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Effect of fertilizer treatments and soil moisture regimes on Rice plants (*Oryza Sativa* L.) Iron and Manganese Content (mg/pot) by different rice parts of two varieties at harvest.

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Abstract : A greenhouse experiment was carried out using El kanater clay loam soil to study the influence of soil moisture regimes and different fertilizer treatments on yield of two rice varieties and micro nutrients content.

The obtained results can be summarized in the following :

Yield of rice plants (straw and grain yield) were highly significantly increased by using soil moisture regime of (M1) followed by M2 and M3 in decreasing order.Soil moisture regimes significantly affected the uptake of Fe and Mn by the different rice parts (roots, straw and grains) of the two rice varieties (Giza 176 and Sakha 102). The highest Fe and Mn concentration in roots were obtained by using M3 followed by M2 and M1 in descending order.

Results indicated that all the used fertilizer treatments i.e. inorganic fertilizer (F1 and F2) organic fertilizer (F4) and their combination (F3) significantly increased the yield dry matter, total uptake of Fe and Mnby different rice part (roots, straw and grains) as compared with those obtained under non fertilized treatment (F0).

Inorganic fertilizers (F1 and F2) treatments significantly increased the yield, concentration and the total uptake of Fe and Mnas compared with those obtained by using the organic fertilizer treatment (F4).

In the pot experiment, the highest straw and grain yields of the verities Sakha 102 and Giza 176 were obtained when the fertilizer treatment of F3 (23 Kg N + 15 Kg P2O5 + 52 Kg K2O/ Fed. + 1.5 ton chicken manure) was used followed by F2, F1 and F4.

The highest values of the yield (roots, straw and grain), concentration and the total uptake of Fe and Mnwere obtained by using the fertilizer treatment of F3 (organic and inorganic in combination) followed by the two rates of inorganic fertilizer treatments (F2 and F1) and F4 (organic fertilizer alone) in descending order.

The interaction between soil moisture regimes and fertilizer treatments significantly affected the concentrations and the total uptake of Fe and Mnby the two rice varieties. The highest concentration and uptake values were obtained under soil moisture regime of M1 and using fertilizer treatment of F3 (M1F3), while the lowest values were obtained under soil moisture regimes of M3 and without fertilizers (M3 F0).While in roots, the highest values of Mn concentration were obtained under soil moisture of M3 and using fertilizer treatment F3, while the lowest values were obtained under M1 and F0.

Key Words: Organic and Inorganic fertilizers, Soil moisture, Macro, Rice varieties, Yield, Micro Nutrients.

Introduction:

Rice (*Oryza sativa* L.) root systems play an important role in uptake of water and nutrients from soil[1]. Soil reduction resulting from flooding can change availability of nutrients to plants via changes in chemical species (e.g., increasing solubility of Fe) [2].

The reduction of Mn and Fe is one of the most important chemical transformations that occurs in waterlogged soils. Previous studies indicated that waterlogging significantly increased water soluble Mn^{2+} and Fe^{2+} ions. Concentrations in soils[3,4]. [5]who stated that, in wetlands, large quantities of dissolved organic matter (DOM) are dolubilized under reducing conditions. Which the following processes account for this phenomenon. Release of organic matter (OM) from Mn-and Fe- oxthydroxides that undergo reductive did dilution; and iii) desorption of OM from soil minerals due to PH changes. Also, [6]studied the effect of some animal manures on rice yield and micro nutrients, the manure application increased grain yield and concentration of Fe^{2+} and Mn^{2+}. Furthermore, [7]in their study on the advantages of organic fertilizer treatment under soil moisture regime of M1 (F3M1) recorded the highest values of concentration of Fe^{2+} and Mn^{2+} in soil solution. This research was conducted to find out the effect of soil moisture regimes and different fertilizer treatments on micro nutrients in rice plants.

Materials and Methods:

Pot experiment was conducted in the greenhouse of NRC, Dokki, Giza, Egypt, to study the influence of different moisture regimes and fertilizer treatment on macro nutrients and yield of rice plants. Soil samples at a depth of (0-03cm) from the surface layer of clay loam soil has a pH of 7.96; 1.8% O.M; 2.7% CaCo3; 26.7% sand, 39.6% silt and 33.7% clay. A total of 45 plastic post, contain air dried soil were arranged in a complete randomize design.

The irrigation treatments were used as follow: M1, M2 and M3, watering at every 4, 6 and 8 days irrigation interval respectively, and the fertilizer treatment were:

F0: control (11. 56kg N+ 3.75 kg P2O5 + 13 kg K2O/fed).
F1: (46 kg N+ 15 kg P2O5 + 52 kg k2O/fed).
F2: (69kg N+ 15 kg P2O5 + 52 kg K2O/fed).
F3: (23 kg N+ 15 kg P0O5 + 52 kg K2O/fed + 1.5 ton chicken manure).
F4: (3 ton chicken manure).

Table (1):Some properties of the organic composts used in the experiments:

Compost	*pH (1:10)*	*Ec ds/m*	*C/N*	*N P K %*			*Fe Mn Zn (ppm)*		
Chicken manure	6.43	3.00	19.8	2.20	00.70	2.20	176.6	170.00	48.00

Urea (46% N), superphosphate (15.5% P2O5) and potassium sulphate (48% K2O) were the sources of nitrogen, phosphorus and potassium, respectively. The chicken manure properties was as table (1). Four weeks old seedling of sakha 102 and Giza 176 were transplanted at rate of 9 plants per pot containing different treatment. Each treatment was replicated thrice, the numbers of tillers were recorded and the plants were finally harvested at maturity. Root volume, root weight, grain and straw yields were also recorded. Straw and grains were oven dried at 70ºC and ground samples of straw and grains were digested with concentrated sulphuric acid and hydrogen peroxide then the total Fe and Mn were determent.

Rice grains and straw yield of the two varieties obtained from each pot was separately determined and chemically analyzed (determination was carried out as described by[8,9]. Statistical analysis were performed using the least significant difference L.S.D) method at 1% and 5% according to[10].

Results and discussion

Effect on Iron:

Tables (2&3) and Figs. (1-4) show that yield of rice plants, Fe concentration and uptake by two rice varieties at harvest as affected by different fertilizer treatments and soil moisture regimes (M1, M2 and M3).

Effect of soil moisture regime:

The chemistry of flooding soils is dominated by iron than by any other redox elements. The major reason for this dominance is the large amount of iron that can undergo reduction, usually exceeding the total amount of other redox elements by a factor of 10 or more. Although iron compounds in the soil are somewhat difficult to reduce and remain in ferric form as long as O2, NO-3 and NO-2 are present.

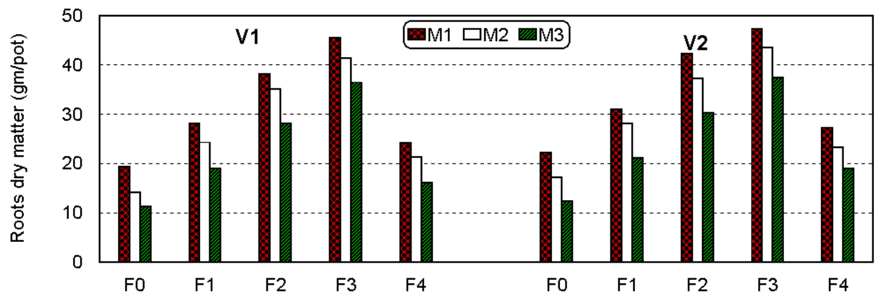

Fig. (1): Roots dry matter (gm/pot) at harvest of two rice varieties as influnced by fertilizer treatments and soil moisture regimes.

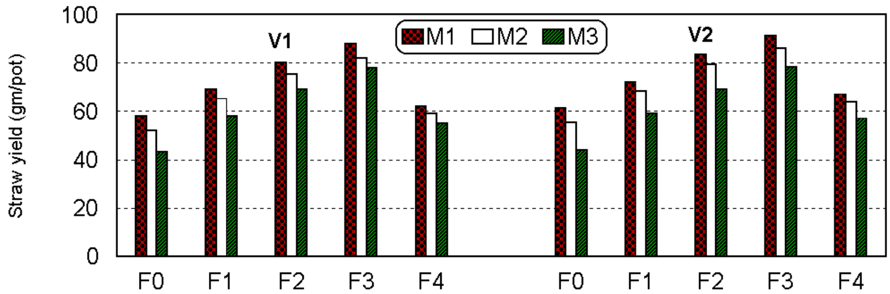

Fig. (2): Straw yield (gm/pot) of two rice varieties at harvest as influnced by fertilizer treatments and soil moisture regimes.

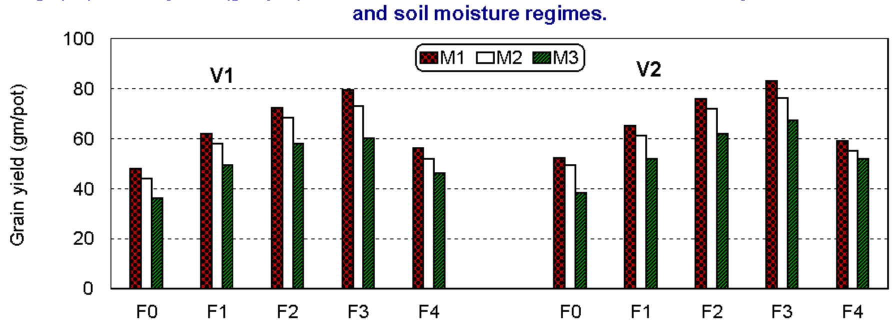

Fig. (3): Grain yield (gm/pot) of two rice varieties at harvest as influnced by fertilizer treatments and soil moisture regimes.

Table (2): Iron concentration (ppm) in different rice parts of two varieties at harvest as affected by different fertilizer treatments and soil moisture regimes.

Treatments	Roots			Mean of fertilizer	Straw			Mean of fertilizer	Grains			Mean of fertilizer
	Soil moisture regimes				Soil moisture regimes				Soil moisture regimes			
	M_1	M_2	M_3		M_1	M_2	M_3		M_1	M_2	M_3	
First variety (Giza 176)												
F_0	1091	1210	1330	**1210**	171	153	103	**142**	115	105	85	**102**
F_1	1520	1600	1820	**1647**	245	200	170	**205**	151	135	118	**135**
F_2	1890	1932	2230	**2017**	288	261	234	**261**	195	185	137	**172**
F_3	2380	2420	2560	**2453**	343	310	282	**311**	240	225	57	**207**
F_4	1335	1390	1510	**1412**	210	177	148	**178**	138	118	101	**119**
Mean of S.M.R.	**1643**	**1710**	**1890**	**1748**	**251**	**220**	**187**	**219**	**168**	**154**	**120**	**147**
L.S.D. for S.M.R. at	5% : 69.272		1%: 93.46		5%: 4.237		1%: 5.72		5% 3.253		1% 4.39	
L.S.D. for fertilizer at	5% : 53.658		1%: 72.39		5%: 3.282		1%: 4.43		5% 2.520		1% 3.40	
L.S.D. for (M × F) at	5% : 119.983		1%: 161.87		5%: 7.338		1%: 9.90		5% 5.634		1% 7.60	
Second variety (Sakha 102)												
F_0	1280	1350	1450	**1360**	199	174	139	**171**	130	115	100	**115**
F_1	1780	1840	2020	**1880**	285	248	210	**248**	184	162	128	**158**
F_2	2175	2250	2580	**2335**	340	300	276	**305**	236	210	165	**204**
F_3	2640	2730	2890	**2753**	395	355	317	**356**	282	258	230	**257**
F_4	1420	1500	1600	**1507**	240	200	171	**204**	158	140	112	**137**
Mean of S.M.R.	**1859**	**1934**	**2108**	**1967**	**292**	**255**	**223**	**257**	**198**	**177**	**147**	**174**
L.S.D. for S.M.R. at	5% : 55.815		1%: 75.30		5%: 7.631		1%: 10.30		5%: 7.227		1%: 9.75	
L.S.D. for fertilizer at	5% : 43.234		1%: 58.33		5%: 5.911		1%: 7.97		5%: 5.598		1%: 7.55	
L.S.D. for (M × F) at	5% : 96.675		1%: 130.43		5%: 13.218		1%: 17.83		5%: 12.517		1%: 16.89	
L.S.D. for (1^{st}× 2^{nd}) varieties at	**5%: 27.596**		**1%: 36.813**		**5%: 2.723**		**1%: 3.633**		**5%: 2.450**		**1%: 3.269**	

Table (3): Iron uptake (mg/pot) by different rice parts of two varieties at harvest as affected by different fertilizer treatments and soil moisture regimes.

Treatments	Roots			Mean of fertilizer	Straw			Mean of fertilizer	Grains			Mean of fertilizer
	Soil moisture regimes				Soil moisture regimes				Soil moisture regimes			
	M_1	M_2	M_3		M_1	M_2	M_3		M_1	M_2	M_3	
First variety (Giza 176)												
F_0	20.97	16.94	14.83	**17.58**	9.92	7.96	4.43	**7.44**	5.53	4.63	3.07	**4.41**
F_1	42.74	38.75	34.58	**38.69**	16.93	13.03	9.88	**13.28**	9.36	7.83	5.81	**7.67**
F_2	72.16	67.85	62.66	**67.56**	23.10	19.62	16.15	**19.62**	14.06	12.61	7.95	**11.54**
F_3	108.17	100.14	93.18	**100.50**	30.18	25.42	22.00	**25.87**	19.02	16.45	9.42	**14.96**
F_4	32.21	29.58	24.16	**28.65**	13.04	10.47	8.16	**10.56**	7.73	6.14	4.67	**6.18**
Mean of S.M.R.	**55.25**	**50.65**	**45.59**	**50.59**	**8.63**	**15.3**	**12.12**	**15.35**	**11.14**	**9.53**	**6.18**	**8.95**
L.S.D. for S.M.R. at	5% : 1.261		1%: 1.70		5%: 0.179		1%: 0.24		5% 0.090		1% 0.12	
L.S.D. for fertilizer at	5% : 0.977		1%: 1.32		5%: 0.138		1%: 0.19		5% 0.070		1% 0.09	
L.S.D. for (M × F) at	5% : 2.184		1%: 2.95		5%: 0.309		1%: 0.42		5% 0.156		1% 0.21	
Second variety (Sakha 102)												
F_0	28.38	23.09	17.91	**23.13**	12.18	9.60	6.12	**9.30**	6.77	5.67	3.81	**5.42**
F_1	53.90	51.80	42.72	**49.47**	20.52	16.89	12.42	**16.61**	12.00	9.90	6.66	**9.52**
F_2	91.68	83.52	77.79	**84.33**	28.33	23.77	19.08	**23.73**	17.94	15.12	10.23	**14.43**
F_3	124.56	118.54	108.26	**117.12**	35.95	30.53	24.77	**30.42**	23.43	19.65	15.44	**19.51**
F_4	38.60	34.83	30.40	**34.61**	16.08	12.80	9.75	**12.88**	9.34	7.73	5.82	**7.63**
Mean of S.M.R.	**67.42**	**62.36**	**55.42**	**61.73**	**22.61**	**18.72**	**14.43**	**18.59**	**13.90**	**11.61**	**8.39**	**11.30**
L.S.D. for S.M.R. at	5% : 3.178		1%: 4.29		5%: 0.751		1%: 0.101		5%: 0.090		1%: 0.120	
L.S.D. for fertilizer at	5% : 2.462		1%: 3.32		5%: 0.582		1%: 0.78		5%: 0.069		1%: 0.09	
L.S.D. for (M × F) at	5% : 5.505		1%: 7.43		5%: 1.301		1%: 1.75		5%: 0.155		1%: 0.21	
L.S.D. for (1^{st} × 2^{nd}) varieties at	**5%: 1.234**		**1%: 1.646**		**5%: 0.239**		**1%: 0.318**		**5%: 0.039**		**1%: 0.053**	

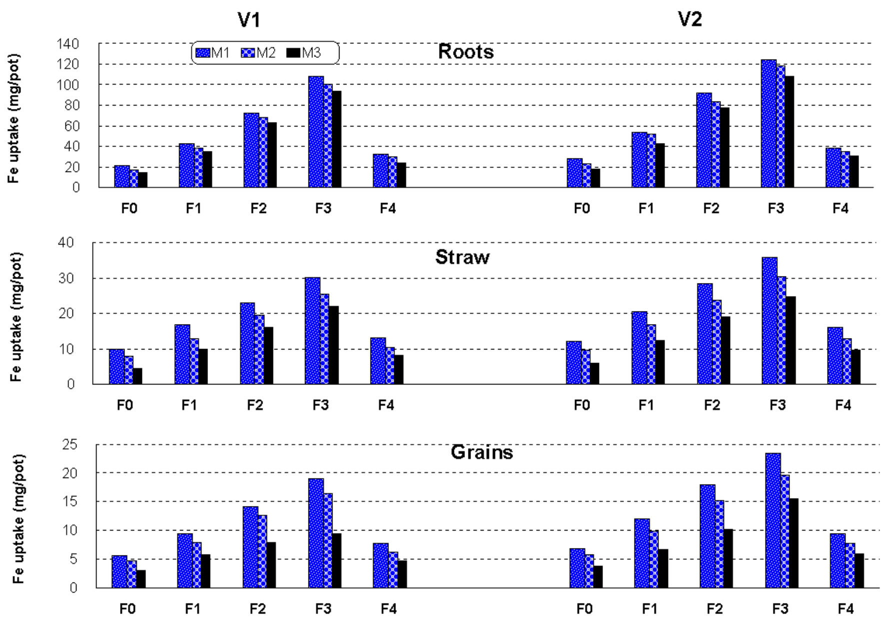

Fig. (4) : Iron uptake (mg/pot) by different rice parts of two varieties at harvest as affected by different fertilizer treatments and soil moisture regimes (M1, M2 and M3).

Results indicate that the soil moisture regimes significantly affected yield, Fe concentration and total uptake in the different parts of the rice varieties under study. The highest Fe and Mn concentration in roots were obtained by using M3 followed by M2 and M1 in descending order. Confirm these results[11,12,13]reported that concentration of heavy metals in roots are always higher than those of shoots or fruits. Thus may indicate the translocation of these elements form roots to shoots was low.

Results indicate that Fe. concentration and uptake by the different parts of the two rice varieties were significantly affected with soil moisture regimes (S.M.R.) regardless of the effect of fertilizers treatments. Soil moisture regime of M1 gave the highest values followed by M2 and M3 in decreasing order.

The increase in the soluble Fe and Mn under moisture condition in the soil (M1) appeared to the largely influenced by a combination of low redox potential and low pH tables (2&3) caused by the higher soil moisture regime. The same increase in Fe and Mn but to a losses degree, was observed under soil moisture M2 and M3. The latter had the least effect on Fe and Mn.

The iron concentration and uptake reported here in this investigation are similar to those reported by[14,15]who found that very high tissue concentration of Fe were observed especially in plants grown under submergence as compared with other soil moisture regimes. The increase might be due to the reduction of Fe (111) compounds to Fe (11) under flooded conditions[15]. The beneficial influence of the submergence treatment M1 may be due to the fact that the alkali and calcareous sodic soils underwent a reduction in pH, an increase in PCO2, a decrease in redox potential and other physicochemical changes within two weeks of flooding[17] and thereby the availability of several plant nutrients were increased particularly that of Fe and Mn[18,19,4]which are required by rice in higher amount and the higher Fe. concentration and uptake were obtained in roots followed by straw and grains in descending order. Also data show that variety Sakha 102 out yielded the variety Giza 176 in Fe concentration and uptake. These results took the same trend of the growth and yields of rice plants.

Effect of fertilizer treatments:

With respect to fertilizer treatments yield of rice, Fe. concentration and uptake by the different parts of the two rice varieties were significantly increased as comparing with non-fertilized soil (F0). Regarding the effect of the first inorganic fertilizer (F1) rate on Fe concentration and uptake appreciable increased with increasing the rate to F2. Inorganic fertilizer treatments F1 and F2 increased Fe concentration and uptake in roots, straw and grains as compared with organic fertilizer treatment (F4). The highest concentration and uptake of iron were obtained by using the F3 (organic and inorganic fertilizers combination) followed by F2, F1, F4 and F0 in descending order [20]this may be due to the combination of high soil organic matter and low pH appear to be particularly conductive to solubilization of Fe under submergence because of the synergistic interaction of low redox potential and high hydrogen ion activity[21,22].

Confirm the obtained results [23]stated that iron uptake increased significantly with fertilizer application of green manure at both moisture used levels.

Interaction of M X F:

Data show that the highest Fe concentration in roots were obtained under soil moisture regime of M3 and by using the fertilizer treatment of F3 (2560 and 2890 ppm in the two varieties, respectively). While the lowest ones were obtained under soil moisture of M1 and nonfertilized (F0) soil (1091 and 1280 ppm, respectively). Furthermore, Fe concentration and uptake by straw and grains took reverse trend than in roots i.e the highest values were obtained under M1F3 and the lowest values under M3F0. Confirm these results [24,25]who stated that nitrogen fertilization resulted in an increase in both Fe and Mn concentrations in rice plants, being greater for continuous than for intermittent flooding.

Data in Table (2) show that using the first level of inorganic fertilizer (F1) under the lower soil moisture stress M3 did not show any significant effect on Fe concentration in straw and grains of the two rice varieties when they compared with the higher soil moisture level (M1)without any fertilizer (F0). On the other hand, addition the organic fertilizer treatment (F4) under the lower soil moisture M3 significant decreased Fe. Concentration in straw and grains of the two rice varieties as compared with the higher moisture level (M) without addition any fertilizers (F0). These result mean that inorganic fertilizer treatment (F1) release more Fe under, the lower moisture level (M3) than the organic fertilizer under the same moisture level.

Effect on Mn :

Data presented in Tables (4&5) and illustrated in Fig. (5) show the effect of three moisture regime levels and different fertilizer treatments on Mn-content and uptake by the different parts of two rice varieties.

Effect of Soil moisture regime:

Data reveal that Mn concentration and uptake in the different rice, parts significantly affected by soil moisture regimes. Mn concentration in the roots increased significantly by decreasing soil moisture from M1 to M3. On the other hand, Mn concentration in straw and grains as well as Mn uptake in roots, straw and grains increased significantly by increasing soil moisture regimes. The highest values were obtained under soil moisture regime of M1 followed by M2 and M3 in descending order. Confirm these results[21,14,26,13] who stated the uptake Mn was significant higher at submergence as compared with other soil moisture in the one week drainage treatment than the two weeks. They added that the same increase in Mn concentration but to a lesser degree was observed under field capacity than was considered in an intermediate stage between saturation and alternate stage (wet/dry) conditions. The latter had the least effect on Mn, On the contrary [24]stated that Mn concentration increased with intesmittent than with continuous flooding and Mn uptake was inhibited by soil saturation compared with drained treatment. Results show that the highest values of Mn concentration were obtained in roots followed by straw and grains in descending order, while Mn uptake values were higher in straw followed by roots and grains in decreasing order.

Table (4): Manganese concentration (ppm) in different parts of two rice varieties at harvest as affected by different fertilizer treatments and soil moisture regimes.

Treatments	Roots			Mean of fertilizer	Straw			Mean of fertilizer	Grains			Mean of fertilizer
	Soil moisture regimes				Soil moisture regimes				Soil moisture regimes			
	M_1	M_2	M_3		M_1	M_2	M_3		M_1	M_2	M_3	
First variety (Giza 176)												
F_0	89	110	128	**109**	71	58	40	**56**	25	22	15	**21**
F_1	133	143	170	**149**	97	85	70	**84**	33	29	23	**28**
F_2	195	205	230	**210**	122	110	98	**110**	43	37	32	**37**
F_3	238	245	260	**248**	138	130	117	**128**	53	46	41	**47**
F_4	110	118	135	**121**	86	79	66	**77**	30	27	21	**26**
Mean of S.M.R.	**153**	**164**	**185**	**167**	**103**	**92**	**78**	**91**	**37**	**32**	**26**	**32**
L.S.D. for S.M.R. at	5% : 3.689	1%: 4.98			5%: 3.467	1%: 4.68			5% 1.414	1% 1.910		
L.S.D. for fertilizer at	5% : 2.857	1%: 3.86			5%: 2.685	1%: 3.62			5% 1.096	1% 1.48		
L.S.D. for (M × F) at	5% : 6.389	1%: 8.62			5%: 6.004	1%: 8.10			5% 2.450	1% 3..30		
Second variety (Sakha 102)												
F_0	120	132	145	**132**	88	73	55	**72**	32	27	21	**27**
F_1	155	167	181	**168**	118	105	85	**103**	45	39	33	**39**
F_2	220	235	252	**236**	138	127	117	**127**	54	48	44	**49**
F_3	278	293	310	**294**	154	146	135	**145**	64	59	54	**59**
F_4	138	150	164	**151**	98	92	83	**91**	40	35	30	**35**
Mean of S.M.R.	**182**	**195**	**210**	**196**	**119**	**109**	**95**	**108**	**47**	**42**	**36**	**42**
L.S.D. for S.M.R. at	5% : 6.676	1%: 9.01			5%: 3.157	1%: 4.26			5%: 2.562	1%: 3. 46		
L.S.D. for fertilizer at	5% : 5.171	1%: 6.98			5%: 2.446	1%: 3.30			5%: 1.985	1%: 2.68		
L.S.D. for (M × F) at	5% : 11.563	1%: 15.60			5%: 5.469	1%: 7.38			5%: 4.438	1%: 5.99		
L.S.D. for (1^{st}× 2^{nd}) varieties at	**5%: 2.325**	**1%: 3.101**			**5%: 1.472**	**1%: 1.963**			**5%: 0.903**	**1%: 1.205**		

Table (5): Manganese uptake (mg/pot) by different parts of two rice varieties at harvest as affected by different fertilizer treatments and soil moisture regimes.

Treatments	Roots			Mean of fertilizer	Straw			Mean of fertilizer	Grains			Mean of fertilizer
	Soil moisture regimes				Soil moisture regimes				Soil moisture regimes			
	M_1	M_2	M_3		M_1	M_2	M_3		M_1	M_2	M_3	
First variety (Giza 176)												
F_0	1.71	1.54	1.43	**1.56**	4.12	3.02	1.72	**2.95**	1.20	0.97	0.54	**0.90**
F_1	3.74	3.46	3.23	**3.48**	6.70	5.54	4.07	**5.44**	2.05	1.68	1.13	**1.62**
F_2	7.45	7.20	6.46	**7.04**	9.79	8.27	6.96	**8.34**	3.10	2.52	1.86	**2.49**
F_3	10.82	10.14	9.46	**10.14**	12.14	10.66	8.89	**10.56**	4.20	3.36	2.46	**3.34**
F_4	2.65	2.51	2.16	**2.32**	5.33	4.67	3.64	**4.55**	1.68	1.40	0.97	**1.35**
Mean of S.M.R.	**5.27**	**4.90**	**4.55**	**4.91**	**7.62**	**6.43**	**5.06**	**6.37**	**2.45**	**1.99**	**1.39**	**1.94**
L.S.D. for S.M.R. at	5% : 0.033		1%: 0.04		5%: 0.032		1%: 0.04		5% 0.027		1% 0.04	
L.S.D. for fertilizer at	5% : 0.025		1%: 0.03		5%: 0.025		1%: 0.03		5% 0.021		1% 0.03	
L.S.D. for (M × F) at	5% : 0.057		1%: 0.08		5%: 0.055		1%: 0.07		5% 0.046		1% 0.06	
Second variety (Sakha 102)												
F_0	2.66	2.26	1.79	**2.24**	5.39	4.03	2.42	**3.95**	1.67	1.33	0.80	**1.27**
F_1	4.69	4.70	3.83	**4.41**	8.50	7.15	5.03	**6.89**	2.93	2.38	1.72	**2.34**
F_2	9.27	8.72	7.60	**8.53**	11.50	10.06	8.09	**9.88**	4.10	3.46	2.73	**3.43**
F_3	13.12	12.72	11.61	**12.48**	14.01	12.56	10.55	**12.37**	5.32	4.49	3.62	**4.48**
F_4	3.75	3.48	3.12	**3.45**	6.57	5.89	4.73	**5.73**	2.36	1.93	1.56	**1.95**
Mean of S.M.R.	**6.70**	**6.38**	**5.59**	**6.22**	**9.19**	**7.94**	**6.16**	**7.76**	**3.28**	**2.72**	**2.09**	**2.69**
L.S.D. for S.M.R. at	5% : 0.084		1%: 0.11		5%: 0.076		1%: 0.10		5%: 0.087		1%: 0.12	
L.S.D. for fertilizer at	5% : 0.065		1%: 0.09		5%: 0.059		1%: 0.08		5%: 0.067		1%: 0.09	
L.S.D. for (M × F) at	5% : 0.145		1%: 0.20		5%: 0.132		1%: 0.18		5%: 0.150		1%: 0.20	
L.S.D. for (1^{st}× 2^{nd}) varieties at	**5%: 0.028**		**1%: 0.037**		**5%: 0.025**		**1%: 0.034**		**5%: 0.027**		**1%: 0.037**	

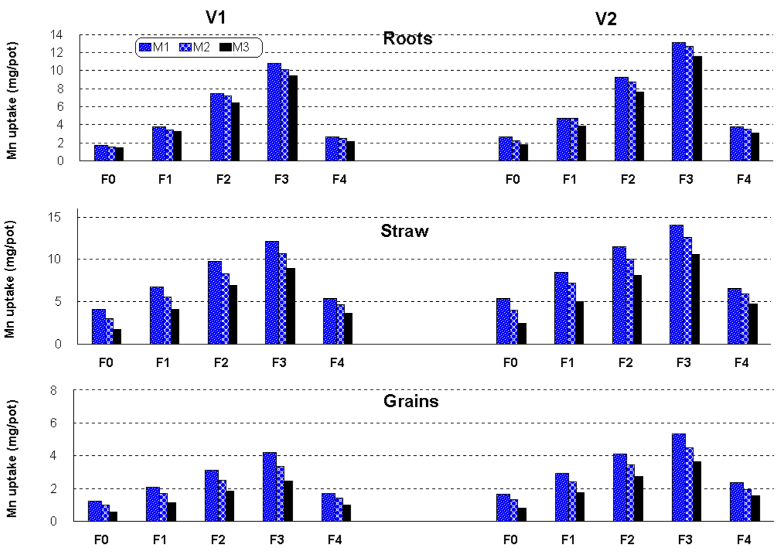

Fig. (5) : Manganese uptake (mg/pot) by different rice parts of two varieties at harvest as affected by different fertilizer treatments and soil moisture regimes (M1, M2 and M3).

Effect of fertilizer treatments:

Data indicate that Mn concentration and uptake by the different parts of the two rice varieties were significantly affected by the fertilizer treatments. All the used fertilizers significantly increased Mn concentration and uptake as compared with control treatment (F0). The highest values in concentration and uptake were obtained by using the fertilizer treatment of F3 (organic and inorganic in combination) follow by F2, F1, F4 and F0 in descending order. These results mean that in organic fertilizer treatments were more effective on Mn concentration and uptake by rice plants than the treatment (F0), while the combination between organic and inorganic (F3) significantly increased Mn concentration and uptake as they as compared with inorganic fertilizer F1 and F2 each alone. [23,26]stated that Mn concentration and uptake by rice plants increased appreciably with increasing rate of N-fertilization.

Generally, data in Tables (4 & 5) show that Mn concentration under the fertilizer treatments or different soil moisture regimes were greatly lower than those of Fe. concentration under the same conditions.

Interaction: MXF

Data show that Mn concentration and uptake responded greater to fertilizer treatments under soil moisture regime of M1 than the other two soil moistures M2 and M3. In roots, the highest values of Mn concentration were obtained under soil moisture of M3 and using fertilizer treatment F3, while the lowest values were obtained under M1 and F0. Furthermore, data indicate that the highest Mn concentration in straw and grain as well as Mn-uptake in roots, straw and grains were obtained under soil moisture of M1 and fertilizer treatment F3. The lowest values of Mn uptake of roots, straw and grains as well as Mn concentration of the straw and grains were obtained under soil moisture of M3 and unfertilized treatment (F0).

Confirm these results[23,27]stated that nitrogen fertilization resulted in an increase in both Fe and Mn concentration in rice plants, being greater for continuous than for intermittent flooding.

Data in Table (5) show that there was non-significant difference between the treatment M1 F0 and both M3F1 and M3F4 on Mn concentration in straw and grains for both rice varieties. While in roots of both varieties, Mn concentration was significant increased by using M3F1 and M3F4 as compared with the treatment M1 F0. These results show that the first inorganic fertilizer treatment F1 and the organic fertilizer treatment F4 did not affect Mn concentration in straw and grains under soil moisture stress (M3) as compared with high moisture level (M1) without any fertilizer. In this concern, [1]who stated that incorporation of organic sources into paddy soil markedly improved root to various soil moisture regimes. All flooded treatment demonstrated moderately reduced soil condition (Eh<350mV.) concencentration of P, Mn and Fe where significantly higher in flooded plants, likely du to the increased folubility of these nutrients.

Generally, in soils with high Fe: Mn ratio, the apparent solubility of Mn can be reduced to less than solubility of rhodochrosite because of coprecipitation with Fe [29]. In acid soils, cation exchange is the dominant mechanisms governing Mn^{2+} activities[30]. The reduction of Mn and Fe is one of the most important chemical transformation that occurs in water logged soils. Previous studies indicated that water logging increased water soluble Mn^{+2} and Fe^{+2} ions conc. in soils[3]**.** The chemistry of soil manganese is important to the nutrition of lowland rice and to the processes of soil formation in flooded and poorly drained soils. Along with the reduction of NO^{-}_{3} that accompanies O_2 depletion in a waterlogged soil, insoluble oxidized manganic compounds (Mn^{4+}) are reduced to the more soluble manganous (Mn^{2+}) form. An increase in Mn^{2+} in the soil solution and on the exchange complex is one of the first measurable effects of reducing conditions. This reduction can be either chemical or microbiological although microbiological reduction is likely to predominate in waterlogged rice soils that are at about pH 5.5 to 6.

Conclusion

1. Soil moisture regimes and different fertilizer treatments cause a marked effect on the growth, yield and the behavior of different nutrients in rice plants as well as in soil solution.
2. The obtained information on fertilizer treatments may lead to more rational basis for the selection of the fertilizer sorts and levels to suit particular combination of soil, water management and rice varieties.
3. In conclusion, we feel it is worthy to recommend for further studies of soil moisture regimes and different fertilizers (organic and inorganic) to get the best soil moisture level and fertilizers to obtain the best and the highest economically yield of rice.
4. We must recommended that it is better to give rice plants organic and inorganic fertilizer in combination, and use the submergence treatment as the best soil moisture regime to obtain the highest yield of rice.

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