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EFFECT OF MICRONUTRIENTS FOLIAR APPLICATION ON PRODUCTIVITY AND QUALITY OF SOME FABA BEAN CULTIVARS (*Vicia faba* L.)

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ABSTRACT

Two field experiments were conducted at Agric. Exp. Res. Sta., Fac. Agric., Cairo Univ., during 2011/2012 and 2012/2013 seasons to study the effect of five foliar application of micronutrients (F1: control "spraying water only, F_2: Fe+ Mn at 5 g L^{-1} , F_3: Fe+Zn at 5g L^{-1} , F_4: Mn+Zn at 5 g L^{-1} and F5: Fe+Mn+Zn at 5 g L^{-1}) on yield and seed quality of three cultivars of faba bean (Giza 3, Sakha 1 and Giza 716). A spilt plot design in a randomized complete blocks arrangement with three replications was used. Micronutrients treatments were randomly assigned for main plots while, faba bean cultivars were randomly arranged for sub plots. Results showed that foliar application treatments significantly increased all yield traits and protein content compared with control treatment in both seasons. Spraying Fe+Mn+Zn mixture produced the greatest plant height (103.3 and 107.3 cm), number of branches plant^{-1}(3.46 and 3.60), number of pods plant^{-1} (18.40 and 18.80), pods weight plant^{-1} (38.67 and 40.03 g) , number of seeds pod^{-1} (3.39 and 3.42), 100-seed weight (65.53 and 65.77 g), seed yield plant $^{-1}$(35.80 and 37.90 g), seed yield (1746 and 1786 kg/fed.), straw yield (4536 and 4618 kg/fed.) , biological yield (6283 and 6405 kg/fed.) , harvest index (27.97 and 28.55%) and protein content (27.97 and 28.55 %) in both seasons, respectively. Giza 3 cultivars was superior in yield traits and protein content followed by Sakha 1 cultivar. However, Giza 716 cultivar gave the lowest values of yield traits and protein content in both seasons.

Keywords: Faba bean, Cultivars, Foliar application, Iron, Manganese ,Zinc, yield, Protein.

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important legume crops in Egypt. It can be used as a dietary item alone or can serve as a potential supplement to cereal diet, especially for the preparation of inexpensive protein rich food (Al-Kaisey *et al.*, 2002). Most of Egyptian crops suffering from the deficiency of micronutrients particularly Zn, Fe, and Mn due to low availability in the soil, high demand of crops, nutrients imbalance or unfavorable agronomic practices (Wallace, 1980; El- Fouly, 1983; El-Fouly *et al.* 1984; and Fawzi *et al.* 1987). Mahady (1990) reported that foliar application of ZnSO4 for faba bean plants increased the number of pods/plant and seed yield. Also, foliar application of micronutrients to *Vicia faba* at this stage increased number of flowers and pods. Moreover, spraying with micronutrients increase yield and its components under Egyptian soils conditions (Eweida *et al.*, 1980; El-Sheikh 1981; Fawzi *et al.* 1983; Hadi *et al.* 1985; Fouly and Rezk, 1986 and Gomma *et al.*1986). Abdel (2006) indicated that spraying faba bean plants with 100 mg L^{-1} Fe EDDHA significantly increased seed yield by (19.75%). El Fouly *et al.* (2010) concluded that foliar

application of micronutrients (mixture of, Fe, Mn, Zn) have a positive effect on growth and nutrients uptake of faba bean plants irrigated with saline water either before or after salinity treatments. Ali (2011) stated that that foliar application can be considered as one of the best method for micronutrients application. For most grain legumes period of seeds filling can be considered as the most critical stage affecting crop yield. Bozorgi *et al.* (2011) found that foliar application by zinc (1g/L) increased plant height, number of pods/plant, number of seeds/pod, 100 seed weight, seed yield (kg/ha), straw yield (kg/ha), biological yield (kg/ha) and harvest index (%). Salem and El-Gizawy (2012) found that micronutrients fertilization using Fe+Zn+Mn treatment was the most effective on yield and its components. Abd El-Razek *et al.* (2013) found that spraying with Fe+Zn+Mn increased yield and yield components, while, the highest number of branches/plant were found with Fe+Zn, in the combined data. Also, total chlorophyll significantly increased in all treatments sprayed with micronutrients compared with non-treated (control). Farag *et al.* (2014) found that micronutrient mixtures exceeded the control in leaf area/plant, LAI, chlorophyll a , b , number of branches/plant, pods and seeds/plant; seed index, straw, and biological yields/feddan. Results revealed that application of (Fe+Zn+Mn) micronutrient mixture was more effective on each of growth and yield than application of (Fe+Zn++Mn+Mo) micronutrient mixture,. Regarding faba bean cultivars, many investigators had reported high variability among faba bean cultivars for growth characters, yield and yield components and quality among of them Gomaa, 1996; El-Hosary and Mehasen, 1998 and Tageldin and Mehasen, 2004. The objective of this research was to study the effect of foliar application of micronutrient mixtures on yield, yield component and seed quality of some faba bean cultivars.

MATERIALS AND METHODS

Two field experiments were conducted in 2011/2012 and 2012/2013 seasons at the Agricultural Experimental Research Station, Faculty of Agriculture, Cairo University to study the effect of five treatments of micronutrients foliar application(F_1: control, F_2: Fe+ Mn at 5 g L^{-1} , F_3: Fe+Zn at 5g L^{-1} , F_4: Mn+Zn at 5 g L^{-1} and F5: Fe+Mn+Zn at 5 g L^{-1}) on yield and seed quality of three cultivars of faba bean (Giza 3, Sakha 1 and Giza 716. Foliar application treatments applied twice, the first at 45 days after sowing and the second at 60 days after sowing. Commercial Fe 12.5%, Mn 12.5 and Zn 12.5% were used in the experiments. Micronutrients were spray at 5 g L^{-1} water. A spilt plot design in a randomized complete blocks arrangement with three replications was used to conduct all trials. The five micronutrients foliar application were randomly assigned for main plots. The three faba bean cultivars were randomly arranged for sub plots. The experimental plot consisted of 5 ridges spaced 60 cm apart with 4 meters long (12 m^2). The preceding summer crop was maize in both seasons. In both seasons, the soil of experiments was analyzed as follow:

Table1:Physical and chemical analysis of soil at experimental site in 2011/12 and 2012/13 seasons.

Season	Clay %	Silt %	Sand %	Organic %	pH -	Salinity $ds.m^{-1}$	N ppm	P ppm	K ppm	Zn ppm	Fe ppm	Mn ppm
2011/12	38.3	23.2	38.5	1.8	7.8	0.84	36	15.7	210	0.64	12.9	8.4
2012/13	37.9	24.3	37.8	1.7	7.9	0.76	38	15.4	211	0.53	12.8	9.2

Sowing date was on November 13th and 14th in 2011/2012 and 2012/2013 seasons, respectively Phosphorus was added before ridging in the form of super phosphate (15.% P_2O_5) at the rate of 100 kg/feddan. Ammonium nitrate (33%) as a source of nitrogen was applied at the level of 20 kg N/feddan, also potassium sulphate (48-52 K_2O) was used as a source of potassium on the level of 24 kg K_2O/feddan, both nitrogen and potassium fertilizers were applied before the first irrigation. The normal cultural practices for growing faba bean were practiced. At harvest, ten individual guarded plants were randomly taken from the central three ridges that are devoted to determine seed yield and its components. The following traits were estimated: Plant height (cm): from ground level to the top of plant, number of branches/plant, number of pods/plant, pods weight/plant, number of seeds/pods,100-Seed weight (g), seed yield /plant (g). Seed, straw and biological yield (kg/plot): was determined at harvest from plants of the central three ridges of each plot and then convert to (kg/feddan). Harvest index percentage: Ratio of seed weight to biological yield without dropped leaves at harvest multiplied by 100.

At laboratory, seed crude protein percentage was estimated according the improved Kjeldahl method of AOAC (1990). Data were subjected to analysis of variance according to the split plot design according to the procedure outlined by Steel and Torrie (1997). Treatment means were compared based on least significant difference (LSD) at probability level of 0.05. Finally, all statistical analysis was carried out using "MSTAT-C" program.

RESULTS AND DISCUSSION

Effect of micronutrients foliar application:

Yield traits:

Data presented in Table (2) showed that foliar application with Fe , Zn and Mn in combination of them significantly increased all yield traits in 2011/2012 and 2012/2013 seasons. The tallest faba bean plants (103.3 and107.3 cm) was obtained with spraying Fe+Mn+Zn followed by Mn+Zn (100.3 and 102.7cm), while the shortest plants (82.60 and 85.23 cm) was produced with control treatment (spraying water) in both seasons, respectively. This was in agreement with Bozorgi *et al.* (2011) and Salem and El-Gizawy (2012) who reported that micronutrients foliar application using Fe+Zn+Mn treatment was the most effective treatment regarding plant height. Comparing application of micronutrient mixtures with the control, revealed that supplies (Fe+Mn+Zn) as a micronutrient mixture gave the

highest number of branches plant^{-1} (3.46 and 3.60) followed by Mn+Zn (3.13 and 3.37) followed by Fe+Mn treatment (2.83 and 3.07) in both seasons, respectively, compared with control treatment. Table (2) showed that all foliar application treatments significantly increased number of pods plant^{-1}, pods weight plant^{-1} and number of seeds pod^{-1} in both seasons compared with control. The highest number of pods plant^{-1} (18.40, 18.80), pods weight plant^{-1}(38.67 and 40.03 g) and number of seeds pod-1 (3.39 and 3.42) was produced by spraying Fe+Mn+Zn micronutrient mixture compared with other foliar application treatments in both seasons. However, differences between Fe+Mn , Fe+Zn and Mn+Zn treatments were not significant in both seasons.

Table 2: Effect of micronutrients foliar application on faba bean yield and its components in 2011/2012 and 201/2013 seasons.

Characters	Seasons	Foliar application treatments*					$LSD_{0.05}$
		F_1	F_2	F_3	F_4	F_5	
Plant height (cm)	2011/12	82.60	94.03	96.53	100.3	103.3	6.25
	2012/13	85.23	96.00	98.73	102.7	107.3	6.47
No. of branches /plant	2011/12	2.20	2.80	2.83	3.13	3.46	0.12
	2012/13	2.37	2.90	3.07	3.37	3.60	0.14
No. of pods /plant	2011/12	13.37	14.67	15.73	16.90	18.40	1.21
	2012/13	13.93	15.27	16.30	17.47	18.80	1.24
Pods weight/plant	2011/12	32.47	33.43	34.00	35.73	38.67	0.62
	2012/13	32.93	34.93	36.70	37.87	40.03	0.71
No. of seeds/pod	2011/12	3.12	3.16	3.23	3.31	3.39	0.12
	2012/13	3.16	3.26	3.33	3.38	3.42	0.14
100-Seed weight (g)	2011/12	56.97	59.47	61.43	63.13	65.53	3.72
	2012/13	59.57	60.40	62.03	63.90	65.77	4.11
Seed yield/plant (g)	2011/12	30.43	31.77	33.07	34.40	35.80	1.15
	2012/13	30.83	32.53	33.87	35.37	37.90	1.34
Seed yield (kg /fed.)	2011/12	1563	1606	1622	1671	1746	22.1
	2012/13	1595	1626	1655	1723	1786	24.2
Straw yield (kg/fed.)	2011/12	4362	4397	4433	4490	4536	31.2
	2012/13	4490	4553	4590	4594	4618	34.2
Biological yield (kg/fed.)	2011/12	5925	6003	6055	6161	6283	57.1
	2012/13	6085	6180	6245	6318	6405	69.3
Harvest index (%)	2011/12	26.11	26.60	26.78	27.12	27.97	0.16
	2012/13	26.41	26.65	27.00	27.47	28.55	0.24

***F1: control , F2: : (Fe+Mn) , F3: (Fe+Zn), F4(Mn+Zn) and F5: (Fe+Mn+Zn)**

It is clear from the data given in Table (2) that spraying with Fe+Mn+Zn recorded the highly significant values of 100-seed weigh (65.33 and 65.77 g) and seed yield plant^{-1} (35.80 and 37.90 g) compared with other treatments in both seasons, respectively. The increase of yield components due to micronutrient application might be due to their positive effect on seed yield component. Seed yield (kg/fed.), straw yield (kg/fed.) and biological yield (kg/fed.) as influenced by micronutrients foliar application treatments are shown in Table (2). Foliar application with Fe+Mn+Zn produced the highest seed yield (1746.7 and 1786.7 kg/fed), straw yield (4536.7 and 4618.3 kg/fed.) and biological yield (6283 and 6405 kg/fed.) in both seasons, respectively, compared with other foliar application treatments. However, the lowest seed yield (1563 and 1595 kg/fed.), straw yield (4362 and 4490 kg/fed.) and biological yield (5925 and 085 kg/fed.) was recorded at control

treatment in both seasons. It worth to mention that supplies of micronutrient (Fe+Zn+Mn) was superior also in yield attributes. This may be due to their positive effects on assimilates translocation, activation of photosynthetic enzymes , chlorophyll formation and improvement of plant growth (Farag *et al.* 2014). Harvest index (%)expressed as ratio of seed weight to biological yield without dropped leaves at harvest. Generally, harvest index (%) was significantly affected by foliar application treatments in both seasons (Table 2). Furthermore, foliar application with (Fe+Mn+Zn) gave the highest value of harvest index (27.97 and 28.55 %) compared with other treatments in both seasons. The increase of yield components due to micronutrients application might be due to their positive effects on assimilates translocation, activation of photosynthetic enzymes, chlorophyll formation and improvement of plant growth (Farag *et al.* 2014). The meliorating effect of micronutrients was also reported by many investigator among of them Mahady (1990), El-Fouly *et al.* (2010), Bozorgi *et al.* (2011), Abd El-Rzek *et al.* (2013) and Farag *et al.* (2014).

Protein content:

Fig.1 demonstrate the effect of micronutrients foliar application treatments on protein content (%) of faba bean seeds in 2011/2012 and 2012/2013 seasons. Faba bean seed protein content increased gradually with foliar application treatments in both seasons. It worth to note that Fe+Mn+Zn treatment surpassed other treatments in seed protein content(%). However, the lowest protein content (26.11 and 26.41%) was obtained with control treatment in both seasons.

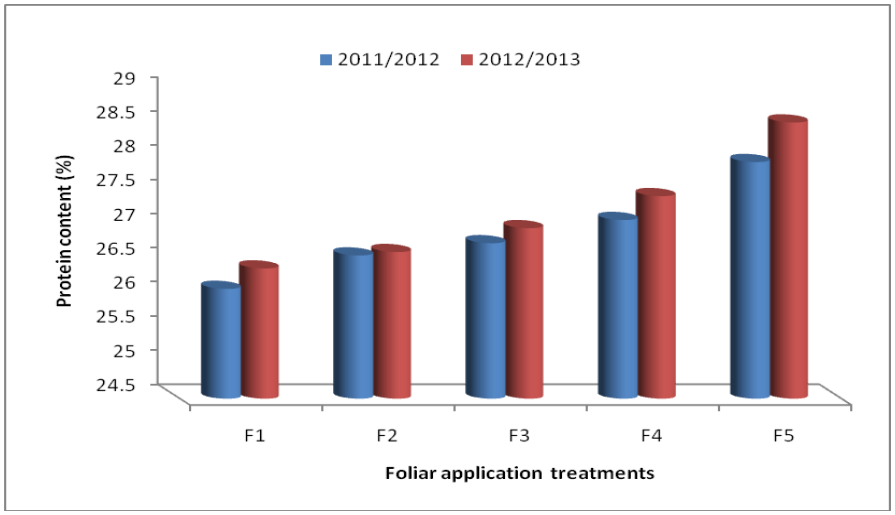

Fig.1: Effect of foliar application treatments on protein content(%) of faba bean seeds in 2011/2012 and 2012/2013.

Effect of faba bean cultivars:

Yield traits:

Data in Table (3) showed that the effect of some faba bean cultivars on yield traits in 2011/2012 and 2012/2013 seasons. The differences between the three faba bean cultivars were significant in all yield traits in both seasons , except number of seeds pod^{-1} in both seasons. Results showed that Giza 3 cultivar gave the highest plant height (99.48 and 101.9 cm) followed by Sakha 1 (94.56 and 97.08 cm)in both seasons, respectively. However, Giza 716 cultivar produced the lowest plant height (92.42 and 94.94 cm) in both seasons, respectively. Moreover, Giza 3 cultivar was superior in number of branches plant^{-1} compared with other two cultivars in both seasons. While, Sakha 1 cultivar ranked in the second order followed by Giza 716 in both seasons. Number of pods plant^{-1} was significantly affected by faba bean cultivars in both seasons (Table 3). Giza 3 cultivar recorded the highest number of pods plant^{-1} (1612 and 17.04) followed by Sakha 1 cultivar (15.82 and 16.12) followed by Giza 716 (15.44 and 15.90) in both seasons, respectively. The same trend was observed regarding to pods weight plant^{-1} (g) in both seasons. Giza 3 produced the greatest pods weight plant^{-1} (35.56 and 37.34 g) in both seasons, however, Giza 716 gave the lowest pods weight plant^{-1} (34.22 and 36.08 g) in both seasons, while, Sakha1 was in between.

Table 3: Effect of some faba bean cultivars on yield and yield components in 2011/2012 and 2012/2013 seasons.

Characters	Season	Faba bean cultivars			$LSD_{0.05}$
		Giza 3	Sakha 1	Giza 716	
Plant height (cm)	2011/12	99.48	94.56	92.42	2.3
	2012/13	101.9	97.08	94.94	3.4
No. of branches /plant	2011/12	3.12	2.90	2.62	0.13
	2012/13	3.32	3.10	2.76	0.15
No. of pods/plant	2011/12	16.12	15.82	15.44	0.21
	2012/13	17.04	16.12	15.90	0.23
Pods weight /plant (g)	2011/12	35.56	34.80	34.22	0.24
	2012/13	37.34	36.06	36.08	0.27
No. of seeds/pod	2011/12	3.28	3.24	3.21	NS
	2012/13	3.35	3.31	3.27	NS
100-Seed weight (g)	2011/12	62.34	61.16	60.30	0.12
	2012/13	63.38	62.46	61.16	0.14
Seed yield /plant (g)	2011/12	34.28	33.22	31.78	0.34
	2012/13	35.16	34.24	32.90	0.37
Seed yield (kg/fed.)	2011/12	1679	1632	1613	18.1
	2012/13	1718	1666	1647	17.3
Straw yield (kg/fed.)	2011/12	4533	4428	4370	38.2
	2012/13	4589	4580	4538	42.1
Biological yield (kg/fed.)	2011/12	6212	6060	5983	38.4
	2012/13	6307	6246	6186	39.7
Harvest index (%)	2011/12	27.01	26.93	26.97	0.12
	2012/13	27.23	26.67	26.62	0.14

Regarding number of seeds pod^{-1} the differences between faba bean cultivars were not significant in both seasons. Data given in Table (3) clearly indicate that, faba bean cultivar Giza 3 produced, the heaviest seeds expressed as

100-seed weight (62.34 and 63.38 g), and highest seed yield plant-1 (34.28 and 35.16 g) followed by faba bean cultivar Sakha 1 (61.16, 62.46 g and 33.22 , 34.24 g)for previous traits, respectively, in both seasons. However, faba bean cultivar Giza 716 recorded the lowest means (60.30, 61.16 g and 31.78, 32.90 g) for the previous traits, respectively, in both seasons.

Results presented in Table (3) show that, seed yield (kg/fed.), straw yield (kg/fed.) and biological yield (kg/fed.) of the three faba bean cultivars was varied in both seasons. It was evident that faba bean cultivar Giza 3 surpassed in seed yield (1679 and 1718 kg/feddan) , straw yield (4533 and 4589 kg/feddan) and biological yield (6212 and 6307 kg/feddan) the other two cultivars (Sakha 1 and Giza 716). Meanwhile, faba bean cultivar Giza 716 produced the lowest values of seed yield (1613 and 1647 kg/feddan), straw yield (4370 and 4538 kg/feddan) and biological yield (5983 and 6186 kg/feddan).

Regarding the influence of the three faba bean cultivars the results in Table (3) revealed significant differences in harvest index (%) in both seasons. Giza 3 cultivar gave the highest harvest index (27.01 and 27.23%) compared with other two cultivars in both seasons, respectively. However, the differences between Sakha 1 and Giza 716 were not significant in both seasons (Table 3).

Supereminence of Giza 3 cultivar over both Sakha 1 and Giza 716 cultivars was obvious not only in seed, straw and biological yields , but also in each of plant height, number of branches plant^{-1}, number of pods plant^{-1}, weight of pods plant^{-1}, 100 seed weight plant and seed yield plant^{-1}. Similar views were expressed by Gomaa, 1996; El-Hosary and Mehasen, 1998 and Tageldin and Mehasen, 2004.

Protein content:

Fig.2 illustrate the difference between three faba bean cultivars in seed protein content (%) in both seasons. Giza 3 cultivar gave the highest protein content (27.14 and 27.4 %) followed by Sakha 1 cultivar (26.92 and 27.18%), respectively, in both seasons. However, Giza 716 faba bean cultivar produced the lowest protein content (26.69 and 27.01%), respectively in both seasons.

Interaction effect:

Seed yield (kg/feddan)

It is obvious from Fig.3 that the dualist interactions between the foliar application treatments and faba bean cultivars was significant in seed yield (kg/feddan) in both seasons. It is worth to note that the interaction effects on seed yield (kg/feddan) was in conformity with the main effects, using foliar spraying micronutrient application (Fe+Mn+Zn) with Giza 3 cultivar produced the highest seed yield (kg/fed.), while the lowest seed yield was obtained due to control treatment with Giza 716 faba bean cultivar. Moreover, all foliar micronutrient mixtures increased seed yield (kg/fed.) at all faba bean cultivars.

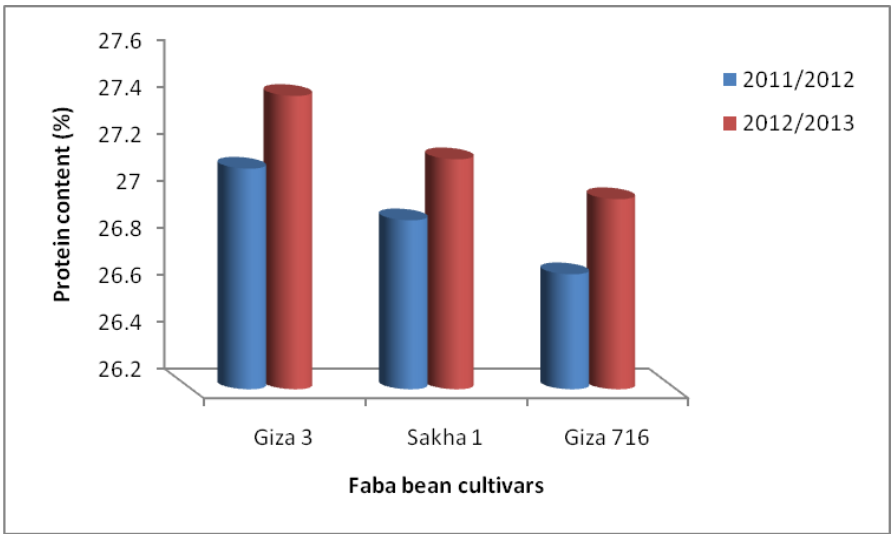

Fig.2: Effect of some faba bean cultivars on protein content of seeds in 2011/2012 and 2012/2013 seasons.

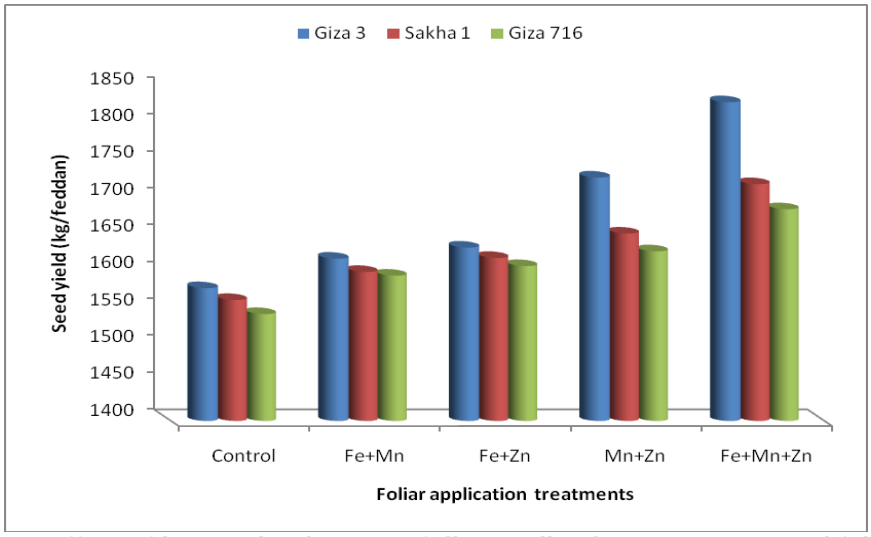

Fig.3 Effect of interaction between foliar application treatments and faba bean cultivars in 2011/2012 season.

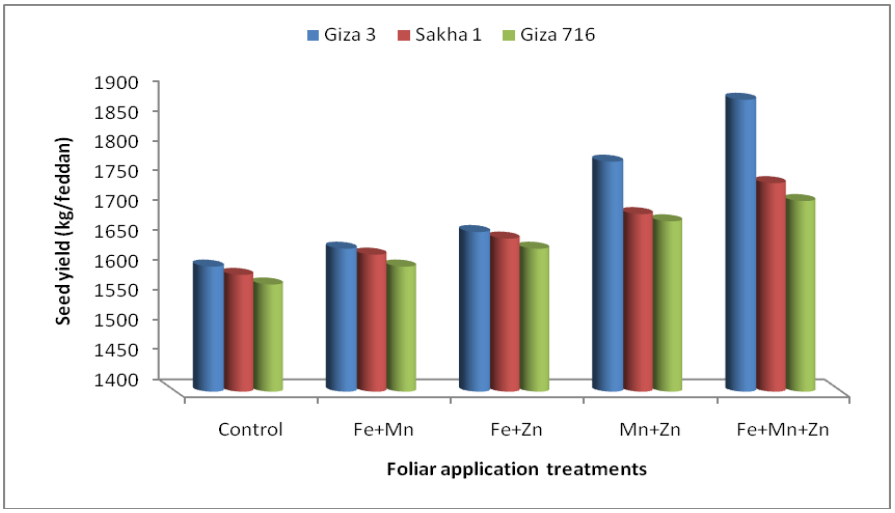

Fig.4: Effect of interaction between foliar application treatments and faba bean cultivars in 2011/2012 season.

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تأثير التسميد الورقي بالعناصر الصغرى على إنتاجية وجودة بعض أصناف الفول البلدي

محمود الجوهري رجب مكي
قسم المحاصيل-كلية الزراعة –جامعة القاهرة

أقيمت تجربتان حقليتان خلال موسمي ٢٠١٢/٢٠١١ و ٢٠١٣/٢٠١٢ في محطة التجارب و الأبحاث الزراعية – كلية الزراعة –جامعة القاهرة؛ بهدف دراسة تأثير الرش بمخاليط العناصر الصغرى "حديد + منجنيز "؛ "حديد+زنك" ؛ "منجنيز +زنك" ؛ "حديد + منجنيز + زنك" ومعاملة المقارنة "رش ماء فقط" على صفات المحصول و مكوناته وجودة بذور ثلاثة أصناف من الفول البلدي هي جيزة ٣ و سخا ١ و جيزة ٧١٦ و وأوضحت النتائج المتحصل عليها ما يلي :

١-تأثير الرش بالعناصر الصغرى:

أظهرت النتائج تأثيرا معنويا للرش بمعاملات العناصر الصغرى على جميع صفات المحصول و مكوناته و نسبة البروتين ؛ حيث أدى الرش بأي من مخاليط العناصر الصغرى إلى زيادة معنوية في صفات المحصول و مكوناته مقارنة بمعاملة الكنترول "رش بالماء فقط". و أدى الرش بمخلوط العناصر الثلاثة "حديد+منجنيز+زنك" إلى الحصول على أعلى القيم في صفات طول النبات عند الحصاد وعدد فروع النبات و عدد قرون النبات و ووزن قرون النبات و عدد بذور القرن و وزن الـ١٠٠ بذرة و محصول النبات الفردي و المحصول من البذور و القش والمحصول البيولوجي للفدان و دليل الحصاد و نسبة البروتين في البذور مقارنة بباقي المعاملات في الموسمين.

٢-تأثير الأصناف:

تشير النتائج إلى وجود فروق معنوية بين أصناف الفول البلدي الثلاثة في صفات المحصول ومكوناته ونسبة البروتين خلال موسمي الدراسة ؛ كما توضح النتائج تفوق الصنف جيزة ٣ في جميع الصفات المدروسة يليه الصنف سخا ١ وسجلت أقل القيم للصنف جيزة ٧١٦ في موسمي الدراسة ؛ بينما لم تكن الفروق بين الأصناف معنوية في صفة عدد البذور في القرن.

٣-تأثير التفاعل :

كان تأثير التفاعل معنويا على صفة محصول البذور (كجم /الفدان) في موسمي الدراسة ؛ حيث استجابت الأصناف الثلاثة للرش بالعناصر الصغرى وكان الصنف جيزة ٣ أكثر استجابة للرش بالعناصر الصغرى و أعطى أعلى القيم لجميع الصفات تحت الدراسة يليه الصنف سخا ١ ثم الصنف جيزة ٧١٦ خلال موسمي الدراسة.

تحت ظروف هذه الدراسة يمكن التوصية بزراعة الصنف جيزة ٣ و الرش بمخلوط العناصر الصغرى (حديد+ منجنيز+ زنك) للحصول على محصول مرتفع من البذور في الفول البلدي.