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RESPONSE OF RICE PLANT GROWN ON NEWLY RECLAIMED SALINE SOIL TO A MIXTURE OF CHELATED FE, MN AND ZN APPLIED BY DIFFERENT METHOD AND RATES

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ABSTRACT

Two field experiments were carried out on a newly reclaimed saline soil during two successive summer seasons (2007 and 2008) at Sahl El-Hossinia , El-Sharkia Governorate , Egypt .The aim is to test the response of rice to applied chelated Fe, Mn and Zn in the form of EDTA. Application comprised three different methods; coating, soaking and foliar spray.In the coating method application of each nutrient was at a rate of 0.1,0.2,0.3g/Kg grains. For soaking and foliar application, these elements were applied at 150,250,350 mg/Kg grains. Soaking was performed in 100L and lasted for 24 hours. However, these nutrients were sprayed at a rate of 200L/fed.The yield and its components as well as the content and the uptake of macro and micronutrients of rice grain (Oryza- *Sativa*) Cv. Giza 178 were appraised. Results revealed that applying micronutrients by soaking method was very effective on grain yield compared to the other applied treatments. The percentages increase ranged from 142.23 to 178.81, while in coating treatment they ranged from 85.8 to 117.42and in foliar treatments from 89.37 to 112.08 over control; as an average of both seasons. Elevating the rate of applied chelated compounds caused significant increases in the straw and grain yields, while 1000 grain weight was not significantly affected. The results disclosed that phosphorus content in straw and grain in response to the studied treatments gave a significant increase. Nonetheless, N and K contents showed no significant response. As for the concentrations of Fe, Mn and Zn in the straw there was a significant effect due to both methods and rates of application. But, for the grains they had significant effect in the case of Zn application only. The uptake of N, P, Fe and Zn in straw besides N, P, Mn and Zn in grains were significant increase by application of either methods or rates of the mixture chelated micronutrients. Data revealed that the increment response for the methods of application of micronutrients could be arranged as follows: soaking>coating>foliar. Soaking at the rate of 350mg/Kg^{-1} gave the best results for the yield of rice and its components .

Keywords: Micronutrients (EDTA), saline soil, rice productivity, soaking, coating, foliar.

INTRODUCTION

Micronutrient requirements for plant, animal, and human are rather low. However, they are essential for vital cell functions. Deficiency of these elements can greatly disturb plant yield and quality, and the health of both domestic animals and humans (Malakouti, 2007). Nonetheless, nutrients absorption by plants is substationally affected in saline soil. Alam et al. (2001) noted that salinity affects the growth of rice in varying degrees at all stages of its life cycle starting from germination up to maturity. These effects may vary depending on the stage of plant development. Several studies indicated that rice is tolerant during germination and becomes very sensitive during early seedling stage. Thereafter, gains tolerance during vegetative growth but again becomes sensitive during pollination and fertilization. However, it increasingly becomes more tolerant at maturity stage. FAO (1995) confirmed that the majority of salt-affected soils in Egypt are located in the Northern-Central part of the Nile Delta and on its Eastern and Western sides. Fifty five percent of the cultivated lands of Northern Delta region are salt-affected. However only twenty per cent of the soils of Southern Delta and middle Egypt region besides twenty five percent located in the Upper Egypt region are salt-affected soils. The Southern part of El-Hussinia plain, Sharkia Governorate, Egypt covering an area of about 141.6 Km^2. Imtiaz et al. (2003) stated that lack of just one micronutrient can greatly reduce plant yield. Adequate nutrition of plant with micronutrients depends on many factors among them is the ability of soil to supply these nutrients, rate of nutrients absorption by the plants, distribution of nutrients to function sites and nutrients mobility within the plant. Anand (1993) studied the effect of three levels of Fe (0.2,0.4, 0.6 mg/Kg) and two levels of Zn(2.5Kg and 10Kg/Fed) and their combinations on the growth and yield of rice grown on a zinc deficient sodic soil. Application of Zn, had significantly enhanced the yield of rice and available Zn in soil and plant Zn content; irrespective of Fe application. Fe application showed a significant improvement in available soil and plant content of Fe and Mn. But, it significantly, decreased Zn content of the crop. He suggested that benefits of Fe application to rice in sodic soils can only be obtained if it is applied along with Zn. El-Bordiny and El-Dewiny (2008) showed that micronutrients availability are governed with pH, OM, clay content, CEC and ESP. Calcium carbonate and gypsum contents are negatively correlated with different micronutrients. Malakouti (2000) found that the addition of each micronutrient (Fe, Zn, Cu, and B) or a combination of Fe + Zn + Cu + B to NPK fertilizer augmented the grain yield of wheat. The highest yield was obtained as all the micronutrients were added along with NPK fertilizers. El-Fouly et al. (2001) noted that application of micronutrients to faba bean and/or wheat showed positive effects on growth and nutrients uptake either before or after the salinlization treatment. They concluded that foliar application of micronutrients could enhance salinity tolerance. Sairam and Tyagi (2004) suggested that foliar spraying with micronutrients, especially Fe, Mn and Zn, increased yield crops and mineral contents of many plant types under saline stress conditions.

The aim of this work is to study the response of grain yield of rice crop grown on newly reclaimed saline soil to different application methods and rates of Fe, Mn and Zn chelates.

MATERIALS AND METHODS

Two field experiments were conducted in two successive summer seasons 2007 and 2008 at the private farm of El-Radwan village of Sahl El-Hossinia, El-Sharkia Governorate, to study, which of micronutrients methods of application namely coating, soaking and foliar and their rates is more efficient in increasing rice yield .

Soil samples at 0 – 30cm depth were collected to determine some physical and chemical properties in a composite sample. Soil samples were subjected to the determination of the available N, P and K as outlined by Black et al. (1965). Available Fe, Mn and Zn in soil were extracted as described by Lindsay and Norvell (1978) and determined by the aid of Atomic Absorption model GBC 932 (Table 1).

The irrigation was practiced through El- Salam canal (Agriculture drainage water mixed with fresh Nile water 1:1). Water irrigation samples were collected from the three sources in both seasons to determine some of their chemical properties at four periods during rice planting, i.e., May, June, August and September. Salinity of the water EC (dSm^{-1}) and soil pH were determined (Table 2).

Table (1): Some soil characteristics for the experimental location

Location	Coarse sand (%)	Fine sand (%)	Silt (%)	Clay (%)		Texture	O.M (%)		$CaCO_3$ (%)
El-Radwan village	2.96	66.04	12.73	18.27		Clay	0.62		10
	pH (1:2.5)	EC (dS/m)	Cations (meq/l)				Anions (meq/l)		
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO^{-}_3	Cl^{-}	SO^{--}_4
	8.29	17.36	9.23	14.99	148	0.93	9.72	120	43.43
	Available macronutrients (mg/kg^{-1})			Available micronutrients (mg/kg^{-1})					
	N	P	K	Fe	Mn	Zn	Cu		
	44	5.39	196	2.36	1.87	0.53	0.085		

Table (2): Some Chemical properties of irrigation water at El-Salam canal during the two growing season for rice plant

Soil properties	Season	El-Salam canal			
		Periods of irrigation*			
		1	2	3	4
EC (dSm^{-1})	1st	1.06	1.14	1.57	1.01
	2nd	1.04	1.26	1.42	1.08
pH	1st	8.02	8.12	8.09	7.96
	2nd	8.09	8.06	8.13	7.99

1- May 2- June 3- August 4- September

The experimental soil layout was subjected to some pretreatments processes as follows: (a) levelling the soil surface by using lazar technique. (b) Deep sub-soiling plough. (c) Establishment of filed drains at a distance of 10m between each of two drains and a deep of 90cm at drain beginning, their drainage water flow towards the main collectors was of 2m in depth and (d) establishment of an irrigation canal in the middle part of the experimental pilot unit.

The micronutrients were applied as a mixture of even ratio of chelated Fe, Mn and Zn in the form of EDTA compound; Fe –EDTA (6 % Fe); Mn –EDTA (13 % Mn) and Zn –EDTA (12%Zn). Rice grains were soaked for 24 hours in a mixture of the previously mentioned micronutrients. Rice grains needed for coating due to one feddan were(80Kg). Foliar spray solution from the mixture of the chelated compounds was applied at a rate of 200L/fed. The experimental **treatments were as the following:**

1- Control (without micronutrients).

2- Grains coating at the rate of (0.1, 0.2 and 0.3g/kg grain) for each nutrient.

3- Grains soaking (150, 250 and 350 mg/L) for each nutrient were lasted for 24 hour in a volume of 100liters.

4- Foliar spraying (150, 250 and 350 mg/L) for each nutrient solution was used at the rate of 200 L/fed added three times; 21, 45 and 60 days from rice sowing.

Experimental fields of both seasons were prepared and divided into plots ($50m^2$) and each treatment was replicated three times in a randomized complete block design. All plots received basal dressing of N, P and K. 100kg N/fed from urea (46 % N) were applied three times 21, 35and 50 day from planting. 200kg /fed from calcium super phosphate (15.5 %P_2O_5) were applied during soil tillage before rice sowing. Potassium sulphate (48 %K_2O) was applied at a rate of 100kg/fed in two split equal doses once before rice sowing and later after 35 days from sowing. Sowing of rice grains was carried out at the 1st and 5th of May in both seasons.

At harvest, grain and straw yields were recorded in ton/fed. Grain samples from each treatment were taken for chemical analysis. Grain and straw samples were wet digested using H_2SO_4 and $HClO_4$ acid mixture1:1(v/v). The digest was then used to determine N, P and K content of both rice grains and straw as described by Chapman and Pratt (1961).As well as Fe, Mn and Zn concentrations were determined using Atomic Absorption Spectrophotometer (GBC 932).

RESULTS AND DISCUSSION

Rice yield and yield components:

Data illustrated in Table (3) show straw and grain yield and 1000 – grain weight of rice plant. Application of various methods and different rates of the mixture of chelated micronutrients compound showed that all treatments significantly augmented rice straw and grain yields. Nonetheless, soaking and foliar methods exhibited higher values compared with coating method in both seasons. Moreover, results indicated that increasing the rate of the mixture chelated micronutrients (Fe, Mn and Zn) played a substantial role in raising the yield of straw and grain. Results also, revealed that there was no significant increase in 1000-grain weight due to the application of various methods and different rates of the mixture of chelated micronutrients compound. The relative increases for straw inst season were 47.98, 55.61 and 56.68 % but they were 41.85, 49.61 and 50.27 % in 2nd season due the rice grains coated with 0.1,0.2 and 0.3g of the mixture of chelating micronutrients compound; compared to control. However, the percentage increases of grain yield were 96.73, 114.55 and 117.42 in 1st and 85.80, 94.19 and 96.16 in 2nd season due to the same corresponding order of coating treatment. These results resemble those reported by Ghaly et al.

(1992) on wheat. They found that the coated wheat seeds with chelated Zn, Fe and Mn increased the grain and straw yields of wheat. The current results indicated that the corresponding relative increases at soaking method were 96.72, 105.29, and 107.31 % in 1st and 88.39 , 96.51 and 125.49 % in 2nd season for straw against 164.75, 171.18 and 178.81 % in 1st and 142.23 , 158.21 and 160.71 % in 2nd season for grain due to soaking at the rates of 150 , 250 and 350 mg/Kg^{-1}.As well as, the relative increases at foliar application method were 49.37,61.60 and 68.16% in 1st and 42.99,54.48 and 62.96% in 2nd season for straw while it were 104.46,110.89 and 112.08% in 1st and 89.38, 91.61 and 92.32% in 2nd season at the same rates. In this respect, Ghaly et al.(1992), Amin et al. (1998) and Badr et al.(1998) demonstrated that significant yield increases could be obtained by treating wheat seeds with (Fe, Mn, Zn) and a mixture of them was more effective than using any of them individually.

Table (3): Effect of some micronutrients applications on rice yield grown in two different seasons (2007-2008)

Treatments	Zn +Mn +Fe	Straw yield (Kg/fed)	Grain (Kg/fed)	Weight of 1000grains(g)
		2007		
control		1.586	1.010	22
Coating (g)	0.1	2.347	1.987	23
	0.2	2.468	2.167	24
	0.3	2.485	2.196	27
Soaking ($mgKg^{-1}$)	150	3.120	2.674	29
	250	3.256	2.739	31
	350	3.288	2.816	33
Foliar ($mgKg^{-1}$)	150	2.369	2.065	25
	250	2.563	2.130	28
	350	2.667	2.142	30
		2008		
Control		1.663	1.120	25
Coating (g)	0.1	2.359	2.081	27
	0.2	2.488	2.175	27
	0.3	2.499	2.197	30
Soaking ($mgKg^{-1}$)	150	3.133	2.713	32
	250	3.268	2.892	33
	350	3.750	2.920	34
Foliar ($mgKg^{-1}$)	150	2.378	2.121	26
	250	2.569	2.146	27
	350	2.710	2.154	31
LSD %5 Methods		0.094	0.093	ns
LSD% 5 Rates		0.104	0.105	ns

It is worthy to mention that the superiority of the applied methods can be ranked as soaking > foliar > coating, for straw yield in both seasons and soaking > coating > foliar for grain yield, in both seasons. This indicates the efficiency of applying micronutrients through grain soaking method to correct micronutrients deficiency rather than coating and/or foliar spray. These findings could be interpreted as soaking give chance to ample amounts of applied micronutrients to be absorbed by the grain; used later in the biological processes. This seems logic if comparing both soaking and coating. But, at the same time one may expect that foliar spray correct micronutrient deficiencies for plant started already to suffer. Monged and Mawardi (1978) and Korayem (1993) noted that soaking rice grain in zinc sulphate solution increased yield of grains due to increasing germination. Wang and Song (2005) , improved seedling vigor and plant growth.

Micronutrients concentration in grain and straw of rice plant:

Data in Tables (4 &5) show that the concentration of Fe, Mn and Zn significant increase in rice straw in both seasons due to the different applications and rates .As for grains, Zn concentration gave significant response but Fe and Mn concentrations did not show any significant results. Examining and interpretation of the results suggest that generally seed and fruits are the least plant organs to be affected by various fertilizer or agriculture practices treatments. Also, it seems that the results are in complete with rice plant requirements to zinc to accelerate the metabolic processes during the reproductive stage which run from panicle initiation to flowering and ripening phase and from flowering to maturity. The highest contents of Fe, Mn and Zn in straw were 134, 75 and 66 mg/kg^{-1}respectively, and 51, 63 and 31mg/Kg^{-1} for grain. Again, the obtained data disclosed the superiority of soaking compared to coating and/or foliar in elevating micronutrients content of both straw and grains. These results coincide with those obtained by Mohammad (2008) who found that the micronutrient-enriched NPK fertilizers increase the concentration of micronutrients in rice grain**.**

Table (4): Macro-Micronutrients concentration in rice straw (2007 -2008)

Treatments	Zn +Mn +Fe	Macronutrients (%)			Micronutrients (mgkg^{-1})		
		N	P	K	Fe	Mn	Zn
				2007			
Control		2.36	0.18	0.99	89	49	34
Coating (g)	0.1	2.58	0.25	1.08	93	53	41
	0.2	2.63	0.29	1.13	98	57	44
	0.3	2.67	0.31	1.17	111	62	46
Soaking (mgKg^{-1})	150	2.77	0.33	1.26	118	66	51
	250	2.83	0.35	1.29	126	69	57
	350	2.96	0.38	1.32	129	70	59
Foliar (mgKg^{-1})	150	2.46	0.23	1.05	96	53	43
	250	2.54	0.28	1.16	98	55	47
	350	2.59	0.30	1.18	104	56	49
				2008			
Control		2.41	0.21	1.02	94	51	26
Coating (g)	0.1	2.61	0.28	1.12	99	55	44
	0.2	2.67	0.32	1.15	107	60	51
	0.3	2.70	0.33	1.19	118	65	60
Soaking (mgKg^{-1})	150	2.82	0.37	1.30	123	71	63
	250	2.89	0.39	1.32	129	74	65
	350	2.98	0.41	1.36	134	75	66
Foliar (mgKg^{-1})	150	2.58	0.26	1.06	99	56	49
	250	2.61	0.30	1.09	105	59	52
	350	2.64	0.33	1.17	109	62	54
LSD %5 Methods		ns	0.051	ns	3.05	0.28	3.24
LSD% 5 Rates		ns	0.057	ns	4.00	0.31	3.62

Table (5): Macro-Micronutrients concentration in rice grains (2007 -2008)

Treatments	Zn +Mn +Fe	Macronutrients (%)			Micronutrients (mgkg-¹)		
		N	P	K	Fe	Mn	Zn
2007							
Control		0.97	0.21	0.35	29	41	13
Coating (g)	0.1	1.09	0.35	0.46	34	46	16
	0.2	1.13	0.41	0.48	37	49	18
	0.3	1.15	0.42	0.51	39	52	21
Soaking ($mgKg^{-1}$)	150	1.34	0.46	0.61	42	53	23
	250	1.39	0.49	0.66	46	56	25
	350	1.42	0.52	0.68	48	59	28
Foliar ($mgKg^{-1}$)	150	1.12	0.33	0.38	31	43	15
	250	1.18	0.37	0.51	36	46	18
	350	1.22	0.41	0.55	38	48	20
2008							
Control		1.02	0.26	0.38	31	43	14
coating (g)	0.1	1.12	0.39	0.50	35	49	18
	0.2	1.15	0.43	0.52	39	53	19
	0.3	1.36	0.44	0.54	42	55	22
Soaking ($mgKg^{-1}$)	150	1.42	0.48	0.62	45	58	24
	250	1.45	0.53	0.69	49	61	28
	350	1.52	0.56	0.71	51	63	31
Foliar ($mgKg^{-1}$)	150	1.13	0.35	0.42	33	46	17
	250	1.18	0.39	0.57	38	49	20
	350	1.20	0.42	0.59	40	51	22
LSD %5 Methods		ns	0.028	ns	ns	ns	0.16
LSD% 5 Rates		ns	0.031	ns	ns	ns	0.18

Nitrogen, phosphorus and potassium concentrations in rice as affected by different methods and rates of micronutrients:

Data in Tables (4 &5) show the effect of different methods and rates of Fe, Mn and Zn chelate on concentration of N, P and K in rice grains and straw. Results revealed that the percentage of N and K contents in straw and grains in response to the different applied methods and rates recorded no significant increase, while P recorded significant increase. The relative increases of N contents in straw were ranged between 2.36 – 2.96 % in 1st and 2.41 – 2.98 % in 2nd season, from 0.18 – 0.38 % in 1st 0.21 – 0.41 % in 2nd season for phosphorus. However, they ranged from 0.99 – 1.32 % in 1st and 1.02 – 1.36 % in 2nd season for K. The relative increases of N, P and K contents in grain ranged between 0.97 – 1.42 % in 1st and 1.02 – 1.52 % in 2nd season for N, from 0.21 – 0.52 % in 1st and 0.26 – 0.56 % 2nd season for P and 0.35 – 0.68 % in 1st and 0.38 – 0.71 % 2nd season for K.

Generally the obtained data showed that N, P and K in straw and grains in response to the different applied methods and rates of chelated micronutrients compound exhibited the following order: soaking > coating > foliar for both seasons; compared to control. These findings could be explained due to the role of micronutrients in enhancing the uptake of macronutrients. In this respect, El-Fouly and Fawzi (1996) noted that micronutrients application led to encourage the growth of root, which in turn take up higher contents of N, P and K and finally being reflected on the yield.

Also, the obtained results are in harmony with those reported by Shams El-Din (1993) who found that the N and P concentrations increased in wheat grains and straw due to application of Zn, Mn, and Fe, applied as foliar spray, seed coating and seed soaking. Moreover, Yurshevich et al. (1985) found that Zn application to barley, increased N, and P content but reduced K content in grain and straw.

Nutrients uptake in straw and grains of rice plant

Statistical analysis in Table (6&7) showed that the various methods and rates of application of a mixture chelated Fe, Mn and Zn exhibit significant response with Fe, Zn, N and P uptake in straw yield for two mentioned seasons. As for K, this finding was true with the methods of application only. Similarly, Mn gave non significant effect with the methods of application besides the rates.

Table (6): Macro-Micronutrients uptake in rice straw (2007 – 2008)

Treatments	Zn +Mn +Fe	Macronutrients (kg fed^{-1})			Micronutrients (kg fed^{-1})		
		N	P	K	Fe	Mn	Zn
				2007			
Control		9.79	2.12	3.53	29	41	13
Coating	0.1 (g)	21.66	6.95	9.14	67	91	32
	0.2 (g)	24.48	8.88	10.40	80	106	39
	0.3(g)	25.25	9.22	11.20	85	114	46
Soaking	150(ppm)	35.83	12.30	16.31	112	142	61
	250(ppm)	38.07	13.42	18.06	126	154	68
	350(ppm)	39.99	14.64	19.15	135	166	79
Foliar	150(ppm)	23.13	6.81	7.85	64	89	31
	250(ppm)	25.13	7.88	10.86	77	98	38
	350(ppm)	26.13	8.78	11.78	81	103	43
				2008			
Control		11.42	2.91	4.26	35	48	61
Coating	0.1 (g)	23.30	8.12	10.41	73	102	37
	0.2 (g)	25.01	9.32	11.31	85	115	41
	0.3(g)	29.87	9.67	11.86	92	121	48
Soaking	150(ppm)	38.52	13.02	16.82	122	157	65
	250(ppm)	41.93	15.32	19.95	142	176	81
	350(ppm)	44.38	16.35	20.73	149	184	90
Foliar	150(ppm)	23.96	7.42	8.91	70	97	36
	250(ppm)	25.32	8.36	12.23	81	105	43
	350(ppm)	25.85	9.05	12.71	86	110	47
LSD % 5 Methods		0.29	0.13	1.89	2.11	ns	0.32
LSD% 5 Rate		0.55	0.10	ns	2.38	ns	0.36

In the case of grains, the results disclosed that Mn, Zn, N and P uptake is significantly affected by the different methods application and rates of chelated micronutrients. Nonetheless, Fe showed such trend with the rates of application only. Moreover, K recorded no significant effect due to either application methods or rates, while Fe gave the same trend with application methods only. The data indicates that the efficiency of applying micronutrients by seed soaking method in correcting micronutrients deficiency that improve nutrient balance, use of NPK fertilizers and yield in turn. It can be noted that micronutrient treatments caused the highest increase in macro and micronutrients. In this respect, Wang and Song (2005) noted that soaking rice seeds in zinc solution at a concentration of 0.3 mg/L led to increase in germination rate, seed activity and membrane penetration of seeds. Furthermore, Attia et al. (2007) revealed that applying micronutrients by seed soaking method was very effective in improving the uptake of macro and micronutrients in grain yield of rice plant.

It is worth mentioning that treated rice grains with soaking method at the rate of 350 $mgkg^{-1}$ from a mixture chelated compound achieved the best results. In other words, soaking method was more suitable for rice. It is worthy also to note that pH and EC of the soil were dropped after harvesting; pH was dropped from 8.29 to7.93 and EC from 17.36 to 12.36.

Table (7): Macro-Micronutrients uptake in rice grain (2007 – 2008)

Treatments	Zn +Mn +Fe	Macronutrients ($kg\ fed^{-1}$)			Micronutrients ($kg\ fed^{-1}$)		
		N	P	K	Fe	Mn	Zn
2007							
Control		37.42	2.85	15.70	141	77	54
Coating	0.1 (g)	60.55	5.86	25.35	218	124	96
	0.2 (g)	64.91	7.16	26.52	242	141	108
	0.3(g)	66.34	7.70	29.10	273	154	114
Soaking	150(ppm)	86.42	10.30	39.31	368	206	159
	250(ppm)	92.14	11.40	42.00	410	225	186
	350(ppm)	97.32	12.50	43.40	424	230	194
Foliar	150(ppm)	58.28	5.45	24.87	227	126	101
	250(ppm)	65.10	7.16	29.73	251	140	120
	350(ppm)	69.10	8.00	31.17	277	149	131
2008							
Control		40.10	3.49	16.96	156	85	43
Coating	0.1 (g)	61.57	6.61	26.42	233	130	104
	0.2 (g)	66.43	7.89	28.61	266	149	127
	0.3(g)	67.47	8.25	29.74	295	162	150
Soaking	150(ppm)	88.35	11.59	40.73	385	222	197
	250(ppm)	94.45	12.75	43.14	421	242	212
	350(ppm)	120.00	15.37	51.00	502	281	247
Foliar	150(ppm)	61.35	6.18	25.21	235	133	117
	250(ppm)	67.05	7.71	28.00	270	152	133
	350(ppm)	71.54	8.94	31.71	295	168	146
LSD % 5 Methods		0.094	0.162	ns	ns	2.48	0.46
LSD% 5 Rate		0.105	0.181	ns	31.32	2.44	0.44

Conclusion

In the light of the obtained results, it can be concluded that using of soaking method application at a rate of 350mg/Kg^{-1} from a chelated compound mixture of micronutrients namely Fe, Mn and Zn could improve the yield of rice plant and its component in a newly reclaimed saline soil.

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استجابة نبات الأرز النامي فى الأراضي الملحية المستصلحة حديثاً للمعاملة بمخلوط من العناصر الصغري باستخدام طرق ومعدلات مختلفة للإضافة

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أجريت تجربتان حقليتان خلال الموسم الصيفي ٢٠٠٧ و٢٠٠٨ في منطقة جنوب سهل الحسينية بمزرعة خاصة بقرية الرضوان بمحافظة الشرقية. لدراسة تأثير اختلاف طرق الإضافة (تغليف- نقع- رش) لبعض العناصر الصغرى حديد ومنجنيز وزنك في الصورة المخلبيةEDTA، وكانت معدلات الإضافة ٠.١ و٠.٢ و٠.٣ جرام لكل كيلو جرام حبوب الأرز في طريقة التغليف، بينما استخدمت تلك العناصر بتركيز ١٥٠ و٢٥٠ و٣٥٠ ملليجرام/كجم من الحبوب وذلك لكل عنصر بطريقة النقع والرش. وتم النقع لحبوب الأرز لمدة ٢٤ ساعة في محلول حجمه ١٠٠ للتر، والرش بمعدل ٢٠٠لتر للفدان، وذلك لدراسة تأثيرها على إنتاجية محصول الأرزصنف جيزة ١٧٨، وتركيز العناصر الكبرى والصغرى وكذلك الكمية الممتصة من تلك العناصر في قش وحبوب الأرز .

وقد أوضحت النتائج ما يلي:

زاد محصول الحبوب المعاملة بتلك العناصر المخلبية الحديد والمنجنيز والزنك حيث وجد أن نسبة الزيادة في محصول الحبوب المعاملة بالنقع تتراوح من ١٤٢.٢٣% إلى ١٧٨.٨١%، وكذلك الحبوب المعاملة بالتغليف من ٨٥.٨% إلى ١١٧.٤٢%، وأيضًا المعاملة بالرش كانت الزيادة في محصول الحبوب من ٨٩.٥٧ إلى ١١٢.٠٨% بالمقارنة بالكنترول.

وجد أنه بزيادة معدلات الإضافة تحت طرق الإضافة المختلفة تؤدى إلى زيادة محصول الحبوب والقش، بينما لم يكن هناك تأثير على وزن ١٠٠٠ حبة .

فقد أوضحت النتائج أن لطرق ومعدلات الإضافة المختلفة تأثير معنوي على تركيز الفسفور، ولكن ليس لها تأثيرًا معنويًا على تركيز النيتروجين والبوتاسيوم.
أما بالنسبة لتأثير طرق الإضافة على حبوب الأرز والقش فقد أظهرت أنه يمكن ترتيبها كما يلى: المعاملة بالنقع > معاملة التغليف > الرش.

- بالنسبة لتركيزا ت كل من الحديد والمنجنيز والزنك فى القش فقد وجد أن هناك تأثير معنوي لكل من طرق ومعدلات الإضافة إما فى الحبوب فإنه لم يكن هناك تأثير معنوي لكل من طرق ومعدلات الإضافة لعنصري الحديد والمنجنيز بينما كان التأثير معنوي لعنصر الزنك فقط.
- اشارت النتائج الى زيادة الكمية الممتصة لكل من النيتروجين –الفوسفور-الحديد والزنك زيادة معنوية فى القش وقد لوحظت ايضا هذه الزيادة المعنوية فى الكمية الممتصة وذلك لكل من النيتروجين–الفوسفور–المنجنيز والزنك في محصول الحبوب.
- يتضح من النتائج أن تأثير طرق الإضافة بالنسبة للعناصر الصغري يمكن ترتيبها كما يلى: النقع ثم التغليف ثم الرش. واخيرًا فقد تبين أن أفضل طرق الإضافة هو النقع وذلك باستخدام ٣٥٠ مليجرام/كيلو جرام حيث حققت أعلى إنتاجية فى محصول الأرز ومحتوياته

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