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EFFECT OF PHOSPHORUS AND SULPHUR APPLICATIONS ON LUPINE (*Lupinus termis* L.) YIELD AND GROWTH MEASUREMENTS

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ABSTRACT

Two field trials were conducted at Shandaweel, Agric. Res. Station, A.R.E., during the growing seasons 2000 and 2001 the work aimed to evaluate the effect of different applications of phosphorus (0, 22.5 and 45 kg P2O5/fed.) and sulphur treatments (0, 30, 60 and 90 kg S/fed.) on yield , nodulation , plant growth, N%, protein content and P% of Lupine *(Lupinus Termis L.)* variety, Giza 2 . A split plot design with four replicates was used, P fertilizers in the main plots and sulphur treatments in the sub-plots.

The obtained data indicated that increasing either P or S rates had a significant effect on yield and its components. The interaction effect of both factors (P and S) was significant on seeds yield, plant growth measurements, nodulation intensity, nitrogen %, protein content and phosphorus %. Combination effect of phosphorus and sulphur applications tended to increase the residual available P in soil after plant harvesting.

INTRODUCTION

Lupine *(lupinus Termis L.)* is one of the most important leguminous crop in Egypt. Lupine plays a vital role by providing high quality protein, particularly for vegetarians and those who cannot afford meat. The crops is also used as livestock feed. It has a significant role in farming systems particularly as a substitute for fallow in cereal-growing areas, where it contributes to sustain ability of production and reduces the need for nitrogen fertilizer by fixing atmospheric nitrogen. Sulphur and phosphorus are considered of special importance for leguminous crops because their essentiality in amino and nucleic acids formation and protein metabolism *(Nayak and Dwivedi, 1990; El-Raies et al, 1997 and Mohamed et al., 1999 & 2001)*. The availability of sulphur depends mainly on the physico-chemical conditions of the soil influencing solubility where as the availability N and P is controlled by the microbial activity in the soil (Mengel and Kirkby, 1978; Gendy *et al.*, 1997 and Mohamed & Saleeb, 1999). Many studies have been carried out to investigate the effect of time, methods and rates of P application on legumes, El-Leboudi *et al.*, 1976 and Mohamed, 1998 found that P fertilizers improved the yield of legume crops. This study sought to determine the effect of sulphur and phosphorus applications on some key growth parameters and assess their importance in affecting the yield of Lupine plants.

MATERIALS AND METHODS

Two field experiments were conducted in Shandaweel Agricultural Research Station, Sohag Governorate, Egypt, during the growing seasons of 1999-2000 and 2000-2001. Analysis of the initial soil is shown in the following Table.

Chemical properties of the soil		Physical properties of the soil	
pH	7.50	Sand %	52.4
EC mmhos/cm. at 25 °C	0.43	Silt %	20.6
O.M %	1.002	Clay %	24.5
Total N (ppm)	546.0	Texture class	sandy clay loam
Available P (ppm)	7.10		

The split plot design with four replicates was used ; P fertilizers in the main plots and sulphur treatments in the sub-plots. Analysis of variance and the comparison between means was made according to Spiegel , 1961.
Level of main and sub treatments were as follows:

1- **Phosphorus treatments:**

P1= Zero P2O5/fed.
P2 = 22.5 kg P2O5/fed.
P3 = 45.0 kg P2O5/fed.

II-**Sulphur treatments.**

a- S1 = Zero S/fed.
b- S2 = 30 kg S/fed.
c- S3 = 60 kg S/fed.
d-S4 = 90 kg S/fed.

Application materials were thoroughly mixed with surface soil during the soil preparation. Lupine seeds *(Lupinus Termis L.)* variety, Giza 2 were sown. A basic rate of nitrogen fertilizer dose (15 kg. N/fed.) belong to legume was added to activate nodulation bacteria. Agricultural practices were made at the recommended levels. After 45 days of sowing, plant samples were collected and prepared to analysis. Data of nodulations and their dry weights were calculated as sequare roots before statistical analysis. At maturity, yield and growth measurements were recorded. Seeds were analyzed for nitrogen and phosphorus. After harvesting soil samples were taken to estimate the available-P in each treatments. Determinations of nitrogen and phosphorus and other conditions of soil and plant, were performed following the standard methods reported by Page *et al.*, 1982.

RESULTS AND DISCUSSION

A. Plant growth:

Data of seeds yield /plant, plant height, number of branches/plant and number of pods/plant as affected by P and S addition doses in both seasons are revealed in Table (1). The result show that increasing P rates had a significant raised the growth measurements in both seasons. Data also, clear

that increasing sulphur applications let to progressively increase all plant growth measurements significantly. Concerning the interaction effect between phosphorus and sulphur, data in Table (1), presented that the increase in seeds yield, plant heights, number of branches and number of pods in both seasons due to the combined effect of P and S was significant. The obtained results are in agreement with El-Raies *et al*, 1997 and Mohamed *et al*, 2001.

B. Nodulation:

Data depicted in Figs (1 and 2) reveal that number of nodules and consequently their dry weights responded significantly to P application. The increase in number of nodules and their weights was associated with the increase in phosphorus rate up to 45 kg/fed. in both seasons. Data also, show that a significant affect on the nodulation development of lupine roots, in a direct correlation, due to increase sulphur treatments. Regarding the combined effect of P and S in both seasons, a highly significant increased was observed in number of nodules. Also, the data of dry weight (g) of nodules/plant followed the same trend of the nodules number, for all experimental variable. No worthy alterations could be mentioned which indicate that nodules dry weight directly reflected their numbers without any specific role of the introduced treatments in their parameters apart *(Romenov et al., 1984 and Mohamed & Saleeb, 1999)*.

Table (1): Effect of Sulphur and phosphorus applications on plant growth of Lupine plant.

S Treat	1999-2000				2000-2001			
S Treat	S1	S2	S3	S4	S1	S2	S3	S4
P treat	Seeds yield (g./plant)							
P1	8.53	12.23	13.08	14.48	9.30	12.23	13.43	14.60
P2	11.95	14.58	17.48	18.28	12.60	14.33	17.78	16.23
P3	16.23	18.35	20.53	22.75	16.25	18.60	21.95	24.48
L.S.D 5%	S = 0.418		P = 0.362		SxP = 0.724			
	Plant height (cm)							
P1	148.5	159.0	161.5	163.25	149.25	158.0	164.75	167.0
P2	159.5	165.5	167.75	171.25	157.50	165.75	170.75	174.0
P3	165.5	171.25	175.75	181.75	164.75	174.25	181.75	187.0
L.S.D 5%	%S = 1.774		P = 1.536		SxP = N.S			
	No. of branches /plant							
P1	4.600	5.075	5.300	5.400	4.150	5.050	5.430	5.60
P2	4.950	5.175	5.775	6.475	4.725	5.350	5.900	6.43
P3	5.575	6.725	8.575	9.350	5.400	6.425	7.925	9.25
L.S.D 5%	S = 0.2277		P = 0.1972		SxP = 0.3942			
	No. of pods/plant							
P1	11.350	14.225	15.70	17.58	10.88	14.18	15.75	17.38
P2	13.925	16.450	18.50	19.75	14.15	15.53	18.18	20.13
P3	17.325	19.800	22.80	24.68	16.88	19.65	21.78	23.65
L.S.D 5%	S = 0.2491		P = 0.2157		SxP = 0.4314			

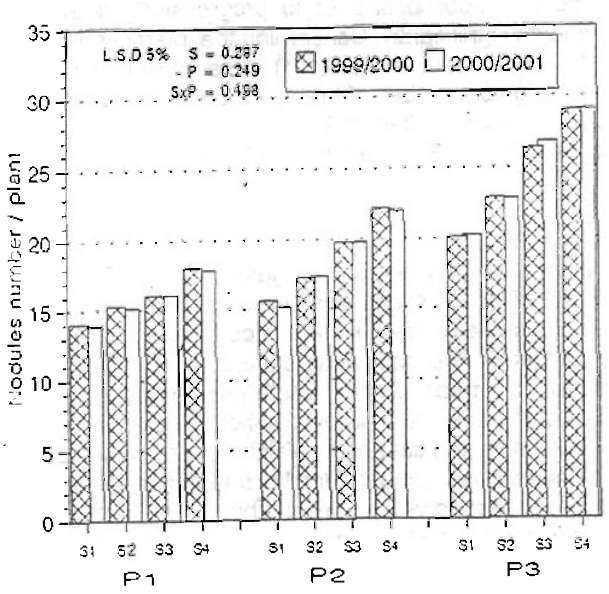

Fig (1): Effect of soil sulphur and phosphorus applications on nodules number

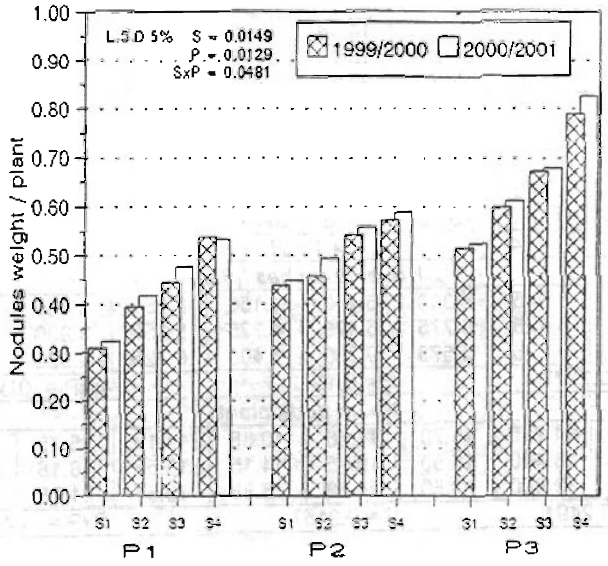

Fig (2): Effect of soil sulphur and phosphorus applications on nodules weight

C. Yield:

It is clearly demonstrated from the results in Table (2) that lupine seeds yield responded significantly to either P or S applications rates up to a certain level, after which additional application increased the seeds yield/fed. The interaction between phosphorus and sulphur was significant, and the highest rate of seeds yield (55.5%) was obtained at the highest doses of P and S (mean increase in both seasons).

Table (2): Effect of sulphur and phosphorus applications on seeds yield (kg/fed.) of Lupine plant.

	1999-2000				2000-2001			
S Treat	S1	S2	S3	S4	S1	S2	S3	S4
P treat	Seeds yield (kg/fed.)							
P1	717.0	781.25	841.75	877.75	738.50	803.75	851.5	883.50
P2	784.0	821.50	890.50	875.25	760.25	835.75	885.5	969.00
P3	929.5	976.75	1016.3	1104.0	910.50	993.50	1044.0	1159.8
L.S.D 5%	S = 13.87		P = 12.01		SxP = 23.88			

D. Nitrogen concentration and protein content:

Values of nitrogen concentration in Lupine plants are given in Table (3). The results clear that N% of Lupine increased significantly with increase P and S rates up to 45 kg P_2O_5 and 90 kg S/fed. respectively, where the maximum level of N-content was reached. On the other word, the combined effect of both P and S was significant on N% in seeds. The increase in N% may be related to better nodulation (Zaroug and Munns, 1980). Data also, reveal that raising either P or S rates had significant effect on protein content. Also the interaction between P and S applications on protein content had the same trend of N % in seeds. (Nayak and Dwivedi, 1990).

Table (3): Effect of sulphur and phosphorus applications on N% and protein content.

	1999-2000				2000-2001			
S Treat	S1	S2	S3	S4	S1	S2	S3	S4
P treat	N% in Seeds							
P1	3.95	4.10	4.31	4.58	3.95	4.10	4.28	4.45
P2	4.10	4.33	4.70	5.05	4.20	4.35	4.58	5.15
P3	4.90	5.25	5.35	5.75	4.70	5.10	5.45	5.73
L.S.D 5%	S = 0.089		P = 0.0769		SxP = 0.1539			
	Protein content in seeds							
P1	24.7	25.35	26.95	28.65	24.70	25.65	26.75	27.80
P2	25.65	27.05	29.40	31.60	26.25	27.10	28.60	32.20
P3	30.60	32.85	33.50	35.90	29.40	31.90	34.10	35.75
L.S.D 5%	S = 0.557		P = 0.483		SxP = 0.965			

E. Phosphorus content:

Total P content in seeds affected significantly by P as well as S applications (Table 4). Increasing the amount of phosphorus up to 45 kg/fed. increased the P% in seeds by about 85.5% over the control. This favourable effect of P fertilizer could be attributed to the vital role of P in the metabolic activities, particularly that dealing with enzyme system and phosiological process such as respiration and photosynthesis (Stephens , 1968 and Mohamed, 1998). The sulphur at the level 90 kg/fed. increased P% in seeds by 45.07%, perhaps, because of a synergistic effect in releasing soil phosphorus (Morok and Dev, 1980) . The interaction of P and S was significant and the highest concentration rates of P in seeds (126.09%) in both seasons.

Table (4): Effect of sulphur and phosphorus applications on P % in seeds.

	1999-2000				2000-2001			
S Treat	S1	S2	S3	S4	S1	S2	S3	S4
P treat	P % In Seeds							
P1	0.215	0.230	0.295	0.320	0.230	0.245	0.305	0.325
P2	0.350	0.360	0.380	0.395	0.345	0.360	0.375	0.405
P3	0.405	0.425	0.455	0.525	0.420	0.440	0.480	0.520
L.S.D 5%	S = 0.0079		P = 0.0069		SxP = 0.0136			

F. Residual soil content of available phosphorus

The results dipicted in Table (5) show the effect of phosphorus and sulphur applications on the residual of available-P in soil.

The available –P increased significantly with every successive application of P and S over the control. The interaction effect of P and S treatment was significant. The rate of increase in available-P due to the combined effect of P and S are somewhat higher than that of the individual one. The increment of available-P may be due to the S-promoted the solubilization of apatite-P already present in or added to the soil (Garcia and Carloni, 1977).

Table (5): Effect of sulphur and phosphorus applications on available P after harvesting.

	1999-2000				2000-2001			
S Treat	S1	S2	S3	S4	S1	S2	S3	S4
P treat	available P (Ppm)							
P1	6.95	7.05	7.10	7.10	6.45	6.90	7.15	7.85
P2	7.25	7.30	7.95	7.95	7.15	7.75	8.15	8.15
P3	8.25	8.35	9.05	9.05	7.45	8.35	9.05	9.65
L.S.D 5%	S = 0.890		P = 0.0769		SxP = 0.1538			

It could be concluded from the discussion that application of P and S at low and high levels affected Lupine growth , yield and its content of N and P. Generally phosphorus application differs in its effect on plant growth, nodulations, yield and nutrients content according to the applied rates especially, in relation to sulphur rates. However, greatest effects were resulted from the interaction between P and S , and the highest positive effect was obtained at the rate of 45kg P_2O_5/Fed and 90 kgS/Fed on all Lupine plant studied paramiters.

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تأثير أضافة الفوسفور والكبريت على محصول الترمس وقياسات النمو

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أجريت تجربتان حقليتان فى محطة البحوث الزراعية بشندويل فى موسمى ٢٠٠٠، ٢٠٠١ لدراسة مدى تأثير اضافة الفوسفور والكبريت على محصول الترمس وقياسات النمو.

وتم استخدام القطع المنشقة بالتجربة حيث كانت معاملات الفوسفور فى القطع الرئيسية والكبريت فى القطع المنشقة ، وقد اوضحت الدراسة ان زيادة معدلات اضافة الفوسفور وكذلك زيادة معدلات اضافة الكبريت كان لهما تأثير معنوى على المحصول وقياسات النمو ، وبينت الدراسة ايضا ان التأثير المتداخل لاضافة كل من الفوسفور والكبريت كان معنويا على المحصول والعقد البكتيرية وكذلك على نسبة كل من النيروجين والفوسفور ومحتوى البذور من البروتين ، وكما أدى إضافة الفوسفور والكبريت الى زيادة فى الكمية المتبقية بالارض من الفوسفور الميسر بعد الحصاد.