J. Product. & Dev. ,11 (1): 103- 121 (2006)

BIOLOGICAL AND CHEMICAL PHOSPHATIC FERTILIZATION EFFECTS ON WHEAT CROP

M.H.A. EL–Mancy and M. Th. A. Kotb
Soil and Water Dept., Efficient Producticity Inst., Zagazig Univ., Zagazig, Egypt.

ABSTRACT

A field experiment was executed on wheat (Triticum aestivum, cv. Sakha 93) at Belbees district, Sharkia Governorate, Egypt during 2004/2005 winter growing season. The purpose of this study was to investigate the effect of application of increasing rates of either raw (rock phosphate) or manufactured (Ca-superphosphate) mineral phosphate fertilizers with and without inoculation of wheat grains by P-biofertilizer with a trade name of Phosphorien on grain and straw yields as well as N, P and K concentration and content in grains and straw. Grain quality, agronomic P efficiency and available P in soil after harvest were also studied. A randomized complete blocks design with three replicates was used. The experiment included 18 treatments. Nine treatments were assigned to four P fertilization rates (3.25, 6.50, 9.75 and 13.00 kg P/fad), two sources of P (ordinary calcium superphosphate, 6.50 % P = 15 % P_2O_5 and rock phosphate, 3.25 % P = 7.50 % P_2O_5) and control treatment (without P application). The same nine treatments were replicated with inoculation wheat grains using Phosphorien.

The results show that treated wheat grains with Phosphorien as a P-biofertilizer significantly increased grain and straw yields as well as N, P and K concentration and their content in grains and straw and both grain quality parameters, i.e. protein percentage and protein yield. Also, inoculation with Phosphorien gave higher values of agronomic P efficiency and available P in soil after harvest. Generally, all P rates applied as super-P or rock-P increased all the aforementioned parameters and super-P was more effective in enhancing them than rock-P at all P rates used. At all P rates, inoculation with Phosphorien under super-P gave, in general, higher values than those obtained at inoculation under rock-P or under both P fertilizers without inoculation. The highest values were obtained by inoculation + application of super-P fertilizer at the rate of 9.75 and 13.00kg P/fad and inoculation + application of rock-P fertilizer at the rate of 13.00kg P/ fad.

Results indicated that treating wheat grains before planting with Phosphorien combined with applying 9.75kg P/fad as super-P or 13.00kg P/ fad as rock-P may be recommended to obtain the maximum yield and nutrient uptake. With Phosphorien inoculation there is a chance of reducing amount of P-fertilizer in the form of super-P or replacing entire super-P with rock-P, which is economically cheaper and it is abundant in Egypt. This would help in reducing production costs of wheat and pollution of environment.

Keywords: Biological & chemical phosphatic, fertilization , wheat crop.

INTRODUCTION

Phosphorus is the second major macronutrient for crop production. The inadequate supply of this nutrient to cereals during early stages of development reduces the number of ears per unit area and consequently crop yield (Mengel and Kirkby, 1987). Conversion of soluble-P to insoluble form in soils is one of the most important problems of phosphate fertilization in Egypt. High pH and presence of calcium carbonate in Egyptian soils help in converting soluble inorganic phosphate fertilizer to less soluble forms, mainly as a precipitated form of tri-calcium phosphate (El-Dahtory *et al.,* 1989 and Kucey, 1989). Mahmoud and Abd El-Hafez (1982) and Miller *et al*. (1990) reported that after fertilization with soluble calcium superphosphate, the level of available phosphorus decreased sharply ; and that a considerable portion was rapidly transformed to tri-calcium phosphate. They concluded that soils in Egypt need high amounts of P to fulfil P requirements for crops. However, applying high rates of mineral P fertilizers not only increases the cost of crop production but also pollute the environment.

Recently, there is a general trend all over the world to increase and promote new agriculture practices for clean crop production. One of the main practices to achieve this goal is to practice " organic farming " and promote the use of biofertilizers of using inoculums of micro- organisms such as phosphate – dissolving bacteria (PDB). This practice would minimize mineral fertilizers application and help in reducing environmental pollution. There are a number preparations of PDB having different commercial names in different countries. In Egypt, biofertilizer with a trade name of " Phosphorien" containing active PDB bacteria inoculum is commercially available ; helping to transform tri-calcium phosphate to mono-calcium phosphate. Phosphorien is a commercial P-biofertilizer produced by the General Organization for Agriculture Equalization Fund (GOAEF), Ministry of Agriculture, Egypt. While application of rock phosphate alone to neutral and alkaline soils is of little positive effect (Dann *et al.,* 1996), it's application combined with PDB inoculum showed positive effects for wheat plant (Zaghloul *et al.,* 1996; El-Naggar, 1999 and Abd El-Rasoul *et al.,* 2003).

The purpose of this study is to assess the comparative effect of application of increasing rates of either raw (rock phosphate) or manufactured (Ca - superphosphate) mineral phosphate fertilizers with and without inoculation of wheat grains by P-biofertilizer with a trade name of Phosphorien on grain and straw yields as well as N, P and K concentration and content in grains and straw. Grain quality, agronomic P efficiency and available P in soil after harvest were also studied.

MATERIALS AND METHODS

Experimental field site and soil characteristics:

A field experiment was executed on wheat (Triticum aestivum, cv. Sakha 93) at Belbees district, Sharkia Governorate, Egypt during 2004/ 2005 winter growing season. Representative samples of the upper 30 cm layer of the experimental soil were taken before performance of the experiment for analyses according to Black (1965) and the soil properties are recorded in Table (1). The soil was sandy clay loam in texture, alkaline in reaction and poor in organic matter content (Table 2). According to critical limits of

Table(1): Physical and chemical properties of soil of the current experiment.

Property	Value	Property	Value
Sand (%)	57.4	Organic matter (%)	1.74
Silt (%)	16.9	Ca C03 (%)	3.14
Clay (%)	25.7	Available macronutrients (mg/kg)	
Textural class	Sandy clay loam	N	38.00
pH (1:2.5; soil: water suspension)	8.12	P	8.74
EC (d S/m)	1.46	K	480.00

Table (2): Critical limits of macro and micro plant nutrients in soil as recommended by Hamissa *et al.* (1993) for wheat and some other crops (L : low; M : medium; H : high).

Plant nutrient	Extractant	Levels in soils	mg/ kg
N	K_2SO_4 (1%)	L M H	< 40 40-80 > 80
P	Sodium bicarbonate	L M H	< 10 10-15 > 15
K	Amn. acetate	L M H	< 200 200-400 > 400
Zn	DTPA	L M H	< 1.0 1.0-1.5 > 1.5
Fe	DTPA	L M H	< 2 2-4 > 4
Mn	DTPA	L H	< 1.8 > 1.8
Cu	DTPA	L H	< 0.5 > 0.5

macro – and micro – nutrients as recommended by Soil and Water Research for various crops as mentioned by Hamissa *et al.* (1993), the soil is rather low in available P and N, but high in available K.

Experimental design and treatments:

A randomized complete blocks design with three replicates was used. The experiment included 18 treatments. Nine treatments were assigned to four P fertilization rates (3.25, 6.50, 9.75 and 13.00 kg P/ fad), two sources of P (ordinary calcium superphosphate, 6.50% P = 15% P_2O_5 and rock phosphate, 3.25% P = 7.50% P_2O_5) and control treatment (without P application). The same nine treatments were replicated with inoculation wheat grains using P-dissolving bacteria (PDB) with a trade name of Phosphorien (*Bacillus megatherium* var. phosphaticum adsorbed on a peat powder as a carrier). It is produced by the Ministry of Agriculture and is widely used by Egyptian farmers.

Agronomic practices:

Wheat was preceded by cotton and after harvesting, the experimental site was fertilized with 5 tons/fad farmyard manure as carbon and energy source to enhance microbial activity, ploughed, leveled and the plots were build up where every one had 15 rows, 4m long and 20cm apart occupying an area of $12m^2$. Wheat grains were sown on 8/11/2004 and irrigated immediately. Just before sowing, grains of wheat (for the inoculated treatments) were washed and inoculated through mixing with biofertilizer Phosphorien inoculum (one active bag, about 400g/70kg seeds) for 30 minutes using Arabic gum as adhesive agent. The experiment field was put under flood irrigation. N and K fertilizers were applied to all plots as ammonium nitrate (33.5% N) and potassium sulphate (40%K) at rates of 75kg N/fad and 20 kg K/fad, respectively. N fertilizer was applied in two equal doses, before the 1st and 2nd irrigations, i.e. after 25 and 55 days from sowing, while K fertilizer was applied in one dose before the 1st irrigation. The studied rates of both superphosthate (super-P) and rock phosphate (rock-P) were added as single dose also before the 1st irrigation. All other cultivation practices used in the region by wheat farmers were followed.

Sampling and determinations :

At harvest, on 3/5/2005, an area of $2m^2$ of the middle five rows of each plot was harvested to determine the dry weight of grain and straw yields as kg/plot, then adjusted to ton/fad. The oven-dried samples of grains and straw were analysed for their content of N, P and K. Total N content was determined using the modified Khjeldahl method as described by A.O.A.C. (1988) and the obtained values were multiplied by 5.7 to obtain the crude protein percentage. P and K contents were determined according to Chapman and Pratt (1961). Soil samples of a top 30 cm layer were taken from each plot after harvest and analysed for available P (Black, 1965). Agronomic P efficiency defined as the economic production obtained per unit of applied P, was calculated according to Craswell and Godwin (1984) as follows:

$$\text{Agronomic P efficiency} = \frac{\text{Grains yield (fertilized)} - \text{Grains yield (unfertilized)}}{\text{P-added}} = \text{kg grains /kg P.}$$

Statistical analysis:

All the obtained data were tabulated and subjected to the analysis of variance according to Gomez and Gomez (1984). The differences between treatments were assessed using the least significance difference (L.S.D.) at 5% level of significance.

RESULTS AND DISCUSSION

Grain and straw yields :

From the data presented in Table (3), it is evident that treating with Phosphorien show a significant increase in both grain and straw yields. On the average of all used P treatments, the percentage increases in grain and straw yields due to inoculation amounted to 10.2 and 10.8%, respectively. This result illustrates the beneficial role of active bacteria in Phosphorien in releasing P from the soil fixed forms. Shinde and Patil (1985) reported that inoculation of wheat seeds with PDB increased the availability of soil P and resulted in grain yield similar to those obtained with 21 kg P/ha as calcium superphosphate. The positive effect of Phosphorien on grain and straw yields of wheat was reported by El-Naggar (1999), Sobh *et al.* (2000) and Abd El-Haleem *et al.,* (2002) who stated that inoculation of wheat with Phosphorien increased grain yield by 10 % and straw yield by 8.7%.

It is obvious from the data regarding the effect of P fertilization that all rates of either super-P or rock-P significantly increased grain and straw yields than the no - P treatment. Comparatively, application of super-P was more effective than rock-P at all applied rates. It is clearly noticed that the differences between rates of super-P and the same rates of rock-P were significant. The superiority of super-P over rock-P reflects the higher availability of super-P . The increase in wheat yields due to using super-P over rock-P was similar to that reported by El-Naggar (1999), Abd El-Rasoul *et al.*(2003) and Ewais *et al.* (2003).

For grain yield, the mean value of the no – P treatment was 2.953 ton/fad, as compared with the mean values of 3.120, 3.320, 3.506 and 3.463 ton/fad, for the 1st, 2nd, 3rd and 4th P rates as super–P , respectively. Comparable the mean values for the same P rates as rock-P were 3.001, 3.130, 3.292 and 3.387 ton/fad, respectively.

It was observed that application of 13.00 kg P/fad as super-P showed a slight decrease in grain yield as compared with 9.75 kg P/fad. Prasad *et al.* (1985) obtained a maximum wheat grain yield in response to 26.2 kg P/ha (equivalent to 11kg P/fad), and in a brown silt loam soil, Campbell *et al.* (1995) obtained highest wheat grain yield at 20kg P/ha.

For straw yield, the mean value for the no – P treatment was 7.962 ton/fad. The mean yield values for the 1st, 2nd, 3rd and 4th P rates as super-P were 8.674, 9.163, 9.451 and 9.527 ton/fad., respectively and were 8.142, 8.491, 8.890 and 9.112 ton/fad for the four same rates of P applied as rock – P, respectively.

Results of interaction between biofertilization and P sources and levels showed a significant effect on both grain and straw yields. It is obvious that inoculation with Phosphorien under all rates of super-P or rock-P resulted in higher grain and straw yields than those without inoculation. The positive effect of biofertilization under both chemical P fertilizers can be attributed to the effect of bacteria of biofertilizer in dissolving insoluble P in soil and/or rock-P. The phosphate dissolving bacteria (PDB) utilize organic compounds as carbon and energy sources and produce organic acids, which can solubilize insoluble inorganic phosphate (Alagawadi and Gaur, 1988 and Gaind and Gaur, 1991). A part from making P available to the crop, there are indications that these

bacteria may produce growth promoting substances such auxins, gibberellins and cytokinins (Yahya and Al-Azawi, 1989 and Hauka *et al.*, 1990). Such substances may improve plant growth and stimulate microbial development (Dashti *et al.,* 1997). Although super-P + biofertilization, generally, gave the highest grain and straw yields, it is clear that rock-P+ biofertilization gave a good grain and straw yields. This illustrates the positive role of biofertilizer as mentioned previously and to the nutrients which are accompanied in rock-P as impurities. The two highest increases of 30.4 and 30.6% in grain yield over the unfertilized uninoculated treatment were obtained by inoculation + application of 9.75kg P/fad as super-P and inoculation + application of 13.00kg P/fad as rock-P, respectively. A maximum increase in straw yield (34.1%) occurred by inoculation + application of 9.75kg P/fad as super-P which does not differ significantly from the straw yield with biofertilization + application of 13.00kg P/fad as super-P (34.2%) or as rock-P(34.0%). Application of either super-P or rock-P at high rates had rather similar results . Thus, there may be possible to replace entire super-P with (rock-P+ P D B inoculation) without reducing wheat yield. It can be concluded that application of rock-P as a cheep source of P to the soil of pH above 7 could be of an economic importance where the PDB particularly, those induced through seeds inoculation, take part in providing plants with their P requirements.

N, P and K in plant :

As shown in Tables (4-7); N, P and K concentration and their uptake in wheat grains and straw significantly increased by inoculation with Phosphorien. On the average of all P treatments, inoculation increased N, P and K concentration by 5.5, 9.6 and 6.5% in grains and by 5.2, 8.7 and 7.9% in straw, respectively. Mahmoud and Gebrail (2001) found that Phosphorien and /or mycorrohizae inoculation significantly increased grain yield as well as N, P and K in plant. In the present study, the percent of increase in the uptake of N, P and K were 15.5, 20.5 and 17.4% respectively in grains and 16.2, 19.5 and 19.4% respectively in straw. The positive effect of Phosphorien inoculation on N, P and K in wheat grain and straw can be attributed to one or more of the followings : (1) releasing the fixed forms of P, either from the soil or from the added P fertilizer, converting it into a ready available form for plant nutrition, (2) an increase in bacterial population and a symbiotic N-fixers (as indicated by El-Ghany *et al.* 1997) and (3) an increase in root growth and physiological activity of plant roots and consequently the increase in efficiency of the root absorbing various nutrients. These results are in agreement with those obtained by El-Naggar (1999), Sobh *et al.* (2000), Abd El-Haleem *et al.* (2002) and Abd El-Rasoul *et al.* (2003).

Super-P increased N, P and K concentration and uptake of wheat grains and straw than rock-P and both gave greater values than the no –P treatment. Increases in plant N, P and K due to application of either source of P was generally progressive as P rates increased. These results are in accordance with those obtained by Bolland (1994), El-Naggar (1999) and Abd El-Rasoul *et al.* (2003) who found that NPK uptake by wheat grains and straw were significantly affected by P-fertilizer, and that super-P was superior to rock-P. They added that the increase of N, P and K uptake were associated with the increase in P rate.

With regard to concentration of macronutrients, there was no interaction between biofertilization and application of P. For the uptake, there were some cases of interaction when increased rate of P was more effective under conditions of inoculation; this occurred with N uptake in grains, and K uptake in straw. It is obvious, in general, that wheat inoculation by Phosphorien under super-P gave the highest values than biofertilization under rock-P. The superiority of the interactions between biofertilization and super-P can be attributed to the high growth of wheat plants due to the increases supply of available P from both fertilizers (super-P and Phosphorien) in addition the secreting a set of growth promoting substances by Phosphorien as suggested previously. Increased growth of wheat roots must have occurred, which as a result of biofertilization, therefore increasing the rate of nutrient uptake. The highest values were obtained under biofertilization at 9.75 and 13.00 kg P/fad as super-P and 13.00 kg P/fad as rock-P.

Quality of wheat grain:

On the averages of all P treatments, inoculation of wheat plants with Phosphorien high significantly increased both grain quality parameters, i.e. protein percentage (content) and protein yield (Table 8). Inoculation increased protein percentage by 5.5% and protein yield by 16.4%. These results are similar to those obtained by El-Naggar (1999).

Data in the table illustrate that all rates of P applied as either super-P or rock-P increased the two protein parameters except for the 1^{st} rate of P as rock-P which showed no response in protein percentage. With respect to protein percentage, the increases were particularly significant at the 2^{nd} rate of P as super-P and 3^{rd} rate of P as rock-P. For protein yield, all P rates as super-P gave significant increases, while with rock-P, the 1^{st} rate showed insignificant increase, but from 2^{nd} rate onwards there were significant increases. This result showed that accumulation of protein in wheat grains required large quantity of P, which was provided by the high rates of P especially as rock-P. Both protein parameters have highest values with application of super-P than rock-P, the differences were significant for protein yield and insignificant for protein percentage.

The results in Table (8) also show that the interaction effects between biofertilization and all P rates as super-P and rock-P were significant in case of protein yield only. At all P rates, biofertilization under super-P, generally gave more values of protein percentage and protein yield than biofertilization under rock-P and under two P fertilizers without biofertilization. The highest values of protein parameters were under biofertilization at 9.75 and 13.00 kg P/fad as super-P and 13.00kg P/ fad as rock-P.

Agronomic P efficiency :

The results in Table (9) reveal that values of agronomic P efficiency were lower with treatments of biofertilization than treatments of no – biofertilization . This is due to the much higher yield given by biofertilization alone in comparison with the yield given by the non- biofertilized no- P treatment. Biofertilization alone gave about 12.3% yield

increase while in presence of P fertilizer the increase caused by biofertilization averaged about 10.2% . For this reason, P efficiency was lower where Phosphorien was present. Biofertilization therefore was very effective in absence of applied P fertilizer.

Comparison between the two P sources showed that P efficiency was higher with super-P than rock-P. The result of agronomic P efficiency was in harmony with those of grain yield and P uptake, where it can be concluded that P biofertilization under super-P was the best interactions.

Available P in soil after harvest :

The contents of available P in soil after harvest are presented in Table (9). Available soil P was positively affected to a large extent by Phosphorien inoculation, particularly in absence of P addition, where the increase was 50.7% as compared with much lower increases of 19.3% in presence of super-P and 18.4% in presence of rock-P. The treatment which was unfertilized with P and inoculated with Phosphorien gave an increase of available P more than any the biofertilized the treatments given super-P or rock-P. Therefore, inoculation of wheat with Phosphorien increased available P in soil. El-Gamal (1996), El-Sayed (1998), Koreish *et al.* (1998) and Abd El-Haleem *et al.* (2002) showed that the phosphate – dissolving bacteria (PDB) increased available phosphorus in soil.

Both of the two P sources gave increases in soil available P. Application of super-P fertilizer increased soil available P more than rock-P fertilizer at all P rates. Contents of available P in the super-P treatments averaged 13.6 mg P/kg as compared with 12.8 mg P/kg in the rock-P treatments. These results agree with those reported by El-Naggar (1999), Kotb *et al.* (1999) and Abd El-Haleem *et al.* (2002).

The interactive effect between P sources and levels and Phosphorien inoculation on available P in soil was significant. It is observed that wheat inoculation with Phosphorien under super-P gave highest values of available P than biofertilization under rock- P and under both super- P and rock-P without biofertilization . Among P rates as super-P , the highest values of available P in soil were shown at the highest two rates with biofertilization. Thus a high two rates of super-P combined with Phosphorien together and raised up available P in soil.

In conclusion, the results of this investigation indicate that treating wheat grains before planting with biofertilizer Phosphorien combined with applying 9.75 kg P/fad as super-P or 13.00 kg P/fad as rock-P may be recommended to obtain the maximum yield and nutrient uptake. Therefore, with Phosphorien inoculation there is a chance of reducing the amount of P-fertilizer in the form of super-P or replacing entire super-P with rock-P which is economically cheaper and it is abundant in Egypt. This would help in reducing production costs of wheat and pollution of environment.

REFERENCES

Abd El-Haleem, A.A.; A.A. Abdel-Salam; A.H. Abdel–Hadi and M.E. Moursy (2002). Positive influence of inoculation with phosphate dissolving bacteria and application of phosphorus on wheat grown on a calcareous soil. J. Agric. Sci., Mansoura Univ., 27 (10): 7163-7180.

Abd El-Rasoul, Sh.M.; S. El-Saadany; N.S. Rizik and H. El-Tabey (2003). Effect of phosphate fertilization and P-dissoliving organisms (P.D.O) on wheat plant grown on a sandy soil in relation to their economic benefits. Egypt. J. Appl. Sci., 18 (4 A): 374-390.

Alagawadi, A.R. and A. Gaur (1988). Associative effect of rhizobium and phosphate-solubilizing bacteria on the yield and nutrient uptake of chickpea. Plant and Soil, 105: 241-246.

A.O.A.C. (1988). *Officical Methods of Analysis*. Association of Official Analytical Chemists. 21st ed., Washington, D.C.

Black, C.A. (1965). Methods of soil analysis. Am. Soc. Agron. Madison, Wisconsin, U.S.A.

Bolland, M.D.A. (1994). Effect of water supply on the response of wheat and tritical to applications of rock phosphate and superphosphate. Fertilizer Research, 39 (1): 43-57.

Campbell, C.A.; J.G. Mcleod; F. Selles; R.P. Zentner and C. Vera (1995). Phosphorus and nitrogen rate and placement for winter wheat grown on fallow brown soil. Can. J. Plant Sci., 76 : 237-243.

Chapman, H.D. and P.F. Pratt (1961). Methods of analysis for soils, plants and waters. Univ. of California, Div. Agric. Sci., Davis, California, USA.

Craswell, E.T. and D.C. Godwin (1984). The efficiency of nitrogen fertilizers applied to cereals in different climates. PP. 1-55 in P.B. Tinker and A. Lauchli (eds). Advances in Plant Nutrihon. Vol. 1. Praeger Scientific. New Yerk.

Dann, P.R.; J.W. Derrick; D.C. Dumaresq and M.H. Ryan (1996). The response of organic and conventionally grown wheat to superphosphate and reactive rock phosphate. Aust. J. Exper. Agric., 36 (1): 71-78.

Dashti, N.; F. Zhang; R.Hynes and D.L. Smith (1997). Application of plant growth – protein & rhizobacteria to soybean (Glycine max “L” merr) increases protein and dry matter yield under short – season conditions. Plant & Soil, 188: 33-41.

El-Dahtory, T.M.; M. Abdel-Nasser; A.R. Abdallah and M.A. Mohandes (1989). Studies on phosphate– solubilizing bacteria under different soil amendments. Minia J. Agric. Res. & Dev., 11 (2): 935-950.

El-Gamal, A.M. (1996). Response of potatoes to phosphorus fertilizer levels and **phosphorine** biofertilizer in the newly reclaimed areas. Assiut J. Agric. Sci., 27: 277-287.

El-Ghany, B.F.A.; M.O.Salem and M.A.F. El-Sibaie (1997). Effect of bacterial inoculation, P and organic fertilization on microbiological properties, growth and production of fenugreek plant under saline calcareous soil conditions. Desert – Institute – Bulletin, Egypt. Publ. 1999, 47 (1): 1-13.

El-Naggar, E.M. A. E. (1999). Efficiency use of bio and chemical fertilizers on wheat. Ph. D. Thesis, Fac. of Agric., Mansoura Univ., Egypt.

El-Sayed, S.A.M. (1998). Influence of rhizobium and phosphate – solubilizing bacteria on nutrient uptake and yield of lentil in the New Valley. Egypt J. Soil Sci., 39: 175-186.

Ewais, Magda A.; Amina M.Abd El-Latif; A.A. El-Masry and Awatef M. Abdel-Megid (2003). The response of rice plant to phosphate – dissolving bacteria and azolla under two phosphrous fertilization rates. Egypt. J. Appl. Sci., 18 (11B): 694-705.

Gaind, S. and A.C. Gaur (1991). Thermotolerant phosphate - solubilizing micro-organisms and their interaction with mungbean. Plant & Soil, 137:141-149.

Gomez, K.A. and A.A. Gomez (1984). Statistical Procedures for Agriculture Research. John Willy and Sons. Inc. New York.

Hamissa, M.R.; A.Serry and N.M. El-Mowelhi (1993). Fertilizer management for corn in Egypt. Soil and Water Research Institute, Cairo, Egypt, P. 36.

Hauka, F.I.A.; M.M.A. El-Sawah and Kh. H. El-Hamdi (1990). Effect of phosphate – solubilizing bacteria on growth and P-uptake by barley and tomatoes in soils amended with rock – or tricalcium – phosphate. J. Agric. Sci., Mansoura Univ., 15 (3): 450-459.

Koreish, E.A.; M.E. El-Fayoumy and H.M. Ramadan (1998). Contribution of Vasicular Arbuscular Mycorrhiza and **Phosphorine** in acquisition of phosphorus and micronutrient by maize (Zia mays, L.) in calcareous soil. Egypt J. Soil Sci., 38 : 101-121.

Kotb, M. Th. A.; M.H.A. El-Mancy and E.E. Kaoud (1999). Efficiency of phosphate biofertilzer "**Phosphorien**" combined with phosphatic fertilizers in enhancing growth, yield and nutrients uptake of faba bean plants. Egypt. J. Appl. Sci., 14(9): 375-383.

Kucey, R.M.N. (1989). Phosphate - solubilizing bacteria and fungi in various cultivated and Virgin Alberta soils. Canadian J. Soil Sci., 63: 671-678.

Mahmoud, A.A. and M.Y. Gebrail (2001). Influence of bio- and mineral phosphorus fertilization on corn (Zea mays, L.). Minufiya J. Agric. Res., 26 (2): 519-530.

Mahmoud, S.A.Z. and A.M. Abd El-Hafez (1982). The role of phosphate mobilizing bacteria in plant nutrition. The 1st OAU/STRC inter. African Conf. on "Biofertilizers". Cairo, Egypt, 22-26 March, 1982.

Mengel, K. and E.A. Kirkby (1987). "Principles of Plant Nutrition". 4th ed. Printed by Lang Druck A G Liebefeld / Bern Published by International Potash Institute P.O. Box, CH-3048 Worblaufen Bern Switizerland, PP. 4.21.

Miller, R.W.; R. L. Danhave and J.U. Miller (1990). An introduction to soil and plant growth. Sixth ed., published by Prentice Hall International Inc., London, 269-279.

Prasad, B.; J. Parsad; R. Parsad and M.K. Sinh (1985). Relative efficiency of some phosphoric fertilizers on crop yield and phosphorus availability in calcareous soil. J. Indian Soc. Soil Sci., 33: 317-321.

Shinde, B.N. and A.J. Patil (1985). Use of P solubilizing cultures and rock phosphate on P availability to wheat in black calcareous soil. Current Research Report, 1: 105-106.

Sobh, M.M.; S.Genaidy and M.Hegazy (2000). Comparative studies on mineral and bio-fertilization for some main field crops in northern Delta soils. Zagazig J. Agric. Res., 27 (1): 171-179.

Yahya, A.L. and S.K. Al-Azawi (1989). Occurrence of phosphate – solubilizing bacteria in some Iraqi soils. Plant & Soil, 117: 135-141.

Zaghloul, R.A.; M.H. Mostafa and A.A. Amer (1996). Influence of wheat inoculation with mycorrhizal fungi, phosphate - solubilizing bacteria and Azospirillum on its growth and soil fertility. *Annals of Agric. Sci.*, Moshtohor, 34 (2): 611-626.

تأثير التسميد الفوسفاتى - الحيوى والكيماوى- على محصول القمح

محمد حبيب أحمد المنسى – محمد ثروت عبد الرحمن قطب

قسم الأراضي والمياه – معهد الكفاية الإنتاجية – جامعة الزقازيق

أجريت تجربة حقلية علي محصول القمح صنف سخا ٩٣ بمنطقة بلبيس– محافظة الشرقية خلال الموسم الشتوى ٢٠٠٤– ٢٠٠٥ لدراسة تأثير إضافة معدلات متزايدة من الأسمدة الفوسفاتية "سوبر فوسفات الكالسيوم، الصخر الفوسفاتى" وذلك فى وجود أو عدم وجود السماد الحيوى "الفوسفورين" علي محصول الحبوب والقش – التركيز والمحتوى من النتروجين والفوسفور والبوتاسيوم في الحبوب والقش – جودة الحبوب متمثلة فى النسبة المئوية للبروتين فى الحبوب ومحصول البروتين – كفاءة استخدام الفوسفور – الفوسفور الميسر فى التربة بعد الحصاد.

أتبع فى التجربة التصميم الإحصائى قطاعات كاملة عشوائية، حيث تضمنت التجربة ١٨ معاملة – كررت كل منها ثلاثة مرات – خصصت تسع معاملات لأربع معدلات من الفوسفور (٣.٢٥، ٦.٥٠، ٩.٧٥، ١٣.٠٠ كجم فوسفور/ فدان) – ومصدران للفوسفور (سوبر فوسفات الكالسيوم، الصخر الفوسفاتى)، بالإضافة إلى معاملة الكنترول "بدون إضافة فوسفور" – تم تلقيح التسع معاملات بالسماد الحيوى الفوسفورين.

<u>من النتائج وجد ما يلى :</u>

١- زاد التلقيح بالفوسفورين معنوياً كل من: محصول الحبوب والقش – محتوى وتركيز النتروجين والفوسفور والبوتاسيوم فى الحبوب والقش – النسبة المئوية للبروتين في الحبوب – محصول البروتين – كفاءة استخدام الفوسفور – الفوسفور الميسر فى التربة بعد الحصاد .

٢- بصفة عامة زادت كل معدلات الفوسفور المضافة سواء فى صورة سوبر فوسفات الكالسيوم أو الصخر الفوسفاتى جميع القياسات تحت الدراسة وكان سماد سوبر فوسفات الكالسيوم ذا تأثير أكبر من تأثير سماد الصخر الفوسفاتى .

٣- أعطى التفاعل بين التلقيح بالفوسفورين وسماد سوبر فوسفات الكالسيوم أعلى زيادة لتلك القياسات مقارنة بالتفاعل بين التلقيح بالفوسفورين والصخر الفوسفاتى .

٤- أعطت معاملات التلقيح بالفوسفورين + سوبر فوسفات الكالسيوم بمعدل ٩.٧٥ كجم ، ١٣.٠٠ كجم فوسفور/ فدان والتلقيح بالفوسفورين + الصخر الفوسفاتي بمعدل ١٣.٠٠ كجم فوسفور/ فدان أحسن النتائج .

مما سبق يمكن بصفة عامة استنتاج أن أحسن محصول للقمح وتلك القياسات المشار إليها يمكن الحصول عليها من تلقيح حبوب القمح بالفوسفورين مع إضافة سماد سوبر فوسفات الكالسيوم بمعدل ٩.٧٥ كجم فوسفور/ فدان أو من تلقيح حبوب القمح بالفوسفورين مع إضافة الصخر الفوسفاتى بمعدل ١٣.٠٠ كجم فوسفور/ فدان "عند التلقيح بالفوسفورين".

ومن ثم يمكن خفض كمية سماد السوبر فوسفات الكالسيوم أو استبدالها بالكامل بالصخر الفوسفاتى حيث أنه أرخص ثمناً ومتوافر بكميات كبيرة فى مصر – الأمر الذى يؤدى إلى تقليل تكلفة إنتاج القمح وأيضا تقليل تلوث البيئة.