Egypt. J. Hort. Vol. 35 pp. 79 - 92 (2008)

Response of Green Bean to Fertilization with Potassium and Magnesium

Huda A. Ibrahim[*], U. A. El-Behairy[**], M. EL - Desuki[*], M. O. Bakry[*] and A. F. Abou -Hadid[**]

[*] *Vegetable Research Dept., National Research Centre, Dokki, Giza, and* [**] *Horticulture Dept., Fac. Agric., Ain-Shams Univ., Shoubra EL-Khima, Cairo, Egypt.*

TWO FIELD experiments were carried out during the two successive growing seasons of 2004/2005 and 2005/2006 in the experimental farm of EL-Bosaily Protected Cultivation Site, El-Behaira governorate, Egypt, to study the effect of different levels of potassium (48, 72 and 96 kg K_2O /fed.) and magnesium (0, 3 and 6 kg MgO/fed.) on the growth, yield and quality of green bean (*Phaseolus vulgaris* L.) cv. Paulista.

With respect to the effect of potassium application, plant growth characters, *i.e.*, plant height. number of leaves and branches, fresh and dry weight and total chlorophyll, as well as green pod yield (early, local, exportable and total green pod yield) and pod quality, i.e., pod length, thickness, fibers content, TSS% and total protein percentage, were increased by increasing the level of K fertilizer from 48 up to 96 kg K_2O/fed.

Concerning the effect of Mg application, the vegetative growth of snap bean plants and green pod yield as well as pod quality were improved by increasing the level of Mg fertilizer from 0 to 6 kg MgO / fed.

The interaction among K and Mg treatments indicated that the values of all vegetative growth parameters, green pod yield and its components were significantly the highest values with the highest levels of potassium and magnesium. As for pod quality, pod length, thickness and fiber were not significantly affected by the interaction treatments. However, TSS and total protein contents were significantly increased with increasing the levels of potassium and magnesium application up to the highest levels.

Kaywords: Potassium, Magnesium, Phaseolus vulgaris L., Paulista, Exportable, Quality.

Green bean (*Phaseolus vulgaris* L.) is one of the most important leguminous crops in Egypt for exportation and local consumption. Mineral nutrient is one of the most important factors, which greatly affect snap bean plant growth and productivity, especially under newly reclaimed soil.

Potassium and magnesium had marked effect on snap bean productivity and quality. Potassium is a regulator for many of the metabolic processes in the cells, plays an important role on promotion of enzyme activity and enhancing the translocation of assimilates and protein synthesis (Devlin and Witham. 1986). Many investigators reported that potassium application caused an increase in plant growth, yield and quality of green bean (Ascenclo, 1987. Costigan , 1987. Evanylo & Zehnder, 1989, Gavras, 1989. Sangakkara *et al.* 1995. Saxena & Verma. 1995, Singh *et al.* 1995. Sangakkara *et al.* 1996a & b. Kanaujia *et al.* 1999, El-Tohamy *et al.* 2001, Islam *et al.* 2004, and Abdel-Mawgoud *et al.*, 2005).

Magnesium is the central atom of the chlorophyll molecule and plays an important non -specific role in the process of phosphate transfer. It also acts as an activator for certain enzymic reactions (Devlin and Witham. 1986). The Mg application enhanced snap bean growth, yield and quality as reported by Fageria & Souza (1991), Boaro *et al.* (1996), Alt *et al.* (1998 & 1999), Wan -Hon *et al.* 1999 Oliveira *et al.* (2000) and Swierczewska & Sztuder (2001).

For that the experiment aimed to study the effect of three levels of K application with three levels of Mg application on growth, yield and quality of snap bean.

Material and Methods

Two field experiments were carried out during the two successive growing seasons of 2004/2005 and 2005/2006 in the experimental farm of EL-Bosaily Protected Cultivation Site, El-Behaira governorate, Egypt.

Seeds of green beans (*Phaseolus vulgaris* L.) cv. Paulista were sown in the first week of September. After preparing the soil for cultivation, ditches of 20 cm width was performed and the distance between the ditches was 75 cm apart. Organic manure and fertilizers (100 and 150 kg/fed. of ammonium sulphate and super- phosphate, respectively) were added through the ditches and then it was covered by sand. Laterals of drip irrigation system were spread over the ditches. Seeds were sown in hills 5 cm apart on both sides of irrigation line. The distance between the planting rows was 25 cm apart.

The soil of the experimental field was sandy in texture. The chemical analysis of the experimental soil is presented in Table 1 and the meteorological data at EL-Bosaily are present in Table 2 .

Treatments

This experiment included 9 treatments which were the combinations between three levels of potassium and three levels of magnesium application. Potassium sulphate (48% K_2O) was applied at 48, 72 and 96 kg K_2O/fed. Magnesium sulphate (9.8% Mg) was applied at 0, 3 and 6 kg MgO/fed.

A split plot design with four replicates was used, the potassium levels were arranged in the main plots and the levels of magnesium were allocated at random

in sub-plots. Plot area was 15 m^2 which contained four lines of drip irrigation with 75 cm in width and 5 m in length.

Data recorded

Plant growth measurements

A representative sample of 6 plants was taken by random 45 days after sowing (flowering stage), from each experimental plot for recording plant height, number of leaves and branches per plant, total fresh weight and dry weight of plant (determined at 65°C for 72 hours using the standard methods as illustrated by A.O.A.C., 1990)

Chlorophyll reading

Chlorophyll reading of the sixth mature leaves was measured as SPAD units using monitor chlorophyll meter (SPAD-501).

Green pod yield and its attributes

At harvest stage (60 days from seeds sowing), green pods were collected along the harvesting season (40 days) and the following data were recorded: early, exportable, local and total green pod yields per feddan.

Green pod quality

A random sample of 100 green pods at 2-picking were taken, average pod length and thickness were recorded.

Nutritive value

A random sample of 50 green pods at 2-picking were taken and the following data were Record: The total soluble solids (TSS %): it was obtained by using the hand refractometer, according to method described by A.O.A.C. (1990). Fiber percentage in pods: it was determined according to Rai and Mudgal (1988). Total protein percentage in pods: a factor of 6.25 was used for conversion of total nitrogen to protein percentage (A.O.A.C., 1990).

All data were subjected to statistical analysis according to the procedures reported by Snedecor and Cochran (1982) and means were compared by Duncan's multiple range tests at the 5 % level of probability (Duncan, 1955). in the two seasons of experimentation.

TABLE 1. Chemical and physical properties of the soil of the experiment analyzed two weeks before cultivation in September of 2004.

Chemical properties							
EC	pH	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-
m/moh		meq/l	meq/l	meq/l	meq/l	meq/l	meq/l
3	7.89	30	10	14.26	1.66	2.5	12.6

Physical properties						
Sand%	Clay%	Silt%	Texture	FC%	PWP%	Bulk density g/ cm3
95.31	4.295	0.36	Sandy	16.77	5.65	1.435

The permanent wilting point (PWP) and field capacity (FC) of the trial soil were determined according to Israelsen and Hansen (1962).

TABLE 2. The maximum, minimum and mean of temperatures; relative humidity and total rain at EL-Bosaily region during 2004/2005 and 2005/2006.

Months	Maximum Temp.(°C)	Minimum Temp.(°C)	Mean Temp.(°c)	Mean RH %	Total Rain (mm)
		2004/2005			
September	33.8	21.26	27.57	52.47	1.22
October	30.62	19.53	25.07	53.84	1.18
November	27.06	13.81	20.43	54.32	0.59
December	20.81	8.45	14.63	54.98	2.42
January	19.02	6.37	12.7	56.74	1.49
		2005/2006			
September	35.11	22.45	28.78	52.87	1.12
October	29.78	18.05	23.92	54.94	1.06
November	25.37	11.87	18.61	55.5	0.32
December	23.2	11.67	17.44	54.87	2.92
January	20.31	7.46	13.88	53.76	2.70

Results and Discussion

Vegetative growth

Data in Table 3 show the effect of potassium and magnesium applications and their interaction on vegetative growth of snap bean plants, i.e., plant height, number of leaves and branches, fresh and dry weight and total chlorophyll. Results cleared that all vegetative growth parameters were gradually and significantly increased by increasing the level of K from 48 up to 96 kg K_2O/fed. This result was true in both growing seasons.

Respecting to the effect of Mg application, the results indicated that the tested characters of vegetative growth of snap bean plants were significantly increased with increasing the level of Mg from 0 up to 6 kg MgO/fed., as shown in both growing seasons.

The interaction effect indicated that all vegetative growth parameters were significantly affected by the interaction treatments. The highest values of vegetative growth were recorded with adding the highest level of K (96 kg K_2O/fed.) and the highest level of Mg (6 kg MgO/fcd.). However, the lowest values were recorded with adding the lowest level of K (48 kg K_2O/fcd.) without Mg application. This result was true in both growing seasons.

The results are in harmony with those reported by Devlin & Witham (1986), Ascencio (1987) ,Costigan (1987), Evanylo & Zehnder (1989), Gavras (1989), Saxena & Verma 1995 , Singh *et al.* (1995), Sangakkara *et al.* (1995),

Sangakkara (1996), Sangakkara *et al.* (1996a and b), Kanaujia *et al.* (1999), El-Tohamy *et al.* (2001), Islam *et al.* (2004) and Abdel-Mawgoud *et al.* (2005). They reported that increasing the level of K fertilizer caused a significant increase in yield.

The increment in vegetative growth of green bean plants by increasing the level of K fertilizer may be due to the role of potassium on regulation of the metabolic processes in the cells, plays an important role on promotion of enzyme activity and enhancing the translocation of assimilates and protein synthesis (Devlin and Witham, 1986).

The increasing of the vegetative growth of green bean plant by increasing the level of Mg fertilizer may be due to the role of magnesium as an activator for certain enzymic reactions, phosphate transfer and chlorophyll synthesis as reported Boaro *et al.* (1996), Alt *et al.* (1999) and Wang-Hong *et al.* (1999).

Green pod yield.

Data in Table 4 show the effect of potassium and magnesium application on green pod yield. With respect to K application, early, local, exportable and total green pod yields were gradually and significantly increased by increasing the level of K from 48 up to 96 kg K_2O/fed.This result was true in both growing seasons, except for local green pod yield in second season, where there was no significant differences between adding 48 and 72 kg K_2O/fed.

Regarding to Mg application, green pod yield and its components were gradually and significantly increased by increasing the level of Mg from 0 up to 6 kg MgO/fed., as shown in both growing seasons. Except for local green pod yield which was not significantly affected by increasing the level of Mg, in both growing seasons.

The interaction effect indicated that green pod yield and its components were significantly affected by the interaction between potassium and magnesium application. The highest values were recorded with adding the highest levels of K and Mg (96 kg K_2O/fed. and 6 kg MgO/fed., respectively), followed by adding the highest level of K with medium level of Mg(3 kg MgO/fed.). But the lowest values were recorded with adding the lowest level of K (48 kg K_2O/fed.) without Mg application. This result was true in both growing seasons for early, exportable and total green pod yield. However, the highest values of local green pod yield were recorded with adding the highest level of K (96 kg K_2O/fed.)and medium level of Mg (3 kg MgO/fed.), in both growing seasons

Added to that, increasing the vegetative growth (Table, 1) caused an increase in total green pod yield and its components as well as gave the best quality of green pod of bean.

The results are in harmony with those reported by Ascencio (1987), Costigan (1987), Evanylo and Zehnder (1989), Gavras (1989), Singh *et al.* (1995), Sangakkara *el al.* (1995), Sangakkara (1996), Sangakkara *et al.* (1996a & b), El-Tohamy *et al.* (2001), Islam *et al.* (2004) and Abdel-Mawgoud *et al.* (2005). They reported that increasing the level of K fertilizer caused a significant increase in vegetative growth.

Moreover, increasing the vegetative growth (Table 1) was reflected on increasing pod yield and gave the best quality of green pods of green bean. The results are in harmony with those reported by Fageria and Souza (1991), Boaro *et al.* (1996), Alt *et al.* (1999), Wang-Hong *et al.* (1999), Oliveira *et al.* (2000) and Swierczewska and Sztuder (2001). They reported that adding magnesium caused increasing in the vegetative growth which reflected on yield of green bean.

Nutrient contents in the leaves

The effect of potassium and magnesium levels on N, P and K % in green bean leaves illustrated in Table °. Regarding the effect potassium level, data showed that increasing potassium increased N and K % significantly in both season while increasing K_2O from 48 kg to 96 kg increased P % significantly but when it increased to 72 kg the difference was not significant.

Regarding Mg level, data showed that increasing Mg level increased N % in the leaves in both seasons and K % in the leaves significantly in the first season while in the second season the difference between 0 level and 3 kg MgO/fed level is not significant and the difference between 3 level and 6 kg MgO/fed level is also not significant. While increasing the level from 0 to 6 kg MgO/fed increased K % significantly. On the contrary, data showed that there was no significant difference of Mg levels on P% in the leaves.

Regarding the interaction among the K levels and Mg levels on N and K % in green bean leaves, data showed that increasing K level to 96 combined with increasing Mg level to 6 kg MgO/fed increased N% in the leaves significantly followed by K at 96 kg combined by Mg at 3 kg MgO/fed. The lowest N% in the leaves was obtained at K level 96 kg combined by Mg at 0 kg MgO/fed.

Regarding P % in the leaves, data in Table 5 showed that the highest level of P % was obtained using K level at 96 kg combined by Mg at 6 kg MgO/fed comparing with K at level 48 combined with Mg at level 0. The difference between these two treatments was significantly in the first season only. Similar findings were found by Gavras (1989), Singh *et al.* (1995), Sangakkara *et al.* (1995) and Abdel-Mawgoud *et al.* (2005).

TABLE 3. Effect of potassium and magnesium levels on plant height (cm), number of leaves and branches per plant, fresh and dry weight of plant (g) and total chlorophyll (SPAD) of green bean plants at flowering stage (45 days after sowing) in 2004/2005 and 2005/2006 seasons.

Treatments		First season (2004/2005)												Second season (2004/2005)									
K_2O (Kg)	MgO (Kg)	Plant height (cm)		Number of leaves per plant		Number of branches per plant		Fresh weight of plant (g)		Dry weight of plant (g)		Total chlorophyll (SPAD)		Plant height (cm)		Number of leaves per plant		Number of branches per plant		Fresh weight of plant (g)		Dry weight of plant (g)		Total chlorophyll (SPAD)	
K_2O levels																									
48		58.20	B	21.02	C	11.39	C	82.88	B	13.63	C	29.00	B	57.79	B	18.17	B	9.65	B	65.48	C	10.30	C	28.54	B
72		58.95	B	23.13	B	12.24	B	88.58	AB	15.52	B	30.03	AB	60.01	AB	18.49	B	10.71	B	75.80	B	12.52	B	29.62	A
96		61.60	A	24.80	A	13.15	A	93.82	A	16.98	A	31.11	A	62.42	A	22.92	A	12.68	A	84.63	A	15.18	A	30.60	A
MgO levels																									
	0	58.38	B	21.92	C	11.44	B	82.79	C	13.90	C	27.15	C	57.79	B	18.70	B	10.06	B	67.34	C	11.46	C	26.83	C
	3	59.55	B	22.83	B	12.35	A	88.46	B	15.38	B	30.27	B	60.01	AB	19.08	B	11.02	AB	75.51	B	12.65	B	29.64	B
	6	60.81	A	24.20	A	12.99	A	94.02	A	16.85	A	32.72	A	62.42	A	21.79	A	11.96	A	83.05	A	13.94	A	32.28	A
Interaction between K_2O and MgO																									
48	0	57.58	d	19.93	f	10.61	d	76.31	e	12.31	d	26.14	f	54.31	d	16.45	c	8.71	c	57.92	d	8.88	e	25.92	f
	3	58.11	d	20.95	ef	11.48	cd	83.58	cde	13.51	cd	29.38	d	57.08	cd	19.36	bc	9.71	de	67.51	cd	10.71	d	28.47	de
	6	58.90	cd	22.17	de	12.08	bcd	88.73	bcd	15.06	bc	31.47	bc	58.48	bcd	18.68	bc	10.52	cde	71.00	c	11.32	d	31.22	abc
72	0	57.17	d	22.24	de	11.39	cd	83.11	de	14.28	bc	27.13	ef	57.27	cd	17.55	c	9.79	cde	67.26	cd	11.37	d	26.79	ef
	3	59.11	cd	22.92	cd	12.27	abcd	88.67	bcd	15.28	b	30.05	cd	59.63	bc	17.34	c	10.75	bcd	75.53	bc	12.42	cd	29.57	cd
	6	60.59	bc	24.22	bc	13.07	abc	93.96	ab	17.00	a	32.91	ab	61.96	bc	20.59	bc	11.61	bcd	84.62	ab	13.93	bc	32.50	ab
96	0	60.40	bc	23.59	bcd	12.32	abc	88.95	bcd	15.10	bc	28.19	de	61.80	bc	22.11	ab	11.68	bc	76.85	bc	14.14	b	27.77	def
	3	61.44	ab	24.62	b	13.30	ab	93.15	abc	17.35	a	31.38	bc	63.32	ab	20.54	bc	12.60	ab	83.51	ab	14.81	b	30.89	bc
	6	62.95	a	26.20	a	13.82	a	99.36	a	18.49	a	33.76	a	66.82	a	26.10	a	13.77	a	93.53	a	16.57	a	33.13	a

Values followed by the same letter (s) are not significantly different at 5 %.

TABLE 4. Effect of potassium, magnesium and iron levels on early, local, exportable and total green pod yield(t/fed.) of green bean in 2004/2005 and 2005/2006 seasons.

Treatments		First season (2004/2005)				Second season (2004/2005)			
K_2O (Kg)	MgO (Kg)	Early green pod yield (t/fed.)	Local Green pod yield (t/fed.)	Exportable green pod yield (t/fed.)	Total green pod yield (t/fed.)	Early green pod yield (t/fed.)	Local green pod yield (t/fed.)	Exportable green pod yield (t/fed.)	Total green pod yield (t/fed.)
K_2O levels									
48		1.61 C	1.94 C	3.15 C	5.09 C	1.55 C	1.90 B	3.08 C	4.98 C
72		2.23 B	2.11 B	3.53 B	5.65 B	2.12 B	2.03 B	3.50 B	5.53 B
96		2.48 A	2.32 A	4.02 A	6.33 A	2.43 A	2.23 A	3.94 A	6.17 A
MgO levels									
	0	1.88 C	2.08 A	3.27 C	5.35 C	1.82 C	2.04 A	3.20 C	5.25 C
	3	2.10 B	2.15 A	3.52 B	5.68 B	2.03 B	2.08 A	3.44 B	5.52 B
	6	2.34 A	2.14 A	3.90 A	6.04 A	2.26 A	2.04 A	3.86 A	5.90 A
Interaction between K_2O and MgO									
	0	1.28 f	1.82 d	2.79 f	4.61 f	1.24 g	1.86 b	2.73 f	4.59 g
48	3	1.56 e	1.99 cd	3.16 e	5.14 e	1.55 f	1.91 b	3.07 e	4.98 fg
	6	1.98 d	2.01 cd	3.49 cd	5.51 de	1.87 e	1.93 b	3.43 cd	5.36 def
	0	1.99 d	2.03 cd	3.35 de	5.38 e	1.95 de	1.98 b	3.28 de	5.26 ef
72	3	2.23 c	2.07 bcd	3.53 cd	5.60 cde	2.07 d	2.03 ab	3.47 bcd	5.50 cde
	6	2.46 ab	2.24 abc	3.73 bc	5.96 bcd	2.35 bc	2.08 ab	3.75 bc	5.83 bcd
	0	2.35 bc	2.37 ab	3.69 bc	6.06 bc	2.27 c	2.29 a	3.61 bc	5.90 bc
96	3	2.51 ab	2.40 a	3.89 b	6.29 ab	2.47 ab	2.30 a	3.79 b	6.09 ab
	6	2.58 a	2.18 abc	4.47 a	6.65 a	2.56 a	2.11 ab	4.41 a	6.52 a

Values followed by the same letter (s) are not significantly different at 5%.

TABLE 5. Effect of potassium, and magnesium levels on N, P and K % in green beans leaves .

Treatments		First season (2004/2005)						Second season (2004/2005)					
K2O(Kg)	MgO (Kg)	N		P		K		N		P		K	
K_2O levels													
48		2.53	C	0.89	B	2.01	C	2.35	C	0.82	B	1.88	C
72		2.84	B	0.97	AB	2.29	B	2.77	B	0.84	AB	2.03	B
96		3.00	A	1.05	A	2.73	A	2.96	A	0.86	A	2.60	A
MgO levels 0.87													
	0	2.53	C	0.94	A	2.25	C	2.50	C	0.88	A	2.09	C
	3	2.84	B	0.97	A	2.34	B	2.69	B	0.89	A	2.17	AB
	6	3.00	A	1.00	A	2.44	A	2.88	A	0.92	A	2.25	A
Interaction between K_2O and MgO 0.95													
	0	2.42	E	0.86	c	1.95	e	2.26	g	0.82	a	1.85	c
48	3	2.53	De	0.89	bc	2.01	e	2.28	fg	0.84	a	1.88	c
	6	2.64	De	0.91	abc	2.09	de	2.49	ef	0.86	a	1.92	c
	0	2.55	De	0.93	abc	2.20	cd	2.51	de	0.87	a	1.99	c
72	3	2.95	Bc	0.98	abc	2.32	c	2.82	bc	0.88	a	2.04	c
	6	3.00	Bc	1.00	abc	2.36	c	2.98	ab	0.91	a	2.05	c
	0	2.79	Cd	1.02	abc	2.61	b	2.73	cd	0.94	a	2.43	b
96	3	3.04	B	1.06	ab	2.70	b	2.97	ab	0.95	a	2.58	b
	6	3.35	A	1.08	a	2.87	a	3.18	a	0.98	a	2.78	a

Green pod quality and nutritive value.

Data in Table 6 show the effect of potassium and magnesium applications and their interaction on green pod quality, *i.e.*, pod length, thickness, fiber content, TSS% and total protein percentage.

With respect to K application, pod length, thickness and fiber content were not significantly affected by increasing the level of K as shown in both growing seasons, except for pod thickness in the second season, which was significantly decreased by increasing the level of K up to the highest level (96 kg K_2O/fed.) as compared with low or medium level of K. Results also showed that TSS% and total protein percentage were gradually and significantly increased by increasing the level of K in both growing seasons. However, no significant differences were detected in protein content between adding 72 and 96 kg K_2O/fed., in the first season.

Regarding to the effect of Mg application, pod length and pod thickness were not significantly affected by Mg application, in both growing seasons. Fiber contents were not significantly affected by Mg application in the first season, however in the second season it was significantly decreased by increasing the level of Mg from 0 up to 6 kg MgO/fed., with no significant differences between adding 3 or 6 kg MgO/fed. The TSS% and total protein content were gradually and significantly increased by increasing the level of Mg from 0 up to 6 kg MgO/fed. This result was true in both growing seasons.

As for the effect of the interaction, pod length, thickness and fiber were slightly affected by the interaction treatments. However, TSS and total protein contents were significantly increased with increasing the levels of potassium and magnesium, the highest values were recorded with adding 96 kg K20/fed. and 6 kg MgO/fed., in both growing seasons.

The results are in harmony with those reported by Evanylo & Zehnder (1989), Gavras (1989), Saxena & Verma (1995), Singh *et al.* (1995), Sangakkara *et al.* (1995), Sangakkara (1996), Kanaujia *et al.* (1999), El-Tohamy *et al.* (2001), Islam *et al.* (2004) and Abdel-Mawgoud *et al.* (2005). They reported that increasing the level of K fertilizer gave the best quality of green pods.

TABLE 6. Effect of potassium and magnesium levels on length and thickness of pod (cm), fiber percentage, T.S.S. and total protein percentage of green bean pods in 2004/2005 and 2005/2006 seasons.

Treatments		First season (2004/2005)										Second season (2004/2005)									
K_2O (Kg)	MgO (Kg)	Length of pod (cm)		Thickness of pod (cm)		Fiber (percentage)		T.S.S.		Total protein percentage		Length of pod (cm)		Thickness of pod (cm)		Fiber (percentage)		T.S.S.		Total protein percentage	
K_2O levels																					
48		12.29	A	0.71	A	6.54	A	4.34	C	15.25	B	12.83	A	0.74	A	5.87	A	4.30	C	14.80	C
72		12.44	A	0.73	A	6.49	A	4.59	B	18.83	A	12.42	A	0.75	A	5.75	A	4.49	B	18.00	B
96		12.44	A	0.73	A	6.53	A	4.80	A	20.75	A	12.41	A	0.72	B	5.93	A	4.72	A	20.22	A
MgO levels																					
	0	12.49	A	0.72	A	6.52	A	4.47	B	16.77	C	12.64	A	0.74	A	6.05	A	4.38	C	16.51	C
	3	12.22	A	0.72	A	6.46	A	4.58	AB	18.40	B	12.51	A	0.74	A	5.79	B	4.50	B	17.44	B
	6	12.46	A	0.73	A	6.58	A	4.68	A	19.64	A	12.52	A	0.73	A	5.71	B	4.61	A	19.05	A
Interaction between K_2O and MgO																					
	0	12.52	ab	0.72	ab	6.50	a	4.23	d	13.50	f	13.48	a	0.74	ab	6.13	a	4.16	f	13.21	e
48	3	11.90	b	0.69	b	6.52	a	4.29	cd	15.20	e	12.58	a b	0.75	a	5.96	ab	4.26	ef	14.46	d
	6	12.46	ab	0.72	ab	6.61	a	4.51	bc	17.04	d	12.42	a b	0.74	ab	5.51	c	4.48	cd	16.72	c
	0	12.35	ab	0.71	ab	6.66	a	4.49	bc	17.16	d	12.29	b	0.75	a	6.37	a	4.39	de	16.95	c
72	3	12.29	ab	0.73	a	6.33	a	4.60	b	19.12	c	12.32	a b	0.75	a	5.34	c	4.51	cd	17.89	c
	6	12.68	a	0.75	a	6.47	a	4.66	ab	20.19	bc	12.66	a b	0.75	a	5.54	c	4.56	bc d	19.15	b
	0	12.60	ab	0.73	ab	6.41	a	4.70	ab	19.66	bc	12.14	b	0.72	ab	5.63	bc	4.61	bc	19.36	b
96	3	12.47	ab	0.74	a	6.51	a	4.84	a	20.86	ab	12.62	a b	0.72	ab	6.07	a	4.74	ab	19.98	b
	6	12.25	ab	0.72	ab	6.67	a	4.87	a	21.73	a	12.46	a b	0.71	b	6.08	a	4.80	a	21.31	a

Values followed by the same letter (s) are not significantly different at 5 %

References

Abdel-Mawgoud, A. M. R., El-Desuki, M., Salman, S. R. and Abou-Hussein, S. D. (2005) Performance of some snap bean varieties as affected by different levels of mineral fertilizers. *Journal of Agronomy.* **4** (3), 242-247.

Alt, D., H. Ladebusch and Melzer, O. (1998) Fertilizing with phosphorus, potassium and magnesium. *Gemuse-Munchen*, 34(6), S2-S7.

Alt, D., Ladebusch, H. and Melzer, O. (1999) Long-term trial with increasing amounts of phosphorus, potassium and magnesium applied to vegetable crops. *Acta Horticulture* **506, 29-36.**

Ascencio, J. (1987) Potassium and calcium distribution patterns along the leaf insertion gradient of bean plants grown in nutrient solutions. *Journal of Plant Nutrition.* **10**, (4), 455-484.

A. O. A. C. (1990) *"Official Methods of Analysis"* 15thed Association of Official Agricultural Chemists. 1045-1106.

Boaro, C. S. F., Moraes, J. A. P. V., de., Rodrigues, J. D., Pedras, J. F., Ono, E. O. and Curi, P. R. (1996) Magnesium content in nutrient solution and development of beans (Phaseolus vulgaris L. cv Carioca). Assessment of the relationship between growth and partitioning of assimilates. *Arquivos de Biologia e Tecnologia.* **39**(3), 585-594.

Costigan, P. A. (1987) A comparison of the effects of residual and freshly applied fertilizer on the growth and yield of dwarf french beans (Phaseolus vulgaris). Acta Horticulturae, **220, 281-288.**

Devlin, R. M. and Witham, F. H. (1986) *"Plant Physiology".* 4th ed CBS publishers and distributors 485, Jan Bhawan, Shadhara, Delhi, 110032 (India).

Duncan, D. B. (1955) Multiple range and multiple F test *J. Biometrics,* **11**, 1-42.

El-Tohamy, W. A., Singer, S. M. El-Behairy, U. A., and Abou-Hadid, A. F. (2001) Effects of low tunnels, plastic mulch and mineral nutrient treatments on chilling tolerance of snap bean plants. *Acta Horticulture.* **559**, 127-134.

Evanylo, G. K. and Zehnder, G. W. (1989) Common ragweed interference in snap beans at various soil potassium levels. *Applied Agricultural Research,* **4(2)**, 101-105.

Fageria, N. K. and Souza, C. M. R. de. (1991). Upland rice, common bean, and cowpea response to magnesium application on an oxisol. *Communications in Soil Science and Plant Analysis.* **22**(17-18), 1805-1816.

Gavras, M. F. (1989) The influence of mineral nutrition, stage of harvest and flower position on seed yield and quality of Phaseolus vulgaris L. *Dissertation-Abstracts-International-B, Sciences and Engineering,* **50** (5), 1697B-1698B.

Islam, M. S., Haque, M. M., Khan, M. M. Hidaka, T. and Karim M. A. (2004). Effect of fertilizer potassium on growth, yield and water relations of bushbean (Phaseolu,c vulgaris L.) under water stress conditions. *Japanese Journal of Tropical Agriculture,* **48**(1). 1-9.

Israelsen, O.W. and Hansen, V. E. (1962) *"Irrigation Principles and Practices"* 3rd ed. Jhon. Wiley and Sons. Inc New York. London .

Kanaujia, S. P., Raj Narayan and Sumati Narayan (1999) Effect of phosphorus and potassium on growth, yield and quality of French bean (*Phaseolus vulgaris* L.) cv. *Contender. Vegetable Science.* **26**(1), 91-92.

Oliveira, I. P. de., Asher, C. J., Edwards, D. G. and Santos R. S. M. dos. (2000) Magnesium sulphate and the development of the common bean cultivated in an Ultisol of Northeast Australia. *Scientia Agricola,* **57**(1), 153-157.

Rai, S. N. and Mudgal, V. D. (1988) Synergistic effect of sodium hydroxid and steam pressure treatment on compositional changes and fiber utilization of wheat straw. *Biological Waster,* **24**, 105-114.

Sangakkara, U. R. (1996) Response of French bean (Phaseolus vulgaris L.) to rate and ratio of potassium fertilizer application. *Pertanika Journal of Tropical Agricultural Science.* **19**(1), 61-67.

Sangakkara, U. R., U. A. Hartwig and J. Nosberger (1995) Growth and nitrogen fixation of Phaseolus vulgaris as affected by temperature, soil moisture and potassium. Nuclear- techniques in soil plant studies for sustainable agriculture and environmental preservation. *Proceedings of an international symposium jointly organized by the International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations, held in Vienna, Austria, 17-2 1-October1994.* 263-272.

Sangakkara, U. R., Hartwig, U. A. and Nosberger, J. (1996a) Root and shoot development of Phaseolus vulgaris L. (french beans) as affected by soil moisture and fertilizer potassium. *Journal of Agronomy and Crop Science.* **177**(3), 145-151.

Sangakkara, U. R., Hartwig, U. A. and Nosberger, J. (1996b) Response of root branching and shoot water potentials of french beans (*Phaseolus vulgaris* L.) to soil moisture and fertilizer potassium. *Journal of Agronomy and Crop Science.* **177(3),** 165-173.

Saxena, K. K. and Verma, V. S. (1995) Podding pattern of frenchbean (Phaseolus vulgaris) as influenced by fertility levels. *Indian Journal of Agronomy,* **40**(3), 439-443.

Singh, A. K., Singh, K., Singh, U. N. Raju, M. S. and Singh, J. P. (1995) Effect of potassium, zinc and iron on yield, protein harvest and nutrient uptake in French bean (Phaseolus vuigaris L.). *Journal of Potassium Research.* **11**(1), 75-80.

Snedecor, C. W. and W. G. Cochran (1982) *"Statistical Methods".* 7th ed. pp. 325-330. The Iowa State Univ. Press, Ames, Iowa, USA.

Swierczewska, M. and Sztuder, H. (2001) Response of cultivated plants to foliar magnesium fertilization. *Soils and Fertilizers.* **65** (8), 1610.

Wang-Hong, Chu-Tian Duo and Liu-Xin Bao (1999) A comparative study on the anatomy of common beans subjected to Mg deficiency and normal Mg supply. *Scientia Agricultura Sinica,* **32**(4), 63-67.

(*Received* 21/6/2008;
accepted 24/7/2008)

استجابة نباتات الفاصوليا الخضراء للتسميد بالبوتاسيوم والماغنسيوم

هدى احمد ابراهيم* ، اسامة احمد البحيرى* ، محمد عثمان بكرى* و ايمن فريد ابو حديد**
*قسم بحوث الخضر – المركز القومى للبحوث و**قسم البساتين – كلية الزراعة – جامعة عين شمس – شبرا الخيمة – القاهرة – مصر .

أجريت تجربتان حقليتان خلال موسمى الزراعة ٢٠٠٤/٢٠٠٥ و٢٠٠٥/٢٠٠٦ بالمزرعة البحثية بالبوصيلى التابعة لمركز البحوث الزراعية بمحافظة الجيزة جمهورية مصر العربية وذلك لدراسة تأثير مستويات (٤٨،٧٢،٩٦كجم K_2O/ فدان) والماغنسيوم (٦،٣،٠ كجم MgO/ فدان) على نمو ومحصول وجودة قرون الفاصوليا الخضراء صنف بوليستا .

أوضحت النتائج ان صفات النمو الخضرى (ارتفاع نبات – عدد الأوراق – عدد الأفرع – الوزن الطازج والجاف للنبات – محتوى الأوراق من الكلوروفيل) وكذلك محصول القرون الخضراء (المحصول المبكر – المحلى – القابل للتصدير – الكلى) وأيضا جودة قرون الفاصوليا (طول القرن – سمك القرن – محتوى القرون من الالياف – المواد الصلبة الكلية النباتية –محتوى القرون من البروتين) قد زادت مستوى البوتاسيوم المضاف من ٤٨ الى ٩٦ كجم K_2O/ فدان .

وبالنسبة لتأثير الماغنسيوم التفاعل بين البوتاسيوم والماغنسيوم أوضحت النتائج ان صفات النمو الخضرى وكذلك محصول القرون الخضراء قد تاثرت بمعنوية بالتفاعل بين البوتاسيوم والماغسيوم وان افضل النتائج تم المحصول عليها بإضافة اعلى مستويات البوتاسيوم والماغنسيوم (٩٦كجم K_2O+ ٦كجم MgO/فدان) ، اما فيما يخص مواصفات جودة القرون فقد أوضحت النتائج ان طول وسمك القرن وحتواها من الالياف لم يتاثر بمعنوية بمعاملات التفاعل فى حين ان المواد الصلبة الكلية الذائبة ومحتوى القرون من البروتين زاد بزيادة مستوى البوتاسيوم والماغنسيوم حتى اعلى مستوياتها (٩٦ كجم K_2O+ ٦ كجم MgO/ فدان) .