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EFFECT OF WATER STRESS AND POTASSIUM FOLIAR APPLICATION ON THE PRODUCTIVITY OF FABA BEAN PLANTS.

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ABSTRACT

Two field experiments were carried out at the Agricultural Experimental Station of National Research Centre at Shalakan, Kalubia Governorate during 2001/2002 and 2002/2003 seasons to study the effect of water stress (missing one irrigation either at flowering or pod formation stage) and foliar application of K (0, 1 and 1.5 L/fed.) on the yield and its attributes as well as carbohydrates content and yield of faba bean (cv. Giza 643).

Results revealed that missing one irrigation at any of the two studied stages significantly reduced plant height, number of both branches and pods per plant, weight of both pods and seeds per plant as well as 100 – seed weight as compared with the control plants. The harmful effect of water stress was more pronounced whenever drought conditions were coincided with pod formation stage. Similar tendency was noticed regarding seed, straw, biological and carbohydrate yields per feddan as well as carbohydrate content. On the other hand, increasing the concentration of K up to 1.5 L/fed. remarkably increased the aforementioned characters. The results suggested that irrigation every 30 days and application of K with 1.5 L/fed. could be recommended for maximum yield of faba bean under similar conditions.

Key words : Faba bean – Potassium – Yield – Water stress.

INTRODUCTION

Faba bean *(Vicia faba L.)* is the most important legume crop in Egypt. In the few last decades, Egypt was forced to import about 20% of the total local faba consumption of faba bean seeds. There after, no surprise that agronomists are dealing with increasing faba bean yield through improving crop management, including application of the different recommended cultural practices, which are mainly bordered by the proper use of irrigation and fertilization. Many workers have recorded great reduction in faba bean yield and its components due to increasing the soil moisture stress (El-Noemani *et al.*, 1990, Abd-El-Haleem, 1994; Xia, 1997; Mwanamwenge *et al.*, 1999 and Abo El-Kheir *et al.*, 2000). Also Bastawisy & Sorial (1998) indicated that treating faba bean plant with K as

a foliar application reduced the abscission of flowers and pods which consequently cause an increase in seed yield. Moreover, Abo El-Kheir (1999) reported that potassium application positively affected growth parameters, yield characters as well as total carbohydrates and protein contents in the seeds.

Ahmed *et al.* (2003) showed that spraying faba bean plant with k significantly increased number of pods/plant, number of seeds/pod, seed yield /plant, 100-seed weight and seed yield, ton/ha.

This work aimed to study the effect of water deficit and potassium fertilization on faba bean production.

MATERIAL AND METHODS

Two field experiments were carried out during the two successive seasons of 2001/2002 and 2002/2003 at the Agricultural Experimental Station of the National Research centre in Shalakan Kalubia Governorate, Egypt. The Soil texture of the experimental site was clay loam in both seasons. The investigation included nine treatments which were the combination of three irrigation treatments and three concentrations of foliar potassium 38% produced by El-Nasr Company for Fertilizers and Pesticides. A split-plot design with three replications was employed. The main plots were devoted to irrigation treatments while the sub-plots were assigned for potassium concentrations. The soil was ploughed twice, ridged and divided into plots. Each plot ($10.5m^2$) consisted of 5 rows of 3.5m in length and 0.6m a part. To avoid the effect of lateral movement of irrigation water, the plots were isolated by borders of 1.5m in width from all sides.

Irrigation treatments were imposed to allow the plants either irrigated every 30 days (control treatment), or missing one irrigation at flowering and pod formation stages which were corresponding to 60 and 90 days from sowing, respectively. In both seasons, faba bean plants of each irrigation treatment were sprayed till drip, after 45 and 60 days from sowing, with either tap water (control), or aqueous solution of potassium (1 and 1.5 L/fed.).

In November 12^{th} and 10^{th} (2001/2002 and 2002/2003) seasons, faba bean seeds *(Vicia faba L.)* cv. Giza 643 were sown in hills, 20cm apart. Seeds previously inoculated with the specific strain of *Rhizobium Leguminosarum L.*,. Thinning to one plant per hill was done at 25 days after planting. The normal agricultural practices for growing faba bean were followed as recommended in the region. Calcium superphosphate (15.5% P_2O_2) was added at a rate of 150 kg/fed. before planting, whereas nitrogen fertilization was applied before the second irrigation at the rate of 50 kg/fed. as ammonium nitrate (33.5% N). At harvest, random sample of nine plants, was taken from each treatment to determine plant height, number of both branches and pods/plant and weight of both pods and seeds /plant as well as 100-seed weight. Seed, straw and biological yields/fed. were estimated using the guarded plants of two central rows from each experimental plot. Total carbohydrates content in the seeds was determined using

the method adopted by Dubois *et al.* (1956). The carbohydrate yield/fed. was calculated by multiplying the Carbohydrate percentage by seed yield/fed.

The obtained date were subjected to the statistical analysis of variance described by Snedecor and Cochran (1980) and the combined analysis of results of the two seasons were applied according to the method adopted by Steel and Torrie (1960).

RESULTS AND DISCUSSION

a) Yield attributes

Data presented in Table (1) show that exposing faba bean plants to water stress by missing one irrigation at any of the two studied reproductive stages (i.e. flowering and pod formation) resulted in significant reduction in plant height, number of both branches and pods per plant and weight of both pods and seeds per plant as well as 100-seed weight as compared with control treatment (irrigation every 30 days). This was true if one irrigation was missed at each of flowering or pod formation stage.

However, the response of faba bean plants to water stress was more pronounced at pod formation stage than at flowering stage. These results are in agreement with those obtained by (Abd El-Haleem, 1994; Kortam, 1995; Xia 1997 and Mwanamweng *et al.*, 1999).

In this concern, Kramer (1995) showed the effect of water stress on plant growth to its effect on cell enlargement which in turn decreases shoot elongation.

The obtained results revealed also that foliar application of K significantly affected the yield attributes i.e. plant height, number of both branches and pods per plant, weight of both pods and seeds per plant and 100-seed weight. Increasing the concentration of K up to 1.5 L/fed. caused a significant increase in the aforementioned parameters. The positive effect of foliar k on increasing yield components was reported by El-Fouly *et al.*, (1989); Bastawisy *et al.*, (1998) and Ahmed *et al.*, (2003).

The interaction effect between water stress and k fertilization treatments was not significant except for 100-seed weight. Spraying 1.5 L/fed. of k under normal irrigation gave the highest 100-seed weight as compared with the other treatments (Table 1).

b) Yield and total Carbohydrate percentage

Data shown in Table (2) elucidate that shortage of water at each of flowering or pod formation stages caused significant reduction in seed, straw, biological yields per feddan, total Carbohydrate percentage yields per feddan, total Carbohydrate percentage and yield/fed. as compared with well irrigated plants. The lowest seed yield (kg/fed.) was obtained from missing one irrigation at pod formation stage. El-Noemani *et al.*, 1990; Xia, 1997; Mwanamwenge *et al.*, 1999; Abo El-Kheir *et al.*, 2000; and Kassab, 2004 came to similar conclusion.

Table (1): Effect of water stress, potassium foliar application and their interaction on yield attributes of faba bean.(combined analysis of 2001/2002 and 2002/2003seasons).

Irrigation treatments	Potassium concentrations L/fed.	Plant height (c m)	No. of branches/ plant	No. of Pods/ plant	Wt. of Pods/plant	Wt. of seeds/plant	100-seed wt.
					(g)		
Irrigation every 30 days (Control)	0	138.22	4.11	25.55	41.78	31.78	70.45
	1	141.11	4.11	26.44	43.33	33.78	73.44
	1.5	142.33	5.11	29.11	45.78	36.44	76.95
	mean	140.55	4.44	27.04	43.63	34.00	73.61
Missing one irrigation at flowering stage	0	134.44	3.55	22.78	38.44	29.33	76.38
	1	137.11	3.78	24.89	40.78	31.89	69.96
	1.5	139.44	4.11	26.78	42.78	33.78	72.47
	mean	137.00	3.81	24.81	40.67	31.67	69.94
Missing one irrigation at pod formation stage	0	131.78	3.11	20.55	36.44	27.33	64.84
	1	134.44	3.22	22.89	38.33	29.44	66.91
	1.5	136.44	3.78	24.89	40.22	32.11	68.62
	mean	134.22	3.37	22.78	38.33	29.63	66.79
Mean values for potassium concentrations	0	134.81	3.59	22.96	38.89	29.48	67.56
	1	137.55	3.70	24.74	40.81	31.70	70.10
	1.5	139.41	4.33	26.92	42.92	34.11	72.68
L.S.D at 5% for:	I	0.93	0.17	0.63	0.83	0.80	0.63
	K	0.67	0.28	0.64	0.57	0.56	0.51
	Ixk	N.S	N.S	N.S	N.S	N.S	0.88

I = Irrigation treatments k = Potassium concentrations I X k = Interaction

Table (2) Effect of water stress ,potassium foliar application and their interaction on yield, seed total carbohydrate content (%) and carbohydrate yield of faba bean.(combined analysis of 2001/2002 and 2002/2003seasons).

Irrigation treatments	Potassium concentrations L/fed.	Seed yield/ fed.	Straw yield /fed.	Biological yield / fed.	Total carbohydrate content (%)	Carbohydrate yield /fed (kg)
		(kg)				
Irrigation every 30 days (control)	0	1581.00	1965.33	3546.33	51.55	815.03
	1	1689.67	2870.33	3760.00	53.97	911.99
	1.5	1887.33	2147.00	4034.33	56.51	1066.63
	mean	1719.33	2060.89	3780.22	54.01	931.22
Missing one irrigation at flowering stage	0	1246.33	1515.33	2761.67	46.92	584...76
	1	1353.33	1715.67	3069.00	49.59	671.17
	1.5	1599.33	1865.33	3464.67	52.56	840.77
	mean	1399.67	1698.78	3098.44	49.69	698.90
Missing one irrigation at pod formation stage	0	1009.67	1157.00	2166.67	41.65	420.56
	1	1190.67	1388.33	2579.00	44.41	528.60
	1.5	1374.33	1583.67	2958.00	47.91	658.53
	mean	1191.56	1376.33	2567.89	44.66	535.90
Mean values for potassium concentrations	0	1279.00	1545.89	2824.89	46.70	606.78
	1	1411.22	1724.78	3136.00	49.32	703.92
	1.5	1620.33	1865.33	3485.67	52.33	855.31
L.S.D at 5% for:	I	56.95	22.55	50.89	0.18	29.18
	K	34.79	19.34	40.07	0.26	16.77
	Ixk	N.S	16.75	69.41	0.46	N.S

I = Irrigation treatments k = potassium concentrations I X k = Interaction

The obtained data reveal that spraying faba bean plants with k resulted in a significant increase in the aforementioned characters as compared with the untreated one. Such increment was in line with the increase in the k concentration up to 1.5 L/fed. The obtained results are in great agreement with those obtained by El-Fouly *et al.*, (1989); Bastawisy *et al.*, (1998); Abo-El-Kheir, (1999) and Ahmed *et al.*, (2003).

The interaction between water stress and K treatments was significant except for seed yield/fed. and Carbohydrate yield/fed. It could be noticed that increasing the concentration of K up to 1.5 L/fed. increased straw yield/fed., Biological yield/fed. and total Carbohydrate percentage under the different treatments. The maximum straw yield/fed., biological yield/fed. and total Carbohydrate percentage was obtained when plants were irrigated normally and sprayed with 1.5 L/fed. of k.

From the aforementioned results it is worthy to conclude that spraying faba bean plants with k minimized the negative effect of water stress on yield and yield attributes.

REFERENCES

Abd El-Haleem, A.K. (1994): Growth and yield of faba bean as affected by inoculation, phosphorous fertilization and irrigation frequency. J. Agric. Sci. Mansoura Univ., 19 (11) : 3563 – 3574.

Abo EL-Kheir, M.S.A. (1999): Response of faba bean to k- fertilization under water stress conditions. Egypt. J. Appl. Sci., 14 (5) : 205 – 216.

Abo El-Kheir, M.S.A.; Abo –Ellil, AA. and El- Zeiny, H.A. (2000): Effect of water stress at different growth stages on three faba bean cultivars. J. Agric. Sic., Mansoura Univ., 25 (3) : 1485 – 1493.

Ahmed, M.K.A.; Zeidan, M.S. and El-Karamany, M.F. (2003): Effect of foliar nutrition with potassium sources on growth, yield and quality of faba bean *(Vicia faba L.)* Egypt. J. Agron. 25, 53 – 58.

Bastawisy, M.H, and Mervat, E. Sorial (1998): Physiological role of spraying some mineral nutrients on the growth, flowering, abscission, endogenous auxin and yield of faba bean . Zagazig. J. Agric Res. 25 (2) : 271.

Dubois, M.; Gilles, K.A.; Hamilton, J.; Rebers, R. and Smith, F. (1956): Calorimetric method for determination of sugar and related substances. Anal. Chem. 28 : 350 – 356.

El-Fouly, M.M.; Fawzi, A.F.A. and El-Baz, F. (1989): Concentration and uptake of N, P and the effect of poatassium sulphate on *(Vicia faba)* FABS Newsletter 25, December 1989, PP 11-12.

El-Noemani, A.A.; El-Zeiny, H.A. and Behairy, T.G. (1990): Yield and quality of faba bean *(Vicia faba L.)* as affected by irrigation intervals and nitrogen. J. Agric. Res. Tanta Univ., 16 (2) : 218 – 228.

Kassab, O.M. (2004): Response of some faba bean varieties to water stress at some growth stages. Egypt. J. Appl. Sci.; 19 (5) : 111 – 120.

Kortam, M.A. (1995): Yield and yield components of broad bean *(Vicia faba L.)* as affected by irrigation frequency, phosphorus and potassium fertilization Egypt. J. Appl. Sci., 10 (9) : 266 – 280.

Kramer, P.J. (1995): Water Relations of Plants and Soils. Academic Press. San Diego, New York, Boston, London, Sydney, Tokyoand Toronto.

Mwanamwenge, J.; Loss, S.P.; Siddique, K.H.M. and Cocks, P.S. (1999): Effect of water stress during floral initation, flowering and podding on the growth and yield of faba bean *(Vicia faba L.)* European J. of Agron., 11 (1) : 1 – 11 (C.F. Field Crop Abstr. Vol. 52, No. 9, 6679).

Snedecor, G.W. and Cochran, W.G. (1980): Statistical Methods. 7th Ed. Iowa State Univ. Press. Iowa, U.S.A.

Steel, R.G.D. and Torrie, J.H. (1960): Principles procedures of statistics. Mc. Grow Hill Book Co. Inc New Yourk. Toronto and London.

Xia, M.Z., (1997): Effects of soil drought during the generative development phase on seed yield and nutrient uptake of faba bean *(Vicia faba)*. Australian J. of Agric. Research 48 (4) : 447 – 451 . (C.F. Field crop Abstr. Vol. 50, No 9, 6669).

تأثير نقص الماء والرش بالبوتاسيوم على إنتاجية نباتات الفول البلدى

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أقيمت تجربتان حقليتان بمزرعة المركز القومى للبحوث بشلقان (محافظة القليوبية) خلال موسمى ٢٠٠١/٢٠٠٢، ٢٠٠٢/٢٠٠٣ بهدف دراسة تأثير معاملات الرى (الرى كل ٣٠ يوم، منع رية واحدة عند كل من مرحلة التزهير، وتكوين القرون) والرش بالبوتاسيوم ٣٨% بمعدل صفر، ١، ١,٥ لتر/فدان وذلك على المحصول ومكوناته ومحتوي ومحصول الكربوهيدرات لنباتات الفول البلدى صنف جيزة ٤٣ ويمكن تلخيص النتائج فيما يلي:

- أدى تعريض النباتات للإجهاد المائى نتيجة منع الرى فى أى من المرحلتين المشار إليهما إلى نقص معنوى فى ارتفاع النبات وعدد كل من الفروع والقرون للنبات ووزن القرون والبذور للنبات وكذلك وزن الـ ١٠٠ بذرة مقارنة بالنباتات المروية ريا عاديا .
- كما أنخفض معنويا كل من محصول البذور والقش والمحصول البيولوجى ومحصول الكربوهيدرات للفدان وكذلك محتوي البذور من الكربوهيدرات عند تعريض النباتات للحرمان من الرى فى أى مرحلة من مراحل النمو المختلفة مقارنة بمعاملة المقارنة. هذا وقد أدى حرمان أومنع الرى فى طور تكوين القرون إلى الحصول على أقل محصول بذور للفدان.
- أدى رش النباتات بالبوتاسيوم ٣٨% بمعدل ١,٥ لتر/فدان إلى زيادة معنوية في كل الصفات المدروسة للمحصول ومكوناته.

يمكن التوصية برش نباتات الفول البلدى بالبوتاسيوم ٣٨% بمعدل ١,٥ لتر/فدان مع استمرار الرى كل ٣٠ يوما وذلك لتحقيق أعلى إنتاجية من محصول الفول البلدى.