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RESPONSE OF PEA PLANTS (*Pisum sativum* L.) TO SUPPLEMENT OF SULPHUR TO THE SOIL AND FOLIAR APPLICATION OF SOME MICRONUTRIENTS

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ABSTRACT

Under field conditions, pea plants cv. Master B were cultivated in a clay loamy soil receiving sulphur at O or 50 kg / fed. and sprayed with Fe at 100ppm, Zn at 50ppm and Mn at 50pmm or a mixture of Fe, Zn and Mn at the previous concentrations as chelated forms. The foliar spray was repeated four times at 10 days intervals starting 45 days after planting. The experiments were carried out during the two successive winter seasons of 1998/1999 and 1999/2000.

1- Sulpur application to the soil significantly increased plant growth parameters (Plant height, no- branches and no-leaves per plant) and contents of Fe, Zn and Mn in leaf tissues. The treatment had merits on reduction of aborted ovules /pod and increased pod weight, no-pods/ plant, total green pods yield, seed index, dry seed yield and protein content in dry seeds.
2- Foliar application with a mixture of Fe, Zn and Mn or Zn alone to pea plants resulted insignificant increase in plant growth characteristics. Contents of Fe, Zn and Mn in leaves followed the same pattens of changes as that mentioned before. Fresh pod yield and its components were increased. Additionally, seed index, dry seed yield and protein content in dry seed were also significantly greater than control.
3- The interaction of sulphure and mixture of Fe, Zn and Mn or Zn alone had significant increase in some plant growth charcters as well as pod fresh yield and its components. Similar results were found for dry seed yield, seed index and protein content of these seeds.

The results indicate that sulphure supplement to the clay loamy soil can be used successfully for peas production in combination with foliar spray of micronutrients.

INTRODUCTION

The necessity of microelements application to plants is undoubtly of great importance, specially after the decrease of these elements in Nile water (Nabhan, 1966). Moreover, the limited supply of manure used in vegetable growing nowadays and the intensive cropping of vegetables three time per year which remove more quantities of micronutrients from the soil. All these factors led us to give more attention to micronutrients application Micronutrients play a very important role in vital processes of plants. They increase the chlorophyll content of leaves, improve photosynthesis which intensify the assimilating activity of the whole plants (Marschner, 1995). The effect of spraying Fe, Zn and Mn on the physiological processes of vegetable crops were studied by many investigators e.g. Kherde and Yawalker (1966); Vagonov and Sorokina (1970) and Andreson and Cartens (1974) on peas; Hassan (1982) on pea and bean plants; Melton *et al.* (1970); Polson and

Adams (1970); Abo-EL-Hassan (1974); Singh (1974); Gonzalez (1980) and EL-Assiouty (1983) on beans; Zaki *et al* (1981) and Youssef *et al.* (2001) on tomato; EL-Beheidi *et al.* (1978); EL-Fadaly (1992) and Alphonse and Saad (2000) on cucumber and Zaki *et al.* (1979) on squach. Because of the alkalinity of the soils in several regions in Egypt, most of the added nutritional elements, particularly P, Mn, Zn and Fe will be unavailable for plants. The *addition of sulphur reduces soil pH due to increasing the availability of the* nutritional elements, increasing the value of electrical conductivity and increasing the content of organic carbon. Many investigators studied the role of sulphur on the previous characters of the soil, such as Kashirad and Bazargani (1972); Ryon *et al.* (1974); EL- Leboudi and Omar (1975); Procopiou *et al.* (1976), EL- Leboudi *et al* (1982); Yousry *et al.* (1984) and *Heter (1985). Besides, the role of sulphur on the growth and yield of* vegetable plants was also studied by Abdel - Al *et al.* (1973) on tomato; Kasim (1984) on pepper; Shaheen *et al.* (1989) on sweet pepper; Omar *et al.* (1990) and Hilal *et al.* (1992) on peas; Lopez *et al.* (1994); Rahman and Hoque (1994) and Sawan and Rizk (1998) on eggplants.

This study aimed to investigate the response of pea plants to the addition *of different levels of sulphur element to the soil and foliar application* of Fe, Zn and Mn.

MATERIALS AND METHODS

This work was carried out at Kaha Research Farm. Kalubia Governorate, during the two successive winter seasons of 1998/1999 and 1999/2000 to study the effect of sulpur and some trace elements on plant growth green pods yield, dry seeds yield, content of Fe, Zn and Mn in leaves, in addition to the protein percentage in dry seeds of pea cv. Master B. The experimental soil was a clay loam texture with pH of 8.1. The soil analysis was done according to Jackson (1967). The physical and chemical analysis of the soil is presented in Table (1). Seeds were sown on one side of beds on 20th of October in both seasons of study. After emergence, seedlings were thinned to one plant per hill, the distance between hills was 10cm. split plot design with four replicates was used. The main plots consisited of two levels of sulphur O and 50 kg feddan which was applied after preparation of soil before planting. The sub-plots were assigned for foliar applications with 100ppm of Fe- EDDHA, 50ppm of Zn EDTA, 50ppm of Mn-EDTA, Fe + Zn + Mn with the previous concentrations and distilled water for control. The spraying of trace elements and distilled water took place four times at 10 days intervals started from 5^{th} of December. All agricultural treatmnets in the area regarding peas cultivation were carried out according to the recommendations of Ministry of Agriculture. Each sub-plot consisted of 8 rows, 4 meters long and 60cm wide Four rows were used to determine the plant growth and chemical constituents of leaves as well as green pods yield. while the other four rows were used to record the dry yield and its components. Ten plants from each plot were selected randomly and the following data were recorded after 15 days from the last foliar application (after 75dayes from plants thinned).

1- Vegetative growth :-

a- Plant height (cm).
b- Number of branches.
c- Number of leaves.

2- Green pods yield:-

At harvesting stage fresh pods yield per plot at each picking was determined. In the meantimes samples of 10 edible green pods from each sub-plot were collected and the following data were recorded:-

a- Average pod weight (g.)
b- Number of pods per plant.
c- Number of seed per fresh pod.
d- Number of aborted ovules per fresh pod.
c- Fresh pods yield (ton/fed).
f- Weight of 100 green seed (g.).

3- Dry yield :-

Four rows were used to determine the following charactres.

a- Weight of 1000 - dry seed : (seed index).
b- Dry seeds yield (ton/fed.)

4- Chemical composition of leaves :-

a- Leaf contents of Fe, Zn and Mn i,e. number 4 and 5 from the top on the main stem at the end of growing seasons. Three plants from each treatment were randomly chosen to determine the previous parameters. Fe, Zn and Mn were estimated in pea leaves digests using Phillips PU 9100 atomc absorption.

Table (1): Physical and chemical analysis of the soil of the experimental site.

A- Physical analysis :-	
Soil texture	Clay loam
Clay %	60.85
Silt %	18.95
Fine sand %	12.65
Coarse sand %	7.55
B- Chemical analysis :-	
available K (mg/100g soil)	0.59
available P (mg/100g soil)	4.48
available N (mg/100g soil)	139.32
Ca^{++} meq/100g	0.76
Mg^{++} meq /100g	0.26
Na^{+} meq /100g	1.61
$CaCo_3^{-}$ meq /100g	2.34
H Co_3 meq /100g	0.49
CL^{-} meq /100g	0.42
So_4^{--} meq /100g	1.37
PH	8.1
EC (mmhos / Cm/25°C	2.11

5- Chemical composition of seeds :-

a- Total protein was determined in dry seeds as g./100g. dry weight by using Micro-kjeldahle method according to *Piper* (1947).

All collected data were exposed to the proper statistical analysis and least significant difference (LSD 0.05) was used for comparison between treatments according to *Snedecor* and *Cochran* (1980).

RESULTS AND DISCUSSION

1- Vegetative growth :-

a- Plant height :-

The results presented in Table 2 show that the plant height was influenced by the sulphur application during the two seasons of study Plant height was significantly greater due to sulphur application compared with control in both years of study. These findings were in agreement with those obtained by *Omar et al.* (1990) on pea; *Rohman* and *Hoque* (1994) and *Sawan* and *Rizk (1998)* on *eggplant. In the meantime foliar spray with* micronutrients significantly affect plant height in both seasons of study. All foliar spray treatments resulted in significant increase in plant height over control. However the most effective treatment was the mixture of Fe + Zn + Mn. These results agreed with those obtained by *EL-Assiouty* (1983) on bean and *Omar et al.* (1990) on pea plants. In addition, the interaction between sulphur and micronutrients was significant. Plants subjected to sulphur application and spraying wih mixture of Fe+ Zn+ Mn gave significantly the highest values of plant height in the two years of study.

b- Number of branches /plant :-

Regarding the effect of sulphur addition on number of branches of pea plants, data presented in Table (2) showed that this treatment increased number of branches per plant in the two seasons of study however the difference was significant in the second season only. Micronutrient treatments had significant effect on no. branches during both seasons of study and the highest values of no- branches / plant were recorded for plants sprayed by Fe + Zn + Mn (2.100 per plant and 2.180 per plant) in the two seasons, respectively. The interaction between the addition of sulphur and spraying with micronutrients was only significant in the second season of study, i.e. highest value was obtained from addition of sulphur and spraying with mixture of Fe + Zn + Mn.

C- Numbr of leaves / plant :-

Data in Table (2) show that addition of sulphur significantly increased number of pea plant leaves in both years of study. These results are in line with those obtained by *Sawan* and *Rizk* (1998). Concerning the effect of spraying different micronutrient treatments on no. leaves / plant Table (2) showed that spraying plants with *Fe + Zn + Mn significantly produced highest* number of leaves per plant as compared with control. These results agreed with those obtained by *Malash* and *Ahmed* (1990); *El-Fadaly* (1992) and *Al-*

Rhones and *Saad* (2000). The interaction between sulphur and micronutrient treatments on no leaves / plant was significant in the second season only, however the highest values were abtained by adding sulphur and spraying plants with mixture of Fe+ Zn + Mn during the two years of study, followed by S + Zn treatment.

Table (2) Effect of sulphur and micronutrients application on vegetative growth of pea plants in 1998/1999 and 1999/2000 seasons.

Treatments		Plant height cm.		No. of branches / plant		No. leaves / plant	
Sulpur	Micronutrients	1998 / 1999	1999 / 2000	1998 / 1999	1999 / 2000	1998 / 1999	1999 / 2000
0	Fe	48.5	49.2	1.800	1.900	20.50	23.70
	Zn	51.4	52.3	1.900	1.950	22.40	24.50
	Mn	50.5	50.6	1.800	1.800	21.40	23.40
	Fe + Zn + Mn	54.5	56.6	2.020	2.100	25.90	27.50
	Control	47.8	48.4	1.800	1.800	19.30	22.50
50	Fe	50.3	51.6	2.100	2.020	22.00	24.60
	Zn	55.6	56.2	2.180	2.200	25.10	28.60
	Mn	53.4	55.6	2.060	2.000	23.10	23.50
	Fe + Zn + Mn	56.7	58.8	2.200	2.180	28.40	28.90
	Control	49.5	50.3	2.020	1.950	22.80	23.10
Mean A							
0 S		50.54	51.40	1.864	1.910	21.800	24.320
50 S		53.10	54.70	2.112	2.070	24.300	25.740
Mean B							
Fe		49.40	50.40	1.950	1.960	21.250	24.150
Zn		53.55	54.25	2.040	2.075	23.750	26.550
Mn		51.95	53.10	1.930	1.900	22.250	23.450
Fe + Zn + Mn		55.60	57.70	2.110	2.140	27.150	28.200
Control		48.50	49.35	1.910	1.875	21.050	22.800
L. S. D. 5%							
A		0.13	0.10	N.S	0.038	1.090	0.390
B		0.18	0.17	0.27	0.032	1.270	0.610
A x B		0.26	0.28	N.S	0.072	N.S	0.870

It could be concluded that addition of sulphur to the soil had a promotion effect on growth of pea plants. These findings are in agreement with that obtained by *Shaheen et al.* (1989a), who reported that sulphur increased the ability of the plant in building metabolities. Additionally, *Omar et al.* (1990) on pea reported that sulphur has been known as a helpful factor for activating vegetative growth. The addition of sulpur to the soil decreased pH value, increased electrical conductivity and increased the available of phosphorus and Fe, Zn and Mn through oxidation of soil microorgonisms which are able to produce sulphuric acid in amounts enough to lower the pH (*Yousry et al* 1984). Many investigators reported that, adding sulphur to the soil caused an increase in growth parameters of vegetable plants (*Shaheen* *et al.*, 1989a and b) on broad bean and sweet pepper; *Omar et al.*, 1990 on pea and *Rahman & Hoque*, 1994 and *Sawan & Zaki*, 1998 on eggplants).

Concerning the foliar spray with Fe, Zn and Mn Which led to increasing vigorous vegetative growth, Many studies indicated that foliar application of Fe, Zn and Mn enhanced growth of vegetable plants (*Anderson & Cartens*, 1974 on peas; *Hassan*, 1982 and *EL-Assiouty*, 1983 on beans; *Malash & Ahmed* 1990; *EL-Fadaly*, 1992 and *Alphonse & Saad*, 2000 on Cucumber plants.

It is clear that each micronutrient has a role in improving plant growth. Zn directly involved in the synthesis of the indole acetic acid (IAA). Mn is directry involved catalitic rates in plants being the enzyme activator of some respiratory enzymes and in reactions of nitrogen metabolism and photosynthesis (*Marschner*, 1995).

Average fresh pod weight (gm):

The effect of sulphur application and spraying of micronutrients on average pod weight is presented in Table 3. Data showed that in the two seasons added sulphur increased significantly the average fresh pod weight than control.

As regard to the effect of micromutrients, plants sprayed with any used micronutrients or mixture of them gave significantly greater average fresh pod weight as compared with control in the two seasons. In the meantime a mixture of the forementioned nutrients surpassed significantly any individual micronutrient applied to the plants in trems of average fresh pod weight in both years of study. The results agreed with those obtained by *EL-Fadaly* (1992) on cucumber and *Youssef et al.* (2001) on tomato.

Concerning the interaction between sulphur addition and spraying microelements, data indicated that there was a significant effect due to the application of these chemicals on average fresh pod weight in the two seasons of the experiment. Plant received sulphur and sprayed with Fe + Zn + Mn recorded the highest average fresh pod weight followed by S x Zn in the two seasons of study.

Number of pods / plants:

Data in Table (3) indicated that addition of sulphur significantly increased number of pods / plant during the two seasons of study. *Omar et al.* (1990) and *Hilal et al.* (1992) worked on peas and *Sawan* and *Rizk* (998) on eggplant, reported that addition of sulphur to the soil increased number of pods or fruits per plant over control.

Ragarding spraying pea plants with microelements data indicated that all microelements increased number of pods / plant as compared with control in both seasons and the highest values were obtained from plants sprayed with mixture of Fe + Zn + Mn followed by plants sprayed with Zn in the two seasons, respectively. In other words, it seems that Zn application was efficient treatment among the other individual micronutrients used in this experiment. These results are in accordance with those obtained by *EL-Fadaly* (1992) on cucumber and *Youssef et al.* (2001) on tomato who found that applying a mixture of Fe, Zn and Mn as chelate (EDTA) increased number of fruits / plant.

The interaction of sulphur x microelements exhibiled significant effect on the no-of pods / plant during the two seasons of study. Generally, the most effective treatment in increasing number of pods was addition of sulphur combined with spraying a mixture of Fe + Zn + Mn. On the other hand, the lowest number of pods per plant was recorded for the control i.e., plants received no sulphur and sprayed with water only.

Number of seeds per pod:

Assessment of mean values of the effect of the treatments included in this experiment on number of seeds per pod are shown in Table (3). Data illustrated that addition of sulphur had no significant effect on this parameter in both seasons of study. These resultes are in line with thise obtained by *Omar et al.* (1990) and *Hilal et al.*(1992).

Concerning the effect of foliar application of micronutrients, results showed that apart from Mn all treatments gave significant increase in number of seeds per pod in both years of study. Moreover, mixture of Fe + Zn + Mn induced significantly the highest values in this concern compared with any other treatment used in two seasons. This point was studied by EL-*Assiouty* (1983) who reported that spraying bean plants with Zn and Mn increased number of seeds per pod but insignificant.

Regarding the interaction of sulphur and micronutrients data in Table(3) showed that addition of sulphur + Zn or sulphur + Fe + Zn + Mn gave significant increase in number of seeds per pod. However, the latter treatments surpassed significantly the former one in this concern in the two years.

Number of aborted ovules per pod :

The illustrated data in Table (3) indicated that, the treatmnet of sulphur appliied decreased significantly the aborted ovules per pod than control in both seasons.

Concerning the effect of micromutrients on the aborted ovules per pod, data in Table (3) showed that the desirable treatment was reflected by spraying mixture of Fe + Zn + Mn in both seasons, which had the lowest values of aborted ovules per pod. Meanwhile, the undesirable treatment was that spraying water only in the first as well as the second seasons.

The interaction between sulphur and mironutrients application was significant. Plants received sulphur and sprayed with mixture of Fe + Zn + Mn produced the lowest values of aborted ovules per pod, followed by S x Zn treatment in both seasons of the experiment. It is obvious that sulphur addition and foliar application of micronutrient had reflected positive decrease in aborted ovules of pods.

This may be due to their positive effect on vegetative growth and chemical constituents which resulted from improving chemical and physical properties of the soil by sulphur application beside receiving sufficient microelements.

Table (3) Effect of application of sulphur and micronutrients on peas average fresh pod weight, no. pods/plant, no. seed/pod and no. aborted ovules/pod in 1998/ 1999 and 1999/2000 seasons.

Treatments		No. pods / plant		Average fresh pod weight (gm)		No. seed / pod		No. aborted ouvles / pod	
Sulpur	Micronutrients	1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000
0	Fe	8.900	8.933	18.96	19.13	8.300	8.363	1.632	1.652
	Zn	8.936	8.965	21.20	21.76	8.572	8.585	1.400	1.462
	Mn	8.863	8.911	19.70	19.84	8.336	8.468	1.550	1.600
	Fe + Zn + Mn	9.225	9.125	23.48	24.15	8.762	8.686	1.330	1.380
	Control	8.752	8.880	16.52	17.18	8.274	8.311	1.830	1.860
50	Fe	9.050	9.018	22.71	23.11	8.384	8.517	1.512	1.542
	Zn	9.110	9.120	24.33	24.92	8.737	8.712	1.382	1.368
	Mn	9.000	9.050	23.28	23.64	8.372	8.627	1.475	1.477
	Fe + Zn + Mn	9.320	9.296	26.88	27.57	8.978	8.994	1.300	1.311
	Control	8.950	8.917	19.23	19.79	8.288	8.476	1.710	1.733
Mean A									
0		8.935	8.963	19.972	20.412	8.449	8.483	1.548	1.591
50		9.086	9.080	23.276	23.806	8.552	8.665	1.476	1.486
Mean B									
Fe		8.975	8.976	20.835	21.120	8.342	8.440	1.572	1.597
Zn		9.023	9.043	22.765	23.340	8.655	8.649	1.391	1.415
Mn		8.932	8.981	21.465	21.740	8.354	8.548	1.513	1.539
Fe + Zn + Mn		9.273	9.211	25.180	25.860	8.870	8.820	1.315	1.346
Control		8.851	8.899	17.875	18.485	8.281	8.394	1.770	1.797
L. S. D. 5%									
A		0.018	0.021	0.037	0.026	N.S	N.S	0.028	0.033
B		0.024	0.028	0.041	0.038	0.077	0.072	0.042	0.048
A x B		0.041	0.047	0.068	0.053	0.098	0.082	0.058	0.068

Fresh pods yield (ton/fed) :

Data in Table 4 show that fresh pod yield of pea plants as tons/fed. were significantly increased by sulphur addition to the soil as compared with control. Many workers studied the effect of sulphur on the yield of vegetable plants and reported that sulphur caused an increase in fruits yield of sweet pepper (*Shaheen et al.*, 1989 b); peas (*Omar et al.*, 1990 and *Hilal et al.*, 1992) and eggplant (*Lopez et al.*, 1994; *Rahman* & *Hoque*, 1994 and *Sawan* & *Rizk*, 1998).

Data also indicated that micronutrients significantly influenced pods fresh yield (Table 4). Plants sprayed with an used micronutrient produced insignificantly higher yield than control. Besides spraying mixture of micronutriens Fe + Zn + Mn onto pea plants resulted significantly greater yield than control or any other individual micronutrient used in both years of study. These results agreed with those obtained by *El-Fadaly* (1992) on cucumber and *Youssef et al.* (2001) on tomato who found that applaying a mixture of Fe, Zn and Mn as Chelate (EDTA) increased number and weight of fruits and produced the highest early and total yields/fed. Simlar results were obtained by *Andreson* and *Cartens* (1974) on peas; *Hassan* (1982) on peas and beans and *Gongalez* (1980) on beans. It has been reported also that increasing fresh pods weight by Zinc application may be due to the fact that Zn had a direct role in indoleacetic acid (IAA) formation as growth regulator in plants (Alphonse and *Saad*, 2000).

In interaction between sulphur addition and foliar application of microelements recorded significant effect on fresh yield of pods (Table 4) Generally Zn alon or mixture of Fe + Zn + Mn had significant increase in pod yield over control in both years of study. The increased yield of fresh pods obtained by application of sulphur and mixture of micromutrients Fe + Zn + Mn could be related to the increase in the number of pods per plants and to the number of seeds per pod and also to the average 100 fresh seed weight.

100 - fresh seed weight (g) :

Data presented in Table 4 show that the effect of sulphur addition on average 100- fresh seed weight (g). Data revealed that there was no significant effect due to sulphur addition on this character in both seasons.

Concerning application of micronutrients, data in the same table indicated that any used micronutrient increased significantly 100 - fresh seed weight over control in the two years of the experimental study. Moreover, mixture of Fe + Zn + Mn had significant increase in these concern over any applied individual micronutrient in both years

Regarding the interaction between sulphur and micro-nutrients, data presented in table 4 indicated that there was significant effect on 100-fresh seed weight. Plants received S and sprayed with a mixture of Fe, Zn and Mn gave significantly the highest values in both seasons of study. As known, sulphur which is considered one of the soil amendments. Such favourable effect was obtained with *Garcia* and *Carloni* (1977) who found that S promoted the solubilization of apatite - P already present, or add to the soil, Moreover, *Hausenviller* (1972) reported many interaction affecting the micronutrients availability by sulphur application, such as Fe, Zn, Mn and Cu. In addition to the favourable effect by foliar application with Fe + Zn + Mn which plays important roles in the physiological processes and important for enzyme system and having a vital role in the metabolism and for carbohydrate manufacture.

Seed index (1000 - dry seed weight) :

Data presented in Table 4 showed that sulphur addition increased significant seed index in both seasons of study as compared with control.

Concerning the effect of micronutrients on seed index, data in Table (4) showed that the differences between micronutrients treatments and control were significant in the two seasons of study. The highest values were recorded for plants sprayed with a mixture of Fe + Zn + Mn followed by plants sprayed by Zn These results are in line with those obtained by *Hassan* (1982) on peas and beans and *EL-Assiouty* (1983) on beans.

The interaction between sulphur addition and micronutrients treatments was significant. Plants received S and sprayed with a mixture of Fe, Zn and Mn gave the highest values followed by plants received S x Zn, while control treatment resulted in the lowest values during the two seasons of experiment.

Table (4) Effect of sulphur and micronutrients application on fresh pod yield (ton/fed.); 100- fresh seed weight (g) seed index; Dry seed yield (ton/fed.) in 1998/1999 and 1999/2000 seasons.

Treatments		Fresh pod weight (ton/fed.)		100 fesh seed weight (gm)		Seed index		Dry seed yield (ton/fed.)	
Sulpur	Micronutrients	1998/1999	1999/2000	1998/1999	1999/2000	1998/1999	1999/2000	1998/1999	1999/2000
0	Fe	2.524	2.790	48.125	48.611	240.20	242.67	1.067	1.080
	Zn	2.811	2.910	49.020	49.346	246.00	247.67	1.169	1.187
	Mn	2.757	2.840	48.300	48.877	244.67	243.33	1.133	1.139
	Fe + Zn + Mn	2.984	3.169	49.445	49.633	248.69	248.22	1.217	1.220
	Control	2.311	2.514	47.667	47.835	237.20	238.67	0.889	0.913
50	Fe	2.938	2 980	48.216	48.936	243.67	244.00	1.135	1.116
	Zn	3.033	3.115	49 188	49.815	247.33	248.33	1.183	1.208
	Mn	2.965	3.050	48.550	48.880	246.20	245.67	1.147	1.169
	Fe + Zn + Mn	3.258	3.325	50.778	51.111	249.33	249.67	1.256	1.273
	Control	2.852	2.884	48.011	48.536	239.33	239.67	0.956	0.993
Mean A									
0		2.677	2.845	48.511	48.860	243.35	244.11	1.095	1.108
5		3.009	3.071	48.949	49.456	245.18	245.47	1.131	1.152
Mean B									
Fe		2.731	2.885	48.71	48.774	241.94	243.34	1.101	1.098
Zn		2.922	3.013	49.104	49.581	246.67	248.00	1.176	1.198
Mn		2.861	2.945	48.425	48.879	245.44	244.50	1.140	1.154
Fe + Zn + Mn		3.121	3.247	50.112	50.372	249.00	248.95	1.237	1.247
Control		2.582	2.699	47.839	48.186	238.27	239.18	0.923	0.953
L. S. D. 5%									
A		0.133	0.139	N.S	N.S	1.13	0.83	0.036	0.033
B		0.147	0.151	0.148	0.153	1.14	1.17	0.053	0.047
A x B		0.163	0.167	0.166	0.175	1.18	1.88	0.067	0.058

Dry seed yield (ton/fed) :

Data in Table (4) showed that the studied sulphur treatments significantly increased seed yield as compared with control in the first and second years of the present work. This result agreed with those obtained by *Omar et al.*(1990) and Hilal *et al.* (1992) on peas.

Regarding the effect of micronutrients on the seed yield of pea plants, it is evident from data in Table 4 that plants sprayed with any of the used micronutrients gave significantly higher dry seed yield than control. In the mean time spraying pea plants with a mixture of Fe, Zn and Mn produced significantly greater dry seed yield over either control or any of the individual micronutrient treatment. This was true in the first and second year of the experiment. These results are in agreement with those obtained by *Hassan* (1982) on peas and *El-Assiouty* (1983) on beans. These results could be due to the increase of seed index and /or numbr of pods.

Concerning the interaction between S addition and microelements, data presented in Table 4 indicated that there was a significant effect on seed yield of pea plants. Plants received S and sprayed with a mixture of Fe, Zn and Mn gave the significantly seed yield as compored with control or any other micronutrient used. Further more any micronutrient included in this experiment had significantly greater dry seed yield than control.

Mineral contents of pea leaves :

The results indicated that sulphur addition significantly increased microelements (Fe, Zn and Mn) contents n pea leaves at the end of experiment in both seasons (Table 5). The results may be attributed to the positive effect of the sulphur on the availabity of micronutrients for plants uptake.

Regarding the effect of micronutrients foliar application on Fe, Zn and Mn contents in pea leaves results in Table (5) showed that spraying Fe or Fe + Zn + Mn as a mixture markedly increased Fe content in pea leaves, in addition to Zn and Mn contents in both seasons. Application of Zn as foliar spray onto plants had a different effect as it gave a significant increase only in Zn content over control in both years of study. Concerning Mn addition, data also indicated that spraying Mn resulted in significant increase in Zn and Mn contents in pea leaves in the two seasons.

The interaction between sulphur addition and foliar application of micronutrients was significant in both seasons except Fe and Mn contents in pea leaves in the first season. The most effective treatment on Zn content was adding sulphur and spraying with the mixture of Fe + Zn + Mn in the two seasons of study.

For the forementioned results under the condition of this study, it could be concluded that Kaha clay loam soil tended to alkaline condition. There fore, sulphur addition and foliar application of micronutrients of Fe, Zn and Mn in chelated form was markedly increased their concentrations in the leaves of peas plants. *EL-Fouly* (1983) reported that foliar application of microlements is highly recommended undr Egyptian conditions. In view of the fact the soil pH exceeds 7.5 and sometimes even 8.0 scme areas show high Ca Co_3 contents which among other factors, make soil application of micronutrients more costly and unpractical. Also, these increases in pea yield and in the contents of micronutrients in pea leaves due to the foliar application of micronutrients agree with the finding of *Soliman* (1996) and *Alphonse* and *Saad* (2000) on cucumber plants. Morover, it seems from data that application of an element usually gave the highest content of this particular element in the leaves than the other elements. These results agree with those obtained by *Malash* & *Ahmed* (1990) and *EL-Fadaly* (1992) who concluded that appling Fe, Zn and Mn tended to increase the contents of these elements in cucumber leaves.

Table (5) Effect of sulphur and micronutrients application on Fe, Zn and Mn contents in leaves and protein content (%) in dry seeds of pea plants 1998/1999 and 1999/2000 seasons.

Treatments Sulpur	Micronutrients	1998-1999 Fe ppm.	Zn ppm.	Mn ppm.	1999-2000 Fe ppm.	Zn ppm.	Mn Ppm.	Protein content % 1998/1999	1999/2000
0	Fe	228	125	163	218	116	155	20 208	20.311
	Zn	220	138	162	206	127	150	22 639	22.424
	Mn	218	115	172	210	110	167	21.667	21.335
	Fe + Zn + Mn	234	135	175	226	132	169	22.875	22.933
	Control	210	112	160	202	101	141	19 911	19.896
50	Fe	236	135	173	234	122	165	20 669	20.933
	Zn	228	145	176	214	139	170	23.133	22.911
	Mn	222	141	184	218	126	181	21.996	21.962
	Fe + Zn + Mn	246	150	183	230	144	187	23 333	23.667
	Control	218	122	170	208	113	153	20 011	20 216
Mean A									
0		222	125	166	212.4	119	156	21.458	21.380
5		230	142	177.2	220.8	128.8	171.6	21.828	21.938
Mean B									
Fe		232	130	168	226	114	160	20.439	20.622
Zn		224	141	169	210	133	160	22.886	22.668
Mn		220	128	178	214	118	174	21.832	21.649
Fe + Zn + Mn		239	142	179	228	138	178	23.104	23.300
Control		214	117	165	205	107	147	19.961	20 056
L. S. D. 5%									
A		6.88	3.11	4.46	5.45	3.02	6.11	0.120	0.172
B		9.36	6.46	10.25	7.72	6.76	8.34	0.160	0.210
A x B		N.S	8.26	N.S	10.22	9.86	12.50	0.228	0.387

Protein content in dry seed (%) :

Data in Table (5) show the effect of sulphur addition, foliar application of Fe, Zn and Mn and the interaction between sulphur and micronutrients on dry seed protein content. Results revealed that protein content of dry seeds produced by pea plants grown in soil received sulphur was significantly *greater than control. Additionally, application of Zn alone or mixture of* micronutrients Fe + Zn + Mn resulted in significantly higher protein content in the dry seeds as cmpared with control or the other micronutrients used in this experiment. It seem that the most efficient element in this concern is Zn. Similar results were obtained from the interaction between sulphur and Zn alone or a mixture of Fe + Zn + Mn. These results agreed with those obtained by *Hassan* (1982) on pea and bean plants and *Zeine et al.* (1984) on bean plants.

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إستجابة نمو ومحصول نباتات البسلة للإضافة الأرضية للكبريت الزراعى والرش ببعض العناصر الصغرى

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تمت الدراسة فى تجربتين حقليتين خلال موسمى الزراعى ١٩٩٨/١٩٩٩ و ١٩٩٩/٢٠٠٠ على نباتات البسلة صنف ماستر ب الجديد لدراسة تأثير إضافة الكبريت الزراعى بمعدل صفر و ٥٠ كجم / فدان إلى التربة قبل الزراعة والرش بالعناصر الصغرى المخلبيه (حديد ١٠٠ جزء فى المليون وزنك ٥٠ جزء فى المليون ومنجنيز ٥٠ جزء فى المليون) وكذلك بمخلوط من تلك العناصر بنفس التركيزات السابقة ٤ رشاشات بفاصل ١٠ أيام بين كل رشة وأخرى وذلك على نمو ومحصول البسلة وكانت أهم النتائج المتحصل عليها هى :-

- أدت إضافة الكبريت إلى زيادة طول النبات وعدد الأفرع وعدد الأوراق وزيادة محتوى الاوراق من الحديد والزنك والمنجنيز، زاد وزن القرن الطازج وقل عدد البذور الغير مكتملة النمو بالقرن وكذلك عدد القرون / نبات والمحصول الكلى الأخضر للقرون وكذلك دليل البذرة (وزن ١٠٠٠ بذرة جافة) ومحصول البذرة الجاف والبروتين الكلى بالبذرة الجافة.
- أدى الرش بمخلوط العناصر الصغرى (حديد – زنك – منجنيز) أو الزنك فقط إلى زيادة معنوية فى صفات النمو الخضرى وزيادة محتوى الأوراق من تلك العناصر، زاد المحصول الطازج للقرون وكذلك الصفات التى درست عليه بالإضافة إلى وزن ١٠٠٠ بذرة جافة (دليل البذرة) ومحصول البذرة الجاف وكذلك محتوى البذرة من البروتين. أدى للتفاعل بين إضافة الكبريت للتربة والرش بمخلوط العناصر السابقة أو بالزنك فقط إلى زيادة معنوية فى صفات النمو الخضرى والمحصول الطازج للقرون وصفات هذا المحصول. كذلك زاد وزن ١٠٠٠ بذرة جافة ومحصول البذرة الجاف والبروتين الكلى بتلك البذرة.

من النتائج المتحصل عليها يمكن أن نوصى بإضافة الكبريت الزراعى للأراضى الطينية مع الرش بالعناصر الصغرى على نباتات البسلة لزيادة المحصول وصفات الجودة به.