)			
	Season 2005-06		Season 2006-07		Season 2005-06		Season 2006-07	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Balady	109.00	6.22	107.00	5.29	150.50	8.54	149.25	9.78
Giza	116.50	5.00	115.00	4.16	157.75	3.10	163.50	5.97
Syria-1	121.75	7.14	122.00	9.38	194.00	17.81	192.75	14.03
Cyprus	121.50	7.23	118.50	8.70	186.00	4.32	147.50	6.45
Hudebia	107.50	5.26	105.75	10.28	143.75	6.24	147.75	6.85

Table: 3. Total no of branches in different faba bean cultivars under irrigated and rain fed conditions.

Cultivars	Rain fed conditions (Jubeiha Research Station)				Irrigated conditions (Jordan University Research Station)			
	Season 2005-06		Season 2006-07		Season 2005-06		Season 2006-07	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Balady	3.00	0.00	2.50	0.58	3.25	0.50	3.75	0.96
Giza	2.75	0.96	3.25	0.96	3.75	0.96	3.50	0.58
Syria-1	3.25	0.50	2.50	0.58	4.25	0.96	4.50	0.58
Cyprus	3.75	0.50	3.50	0.58	3.75	0.50	3.75	0.50
Hudebia	2.75	0.50	3.25	0.50	3.25	0.50	3.50	1.29

Table: 4. Total no of pods per plant in different faba bean cultivars under irrigated and rain fed conditions.

Cultivars	Rain fed conditions (Jubeiha Research Station)				Irrigated conditions (Jordan University Research Station)			
	Season 2005-06		Season 2006-07		Season 2005-06		Season 2006-07	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Balady	14.00	1.63	13.25	2.22	20.75	2.99	22.50	1.29
Giza	14.25	3.30	14.50	3.42	21.25	1.26	20.25	1.71
Syria-1	15.50	3.42	16.00	1.63	19.50	1.29	20.00	2.16
Cyprus	17.50	1.91	18.00	2.16	21.25	0.96	21.50	1.00
Hudebia	15.75	1.71	17.75	2.63	19.50	1.29	19.75	1.50

conditions as compared to that under rain fed conditions in Balady and 5 (table 5). However, in Syria-1 no of seed per pod was higher under rain fed condition as compared to irrigated conditions. Under irrigated conditions highest number of seeds per pod was observed in Hudebia while under rain fed conditions number was maximum in Syria-1.

Weight of pods in different faba bean cultivars varied promptly under irrigated and rain fed conditions. Weight of pods was relatively higher under irrigated conditions as compared to that under rain fed conditions (table 6). Under irrigated conditions, highest weight of pods was observed in Cyprus while under rain fed conditions weight was also maximum in Cyprus. This clearly showed that little difference in pod weight was observed under irrigated condition in this cultivar of faba bean.

DISCUSSION

The period during which the crop's evaporative demand is high coincides with the end of the rainy season; thus, faba bean experiences considerable soil moisture stress during the reproductive growth stage and often produces poor yields (Theib et al., 2005). In our study, total number of pods was relatively higher under irrigated conditions as compared to that under rain fed conditions. A clear differences in pod per plant under limited water supply in faba bean was observed. According to Lossa et al., (1997) the final numbers of nodes were 20 to 24 with early sowing and pod set in this study was adequate for moderate yields and harvest index was consistently high.

Table: 5. Total no of seeds/ pod in faba bean cultivars under irrigated and rain fed conditions.

Cultivars	Rain fed conditions (Jubeiha Research Station)				Irrigated conditions (Jordan University Research Station)			
	Season 2005-06		Season 2006-07		Season 2005-06		Season 2006-07	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Balady	2.25	0.50	2.50	0.58	2.75	0.50	2.75	1.26
Giza	2.25	0.50	2.75	0.50	2.50	0.58	2.50	0.58
Syria-1	3.00	0.00	3.00	0.82	2.00	0.82	2.75	0.50
Cyprus	2.75	0.50	2.25	0.96	2.25	0.96	3.00	0.82
Hudebia	2.50	0.58	2.50	0.58	2.50	0.58	3.00	0.82

Table: 6. Pod weight (g) in different faba bean cultivars under irrigated and rain fed conditions.

Cultivars	Rain fed conditions (Jubeiha Research Station)				Irrigated conditions (Jordan University Research Station)			
	Season 2005-06		Season 2006-07		Season 2005-06		Season 2006-07	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Balady	45.75	4.35	48.50	2.65	61.25	17.02	60.75	12.20
Giza	55.75	4.35	53.25	6.99	64.75	10.87	64.00	9.66
Syria-1	59.75	4.65	58.75	2.50	64.00	6.16	64.25	4.65
Cyprus	66.25	5.06	65.00	4.76	69.75	12.28	67.00	12.49
Hudebia	57.75	9.54	58.50	6.61	63.25	8.14	62.75	6.08

Our results under irrigated conditions are inline with these previous findings. In our study weight of pods was also relatively higher under irrigated conditions as compared to that under rain fed conditions.

Total no of seeds per pod also varied under irrigated and rain fed conditions in some of faba bean cultivars. Total number of seeds per pod was relatively higher under irrigated conditions as compared to that under rain fed conditions in Balady and 5 (table 5). In a previous study it was reported that seed number per pod was relatively consistent across times of sowing, while mean seed weight decreased with delayed sowing in dry environments (Lossa and Siddique 1997). However, in Syria-1 no of seed per pod was higher under rain fed condition as compared to irrigated conditions. In this connection a previous study demonstrated that faba bean can produce impressive biomass and seed yield in a range of dryland Mediterranean-type environments. They demonstrate that given a suitable cultivar, faba bean is adapted to dryland Mediterranean-type environments with 300 to 400 mm yr−1 average rainfall; however, early sowing is critical for high seed yields (Lossa and Siddique 1997).

Water stress has a determinant effect on faba bean vegetative growth, as well as reproductive growth (Minguez et al., 1993). Plant height was promptly affected under rain fed condition as compared to that under irrigated condition during both years. Plant height was less under rain fed condition as compared to irrigated condition in all cultivars. In present total number of branches was comparatively higher under irrigated conditions as under rain fed conditions. Previously, it has been reported that limited water supply through supplemental irrigation (SI) can boost and stabilize faba bean production. The overall mean grain yield, which was 1.13 t/ha under rainfed conditions increased to 1.49, 1.89 under full supplemental irrigation (Theib *et al*., 2005). Similarly, total biomass yield was also considerably reduced under rain fed condition as compared to irrigated condition during both years.

In conclusion, 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. Different cultivars vary in response to water stress as some performed comparatively better under inadequate irrigation.

REFERENCES

De-Costa WAJM, Dennett MD, Ratnaweera U and Nyalemegbe K, 1997. Effects of different water regimes on field-grown determinate and indeterminate faba bean (*Vicia faba* L.). II. Yield, yield components and harvest index. Field Crops Research, 52 (1-2): 169-178.

Lossa SP and Siddique K H M, 1997. Adaptation of faba bean (*Vicia faba* L.) to dryland Mediterranean-type environments I. Seed yield and yield components. Field Crops Research, 52(1-2): 17-28.

Lossa SP, Siddique KHM and Martin LD.1997. Adaptation of faba bean (*Vicia faba* L.) to dryland Mediterranean-type environments II. Phenology, canopy development, radiation absorbtion and biomass partitioning. Field Crops Research, 52 (1-2): 29-41.

Mínguez MI, Ruiz-Nogueira B and Sau, F. 1993. Faba bean productivity and optimum canopy development under a Mediterranean climate. Field Crops Research, 33: 435-447.

Saxena MC, 1991. Status and scope for production of faba bean in the Mediterranean countries. Options Méditerraneennes - Serie Seminaires 10:15-20.

Thalji T and Shalaldeh G, 2006. Effect of date of sowing on faba bean (*Vicia faba* L.) nodulation and performance under semiarid conditions. World journal of Agricultural Sciences 2(4): 477-482.

Theib O, Ahmed H and Mustafa P, 2005. Faba bean productivity under rainfed and supplemental irrigation in northern Syria. Agricultural water management, 73(1): 57-72.