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EFFECT OF ORGANIC MANURE ENRICHED WITH MACRO AND MICRONUTRIENTS:
II. NUTRIENTS UPTAKE BY WHEAT AND THEIR AVAILABILITY IN SAND SOIL

Ali, M.E.*;S.A.IsmailO.H.M.El-Hussieny*and A.M.Abd El-Hafeez****

* Dept. of Soils, Fac. of Agric. Benha, Univ.

** Soil, Water and Environment Res. Inst., A.R.C., Egypt.

ABSTRACT

Two field experiments were performed at Village No. 1, west of Samallote, Minia Governorate, Egypt during 2004/2005 and 2005/2006 seasons to study the effect of four levels of farmyard manure (0, 10, 20 and 30 ton/fed); NPK fertilization doses, (i.e. 0, low (60/15/24) and high (120/30/48) kg of N, P_2O_5 and K_2O/fed) and the micronutrients (Fe, Mn, Zn and Cu) which were applied, soil application or as foliar spraying on N, P, K, Fe, Mn, Zn and Cu uptake by wheat plants (Sids 1 cv) grown on a sandy soil and their availability in soil. The results could be summarized as follows;

Uptake of N, P, K, Fe, Mn, Zn and Cu by wheat plants significantly increased with increasing rate of the applied FYM and NPK, as well as the micronutrients application, where foliar spraying surpassed soil application in both seasons.

The soil availability of N, P and K responded to manuring only. However, phosphorus only significantly increased by increasing NPK fertilization.

Soil available contents of Fe, Mn, Zn and Cu were significantly affected by manuring and micronutrients as soil application, while foliar spray did not affect contents of these micronutrient in both seasons.

It could be concluded that wheat under sand soils should be fertilized with 30 ton FYM/fed; NPK at rate of 120 kg N, 30 kg P_2O_5 and 48 kg K_2O/fed. Also, the micronutrients should be applied to improve both nutrients uptake by wheat plants and their availability in soil.

Keywords: wheat, sand soils, farmyard manure, nutrients uptake, nutrients availability.

INTRODUCTION

It is well known in Egypt that the expansion in wheat cultivation in sand soils is the best solution for curtailing the gab between consumption and production of wheat. However, production of wheat in the sand soils is facing many problems, among them the low clay and organic matter contents and hence the poor soil fertility.

Improving the poor physical, chemical and nutritional properties of these soils are a compacted problem that requires enormous efforts. Using organic manure has been proved to be of vital importance in this concern. Atta Allah and Mohamed (2003), Salem (2003) and Khalil and Aly (2004) reported that N, P and K uptake significantly increased with adding organic manure to wheat plants. Also, El-Koumey (1998) and Mekail *et al.* (2006) stated that organic manure fertilization increased nutrients uptake. On the other hand, soil available nutrients were markedly affected by soil manuring (Negm *et al.*, 2002, El-Ghamry *et al.*, 2005, Ali, Maha, 2007 and Taha, 2007).

Inorganic fertilizes are considered an important source for nutrients in soil where very few soils are able to supply sufficient quantities of all the nutrients. Many workers stated that N, P and K uptake by wheat plants were significantly affected by increasing N, P and K levels (El-Leithi *et al.*, 1996 and Galal, 2007).

Micronutrients application is now a days of considered importance in soils of Egypt, especially the sandy ones where an adequate nutrients supply can be anticipated in the newly reclaimed sandy soils. Macronutrients as well as micronutrients are constantly removed with the harvest of high yielding varieties which require high doses of NPK and substantial quantities of micronutrients. On the other hand, the efficiencies of micronutrients are mainly dependent on the method of application. The alternative approaches for the application of micronutrients includes: soil and foliar application. The positive effect of micronutrients on nutrient uptake were reported by Badr *et a.l* (1991), Mohamed (1994) and Galal (2007). However, the superiority of foliar spray than soil application for improving nutrients uptake was mentioned by Shams El-Din (1993).

The objective of the present investigation was to study the influence of different levels of FYM and NPK fertilization as well as methods of micronutrients application on nutrients uptake by wheat plant and nutrients availability in sandy soil.

MATERIALS AND METHODS

Two field experiments were performed at Village No. 1, west of Samallote, Minia Goveronorate, Egypt (newly reclaimed sand soils) during the winter seasons of 2004/2005 and 2005/2006, to study the response of wheat (*Triticum aestivim* L.), Sids 1 cv to four levels of FYM (0, 10, 20 and 30 ton/fed), three doses of NPK fertilization, i.e. without NPK, low (60/15/24) and high (120/30/48) kg doses N, P_2O_5 and K_2O/fed, respectively. Some micronutrients (Fe, Mn, Zn and Cu) were applied as soil or foliar application. The soil physical and chemical properties of the experimental field were determined as described by Klute (1982) and Page *et al.* (1982) (Table, 1).

Farmyard manure (A) was applied before planting and its chemical compositions within the first and second seasons are shown in Table (2). Nitrogen fertilizer (B) was added as ammonium nitrate (33.5% N) at six equal doses, the first was applied before the first irrigation and the others were added before every irrigation. Phosphorus and potassium were added before planting as mono calcium phosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O), respectively. The micronutrients (C) were added as soil application (10 kg Fe, Mn or Zn sulphate/fed and 5 kg Cu sulphate/fed) before planting whereas foliar spraying was conducted twice, at 45 and 60 days from planting with volume of 400 L/fed, each liter contain 3 g of Fe, Mn or Zn or 1 g Cu sulphate (about 0.6, 1.0, 0.7 and 0.25 g Fe, Mn, Zn and Cu, respectively). Normal agronomic practices were conducted as usual for wheat production in studied regain.

Table (1): Some physical and chemical properties of the studied soil before planting of wheat in the two growing seasons.

Soil properties	Season	
	First season	Second season
Particle size distribution%		
Clay (%)	10.94	11.84
Silt (%)	12.75	9.35
Sand (%)	76.31	78.81
Texture grade	Sandy loam	Sandy loam
Chemical properties		
pH*	8.00	7.98
EC (dS m^{-1})**	1.60	1.65
Organic matter (%)	0.85	0.78
Ca CO_3 (%)	4.20	3.94
Soluble Ca^{2+} m mol L^{-1}***	5.62	5.67
Soluble Mg^{2+} m mol L^{-1}	5.21	5.42
Soluble Na^{+} m mol L^{-1}	2.57	2.90
Soluble K^{+} m mol L^{-1}	2.16	2.58
Soluble CO_3^{2-} m mol L^{-1}	0.00	0.00
Soluble HCO_3^{-} m mol L^{-1}	1.95	2.29
Soluble Cl^{-} m mol L^{-1}	6.89	7.29
Soluble SO_4^{2-} m mol L^{-1}	6.72	6.99
Available N (ug/g)	2.33	2.95
Available P (ug/g)	6.12	8.01
Available K (ug/g)	7.35	9.62
Available Fe (ug/g)	2.39	2.13
Available Mn (ug/g)	1.36	1.12
Available Zn (ug/g)	0.88	0.78
Available Cu (ug/g)	0.42	0.43

* Measured in 1:2.5 soil water suspension.
** Measured in soil paste.
*** Measured in soil paste.

Table (2): Chemical composition of F.Y.M.

Properties	1st Season	2nd Season
Organic matter %	28.50	25.60
Total N%	1.68	1.42
C/N ratio	1:17	1:18
Total N %	0.62	0.56
Total P %	0.19	0.18
Total K %	0.71	0.66
Available Fe (ug/g)	5.2	6.7
Available Mn (ug/g)	3.1	4.6
Available Zn (ug/g)	1.8	2.0
Available Cu (ug/g)	0.9	0.6

At harvest the plots were hand-harvested and plant samples were taken from grains and straw to determine nutrient concentrations according to Jackson (1973), then total nutrients uptake were calculated.

The available soil N, P, K, Fe, Mn, Zn and Cu were determined according to Klute (1982). The data were subjected to statistical analysis according to Sendecor and Cochran (1980). The treatment means were compared by L.S.D. at 5% level of probability.

RESULTS AND DISCUSSION

Nutrients uptake:

The results tabulated in Tables (3-9) showed the effect of manuring and NPK fertilization as well as different methods of micronutrients application on N, P, K, Fe, Mn, Zn and Cu uptake by wheat plants. It is evident that nutrients uptake significantly increased due to FYM application in both seasons. The highest values of the studied nutrients uptake were achieved when wheat plants received 30 ton/fed followed by those supplied with 20 and 10 ton/fed, respectively while the plants without manuring recorded the lowest values of nutrients uptake. This could be due to the decomposition of FYM which resulted in chelated compounds enhanced the availability and uptake of the micronutrients. In addition, FYM contains sufficient amounts of most plant nutrients which were released in available forms upon its decomposition. Similar results were obtained by El-Koumey (1998) and Mekail *et al.* (2006).

Table (3): Nitrogen uptake (kg/fed) as affected by organic manure, NPK fertilization treatments and methods of application of the micronutrients.

Rate of applied O.M (A) ton/fed	Rate of $N/P_2O_5/K_2O$ application (kg/fed) (B)	Micronutrients (C)							
		First season				Second season			
		Control 0.0	Soil appli.	Foliar appli.	Mean	Control 0.0	Soil appli.	Foliar appli.	Mean
0.0	0.0	15.49	16.58	19.03	17.03	13.32	13.28	15.57	14.06
	60/15/24	21.04	22.73	23.76	22.51	18.55	18.85	19.94	19.12
	120/30/48	36.10	37.84	39.51	37.82	28.52	31.46	32.27	30.75
Mean		24.21	25.72	27.43	25.79	20.13	21.20	22.59	21.31
10	0.0	25.67	26.57	30.15	27.46	21.51	22.09	24.13	22.57
	60/15/24	33.08	33.18	33.57	33.27	27.09	28.32	28.61	28.01
	120/30/48	47.83	48.61	49.87	48.77	34.91	35.14	37.08	35.71
Mean		35.52	36.12	37.86	36.49	27.83	28.52	29.94	28.76
20	0.0	35.09	35.65	37.86	36.20	31.81	33.09	33.86	32.92
	60/15/24	40.39	42.62	44.45	42.49	35.87	37.19	39.08	37.38
	120/30/48	50.78	51.40	54.97	52.38	43.52	44.28	45.76	44.52
Mean		42.08	43.22	45.76	43.69	37.07	38.19	39.57	38.28
30	0.0	34.93	36.56	37.90	36.46	41.74	43.88	43.09	42.90
	60/15/24	44.82	45.91	45.94	45.55	45.83	46.36	47.32	46.50
	120/30/48	57.29	58.66	61.35	59.10	53.77	54.80	55.43	54.67
Mean		45.68	47.04	48.40	47.04	47.11	48.35	48.61	48.02
Mean of NPK	0.0	28.00	28.84	31.23	29.36	27.10	28.09	29.16	28.12
	60/15/24	34.83	36.11	36.93	35.96	31.83	32.68	33.73	32.75
	120/30/48	48.00	48.13	51.42	49.52	40.18	41.42	42.63	41.41
Mean of micronutrients		36.87	38.02	39.86		33.04	34.07	35.18	

L.S.D at 0.05	First season							Second season						
	A	B	C	AB	AC	BC	ABC	A	B	C	AB	AC	BC	ABC
	0.57	0.46	0.30	0.91	N.S	N.S	1.28	0.80	0.50	0.34	1.02	N.S	N.S	1.35

Table (4): Phosphorus uptake (kg/fed) as affected by organic manure, NPK fertilization treatments and methods of application of the micronutrients.

Rate of applied O.M (A) ton/fed	Rate of $N/P_2O_5/K_2O$ application (kg/fed) (B)	Micronutrients (C)							
		First season				Second season			
		Control 0.0	Soil appli.	Foliar appli.	Mean	Control 0.0	Soil appli.	Foliar appli.	Mean
0.0	0.0	5.64	6.13	6.50	6.09	4.55	4.60	5.76	4.97
	60/15/24	7.02	7.43	7.49	7.31	6.36	6.41	7.06	6.61
	120/30/48	11.01	11.28	11.53	11.27	8.51	9.77	9.97	9.42
Mean		7.89	8.28	8.50	8.22	6.47	6.96	7.59	7.00
10	0.0	9.04	9.07	10.34	9.48	7.12	7.50	7.99	7.54
	60/15/24	10.50	11.20	11.11	10.93	8.33	8.90	9.38	8.87
	120/30/48	13.95	15.00	15.79	14.91	10.29	10.38	10.59	10.42
Mean		11.16	11.76	12.41	11.78	8.58	8.89	9.32	8.94
20	0.0	12.06	12.13	12.63	12.27	10.20	11.07	11.66	10.98
	60/15/24	12.71	13.93	14.06	13.56	11.06	11.79	12.12	11.65
	120/30/48	15.00	15.47	16.87	15.78	12.06	12.74	13.26	12.69
Mean		13.26	13.84	14.52	13.87	11.10	11.87	12.35	11.77
30	0.0	13.47	14.22	14.29	13.99	12.98	13.35	13.60	13.31
	60/15/24	13.92	14.64	15.06	14.54	13.36	13.84	14.83	14.02
	120/30/48	16.33	17.38	17.74	17.15	14.30	14.74	14.62	14.55
Mean		14.57	15.41	15.70	15.22	13.55	13.98	14.35	13.96
Mean of NPK	0.0	10.05	10.39	10.94	10.46	8.71	9.13	9.75	9.20
	60/15/24	11.04	11.80	11.93	11.59	9.78	10.23	10.85	10.28
	120/30/48	14.07	14.78	15.48	14.78	11.29	11.91	12.11	11.77
Mean of micronutrients		11.72	12.32	12.78		9.99	10.42	10.87	

L.S.D at 0.05	First season							Second season						
	A	B	C	AB	AC	BC	ABC	A	B	C	AB	AC	BC	ABC
	0.08	0.15	0.12	0.37	N.S	0.27	0.54	0.24	0.17	0.16	0.37	N.S	0.30	0.63

As for NPK fertilization, the data at the same Tables revealed that N, P, K, Fe, Mn, Zn and Cu uptake by wheat plants were significantly affected by the level of N, P and K fertilization. The maximum nutrients uptake were obtained with the highest doses of NPK fertilization, i.e. 120/30/48 kg N, P_2O_5 and K_2O/fed, while the wheat plants without NPK application recorded the lowest uptake ones. Such increases in uptake values of all the nutritive elements, is mainly due to N, P and K are considered the most important nutrients for plants. Consequently, their application increased both grains and straw yields, which in turn increased nutrients uptake since nutrient uptake is calculated as multiplying nutrient concentration by grain and straw yields. The results are in line with those obtained by El-Leithi *et al.* (1996) and Galal (2007).

Table (5): Potassium uptake (kg/ed) as affected by organic manure, NPK fertilization treatments and methods of application of the micronutrients.

Rate of applied O.M (A) ton/fed	Rate of $N/P_2O_5/K_2O$ application (kg/fed) (B)	Micronutrients (C)							
		First season				Second season			
		Control 0.0	Soil appli.	Foliar appli.	Mean	Control 0.0	Soil appli.	Foliar appli.	Mean
0.0	0.0	27.92	30.48	33.09	30.50	24.93	25.86	27.12	25.97
	60/15/24	41.55	45.71	47.40	44.89	35.87	37.45	38.77	37.36
	120/30/48	65.33	72.46	73.71	70.50	45.37	47.98	48.39	47.25
Mean		44.93	49.55	51.40	48.62	35.39	37.10	38.10	36.86
10	0.0	45.38	46.25	48.51	46.72	38.39	38.93	40.22	39.18
	60/15/24	52.94	54.89	58.80	55.04	46.09	47.49	47.74	47.11
	120/30/48	78.53	79.91	84.05	80.83	54.61	55.83	57.10	55.85
Mean		58.95	60.35	63.79	61.03	46.36	47.42	48.35	47.38
20	0.0	44.28	49.65	56.57	50.17	48.39	50.71	51.67	50.26
	60/15/24	63.29	67.03	68.19	66.17	56.09	57.84	58.15	57.36
	120/30/48	76.09	80.89	85.36	80.78	62.18	64.54	71.89	66.21
Mean		61.22	65.85	70.04	65.70	55.55	57.70	60.57	57.94
30	0.0	54.76	60.65	62.23	59.21	56.99	59.39	59.94	58.77
	60/15/24	63.43	68.98	70.39	67.00	66.33	67.11	68.39	67.27
	120/30/48	78.17	88.38	89.39	85.31	73.35	73.66	74.37	73.79
Mean		65.32	72.67	74.00	70.66	65.55	66.72	67.57	66.61
Mean of NPK	0.0	43.08	46.75	50.10	46.64	42.18	43.72	43.99	43.29
	60/15/24	55.30	59.15	61.19	58.54	51.09	52.47	53.26	52.28
	120/30/48	74.53	79.91	82.63	79.02	58.88	60.50	62.94	60.77
Mean of micronutrients		57.61	61.94	64.64		50.71	52.24	53.42	

L.S.D at 0.05	First season							Second season						
	A	B	C	AB	AC	BC	ABC	A	B	C	AB	AC	BC	ABC
	2.10	1.77	1.20	3.60	N.S	N.S	4.75	0.69	1.19	0.60	2.43	N.S	N.S	2.58

As regard to micronutrients, the data obtained clearly showed that nutrients uptake values were significantly affected by micronutrients application. It is worthy to notice that micronutrients application as foliar spray resulted in nutrient uptake values higher than the soil application method. Mohamed (1994) mentioned that foliar application of micronutrients was more effective specially under the Egyptian condition, where these nutrients are converted to unavailable forms if they applied to the soil. These results are in good agreement with those obtained by Shams El-Din (1993).

Concerning the interaction, data, in general showed that the highest values of N, P, K, Fe, Mu, Zn and Cu uptake by wheat plants were recorded for the plants sprayed with micronutrients under 30 ton FYM/fed and 120/30/48 kg N, P_2O_5 and K_2O/fed. The plants without manuring or micronutrients on the other hand, recorded the lowest values of the studied nutrient uptake.

Table (6): Iron uptake (g/fed) as affected by organic manure, NPK fertilization treatments and methods of application of the micronutrients.

Rate of applied O.M (A) ton/fed	Rate of $N/P_2O_5/K_2O$ application (kg/fed) (B)	Micronutrients (C)							
		First season				Second season			
		Control 0.0	Soil appli.	Foliar appli.	Mean	Control 0.0	Soil appli.	Foliar appli.	Mean
0.0	0.0	1774.33	2264.15	2747.85	2262.11	1458.25	1707.76	2153.43	1773.15
	60/15/24	2403.22	3137.08	3574.23	3038.17	1871.45	2173.38	2616.57	2220.47
	120/30/48	3631.20	4699.77	4700.30	4343.75	2371.66	2844.54	3275.57	2830.59
Mean		2602.91	3367.00	3674.13	3259.12	1900.45	2241.89	2681.85	2274.73
10	0.0	2734.93	3194.13	3738.10	3222.39	2351.78	2702.30	3178.94	2744.34
	60/15/24	3168.55	3751.62	4179.85	3700.09	2431.82	2996.64	3403.79	2944.08
	120/30/48	3582.74	5382.73	4762.80	4276.09	2704.27	3463.02	3719.68	3295.65
Mean		3162.07	4109.49	4226.91	3855.04	2495.95	3053.98	3434.13	2994.69
20	0.0	3082.05	3247.29	3793.31	3374.22	2894.20	3461.85	3722.95	3359.67
	60/15/24	3252.53	3781.85	4462.08	3832.15	3028.23	3605.47	4024.55	3552.75
	120/30/48	3633.40	5471.55	5923.83	5009.59	3052.10	3825.59	4351.08	3742.92
Mean		3322.66	4166.90	4726.41	3905.32	2991.51	3630.97	4032.86	3551.78
30	0.0	3679.29	4202.49	4754.93	4212.24	3298.26	4026.83	4457.13	3927.41
	60/15/24	3869.02	4218.73	5074.31	4387.36	3500.47	4064.08	4562.04	4042.19
	120/30/48	4243.65	5499.53	6017.29	5253.49	3606.06	4213.64	4723.06	4180.90
Mean		3930.65	4640.25	5282.18	4617.70	3468.26	4101.52	4580.74	4050.17
Mean of NPK	0.0	2817.65	3352.01	3758.33	3309.33	2500.65	2974.68	3428.11	2967.81
	60/15/24	3173.33	3722.32	4322.62	3739.42	2707.99	3209.89	3653.73	3190.54
	120/30/48	3822.74	5263.39	6369.56	5151.89	2933.52	3586.57	4017.34	3512.48
Mean of micronutrients		3271.24	4070.91	4477.41		2714.05	3257.09	3699.06	

L.S.D at 0.05	First season							Second season						
	A	B	C	AB	AC	BC	ABC	A	B	C	AB	AC	BC	ABC
	49.55	49.79	43.93	99.87	88.50	88.29	175.20	33.80	22.73	28.70	46.71	57.97	58.71	110.53

Table (7): Manganese uptake (g/fed) as affected by organic manure, NPK. fertilization treatments and methods of application of the micronutrients.

Rate of applied O.M (A) ton/fed	Rate of $N/P_2O_5/K_2O$ application (kg/fed) (B)	Micronutrients (C)							
		First season				Second season			
		Control 0.0	Soil appli.	Foliar appli.	Mean	Control 0.0	Soil appli.	Foliar appli.	Mean
0.0	0.0	604.92	777.49	966.41	782.94	500.12	628.47	823.03	650.54
	60/15/24	764.20	991.89	1159.88	971.99	665.29	842.96	974.83	827.69
	120/30/48	1196.96	1502.36	1687.78	1462.37	882.60	1192.55	1262.12	1112.42
Mean		855.36	1090.58	1271.35	1072.43	682.67	887.99	1019.99	863.55
10	0.0	919.99	1201.69	1510.54	1210.74	801.63	945.03	1153.06	966.57
	60/15/24	1043.56	1360.86	1522.07	1308.83	937.26	1158.46	1327.47	1141.06
	120/30/48	1283.60	1866.81	2186.16	1778.86	1094.01	1231.54	1493.76	1273.10
Mean		1082.38	1476.45	1739.59	1432.80	944.30	1111.69	1324.76	1126.91
20	0.0	1232.89	1432.34	1690.35	1451.86	1078.61	1306.24	1584.09	1322.98
	60/15/24	1288.98	1569.19	1821.19	1559.79	1134.67	1483.74	1598.31	1405.57
	120/30/48	1468.60	1886.55	2257.66	1870.94	1216.91	1499.00	1698.97	1471.62
Mean		1330.15	1629.36	1923.06	1627.52	1143.39	1429.66	1627.12	1400.05
30	0.0	1439.00	1739.88	2001.05	1726.64	1347.50	1593.03	1755.70	1565.41
	60/15/24	1450.46	1867.08	2057.64	1791.73	1415.83	1756.90	1891.50	1688.08
	120/30/48	1667.87	2261.95	2644.70	2191.50	1552.16	1930.79	2046.83	1843.26
Mean		1519.11	1956.30	2234.46	1903.29	1438.49	1760.24	1898.01	1698.93
Mean of NPK	0.0	1049.20	1287.85	1542.08	1293.04	931.96	1118.19	1328.97	1126.37
	60/15/24	1136.80	1447.26	1640.95	1408.34	1038.26	1310.52	1448.03	1265.60
	120/30/48	1404.07	1879.42	2194.07	1825.85	1186.42	1463.45	1625.42	1425.10
Mean of micronutrients		1196.92	1538.17	1792.19		1052.21	1297.40	1467.47	

L.S.D at 0.05	First season							Second season						
	A	B	C	AB	AC	BC	ABC	A	B	C	AB	AC	BC	ABC
	36.16	37.39	27.31	76.39	57.71	57.71	N.S	52.10	34.02	12.97	69.19	37.89	37.89	N.S

Table (8): Zinc uptake (g/fed) as affected by organic manure, NPK fertilization treatments and methods of application of the micronutrients.

Rate of applied O.M(A) ton/fed	Rate of $N/P_2O_5/K_2O$ application (kg/fed)(B)	Micronutrients (C)							
		First season				Second season			
		Control 0.0	Soil appli.	Foliar appli.	Mean	Control 0.0	Soil appli.	Foliar appli.	Mean
0.0	0.0	800.63	941.53	1173.79	972.00	639.23	729.44	926.67	765.11
	60/15/24	951.89	1145.98	1444.91	1180.93	863.30	908.98	1147.73	973.34
	120/30/48	1353.12	1713.74	1909.70	1658.85	1153.44	1164.83	1555.70	1291.33
Mean		1035.21	1267.08	1509.47	1270.59	885.32	934.41	1210.03	1009.92
10	0.0	1266.30	1458.71	1613.93	1446.31	996.51	1152.82	1408.46	1185.93
	60/15/24	1457.33	1608.33	1865.25	1643.63	1114.52	1264.81	1541.17	1306.83
	120/30/48	1637.67	1964.60	2575.62	2059.29	1123.92	1331.79	1792.17	1415.96
Mean		1453.76	1677.21	2018.27	1716.41	1078.31	1249.80	1580.60	1302.90
20	0.0	1632.05	1806.43	2029.71	1822.73	1254.33	1486.48	1875.87	1538.89
	60/15/24	1647.40	1868.90	2257.34	1924.55	1291.55	1494.16	2054.31	1613.40
	120/30/48	1693.06	2113.02	2671.30	2159.13	1297.41	1628.83	2088.57	1671.60
Mean		1657.50	1929.45	2319.45	1968.80	1281.09	1536.49	2006.24	1607.94
30	0.0	1650.74	1914.06	2154.39	1906.40	1582.85	1746.13	2292.88	1873.95
	60/15/24	1754.62	1923.37	2215.94	1964.64	1628.10	1844.85	2311.24	1928.06
	120/30/48	1996.16	2191.79	2823.48	2337.14	1711.44	1890.06	2468.59	2023.36
Mean		1800.50	2009.74	2397.93	2069.39	1640.81	1827.01	2357.57	1941.80
Mean of NPK	0.0	1337.43	1530.18	1742.95	1536.85	1118.23	1303.39	1625.97	1349.20
	60/15/24	1452.81	1636.64	1945.86	1678.44	1224.36	1378.20	1763.61	1455.39
	120/30/48	1670.00	1995.79	2495.03	2053.61	1321.55	1503.87	1976.25	1600.56
Mean of micronutrients		1486.74	1720.87	2061.28		1228.88	1386.95	1788.61	

L.S.D at 0.05	First season							Second season						
	A	B	C	AB	AC	BC	ABC	A	B	C	AB	AC	BC	ABC
	86.99	52.89	49.30	105.71	N.S	99.53	N.S	33.24	43.43	40.30	79.39	81.31	81.31	160.21

Table (9): Copper uptake (g/fed) as affected by organic manure, NPK fertilization treatments and methods of application of the micronutrients.

Rate of applied O.M(A) ton/fed	Rate of $N/P_2O_5/K_2O$ application (kg/fed)(B)	Micronutrients (C)							
		First season				Second season			
		Control 0.0	Soil appli.	Foliar appli.	Mean	Control 0.0	Soil appli.	Foliar appli.	Mean
0.0	0.0	361.97	448.39	532.83	447.73	264.04	335.75	407.42	335.73
	60/15/24	437.45	574.25	634.73	548.81	342.68	442.10	521.31	435.36
	120/30/48	647.45	793.89	994.65	811.09	447.12	593.77	619.20	553.36
Mean		482.29	605.51	720.73	602.84	351.28	457.20	515.97	441.48
10	0.0	464.49	578.07	773.42	605.32	396.14	429.38	645.11	490.21
	60/15/24	588.71	719.30	861.21	723.07	431.88	538.15	704.06	558.04
	120/30/48	714.90	846.19	1098.55	886.55	454.79	597.65	784.95	610.80
Mean		589.36	714.52	911.05	738.31	427.60	520.06	711.37	553.02
20	0.0	533.45	611.50	879.46	674.80	418.31	498.48	736.79	551.18
	60/15/24	595.82	739.50	965.33	766.88	439.32	539.59	776.75	582.22
	120/30/48	727.51	894.70	1116.90	889.70	505.41	627.87	908.60	680.63
Mean		618.92	715.23	997.23	777.13	454.35	552.31	807.38	604.68
30	0.0	549.11	682.37	952.95	728.14	425.33	593.38	933.59	650.76
	60/15/24	635.48	797.25	1033.37	822.03	480.74	612.57	981.09	691.47
	120/30/48	751.14	899.24	1120.32	923.56	515.39	629.34	1019.47	721.40
Mean		645.24	792.95	1035.54	824.57	473.82	611.76	978.05	687.88
Mean of NPK	0.0	477.25	580.08	784.66	613.99	375.95	464.24	680.72	506.97
	60/15/24	564.36	707.57	853.55	708.49	423.65	533.10	745.80	567.52
	120/30/48	710.25	858.50	1082.60	803.78	480.67	612.15	833.05	641.96
Mean of micronutrients		583.95	703.07	916.13		422.61	538.66	753.19	

L.S.D at 0.05	First season							Second season						
	A	B	C	AB	AC	BC	ABC	A	B	C	AB	AC	BC	ABC
	63.67	33.35	27.51	66.97	56.08	N.S	N.S	67.35	26.45	23.87	52.98	47.79	N.S	N.S

Macro nutrients availability:

Data presented in Tables (10-12) show the effect of manuring, N, P and K fertilization and micronutrients application on nitrogen, phosphorus and potassium availability in the investigated sand soil. The obtained data clearly reveal that farmyard manure increased soil contents of available N, P and K as compared with the treatment without manuring. These increases were proportional to the increase in application rate up to 30 ton FYM/fed. The significant increase in available studied macro nutrients caused by manuring could be due to producing N, P and K through organic materials decomposition, fixation of atmosphereic N and there reflection on soil fertility. Also, such materials might increased the cation exchange capacity of sand soil and consequently reduced losses of nutrients by leaching. These results are in agreement with those obtained by El-Ghamry *et al.* (2005), Ali, Maha (2007) and Taha (2007).

Table (10): Soil available nitrogen (mg kg^{-1}) as affected by organic manure, NPK fertilization treatments and methods of application of the micronutrients.

Rate of applied O.M (A) ton/fed	Rate of $N/P_2O_5/K_2O$ application (kg/fed) (B)	Micronutrients (C)							
		First season				Second season			
		Control 0.0	Soil appli.	Foliar appli.	Mean	Control 0.0	Soil appli.	Foliar appli.	Mean
0.0	0.0	2.25	2.42	2.35	2.34	2.60	2.82	2.75	2.72
	60/15/24	2.30	2.60	2.65	2.53	2.70	2.85	2.82	2.79
	120/30/48	2.60	2.75	2.70	2.68	2.73	2.90	2.85	2.83
Mean		2.38	2.59	2.56	2.51	2.68	2.86	2.81	2.78
10	0.0	3.92	4.15	4.10	4.07	4.10	4.35	4.17	4.21
	60/15/24	4.15	4.27	4.22	4.21	4.12	4.37	4.22	4.24
	120/30/48	4.25	4.52	4.35	4.71	4.22	4.47	4.25	4.15
Mean		4.10	4.31	4.22	4.21	4.15	4.40	4.21	4.25
20	0.0	4.25	4.72	4.60	4.53	5.50	5.60	5.55	5.45
	60/15/24	5.15	5.38	5.25	5.26	5.53	5.65	5.60	5.59
	120/30/48	5.45	5.80	5.75	5.66	5.55	5.90	5.80	5.75
Mean		4.95	5.30	5.20	5.15	5.53	5.72	5.65	5.63
30	0.0	6.12	6.37	6.30	6.26	6.50	6.60	6.55	6.55
	60/15/24	6.27	7.52	6.32	6.70	6.70	6.80	6.70	6.73
	120/30/48	6.52	7.72	7.60	7.28	6.75	6.85	6.80	6.80
Mean		6.30	7.20	6.74	6.75	6.65	6.75	6.69	6.69
Mean of NPK	0.0	4.13	4.41	4.34	4.29	4.68	4.84	4.75	4.76
	60/15/24	4.47	4.94	4.61	4.67	4.76	4.89	4.83	4.83
	120/30/48	4.71	5.20	5.10	5.00	4.81	5.03	4.92	4.92
Mean of micronutrients		4.43	4.85	4.68		4.75	4.98	4.84	

L.S.D at 0.05	First season							Second season						
	A	B	C	AB	AC	BC	ABC	A	B	C	AB	AC	BC	ABC
	0.11	N.S	N.S	N.S	N.S	N.S	N.S	0.21	N.S	N.S	N.S	N.S	N.S	N.S

As for macro and micronutrients application, the data showed that N, P and K availability was not affected by either macro or micronutrients fertilization treatments, except for phosphorus in both seasons where phosphorus availability significantly increased with increasing NPK levels up to the highest doses, i.e. 120/30/48 kg N, P_2O_5 and K_2O/fed, respectively. The effect of NPK fertilization on phosphorus availability is mainly due to increasing plant growth and consequently increasing values of increasing root growth system, which in turn enhanced nutrients uptake, consequently increase available B after it is decomposition.

Table (11): Soil available phosphorus (mg kg^{-1}) as affected by organic manure, NPK fertilization treatments and methods of application of the micronutrients.

Rate of applied O.M (A) ton/fed	Rate of $N/P_2O_5/K_2O$ application (kg/fed) (B)	Micronutrients (C)							
		First season				Second season			
		Control 0.0	Soil appli.	Foliar appli.	Mean	Control 0.0	Soil appli.	Foliar appli.	Mean
0.0	0.0	5.80	6.18	6.35	6.11	7.12	7.23	7.20	7.18
	60/15/24	6.15	7.90	6.22	6.76	8.45	8.59	8.55	8.53
	120/30/48	8.00	8.10	7.87	7.99	9.65	9.87	9.75	9.76
Mean		6.65	7.39	6.81	6.95	8.41	8.56	8.50	8.49
10	0.0	6.25	6.50	6.40	6.38	8.14	8.35	8.25	8.25
	60/15/24	7.87	8.00	8.12	7.99	9.40	9.65	9.57	9.54
	120/30/48	8.35	8.87	8.70	8.64	10.60	10.75	10.65	10.67
Mean		7.49	7.79	7.74	7.67	9.38	9.58	9.49	9.48
20	0.0	7.35	7.65	7.45	7.48	8.50	8.72	8.57	8.60
	60/15/24	8.35	8.57	8.50	8.49	9.63	9.67	9.67	9.66
	120/30/48	9.10	9.72	9.65	9.49	10.70	10.85	10.75	10.77
Mean		8.26	8.65	8.53	8.48	9.61	9.75	9.66	9.67
30	0.0	8.12	8.35	8.55	8.34	9.57	9.75	9.67	9.66
	60/15/24	9.12	9.50	9.35	9.32	10.80	10.95	10.90	10.88
	120/30/48	10.20	10.90	10.29	10.46	11.10	11.32	11.22	11.21
Mean		9.14	9.58	9.40	9.37	10.49	10.67	10.60	10.59
Mean of NPK	0.0	6.88	7.17	7.19	7.08	8.33	8.51	8.42	8.42
	60/15/24	7.87	8.49	8.05	8.14	9.57	9.71	9.67	9.65
	120/30/48	8.91	9.40	9.13	9.15	10.51	10.70	10.59	10.60
Mean of micronutrients		7.88	8.35	8.12		9.43	9.65	9.54	

L.S.D at 0.05	First season							Second season						
	A	B	C	AB	AC	BC	ABC	A	B	C	AB	AC	BC	ABC
	0.11	0.07	N.S	0.14	N.S	N.S	N.S	0.19	0.15	N.S	0.31	N.S	N.S	N.S

Table (12): Soil available potassium (mg kg^{-1}) as affected by organic manure, NPK fertilization treatments and methods of application of the micronutrients.

Rate of applied O.M(A) ton/fed	Rate of $N/P_2O_5/K_2O$ application (kg/fed)(B)	Micronutrients (C)							
		First season				Second season			
		Control 0.0	Soil appli.	Foliar appli.	Mean	Control 0.0	Soil appli.	Foliar appli.	Mean
0.0	0.0	6.05	7.55	7.25	6.95	9.33	9.45	9.42	9.40
	60/15/24	7.62	7.95	7.65	7.74	9.45	9.75	9.00	9.40
	120/30/48	7.65	7.97	7.77	7.80	9.83	9.93	9.87	9.88
Mean		7.10	7.82	7.56	7.49	9.54	9.71	9.43	9.56
10	0.0	7.30	7.87	7.55	7.57	10.95	11.28	11.25	11.16
	60/15/24	8.60	8.79	8.63	8.67	11.15	11.39	11.26	11.27
	120/30/48	8.85	9.03	8.97	8.95	11.25	11.45	11.30	11.33
Mean		8.25	8.56	8.38	8.40	11.12	11.37	11.27	11.25
20	0.0	9.15	9.30	9.20	9.22	12.37	12.70	12.58	12.75
	60/15/24	9.25	9.50	9.40	9.38	12.60	12.87	12.78	12.52
	120/30/48	9.70	9.80	9.75	9.75	12.70	12.90	12.73	12.79
Mean		9.37	9.53	9.45	9.45	12.56	12.82	12.71	12.69
30	0.0	10.00	10.50	10.40	10.30	13.00	13.20	13.18	13.13
	60/15/24	10.80	10.90	10.85	10.86	13.20	13.50	13.27	13.32
	120/30/48	11.50	11.70	11.62	11.61	13.22	13.93	13.70	13.62
Mean		10.77	11.03	10.95	10.92	13.14	13.54	13.38	13.35
Mean of NPK	0.0	8.12	8.80	8.60	8.51	11.41	11.66	11.61	11.56
	60/15/24	9.07	9.28	9.13	9.16	11.60	11.87	11.58	11.68
	120/30/48	9.42	9.62	9.53	9.52	11.75	12.05	11.90	11.90
Mean of micronutrients		8.87	9.23	9.13		11.59	11.86	11.70	

L.S.D at 0.05	First season							Second season						
	A	B	C	AB	AC	BC	ABC	A	B	C	AB	AC	BC	ABC
	0.13	N.S	N.S	N.S	N.S	N.S	N.S	0.15	N.S	N.S	N.S	N.S	N.S	N.S

Micronutrients availability:

Values of available micronutrients as affected by organic manure, NPK and micronutrients fertilization are presented in Tables (13-16). Contents of available Fe, Mu, Zn and Cu significantly increased by manure application. The increase was progressive with increasing rate of the applied manure. The increment contents of available micronutrients are due to the contents of such nutrients applied to the soil within the manure it self. In addition, the organic acids produced from FYM decomposition caused a reduction in soil pH, hence increase nutrients availability. These results are in harmony with the findings of Negm *et al.* (2002) who reported that organic manure improved the availability of nutrients.

Concerning macro and micronutrients, data in the above mentioned Tables revealed that soil available micronutrients, i.e. Fe, Mn, Zn and Cu were not affected by NPK fertilization, while addition of micronutrients as soil application significantly increased available studied micronutrients as compared with foliar application or with no micronutrients application. It is evident to notice that addition of micronutrients as foliar spray not affected the micronutrients availability when compared with no micronutrients application. The effect of soil application method on increasing Fe, Mn, Zn and Cu availability is mainly due to application of these nutrients in the sulphate form which are not easily leached from soil.

Table (13): Soil available iron (mg kg^{-1}) as affected by organic manure, NPK fertilization treatments and methods of application of the micronutrients.

Rate of applied O.M (A) ton/fed	Rate of $N/P_2O_5/K_2O$ application (kg/fed) (B)	Micronutrients (C)							
		First season				Second season			
		Control 0.0	Soil appli.	Foliar appli.	Mean	Control 0.0	Soil appli.	Foliar appli.	Mean
0.0	0.0	1.70	3.50	1.80	2.33	1.40	3.15	1.60	2.05
	60/15/24	1.78	3.32	1.87	2.32	1.42	3.22	1.65	2.10
	120/30/48	1.85	3.80	1.90	2.51	1.50	3.24	1.98	2.24
Mean		1.78	3.54	1.86	2.39	1.44	3.20	1.74	2.13
10	0.0	1.50	3.72	2.52	2.58	1.80	3.45	1.85	2.37
	60/15/24	2.60	3.80	2.53	2.98	1.90	3.60	1.95	2.48
	120/30/48	2.65	3.85	2.62	3.04	1.95	3.75	1.99	2.56
Mean		2.22	3.65	2.56	2.81	1.88	3.60	1.93	2.47
20	0.0	2.80	4.12	2.85	3.25	2.12	4.03	2.22	2.79
	60/15/24	2.92	4.25	2.95	3.37	2.15	4.10	2.23	2.83
	120/30/48	2.95	4.45	2.99	3.46	2.20	4.15	2.34	2.90
Mean		2.89	4.28	2.94	3.37	2.16	4.09	2.26	2.84
30	0.0	3.05	4.27	3.12	3.48	2.35	4.45	2.45	3.08
	60/15/24	3.12	4.35	3.15	3.54	2.50	4.52	2.57	3.19
	120/30/48	3.32	4.60	3.37	3.76	2.57	4.62	2.65	3.28
Mean		3.16	4.41	3.21	3.59	2.47	4.53	2.56	3.19
Mean of NPK	0.0	2.26	3.90	2.57	2.91	1.92	3.77	2.03	2.57
	60/15/24	2.60	3.93	2.63	3.05	1.99	3.86	2.10	2.65
	120/30/48	2.69	4.18	2.72	3.20	2.06	3.94	2.24	2.75
Mean of micronutrients		2.51	3.97	2.66		1.98	3.86	2.12	

L.S.D at 0.05	First season							Second season						
	A	B	C	AB	AC	BC	ABC	A	B	C	AB	AC	BC	ABC
	0.08	N.S	0.08	N.S	N.S	N.S	N.S	0.14	N.S	0.08	N.S	N.S	N.S	N.S

Regarding the interaction effect, data in general, reveal that the micronutrients availability not significantly responded to the interaction between manuring and the methods of micronutrients application. The highest values of available Fe, Mn, Zn and Cu were recorded for the sand soil received 30 ton FYM/fed and supplied with micronutrients as sulphate salts. At the same time the soil without application of both FYM and micronutrients showed the lowest available contents of Fe, Mn, Zn and Cu.

Table (14): Soil available manganese (mg kg^{-1}) as affected by organic manure, NPK fertilization treatments and methods of application of the micronutrients.

Rate of applied O.M(A) ton/fed	Rate of $N/P_2O_5/K_2O$ application (kg/fed)(B)	Micronutrients (C)							
		First season				Second season			
		Control 0.0	Soil appli.	Foliar appli.	Mean	Control 0.0	Soil appli.	Foliar appli.	Mean
0.0	0.0	1.12	1.80	1.20	1.37	0.80	1.30	0.90	1.00
	60/15/24	1.20	2.02	1.42	1.55	0.90	1.40	0.95	1.08
	120/30/48	1.73	2.32	2.22	2.09	0.92	1.42	0.99	1.11
Mean		1.35	2.05	1.61	1.67	0.87	1.36	0.95	1.06
10	0.0	1.50	2.60	1.60	1.90	1.20	1.50	1.32	1.34
	60/15/24	1.60	2.70	1.68	1.99	1.25	1.60	1.38	1.41
	120/30/48	1.70	2.72	1.79	2.07	1.30	1.70	1.42	1.47
Mean		1.60	2.72	1.69	2.00	1.25	1.60	1.37	1.41
20	0.0	1.72	3.22	1.80	2.25	1.60	1.90	1.63	1.70
	60/15/24	2.03	3.52	2.15	2.57	1.70	1.93	1.76	1.79
	120/30/48	2.22	3.55	2.92	2.89	1.80	1.99	1.88	1.89
Mean		1.99	3.43	2.29	2.57	1.70	1.94	1.76	1.80
30	0.0	2.23	4.17	2.30	2.90	1.03	2.20	2.00	1.74
	60/15/24	2.33	4.30	2.35	2.99	1.90	2.32	2.15	2.12
	120/30/48	2.52	4.50	2.65	3.22	2.13	2.40	2.20	2.24
Mean		2.36	4.33	2.43	3.04	1.69	2.31	2.12	2.04
Mean of NPK	0.0	1.64	2.95	1.92	2.17	1.16	1.72	1.46	1.45
	60/15/24	1.79	3.13	1.90	2.27	1.44	1.81	1.56	1.60
	120/30/48	2.04	3.27	2.39	2.57	1.53	1.63	1.62	1.59
Mean of micronutrients		1.82	3.13	2.00		1.38	2.40	1.55	

L.S.D at 0.05	First season							Second season						
	A	B	C	AB	AC	BC	ABC	A	B	C	AB	AC	BC	ABC
	0.11	N.S	0.06	N.S	N.S	N.S	N.S	0.12	N.S	0.09	N.S	N.S	N.S	N.S

Table (15): Soil available zinc (mg kg^{-1}) as affected by organic manure, NPK fertilization treatments and methods of application of the micronutrients.

Rate of applied O.M(A) ton/fed	Rate of $N/P_2O_5/K_2O$ application (kg/fed)(B)	Micronutrients (C)							
		First season				Second season			
		Control 0.0	Soil appli.	Foliar appli.	Mean	Control 0.0	Soil appli.	Foliar appli.	Mean
0.0	0.0	0.65	1.12	0.70	0.82	0.60	0.92	0.70	0.74
	60/15/24	0.82	1.20	0.85	0.96	0.70	1.00	0.75	0.82
	120/30/48	0.95	1.30	0.99	1.08	0.80	1.22	0.85	0.96
Mean		0.81	1.21	0.85	0.96	0.70	1.05	0.77	0.84
10	0.0	1.25	1.60	1.31	1.39	0.80	1.20	0.90	0.97
	60/15/24	1.30	1.77	1.31	1.46	0.85	1.22	0.98	1.02
	120/30/48	1.32	1.92	1.83	1.69	0.92	1.32	1.30	1.18
Mean		1.29	1.76	1.48	1.51	0.86	1.25	1.06	1.06
20	0.0	1.52	1.83	1.60	1.65	1.20	1.52	1.22	1.31
	60/15/24	1.62	1.93	1.70	1.75	1.22	1.55	1.25	1.34
	120/30/48	1.65	1.99	1.88	1.84	1.27	1.62	1.31	1.40
Mean		1.59	1.92	1.73	1.75	1.23	1.56	1.26	1.35
30	0.0	1.60	2.12	1.70	1.81	1.42	1.60	1.50	1.51
	60/15/24	1.70	2.13	1.92	1.92	1.47	1.70	1.55	1.57
	120/30/48	1.80	2.33	1.98	2.04	1.50	1.80	1.65	1.65
Mean		1.70	2.19	1.87	1.92	1.47	1.70	1.57	1.58
Mean of NPK	0.0	1.25	1.67	1.33	1.42	1.00	1.31	1.08	1.13
	60/15/24	1.36	1.73	1.44	1.51	1.06	1.37	1.13	1.19
	120/30/48	1.43	1.88	1.67	1.66	1.12	1.28	1.28	1.23
Mean of micronutrients		1.35	1.77	1.48		1.06	1.39	1.17	

L.S.D at 0.05	First season							Second season						
	A	B	C	AB	AC	BC	ABC	A	B	C	AB	AC	BC	ABC
	0.11	N.S	0.06	N.S	N.S	N.S	N.S	0.12	N.S	0.06	N.S	N.S	N.S	N.S

Table (16): Soil available copper (mg kg^{-1}) as affected by organic manure, NPK fertilization treatments and methods of application of the micronutrients.

Rate of applied O.M (A) ton/fed	Rate of $N/P_2O_5/K_2O$ application (kg/fed) (B)	Micronutrients (C)							
		First season				Second season			
		Control 0.0	Soil appli.	Foliar appli.	Mean	Control 0.0	Soil appli.	Foliar appli.	Mean
0.0	0.0	0.40	0.70	0.42	0.51	0.32	0.60	0.35	0.42
	60/15/24	0.50	0.80	0.52	0.61	0.35	0.70	0.37	0.47
	120/30/48	0.55	0.92	0.57	0.68	0.40	0.75	0.42	0.52
Mean		0.48	0.81	0.50	0.60	0.36	0.68	0.38	0.47
10	0.0	0.70	0.80	0.72	0.74	0.50	0.70	0.52	0.57
	60/15/24	0.75	0.85	0.82	0.81	0.60	0.85	0.62	0.69
	120/30/48	0.82	0.92	0.87	0.87	0.62	0.92	0.69	0.74
Mean		0.76	0.86	0.80	0.81	0.57	0.82	0.61	0.67
20	0.0	0.87	1.20	0.89	0.99	0.85	1.00	0.87	0.91
	60/15/24	0.98	1.30	1.00	1.09	0.92	1.12	0.94	0.99
	120/30/48	1.00	1.35	1.12	1.16	0.98	1.20	0.99	1.06
Mean		0.95	1.28	1.00	1.08	0.92	1.11	0.93	0.99
30	0.0	1.30	1.80	1.40	1.50	1.10	1.40	1.17	1.22
	60/15/24	1.40	2.03	1.50	1.64	1.22	1.45	1.24	1.30
	120/30/48	1.50	2.92	1.60	2.00	1.32	1.55	1.35	1.41
Mean		1.40	2.25	1.50	1.72	1.21	1.47	1.25	1.31
Mean of NPK	0.0	0.82	1.12	0.86	0.93	0.69	0.77	0.73	0.74
	60/15/24	0.91	1.24	0.96	1.04	0.77	0.84	0.79	0.80
	120/30/48	0.97	1.53	1.04	1.18	0.83	1.10	0.86	0.93
Mean of micronutrients		0.90	1.30	0.95		0.77	1.02	0.79	

L.S.D at 0.05	First season							Second season						
	A	B	C	AB	AC	BC	ABC	A	B	C	AB	AC	BC	ABC
	0.10	N.S	0.05	N.S	N.S	N.S	N.S	0.11	N.S	0.05	N.S	N.S	N.S	N.S

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تأثير الأسمدة العضوية المثراه بالعناصر الكبرى والصغرى على القمح فى الأراضى الرملية
٢ــ امتصاص العناصر وصلاحيتها

محمد السيد على* ، صفوت أحمد إسماعيل** ، عمر حسينى محمد الحسينى* و أحمد محمد عبد الحفيظ**
* قسم الأراضى ــ كلية الزراعة ــ جامعة بنها
** معهد بحوث الأراضى والمياه والبيئة ــ مركز البحوث الزراعية

أقيمت تجربتان حقليتان بالقرية الأولى غرب سمالوط بمحافظة المنيا، ممثلة للأراضى الرملية الحديثة الاستصلاح لدراسة تأثير أربع مستويات من التسميد العضوى (صفر، ١٠، ٢٠، ٣٠ طن سماد بلدى للفدان) ثلاث مستويات من السماد المخلوط من النتروجين والفوسفور والبوتاسيوم (بدون تسميد، مستوى منخفض (٢٤/١٥/٦٠) ومستوى مرتفع (٤٨/٣٠/١٢٠) كجم نتروجين، فو٢أ٥، بو٢أ للفدان على الترتيب) وكذلك إضافة العناصر الصغرى (حديد + منجنيز + زنك + نحاس) بطرق مختلفة وهى بدون إضافة وإضافة أرضية قبل الزراعة والإضافة رشاً على النبات، على امتصاص العناصر الصغرى والكبرى لنبات القمح وكذلك صلاحيتها فى التربة. ويمكن تلخيص أهم النتائج فيما يلى:

أزداد امتصاص عناصر النتروجين والفوسفور والبوتاسيوم والحديد والمنجنيز الزنك والنحاس بنبات القمح بزيادة كلا من التسميد بالأسمدة العضوية والعناصر الكبرى وكذلك إضافة العناصر الصغرى مع أفضلية لأضافتها رشاً عن الإضافة الأرضية.

كما استجابت صلاحية عناصر النتروجين والفوسفور والبوتاسيوم بالتربة للتسميد العضوى فقط، بينما أزداد صلاحية الفوسفور بزيادة التسميد بالعناصر الكبرى.

وتأثرت صلاحية الحديد والمنجنيز والزنك والنحاس بإضافة كلا من الأسمدة العضوية والعناصر الصغرى أرضاً قبل الزراعة، بينما لم تتأثر صلاحية هذه العناصر بإضافة أسمدة العناصر الصغرى رشاً على النبات فى موسمى الزراعة.

ويمكن من هذه الدراسة التوصية بإضافة الأسمدة العضوية حتى ٣٠ طن/فدان وأسمدة النتروجين والفوسفور والبوتاسيوم بمعدل ١٢٠، ٣٠، ٤٨ كجم ن، فو٢أ٥، بو٢أ على الترتيب مع التوصية بإضافة العناصر الصغرى لتحسين أمتصاص العناصر بواسطة نبات القمح وكذلك صلاحيتها فى التربة.