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RESPONSE OF FABA BEAN TO FOLIAR APPLICATION OF COPPER AND MOLYBDENUM UNDER PHOSPHORUS FERTILIZATION LEVELS

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ABSTRACT

Response of faba bean (*Vicia faba*, L.) variety Giza 184 to foliar application of copper and molybdenum was studied as possible factors to improve its yield and quality under phosphorus fertilization levels. Two field experiments were carried out at Sakha Agricultural Research Station Farm, Kafr El-Sheikh Governorate, during the two successive winter seasons of 2003/2004 and 2004/2005. Split plot design with four replicates was used. The main plots were assigned to three phosphorus application levels of 0(P_0), 15 (P_1) and 30 (P_2) kg P_2O_5 fed^{-1} as superphosphate 15.5% P_2O_5. The sub plots were allotted for seven micronutrients foliar spray treatments of 0, 50 ppm copper (Cu_1), 100 ppm copper (Cu_2), 30 ppm molybdenum (Mo_1), 60 ppm molybdenum (Mo_2), Cu_1 + Mo_1 and Cu_2 + Mo_2. The results can be summarized as follows:

The effect of microelements application on seeds, straw and biological yields were highly significant. The highest mean values were recorded with Cu_2 spraying, while the lowest values were obtained with P fertilizer only. The interaction between P levels and microelements spraying high significantly affected faba bean seed and straw, yields were obtained with P_0Cu_2 treatments. Phosphorus treatments affected the response of copper treatment, the least effect was under P_2 treatment. The sequence effect of P treatments only can be arranged as follows: $P_1 > P_0 > P_2$ in both seasons. Phosphorus heavy additions adversely affected faba bean yield. Increasing P fertilizers from 15 to 30 kg P_2O_5 fed^{-1} led to decrease the net return of faba bean compared to the control. The highest net return values of 825, 5 and 748 L.E., fed^{-1} were obtained under P_0 Cu_2 treatment in the first and second seasons, respectively. Increasing P fertilizer led to decrease the net return from faba bean treated with the copper fertilizer. The treatment of Cu_2 had the highest nitrogen and protein contents in both seasons. Available N and P in the soil increased with increasing P fertilizer level.

INTRODUCTION

Application of various micronutrients by foliar spray is an accepted practice for many crops. Copper was observed to be necessary for nodulation probably of its role in cytochrome system and oxidation respiration (Hamissa *et al.,* 2000). Faba bean gave the highest Cu-efficiency for pod and grain production than yellow lupine and soybean (Henryka Seligo, 1998). Faba bean used indigenous soil Cu more efficiency than wheat, chickpea and Lentil (Brennan and Bolland, 2003).

Molybdenum, (Mo) deserves special attention as a major requirement for plant growth. The function of Mo is closely related to plant N metabolism, and Mo deficiency is manifested as deficiency of plant N (Mendel and Hansch, 2002). Moreover Mo is more available for plants at higher soil pH values. The plants requirement for Mo is very low, but, nevertheless, Mo deficiency has been reported for many plant species including herbs, field crops and trees (Gupta, 1997). The uptake of Mo could occur via the phosphate uptake system (Heuwinkel *et al.,* 1992). When legumes are deficient in Mo unusual proliferation of nodules is observed (Marschner, 1995). The foliar fertilization of bean with Mo at the beginning of flower bud formation resulted in a 3% increase in seed weight per plant and seed yield (Ewa *et al.,* 2004).

Most Egyptian soils considerably contain high total phosphorus. Phosphorus is the major nutrient for grain production of faba bean in neutral to alkaline soils (Bolland *et al.,* 2000). Most Egyptian farmers used to add more P-fertilizers to faba bean fields. As a result available phosphorus tended to be higher and results showed adversely effects due to heavy P-fertilization. The critical level of $NaHCO_3$-extractable P was 7 ppm for faba bean (Matar *et al.,* 1987). At 12 ppm available P in clay soil, P rates had no effect on most yield component except the number of branches per plant of *Vicia faba*. (Salem and El-Nakhlawy, 1987). Seed yield of faba bean (Giza 3) was slightly increased by fertilizer rate of 15.5 kg P_2O_5 fed^{-1} compare to check treatment, but it was decreased when crops given phosphorus over this rate (Selim and El-Sessy, 1991, Gomaa, 1991 and El-Zeiny *et al.,* 1990).

The objective of the present study was to examine the influence of copper foliar spray, molybdenum foliar spray and their interaction on faba bean productivity, quality and some nutrients content of the plant and availability of the soil under the conditions of phosphorus fertilization levels.

MATERIALS AND METHODS

Two field trails were conduced at Sakha Agricultural Research Station Farm during the two successive winter seasons of 2003-2004 and 2004-2005 using faba bean (*Vicia faba*) variety Giza 184 to assess the effect of phosphorus fertilizers levels and spraying with some microelements on faba bean productivity.

The recommended seeds rate (60 kg fed^{-1}) was planted on one side of the ridges, 2-3 seeds in each hill, 20 cm between the hills and 60 cm between the ridges. The sowing dates were November, 19^{th} and 21^{st} in the first and second season, respectively. The experimental treatments were arranged in split plot design with four replicates. The main plots were randomly assigned to three phosphorus application levels as follows: 0 (P_0), 15 (P_1) and 30 (P_2) kg P_2O_5 fed^{-1} phosphorus fertilizer was added as calcium super phosphate (15.5% P_2O_5) during seedbed preparation.

The sub plots were assigned to foliar fertilization with micro-elements as follows: control (spraying with water only) (W), 50 mg L^{-1} copper (Cu_1), 30 mg L^{-1} molybdenum (Mo_1), 100 mg L^{-1} copper (Cu_2), 60 mg L^{-1} molybdenum (Mo_2), Cu_1 + Mo_1 and Cu_2 + Mo_2. Copper was applied as $CuSO_4$. $5H_2O$ and molybdenum as ammonium molybdate [(NH_4) Mo_7 O_{24}. 1.5 H_2O]. The foliar fertilization was repeated two times, 15^{th} Jan. and repeated 10^{th} Feb. The plot area was 9.6 m^2 in both seasons. The recommended dose of nitrogen (20 kg N fed^{-1}) was added on two equal doses, (during seedbed preparation and before the first irrigation) in the form of ammonium nitrate 33% as well as the recommended dose of potassium was added (24 kg K_2O fed^{-1})as potassium sulphate 48% K_2O before the first irrigation. The other recommended cultural practices were followed as recommended. Prior the setting up the experiment every year soil samples were taken for physical and chemical analyses for some properties that were done according to Black *et al.* (1965), which shown in Table 1.

Table 1:Some properties of the experimental soils.

Experimental season	Sand %	Silt %	Clay %	Soil texture	pH● (1: 2.5)	EC* dSm^{-1}	Organic matter %	Available nutrients mg kg^{-1} N	P	K	Cu	Mo
2003/04	20.80	21.52	57.68	Clayey	7.9	2.60	1.64	25.6	9.4	300	1.30	0.4
2004/05	20.70	21.30	58.00	Clayey	8.2	2.80	1.52	22.4	8.6	320	1.36	0.36

*** Soil paste extract** **● 1: 2.5 soil water suspension**

The faba bean seedlings were thinned to two plants per hill before the first irrigation. After faba bean harvest, the seed and straw yields were weighted, seed and straw samples were collected, oven dried at 65°C, fine ground and wet digested according to Jackson (1958). Nitrogen percentage was determined by kjeldahl method and phosphorus percentage was determined colorimetrically (Jackson, 1958). Nitrogen and phosphorus content were calculated by multiplying N% and P% by yield kg fed^{-1}. Protein (kg fed^{-1}) were calculated by multiplying N content (kg fed^{-1}) by the coefficient of 6.25. At harvest, soil samples (0-30 cm) were collected and residual available N and P were determined according to the method described by Black *et al.* (1965).

Under each treatment, the income from faba bean crop was estimated by using the prices of crop yield minus the cost of the used fertilizer in each treatment. The obtained data were statistically analyzed according to Gomes and Gomes (1984). The less significant differences were determined between the measuring parameters means using MSTATC Computer Programe.

RESULTS AND DISCUSSION

Data presented in Table 2 show that, increasing of P fertilizer levels from 0 to 30 kg P_2O_5/fed.$^{-1}$ led to no significant differences of faba bean seed yield in the first season, whereas there were significant differences in the second season. The lowest mean values (1486 and 1522 kg/fed^{-1}) were recorded with 30 kg P_2O_5 fed^{-1} in the first and second seasons, respectively. On the other hand the highest mean values (1537 and 1594 kg fed.$^{-1}$) were obtained with the check treatment. Neither faba bean straw nor biological yield had significant affect by using the phosphorus fertilization levels in both seasons. The lowest mean values of straw yield were observed with the highest level of phosphorus (30 kg P_2O_5 fed^{-1}).

The data show significant effects of P levels application on faba bean 100 seeds weight were observed. The lowest mean values (71.3 and 71.7 g) were recorded with P_2 treatment in the first and second seasons, respectively. These results could be attributed to the presence of more native available P in the soil (9.4 and 8.6 mg kg^{-1}) for both seasons (Table 2). These results could be enhanced by those obtained by Bolland *et al.* (1999) who found that, the responses were much smaller for faba bean to increase application of P fertilizer. Matar *et al.* (1987) showed that the critical levels of $NaHCO_3$-extractable P was 7 mg kg^{-1} soil for faba bean.

Table 2: Means of seeds, straw, biological yields (kg fed^{-1}) and 100 seed weight (g) as affected by phosphorus fertilizer levels and microelements (Cu, Mo foliar spray) in 2003/ 2004and 2004/ 2005 seasons .

Variables / Treatments	Seeds yield kg fed^{-1}		Straw yield kg fed^{-1}		Biological yield kg fed^{-1}		100-seeds weight (g)	
	Seasons		Seasons		Seasons		Seasons	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
P_0	1537	1594	3126	3128	4664	4723	72.7	73.1
P_1	1515	1582	3010	3075	4525	3668	72.6	73.1
P_2	1486	1522	2977	3019	4463	4541	71.3	71.7
F-test	N.S	**	N.S	N.S	N.S	N.S	*	*
L.S.D. 0.05		45.06					1.07	0.88

Data presented in Table 3 show that spraying with the used microelements significantly affected faba bean seed, straw and biological yields in both seasons. The highest seed yield was recorded with Cu_2 foliar spraying treatment (1620 and 1678 kg fed^{-1}) in the first and second season, respectively. While the lowest seed yield (1394 and 1454 kg fed^{-1}) were obtained with the check treatment (W). Increasing Cu concentration spraying (from Cu_1 to Cu_2) led to increase the seed, straw and biological yields, in both seasons. Sparing of Mo was significantly affected faba bean seed yield as compared to the check treatment (water spraying) in both seasons. Increasing Mo concentration of spraying solution did not increase the seed yield in both seasons.

Table 3: Effect of copper and molybdenum foliar spraying on faba bean seeds, straw and biological yields (kg fed^{-1}) and 100 seeds weight (g) in 2003/2004 and 2004/2005 seasons.

Variables / Treatments	Seeds yield (kg fed^{-1})		Straw yield (kg fed^{-1})		Biological yield (kg fed^{-1})		100-Seeds (g)	
	Seasons		Seasons		Seasons		Seasons	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
W (check)	1394	1454	2886	2906	4281	4360	72.3	72.1
Cu_1	1530	1583	2878	2999	4408	4582	72.7	72.9
Cu_2	1620	1678	3474	3406	5093	5073	72.4	72.8
Mo_1	1479	1564	3017	3106	4497	4670	73.4	73.2
Mo_2	1464	1500	2712	2828	4176	4328	70.7	72.5
Cu_1Mo_1	1515	1551	2998	3095	4512	4646	70.3	71.4
Cu_2Mo_2	1584	1634	3300	3180	4884	4814	73.7	73.6
F-test	**	**	**	**	**	**	N.S	N.S
L.S.D. 0.05	101.00	85.61	174	222.2	240.0	351.0		

P_0 zero phosphorus, P_1 = 15 kg P_2O_5 fed^{-1}, P_2 = 30 kg P_2O_5 fed^{-1}
Cu_1 = 30 mg L^{-1} copper, Cu_2 = 60 mg L^{-1} copper, Mo_1 = 30 mg L^{-1}, M_2 = 60 mg L^{-1}
(W) spraying with water (check treatment)

Application of Cu + Mo treatments tended to increase the faba bean seed yield significantly greater than that obtained from plots received Mo_1 and Mo_2 treatments, but it did not reach to Cu treatments productivity. The most favourable treatment was Cu fertilization at the level of 100 mg L^{-1}, followed by Cu_1 and Cu + Mo treatments.

The lowest mean straw yield values (2712 and 2828 kg fed^{-1}) were obtained from plots treated with Mo_2 (60 mg L^{-1}) treatment. Also, the lowest mean biological yield values (4173 and 4328 kg fed^{-1}) were observed with Mo_2

treatment. The previous data of seed, straw and biological yields may be due to enhancing nodulation and produced healthy plants. These results could be enhanced by the obtained by Vieira *et al.* (1998) who pointed that, foliar fertilization with Mo rates from 14 to 100 ppm, increased the seed yield, dry matter, reductase and nitrate nitrogenase activities, also the number of root nodules. And the findings by Hamissa *et al.* (1970) who pointed that copper was observed to be necessary for nodulation.

Hundred seed weight did not significantly affected by microelements application in both seasons. The highest 100 seeds weight values of 73.7 and 73.6 g were obtained from the plots received Cu 100 mg L^{-1} + Mo 60 mg L^{-1} foliar in the first and second seasons, respectively. These results may be due to Cu and Mo fertilization led to increase of plant growth tillering and yield component, whereas it was led to slightly increase of 100 seeds weight. The results could be enhanced by the obtained by Brennan and Bolland (2003).

Table 4 and Fig.1shows that the interaction between phosphorus levels, copper sparing and molybdenum spraying were high significantly affected faba bean seeds yield in both seasons. The highest seeds yield values of 1691 and 1724 kg fed^{-1} were obtained with application of P_0Cu_2 treatment, while the lowest values of 1333 and 1400 kg fed^{-1} were detected with P_2 W (Spraying with water under 30 kg P_2O_5 fed^{-1}) treatment, in the first and second seasons, respectively.

Table 4: Effect of the interactions between the phosphorus levels and microelements treatments on faba bean seeds and straw yields and the net return (L.E. fed^{-1}) in both 2003/2004 and 2004/2005 seasons.

Variables		Yields				Price of the increase over control L.E. fed^{-1}				Total price L.E. fed^{-1}		Fert. cost L.E fed^{-1}	Net return of treatments	
		Seeds		Straw		Seeds		Straw					L.E. $fed.^{-1}$	
Treatments.		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd		1st	2nd
P_0	W	1405	1460	2911	2847	-	-	-	-	-	-	-	-	-
	Cu_1	1613	1683	3334	3273	416	446	21.5	213	627.5	659	13	614.5	646
	Cu_2	1691	1724	3450	3319	572	528	269.5	236	841.5	764	16	825.5	748
	Mo_1	1458	1600	3297	3340	106	280	193	246.5	299	526.5	15	284	511.5
	Mo_2	1502	1533	2384	2547	194	146	-263.5	-150	-69.5	-4.0	20	-9.5	-24
	Cu_1Mo_1	1455	1493	3257	3247	100	66	173	200	273	266.0	18	255	248
	Cu_2Mo_2	1630	1667	3249	3327	450	474	169	240	619	714	26	593	688
P_1	W	1444	1500	3047	3123	78	80	68	138	146	218	56	90	162
	Cu_1	1498	1560	2544	2747	186	200	-183.5	-50	2.5	150	69	-66.5	81
	Cu_2	1589	1697	3847	3753	368	274	468	453	836	727	72	764	655
	Mo_1	1488	1568	3083	3038	166	216	86	95.5	252	311.5	71	181	240.5
	Mo_2	1458	1503	2766	2973	106	46	-72.5	63	34	109	76	-42	33
	Cu_1Mo_1	1586	1617	2864	3007	362	318	-43.5	80	318.5	398	74	244.5	324
	Cu_2Mo_2	1538	1630	2919	2887	266	340	4	40	270	380	82	188	298
P_2	W	1333	1400	2700	2750	-144	-120	-105.5	-48.5	-24.95	-168.5	112	-361.5	-280.5
	Cu_1	1479	1507	2755	2977	148	94	-78	65	70	159	125	-55	34
	Cu_2	1577	1613	3125	3147	3.44	306	107	150	451	456	128	323	328
	Mo_1	1492	1523	2672	2940	174	126	-119.5	46.5	54.5	172.5	127	-72.5	45.5
	Mo_2	1431	1463	2986	2963	92	6	37.5	58	89.5	64	132	-42.5	-68
	Cu_1Mo_1	1502	1543	2873	3032	194	186	-19	92.5	175	278.5	130	45	148.5
	Cu_2Mo_2	1585	1607	3731	3327	360	294	410	240	770	534	138	632	396
F-test		**	**	**	**									
L.S.D. 0.05		187.9	159.3	315	438.0									

Price of one kg seeds = 2 L.E. **Cost of P fertilizer = 56 L.E/15 kg P_2O_5**
Price of one kg straw = 0.5 L.E **Cost of Cu_1 fertilizer = 13 L.E./fed.**
Cost of Cu_2 fertilizer = 16 L.E/fed.

Regarding phosphorus treatments only (P_0, P_1 and P_2), the data show that P_1 (15 kg P_2O_5 fed^{-1}) was the best, while P_2 (30 kg P_2O_5 fed^{-1}) was the lowest of faba bean yield in both seasons. For example, the values of seeds 1444 and 1333 kg fed^{-1} were obtained with P_1 and P_2 treatments in the first season. The phosphorus treatments take the same trend with faba bean straw yields as shown in Table 4 and Fig. 1.

Also, the copper treatments were more effective under P_0 treatment, while it were less effective under P_2 treatment on faba bean seeds and straw yields in both seasons. Similar findings were recorded by Selim and El-Sessy (1991) who found that seed yield was slightly increased by a fertilizer rate of 15 kg P_2O_5 fed^{-1} as compared to zero application, but it was lower in crop given 23 kg P_2O_5 fed^{-1}. Also, Ewa Janeczek *et al.* (2004) and Vieira *et al.* (1998) found clear response of faba bean seeds due to foliar fertilization with Mo rates.

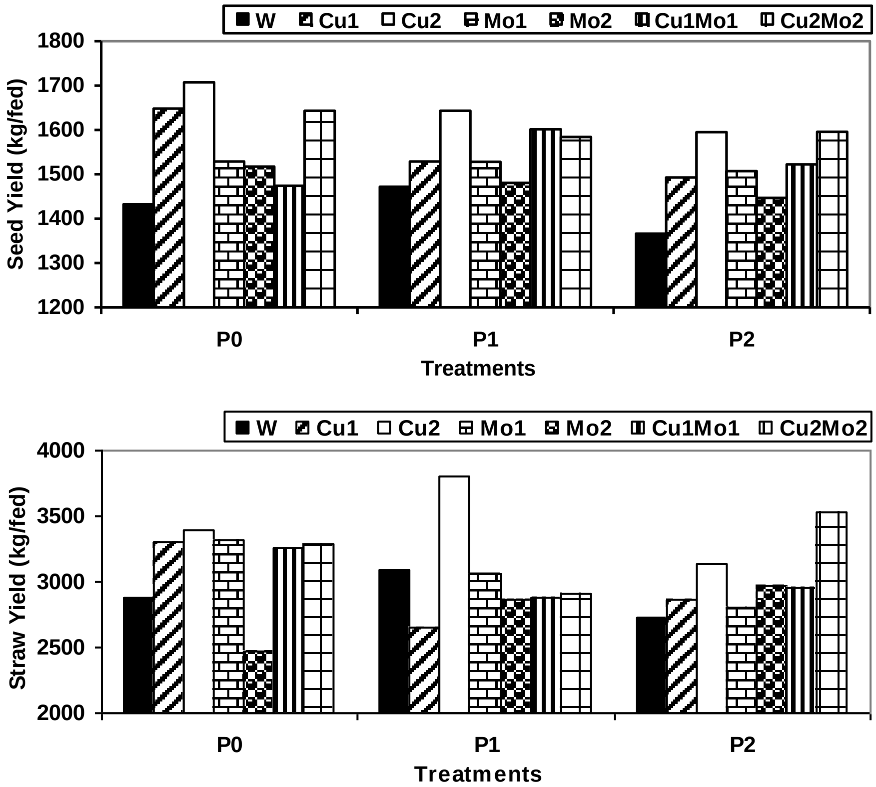

Fig. 1: Effect of the interactions between the phosphorus levels and microelements treatments on faba bean seeds and straw yields (mean of two seasons).

Data in Table 4 show that 15 kg P_2O_5 fed^{-1} treatment led to net return of 90 and 162 L.E fed^{-1} in the first and second seasons respectively. While increasing phosphorus up to 30 kg P_2O_5 fed^{-1} led to decrease the income of faba bean than the control (no phosphorus). The lowest return values of -361.5 and -280.5 L.E. fed^{-1} were obtained under P_2 (30 kg P_2O_5 fed^{-1}) treatments in the first and second seasons, respectively.

Increasing concentration of copper application alone or with Mo treatments led to increase the net return of faba bean crop in both seasons. The highest faba bean net return values of 825.5 and 748 L.E. fed^{-1} were recorded under P_0 Cu_2 treatment in the first and second season, respectively. It is clear that increasing of phosphorus led to decrease the net return from faba bean treated with the copper spraying. The faba bean net return from Mo_1 fertilization was lower than Cu treatments and higher than Mo_2 treatment. Also, there was lost in the net return values when molybdenum was added with the phosphorus fertilizer together. Application of Cu_2 + Mo_2 treatment led to increase the net return (L.E. fed^{-1}), but it was not reached to the net return from Cu_2 treatment alone.

Table 5 show that no significant effects of phosphorus levels on nitrogen and protein contents of faba bean seeds in both seasons while, there was a significant effect on P content in the first season only. The highest mean value of 4.7 kg fed^{-1} was obtained with 30 g P_2O fed^{-} (P_2). These findings could be enhanced with those obtained by Henry *et al.* (1995) who reported that, seed P concentration was directly related to P rates.

Data revealed that phosphorus levels application of faba bean had not significant effects on N content, protein and P content of faba bean straw yield in both seasons. This may be due to available soil phosphorus which was greater than the critical P level for faba bean which produced healthy plants without phosphorus fertilizer application. These results are in agreement with those obtained by Matar *et al.* (1987) who showed that, the critical P level for faba bean was 7 mg kg^{-1}.

Table 5: Effect of phosphorus application levels on N-content, protein content and phosphorus content (kg fed^{-1}) of faba bean seeds and straw in 2003/2004 and 2004/2005 seasons.

Variables / Treat.	Seeds						Straw					
	N content		Protein content		P content		N content		Protein content		P content	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
P_0	49.48	51.50	309.25	321.88	4.01	4.34	25.18	24.63	157.38	153.94	0.45	0.47
P_1	49.50	52.98	309.38	331.13	4.70	4.82	23.05	23.35	144.06	145.94	0.49	0.51
P_2	47.10	50.09	294.38	313.06	4.56	4.77	22.04	22.47	137.75	140.44	0.45	0.46
F-test	N.S	N.S	N.S	N.S	**	N.S	N.S	N.S	N.S	N.S	N.S	N.S
L.S.D. 0.05					0.51							

Table 6 indicate that N content of seeds and straw significantly increased in the first season and high significantly in the second season. The highest mean values (52.93 and 56.02 kg fed^{-1}) of seeds yield and (29.84 and 30.15 kg fed^{-1}) of the straw yield were recorded with Cu_2 treatments in the first and second seasons, respectively. Increasing Cu spray concentration form Cu_1 to Cu_2 treatment led to increase seeds and straw N contents in both seasons. while praying with Mo alone or with Cu_1 together led to significant increasing of N content as compared to the check treatment. But Cu, treatments alone were most favourable than the other treatments.The microelements foliar spray application had high significantly affect on faba bean seeds and straw protein contents in both seasons, except the protein content of seeds in the first season it was found to be significant. The highest mean seeds and straw protein content values of 380.81, 350.13 and 186.53, 188.43 kg fed^{-1} were obtained by the application of Cu_2 (100 mg L^{-}) treatment in the first and second seasons respectively.

Data presented in Table 6 show that, there were clear response of seed and straw P content due to copper and molybdenum foliar spraying in both seasons. The highest means values of 5.22 and 5.34 kg P fed^{-1} were obtained by application of Cu_2 + Mo_2 treatment in the first and second seasons, respectively. The response was significant in both seasons, it was often related to the treatments which causes high yield of faba bean in both seasons. Also, data show that straw P content was high significantly effected in both seasons. The highest P straw content values of 0.56 and 0.54 kg P fed^{-1} were recorded under Cu_2 + Mo_2 treatment in the first and second season, respectively. Phosphorus content was increased with the treatments which causes high yield in faba bean seed and straw yields in both seasons.

These results may be due the balance of macro and microelements for the plant and symbiotic fixing bacteria in the soil, which led to healthy plants and good productivity.

These findings are in agreement with those obtained by Henryka Seliga (1998) who reported that, the nitrogen accumulation in the plants were increased by copper supply in faba bean. Mendel and Hansch (2002) who pointed out that, Mo is closely related to plant N metabolism and Mo deficiency is manifested as deficiency of plants N.

Table 6: Nitrogen, protein and phosphours contents (kg fed^{-1}) of faba bean seeds and straw yields as affected by Cu and Mo foliar spraying in 2003/2004 and 2004/2005 seasons.

Variables	Seeds						Straw					
	N content		Protein content		P content		N content		Protein content		P content	
Treatments	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
W	46.92	47.63	293.25	297.68	3.80	3.83	20.79	20.15	129.94	125.94	0.48	0.49
Cu_1	48.60	51.9	303.79	324.38	4.4	4.60	22.18	22.88	138.63	143.00	0.43	0.45
Cu_2	52.93	56.02	380.81	350.13	4.60	5.11	29.84	30.15	186.53	188.43	0.49	0.51
Mo_1	50.65	53.06	316.56	331.65	4.52	4.64	22.06	23.09	137.88	144.30	0.48	0.52
Mo_2	45.92	49.49	287.00	309.31	3.93	4.38	21.81	20.46	136.31	127.87	0.36	0.41
Cu_1Mo_1	49.23	51.80	307.69	323.75	4.46	4.61	24.15	24.64	150.94	154.00	0.42	0.46
Cu_2Mo_2	46.59	50.74	291.19	317.13	5.22	5.34	23.13	23.02	144.56	143.88	0.56	0.54
F-test	*	**	*	**	*	*	*	**	**	**	**	**
L.S.D.0.05	5.8	4.42	28.27	30.72	1.00	0.98	4.05	2.61	23.77	17.04	0.063	0.073

Data presented in Table 7 show that phosphorus levels clearly affected available nitrogen in the soil at harvest of faba bean in both seasons. the highest mean values of 32.49 and 32 mg N kg^{-1} soil were obtained under P level of 30 kg P_2O_5 fed^{-1} in the first and second seasons, respectively. Also, data show that foliar spraying with microelements clearly affected the available N in the soil at harvest of faba bean in both seasons. The highest mean values of 34.73 and 33.6 mg N kg^{-1} soil were detected under Mo_2

(spraying with 60 mg Mo L^{-1}) treatment in both seasons. Regarding the interaction effects between phosphorus levels and microelements on the available nitrogen of the soil after faba bean harvest show that, the highest available N values of 39.8 and 36.4 mg N kg^{-1} soil were obtained with Mo_2 under P_2 treatment in both seasons.

Generally, available N increased with increasing the levels of added phosphorus fertilizers, as well as the application of foliar Mo treatments led to increase available N in the soil at harvest in both seasons.

Data presented in Table 7 show that, the phosphorus application levels clearly affected the available P in the soil at harvest of faba bean. The highest values of 19.57 and 19.69 mg P kg^{-1} soil were observed under P_2 (30 kg P_2O_5 fed^{-1}) treatment in both seasons. Results also show that foliar spraying of microelements affected the available P in the soil. The highest mean values of 21 and 20.50 mg P kg^{-1} soil were detected under Mo_2 treatment in the first and second seasons, respectively. The interaction between P levels application and spraying with microelements fertilizers led to affecting the available P in the soil. The highest values were detected under P_2 with foliar spraying of Mo, treatment in both seasons. These results may be attributed to enhancing hosted microorganisms with plant in the soil which led to increase plant growth and the organic acid released from the roots, as well as to increase microorganisms activities due to presented of the molybdate element and increasing the nodules number and the symbiotic nitrogen fixed. These results are inagreement with those obtained by Hassanein (1995), Mendel and Hansch (2002).

Table 7: Effect of phosphorus levels, microelements foliar spraying and their interaction on available N and available P (mg kg-1 soil) at harvest of faba bean in 2003/2004 and 2004/2005 seasons.

Variables / Treatments	Available N mg kg^{-1} soil								Available P mg kg^{-1} soil							
	1st season				2nd season				1st season				2nd season			
	P_0	P_1	P_2	Mean	P_0	P_1	P_2	Mean	P_0	P_1	P_2	Mean	P_0	P_1	P_2	Mean
O	25.2	25.2	25.2	25.2	25.2	235.2	25.2	25.2	14.0	17.8	17.5	16.43	13.0	17.5	17.8	16.10
Cu_1	25.2	25.2	28.0	26.1	28.0	28.0	30.8	28.93	17.5	17.8	17.5	17.60	16.5	17.5	17.5	17.17
Cu_2	22.4	22.4	33.6	26.13	26.6	25.2	33.6	28.47	18.0	18.5	19.5	18.67	17.5	19.5	19.5	18.83
Mo_1	25.2	30.8	36.4	30.8	28.0	30.8	33.6	30.8	20.0	17.5	22.5	20.0	19.5	18.5	22.5	20.17
Mo_2	30.8	33.6	39.8	34.73	30.8	33.6	36.4	33.6	20.0	20.5	22.5	21.0	19.0	20.0	22.5	20.50
Cu_1Mo_1	28.0	28.0	30.8	28.93	28.0	30.8	30.8	29.7	16.2	17.0	17.5	16.9	17.0	17.5	18.5	17.67
Cu_2Mo_2	28.0	30.8	33.6	30.8	30.8	33.6	33.6	32.67	17.5	17.5	20.0	18.33	18.0	18.5	19.5	18.67
Means	26.4	28.0	32.49	-	28.2	29.6	32	-	17.6	17.87	19.57	-	17.21	18.43	19.69	-

CONCLUSION

1. The highest values of faba bean seeds, straw, biological yield, N and protein contents were obtained by Cu_2 spraying treatment in both seasons.
2. Application of Mo_1 treatment led to increase faba bean seed and straw yields and it was higher than application of Mo_2 treatment.
3. Application of phosphorus with microelements fertilizers led to decrease the positive effects on faba bean crop.
4. The nitrogen, protein and phosphorus contents in faba bean seeds and straw were significantly affected by microelements application.

5. Application of Mo_2 treatment led to increase faba bean seed yield and decreasing straw yield compared to the yield of plots which not received any treatment (control).
6. Available N and P after harvest in the soil increased with increasing phosphorus fertilizers and also were increased under foliar spraying with Mo_2 treatment with or without P fertilizer.
7. The highest net return values of 825.5 and 748 L.E. were obtained under Cu_2 (100 mg L^{-1}) in the first and second season, respectively.

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إستجابة الفول البلدى لإضافة النحاس والموليبدنم رشا تحت مستويات التسميد الفوسفاتى

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أجريت تجربتان حقليتان فى مزرعة محطة البحوث الزراعية بسخا ـ محافظة كفرالشيخ خلال الموسمين الشتويين 2004/2003م ، 2005/2004م وذلك بهدف دراسة إستجابة الفول البلدى صنف جيزه 184 للتسميد الفوسفاتى ولإضافة عنصرى النحاس والموليبدنم رشا. وكان التصميم الإحصائى المستخدم هو القطع المنشقة فى أربع مكررات وقد خصصت القطع الرئيسية لإضافة الفوسفور بثلاثة مستويات وهى صفر ، 15 ، 30كجم فو$_2$أ$_5$/فدان فى صورة سماد السوبر فوسفات 15.5% فو$_2$أ$_5$. وخصصت القطع الشقية للرش بسبع معاملات من المغذيات الصغرى وهى صفر ، 30ملجم/لتر مولبدنم ، 60ملجم/لتر مولبدنم /لتر ، 100ملجم نحاس + 60ملجم مولبدنم /لتر.

وتتلخص النتائج فيما يلى:

كان تأثير إضافة العناصر الصغرى عالى المعنوية على محصول الحبوب والقش والمحصول فى الموسمين. وقد أدى استخدام النحاس رشا بمعدل 100 مليجرام/لتر إلى الحصول على أعلى القيم بينما كانت أقل القيم مع استخدام الفوسفور منفردا.

وقد أثر التفاعل المشترك بين مستويات الفوسفور والعناصر الصغرى على محصول الحبوب والقش تأثيرا عالى المعنوية فى الموسمين وأعطت المعاملة 100 مليجرام/لتر نحاس عند عدم إضافة الفوسفور أعلى النتائج.

وقد أثرت معاملات الفوسفور على تأثير معاملات النحاس حيث كانت أقل قيمها تحت المستوى الأعلى من الفوسفور. وكان ترتيب تأثير معاملات الفوسفور كالآتى: 15كجم/فدان > صفر > 30كجم/فدان فى الموسمين. الاضافات العالية من الفوسفور كان لها تأثير عكسى على انتاجية الفول.

وقد أدت زيادة التسميد الفوسفاتى من 15 إلى 30كجم/فدان لنقص صافى العائد بالجنيه المصرى مقارنة بالكنترول. وكان أعلى عائد تم الحصول عليه هو 825.5 ، 748.0 جنيه مصرى لكل فدان فى الموسم الأول والثانى على التوالى وذلك من المعاملة 100ملجم نحاس/لتر بدون إضافة فوسفور وقد أدى زيادة السماد الفوسفاتى لتقليل العائد من معاملات النحاس على محصول الفول البلدى. وقد أعطت المعاملة 100ملجم/لتر أيضا أعلى محتوى للنيتروجين والبروتين فى الموسمين. وقد أدى زيادة مستوى التسميد الفوسفاتى لزيادة النيتروجين والفوسفور الميسر فى الأرض.