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EFFECT OF PHOSPHATE FERTILIZER SOURCES AS WELL AS PHOSPHATE DISSOLVINGMICROORGANISMS IN RHIZOSPHERE MICROFLORAAND PLANT GROWTH OF MAIZE PLANT.

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ABSTRACT

Forty ,isolates of phosphat dissolving Microorganisms (PDM) selected at random and screened for their efficiency .All isolates had an ability to solubilize inorganic phosphate. The more active 10 isolates were further studied for ability to solubilize phosphorus in Bunt and Rovira agar medium to determined solubilizing index .The counts of bacteria,spore formers,PDM and actinomycetes were higher in either amended or inoculated treatments compared to unamended or uninoculated. Generally high counts of these microorganisms were recorded in the rhizosphere of plants inoculated with mixed inocula .Difference in counts of these microorganisms were found according to p-fertilizer sources as well as type of microbial inocula.

The highest values of vegetative growth parameters were obtained on plants fertilized by rock phosphate compared with those fertilized with super phosphate. Generally nitrogen and phosphorus percentages varied according to PDM and phosphorus fertilization source .In treatment inoculated and amended with rock phosphate higher N% and P% were recorded compared to inoculated with inoculant with mixed followed by VAM then PDB.

Key words: Rock phosphate, vesicular mycorrhiza, phosphate dissolving bacterium

INTRODUCTION

P-biofertilizer can increase the availability of accumulated P for plant growth by solubilisation .In additions, the microorganisms involved in P solubilisation can enhance plant growth by increasing the efficiency of biological nitrogen fixation , enhancing the availiabity of other trace elements ,and by production of plant growth promoting substance (**Gyaneshwar *et al* .,2002**). Mover, biofertilizer technology has taken a part not only to minimize production costs but also to avoid the environmental hazards (**Galal *et al* .,2001)** .Rock phosphate (RP)has been used as row P-fertilizer alone or in combination with P-dissolving microorganisms by many investigators P-fertilizer by sheap natural source (**Badran and Hassanien 2000).**

The transformation of phosphorus is considered to be one of the most important problems of phosphate fertilization in Egypt(**Abdallah *et al.*,1984).Azazy *et al* (1988)** revealed that biofertilization by PDB increased the total bacterial count, fungi, phosphate dissolvers and symbiotic N2-fixers in cultivated soil. **Mahmoud (1993)** emphasized that axins, gibberellins and cytokines are produced by PDB which improve growth of plants and produced high growth parameters, nutrient consent ,protein content in grains and yield of crop.Mycorrhiza fungi increased the growth, nutrient content and promoting substance production in the host plant increased the availability of most nutrient specially P and some micro-elements which encouraged the proliferation of different soil microorganisms (**Gendiah and Zaghloul ,1997**).

This study was conducted on maize plant to investigate the of effect some phosphate fertilizer source. (rock phosphate and super phosphate phosphate- solubilizing microorganisms (Vesicular- arabuscular mycorrhiza VAM and PDB) either single and \or in combination with rhizosphere microflora and growth of maize plant.

MATERIALS AND METHODS

1-Isolation of PDB. Soil from rhizosphere of maize and onion were used for isolation of phosphate –dissolvers .The Bunt and Rovira medium (1955) modified by **Abdel-Hafez(1966)** was used. The prepared dishes were incubated at 30^{o}c for 48 hrs. Forty colonies which showed positive reaction on the plates prepared for PDB which had a well-defined clear zone were isolated at random to study their efficiency.- Isolates were purified by successive streaking on the same media mentioned before.

2-Selection the most efficient isolates. The selected isolates were inoculated in the phosphate –dissolving liquid medium .the pH of the medium was adjusted to 7.4 to ensure a minimal concentration of the soluble phosphate .Ninety ml aliquot of the medium were placed in 250 ml Erlenmeyer flask . Tricalcium phosphate was added to each flask at the rate of 0.2 g, then the flasks were autoclaved and the glucose was added. Flasks were inoculated with the tested microorganisms and incubated at 30^{o}C. Changes in the pH and the amounts of soluble phosphates were measured after 14 days of incubation. The quantity of soluble phosphates found according to (Olsen et al 1954) and the change in pH were taken as a measurement of the efficiency of the organisms **(Abdallah *et al* ., 1984).** The solubilizing index (SI) was deteremined according to **(Edi-premono *el al.*, 1996).**

3.1- Phosphate dissolving bacteria (PDB) inocula. For preparation of bacterial inocula, modified Bunt and Rovira medium **(Abdel-Hafez 1966)** was inoculated by the more effective four isolates of PDB then incubated at 30^{o}C for 7 days till the viable count reached 10^8 cell/ml. Maize plants were inoculated with PDB at sowing time.

3.2- Mycorrhiza inocula. A mixture of vesicular mycorrhiza (VAM) (*Glomus fasiclatum* and *Glomus mossas*) originally extracted from around the root of onion plant grown on clay soil was used in this experiment.The VAM fungus was prepared on onion plants using the propagation described by **Al-Fassi *et al*.,(1990**). After three months from onion cultivation .The mycorrhiza root of onion bulbs together with its adjacent soil were collected and used for inoculation with mycorrhiza .The mycorrhiza inoculum composed of infected roots and its rhizosphere soil were added just before sowing at a rate of 10 g\pot. (5 Kg soil).

Soil samples were collected from the top 15 cm layer from the Experimental Farm ofFaculty of Agriculture, Minia University, Egypt .Soil was air dried and thoroughly mixed. The soil used in this research was clay loam (organic matter 1.69%, total nitrogen 0.09, total phosphorus 12.62 ppm.,pH 8.01,CaCo3 1.82% and E.c. 0.65 ds/m.

4-Pot experiment. Pot experiments Greenhouse were carried out during 2018\2019 growing seasons at the Microbiological Dept. Fac of Agric Minia Univ.Egypt to study the effect of maize inoculation with phosphate solubilizing microorganisms under different sources of phosphate fertilizer on growth of maize, as well as counts of some microorganisms in rhizosphere of maize. Plastic pots 30 cm diameter were filled with five kg soil and planted with maize (zea mays var Giza 3). The experiment was designed as split-split design. The pots were divided into four groups and each group was divided into 3sub-groups. The first group unamended and uninoculated, while the seconded group, inoculated with PDB and amended with either rock phosphate or super phosphate (15.5 % P_2O_5) at rate of 30 kg phosphorus\Fadden .Moreover, the third group inoculated with VAM and amended with either rock phosphate or super phosphate . While, the fourth group inoculated with mixed inocula from PDB and VAM and amended with either rock phosphate or super phosphate .The total treatments was 4x3=12(Table 4).Cultivation process was performed by sowing four grain of maize cultivar, Giza 3 was used in this study. The grains of this cultivar were obtained from Dep. of Agronomy Fac. of Agric. Minia University.

Plant samples were taken after 15,30,60,and 90 days from sowing for determination of total counts of bacteria ,actinomycetes ,spore forming bacteria and phosphate dissolving bacteria by using **Oxide manual medium (1965)** for total bacteria, sporeformers and actinomycetes. **Bunt and Rovira (1955)** modified by **Abdel-Hafez *et al* (1966)** was used for counting inorganic phosphate-dissolvers. The root infection rates were evaluated by the technique reported by (Philips and Hayman 1970)

REULTS AND DISCUSSION

1- Isolation and selection of the most efficient phosphate dissolver . Results in Table(1) generally indicated that all isolates had an ability to solubilize inorganic phosphate .During the incubation period of the selected isolates. The pH values showed an inverse correlation with the quantity of soluble phosphorus .As the pH of the media decreased the quantity of soluble phosphorus increased. For example the amounts of soluble phosphorus of isolates No 35 (the more active) were 552 ppm while pH values was 3.08 Moreover in isolates No 18 (low active) were 143.22 ppm and pH values was 5.40.The most efficient 10 isolates were No 6,7,9,13,14, 20,25,31,34and 35.The obtained results show that amounts of phosphorus solubilized ranged from 143.22 to 552. On the other hand pH value in medium of isolates ranged from 3.90 to 7.20.

1-1 Solubilizing index (SI). The more active 10 isolates were further studied for ability to solubilize phosphorus in Bunt and Rovira agar medium to detriments olubilising index.The obtained results (Table 2) show that solubilized amount of P and the determined phosphate solubilization index for the tested isolated are compatible with the acidity (pH values) produced in their cultures. This indicated that the organic acid produced from fermentation of sugar in medium by bacteria isolates are the main cause of solubilization.

The highest phosphate solubilizing index was recorded by the isolates No 35 and the lowest by isolates No 13. Many researchers provide that PSB plays a key role in soil organic P transformations (**Frossard *et al.*, 1995**) through excretion of phosphatase enzymes (**Eichler *et al.*, 2004**), mineralization of P from organic sources **(Gressel and McColl, 1997).**

1-3 Morphological grouping of most efficient PDB isolates.

The obtained results in show (Table 2) that aerobic spore-formers exceeds other groups out of the 10 isolates 6 were aerobic sporoforming (60%). All isolates showed positive reaction with Gram staining .The abundance of spore formers (60%) in the most efficient isolates is important particularly in Egyptian soils. The spore formers and actinomycete are well known to resist adverse conditions such as high temperature and dryness (**Alexander, 1977**) to which our soil are subjected most of the year.The results are in agreement with those reported by **Gamal- Eldin *et al* 2008 ,** ,who reported that microbial solubilization of mineral phosphate might be either due to excretion of organic acids causing acidification of the external medium (**Whitelaw, 2000**) or the excretion of chelation substances (such as siderophores) that form stable complexes with phosphorus adsorbent (aluminium ,iron and calcium) (**,Hamdali *et al* ., 2008)** and those release the attached phosphate in soluble form. The major organic acid reportedly produced PDM are citric acids , gluconic acid , lactic acid and oxalic acid (**Chen *et al* .,2006 and Yi *et al* ., 2008).**

2- **Effect of inoculation with VAM and PBD on counts of rhizosphere microflora of maize plants**.

2-1 Total count of bacteria. Data in Table (3) clearly indicate that inoculation of maize plant with mixed PDB, and VAM gave higher counts of total bacteria as compared with other treatments. This trend was observed during all growth stages. Data in Table (3) also indicate that inoculation maize grains with VAM gave higher counts of bacteria than its inoculation with PDB only. Highest counts were recorded at 60 days, the obtained figure with treatments amended with rock phosphate were 92.3 $x10^7$ and 84.6 $x10^7$ respectively. On the other hand, in treatments amended with super phosphate the obtained figures were 80.2 $x10^7$ and 78.6 $x10^7$ respectively, in treatment inoculated with VAM or PDB respectively. On the other hand , combined inoculation of PDB and VAM had higher increase in count of bacteria count, the combined treatments of PDB and VAM seemed to more effective than the single ones the best results were obtained by using rock phosphate and mixed inoculation of PDB and VAM (combinedly).

The obtained results clearly show that higher counts in both soil amended with rock phosphate or superphosphate were recorded in treatments inoculated with mixed of VAM and PDB followed by treatments inoculated with VAM only thes treatment inoculated with PDB .At 60 days the obtained figures were in case of soil amended with rock phosphate were 95.6 $x10^7$,92.3 $x10^7$ then 84.4 $x10^7$,while in soil amended with super phosphate 83.3 $x10^7$, 80.2 $x10^7$ then 78.6 $x 10^7$respectively.Similar results were obtained by **El-Morsy *et al*,(2015)**who found that the best results on counts of microorganism in rhizosphere of sweat potato were obtained by using rock phosphate in presence of PSM and VAM-fungi.It was reported that the plant species or cultivar especially the composition of root exudates plays a key role in the diversity of rhizobacterial populations colonizing the root **(Kremer *et al* ,1990,)**

Differences in numbers and composition of microorganisms in rhizosphere of different plants species and even different varieties within species have been reported. This may influenced by specific root exudates or other factors possibly controlled by specific genes in plant **(Kramer *et al* 1990).** Results were found by **Azazy *et al*., (1988)** who reported that biofertilization by phosphate dissolving bacteria increased the total bacterial count, fungi, phosphate dissolvers and asymbiotic nitrogen fixers in cultivated soil.

2-2 Count of PDB. With regard to the effect of inoculation ,the obtained results show that treatments inoculated with PDB gave higher counts as compared with those inoculated with VAM .At 60 days in treatment amended with rock phosphate the counts were 98.3 $x 10^6$ compared to 86.1 $x 10^6$ in treatment inoculated with VAM . On the other hand, generally highest counts were recorded in treatments inoculated with mixed of VAM and PDB. The superiority effect of mixed inoculant (VAM +PDB) explained by the combined action of both inoculation.The effects of interaction between p-source and PSM on maize plants are shown in Table (3). It is clear from the data that the combined treatments are of much superior effect to single ones . Highest count were observed in case of treatment of rock phosphate with mixed inoculation of both VAM and PDB .Followed by inoculated with PDB then treatments inoculated with VAM, the obtained figures at 60 days were 99.3 ,98.3 then 86.1 x10 ^{6} respectively.(**Zafarul-Hye *et al*., 2007; Naik *et al*., 2008)** who found that The application of *Bacillus megaterium* increased the total bacterial count compared to the Un-inoculated plants; however the total count of bacteria decreased in the high levels of rock phosphate. The recorded data was agreed with**.**

2-3 Count of Sporeformers. The obtained results in Table3 generally show that higher count of spore formers in treatments inoculated with both VAM and \or PDB at all stages of plant growth.The obtained results also show that the counts of spore formers increased with increase in plant age reached the maximum at 60 days then decreased. The obtained results clearly show that in treatment inoculated with either VAM or Mixed and amended with superphosphate in general gave higher counts than treatment amended with rock phosphate .In treatments inoculated with mixed (VAM +PDB), at 60 days , the obtained figures were 97.6 x 10 ^{3} compared to 77.6 x 10 ^{3} amended with superphosphate and rock phosphate respectively.

2-4 Count of Actinomycetes. Results in Table (3) clearly show that high counts of these microorganisms were recorded in treatments amended with rock phosphate and inoculated with mixed of PDB and VAM ,the obtained figures at 60 days were 96.6 x 10 ^{3} as compared 78.3 x 10 ^{3}. Moreover in general, in all treatments, the higher counts were recorded at 60 days then decreased .Also higher counts were recorded in treatments inoculated with mixed inoculated followed byPDB then VAM. The obtained figures at 60 days were in treatment received rock phosphate were96.6 x 10^{3},86.1x 10 3 then 79.3 x 10 ^{3}respectively.

3-Effect of inoculation as well as fertilizers sources on some agronomic aspects of maize pant .

Data in (Table 4) show that the vegetative growth of maize received chemical P-fertilizer sources were generaly better than plants of the control treatments. Moreover the growth of maize plants inoculated with either PDB or and VAM were generally higher than plants of the control treatment. The highest values of vegetative growth parameters were obtained on plants fertilized with rock phosphate compared with those fertilized with super phosphate . Increases in plant height, number of leaf, as well as fresh and dry weight/plant were observed. It is notable, that there were no significant effects between super phosphate or rock phosphate fertilizer.

3-1 Plant height. Inoculating with mixed inoculant (BDP + VAM) and amended with rock phosphate caused more effective on plant height.The obtained figures at 90 days were 179.75 compared with 158.08 or/ 168.50 in case of PDB or VAM.

3-2 Fresh and dry weights . Data in Table(4) show that the interaction of inoculation with PDB,VAM single or mixed in presence of different sources of p-fertilizer had primitive effect on fresh and dry weigh of maize pants .These parameters significantly increased as a result of inoculation and fertilizer .The highest values of these parameters recorded in soil amended with rock phosphate inoculated with mixed inoculants followed by VAM treatment then PDB ,the obtained figures for fresh weight and dry weight at 90 days were 169.05 , 162.10 and 154.7 for fresh weight and 69.43 , 64.40 and 62.3 for dry weight respectively.

The use of phosphate rock as a source of P in maize crops with the inoculation of bacterial strains can increase up to 10 % the uptake of this element in comparison with the non-inoculated control supplied with phosphate rock. Phosphate solubilizing microorganisms solubilized P to be available-P with its ability to secrete organic acids that can break complex P compounds in the soil (**Whitelaw, 2000**).increases phosphorus uptake and photosynthesis.

This result indicated the very important role of mycorrhiza in the availability of phosphorus from the unavailability sources like rock phosphate. Then, rock phosphate could be a useful substance for VAM infected plants even at high pH values. Also, this result showed the importance of inoculation with V AM in case of soils with high pH values even when super phosphate was used as by **Zaghloul *et al.*, (1996).**

4- Effect of inoculation as well as fertilizer sources on nitrogen % and phosphorus % in maize plant.

Results in Table (5) indicate that nitrogen and phosphorus percentages in maize plants were affected by inoculation with VAM and phosphate dissolving bacteria single or/ and mixed in presence of either rock phosphate or super phosphate. The results presented in Table (5) revealed that N content in plant varied according to soil amendment as well soil inoculation.

Generally nitrogen and phosphorus percentage varied according PDM and phosphorus fertilization source. In treatments inoculated and amended with rock phosphate higher N% and P% were recorded in treatment inoculated with mixed inoculant followed by VAM then PDB.

5- Effect of inoculation as well as fertilizer sources on rate of root infection by VAM of maize plant.

Results in Table (6) indicated that infection percentage in the maize plant was significantly affected by inoculation with VAM in the soil .This increase may be due to the principle mechanism that carried out by mycorrhiza to benefit the plant growth through production of some useful materials transferred to the plant root zone creating a direct effect on plant growth .These materials could be hormones, axons, (GAS) and (CKS) that mycorrhiza release in the root zone and positively affect root growth and extension .The result could also attributed to more absorption of nutrients which reflect more growth activity ,nitrogenous compound assimilation forming growth substances, more e cell division and elongation .Similar results and similar explanation were reported**;Grandcourt *et al* ., (2004), Ghazi *et al* ., (2007) and Ali *et al* .,(2009).**

Table (1) Amount of phosphates soluilized by the selected isolates and pH values.

No of isolate	***Soluble-p(ppm)***	***pH value***	***No of isolate***	***Soluble-p(ppm)***	**pH value**
1	173.25	4.80	21	179.20	4.69
2	477.00	3.05	22	171.66	4.80
3	148.50	5.33	23	149.22	5.30
4	170.22	4.80	24	155.00	5.20
5	146.22	5.40	25*	522.00	4.00
6*	493.11	4.00	26	173.00	4.73
7*	550.00	3.90	27	180.00	4.66
8	242.11	4.25	28	182.00	4.60
9*	492.00	4.00	29	160.00	5.10
10	151.23	5.55	30	467.00	3.93
11	470.11	5.00	31*	495.00	4.00
12	450.22	5.35	32	220.00	4.45
13*	480.23	4.35	33	176.00	4.70
14*	482.11	4.00	34	550.00	3.90
15	470.22	4.40	35*	552.00	3.95
16	167.75	4.90	36	177.00	4.50
17	176.11	4.70	37	467.00	4.00
18*	143.22	5.40	38	150.11	4.40
19	171.06	4.75	39	220.00	4.26
20*	550.00	3.90	40	420.00	4.00
			Control		7.20

***= The most efficient Isolates**

Table (2): The solubilizing index and morphological examination of the most efficient isolates .

Isolated nunmber	Soluble p(ppm)	pH values	Inhibition zone (cm)	Morphological examination	Gram stain action
6	493.11	4.00	3.18	Aerobic sporeformers	G +
7	550.00	3.90	3.11	Aerobic sporeformers	G +
9	492.00	4.00	3.10	Aerobic sporeformers	G +
13	480.23	4.35	2.80	Cocci	G +
14	482.00	4.00	2.81	Short rod	G +
20	550.00	3.90	3.10	Aerobic sporeformers	G +
25	522.00	4.00	2.89	Short rod	G +
31	495.00	4.00	2.84	mycelial formers	G +
34	550.00	3.90	3.15	Aerobic sporeformers	G +
35	552.00	3.95	3.18	Aerobic sporeformers	G +

Table (3): Effect of phosphate fertilizer sources and some phosphate solubilizing microorganism on total cunts x 10^7 ,PDB x10 ^{6}sporeformers ($x10^4$) and actinomycetes ($x10^3$) in rhizosphere of maize plant.

Treatment		Total cunts x 107				PDB x 10^6				Spore formers x10^4				Actinomycetes X10^4			
		15 day	30 day	60 day	90 day	15 day	30 day	60 day	90 day	15 day	30 day	60 day	90 day	15 day	30 day	60 day	90 day
Uninoculated	Unamended	22.3	36.6	45.6	33	61.6	41.1	38.6	33.1	22.3	36.6	45.6	33.1	3.6	7.2	22.3	12.2
	Super	46.2	50.0	72.3	42.3	39.1	67.1	82.0	69.2	30.6	46.1	60.1	29.6	19.3	20.6	50.4	36.7
	Rock	30.6	46.0	65.0	29.6	55.0	63.2	72.1	55.3	37.1	46.2	65.1	56.1	13.6	34.7	49.3	94.3
PDB	Unamended	42.6	54.3	69.6	51.6	37.1	47.1	52.2	36.3	32.2	48.6	66.3	47.3	17.7	36.1	77.1	77.1
	Super	40.3	53.6	78.6	38.6	48.3	77.3	86.2	71.3	35.6	90.1	75.2	52.2	22.5	38.2	80.1	80.1
	Rock	43.3	54.6	84.6	40.6	56.2	77.1	98.3	76.3	50.6	80.4	96.3	63.1	27.6	86.1	86.1	86.1
VAM	Unamended	30.1	39.6	64.3	31.3	48.2	59.2	66.3	52.1	35.6	52.4	64.3	60.3	13.7	31.2	91.3	91.3
	Super	40.2	53.6	80.2	39.6	66.1	86.1	84.4	61.2	58.6	70.2	96.3	71.6	22.6	36.7	77.4	80.6
	Rock	50.3	67.6	92.3	44.3	52.4	62.4	86.1	66.3	50.6	79.3	87.2	76.2	16.1	38.6	79.3	86.3
PDB+VAM	Unamended	32.2	36.6	50.6	30.6	38.6	52.1	79.6	76.4	22.6	58.6	69.3	68.2	11.1	30.6	92.3	56.3
	Super	47.3	64.6	83.3	42.3	48.2	62.3	90.1	72.4	55.2	87.3	97.6	96.2	24.2	38.6	78.3	40.3
	Rock	62.0	81.0	95.6	50.3	57.3	66.1	99.3	82.6	37.6	56.3	77.6	90.6	20.1	42.6	96.6	46.6

Table (4) : Effect of phosphate dissolving bacteria and Mycorrhizal fungi on plant height, fresh weight ,dry weight and number of levees in 90 days on maize plant.

Treatment		**Plant height (cm)**	**Fresh eight (gm /pot)**	**Dry weight (gm /pot)**	**Leaves number**
Inoculated	Un amended	96.25*	120.40**	52.90*	11.50*
	SUOPER	149.70	127.45	60.50	11.00
	ROCK	150.75	154.75	63.55	12.00
PDB	Un amended	146.25	124.50	59.35	11.50
	SUOPER	156.50	145.25	60.75	12.50
	ROCK	158.50	154.65	62.30	12.50
VAM	Un amended	150.50	131.50	57.45	11.50
	SUOPER	166.50	143.75	61.90	11.50
	ROCK	168.75	162.10	64.40	12.50
PDB+VAM	Un amended	159.25	141.45	58.05	10.00
	SUOPER	163.50	163.90	66.55	14.60
	ROCK	179.75	169.05	69.45	14.00
	SE	13.58	2.60	1.39	0.47

Table (5): Effect of phosphorus fertilization and inoculation with mycorrhiza on nitrogen % and phosphorus % of maize plant.

Enter action	**Treatment**	**Nitrogen %**	**Phosphorus %**
Unioculated	Un amended	1.032 ns	0.210 ns
	Super	1.718 ns	0.253 ns
	Rock	1.021 ns	0.247 ns
PDB	Un amended	1.289 ns	0.239 ns
	Super	1.532 ns	0.288 ns
	Rock	1.550 ns	0.276 ns
VAM	Un amended	1.258 ns	0.231 ns
	Super	1.709 ns	0.291 ns
	Rock	1.778 ns	0.285 ns
PDB+VAM	Un amended	1.377 ns	0.252 ns
	Super	1.835 ns	0.299 ns
	Rock	2.134 ns	0.311 ns
SE		0.361	0.19

Table (6): Effect of phosphorus fertilization and inoculation with mycorrhiza on Infection % of maize plant.

	Treatment	Infection %
Inoculated	Un amended	10
	Super	25
	Rock	18
PDB	Un amended	32
	Super	43
	Rock	40
VAM	Un amended	64
	Super	82
	Rock	89
PDB+VAM	Un amended	85
	Super	96
	Rock	98

REFERENCES

Abdallah, A. R.; El-Dahtory,Th., Abdel-Moneim,A. A.andSafwat, M. S. A. (1984). Effect of inoculation with *Bacillus megatherium* var phosphaticum and root nodule bacteria on rhizosphere microflora and yield of some leguminous plants. Minia J. Agric. Res. &Develop., 6: 4-10.

Abdel-Hafez, A. M. (1966). Some studies on acid producing microorganisms in soil and rhizosphere with special reference to phosphate dissolvers. Ph. D. Thesis, Agric.Botany Dept. Fac. of Agric. Ain Sahms Univ., Egypt.

Alexander, M. (1977): Introduction to Soil Microbiology. John Wiley and Sons Inc., New York, USA.

Alexander, W. D. (1977).A short synopsis of the most essential poinst in Hawaiian grammar. Vermount: Charles E. Tuttle Company.

Al-Fassi, F. A., Abo-Zineda, R. A., Mahbari., A. A. and Ramadan ,E.M.(1990). Effect of inoculation with Vesicular Arbscular Mycorrhiza on plant growth Ann.Agric .Sci. Fac.Agric Ain Shams Univ 35(1) 125-142.

Ali, M. A., Louche, J., Legname, E., Duchemin, M and Plassard ,C. (2009) .Pinuspinaster seedlings and their fungal symbionts show high plasticity in phosphorus acquisition in acidic soils. Tree Physiol 29:1587–1597.

Azazy, M.A.,Saber, M.S.M. and Boutros, B.N. (1988): The use ofbiofertilizers and conditioners in citrus nurseries in relation to microflora contributing to soil fertility. Egypt. J. Microbiol. 23(3): 389-402.

Badran, F. S. and Hassanein, M. M. (2000) : Effect of rock phosphate source on growth, flowering, corm formation and chemical constituents of Gladiolus grandiflorus (cv. Peter Pears). Proc. The and Scientific Conference of Agricultural Sciences.

Bunt, J. S. and Rovira, A. D. (1955). Microbiological studies of some subantractic soils. Journal of Soil Sci., 6: 114-128.

Chen, Y. P., Rekha, P. D., Arun, A. B., Shen, F. T., Lai, W. A., and Young, C. C. (2006). Phosphate solbilizing bacteria from subtropical soil and their tricalcium phosphate solubilizing abilities. Applied soil ecology, 34 (1), 33-41.

Eichler, M.,Schnug, C.E. and Ppen,D.K. (2004).'Soil Acid and Alkaline Phosphatase Activities in Regulation to Crop Species and Fungal Treatment'. Landbauforschung V54, 01-05

Edi Premono, M., Moawad, A.M and Vlek, P.L.G (1996). Effect of phosphate-soulbilizaing *pseudomonas putida* on the growth of maize its survival in the rhizospher. In dones J. Crop Sci 11:13-23.

El Morsy, E. M., Ahmed, M.A and Ahmed, A. A. (2015). Attenuation of renal ischemia/reperfusion injury by açaíextract preconditioning in a rat model. Life sciences, 123, 35-42.

Frossard, E., Brossard, M., Hedley, M. J.andMetherell, A. (1995). Reactions controlling the cycling of p in soils.In 'Phosphorus in the Global Environment'. (Ed H Tiessen) (SCOPE, John Wiley and Sons Ltd).

Galal, G., McDonnell, J and Paul, R. (2001). The Utility of Qualitative Modeling in Architectural Evaluation. AMCIS 2001 Proceedings, 270.

Gamal-Eldin, H., Elbadry, M., Mahfouz, S and Abdelaziz, S. A. (2008). Screening of Fluorescent Pseudomonads Bacteria Isolated From Rhizospheres of Cultivated And Wild Plants In Vitro For Plant Growth Promoting Traits. Journal of Plant Production, 33(5), 3365-3383.

Gendiah, H. M and Zaghloul, R. A. (1997). Effect of biofertilization and biological control on growth and chemical constituents of volkameriana seedlings. Annals of Agricultural Science, Moshtohor, 35(4), 2303-2325.

Ghazi, I., Fernandez- Arrojo, L., Garcia- Arellano, H., Ferrer, M., Ballesteros, A and Plou, F. J. (2007). Purification and kinetic characterization of a fructosyltransferase from Aspergillusaculeatus. Journal of biotechnology, 128(1), 204-211.

Grandcourt, E.M., Al Abdessalaam, T.Z., Francis, F.and Al Shamsi, A.T.,(2004). Biology and stockassessment of the Sparids, AcanthopagrusbifasciatusandArgyropsspinifer (Forsskål, 1775), in the Southern Arabian Gulf. Fisheries Research, 69, 7-20.

Gressel, N. and McColl, J.G. (1997). Phosphorus mineralization and organic matter decomposition: A critical review. In 'Driven by Nature: Plant Litter Quality and Decomposition'. (Eds G Cadisch, KE Giller) pp 297-309. (CAB International).

Gyaneshwar, P. Kumar, G.N. Parekh, L.J and Poole, P.S. (2002) . Role of soil microorganisms in improving P nutrition of plants. Plant and Soil. 245(1):83–93. doi: 10.1023/A:1020663916259.

Hamdali, H., Hafidi, M., Virolle, M. J and Ouhdouch, Y (2008) .Growth promotion and protection against damping-off of wheat by two rock phosphate solubilizing actinomycetes in a P-deficient soil under greenhouse conditions. Appl Soil Ecol 2008, 40: 510-517.

Kremer, R. J., Begonia, M. F. T., Stanley, L.and Lanham, E. L. (1990). Characterization of rhizobacteria associated with weed seedlings. Appl. Environ. Microbiol. 56:16491655.

Mahmoud, A.-L.E.(1993). Toxigenic fungi and mycotoxin content in poultry feedstuff ingredients. Journal of Basic Microbiology, **33**, 101 104.

Naik, P. R., Raman, G., Narayanan ,K. B. and Sakthivel, N. (2008). Assessment of genetic and functional diversity of phosphate solubilizing fluorescent pseudomonads trains from rhizospheric soil. B.M.C. Microb., 8-230.

Olsen, S.R.; Cole, C.V.; Watanabe, F.S. and Dean, L.A. (1954). Estimation of available phosphorus in soil by extraction with sodium biocarbonate. U.S. Dept. Agr. Cir. 939.19.p.

.

Oxoid Manual (1965) The Oxoid manual of culture media, ingredients and other laboratory services. 3rd ed Oxoid, London

Phillips, j.m. and hanyman, d.s. (1970). Improved procedures for clearing roots and stainig parasitic and vesicular-arbuscular mycorrhizae fungi for rapid assessment of infection. Transaction of the british mycological soc. 55,158-161.

Whitelaw, M.A. (2000). Growth promotion of plants inoculated with phosphate solubilizing fungi. Adv. Agron., 69: 99– 151.

Yi,Y., Huan, W.G. and Ge, Y. (2008). Exopolysaccharide: a novel important factor in the microbial dissolution of tricalcium phosphate. Worled J. Microbiol. Biptecnol. 24: 1059- 1065.

Zafar,U.l.,Zahir, M. Z.A.,Shahzad, S.M.,Naveed, M. ,Arshad,M. and Khalid,M. (2007). Preliminary screening of rhizobacteria containing ACC deaminase for promoting growth of lentil seedlings under axenic condition. Pak. J. Bot., 39: 1725-1738

Zaghloul, R. A., Mostafa, M. H and Amer, A. A. (1996). Influence of wheat inoculation with mycorrhizal fungi, phosphate-solubilizing bacteria and Azospirillum on its growth and soil fertility. Annals of Agric. Sci, 611-626.

الملخص العربي

تأثير مصادر مختلفة من التسميد الفوسفورى والتلقيح بالميكروبات المذيبة للفوسفات على ميكروبات الريزوسفير والنمو لنبات الذرة

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في هذه الدراسة تم عزل 40 عزله من تربه ريزوسفير نباتات الذرة المأخوذة من مزرعة كليه الزراعه.أظهرت هذه العزلات قدرتها فى إذابة الفوسفات فى البيئه .ولقد لوحظ تأثير عكسي بين إذابة الفوسفات وانخفاض رقم pH البيئة .تم اختيار أعلى العزلات وتم تلقيح حبوب الذرة قبل الزراعة بعزلات البكتريا وفطريات الميكروهيزا فى وجود مصادر مختلفة من الفوسفور (سوبر فوسفات –الفوسفات الصخري)لدراسة تأثير التلقيح وأعداد الميكروبات فى منطقه ريزوسفير لنبات الذرة.وجد ان أعداد الميكروبات العدد الكلى للبكتريا و الميكروبات المذيبة للفوسفات والميكروبات المكونة للجراثيم والأكتينوميسيتات يزداد بزيادة عمر النبات واختلفت الأعداد حسب نوع التلقيح سواء منفردا او مختلطة او مصدر الفسفور فى التسميد . وعموما ازداد الأعداد بوجه عام فى حاله التلقيح المختلط وفى وجود التسميد بصخر الفوسفات. أوضحت النتائج في المعاملات التي لقحت بخليط من الميكروبات أعطت أعلى قيم في أطوال النباتات والوزن الرطب والجاف وكانت معامله التسميد بالصخر الفوسفات أعلى من معامله السوبر فوسفات كما أن التلقيح بخليط الميكروبات أعطى أعلى قيم للفوسفور والنيتروجين فى نبات الذرة .