Journal of Plant Production

Journal homepage: www.jpp.mans.edu.eg
Available online at: www.jpp.journals.ekb.eg

Influence of Proceeding Crop and Foliar-Applied Micronutrients on Faba Bean Productivity and Seed Quality

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ABSTRACT

Field experiment was conducted at Sers Al-Layan Agricultural Research Station, ARC, Monofia Government, Egypt during 2018-2019 and 2019-2020 seasons. It aimed to study the effect of proceeding crop and foliar-applied micronutrients on seed yield and quality of faba bean. Three proceeding crops were used, maize(S1) –maize- Eg- clovr(fahl) (S2) - soybean (S3). Moreover, three treatments of foliar-applied micronutrients were applied; one application after 45 day from sowing(M2) or two applications after 45 and 60 days from sowing(M3) compared to without application (as control(M1)).The experiment was arranged in split-plot design with three replications.The proceeding crop was occupied in the main- plots while the micronutrients treatments were arranged in sub-plots. The proceeding crop displayed significant difference in seed yield/fad, its components and seed quality. Faba bean after legume crops(S2 and S3) had highest values for all studied traits. All studied traits were affected significantly by foliar-applied micronutrients except number of branches/plant only in the first season. M3 displayed highest performance in seed yield/fad and its component and seed quality. All evaluated traits were affected significantly by the interaction except number of branches.Faba been after legume crops and, sprayed by micronutrients after 45 and 60 days from sowing(S2M3) exhibited the highest performance of seeds content from micronutrients and protein.S2M3 gave the highest values of total and net return (30881 and 20013 LE) and (36679 and 25686 LE) in two seasons respectively.The finding of this study is sowing faba bean after legume crops and spraying by micronutrients at 45 and 60 days after sowing.

Keywords: faba bean, proceeding crop, micronutrients, net return, yield.

INTRODUCTION

Faba bean (*Vicia faba L.*) is one of the most important crops in Egypt because seeds of faba bean are a good source of protein, energy, and fiber, accordingly, it is widely grown for food and feed (Duc, 1997). The protein content of faba bean ranges from 24% to 35% of the seed dry matter (Crépon *et al.* 2010). In addition to being an excellent source of protein and starch, it contains valuable mineral micronutrients (Crépon *et al.* 2010). Faba bean is one of the major field crops grown in Egypt which plays a role in crop rotation. It has excellent ability to fix atmospheric nitrogen. The cultivated area was67763fad in 2019 and produced 134274 ton (FAOSTAT, 2020). There is a gap between faba bean production and its consumption by 65%, which costs the country billions of dollars. This is due to existence of several problems that obstruct increasing the area and production of faba bean including limited land and water, and intense competition with other winter crops such as wheat and Egyptian clover in addition to marketing problems.

Maximization of yield and net return depend on type and modifications in cultural practices, of these modifications, the sequential systems had positive effects on faba bean yield. In this respects, Metwally (1997) reported that faba bean grown after soybean was better than that grown after sunflower in yield and yield components. Greish *et al.*(2000) showed that yield and yield attributes of faba bean which planted after groundnut was the best compared to sesame or sunflower. Wafaa, (2006) showed that plant height, number of branches/plant ,seed yield/fad and its components were significant effected by preceding crops and so planting faba bean after legume crops was higher as compared with after cotton or rice.

Micronutrients are essential elements for growth, fruiting and hence play an important role in enzyme function in plants . Mengel *et al.*, (2001), Rehm and Sims(2006) and Fageria, 2009 indicted that micronutrients fertilizers are being applied to increase faba bean growth and play important role in yield improvement. Usama *et al.* (2013) reported that foliar application with Fe^{+} Zn^{+} Mn increased yield and yield components of faba bean. In addition, Atiia *et al.* (2016) showed that foliar application with micronutrients significantly increased faba bean yield and yield attributes as well as seed quality. Sawan *et al.*, (2008) and Hamouda *et al.*, (2018) showed that Zinc is an important element and so Zinc and iron take over different roles in the crop, such as formation, partitioning and utilization of photosynthesis assimilate.. Zinc is a micronutrient needed in small amounts by crop plants, but it's importance in crop production has increased in recent years (Fageria, 2009). (Abd El-Hady, 2007 ; Millaleo *et al.*, 2010). Jin *et al.*, (2008) indicated that Fe concentration and protein in seeds increased significantly by foliar application using

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DOI: 10.21608/jpp.2020.149801

combination of Fe and B, Zn compared with untreated plants. Also, it plays an essential role in plant physiology where it actives some enzymes such as dehydrogenises. Increased food crop content of zinc leads to improving the nutritional status of the plants, as well as humans (Hafeez *et al*., 2013).

The main objective of this study is determining the best proceeding crop as well as the suitable treatment of micronutrients foliar application to increase faba bean production and economic return.

MATERIALS AND METHODS

Field experiment was conducted at Sers Al-Layan Agricultural Research Station, ARC, Monofia Governorate, Egypt ((Lat. 30 º 44′ 22″ N, Long 30º 58 ′09″ E),during 2018-2019and 2019-2020 seasons. The effect of proceeding crop and micronutrients foliar application on faba bean were investigated. Three proceeding crops were used; maize – soybean- Maize / Eg-clover (Fahl) (Eg-clover was planted on the same ridge of maize after harvesting maize).Moreover, three treatments of foliar-applied micronutrients were applied; one application after 45 days from sowing or two applications after 45 and 60 days from sowing compared to without application (as control). The micronutrients consisted of Zinc mixed, manganese and copper with a concentration of 0.05, iron with a concentration of 0.1% and boron with a concentration of 0.02%. All combinations were in chelated form (the commercial compound BLOOMTASTIC). The combinations were sprayed at a rate of 5 cm/liter and the rate of spray solution was 200 liters of water/fed.

The experiment was arranged in split-plot design with three replications. The proceeding crop was occupied in the main plots while the micronutrients treatments were arranged in sub- plots. The experiment included nine treatments which were the combinations between three proceeding crops and three applications of foliar micronutrients. The treatments were coded as S1 is maize before faba bean, S2 is maize/Eg. clover (fahl) before faba bean, S3 is soybean before faba bean, M1 is faba bean without foliar micronutrients applications(control), M2 is one application of micronutrients after 45 days from sowing and M3 is two application of micronutrients at 45 and 60 days from sowing at the same rate per sprinkle.

The area of experimental plot was10.8 m² which consisted of 6 ridges (3 m long×0.6 m width).(the distance between plants of faba bean was 25 cm, and 2 plants/hill, it gave 84000plant/fad. and Faba bean was planted on two sides of the ridge)..The experiments were carried out in clay soil. Soil analysis of the experimental site (0-30 cm depth) are stated in Table (1) according to standard methods described by Piper (1950) and Jackson (1973). DTPA-extractable Fe, Mn and Zn were measured in soil. The sample of soil was taken before planting faba bean.

Cultivars, sowing and harvesting dates were presented in table 2,Other agronomic practices were applied according to technical recommendations.

Table 1. Physical and chemical properties of soil at the experimental site before planting faba bean.

Soil analysis	Preceding crops		
	Eg clovr (Fahl)	Maize	Soybean
Mechanical analysis			
Sand (%)	59.10	59.10	59.00
Silt (%)	20.10	21.10	20.00
Clay (%)	20.80	19.80	21.00
Soil texture	Clay loamy	Clay loamy	Clay loamy
Chemical analysis			
Nitrogen (%)	0.24	0.22	0.27
Phosphorous (ppm)	22.55	22.96	22.43
Potassium (ppm)	46.00	45.10	45.50
Iron (ppm)	0.35	0.32	0.31
Mn (ppm)	0.10	0.20	0.00
Zn (ppm)	0.24	0.25	0.24
Cu (ppm)	0.35	0.36	0.35

The mechanical and chemical analyses of the soil were carried out at the faculty of agriculture, Zigzag University.

Table 2. Cultivars, sowing and harvesting dates of used crops.

Sequential crops	Cultivar	Planting date		Harvesting date	
		2018/2019	2019/2020	2018/2019	2019/2020
Faba bean	Giza 843	25 th November	27 th November	24 th April	26th April
Maize '	S.C10	9th May	15 th May	5thSeptember	10th September
Soybean	. Giza 111	28th May	29th May	2nd October	1st October
Eg. clover(Fahl)	Giza 1	9th September	16th September	20 th November	21th November

Recorded data at harvest, ten individual plants of faba bean were randomly taken from each experimental area. The measured traits were plant height, number of branches/plant, number of pods/plant, weight of pods/plant, 100-seedsweight, biological weight (ton)/fad, straw yield(ton)/fad, seed yield(ardab)/fad. Also, straw yield (ton)/fad and seed yield / fad (ardab) of maize and seed yield / fad (ardab) and straw yield (ton)/fad of soybean were taken ,as well as, cutting weight /fad (ton) of Eg clover(Fahl) . Nitrogen content in the seeds was determined by using micro-kjeldahl methods by the method described by Olsen *et al*. (1954). The protein percentage in the seeds was calculated by multiplying N% × 6.23. The micronutrients; Fe, Zn and Mn in the faba bean seeds were determined after digestion by using Perkin-Elmer 2365 Atomic Absorption spectrophotometer as described in the A.O.A.C. (2002).

Cereal units

Cereal units' calculation was stated for whole year structure. Cereal units were showed by Brockhaus (1962) to express agronomic gains from crops based on the products either main-products or by-products. Cereal units for crops, estimated per 100kg, as follow:

Main product: maize= 1 unit, faba bean= 1.2, soybean=1.5and Eg clover (fahl) =0.14 unit. By product : maize straw=0.15 unit, soybean straw=0.25 and faba bean straw=0.25.

Economic evaluation

Economic return was determined of total return, costs for crops and net returns

Total return = yield a × price a + yield b × price b+ yield c × price c

The prices were presented as market prices.

Net return / fad *(*L.E)

Net return / fad = total return – variable costs

The prices of crops in the farm was :ardab of maize=320 LE in two seasons., ardab of faba bean=2200 LE. in two seasons, straw crop value of faba bean =125 LE in two seasons, ton of soybean = 5000 and 6000 LE at 2018 and 2019

seasons respectively and average of forage price for cutting=3840 LE in two seasons..

Statistical analysis

The measured variables were analyzed by ANOVA using MSTATC statistical package (Freed, 1991). To test the difference between treatment means at 0.05 level, we used least significant difference(LSD) method as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

A- Effect of proceeding crop

1- Yield and its components

Sequential systems were significantly affected on pods weight /plant, 100- seeds weight, seed yield / plant and hence straw yield/fad., biology yield/fad. and seed yield/fad. in two seasons and plant height and number of pods/plant in one season whereas number of branches was not affected significantly (Table 3)

In general, faba been after legumes crops *i.e* Egyptian clover (Fahl) and soybean had the highest values for plant height, number of pods/plant, weight of pods/plant, 100-seeds weight, seed yield / plant and/ fad., straw yield/fad. and biology yield/fad, as compared with faba bean after maize in the two seasons. Number of branches/plant take the same trend but it did not reach to significant in the two season. These results may be due to legumes are known to can increase soil fertility, especially soil N (Table 1) and organic matter to improve soil physical properties and consequently, to enhance the growth of the crops, these results were in agreement with Greish *et al.*(2000) and Wafaa, (2006). Seed yield/fad. after legume crops was superior to that after maize as results of increasing yield components (Wafaa, 2006). Planting faba bean after maize gave the lowest value of yield components in two seasons, these results may be due to more nitrogen exploitation by maize than legume crops.

In respect to the first season, pods weight/plant, 100-seeds weight and seed yield/ plant were increased by(4.5% and 1.5%), (4.2% and 0.5%) and (10.8 % and 7.5%) in Faba been after legumes crops(soybean- Eg clover(Fahl)) as compared with faba bean after maize. Sowing Faba been after legumes crops such as soybean- Eg clover (Fahl) were increased by (4.9% and 9.28%), (41% and 23 %),(25.3 % and 13.6%),(6.99 and 1.54),(15.7% and11.9%), (13.3 and 18.4%), (0.33% and 15.56) and (3.95% and 16.28%) for plant height, number of pods/plant, weight of pods/plant, 100-seed weight, seed yield / plant, per fad., straw yield/fad. and, biology yield/fad. respectively in second season as compared with faba ben after maize. These data was in agreement with Metwally (1997), Greish *et al* (2000) and Wafaa, (2006). Although, faba bean after legumes gave the highest results in seed yield/fad. and yield components but there are significant difference between soybean and Eg clover (Fahl) may be the legumes crops have different in ability of N fixation which played major role improving the amount of biological N fixation

2- Seed quality characters

Results showed significant differences between proceeding crop on faba bean seed contents of micronutrients (Fe, Zn and Mn) and protein in both seasons (Table 3).Data presented in table (3) indicate that the higher values of seeds content of micronutrients and protein were obtained from faba bean after legume crops compared with faba bean after maize. Sowing faba bean after soybean increased the content of Fe, Zn and protein in faba bean seed by 14.9, 22.1 and 5.4% while after alfalfa by 7.7, 6.5 and 14.0% respectively, in the first season compared with faba bean after maize. Meanwhile, in the second season sowing faba bean after soybean increased Fe, Zn, Mn concentrations and protein content in faba bean seeds by 49.8, 23.3, 20.0 and 4.5%while by 9.2, 24.7, 16.7 and 7.3%respectively compared with faba bean after maize. The highest micronutrients concentration and protein content in faba bean seeds after legumes were due to increasing soil fertility, especially soil N leading to higher N uptake and assimilates translocation to seeds in pods compared to maize. In this direction iron content of grain wheat peaked when peas and blue lupine were the proceeding crops (Pszczolkowska *et al.,* 2018).

Table 3. Yield and yield components as well as seed quality of faba bean as affected by proceeding crop S) at 2018/2019 and 2019/2020 seasons.

characters Sequential systems (S)	Plant height (cm)	No. branches/plant	No. pods/plant	Weight pods/ Plant (g)	Seed 100 weight (g)	Seed yield /plant (g)	Seed yield/ fad. (ardab)	Straw yield/ fad. (ton)	Biology yield/fad. (ton)	Fe (ppm)	Zn (ppm)	Mn (ppm)	Protein (ppm)
					(2018/2019)								
Maize /Faba bean(S1)	104.6	2.17	9.8	29.25	74.03	20.26	8.00	2.45	3.65	261	77	28	22.57
Maize / Eg clovr (Fahl)/ Faba bean (S2)	103.7	2.38	10.2	29.71	74.47	21.78	8.35	2.79	4.05	281	82	30	25.72
Soybean / Faba bean (S3)	105.1	2.63	10.4	30.61	77.21	22.45	8.92	2.77	4.11	300	94	32	23.79
LSD0.05 (S)	N.S	N.S	N.S	0.57	1.48	0.71	0.18	0.55	0.16	6.21	0.79	N.S	0.77
					(2019/2020)								
Maize /Faba bean(S1)	105.3	2.95	9.99	29.49	75.73	21.23	8.47	3.02	4.30	261	73	30	23.98
Maize / Eg clovr (Fahl) Faba bean (S2)	115.0	3.15	12.3	33.49	76.90	23.76	10.03	3.49	5.00	285	91	35	25.72
Soybean / Faba bean (S3)	110.4	3.06	14.1	36.93	81.03	24.57	9.60	3.03	4.47	391	90	36	25.06
LSD0.05(S)	3.5	N.S	0.36	1.34	2.185	0.86	0.40	0.32	0.13	10.60	5.03	3.38	1.21

b. Effect of micronutrients application

1-yield and yield component of faba bean

All studied traits significantly affected by micronutrients application in the two seasons except no. branches/plant in the first season and biological yield/fad. in second season were insignificant (Table 4), these results were agreement with obtained by Salem *et al.* (2014) who indicated that positive effect of micronutrients spraying on the yield and yield attributes of faba bean except for number of branches /plant and number of seeds/pod. In general, sprayed faba bean with micronutrients exhibited increased yield and yield components, compared with untreated ones,

these results were agreement with obtained by El-Hosary and Mehasen (1998), El-Masri *et al*. (2002) and El-Sobky and Yasin (2017) who said that micronutrients spraying caused significant increase in seed yield and yield attributes as well as seed quality. The increment in yield components was due to increasing the rates of photochemical reactions and activities of the carboxylation enzymes as well as carbonic anhydrase.

Also, the improvement in biological yield was due to association of the micronutrients with metal proteins, presence in cytochrome oxidase and its required for proper development and differentiation of tissues(Wassel *et al.*, 2007). Application of micronutrients led to increasing yield components which had main role in increasing seed yield/fad. On the other hand, faba bean without application of micronutrients gave the lowest value in seed yield/fad. and its components. Sprayed faba beans at 45 and 60 days after sowing recorded the best performance. These results are in accordance with Atiia *et al* (2016) who reported that the application of micronutrient at the pod filling stage significantly increased yield. Also, Abdrabou (1992) said that The foliar application of Mn, Fe and Zn^{+} Mn^{+} Fe had significant effect on seed yield/fad. where foliar spraying at 40 and 60 days after sowing had positive effect on yield of faba beans cv. Giza-2.

Foliar-applied micronutrients two times at 45 and 60 days after sowing increased weight of pods/plant, 100-seeds weight, seed yields/plant by 23.4, 14.5 and 23.4% in the first season and 12.4, 4.3 and 9.5% in the second season respectively compared with untreated plants.. In this context, Bedeer (1984) concluded that timing of spraying is very important during different growth stages. Since applying foliar micronutrients before flowering promoted earlier flowering and helps in production of indole acetic acid which increased leaves area and more sugar.

2**. quality characters of faba bean seeds**

The results are presented in table (4) showed highly significant differences between micronutrients applications on micronutrients concentration (Fe, Zn and Mn) and protein content of faba bean seeds at the two seasons. Sprayed faba bean by 45, 60 days and 45 days after sowing were the best applications compared with control (spray with water). These increases were (140.6% and 48.8%), (46.1% and 24.9%), (36% and 20%) and (8.4% and 6.2%) for Fe, Zn and Mn concentrations and protein content, respectively in first season. Furthermore, Fe, Zn and Mn concentrations and protein content in the second season increased by (101.4% and 64.6%), (62% and 24.2%), (61.5% and 26.9%) and (6.% and 3.4%) respectively, as affected by spraying faba bean by 45, 60 days and 45 days after sowing compared with control (spray with water). So, foliar micronutrients applicationsat45, 60 days and 45 days after sowing were the best treatments for seed quality. These increment indicated that micronutrients are essential for growth, fruiting and hence play an important role in enzymes function in plants (Mengel *et al*., 2001; Fageria, 2009). Also, the enhanced effects of the micronutrients (Fe, Mn and Zn)was due to their impacts as a metal component of enzymes or regulatory for the others involved in photosynthesis and other physiological processes as well as play a major role as antioxidants (Abd El-Hady, 2007 ;Millaleo *et al*., 2010). These results are in accordance with those reported by El-Masri *et al*. (2002) andAtiia *et al*. (2016) who indicated that foliar application with micronutrients had significantly increased faba bean seed quality. Also, Jin *et al*. (2008) indicated that Fe concentration in seed increased significantly by 18.9% using the foliar application of Fe and B and Zn. Similar result was obtained by Allam (1993) who reported that foliar application of Zn and Mn had significant effect on protein content of faba bean seeds. At contrast, El-Sobky and Yasin (2017) reported that micronutrient spraying treatments had insignificant effect on seed protein content compared with the control treatment.

Table 4. Yield and yield components as well as seed quality of faba been as affected by foliar micronutrients applications time (M) at 2018/2019 and 2019/2020 seasons.

characters / Micronutrients applications time	Plant height (cm)	No. branches/plan	No. pods/plant	Weight pods/ Plant (g)	100--Seed weight (g)	Seed weight /plant (g)	Seed yield /fad. (ardab)	Straw yield /fad. (ton)	Biology yield/ fad. (ton)	Fe (ppm)	(ppm) Zn	Mn (ppm)	Protein (ppm)
(2018/2019)													
(Control)without application (M1)	99.22	2.24	9.36	26.692	69.732	18.91	8.05	2.05	3.269	172	68	25	22.92
One application after 45 days(M2))	104.13	2.34	10.2	29.938	76.064	22.359	8.48	2.79	4.079	256	85	30	24.35
Two application after 45 and 60 days (M3)	110.20	2.58	11.0	32.949	79.820	23.329	8.75	3.15	4.479	414	100	34	24.85
LSD0.05(M)	2.10	NS	0.83	0.674	3.322	1.534	0.70	0.43	0.096	7.77	3.72	1.68	1.56
(2019/2020)													
(Control)without application (M1)	106.95	2.778	10.8	32.024	76.539	22.414	8.066	3.63	4.840	201	66	26	24.11
One application after 45 days(M2))	109.40	3.111	12.0	31.918	77.661	22.621	9.616	2.99	4.447	332	82	33	24.95
Two application after 45 and 60 days (M3)	114.44	3.289	13.0	35.984	79.806	24.540	10.432	2.92	4.493	405	107	42	25.70
LSD0.05(M)	3.403	0.193	0.44	1.420	0.11	0.730	0.767	0.61	N.S	14.15	2.62	1.82	1.19

c-Interaction between proceeding crop and micronutrients application

1-yield and yield components of faba bean

Plant height, no. pods/plant, weight of pods/plant, seed yield/plant, straw yield/fad., biological yield/fad. and seed yield /fad. affected significantly by the interaction between micronutrients application and proceeding crop except no. branches/plant in the two seasons(Table 5). Faba been after legume crops that sprayed by micronutrients after 45 and 60 days after sowing displayed the highest performance. In general, sprayed faba bean by micronutrients after legume crops increased yield and its components, compared with untreated plants. While sowing faba bean after maize and untreated by micronutrients recorded the lowest seed yield and its attributes. These results were showed in Table 5.

2- quality characters of faba bean seeds

Data in table 5 indicated that the faba bean seed content of micronutrients (Fe, Zn, and Mn) and protein affected significantly by interaction between proceeding crop and micronutrients applications in both seasons. The highest Fe, Zn, Mn and protein seed contents were obtained from interaction between faba bean sprayed with micronutrients at45 and 60 days that was sown after legume crops . On the other hand interaction between spraying by water (control) with all proceeding crops gave lower concentrations of micronutrients and protein content of faba bean seeds. These results indicated that sowing faba bean after legume crops and spraying with micronutrients at 45 and 60 days after sowing were the best treatments to obtain faba bean seeds with a high content of micronutrients and protein.

Table 5. Yield and yield components as well as seed quality of faba bean as affected by interactions between sequential systems(S) and foliar micronutrients applications time(M) during 2018/2019 and 2019/2020 seasons.

S	characters / Interaction	Plant height (cm)	No. branches/plant	No. pods/plant	Weight pods/ plant (g)	Seed 100 weight (g)	Seed weight /plant (g)	Seed yield /fad (ardab)	Straw yield /fad. (ton)	Biology yield/ fad. (ton)	Fe (ppm)	Zn (ppm)	Mn (ppm)	Protein (ppm)
						(2018/2019)								
	M1	101.6	2.1	8.46	26.953	69.773	18.020	7.53	1.93	3.066	182	63	27	20.59
S1	M2	101.9	2.19	10.2	28.910	74.810	21.210	7.90	2.55	3.742	198	81	28	22.14
	M3	110.3	2.22	10.8	31.893	77.530	21.553	8.58	2.85	4.143	403	89	30	24.98
	M1	98.000	2.06	9.83	27.450	67.140	19.300	7.92	2.14	3.337	160	73	21	25.85
S2	M2	104.13	2.37	10.6	30.633	76.380	23.213	8.47	3.15	4.433	275	83	31	25.04
	M3	109.13	2.67	10.4	31.060	79.570	22.827	8.67	3.09	4.407	410	91	38	26.41
	M1	98.000	2.56	9.80	25.673	72.283	19.113	8.71	2.09	3.403	175	68	27	22.33
S3	M2	106.33	2.46	9.70	30.270	77.003	22.653	9.07	2.69	4.063	295	91	33	25.88
	M3	111.13	2.86	11.9	35.893	82.360	25.607	9.00	3.53	4.887	430	122	35	23.17
LSD0.05(S XM)		N.S	N.S	N.S	1.168	2.25	2.656	0.20	0.71	0.166	13.46	6.45	2.91	2.71
						(2020/2019)								
	M1	101.53	2.800	7.93	29.127	75.71	21.443	6.903	3.32	4.360	175	61	24	21.58
S1	M2	102.86	2.867	10.5	30.103	73.43	20.893	8.797	3.25	4.57	260	77	31	24.61
	M3	111.50	3.200	11.4	29.253	78.06	21.363	9.737	2.50	3.96	350	82	34	25.76
	M1	111.33	2.733	11.3	30.490	73.433	21.343	8.670	4.19	5.500	190	63	26	26.29
S2	M2	116.33	3.267	12.1	30.163	76.950	23.020	10.603	3.02	4.610	281	84	35	25.42
	M3	117.50	3.467	13.4	39.840	80.317	26.927	10.817	3.26	4.893	385	125	46	25.46
	M1	108.00	2.800	13.2	36.457	80.46	24.457	8.293	3.41	4.660	240	74	29	24.48
S3	M2	109.00	3.200	13.5	35.487	82.6	23.950	9.447	2.73	4.157	455	84	34	24.83
	M3	114.33	3.200	15.6	38.860	81.03	25.330	10.743	3.00	4.62	480	113	47	25.89
LSD0.05(S XM)		3.45	N.S	0.77	2.460	N.S	1.281	0.55	0.50	0.16	24.51	4.54	3.15	2.07

d-Cereal units and economic return

1- Cereal units

Cereal units of faba bean gown after Eg clover (fahl) in system (Maize/ Eg clovr (Fahl) /faba bean) was superior to faba bean grown after other crops(Table 6). These results were due to planting Eg clover (fahl) after maize as Catch crops increased total cereal units where Eg clovr (Fahl) gave15.61 and 15.64 of cereal unit in two season. This the increasing was (30% and 48.4%) and (33.6% and 56.9%) in first and second season respectively compared with the other treatments.

Table 6. Cereal unit as affected proceeding crop(S) of sequences (whole year structure) in 2018/2019 and 2019/2020 seasons

	Summer crops		Catch crops	Winter crops		Total CU.s of sequence
Product / **Crop sequence**	**Main product**	**By product**	**Main product**	**Main product**	**By product**	
			(2018/2019)			
Maize/faba bean	30.4	3.68	-	14.88	6.12	55.08
Maize/ Eg clovr (Fahl) /faba bean	30.1	3.65	15.61	15.53	6.97	71.86
Soybean/ Faba bean	19.35	5.55	-	16.59	6.92	48.41
			(2019/2020)			
Maize/faba bean	32.5	3.71	-	15.75	7.55	59.51
Maize Eg clovr (Fahl)/faba bean	32.8	3.74	15.64	18.65	8.72	79.55
Soybean/ Faba bean	19.5	5.75	-	17.85	7.57	50.67

2- Economic return

Total and net returns differed by proceeding crops and foliar applications date. Regarding the proceeding crop, the results revealed that faba bean after legumes crops had highest values of total and net returns especially when Eg clover was planted as crop seedling before faba bean. compared with faba bean after maize(table 8) because total and net return depend on total production of summer crops and winter crops(table 7).

, The total and net returns of faba bean after Eg clover(fahl) in the triple cropping system (Maize- Eg clover(fahl / Faba bean) gave the highest values of total and net returns(30681 LE. and 19158LE. in first season. Also, it gave 35075LE and 24082 in the second season (Table 8).

While, sowing faba bean after maize in double cropping system (Maize /Faba bean) gave the lowest values in total and net returns, *i.e.* 25308 and 15129, and 27511 and 17207 LE / fad. in first and second season, respectively. These results are in agreement with those obtained by El -Mehy *et al.* (2014) who reported that crop sequences had significant effect on, seed yield/fad, cereal units, total income and total net income of wheat. Legume as preceding crops for wheat gave significantly higheest grain yield and net income

In refer to foliar micronutrients application, sprayed faba beans with micronutrients increased total return and net return, compared with untreated plants that were sprayed by water (control). The increment in total and net return due to the increase in yield. These results may be related to increasing in the rates of photochemical reactions and activities of the carboxylation enzymes as well as carbonic anhydrase which led to increase production. Sprayed faba bean plants at 45 and 60 days after sowing was the highest in total and net return. It gave 28560. and 18418 LE in the first season and 33210, 22918 LE in the second season. on other hand , spray faba bean by water gave the lowest value of total and net return . The results indicated that sowing faba bean after legume crops and spraying with micronutrients at 45 and 60 days after sowing were the highest of total and net return, it gave(30881 and 20013) and (36679 and 25686) in first and second season ,respectively, while planting faba bean after maize without application micronutrients gave the lowest value of total and net return (24014 and 13835) and (24206 and 13902) in first and second season respectively.

Table7. productivity of crop sequence (Ton) at 2018-2019 and 2019-2020 seasons

	Summer crops		Catch crops	Winter crops	
Product **Crop sequence**	**Main product**	**By product**	**Main product**	**Main product**	**By product**
	(2018/2019)				
Maize/faba bean	3.04	2.45	-	1.24	2.45
Maize/ Eg, clovr (Fahl) /faba bean	3.01	2.43	11.15	1.294	2.79
Soybean/ Faba bean	1.29	2.22	-	1.382	2.77
	(2019/2020)				
Maize/faba bean	3.25	2.47	-	1.312	3.02
Maize/ Eg. clovr (Fahl) /faba bean	3.28	2.49	11.17	1.55	3.49
Soybean/ Faba bean	1.3	2.30	-	1.488	3.03

Table 8. Total return, costs and net return as affected by sequential systems(S) and micronutrients application date (M) and their interactions 2018/2019 and 2019/2020 seasons.

	Total return				Costs				Net return			
S **M**	**Maize / Faba bean(S1)**	**Maize / Eg clover(fahl) / Faba bean(S2)**	**soybean / Faba bean(S3)**	**Mean**	**Maize /Faba bean(S1)**	**Maize / Eg clover(fahl) / Faba bean(S2)**	**soybean / Faba bean(S3)**	**Mean**	**Maize / Faba bean(S1)**	**Maize / Eg clover(fahl) / Faba bean(S2)**	**soybean / Faba bean(S3)**	**Mean**
					(2018/2019)							
(Control)without application (M1)	24014	28753	26658	26475	10179	10868	9379	10142	13835	17885	17279	16333
One application after 45 days(M2))	25140	30471	27752	27787	10179	10868	9379	10142	14961	19603	18373	17645
Two application after 45 and 60 days (M3)	26785	30881	28015	28560	10179	10868	9379	10142	16606	20013	18636	18418
Mean	25308	30026	27459	27597	10179	10868	9379	10142	15129	19158	18080	17455
					(2019/2020)							
(Control)without application (M1)	24206	32408	27745	28119	10304	10993	9579	10292	13902	21415	18166	17827
One application after 45 days(M2))	28327	36093	29934	31451	10304	10993	9579	10292	18023	25100	20355	21159
Two application after 45 and 60 days (M3)	30020	36679	32931	33210	10304	10993	9579	10292	19716	25686	23352	22918
Mean	27511	35075	30435	31007	10304	10993	9579	10292	17207	24082	20856	20715

The prices of crops in the farm were: ardab of maize=320 LE., ardab of faba bean=2200 LE., straw crop value of faba bean =125 LE, ton of soybean = 5000 and 6000 LE at 2018 and 2019 seasons respectively and average of forage price for cutting=3840 LE. as market prices. .

CONCLUSION

The finding of this study is useful to increase faba bean production ,total and net return in Egypt by sowing faba bean after soybean or Eg clover and spraying faba bean by micronutrients (the commercial compound BLOOMTASTIC. the combinations were sprayed at a rate of 5 cm/liter) at 45 and 60 days after sowing. These cropping systems produced high production of faba bean with good quality, in addition to increasing economic and net returns.

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تاثيرالمحصول السابق والرش بالعناصر الصغري على انتاجيه وجوده بذور الفول البلدى

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أجريت هذه الدراسة في محطة البحوث الزراعية بسرس الليان ، مركز البحوث الزراعية ، محافظة المنوفيه ، مصر خلال موسمي 2019/2018 و 2020/2019 لدراسة تأثير المحصول السابق والرش بالعناصر الصغري على المحصول ومكوناته و صفات الجوده للفول البلدي. تم استخدم ثلاث محاصيل سابقه: ذره , ذره ثم برسيم فحل, فول صويا بالاضافه لثلاث أنظمة رش بالعناصر الصغري(رش بالماءفقط (مقارنه) –رشه واحده بعد 45 يوم من الزراعة ورشتين عند 45 و 60يوم من الزراعة بنفس معدلات الرش). تم استخدم تصميم القطع المنشقة مره واحده فى 3 مكررات حيت تم تصميم المحاصيل السابقه فى القطع الرئيسية بينما معاملات الرش بالعناصر الصغري فى القطعة المنشقه. اوضحت النتائج ان المحاصيل السابقه اثرت معنويا في محصول الفول البلدى ومكوناته وصفات الجوده. كذلك اظهرت النتائج تفوق محصول الفول البلدى ومكوناته عند زراعته عقب المحاصيل البقوليه في كل صفات الدراسه بالمقارنه بزراعه الفول البلدى عقب الذرة . كل صفات الدراسه تاثرت معنويا باضافه العناصر الصغرى ما عدا عدد الافرع/ نبات. رش الفول البلدى بالعناصر الصغري بعد 45 و 60 يوم من الزراعة اعطت اعلي القيم في المحصول ومكوناته وصفات الجوده. كذلك استجابت هذه الصفات للتفاعل حيث اظهرت النتائج ان اعلي قيمه للتفاعلات عند زراعه الفول عقب المحاصيل البقوليه ورش الفول مرتين عند 45 و60 يوم من الزراعهزراعه الفول البلدى في (الذرة / البرسيمالفحل / الفول) مع رش الفول البلدى عند عمر 45و 60 يوم اعطت اعلي عائد كلي وصافي العائد (30681 و 20013) و(36679 و 25686) جنيه في الموسم الاول والثانى بالترتيب..لذلك توصى الدراسه بزراعه الفول البلدى عقب المحاصيل البقوليه مع رش العناصر الصغري في عمر 45 و60 يوم من الزراعة.