Effect of Sulphur and Phosphorus on the Growth, Yield and Nutrient Contents of Cowpea (*Vigna sinensis* L.) Grown in Clay Soil

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ABSTRACT

Field experiment was carried out during the growth season 2005/2006 at Agricultural Research Station (Abis), Faculty of Agriculture Saba Basha, University of Alexandria. Fertilizer P treatments were arranged within S treatments in three replicates in split-plot design, with S treatments as the main plot and P treatments as the sub-plot. The area of each plot was 10.5 m^2 (3 m length and 3.5 m width). All plots had received sulphur as agriculture sulphur (99.9 % S) and phosphorus as superphosphate fertilizer (15.5 % P_2O_5) before planting. Cowpea (*Vigna sinensis* L.) variety Cream 7 was seeded in ridges at 70 cm spacing between ridges and 20 cm distance between hills. The S was applied at rates of 0, 50, 100 and 150 kg S/fed., and P was applied at rates of 0, 15, 30 and 45 kg P_2O_5/fed. The results obtained showed significant increases of dry weights of shoots, roots, grains yield, and also N, P, K concentrations in shoots and roots, N, P and K uptake in shoots, amounts of available P and water soluble sulphate in soil with increasing sulphur application up to 150 kg S/fed., while, the soil pH was decreased. The average relative increases in dry weights of shoots were 15.57, 36.4 and 73.87 % with respect to the control and those of root were 18.39, 33.91 and 44.83 %, while those of grains yield were 5.12, 9.4 and 15.49 % with S dose 50, 100 and 150 kg S/fed. respectively. Significant increases both in dry weight of shoots, roots and the grains yield, N, P, K concentrations in shoots or roots, N, P, K uptake in shoots, available P in soil, and water soluble sulphate in soil with increasing phosphorus application. Also, the soil pH was decreased. The interaction effect between S and P had significant effect on these characters except water soluble sulphate. The obtained results, generally, showed that application of sulphur to the clay soil, as soil amendment, had increased the grains yield of cowpea and also the contents of N, P and K in plants. The results also showed that sulphur application improved P efficiency and increased its availability in soil.

INTRODUCTION

Cowpea **(***Vigna sinensis* **L.)** is an important grain legume in the dry regions and marginal areas of the tropics and subtropics. It is particularly important in West Africa with over 9.3 million tones annual production (Ortiz, 1998). The grains are good source of protein, while the haulms are valuable source of livestock protein and for enhancing soil fertility through biological N fixation (Giller 2001).

Phosphorus and sulphur elements are considered of especial importance for leguminous plants because their essentiality in amino and nuclic acids formation and protein metabolis (El-Raies *et al.*, 1997).

Phosphorus plays a key role in symbiotic nitrogen fixation by accelerating N fixation process in legumes (Tiwari, *et al.* 2002) and establishment of root system, seed formation and hastening maturity (Saravana-Pandian and Annaduria, 2005). Sulphur plays a vital role in metabolic activities of the plant especially by improving the activities of proteolytic enzymes and oil synthesis (Saravana Pandian and Annaduria, 2005). The role of sulphur in plants is to help in the formation of plant proteins, and it is essential for the formation of chlorophyll. It also helps in the efficient use of phosphorus in plants, (Inter. Plant Nutr. Inst., 2008). The availability of P increased with increasing both sulphur application rates and inoculated period of soils with sulphur oxidizing bacteria (Abd-Elfattah *et al.*, 2005). Earlier studies revealed that both synergistic and antagonistic relationship between P and S. However, the recent researches have shown that the nature of P and S relationship depends on their rate of application and crop species (Bapat *et al.* 1986). Owolade, *et al.* (2006) found that application of phosphorus significantly increased the number of petioles, pods, nodules, seed/pod, leaf area and yield of cowpea. Plant dry weight, nitrogen and phosphorus uptake increased grains yield with rock phosphate and sulphur applications as compared with the control (Saber and Kabesh, 1990).

The objectives of this study were to determine the combined effects of sulphur and phosphorus treatments on the growth, yield and nutrients contents of Cowpea (*Vigna sinensis* L.) grown in clay soil and, their effects on some chemical properties of soil.

MATERIALS AND METHODS

Field experiment was carried out during the growth season 2005/2006 at the Agricultural Research Station (at Abis), Faculty of Agriculture, Saba Bacha, and University of Alexandria. The experimental soil was analyzed, according to the methods outlined in Black (1965) and Page *et al*., (1982) for the determination of some soil physical (particle size distribution: sand, silt and clay) and chemical (salinity, soluble ions, O.M., pH, total carbonate, total N and available-P) properties. The obtained data are presented in Table (1).

Experimental Layout:

In this study, fertilizer P treatments were arranged within S treatments in a three replicates in split-plot design, with S treatments as the main plot and P treatments as the sub-plot. The area of each plot was 10.5 m^2 (3 m length and 3.5 m width). The sulphur was applied as agriculture sulphur (99.9 % S) and phosphorus as superphosphate fertilizer (15.5 % P_2O_5) before planting. Cowpea (*Vigna sinensis* L.) variety Cream 7 was seeded in ridges at 70 cm spacing between ridges and 20 cm distance between hills at 4th May 2005. The S was applied at rates of 0, 50, 100 and 150 kg S/fed., and P was applied at rates of 0, 15, 30 and 45 kg P_2O_5/fed. The nitrogen (50 kg N/Fed) was applied as ammonium sulphate (20.5 % N) after two weeks of planting, and potassium was applied at a rate of 50 kg/fed as potassium sulphate (48 % K_2O) in two equal doses. The first dose was added before the first irrigation and the second dose was added at flowering stage. The common agricultural practices were carried out during the field experiment. Seeds yield was determined by hand-harvest of plants of the middle ridge from each plot.

Table (1). The average values of the main physical and chemical properties of the experimental soil

Soil properties	Values	Soil properties	Values
Particle size distribution:		Water soluble ions: (meq/L)	
Sand %	36.72	Ca^{++}	5.46
Silt %	17.21	Mg^{++}	3.48
Clay %	46.07	Na^{+}	7.60
Soil texture	Clay	K^{+}	0.91
pH*	8.29	$HCO^{=}_3$	2.80
EC** (dS/m)	2.46	Cl^{-}	14.53
Total $CO^{=}_3$ %	7.97	$SO^{=}_4$	0.35
Organic-C %	0.87	Total N, %	0.07
Total P (mg/kg soil)	207.36	Available P (mg/kg soil	5.08

* measured in 1: 1 soil- water suspension   ** measured in 1: 1 soil-water extract

Sampling and Analysis:

Plant:

Samples of plant shoots and roots were collected at flowering stage and the grains were collected at harvest from the middle ridge of each plot, washed with tap water then with distilled water and oven dried at 70˚C for 48 h then ground finely and the dry weight of shoots and roots were measured (Chapman and Pratt, 1961). The oven-dried plant material was wet-digested with H_2SO_4-H_2O_2 (Lowther, 1980) and the following determinations were carried out in the digested solution. Potassium was measured using flame photometer, total phosphorus were determined colorimetrically by vanadomolbydate using spectrophotometer, (Chapman and Pratt, 1961) and total nitrogen was determined by Microkjeldehl (Page *et al.*, 1982). The grains yield was determined after hand harvesting of plants of the middle ridge of each plot.

Soil:

Samples of soil (0-20 cm) were collected during flowering stage of cow pea plant and the amount of available phosphorus in the soil was determined by extraction with 0.5 M sodium bicarbonate pH 8.5and P was measured using spectrophotometer (Chapman and Pratt, 1961). Also, $SO_4^{=}$ content in the soil solution and soil pH were determined according to the methods described by Page *et al.* (1982).

The obtained data were statistically analyzed for ANOVA and the values of L.S.D. were calculated, to test the differences between the studied treatments, according to Steel and Torrie (1980). In addition, multiple regressions were calculated (CoHort Sofware, 1995).

RESULTS AND DISCUSSION

Table (2) showed significant increases of the dry weights of shoots and root and the grain yield, with increasing sulphur application. The average relative increases in the dry weight of shoots were 15.57, 36.4 and 73.87 %, with respect to the control, and those of root were 18.39, 33.91 and 44.83 %, while those of grains were 5.12, 9.4 and 15.49 % with S dose 50, 100 and 150 kg S/fed. respectively. These data indicated that S can improve yield of cowpea through its stimulating effect on several biochemical reactions in the plant (Mengle and Kirkby, 1982) and (Inter. Plant Nutr. Inst., 2008).

With respect to phosphorus fertilization, Table 2 showed significant increases in dry weights of shoots, roots and grain yield with increasing phosphorus application. The significant response of cowpea to P application in terms of dry weight of shoots, roots and the grain yield is an indication of the importance of P for the performance of cowpea in the field (Tenebe *et al.*, 1995 and Ankomah *et al.,* 1995). Okeleye and Okelana (1997) observed significant increase in grain yield, total dry matter of cowpea varieties in response to P application. The favorable effect of phosphorus on yield may be due to its role in the constitution of ribonucleic acid, deoxyribonucleic acid and ATP which regulate the metabolic processes in plant, helping in root formation, nitrogen fixation and crop yield (Tiwari, *et al.* 2002). The observed increase in cowpea grain yield, due to increase of applied P, is in consonance with the results reported by Sheoran, *et al.* (1994); Teneba *et al.* (1995); Ankomah *et al.* (1995); Mishra and Baboo, (1999); Kolawole *et al.* (2002) and Owolade *et al.* (2006).

Table (2): The average value of the dry weight of shoots and roots and grain yield as affected by sulphur and phosphorus application

Treatments		Dry weight of shoots g/plant	Dry weight of roots g/plant	Grain yield, kg/fed.
kg S /fed	kg P_2O_5/fed			
0	0	18.12	0.97	275.19
	15	22.58	1.59	541.21
	30	25.20	2.02	587.43
	45	31.48	2.38	730.00
average		24.34	1.74	569.29
50	0	23.79	1.56	502.59
	15	26.73	1.73	559.79
	30	28.67	2.25	608.39
	45	33.34	3.12	756.20
average		28.13	2.06	598.41
100	0	28.36	1.30	515.42
	15	30.33	1.83	565.75
	30	33.49	2.80	649.23
	45	40.64	3.39	760.88
average		33.20	2.33	622.82
150	0	30.96	1.45	528.13
	15	38.44	1.93	579.34
	30	45.89	2.63	693.42
	45	53.98	4.07	828.99
average		42.32	2.52	657.47
Over all mean	0	25.31	1.22	505.33
	15	29.52	1.77	561.52
	30	33.31	2.43	634.61
	45	39.86	3.24	746.52
$L.S.D._{0.05}$				
Sulphur rate (S)		1.37	0.08	15.45
Phosphorus rate (P)		0.87	0.04	14.69
S x P		1.75	0.08	29.60

Table 2 showed also that the interaction effect between S and P significantly increased the dry weight of shoot, roots and grain yield. The highest values of these characters were obtained with 150 kg S/fed and 45 kg P_2O_5/fed.

In order to evaluate mathematically the effect of S and P rates, multiple regression equation was developed where the grain yield or dry weight of shoot (Y) was correlated with S (X_1) and P (X_2) applications. The regression equations for these relationships can be represented as follows:

Grain yield = $452.283 + 0.476 X_1 + 0.576 X_2$ $R^2 = 0.945$ ($P<0.01$)

Shoots dry weight = $16.034 + 0.118 X_1 + 0.316 X_2$ $R^2 = 0.919$ ($P<0.01$)

These equations indicate that the grain yield is highly affected by both S (X_1) and P (X_2). The regression equation (Fig. 1) at each level of S application, revealed the expected grain yield (kg/fed.) or shoots dry weight (g/plant) which are calculated from the origin data. This chart makes sure that phosphorus is very important to grain yield while sulphur comes after under the current experimental conditions. Similar results were obtained by El-Raies, *et al.* (1997).

Nutrients concentrations:

Table 3 showed that N, P and K concentrations in shoots and roots of plant increased significantly with increasing sulphur application. The positive significant effect of sulphur on N, P and K contents in plant organs were also obtained by Singh and Aggarwal (1998). Also phosphorus application significantly increased N, P and K concentrations in the shoots and roots. The interaction effects between sulphur and phosphorus significantly increased N, P and K concentrations in shoots and roots and the highest values were obtained with 150 kg S/fed. plus 45 kg P_2O_5/fed.

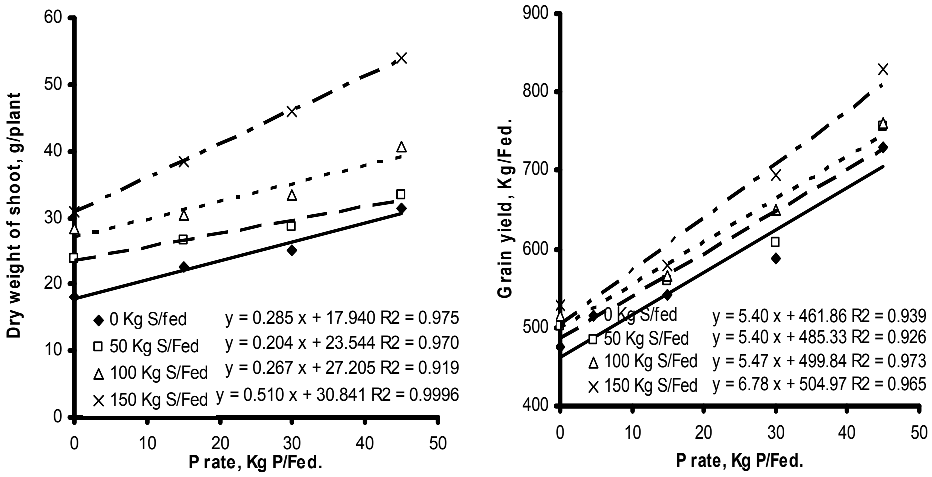

Fig.(1). The relationship between dry weight of shoots (g/plant) or grain yield (kg/fed) and phosphorus rates at different sulphur applications.

Nutrients uptake:

The uptake of N, P and K were increased with increasing rates of sulphur or phosphorus fertilization (Table 4). Similar results were obtained by Saber and Kabesh (1990). Hern *et al.* (1988) found that application of sulphur increased N uptake. It is also clear that the interaction effects between sulphur and phosphorus significantly increased N, P and K uptake by plant.

The following are the multiple regression equations between P or N or K uptake (Y) and both sulphur (X_1) and phosphorus (X_2) treatment:

N uptake = $0.424 + 0.005\ X_1 + 0.016\ X_2$ $R^2 = 0.914$ ($P<0.01$)

P uptake = $0.004 + 7.8 \times 10^{-4}\ X_1 + 0.004\ X_2$ $R^2 = 0.833$ ($P<0.01$)

K uptake = $0.115 + 0.002\ X_1 + 0.010\ X_2$ $R^2 = 0.887$ ($P<0.01$)

The comparison of the slopes of each variable in the equation of N uptake (0.005: 0.016) gives a quantative estimate for efficiency of one variable to the other. Thus, the efficiency of S and P application rates would be equal to 1: 3.2. Also, the efficiency of each of the above variables can be represented by the slope ratio as 0.00078: 0.004 or 1: 5.13 (P uptake). Also, K uptake, the efficiency of S rate: P rate would equal to 0.002: 0.010 or 1: 5.

These data indicated that N, P and K uptake by cowpea were affected by the two variables especially by P.

The relationship between shoots dry weight or grains yield and P uptake was expressed by a straight line equation at each sulphur rate (Table 5).

A significant positive correlation was found between grains yield or dry weight of shoots and P application rates at different rates of sulphur.

Table (3): Concentrations of N, P and K in shoots and roots of cowpea plant as affected by sulphur and phosphorus application.

Treatment		N, %		P, %		K, %	
Kg S/fed	kg P_2O_5/fed	Shoots	Roots	Shoots	Roots	Shoots	Roots
0	0	3.04	1.28	0.225	0.255	1.09	1.06
	15	3.24	1.39	0.359	0.378	1.36	1.56
	30	3.56	1.58	0.422	0.455	1.56	1.64
	45	3.67	1.68	0.459	0.548	1.71	1.88
average		3.38	1.48	0.366	0.409	1.43	1.54
50	0	3.05	1.31	0.274	0.282	1.21	1.28
	15	3.37	1.47	0.373	0.391	1.40	1.60
	30	3.57	1.64	0.433	0.475	1.58	1.70
	45	3.72	1.72	0.633	0.580	1.78	1.94
Average		3.43	1.54	0.428	0.432	1.49	1.63
100	0	3.11	1.34	0.324	0.304	1.27	1.40
	15	3.44	1.49	0.388	0.401	1.48	1.62
	30	3.60	1.66	0.436	0.497	1.60	1.72
	45	3.78	1.77	0.662	0.649	1.95	2.10
Average		3.48	1.57	0.453	0.463	1.58	1.71
150	0	3.21	1.36	0.348	0.356	1.30	1.48
	15	3.49	1.53	0.399	0.433	1.54	1.64
	30	3.62	1.68	0.443	0.523	1.63	1.76
	45	3.97	1.94	0.719	0.704	2.08	2.26
Average		3.57	1.63	0.477	0.504	1.64	1.79
Over all mean	0	3.10	1.32	0.293	0.299	1.22	1.31
	15	3.38	1.47	0.380	0.401	1.44	1.61
	30	3.59	1.64	0.434	0.487	1.59	1.71
	45	3.78	1.78	0.618	0.620	1.88	2.05
$L.S.D._{0.05}$							
Sulphur rate (S)		0.02	0.02	0.01	0.008	0.03	0.03
Phosphorus rate (P)		0.02	0.02	0.01	0.004	0.03	0.03
S x P		0.04	0.03	0.02	0.008	0.06	0.05

Table (4): The effect of sulphur and phosphorus rates on N, P and K uptake (g/shoot).

Treatment		N uptake	P uptake	K uptake
Kg S /fed	kg P_2O_5/fed			
0	0	0.55	0.041	0.198
	15	0.73	0.081	0.307
	30	0.90	0.106	0.393
	45	1.15	0.144	0.538
average		0.83	0.093	0.359
50	0	0.73	0.065	0.288
	15	0.90	0.100	0.374
	30	1.02	0.124	0.453
	45	1.24	0.211	0.593
average		0.97	0.125	0.427
100	0	0.88	0.092	0.363
	15	1.04	0.118	0.449
	30	1.21	0.146	0.536
	45	1.54	0.269	0.797
average		1.17	0.156	0.536
150	0	0.99	0.108	0.406
	15	1.34	0.153	0.592
	30	1.66	0.203	0.748
	45	2.14	0.388	1.123
average		1.53	0.213	0.722
Over all mean	0	0.79	0.077	0.314
	15	1.00	0.113	0.431
	30	1.20	0.145	0.532
	45	1.52	0.253	0.767
$L.S.D._{0.05}$				
Sulphur rate (S)		0.06	0.006	0.029
Phosphorus rate (P)		0.04	0.005	0.021
S x P		0.07	0.010	0.416

Table (5): Regression models describing the relationship between P uptake (X) and dry weight of shoots or grains yield (Y).

Sulphur rate, kg S/fed.	**Regression equation** X= P uptake, (g/shoot) Y = dry weight (g/shoot)	R^2	**Regression equation** X= P uptake, (g/shoot) Y = grains yield (kg/fed.)	R^2
0	Y=12.43 + 128.14 X	0.987	Y= 357.3 + 2431.9 X	0.949
50	Y= 20.14 + 63.92 X	0.985	Y= 388.7 + 1744.5 X	0.999
100	Y= 22.54 + 68.26 X	0.985	Y= 415.9 + 1324.3 X	0.935
150	Y= 26.21 + 75.64 X	0.886	Y= 432.4 + 1056.8 X	0.946

Soil chemical properties:

Table 6 revealed that increasing sulphur application significantly increased the amounts of available P, and water soluble sulphate in soil. The highest values of these characters were recorded with application of 150 kg S/fed. The soil pH significantly decreased with increasing sulphur and that application of 150 kg S/fed. produced the lowest soil pH (7.82). Very close results were obtained by Mengle and Kirkby (1982); Hilal *et al.*, (1990) and Abd-Elfattah *et al.* (2005). Also, increasing phosphorus application significantly increased available P, water soluble sulphate and decreased soil pH. It is also clear that the interaction effect, between sulphur and phosphorus, was significant with respect to the amount of available P and soil pH.

Available P (Y) was regressed against S (X_1) and P (X_2) applications. It is clear that the available P was positively correlated with these two variables. The regression equation for this relationship is:

Available P = 5.013 + 0.025 X_1 + 0.358 X_2 $R^2 = 0.972$ ($P<0.01$)

The comparison of the slopes of each variable in the equation (0.025:0.358) gives a quantitative estimate for the efficiency of one variable to the other. Thus, the efficiency of S and P rates in the soil would be equal to 1:14.32 with respect to available P in soil.

The relationship between available P and shoots dry weight (g/plant) or grains yield is shown in Fig. 2. It is clear that the dry weight of shoots or grains yield were increased significantly by increasing available-P in soil at the different rates of sulphur. Soil available P linearly correlated with dry weight of shoots or grains yield at each sulphur rate. These relationships are expressed by simple regression equations which are presented in Fig2.

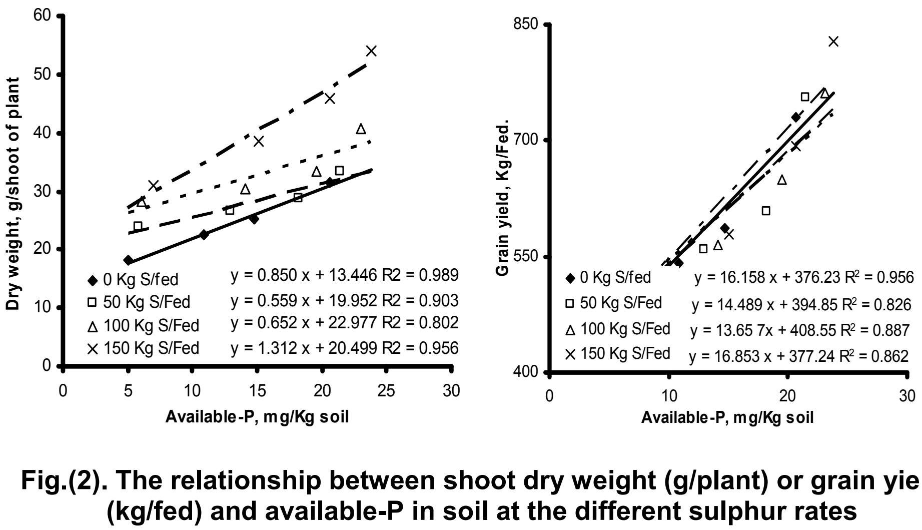

Fig.(2). The relationship between shoot dry weight (g/plant) or grain yield (kg/fed) and available-P in soil at the different sulphur rates

Table (6): The effect of sulphur and phosphorus application rates on the amounts of available P, water soluble sulphate and soil pH.

Treatments		Available P mg/Kg soil	$SO_4^{=}$, meq/100 g soil	pH
Sulphur rate, kg /fed	Phosphorus rate, kg P_2O_5/fed			
0	0	5.08	0.35	8.29
	15	10.87	0.40	8.26
	30	14.74	0.42	8.25
	45	20.61	0.43	8.24
average		12.82	0.40	8.26
50	0	5.87	0.39	8.21
	15	12.93	0.41	8.18
	30	18.25	0.44	8.16
	45	21.45	0.46	8.12
average		14.62	0.42	8.17
100	0	6.07	0.40	8.15
	15	14.08	0.43	8.11
	30	19.55	0.46	8.06
	45	23.06	0.48	8.01
average		15.69	0.44	8.08
150	0	6.99	0.43	8.07
	15	15.11	0.46	7.91
	30	20.61	0.48	7.69
	45	23.80	0.50	7.61
average		16.63	0.47	7.82
Over all mean	0	6.00	0.39	8.18
	15	13.25	0.43	8.11
	30	18.29	0.45	8.04
	45	22.23	0.47	7.99
$L.S.D._{0.05}$				
Sulphur rate (S)		0.204	0.001	0.033
Phosphorus rate (P)		0.326	0.012	0.035
S x P		0.657	N.S.	0.070

It can be concluded from the obtained results that application of sulphur to the clay soil, as soil amendment, had increased the grain yield of cowpea and the contents of N, P and K in plant. Also, sulphur application decreased to some extent soil pH and improved P efficiency and increased its availability in soil.

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الملخص العربي
تأثيرالكبريت والفسفور على النمو والمحصول والمحتوى الغذائي لنبات اللوبيا النامي في أرض طينية

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أجريت تجربة حقلية في موسم 2006/2005 بمزرعة كلية الزراعة سابا باشا- أبيس- جامعة الإسكندرية وذلك لدراسة تأثيرالكبريت والفسفور على النمو والمحصول والمحتوى الغذائي لنبات اللوبيا. وكان التصميم الإحصائي القطعة المنشقة بثلاث مكررات. وزعت معاملات التسميد الفسفوري عشوائيا داخل معاملات الكبريت وكانت مساحة الوحدة التجريبية 10.5 م^2 (3 متر طول × 3.5 متر عرض). اضيفت معاملات الكبريت والفسفور للوحدات التجريبية قبل الزراعة. تمت زراعة اللوبيا صنف كريم 7 في خطوط المسافة بين كل خطين 70 سم والمسافة بين الجور 20 سم. وقد استخدم الكبريت بمعدلات صفر، 50، 100 و 150 كجم للفدان كعامل رئيسي بينما استخدم الفسفور بمعدلات صفر، 15، 30 و45 كجم فو$_2$أ$_5$ للفدان كعامل ثانوي. وتوضح النتائج زيادة معنوية للوزن الجاف للمجموع الخضري والمجموع الجذري معنويا ومحصول الحبوب كما زاد تركيز النيتروجين والفسفور والبوتاسيوم في المجموع الخضري والجذري والممتص من النيتروجين والفسفور والبوتاسيوم في المجموع الخضري وكذلك الفسفور المتاح في الأرض وتركيز الكبريتات الذائبة في ماءالتربة بزيادة معدلات الكبريت المضافة حتى 150 كجم كبريت للفدان. ومن ناحية أخرى انخفضت درجة حموضة التربة بزيادة معدلات الكبريت المضافة. كانت الزيادة النسبية للوزن الجاف للمجموع الخضري هي 15.57 و 36.4 و 73.87 % بالمقارنة بالكنترول، بينما كانت الزيادة النسبية للوزن الجاف للمجموع الجذري هي 18.39 و 33.91 و 44.83 % بالمقارنة بالكنترول، كما كانت الزيادة النسبية لمحصول الحبوب هي 5.12 و 9.4 و 15.49 % بالمقارنة بالكنترول وذلك لمعدلات كبريت 50، 100 و 150 كجم للفدان على التوالي. كذلك أوضحت النتائج زيادة معنوية في الوزن الجاف للمجموع الخضري والمجموع الجذري ومحصول الحبوب للفدان وتركيز النيتروجين والفسفور والبوتاسيوم في المجموع الخضري والجذري والممتص من النيتروجين والفسفور والبوتاسيوم في المجموع الخضري والفسفور المتاح وتركيز الكبريتات في التربة بزيادة معدلات الفسفور المستخدمةوايضا قلت درجة حموضة التربة بزيادة معدلات الفسفور المضافة.

وكان تأثير التداخل بين معدلات الكبريت والفسفور معنويا على كل الصفات تحت الدراسة ماعدا تركيز الكبريتات في التربة. ويمكن ايجاز النتائج المتحصل عليها من هذه الدراسة بصفة عامة، بأن إضافة الكبريت للتربة الطينية كمحسن قد أدى إلى زيادةمحصول الحبوب لنبات اللوبيا ومحتواها من النيتروجين والفسفور والبوتاسيوم وايضا أدى إلى تحسينمن كفاءة الفسفور وصلاحيته في التربة.