Response of Two Fenugreek (*Trigonella* foenumgraecum L.) Cultivars To Foliar Application with Brassinosteroids

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ABSTRACT

Two field experiments were carried out at the Experimental Station of the National Research Centre at Shalkan, Kaluobia Governorate, during the two successive seasons of 2004/2005 and 2005/2006 to study response of two fenugreek cultivarsto foliar application with brassinosteroids. The main results were:

1-The two fenugreek cultivars under study, cv. Giza-2 and cv. Giza-30 were significantly different in growth characters at the different stages of growth and yield and its components, as well as, chemical constituents of seeds (carbohydrates, proteins, and fixed oil percentages) and protein and fixed oil yields "Ton/fed".Moreover, cv. Giza-30 cultivar significantly outweighed cv. Giza-2 in growth characters, yield and its components, carbohydrates; protein and fixed oil percentages as well as protein and fixed oil yields per feddan.

2-Foliar application with different concentrations of brassinosteroides (i.e. control, 50.0, 100.0, 150.0 and 200 mg/l) significantly affected growth characters at 75, 90 and 105 days after sowing, yield and its components, chemical constituents of seeds, protein yield/fed and fixed oil yield/fed. Furthermore, foliar application with 200 mg/l BR_S recorded the highest significant values of growth characters, yield and its components, carbohydrate%; protein%; fixed oil% per seeds, as well as protein yield/fed and fixed oil% compared with control, 50.0; 100.0, 150.0 mg/l BR_S.

3-With respect of the interaction between fenugreek cultivars and diffeent concentrations of brassinosteroid, the effects were significant on all characters studied except protein% per seeds. Generally, spraying cv. Giza-30 with 200 mg/l BR_S recorded the greatest significant values of growth characters, yield and its components, carbohydrate% and fixed oil% per seeds, protein yield/fed and fixed oil yield/fed.

INTRODUCTION

Fenugreek (Trigonella foenum-graecum L.) is an erect annual herb of the bean family leguminosae. It has long been cultivated in the Mediterranean area, in India and in North Africa. The seed is produced as a spice, as a vegetable for humans, as forage for cattle, and for medicinal purposes. Seeds also contain many substances like volatile oils, fixed oil, protein, sugar, mucilage, alkaloids and saponins, which are commercially useful as raw material for steroid hormone synthesis. The multiple uses for this plant, in foods, as a spice and in medicine, as colic flatulence in dysentery, diarrhea, as galactagolat, dyspepsia, with loss of appetite, chronic cough, enlargement of liver and spleen, gait and diabetes. Recent studies indicate that fenugreek seeds substantially contain the steroidal substance diosgenin which is used as a starting material in the synthesis of sex hormones and oral contraceptives (Shalaby et al, 1999).

Thus, these uses make it worthy enough to study response of two fenugreek cultivars to foliar application with brassinosteroid at different concentrations to show its effects on the growth, seed yield and different chemical components of seeds such as fixed oil and protein.

MATERIALS AND METHODS

The present investigation was carried out during two successive seasons of 2004/2005 and 2005/2006 at the Experimental Station of the National Research Centre at Shalkan, Kalubia Governorate to study response of two fenugreek cultivars, cv. Giza-2 and cv. Giza 30 to foliar application with five concentration from Brs, 0.0, 50, 100, 150 and 200 mg/l Br.

Fenugreek seeds were obtained from Agriculture Research Centre, Ministry of Agriculture. Each experiment was laid in a split-plot design with four replications. The experimental unit consisted of 15 rows, each of 2 meter length and 20 cm between rows, where, the size of each plot was 6 square meter. Seeds were drilled in singles along the row at a rate of 30 kg/fed. Then 100.0 kg calcium super-phosphate (15.5/ P_2O_5) were applied. Sowing took place on 26th, and 27th November in the two experimental seasons, respectively. Normal cultural practices of fenugreek (irrigation, fertilization and weed control) were conducted in the usual manner followed by the farmer of this district.

Tepole as a surfactant was added to the spray solution at a rate of 1ml/l. The volume of the spraying solution was maintained just to cover completely the plants foliage till drip. The plants were sprayed twice. The first spray was applied ten days before flowering as guided by the indicator plants, the second spray was performed ten days later. Tap water was sprayed in the same previous manner on plants which served as control. Sample of ten guarded plants from each plot

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were taken for growth measurements at random from the middle rows of every plot during the two growing seasons on three dates of fifteen days intervals starting on 75 days after sowing, where, plant height, number and dry weight of branches and leaves; were estimated. Meanwhile, number of flowers and number and dry weight of pods per plant were estimated after 90 and 105 days from sowing. In addition, leaves area (LA) "cm^2/plant" was measured according to Bremner and Taha (1996).

At harvest, ten guarded plants were taken out at random from the middle rows of each plot to determine yield attributes, i.e. plant height "cm", number of branches and pods and pods dry weight g/plant, and pod length "cm". All plants of each plot were harvested to estimate seed yield, straw yield and biological yield "Ton/fed".

Total carbohydrate determination was carried out colorimetrically by using Spikol-Carl Ziess Spectro-Colorimeter (Dubois et al., 1956).

In addition, to calculate protein and fixed oil yields "kg/fed", fixed oil (%) and crude protein (%) were determined using the method described by A.O.A.C. (1988) statistical analysis was performed according to Snedecor and Cochran (1990). Treatment means were compared by L.S.D test. Combined analysis was made for the two growing seasons as results followed similar trend.

RESULTS AND DISCUSSION

A) Cultivar differences:

Data presented in Table1.show that there were significant differences between fenugreek cultivars in plant height, number of branches/plant, number of leaves/plant, number of flowers/plant, number of pods/plant, branches dry weight/plant, leaves dry weight/plant, pods dry weight/plant, and leaves area/plant at different stages of growth. Furthermore, it is clear that cv. Giza-30 significantly surpassed cv. Giza-2 in all previous growth characters. It is note worthy to mention that number of leaves/plant, number of flowers/plant, branches dry weight/plant, leaves dry weight/plant and leaves area/plant tended to decrease after 90 days from sowing, meanwhile, the rest of growth parameters tended to increase with advance in age until 105 days after sowing.

Regarding yield and its components, data illustrated in Table 2. observed that cv. Giza-2 and cv. Giza-30 significantly differed in yield and its components, in addition, cv. Giza-30 yielded the greatest mean values of plant height, number of branches/plant, number of pods/plant, pods weight/plant, pod length, seed yield/plant, straw yield/plant, seed yield/fed, straw yield/fed as well as biological yield/fed. Compared with cv. Giza-2. Furthermore, cv. Giza-30 characterized by its highest percentages of carbohydrate, protein, and fixed oil per seeds and consequently protein yield and fixed oil yield/fed compared with Giza-2 cultivar.

The differences among fenugreek cultivars in growth characters, yield and its components and chemical constituents per seeds may be due to the differences in number of modules formed the root of the tested cultivars, consequently the growth, yield and its components and chemical constituents of each cultivar may depend mainly on nitrogen fixation (Tawfic et al, 1991), also, to the differences in partition and migration of photosynthate between cultivars (Ahmed et al, 1997), differences in the endogenous hormones content (Shalaby and El-Ashry, 2001) and to the differences between cultivars in their response to the environmental conditions and its genetical differences (Shoman et al, 2006).

It is noteworthy to mention that our results are supported by Mangal et al (1987), Sharma and Bhati (1987), Sharma et al (2001) and Maamoun and Ahmed (2006).

B) Effect of Brassinosteroids Concentrations:

Table1. shows that plant height, number of branches/plant, number of leaves/plant, number of flowers/plant, number of pods/plant, branches dry weight/plant, leaves dry weight/plant and leaves area/plant were significantly increased by increasing foliar application with brassinosteroid up to 200 mg/l at both sampling date, however, the effect of the increase over 150 mg/l BRs treatments on number of leaves/plant, leaves dry weight/plant and pods dry weight/plant failed to reach the significant level at 0.05 Moreover, the effect of brassinosteroid on chemical constituents of seeds (i.e. carbohydrate, protein and fixed oil percentages) and protein and fixed oil yields/fed were significant. In addition, foliar application with 200 mg/l brassinosteroid recorded the highest significant values from carbohydrate; protein and fixed oil percentages, protein yield/fed and fixed oil yield/fed. Compared with control (Tap water), 50, 100 and 150 mg/l concentrations Table 2. with respect to the effect of brassinosteroid concentration on yield and its components, data illustrated in Table 3. show that plant height, number of branches and pods/plant, pods dry weight/plant, pod length, seed and straw yield per plant and/or fed and biological yield/fed, response significantly to the different concentration of brassinosteroid. In addition, foliar application with 200 mg/l brassinosteroid significantly exceeded control, 50, 100 and 150 mg/l brassinosteroid in yield and its components.

Table2. Effect of cultivar differences, BA and their interaction photosynthetic pigment contents/leaves (mg/g dry wt.) of fenugreek plants at 95 days after sowing (Average of 2004/2005 and 2005/2006 seasons)

Treatments	Characters	Chemical constituents of seeds			Protein yield "Ton/fed"	Fixed oil yield "Ton/fed"
		Carbohydrate %	Protein %	Fixed oil		
	Interaction :					
cv. Giza-2	Tap water	48.71	18.11	10.85	102.5	61.41
	50 mg/l BA	49.01	18.57	11.07	117.92	70.29
	100 mg/l BA	49.54	19.12	11.28	136.33	80.43
	150 mg/l BA	51.18	19.64	11.76	158.10	94.67
	200 mg/l BA	52.65	20.07	12.00	171.0	102.24
cv. Giza-30	Tap water	49.50	18.36	11.02	117.69	70.64
	50 mg/l BA	49.87	18.71	11.40	134.52	81.97
	100 mg/l BA	50.44	19.30	11.75	150.73	91.77
	150 mg/l BA	51.75	19.96	12.26	193.81	119.04
	200 mg/l BA	52.95	20.38	12.40	202.37	123.13
L.S.D. at 5% level		0.03	n.s	0.05	3.91	5.61
Cultivars :						
cv. Giza-2		50.22	19.10	11.39	137.17	81.81
cv. Giza-30		50.90	19.34	11.77	159.82	97.31
L.S.D. at 5% level		0.20	0.06	0.6	1.18	1.09
B.A. Concentrations :						
Tap water		49.11	18.24	10.94	110.10	66.03
50 mg/l BA		49.44	18.64	11.24	126.22	76.13
100 mg/l BA		49.99	19.21	11.52	143.53	86.10
150 mg/l BA		51.47	19.80	12.01	175.96	106.86
200 mg/l BA		52.80	20.23	12.20	186.69	112.69
L.S.D. at 5% level		0.02	0.06	0.03	2.30	3.30

It is noteworthy to mention that the favourable effect of brassinosteroids on growth characters and yield and its components of fenugreek plants can be attributed to stimulating leaf elongation (Braun and Wild, 1984) and the increase in fresh and dry weight of leaves and shoots (Krizek and Mandava, 1982). It is appear that application of Brassinosteroids to intact plant such (lettuce, cucumber, mustard, and wheat) grown under hydroponic conditions to stimulate growth of whole plants including the roots (Gregory and Mandava, 1982 and Braun and Wild, 1984). In addition, Petzold et al. (1992) reported that BR promoted sucrose uptake in faba bean plants and this probably due to modulation of H^+ ATP as activity as indicated by Vmax values for sucrose uptake. They added that in 24-h experiments brassinosteroids enhanced translocation of ^{14}C compounds to the apical sink region, also, treatment of the sink promoted ^{14}C translocation to the sink. They concluded that brassinosteroids affected phloem unloading of ^{14}C compounds. Furthermore, brassinosteroids is considered to play a rate in the synthesis of growth hormones in plant at promote protein synthesis such as amino acid tryptophan as precursor of IAA (Yokota et al, 1987), whereas, positive response of growth and flowering to BRs treatment may be due to the significant increase in RNA and DNA polymerase activity and the synthesis of RNA and DNA and protein in beans and mungbean (Kalinich et al, 1995), also, showed that increased IAA and GA like growth substances (Shalaby and Abdel-Halim,1995 and Shalaby and Talaat (1998). In addition, Shalaby (2001 a and b) found that foliar spraying with brassinosteroids significantly affected on growth characters, photosynthetic pigments content, chemical constituents in dried seeds, endogenous hormone contents and yield and its components. It is noteworthy to mention that the positive response of

Table3. ffect of fenugreek cultivars and brassinosteroids concentrations and their interaction on yield and its components of fenugreek plants (Average of 2004/2005 and 23005/2006 seasons)

Treatments	Yield and its components	Plant height cm	No of branches / plant	No. of pods/ plant	Pods dry wt. cm	Pod length cm	Seed yield g/plant	Straw yield g/plant	Seed yield ton/fed	Straw yield Ton/fed	Biological yield ton/fed
	Interaction:										
cv. Giza-2	**Tap water**	54.55	8.53	24.30	38.12	8.51	31.49	36.28	0.566	0.712	1.278
	50 mg/l BA	57.90	9.11	26.80	41.50	8.86	33.44	39.64	0.635	0.839	1.474
	100 mg/l BA	62.14	9.35	31.50	47.80	10.04	37.58	44.13	0.713	0.917	1.630
	150 mg/l BA	65.60	10.0	34.28	49.31	10.50	40.02	48.5	0.805	1.081	1.886
	200 mg/l BA	69.34	10.60	37.0	50.10	11.0	41.46	50.36	0.852	1.112	1.964
cv. Giza-30	**Tap water**	59.70	9.70	28.70	45.71	9.06	38.90	44.19	0.641	0.805	1.445
	50 mg/l BA	64.19	10.25	32.40	48.62	9.70	40.36	47.28	0.719	0.921	1.640
	100 mg/l BA	67.26	10.60	34.80	51.20	10.80	42.12	51.12	0.781	0.996	1.777
	150 mg/l BA	71.82	10.90	37.90	56.18	11.70	45.18	54.70	0.971	1.113	2.084
	200 mg/l BA	78.11	11.00	39.20	59.26	12.12	47.12	56.14	0.993	1.256	2.249
L.S.D at 5% level		1.07	0.22	0.65	1.17	0.19	0.39	2.21	0.051	0.085	0.255
Cultivars :											
cv. Giza-2		50.33	9.52	30.78	45.37	9.78	36.8	43.78	0.714	0.932	1.646
cv. Giza-30		68.22	10.49	34.6	52.19	10.68	42.74	50.69	0.821	1.018	1.839
L.S.D at 5% level		1.16	0.04	1.27	1.73	0.06	1.03	1.40	0.08	0.02	0.05
BR concentrations		57.13	9.12	26.5	41.92	8.79	8.79	40.24	0.604	0.759	1.363
Tap water		61.05	9.68	29.6	45.06	9.28	9.28	43.46	0.677	0.880	1.557
50 mg/l		64.7	9.98	33.15	49.5	10.42	10.42	47.63	0.747	0.957	1.704
100 mg/l		68.71	10.45	36.09	52.75	11.10	11.10	51.6	0.888	1.097	1.985
150 mg/l		73.73	38.1	38.1	54.68	11.56	11.56	53.25	0.923	1.184	2.107
200 mg/l											
L.S.D at 5% level		0.63	0.13	0.38	0.69	0.11	0.23	1.30	0.03	0.05	0.15

Brassinosteroids on growth characters,chemical constituents of seeds and yield and its components of fenugreek plants in this study are in full agreement with those obtained by Shalaby and Abdel-Halim (1995), Helmy et al (1997), Shalaby and Talaat (1998), Shalaby and Zaki (1999), Shalaby (2001 a and b) and Yousef (2004).

C) Effect of the interaction:

Data recorded in Table 1. indicate that growth parameters of fenugreek plants (i.e. plant height, number of branches; leaves; flowers and pods/plant, dry weight of branches, leaves and pods/plant and leaves area/plant at the different stages of growth. Also, the interaction caused significant effects on carbohydrate and fixed oil percentages per seeds Table2. and yield and its components (i.e. plant height, number of branches and pods/plant, pods dry weight/plant, pod length, seed and straw yields/plant and/or fed. and biological yield/fed. Table 3.

It is noteworthy to mention that foliar application of cv. Giza-30 with 200 mg/l BRs was the most favourable treatment for growth characters (Table 1), chemical constituents of seeds, protein yield/fed and fixed oil yield/fed Table2. and yield and its components compared with other ten treatments under study.

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الملخص العربي

استجابة صنفين من الحلبة للرش بالبراسينوستيرويد

ليلى كمال بلبع

أجريت تجربتان حقليتان بمحطة التجارب الزراعية للمركز القومى للبحوث بشلقان – القناطر الخيرية – محافظة القليوبية خلال الموسمين الزراعيين 2005/2004 و 2006/2005 لدراسة صنفين من الحلبة للرش بالبراسينوستيرويد.

-اختلف الصنفين جيزة-2 وجيزة-3 معنويا فى صفات النمو خلال مراحل النمو المختلفة والمحصول ومكوناته وكذلك المكونات الكيمائية للبذور النسبة المئوية للكربوهيدرات والبروتين والزيت ومحصول البروتين ومحصول الزيت (طن/فدان) بالإضافة إلى ذلك، فإن الصنف جيزة -30 تفوق معنويا على الصنف جيزة -2 فى صفات النمو، المحصول ومكوناته، النسبة المئوية للكربوهيدرات والبروتين والزيت بالبذور، بالإضافة إلى محصول البروتين والزيت للفدان.

-أدى الرش الورقى بالتركيزات المختلفة من البراسينوستيرويد (كونترول، 50، 100، 150 و200 ملجم/لتر) إلى حدوث تأثير معنوى على صفات النمو عند عمر 75، 90، 150 يوماً من الزراعة، المحصول ومكوناته، والمكونات الكيميائية للبذور ومحصول البذور والزيت للفدان. هذا وقد أدى الرش بتركيزات 200 ملجم/لتر براسينوستيرويد إلى الحصول على أعلى قيم من صفات النمو، المحصول ومكوناته، النسبة المئوية للكربوهيدرات والبروتين ومحصول الزيت بالبذور بالإضافة إلى محصول البروتين والزيت مقارنة بتركيزات الكونترول، 50 ، 100 ، 150 ملجم/لتر.

-بالنسبة للتفاعل بين أصناف الحلبة والتركيزات المختلفة من البراسينوستيرويد فإن التأثير على جميع الصفات المدروسة كان معنويا عدا النسبة المئوية للبروتين بالبذور.

وعلى وجه العموم فإن رش صنف الحلبة جيزة-30 بمعدل 200 ملجم/لتر من البراسينوستيرويد سجل أعلى قيم من صفات النمو، المحصول ومكوناته، النسبة المئوية للكربوهيدرات والزيت بالبذور بالإضافة إلى محصول البروتين والزيت للفدان.