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RESPONSE OF FABA BEAN TO LEVEL AND PLACEMENT METHODS OF POTASSIUM APPLECATIONS IN SANDY SOIL AT NORTH SINAI

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ABSTRACT

Applying K fertilizer into drip irrigation system is not routinely practiced for faba bean under desert conditions. Vegetative growth, seed and straw yield, K contents in tissues and soil as affected by application of K through drip irrigation system compared to side dressed application was studied under field experiment at El-Maghara Research Station of Desert Research Center - North Sinai. The experimental treatments included 1) six levels of K (0, 30, 60, 90, 120, 150) kg K_2O/fed. added each two weeks where all plots were drip irrigated and 2) two placement methods (fertigated and side dressed) were compared for growth and yield characteristics.

Increasing rates of K through drip irrigation system increased significantly plant height number of branches / plant, number of pods/ plant and straw & seed yield / fed. where, the application of 120 kg K_2O/fed. produced the highest response. The adequate range of K content in faba bean tissues is ranging from about 2 to 3%. The repeated application of K through drip irrigation system was significantly more effective than side dressed application where considerable amount of K can be lost by leaching in sandy soil. Movement of K below drip irrigation system is expected if application is concentrated by applying the fertilizer to small volume of soil under drippers. An increasing necessity is encourage to introduce faba bean cropping with fertigated system under desert conditions of North Sinai.

Keywords: Faba bean, Placement method, Potassium applications, Drip irrigation.

INTRODUCTION

The main source of protein in the diet of most Egyptians is faba bean (*Vicia faba* L.). As it is a leguminous crop, it improves soil fertility. Development of cultivars with high yield in water and nutrient limited environments is a main goal. Omar *et al.*, 1998 screened some faba bean genotypes under calcareous soil and rainfall conditions of Maryout at North Western Coast of Egypt. They concluded that, Giza Blanca ranked first for seed index and fourth for seed yield / m^2 when compared to ten newly bred lines.

Response of faba bean fertilization has been documented especially in the light textured and calcareous soils of desert. In such researches, the proper levels, source, time of N, P, K and micronutrient fertilizers, interactions between nutrients and number of irrigations have been investigated (Shehata *et al.* 1989; Shehata *et al.* 1991; Moussa, 1992; Dahdoh *et al.* 1993; Gendy *et al.* 1995; Hatem *et al.* 1990; Hassan *et al.* 1997).

The application of K is essential to maintain an acceptable level of yield and reducing the detrimental effects of excess Mg and Na on crop production. This element activates numerous enzymes and it is required for stomata opening. It promotes the translocation of the nitrogenous compounds

towards the seeds at maturity and increases protein mobilization from the stems and leaves (Koch and Mengel, 1977 and Mengel and Kirkby, 1987).

The sandy soils have much lower exchange capacities than those of the heavy ones. Addition of K fertilizer to sandy soils would result in adsorption of less proportion of the added K. The un-adsorbed part stays in the soil solution and removed in leaching water causing a large quantity losing from the sandy soil, which had low cation exchange capacity (Tisdal *et al.* 1985). In such conditions, K is necessary to be available at least up to physiological ripening , as many crops appear to need large requirements from K where it is low in sandy soil.

It is necessary for the Egyptian economics to faba bean cropping under desert conditions of North Sinai. At the same time applying K fertilizer through drip irrigation system is not routinely practiced for faba bean under desert conditions. So, vegetative characters (height, number of branches and number of pods per plant), straw and seeds yield of faba bean, in addition to K contents in tissues and soil as affected by application of different rates of K fertilizer through drip irrigated system during the growing season compared to side dressed applications was investigated.

MATERIALS AND METHODS

A field experiment was carried out at El-Maghara Research Station of Desert Research Center at North Sinai (30° 43' N, 33° 19' E) during winter season of 2000/2001. Physical and chemical properties of the soil are indicated in Table (1). Groundwater from well which contains about 2500 mg / kg of salinity was used through drip irrigation system. Faba bean [*Vicia faba* L. Var. Giza Blanca (selected from Spanish variety, Reina Blanca)] seeds were sown in the experimental site at distance of 75 cm between drip irrigation lines and 30 cm. spacing between drippers with two seeds per hill.

Where K level in soil of the experimental site lies in the low available range (0-60 mg/kg), the experimental treatments included six levels of potassium sulfate: 0, 30, 60, 90, 120, 150 kg K_2O/fed., splitted equally and added as dissolved materials each two weeks with the drippers irrigation water. Two placement methods, fertigated and side dressed application were compared using the rate of 120 kg K_2O/fed. Rates of 30 kg P_2O_5/fed and 20 kg N/fed were supplied to all treatments. The experimental design randomized block with four replications.

Table (1): Some soil physical and chemical properties at the experimental site.

Soil Texture	pH paste	ECe dSm^{-1}	O.M. %	$CaCO_3$ %	Total N%	P	K	Fe	Mn	Zn	Cu
						mg/kg					
Sandy	8.0	1.5	0.45	14.9	0.02	2.8	29.1	6.5	2.3	0.8	0.2

At harvest straw and seeds yield/fed. as well as plant height, number of branches/plant and number of pods/plant were recorded. All data was subjected to the ordinary analysis of variance and Duncan's multiple range

test (Duncan, 1955) was used to verify the significance of mean performance for all traits studied. Potassium content in tissue were determined (Chapman and Pratt, 1961). After harvesting, soil samples were taken beside each dripper to 25 cm depth representing each treatment and subjected to the determination of available K in soil as indicated by Black (1965).

RESULTS AND DISCUSSION

Growth and yield parameters:

Data in Table (1) indicate that increasing levels of K through drip irrigation system increased significantly plant height, number of branches and number of pods/plant. Data suggested that application of 120 kg K_2O/fed. gave the highest values for such traits with insignificant differences when compared to 150 kg/fed. A positive correlation coefficient was detected between K levels and each of plant height, number of branches / plant and number of pods / plant.

Seeds and straw yield of faba bean increased significantly with increasing application rate of K (Table 1). The rate of 120 kg/fed. K_2O yielded the highest seeds and straw yield as kg/fed. The amount of straw needed to yield one kg of grains was about 1.16 kg straw. The positive correlation coefficient between K levels added and seeds yield was 0.98. Increasing K fertilization from 120 to 150 kg K_2O/fed. had a negative response (not significant) on the studied growth, yield components and seeds & straw yield.

Table (2): Effect of potassium on growth parameters, yield and yield components of faba bean.

K treatments (Kag/fed.)*	Plant height (cm)	No. branches/ plant	No. pods/ plant	Straw yield (kg/fed.)	Seeds yield (kg/fed.)
0	51.6 D#	1.5 C	8.7 D	938 E	710 E
30	60.0 C	2.9 BC	9.5 CD	1202 D	1065 D
60	63.4 BC	3.3 AB	10.8 C	1396 C	1171 C
90	67.2 AB	3.8 AB	12.7 B	1704 B	1531 B
120	70.1 A	4.7 A	16.4 A	1970 A	1732 A
150	68.5 A	3.9 AB	15.6 A	1963 A	1704 A
Mean	63.47	3.35	12.28	1528.8	1318.8

*Soluble potassium added through drip irrigation system.
#Values followed by the same letter(s) in column are not significantly different at 0.05 level of Duncan's multiple range test.

Potassium contents in tissues:

Potassium contents in faba bean tissues increased significantly with increasing K rates from 0 to 150 kg K_2O/fed., fertigated to soil (Fig. 1). The K contents in tissues ranged from about 1% to 3% as affected by K application. It includes a considerable variation in the points between deficient and adequate nutrient concentration. The adequate range of K content in faba bean tissue is ranged from 2.2 to 3.2% (Bishop *et al.* 1976). This adequate

range is in agreement with application of 120 kg K_2O/fed. with about 2.5% of K content in tissue, which produced the highest yield. Generally, tissue in drip-applied K began increasing in K content with 30 kg K_2O/fed. (1.04%) compared to control treatment (0.88%). Tissues should have more than 1% K depending upon plant species, where plant need relatively large amount of concentration must be available throughout the growing season.

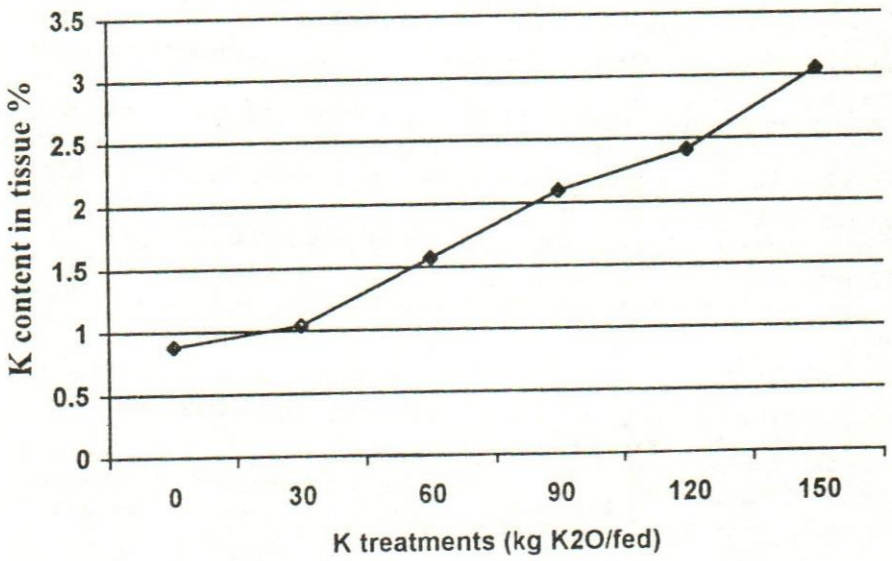

Fig. (1): Content of K in tissue of faba bean as affected by drip applied potassium

Potassium content in soil:

Information gained from soil analysis as affected by fertigation is used to evaluate the fertility status of the soil under the drippers and to provide a base for recommendation on the amount of fertilizer to apply. Potassium availability in soil increased significantly by increasing K rates through drip irrigation system (Fig. 2). Available K in soil under drippers ranged from 29.1 mg kg^{-1} as control treatment to 148.5 mg/ kg as affected by 150 kg K_2O/fed. treatment. The range of 0 to 60 mg/kg K is classified as low and from 60 to 120 mg/kg K is considered as a medium range. Higher than this concentration of available K in soil can be ranged from adequate to high (Soltanpour and Schwab, 1977 and Soltanpour *et al.* 1979).

Potassium fertigated into the drip irrigation system was to give a continuous K concentration throughout the growing season. It can be absorbed and moves into the soil within the active root zone of the crop and potassium application can increase the residual of available K under faba bean cultivation.

The sandy soil had a much lower exchange capacity than heavier soils. It is therefore able to hold a much lower amount of K. In sandy soil, considerable amount of K can be lost by leaching The repeated application of soluble K with irrigation water in sandy soil is more effective under such condition, where addition of K would result adsorption of less proportion of added K.

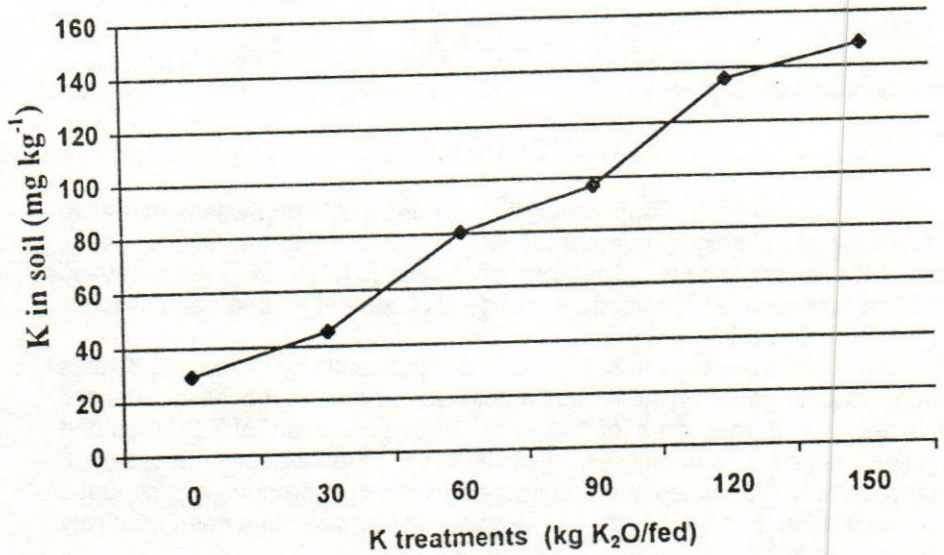

Fig. (2): Ammonium bicarbonate extractable K in soil were K was added through drip irrigation system

Methods of K application:

The two methods of K application were compared with the control treatment in which no K added. The application of K through drip irrigation system (fertigated) and side dressed produced significant difference in plant height, number of branches/plant, number of Pods/plant and seeds & straw yield (Table 2). Fertigation method resulted a higher response than the side dressed application with 120 kg K_2O/fed. treatment. Fertigation method produced 22%, 15% and 31% more than the side dressed method for seeds yield/fed., plant height and number of pods/plant, respectively. The efficiency of fertigated method can be attributed to the large amount of nutrient applied through drip irrigation system over a small volume of soil and to saturation of exchange sites which resulted from K movement to greater depths within the active root zone of the crop.

In sandy soil where K is low, side dressed application is often more effective than broadcasting. Unsatisfactory distribution of K can occur under some condition and with low rates of fertilization. Under side dressed a large proportion of the nutrients may be deposited or leached compared to frequent application of soluble K with drip irrigation.

Table (3): Effect of K placement methods on growth and yield parameters.

K placement method	Plant height (cm)	No. of branches/ plant	No. of pods/ plant	Straw yield (kg/fed.)	Seeds yield (kg/fed.)
Control	51.6 C#	2.3 C	8.5 C	938 C	710 C
Fertigation	70.1 A	4.7 A	16.4 A	1970 A	1732 A
Side dressed	61.1 B	3.8 B	12.5 B	1604 B	1414 B

#Values followed by the same letter(s) in column are not significantly different at 0.05 level of Duncan's multiple range test.

CONCLUSION

Increasing rates of K application through drip irrigation system increased significantly plant height, number of branches/plant, number of pods/plant, straw and seeds yield / fed. The application rate of 120 kg K_2O/fed produced the highest response. The adequate range of K content in faba bean tissue is ranging from 2 to 3 %.

Potassium availability in soil increased significantly by increasing K rates through drip irrigation system. It is readily absorbed and moves into the soil within the active root zone of the crop. The application of K through drip irrigation system was more effective than side dressed application. Potassium was fertigated into drip irrigation system to produce a continuous K concentration throughout the growing season where plant need relatively large amount of K.

The repeated application of K with irrigation water in sandy soil is highly effective, the reason that sandy soil had a much lower exchange capacity than heavier soil. Movement of K below drippers is expected if application is concentrated by applying the fertilizer to small soil volumes. It would in position that the distribution of K in the center of the root system, where the content of water is relatively steady and high over time.

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استجابة محصول الفول البلدى لمعدل و طرق إضافة السماد البوتاسى فى الأراضى الرملية بشمال سيناء

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إن التسميد البوتاسى من خلال مياه الرى بالتنقيط مقارنة بالطرق التقليدية للتسميد فى محصول الفول البلدى لم يسبق ممارسته بصورة شائعة فى الأراضى الرملية الصحراوية. لذلك فقد أقيمت هذه التجربة الحقلية بمحطة بحوث المغارة (شمال سيناء) التابعة لمركز بحوث الصحراء لتقييم تأثير إضافة معدلات مختلفة من البوتاسيوم (صفر، ٣٠، ٦٠، ٩٠، ١٢٠، ١٥٠ كجم / فدان بو ٢ ا) . و مقارنة طرق الإضافة (مع مياه الرى بالتنقيط أو بجانب النبات بطريقة السرسبة) على محصول الفول البلدى (صنف جيزه بلانكا) و ذلك من خلال دراسة صفات النمو و الكفاءه المحصوليه و محتوى الأنسجة من عنصر البوتاسيوم مع تحليل التربة اسفل النقاطات لتقدير نسبة البوتاسيوم الميسر.

وقد أوضحت النتائج وجود فروق معنوية فى طول النبات و عدد الأفرع ، عدد القرون بالنبات ، محصول البذور و القش بالفدان. و قد أعطت المعاملة ١٢٠ كجم / فدان (بو ٢ ا) أعلى إنتاجية يقابله ٢,٥% بوتاسيوم فى الأنسجة و هو فى حدود الكفاية. كما حقق التسميد البوتاسى زيادة معنوية من خلال الرى بالتنقيط مقارنة بطريقة الإضافة التقليدية (سرسبة).

أعطى التسميد البوتاسى المتكرر من خلال الرى بالتنقيط زيادة معنوية فى محتوى التربة من البوتاسيوم اسفل النقاطات حيث أن التربة الرملية تتعرض للغسيل بالإضافة إلى السعة التبادلية الكاتيونية الضعيفة لها.

إن مستوى السماد البوتاسى من خلال الرى اسفل النقاطات تساعد على زيادة تركيز السماد فى منطقة انتشار الجذور من خلال حجم محدود من التربة خلال موسم النمو ، لذا يقترح تشجيع زراعة المحاصيل الهامه و الأساسية تحت ظروف الأراضى الرملية و ندرة المياه بنظام التسميد من خلال مياه الرى بالتنقيط.