Minia J. of Agric. Res. & Develop.
Vol. (٣٠) No. ١ pp ٦٧-٨٦ , ٢٠١٠

FACULTY OF AGRICULTURE

EFFECT OF PHOSPHORUS, POTASSIUM AND SULPHUR FERTILIZATION ON YIELD AND YIELD COMPONENTS OF FABA BEAN GROWN ON SILTY CLAY LOAM SOIL

M . A . Ahmed , G . A . Abd El-Hafez , and A . M . Gabra
Soils, Water and Envir. Res. Inst. and Field Crops Res. Instit. Agric. Res. center , Giza . Egypt .

Received ١٠ Jan. ٢٠١٠ Accepted ١٥ March ٢٠١٠

ABSTRACT

Two field experiments were conducted in split – split plot design at Mallawi Agric. Res. Station, Minia Governorate Egypt, during ٢٠٠٥ / ٢٠٠٦ and ٢٠٠٦ – ٢٠٠٧ seasons to study the response of faba bean (vicia faba L .) cultivar Giza ٨٤٣ to phosphorus fertilizer levels (١٥ , ٣٠ and ٤٥ kg P_2O_5 / feddan) ; potassium fertilizer levels (٢٤ and ٤٨ kg K_2O / fed) and sulphur fertilizer levels (٠.٠ and ٧٥ kg / fed)

The studied parameters were; number of pods/plant, ١٠٠ seed weight, seeds and straw yields , protein percentage in the seeds and phosphorus and potassium uptake by seeds and straw . The obtained results showed that increasing P levels from ١٥ to ٣٠ or ٤٥ kg P_2O_5/fed. significantly increased all the studied parameters except potassium uptake by the seeds was not significant in growing seasons . All parameters were significantly increased by increasing the levels of potassium fertilization from ٢٤ to ٤٨ kg K_2O/ fed, except number of pods / plant in the second season and straw yield (ton / fed) in the two seasons which their increases ,were not significant. Increasing sulphur levels from ٠.٠ to ٧٥ kg S/fed. significantly increased all studied parameters .

The effect of the interactions between the three studied factors on all parameters was not significant except the interaction

between sulphur and phosphorus which significantly affected phosphorus uptake by straw in the second season only .

The present results suggested that the best combination treatment was ٣٠ kg P_2O_5/ fed , ٤٨ kg K_2O/fed and ٧٥ kg S / fed .

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INTRODUCTION

Faba bean (vicia faba L.) is an important grain legume crop since it is a source of protein, and a substantial crop for food production in Egypt, The increase in the number of population in Egypt demand high crop yields as a solution for food security.

Most unfarmed soils contain too little phosphorus for good yields of cultivated crops, and phosphates have usually been the first fertilizers used in improving land for agriculture. As phosphate dose not move easily in soil , being precipitated forms with only slight solubilities , crop roots never reach more than one – quarter or one – third of a dressing of phosphorus fertilizer in a single year . The remainder of the phosphorus accumulates as residues which , after many years, may account for half of the total phosphorus present in soil. These residues are useful to following cropes , and most manuring schemes increase the reserves of soluble phosphorus in soil (Cooke ١٩٨٢) .

Many investigators reported that increasing the levels of phosphorus fertilization significantly increased both seeds and straw yields , protein content in the seeds , phosphorus content in plants , phosphorus uptake by seeds and straw (Mwafy, ١٩٩٥ ; El Kalla et al . , ١٩٩٧ ; Mohamed et al ١٩٩٩ ; Abou Hussien et al, ٢٠٠٢ ; Azer Sohoir et al, ٢٠٠٣; Khalil et al, ٢٠٠٤ and Ahmed et al, ٢٠٠٥). Bapat et al (١٩٨٦) and Owolade et al, (٢٠٠٦) found that application of phosphorus increased significantly the number of pods / plant , seeds/pod , leaf area and yield of cowpea .

Potassium is an essential element for all living organisms and in plants important cation involved in phosiological mechanism (Beringer et al , ١٩٨٣ ; Duke and Collins , ١٩٨٥ and Steudle, ١٩٩٤). In particular , the ability of ATP ases in membranes to maintain active transport is highly dependent on adequate K supply. Thus, efficient cell development and growth of plant tissues , translocation , storage of assimilates and other internal function , which are based on many

physiological, biochemical and biophysical interaction, require adequate K in the cell sap (Lindhauer , ١٩٨٩ ; Morschner , ١٩٩٥ and Ruggiero et al . , ١٩٩٩) . Potassium application in poorly fertile soil is essential to obtain high yield, since it plays an important role in many processes in plant cells.

Bochniarz et al, (١٩٨٧) found that potassium fertilization had significant beneficial effect on seeds yield on soil poor in K contents . El-Fouly and Fawzi (١٩٨٩) suggested that , potassium might be a limiting factor under conditions of high yield , addition of ١٢٠ kg K_2 O/ha gave considerable yield increases . Hewedy et al, (١٩٩٤) pointed out that spraying plants of common bean with potassium sulphate ٢٪ increased seed yield. Ismail and Hagag , (٢٠٠٥) found that spraying plants of faba bean by P and K induced significant increases in seeds and straw as well as seed protein and P and K contents compared with the control treatment . Abd EL – Latif , Amina (٢٠٠٦) reported that the increment in potassium fertilizer levels of faba bean significantly increased No. of bods / plant , total yield and seed content of protein ; P and K uptake . Sulphur is an essential element for protein synthesis Abou Baker et al (١٩٩٤) ; Dwivedi and Nayak (١٩٩٨) , Singh et al , (١٩٩٧) and EL Saadany and Abd–EL Rasoul (١٩٩٩) found that application of S improved legume plant biomass , nodulation , seed and straw yield and N and S uptake .

Sulphur exerted a positive effect on the soil properties , this effect might be due to the action of acidity produced as a result of sulphur oxidation by micro-organisms, EL-Leboudi and Omar (١٩٧٥) mentioned that the PH values of the soil were decreased through oxidation of applied sulphur by soil . micro-organisms which it is able to produce sulphuric acid in amount enough to lower the PH .

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Yousry et al (١٩٨٤) reported that sulphur was generally favourable for available phosphorus particularly when applied at high rates . Azer Sohair et al (٢٠٠٣) reported that there was a significant response in seed yield, straw yield , crude protein and P content by addition of sulphur to faba bean . It is well known that availability and uptake of many plant nutrients are affected by levels of the other nutrients present in the growth medium . In particular, the interactions between phosphorus , potassium and sulphur in the plants and soils have been reported by many worker's , (Nayak and Dwivedi, ١٩٩٠ ; Kamh et al, ١٩٩١; Kanany et al, ٢٠٠٠ and Azer Sohair et al, ٢٠٠٣.

Bahl et al (١٩٩٠) , indicated that the combining S with ١٥ kg $P_٢ O_٥$ resulted in a further increase in protein amounted to ٨.٦٧ % due to the important role played by S in protein synthesis in addition of being an integral part of some amino acids .

The objective of this study was to examine the effect of applying different levels of phosphorus , potassium and sulphur fertilization on the number of pods / plant , ١٠٠ seed weight (g) , yield of seed and straw, protein and phosphorus and potassium uptake by plants and seeds .

MATERIALS AND METHODS :

A field experiment was conducted during two successive growing seasons (٢٠٠٥ / ٢٠٠٦ and ٢٠٠٦ / ٢٠٠٧) at the experimental farm of Mallawi Agricultural Research Station, EL-Minia Governorate , Egypt . The experiment included three factors ١] two levels of sulphur application (٠.٠ and ٧٥ kg S / fed .) arranged in the main plots; ٢] two levels of potassium (٢٤ and ٤٨ kg $K_٢O$ / fed.) allocated to the sub–plots and ٣] three levels of phosphorus (١٥,٣٠ and ٤٥ kg $P_٢ O_٥$ / fed.) distributed in sub-sub plots . These factors consisted of ١٢

treatments combinations, using split – split – plot design with three replicates .

The experimental unit was ١٢ $m^{٢}$ ٤.٠ m in length and ٣.٠ m . in width. Soil physical and chemical properties were determined on soil samples, at depth of (٠- ٣٠ c.m) according to Jackson (١٩٧٣), Olsen and Sommers (١٩٨٢) and Gee and Bauder (١٩٨٦) and the data are shown in (Table ١). Phosphorus , Potassium and sulphur treatments were added during soil preparation , phosphorus was in the form of calcium superphosphate (١٥.٥٪ $P_{٢}$ $O_{٥}$) potassium was used in the form of potassium sulphate (٤٨٪ $K_{٢}O$). Nitrogen fertilizer was in ammonium nitrate form (٣٣.٥٪ N) and added at the rate of ١٥٪ kg N/fed immediately before sowing .

The previous crop was maize in both growing seasons . The faba bean cultivar was Giza . ٨٤٣ sown at ١١th and ١٣th of November ٢٠٠٥ and ٢٠٠٦ seasons respectively at rate a of ٥٠ gk/seeds/feddan . Agricultural practices that commonly used at El Minia were applied.

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Table ١ : Physical and chemical properties of the experimental soil samples.

Physical and chemical properties	First season	Second season
Physical properties		
Particle size distribution		
Sand (%)	٧.٦٥	٨.١
Silt (%)	٥٥.١٥	٥٣.٣٥
Clay (%)	٣٧.٢٠	٣٨.٥٥
Texture grade	**Silty clay loam**	**Silty clay loam**
Chemical properties		
PH (soil – water suspension ratio ١ : ٢.٥	٨.١٥	٨.٠٨
Ec (ds m^{-1}) soil – water extract (ratio ١ : ٥)	١.٧٥	١.٨٣
Organic matter (%)	١.١٦	١.١٢
Soluble cations (meq / l .) :		
Calcium (Ca^{++})	٨.١٥	٨.٦٥
Magnesium (Mg^{++})	٣.٨٥	٣.٦٥
Sodium (Na^{+})	٤.٨٥	٤.٥٥
Potassium (K^{+})	٠.٣٠	٠.٣١
Soluble anions (meq / l.) :		
Carbonate (CO_3^{--})	٠.٠	٠.٠
Bicarbonate ($H CO_3$)	٣.٩٥	٣.٧٥
Chloride (CL^{-})	٥.٩٧	٥.٦٥

Sulphate (SO_4^{2-})	٧.٤٥	٧.٥٨
Available nitrogen (ppm)	٢٢.٣٤	٢١.٤٥
Available phosphorus (ppm)	٨.٥٥	٨.٣٥
Available potassium (ppm)	١٧٣.٠	١٧٨.٠

Effect of fertilization on Faba bean yield and yield components

Number of pods / plant , ١٠٠ seed weight (g /and seeds and straw yields were recorded at harvest. The faba bean seed yield was calculated as ardab/feddan. While straw yield was calculated as ton/feddan .

Samples of seeds and straw were dried individually in the oven at ٦٥^{o}C, weighed, ground using a plant mill and sieved to pass through a ٠.٥ mm screen. The dried and ground plant materials were mixed thoroughly and a representative subsample was taken and analyzed for N total P and K.

Plant samples were digested in concentrated sulpharic acid ($H_٢SO_٤$) and hydrogen peroxide ($H_٢O_٢$) . Nitrogen was determined using modified micro K jeldahl method (AOAC ١٩٨٠). Protein content in seeds was calculated by multiplying the total nitrogen by a factor of ٦.٢٥. Phosphorus was determined in plant digests calorimetrically using the Spectrophotometer according to the method described by Chapman and Pratt (١٩٦١) Potassium was determined according to Jackson (١٩٧٣) .

Statistical analysis was carried out according to Gomez and Gomez (١٩٨٤), and differences between means of the different treatments were compared using LSD at ٥ % level .

RESULTS AND DISCUSSION

The effect on number pods and seed weight

Data presented in Table ٢ show effect of sulphur , potassium and phosphorus levels and their interactions on number of pods/plant and ١٠٠ seed weight (g) of faba bean in the two growing seasons. Increasing the level of sulphur fertilization from ٠.٠ to ٧٥ kg

S/feddan significantly increased the number of pods/plant and ١٠٠ seed weight (g) compared with unfertilized plants in the two growing seasons. Similar results were reported by Singh et al (١٩٩٧) , EL-Saadany and Abd-EL Rasoul (١٩٩٩) and Azer Sohair et al (٢٠٠٣).

Effect of fertilization on Faba bean yield and yield components

Table ٢: Effect of sulphur , potassium and phosphorus fertilizer and their interactions on number of pods / plant and ١٠٠ seed weight (g) in the first and second seasons .

Treatments			Number of pods / plant		١٠٠ seed weight (g)	
Sulphur levels kg/fed	Potassium levels kg K_2O/ fed	Phosphorus levels kg P_2O_5/ fed	٢٠٠٥/ ٢٠٠٦	٢٠٠٦/ ٢٠٠٧	٢٠٠٥/ ٢٠٠٦	٢٠٠٦/ ٢٠٠٧
٠.٠	٢٤	١٥	١١.٠٠	١٠.٠٠	٥٦.٢	٥٥.٦
		٣٠	١٢.٣٠	١٣.٣٠	٥٧.٩	٥٨.٠
		٤٥	١٤.٠	١٥.٠٠	٥٩.٤	٥٩.٢
	٤٨	١٥	١٢.٠	١٠.٧	٥٩.٤	٥٧.٢
		٣٠	١٣.٧	١٣.٧	٥٩.٥	٥٩.٨
		٤٥	١٤.٧	١٥.٣	٦٠.٧	٦٠.٧
٧٥	٢٤	١٥	١٢.٧	١٢.٧	٥٨.٧	٥٨.٣
		٣٠	١٤.٠	١٥.٣	٦٠.٧	٦١.٣
		٤٥	١٥.٧	١٦.٣	٦٠.٨	٦١.٥
	٤٨	١٥	١٣.٣	١٢.٧	٥٩.٧	٥٩.٥
		٣٠	١٥.٠٠	١٥.٧	٦٢.٧	٦٢.٤
		٤٥	١٦.٧	١٧.٣	٦١.٣	٦١.٩
Mean of sulphur levels kg/fed		٠.٠	١٢.٩	١٣.٠٠	٥٨.٩	٥٨.٤
		٧٥	١٤.٦	١٥.٠٠	٦٠.٦	٦٠.٨
Mean of potassium levels kgK_2O/fed		٢٤	١٣.٣	١٣.٨	٥٨.٩	٥٩.٠
		٤٨	١٤.٢	١٤.٢	٦٠.٥	٦٠.٣
Mean of phosphorus levels kg P_2O_5/fed		١٥	١٢.٣	١١.٥	٥٨.٥	٥٧.٦
		٣٠	١٣.٨	١٤.٥	٦٠.٢	٦٠.٠
		٤٥	١٥.٣	١٦.٣	٦٠.٦	٦٠.٨

L.S.D at ٥٪ level				
Sulphur levels (A)	٠.٤١	٠.١٩	٠.٧٦	٠.٢٦
Potassium levels (B)	٠.٣٩	N . S .	٠.٥٠	٠.٦٠
Phosphorus levels (C)	٠.٣٨	٠.٢٤	٠.٤٨	٠.٥٤
A x B	**N.S.**	**N.S.**	**N.S.**	**N.S.**
A x C	**N.S.**	**N.S.**	**N.S.**	**N.S.**
B x C	**N.S.**	**N.S.**	**N.S.**	**N.S.**
A x B x C	**N.S.**	**N.S.**	**N.S.**	**N.S.**

The number of pods / plant and ١٠٠ seed weight (g) were significantly increased when the level of potassium fertilization was increased from ٢٤ to ٤٨ kg K_2O/fed in the two growing seasons except in the second season the increase in number of pods / plant was not significant .

Increasing the level of phosphorus fertilization from ١٥ to ٣٠ or ٤٥ kg P_2O_5/fed significantly increased the number of pods/plant and ١٠٠ seed weight in the two growing seasons . These results are coincide with the findings of other researchers (Mwafy, ١٩٩٥ ; Abou Hussien et al , ٢٠٠٢ and Khalil et al, ٢٠٠٤) .

The highest values of number of pods / plant (١٦.٧ and ١٧.٣) were obtained when faba bean plants were fertilized with ٤٥ kg P_2O_5 /fed combined with ٤٨ kg K_2O/fed and ٧٥ kg S/ fed in the two growing seasons respectively .

The effect of the interactions between the three studied factors (sulphur x potassium , sulphur x phosphorus , potassium x phosphorus and sulphur x potassium x phosphorus) on number of pods / plant and ١٠٠ seed weight (g) was not significant in the two growing seasons .

The effect on seed and straw yield:

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Data in Table ٣ reveal that seeds and straw yield of faba bean increased significantly with increasing the level of sulphur fertilization from ٠.٠ to ٧٥ kg S/ fed compared with unfertilized plants in the two growing seasons. The results are in line with those obtained by Kanany et al (٢٠٠٠) and Azer Sohair et al (٢٠٠٣) .

Increasing the level of potassium fertilization from ٢٤ to ٤٨ kg $K_٢$ O/fed significantly increased seeds yield in the two growing seasons, while the increase in straw yield in the two growing seasons was not significant. These results are in harmony with those reported by Bochniarz et al. (١٩٨٧) and Hewedy et al. (١٩٩٤).

Increasing the level of phosphorus fertilization from ١٥ to ٣٠ or ٤٥ kg $P_٢ O_٥$/ fed significantly increased seed and straw yields in the two growing seasons . Similar results were obtained by Mohamed et al. (١٩٩٩) ; K halil et al ., (٢٠٠٤) and Ahmed et al .,(٢٠٠٥) .

The highest values of seeds yield (١٣.٢ and ١٢.٥ ardab / feddan) were obtained when faba bean plants were fertilized with ٤٨ kg $K_٢$ O / fed. combined with ٣٠ kg $P_٢ O_٥$ / fed and ٧٥ kg S / fed in the first and second growing seasons respectively . Also the highest values of straw yield (٣.٢ ton / fed) was obtained when faba bean plants were fertilized with ٤٨ kg $K_٢O$/fed combined with ٣٠ kg $P_٢ O_٥$ / fed and ٧٥ kg S/ fed . in the first season while the highest value of straw yield (٣.٢ ton fed . in the second season was obtained when faba bean plants were fertilized with ٤٨ kg $K_٢$ O/ fed combined with ٤٥ kg $P_٢ O_٥$/ fed and ٧٥ kg S/ fed . It is well known that availability and uptake of many plant nutrients are affected by the levels of the other nutrients present in the growth medium. The interactions between phosphorus , potassium and sulphur in the plants and soils have been reported by

many worker's , (Kamh et al, ١٩٩١ ; Kanany et al , ٢٠٠٠ and Azer Sohair et al , ٢٠٠٣

The present results clearly demonstrated that application of phosphorus fertilizer at the rate of ٣٠ kg $P_{٢}$ $O_{٥}$ / fed combined with potassium fertilizer at the rate of ٤٨ kg $K_{٢}$ O/ fed and ٧٥ kg S/ fed to the silty clay loam soil cultivated increased seeds and straw yield .

The effect on protein content:

Results in Table ٣ show protein content of faba bean seeds as affected by the application of sulphur , potassium and phosphorus fertilization during the two growing seasons . It was noticed that increasing the level of sulphur fertilization from ٠.٠ to ٧٥ kg S / fed significantly increased protein percentage in the seeds compared with unfertilized plants in the two growing seasons. Similar results were reported by Azer Sohair et al (٢٠٠٣).

Increasing the level of potassium fertilization from ٢٤ to ٤٨ kg $K_{٢}O$/fed significantly increased protein percentage in the seeds in the two growing seasons . These results are in accordance with those reported by Abd El- Latif , Amina (٢٠٠٦) .

Increasing the level of phosphors fertilization from ١٥ to ٣٠ or ٤٥ kg $P_{٢}$ $O_{٥}$ / fed significantly increased protein percentage in the seeds in the two growing seasons .

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The present findings are in agreement with those obtained by other researchers (Mwafy ١٩٩٥ ; Abou hussien et al ٢٠٠٢ ; Khalil el al, ٢٠٠٤ and Ahmed et al ., ٢٠٠٥) who reported that increasing the level of phosphorus fertilization significantly increased protein content in the seeds of faba bean . A possible explanation for the increase in protein percentage in faba been seeds is the beneficial effect of phosphorus fertilizer on activation of microbial population nodules to fix more N that used by plants in protein synthesis (Bhadoria et al ., ١٩٩٧) .

The highest values of protein percentage in the seeds (٢٢.٣ and ٢٢.٣٥ %) were obtained when faba bean plants were fertilized with ٣٠ kg P_2O_5 / fed. combined with ٤٨ kg K_2O / fed. And ٧٥ kg S / fed. in the first and second growing seasons, respectively .

The effect on phosphorus uptake:

Results in Table ٤ indicated that phosphorus uptake by straw and seeds increased significantly by increasing the level of sulphur fertilization from ٠.٠ to ٧٥ kg S /fed compared with unfertilized plants in the two seasons . Also, Azer Sohair et al (٢٠٠٣) reported similar results.

Increasing the level of potassium fertilization from ٢٤ to ٤٨ kg K_2O / fed significantly increased phosphorus uptake by seeds and straw in the two seasons . These results are in harmony with those reported by Abd El- Latif , Amina (٢٠٠٦) .

Increasing the level of phosphorus fertilization from ١٥ to ٣٠ or ٤٥ kg P_2O_5 /fed significantly increased phosphorus uptake by seeds and straw in the two seasons . These results are in line with those obtained by Badr Rl-Din and Moawad (١٩٨٨) and Ahmed et al

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(٢٠٠٥) .

The highest values of phosphorus uptake by seeds (١٢.٧ and ١٢.٠ kg P/ feddan) and phosphorus uptake by straw (٦.١٩ and ٦.١٢ kg P / feddan) were obtained when faba bean plants were fertilized with ٤٥ kg P_2O_5 fed, combined with ٤٨ kg K_2O / fed and ٧٥ kg S / fed in the first and second growing seasons respectively . Similar results were obtained by Ismail and Hagag (٢٠٠٥) .

Table ٤: Effect of sulphur , potassium and phosphorus fertilizer and their interactions on phosphorus uptake by seeds and by straw of faba bean in the first and second seasons :

Treatments			Phosphorus uptake by the seeds of faba bean (kg P /fed.)		Phosphorus uptake by the straw of faba bean (kg P /fed.)	
Sulphur levels kg S /fed	Potassium levels kg K_2O/ fed	Phosphorus levels kg P_2O_5/ fed	٢٠٠٥/ ٢٠٠٦	٢٠٠٦/ ٢٠٠٧	٢٠٠٥/ ٢٠٠٦	٢٠٠٦/ ٢٠٠٧
٠.٠	٢٤	١٥	٥.٧	٥.٣	٢.٣٣	٢.٣١
		٣٠	٨.٩	٨.٣	٣.٢٢	٢.٦٨
		٤٥	١٠.٥	٩.٩	٤.٣١	٤.٠٦
	٤٨	١٥	٧.٠	٧.٠	٢.٩٣	٢.٨٣
		٣٠	١٠.٢	٩.٨	٤.٢٩	٤.١٩
		٤٥	١١.٧	١١.٦	٤.٨٩	٤.٥٠
٧٥	٢٤	١٥	٦.٩	٦.٩	٣.٢٠	٣.١٥
		٣٠	١٠.٠	١٠.٢	٤.٩١	٤.٧٦
		٤٥	١١.٤	١١.٦	٥.١٦	٥.٥٨
	٤٨	١٥	٨.٩	٩.٠	٣.٩٠	٣.٨١
		٣٠	١٢.٣	١١.٨	٥.٦٤	٥.٧٥
		٤٥	١٢.٧	١٢.٠	٦.١٩	٦.٢٣
Mean of sulphur levels kg S /fed		٠.٠	٩.٠	٨.٦	٣.٧	٣.٤
		٧٥	١٠.٤	١٠.٢	٤.٨	٤.٩
Mean of potassium levels kgK_2O/fed		٢٤	٨.٩	٨.٧	٣.٩	٣.٨
		٤٨	١٠.٥	١٠.٢	٤.٦	٤.٦
Mean of phosphorus levels kg P_2O_5/fed		١٥	٧.١	٧.٠١	٣.١	٣.٠٣
		٣٠	١٠.٣	١٠.٠١	٤.٥	٤.٣٠

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	٤٥	١١.٦	١١.٣	٥.١	٥.١
L.S.D at ٥٪ level					
Sulphur levels (A)		٠.٥١	٠.٧٦	٠.٣٥	٠.٤٤
Potassium levels (B)		٠.٢١	٠.٢٨	٠.١٣	٠.١١
Phosphorus levels (C)		٠.٣٠	٠.٣٧	٠.٢٨	٠.٢١
A x B		**N.S.**	**N.S.**	**N.S.**	**N.S.**
A x C		**N.S.**	**N.S.**	**N.S.**	٠.٢٥
B x C		**N.S.**	**N.S.**	**N.S.**	**N.S.**
A x B x C		**N.S.**	**N.S.**	**N.S.**	**N.S.**

The interaction effect between the three studied factors on phosphorus uptake by seeds and straw were not significant in the two seasons . With the exception of the interaction between sulphur and phosphorus which significantly increased the phosphorus uptake by straw in the second growing season only .

The effect on potassium uptake :

Data in Table ٥ indicate that increasing the level of sulphur fertilization from ٠.٠ to ٧٥ kg S./fed significantly increased potassium uptake by seeds and straw in each seasons compared with unfertilized plants . These results are in the line with those found by El – Leboudi and Omar (١٩٩٥) .

Increasing the level of potassium from ٢٤ to ٤٨ kg K_2O/fed significantly increased potassium uptake by seeds and straw in the two growing seasons . The present findings are in agreement with those obtained by other researchers (Ismail and Hagag , ٢٠٠٥ and Abd El – Latif , Amina ٢٠٠٦) .

It can be seen that potassium uptake by faba bean seeds was not significantly increase by increasing the level of phosphorus fertilization from ١٥ to ٣٠ or ٤٥ kg P_2O_5 /fed in the first seasons only

Potassium uptake by straw significantly increased with increasing the level of phosphorus fertilization from ١٥ to ٣٠ kg P_2O_5 / fed in

the two growing seasons , while it was not significant when the level of phosphorus fertilization was increased from ١٥ to ٤٥ kg $P_2 O_5$ / fed in the two growing seasons. Similar results were obtained by Kamh , et al . , (١٩٩١) who indicated that the K content in straw and grains of wheat were decreased with high levels of phosphorus fertilization .

The highest values of potassium uptake by seeds (١٧.٨ and ١٦.٧ kg K/ feddan) and potassium uptake by straw (٥٨.٧ and ٥٨.٦ kg K/fed) were obtained when faba bean plants were fertilized with ٣٠ kg $P_2 O_5$ / fed combined with ٤٨ kg $K_2 O$ / fed and ٧٥ kg S / fed in the first and second growing seasons , respectively .

The interaction effect between the three studied factors on potassium uptake by seeds and straw were not significant in the two growing seasons.

From the abovementioned results it is clear that the optimum yield and the highest protein content in faba bean seeds were obtained with fertilization at the rate of ٣٠ kg $P_2 O_5$ / fed combined with ٤٥ kg $K_2 O$ / fed and ٧٥ kg S/ fed.

Table ٥: Effect of sulphur , potassium and phosphorus fertilizer and their interactions on potassium uptake by seeds and by straw of faba bean in the first and second seasons :

Treatments			potassium uptake by the seeds of faba bean (kg K /fed.)		potassium uptake by the s traw of faba bean (kg K /fed.)	
Sulphur levels kg /fed	Potassium levels kg K_2O/fed.	Phosphorus levels kg P_2O_5/ fed	٢٠٠٥/ ٢٠٠٦	٢٠٠٦/ ٢٠٠٧	٢٠٠٥/ ٢٠٠٦	٢٠٠٦/ ٢٠٠٧
٠.٠	٢٤	١٥	١٣.٢	١٢.٦	٣٦.٠	٣٨.٦
		٣٠	١٤.٣	١٣.٦	٣٨.٢	٣٧.٤
		٤٥	١٤.١	١٣.٥	٤٢.٠	٤٠.٩

Effect of fertilization on Faba bean yield and yield components

	٤٨	١٥	١٥.٨	١٥.٦	٤٤.٧	٤٥.٢
		٣٠	١٦.٧	١٥.٤	٤٤.٧	٤٧.٣
		٤٥	١٦.٠	١٥.٤	٤٢.٥	٤٠.٦
٧٥	٢٤	١٥	١٥.٠	١٥.٠	٤٤.٩	٤٣.٣
		٣٠	١٤.٥	١٤.٥	٤٩.٩	٥١.٠
		٤٥	١٤.٩	١٤.٣	٤٣.٢	٤٣.٦
	٤٨	١٥	١٧.١	١٦.٤	٥٢.٠	٥٣.٢
		٣٠	١٧.٨	١٦.٧	٥٨.٧	٥٨.٦
		٤٥	١٦.٥	١٥.٤	٥١.٦	٥٣.٧
Mean of sulphur levels kg S /fed		٠.٠	١٥.٠١	١٤.٣٥	٤١.٩	٤١.٧
		٧٥	١٦.٠	١٥.٥	٥٠.٠	٥٠.٦
Mean of potassium levels kgK_2O/fed		٢٤	١٤.٣	١٣.٩	٤٢.٤	٤٢.٤
		٤٨	١٦.٦	١٦.٠	٤٩.٥	٤٩.٨
Mean of phosphorus levels kg P_2O_5/fed		١٥	١٥.٣	١٤.٩	٤٤.٤	٤٥.٠٥
		٣٠	١٥.٨	١٥.٠٥	٤٨.٦	٤٨.٦
		٤٥	١٥.٤	١٤.٧	٤٤.٨	٤٤.٧
L.S.D at ٥٪ level						
Sulphur levels (A)			٠.٣٠	٠.٣٢	٣.٩٨	٣.٤٢
Potassium levels (B)			٠.٤٠	٠.٦٢	١.٩٣	١.٧٢
Phosphorus levels (C)			**N.S.**	**N.S.**	١.٥٨	١.٤٨
A x B			**N.S.**	**N.S.**	**N.S.**	**N.S.**
A x C			**N.S.**	**N.S.**	**N.S.**	**N.S.**
B x C			**N.S.**	**N.S.**	**N.S.**	**N.S.**
A x B x C			**N.S.**	**N.S.**	**N.S.**	**N.S.**

REFERENCES

A . O . A . C (١٩٨٠) . Official Method of Analysis . ١٣ th ed . , Association of Official Agricultural chemists , Washington , D . C .

Abd EL – Latif, Amina M . (٢٠٠٦). Effect of potassium and Foliar spraying with molybdenum on broad bean plants grown on a sandy soil . Egypt , J . of Appl . Sci . , ٢١ (٨) .

Abou Bakr , A . A . ; Mahdy , M . A . ; Osman , A. O. and Esmail , S. A. (١٩٩٤) . Effect of Gypsum and phosphorus application on peanut yield and quality . Egypt , J . Appl . Sci . : ٩ (١٠) : ٣٥٨-٣٧١ .

Abou Hussien , E. A. ; Abou EL – Fadl . M . A . ; Ramadan , S . A . , and Khalil, H. (٢٠٠٢). Response of wheat and broad bean plants to phosphorus under different soil conditions . Egypt J . Agric . Res . ٨٠ : I pp . ٤١-٥٥ .

Ahmed , M . A . ; Hassan , A . H . , and Hassouna , A . B . (٢٠٠٥) . Effect of nitrogen and phosphorus fertilization and inoculation with Rhizobium Legumin osarum on faba bean . Minia J of Agric Res. & Develop . Vol. (٢٥) No .٣ pp ٥٨٧ - ٦١٦

Azer Sohair , A . , Awad , A . M . , Jaklin , G . Sadek ; Khalil , F . A .; and Eglal M . A . EL – Aggory (٢٠٠٣) . A comparative study on the effect of elemental S and biophosphatic fertilizers on the response of faba bean (vicia faba L .) to P fertilization . Egyptian J. of Appli . Sci . ١٨ : ٧ . pp . ٣٢٤ - ٣٦٣ .

Badr EL - Din and Moawad (١٩٨٨) Enhancement of nitrogen fixation in lentil , faba bean , and soybean by dual

inoculation with Rhizobia and mycorrhizae . Plant and Soil ١٠٨ , pp . ١١٧ – ١٢٣ .

Bahl , G . s . ; paricha , N . S . and Baddesha H . S . (١٩٩٠) . Sulphur nutrient of three varieties of Indian mustard at three stages of growth . Indian , J . of Agric . Sci . ٦٠ (٨) : ٥٥٦ – ٥٥٨ .

Bapat , P . N . ; sinha , S . B . and tripathi , B . R . (١٩٨٦) . Effect of S and P on yield and nutrient content of black gram . J . Indian Soc . soil Sci . ٣٤ : ٨٢ – ٨٦ .

Beringer , H . ; Haeder , H . E . and Lindhauer M . G . (١٩٨٣) . Water relationship and incorporation of $C^{١٤}$ assimilates in tuber of potato plants differing in potassium nutrition . plant physiol . , ٧٣ ; ٩٥٦ .

Bhadoria , R . B . S . ; Tomer , R . A . S . ; Khan , H . ; and Sharma , M . K . (١٩٩٧) . Effect pf phosphorus and sulphur on yield and quality of cluster bean (Cyamopsis tetragonolaba) . Indien J . Agron . , ٤٢ : ١ . pp . ١٣١ – ١٣٤ .

Bochniarz , J . ; Bochniarz , M. and Lenartowicz ,w . (١٩٨٧) . Effect of potassium and nitrogen fertilization on productivity of faba bean (Vicia faba L.) grown for seeds Pamietnik – Pulawski , Ploland . ٨٩ : ٥٧ – ٦٧ .

Chapman , H . D . ; and Pratt , P . F . (١٩٦١) : Mrthods of Analysis for soils , plants and waters . Edited by Homer D . Chapman and Parker F . Pratt . Division of Agricultural sciences , university of California , Berkely , U . S . A . , ٣٠٩ P .

Cooke , G . W . (١٩٨٢) . Fertilizing for maximum yield . Edited by G . W . Cooke . Third edition .

Duke , S . H . and Collins M . M . (١٩٨٥) : Role of potassium in legume dinitrogen fixation in : Potassium in Agriculture . R . Munns (Ed) p . ٤٤٣ . Soc . Agron . , Madison , USA .

Dwivedi , A . K . and Nayak G . S . (١٩٩٨) . Effect of nitrogen and sulphur fertilizer application in a black soil . Fabis News Letter ١٩٩٨ . No ٤١ : ١٨ – ٢٠ .

E L _ Gizy , Samira . M ; EL – Boghdady , A . and Anisa Ismail (١٩٩٥) : Effect of foliar spray with some nutrients on dry yield of cowpea plants . Egypt , J . Appl . ١٠ (١٢) ٢٠١ – ٢٠٨ .

EL – Fouly ; M . M . and Fawzi , F . A . (١٩٨٩) : Concentration and uptake of N , P . and K and the effect of potassium sulphate on vicia faba L . FABIS – Newsletter , ICARDA . Faba bean information service . ٢٥ : ١٨ – ٢٢ .

EL – Kalla , A . E . ; Mostafa , A . K . ; Leilah , A . A . ; and Rokia , A . Awad (١٩٩٧) . Mineral and biophosphatic fertilization for intecropped faba bean and onion . Egypt J . Agric . Res . , ٧٧ : ١ . pp . ٢٥٣ – ٢٧١ .

EL – Leboudi , A . and Omar F . (١٩٧٥) . The improvement of the phosphorus availability to tomato grown in calcareous soil , Beitrage , trop . Landwirtsch . Veterinarmed . ١٣ : ٣٠١ .

EL – Saadany , S . M . and Abd – EL Rasoul Sh . M . (١٩٩٩) . Effect of Gypsum , FYM and " Phosphorine " application on peanut crop grown on newly reclaimed sandy soil . Egypt , J. Apple .Sci.; ١٤(٧):٦١١ – ٦٢٥ .

EL – Shikha , S . A . ; Easa , M . O . ; Behiry , E . M . K . and Raslan M . I . (٢٠٠٥) . Effect of K – fertilization on faba bean productivity under sandy soil condition . Egypt , J . Appl . Sci . , ٢٠ (١) .

Gee , G . W . and Bauder , J . U . (١٩٨٦) . Particle size analysis . In : Methods of Soil Analysis . Part I , second edition (editor : A Klute) . Agronomy Ser . No . ٩ . American Society of Agronomy Inc . Madison , Wisconsin , U . S . A , ١٩٨٦ .

Gomez , K . A . and Gomez , A . A . (١٩٨٤) . statistical procedures for agricultural research , ٢nd Ed . John Wiley & sons .

Hewedy , A . ; Hafez , M . and Anwar , M . M . (١٩٩٤) : The effect of some nutrients and bio-stimulants on plant growth , yield

and quality of common bean . Monofya , J . Agric ., Res ., ١٩ (٤)١٩٢٩–١٩٤٤.

Hussein , A . H . A . ; Kadry W . ; Dessouky , R . F . ; Hassanein A . M . and EL-Deeb M . A . (١٩٩٣) . Effect of different levels and application methods of phosphorus on disease severity of chocotate spot and must , yield and yield components of faba bean in calcareous soil . Egypt J . Appl Sci . ٨ (٧) ٣٨٧-٣٩٧ .

Ismail , K . M . and Hagag A . A . (٢٠٠٥) . Response of faba bean yield
(visia faba L .) to phosphorus and potassium under different method of application in sandy soils . J . Agric . Sci Mansoura univ . , ٣٠ (٢) : ١٦٠١-١٦١٠ .

Jackson . M . L . (١٩٧٣) . Soil chemical analysis . Printice Hall Inc . England cliff . N . Y .

Kamh , R . N . , Mousa , B . I . and Khalil , K.W. (١٩٩١) : Wheat response to N , P and K fertilizion under sprinkler irrigation . Desert Inst . Bull ., A . R . E . , ٤١ (٢) : ٢٧٥ – ٢٨٨ .

Kanany , R . E ; Abd EL-Magid , A . A ; Abu EL-Fatoh , H.H and Hamissa , A M . (٢٠٠٠) . Effect of the addition of sulphur , phosphorus , some micronutrients and potassium in soybean productivity X^{th} international colloquium for the optimization of plant nutrition . Cairo Sheraton , Cairo , Egypt .

Khalil , F . A . ; EL – Shaikh , K . A . A . ; and EL-Lithy , R . E . (٢٠٠٤) . Response of two faba bean cultivars to different levels of phosphorus and sulphur applications . Assiut J . Agric . Sci . , Vol . ٣٥ , No . ٢ .

Lindhauer , M . (١٩٨٩) : Role of potassium in cell extension , growth and storage of assimilates . In Methods of potassium – Research in plants p . ١٦١ . International potash Institute , Berne . Switzeland .

Mohamed , E . I . ; Zayed , G . A . ; and Khalil , F . A . (١٩٩٩) . Effect of different phosphorus sources and levels on the productivity and chemical composition of faba bean (vicia faba L .) . Egyptian J . of Appli . Sci .١٤ : ٧ . pp . ٣٠٩-٣١٨ .

Morschner , H . (١٩٩٥) . Mineral nutrition of higher plants ٢nd ed , Academic Press . London . U K . ٨٨٩ .

Mwafy , S . A . (١٩٩٥) . Studies on faba bean (vicia faba L .) M . Sc . Thesis , Faculty of Agriculture , Zagazig University , Egypt .

Nayak , G . S . and Dwivedi , A . K . (١٩٩٠) . Interaction of sulphur and phosphorus fertilizers on yield and nutrient composition of faba bean grow on black soils of central . India . FABIS Newsletter . ٢٧ : ١٣ – ١٥ .

Olsen , S . R . ; and Sommers , L . E . (١٩٨٢) . phosphorus . In : Methods of Soil Analysis . Part ٢ . second edition (editors : A . L . page ; R . H . Miller ; and D . R . Keeney) . Agronomy Ser . No .٩ . American Society of Agronomy , Madison . Wisconsin , U.S.A. l ١٩٨٢ , pp ٤٠٣ – ٤٣٠ .

Owolade , O . F . ; Adediran , J . A . ; Akand . M . A . and Alabi , B . S . (٢٠٠٦) . Effect of application of phosphorus fertilizer on brown blotch disease of cowpea . African J . Biotechnology ٤ : ٣٤٣ – ٣٤٧ .

Ruggiero , C . ; Pascale S . D . and Fagnano , M . (١٩٩٩) : plant and soil resistance to water flow in faba bean vicia faba L . major Harz . Plant and Soil , ٢١٠ – ٢١٩ .

Singh , J . P . ; Faradar , J . C . and Gupta , B . R . (١٩٩٧) . Sulphur fertilization for increased production of summer mung (vigna radiate L.) ; J . of the Indian Society of soil Sci . ٤٥ (٨) : ٥٢٦ – ٥٢٨ .

Steudle , E .(١٩٩٤): Water transport across roots . plant and soil ١٦٧ ;٧٩.

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Yousry , M . ; EL – Laboudi , A . and khater A . (١٩٨٤) . Effect of sulphur and petrolcum by produced on soil characteristics . II . Availability of some nutrients in a calcareous soils . Egypt J . Soil Sci.,٢٤ (٣):١٩٥–٢٠١ .

تأثير التسميد الفوسفاتى والبوتاسى والكبريت على محصول ومكونات الفول البلدي النامى فى تربة طمييية طينية سلتية

احمد محمد احمد – جمال عبد العزيز عبد الحافظ – عادل مجدى جبرة

معهد بحوث الاراضي والمياه والبيئة ، معهد بحوث المحاصيل

مركز البحوث الزراعية – الجيزة – مصر

أقيمت تجربتان حقليتان فى قطع منشقة مرتين فى مزرعة محطة البحوث الزراعية بملوى – محافظة المنيا مصر خلال موسمى الزراعية ٢٠٠٥/٢٠٠٦ ، ٢٠٠٦/٢٠٠٧ لدراسة استجابة الفول البلدى (جيزة ٨٤٣) لمستويات مختلفة من التسميد الفوسفاتى (١٥ ، ٣٠ ، ٤٥ كجم فو٢ أ ٥ / فدان) ، والبوتاسى (٢٤ ، ٤٨ كجم بو ٢ أ / فدان) والكبريت (صفر ، ٧٥ كجم كبريت / فدان) .

تم تقييم صفات عدد القرون / نبات ، وزن ال ١٠٠ بذرة بالجرام ، محصول البذور (اردب / فدان) ومحصول القش (طن / فدان) ، المحتوي البروتينى للبذور ، امتصاص الفوسفور والبوتاسيوم بواسطة البذور والقش بالكيلو جرام / فدان لقياس اثر هذه المعاملات .

وقد اظهرت النتائج المتحصل عليها أن زيادة مستوى التسميد الفوسفاتى من ١٥ إلى ٣٠ أو ٤٥ كيلو جرام فو٢ أ ٥ / فدان ادت إلى زيادة معنوية فى كل الصفات محل الدراسة ما عدا البوتاسيوم الممتص بواسطة البذور حيث كانت الزيادة غير معنوية فى موسمى الدراسة .

وكانت هناك زيادة معنوية فى كل الصفات محل الدراسة نتيجة لزيادة مستوى التسميد البوتاسى من ٢٤ إلى ٤٨ كجم بو ٢ أ / فدان ما عدا عدد القرون / نبات فى الموسم الثانى ومحصول القش (طن / فدان) فى موسمى الدراسة فقد كانت الزيادة غير معنوية .

أدت زيادة مستوى الكبريت من صفر إلى ٧٥ كجم كبريت / فدان إلى زيادة معنوية فى كل الصفات المدروسة .

كان تأثير التفاعلات بين العوامل الثلاثة على كل الصفات غير معنوى ما عدا التفاعل بين الكبريت والفوسفور فكان التأثير معنوياً على الفوسفور الممتص بواسطة القش فى الموسم الثانى فقط . كانت افضل المعاملات هى ٣٠ كجم فو٢ أ ٥ / فدان ، ٤٨ كجم بو ٢ أ / فدان ، ٧٥ كجم كبريت / فدان .