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INFLUENCE OF PHOSPHORUS SOLUBILIZING BACTERIA, FARMYARD MANURE AND IRON FERTILIZER SOURCSES ON PHOSPHORUS AVAILABILITY AND ITS REFLECTION ON WHEAT PRODUCTIVITY

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ABSTRACT

A field experiment was carried out for two winter seasons 2003/2004 and 2004/2005 in sandy soil under the inoculation with solubilizing bacteria (*Bacillus.megatherium*). Spilt-split plot design was used where two phosphorus sources (rock phosphate, RP, and super phosphorus, SP), two P fertilizer rates (75 kg P_2O_5 fed^{-1} and 150 kg P_2O_5 fed^{-1}) and two rates of farmyard manure ,FYM, (10m^3 fed^{-1} and 15m^3 fed^{-1}). All plot of experiments were foliar treated with either $FeSO_4$ or Fe-EDTA .

At flowering stage, results showed that photosynthetic pigment (chlorophyll a (Chl a), chlorophyll b (Chl b) and carotene ,Car) contents of wheat leaves were superior when 15m^3 fed^{-1} FYM was applied as compared to 10 m^3 FYM . Also inoculation with *B.megatherium* positively affected Chl a,Chl b and Car as compared to non inoculation. The highest values of chlorophyll content were recorded when applied 15 m^3 fed^{-1} FYM , inoculation by *B.megatherium* in combination with SP and sprayed Fe-EDTA.

Moreover, dry weight of both shoots and roots, at flowering stage, increased due to 15m^3 fed^{-1} FYM combined with high rate of SP application as well as RP was superior when combined with 10 m^3 fed $^{-1}$ FYM and inoculation with *B.megatherium*.

In addition, data indicated that FYM applied at a rate 15m^3 fed^{-1} increased N,P & K uptake by both shoots and roots, at flowering stage, of wheat plant as compared to low rate 10m^3 fed^{-1} FYM. Similar trend was obtained when soil inoculated with *B.megatherium* as compared to no inoculation. Results also revealed that low rate of rock phosphate (RPA) was more effective for N,P&K uptake as compared to the other RB rate (RBP) , opposite trend was recorded for high rate of super phosphate (SPP), which, increased N,P&K uptake by both shoots and roots. Generally, foliar application of $FeSO_4$ was superior for both N,P&K uptake by shoots and roots.

At harvest stage, wheat took the same direction for N,P&K uptake by yield components(straw and grains), in spite of Fe-EDTA was superior as compared to $FeSO_4$.

On the other hand, mean values of wheat yield components increased significantly due to the application of high rate of FYM ; these increases were 14.0%,11.4% and 3.47% for straw, grains and weight of 1000 grains, respectively. High rates of both RP and SP were more affective as compared to lower rate under spraying with Fe-EDTA. The interaction between tested treatments showed that the highest grain yield of wheat was accompanied with 15 m^3 fed^{-1} FYM application, inoculation with *B.megatherium* combined with SPB and foliar application with Fe-EDTA.

Keyword: FYM, superphosphate ,rock phosphate , *B.megatherium* ,Fe-EDTA, $FeSO_4$, wheat yield ,macronutrients uptake, micronutrients uptake

INTRODUCTION

Crop yield is frequently constrained by availability of major nutrients, including phosphorus. Phosphorus is one of essential nutrients required by both plant and microorganisms, their major physiological roles are the accumulation and release of energy during cellular metabolism (Marchner, 1995) . Most soils contain substantial reserves of total P, most of it remains relatively inert , and only less than 10% of soil P enters the plant – animal cycle (Kucey *et al.*, 1989).Consequently P deficiency is widespread and P fertilizers are almost universally required to maintain crop production. Although the P in these fertilizers is initially plant available, it is rapidly fixed as water –insoluble calcium phosphate in alkaline soils or iron and aluminum phosphates in acidic soils (Singh and Kapoor ,1994).In addition , phosphorus fertilizers are expensive ,so, we have been reduced the amount applied and /or solubility the phosphorus in the soils. Also, the supply of P to crops can only be increased by additions of manure, rock phosphate or inorganic fertilizers.The P fertility problems could possibly be decreased by applying P as a rock phosphate (Ayaga *et al.*, 2006)

In Egyptian soils calcium phosphate is present and can be dissolved and made available to plants by soil rhizosphere microorganisms through the production of organic acids (Rodriguez and Fraga,1999). Therefore, the inoculation of soil with phosphate solubilizing microorganisms may alleviate this problem (Illmer *et al.* 1995 and Johri *et al.* 1999).

On the other hand, organic matter (FYM) is a source and a sink of plant nutrients in the soil, and is important in maintaining soil tilth , improving aeration and infiltration of water, promoting water retention, reducing erosion, and controlling the efficacy and fate of applied pesticides (Gregorich *et al.* 1993).In addition, FYM improved water holding capacity in soil which leading to more efficient utilization of inorganic P fertilizer. Also, added farmyard manure may block P-absorbing sites in the soil , so increasing P-availability (Ayaga *et al.*, 2006).

Many reports have also revealed various aspects of biology of soils amended with organic matters, including the number of general microorganisms (Nishio and Kusano,1980), biomass of bacteria and fungi (Sakamoto and Oba,1992; Lundquist *et al.*,1999).A further explanation is that the FYM is stimulating the synthesis of soil microbial biomass and labile microbial metabolites. This biomass will have a large demand for P, which will thus be immobilized in labile forms in both the cells of the living soil microorganisms and their associated pool of metabolites. Thus the biomass is acting as a labile pool of P which is protected from fixation but becomes plant –available during biomass turnover (Ayaga *et al.*, 2006).

Recently ,several reports (Dungan *et al.*, 2003; Wada and Toyota,2004 ; Girvan *et al.*, 2005) have found that organic amendment may enhance soil functional stability mediated by soil microbial community. Hence, combined application of inorganic P with FYM resulted in yields may be significantly greater than if either is applied as a single dressing (Sanchez,1990, Jansen,1993; Smaling and Braun,1996; TSBF,1996).

Concerning the effect of inoculation with phosphate solubilizing bacteria on plant growth (Heggo and Barakah (1993) found that maize inoculation with phosphate dissolving bacteria increased plant growth, N,P and K contents as well as micro-nutrients content. Sharif (1999) added that the plant fertilized with hardly soluble rock phosphate and inoculated with *B.megatherium* produced significantly higher shoot dry weight as compared to plants treated only with soluble monocalcium phosphate in soil.

On the other hand, interaction of P and Fe leading to Fe chlorosis appears to be caused by an internal immobilization of Fe probably due to formation of Fe phosphate (Ayed, 1970).other mechanisms of Fe reduction by P application may be inhibition of Fe absorption by roots and of Fe transport from roots to shoots, and inactivation of plant Fe (Elliott and Lauchli ,1985, and Moraghan and Mascagni ,1991).

The main aim of this work was of this work therefore to test whether addition of different forms and rates of P in combination with FYM and inoculation with some microorganisms on P availability and wheat productivity. A secondary aim was to study the interaction between p treatments and different sources of Fe foliar application on wheat growth.

MATERIALS AND METHODS

A field experiment was conducted in a sandy soil at Ismailia Agric. Res. Station (ARC) for two consecutive winter seasons (2003/2004 and 2004/2005) to study the effect of using different phosphorus combinations with both farmyard manure (FYM) and P-solublizing bacteria (*Bacillus megatherium*) inoculation on improving soil P-availability and wheat (Triticum aestivum L.,C.V Giza 168) productivity. Phosphorus was applied in two forms and rates; both of them inoculated or non – inoculated with *B. megatherium* in combination with various rates of farmyard manure (FYM) and different iron sources .Table (1,a) indicates soil analysis of the experimental sites while farmyard manure constituents analysis is described in Table (1,b).

The experiments were laid out in spilt –split plot design with three replications for each experiment unit .The main treatments were FYM applied at two rates (10m^3 and 15 m^3 fed $^{-1}$) ,each treatment was spread over plots and thoroughly incorporated into the surface soil layer,2 weeks before planting.

The sub-main treatments were phosphorus fertilizers including two forms (rock phosphate 15 % P_2O_5, RP) and super phosphate 15.5 % P_2O_5 , SP) ;using two P fertilizers rates i.e., 75 Kg P_2O_5 and 150 Kg P_2O_5, which are equal to 50% and 100% of phosphorus recommended dose for wheat crop. In each plot ,inoculation or non-inoculation with *B. megatherium* and mixed with the surface soil layer at sub-sub main treatments. All plots received recommended rates of nitrogen and potassium (100 Kg N fed^{-1} as ammonium sulphate 20.5% N) and 48 Kg K_2O fed^{-1} as potassium sulphate (48% K_2O) .Nitrogen fertilizer was divided into two equal doses; the first was added before sowing and one month later ,respectively. Both phosphorus treatments and potassium fertilizers were completely added to the soil before planting and combined with farmyard manure. The recommended practices of cultivation were applied till crop maturity.

Table (1,a): Some physical and chemical properties of the experimental soil

Soil characteristics			
Particle size distribution		**Cations and anions in sat.extract (meq/L)**	
Coarse sand	70.20	SP(water saturation)	23.2
Fine sand	19.70	Ca^{++}	2.00
Silt	3.00	Mg^{++}	1.30
Clay	7.10	Na^{+}	1.40
Texture class	Sandy	K^{+}	1.00
$CaCO_3$	1.15	CO_3^{--}	-
OM%	0.40	HCO_3^{-}	1.53
pH(1:2.5 soil suspension)	7.80	CL^{-}	1.80
EC dS/m(in pest extract	0.60	SO_4^{--}	2.37
Available macronutrients (ppm)			
N	P		K
65	25		80

Table (1,b): Main characteristics of the farmyard manure (FYM) used in the experiment

OM %	OC %	pH (1:10)	EC dS m^{-1}	Total macronutrients (%)			Available macronutrients mg Kg^{-1}			
				N	P	K	NO_3	NH_4	P	K
30.1	17.2	8.15	3.25	0.45	0.44	0.71	154	246	756	1433

After 30 and 45 days from wheat planting, Iron treatments were applied with two sources, ferrous sulphate (3 g L^{-1}) and Fe - EDTA (0.5 g L^{-1}) were sprayed on the growing plant leaves.

Wheat plant samples were taken from each plot at flowering stage (75 days) and harvest stage (120 days) for both tested growth seasons. At flowering stage , leave samples of wheat were taken from each plot to determine photosynthetic pigments (chlorophyll a, b and caroteniod) according to the method of Wattstein (1957) .

After wheat maturity ,wheat was harvested and yield components (grains, straw and weight of 1000 grain) of each plot were recorded.

Plant samples of wheat was collected from bulk plot, weighed, oven dried at 70 C°, ground and prepared for digestion using H_2SO_4 and H_2O_2 using the method described by Black (1982). The digests were then subjected to measurement for macronutrients (N, P and K) using procedures described by Chapman and Pratt (1961).

Obtained results were subjected to statistical analysis according to Snedecor and Cochran (1980) and the treatments were compared by using L.S.D. at 0.05 level of probability.

RESULTS AND DISCUSSION

1-Photosynthetic pigment

Table (2) represents the photosynthetic pigments (chlorophyll a, chl a, chlorophyll b, chl b, and Carotenes, car) contents in fresh tissue of the studied wheat leaves at flowering stages . Results clear that applied FYM at a rate 15m^3 /fed, generally , increased significantly photosynthetic pigments as compared to low rate of FYM 10 m^3/fed. Mean percentages of these increases reached to13.1 ,10.9 and 15.8 for Chl a, Chl b and car, respectively.

Data also clear that, inoculation the soil by *B. megatherium* was positively affected on photosynthetic pigments (Chl a ,Chl b , and Car).Mean increases percentages of inoculation treatment were 5.41 ,8.02 and 20.3 for (Chl a ,Chl b , and Car) ,respectively, as compared to non- inoculation.

With respect to phosphorus fertilizers ,data indicated that high rate of superphosphate (SPB) was superior as relatively lower rate and / or rock phosphate (RP) with different rates. In addition, mean values of chl a , chl b and car show that no significant effect between RPA (low rate of rock phosphate) and higher rate (RPB).

Moreover, foliar application of Fe-EDTA was positively affected on photosynthetic pigments (chl a ,chl b , and car) as compared to $FeSO_4$ .Mean values of chlorophyll contents show that chl b was high effected by applied Fe-EDTA ,as compared to Chl a and /or Car ; the increases in Chl b reach to 6.20% as well as 3.57% and 5.88% for Chl b and Car ,respectively.

The interaction between studied treatments reveal that, (Chl a ,Chl b, and Car) were increased when FYM was applied at a rate of 10m^3 /fed in combination with high rate of RP and foliar application of Fe either $FeSO_4$ and /or Fe-EDTA. Such results is true only when applied SPB with $FeSO_4$. These results are in harmony with Abadia *et al.*(1989) and El-etr and Asmayaw (2003) who found that foliar application of Fe was beneficial for chlorophylls physiologically, such Fe application increases the thylakoidal membrane system in higher plants and increases in photosynthetic pigments (Val *et al.*,1987).

Application FYM at a rate of 15 m^3/fed was decreased (Chl a ,Chl b , and Car) content when applied high rate of RPB with $FeSO_4$ as well as SPB and foliar application of Fe-EDTA.

Again, applied FYM with 15 m^3 /fed , inoculation with *B. megatherium* in combined with SPB and foliar application of Fe-EDTA was the best treatment affected on Chl a ,Chl b , and Car contents.

Table (2):-Photosynthetic pigment contents (mg/g) fresh weight of wheat leaves as affected by applied FYM, inoculation , P fertilizers and Fe treatments (Average data for two seasons)

P Forms	P levels	Fe source	FYM ($10m^3$ fed^{-1}) Chlorophyll a (mg/g)	FYM ($10m^3$ fed^{-1}) Chlorophyll b (mg/g)	FYM ($10m^3$ fed^{-1}) Caroteins (mg/g)	FYM ($15m^3$ fed^{-1}) Chlorophyll a (mg/g)	FYM ($15m^3$ fed^{-1}) Chlorophyll b (mg/g)	FYM ($15m^3$ fed^{-1}) Carotene (mg/g)
Inoculation								
RP	A	Fe1	8.97	6.10	1.30	11.6	7.60	1.79
	B		10.6	6.70	1.61	10.5	7.04	1.53
SP	A		10.0	6.37	1.20	11.2	8.07	1.93
	B		13.1	7.92	1.88	15.0	8.41	1.99
RP	A	Fe2	9.92	7.10	1.27	10.6	7.43	1.53
	B		10.4	7.43	1.77	12.0	7.97	1.83
SP	A		13.3	7.70	1.97	13.8	8.73	2.13
	B		10.0	6.63	1.70	15.7	7.37	2.07
Non- inoculation								
RP	A	Fe1	10.2	5.88	1.22	11.1	6.74	1.55
	B		10.3	6.05	1.49	9.87	6.50	1.28
SP	A		9.65	5.69	1.13	11.1	7.05	1.49
	B		11.8	7.18	1.45	13.6	7.56	1.63
RP	A	Fe2	9.80	6.66	1.04	11.4	6.91	1.19
	B		10.6	6.79	1.11	10.2	7.67	1.43
SP	A		12.8	7.69	1.94	13.4	7.77	2.10
	B		9.93	6.38	1.21	11.9	7.30	1.56
Mean of FYM			10.7	6.77	1.46	12.1	7.51	1.69

Mean values		Chlorophyll a	Chlorophyll b	Carotene
inoculation	inoculation	11.7	7.41	1.72
	Non-inoculation	11.1	6.86	1.43
P - fertilizers	RPA	10.9	6.80	1.30
	RPB	10.1	7.02	1.56
	SPA	12.2	7.34	1.74
	SPB	12.4	7.38	1.69
Fe sources	Fe1	11.2	6.92	1.53
	Fe2	11.6	7.35	1.62

LSD at 0.05% For Chlorophyll b				LSD at 0.05% For Chlorophyll b			
inoculation A	=1.14	B*D	=1.18	Inoculation A	=2.09	B*D	=0.73
FYM B	=1.50	C*D	=1.66	FYM B	=0.63	C*D	=1.04
P fert. C	=1.18	A*B*D	=1.66	P fert. C	=0.73	A*B*D	=1.04
Fe- source D	=1.02	A*B*C	=2.35	Fe- source D	=0.93	A*B*C	=1.46
A*B	=2.13	A*C*D	=2.35	A*B	=0.89	A*C*D	=1.46
A*C	=1.66	B*C*D	=2.35	A*C	=1.04	B*C*D	=1.46
B*C	=1.66	A*B*C*D	=3.33	B*C	=1.04	A*B*C*D	=2.07
A*D	=1.18			A*D	=0.73		

LSD at 0.05% For Carotene:-

Cont. (Table, 2)

4FYM B	=0.29	C*D	=0.35
P fert. C	=0.25	A*B*D	=0.35
Fe- source D	=0.28	A*B*C	=0.50
A*B	=0.41	A*C*D	=0.50
A*C	=0.35	B*C*D	=0.50
B*C	=0.35	A*B*C*D	=0.71
A*D	=0.25		

2-Wheat growth :-

A :-Dry weight at flowering stage

As indicated in Table (3) dry weight of both shoot and root of wheat plant at flowering stage were increased significantly with increasing FYM application; application of 15 m^3/fed FYM was superior for both shoots and roots growth as compared to 10m^3/fed.Also mean values of growth parameters (shoots and roots) show that Inoculation with *B. megatherium* was positively affected the dry matter of shoots and roots as compared to non- inoculated treatments . El-Komy (2005) reported that plant dry weight of wheat inoculated with *B. megatherium* significant was higher than no inoculated , such results may be due to that calcium phosphate in alkaline soil dissolved and made available to plant by soil rizosphere microorganisms through the production of organic acids. Therefore ,the inoculation of soil with phosphate solubilizing microorganisms may alleviate this problem.

In addition, mean values of dry mater production showed that superphosphate treatment (SP) was superior for both shoots and roots as compared to rockphosphate (RP) treatment. Also, foliar application of $FeSO_4$ (Fe1) was increased insignificant dry weight of both shoots and roots as compared to Fe-EDTA.

Responses of shoots and roots to interaction treatments reveal that , under FeSO4 treatment, regardless inoculation , application high rate of RP combined with different rates of FYM decreased both shoots and roots dry weights .Similar trend was only obtained with the application of high rates of superphosphate (SP) combined with low rate FYM (10m^3/fed) and inoculation with *B. megatherium* .Obtained data may be due to that the P-solubilisers bacteria also produce fungistatic and growth promoting substances ,which, influence plant growth.The performance of these microorganisms is affected by availability of carbon source ,P concentration ,particle size of rock phosphate(El-komy,2005).

Regarding the application of Fe-EDTA, results show that both shoots and roots dry weight were increased as superphosphate(SP) rate increased; such data was only obtained either with the application of RP combined with 10m^3 /fed and bacterial inoculation or with the application of 15m^3/fed FYM and no inoculation treatments.

From the above mentioned data ,it can be noted that, the application of SPB combined with inoculation by *B. megatherium* and 15m^3/fed FYM, generally, gave the highest values for dry matter content for both shoots and roots at flowering stage of wheat plant.

Table (3):- Dry weight of both shoots and roots (g/plant) of wheat plant at flowering stage as affected by applied FYM, inoculation , P fertilizers and Fe treatments (Average data for two seasons)

P		Fe	FYM ($10m^3$/fed)		FYM ($15m^3$/fed)	
forms	levels	source	Dry weight of shoots (g/plant	Dry weight of roots (g/plant	Dry weight of shoots (g/plant	Dry weight of roots (g/plant
Inoculation						
RP	A	Fe1	7.71	4.33	8.14	5.98
	B		6.45	3.88	7.81	5.37
SP	A		7.56	5.47	7.50	4.88
	B		6.93	3.78	7.67	5.59
RP	A	Fe2	6.59	3.50	7.54	4.69
	B		6.65	3.88	7.49	4.08
SP	A		6.38	4.40	8.17	5.15
	B		8.09	5.01	8.31	6.06
Non- inoculation						
RP	A	Fe1	7.08	3.33	7.78	5.20
	B		5.92	3.00	6.81	4.23
SP	A		6.33	3.52	6.68	3.89
	B		7.42	4.20	7.49	4.88
RP	A	Fe2	6.17	3.38	6.18	3.82
	B		5.85	3.30	6.95	3.84
SP	A		5.90	3.90	6.89	4.28
	B		7.34	4.56	7.45	5.06
Mean of FYM			6.77	3.96	7.47	4.81

Mean values		shoots	roots
inoculation	inoculation	7.47	4.03
	Non-inoculation	6.77	4.75
P - fertilizers	RPA	6.50	3.96
	RPB	7.03	4.27
	SPA	7.05	4.22
	SPB	7.90	5.10
Fe sources	Fe1	7.27	4.47
	Fe2	6.97	4.31

LSD at 0.05% For shoots :-				LSD at 0.05% For roots :-			
Inoculation A	= 1.03	B*D	= 0.46	Inoculation A	= 085	B*D	= 0.44
FYM B	= 0.81	C*D	= 0.65	FYM B	= 0.72	C*D	= 0.62
P fert. C	= 0.46	A*B*D	= 0.65	P fert. C	= 0.44	A*B*D	= 0.62
Fe- source D	= 0.33	A*B*C	= 0.92	Fe- source D	= 0.29	A*B*C	= 0.87
A*B	= 1.15	A*C*D	= 0.92	A*B	= 1.02	A*C*D	= 0.87
A*C	= 0.65	B*C*D	= 0.92	A*C	= 0.62	B*C*D	= 0.87
B*C	= 0.65	A*B*C*D	= 1.30	B*C	= 0.62	A*B*C*D	= 1.24
A*D	= 0.46			A*D	= 0.44		

B:-Yield components of wheat

Data presented in Table (4) reveal that, mean values of wheat yield components (straw, grains and weight of 1000 grain) increased significantly due to tested FYM ,inoculation , P- fertilizers and Fe-EDTA treatment.

With respect to FYM application, obtained data reveal that, yield of wheat (straw ,grains and weight of 1000 grain increased significantly by increasing the rate of FYM from $10m^3$/fed to $15m^3$/fed. These increases reach to 14.0%,11.4% and 3.47% for both straw ,grains and weight of 1000 grain ,respectively.

Also ,high increment of wheat yield was observed due to inoculation with *B. megatherium rather* than without inoculating, Table (4).Inoculation with *B. megatherium* caused an increase in wheat yield components being 10.3%,15.5% and 8.79% for straw ,grains and weight of 1000 grain, respectively ,as compared to non- inoculated treatments.

Moreover, mean values show that high rate of P fertilizer as superphosphate (SPB) was superior for wheat production as compared to low rate(SPA) .Similar trend was encountered with high rate of rock phosphate (RPB) which increased straw yield and weight of 1000 grains of wheat, but no –significant effect was recorded in grain yield due high rate of RPB application.

Table (4):Yield components of wheat plant as affected by applied FYM, inoculation , P fertilizers and Fe treatments (Average data for two seasons)

Inoculation	P-fertilizers form	P-fertilizers rate	Fe source	FYM($10m^3$) Straw yield (ton fed^{-1})	FYM($10m^3$) Grains yield (ton fed^{-1})	FYM($10m^3$) Weight of 1000 grains	FYM($15m^3$) Straw yield (ton fed^{-1})	FYM($15m^3$) Grains yield (ton fed^{-1})	FYM($15m^3$) Weight of 1000 grains
Inoculation	RP	A	Fe1	4.50	2.29	43.7	4.97	2.48	44.4
		B		4.27	2.15	43.5	4.47	2.37	44.1
	SP	A		4.13	2.49	47.1	4.53	2.40	43.8
		B		4.00	2.32	43.1	4.83	2.70	48.6
	RP	A	Fe2	4.17	2.24	44.0	4.63	2.36	48.5
		B		4.87	2.37	46.6	5.06	2.41	47.9
	SP	A		4.83	2.27	43.7	5.33	2.43	45.8
		B		4.97	2.33	48.3	6.03	2.74	49.3
Non-inoculation	RP	A	Fe1	4.40	2.09	42.9	4.50	2.09	43.1
		B		4.10	1.53	40.7	4.33	1.84	40.8
	SP	A		3.80	1.65	39.9	4.23	2.24	41.2
		B		3.83	2.28	43.5	4.70	2.40	45.1
	RP	A	Fe2	3.57	1.81	42.7	4.17	2.03	44.6
		B		3.87	1.87	44.3	4.56	2.19	45.9
	SP	A		4.40	2.02	41.9	4.87	2.24	38.5
		B		4.70	2.26	42.0	5.50	2.56	43.7
Mean values of FYM				4.21	2.10	43.2	4.80	2.34	44.7

Mean values of		Straw	grains	Weight of 1000 grains
inoculation	inoculation	4.72	2.38	45.8
	Non-inoculation	4.28	2.06	42.1
P - fertilizers	RPA	4.36	2.20	44.0
	RPB	4.44	2.06	44.6
	SPA	4.52	2.16	42.4
	SPB	4.69	2.46	44.9
Fe sources	Fe1	4.35	2.00	43.5
	Fe2	4.66	2.24	44.4

LSD at 0.05% For straw :-				
Inoculation	A	=4.72	B*D	=0.38
FYM	B	=4.28	C*D	=0.54
P fert.	C	=0.38	A*B*D	=0.54
Fe- source	D	=0.27	A*B*C	=0.76
A*B		=0.72	A*C*D	=0.76
A*C		=0.54	B*C*D	=0.76
B*C		=0.54	A*B*C*D	=1.07
A*D		=0.38		

LSD at 0.05% For grains :-				
Inoculation	A	=0.73	B*D	=0.20
FYM	B	=0.45	C*D	=0.29
P fert.	C	=0.20	A*B*D	=0.29
Fe- source	D	=0.14	A*B*C	=0.40
A*B		=0.41	A*C*D	=0.41
A*C		=0.29	B*C*D	=0.41
B*C		=0.29	A*B*C*D	=0.58
A*D		=0.20		

LSD at 0.05% For 1000 grain:-				
Inoculation	A	=5.08	B*D	=1.64
FYM	B	=1.20	C*D	=2.33
P fert.	C	=1.64	A*B*D	=2.33
Fe- source	D	=1.16	A*B*C	=3.29
A*B		=1.69	A*C*D	=3.29
A*C		=2.33	B*C*D	=3.29
B*C		=2.33	A*B*C*D	=4.65
A*D		=1.64		

On the other hand, Fe-EDTA achieved a significant effect in straw yield and weight of 1000 grain as compared to anther tested source ($FeSO_4$) but no significant affect was recorded between two Fe sources towards grains yield.

Comparing the effect of P-fertilizer (rate &form)under different rates of FYM and inoculation, Table (4)reveal that under ($FeSO_4$) treatment, low rate of rock phosphate (RPA)was favorable to wheat yield components as compared to high rate. An opposite trend was recorded ,generally, with SP treatments under either non-inoculation treatment or 15 m^3/fed FYM and inoculation by *B. megatherium.* treatment. Masto *et al.*(2006) stated that application of P fertilizer and manure has a significant effect on soil biological indicators with different magnitudes on soil organic matter, microbial quotient and phosphatase activity.

From the above mentioned data it can be noted that high significant values of wheat yield (straw, grains and weight of 1000 grains) were obtained when FYM 15 m^3/fed, inoculation by *B. megatherium* and foliar sprayed with Fe-EDTA were applied. These results are in agreement with those of Sanchez(1990) ; Jansen(1993); Smaling and Braun(1996) and TSBF (1996) who suggested that by combining applications of inorganic P with FYM the resulting yields may be significantly greater than if either is applied as a single dressing.

3- Nutrients status in wheat plant:-

A:-Macronutrients uptake by wheat plant at flowering stage:-

Table (5) shows data representing the N,P and K uptake of shoots and roots at flowering stage of wheat plant. Data reveal that mean values of N,P and K uptake increased significantly in both shoots and roots due FYM application at rate 15m^3/fed as compared to low rate of FYM 10m^3/fed .These increases reach to 20.9 ,21.0 and 18.5 for shoots as well as 25.5 ,41.4 and 34.7 for roots for N ,P and K uptake ,respectively. In addition, high rate (FYM 15m^3/fed) was more positively effective on macronutrients uptake by roots as compared to shoots.

Hence, similar trend was obtained for soil inoculation with *B. megatherium* as compared to non-inoculated soil. The increases in N uptake reached to 22.1% and 25.1% for both shoots and roots ,respectively, as compared to non- inoculated soil. These results were also obtained for P uptake which recorded increases of 26.1 for shoots and 41.4% for roots along with K uptake ,which, recorded increments 25.1 for shoots and 35.3 for roots as compared to non- inoculated treatments. Again, inoculation with *B. megatherium* was more affective on N,P and K uptake by roots as compared to shoots. Heggo and Barakah (1993) reported that maize inoculation with phosphate dissolving bacteria increased plant growth N,P, and K content.

With regard to applied P-forms and levels, Table (5) indicated that mean values of RPA generally gave the highest values of nutrients uptake (N,P and K) by shoots and roots during the flowering stage. An opposite trend was encountered with high rate of superphosphate (SPB) ,which, increased N,P and K uptake especially in roots.

Table (5):-Macronutrients uptake by wheat plant at flowering stage as affected by applied FYM, inoculation , P -fertilizers and Fe treatments (Average data for two seasons)

FYM rates	P Forms	P Levels	Fe Sources	Uptake of shoots (mg/plant) N	P	K	Uptake of Roots (mg/plant) N	P	K
	Inoculation								
10 m^3	RP	A	Fe1	222	61.0	215	50.5	27.0	36.8
		B		155	38.4	189	46.5	25.2	33.5
	SP	A		228	44.4	179	44.2	20.0	28.2
		B		232	55.3	212	61.1	30.0	45.1
	RP	A	Fe2	194	47.1	176	44.3	25.8	32.7
		B		198	40.9	193	42.0	17.3	36.2
	SP	A		194	50.4	171	51.7	23.5	38.1
		B		242	51.0	198	57.6	30.2	44.9
	Non- inoculation								
	RP	A	Fe1	173	50.4	191	35.7	14.9	21..8
		B		144	30.2	121	34.3	13.8	21.4
	SP	A		181	40.9	179	41.1	15.7	23.9
		B		201	44.7	202	47.2	19.8	29.9
	RP	A	Fe2	177	40.3	148	36.5	16.1	25.3
		B		139	23.1	144	35.2	15.6	23.8
	SP	A		163	42.4	137	44.5	19.3	32.4
		B		215	50.2	190	48.1	22.3	36.1
	Inoculation								
15 m^3	RP	A	Fe1	254	66.5	239	66.4	39.7	58.0
		B		239	52.6	234	63.9	31.1	46.0
	SP	A		257	52.1	219	57.4	27.9	46.9
		B		259	64.8	235	66.9	38.6	48.8
	RP	A	Fe2	249	58.9	234	55.9	34.2	47.2
		B		230	47.9	207	48.8	23.4	33.1
	SP	A		261	68.4	224	61.8	30.7	48.5
		B		267	74.5	261	71.1	42.7	59.4
	Non- inoculation								
	RP	A	Fe1	208	56.6	223	55.9	32.1	44.5
		B		201	38.7	154	48.9	21.2	32.7
	SP	A		215	44.1	206	44.9	21.5	36.3
		B		238	52.6	209	58.1	32.2	39.1
	RP	A	Fe2	194	48.7	183	44.9	19.5	31.3
		B		151	36.2	155	40.4	18.9	29.5
	SP	A		216	52.5	165	50.9	23.9	38.7
		B		220	52.9	193	55.2	25.9	40.9
Mean values of FYM			10 m^3	191	45.0	178	45.0	21.0	31.9
			15 m^3	231	54.5	211	56.5	29.7	42.8
Mean values for inoculation	Inoculation			232	55.5	214	56.4	29.7	42.9
	Non-inoculation			190	44.0	175	45.1	21.0	31.7
P - fertilizers	RPA			207	53.7	198	49.1	25.8	38.0
	RPB			185	38.5	179	46.2	21.2	32.0

Cont. (Table , 5)

	SPA	239	52.3	207	49.5	22.8	36.6
	SPB	215	54.5	196	58.1	31.6	42.7
Fe sources	Fe1	215	50.1	205	52.2	26.4	37.5
	Fe2	207	49.4	184	49.3	24.3	37.2

LSD at 0.05% for N in shoots				LSD at 0.05% for N in roots			
inoculation A	=29.8	B*D	=21.8	Inoculation A	=10.6	B*D	=5.78
FYM B	=21.2	C*D	=30.8	FYM B	=6.51	C*D	=8.18
P fert. C	=21.8	A*B*D	=30.8	P fert. C	=5.78	A*B*D	=8.18
Fe- source D	=15.4	A*B*C	=43.5	Fe- source D	=4.08	A*B*C	=11.6
A*B	=30.0	A*C*D	=43.5	A*B	=9.19	A*C*D	=11.6
A*C	=30.8	B*C*D	=43.5	A*C	=8.18	B*C*D	=11.6
B*C	=30.8	A*B*C*D	=61.6	B*C	=8.18	A*B*C*D	=16.4
A*D	=21.8			A*D	=5.78		=5.78

LSD at 0.05% For P in Shoots				LSD at 0.05% For P in roots			
inoculation A	=8.66	B*D	=4.64	Inoculation A	=9.37	B*D	=3.82
FYM B	=6.05	C*D	=6.56	FYM B	=6.60	C*D	=5.40
P fert. C	=4.64	A*B*D	=6.56	P fert. C	=3.82	A*B*D	=5.40
Fe- source D	=3.27	A*B*C	=9.27	Fe- source D	=2.70	A*B*C	=7.63
A*B	=8.55	A*C*D	=9.27	A*B	=9.33	A*C*D	=7.64
A*C	=6.56	B*C*D	=9.27	A*C	=5.40	B*C*D	=7.64
B*C	=6.56	A*B*C*D	=13.1	B*C	=5.40	A*B*C*D	=10.8
A*D	=4.64			A*D	=3.82	B*D	=3.82

LSD at 0.05% For K in shoots				LSD at 0.05% For K in roots			
inoculation A	=27.9	B*D	=18.2	Inoculation A	=9.27	B*D	=5.17
FYM B	=26.5	C*D	=25.8	FYM B	=11.8	C*D	=7.31
P fert. C	=18.2	A*B*D	=25.8	P fert. C	=5.17	A*B*D	=7.31
Fe- source D	=12.9	A*B*C	=36.5	Fe- source D	=3.65	A*B*C	=10.3
A*B	=37.4	A*C*D	=36.5	A*B	=16.6	A*C*D	=10.3
A*C	=25.8	B*C*D	=36.5	A*C	=7.31	B*C*D	=10.3
B*C	=25.8	A*B*C*D	=51.6	B*C	=7.31	A*B*C*D	=14.6
A*D	=18.2	B*D	=18.2	A*D	=5.17		

Comparing the effect of Fe-sources, at flowering stage, obtained data show that foliar application of Fe SO4 had positively affected the macronutrients uptake by both shoots and roots as compared to Fe-EDTA. These increases were 3.86%,1.42% and 11.4% for shoots along with 3.88% ,8.64% and 0.81% for roots, respectively.

However, it is worth to mention that high values of (N,P and K) uptake by wheat plant at flowering stage were recorded when FYM15m^3/fed was applied in combination with (SPB), soil inoculation with *B. megatherium* and foliar application Fe-EDTA . Obtained data agree with Ayaga *et al.* (2006) who reported that the combined use of organic and inorganic fertilizers may promote increased biological cycling, enhanced availability and consequently improved plant uptake .

B:-Macronutrient uptake by wheat yield :

Data in Table (6) indicated that N,P& K uptake in wheat yield responded to the applied tested treatments. High rates of FYM 15m^3 fed^{-1} affected significantly the N,P&K uptake as compared to low rates 10m^3 fed^{-1}. These increases were 17.1 , 19.8 & 23.8 (straw) and 20.1 , 21.9 & 15.4 (grains) for N,P&K , respectively. Obtained data are in harmony with those noted by Masto *et al.*(2006) who reported that applying farmyard manure (FYM) plus NPK fertilizer significantly increased soil organic carbon, microbial biomass and phosphatase activities.

Also, inoculation with *B. megatheriun* significantly affected N,P and K uptake by wheat yield as compared to non-inoculation. Mean values of inoculated treatments increased by 16.1% , 27.9% & 20,2% (straw) and 24.1% , 22.9% & 25% for (grains) for N,P&K uptake by wheat yield , respectively. El-Komy (2005) suggested that inoculation of wheat plant with *B. megatheriun* provided more balanced nutrition for the plants and improvement in N and P uptake is the major mechanism of microorganisms and phosphate solubilizing bacteria.

Moreover, application of Fe as Fe-EDTA was favored for nutrients uptake by wheat yield as compared to $FeSO_4$. Applied Fe-EDTA caused an increase in nitrogen uptake by 6.94% for straw and 1.84% for grains and increased P uptake by both straw and grains being 3.46% and 2.87% , respectively . The highest increases were recorded for K uptake 8.67% and 6.42% for both straw and grains , respectively.

Concerning the effect of P fertilizers (forms and rates), mean values of obtained data how that no significant effect was recorded between two sources of either RP or SP forms ; high rate of two forms were superior of N,P&K uptake of straw as relative to lower rate. An opposite trend was observed for grain yield, which , generally decrease N,P&K uptake were observed with increasing P fertilizer rate.

Comparing the interaction effect between tested treatments data reveal that the highest yield of wheat (straw and grains) was obtained due to FYM 15m^3 fed^{-1} , inoculation by *B. megatheriun* , in combined with SP as a source of P fertilizer and foliar application of Fe-EDTA.

Table (6):-Macronutrients uptake by wheat plant (g/plot) as affected by applied FYM, inoculation , P fertilizers and Fe treatments (Average data for two seasons)

FYM rates	P Forms	P Levels	Fe Sources	Uptake of straw (g/plot) N	Uptake of straw (g/plot) P	Uptake of straw (g/plot) K	Uptake of grains (g/plot) N	Uptake of grains (g/plot) P	Uptake of grains (g/plot) K
10 m^3	Inoculation								
	RP	A	Fe1	58.9	30.4	32.4	113	23.7	114
		B		58.4	27.8	30.4	106	22.6	109
	SP	A		58.9	29.9	32.1	126	28.6	117
		B		54.9	27.8	30.7	105	27.1	117
	RP	A	Fe2	60.1	27.3	28.8	108	25.9	124
		B		66.6	31.5	35.4	113	26.6	140
	SP	A		63.2	30.6	36.5	95.8	22.7	102
		B		67.6	35.2	38.9	119	24.6	113
	Non- inoculation								
	RP	A	Fe1	55.8	25.6	28.2	99.9	19.2	92.3
		B		52.8	24.2	26.3	59.2	136	80.6
	SP	A		50.7	24.1	26.9	66.9	17.5	83.0
		B		52.5	24.6	29.3	111	24.9	97.2
	RP	A	Fe2	46.7	19.1	23.7	79.1	16.6	83.4
		B		49.5	25.3	24.9	88.6	17.1	92.4
	SP	A		56.9	24.9	31.8	113	24.3	107
		B		47.5	20.2	26.8	93.4	22.0	98.3
20 m^3	Inoculation								
	RP	A	Fe1	65.9	34.2	37.5	146	29.6	130
		B		63.2	32.4	37.5	136	27.1	116
	SP	A		62.2	32.2	34.2	120	32.1	134
		B		71.3	38.4	41.5	140	32.6	137
	RP	A	Fe2	68.2	32.7	36.2	119	27.6	118
		B		73.8	35.7	40..8	140	27.9	139
	SP	A		71.7	35.7	42.9	124	34.2	140
		B		86.3	46.9	54.8	148	34.7	147
	Non- inoculation								
	RP	A	Fe1	58.9	29.5	31.2	104	20.5	95.8
		B		56.6	26.7	30.8	89.8	18.5	93.8
	SP	A		57.7	25.3	31.1	105	24.9	110
		B		66.4	29.5	37.6	120	27.5	115
	RP	A	Fe2	55.3	22.6	29.7	97.1	19.9	102
		B		60.6	30.3	33.1	107	20.9	105
	SP	A		62.9	27.9	37.3	107	26.3	111
		B		74.3	33.0	42.1	132	30.8	127
Mean values of FYM			10 m^3	56.3	26.8	30.2	99.8	22.3	104
			15 m^3	65.9	32.1	37.4	120.9	27.2	120
Mean values for									
Inoculation	Inoculation			65.7	33.0	36.9	122	27.9	125
	Non-inoculation			56.6	25.8	30.7	98.3	21.5	100
P – fertilizers	RPA			58.7	27.2	30.7	113	22.9	105
	RPB			60.2	29.8	32.7	99.9	21.7	112
	SPA			60.0	28.6	33.9	126	28.4	119
	SPB			65.6	32.1	37.9	102	25.9	113
Fe sources	Fe1			59.1	28.9	32.4	109	24.4	109
	Fe2			63.2	29.9	35.2	111	25.1	116

LSD at 0.05% for N in straw

Inoculation A	=7.45	B*D	=5.73
FYM B	=7.06	C*D	=8.11
P fert. C	=5.73	A*B*D	=8.11
Fe- source D	=4.05	A*B*C	=11.5
A*B	=9.98	A*C*D	=11.5
A*C	=8.11	B*C*D	=11.5
B*C	=8.11	A*B*C*D	=16.2
A*D	=5.73		

LSD at 0.05% For P in straw

Inoculation A	=5.70	B*D	=3.25
FYM B	=4.21	C*D	=4.60
P fert. C	=3.25	A*B*D	=4.60
Fe- source D	=2.30	A*B*C	=6.51
A*B	=5.94	A*C*D	=6.51
A*C	=4.60	B*C*D	=6.51
B*C	=4.60	A*B*C*D	=9.20
A*D	=3.25		

LSD at 0.05% For K in straw

Inoculation A	=4.41	B*D	=3.32
FYM B	=4.15	C*D	=4.69
P fert. C	=3.32	A*B*D	=4.69
Fe- source D	=2.34	A*B*C	=6.63
A*B	=5.87	A*C*D	=6.63
A*C	=4.69	B*C*D	=6.63
B*C	=4.69	A*B*C*D	=9.38
A*D	=3.32		

LSD at 0.05% for N in grains

Inoculation A	=31.2	B*D	=12.2
FYM B	=17.8	C*D	=17.2
P fert. C	=12.2	A*B*D	=17.2
Fe- source D	=8.59	A*B*C	=24.3
A*B	=25.2	A*C*D	=24.3
A*C	=17.2	B*C*D	=24.3
B*C	=17.2	A*B*C*D	=34.4
A*D	=12.2		

LSD at 0.05% For P in grains

Inoculation A	=8.31	B*D	=2.46
FYM B	=3.17	C*D	=3.48
P fert. C	=2.46	A*B*D	=3.48
Fe- source D	=1.74	A*B*C	=4.92
A*B	=4.19	A*C*D	=4.92
A*C	=3.48	B*C*D	=4.92
B*C	=3.48	A*B*C*D	=6.95
A*D	=2.46		

LSD at 0.05% For K in grains

Inoculation A	=42.8	B*D	=13.5
FYM B	=18.5	C*D	=19.1
P fert. C	=13.5	A*B*D	=19.1
Fe- source D	=9.55	A*B*C	=27.1
A*B	=26.1	A*C*D	=27.1
A*C	=19.1	B*C*D	=27.1
B*C	=19.1	A*B*C*D	=38.3
A*D	=13.5		

C:-Micronutrients uptake by wheat yield:

Table (7) shows data representing the Fe, Mn, Zn & Cu uptake by wheat yield (straw and grains).

Table (7):-Micronutrients uptake by wheat yield (g/plot) as affected by applied FYM, inoculation, P fertilizers and Fe treatments (Average data for two seasons)

FYM rates	P Forms	P Levels	Fe Sources	Uptake of straw Fe (g/plot)	Mn (mg/plot)	Zn (mg/plot)	Cu (mg/plot)	Uptake of grains Fe (g/plot)	Mn (mg/plot)	Zn (mg/plot)	Cu (mg/plot)
				Inoculation							
10m³	RP	A	Fe1	6.78	174	197	31.5	4.69	98.6	484	51.5
		B		6.57	183	195	98.2	4.63	90.1	338	49.5
	SP	A		7.74	140	386	77.2	4.76	109	333	57.0
		B		5.59	91.8	419	72.8	5.30	101	331	91.1
	RP	A	Fe2	6.31	169	396	74.3	4.78	93.9	364	52.7
		B		8.55	198	332	111	4.54	99.9	408	58.6
	SP	A		8.99	194	497	86.7	4.62	102	441	47.3
		B		8.09	172	510	111	4.49	97.4	398	63.2
				Non- inoculation							
	RP	A	Fe1	6.53	115	170	29.5	4.23	80.5	209	26.1
		B		6.04	148	146	61.6	2.90	55.8	192	30.9
	SP	A		5.71	110	303	51.9	4.43	66.4	265	38.9
		B		5.35	85.2	377	66.1	3.57	63.3	210	41.0
	RP	A	Fe2	4.91	135	248	35.5	3.89	55.5	274	33.9
		B		6.74	117	151	75.1	3.24	56.1	214	40.4
	SP	A		6.67	127	317	66.4	4.49	79.9	264	45.0
		B		5.37	103	299	77.7	4.33	74.4	188	50.6
				Inoculation							
15m³	RP	A	Fe1	8.00	204	637	87.9	6.19	180	551	58.4
		B		7.69	207	341	93.7	5.80	142	416	108
	SP	A		10.1	161	556	94.5	6.72	173	595	108
		B		7.84	168	608	117	6.28	159	527	107
	RP	A	Fe2	7.89	205	452	105	6.10	151	472	61.5
		B		9.86	226	437	124	5.67	144	423	100
	SP	A		10.4	269	617	96.2	7.08	185	617	108
		B		11.1	215	676	144	6.69	174	510	101
				Non- inoculation							
	RP	A	Fe1	6.95	127	509	42.7	4.28	128	298	36.2
		B		6.57	166	299	82.9	3.61	96.8	316	73.2
	SP	A		8.67	136	366	66.5	5.89	128	369	85.4
		B		7.39	152	460	96.2	5.39	127	317	88.6
	RP	A	Fe2	6.68	147	315	44.2	4.79	138	393	40.2
		B		8.19	175	285	91.4	3.78	101	252	79.8
	SP	A		8.35	149	468	82.7	6.30	141	399	98.3
		B		8.46	187	546	124	5.71	143	250	62.3
Mean values of FYM			10 m³	6.62	141	309	70.4	4.31	82.8	301	48.6
			15 m³	8.39	181	473	93.3	5.64	145	419	82.2
			Mean values for								
noculation	Inoculation			8.22	186	454	95.3	5.52	131	444	76.4
	Non-inoculation			6.79	136	329	68.4	4.43	95.9	276	54.4
P - fertilizers	RPA			6.76	160	365	56.3	4.87	116	368	45.1
	RPB			7.53	177	273	92.2	4.27	98.1	320	67.5
	SPA			8.33	161	439	77.8	5.54	123	410	73.5
	SPB			7.407	147	487	101	5.22	117	341	75.5
Fe sources	Fe1			7.09	148	373	73.1	4.92	113	353	65.6
	Fe2			7.91	174	409	90.5	5.03	115	367	65.1

LSD at 0.05% for Fe in straw

Inoculation A	=0.97	B*D	=0.72
FYM B	=0.89	C*D	=1.02
P fert. C	=0.72	A*B*D	=1.02
Fe- source D	=0.51	A*B*C	=1.44
A*B	=1.26	A*C*D	=1.44
A*C	=1.02	B*C*D	=1.44
B*C	=1.02	A*B*C*D	=2.03
A*D	=0.72		

LSD at 0.05% For Mn in straw

Inoculation A	=24.6	B*D	=20.2
FYM B	=22.6	C*D	=28.5
P fert. C	=20.2	A*B*D	=28.5
Fe- source D	=14.2	A*B*C	=40.3
A*B	=31.94	A*C*D	=40.3
A*C	=28.5	B*C*D	=40.3
B*C	=28.5	A*B*C*D	=57.0
A*D	=20.2		

LSD at 0.05% For Zn in straw

Inoculation A	=43.4	B*D	=55.2
FYM B	=40.4	C*D	=78.1
P fert. C	=55.2	A*B*D	=78.1
Fe- source D	=38.9	A*B*C	=110
A*B	=56.9	A*C*D	=110
A*C	=78.1	B*C*D	=110
B*C	=78.1	A*B*C*D	=156
A*D	=55.2		

LSD at 0.05% for Cu in straw

inoculation A	=22.3	B*D	=10.9
FYM B	=9.08	C*D	=15.4
P fert. C	=10.9	A*B*D	=15.4
Fe- source D	=7.66	A*B*C	=21.7
A*B	=12.8	A*C*D	=21.7
A*C	=15.4	B*C*D	=21.7
B*C	=15.4	A*B*C*D	=30.7
A*D	=10.1		

LSD at 0.05% For Fe in grains

Inoculation A	=1.39	B*D	=0.50
FYM B	=0.65	C*D	=0.70
P fert. C	=0.50	A*B*D	=0.70
Fe- source D	=0.35	A*B*C	=0.99
A*B	=0.92	A*C*D	=0.99
A*C	=0.70	B*C*D	=0.99
B*C	=0.70	A*B*C*D	=1.40
A*D	=0.50		

LSD at 0.05% For Mn in grains

Inoculation	=31.4	B*D	=11.5
FYM B	=12.3	C*D	=16.3
P fert. C	=11.5	A*B*D	=16.3
Fe- source D	=8.11	A*B*C	=22.9
A*B	=17.4	A*C*D	=22.9
A*C	=16.3	B*C*D	=22.9
B*C	=16.3	A*B*C*D	=32.5
A*D	=11.5		

LSD at 0.05% for Zn in grains

inoculation A	=39.9	B*D	=45.2
FYM B	=56.2	C*D	=63.9
P fert. C	=45.2	A*B*D	=63.9
Fe- source D	=31.9	A*B*C	=90.5
A*B	=79.4	A*C*D	=90.5
A*C	=63.9	B*C*D	=90.5
B*C	=63.9	A*B*C*D	=127
A*D	=45.2		

LSD at 0.05% For Cu in grains

Inoculation A	=10.9	B*D	=7.98
FYM B	=6.93	C*D	=11.3
P fert. C	=7.98	A*B*D	=11.3
Fe- source D	=5.63	A*B*C	=15.9
A*B	=9.79	A*C*D	=15.9
A*C	=11.3	B*C*D	=15.9
B*C	=11.3	A*B*C*D	=22.6
A*D	=7.98		

Obtained data revealed that values were positively affected by high rate of FYM $15m^3 fed^{-1}$ as compared to $10m^3 fed^{-1}$.

The increases of micronutrients uptake were 26.7% , 28.4% , 53.1% & 32.5% for straw and 30.9% , 75.1% , 39.2 &69.1% for grains for Fe , Mn , Zn & Cu uptake , respectively.

Furthermore, inoculation with *B. megatheriun* increased the micronutrients uptake by wheat plants. These increases ranged between 21.1% to 39.3% for straw along with 18.9% to 40.4 % for grains. (Heggo and Barakah,1993)

Also, Fe sources had affected micronutrients uptake by wheat; Fe-EDTA positively affected all micronutrients uptake as compared to $FeSO_4$. Obtained results are in harmony with Ayed (1970) who reported that interaction of P and Fe led to Fe chlorosis ,which, appeared to be caused by internal immobilization of Fe probably due to formation of Fe phosphate.

With respect to P fertilizer, mean values in Table (7) show that, except for high rates of RP in straw, the application of high rate of P fertilizer (RP or SP) decreased Fe uptake for both straw and grains. Similar trend was obtained with Zn uptake in spite of the application high SP rate increased Zn uptake in straw. Cu uptake had taken an opposite trend which increased as a result of the applied high rates of either SP or RP. Elliott and Lauchli (1985)and Moraghan and Mascagni (1991) reported that the mechanisms of Fe reduction by P application may be the inhibition of Fe absorption by roots and of Fe transport from roots to shoots and inactivation of plant Fe.

Generally, applied $15m^3$ fed^{-1} FYM, inoculation by *B. megatheriun*, applied SP and Fe-EDTA was the best treatments for micronutrients uptake by wheat yield.

Concision

Wheat Plants inoculated with by *B. megatherium* combined with either 15 m^3/ fed FYM and Fe – EDTA ,proved with the full dose of super – phosphate gave higher values of total N , P and K in grains than those provided with the half dose of P – fertilizer . Also, rock phosphate as cheap Source of phosphorus , could substitute superphosphate for wheat fertilization in the presence of phosphate solubizing microorganisms .

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تأثير البكتيريا المذيبة للفوسفات والسماد البلدى ومصادر التسميد بالحديد على تيسر الفوسفور وانعكاس ذلك على انتاجية القمح

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اجريت تجارب حقلية فى موسمين شتويين زراعيين متتالين ٢٠٠٣/٢٠٠٤ ، ٢٠٠٤/٢٠٠٥ تحت ظروف الارض الرملية مع التلقيح ببكتريا *Bacillus megatherium* .تم استخدم مصدرين من الفوسفور (سوبر فوسفات- وصخر الفوسفات بمعدلين (٧٥كجم فو٢ا٥ ، ١٥٠كجم فو٢ا٥) فى تصميم احصائى قطع منشقة مرتين وذلك مع معدلين من السماد البلدى (١٠ م٣/فدان ، ١٥ م٣/فدان)، كما تم رش القطع التجريبية سواء بكبريتات الحديدوز او الحديد المخلبى.

فى مرحلة التزهير اظهرت النتائج ان المحتوى من كلورفيل ا،ب والكاروتين فى اوراق القمح قد زاد عند اضافة ١٥ م٣/فدان من السماد البلدى بالمقارنة باضافة ١٠ م٣/فدان ايضا كان التلقيح ببكتريا *Bacillus megatherium* له تاثير ايجابى على محتوى كلورفيل ا،ب والكاروتين بالمقارنة بالمعاملات الغير الملقحة واشارت النتائج هن اعلى القيم لمحتوى الكلورفيل عند اضافة ١٥ م٣/فدان سماد بلدى مخلوط بالسوبر فوسفات والتلقيح ببكتريا *Bacillus megatherium* والرش الحديد المخلبى.

علاوة على ذلك زادت المادة الجافة للجذور والساق فى مرحلة التزهير عند اضافة ١٥ م٣ من السماد البلدى مخلوط مع السوبر فوسفات بينما تفوق الصخر الفوسفاتىعند اضافته مخلوطا مع١٠ م٣ سمادبلدى والتلقيح ببكتريا *Bacillus megatherium*.

اكدت النتائج ايضا ان اضافة ١٥م٣/ فدان من السماد البلدى ادت الى زيادة امتصاص النتروجين والفوسفور والبوتاسيوم فى كل من الساق والجذر فى مرحلة التزهير لنبات القمح بالمقارنة باضافة ١٠ م٣/فدان سماد بلدى. ولقد اعطى التلقيح ببكتريا *Bacillus megatherium* نفس الا تجاه بالمقارنة بعدم التلقيح. بالنسبة للتسميد الفوسفاتى اوضحت النتائج ان المعدل الاقل من الصخر الفوسفاتى (RPA) كان اكثر تاثيرا فى امتصاص NPK لكل من الساق والجذر وكانت اضافة كبريتات الحديدوز ذات تاثيرا معنويا على امتصاص NPK لكل من الساق والجذر.

اظهرت النتائج ان امتصاص NPK فى مرحلة الحصاد كان مشابها لمرحلة التزهير وذلك لكل من القش والحبوب بالرغم من تفوق المعاملات المضاف اليها الحديد المخلبى بالمقارنة للمعاملات المضاف اليها$FeSO_4$.

من جهة اخرى سجلت القيم المتوسطة للمكونات المحصوليه للقمح زيادة نتيجه اضافة المعدل الاعلى من السماد البلدى وهذه الزيادة وصلت الى ١٤ % ، ١١,٤ % و ٣,٤٧ % لكل من القش والحبوب ووزن ١٠٠٠ حبة على التوالى وكان المعدل الاعلى من كل السوبر فوسفات والصخر الفوسفاتى اكثر كفاءة من المعدل الاقل مع اضافة Fe EDTA- رشا.

اظهرت النتائج ان التفاعل بين المعاملات المتغيرة الى ان اعلى محصول للحبوب تم الحصول عليه عند اضافة ١٥ م٣ من السماد البلدى والتلقيح ببكتيريا *B . megatheriun* و اضافة المعدل الاعلى من السوبر فوسفات واضافة الحديد المخلبى Fe- EDTA رشا.