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Phosphorus Nutrition of Barley Plant as Affected by Zinc, Manganese and Organic Matter Application to Saline Soils

E.A. Abou Hussien, M.M. Shehata, and M.A. El-Sherief*
*Soil Sci. Dept., Fac. of Agric., Minofiya University, and *Soil and Water Res. Inst., Agric. Res. Centre, Giza, Egypt.*

ALLUVIAL saline soil samples were collected from surface layer of El-Kadesia Village; Kafr El-Sheikh Governorate. A pot experiment was carried out in complete randomized blocks design. Pots were treated with superphosphate or bone powder as phosphatic fertilizers at 0,30,60 and 90 ppm P_2O_5. Zn (0,4 and 8ppm), Mn (0,4 and 8ppm) or farmyard manure (FYM) (0,2 and 4%) was added alone or in combination with P-fertilizers. Barley plants were grown as test crop.

Application of P-fertilizers alone or together with either Zn, Mn or FYM resulted in a clear increase of barley dry weight. This increase for plants treated with superphosphate was more than those treated with bone powder. The response of barley plants for added P-depended on the P source, P level and other treatments under study where the high response was obtained in the plants treated with superphosphate at 90ppm P_2O_5 with 4% FYM. The lower response was found in the treatment of bone powder at all added levels. N,P,K,Zn and Mn concentrations and their uptake by barley plants varied according to the experimental treatments.

Keywords: Phosphorus, Zinc, Manganese, Organic matter, Salinity.

Cereals are considered one of the most important crops in many countries of the world. In this respect, barley is one of the most valuable cereals. It is cultivated in almost countries of the world, expect the tropical regions. Barley is a major source of food for large number of people living in the cool and semi-arid regions. Barley grain contents 12.5% moistrure, 11.5% albuminolds, 74%

carbohydrates, 1.3% fat, 3.9% crude fiber and 1.5% ash. Barley thrives in salt affected soils during the phases of the reclamation of these soils.

Phosphorus is very important element to plant growth and plays a key role in metabolic processes such as the conversion of sugar into starch and cellulose (Mengel and Kirkby, 1987). Thompson and Troeh (1979) showed that, P is needed in cell divisions, at formation, transformation of starch, seed germination, synthesis of ucleoproteins and some other vital processes. Haldar and Mandal (1981) and El-Shafie (1994) studied the effect of P and Zn application in different soils on the growth and nutrients uptake of rice and broad bean, they found that application of P and Zn significantly increased the dry matter yield of shoots, grains and roots. Also, Shama (1996) studied the effect of P and Mn application of wheat growth and its uptake of N,P, K, Fe, Mn and Zn.

The present work was carried out to study the response of barley plants (*Hordeum vulgar* L) grown on alluvial saline soil to phosphatic nutrition as affected by P sources, and application rates as alone or in combinations with different rates of Zn, Mn and FYM. Also, the different effects of previous treatments on plant growth and its chemical composition was determined.

Material and Methods

Surface soil samples (0-30 cm) representing an alluvial saline soil were collected from Al-Kadesia Village, Al-Hamoul Region, Kafr Bl-Sheikh Governorate, Egypt. The soil samples were air dried, ground, mixed, sieved through a 2 mm sieve. Physical and chemical properties of this soil and its content of some nutrients were determined according to Jackson (1973) and Cottenie *et al.* (1982). The obtained data were recorded in Table 1 a,b and c.

Plastic pots of 15 cm diameter and 17 cm depth were used in this study. Two kg of soil sample were placed in each pot. The randomized complete blocks design was employed in this study, where three replicates were used for each treatment. Pots were divided to four groups. First group of pots (24) was divided into two subgroups. One subgroup was treated with superphosphate (15.5% P_2O_5) as a mineral P source at,0.30,60 and 90 ppm P_2O_5, while the other subgroup was treated with bone powder (4.22% P_2O_5) as an organic P source at 0,30,60 and 90 ppm P_2O_5. The second group of pots (48) was treated with the previous mentioned treatments of phosphatic fertilizers and $ZnSO_4 7H_2O$ at levels of 0,4 and 8 ppm Zn. The third group (48 pots) was treated with the previously treatments of phosphatic fertilizers and $MnSO_4 7H_20$ at levels of 0,4 and 8 ppm Mn. The fourth group (48 pots) was treated with the previous treatment of phosphatic fertilizers as well as farmyard manure (FYM) at levels of 0,2 and 4%. The chemical analysis for the used FYM was done according to Cottenie *et al* (1982) and the obtained data were recorded in Table 2. All phosphatic fertilizers and FYM treatments were added before cultivation.

All pots were fertilized at the recommended rates of N and K fertilizers. The N was added as $NH_4\,NO_3$ (33,5) N) at a rate of 250 mg $NH_4\,NO_3$ / pot (125 kg / Fed.), while the K was added as K_2SO_4 (48% K_2O) at a rate of 200 mg K_2SO_4 / pot (100 kg/ fed.).

TABLE 1. Physical and chemical characteristics of the studied soil and its content of some nutrients.

a- Physical characteristics

Field capacity (%)	Partical size distribution (%)				Texture grade
	Coarse sand	Fine sand	Silt	Clay	
38.8	10.10	12.20	28.86	48.84	clay

b- Chemical characteristics

EC dSm-1 at 25 °C	pH1:2.5 soil water susp	Total CaCO3 %	O.C %	Soluble ions in saturated soil extract(meq/100 g soil)							
				Cations				Anions			
				Ca^{2+}	Mg^{2+}	Na^+	K^+	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}
13.4	7.34	3.08	0.96	26.5	18.9	63.3	25.3	0.0	1.5	99.4	33.1

c- Macro-and micronutrients

Available macronutriens			Zn and Mn extracted by DTPA	
N(ppm)	P(ppm)	K(ppm)	Mn(ppm)	Zn(ppm)
41.15	4.22	482	2.15	0.28

TABLE 2. The chemical analysis of the used Farm Yard Manure (FYM).

OM %	Total-N %	Total-P %	Total-K %	Zn and Mn extracted by DTPA	
				Mn(ppm)	Zn(ppm)
42.22	2.34	0.52	1.10	0.75	5.75

Each pot was planted with 10 grains of barley, and the water was added at the field capacity of the soil every two days. After 11 days from planting, the seedlings were thinned to 5 plants. All pots were fertilized with the previous rates of N and K after 20 days from planting. The treatments with either Zn or Mn were carried out after 7 days from previous treatments. After 60 days from planting all vegetative organs of plants were harvested at soil surface, washed with distilled water, air dried, oven dried at 70°C until the weights became constant, weighted and ground (0.5g) of dried plant sample was digested with 5 ml of concentrated H_2SO_4 on a hot sandy plate at 270°C. Repeated quantities of $HCLO_4$ were added until the digest was clear. The digest was diluted to 100 ml with distilled water (Cottenie,1980). N,P,K,Zn and Mn were determined in the plant digest according to Cottenie (1980) and Cottenie *et al.* (1982).

Results and Discussion

Dry matter yield

Data recorded in Table 3 show that both phosphatic fertilizers increased dry matter yield of barley plants (g/pot) compared with the control. This may be attributed to the important role of P on the roots growth and proliferation of plants which increase nutrients uptake and also to P role in plant metabolism, which increase nutrients absorption leading to an increase in dry weights (Mengel and Kirkby, 1987). Similar results were obtained by El-Shafie (1994) and Mersal (1996). Results also show that either absolute values of barley plants dry matter or its relative increase (%) obtained with superphosphate were higher than those with bone powder additions at the same level. These increases of plants dry matter are parallel to P and other nutrients availability in the studied fertilizers (Faiyad, 1987). These findings are in harmony with those obtained by Fox *et al.* (1986).

The application of Zn and Mn individually increased dry matter yield of barley plants (Table 3),but the relative increase of dry weight with Zn additions was higher than those with Mn additions at the same levels. The positive effect of Zn on plant growth may be due to its effect as a material component of some enzymes or regulatory for the others, Zn has an essential role in tryptophane synthtase and metabolism (Romheld and Marshchner, 1991). Also the encouraging effect of Mn on plant growth could be explained through its role as an essential component of organize and phosphotransferase (Clarkson and

TABLE 3. Dry matter yield (g/pot) and relative increase (%) of barley plants as affected by different additions of P, Zn, Mn and FYM

P-Source	added P_2O_5ppm	Control		Zn (ppm)				Mean	Mn (ppm)				Mean	FYM (%)				Mean
		0		4		8			4		8			2		4		
		g/pot	R.I	g/pot	R.I	g/pot	R.I		g/pot	R.I	g/pot	R.I		g/pot	R.I	g/pot	R.I	
Control	0	0.855	0	1.065	24.56	1.233	44.21	1.051	1.011	18.25	1.146	34.04	1.004	0.966	12.98	1.110	29.82	0.977
Super phosphate	30	1.215	42.11	1.455	70.18	1.620	89.47	1.430	1.320	54.39	1.365	59.65	1.300	1.263	47.72	1.3411	56.84	1.273
	60	1.416	65.61	1.569	83.51	1.713	100.35	1.567	1.425	66.67	1.476	72.63	1.39	1.350	57.89	1.443	68.77	1.403
	90	1.470	71.93	1.590	85.96	1.845	115.79	1.635	1.535	79.30	1.680	96.49	1.561	1.500	75.44	1.593	86.32	1.521
	Mean	1.239		1.420		1.604			1.322		1.417			1.270		1.372		
Bone powder	30	0.975	14.04	1.119	30.88	1.236	44.56	1.110	1.065	24.56	1.146	34.04	1.026	1.026	20.00	1.134	32.63	1.045
	60	1.056	23.51	1.305	52.63	1.386	62.11	1.249	1.194	39.65	1.260	47.37	1.170	1.170	36.84	1.215	42.11	1.147
	90	1.101	28.77	1.440	68.42	1.530	78.95	1.357	1.305	52.63	1.371	60.35	1.259	1.245	45.61	1.323	54.74	1.223
	Mean	0.997		1.232		1.346			1.144		1.231			1.102		1.196		
L.S.D at 5%		Zn		0.0388					Mn		0.0436			FYM		0.0284		
		P-le		0.0448					p-le		0.0504			P-le		0.0328		
		P-so		0.0317					P-so		0.0356			P-so		0.0232		
		P-le X P-so		0.0634					P-le X P-so		0.0712			P-le X P-so		0.0464		

Hanson, 1980). These results are in agreement with those obtained by Faiyad (1992), El-Shafie (1994) , Mahgoub (1995) and Shama (1996). Results in Table 3 also show that the interaction effect between either Zn or Mn and P on barley dry matter production was positive, where these weights obtained when Zn or Mn applied with P were more than those found with individual additions of Zn,Mn and P at different experimental treatments. It could be remarked that combined effect between both P source and Zn on the dry weight of barley plants was more than those of P and Mn. The absolute values of the dry weight of barley plants treated with superphosphate were higher than those obtained for plants treated with bone powder at the same level of applied Zn,Mn and P. The relative increase (%) of dry weight of barely plants followed the same trend obtained with the dry weights, where this order (with application of superphosphate or bone powder) was Zn + P > Mn + P > P > Zn > Mn. These results agreed with those obtained by Faiyad (1992), El-Shafie (1994), Mahgoub (1995), and Shama (1996).

Data also show that, addition of FYM at a rate of 2 and 4% alone or with P caused markedly increases of dry weight (Table 3) where the relative increase (%) of barley dry weights increased from 12.95% for the treatments of 2% FYM to 86.32% when the slant treated with 4% FYM and 90 ppm P_2O_5 as super phosphate together. These increases can be attributed to the improving effect of organic matter on physical and chemical soil properties and its content of the available nutrients (Mengel and Kirkby, 1987). The obtained dry weights and their relative increases of plants treated with superphosphate and FYM together were higher than those obtained with bone powder and FYM at the same addition levels of P and FYM. These results are in agreement with those obtained by El- Koumey *et al.* (1993 a), Radwan *et al.* (1993) and El-Fiki (1994).

Macronutrients

Data in Table 4 show that N and P concentrations and their uptake along with K uptake (mg/pot) of barley plants grown on alluvial saline soil increased by increasing P applied from 0 to 90 ppm P_2O_5. The relative increase (RI) of N, P and K uptake (%) resulted from superphosphate application which was higher than those obtained with bone powder. This may be due to the effect of phosphatic fertilizers on plant growth and its absorption of nutrients. The superiority effect of superphosphate may be attributed to its solubility, which was more than that of bone powder. The decreases of K- concentration may be

TABLE 4. Effect of P, Zn, Mn and FYM* on N, P and K concentration (%) and uptake (mg/ pot) of barley plants .

P-source	(Added P2O5)ppm	The element	Control			Zn (ppm)						Mn (ppm)						FYM (%)					
						4			8			4			8			2			4		
			%	mg/ pot	R.I*	%	mg/ pot	R.E	%	mg/ pot	R.E	%	mg/ pot	R.E	%	mg/ pot	R.E	%	mg/ pot	R.E	%	mg/ pot	R.E
contro	0	N	1.83	15.7	0.0	1.95	20.8	32.7	2.11	26.0	66.3	1.87	18.9	20.8	2.05	23.5	50.1	2.22	21.5	37.1	2.28	25.3	61.7
		P	0.30	2.6	0.0	0.38	4.1	56.4	0.36	4.4	69.1	0.37	3.7	43.2	0.29	3.3	28.2	0.40	3.9	49.0	0.41	4.6	75.7
		K	1.52	13.0	0.0	1.65	17.6	35.2	1.72	19.7	91.8	1.60	16.2	24.5	1.55	17.8	36.6	1.73	16.7	28.5	1.88	20.9	60.5
Super phosphate	30	N	1.98	24.1	53.7	2.03	29.5	88.8	2.15	34.8	122.6	1.96	25.9	65.3	2.10	28.7	83.2	2.25	28.4	81.6	2.36	31.7	1.22
		P	0.40	4.8	85.3	0.45	6.56	153.3	0.42	6.8	161.4	0.43	5.7	119.3	0.39	5.3	106.2	0.48	6.0	133.2	0.50	6.6	156.4
		K	1.42	12.3	32.7	1.50	22.6	75.3	1.55	24.5	88.2	1.48	19.5	50.3	1.46	19.9	53.3	1.67	21.1	62.2	1.75	23.5	80.5
	60	N	2.05	29.0	85.5	2.08	32.6	108.6	2.21	36.1	13 09	2.08	29.6	89.4	2.16	31.9	103.7	2.27	3.07	95.9	2.40	34.6	121.3
		P	0.46	6.5	151.4	0.52	8.1	212.0	0.59	10.0	286.9	0.49	7.0	168.3	0.46	6.7	159.5	0.51	7.3	181.5	0.56	8.0	210.4
		K	1.28	18.1	39.5	1.40	23.4	79.9	1.49	24.0	84.8	1.37	19.5	50.2	1.32	19.5	49.9	1.54	21.8	67.6	1.63	21.5	80.9
	90	N	2.05	30.1	92.6	2.10	33.4	113.4	2.25	41.5	165.2	2.08	31.9	103.8	2.20	36.6	136.2	2.27	34.1	117.6	2.42	38.6	146.3
		P	0.52	7.6	195.0	0.57	9.1	249.8	0.54	9.9	281.9	0.54	8.3	220.9	0.51	8.6	230.9	0.59	8.9	242.9	0.62	9.8	278.4
		K	1.25	18.4	41.4	1.32	25.9	99.4	1.36	24.4	87.3	1.28	19.6	50.9	1.25	20.0	53.9	1.42	21.3	63.9	1.48	23.6	81.4
Mean		N	1.98	24.7		2.04	29.1		2.18	34.6		2.00	26.5		21.3	35.6		2.23	28.7		2.37	32.8	
		P	0.42	5.4		0.98	6.9		0.48	7.8		0.46	6.2		0.41	6.0		0.50	6.5		0.52	7.3	
		K	1.37	16.7		1.97	22.4		1.53	23.1		1.93	18.7		1.90	19.3		1.59	20.2		1.69	22.9	
Bone powder	30	N	1.87	18.2	16.5	1.94	21.7	38.7	1.99	24.6	57.2	1.90	20.2	29.3	1.90	31.8	39.1	2.10	21.6	3.77	2.15	24.5	56.5
		P	0.33	3.3	25.5	0.37	3.7	44.0	0.35	4.3	66.0	0.36	3.8	46.7	0.33	3.8	47.5	0.37	3.8	46.0	0.38	4.4	66.8
		K	1.50	14.6	12.5	1.58	18.7	43.8	1.67	19.5	50.2	1.55	16.5	27.0	1.50	17.2	32.2	1.67	17.1	31.8	1.80	20.4	57.0
	60	N	1.92	20.3	29.6	2.00	26.1	66.0	2.08	28.6	84.2	1.98	23.6	51.1	2.05	25.8	65.1	2.18	25.5	63.0	2.25	27.3	74.7
		P	0.35	3.7	43.6	0.40	5.2	100.4	0.37	5.1	95.4	0.37	4.4	71.4	0.35	4.4	70.3	0.41	4.7	83.0	0.92	5.1	98.1
		K	1.35	15.3	17.4	1.52	20.6	58.6	1.58	21.1	62.1	1.48	17.7	35.9	1.41	17.8	36.7	1.59	18.6	43.1	1.70	20.7	58.9
	90	N	1.95	21.5	37.2	2.00	28.8	89.0	2.18	33.4	113.1	2.00	26.1	66.8	2.10	28.8	89.0	2.30	28.6	83.1	2.33	30.8	97.0
		P	0.39	4.2	63.7	0.43	6.2	137.8	0.41	6.2	139.2	0.41	5.4	107.7	0.37	5.1	95.8	0.43	5.3	105.8	0.44	5.8	122.4
		K	1.29	15.7	20.8	1.38	20.5	57.3	1.43	21.1	62.4	1.36	17.8	36.5	1.32	18.1	39.2	1.43	17.8	36.9	1.55	20.5	57.8
Mean		N	1.89	18.9		1.97	24.4		2.09	28.2		1.94	22.1		2.03	27.5		22.0	24.3		2.26	27.2	
		P	0.34	3.5		0.40	4.8		0.37	5.0		0.38	4.3		0.34	4.2		0.40	4.4		0.91	4.9	
		K	1.42	14.7		1.53	19.3		1.60	20.4		1.49	17.0		1.44	17.7		1.60	17.6		1.73	20.6	

* : Farm Yard Manure ** : Relative Increase (%).

due to the antagonism between P and K absorption by plants.These results are in agreement with those obtained by El-Koumey *et al.* (1993), El-Shafie (1994), Mersal (1996) and Shama (1996).

Results in Table 4 also show that N,P and K concentrations and their uptake (mg/pot) by barley plants increased by increasing Zn application from 4 to 8 ppm alone or combined with phosphatic fertilizers. The relative increase (RI) of N,P and K uptake by barley plants treated with Zn alone was lower than those treated with Zn and P together. Also barley plants fertilized by superphosphate gave high relative increase of N,P and K uptake compared to those treated with bone powder. These results are in agreement with those obtained by Hemantarajan and Garge (1984), Sayed *et al.* (1984), El-Shafie (1994) and Mahgoub (1995). In addition, the presented data in Table 4 show that, both N and P concentrations, uptake of barley plants and their relative increase (RI) were increased by increasing applied Mn alone or with phosphatic fertilizers. This increase was very clear when Mn was added with P. The relative increase of N or P uptake by plants treated with superphosphate was more than those obtained by plants treated with bone powder at the same added levels of P and Mn. Application of Mn alone at 4 ppm slightly increased K concentration (%), but slightly decreased when Mn was added at 8 ppm. On the other hand, addition of Mn caused a marked increase in K uptake (mg/pot) by barley plants compared to untreated plants. K uptake and its relative increase markedly increased when P was applied with Mn together. This increase was very clear when barley plants were treated with superphosphate compared with those treated with bone powder. The effect of micronutrients on N,P and K content of barley plants can be discussed on the basis of the effect of these nutrients on the plant growth and their effective roles in different enzymatic funetions. Also, the addition of micronutrients (Zn and Mn) makes the plants grow well, consequently the absorbing efficiency of plants increases (Mengel and Kirkby, 1987). Similar results were obtained by Faiyad (1992), El-Shafie (1994), Mahgoub (1995) and Shama (1996).

Application of FYM either alone (2 and 4%) or in combination with phosphatic fertilizers resulted in a marked increase in N,P and K- concentrations (%), and uptake (mg/pot) as well as their relative increase (RI) of barley plants in all experimental treatments (Table 4). These increases for barley plants treated with superphosphate were greater compared with those for plants treated with bone powder at every experimental treatment. This may be due to relatively high availability of N,P and K in the added FYM and improving soil properties as affected by organic matter addition. These results are in agreement with those obtained by Abdel-Latif and Abdel-Fattah (1983), Radwan *et al.* (1993) and El-Fiki (1994).

Micronutrients

Data show that phosphorus application alone increased Zn uptake (ug/pot) by plants up to 30 ppm P_2O_5 (Table 5) then Zn uptake gradually decreased with increasing P addition. Also P application generally decreased Zn concentration in plants (ppm) compared with the untreated plants but the values of Zn concentration obtained for plants treated with superphosphate were lower than those obtained with bone powder at all levels of P. On the other hand, values of Zn uptake and its relative increase were relatively higher with superphosphate than those obtained with bone powder. This may be due to deposits caused by reactions between P and Zn and also, the decreases in the rate of transloction of Zn from roots (Abdel-Aziz *et al.*, 1982). Similar results were obtained by Megalah *et al.* (1993) and El-Shafie (1994) .

Of course, Zn application alone (4 and 8 ppm Zn) resulted in an increase for both Zn concentration (ppm) and its uptake (ug/pot) by barley plants grown on alluvial saline soil. On the other hand, application of P and Zn together at different levels resulted in a marked decrease in Zn concentration (ppm), Zn uptake (ug/pot) and its relative increase (RI %) of barley plants compared to plants treated with Zn alone. Also the same data show that, increasing the level of applied Mn from 4 to 8 ppm either alone or in combination with phosphatic fertilizers resulted in a relative decrease of Zn concentration compared with the control. In contrast, Zn uptake and its relative increase for barley plants were relatively higher than those untreated plants, but both Zn uptake and its relative increase decreased with increasing Mn addition from 4 to 8 ppm either alone or in combination with P. This may be due to antagonism between cations or deposits caused by reactions with anions which caused less available Zn in soil. These results are in agreement with those obtained by Faiyad (1992) and Shama (1996).

Data in Table 5 show that, the application of Mn individually resulted in an increase of Mn concentration (ppm), Mn uptake (ug/pot) and its relative inerease (%) for barley plants grown on alluvial saline soil. Application of P and Mn together resulted in a gradual decrease of Mn concentration with increasing the applied P levels at all rates of Mn addition. Mn uptake and its relative increase of barley plants increased with increasing Mn application at all levels of P. Also, Mn uptake and its relative increase obtained with superphosphate were more

TABLE 5. Effect of P, Zn, Mn and FYM* on Zn and Mn concentrations (ppm) and uptake (ug/pot) by barley plants .

P-source	(Added P2O5)ppm	The element	Control			Zn (ppm)						Mn (ppm)						FYM (%)					
						4			8			4			8			2			4		
			ppm	ug/pot	R.I*	ppm	ug/pot	R.I	ppm	ug/pot	R.I	ppm	ug/pot	R.I	ppm	ug/pot	R.I	ppm	ug/pot	R.I	ppm	ug/pot	R.I
Super phosphate	0	Zn	21.6	18.5	0.0	26.3	28.0	52.0	31.5	38.8	110.7	21.0	21.2	15.3	18.1	20.8	12.8	24.3	23.5	27.2	79.5	32.8	77.7
		Mn	55.5	47.5	0.0	67.2	71.6	50.8	62.1	77.7	63.8	74.5	75.3	58.7	81.7	93.6	97.3	70.2	67.8	42.9	74.5	82.7	74.3
	30	Zn	18.1	22.0	19.3	22.7	33.0	78.8	26.3	42.6	131.2	15.1	20.0	8.3	13.7	18.7	-1.5	22.0	27.8	50.8	25.1	31.7	82.9
		Mn	60.1	73.0	53.9	65.6	45.5	101.2	58.2	94.3	98.7	71.3	94.1	98.4	78.2	106.7	125.0	63.4	86.6	82.1	69.8	43.6	97.3
	60	Zn	11.6	16.5	10.7	17.7	27.7	50.7	24.3	41.7	126.4	9.1	13.0	-29.7	7.7	11.4	-18.2	15.5	21.0	13.6	19.2	27.8	51.0
		Mn	57.8	81.8	72.5	59.8	93.8	97.7	56.8	97.5	105.4	69.2	98.6	107.8	76.2	112.5	137.0	53.5	85.7	80.7	67.1	96.8	104.1
	90	Zn	8.2	12.0	-34.8	12.7	20.1	9.1	18.7	34.5	87.2	6.6	10.1	-44.9	5.11	8.6	-53.5	11.9	17.8	-3.6	16.1	25.6	38.7
		Mn	42.3	82.2	31.0	52.5	83.5	75.9	41.8	77.1	62.5	64.3	98.6	107.7	68.1	114.4	141.1	60.0	90.0	89.7	63.5	101.2	113.2
Mean		Zn	14.9	17.2		19.8	27.2		25.2	39.4		13.0	16.1		11.2	14.9		18.4	22.5		22.5	30.0	
		Mn	53.9	66.4		63.5	86.1		55.0	86.7		69.8	92.0		76.1	106.8		65.5	83.5		68.8	93.6	
Bone powder	30	Zn	20.1	19.6	6.4	25.1	28.1	52.4	29.8	36.9	100.1	18.5	19.7	6.9	16.0	18.4	-0.4	24.1	29.7	34.2	28.7	32.6	76.7
		Mn	63.2	61.6	29.9	66.6	74.5	57.1	60.5	74.8	57.6	73.0	77.8	63.9	80.1	91.8	93.5	69.5	71.3	50.3	73.2	33.0	74.9
	60	Zn	14.2	14.9	-18.9	19.5	25.5	38.1	27.1	37.7	104.0	12.1	14.4	21.9	10.2	12.9	-30.1	18.1	21.2	15.0	25.0	30.4	60.0
		Mn	60.7	64.1	35.1	65.5	85.5	80.2	58.0	80.4	69.4	71.8	76.5	61.2	77.3	97.4	105.3	66.4	77.7	63.7	71.9	87.4	84.1
	90	Zn	10.1	11.4	-38.4	14.9	21.9	16.0	23.3	35.5	93.0	9.3	12.2	-34.1	7.0	9.6	-47.9	12.3	15.3	-17.3	20.1	26.6	44.3
		Mn	44.1	48.6	23.2	57.3	82.5	73.9	48.4	74.1	56.1	72.2	99.2	98.6	75.5	103.5	118.2	61.9	77.1	62.4	69.1	91.4	92.7
Mean		Zn	16.5	16.1		21.4	25.7		27.9	35.4		15.2	16.9		12.8	13.0		19.7	21.2		25.8	30.6	
		Mn	55.9	55.4		64.2	78.5		57.5	76.7		72.9	80.9		78.7	96.6		67.0	73.5		72.2	92.7	

* : Farm Yard Manure ** : Relative Increase (%).

than those obtained with bone powder. On the other hand Mn concentration of barley plants treated with bone powder was more than that treated with superphosphate. This may be due to the different effects of the used P fertilizers on dry matter yield and on Mn availability in soil and its translocation through different parts of plant (Mengel and Kirkby, 1987 and Megalah *et al.*, 1993).These results are in harmony with those obtained by Faiyad (1992), Mahgoub (1995) and Shama (1996).

Zinc application alone at low level (4 ppm) resulted in an increase of Mn concentration (ppm) of barley plants compared to the control (Table 5), but slightly decreased with increasing rate of applied Zn from 4 to 8 ppm. Also, Zn application alone resulted in an increase of Mn uptake by barley plants compared with the untreated plants. Data also show that P and Zn application together, generally caused a gradual decrease in Mn concentration with increasing both Zn application from 4 to 8 ppm and P from 30 to 90 ppm P_2O_5. Mn uptake by plants increased with increasing of added Zn compared with the control. The obtained values of Mn uptake with superphosphate application were relatively higher than those obtained with bone powder at all treatments under study. These findings are in agreement with those obtained by Mahgoub (1995) and Hassan (1996).

Also, data in Table 5 show that application of FYM alone caused a marked increase in concentration (ppm) and uptake of both Zn and Mn by barley plants compared with the untreated plants. Data also show that, the combination of FYM and P resulted in an increase of both Zn and Mn concentrations with increasing FYM addition, but gradually decreased with increasing P levels. Both Zn and Mn uptake and their relative increases increased with increasing both FYM and added P. These results were obtained with either superphosphate or bone powder application, but the values of Zn and Mn uptake and their relative increase obtained with superphosphate were higher than those obtained with bone powder at all treatments under study. This trend resulted from the role of organic matter and its humic acids production in promoting the uptake of Zn and Mn by higher plants (Nour El-Dein, 1996). These results are in agreement with those obtained by Faiyad (1987), Megalab *et al.* (1993) and El-Fiki (1994) .

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التغذية الفوسفورية لنبات الشعير وتأثرها بإضافة الزنك والمنجنيز والمادة العضوية للأرض الملحية

الحسيني عبد الغفار أبو حسين ، محمد مصطفى شماته و محمد عباس الشريف *

قسم علوم الأراضي - كلية الزراعة - جامعة المنوفية و * معهد بحوث الأراضي والمياه والبيئة - مركز البحوث الزراعية - الجيزة - مصر .

أحضرت عينات أرض رسوبية ملحية من الطبقة السطحية من قرية القاديسية محافظة كفر الشيخ لاستخدامها فى إجراء تجربة أصص فى تصميم قطع كاملة العشوائية حيث عوملت الأصص بأى من السوبر فوسفات أو مسحوق العظام عند معدلات صفر و ٣٠ و ٦٠ و ٩٠ جزء فى المليون فو٢أ٥ وكذلك فقد تم إضافة الزنك (صفر ٤ و ٨ جزء فى المليون) والمنجنيز (صفر ، ٤ ، ٨ جزء فى المليون) أو سماد المزرعة (صفر ، ٢ ، ٤ ٪) على حدة أو مع الأسمدة الفوسفاتية وقد استخدم نبات الشعير كنبات إرشادي .

لقد نتج عقب إضافة الأسمدة الفوسفاتية على حدة أو مع أي من الزنك أو المنجنيز أو سماد المزرعة زيادة واضحة فى محصول المادة الجافة لنباتات الشعير وكانت الزيادة أكثر وضوحا فى النباتات المعاملة بالسوبر فوسفات عن تلك المعاملة بمسحوق العظام ولقد ارتبطت استجابة نباتات الشعير للأسمدة الفوسفاتية بمصدر الفوسفور ومستوي الفوسفور المضاف والمعاملات الأخرى تحت الدراسة حيث تم الحصول على أعلى استجابة مع السوبر فوسفات عند ٩٠ جزء فى المليون فو٢أ٥ مع ٤٪ سماد مزرعة أما أقل إستجابة فكانت مع مختلف مستويات الإضافة لمسحوق العظام . ولقد اختلفت تركيزات كل من النيتروجين والفوسفور والبوتاسيوم والزنك والمنجنيز وكذلك الممتص منها بواسطة نباتات الشعير طبقا للمعاملات التجريبية .