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EFFECT OF FERTILIZATION WITH K AND CA ON VEGETATIVE GROWTH, YIELD AND QUALITY OF SOME SNAP BEANS CULTIVARS.

BY

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ABSTRACT

Two field experiments were carried out in the two successive summer seasons of 1998 and 1999 at the Agricultural Experimental Station, Faculty of Agriculture, Cairo University at Giza. These experiments aimed to study the effect of foliar fertilization with potassium sulphate (37% K_2O) at a rate of 2%, calcium nitrate (19% CaO) at a rate of 1% and their interaction on the vegetative growth, green pods yield and pods quality of three snap bean cvs. Bronco, Tema and Flexo. The results could be summarized as follows:

Vegetative growth characters expressed as plant height, number of branches, fresh and dry weight per plant were significantly increased with foliar fertilization with K_2SO_4 alone or combined with Ca $(NO_3)_2$.

Moreover, the results indicated that foliar fertilization with either K_2SO_4 or K_2SO_4 +$Ca(NO_3)_2$ were the most effective treatments on all pod characters; i.e. weight, length, and thickness. Also, the highest early and total yield of green pods were obtained by spraying plants with K_2 SO_4 or Ca $(NO_3)^2$.

Key words: snap bean – *phaseolus vulgaris* – cultivars – vegetative growth – yield – pod quality – foliar fertilization – calcium – potassium .

INTRODUCTION

Snap bean (*Phaseolus vulgaris* L.) is one of the major leguminous vegetable crops grown in Egypt for local consumption, industrial purposes and export especially during the period from December to May. Green pods quality of snap beans is related to cultivars and pre-harvest treatments. The most effective pre-harvest treatments was the fertilization especially with nutrients affective on pods durability during harvesting and handling.

Many researchers studied the effect of foliar spray with potassium on snap bean plants. They found that foliar spray with KCL at 1% concentration twice at flowering and pod formation stages increased plant height (Ramamoorthy *et al.*, 1995), number of branches and dry matter of leaves

(Hewedy *et al.*, 1994) and vegetative growth by foliar application with potassium sulphate at rate of 0.2% (Attia *et al.*, 1988).Also, spray with potassium led to an increase in yield. Ramamoorthy *et al.* (1995) on *Phseolus mango*, found that foliar spray of 1 % KCl increased grain yield compared with control. Also, El-Seifi (1997) studied the effect of foliar nutrition with potassium at rate of 9, 12 and 15 kg K_2O /fed. on snap bean pods of (*Phaseolus vulgaris* L.) cv. Bronco. The results indicate that spraying snap bean plants with K_2O at the rate of 15 kg/fed. gave the highest total green pods yield compared with the control. According to pods characters, El-Seifi (1997), indicated that spraying snap bean plants with K_2O at 15 kg/fed. was the most effective treatment in increasing pods characters, i.e. length, thickness, fresh weight and dry weight.

Many researchers studied the effect of foliar spray with calcium on snap bean plants. El-Tohamy (2000), found that plant height and fresh weight of plant were increased by foliar fertilization with $CaCl_2$ (25 mM). On the contrary, Quintana *et al.* (1999a) reported that adding Ca to snap bean plants via soil fertilization did not increase pods yield.

MATERIALS AND METHODS

This study was conducted at the Experimental Station, Faculty of Agriculture, Cairo University, Giza. to study the effect of foliar application with calcium and potassium on growth, green pods yield and its quality of green pods during the two successive summer seasons of 1998 and 1999. Seeds of three snap bean cvs. Bronco, Flexo and Tema (from Asgrow seed comp. USA) were sown on 29th February in both seasons.

The soil of the experimental area was loamy clay in texture with PH 7.79 and contain 56.0 mm/L Ca and 400 ppm K available.

This experiment was conducted to study the effect of foliar application treatments on three snap bean cultivars. The experiment included 12 treatments which were the combination of three cultivars and four foliar fertilization treatments as follows.

1-Bean cultivars: Bronco, Tema and Flexo.

2-Foliar fertilization treatments:

a-Foliar application with calcium nitrate 19% CaO at a rate of 1%.

b-Foliar application with potassium sulphate 37% K_2O at a rate of 2%.

c-A combination between calcium and potassium at the same concentrations.

d-Control (Foliar application with water).

These treatments were arranged in a split-plot design with three replications.

The bean cultivars were assigned in the main plots and the treatments of fertilization were randomly distributed in the sub-plots. The experimental area was 14 m^2 and consisted of five ridges, each 4-m long and 0.7-m-wide. Seeds were sown on one side of the ridge in hills at 15 cm a part. The foliar treatments

were done 30 days after planting and at one week intervals for 3 times. All the other agricultural practices required for snap bean production were done as commonly followed in the district.

Data recorded:

1-Plant growth measurements:-

Five plants were taken randomly from each experimental plots as a representative sample for measuring the following characters:

Plant length (cm), number of branches per plant and dry fresh as well as weight per plant (g).

2-Yield and its quality: -

a- Early yield (first three pickings): weight of green pods taken from each plot and the following variables were calculated: Average yield of green pods/feddan.

b- Marketable yield: Weight of straight, free of defect and free of discoloration pods were calculated during all pickings.

c- Total yield: Weight of green pods were taken during all harvests from each plot and the average weight of green pods/feddan was calculated.

3-Pods characteristics:

Twenty pods were taken randomly from each experimental plot for measuring the following characters: Average pod weight (g), pod length (cm), pod width (mm) and pod color measuring by using bean color chart i.e. light green = 1, medium green = 2 and dark green = 3.

RESULTS AND DISCUSSION

A. Vegetative growth characters:

1- Effect of cultivars:

Data presented in Table (1) show the response of the studied cultivars to the effect of foliar fertilization with $Ca(NO_3)_2$ and K_2SO_4 and their interaction on plant height and number of branches during the two successive seasons of 1998 and 1999. Data reveal that, Tema cv. gave the tallest plants and number of branches, where as Flexo cv. gave the shortest ones. These results were true in both growing seasons. As regard to the effect of cultivars on fresh and dry weight per plant, data in Table (1) indicate also that fresh and dry weight per plant were significantly influenced by cultivar. In this respect, Tema cv. had higher values compared with the other two cultivars.Obtained result might be due to genetic differences between cultivars. Similar results were detected by (Lupu *et al.*, 1993; Negi and Shekhar, 1993 and Singer *et al.*, 1996) who found significant differences in plant growth characters among cultivars.

2- Effect of spray treatments:

Table (1) show the effect of spraying snap bean plants with calcium and potassium as well as their combination on plant height, number of branches, fresh and dry weight/plant. Such data reveal that there were significant differences among the tested treatments for both plant height and number of branches during

both growing seasons, i.e. 1998 and 1999. The application of potassium sulphate at 2% K2O on bean plants increased plant height, number of branches, fresh and dry weight per plant in both seasons compared with others studied treatments. On the other hand, the lowest values were obtained in case of the control treatment. Obtained results are in agreement with those reported by Hewedy *et al.* (1994) and Ramamoorthy *et. al.* (1995) working on snap bean. In this regard, potassium plays an important role in the functions of enzymes needed for the vital processes and growth (El-Seifi, 1997).

3- Effect of the interaction:

Data in Table (1) show the effect of the interaction between cultivars and foliar fertilization treatments on vegetative growth parameters of snap bean plants, i.e .plant height, number of branches as well as fresh and dry weight per plant.

It is clear from the obtained data that using K_2SO_4 combined with any cultivar gave the highest values of different studied plant growth characters, plant height and number of branches and fresh and dry weight per plant .

Generally, the combination between Tema cv. and K_2SO_4 reflected the highest values for all growth parameters. These results were true in both seasons of the study, i.e. 1998 and 1999.

B-Total yield and its components:

1- Effect of cultivars:

Table (2) show the effect of cultivars and foliar application with calcium nitrate and potassium sulphate and their interaction on early, Total and marketable yields. As shown in these Table, Bronco cultivar significantly surpassed the other two cultivars in their early and total yield. These results were true in both seasons of the study, i. e. 1998 and 1999. Meanwhile, Flexo cv. in the first season and Tema cv. in the second produced markedly higher marketable yield without of significant difference in the first season only.

These results may be attributed to the genetic differences among cultivars and their response to environmental conditions. Obtained results are supported by those of (Bieshenuel, 1992, Amoli and Sadeghi, 1992; Negi and Skekhar (1993) and Jadhao (1993), who reported that snap bean cultivars differ significantly in yield.

2- Effect of fertilization:

Illustrated data in Table (2) indicate that all fertilization treatments increased yield and its components compared with the control . In this regard, using K_2SO_4 at 2% as K2O gave the highest values for both early and total yield. While the combination between Ca $(NO_3)_2$ and K_2SO_4 gave the maximum marketable yield. These results were true in both seasons of this work.. The icreasing effect of using K on early and total yield may be due to that potassium is essential for efficient water relationships in plants, formation and translocation of carbohydrates and activation of some enzymes. Plant requirements for K vary

from high to very high, depending on the species and plant size. These results are in agreements with those obtained by Alan and Guvence (1994) using NPK+ trace elements, EL-Seifi (1997) using KCl, Hassanien *et al.* (1996) using N + K_2O, Gu (1998) using KNO_3 and EL-Habbasha *et al.* (1996) using K_2SO_4. All investigators indicated that spraying snap bean plants and some vegetable crops increased early and total yield.

Table (1): Effect of foliar fertilization with calcium nitrate and potassium sulphate and their combination on plant vegetative growth characteristics.

Cultivars		Plant length (cm)		Number of branches		Plant fresh weight(g)		Plant dry weight(g)	
		1998	1999	1998	1999	1998	1999	1998	1999
Bronco		24.96	29.43	1.66	1.83	١٩,٤٠	24.72	2.66	3.08
Tema		27.39	30.38	1.87	2.09	28.94	31.02	3.57	3.69
Flexo		20.08	26.36	1.58	2.02	14.99	19.62	2.37	2.49
L.S.D $_{0.05}$		5.84	1.42	0.44	0.42	5.53	4.84	0.56	0.66
Treatments									
$Ca(NO_3)_2$		24.01	28.50	1.58	1.80	21.68	24.29	3.03	3.51
K_2SO_4		26.73	31.64	2.25	2.41	24.33	27.09	3.49	3.58
$Ca(NO_3)_2$+K_2SO_4		25.17	28.92	1.80	1.94	21.28	26.23	2.69	2.71
Control		20.67	23.35	1.94	1.36	17.17	21.41	2.26	2.92
L.S.D $_{0.05}$		0.81	1.46	0.40	0.42	1.69	2.05	0.36	0.58
Interaction									
Bronco	$Ca(NO_3)_2$	24.72	30.00	1.50	1.50	20.91	22.77	2.83	3.03
	K_2SO_4	27.47	32.08	2.00	2.50	23.62	26.97	3.06	4.28
	$Ca(NO_3)_2$+K_2SO_4	26.19	28.50	1.91	1.75	18.09	25.88	2.70	2.70
	Control	21.47	22.89	1.25	1.33	14.99	21.48	2.07	2.39
Tema	$Ca(NO_3)_2$	27.17	31.17	1.83	2.00	29.11	30.63	3.80	4.86
	K_2SO_4	30.64	34.25	2.66	2.50	31.78	34.00	4.51	3.99
	$Ca(NO_3)_2$+K_2SO_4	28.62	30.83	1.81	2.16	30.01	32.87	3.05	3.15
	Control	23.14	25.17	1.16	1.33	24.87	26.47	2.82	4.10
Flexo	$Ca(NO_3)_2$	20.15	24.33	1.41	1.91	15.02	19.48	2.46	2.65
	K_2SO_4	22.06	28.58	2.08	2.50	17.57	20.30	2.90	2.48
	$Ca(NO_3)_2$+K_2SO_4	20.70	27.42	1.66	1.91	15.74	19.95	2.29	2.29
	Control	17.42	22.00	1.16	1.41	11.64	16.27	1.90	2.27
L.S.D 0.05		1.41	2.54	0.70	0.74	2.93	3.55	0.63	1.01

3- Effect of the interaction:

Data in Tables (2) demonstrated that within each cultivar using the combination between $Ca(NO_3)_2$ + K_2SO_4 gave the highest values for all yield characters, i.e. early, total and marketable yield.

Table (2): Effect of foliar fertilization with calcium nitrate and potassium sulphate and their combination on green pods yield and its components.

Cultivars		1998			1999		
		Early yield (Ton/ fed.)	Marke-table yield(%)	Total yield (Ton/ fed.)	Early yield (Ton/ fed.)	Marke-table yield(%)	Total yield (Ton/fed.)
Bronco		1.47	90.52	2.57	1.24	89.37	2.69
Tema		1.07	90.74	2.56	0.96	90.39	2.56
Flexo		0.57	91.05	1.34	0.61	88.69	1.40
L.S.D $_{0.05}$		0.11	0.66	0.21	0.23	1.13	0.15
Treatments							
$Ca(NO_3)_2$		1.00	89.91	1.97	0.84	88.76	2.05
K_2SO_4		1.12	91.32	2.40	0.99	89.88	2.41
$Ca(NO_3)_2+K_2SO_4$		1.10	92.01	2.36	1.14	90.75	2.50
Control		0.91	89.84	1.88	0.78	88.55	1.91
L.S.D $_{0.05}$		0.08	0.64	0.54	0.17	0.98	0.12
Interaction							
Bronco	**$Ca(NO_3)_2$**	1.43	89.91	2.29	1.18	88.87	2.43
	K_2SO_4	1.54	91.24	2.93	1.38	89.84	2.89
	$Ca(NO_3)_2+K_2SO_4$	1.61	91.51	2.84	1.35	90.05	3.03
	Control	1.29	89.43	2.21	1.06	88.73	2.40
Tema	**$Ca(NO_3)_2$**	1.03	89.64	2.40	0.84	89.56	2.45
	K_2SO_4	1.20	91.00	2.78	0.93	91.21	2.79
	$Ca(NO_3)_2+K_2SO_4$	1.12	92.54	2.81	1.30	91.66	2.85
	Control	0.93	89.77	2.24	0.75	89.13	2.15
Flexo	**$Ca(NO_3)_2$**	0.54	90.19	1.23	0.50	87.85	1.26
	K_2SO_4	0.63	91.71	1.49	0.66	88.59	1.55
	$Ca(NO_3)_2+K_2SO_4$	0.59	91.97	1.44	0.77	90.53	1.61
	Control	0.51	90.33	1.21	0.52	87.80	1.17
L.S.D $_{0.05}$		0.153	1.121	0.940	1.310	1.712	0.224

A- Pods quality:

1- Effect of cultivars:

Data presented in Table (3) show the effect of fertilization treatments, cultivars and their interactions on physiological pods characters, i.e. pod length, diameter, weight and color.

Data shows that all the studied physical pod parameters were affected by cultivars. In this regard, Tema cv. gave the highest values for all characters followed by Bronco cv., where as Flexo cv. showed the lowest values. These results might be atributed to the genetic differences between cultivars. These results are confirmed by the findings of Hanafy (1973), EL-Gizy (1994), EL-Asdoudi and Ouf (1994) and Shahein *et al.* (1996), who found that pod length, diameter and weight were affected by cultivars.

2- Effect of fertilization:

Data presented in Table (3) show the effect of foliar fertilization treatments on pod quality, data indicate that, all fertilization treatments, i.e. Ca $(NO_3)_2$, K_2SO_4 and their interaction increased all studied parameters of pod quality i.e. pod length, diameter and weight.

In this regard, K_2SO_4 and K_2SO_4+Ca $(NO_3)_2$ showed the highest values for there characters, the lowest values were recorded in the control, these results are in accordance with those obtained by (EL-Seifi, 1997) on snap bean, Parker and Boswel (1980) and Hassanein *et al.* (1996) working on soybean and EL-Mansi *et al.* (1991) working on broad bean, they found that using K as a foliar spray gave the most effective increasment in pod characteristics.

Table (3): Effect of foliar fertilization with calcium nitrate and potassium sulphate and their combination on physical pods quality.

Cultivars		Pod length (cm)		Pod diameter (mm)		pod weight (g)		pod color	
		1998	1999	1998	1999	1998	1999	1998	1999
Bronco		13.74	12.60	6.90	6.87	6.79	5.06	1.23	1.96
Tema		14.02	14.09	6.53	7.17	6.94	5.32	1.31	1.51
Flexo		11.68	12.56	5.22	5.60	5.66	3.2	2.05	1.86
L.S.D $_{0.05}$		0.32	0.67	0.43	0.40	0.66	0.32	0.10	0.31
Treatments									
Ca $(NO_3)_2$		13.04	12.85	6.08	6.47	6.38	4.42	1.53	1.61
K_2SO_4		13.76	13.43	6.51	7.02	6.80	4.73	1.57	1.63
Ca $(NO_3)_2$+K_2SO_4		13.07	13.06	6.22	6.56	6.49	4.53	1.52	1.70
Control		12.72	12.34	6.06	6.43	6.23	4.21	1.50	1.37
L.S.D $_{0.05}$		0.35	0.29	0.22	0.31	0.31	0.33	0.21	0.18
Interaction									
Bronco	Ca $(NO_3)_2$	13.70	13.23	6.83	7.00	6.60	5.16	1.20	1.26
	K_2SO_4	14.13	13.00	6.26	7.30	7.16	5.23	1.23	1.46
	Ca $(NO_3)_2$+K_2SO_4	13.53	12.63	6.83	7.00	6.93	5.20	1.30	1.66
	Control	13.60	11.77	6.70	6.66	6.46	4.76	1.20	1.33
Tema	Ca $(NO_3)_2$	13.77	14.30	6.26	6.69	7.00	4.86	1.23	1.63
	K_2SO_4	14.60	14.23	6.93	7.70	7.23	5.50	1.43	1.56
	Ca $(NO_3)_2$+K_2SO_4	14.00	14.07	6.60	6.96	6.73	5.20	1.30	1.46
	Control	13.73	13.40	6.33	7.03	6.80	5.00	1.30	1.33
Flexo	Ca $(NO_3)_2$	11.67	12.80	6.16	5.46	5.56	3.23	2.16	1.93
	K_2SO_4	12.53	13.07	6.33	6.06	6.00	3.46	2.06	1.86
	Ca $(NO_3)_2$+K_2SO_4	11.67	12.47	6.23	5.73	5.66	3.20	1.96	1.96
	Control	10.83	11.87	6.16	5.60	5.43	2.86	2.00	1.46
L.S.D $_{0.05}$		0.60	0.51	0.39	0.53	0.55	0.57	0.21	0.31

The simulative effect of foliar spray with Ca and K on snap bean might be due to the greater importance of these substances in the physiological process inside the plant.

3- Effect of the interaction:

Concerning the interaction between cultivars and foliar application, the obtained data shows that under each cultivar, all fertilization treatments increased pod characters, the most effective treatment was recorded by the treatment of K_2SO_4 in all cultivars.

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تأثير التسميد بالبوتاسيوم والكالسيوم على النمو الخضرى والمحصول وجودة القرون على بعض أصناف الفاصوليا

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أجريت تجربتان حقليتان في الموسم الصيفي لعامي ١٩٩٨ ، ١٩٩٩ في محطة التجارب الزراعية التابعة لكلية الزراعة جامعة القاهرة بالجيزة ، بهدف دراسة تأثير التسميد الورقي بكل من سلفات البوتاسيوم بتركيز٢% (K_2O ٣٧%) ونترات الكالسيوم بتركيز١% (١٩% أكسيد كالسيوم) على النمو الخضري والمحصول ومكوناته وجودة القرون وذلك لثلاث أصناف من الفاصوليا الخضراء هي برونكووتيما وفلكسو.وكانت أهم النتائج التي تم الحصول عليها هي :

- لزادت مواصفات النمو الخضري (طول النبات – عدد الأفرع – الوزن الطازج – الوزن الجاف للنبات) زيادة معنوية مع التسميد الورقي بسلفات البوتاسيوم ٢%

منفردا أو مخلوطا مع نترات الكالسيوم ١% كما أدت هاتين المعاملتين إلى زيادة معنوية في مواصفات الجودة للقرون المتمثلة في طول ووزن وعرض القرن وذلك في جميع الأصناف .

- التسميد الورقي بسلفات البوتاسيوم ٢% منفردا أو مضافا إليه نترات الكالسيوم ١ % أدى إلى زيادة معنوية في المحصول المبكر والكلي مقارنة ببقية المعاملات في جميع الأصناف