7 *Egypt. J. Agron.* **Vol. 28**, No.2, pp. 81- 97 (2006)

Effect of Potassium Fertilizations on Yield and Yield Components and Seed Composition of Two Fenugreek (*Trigonella foenum-graecum* L.) Cultivars under Saline Water Conditions

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TWO FIELD experiments were conducted at Ras-Sudr Research Station, South Sinai Governorate during the two successive seasons, 2003/2004 and 2004/2005. Each experiment was arranged in split-split plot design with four replications. Main aim of this research was to show the effect of soil and / or foliar potassium (K) fertilization either on the yield and its components and seed chemical composition on performance in two Fenugreek (*Trigonella foenum-graecum* L.) cultivars (Giza 2 and Giza 30) under saline water conditions. For this, three parts of potassien (0, 0.5, and 1 L potassien / fed.) foliar and four parts of soil application (0, 50, 100, and 150 kg potassium sulfate / fed.) were applied.

All obtained results can be summarized as follows:

1- Increasing (K) fertilization either soil (150 kg potassium sulfate/ fed. equal 72 K_2O) and / or foliar (1 L potassien / fed. dissolved in 200 L water / fed.) application led to increasing the yield and its components in two seasons.

2- Cultivar Giza 2 fertilized with 150 kg potassium sulfate /fed. and sprayed with 1L potassein / fed. reached the highest value in biological, seed, and straw yields (kg/fed.) in chemical analysis in seeds according to untreated plants.

3- The highest increasing rate from potassium fertilizations have been realized significantly in yield and yield components and chemical compositions of the total ash (reached their maximum values of 3.5 and 3.4 %, in the 1st and 2nd seasons respectively),crude fiber (20 and 30 %), fat content (7.10 and 7.27 %), the percentage of total N (3.2 and 3.6), protein (20 and 22.5%), Ca (73 and 75.45 mg /100g seed), Na (15 and 18 mg/100g seed), K (25 and 30 mg/100g seed), total carbohydrates (52 and 55 %), soluble carbohydrates (39 and 31 %), protein amino acids (were determined qualitatively), total flavonoids (3.1 and 3.4 mg/100g seed), total alkaloids (0.86 and 1.0 mg/100g seed) and saponin (1.17 and 0.99 mg/100g seed)for the combination of high foliar (1 L potassien / fed.) + soil (K) application (150 kg potassium sulfate / fed.) in Giza 2 at 5 % probability.

Keywords: Fenugreek, Soil and foliar fertilization, Chemical compositions, Saline water

Ras-Sudr which is located at Suez Gulf in southern Sinai area, Egypt, was considered among the horizontal agricultural expansion in that Desert region. Crop production is confronted with several agricultural constraints such as soils texture, calcareous nature, poor structure, high salinity and low organic matter content. The problem of soil salinity is further increasing because of the using with inadequate quality water for irrigation. These factors lead to inferior soil-water properties that retard crop optimal growth and maximal production (Khalil *et al.*,1991).

Fenugreek (*Trigonella foenum-graecum* L.) is semi-tolerant to saline irrigation water (Gupta & Yadav, 1986), and it is undoubtedly one of the oldest cultivated crops in the Mediterranean countries, North Africa and USA as a food, spice, medicinal, dye and forage plant (Shalini & Sudesh, 2003). The seeds of fenugreek have been used medicinally all through the ages and were held in high repute among the Egyptians for medicinal and culinary purposes. An essential oil is obtained from its seeds and it was used as a food flavoring and medicinally (Blumenthal *et al.,* 2000).

It is well known that both high sodium chloride and high pH level induce (K) deficiency. An alternative strategy to cope with salinity could; therefore, be to attempt to supplement (K) where the growth medium is known to be or may become saline at some time during the crop growth cycle (Satti & Yahyai, 1995). It is well accepted that concentration of (K) is much lower in the plants grown at high sodium chloride; therefore, supplementary (K) application could enhance the (K) concentration within the plants. These findings suggest that supplementary (K) can improve plant growth, yield and its quality grown under saline conditions (Greenway & Munns, 1980).

On the other hand, the responses of Fenugreek cultivars to environmental stresses are varied and generally involve some alternation in protein synthesis (Zidan & Elewa, 1992). The proline accumulation may occur due to its role in osmoregulation. It has been suggested to act as a compatible cytoplasm osmotic and may enhance salt tolerance (Zidan & Elewa, 1992). This could be achieved by using tolerant cultivars as well as by improving cultural practices such as balanced fertilizer. Mineral nutrient deficiencies are considered major constraints limiting legume nitrogen fixation and yield. From them, (K) deficiency does not seem to affect directly N concentration in the leguminous plants, but it can seriously inhibit N2-fixation by reducing the plant growth (Andrew, 1976). The goal of this experiment was to study the effect of (K) foliar application as potassien and (K) soil application as potassium sulfate compared with two fenugreek cultivars (Namely, Giza 2 and Giza 30) under saline or brackish water.

Material and Methods

Two field experiments were carried out at Ras-Sudr Agricultural Experimental Station of Desert Research Center, South Sinai Governorate in

Egypt during 2003/2004 and 2004/2005 winter seasons. Each experiment was arranged in split-split plot design with four replications.

Three rates (every rate dissolved in 200 L water / fed.) of potassien foliar application (0, 0.5, and 1 L potassien / fed.) and four rates of (K) soil application as potassium sulfate (0, 50, 100, and 150 kg potassium sulfate / fed.) were applied on two fenugreek cultivars (Giza 2 and Giza 30) in the study. Used cultivars were obtained from Agriculture Research Center at Giza and were successively washed and treated with *Rhizobium melitoti* suspension before sowing to N2-fixation by reducing the plant growth (Andrew, 1976).

Potassium soil application and potassien foliar treatments were applied after 40 and 70 days from the sowing, respectively. The two rates of (K) foliar as potassien (30% K_2O+ 10% P_2O_5) sprayed by a hand compression-type Knapsack sprayer using flood jet nozzle and treatment were allocated to main plots, while the cultivars and (K) soil application treatments were allocated to sub-plot and sub-sub plot, respectively.

The physical and chemical analysis results of the soil were determined according to Richard (1954) and presented in Tables (1&2). The soil is highly calcareous, loamy sand in texture with high salt content.

TABLE 1. Physical analysis of Ras-Sudr soil.

Character Season	% Sand	% Silt	% Clay	Soil texture	O.M.	$CaCO_3$ %
2003-2004	80.50	11.40	8.10	Sandy loam	0.48	52.30
2004-2005	74.47	16.90	8.63	Sandy loam	0.40	54.30

TABLE 2.Chemical analysis of Ras-Sudr soil.

Character	pH	EC dS/m	Soluble Cations (meq/100g)				Soluble Anions (meq/ 100g)			
Season			K^+	Na^+	Mg^{++}	Ca^{++}	SO_4^{--}	Cl^-	HCO_3^-	CO_3^-
2003/2004	7.28	8.36	20.4	12.98	35.83	0.54	14.75	12.5	3.00	--
2004/2005	8.1	9.58	22.60	10.60	34.00	0.40	14.50	15.8	2.1	--

The experiments were irrigated by saline water. The salinity level was being reached 4249 ppm in the first season and 4442 ppm in the second season. On the other hand, plot area was 2x3m size and each one containing 8 rows. Each row was three meter long and distance was 25 cm between rows. Fenugreek cultivars were obtained from Agriculture Research Center at Giza, Egypt and were successively washed and treated with *Rhizobium melitoti* suspension before sowing. Seeds were sown at rate of 10 kg / fed. on December, 6^{th} and 4^{th} in 2003, 2004 seasons, respectively.

The recommended cultural practices of growing fenugreek plants were applied. At harvest time, ten guarded and tagged plants were selected from each plot and followings were determined: plant height (cm), number of branches / plant, number of pod /plant, length of pod (cm), number of seed /pod, seed weight/pod and seed index. Moreover, biological yield (kg/fed.) seed yield (kg/fed.) and straw yield (kg/fed.) .

All obtained data were subjected to the statistically analysis in a split-split plot design and comparisons were done using LSD test grouping at the 5 % probability level (Snedecor & Cochran, 1969).

The higher rates of K foliar and soil application treatments in addition to the control on the two cultivars were subjected to chemical analysis; 1- Preliminary photochemical screening of the seeds were achieved for testing the volatile oils (Balbaa *et al.* 1986), flovonoids (Wall *et al.* 1954), alkaloids, (Woo *et al.* 1977), saponins (Balbaa, 1981) 2- Determination of inorganic (ash and crude fiber) and organic matter percentages (Askar & Treptow, 1993), 3- Determination of total and soluble carbohydrates (Chaplin & Kennedy, 1994), 4- Percentage of nitrogen was determined by using the Micro-Kjeldahl method (Pregle, 1945), Seed protein concentration was calculated by (% N X 6.25), 5- Determination of total lipid percentage. 6- Assay of elements: Na, K & Ca were determined using flame emissive spectrometry while Zn, Cu, Fe and Mn were determined by Atomic Absorption (Pregle, 1945), 7- Determination of qualitatively protein amino acids (Pellet & Young 1980), 8- Estimation of total active constituents, total flavonoids of the seeds were determined spectrophtomitically (Karawya & Aboutable, 1982).

Results and Discussions

1) Fenugreek yield and yield components

a- Effect of the foliar application

Data in Table 3 show that increasing the potassein foliar application rates from 0.5 to 1 L potassein /fed. led to increasing significantly all characters in two years compared with the control.

High foliar application (1L potassein / fed.) overed the low foliar application (0.5 L potassein / fed.) by 50.7, 20.77 and 61.29% in the first season, and 65.86, 54.14 and 69.62 % in the second season for biological, grain and straw yields, respectively. The increase of values of characters due to the basal and foliar application of (K) might have an important role in photosynthesis and its possible role in plant metabolism involved activation of large of enzymes. Kaya *et al.* (2001) found that application of (K) mitigated the detrimental effect of high salt. Plants received higher rate of (K) produced higher seed weights compared with untreated ones. This indicates that (K) deficiency is only, partly, responsible for the reduction of seed yield and productivity under high salinity conditions.

TABLE 3. Response of fenugreek yield and its components to potassien foliar applications .

Character / Treatment	Plant height cm	No. of branches /plant	No. of pod /plant	Length of pod /cm	No. of seed /pod	Seed weight /pod	Seed index	Biological yield kg/fed.	Seed yield kg/fed.	Straw yield kg/fed.
2003 / 2004 season										
Control	19.917	2.329	5.442	9.025	11.058	0.120	7.960	174.958	38.895	136.013
0.5 L /fed.	21.688	3.021	6.338	9.296	12.183	0.191	8.785	235.187	61.475	173.712
1 L / fed.	25.542	4.471	10.196	10.200	13.983	0.348	11.427	354.433	74.246	280.187
LSD at5%	0.4363	0.1215	0.2314	0.2494	0.1887	0.1163	0.1774	3.8791	1.0213	6.5997
2004 / 2005 season										
Control	16.988	1.563	3.554	5.521	8.250	0.088	7.803	82.95	24.159	58.791
0.5 L /fed.	17.675	1.904	4.004	6.983	8.710	0.089	8.653	112.113	27.158	84.955
1 L / fed.	19.158	2.633	6.121	8.317	9.820	0.141	11.311	185.946	41.86	144.986
LSD at 5%	0.2573	0.0306	0.1824	0.2123	0.1387	0.0445	0.1505	4.0223	0.5701	2.7502

N.S = not significant at 5%.

b- Effect of the cultivars

Data in Table 4 show that Giza 2 cultivar was superior to Giza 30 cultivar in the two seasons and significantly higher in all characters (biological, grain and straw yields) in both seasons except seed weight / pod in both seasons. Giza 2 surpassed Giza 30 by 71.74, 47.63 and 79.80 % in the first season, and 22.69, 96.33 and 11.51 % in the second season, for biological, grain and straw yields, respectively.

TABLE 4. Response of two fenugreek cultivars on yield and its components to different potassium applications

Character / Treatment	Plant height cm	No. of branches /plant	No. of pod /plant	Length of pod /cm	No. of seed /pod	Seed weight /pod	Seed index	Biological yield kg/fed.	Seed yield kg/fed.	Straw yield kg/fed.
2003 / 2004 season										
Giza 30	20.022	2.461	5.540	8.608	11.636	0.257	8.046	187.578	47.011	140.567
Giza 2	24.742	4.086	9.106	10.406	13.181	0.183	10.735	322.142	69.401	252.741
LSD at5%	0.2205	0.1057	0.1807	0.1289	0.0973	Ns	0.2159	2.2803	1.4048	5.3767
2004 / 2005 season										
Giza 30	16.669	1.697	3.675	6.045	8.517	0.091	7.834	158.970	20.963	138.001
Giza 2	19.211	2.369	5.445	7.836	9.339	0.121	10.673	195.039	41.156	153.883
LSD at5%	0.0909	0.0781	0.1559	0.0634	0.1304	Ns	0.1032	2.3971	0.4707	2.6993

N. S = not significant at 5%

According to obtained results, Giza 2 was the more tolerant than Giza 30 to the salinity. This result is supported by Mangal *et al.* (1987), Sharma & Bhati (1987) and Sharma *et al.* (2001).

c-Effect of (K) soil application

Data in Table 5 show that increasing (K) soil application as potassium sulfate from 50 up to 150 kg potassium sulfate / fed., led to increasing significantly all yield and its components under the study in both seasons; whereas, in the second season seed weight /pod. High soil application (150 kg potassium sulfate /fed.,) overed the low soil application (50 kg potassium sulfate /fed.,) by 24.06, 31.58 and 111.80 % in the first season, and, 29.19, 35.69 and 27.19% in the second season, for biological, grain and straw yields, respectively.

These results are in agreement with the reports of Detroja *et al.* (1995), Detroja *et al.* (1996), Nowak *et al.*,(1996) and James & Rajendra (1997). They found that application of (K) in the planting furrow is advantageous when soils are poor in (K). Application of high rates of (K) in the planting furrow may result in a localized salinity problem, causing seedling injury. Split application of (K) is recommended to avoid salinity effects and leaching losses both in annual and perennial crops. These may be due to additions of (K) fertilizer which resulted in adsorption of a much higher proportion of the added (K) than it would in the case of the sandy soil.

TABLE 5. Response of fenugreek yield and its components to K soil applications .

Character / Treatment	Plant height cm	No. of branches /plant	No. of pod /plant	Length of pod /cm	No. of seed /pod	Seed weight /pod	Seed index	Biological yield kg/fed.	Seed yield kg/fed.	Straw yield kg/fed.
2003 / 2004 season										
Control	20.578	2.717	5.861	8.466	11.339	0.119	7.951	205.53	44.423	161.107
50 kg K/ fed.	21.600	3.133	6.800	9.161	12.000	0.141	8.916	240.87	54.024	186.846
100 kg K /fed.	22.995	3.450	7.822	9.811	12.844	0.232	9.832	274.22	63.288	210.932
150 kg K / fed.	24.356	3.794	8.817	10.589	13.450	0.388	10.863	298.83	71.087	227.743
LSD at5%	0.2716	0.0820	0.2459	0.1003	0.1616	0.0959	0.1287	5.9944	2.0606	9.3396
2004 / 2005 season										
Control	16.789	1.672	3.300	5.945	8.033	0.081	7.736	103.617	24.848	78.769
50 kg K /fed.	17.589	1.872	4.095	6.556	8.594	0.105	8.782	117.578	27.756	89.822
100 kg K /fed.	18.267	2.156	5.039	7.356	9.200	0.117	9.677	134.911	33.972	100.939
150 kg K /fed.	19.117	2.433	5.806	7.906	9.883	0.124	10.827	151.907	37.661	114.246
LSD at 5%	0.1071	0.0417	0.0965	0.0954	0.0728	Ns	0.1543	3.9495	0.5231	3.0027

N. S = not significant at 5%

The unabsorbed part of (K) remains in the soil solution and is removed in leaching water. Nehara *et al.*(2002), reported that increasing levels of (K) up to 45 kg / ha led to significant increases in all the yield attributes of fenugreek (pods per plants, seeds per pod and length of pod), and yield (seed, straw and biological yields). Moreover, Data *et al.* (2000) found that the highest rate of (K) gave higher 100-seed weight, and the highest (K) rate of (120 kg K_2O / ha) increased number of seeds / pod and seed yield / ha.

d-Effect of the interaction among (K) soil and foliar application, and fenugreek cultivars

Data in Table 6 show that the interaction among (K) soil and foliar applications, and two fenugreek cultivars was found out statistically significant for the yield and yield components in two seasons, except seed yield in the first season and number of seed / pod and seed weight /pod in the second season. According to the results, best treatment was found out as Giza 2 which was fertilized with 150 kg potassium sulfate / fed. (by soil) and sprayed with 1 L potassien / fed. (as foliar)in two seasons.

TABLE 6. Effect of the interaction among (k) soil and foliar application, and fenugreek cultivars

Treatment		Character	Plant height cm	No. of branches /plant	No. of pod /plant	Length of Pod /cm	No. of seed /pod	Seed weight /pod	Seed index	Biological yield kg/fed.	Seed yield kg/fed.	Straw yield kg/fed.
2003/2004 season												
Control foliar	**Giza 30**	Control	17.5	2.00	4.40	7.13	10.17	0.077	5.80	113.20	26.62	86.58
		50 kg K/fed.	18.6	2.17	4.77	7.76	10.60	0.088	7.07	122.43	33.09	89.34
		100 kg /fed.	19.2	2.20	5.00	8.40	10.97	0.129	7.56	132.10	37.34	94.76
		150kgK/fed.	19.7	2.33	5.37	9.60	11.24	0.157	7.98	146.60	39.05	107.55
	Giza2	Control	19.2	2.23	4.90	8.40	10.80	0.089	7.53	145.40	36.24	109.16
		50 kg K/fed.	20.0	2.37	5.56	9.60	11.17	0.125	8.84	203.50	40.73	162.77
		100 kg /fed.	21.8	2.57	6.27	10.40	11.67	0.142	9.13	251.40	47.33	204.07
		150kgK/fed.	23.3	2.76	7.26	10.83	11.87	0.154	9.74	285.00	50.77	234.23
0.5L/fed.	**Giza 30**	Control	19.0	2.23	4.80	7.77	10.74	0.084	6.93	157.30	36.74	120.56
		50 kg K/fed.	19.9	2.30	4.94	8.33	11.17	0.093	7.24	169.30	41.51	127.79
		100 kg /fed.	20.7	2.40	5.27	8.83	11.50	0.533	7.83	194.70	51.91	141.04
		150kgK/fed.	21.1	2.53	5.53	9.70	11.83	1.373	8.50	202.00	60.96	142.79
	Giza2	Control	20.3	3.00	5.86	9.20	11.77	0.141	8.58	234.00	56.73	177.27
		50 kg K/fed.	21.5	3.47	6.70	9.53	12.30	0.173	9.37	278.20	73.09	205.11
		100 kg /fed.	23.4	3.83	8.27	10.23	13.80	0.187	10.39	312.60	82.23	230.37
		150kgK/fed.	21.4	4.43	9.30	10.80	14.37	0.199	11.23	333.30	88.63	244.67
1L /fed	**Giza 30**	Control	20.2	2.47	5.46	7.93	12.10	0.111	8.05	192.50	42.79	149.71
		50 kg K/fed.	20.7	2.67	6.37	8.67	12.37	0.124	8.89	232.60	51.95	180.65
		100 kg /fed.	21.5	3.00	6.93	9.13	13.37	0.141	9.49	269.70	62.60	207.10
		150kgK/fed.	21.9	3.27	7.67	10.00	13.60	0.165	11.18	318.40	79.56	238.84
	Giza2	Control	27.3	4.37	9.74	10.34	12.60	0.211	10.58	390.70	67.43	323.27
		50 kg K/fed.	29.0	5.83	12.43	11.07	14.40	0.237	12.09	439.10	83.76	355.34
		100 kg /fed.	31.3	6.73	15.20	11.90	15.77	0.258	14.58	484.80	98.31	386.49
		150kgK/fed.	32.8	7.43	17.76	12.53	17.80	0.279	16.55	507.60	107.56	400.04
LSD at 5%			0.6659	0.2012	0.6031	0.2458	0.3962	0.2352	0.3155	14.6969	N.S	22.8986
In 2004/ 2005												
Control foliar	**Giza 30**	Control	15.2	1.00	2.20	4.23	7.14	0.051	5.36	59.7	13.68	46.02
		50 kg K/fed.	15.8	1.30	2.67	4.64	5.53	0.053	6.90	64.8	15.42	49.38
		100 kg /fed.	16.1	1.43	3.47	5.10	8.20	0.067	7.47	70.8	17.19	53.61
		150kgK/fed.	16.8	1.63	3.87	5.54	8.67	0.068	7.87	83.4	18.78	64.62
	Giza2	Control	16.9	1.53	3.14	5.26	7.74	0.065	7.33	76.6	27.07	49.53
		50 kg K/fed.	17.5	1.73	3.60	5.74	8.40	0.073	8.72	88.5	30.45	58.05
		100 kg /fed.	18.3	1.83	4.33	6.53	8.87	0.085	9.09	102.5	33.75	68.75
		150kgK/fed.	19.5	2.03	5.17	7.13	9.47	0.104	9.68	117.3	36.76	80.54
0.5L/fed.	**Giza 30**	Control	17.3	1.53	2.50	5.34	7.44	0.057	6.75	78.4	16.36	62.04
		50 kg K/fed.	16.2	1.67	3.17	5.90	7.90	0.075	7.15	80.7	17.69	63.01
		100 kg /fed.	16.9	1.83	3.84	6.67	8.44	0.083	7.54	92.9	19.51	73.39
		150kgK/fed.	17.3	2.00	4.17	7.10	9.23	0.096	8.39	108.8	20.84	87.96
	Giza2	Control	17.7	1.73	3.57	6.73	8.40	0.085	8.74	104.0	30.94	73.06
		50 kg K/fed.	18.4	1.90	4.43	7.27	8.97	0.095	9.31	116.9	33.75	83.15
		100 kg /fed.	18.8	2.17	4.93	8.16	9.43	0.107	10.25	148.1	37.48	110.62
		150kgK/fed.	20.1	2.40	5.43	8.70	9.90	0.114	11.09	158.2	40.69	117.51
1L /fed	**Giza 30**	Control	16.4	1.73	3.30	5.86	8.44	0.084	7.98	109.9	21.50	88.40
		50 kg K/fed.	17.2	1.87	4.03	6.57	9.17	0.094	8.56	123.3	25.57	97.73
		100 kg /fed.	17.7	2.03	5.10	7.47	9.74	0.101	9.37	127.7	30.85	96.85
		150kgK/fed.	18.5	2.23	5.80	8.14	10.34	0.117	10.71	140.1	34.15	105.95
	Giza2	Control	18.6	2.50	5.10	8.23	9.07	0.141	10.26	192.9	39.54	153.36
		50 kg K/fed.	20.5	2.77	6.67	9.24	9.60	0.162	12.05	231.3	43.65	187.65
		100 kg /fed.	21.8	3.63	8.57	10.20	10.53	0.184	14.33	267.5	65.05	202.45
		150kgK/fed.	22.6	4.20	10.40	10.83	11.70	0.209	17.24	294.8	74.56	220.24
LSD at 5%			0.2626	0.1020	0.2366	NS	0.1787	NS	0.3782	9.6833	1.2826	7.3621

N. S = not significant at 5%

The foliar and high soil applications were given the highest value and this may be due to the physiological fact that (K) is involved in plant metabolism as well as large number of enzymes that are activated by (K). In addition, yield increasing of the fenugreek cultivars through the soil application or soil + foliar application may be explain: (i) the induction of nutrient absorption by root system, (ii) increasing of the plant internal translocation capacity and finally, (iii) the transportation of the nutrients essential to plant metabolism.

2) *Chemical composition*

a-Effect of the interaction among (K) soil and foliar application, and fenugreek cultivars

Data in Table 7 and Fig. (1, 2a, 2b, 3, 4 and 5) show that the interaction among (K) soil and foliar applications, and two fenugreek cultivars was significant on {percentage of ash, crude fiber, fat, (N), protein, (Ca), (Na), (K), total carbohydrates, soluble carbohydrates, protein amino acids, flavonoids, alkaloids and saponin}. The chemical compositions was of the total ash (reached their maximum values of 3.5 and 3.4 %, in the 1st and 2nd seasons respectively),crude fiber (20 and 30 %), fat content (7.10 and 7.27 %), the percentage of total N (3.2 and 3.6), protein (20 and 22.5%), Ca (73 and 75.45 mg /100g seed), Na (15 and 18 mg/100g seed), K (25 and 30 mg/100g seed), total carbohydrates (52 and 55 %), soluble carbohydrates (39 and 31 %), protein amino acids (were determined qualitatively), total flavonoids (3.1 and 3.4 mg/100g seed), total alkaloids (0.86 and 1.0 mg/100g seed) and saponin (1.17 and 0.99 mg/100g seed) for the combination of high foliar (1 L potassien / fed.) + soil (K) application (150 kg potassium sulfate / fed.) in Giza 2 at 5 % probability. Giza 2 (fertilized by 150kg potassium sulfate /fed. and foliar with 1L potassien /fed.) was reached the higher values significantly in all chemical analysis than sodium analyzes in two seasons.

TABLE 7. Effect of the interaction among (K) soil and foliar application, and fenugreek cultivars on amino acids* of fenugreek seeds.

Treatments		Name of amino acids	Glycine	Lysine	Arginine	Aspartic acid	Alanine	Proline	Valine	Phenyl-alanine	Lucien	Tryptophane	Orientien
Control K foliar	Giza 30	Control	+	+	+	+	+	+	+	+	+	-	-
			+	+	+	+	+	+	+	+	+	-	-
		150kg (K)	+	+	+	+	+	+	+	+	+	-	-
			+	+	+	+	+	+	+	+	+	-	-
	Giza2	Control	-	+	-	+	+	+	-	+	+	-	+
			-	+	-	+	+	+	-	+	+	-	+
		150kg (K)	-	+	-	+	+	+	-	+	+	-	+
			-	+	-	+	+	+	-	+	+	-	+
1L /fed	Giza 30	Control	-	-	+	+	+	+	-	-	+	-	+
			-	-	+	+	+	+	-	-	+	-	+
		150kg (K)	-	-	+	+	+	+	-	-	+	-	+
			-	-	+	+	+	+	-	-	+	-	+
	Giza2	Control	+	+	+	+	+	+	+	+	+	+	-
			+	+	+	+	+	+	+	+	+	+	-
		150kg (K)	+	+	+	+	+	+	+	+	+	+	-
			+	+	+	+	+	+	+	+	+	+	-

(+) Presence; (-) Non existence; First line belongs to 2003/2004; Second line belongs to 2004/2005 in each cell

(*) protein amino acids were determined qualitatively

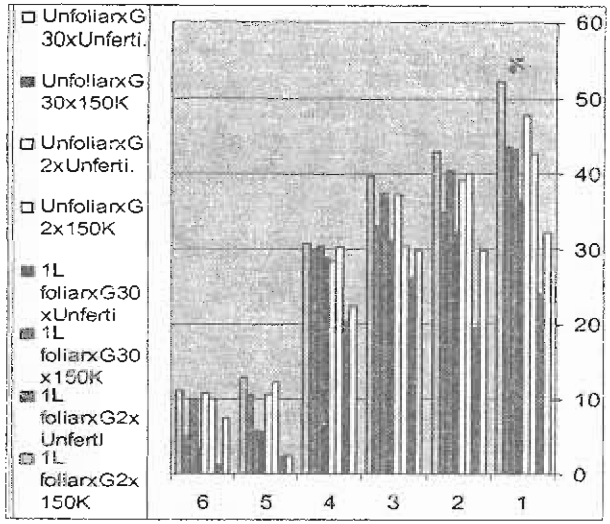

Fig. 1. Effect of the interaction among (*K*) soil and foliar applications, and fenugreek cultivars on: 1- total carbohydrates (%) in the first season, 2-total carbohydrates in the second season, 3-soluble carbohydrates (%) in the first season, 4- soluble carbohydrates in the second season, 5-insoluble carbohydrates in the first season and 6- insoluble carbohydrates in the second season.

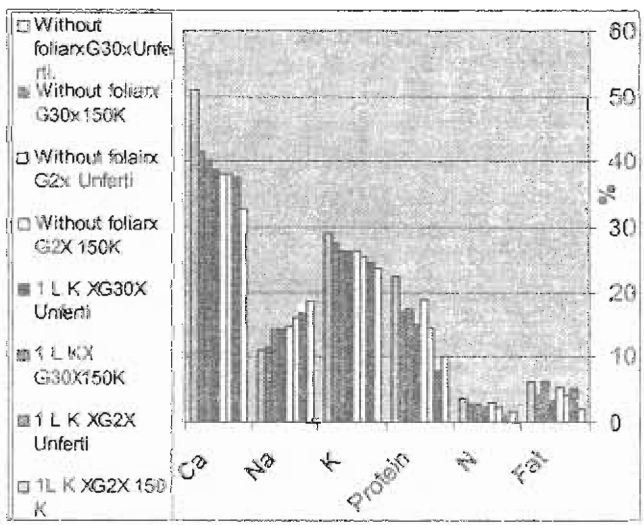

Fig.2a. Effect of the interaction among (K) soil and foliar applications, and fenugreek cultivars on macro- elements (mg/100g seed), fat, and protein (%) in the first season.

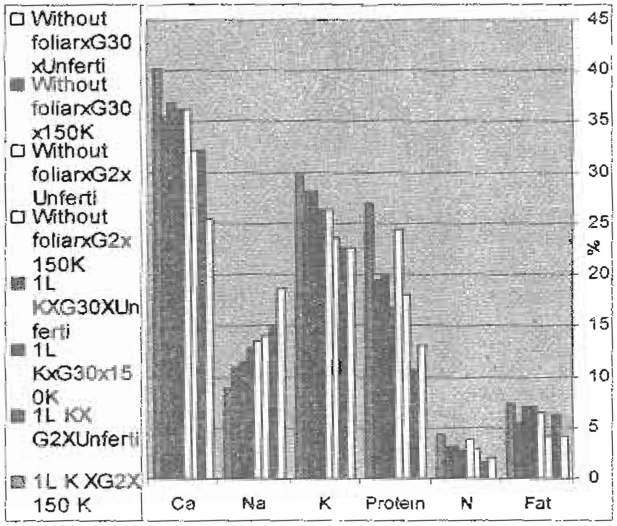

Fig. 2b. Effect of the interaction among (K) soil and foliar applications, and fenugreek cultivars on macro- elements (mg/100g seed), fat, N and protein (%) in the second season.

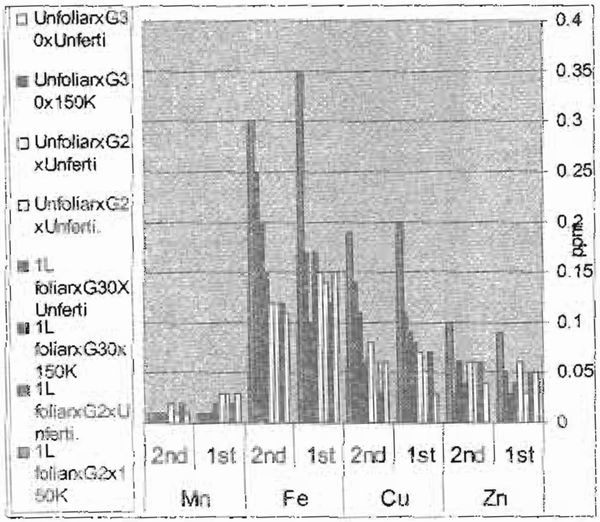

Fig. 3. Effect of the interaction among (K) soil and foliar applications, and fenugreek cultivars on trace elements (ppm) in both seasons.

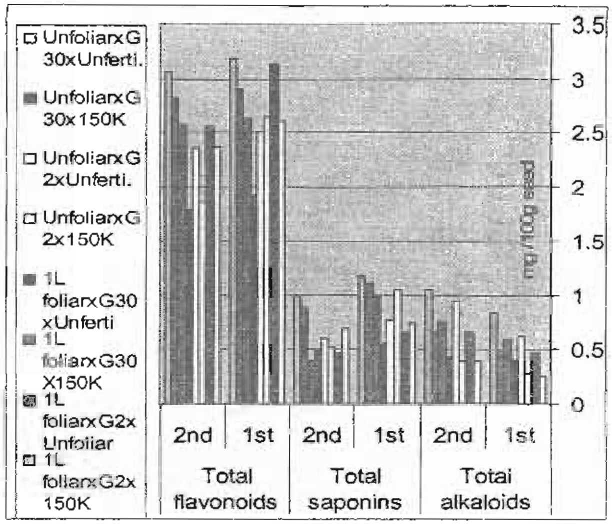

Fig. 4. Effect of the interaction among (K) soil and foliar applications, and fenugreek cultivars on some chemical constituents (mg /100g seed).

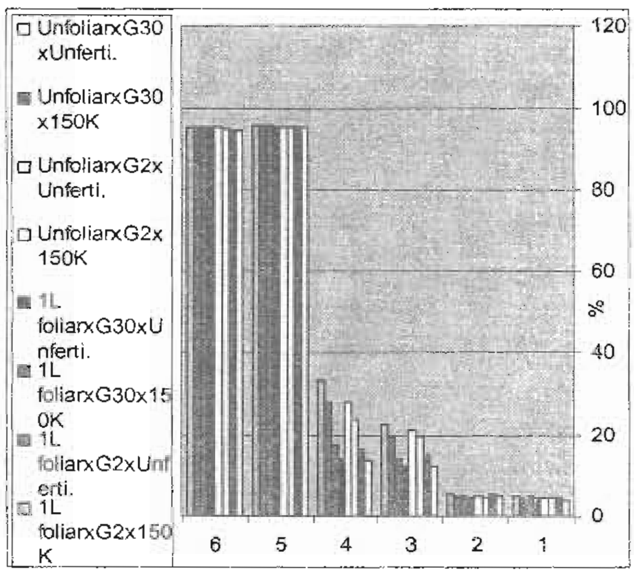

Fig. 5. Effect of the interaction among (K) soil and foliar application, and fenugreek cultivars on: 1- ash in the first season, 2- ash in the second season, 3- crude fiber in the first season, 4- crude fiber in the second season, 5- organic matter in the first season and 6- organic matter in the second season. (%)

The obtained results agreed with Lust (1974) who found that potassium promotes certain enzyme reactions and acts with sodium to maintain normal pH levels and responsible for the balance between fluids inside and outside the cell. While, calcium is an important mineral for the construction of cell walls. It is a co-factor of a lot enzymes, including those involved in the phosphorylation processes. Macro elements (Na), (Ca) and (K) are nutritionally important elements.

Walker *et al.* (1982) found that application of (K) improved the % N and helped in the translocation of N whatever was available to plant. De Smet *et al.* (1992), Shadded & Zidan (1989) stated that soluble carbohydrate and proline contents increased while amino acid content of fenugreek seeds decreased by increasing salinity. The high protein content (32-36%) of fenugreek seed may be due to its favorable. All amino acid composition, except glutamic acid had negative increase in the two cultivars under different treatments. These results agreed with many researchers; Sanvaire *et al.* (1976) reported that fenugreek seeds contain protein high in lysine and L – tryptophane. Moreover, free amino acids, including proline, progressively accumulated as salinity increased. Nour and Magboul (1986) stated that fenugreek seeds obtained are rich in leucine, valine, lysine and phenylalanine. Fenugreek seeds are very rich source of lysine, which are comparable with the protein egg and commonly used legumes (De Smet *et al.*, 1992). Alkaloids are used as defensive agents and they may be moved around the plant to those parts needing greater protection during growth and development. Fenugreek seeds contain steroidal saponins, diosgenine and its isomers; gitogenin, tigogenin, and yamogenin beside neotigogenin. The steroidal saponins are thought to inhibit cholesterol absorption and synthesis.

From the obvious results, Giza 2 cultivar cultivated under saline water conditions and applied soil potassium fertilization (150 kg potassium sulfate/ fed.) + foliar application by (1 L potassien /fed.) produced higher yield and its components and chemical composition in South Sinai and similarity region.

*Acknowledgement:*The authors are grateful to Prof. Dr., Abla H. Ashoub Prof. of Agronomy, Dept. of Plant Production, Desert Research Center for her valuable support and encouragement.

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(*Received* 12/4/2006;
accepted 25/7/2006)

تأثير التسميد البوتاسى على المحصول ومكوناته والتركيب الكيماوي لصنفين من الحلبة تحت ظروف المياة المالحة

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أجريت تجربتان حقليتان بمحطة بحوث راس سدر التابعة لمركز بحوث الصحراء بمحافظة جنوب سيناء خلال موسمين زراعيين متتاليين ٢٠٠٣/٢٠٠٤ & ٢٠٠٤/٢٠٠٥ لدراسة ثلاث مستويات من التسميد البوتاسى المعدني الارضى بمعدل (٥٠، ١٠٠، ١٥٠ كجم بوتاسيوم /فدان) في صورة كبريتات بوتاسيوم مقارنة بدون تسميد ومعدلين من الرش بالبوتاسيوم بتركيز (٠,٥، ١ لتر / فدان) في صورة بوتاسين بعد إذابة كل تركيز في ٢٠٠ لتر ماء مقارنة بدون معاملة وذلك بعد ٤٠ و ٧٠ يوم من الزراعة على صنفين من الحلبة (جيزة ٢ و جيزة ٣٠) والتي تم ريهم بماء بئر تصل درجة ملوحتة ٤٢٤٩ جزء في المليون في الموسم الأول و ٤٤٤٢ جزء في المليون في الموسم الثاني و تأثير ذلك على الإنتاجية والصفات الكيماوية لبذور الحلبة تحت ظروف مياة الآبار المالحة.

وأوضحت الدراسة النتائج آلاتية:

١– تزداد صفات المحصول ومكوناتة زيادة معنوية بزيادة التسميد الو رقى بالبوتاسين من ٠,٥ –١ لتر / فدان في كلا الموسمين .

٢– تفوق الصنف جيزة ٢ تفوقا معنويا على الصنف جيزة ٣٠ فى كلا الموسمين وبذلك نوصى بزراعتة تحت ظروف الاراضى الملحية.

٣–تزداد صفات المحصول ومكوناتة زيادة معنوية بزيادة التسميد الارضى بالبوتاسيوم من ٥٠ إلى ١٥٠ كجم كبريتات بوتاسيوم / فدان في كلا الموسمين.

٤– تفوق الصنف جيزة ٢ تفوقا معنويا عند الرش بالبوتاسين بمعدل ١ لتر / فدان مع التسميد الارضى بالبوتاسيوم بمعدل ١٥٠كجم كبريتات بوتاسيوم / فدان في بعض صفات المحصول ومكوناتة فى كلا الموسمين.

٥– أعطى الصنف جيزة ٢ والمسمد ١٥٠ كجم كبريتات بوتاسيوم / فدان والمعامل بالبوتاسين رشا بمعدل ١ لتر / فدان اعلى مكونات كيمائية لبذور الحلبة (% الرماد– الالياف الخام – الدهون– النتروجين– البروتين– العناصر المعدنية الكبرى الكالسيوم و الصوديوم و البوتاسيوم– الكربوهيدرات الكلية– الأحماض الامينية – الفلافونات– القلويدات) و بالنسبة للصوديوم كان اقل هذة المكونات الكيمائية في كلا الموسمين.

٦– اظهر البحث وجود استجابة واضحة لإضافة عنصر البوتاسيوم للاراضى المتأثرة بالاملاح لوجود نقص ملحوظ في مثل هذة الاراضى وينصح كذلك بالرش بنفس العنصر فى محصول الحلبة.

٧– يوصى في الاراضى المتأثرة بالأملاح بزراعة محصول الحلبة صنف جيزة ٢ تحت المستوى المرتفع من التسميد البوتاسي الارضى(بمعدل ١٥٠كجم كبريتات بوتاسيوم / فدان) والو رقى(بمعدل ١ لتر بوتاسين / فدان) تحت الظروف المماثلة لجنوب سيناء (منطقة راس سدر).