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EVALUATION OF SOME PROMISING LINES OF FENUGREEK PLANT UNDER DIFFERENT SEEDING RATES AND SPRAYING WITH POTASSEIN – P

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ABSTRACT

Two field trials were carried out at El-Gimiza Research Station Farm during 2005/2006 and 2006/2007 seasons to study the effect of spraying potassein-P (30% K_2O and 10% P) and three seeding rates (24, 36 and 42 kg/fed) on growth, seed yield, fixed oil, carbohydrate and protein percentages of two varieties (Giza 2 and Giza 30) and two promising strains (16 and 29) of fenugreek plant.

The results showed that fenugreek strain 29 was the latest in flowering and maturity. Strain 29 exceed Giza 2 var., Giza 30 var. and strain 16 in plant height, branches and pods number, 1000 seed weight and protein percentage. Whereas strain 29 and Giza 2 var. recorded the maximum seed and oil yield and carbohydrate percentage. Spraying of potassein-P significantly increased all characters under study than unspraying. Sowing fenugreek at low seed rate of 24 kg/fed significantly increased branches number, seed yield and its components, percentage and yield of oil and protein percentage.

Data showed that the interaction of varieties X seeding rates had significant effects on all studied characters except plant height and oil percentage. All the interactions were significant concerning 1000 seed weight and protein percentage.

GLC analysis of fatty acids showed that the total percentage of unsaturated fatty acids was higher than the value of saturated one in all varieties and strains fixed oil. Linoleic acid was major components of unsaturated fatty acid. Giza 30 variety and strain 29 recorded the highest value of linolenic unsaturated fatty acid.

The best treatment for highest yield of seed and oil was that of sowing Giza 2 var. at low seed rate of 24 kg/fed and spraying with potassein-P while, maximum yield of seed and oil and protein percentage could be achieved by sowing promising strain 29 at 24 kg/fed seeding rate and spraying with potassein-P.

INTRODUCTION

Fenugreek (*Trigunella foenum graecum*) is an annual herb belonging to Family Fabaceae, fenugreek seed is getting a lot of attention lately for its many medicinal virtues. It is very effective diabetes treatment, promoting substantial reduction in blood sugar and blood cholesterol (Bordia, 1997). Fenugreek is expectorant and inflammatory; it contains B vitamin that prevents pellagra and diogennin, which has gotten attention lately for its role in preventing breast cancer (Abdel-Barry *et al.,* 1997). The seeds also contain hormone precursors that increase breast milk, yield oral contraceptives, restore some hair growth, Scented seed contains vitamins (A, B and C), Iron, minerals and 23% protein as mentioned by (Rinzler, 1990).

It contains two alkaloids (tregonilline and choline), carbohydrate, fixed oil, mucilage and saponine.

Regarding the effect of seeding rates, Eid *et al*., (2002) stated that increasing plant density increased plant height and carbohydrate percentage, decreased branches number and protein percentage of fenugreek. Ezzat (1994)stated that the lower seed rate of 45-50 kg/fed was optimal to produced the highest seed yield/fed in north Egypt, Ezzat *et al*., (2005) on lentil, El-Metwally *et al.,* (2007) on chickpea found that plant height was markedly increased with increasing plant up to 54 plants/m^2. while, the maximum number of branches, seed index (gm), seed yield per plant and per feddan could be achieved with lowest density 40 plant/ m^2 and El-Dauby *et al*., (2002) on soybean found that low plant density gave more branches, pods, 100 seed weight, fixed oil % and shortest plant.

Potassium and phosphorus fertilization maintain high productivity and good quality of different crops. Potassium plays an important role in metabolic processes (Bonnet 1963), enhancing Co_2 assimilation, photosynthetic rate and more accumulation of carbohydrate (Peoples and Koch 1979 and Evans and Sorger 1966). The important role of phosphorus as it is one of the main constituent of meristematic tissues for new cells building and growth apical responsible of increasing plant height (Russel and Russel 1961). Several authors pointed out to the importance of K and P fertilization for fenugreek plants, El-Sherbeny *et al*., (1987), illustrated that using P (6.5 - 21%) and K (2.5 - 17%) fertilizers as foliar sprays increased plant height, pods number per plant, weight of 100 seeds, total carbohydrate and fixed oil % significantly, Similar results are obtained on fenugreek by Shadia and Zayed (1994), Chaudhary (1999). Also, Dayanad *et al.,* (2002), found that increasing the levels of potassium significantly improved protein content in fenugreek seeds. Mohamed and Naguib (2002), reported that foliar application with potassein-P increased significantly plant height, number of pods, weight of 100 seeds, seed yield per plant and per feddan, total lipids, protein and carbohydrate percentage.

This study aimed to investigate the effect of spraying with potassein-P and seeding rates on the growth, seed and oil yield, carbohydrate and protein percentage of two varieties and two strains of fenugreek plant.

MATERIALS AND METHODS

This experiment was carried out in the Experimental farm of the Agricultural Research Station at El-Gimmeiza for two successive seasons 2005/2006 and 2006/2007 to study the effect of foliar spray with potassein-P and three seeding rates on two varieties and two promising strains of fenugreek plant.

The experimental soil was clayloam with pH value of 7.8, E.c was 1.88 d s/m, available N, P and K were 39, 7.8 and 430 ppm, respectively. The seeds were obtained from Legume Crops Section Field Crops Institute, ARC. Fenugreek seeds were sown on 8^{th} and 12^{th} Nov. in the first and second seasons, respectively. This investigation was treated as split-split-plots design with three replicates.

The main plots were varieties and strains as follows:

1- Giza 2 var. 2- Giza 30 var. 3- Strain 16 4- Strain 29

The sub-plots were spraying with- as follows:

1- Un foliar sprayed with potassien-P.

2- Foliar sprayed with potassein-P which contains (30% K_2O and 10% P)

The sub-sub plots were as follows:

1- Planting seeds on both sides of the ridge 70 cm apart and 200 cm long i.e. 24 kg/fed seeding rate (2 ridges/plot).

2- Planting seeds on raised beds, wide ridges of 140 cm and 200 cm long in the 5 middle rows i.e. 36 kg/fed seeding rate.

3- Planting seeds on raised beds, wide ridges of 140 cm and 200 cm long in the 6 middle rows i.e. 42 kg/fed seeding rate.

The plants were fertilized at the rate of 150 kg/fed calcium supper phosphate (15.5 P_2O_5) before planting and 75 kg/fed ammonium sulphate (20.5%N) was added at sowing. Potassein-P spray was conducted at two times, the first one after 45 days from sowing, while the second one was at the complete flowering stage. Days from sowing to 50% flowering and days from sowing to 95% maturity were recorded. At the harvest time date 14th and 19th of May during the 1st and 2nd seasons, respectively the following data were recorded. Plant height, branches and pods number per plant, 1000 seed weight, seed yield per plant (gm.) and per feddan (kg.) fixed oil percentage and fixed oil yield, total carbohydrate and protein percentage.

Fixed oil was extracted by soxhelt according to the method of A.O.A.C (1990). The values of crude protein percentage were calculated as total nitrogen percentage and then multiplied by 6.25 according to Tripathi *et al*., (1971). Total carbohydrates in dry seeds were determined according to Dubois *et al*., (1956). G.L.C analysis technique was used to separate and identify the Fatty acids of fixed oil of fenugreek seed,the separation of fatty acid methyl esters was conducted with column: SP-2310, 55% cyanopropyl phenyl silicon (1.5×4mm).Column was used with a temperature program of 70-190^o at 8^o/ min. The injector and detector temperatures were maintained at 250 and 300^o, respectively. Nitrogen was used as a carrier gas at a rate of 30 mL/ min. Statistical analysis was carried out according to Snedecor and Cochran (1972).

RESULTS AND DISCUSSION

1- Earliness:

Data in Table (1) reveals that strain 16 was the earliest in 50% flowering and 95% maturity as it matured at 149.25 days. While, promising strain 29 and Giza 2 var. were the latest in flowering and maturity as they matured at 153.25 and 152.25 days, respectively.

Table (1): Mean values of earliness as affected by fenugreek varieties

Varieties / Days	Giza 2	Giza 30	Strain 16	Strain 29	L.S.D
From sowing to 50% flowering	51.75	50.00	48.25	53.00	1.73
From sowing to 95% maturity	152.25	150.50	149.25	153.25	1.29

2- Plant height:

Results in Table (2) showed that strain 29 produced tallest plant (94.0 and 94.2 cm) in both seasons, compared to varieties Giza 2, Giza 30 and strain 16 with significant differences.

Table (2) : Effect of potassein-P and seeding rates on plant height of some fenugreek varieties during 2005/2006 and 2006/2007 seasons.

Varieties and strains	Potassein-P	2005/2006				2006/2007			
		Seeding rates (SR)			Means	Seeding rates (SR)			Means
		24	36	42		24	36	42	
Giza 2 var.	No pot.	84.0	92.3	94.3	**90.2**	85.3	93.0	94.3	**90.8**
	Pot.	88.0	96.0	97.3	**93.7**	92.3	96.3	96.0	**94.8**
Means		**86.0**	**94.1**	**95.8**	**91.9**	**88.8**	**94.6**	**95.1**	**92.8**
Giza30 var.	No pot.	90.6	93.3	94.6	**92.8**	88.0	94.0	93.3	**91.7**
	Pot.	90.6	96.3	98.0	**94.9**	91.6	97.0	99.0	**95.8**
Means		**90.6**	**94.8**	**96.3**	**93.9**	**89.8**	**95.5**	**96.1**	**93.8**
St. 16	No pot.	86.0	92.3	93.6	**90.6**	87.6	93.0	92.0	**90.8**
	Pot.	89.3	96.6	100.0	**95.3**	90.0	98.0	100.0	**96.0**
Means		**87.6**	**94.5**	**96.8**	**92.9**	**88.8**	**95.5**	**96.0**	**93.4**
St.29	No pot.	86.3	95.0	97.3	**92.8**	88.6	95.3	95.6	**93.2**
	Pot.	90.3	96.3	99.0	**95.2**	90.3	97.6	98.0	**95.3**
Means		**88.3**	**95.6**	**98.1**	**94.0**	**89.5**	**96.5**	**96.8**	**94.2**
Means pot	No pot.	86.7	93.2	95.0	**91.6**	87.4	93.8	93.8	**91.6**
	Pot.	89.5	96.3	98.5	**94.7**	91.0	97.2	89.2	**95.5**
Means (SR)		**88.1**	**94.7**	**96.7**	**93.1**	**89.2**	**95.5**	**96.0**	**93.5**

L.S.D. at 0.05		
A=Varieties (Var.) &strains(st.)	1.27	1.19
B=Potassein-P (Pot.)	0.68	0.99
C=Seeding rates kg / fed (SR)	0.86	0.85
AB	1.37	N.S
AC	1.73	N.S
BC	N.S	N.S
ABC	N.S	2.43

Spraying potassein-P significantly surpassed unsprayed treatment in this respect. Maximum plant height (94.7 and 95.5 cm) were achieved with application of potassein-P in both seasons, respectively, as shown in Table (2).This increase could be attributed to the important role of potassium in metabolic processes, enhancing Co_2 assimilation and increased translocation rate of photosynthesis (Bonnet 1963, Peoples and Koch 1979) , Besides the important role of phosphorus as it is one of the main constituents of meristematic tissues for new cell building and growth apical responsible of

increasing plant height(Russel and Russel 1961). Similar results were obtained by El-Sherbeny *et al.,* (1987), Shadia and Zayed (1994), Mohamed and Naguib (2002) on fenugreek

In both seasons, seeding rates had significant effects on plant height; increasing seeding rates resulted in tallest plant (96.7 and 96.0 cm). This increase in plant height might be due to competition among plants for light in dense population. Similar finding was found by Eid *et al*., (2002) on fenugreek Ezzat *et al*., (2005) on lentil El-Douby *et al*., (2002) on soybean and El-Metwally *et al*., (2007) on chickpea.

Table (2) showed that the interactions between varieties X potassein-P application , varieties X seeding rates and triple interaction were significant in one season only while, potassein-P X seeding rates was insignificant in both seasons .

3- Number of branches and pods / plant:

Data in Tables (3 and 4) indicate that strain 29 exhibited a significant superiority over Giza 2. Giza 30 varieties and strain 16 in branches and pods number, which rcorded (4.97 and 5.83) and (8.36 and 9.66) in both seasons, respectively.

Table (3): Effect of potassein-P and seeding rates on number of branches/plant of some fenugreek varieties during 2005/2006 and 2006/2007 seasons.

Varieties and strains	Potassein-P	2005/2006				2006/2007			
		Seeding rates (SR)			Means	Seeding rates (SR)			Means
		24	36	42		24	36	42	
Giza 2 var.	No pot.	5.30	4.26	4.26	**4.61**	6.20	5.06	4.93	**5.40**
	Pot.	5.66	4.80	4.66	**5.04**	6.63	5.60	5.46	**5.90**
Means		**5.48**	**4.53**	**4.46**	**4.82**	**6.41**	**5.33**	**5.20**	**5.65**
Giza30 var.	No pot.	4.50	4.06	4.13	**4.23**	5.30	4.66	4.76	**4.91**
	Pot.	4.90	4.26	4.33	**4.50**	5.70	5.06	5.06	**5.27**
Means		**4.70**	**4.16**	**4.23**	**4.36**	**5.50**	**4.86**	**4.91**	**5.09**
St. 16	No pot.	4.46	3.96	3.90	**4.11**	5.26	4.66	4.46	**4.80**
	Pot.	4.80	4.16	4.16	**4.37**	5.66	4.90	4.80	**5.12**
Means		**4.63**	**4.06**	**4.03**	**4.24**	**5.46**	**4.78**	**4.63**	**4.96**
St.29	No pot.	5.06	4.90	4.56	**4.84**	6.06	5.56	5.36	**5.66**
	Pot.	5.56	4.96	4.76	**5.10**	6.50	5.86	5.66	**6.01**
Means		**5.31**	**4.93**	**4.66**	**4.97**	**6.28**	**5.71**	**5.51**	**5.83**
Means pot	No pot.	4.83	4.30	4.21	**4.45**	5.70	4.99	4.88	**5.19**
	Pot.	5.23	4.55	4.48	**4.75**	6.12	5.35	5.25	**5.57**
Means (SR)		**5.03**	**4.42**	**4.35**	**4.60**	**5.91**	**5.17**	**5.06**	**5.38**

L.S.D. at 0.05		
A=Varieties (Var.) &strains(st.)	0.06	0.06
B=Potassein-P (Pot.)	0.02	0.05
C=Seeding rates kg / fed (SR)	0.06	0.05
AB	0.05	N.S
AC	0.12	0.11
BC	0.08	N.S
ABC	N.S	N.S

Table (4): Effect of potassein-P and seeding rates on number of pods/plant of some fenugreek varieties during 2005/2006 and 2006/2007 seasons.

Varieties and strains	Potassein-P	2005/2006				2006/2007			
		Seeding rates (SR)			Means	Seeding rates (SR)			Means
		24	36	42		24	36	42	
Giza 2 var.	No pot.	9.00	7.30	7.23	**7.84**	9.96	8.56	8.36	**8.96**
	Pot.	9.60	8.00	7.76	**8.45**	10.66	9.30	9.16	**9.71**
Means		**9.30**	**7.65**	**7.50**	**8.15**	**10.31**	**8.93**	**8.76**	**9.33**
Giza30 var.	No pot.	7.46	6.90	7.03	**7.13**	8.80	7.86	8.00	**8.22**
	Pot.	8.13	7.23	7.23	**7.53**	9.46	8.36	8.46	**8.76**
Means		**7.80**	**7.06**	**7.13**	**7.33**	**9.13**	**8.11**	**8.23**	**8.49**
St. 16	No pot.	7.56	6.63	6.56	**6.92**	8.76	7.76	7.46	**8.00**
	Pot.	8.00	7.06	6.96	**7.34**	9.40	8.06	7.96	**8.47**
Means		**7.78**	**6.85**	**6.76**	**7.13**	**9.08**	**7.91**	**7.71**	**8.23**
St.29	No pot.	8.56	8.16	7.66	**8.13**	9.96	9.36	8.86	**9.40**
	Pot.	9.40	8.36	8.00	**8.58**	10.66	9.76	9.36	**9.93**
Means		**8.98**	**8.26**	**7.83**	**8.36**	**10.31**	**9.56**	**9.11**	**9.66**
Means pot	No pot.	8.15	7.25	7.12	**7.50**	9.37	8.39	8.17	**8.64**
	Pot.	8.78	7.66	7.49	**7.98**	10.05	8.87	8.74	**9.22**
Means (SR)		**8.46**	**7.45**	**7.30**	**7.74**	**9.71**	**8.63**	**8.45**	**8.93**

L.S.D. at 0.05		
A=Varieties (Var.) & strains(st.)	0.12	0.10
B=Potassein-P (Pot.)	0.09	0.09
C=Seeding rates kg / fed (SR)	0.05	0.07
AB	N.S	N.S
AC	0.10	0.15
BC	0.07	N.S
ABC	0.14	N.S

As shown in Tables (3 and 4) pods number followed the same trend of branches number. Where, spraying of potassein-P significantly increased branches and pods number comparing to unsprayed treatment. This increase may be due to the important role of potassium in enhancing photosynthates and translocation (Bonnet 1963 and Peoples and Koch 1979). Besides, phosphorus, which is required more by meristematic tissues (Russel and Russel 1961). These results were in line with El-Sherbeny *et al*., (1987), Shadia and Zayed (1994) and Mohamed and Naguib, (2002) on fenugreek.

Results given show that, low seed rate of 24kg/fed resulted in the largest number of branches and pods / plant compared to the higher seed rates of 36 and 42 kg/fed . These increases may be due to the favourable environmental needs such as light and more available nutrients from soil. Eid *et al* ., (2002) on fenugreek El-Douby *et al*., (2002) on soybean , Ezzat *et al*., (2005) on lentil and El-Metwally *et al.,* (2007) on chickpea .

The interaction between varieties X potassein-P was significant for branches number in one season only and was insignificant in both seasons for pods number. On the other hand, the interaction of varieties X seeding rates had significant effects on branches and pods number in both seasons. The interaction of potassein-P X seeding rates had significant effect on two parameters in one season only. The triple interaction significantly affected

pods number in the first season only but it was not significant in both seasons for branches number as shown in Tables (3 and 4).

4- 1000 seed weight:

Table (5) reveals that the strain 29 had the largest seed weight (11.96 and 14.03 gm) in the first and second seasons. The weight of 1000 seed from four varieties was in order to: strain 29 > Giza 2 var. > Giza 30 var. > strain 16.

Table (5): Effect of potassein-P and seeding rates on 1000 seed weight of some fenugreek varieties during 2005/2006 and 2006/2007 seasons.

Varieties and strains	Potassein-P	2005/2006				2006/2007			
		Seeding rates (SR)			Means	Seeding rates (SR)			Means
		24	36	42		24	36	42	
Giza 2 var.	No pot.	11.89	10.36	9.62	**10.62**	14.87	12.37	12.18	**13.14**
	Pot.	13.58	11.38	11.11	**12.02**	15.64	13.40	13.20	**14.08**
Means		**12.73**	**10.87**	**10.37**	**11.32**	**15.25**	**12.89**	**12.69**	**13.61**
Giza30 var.	No pot.	10.67	7.76	9.90	**10.11**	12.68	11.42	11.53	**11.87**
	Pot.	11.71	10.25	10.41	**10.79**	13.66	12.07	12.24	**12.66**
Means		**11.19**	**10.01**	**10.15**	**10.45**	**13.17**	**11.74**	**11.89**	**12.27**
St. 16	No pot.	10.74	9.51	9.29	**9.85**	12.62	11.30	10.81	**11.57**
	Pot.	11.41	10.10	9.91	**10.47**	13.58	11.69	11.52	**12.26**
Means		**11.07**	**9.81**	**9.60**	**10.16**	**13.10**	**11.49**	**11.16**	**11.92**
St*.29	No pot.	12.32	11.71	10.95	**11.66**	14.64	13.48	12.86	**13.66**
	Pot.	13.40	11.97	11.40	**12.26**	15.61	14.06	13.52	**14.39**
Means		**12.86**	**11.84**	**11.17**	**11.96**	**15.13**	**13.77**	**13.19**	**14.03**
Means pot	No pot.	11.40	10.33	9.94	**10.56**	13.70	12.14	11.84	**12.56**
	Pot.	12.53	10.92	10.70	**11.38**	14.62	12.80	12.62	**13.35**
Means (SR)		**11.96**	**10.63**	**10.32**	**10.97**	**14.16**	**12.47**	**12.23**	**12.95**

L.S.D. at 0.05		
A=Varieties (Var.) &strains(st.)	0.08	0.19
B=Potassein-P (Pot.)	0.03	0.06
C=Seeding rates kg / fed (SR)	0.05	0.06
AB	0.07	0.12
AC	0.11	0.12
BC	0.08	0.08
ABC	0.16	0.17

Treatment with potassein-P caused significant increase in 1000 seed weight (11.38 and 13.35 gm) against (10.56 and 12.56 gm) with untreated plants. This increase may be due to the effect of potassium and phosphorus on maintaining high productivity and good quality of yield. El-Sherbeny et al., (1987) and Mohamed and Naguib (2002) came to the same results on fenugreek.

As shown in Table (5) marked values of 1000 seed weight (11.96 and 14.16 gm) were obtained by sowing plants at 24 kg/fed seeding rate comparing to least values with 36 and 42 kg/fed seeding rates. Similarly , El-Douby et al., (2002) on soybean, Ezzat *et al*., (2005) on lentil and El-Metwally *et al.,* (2007) on chickpea.

Double and triple interactions of the applied treatments indicated significant response in both seasons. The highest value of 1000 seed weight was recorded with Giza 2 var. and strain 29 X potassein -P foliar X 24kg/fed seeding rate.

5- Seed yield per plant and per feddan:

Data in Tables (6 and 7) clear that strain 29 and Giza 2 var. surpassed Giza 30 var. and strain 16 in seed yield per plant and per feddan. The highest seed yield per feddan (863.2 and 1009.5 kg) and (841.2 and 983.5 kg) were recorded by strain 29 and Giza 2 var. in both seasons, respectively.

Spraying potassein-P had significant effects on seed yield per plant and per feddan (Tables 6 and 7). Thus, spraying potassein-P resulted in highest yield per feddan (824.7 and 965.5 kg) against (773.5 and 903.7 kg) with unsprayed plants. These results show the importance of k and p nutrients in increasing the percentage of flowering and setting and hence the seed yield. Similar results were obtained on fenugreek by Shadia and Zayed (1994), Chaudhary (1999) and Mohamed and Naguib (2002).

Also the same Tables (6 and 7) clearly show that the maximum seed yield per plant and per feddan was achieved with lowest seeding rates. Seed yield per feddan reached to 874.0 and 1017.7 with 24 kg /fed seeding rate, while, increasing seeding rate up to 42 kg /fed significantly decreased these parameters in both seasons. These increases may be due to favorable environmental conditions encouraging growth consequently producing more seeds. Similarly, Ezzat (1994), Ezzat *et al.,* (2005) on lentil and El-Metwally *et al*., (2007) on chickpea.

Table (6): Effect of potassein-P and seeding rates on seed yield/plant (gm) of some fenugreek varieties during 2005/2006 and 2006/2007 seasons.

Varieties and strains	Potassein-P	2005/2006				2006/2007			
		Seeding rates (SR)			Means	Seeding rates (SR)			Means
		24	36	42		24	36	42	
Giza 2 var.	No pot.	15.50	10.04	8.38	**11.31**	17.80	11.64	9.91	**13.11**
	Pot.	16.43	10.68	9.17	**12.09**	18.95	12.76	10.82	**14.18**
Means		**15.96**	**10.36**	**8.77**	**11.70**	**18.37**	**12.20**	**10.36**	**13.64**
Giza30 var.	No pot.	12.85	9.50	7.83	**10.06**	15.28	11.14	9.15	**11.86**
	Pot.	14.10	10.05	8.35	**10.83**	16.41	11.84	9.68	**12.64**
Means		**13.47**	**9.77**	**8.09**	**10.45**	**15.85**	**11.49**	**9.42**	**12.25**
St. 16	No pot.	12.96	8.96	7.69	**9.87**	15.22	10.42	9.08	**11.57**
	Pot.	13.82	9.56	8.06	**10.48**	16.22	11.18	9.53	**12.31**
Means		**13.39**	**9.26**	**7.88**	**10.18**	**15.72**	**10.80**	**9.31**	**11.94**
St.29	No pot.	14.75	10.51	9.37	**11.54**	17.56	12.33	10.80	**13.56**
	Pot.	16.17	11.03	6.90	**12.26**	18.69	12.95	11.27	**14.30**
Means		**15.46**	**10.77**	**9.48**	**11.90**	**18.12**	**12.64**	**11.03**	**13.93**
Means pot	No pot.	14.01	9.75	8.32	**10.69**	16.46	11.38	9.73	**12.53**
	Pot.	15.13	10.33	8.79	**11.42**	17.57	12.18	10.32	**13.36**
Means (SR)		**14.57**	**10.04**	**8.56**	**11.05**	**17.01**	**11.78**	**10.03**	**12.94**

L.S.D. at 0.05		
A=Varieties (Var.) &strains(st.)	.34	.28
B=Potassein-P (Pot.)	.11	.17
C=Seeding rates kg / fed (SR)	.13	.12
AB	N.S	N.S
AC	.27	.25
BC	.19	.17
ABC	N.S	N.S

Table (7): Effect of potassein-P and seeding rates on seed yield/fed (kg) of some fenugreek varieties during 2005/2006 and 2006/2007 seasons.

Varieties and strains	Potassein-P	2005/2006				2006/2007			
		Seeding rates(SR)			Means	Seeding rates (SR)			Means
		24	36	42		24	36	42	
Giza 2 var.	No pot.	927.3	754.3	753.3	**811.6**	1068.0	891.6	872.6	**944.1**
	Pot.	986.0	825.3	801.3	**870.8**	1137.3	974.0	957.3	**1022.8**
Means		**956.6**	**789.8**	**777.3**	**841.2**	**1102.6**	**932.8**	**915.0**	**983.5**
Giza30 var.	No pot.	771.0	704.6	712.3	**729.3**	917.0	823.6	835.3	**858.6**
	Pot.	845.3	751.6	754.0	**783.6**	985.0	868.6	887.6	**913.7**
Means		**808.1**	**728.1**	**733.1**	**756.5**	**951.0**	**846.1**	**861.5**	**886.2**
St. 16	No pot.	777.3	692.3	672.3	**714.0**	886.3	818.0	782.0	**828.7**
	Pot.	829.3	725.3	717.3	**757.3**	973.3	858.3	838.3	**890.0**
Means		**803.3**	**708.8**	**694.8**	**735.6**	**929.8**	**828.1**	**810.1**	**859.3**
St.29	No pot.	885.3	844.0	788.3	**839.2**	1053.3	971.6	925.0	**983.3**
	Pot.	970.3	864.0	827.3	**887.2**	1121.3	1014.0	971.6	**1035.6**
Means		**927.8**	**854.0**	**807.8**	**863.2**	**1087.3**	**992.8**	**948.3**	**1009.5**
Means pot	No pot.	840.2	748.8	731.5	**773.5**	981.1	876.2	853.7	**903.7**
	Pot.	907.7	791.5	775.0	**824.7**	1054.2	928.7	913.7	**965.5**
Means (SR)		**874.0**	**770.2**	**753.2**	**799.1**	**1017.7**	**902.5**	**883.7**	**934.6**

L.S.D. at 0.05		
A=Varieties (Var.) &strains(st.)	24.8	25.7
B=Potassein-P (Pot.)	8.6	10.7
C= Seeding rates kg / fed (SR)	7.2	12.0
AB	N.S	N.S
AC	14.5	24.1
BC	10.3	N.S
ABC	20.6	N.S

Tables (6 and 7) indicate that the interaction of varieties X potassein-P was insignificant for seed yield per plant and per feddan in both seasons.While, varieties X seeding rates was significant for both parameters in the two seasons.

Potassein-PX seeding rates was significant for seed yield per plant in both seasons. While, it was significant in one season only for seed yield per feddan. The highest seed yield per plant and per feddan were obtained by strain 29 and Giza 2 var. X foliar potassein- P X 24 kg / fed seeding rate.

6- Fixed oil percentage and oil yield / fed:

Table (8) showed that Giza 2 var. surpassed other cultivars in fixed oil% in the first season, while in the second season, the highest oil% was recorded by strain 16. On the other hand, Table (9) shows that strain 29 and Giza 2 var. surpassed other varieties in oil yield / fed in both seasons, this may be to the superiority of strain 29 and Giza 2 var. in seed yield per feddan.

Also, the same Tables (8 and 9) show that sprayed of potassein-P caused significant increase in oil% and oil yield / fed. So, oil yield per feddan reached to 52.49 and 58.99 kg in both seasons, respectively. El-Sherbeny *et al.*, (1987), Shadia and Zayed (1994) and Mohamed and Naguib (2002) on fenugreek came to the same results.

Table (8): Effect of potassein-P and seeding rates on fixed oil % of some Fenugreek seeds varieties during 2005/2006 and 2006/2007 seasons.

Varieties and strains	Potassein-P	2005/2006				2006/2007			
		Seeding rates (SR)			Means	Seeding rates (SR)			Means
		24	36	42		24	36	42	
Giza 2 var.	No pot.	6.24	5.64	5.58	**5.82**	5.70	5.69	5.65	**5.68**
	Pot.	6.40	6.31	6.43	**6.38**	6.58	6.61	6.42	**6.53**
Means		**6.32**	**5.98**	**6.00**	**6.10**	**6.14**	**6.15**	**6.03**	**6.11**
Giza30 var.	No pot.	5.50	4.94	4.71	**5.05**	5.67	5.73	5.79	**5.73**
	Pot.	6.33	6.10	5.97	**6.13**	6.37	6.13	6.19	**6.23**
Means		**5.92**	**5.52**	**5.34**	**5.59**	**6.02**	**5.93**	**5.99**	**5.98**
St. 16	No pot.	5.65	4.94	4.71	**5.10**	6.07	5.62	5.71	**5.80**
	Pot.	6.40	6.34	6.36	**6.37**	6.63	6.41	6.36	**6.46**
Means		**6.03**	**5.64**	**5.54**	**5.73**	**6.35**	**6.01**	**6.03**	**6.13**
St.29	No pot.	5.78	5.45	5.62	**5.62**	5.45	5.70	5.88	**5.68**
	Pot.	6.63	6.49	6.47	**6.53**	6.47	6.24	6.42	**6.38**
Means		**6.20**	**5.97**	**6.04**	**6.07**	**5.96**	**5.97**	**6.15**	**6.03**
Means pot	No pot.	5.79	5.24	5.16	**5.40**	5.72	5.68	5.76	**5.72**
	Pot.	6.44	6.31	6.30	**6.35**	6.51	6.34	6.35	**6.40**
Means (SR)		**6.12**	**5.78**	**5.73**	**5.87**	**6.12**	**6.01**	**6.05**	**6.06**

L.S.D. at 0.05		
A=Varieties (Var.) &strains(st.)	0.17	0.10
B=Potassein-P (Pot.)	0.05	0.07
C= Seeding rates kg / fed (SR)	0.10	0.10
AB	0.10	0.14
AC	N.S	0.20
BC	0.14	N.S
ABC	N.S	N.S

As for seeding rates, oil yield per feddan followed the same trend of oil percentage. since, the highest oil yield per feddan (53.71 and 62.36 kg) was achieved by low seed rate of 24 kg / fed. Similar findings were obtained by El-Douby *et al.,* (2002) on soybean.

The interaction of varieties X potassein-P was significant for fixed oil% and oil yield in both seasons. Oil % was significantly affected by interactions of varieties X potassein-P and potassein-P X seeding rates in one season only, while, oil yield was significantly affected by varieties X seeding rates in both seasons, potassein-P X seeding rates and triple interaction were significant in one season only for oil yield. However, the highest oil yield was obtained by strain 29 and Giza 2 var. X potassein-P foliar X 24 kg / fed seeding rate.

Table (9): Effect of potassein-P and seeding rates on oil yield/fed (kg) of some fenugreek seeds varieties during 2005/2006 and 2006/2007 seasons.

Varieties and strains	Potassein-P	2005/2006				2006/2007			
		Seeding rates (SR)			Means	Seeding rates (SR)			Means
		24	36	42		24	36	42	
Giza 2 var.	No pot.	57.84	42.58	42.05	47.49	60.90	50.75	49.27	**53.64**
	Pot.	63.18	52.10	51.52	55.60	74.85	64.33	61.48	**66.89**
Means		**6.051**	**47.34**	**46.79**	**51.54**	**67.88**	**57.54**	**55.37**	**60.26**
Giza30 var.	No pot.	42.46	34.82	33.62	36.97	51.97	47.26	48.43	**49.22**
	Pot.	53.58	45.83	45.04	48.15	62.73	53.25	54.91	**56.96**
Means		**48.02**	**40.33**	**39.33**	**42.56**	**57.35**	**50.25**	**51.67**	**53.09**
St. 16	No pot.	43.97	34.24	31.73	36.65	53.83	46.01	44.71	**48.18**
	Pot.	53.15	46.00	45.64	48.26	64.53	55.03	53.88	**57.64**
Means		**48.56**	**40.12**	**38.68**	**42.45**	**59.18**	**50.52**	**49.04**	**52.91**
St.29	No pot.	51.19	46.01	44.37	47.19	57.48	55.45	54.35	**55.76**
	Pot.	64.31	56.05	53.48	57.95	72.63	63.35	62.37	**66.12**
Means		**57.75**	**51.03**	**48.93**	**52.57**	**65.06**	**59.40**	**58.36**	**60.94**
Means pot	No pot.	48.87	39.41	37.94	42.07	56.04	49.86	49.19	**51.70**
	Pot.	58.55	49.99	48.92	52.49	68.69	58.99	58.03	**61.90**
Means (SR)		**53.71**	**44.70**	**43.43**	**47.28**	**62.36**	**54.43**	**53.61**	**56.80**

L.S.D. at 0.05		
A=Varieties (Var.) &strains(st.)	2.77	1.64
B=Potassein-P (Pot.)	0.59	1.05
C= Seeding rates kg / fed (SR)	0.93	1.24
AB	1.19	2.11
AC	1.86	2.48
BC	N.S	1.76
ABC	2.63	N.S

7- Carbohydrate percentage:

Table (10) showed that Giza 2 var. and strain 29 surpassed Giza 30 var. and strain 16 in carbohydrate percentage , which reached to (47.06 and 48.47 %) and (46.47 and 44.75 %) for Giza 2 var. and strain 29 in both seasons, respectively .

Spraying of potassein-P gave significant increase in carbohydrate percentage of seed comparing to unsprayed plants. This increase may be due to the important role of potassium in increasingCo_2 assimilation, photosynthetic rate and more accumulation of carbohydrates (Evans and Sorger 1966 and Peoples and Koch 1979). Similar results were obtained by El-Sherbeny et al., (1987) and Mohamed and Naguib (2002) on fenugreek.

Table (10) clears that carbohydrate percentage of seed increased significantly with increasing seeding rates, this increase reached the highest level (45.60 and 46.79 %) with highest seed rate of 42 kg / fed. Eid et al., (2002) on fenugreek came to the same results. Data in Table (10) showed that, the highest carbohydrate percentage was obtained by Giza 2 var. and strain 29 combined with foliar potassein-P and / or combined with 42 kg / fed seeding rate. While, the interaction of potassein-P X seeding rates and triple interaction was significant in the second season only.

Table (10): Effect of potassein-P and seedin rates on carbohydrate % of some fenugreek seeds varieties during 2005/2006 and 2006/2007 seasons.

Varieties and strains	Potassein-P	2005/2006				2006/2007			
		Seeding rates (SR)			Means	Seeding rates (SR)			Means
		24	36	42		24	36	42	
Giza 2 var.	No pot.	42.62	43.48	43.48	**43.19**	45.73	46.55	45.66	**45.98**
	Pot.	49.49	51.20	52.14	**50.94**	50.33	50.60	52.00	**50.97**
Means		**46.05**	**47.34**	**47.81**	**47.06**	**48.03**	**48.57**	**48.83**	**48.47**
Giza30 var.	No pot.	39.65	38.73	46.82	**41.73**	38.36	40.77	47.22	**42.11**
	Pot.	36.52	44.34	44.34	**41.73**	38.77	51.16	50.68	**46.87**
Means		**38.08**	**41.53**	**45.58**	**41.73**	**38.56**	**45.96**	**48.95**	**44.49**
St. 16	No pot.	32.85	32.62	33.47	**32.98**	36.08	36.33	37.57	**36.66**
	Pot.	50.09	46.82	49.02	**48.64**	46.11	48.64	50.92	**48.55**
Means		**41.47**	**39.72**	**41.24**	**40.81**	**41.09**	**42.48**	**44.24**	**42.60**
St.29	No pot.	43.41	44.34	44.34	**44.03**	41.54	36.73	39.18	**39.15**
	Pot.	46.53	49.02	51.20	**48.91**	48.84	51.13	51.10	**50.35**
Means		**44.97**	**46.68**	**47.77**	**46.47**	**45.19**	**43.93**	**45.14**	**44.75**
Means pot	No pot.	39.63	39.79	42.02	**40.48**	40.42	40.09	42.40	**40.97**
	Pot.	45.65	47.84	49.17	**47.55**	46.01	50.38	51.17	**49.19**
Means (SR)		**42.64**	**43.81**	**45.60**	**44.01**	**43.22**	**45.23**	**46.79**	**45.08**
L.S.D. at 0.05									
A=Varieties (Var.) & strains(st.)					1.44				1.39
B=Potassein-P (Pot.)					0.93				0.50
C= Seeding rates kg / fed (SR)					1.45				1.23
AB					1.86				1.01
AC					2.90				2.46
BC					N.S				1.74
ABC					N.S				3.48

8- Protein percentage:

Results in table (11) indicated that strain 29 significantly surpassed the other tested cultivars which recorded the highest value (29.16 and 29.0 %) in both seasons, respectively.

The same Table (11) showed that foliar of potassein-P gave more of seed protein % than without foliar. These results are in agreement with Dayanand et al., (2002) and Mohamed and Naguib (2002) on fenugreek. Also, results of Buntehof Agric. Res. Sta. (1978 / 79) confirm that at higher K - level more of the absorbed nitrogen is used for protein formation.

Regarding seeding rates, Table (11) indicated that cultivation in low seed rate of 24 kg/fed gave a highest value of protein percentage 29.61 and 30.22%) than higher seed rate of 36 and 42 kg / fed in both seasons, respectively . Eid et al., (2002) on fenugreek came to the same results.

Also, Table (11) showed that the double and triple interactions were significant in the two seasons. So, the best protein percentage (31.54 and 31.50%) was obtained from strain 29 X spraying potassein-P X low seed rate of 24 kg / fed.

Table(11):Effect of potassein-P and seeding rates on protein % of some fenugreek seeds varieties during 2005/2006 and 2006/2007 seasons.

Varieties and strains	Potassein-P	2005/2006				2006/2007			
		Seeding rates (SR)			Means	Seeding rates (SR)			Means
		24	36	42		24	36	42	
Giza 2 var.	No pot.	29.12	26.25	25.51	**26.96**	30.58	28.19	23.14	**27.30**
	Pot.	30.18	27.62	27.74	**28.51**	31.00	28.63	23.96	**27.86**
Means		**29.65**	**26.93**	**26.62**	**27.73**	**30.79**	**28.41**	**23.55**	**27.58**
Giza30 var.	No pot.	28.18	24.50	25.32	**26.00**	27.39	26.52	24.25	**26.05**
	Pot.	29.77	28.22	27.18	**28.39**	30.81	29.13	27.16	**29.03**
Means		**28.97**	**26.36**	**26.25**	**27.19**	**29.10**	**27.82**	**25.70**	**27.54**
St. 16	No pot.	27.55	26.72	25.33	**26.53**	29.23	25.00	24.93	**26.38**
	Pot.	29.92	27.14	28.50	**28.52**	30.50	28.62	28.03	**29.05**
Means		**28.73**	**26.93**	**26.91**	**27.52**	**29.86**	**26.81**	**26.48**	**27.71**
St.29	No pot.	30.66	28.50	27.11	**28.75**	30.77	28.02	27.07	**28.62**
	Pot.	31.54	29.28	27.90	**29.57**	31.50	29.25	27.44	**29.39**
Means		**31.10**	**28.89**	**27.50**	**29.16**	**31.13**	**28.63**	**27.25**	**29.00**
Means pot	No pot.	28.87	26.49	25.81	**27.06**	29.49	26.93	24.84	**27.09**
	Pot.	30.35	28.06	27.83	**28.74**	30.95	28.90	26.64	**28.83**
Means (SR)		**29.61**	**27.27**	**26.82**	**27.90**	**30.22**	**27.92**	**25.74**	**27.96**

L.S.D. at 0.05		
A=Varieties (Var.) &strains(st.)	0.19	0.17
B=Potassein-P (Pot.)	0.14	0.21
C= Seeding rates kg / fed (SR)	0.13	0.18
AB	0.29	0.42
AC	0.27	0.36
BC	0.19	0.25
ABC	0.39	0.50

9- Fatty acid composition:

Separation of fixed oil obtained from four fenugreek varieties by GLC showed in Table (12) and Fig. 1,2,3and 4 revealed the presence of the following fatty acid: palmitic acid, stearic acid, oleic acid, linoleic acid**,** linolenic acid. The value of the total unsaturated fatty acids was higher than the value of saturated one in all varieties.

Table (12): Fixed oil constituents of fenugreek varieties.

Components \ Varieties	Giza 2 var.	Giza 30 var.	Strain 16	Strain 2
1. Palmitic 16:0	33.27	24.10	27.12	30.13
2. Stearic 18:0	6.71	9.41	9.54	8.74
Total saturated	**39.97**	**33.51**	**36.66**	**38.87**
3. Oleic 18:1	16.48	18.40	20.64	19.40
4. Linoleic 18:2	30.70	31.59	33.82	25.77
5. Unknown	2.46	1.75	1.84	1.85
6. Linolenic 18:3	10.39	14.75	7.04	14.11
Total unsaturated	**57.57**	**64.74**	**61.50**	**59.28**

Giza 30 variety recorded the maximum value of the unsaturated fatty acids (64.74%) followed by strain 16 (61.50%), strain 29 ranked the third (59.28%), while Giza 2 variety came the last which recorded (57.57%). Linoleic acid (18:2) was the major unsaturated fatty acid followed by oleic acid (18:1) and followed by linolenic acid (18:3) in the fixed oil of seeds. Giza 30 variety and strain 29 recorded the highest value of linolenic acid comparing to Giza 2 variety and strain 16. These results reflect the medicinal value of unsaturated fatty acid of the oil as a potential meventive agent in a number of health disorders as heart diseases and hyper chalsteralonenia

fig

fig

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تقييم بعض السلالات المبشرة لمحصول الحلبة تحت ظروف معدلات تقاوي مختلفة والرش بالبوتاسين-فو

نوال جورج غالى
قسم النباتات الطبية والعطرية - معهد بحوث البساتين - مركز البحوث الزراعية

أقيمت تجربتين حقليتين فى المزرعة البحثية لمحطة بحوث الجميزة خلال الموسمين الزراعيين ٢٠٠٥/٢٠٠٦، ٢٠٠٦/٢٠٠٧ لدراسة تأثير الرش بالبوتاسين - فو (٣٠% بوتاسيوم، ١٠% فوسفور) وثلاث معدلات من التقاوي (بمعدل ٢٤، ٣٦، ٤٢ كجم / فدان) على النمو ومحصول البذور والزيت الثابت والنسبة المئوية للكربوهيدرات والبروتين لصنفين من الحلبة وهما جيزة ٢ وجيزة ٣٠ وكذلك سلالتين مبشرتين هما ١٦، ٢٩.

وقد أظهرت النتائج ان:

السلالة ٢٩ تأخرت فى التزهير والنضج عن الصنف جيزة ٢ وجيزة ٣٠ والسلالة ١٦ ولكنها تفوقت عنهم فى ارتفاع النبات وعدد الفروع والقرون ووزن ١٠٠٠ حبه والنسبة المئوية للبروتين فى حين أعطت السلالة ٢٩ والصنف جيزة ٢ أعلى محصول من البذور والزيت والنسبة المئوية للكربوهيدرات. أدى الرش بالبوتاسين - فو الى زيادة معنوية فى جميع الصفات التى تم دراستها بالمقارنة بالنباتات التى لم ترش. أدت الزراعة بأقل معدل ٢٤ كجم تقاوى/فدان إلى زيادة معنوية فى عدد الفروع ومحصول البذور ومكوناته والنسبة المئوية للزيت ومحصول الزيت والنسبة المئوية للبروتين.

- وقد كان للتفاعل بين الأصناف ومعدلات التقاوى للفدان تأثيرا معنويا على جميع الصفات التى تم دراستها ماعدا ارتفاع النبات والنسبة المئوية للزيت وأظهرت النتائج أن جميع التفاعلات كان لها. تأثيرا معنويا على وزن ١٠٠٠ بذرة والنسبة المئوية للبروتين.
- أعطى التحليل الكروماتوجرافى للزيت الثابت لكل الأصناف أعلى نسبه للأحماض الدهنيه الغير مشبعه مقارنه بالأحماض الدهنيه المشبعه . وقد كان اللينوليك هو المكون الرئيسى فى الأحماض الدهنيه الغير مشبعه. وسجل صنف جيزه ٣٠ أعلى قيمه من الأحماض الدهنيه الغير مشبعه وأعلى قيمه للحمض الدهنى لينولينك مقارنه بباقى الأصناف.
- أن أفضل معاملة للحصول على اعل محصول من البذور والزيت هى زراعة الصنف جيزة ٢ بمعدل ٢٤ كجم تقاوى/فدان والرش بالبوتاسين - فو بينما للحصول على أعلى محصول من البذور والزيت وأعلى نسبة من البروتين يمكن زراعة السلالة المبشرة ٢٩ بمعدل ٢٤ كجم تقاوى/فدان والرش بالبوتاسين - فو.