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EFFECT OF MINERAL PHOSPHATE AND ORGANIC FERTILIZERS ON PLANT GROWTH AND NUTRIENT CONTENTS OF FABA BEAN GROWN ON DIFFERENT SOILS

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ABSTRACT: ***The persent study was carried out to investigate the effect of phosphate fertilizers, organic manures and their interactions on growth and nutrient contents of faba bean plants at 60 days after sowing. A pot experiment was conducted using alluvial and sandy soils. Super phosphate and rock phosphate were used at rates of 0, 15, 30 and 60 kg P_2O_5 / fed., corresponding to 100, 200, and 400 kg / fed. of super phosphate, and 238, 476 and 952 kg / fed. of rock phosphate, based on their P_2O_5 content (15% for super and 6.3% for rock phosphate). Organic manures namely poultry, farmyard and poudrette were added at rates of 0, 2 and 4% organic matter.***

The obtained results are summarized in the following: Phosphorus fertilizers significantly increased the dry weight of faba bean plants in both soils. Super phosphate gave better results than the rock phosphate. Increasing the levels of phosphorus fertilizers enhanced the dry weight of the plants. Application of phosphorus fertilizers generally increased the contents of N, P, K, Ca, Mn, Mo, Cu, Fe, Cd and Pb in plant tissues. Increasing the levels of phosphorus up to 60 kg P_2O_5 / fed. increased the concentrations and uptake of elements by the plants. Organic manures significantly increased the dry weights of the plants in both the alluvial and sandy soils, poudrette gave the best effect. Organic additives increased concentrations and uptake of elements by the plants, where poudrette gave the best results, followed by farmyard and poultry manures. Higher doses of the applied manures resulted in better figures. The alluvial soil recorded the higher values of dry weights and nutrient uptake than the sandy one, whereas, the later had a higher response to the organic and inorganic fertilization. Combination of phosphate fertilizers and organic manures gave significant positive effects. Poudrette manure with super phosphate showed the best results of this study.

Key words: ***Phosphorus fertilization, Organic manures, Nutrients uptake, Faba bean, Legumes.***

INTRODUCTION

Phosphorus has been called "The key of life", because it is directly involved in most vital processes. It is known that the world's population is expanding rapidly. Improving human health is a key component of the future agriculture globally. Plant nutrition requires the application of knowledge from basic and applied research to improve the nutrient status of crops. Efficient use of fertilizers, optimizing crop yield, and minimizing environmental pollution is therefore a critical issues (Rus *et al.,*2005).

Most of newly reclaimed lands in Egypt are sandy soils. Egypt has long been a country of excess population pressure, the cultivation of newly reclaimed sandy soils is one of the prospective solutions to face the increase in menkind food. Sandy soils are very poor in organic matter and plant nutrients (Abdel -Wahab et al., 2006). Mineral fertilizers have been extensively used in recent years to increase agricultural production with a probable environmental pollution. The potential risk of environmental pollution has created an international movement toward clean agriculture (e.g. organic farming). The importance of organic matter to agriculture on arid and semi-arid regions is second only to that of water. Organic materials can increase soil productivity by improving physical, chemical and biological properties of soil(El-Shouny, 2006). On the other hand, phosphate fertilizers especially super phosphate is extensively used as a source of phosphorus to crops. Rock phosphate is a natural source of phosphorus for plant nutrition.

Objective of this study was to evaluate the effect of different forms and rates of phosphate fertilizers (super phosphate and rock phosphate), organic manures (poultry, farmyard and poudrette) and their interaction on vegetative growth and nutrients contents of faba bean plants grown on alluvial and sandy soils of Egypt.

MATERIALS AND METHODS

The present investigation was undertaken to evaluate the effect of different organic and inorganic fertilizers as a soil amendments on vegetative growth and nutrients uptake by faba bean plants. Organic manures, namely, poultry, farmyard and poudrette, were applied at the rates of 0, 2 and 4% organic matter. Phosphate fertilizers, i.e. super phosphate "$Ca(H_2PO_4)_2$" and rock phosphate "$Ca_{10}(PO_4)_6 Fe_2$" were added at the rates of 0,15, 30 and 60 kg P_2O_5 / fed. Faba bean was chosen as a test leguminous plant to be cultivated on two different soils namely, alluvial and sandy. Soil samples were collected from the surface layer (0-30 cm) of the following locations in Minufiya Governorate:

1) Alluvial soil from the experimental farm, Fac of Agric., Minufiya Univ., Shibin El Kom.

2) Sandy soil from Quesna.

Soil samples were air-dried, ground to pass through a 2-mm sieve and analyzed for some physical and chemical properties (Tables1&2) according to Jackson (1973).

Table (1): Physical analysis of soils under consideration.

Soil	Soil moisture content at F.C., %	Organic matter %	Total $CaCO_3$ %	Particle size distribution, %			Textural grade
				Sand	Silt	Clay	
Alluvial	33.80	1.88	2.88	12.40	33.20	54.40	Clayey
Sandy	14.80	0.38	1.20	74.40	14.40	11.20	Sandy

Table (2): Chemical analysis of soils under consideration.

Soil	pH(1:2.5,soil/water suspension)	E.S.P, %	EC,m dsm^{-1} at 25 C^{o}	Available N, mg/100g soil	Available P, mg/100g soil	DTPA - extractable μgg^{-1}			Soluble ions, meq/100g soil (soil:water extract, 1:5)							
									Anions				Cations			
						Fe	Mn	Cu	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
Alluvial	7.8	4.80	0.42	62	5.40	6.8	12.8	4.2	_	.83	2.60	0.82	0.90	0.44	2.30	0.61
Sandy	7.9	0.92	0.25	38	1.40	4.2	6.5	1.4	_	0.64	1.78	0.28	1.32	0.34	0.73	0.31

A pot experiment was conducted in 6 replicates for each treatment, 5 kg of soil were packed in plastic pots after thoroughly mixed with calculated amounts of phosphate forms (super phosphate and rock phosphate), at the rates of 15, 30 and 60 kg P_2O_5 / fed., corresponding to 100, 200 and 400 kg / fed.for super phosphate and 238, 476 and 952 kg / fed. for rock phosphate, (based on their original P_2O_5 contents, e.g. 15% for super phosphate and 6.3% for rock posphate). Also, the soil samples of each treatment, were thoroughly mixed with the calculated amounts of organic manures poultry, farmyard and poudrette, at the rates of 0, 2 and 4% by organic matter. Some chemical data of the organic manures used appear in Table (3).

Table (3): Chemical analysis of the organic manures used.

Manure	O.M , %	Organic C,%	Total N, %		Macronutrients, %				Micronutrients, μgg^{-1}							
				C/N ratio	P	K	Ca	Mg	Zn	Co	Mn	Mo	Fe	Pb	Cd	Cu
Poultry	46.20	26.80	1.40	19	0.68	0.42	0.55	0.32	98	11	88	6	265	25	6	82
Farmyard	20.34	11.80	0.84	14	0.22	0.30	0.11	0.10	80	9	102	7	120	16	4	72
Poudrette	18.01	10.45	0.87	12	0.25	0.22	0.45	0.32	120	12	97	10	168	14	3	60

Faba bean seeds (*Vicia faba* misr 5) were inoculated with specialized rhizobia (*Rhizobiun leguminosarum*) prior to sowing, to ensure efficient dinitrogen fixation. Soil pots were arranged in a randomized complete block design with 3 replicates. 8 seeds of faba bean were planted in each pot (in 15 October). Soil moisture was mentained all pots throughout the experimental duration at 60% of the water-holding capacity of each soil, using Hogland solution (Marschner, 1998) and / or water. Such nutritional solution was devoid of phosphorus and containing a limited amount of nitrogen. Regular compensation had been undertaken by the addition of equal valumes of water to all pots of each soil, every three days. After complete germination, seedlings were thinned to 4 plants /pot. After full tillering stage (60 days after planting), samples of plants were collected. Dry weights of the plants were recorded and statistically analyzed, ground, digested and prepared for chemical analysis for N, P, K, Ca, Fe, Cu, Mo, Mn, Pb and Cd, according to Chapman and Pratt (1961).

RESULTS AND DISCUSSION

1.Effect of phosphate fertilizers, organic manures and their interaction on vegetative growth of faba bean plants

The effect of super phosphate and rock phosphate at their different levels on the dry weights of faba bean plants grown on clay and sandy soils is illustrated in Table (4). The results showed that application of phosphorus fertilizers significantly increased faba bean dry weights of both soils, by the order: super phosphate > rock phosphate > unfertilized plants. That increase was due to the role of phosphorus in root growth and proliferation. Super phosphate, due to its acidic effect on soil pH, surpassed the rock phosphate. Plants grown on the alluvial soil attained higher plant dry weights than the sandy one, due to the better physical, chemical and biological properties, as well as, the higher content of organic matter of the clay soil (see Tables1&2).

Also, it is worthy to mention that, the sandy soil had a higher response of its plants to phosphate fertilization than the alluvial one.

Increasing the levels of phosphate level up to 60 kg P_2O_5 / fed. of both fertilizers significantly increased the plant dry weights of the two soils. Many investigators illustrated the importance of phosphorus fertilizers for soil productivity and plant growth (Faiyad, 1994, Abd Alla et al., 2007, Ciereszko and Balwicka, 2005 and El-Shouny et al.,2008).

Data of Table (4) showed that application of manures tremendously enhanced the dry weights of the faba bean plants grown on both soils. Remarkable increases in the dry weights of plants were recorded at the higher doses of organic additives (4%). All observations emphasize the beneficial effect of manure on plant growth. It is well known that, organic matter favours plant growth via providing the nutrients in available forms for absorption. Effect of the different forms of manures was arranged as follows: poudreete > farmyard > poultry > control. Such results oppositely reflect the values of C/N ratio of the applied manures (Table 3), where the narower was the better. Similar results were obtained by Ewais et al.(2004); Ortas et al. (2005) and El-Shouny et al. (2008).

Interaction between the phosphate fertilization and organic manures gave positive results on plant growth. The response was clearer in the sandy soil than the alluvial one, due to improving the poor conditions of the sandy soil tested. The interaction between poudrette and super phosphate showed the best effect. Similar results were obtained by Sherif and Sherif, (2005); Ayaga et al. (2006) and El-Shouny et al. (2008).

2-Effect of phosphate fertilizers, organic manures and their interaction on nutrinets uptake

Generally, data in Tables (5 to14) showed that application of phosphorus fertilizers increased elements uptake (N, P, K, Ca, Fe, Cu, Mo, Mn, Pb and Cd) by the plants grown on both soils, except some microelements (Fe, Cu, Mn) at the higher doses of phosphate which decreased, especially in their concentrations, but the total amounts taken up were combined with the dry matter yield. The increase in elements uptake was mainly related to the enhancing effect of phosphate fertilization on yield components. The promoting effect of phosphorus on mineral composition of faba bean may be due to the fundamental role of phosphorus in the synthesis of nucleoproteins and a large number of enzymatic reactions catalyzing the phosphorylation process (Marschner,1998). Super phosphate surpassed the rock phosphate in such action. This may be due to the nature and the chemical composition of either fertilizer. It is worthy to note that the increase in elements uptake by plants was parallel to phosphorus availability in the studied fertilizers. Data also showed that the increase in elements uptake by the plants was favoured by elevating the levels of phosphorus upto 60 kg

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P_2O_5 / fed.. The alluvial soil came surperior to the sandy one concerning the elements uptake by the growing plants, but the later had a higher response of its plants to phosphate fertilization.

Effect of phosphorus fertilizers on plant contents of microelements, data of Tables (5 to 14) showed that, in some cases the increasing levels of phosphous added decreased some microelements concentration, such as Mn, Cu and Fe, and in some litlle cases diminished the total amounts taken up; this may be due to any decrease in microelements availability in soil owing to the formation of insoluble compounds with phosphate, or any decrease in the rate of translocation of the element from the roots to the tops. Similer results were obtained by Kanwal et al. (2005), Kaori et al. (2005) and Zhuoping et al. (2005).

Data of Tables (5 to 14) showed that application of manures significantly increased the elements uptake by faba bean plants grown on both soils. This is due to the beneficial effect of the organic ammendements on plant growth, via improving soil properties and particularly its nutritional status quantitatively and qualitatively. In such concern, the different manures were ranked as follows: poudrette > farmyard > poultry > control. Such order oppositely followed the values of C/N ratio (see Table 3), controlling the rate of mineralization and hence liberation of nutirents in available forms. Likewise, increasing the level of each manure up to 4% (Organic matter basis) significantly increased the concentrations and total amounts of elements taken up from both soils, with superiority of the alluvial soil above the sandy one , but the sandy soil showed a higher response to the experimental treatments. Similar results were obtained by Correa *et al.* (2005), Mansour (2007) and El-Shouny *et al.* (2008). The interaction between phosphorus fertilization and organic manures gave a positive effect on elements uptake by plants and their concentrations from the two soil. Poudrette manure with super phosphate were superior in such concern, but in two cases rock phosphate with organic fertilization gave better action, particularly in case of some microelements. Organic manures play an important role in nutrients solubility in soil, and subsequently, increasing their concentrations and uptake especially through production of organic acids during their decomposition, as well as their well known chelating action for calcium ions in soils of above neutral reaction. (Csathó *et al.,* 2005, Jiao et al., 2005 and Ortas et al., 2005). Noteworthy, that rock phosphate is a natural and inexpensive source of phosphorus mainly and other macro- and micronutrients, hence its utilization together with manures is recommended for agricultural practices of organic farming.

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تأثير الأسمدة الفوسفاتية و العضوية علي نمو نبات الفول البلدى ومحتواه العنصري في أراضي مختلفة

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الملخص العربي

أجرى هذا البحث لدراسة و تقييم تأثير الأسمدة الفوسفاتية والعضوية والتداخل بينهم علي نمو نبات الفول البلدي ومحتواه من العناصر الغذائية. فقد أجريت تجربة أصص استخدمت فيها نوعين من الأراضي هما رسوبية طينية ورملية. وأضيفت الأسمدة الفوسفاتية (سوبر الفوسفات و صخر الفوسفات) بمعدلات صفر، ١٥، ٣٠، ٦٠كجم فو٢٥١ / فدان (أي بمعدل ١٠٠، ٢٠٠، ٤٠٠كجم سوبر فوسفات و ٢٣٨ ، ٤٧٦ ، ٩٥٢ كجم صخر الفوسفات للفدان). واستخدم كل من زرق الدواجن و السماد البلدي و البودريت كأسمدة عضوية ، أضيفت بمعدلات صفر ، ٢ ، ٤% مادة عضوية. و بعد اكتمال النمو الخضري (حوالي ٦٠ يوم بعد الزراعة) حصدت النباتات و حللت كيميائيا. و قد أظهرت النتائج ما يلي :

١- أدت إضافة الأسمدة الفوسفاتية إلي زيادة معنوية للأوزان الجافة لنبات الفول في كلا الأرضين ، و كانت هذه الزيادة متمشية مع كمية الفوسفور الذائب في كل سماد، حيث تفوق السوبر فوسفات علي صخر الفوسفات .

٢- أدت إضافة الأسمدة الفوسفاتية إلي زيادة التركيزات و المحتوي الكلى للعناصر داخل النبات (النيتروجين، الفوسفور، البوتاسيوم، الكالسيوم، المنجنيز، المولبيدنيوم، النحاس، الحديد، الكادميوم والرصاص)، فيما عدا بعض الحالات بالنسبة للعناصر الصغرى التي ترددت بين الزيادة والنقصان أو ظلت بلا تغيير، خاصة عند المستويات العالية من التسميد الفوسفاتي و تحديدا مع السوبر فوسفات ، وبصفة خاصة زاد الامتصاص بزيادة معدلات الإضافة حتى ٦٠ كجم فو٢٥١/فدان .

٣- أدت إضافة الأسمدة العضوية إلي زيادة معنوية للأوزان الجافة للفول البلدي في كلا الارضين وكان لسماد البودريت تأثيرا مميزا عن باقي الأسمدة المستخدمة خلال مرحلة النمو الخضري هذه. وكذلك ارتفعت تركيزات العناصر والكميات الممتصة منها. وبزيادة مستوى الإضافة من الأسمدة حتى ٤% (مادة عضوية) زادت كميات العناصر الممتصة داخل النبات .

٤- أعطت الأرض الرسوبية أعلى النتائج للأوزان الجافة للنباتات وتركيزات العناصر والكميات الممتصة منها بالمقارنة بالأرض الرملية ، ولكن هذه الأخيرة أظهرت استجابة أكثر للتسميد المعدني والعضوي المستخدمين .

٥- كان للتداخل بين الأسمدة المعدنية والعضوية أثرا إيجابيا ومعنويا علي الأوزان الجافة لنبات الفول و امتصاص العناصر وتفوق البودريت مع السوبر فوسفات علي جميع المعاملات .

٦- بالرغم من تفوق سماد السوبر فوسفات علي صخر الفوسفات بصفة عامة ، إلا أن الأخير أعطى نتائج مرضية إلي حد ما تحت ظروف الدراسة .

٧- يعتبر صخر الفوسفات مصدرا طبيعيا وغير مكلف للفوسفور، لذا فإن استخدامه مع الأسمدة العضوية يوصى به في المعاملات الزراعية للزراعة العضوية

Table (4): Effect of P-fertilizers and organic manures on dry weights of faba bean plants(g/plant) grown on the alluvial and sandy soils, at 60 days after sowing.

P. fertilizers	P. levels, kg P_2O_5 / fed.	Alluvial soil								Sandy soil							
		Manures								Manures							
		Control	Poultry		Farmyard		Poudrette		Mean	Control	Poultry		Farmyard		Poudrette		Mean
		Organic matter,%								Organic matter, %							
		0	2	4	2	4	2	4		0	2	4	2	4	2	4	
Control		0.78	0.91	0.93	0.81	0.99	1.04	1.14	0.93	0.47	0.67	0.68	0.70	0.67	0.73	0.74	0.67
super phosphate	15	0.88	1.01	1.02	1.08	1.03	1.16	1.18	1.04	0.65	0.68	0.73	0.71	0.74	0.73	0.78	0.72
	30	1.00	1.04	1.05	1.07	1.10	1.18	1.22	1.09	0.68	0.70	0.74	0.73	0.75	0.74	0.85	0.74
	60	1.00	1.03	1.11	1.28	1.25	1.32	1.34	1.20	0.69	0.72	0.75	0.78	0.90	0.80	0.95	0.80
	Mean	0.91	1.01	1.03	1.04	1.10	1.18	1.22		0.62	0.69	0.73	0.73	0.78	0.75	0.83	
Rock phosphate	15	0.83	0.84	0.85	1.01	1.00	1.05	1.06	0.95	0.61	0.63	0.63	0.64	0.65	0.65	0.92	0.67
	30	0.91	0.94	1.01	1.01	1.02	1.07	1.13	1.01	0.63	0.64	0.66	0.68	0.70	0.71	0.98	0.72
	60	0.95	1.02	1.05	1.07	1.11	1.13	1.14	1.07	0.67	0.68	0.72	0.70	0.75	0.73	0.80	0.71
	Mean	0.87	0.94	0.96	0.96	1.03	1.07	1.12		0.59	0.66	0.67	0.68	0.71	0.70	0.80	
L.S.D., at 5% :										L.S.D., at 5% :							
Mineral fertilizers "A" = 0.06										Meniral fertilizers "A" = 0.11							
Organic manures "B" = 0.06										Organic manures "B" = 0.11							
Interaction "A" x "B" = 0.33										Interaction "A" x" B"= 0.34							

Table(5): Effect of mineral phosphate and organic fertilization on nitrogen uptake by faba bean plants grown on the alluvial and sandy soils, at 60 days after sowing .

P- fertilizers	P. levels, kg P_2O_5 / fed.	Manures (organic matter, %)														Mean
		Control		Poultry				Farmyard				Poudrette				
		0		2		4		2		4		2		4		
		%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	mg/plant
Alluvial soil																
Control		2.22	17.32	2.50	24.07	2.62	24.24	2.22	16.75	2.22	22.03	2.72	28.29	2.44	27.82	22.93
Super phosphate	15	2.56	22.40	2.62	26.40	2.88	29.16	2.64	27.59	2.80	28.84	2.84	32.87	3.42	40.18	29.65
	30	2.62	26.07	2.72	28.15	2.92	30.66	2.78	29.74	3.02	33.07	2.88	34.05	3.82	46.60	32.62
	60	2.72	27.20	2.82	29.11	2.94	32.71	2.78	35.65	3.04	39.22	2.96	39.00	3.90	52.36	36.48
	Mean		23.17		26.93		29.19		27.44		30.78		33.56		41.75	
Rock phosphate	15	2.30	19.03	2.34	19.66	1.96	16.66	2.02	20.45	2.12	21.20	2.14	22.36	3.80	40.10	23.28
	30	2.32	21.17	2.36	22.13	2.18	21.91	2.04	20.66	2.24	22.91	2.60	27.95	3.40	38.25	25.00
	60	2.40	22.80	2.42	24.69	2.20	22.99	2.20	23.54	2.28	25.31	2.54	28.70	3.60	48.33	28.06
	Mean		20.08		22.63		21.45		20.50		22.86		26.95		38.68	
Sandy soil																
Control		2.00	9.45	2.25	15.08	2.34	15.80	2.27	15.90	2.36	16.88	2.45	17.78	2.92	21.6	16.08
super phosphate	15	2.32	14.98	2.41	16.28	2.59	18.90	2.38	16.90	2.60	19.3	2.56	18.83	3.08	23.95	18.45
	30	2.38	16.08	2.45	17.15	2.63	19.48	2.50	18.13	2.72	20.40	2.59	19.18	3.44	29.25	19.95
	60	2.45	16.90	2.54	18.30	2.65	19.88	2.50	19.50	2.74	24.65	2.67	21.35	3.52	33.45	22.03
	Mean		14.38		16.70		18.53		17.60		20.30		19.30		27.08	
Rock phosphate	15	2.20	13.30	2.15	13.55	2.34	14.63	2.40	15.25	2.44	15.93	2.44	15.85	2.82	25.80	16.33
	30	2.26	14.13	2.38	15.13	2.44	16.10	2.42	16.40	2.53	17.70	2.48	17.50	2.90	21.03	16.85
	60	2.28	14.95	2.40	16.33	2.50	18.00	2.44	17.08	2.60	19.50	2.48	18.10	2.94	23.53	18.20
	Mean		12.98		15.03		16.13		16.15		17.50		17.30		23.00	

Table (6): Effect of mineral phosphate and organic fertilization on phosphorus uptake by faba bean plants grown on the alluvial and sandy soils, at 60 days after sowing .

P - fertilizers	P. levels, kg P_2O_5 / fed.	Manures (organic matter, %)														
		Control		Poultry				Farmyard				Poudrette				Mean
		0		2		4		2		4		2		4		
		%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	mg/plant
Alluvial soil																
Control		0.16	1.16	0.18	1.73	0.21	1.97	0.21	1.81	0.24	2.38	0.26	2.71	0.28	3.19	2.13
super phosphate	15	0.24	2.10	0.25	2.52	0.25	2.53	0.26	2.72	0.27	2.78	0.28	3.24	0.32	3.76	2.81
	30	0.25	2.49	0.28	2.90	0.26	2.73	0.28	3.00	0.27	2.96	0.30	3.55	0.32	3.91	3.08
	60	0.26	2.60	0.30	3.10	0.26	2.89	0.30	3.85	0.30	3.87	0.32	4.21	0.36	4.83	3.62
	Mean		2.15		2.56		2.60		2.97		3.00		3.43		3.92	
Rock phosphate	15	0.22	1.82	0.23	1.93	0.25	2.46	0.23	2.33	0.24	2.40	0.24	2.51	0.26	2.74	2.24
	30	0.24	2.19	0.25	2.35	0.26	2.61	0.25	2.53	0.26	2.66	0.24	2.58	0.30	3.38	2.63
	60	0.24	2.28	0.26	2.54	0.26	2.72	0.27	2.89	0.28	3.11	0.28	3.17	0.30	3.42	2.88
	Mean		1.93		2.29		2.38		2.52		2.64		2.74		3.18	
Sandy soil																
Control		0.14	٠.٧٤	0.18	١.٢١	0.19	١.٢٨	0.13	٠.٩١	0.20	١.٤٣	0.21	١.٥٢	0.22	١.٦٣	١.٢٥
super phosphate	15	0.19	١.٢٣	0.20	١.٣٥	0.20	١.٤٦	0.21	١.٤٩	0.22	١.٦٣	0.23	١.٦٩	0.26	٢.٠٢	١.٥٥
	30	0.20	١.٣٥	0.23	١.٦١	0.21	١.٥٦	0.23	١.٦٧	0.22	١.٦٥	0.24	١.٧٨	0.28	٢.٣٨	١.٧١
	60	0.21	١.٤٥	0.24	١.٧٣	0.21	١.٥٨	0.24	١.٨٧	0.24	٢.١٢	0.28	٢.٢٤	0.32	٣.٠٤	١.٠١
	Mean		1.19		1.48		1.47		1.50		1.72		1.81		2.27	
Rock phosphate	15	0.18	1.09	0.19	1.20	0.18	1.13	0.18	1.14	0.19	1.24	0.19	1.24	0.28	2.56	1.37
	30	0.19	1.19	0.20	1.27	0.21	1.39	0.20	1.36	0.21	1.58	0.14	1.34	0.24	1.74	1.41
	60	0.19	1.25	0.21	1.43	0.21	1.51	0.22	1.54	0.24	1.80	0.23	1.68	0.24	1.92	1.59
	Mean		1.07		1.28		1.33		1.27		1.51		1.45		1.97	

Table (7): Effect of mineral phosphate and organic fertilization on potassium uptake by faba bean plants grown on the alluvial and sandy soils, at 60 days after sowing .

P -fertilizers	P. levels, kg P_2O_5 / fed.	Manures (organic matter, %)														
		Control		Poultry				Farmyard				Poudrette				Mean
		0		2		4		2		4		2		4		
		%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	mg/plant
Alluvial soil																
Control		2.8	21.85	3.2	30.80	3.4	31.45	3.4	25.68	3.6	35.73	2.8	29.13	3.1	35.40	30.10
super phosphate	15	3.2	28.00	3.4	34.25	3.5	35.45	3.5	36.58	3.6	37.08	3.8	43.98	4.2	49.35	37.80
	30	3.2	31.85	3.4	35.2	3.4	35.7	3.6	38.53	3.6	39.43	3.8	44.93	4.2	51.25	39.55
	60	3.4	34.00	3.6	37.18	3.7	41.18	3.7	47.45	3.7	35.13	3.8	50.08	4.2	56.38	44.85
	Mean		28.93		34.35		35.95		37.05		40.00		42.03		48.10	
Rock phosphate	15	2.9	24.00	2.9	24.35	3.0	25.50	3.3	33.90	3.2	32.00	4.1	35.95	4.6	37.98	30.60
	30	3.2	29.20	3.2	30.00	3.3	33.18	3.3	33.43	3.4	34.78	3.6	38.70	3.8	42.75	34.58
	60	3.4	32.30	3.5	35.70	3.6	37.55	3.6	38.53	3.7	41.08	3.8	42.95	3.8	43.33	38.78
	Mean		26.85		30.23		31.95		32.25		35.90		36.05		39.88	
Sandy soil																
Control		1.3	6.90	1.4	9.38	2.4	16.20	2.4	16.80	2.5	17.88	2.5	18.13	2.5	18.50	14.78
super phosphate	15	2.3	14.83	2.7	18.23	2.7	19.70	2.7	19.18	2.5	18.58	3.1	22.73	3.4	26.13	19.93
	30	2.3	15.53	2.7	18.90	2.8	20.73	2.9	21.03	2.5	18.75	3.1	22.95	3.4	28.58	20.93
	60	2.4	16.55	2.9	20.88	2.9	21.75	3.0	23.40	2.6	93.6	3.2	25.60	3.4	31.93	23.35
	Mean		13.45		16.85		19.60		20.10		19.65		22.38		26.28	
Rock phosphate	15	2.1	12.70	2.3	14.50	2.4	15.00	2.5	15.88	2.5	16.33	2.8	18.20	2.9	19.28	15.98
	30	2.3	14.38	2.6	16.53	2.6	17.15	2.6	17.63	2.7	18.90	2.9	20.45	2.9	21.03	18.03
	60	2.4	15.73	2.8	19.05	2.8	20.15	2.9	20.30	3.0	22.50	2.9	21.18	3.1	24.80	20.53
	Mean		12.43		14.85		17.13		17.65		18.90		19.50		20.90	

Table (8): Effect of mineral phosphate and organic fertilization on calcium uptake by faba bean plants grown on the alluvial and sandy soils, at 60 days after sowing .

P – fertilizers	P. levels, kg P_2O_5 / fed.	Manures (organic matter, %)														Mean
		Control		Poultry				Farmyard				Poudrette				
		0		2		4		2		4		2		4		
		%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	mg/plant
Alluvial soil																
Control		0.58	4.53	0.60	5.48	0.74	6.85	0.72	5.80	0.74	7.35	0.80	8.33	0.84	9.58	6.85
Super phosphate	15	0.70	6.13	0.76	7.65	0.76	7.70	0.78	8.15	0.80	8.25	0.98	11.35	0.98	11.53	8.69
	30	0.72	7.18	0.78	8.09	0.80	8.40	0.80	8.55	0.82	8.98	1.20	14.20	1.40	17.08	10.35
	60	0.74	7.40	0.80	8.28	0.82	9.13	0.84	10.78	0.86	11.10	1.40	18.45	1.62	21.75	12.40
	Mean		6.30		7.38		8.03		8.33		8.93		13.08		15.00	
Rock phosphate	15	0.64	5.30	0.72	6.05	0.72	6.13	0.74	7.50	0.76	7.60	0.82	8.58	0.90	9.58	7.25
	30	0.68	6.20	0.74	6.95	0.76	7.65	0.76	7.70	0.78	7.96	0.78	8.38	0.96	10.80	7.95
	60	0.70	6.65	0.76	7.75	0.76	7.95	0.78	8.35	0.82	9.10	0.88	9.95	1.20	13.70	9.05
	Mean		5.68		6.55		7.15		7.35		8.03		8.8		10.9	
Sandy soil																
Control		0.49	2.33	0.60	4.03	0.70	4.73	0.70	4.90	0.72	4.83	0.74	5.38	0.74	5.48	4.53
Super phosphate	15	0.62	4.00	0.64	4.33	0.72	5.25	0.72	5.13	0.74	5.75	0.74	5.45	0.76	5.90	5.13
	30	0.62	4.18	0.68	4.78	0.74	5.48	0.74	5.38	0.76	5.70	0.76	5.63	0.80	6.80	5.43
	60	0.70	4.83	0.72	5.18	0.74	5.55	0.78	6.10	0.78	7.03	0.88	7.05	1.02	9.70	6.50
	Mean		3.83		4.58		5.25		5.38		5.83		5.88		6.98	
Rock phosphate	15	0.60	3.63	0.70	4.43	0.76	4.75	0.72	4.58	0.74	4.83	0.78	5.08	0.70	6.40	4.83
	30	0.64	4.00	0.70	4.45	0.72	4.75	0.74	5.03	0.74	5.18	0.76	5.35	0.70	6.85	5.10
	60	0.66	4.33	0.72	4.90	0.74	5.33	0.74	5.18	0.78	5.85	0.80	5.85	0.74	5.93	5.35
	Mean		3.58		4.45		4.90		4.93		5.18		5.43		6.18	

Table (9): Effect of mineral phosphate and organic fertilization on iron uptake by faba bean plants grown on the alluvial and sandy soils, at 60 days after sowing .

P - fertilizers	P. levels, kg P_2O_5 / fed.	Manures (organic matter, %)														
		Control		Poultry				Farmyard				Poudrette				Mean
		0		2		4		2		4		2		4		
		ppm	µg/plant	Ppm	µg/plant	ppm	µg/plant	Ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	µg/plant
Alluvial soil																
Control		204	159	310	283	340	315	380	306	380	377	408	424	420	479	335
super phosphate	15	315	276	322	325	370	375	382	399	388	400	412	477	420	494	392
	30	330	328	332	344	374	393	390	417	390	427	420	497	430	525	419
	60	200	200	336	347	370	412	380	487	380	475	424	559	442	59.4	439
	Mean		241		325		374		403		420		489		523	
Rock phosphate	15	312	408	342	287	374	318	382	387	384	384	410	429	440	464	361
	30	320	292	324	304	368	370	384	389	390	399	390	419	432	486	380
	60	230	219	330	337	380	397	380	407	398	442	430	486	430	490	397
	Mean		232		303		350		372		401		440		480	
Sandy soil																
Control		163	77	250	168	270	182	304	213	304	204	350	254	405	300	200
super phosphate	15	252	163	257	174	296	216	305	217	310	230	370	272	378	294	224
	30	264	178	265	186	299	221	312	226	312	234	378	280	387	329	236
	60	160	111	268	193	296	222	304	238	304	274	381	305	397	377	246
	Mean		132		176		211		223		236		278		325	
Rock phosphate	15	249	151	275	173	291	182	315	200	317	207	369	240	378	346	214
	30	256	160	259	165	294	194	307	206	312	219	351	248	388	380	225
	60	184	121	264	180	304	219	304	213	318	231	387	283	387	310	223
	Mean		127		171		194		208		217		256		334	

Table (10): Effect of mineral phosphate and organic fertilization on cupper uptake by faba bean plants grown on the alluvial and sandy soils, at 60 days after sowing .

P - fertilizers	P. levels, kg P_2O_5 / fed.	Manures (organic matter, %)														Mean
		Control		Poultry				Farmyard				Poudrette				
		0		2		4		2		4		2		4		
		ppm	µg/plant	ppm	µg/plant	Ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	µg/plant
Alluvial soil																
Control		20	15.5	26	23.8	28	26	30	24.3	32	31.8	34	35.3	36	41	26.3
Super phosphate	15	26	22.8	26	26.3	28	28.3	32	33.5	32	33.0	36	41.8	38	44.8	33.0
	30	22	22	26	27.0	28	29.5	32	34.3	34	37.3	38	45.0	38	46.3	34.5
	60	18	18.0	28	29.0	28	31.3	30	38.5	32	41.3	36	47.5	38	51.0	36.8
	Mean		19.5		26.5		28.8		32.8		35.8		42.5		45.8	
Rock phosphate	15	26	21.5	26	21.8	28	23.8	28	28.3	30	30.0	32	33.5	34	36.0	27.8
	30	26	23.8	26	24.5	28	28.3	30	30.5	32	32.8	34	36.5	36	40.5	31.0
	60	22	21.0	24	24.5	28	29.3	30	32.0	32	35.5	34	38.5	36	41.0	31.8
	Mean		20.5		23.8		26.8		28.8		32.5		36.0		39.8	
Sandy soil																
Control		18	8.5	20	13.5	24	16.3	22	15.3	29	19.5	31	22.5	30	20.0	16.5
Super phosphate	15	23	14.8	23	15.5	24	17.5	28	20.0	29	21.5	33	24.3	35	26.0	20.0
	30	19	12.8	24	16.8	24	17.8	28	20.3	31	23.3	36	26.8	35	26.3	20.5
	60	16	11.0	24	17.3	22	16.5	27	21.0	27	24.3	33	26.5	34	30.5	21.0
	Mean		11.8		15.8		17.0		19.3		22.3		25.0		25.8	
Rock phosphate	15	23	14.0	23	15.0	24	15.0	25	16.0	27	17.8	32	20.8	36	23.5	17.5
	30	23	14.5	23	14.5	22	14.5	27	18.3	29	20.3	31	21.8	33	23.0	18.0
	60	18	11.8	21	14.3	22	15.8	27	19.0	29	21.8	31	22.8	33	24.8	18.5
	Mean		12.3		14.3		15.5		17.3		19.8		22.0		22.8	

Table (11): Effect of mineral phosphate and organic fertilization on molybdenum uptake by faba bean plants grown on the alluvial and sandy soils, at 60 days after sowing .

P- fertilizers	P. levels, kg P_2O_5 / fed.	Manures (organic matter, %)														Mean
		Control		Poultry				Farmyard				Poudrette				
		0		2		4		2		4		2		4		
		ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	µg/plant
Alluvial soil																
Control		0.32	0.25	0.44	0.40	0.44	0.40	0.46	0.37	0.48	0.48	0.62	0.65	0.64	0.73	0.47
Super phosphate	15	0.42	0.37	0.46	0.46	0.46	0.47	0.48	0.50	0.48	0.50	0.80	0.93	0.80	0.94	0.60
	30	0.46	0.46	0.54	0.56	0.56	0.59	0.58	0.62	0.60	0.66	0.82	0.97	0.92	1.12	0.71
	60	0.46	0.46	0.68	0.70	0.72	0.80	0.72	0.93	0.82	1.06	1.02	1.35	1.12	1.51	0.96
	Mean		0.39		0.53		0.57		0.61		0.67		0.97		1.08	
Rock phosphate	15	0.40	0.33	0.42	0.35	0.42	0.36	0.44	0.45	0.48	0.48	0.60	0.63	0.66	0.66	0.47
	30	0.42	0.38	0.44	0.41	0.44	0.44	0.46	0.46	0.46	0.47	0.80	0.86	0.92	1.04	0.58
	60	0.46	0.44	0.66	0.67	0.70	0.73	0.70	0.75	0.72	0.80	0.92	1.04	1.02	1.16	0.80
	Mean		0.35		0.46		0.49		0.51		0.56		0.80		0.90	
Sandy soil																
Control		0.27	0.13	0.35	0.24	0.35	0.24	0.37	0.26	0.38	0.26	0.48	0.35	0.50	0.37	0.26
Super phosphate	15	0.34	0.22	0.37	0.25	0.37	0.27	0.38	0.27	0.38	0.28	0.64	0.27	0.64	0.50	0.32
	30	0.37	0.25	0.43	0.30	0.49	0.36	0.47	0.34	0.48	0.36	0.66	0.49	0.74	0.63	0.39
	60	0.38	0.26	0.54	0.39	0.58	0.44	0.58	0.45	0.66	0.60	0.82	0.66	0.90	0.86	0.52
	Mean		0.22		0.30		0.33		0.33		0.37		0.49		0.59	
Rock phosphate	15	0.32	0.19	0.34	0.22	0.40	0.25	0.38	0.24	0.42	0.28	0.50	0.33	0.50	0.46	0.28
	30	0.34	0.21	0.35	0.22	0.35	0.23	0.37	0.25	0.37	0.26	0.64	0.45	0.63	0.63	0.32
	60	0.38	0.25	0.53	0.36	0.56	0.41	0.56	0.39	0.58	0.44	0.74	0.54	0.83	0.67	0.44
	Mean		0.20		0.26		0.28		0.29		0.31		0.42		0.53	

Table (12): Effect of mineral phosphate and organic fertilization on manganese uptake by faba bean plants grown on the alluvial and sandy soils, at 60 days after sowing .

P - fertilizers	P. levels, kg P_2O_5 / fed.	Manures (organic matter, %)														Mean
		Control		Poultry				Farmyard				Poudrette				
		0		2		4		2		4		2		4		
		ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	µg/plant
Alluvial soil																
Control		60	47	68	62	80	74	90	73	94	93	102	106	102	116	81
super phosphate	15	78	68	78	79	84	85	94	98	96	99	108	125	114	134	98
	30	66	66	84	87	84	88	94	100	98	107	114	135	118	144	104
	60	54	54	76	79	80	89	90	116	96	124	108	142	118	159	109
	Mean		59		77		84		97		106		127		553	
Rock phosphate	15	78	65	79	66	85	72	84	85	94	94	96	100	112	118	86
	30	68	64	79	74	82	83	90	91	96	98	98	105	108	117	90
	60	66	63	72	56	80	84	90	96	96	107	98	111	108	123	91
	Mean		60		65		78		86		98		106		119	
Sandy soil																
Control		44	21	64	43	72	49	78	55	88	59	88	64	96	71	52
super phosphate	15	69	45	69	47	74	54	80	57	88	65	99	73	105	82	60
	30	53	36	72	51	74	55	80	58	92	69	108	80	107	91	63
	60	48	33	72	52	66	50	81	63	81	73	99	79	104	99	64
	Mean		34		48		52		58		67		74		86	
Rock phosphate	15	69	42	70	44	79	50	80	51	90	59	98	64	92	84	55
	30	69	43	70	45	76	50	86	58	84	59	93	66	94	92	59
	60	54	36	63	43	67	48	80	56	84	63	91	67	90	72	55
	Mean		35		44		49		55		60		65		80	

Table (13): Effect of mineral phosphate and organic fertilization on lead uptake by faba bean plants grown on the alluvial and sandy soils, at 60 days after sowing .

P - fertilizers	P. levels, kg P_2O_5 / fed.	Manures (organic matter, %)														Mean
		Control		Poultry				Farmyard				Poudrette				
		0		2		4		2		4		2		4		
		ppm	µg/plant	ppm	µg/plant	Ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	µg/plant
Alluvial soil																
Control		1.2	0.9	1.4	1.3	2.2	2.0	1.6	1.3	2.4	2.4	1.8	1.9	2.8	3.2	1.9
super phosphate	15	2.2	1.9	2.3	2.3	2.4	2.4	2.4	2.5	2.4	2.5	2.6	3.0	2.9	3.4	2.6
	30	3.0	3.0	3.2	3.3	3.2	3.4	3.4	3.7	3.4	3.7	3.6	4.3	3.8	4.6	3.7
	60	3.2	3.2	3.4	3.5	3.4	3.8	3.6	4.6	3.6	4.7	3.8	5.0	3.8	5.1	4.3
	Mean		2.3		2.6		2.9		3.0		3.3		3.5		4.1	
Rock phosphate	15	1.4	1.2	2.2	1.9	2.3	2.0	2.2	2.2	2.3	2.3	3.2	3.4	3.3	3.5	2.3
	30	1.8	1.7	3.0	2.8	3.0	3.0	3.1	3.2	3.3	3.4	3.4	3.7	3.6	4.1	3.1
	60	1.8	1.7	3.1	3.2	3.2	3.4	3.2	3.4	3.4	3.8	3.4	3.9	3.6	3.9	3.3
	Mean		1.4		2.3		2.6		2.5		3.0		3.2		3.7	
Sandy soil																
Control		0.8	0.4	1.0	0.7	1.5	1.0	1.1	0.8	1.6	1.0	1.4	1.0	2.2	1.6	1.0
super phosphate	15	1.5	1.0	1.6	1.1	1.7	1.3	1.7	1.2	1.9	1.4	2.0	1.5	2.3	1.8	1.3
	30	2.1	1.4	2.2	1.6	2.2	1.6	2.4	1.8	2.4	1.8	2.7	1.8	3.1	2.6	1.8
	60	2.2	1.5	2.4	1.7	2.4	1.8	2.5	2.0	2.5	2.3	2.9	2.3	3.1	3.0	2.1
	Mean		1.1		1.3		1.4		1.4		1.6		1.7		2.3	
Rock phosphate	15	1.0	0.6	1.5	1.0	1.6	1.0	1.6	1.0	1.8	1.2	2.2	1.4	2.6	2.4	1.2
	30	1.3	0.8	2.1	1.3	2.1	1.4	2.2	1.5	2.3	1.6	2.6	1.8	2.7	2.6	1.6
	60	1.4	0.9	2.1	1.4	2.3	1.7	2.3	1.6	2.4	1.8	2.6	1.7	2.9	2.3	1.6
	Mean		0.7		1.1		1.3		1.2		1.4		1.5		2.5	

Table (14): Effect of mineral phosphate and organic fertilization on cadmium uptake by faba bean plants grown on the alluvial and sandy soils, at 60 days after sowing .

Alluvial soil																
P – fertilizers	P. levels, kg P_2O_5 / fed.	Manures (organic matter, %)														
		Control		Poultry				Farmyard				Poudrette				Mean
		0		2		4		2		4		2		4		
		ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	ppm	µg/plant	µg/plant
Control		0.15	0.12	0.18	0.17	0.28	0.26	0.20	0.16	0.30	0.30	0.23	0.24	0.35	0.40	0.24
super phosphate	15	0.28	0.25	0.29	0.29	0.30	0.31	0.30	0.31	0.30	0.31	0.33	0.38	0.36	0.43	0.33
	30	0.38	0.38	0.40	0.42	0.40	0.42	0.43	0.46	0.48	0.53	0.45	0.53	0.68	0.83	0.51
	60	0.40	0.40	0.42	0.44	0.43	0.48	0.45	0.58	0.49	0.63	0.48	0.63	0.78	1.05	0.60
	Mean		0.29		0.33		0.37		0.38		0.44		0.45		0.68	
Rock phosphate	15	0.18	0.15	0.25	0.21	0.32	0.27	0.28	0.28	0.32	0.32	0.40	0.42	0.41	0.43	0.30
	30	0.23	0.21	0.38	0.36	0.38	0.38	0.39	0.40	0.42	0.43	0.43	0.46	0.45	0.51	0.39
	60	0.23	0.22	0.39	0.38	0.40	0.42	0.40	0.43	0.43	0.48	0.45	0.51	0.49	0.56	0.43
	Mean		0.18		0.28		0.33		0.32		0.38		0.41		0.48	
Sandy soil																
Control		0.11	0.05	0.13	0.09	0.19	0.13	0.14	0.10	0.20	0.14	0.18	0.13	0.28	0.21	0.12
super phosphate	15	0.19	0.12	0.20	0.14	0.21	0.15	0.22	0.16	0.24	0.18	0.25	0.19	0.29	0.23	0.17
	30	0.26	0.18	0.28	0.20	0.29	0.22	0.30	0.22	0.30	0.23	0.34	0.25	0.39	0.33	0.23
	60	0.28	0.19	0.30	0.22	0.32	0.24	0.31	0.24	0.32	0.29	0.36	0.29	0.41	0.39	0.27
	Mean		0.13		0.16		0.19		0.18		0.21		0.22		0.29	
Rock phosphate	15	0.13	0.08	0.19	0.12	0.20	0.13	0.20	0.13	0.22	0.15	0.30	0.20	0.33	0.30	0.16
	30	0.16	0.10	0.26	0.17	0.26	0.17	0.28	0.19	0.29	0.20	0.33	0.23	0.36	0.35	0.20
	60	0.18	0.12	0.28	0.19	0.29	0.21	0.29	0.20	0.31	0.23	0.33	0.22	0.36	0.29	0.21
	Mean		0.09		0.14		0.16		0.16		0.18		0.20		0.29	