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GROWTH AND YIELD OF PEA (*Pisum sativum*, L.) PLANTS AS AFFECTED BY APPLICATION OF SULPHUR AND NPK MIXTURE.

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ABSTRACT

A study has been conducted on pea cv. master B at kaha Vegetable Research Station, Ministry of Agriculture, Kalubia Governorate during the two successive seasons of 1998/1999 and 1999/2000. The effect of sulphur incorporation into the soil (0 and 50 kg/fed.) and NPK fertilization levels (30: 22.5:36; 40:30:48 and 50:37.5:60 kg/fed.) on growth, pod yield and yield components, as well NPK contents in leaves and protein content in dry seed. Sulphur supplement to the soil significantly increased plant height, leaf number / plant, total fresh pod yield, pod weight, number of green pod/ plant, average weight of 100-fresh seeds, seed-index, dry seed yield and NPK contents in leaves.

Fertilization with NPK at the medium (40:30:48 kg/fed.). or high (50:37.5:60 kg/fed.) rates induced significant increase in plant height and leaf number /plant as compared with the low rate (30: 22.5.36 kg/fed.) The same trend was recorded for average fresh pod weight, number of green pods / plant, number of fresh seeds/ pod, total fresh pod yield, 100 - fresh seed weight, seed-index, dry seed yield and NPK content in leaves. There was no significant difference between the high or medium rates of NPK fertilizers on the pervious characters. The interaction between sulphur and NPK application increased significantly plant height, number of pods /plant, average 100- fresh seed weight, seed-index and dry seed yield due to the addition of sulphur to the high or medium rates of NPK levels as compared with no-sulphur and low rate of NPK.

INTRODUCTION

(Pea crop (*Pisum sativum* L.) is a popular and one of the common foods in the temperate zone and to a lesser extent in the subtropical regions of the world). One of the major challangens nowadays is increasing productivity of vegetable crops to meet the increasing demand for food due to increased human population. There are several ways to increase vegetable crops productivity, including the improve of soil conditions and the application of suitable levels of fertilizers. It is well known that incorporating sulphur into the soil help decreasing salinity as well as pH and in turn increasing the availability of some nutritional elements (*Yousry et al.*, 1984), the content of organic carbon, the outotrophic sulphur-oxidizing bacteria and the concentration of available soil sulphate (*Badawy* 1978). However, in some reports adding sulphur to the soil gave rise to significant increments in growth, seed yield, seed protein (*Aulakh* & *Pasricha* (1977) on mung bean), number of leaves, branches, yield of fresh pods (*Omar et al.*, (1990) on pea), seed yield and uptake of N, P & K (*Singh* & *Singh* (1992) on pea) and N, P & K in leaves (Hewedy 1999 on tomato). From, another point of view, it was found that increasing N, P & K levels in some experiments on peas increased

significantly plant height, number of leaves, yield of pods, number and weight of seeds per pod (*Abo Bakr et al.*, 1993a), number of pods /plant, seeds index and protein content in dry seeds (*Mohamed & EL-Kobbany 1999 and Shokr 2000*).

The aim of this study was to find out the effect of sulphur and NPK elements on growth, yield and pod quality of pea plants.

MATERIALS AND METHODS

An experiment was conducted during the two successive seasons of 1998/1999 and 1999/2000 at Kaha Research Farm, Ministry of Agriculture, Kalubia Governorate to study the effect of sulphur and levels of NPK fertilizer on growth and productivity of pea cv. Master B. The soil is clay loam in texture with pH 8.22. Data of physical and chemical analyses of the experimental soil are shown in Table 1 which were conducted according to *Jackson* (1967). The experiment contained 6 treatments, which were the simple combination between 2 levels of sulphur (0 and 50kg S/fed.) and 3 levels of NPK (30: 22.5: 36; 40:30: 48 and 50: 37.5 : 60 kg/fed.) These three levels of NPK represented low, medium and high rates of fertilzation, respectively. The fertilizers were applied in the forms of ammonium sulphate (20.5% N0), calcium super phosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O) as sources of N,P and K, respectively. The sulphur was incorborated into the soil during its preparation before seeding. The NPK treatments were added at two equal doses, first during the preparation of soil and second after 45 days from planting. Seeds were sown one side of the beds on 27 October in both years. After emergence, seedlings were thinned to one plant per hill where the distance between hills was 10cm. The experimental design was split plots with 4 replications where sulphur levels were arranged within the main plots and the NPK rates were presented as sub-plots. Each sup-plot consisted of 8 rows, 4m long and 60 cm. apart. Four rows were used to determine N, P and K contents in leaves and green pods yield. However the other four rows were used to record dry seed yield and its components. The normal cultural practices were followed according to the recommendations of Ministry of Agriculture. Ten plants from each plot were selected randomly and the following data were recorded:

1- **Vegetative growth.**
   - a- Plant height (cm.)
   - b- Number of branches / plant.
   - c- Number of leaves / plant.

2- **Green pod yield.**

   At harvest, samples of the mature green pods (about 30 days age) from each sub-plot were taken and the following data were recorded:
   - a- Average pod weight (g)
   - b- Number of pods per plant.
   - c- Number of seeds per pod.
   - d- Weight of 100-green seeds (g).
   - e- Total green pods yield (ton/fed).

3- Dry yield:

The following characters were determined.

a- Weight of 1000 - dry seed (seed index).

b- Dry seeds yield (Ton/fed).

4- Chemical composition of leaves:

a- Leaf contents of N, P and K; were determined in the fourth and fifth/ leaves from the top of the main stem from three plants of each treatment chosen at random according to the methods described by *Piper* (1947), *Mettk-Johen* (1970) and *Richard* (1954) respectively

5- Chemical composition of seeds:

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

All collected data were subjected to the proper statistical analysis according to Snedecor and Cochran (1980).

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

Item	Content
A- Physical analysis :-	
Soil texture	Clay loam
Clay %	62.25
Silt %	19.25
Fine sand %	11.72
Coarse sand %	6.38
B- Chemical analysis :-	
available K (mg/100g soil)	0.61
available P (mg/100g soil)	4.93
Total nitrogen (mg/100g soil)	147.32
Ca^{++} meq/100g	0.73
Mg^{++} meq /100g	0.31
Na^{+} meq /100g	1.48
$CaCO_3$ meq /100g	2.41
$H CO_3$ meq /100g	0.47
CL^{-} meq /100g	0.39
SO_4^{--} meq /100g	1.42
PH	8.22
EC (mmhos / Cm/25°C	2.18

RESULTS AND DISCUSSION

1- Vegetative growth :-

Effect of sulphur addition and NPK fertilizers on vegetative growth was presented in Table (2). Results showed that plant height and number of leaves were significantly increased by sulphur application in both years of study. However, number of branches was not affected by sulphur treatment. These findings are in agreement with that obtained by Shaheen *et al.* (1989

a) on broad bean who reported that sulphur increased the capacity of the plant in building metabolities. Also, *Omar et al.* (1990) on pea, reported that sulphur has been known as helpful factor for activating vegetative growth and in turn increased the number of leaves and branches. In addition, *Mohamed & Qundil* (1998) on pea; *Hewedy* (1999) on tomato; *Rahman & Hoque* (1994) and *Sawan & Rizk* (1998) on eggplant reported that adding sulphur to soil caused an increase in growth parameters.

Data in Table (2) reveal that plant height was increased significantly by addition of the medium or high rates over the low rate of NPK in both years of study. However, there was no significant differences between medium and high rates of NPK in this concern. Similar results were obtained for leaf number/ plant. On the other hand, NPK application had no clear effect on number of branches per plant. The promotive effect of the medium or high levels of NPK may be due to the role of nitrogen on phytohormones as CYT cell division and enlargement, phosphorus as constituent for development of meristemic tissue (*Russell*, 1988) and potassium which plays a vital role for normal cell division, translocation of carbohydrates and also has a metabolic role (*Black* 1960). The present results were in agreement with those reported by *Bakry* et al. (1984) and Mohamed *& EL-Kabbany* (1999) who stated that increasing NPK levels up to 60 kg/fed. caused an increase in plant height and number of leaves / plant in pea plants.

Data on plant height, number of leaves and branches as affected by the interaction of sulphur and NPK levels application are presented in Table (2). Results show that plant height was significantly increased by the interaction of sulphur

Table (2): Effect of sulphur and NPK levels on growth parameters of pea plants in 1998/1999 and 1999/2000 seasons.

Treatments		Plant height cm.		Number. of branches		Number of leaves	
Sulphur A	N: P: K B	1998/1999	999/2000	1998/1999	999/2000	1998/1999	1999/2000
	30:22 5:36	41 500	42.250	1.735	1 750	19.667	19.875
0	40:30 :48	44.330	44.950	1.875	1.925	21.825	21.550
	50:37.5:60	44 500	44.750	1.915	1.945	22.150	21.333
	30:22.5.36	42.450	43.500	1.833	1.885	21.125	21.333
50	40:30 .48	45.250	46.650	1.985	1.990	24.250	24.666
	50:37.5.60	45.750	46.330	1.975	2.025	24.333	24.750
	Mean A						
	0 S	43.443	43.983	1.842	1.873	21 214	20.919
	50 S	44.483	45.493	1.931	1.960	23 238	23.583
	Mean B						
	Low	41.965	42.875	1.784	1.808	20 398	20.604
	Medium	44.790	45 800	1.930	1.958	23 038	23.108
	High	45.125	45.540	1.945	1.985	23.242	23.042
	L. S. D. 5%						
	A	0.635	0.563	N.S	N.S	0.733	0.586
	B	0.667	0.348	N.S	N.S	0.853	0.616
	A x B	0.815	0.738	N.S	N.S	N.S	N.S

and NPK at the medium and high levels over that of no sulphur with the same rates of NPK in both years of study. This indicated the importance of adding sulphur to NPK. However, the shortest plants resulted from sulphure + lowest rate of NPK treatment. Plant height obtained from the medium and high levels of NPK, with or without sulphur did not differ significantly. Concerning leaf and branches number, the interaction between sulphur and different rates of NPK had no significant effect in both years of study.

2- Total yield of fresh pods and its components:-

Data in Table (3) show that total yield of fresh pods, pod fresh weight and number of pods/ plant were significantly increased by the addition of sulphur into the soil than the control (no-sulphur) in the two seasons of study. Also, number of seeds/ pod had similar trend but not significant. However, these results are in line with those obtained by *Abdel-AL et al.* (1973) and *Hewedy* (1999) on tomato; Shaheen *et al.* (1989b) on sweet pepper; *Omar et al* (1990), *Mohamed* & *Qundil* (1998)on peas, *Dhankar et al.* (1991) on pulse crops (Phaseolus aureus and Vigna unguiculata) and *lopez Contarero et al.* (1994), Rahman & Hoque (1994) and *Sawan* & Risk (1998) on eggplant.

Results on the total yield of fresh pods, pod freshweight, number of pods /plant and number of green seeds/pod as affected by the addition of NPK levels are presented in Table (3). Data reveal that plants received NPK at the medium (40:30:48) or high (50: 37.5: 60) rates produced heavier pods, higher number of pods/ plant and higher total fresh yield than the low rate (30. 22.5. 36) in both seasons. There were no significant differences between the medium and high rates of NPK in these parameters in the two seasons.

Table (3): Effect of sulphur and NPK levels on average pod weight, no-pods/ plant, no-seeds/pod and total fresh pods yield in 1998/ 1999 and 1999/2000 seasons.

Treatments		Total yield of fresh pods		Pod fresh weight g		No. of pods/ plant		No-seeds / pod	
Sulphur A	N: P: K B	1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000
0	30:22.5:36	3.024	3.105	8.125	8.208	16.560	17 030	7.831	7 931
	40:30 :48	3.215	3.235	8.183	8.311	18.200	18.950	8.236	8.288
	50.37.5:60	3.248	3.249	8.206	8.312	18.820	19.330	8.228	8.311
50	30:22.5:36	3.416	3.441	8.268	8.381	20.200	20 130	8.315	8.411
	40:30 :48	3.631	3.685	8 693	8.721	24.070	25.400	8.630	8.705
	50:37.5:60	3.682	3.729	8.702	8.717	25.400	26.150	8.648	8.721
Mean A									
0 S		3.162	3.196	8.171	8.277	17.860	18.437	8.098	8.177
50 S		3.576	3 618	6.554	8 608	23.223	23.893	8.531	8 612
Mean B									
Low		3.220	3.273	8.197	8.295	18.380	18.580	8 073	8.171
Medium		3.423	3.460	8.438	8 518	21.135	22.175	8 433	8.497
High		3.465	3 489	8.454	8.515	22.110	22.740	8.438	8 516
L. S D 5%									
A		0 138	0.153	0.188	0.162	1.837	1.615	N S	N.S
B		0.205	0.197	0.207	0.189	2.194	1.972	N.S	N.S
A x B		N.S	N S	N.S	N.S	2.307	2.147	N.S	N.S

These results were in agreement with those obtained by *Bakry et al.* (1984) and *Shokr* (2000) on peas and *Hewedy* & *Mohamed* (1994) on beans,

Thus, it can be stated here that the increase in total yield of fresh pods may be due mainly to the increase in average pod weight as well as the number of pods / plant. Moreover, the increase in total yield could be related to the increase in plant growth which led to more active photosynthesis. However, application of higher rates of NPK resulted in meeting the demand of the plants to these elements but, the insignificant effect between the medium and high rates on these parameters clear that the medium rate of NPK is more suitable for fertilizing pea plants under the conditions of this experiment from the economical point of view.

Table (3) presents the interaction of S x NPK treatments. Data showed no significant effect on pod fresh weight, number of seeds/pod or total yield of fresh pods. However, number of pods/ plant was significantly higher for medium and high rates of NPK + sulphur than the other used treatments in both years. The same findings were indicated by *Sawan & Rizk* (1998) on cowpea.

The results presented in Table 4 show that the average weight of 100-green seeds, average weight of 1000 - dry seeds (seed index) and dry seed yield were significantly greater due to sulphur supplement than the control with zero sulphur in the two seasons of study. These results were in line with those obtained by *Hilal et al.* (1992) and *Singh & Singh* (1992) on peas and *Aulakh & pasricha* (1977) on mung (*Phaseolus aureus* L.).

Data in Table (4) show the effect of NPK fertilization levels on fresh seed weight, seed index and dry seed yield. Results indicated that all previous parameters were significantly affected by NPK treatments in the two growing seasons. Plants fertilized with NPK at the high rate of 50:37.5: 60 kg/fed. had the heaviest fresh seed weight, highest values of seed index and dry seed yield followed by the medium rate of 40:30:48 kg/fed. The lowest values were obtained from the lowest rate of fertilization. Such enhancement of average fresh seed weight, and seed-index may be one of the main reasons for increase in the fresh and dry seed yields. In this respect, *Abo-Bakr et al.* (1993b) found that NPK fertilizers at the rate of 50.30 and 25 kg/fed. markedly increased the dry seed yield of pea plants. With faba bean plants, *Hammam* (1995) reported that seed yield was significantly increased with NPK fertilizer applications. Moreover *Mohamed & EL-Kabbany* (1999) showed that seed index was significantly affected by increasing NPK fertilizer rates. Recently, *Shokr* (2000) on pea plants, reported that NPK fertilizers induced significant increase in fresh seed weight, seed-index and dry seed yield and found that the best treatments in this respect was (40:48:24) followed by (40: 40: 40). The results in Table (4) demonstrated that there were significant differences due to the interaction between sulphur addition and NPK fertilization on fresh seed weight, seed-index and dry seed yield in both seasons. Plants received sulphur and fertilized with NPK at high rate (50:37.5:60) had the highest values of average fresh seed weight, seed-index and dry seed yield. On the contrary, the lowest values of the previous parametres were recorded for plant received the low rate of NPK (30:22.5:36) without sulphur in both years of the experiment.

Table (4): Effect of sulphur and NPK levels on weight of 100. green seeds (g), weight of 1000. dry seeds (seed index) (g) and dry seed yield (ton/fed.) in 1998/1999 and 1999/2000 seasons.

Treatments		100- fresh seed weight (g)		Seed index (1000-seeds weight g.)		Dry seed yield (ton/fed.)	
Sulphur A	N: P: K B	1998/1999	1999/2000	1998/1999	1999/2000	1998/1999	1999/2000
0	30:22.5:36	51.261	52.418	211.467	215 011	0 797	0.818
	40:30 :48	51.839	53.115	218.835	224.924	0.843	0.863
	50:37.5:60	52 211	53.204	229.513	231.372	0.861	0.881
50	30:22.5:36	51.619	52.906	241.223	246 066	0.839	0 847
	40:30 :48	52.226	54 831	267 153	275.415	0.881	0.874
	50:37 5.60	52 841	54.992	276 609	279 333	0 893	0.917
Mean A							
0 S		51 770	52 912	219 938	223 769	0 834	0.854
50 S							
Mean B		52.229	54.243	261.662	266 938	0.871	0 879
Low		51 440	52.662	226.345	230 539	0 818	0 833
Medium		52.033	53.973	242.994	250.170	0.862	0.869
High		52.526	54.098	253.061	255.353	0.877	0 899
L. S. D. 5%							
A		0.047	0.038	5.317	6.012	0.022	0 018
B		0.079	0.071	7.176	9 333	0.027	0.022
A x B		0.127	0.119	10.138	12.725	0.033	0 029

Mineral compositon of pea leaves :-

Data in Table (5) indicated that sulphur incroporated into the soil significantly increased the three major elements N, P and K contents in pea leaves in the two years of experiment. These increments of N, P and K content in leaves by S application may be explained by *Yousry et al.* (1984) and *Heter* (1985) who reported that the addition of sulphur decreases pH value of soil extract and so increase the availability of many elements in rooting zone, which in turn increase their absorption by plants, Many investigators founed positive relationshipe between sulphur addition and NPK content in foliate such as *EL-Leboudi & Omar* (1975) on tomato; *Niranjana & Devi* (1990) on sweet pepper; *Singh & Singh* (1992) on pea and *Sawan & Rizk* (1998) on eggplant.

Data in Table (5) present leaves content of nitrogen, phosphorus and potassium as influenced by the different rates of NPK fertilizers. With increasing NPK from low (30:22.5:36) to medium (40:30:48) or high (50:37.5:60) rates the percentages of nitrogen, phosphorus and potassium raised to reach its peaks with addition of high NPK rate. The significant increase resulted from adding high or medium rate over that of low rate but no significant difference existed between the upper two rates in the two years of study. These increments might be attributed to the presence of sufficient NPK in rooting zone which enabled the roots to absorpe their requirements of these elements. The obtained results are in agreement with those reported by *Zaghloul et al.* (1988) on pea and *EL-Afifi & Darweesh* (1990) on bean, who reported that increasing the rate to 40:36:48 kg NPK/ fed. enhanced NPK contents in leaves. The same conclusion was reported by *Ogbadu & Easmon* (1989) and *Sawan & Rizk* (1998) on eggplants.

Table (5): Effect of sulphur and NPK levels on NPK leaf content and dry seed protein of pea in 1998/1999 and 1999/2000 seasons.

Treatments		N %		P %		K %		Dry seed protein content %	
Sulphur A	N: P: K B	1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000
0	30:22.5:36	3.312	3.402	0.270	0.258	2.351	2.419	19.735	19.933
	40:30 :48	3.446	3.473	0.297	0.277	2.602	2.497	20.103	21.204
	50:37.5:60	3.462	3.509	0.306	0.279	2.618	2.545	20.114	21.310
50	30:22.5:36	3.482	3.446	0.288	0.281	2.437	2.581	21.106	22.005
	40:30 :48	3.536	3.522	0.366	0.296	2.659	2.741	21.739	22.315
	50:37.5:60	3.569	3.548	0.331	0.308	2.704	2.793	22.217	22.298
Mean A									
0 S		3.407	3.462	0.291	0.271	2.524	2.487	19.984	20.816
50 S		3.528	3.505	0.318	0.295	2.600	2.705	21.687	22.206
Mean B									
Low		3.397	3.424	0.279	0.270	2.394	2.500	20.421	20.969
Medium		3.491	3.498	0.317	0.287	2.631	2.619	20.921	21.760
High		3.515	3.529	0.319	0.294	2.661	2.670	21.166	21.804
L. S. D. 5%									
A		0.016	0.037	0.014	0.012	0.063	0.081	N.S	N.S
B		0.048	0.051	0.019	0.016	0.088	0.107	N.S	N.S
A x B		N.S	N.S	N.S	N.S	N.S	N S	N.S	N.S

The interaction between sulphur and NPK treatments recorded no significant effect on the contents of nitrogen, phosphorus and potassium in leaves tissues of pea plant

Protein content in dry seed :-

Data presented in Table 5 show that protein content in dry pea seed was not effected by neither sulphur addition nor NPK fertilizers in both seasons of study. Also, the interaction between S X NPK fertilizers had no significant effect on this character in both seasons of study.

From the previous results, it could be concluded that sulphur supplement together with NPK application at a rate of medium (40: 30:48) or high rate (50:37.5:60) had significant increase in pea vegetative growth and fresh and dry seed yields. These findings could be recommended for pea production grown at the conditions of this experiment.

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تأثير التفاعل بين معاملة التربة بالكبريت والتسميد بمخلوط NPK على النمو والمحصول لنبات البسلة

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أجريت دراسة بمزرعة بحوث الخضر بقها التابعة لوزارة الزراعة – محافظة القليوبية أثناء موسمى ١٩٩٨/١٩٩٩ ، ١٩٩٩/٢٠٠٠ بهدف دراسة تأثير إضافة الكبريت الزراعى (صفر – ٥٠ كيلو جرام/فدان) و٣ مستويات من مخلوط NPK (٣٠- ٥-٢٢,٥ ، ٣٦ – ٤٠-٣٠-٤٨. ٥٠-٣٧,٥ – ٦٠ كجم/ فدان) على النمو والمحصول وجودة القرون فى البسلة صنف ماستر ب وصممت التجارب بطريقة القطع المنشقة.

وأوضحت النتائج أن إضافة الكبريت للتربة أدى إلى زيادة معنوية فى طول النبات وعدد الأوراق / نبات والمحصول الطازج الكلى للقرون ووزن القرن وعدد القرون / نبات ووزن ١٠٠ بذرة طازجة ووزن ١٠٠٠ بذرة جافة (دليل البذرة) والمحصول الكلى الجاف للبذور وكذلك محتوى الأوراق من النتروجين والفوسفور والبوتاسيوم.

أدت إضافة مخلوط NPK بالمستوى المرتفع (٥٠-٣٧,٥-٦٠ جم/فدان) أو المستوى المتوسط (٤٠-٣٠-٥٠ كجم/فدان) إلى زيادة معنوية فى طول النبات وعدد الأوراق / نبات والمحصول الكلى للقرون الطازجة ووزن القرن وعدد القرون / نبات ووزن ١٠٠ بذرة طازجة ودليل البذرة (وزن ١٠٠٠ بذرة جافة) والمحصول الكلى للبذور الجافة وزيادة محتوى الأوراق من النتروجين والفوسفور والبوتاسيوم.

وبينت النتائج بأنه لا يوجد فروق معنوية بين المعدل العالى والمعدل المتوسط من NPK على جميع الصفات السابقة. كان لمعاملات التفاعل بين إضافة الكبريت ومخلوط NPK ذات المستوى المتوسط والعالى تأثير معنوى إيجابى على طول النبات وعلى عدد القرون/ نبات ووزن ١٠٠ بذرة طازجة ودليل البذرة والمحصول البذرى الجاف بالمقارنة بمعاملة عدم إضافة الكبريت والمستوى المنخفض من NPK.