FOLIAR FERTILIZATION OF LENTIL AND LUPIN IN SANDY SOILS WITH THE SUPERNATENT OF SUPER-PHOSPHATE AND K-SULPHATE

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Abstract

Phosphorus and potassium supply to leguminous crops is necessary especially at the flowering and setting stages. A 2-year field experiment was carried out at Ismailia Agricultural Research Station in 1994/95 and 1995/96 growing seasons to evaluate the effect of foliar application of the supernatant of soaked Ca-superphosphate (SP) and K-sulphate (KS) both at the rate of 5 kg/fed., (5 kg Sp + 5 kg KS) /fed. (10 kg SP + 5kg KS) / fed. or (5kg SP+10 kg KS)/fed. on yield and its components of lentil and lupin as well as seed contents of protein, phosphorus and potassium.

Foliar spray with the solutions of SP at the rate of 5 kg/fed. or the mixture of 10 kg SP+ 5 kg KS/fed. induced significant increases in yield and yield components of both crops during the two growing seasons compared to the control, except the lupin straw yield which was not significantly affected by all studied treatments. Foliar application of 10 kg SP + 5 KgKS/fed. was superior to 5 kg SP/fed. in most cases with no significant differences. Both lentil and lupin plants were not significantly affected by the other treatments except the straw yield and seed potassium content of lentil which showed significant increases due to foliar application of KS (5 kg/fed.) and 5 kg SP + 10 kg KS/fed. Seed contents of protein and phosphorus were not significantly affected by the studied treatments.

INTRODUCTION

Lentil (*Lens Culinaris, Medic*) and Lupin (*Lupinus Termis L.*) are important legume crops as a source of cheap available protein for human consumption in Egypt. Now, the area grown by the two crops inceased in the Nile Delta and the newly re-

claimed soils (sandy soils) which are considered for future expansion and attention should be taken with respect to their nutritional status.

Addition of P and K nutrients maintain high productivity and good quality of different crops. Many investigators working on lentil found that P fertilization induced significant increases in yield of seed and straw as well as seed protein and P contents (Ali 1981, Zeidan *et al.*, 1986; Bremer *et al.*, 1989; El-Ghareib *et al.*, 1989, and Okaz *et al.* 1994). Simillar results were obtained when P fertilizer was used on lupin (Abd El-Hady 1987, and Amin 1987). Also, Abd El-Lateef (1996) showed that P fertilization caused significant increases in yield and quality of mungbean. He added that mungbean above ground biomass weight showed the greatest response when plants were fertilized with 32 kg P_2O_5/fed and sprayed with K (36% K_2O solution).

Okaz *et al.* (1994) stated that yield components of lentil were not significantly affected by potassium soil application in sandy soils, while seed K content was signifciantly increased.

Sharma and Singh (1986), and Bremer *et al.* (1989) found that P fertilizer did not affect lentil seed protein content. Also, Abd El-Lateef (1996) showed that protein percentage in mungbean seeds was not affected by either soil (P_2O_5) or foliar (K_2O) application.

Hussein *et al.* (1993) reported that foliar application of P_2O_5 2% resulted in the highest faba bean yield components and seed yield as well as seed crude protein percentage. Hewedy (1994) pointed out that spraying plants of common bean with potassium sulphate increased seed yield. Seed yield of cowpea was also increased by 20.71 and 8.5% by foliar application of super-phosphate 3% and K-sulphate 2% (El-Gizy *et al.*, 1995); P and K treatments decreased the damaged seed and increased seed protein percentage.

The aim of this research is to study the effect of foliar spray of the supernatent of soaked Ca-superphosphate (15% P_2O_5) and K-sulphate (48% K_2O) alone or in different ratios on yield components, yield and seed chemical composition of lentil and lupin crops grown under sandy soil conditions.

MATERIALS AND METHODS

Two field experiments were carried out at Ismailia Agricultural Research

Station during the two successive growing seasons 1994/1995 and 1995/1996. One experiment was devoted for lentil crop and the other for lupin. The main objective of this research is to study the effect of foliar application of the supernatent of soaked Ca-superphosphate and K-sulphate alone or in different ratios on yield components, yield and seed chemical composition of the two crops grown on new reclaimed sandy soils. Ca-superphosphate (15% P_2O_5) and potassium sulphate (48% K_2O) were used at the following rates:

1- 5 Kg superphosphate (SP) / fed.

2- 5 Kg K sulphate (KS)/fed.

3- (5 Kg SP + 5 Kg KS) / fed.

4- (10 Kg SP + 5 kg KS)/fed.

5- (5 Kg SP + 10 Kg KS)/fed.

The above mentioned amounts of Ca-superphosphosphate and K-sulphate as well as their mixtures were soaked in 100L. water (the quarter of the final volume) and kept overnight then decanted and filtered through a piece of cloth and completed to 400 L.

The plants of both crops received two sprays of this solution at the beginning of flowering and setting (early pod formation) stages using wetting agent, Triton-B, 0.5 ml/L.

Primary addition of N, P kg N and K fertilizers was practiced as soil application for all plots. Nitrogen at the rate of 15 kgN/fed as ammonium sulphate (20.6% N) was used after two weeks from sowing. Phosphorus at the rate of 30 kg P_2O_5/ fed as Ca super-phosphate (15 % P_2O_5) and K at the the rate of 24 K_2O/fed. as K-sulphate (48% K_2O) were added at sowing. Chemical analyses of the experimental soils presented in Table (1).

Available N was extracted by 1% K_2SO_4 solution and determined using Kjeldahl method (A.O.A.C. 1970). Available P was extracted by 0.5 N NaHCO3 solution (pH 8.5) and determined according to Olsen method (Jackson 1958), while available K was extracted by 1.0 N neutral ammonium acetate (Black 1965). Available Fe, Zn and Mn were extracted by the DTPA method (Lindsay and Norvell 1969) and determined by atomic absorption spectrophotometer.

The experimental design was complete randomized blocks with four replicates.

Plot area was 10.5 m^2 (3.0 x 3.5 m) with fifteen lines in each plot for lentil and 6 for lupin. Distance between hills was 20 cm and thinning took place 30 days after sowing (two plants per hill). Seeds of lentil (variety Giza 9) and lupin (variety Giza 5) were at the rate of 50 kg /fed. Seeds were inoculated with *Rhizobium sp.* strains.

The other cultural practices were carried out according to the usual methods adopted for lentil and lupin crops. At maturity, five guarded plants were taken from a certain line or row in each plot to evaluate yield attributes.

Table 1. Soil chemical analyses of the experimental sites during the two growing seasons.

Soil properties	Lentil		Lupin	
	1994/95	1995/96	1994/95	1995/96
pH (1:2.5, soil: water)	7.65	7.50	7.70	7.80
EC. mmoh./cm (1:5, soil: water)	0.27	0.23	0.27	0.23
$CaCO_3$ (%)	0.50	0.17	0.17	0.13
Available N (ppm)	10.00	40.00	50.00	40.00
Available P (ppm)	2.20	2.40	1.80	1.40
Available K (ppm)	80.10	53.50	89.00	53.50
Available Fe (ppm)	1.32	1.30	1.14	1.40
Available Zn (ppm)	0.28	0.54	0.58	0.30
Available Mn (ppm)	0.68	0.60	1.32	0.64

Seeds of lentil and lupin were subjected to chemical analyses to determine protein, phosphorus, and potassium contents. Nitrogen percentage was determined by micro-Kjeldahl apparatus as described by A.O.A.C. (1970), then multiplied by 6.25 to obtain protein percentage. Phosphorus was determined colourimeterically according to Jackson (1958). Potassium was determined colourimeterically according to Jackson (1958). Potassium was estimated in digested material by flamephotometer (Chapman and Pratt, 1961). The data subjected to statistical analysis and the averages were compared by L.S.D. as mentioned by Snedecor and Cochran (1971).

RESULTS AND DISCUSSION

1- Yield components :

Data in Table (2) indicated that spraying lentil and lupin plants with the solu-

tions of soaked superphosphate (SP) alone at the rate of 5 kg/fed. or with the mixture of 10 kg SP + 5 kg K-sulphate (KS)/fed significantly increased the yield components of both crops under study, i.e. plant height, number of branches and pods/plant pod weight/plant and seed index during the two growing seasons compared with the untreated plants, except the lupin height which was not significantly affected by application of 5 kg SP /fed. Moreover, the two previous treatments gave higher mean values than those obtained by spraying KS (5 kg/fed.) alone which showed insignificant effects on the above mentioned characters. The positive effect of SP application could be attributed to (1) the increase in the effeciency of both plants to photosynthesate metabolites by P which reflected on increasing the production of more sizeable organs, (2) phosphorus also exerts a very inmportant role in the energy storage and its transfer in the plant, and thus, (3) phosphorus encouraged the vegetative growth of both plants and flowering, fruiting and seed set. This might interpret the increased number of branches and pods/plant due to phosphorus application. In this respect Hussein *et al.* (1993) demonstrated that foliar application of P_2O_5 (2%) gave the highest faba bean yield components. However, El-Gizy *et al.* (1995) reported that shelling percentage, pod length and number of seed/pod of cowpea did not show any response to foliar application of P as superphosphate or K as potassium sulphate.

In one season only, pod weight of letntil/plant, and plant height and seed index of lupin were significantly increased by KS application as shown in Table (2). In this respect, Okaz *et al.* (1994) showed that yield components of lentil were not significantly affected by soil KS application except the number of pods/plant which was significantly reduced.

Noteworthy, there was no significant difference between the treatments of foliar application of 5 kg SP/fed. and the combination of 10 kg SP + 5kg KS except that the lupin plant height showed significant reductions in most yield components compared to these two treatments. In this connection; Abd El-Lateef (1996) found that mungbean above ground biomass weight showed the greatest response when plants were fertilized with 32 kg P_2O_5/fed. and foliar sprayed with 36% K_2O solution.

2- Seed and straw yields :

Highly significant increases in seed and straw yeilds of lentil per plant or feddan over the control treatment were obtained either from the treatment SP at the

Table 2. Effect of foliar application of super-phosphate and potassium sulphate on yield components of lupin during 1994/1995 and 1995/1996 seasons.

Treatments*	Plant height (cm)		Number of branches/plant		Number of pods/plant		Weight of pods (g/plant)		(Seed index) 1000-seeds weight (g)	
	1994/95	1995/96	1994/95	1995/96	1994/95	1995/96	1994/95	1995/96	1994/95	1995/96
Lentil										
Control	32.8	29.4	4.43	3.48	15.53	13.60	0.462	0.468	25.58	25.08
5 kg SP/fed	37.9	34.9	6.40	5.30	24.90	23.85	0.939	0.840	27.48	26.17
5 Kg KS/fed.	33.1	30.5	5.38	4.73	19.63	14.00	0.690	0.552	25.75	25.66
(5 kg SP + 5 kg KS)/fed.	37.2	32.4	5.08	4.28	18.30	19.58	0.740	0.668	26.14	25.32
(10 kg SP+ 5 kg KS)/fed.	39.2	35.8	5.73	6.00	25.75	24.53	0.984	0.863	28.10	27.00
(5 kg SP + 10 kg KS)/fed.	36.2	31.5	4.93	3.85	17.53	17.50	0.677	0.552	24.85	25.40
L.S.D. at 0.05	3.0	4.8	1.16	1.55	6.34	5.49	0.327	0.049	1.91	0.98
Lupin										
Control	60.4	67.6	13.5	13.8	10.6	14.8	11.94	13.77	24.21	23.51
5 kg SP/fed	61.5	69.5	17.1	18.2	13.6	18.2	15.55	18.77	27.70	25.85
5 Kg KS/fed.	59.5	75.0	13.5	13.8	10.1	16.5	11.81	13.67	26.47	26.23
(5 kg SP + 5 kg KS)/fed.	58.4	67.2	12.8	13.5	10.7	15.1	9.01	11.31	27.98	26.66
(10 kg SP+ 5 kg KS)/fed.	66.6	75.6	17.4	19.9	14.2	18.9	17.55	19.02	27.17	22.64
(5 kg SP + 10 kg KS)/fed.	59.6	69.2	13.4	16.9	10.1	17.5	14.66	16.55	27.32	26.16
L.S.D. at 0.05	4.0	4.1	1.9	1.7	2.7	3.0	4.31	4.68	1.80	2.75

*SP : Ca-superphosphate (15% P_2O_5) KS : K-sulphate (48% K_2O).

rate of 5 kg/fed or the treatment 10 kg SP combined with 5 kg KS/fed as shown in Table (3). Similar results were nearly obtained with lupin except the straw yield/ fed. which was not significantly affected by the treatments under study (Table 4). Such results may be attributed to the important role of phosphorus in energy storage and transfer metabolite compounds raised in fertilized plants. These results agree with those obtained by Hussein *et al.* (1993) on faba bean and El-Gizy *et al.* (1995) on cowpea, Kene *et al.* (1991) on groundnut, Soliman *et al.* (1991) on common bean and Srinivasan and Ramasamy (1992) on cowpea who found that foliar application with superphosphate increased seed yield.

Seed yield of both lentil and lupin was also increased significantly by foliar spray with 5 kg SP + 10 kg KS/fed. This treatment also recorded the highest straw yield of lentil. The lupin straw yield was not affected as previously mentioned. On the other hand, seed and straw yields/plant were not significantly affected by foliar application of 5 kg SP/fed. combined with either 5 kg or 10 kg KS/fed. as shown in Tables (3) and (4).

3- Seed contents of Protein, phosphorus and potassium:

Data presented in Tables (5) and (6) clearly indicated that the foliar spray with SP and/or and KS in different levels did not show significant effects on protein, phosphorus and potassium percentages of lentil and lupin seeds in both seasons, except seed potassium content of lentil which was significantly increased by foliar application of 5 kg KS or 5 kg SP+10 kg KS compared to the control treatment during the two growing seasons. These findings were in agreement with those obtained by Sharma and Singh (1986), Bremer *et al.* (1989), and Abd-El-Lateef (1996). Okaz *et al.* (1994) stated that seed potassium content of lentil plant was significantly increased with potassium fertilizer. However, Hussein *et al.* (1993) indicated that foliar application of P_2O_5 (2 % solution) gave the highest significant increase in crude protein percentage of faba bean seeds. Also, El-Gizy *et al.* (1995) reported that foliar application of superphosphate and K-sulphate increased proterin percentage of cowpea.

Table 4. Effect of foliar application of Ca-superphosphate and potassium sulphate on lupin yield during 1994/1995 and 1995/1996 seasons .

	Seed yield (g/plant)		Straw yield (g/plant)		Seed yield (ardab**/fed)		Straw yield (ton/fed.)	
	1994/95	1995/96	1994/95	1995/96	1994/95	1995/96	1994/95	1995/96
Control	9.87	9.86	17.36	18.74	4.58	4.47	0.95	0.99
5 kg SP/fed	14.29	14.52	21.86	23.61	6.65	6.17	1.14	1.14
5 kg KS/fed.	9.81	9.50	18.25	21.08	4.84	5.38	0.96	1.01
(5 kg SP + 5 kg KS) fed.	7.71	11.47	13.47	19.24	4.90	5.27	1.13	1.02
(10 kg SP + 5 kg KS) fed.	13.39	13.59	20.89	23.42	6.20	6.52	1.09	1.06
(5 kg SP + 10 kg KS) fed.	10.89	12.49	19.95	23.29	6.12	5.81	1.02	1.21
L.S.D. at 0.05	2.64	3.60	4.42	4.62	0.72	1.20	N.S.	N.S.

*SP = Ca-superphosphate (15 % P_2O_5)

KS = K-sulphate (48% K_2O).

Ardab = 150 kg

Table 3. Effect of foliar application of Ca-superphosphate and potassium sulphate on lentil yield during 1994/1995 and 1995/1996 seasons .

Treatments*	Seed yield (g/plant)		Straw yield (g/plant)		Seed yield (ardab**/fed)		Straw yield (ton/fed.)	
	1994/95	1995/96	1994/95	1995/96	1994/95	1995/96	1994/95	1995/96
Control	0.329	0.335	0.685	0.607	1.37	1.43	0.735	0.638
5 kg SP/fed	0.777	0.719	1.052	0.912	2.34	2.21	1.068	1.120
5 kg KS/fed.	0.531	0.502	0.963	0.611	2.22	1.80	1.003	0.855
(5 kg SP + 5 kg KS) fed.	0.441	0.469	0.928	0.834	2.13	1.84	0.808	0.725
(10 kg SP + 5 kg KS) fed.	0.734	0.701	1.055	0.955	2.72	2.51	1.025	0.853
(5 kg SP + 10 kg KS) fed.	0.528	0.440	0.820	0.617	2.21	2.10	1.163	1.203
L.S.D. at 0.05	0.210	0.167	0.246	0.244	0.69	0.62	0.246	0.187

*SP = Ca-superphosphate (15 % P_2O_5)

KS = K-sulphate (48% K_2O).

** Ardab = 160 kg

Table 5. Effect of foliar application of Ca-superphosphate and potassium sulphate on protein, phosphorus, and potassium percentage in lentil seeds during 1994/95 and 1995/96 seasons.

Treatments*	Protein (%)		Phosphorus (%)		Potassium (%)	
	1994/95	1995/96	1994/95	1995/96	1994/95	1995/96
Control	26.78	25.17	0.309	0.276	1.27	1.19
5 kg SP/fed	29.03	28.5	0.403	0.355	1.41	1.21
5 kg KS/fed.	29.73	29.01	0.344	0.317	1.49	1.33
(5 kg SP + 5 kg KS) fed.	29.45	27.12	0.407	0.316	1.29	1.26
(10 kg SP + 5 kg KS) fed.	29.65	28.25	0.411	0.364	1.55	1.28
(5 kg SP + 10 kg KS) fed.	27.98	27.37	0.4	0.296	1.59	1.42
L.S.D. at 0.05	N.S.	N.S.	N.S.	N.S.	0.14	0.12

* SP : Ca- superphosphate (15% P_2O_5)
KS : K-sulphate (48% K_2O)

Table 6. Effect of foliar application of Ca-superphosphate and potassium sulphate on protein, phosphorus, and potassium percentage in lupin seeds during 1994/95 and 1995/96 seasons.

Treatments*	Protein (%)		Phosphorus (%)		Potassium (%)	
	1994/95	1995/96	1994/95	1995/96	1994/95	1995/96
Control	31.55	30.2	0.318	0.284	1.065	1.016
5 kg SP/fed	35.03	34.03	0.39	0.403	1.072	1.058
5 kg KS/fed.	34.63	34.4	0.349	0.312	1.11	1.02
(5 kg SP + 5 kg KS) fed.	33.63	32.23	0.343	0.305	1.13	1.04
(10 kg SP + 5 kg KS) fed.	34.65	33.58	0.384	0.93	1.032	1.043
(5 kg SP + 10 kg KS) fed.	31.43	33.33	0.292	0.282	1.038	1.053
L.S.D. at 0.05	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

* SP : Ca- superphosphate (15% P_2O_5)
KS : K-sulphate (48% K_2O)

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التغذية الخضرية بواسطة منقوع السوبر فوسفات وكبريتات البوتاسيوم للعدس والترمس فى الاراضى الرملية

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معهد بحوث الاراضى والمياه والبيئه – مركز البحوث الزراعية – الجيزة .

يعتبر امداد المحاصيل البقولية بعنصرى الفوسفور والبوتاسيوم ضرورى خاصة عند مرحلتى التزهير والعقد. لهذا أقيمت تجربة حقلية فى محطة البحوث الزراعية بالاسماعيلية اثناء موسمى الزراعة ١٩٩٤ / ١٩٩٥ ، ١٩٩٥ / ١٩٩٦ لتقييم تأثير الرش بمحاليل منقوع السوبر فوسفات وكبريتات البوتاسيوم كل بمعدل ٥ كجم / فدان بالاضافة الى مخاليطهم بنسب مختلفة (٥ كجم سوبر فوسفات + ٥ كجم كبريتات بوتاسيوم) / فدان (١٠ كجم سوبر فوسفات + ٥ كجم كبريتات بوتاسيوم)/ فدان (٥ كجم سوبر فوسفات + ١٠ كجم كبريتات بوتاسيوم) / فدان على محصول العدس والترمس ومكوناتهما بالاضافة الى محتويات البذور من البروتين والفوسفور والبوتاسيوم.

اوضحت النتائج ان الرش بمنقوع ٥ كجم سوبر فوسفات / فدان والمخلوط المكون من (١٠ كجم سوبر فوسفات + ٥ كجم كبريتات بوتاسيوم) / فدان أحدث زيادة معنوية فى محصول العدس والترمس ومكوناتهما اثناء موسمى الزراعة بالمقارنة بمعاملة الكنترول ماعدا محصول قش الترمس الذى لم يتاثر معنويا بجميع المعاملات المستخدمه. وقد تفوق الرش بمنقوع مخلوط (١٠ كجم سوبر فوسفات + ٥ كجم كبريتات بوتاسيوم)/ فدان فى معظم الحالات، ولكن بدون فرق معنوى بينه وبين منقوع السوبر فوسفات فقط بمعدل ٥ كجم / فدان كما أوضحت النتائج ان كل من نباتات العدس والترمس لم تتأثر معنويا بباقى المعاملات فيما عدا محصول القش للعدس ومحتوى بذوره من البوتاسيوم اللذان اظهرا زيادة معنوية نتيجة الرش بمنقوع كبريتات البوتاسيوم بمفرده بمعدل ٥ كجم / فدان أو مخلوطه (١٠ كجم + ٥ كجم سوبر فوسفات) / فدان . هذا ولم يتأثر محتوى البذور من البروتين والفوسفور بالمعاملات المختلفة.