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IMPACT OF COMPOST AND PHOSPHATE FERTILIZERS UTILIZATIUON ON PHOSPHORUS AVAILABLILITY AND SOME CROPS PRODUCTIVITY ON SANDY SOILS

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ABSTRACT: ***A field experiment was carried out at Ismalia Agricultural Experimental Station during the winter season (2005/ 2006) and summer season (2006) to asses the influence of organic, inorganic P-fertilization and Bio-fertilizers on soil available phosphorus of sandy soil under lupine and maize crops. The experiment was laid out in a split – split design with three replicates. Compost as organic fertilizer was placed in the main plots, while P- fertilizer in the sub plots. Bio-fertilizer was in the sub sub plots.***

The obtained results indicated that applying 5 ton compost/fed to sandy soil intensified organic matter content and available NPK of tested soil. This increment may be due to the beneficial effect of organic matter in improving the nutritional status of soil. Whereas, the inoculation by Bacillus polymyxa heightened the values of available NP in the studied sandy soil. This increment may be elucidated by the ability of Bacillus polymyxa to fix nitrogen in rhizosphere, which is reflected increasing on available nitrogen in inoculated treatments. In the same time, it helps in solubilizing the insoluble phosphates and makes it available to the plant.

Applying 50% of the recommended phosphate does in the form of super phosphate at preplanting, while the rest was equally applied in two does after planting (SP2 treatment) intensified soil available phosphorus and phosphorus concentration of lupine and maize grains. On contrary, applying 100% of the recommended phosphate does in the form of rock phosphate at preplanting (RP1 treatment) increased the soil availability of phosphorus to the plant. It was noticed that the maximum value of protein concentration attained by the interaction between addition compost (5 ton/fed) and (SP1) treatments under lupine crop.

The highly significant increment of lupine and maize grain yields were realized by applying compost at (5-ton/fed) plus (SP2) treatment and inoculated with Bacillus polymyxa. Although, the lowest one was obtained by applying no compost, RP2 treatment and no inoculated.

Key words: ***Sandy soil, Compost, Super phosphate, Rock phosphate, Bacillus polymyxa Available phosphorus***

INTRODUCTION

The newly cultivated lands in Egypt are mainly sandy and sandy calcareous soils, which are very poor in organic matter and plant nutrients. Deficiency in plant-available phosphorus is considered a major limiting factor to food production in many agricultural soils. Mineral resources are necessary to restore soil phosphorus content. Where conventional P fertilizers are highly limited due to cost or to mitigate adverse environmental effects, local sources of rock phosphate are being increasingly recognized for potential use as alternative phosphorus fertilizers. The main obstacle associated with using directly applied rock phosphate is that the phosphate released is often unable to supply sufficient plant phosphorus for crop uptake. Plant and microbial-based mechanisms are low-cost, appropriate technologies to enhance the solubilization and increase the agronomic effectiveness of rock phosphate. Common mechanisms of rock phosphate dissolution including proton and organic acid production will be reviewed for both plants and microorganisms. (Sanchez *et al.,* 1997 and Hoberg *et al*., 2005).

Concerning the effect of plants on P availability, it was found that legumes have been shown to increase the dissolution and utilization of rock phosphate (RP) P compared with non-legumes mainly due to rhizosphere processes (Vanlauwe *et al.*, 2000 and Horst *et al*., 2001). Non-mycorrhizal plants such as white lupine *(Lupinus albus L.)* that form root clusters have been found to effectively utilize P from (RP) particularly when soils are deficient in P. This not only positively affect soil properties and increases nitrogen (N) supply, but also increases P supply to the main crop (Kabir and Koide 2002; Polthanee *et al*., 2002).

Certain microorganisms are capable of solubilizing (RP) and are collectively termed phosphate-solubilizing microorganisms. *Rhizobacteria*, from the *genera Pseudomonas, Bacillus, and Rhizobium*, are among the most powerful phosphate solubilizing bacteria (Rodriguez and Fraga 1999). Both plants and microorganisms are known to produce organic acids in varying concentrations and types. (Richardson 2001; and Zheng *et al*., 2005). The ability of organic acids to solubilize rock phosphate is attributed to the following mechanisms: acidification, chelation, and exchange reactions (Omar 1998).

Several studies have investigated potential advantages of using composts in agriculture, Li *et al*., 2000; and Ozores-Hampton and Deron 2002, reported the advantages of compost include enhanced soil physical, chemical, and microbial properties. Madhumita *et al*., (1993) observed an increase in P – fertilizer use efficiency through the addition of various animal manures.

With respect to the effect of different fertilizers types on crop yield, many studies demonstrated that the mineral fertilizers highly increased maize grain and stover yields particularly during the first four years. The highest yields of maize were obtained with the application of mineral fertilizers associated with organic manure. The (RP) also increased maize stover yield during the first three years. The beneficial effect of the (RP) on maize yields may probably be due to its effect on P availability and soil acidity. The applied 100% P pre planting gave the higher yield of tomatoes than with split fertilizer applications. Super phosphate application increased P, K and Fe amounts in the tissues of spinach plants. (Bado *et al*., 1997 and Camilia *et al*., 2006). Debosz *et al*. 2002; and Speir *et al* 2004 noticed an increase in crop yield through the addition of compost.

Baqual and Das (2006) studied the influence of Bio-fertilizers on macronutrients uptake by the mulberry plant. They achieved that the inoculation of phosphate led to solubilizing macro – nutrients, nitrogen-fixing bacteria with reduced dose of inorganic fertilizers had resulted in significant improvement in uptake of nitrogen, phosphorus and potassium through mulberry leaf. El sedfy *et al*., (2007) revealed that the maximum values of phosphorus concentration of wheat grains and the grain yield were attained for 5-ton compost/fed plus inculcation by *Saccharomyces Cerevisiae* and 5-ton compost/fed plus inculcation by *Bacillus polymyxa* respectively. El Kramany *et al*., (2007) found clear significant differences between treatments for all studied characters of Groundnut crop. Treatment of 25% recommended. Chem. fert. (NPK) + 75% org (FYM) +bioertilizer (microbein) came in the first order for groundnut yield, yield components, oil yield (kg/fed.); P% Fe,Zn (ppm). Except for no. of seeds/pod and weight of straw (g/plant) 50% chem. +50%org. + (microbein) was the best treatment. The highest seed index; harvest index; oil %; protein%; protein yield (kg/fed.) ; N% and Mn (ppm) recorded by 75% recommended .chem.(NPK) +25%org.+(microbein). As showed by other works Bationo and Mokwunge (1991) concluded that the high responses of west African weakly acidic Ultisols to fertilizers may be explained by the poverty of this soil in nutrients and the low content in organic mater. Therefore, all additions of fertilizers or high quality organic mater can significantly increase crop yields

The work was undertaken to evaluate the effect of compost, P - fertilization and Bio – fertilizers on the nutrients availability of sandy soil and their effect on the yield and chemical composition of lupine and maize crops.

MATERIALS AND METHODS

A field experiment was conducted at Ismailia Agricultural Experimental Station through the winter season (2005-2006) and summer season (2006) to asses the influence of organic, inorganic P- fertilization and Bio – fertilization

on NPK availability, lupine and maize productivity. The experiment was laid out in a split- split design with three replicates. Organic fertilizer was placed in the main plots, while p – fertilizer in the sub plots. Bio - fertilizers was in the sub - sub plots. Some physical and chemical characteristics of the surface soil under investigation as well as compost were analyzed according to Jackson (1967) and shown in Tables (1and 2).The treatments were:

Organic fertilizer

1- **No compost.**
2- **5 ton compost/fed which added before planting.**

Phosphorus fertilizers

1- **100 % of the recommended phosphate does (31 Kg P_2O_5\fed) which applied before planting in the form of Super phosphate, donated as (SP1).**
2- **50 % of the recommended phosphate does (15.5 Kg P_2O_5/fed) which applied at preplanting, while the rest was equally applied in tow doses after 30 and 45 days from planting, respectively in the form of super phosphate fertilizer, donated as (SP2).**
3- **100% of the recommended phosphate does (52 Kg P_2O_5/fed) which applied at preplanting in the form of rock phosphate fertilizer, donated as (RP1).**
4- **50 % of the recommended phosphate dose (26 Kg P_2O_5 /fed) which applied at preplanting in the form of rock phosphate fertilizer, while the rest was equally applied in two doses after 30 and 45 days from planting, respectively, donated as (RP2).**

Inoculation

1- **Uninoculated, this donated as (BIO1).**
2- **Inoculated with *Bacillus Polymxa*, this donated as (BIO2).**

Bacillus Polymxa (Local strain) was cultured on nutrient both media and inculcated were put in an incubator at 28 C°. Liquid culture (1×10^8 cfu) was added to sailed carrier consisting of vermiculite and peat lupine and maize grains were inoculated by seed dressing by using the Arabic gum as adhesive materials at rate of 400 g/60 Kg grains.

The Bio-fertilizers was prepared by adding equal amounts of the micro-organisms to a carrier material. Lupine and maize grains were mixed carefully with *Bacillus Polymxa* and gum then, spread on a plastic sheet away to direct sun light for a short time before planting.

The applied compost was mixed with the surface soil layer by hatchet. Then, the area was planted by grains of lupine *(Lupinus albus L.)* C.V.Giza I and maize *(Zea maysL.)* var Giza 351 for two successive growth seasons

(2005- 2006) under sprinkler irrigation system. The recommended dose of macro and micro nutrients were added for both crops.

At harvest time (6 and 4 months) after sowing lupine and maize respectively, plants of each plot were cut, air-dried and grain yields (Kg/fed) were achieved. Oven plant samples were analyzed for N, P and K as described by Chapman and Pratt (1961). Soil samples were analyzed for available NPK according to the method described by Dewis and Freitas (1970). Organic carbon was determined by modified Walkely – Black method (Jackson,1976). Analysis of Variance was statistically analyzed according to Snedecor and Cochroan (1976) using SAS program (SAS institute, 1982).

Table (1): Particle size and Chemical analysis of the studied soil.

Particle size distribution									Textural class		
Sand %				Silt %		Clay %					
Coarse sand		Fine sand									
73.61		15.23		0.34		10.82			Sand		
Soil Chemical analysis											
pH (1:2.5)	EC dSm^{-1}	$CaCO_3$ %	OM %	Soluble cations Meq/l				Soluble anions Meq/l			
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
8.04	0.39	0.28	0.35	0.24	0.32	2.62	0.24	-	0.21	0. 32	2.89
Available Nutrients (ppm)											
N				P				K			
15				5				49.5			

Table (2): Chemical Analysis of Compost

Analysis	Values
Moisture %	33.51
Ph (1:10)	6.51
EC (1:10) dSm^{-1}	4.58
$N-NH_4$ (ppm)	100
$N-NO_3$ (ppm)	20
Total N %	1.37
OM %	37.56
O.C %	21.79
Ash %	62.40
C\N ratio	15.5:1
Total P	0.24
Total K	0.61

RESULTS AND DISCUSSION

1- Organic matter (%) as affected by organic, Bio and phosphate fertilizers :

Data presented in Table (3) showed that the addition of compost was accompanied by a significant increase in soil organic matter compared with the untreated soil (control) where, it reached as a mean values about of (0.52% and 0.49 %) after lupine and maize respectively in composted soil. Statistically, there were highly significant effect of compost on increasing organic matter content in soil after harvesting both lupine and maize plants. The combined treatments involving compost plus rock Phosphate (RP) under the inoculation with *Bacillus Polymyxa* (BIO2) exhibited higher content of organic matter in the treated soil with the mean value of o.54 % and o.51 % after lupine and maize respectively. This may be due to either the higher initially organic matter in the added compost (37.56%) which builds up the organic matter in soils or the increase of root growth of lupine and maize plants because of the applied mineral fertilizers, which contribute organic matter content increase. (Ouedraogo *et al*., 2001)

Table (3): Soil organic matter (OM %) as affected by organic, Bio and phosphate fertilizers.

Organic fertilizer	P-fertilizer	BIO fertilizer	OM% after harvesting	
			Lupine	Maize
NO Compost	SP1	BIO1	0.46	0.44
		BIO2	0.42	0.40
	SP2	BIO1	0.39	0.37
		BIO2	0.44	0.40
	RP1	BIO1	0.44	0.41
		BIO2	0.46	0.44
	RP2	BIO1	0.46	0.44
		BIO2	0.46	0.44
5 ton Compost/fed	SP1	BIO1	0.50	0.48
		BIO2	0.57	0.52
	SP2	BIO1	0.50	0.48
		BIO2	0.46	0.44
	RP1	BIO1	0.50	0.48
		BIO2	0.51	0.49
	RP2	BIO1	0.57	0.53
		BIO2	0.57	0.53
LSD at 5% for:				
Organic fertilizer			0.0170	0.0126
Organic*Bio*P-fertilizer			N.S	N.S

2- Available NPK of soil as affected by organic, Bio and phosphate fertilizers

2.1. Available Nitrogen:

Availability of nitrogen exhibited differences among the studied treatments in soil under investigation, Tables (4 and 5). Soil available N content showed superiority in soils that received compost at (5-ton /fed) and scored mean values of (30.29 ppm and 28.21 ppm) under lupine and maize respectively. The content of available nitrogen increased in the soil treated by biofertilizers compared to untreated one. Hence, the inoculation with *Bacillus Polymyxa* (BIO2) heightened the value of available N in the treated sandy soil to reach about of (29.69 ppm and 27.67 ppm) under lupine and maize respectively. While the combined treatment of compost plus inoculation scored the highest available nitrogen content with mean values of (31.06 ppm and 29.09 ppm) under lupine and maize respectively. Statistically, there was highly significant effect of interaction between compost and biofertilizer treatments on available nitrogen content. While, the treatment of compost at (5-ton/fed) plus (RP2) and (BIO2) achieved the highest content of available N with the mean values of (31.28 ppm and 29.78 ppm) after lupine and maize respectively.

The increased in nitrogen availability in the previously mentioned treatments may be due to the beneficial effect of compost in improving the nutritional status particularly nitrogen in the soil (Camilia *et al*., 2006). On the other hand, the activity of studied microorganisms encourages the mineralization of applied compost. These results are corresponding with those obtained by (El- Sedfy *et al*., 2007).

2.2. Available Phosphorus:

Data in Tables (4 and 5) depict the effect of adding compost, phosphate fertilizers and biofertilizer on the availability of soil P at the end of harvesting stage of lupine and maize plants. It is clear that, all of the used soil fertilizers greatly increased the availability of soil P as compared to untreated soil plots (control), initial state as showed in Table (1). In this connection, the treatment of compost (5-ton/fed) gave the highest available P content. It reached as mean values of (10.48 ppm and 9.49 ppm) after lupine and maize respectively. This is may be due to the influence of compost decomposition in reducing soil pH values by organic and inorganic acids, which increase the availability of soil P. Such results were in a good agreement with those reported by (Hashem *et al*., 1992).

Regarding the effect of phosphate fertilizers on the availability of soil P, Data in Tables (4 and 5) revealed that the treatment of super phosphate (SP2) at (15.5 Kg P_2 O_5/fed) recorded the highest available P content in soil. It

scored mean values of (13.45 ppm and 12.05 ppm) after lupine and maize respectively. Statistically, there was highly significant effect of using super phosphate on the content of available P under lupine and maize. The results demonstrated that the inoculation with *Bacillus Polymyxa* (BIO2) intensified the available P content with mean values of (10.33 ppm and 9.40 ppm) after lupine and maize respectively. This increase may be attributed to phosphate solubilizers in soils (pH 5-6.5) help in solubilizing the insoluble phosphates and make it available to the plant (Filitte Stphen, 2003).

When compost and super phosphate at rate of (15.5 Kg P_2 O_5/fed) is applied together under the effect of biofertilizers as P solubilizing bacteria available P is significantly increased more than the sum of the increase from either applied singly, hence, available P content scored the mean values of (12.22 ppm and 11.02 ppm) for lupine and maize respectively. Therefore, the increase of available P content in aforesaid treatment might have been due to favorable effect of compost and super phosphate fertilizer in increasing the soil organic and inorganic P fraction. It is worthy to mention that the influence of different phosphate fertilizers on the values of available phosphorus can be arranged as follows: SP2>SP1>RP1>RP2. It was found that under lupine crop more pronounced values of available phosphorus were realized than under maize crop. These high values may be due to incorporating green manure crops into soil may increase P bioavailability for succeeding crops. This increment may be ascribed to synergistic effect between super phosphate and organic matter for increasing soil available P, K and Fe status. The results indicate the importance of conjunctive use of the insoluble super phosphate or rock phosphate with organic matter for creating proper condition to get the maximum benefit of the native elements in rock and super phosphate. (Michel Ca Vigelli and Steve Thien, 2003).

The higher available nutrients status, due to combined use of organic matter, which is more easily hydrolyzed by the organic materials, made the solubilization of P, K and Fe from insoluble rock phosphate or super phosphate easier and resulted in an increased by the regulation of nutrients release from phosphorus sources. These results were in an agreement with (Camilia *et al*., 2006).

P solubilizers in soil help in solubilizing the insoluble phosphate and make it available to the plants. The improvement of available P due to inoculation treatment can be attributed to the favorable effect of *Bacillus Polymyxa phosphate* solubilizing bacteria survived longer around mycorrhizal roots of maize plants and acted synergistically with mycorrhiza (Azcon *et al*., 1976).

Table (4): Available NPK of soil (ppm) as affected by organic, Bio and phosphate fertilizers after lupine harvesting.

Organic fertilizer	P-fertilizer	BIO fertilizer	N (ppm)	P (ppm)	K (ppm)
NO Compost	SP1	BIO1	25.40	9.40	85.60
		BIO2	28.20	9.26	53.90
	SP2	BIO1	24.95	12.50	64.33
		BIO2	28.47	13.40	64.67
	RP1	BIO1	22.57	8.65	64.80
		BIO2	28.33	9.35	75.37
	RP2	BIO1	25.00	6.53	75.37
		BIO2	28.24	7.44	64.00
5 ton Compost/fed	SP1	BIO1	30.50	10.40	85.93
		BIO2	31.00	10.60	53.90
	SP2	BIO1	28.48	13.40	75.36
		BIO2	30.71	14.52	75.37
	RP1	BIO1	30.50	9.46	64.55
		BIO2	31.00	9.65	64.53
	RP2	BIO1	28.58	7.42	65.00
		BIO2	31.55	8.42	76.37
LSD for:					
Organic fertilizer			0.636	0.2796	N.S
Bio- fertilizers			0.443	0.2796	4.430
P-fertilizer			N.S	0.2796	N.S
P-fertilizer rate			N.S	0.2796	N.S
Orgnic *Bio.			0.626	N.S	N.S
Organic* P-ferti			0.626	N.S	N.S
P-fertilizer*rate			N.S	0.3955	N.S
Bio* P-fertilizer			N.S	N.S	6.264
Organic*Bio*P-fertilizer			N.S	N.S	N.S

2.3. Available Potassium:

With respect to potassium availability data presented in Tables (4 and 5) revealed that the highest mean values of available K (70 ppm and 115.39 ppm) were attained for soil that treated with compost after lupine and maize harvesting respectively. The improvement effect of organic materials on the increase of potassium availability may due to the decomposition of organic matter and release of nutrients in the available form (Awad *et al*., 2003). The results appear that neither phosphate fertilization nor the Bio- fertilizer affect on available potassium values.

Table (5): Available NPK of soil (ppm) as affected by organic, Bio and phosphate fertilizers after maize harvesting.

Organic fertilizer	P-fertilizer	BIO fertilizer	N (ppm)	P (ppm)	K (ppm)
NO Compost	SP1	BIO1	24.53	8.49	101.47
		BIO2	27.50	8.63	109.07
	SP2	BIO1	22.67	11.47	97.50
		BIO2	25.37	11.67	109.07
	RP1	BIO1	21.53	8.37	117.17
		BIO2	26.67	8.41	85.60
	RP2	BIO1	23.50	5.70	101.47
		BIO2	25.45	6.61	117.00
5 ton Compost/fed	SP1	BIO1	27.53	9.41	118.53
		BIO2	28.37	9.59	111.40
	SP2	BIO1	27.27	11.67	112.43
		BIO2	28.45	13.40	115.60
	RP1	BIO1	27.54	8.51	118.53
		BIO2	29.55	9.35	111.40
	RP2	BIO1	27.00	6.53	118.53
		BIO2	30.00	7.50	116.67
L.S.D for:					
Organic fertilizer			0.4133	0.1658	3.8642
Bio- fertilizers			0.4133	0.1658	N.S
P-fertilizer			0.4133	0.1658	N.S
P-fertilizer rate			0.4133	0.1658	N.S
Orgnic *Bio.			0.5845	0.2344	N.S
Organic* P-ferti			0.5845	N.S	N.S
P-fertilizer*rate			0.5845	0.2344	N.S
Bio* P-fertilizer			0.5845	N.S	5.4649
Organic*Bio*P-fertilizer			N.S	N.S	N.S

3- Protein concentration of lupine and maize grains as affected by Bio and phosphate fertilizers

The results in Tables (6 and 7) revealed that, the maximum values of protein concentration were resulted in lupine and maize grains which receiving (5-ton/fed) compost. This significant increment may be ascribed to higher content of available nitrogen in soils which treated by (5- ton/fed) compost than no compost treatment, Tables (4 and5) These results were corresponding with (El – Sedfy *et al*., 2007).

The obtained results clarified that the inoculation with *Bacillus Polymyxa* (BIO2) significantly intensified the protein concentration of lupine and maize grains from to reach 21.50% and 12.61% respectively, Tables (6 and 7). These results may be elucidated by the ability of *Bacillus Polymxa* to fix nitrogen in rhizospher, which is reflected by increasing of available nitrogen in inoculated treatments, Tables (4 and 5).

Table (6): Protein concentration (%) of lupine grains as affected by organic, Bio and phosphate fertilizers .

Organic fertilizer	P - fertilization								Means of organic fertilizers
	SP1		SP2		RP1		RP2		
	BIO1	BIO2	BIO1	BIO2	BIO1	BIO2	BIO1	BIO2	
No compost	20.50	21.10	20.1	22.20	19.70	21.30	20.50	21.30	20.84
5 ton/fed compost	22.10	22.40	18.70	19.70	20.70	21.80	21.50	22.00	21.11
Means of p-fertilizers	21.50		20.20		20.90		21.32		20.98

Means of BIO2 =20.50 BIO2=21.50
L.S.D at 5% for:
Organic fertilizers = 0.135
P- Fertilization =0.0687
Inoculation =0.0375
Organic fertilizers × P- Fertilization = 0.098
Organic fertilizers× Inoculation = N.S.
P- Fertilization × Inoculation = N.S.
Organic fertilizers × P- Fertilization× Inoculation = N.S.

Concerning the impact of interaction between compost and phosphorus fertilization on protein concentration of lupine grains, it was noticed that the maximum value of protein concentration attained by the interaction between addition compost (5-ton/fed) and (SP1) treatment under lupine crop. While, no significant effect was achieved on protein concentration of maize grains as affected by the interaction between organic matter and phosphate fertilization, Table (7).

No significant effect of the interaction between organic manure and Bio-fertilizer inoculation was observed on protein concentration of lupine and maize grains, Tables (6 and7).

The effect of interaction between phosphate fertilization and Bio-fertilizer inoculation had no significant increment on protein concentration in lupine

grains, Table (6). However, the highly significant increment of protein concentration was realized in maize grains by the interaction between applied treatment (SP2) and inoculated by *Bacillus Polymxa*, Table (7).

Table (7): Protein concentration (%) of maize grains as affected by organic, Bio and phosphate fertilizers.

Organic fertilizer	P - fertilization								Means of organic fertilizers
	SP1		SP2		RP1		RP2		
	BIO1	BIO2	BIO1	BIO2	BIO1	BIO2	BIO1	BIO2	
No compost	11.80	12.30	12.50	13.10	11.50	11.80	10.80	10.80	11.83
5 ton/fed compost	13.10	13.50	13.80	14.40	12.60	13.04	11.90	11.90	13.03
Means of p-fertilizers	12.70		13.50		12.20		11.40		12.45

Means of BIO2= 12.25 BIO2 =12.61
L.S.D at 5% for:
Organic fertilizers = 0.032
P- Fertilization =0.056
Inoculation =0.039
Organic fertilizers × P- Fertilization = N.S.
Organic fertilizers× Inoculation = N.S.
P- Fertilization × Inoculation = 0.078
Organic fertilizers × P- Fertilization× Inoculation = N.S.

No significant effect of interaction between compost, phosphate fertilizers and Bio-fertilizer inoculation was attained on protein concentration of lupine and maize grains, Tables (6 and 7).

4- Phosphorus concentration of lupine and maize grains as affected by organic, Bio and phosphate fertilizers

Data presented in Tables (8 and 9) showed that, the highly significant increments of phosphorus concentration were achieved in lupine and maize grains which receiving compost at (5-ton/fed). These increments may be attributed to high value of available phosphorus in treated soil by compost. These results are in agreement with (John and Stanley, 1988; Morel and Fardeau, 1989 and El Sedfy *et al*., 2007).

It has mentioned above that the values of available phosphorus in different phosphate fertilizers treatments can be arranged as follows: SP2>SP1>RP1>RP2. Similarly, the results in Tables (8 and 9) reveal that the

Table (8): Phosphorus concentration (%) of lupine grains as affected by organic, Bio and phosphate fertilizers.

Organic fertilizer	P – fertilization								Means of organic fertilizers
	SP1		SP2		RP1		RP2		
	BIO1	BIO2	BIO1	BIO2	BIO1	BIO2	BIO1	BIO2	
No compost	0.58	0.61	0.63	0.66	0.54	0.57	0.50	0.53	0.58
5 ton/fed compost	0.63	0.66	0.69	0.72	0.59	0.62	0.55	0.58	0.63
Means of p-fertilizers	0.62		0.68		0.58		0.54		0.61

Means of BIO2 = 0.59 BIO2 = 0.62
L.S.D at 5% for:
Organic fertilizers = 0.0108
P- Fertilization = 0.0049
Inoculation = 0.0031
Organic fertilizers × P- Fertilization = 0.007
Organic fertilizers× Inoculation = 0.004
P- Fertilization × Inoculation = 0.006
Organic fertilizers × P- Fertilization× Inoculation = 0.009

Table (9): Phosphorus concentration (%) of maize grains as affected by organic, Bio and phosphate fertilizers.

Organic fertilizer	P – fertilization								Means of organic fertilizers
	SP1		SP2		RP1		RP2		
	BIO1	BIO2	BIO1	BIO2	BIO1	BIO2	BIO1	BIO2	
No compost	0.52	0.56	0.56	0.60	0.50	0.53	0.47	0.49	0.53
5 ton/fed compost	0.55	0.59	0.59	0.65	0.53	0.56	0.50	0.52	0.56
Means of p-fertilizers	0.56		0.60		0.53		0.50		0.55

Means of BIO2=0.53 BIO2=0.56
L.S.D at 5% for:
Organic fertilizers = 0.0038
P- Fertilization = 0.0041
Inoculation = 0.0027
Organic fertilizers × P- Fertilization = 0.0058
Organic fertilizers× Inoculation = 0.0037
P- Fertilization × Inoculation = 0.0053
Organic fertilizers × P- Fertilization× Inoculation = 0.0074

maximum values of phosphorus were achieved by (SP2) treatment than (SP1) treatment, Tables (4 and 5). While, applying the phosphorus fertilizer in the form of rock phosphate, it was observed that (RP1) treatment gave a more pronounced value of phosphorus concentration in lupine and maize grains than (RP2) treatment, Tables (8 and 9). This increment may be ascribed to the reason, which mentioned above.

Data presented in Tables (8 and 9) appeared that the highly significant of phosphorus concentration in lupine and maize grains were realized by inoculation with *Bacillus polymyxa.* This increment may be elucidated by the ability of Bio –fertilizers that can supplement the chemical fertilizers for meeting the nutrient needs and help in improving yield and quality of crop plants (Filitte Stephen, 2003).

Concerning the effect of interaction between organic manure and phosphate fertilizer on phosphorus concentration, the highest values of P was attained by applying compost at (5-ton/fed) and (SP2) treatment. While the lowest one was obtained by applying no compost and (RP2) treatment.

Regarding the impact of interaction between compost and Bio-fertilizer inoculation on phosphorus concentration of lupine and maize grains, the maximum value of phosphorus concentration achieved by applying compost at (5- ton/fed) and inoculation with *Bacillus polymyxa* . Although the least one was attained by applying no compost and no inoculation.

The statistical analyses showed that the highly significant effect of interaction between phosphate fertilizer and bio-fertilizer on phosphorus concentration in lupine and maize grains, it was observed that the maximum value of phosphorus concentration was attained by applying (SP2) treatment and inoculated by *Bacillus polymyxa*. While the minimum one was achieved by applying (RP2) treatment and without inoculation.

Concerning the influence of interaction between compost, phosphate fertilizer and Bio - fertilizers on phosphorus concentration of lupine and maize grains, the highly significant increment of phosphorus concentration was attained by applying compost at (5- ton /fed) plus (SP2) treatment and inoculation by *Bacillus polymyxa*. However, the lowest one was achieved by applying no compost, (RP2) treatment and no inoculation.

5- Potassium concentration of lupine and maize grains as affected by Organic, Bio, and phosphate fertilizations

Data presented in Tables (10 and11) indicated that lupine and maize grains receiving compost at (5-ton/fed) achieved the highly significant increment of potassium concentration against no compost. This increment may be attributed to higher values of available potassium in soil treated by 5 ton compost/fed than no compost, Tables (4 and 5).

The results in Tables (10 and11) showed that applying (SP2) treatment realized more pronounced values of potassium concentration in lupine and maize grains than (SP1) treatment. This increment may be due to the effect of super phosphate application. Similar results were obtained by (Camilia *et al*., 2006).

Data presented in Table (11) revealed that potassium concentration of maize grains was significantly increased as affected by the inoculation with *Bacillus polymyxa*.

Concerning the impact of interaction between organic manure and phosphate fertilizers on potassium concentration of lupine and maize grain, it was observed that the maximum value of potassium concentration obtained by the interaction between applying compost at (5-ton / fed) and (SP2) treatments.

Table (10): Potassium concentration (%) of lupine grains as affected by organic, Bio and phosphate fertilizers.

Organic fertilizer	P – fertilization								Means of organic fertilizers
	SP1		SP2		RP1		RP2		
	BIO1	BIO2	BIO1	BIO2	BIO1	BIO2	BIO1	BIO2	
No compost	0.57	0.55	0.52	0.57	0.57	0.60	0.60	0.57	0.57
5 ton/fed compost	0.57	0.57	0.68	0.65	0.71	0.61	0.69	0.61	0.64
Means of p-fertilizers	0.57		0.61		0.62		0.62		0.61

Means of BIO2=0.61 BIO2=0.59
L.S.D at 5% for:
Organic fertilizers = 0.0108
P- Fertilization = 0.0049
Inoculation = 0.0031
Organic fertilizers × P- Fertilization = 0.007
Organic fertilizers× Inoculation = 0.004
P- Fertilization × Inoculation = 0.006
Organic fertilizers × P- Fertilization × Inoculation = 0.009

Regarding the effect of interaction between organic and Bio- fertilizer inoculation on potassium concentration in lupine and maize grains, the highest value of potassium concentration obtained by applying compost at (5-ton/fed) and no inoculated. Although the lowest one was attained by, the interaction between no compost and no inoculated.

The statistical analysis showed that the highest significant effect of the interaction between phosphate fertilizers and Bio- fertilizer inoculation on potassium concentration in lupine and maize grains obtained by applying (RP2) treatment and no inoculated. However, the lowest one was achieved by applying (SP1) treatment and inoculated by *Bacillus polymyxa*

Table (11): Potassium concentration (%) of maize grains as affected by organic, Bio and phosphate fertilizers.

Organic fertilizer	P - fertilization								Means of organic fertilizers
	SP1		SP2		RP1		RP2		
	BIO1	BIO2	BIO1	BIO2	BIO1	BIO2	BIO1	BIO2	
No compost	0.31	0.39	0.51	0.49	0.39	0.41	0.47	0.51	0.44
5 ton/fed compost	0.41	0.47	0.59	0.51	0.51	0.49	0.51	0.53	0.50
Means of p-fertilizers	0.40		0.53		0.45		0.51		0.47

Means of BIO2=0.46 BIO2=0.48
L.S.D at 5% for:
Organic fertilizers = 0.0006
P- Fertilization = 0.0006
Inoculation = 0.0004
Organic fertilizers × P- Fertilization = 2.85
Organic fertilizers× Inoculation =1.85
P- Fertilization × Inoculation = 2.62
Organic fertilizers × P- Fertilization× Inoculation = 3.71

Data in Table (10) showed highly significant potassium concentration in lupine grain obtained by applying compost at (5-ton /fed) plus (RP1) treatment and no inoculated. This is due to the effect of interaction between organic manure, phosphate fertilizer and bio-fertilizer inoculation on potassium concentration. While, the highest potassium concentration of maize grain realized by applying compost at (5-ton /fed) plus (SP2) treatment and no inoculated, Table (11).

6- Lupine and Maize grains yields (Kg/fed) as affected by organic, Bio and phosphate fertilizers.

Data presented in Tables (12 and13) demonstrated that treatments which receiving compost at (5-ton /fed) had higher significant increment of lupine grain yield than no compost treatment. This increment may be elucidated to the beneficial effect of organic matter on soil available NPK and consequently the protein, phosphorus and potassium concentrations of lupine and maize grains intensified, Tables (4-11).These results are coinciding with those obtained by (EL- Sedfy et. al., 2007).

The results in Tables (12 and 13) showed that the maximum values of lupine and maize grain yields were realized by (SP2) treatment. This increment may be scribed to high values of available phosphorus resulted in applying super phosphate and consequently phosphorus concentration of lupine and maize grains increased.

Table (12): Lupine grains yield (Kg/fed) as affected by organic, Bio and phosphate fertilizers.

Organic fertilizer	P - fertilization								Means of organic fertilizers
	SP1		SP2		RP1		RP2		
	BIO1	BIO2	BIO1	BIO2	BIO1	BIO2	BIO1	BIO2	
No compost	802.1	876.7	826	907.3	664.1	703.3	608.5	675.7	758
5 ton/fed compost	835	925	995.3	1083.2	695.5	750.5	674.2	726.4	835.6
Means of p-fertilizers	859.7		953		703.4		671.2		796.8

Means of BIO2 = 762.6 BIO2 = 831
L.S.D at 5% for:
Organic fertilizers = 26
P- Fertilization = 6.11
Inoculation = 7.20
Organic fertilizers × P- Fertilization = 8.65
Organic fertilizers× Inoculation = 10.18
P- Fertilization × Inoculation = 14.39
Organic fertilizers × P- Fertilization× Inoculation = 20.37

Table (13): Maize grains (Kg/fed) as affected by organic, Bio and phosphate fertilizers.

Organic fertilizer	P - fertilization								Means of organic fertilizers
	SP1		SP2		RP1		RP2		
	BIO1	BIO2	BIO1	BIO2	BIO1	BIO2	BIO1	BIO2	
No compost	3455	3547.7	3838.7	3942	2950	3381.3	2010	2410	3191.8
5 ton\fed compost	3637	3727	4041	4141	3274	3784.3	2224.3	2709.7	3442.3
Means of p-fertilizers	3591.7		3990.7		3347.4		2338.5		3317.1

Means of BIO2 = 3178.80 BIO2 = 3455.37
L.S.D at 5% for:
Organic fertilizers = 12.13
P- Fertilization = 6.019
Inoculation = 4.61
Organic fertilizers × P- Fertilization = N.S.
Organic fertilizers× Inoculation = N.S.
P- Fertilization × Inoculation = 9.22
Organic fertilizers × P- Fertilization× Inoculation = 13.04.

From the above results, it was observed that the influence of different phosphate fertilizer on the values of lupine and maize grains yields could be arranged as follows: SP2>SP1>RP1>RP2. These results agreement with (Paulo Louzada, 1992) who mentioned that several trails have been implemented in general fertilization programs of the company's plantations. The results of these trails indicated that phosphorus was the only element significantly increasing productivity.

Data in Tables (12 and 13) revealed the inoculation with *Bacillus polymyxa* significantly intensified the grain yield of lupine and maize from 762.6, 3178.8 (Kg/fed) for uninoculated to 831.0 and 3455.43(Kg/f) for inoculated with *Bacillus polymyxa*, respectively.

This increment can be elucidated to P solublizers in soils help in solublizing the insoluble phosphates and make it available to the plant. Thus, Bio–fertilizers can supplement the chemical fertilizers for meeting the nutrient needs and help in improving yield (Filitte Stephen, 2003).

Concerning the effect of interaction between organic manure and phosphate fertilizers on lupine and maize grain yields, it was found that the highly significant increment of lupine and maize grain yields were achieved

by applying compost at (5- ton/fed) and (SP2) treatments. While, the minimum grain yield values of lupine and maize were obtained by applying no compost and (RP2) treatment.

Regarding the impact of interaction between organic fertilizer and inoculation with *Bacillus polymyxa* on lupine and maize grains yield, the results appeared that supplying compost at (5 ton/ fed) and inoculated with *Bacillus polymyxa* gave the highly significant increment of lupine and maize grains yields. However, the lowest one was obtained by applying no compost and no inoculated.

The statistical analysis showed that the highly significant increment of lupine and maize grains yield as affected by the interaction between P-fertilizers and inoculation with *Bacillus polymyxa* were achieved by (SP2) treatment and inoculated by *Bacillus polymyxa*. Although, the lowest one was obtained by (RP2) treatment and no inoculated.

In regard to the effect of interaction between applying organic manure, phosphate fertilizers and Bio – fertilizer inoculation on lupine and maize grains yield, it was found that the highly significant increment of lupine and maize grain yields were realized by applying compost at (5-ton /fed) plus (SP2) treatment and inoculated with *Bacillus polymyxa.* Although, the lowest one was obtained under uncomposted soil plus (RP2) treatment and no inoculated, Tables (12 and13).

From the above results, it can be concluded that applying 50% of the recommended phosphate dose at preplanting in the form of super phosphate fertilizer, while the rest was equally applied in two doses after planting in order to maximize soil available phosphorus and phosphorus concentration of lupine and maize grains. For the same purpose, it could be recommended to apply 100% of the recommended phosphate dose at preplanting in the form of rock phosphate.

The results pointed to the beneficial effect of a compost plus phosphate and bio fertilizers mixture as alternative nutrition systems on the available NPK, protein and grain yield of lupine and maize. Alternative nutrition systems could have environmental advantages when compared to conventional fertilizers that can supplement the chemical fertilizers for meeting the nutrient needs and help in improving yield and quality of crop plants.

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تأثير إضافة الكمبوست والتسميد الفوسفاتى والحيوى على تيسر الفوسفور وإنتاجية بعض المحاصيل فى الأراضى الرملية

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الملخص العربى

أقيمت تجربة حقلية فى محطة البحوث الزراعية بالإسماعيلية خلال الموسم الشتوى (٢٠٠٥/٢٠٠٦) والموسم الصيفى (٢٠٠٦) لدراسة تأثير إضافة الكمبوست كسماد عضوى مع التسميد الفوسفاتى والحيوى على تيسر الفوسفور فى الأراضى الرملية تحت محصولى الترمس و الذرة الشامية. وكان تصميم التجربة بنظام القطع المنشقة مرتيين فى وجود ثلاثة مكررات بحيث كان التسميد العضوى يمثل للوحدة الرئيسية للتجربة بينما يمثل التسميد الفوسفاتى الوحدة تحت رئيسية للتجربة ومثل التسميد الحيوى الوحدة تحت التحت رئيسية.

وكان أهم النتائج المتحصل عليها كالأتى :–

- إضافة كل من ٥ طن كمبوست/فدان للأرض الرملية مع التلقيح البكتيرى ببكتريا ***Bacillus Polymyxa*** أدى إلى تيسر النتروجين والفوسفور فى الأراضى الرملية.
- إضافة٥٠٪ من الإحتياجات الفوسفاتية الموصى بها قبل الزراعة فى صورة سوبر فوسفات ونسبة ٥٠٪ الباقية أضيفت على دفعتين متساويتيين بعد الزراعة (SP2) زادت من تيسر الفوسفور فى الأرض الرملية وبالتالى زيادة تركيز الفوسفور والبروتين فى حبوب الترمس والذرة الشامية.
- إضافة ١٠٠٪ من الإحتياجات الفوسفاتية الموصى بها فى صورة صخر الفوسفات (RP1) أدت إلى تيسر الفوسفور للنبات فى الأراضى الرملية.
- أعلى محصول لحبوب الترمس والذرة الشامية أمكن الحصول عليه باضافة ٥ طن كمبوست +(SP2)+ التلقيح البكتيرى ببكتريا ***Bacillus Polymyxa*** بينما أقل محصول لكل من الترمس والذرة الشامية أمكن الحصول عليه بدون إضافة كمبوست + (RP2) وبدون التلقيح البكتيرى.