Menoufia J. Soil Sci., Vol. 2 April (2017): 119 - 134

BALANCED FERTILIZATION OF NITROGEN AND MICRONUTRIENTS FOR WHEAT GROWN IN SALT AFFECTED SOILS

R. A. El-Dissoky[(1)], R. A. Ramadan[(2)] and I. A. A. Hegab[(1)]
Soils, Water and Environment Res. Inst., Agric. Res. Center. Giza, Egypt.
Wheat Res. Dept., Field Crops Res. Inst., Agric. Res. Center. Giza, Egypt.
R.eldissoky@yahoo.com

Received: Feb. 13 , 2017 Accepted: Mar. 6 , 2017

ABSTRACT: *The balanced fertilization become necessary for sustainable agriculture under conditions of old and newly soils. Moreover the balanced fertilization under stress conditions especially salinity stress becomes more important. Micronutrients are part of many crucial physiological plant processes which plants suffered from their uptake in salted affected soils, and combined application of N and micronutrients helps in improving plant growth, yield and its quality. So, two field experiments were conducted at salt affected soils at Tag Al-Ezz Research station (Latitude 30.9° 68.6' N, Longitude 31.6° 96.5" E), Dakahlia Governorate, Egypt, during growing winter seasons of 2014/2015 and 2015/2016, to evaluate the effect of applying rates of N fertilizer (50, 75 and 100 % of recommended N "i.e. 75 kg N fed^{-1}") along with foliar application of micronutrients in chelated form; Fe- EDTA, Zn- EDTA and Mn-EDTA (F_0: control, F_1: two sprays at tillering and elongation stages and F_2: three sprays at tillering, elongation and heading stages) on wheat yield and its components, grain quality, NPK and micronutrients contents as well as K/Na ratio in straw and grain. Results showed that all parameters of wheat yield were significantly increased with foliar application of micronutrients at the three stages (tillering, elongation and heading stages), under nitrogen fertilization rate 100 % of recommended N (75 kg N fed^{-1}). Also, the results reveal that grain quality, i.e. 1000-grain weight, protein %, P, Fe and Zn concentrations significantly increased with nitrogen rates and foliar micronutrients applications. The uptake of macro and micro nutrients increased with increasing N rate and number of sprays micronutrients. Plant growth improved under the condition of salt affected soil with foliar spraying micronutrients and the highest N rate (75 kg N fed^{-1}), and this was clear from plant height, straw and grain yields and concentrations of K and Na and K/Na ratio. Interaction between the highest N rate and foliar spray of micronutrients at three growth stages recorded the highest mean of grain yield (19.24 ardab fed^{-1}) and straw yields (5368 kg fed^{-1}).*

Key words: *Micronutrients, nitrogen, salt affect soils and wheat yield.*

INTRODUCTION

Wheat (*Triticum aestivum,* L.) is the first strategic cereal crop in Egypt, and there is a gap between production and consumption. Increasing wheat production could be achieved through maximizing the yield per unit area or invading deserts to expand the cultivated area and/or raise the productivity of salinity soils that is one of the major problems that face Egyptian agriculture, because of semiarid climate and shortage of irrigation water, which return on productivity of crops that decreased in these soils. Salinity can change the micronutrient concentrations in plants, depending upon the type of crop species and levels of salinity (Sharpley, *et al.,* 1992). Hu and Schmidhalter (2001) found that the effects of salinity on concentrations of Mn, Zn, Fe and B in plants are complex, and the changes in Mn, Zn, Fe and B concentrations under saline conditions depended upon the levels of macronutrients and salinity and the plant organs. Faizy, *et al*., (2010) showed that grain yield of wheat significantly decreased by about 13.74% and 24.11% and straw yield by about 23.46% and 32.85% with increasing soil salinity levels to 5.4 and 10 dSm^{-1}, respectively. Ghogdi *et al*., (2012) found that salinity stress (5, 10, 15 dSm^{-1}) decreased K^+ content, K^+/Na^+ ratio and grain yield; however Na^+ content in all the genotypes of wheat were increased. They also, showed that the salinity tolerance in tolerant cultivars as clearly by lower decrease in grain yield is associated with the lower sodium accumulation and higher K^+/Na^+ compared to the sensitive cultivars.

Fertilization plays a vital role under salinity conditions for improving plant productivity, especially foliar fertilization. As mentioned by many researchers, the efficiency of foliar fertilization is higher than that of soil fertilizer application in these situations. El-Fouly *et al.,* (2001) noted that application of micronutrients to wheat showed positive effects on growth and nutrients uptake under treatment of salinity. They concluded that foliar application of micronutrients could enhance salinity tolerance. Ling and Silberbush, (2002) illustrated that foliar nutrients application under drought and salinity conditions may be able to exclude or include water. Sairam and Tyagi (2004) suggested that foliar spraying with micronutrients, especially Fe, Mn and Zn increased yield crops and mineral contents of many plants types under saline stress conditions.

Many researches provided the importance of micronutrients; Mengle and Kirkby (2001) showed that micronutrients are essential elements for plant life particularly under limited condition. Iron (Fe), zinc (Zn), copper (Cu) and manganese (Mn) are essential micronutrients for plants and humans, and a deficiency of just one of these nutrients can greatly reduce plant yield and even cause plant death. Micronutrient deficiency, especially Fe and Zn deficiency is widespread in humans (FAO, 2002).

Abd El-Magid (2001) found that the mixture of Zn + Fe + Mn gave highest protein content in leaves and kernels as well as yield of wheat and barley. In field study in salt affected soils, Nassar *et al.,* (2004) found that to obtain the highest economic wheat grain and straw yields, wheat plants must fertilized with the optimum rate of N (75 kg N fed^{-1}), they also showed that foliar spray of micronutrients promote the use efficiency of N-fertilization, and reflected on grain and straw yields and gave better nutritive content than the control (plants fertilized with recommended dose of N and did not spray with micronutrients). Abu El-Fotoh *et al.,* (2006) reported that application of 75 kg N fed^{-1} + 100 kg single super phosphate + 50 kg potassium sulphate fertilizer in combination with foliar application of 0.2 g/L of each chelate Zn, Fe and Mn caused significant increment in wheat grain yield under salinity clayey soil condition. Also, they showed that wheat grain yield increased by 19 % with foliar micronutrients.

Marschner (1995) reported that Zn-deficient plants reduced the rate of protein synthesis and protein content drastically but increased the accumulation of amino acids. Negm and Zahran (2001) found that foliar application of 1 g mixture 1:1:1/L of Fe-chelate, Zn-chelate and Mn-chelate at booting stage only or along with either tillering or elongation stage had the most significant effect on increasing wheat grain and straw yields on sandy soils. In field experiment on clay loam soil, Habib (2009) showed that foliar application of Zn and Fe at tillering and heading stages increased grain yield and its quality compared with control, since Zn concentration increased from 12.17 to 20.27 mg. kg^{-1} and Fe concentration increased from 84.93 to 139.6 mg. kg^{-1}. Also, Zeidan *et al.,* (2010) indicated that grain yield, straw yield, 1000-grain weight and number of grains/spike, Fe, Mn and Zn concentrations in grain and protein content were significantly increased by foliar application of micronutrients (1% $FeSO_4$, 0.5% $ZnSO_4$ and 0.5% $MnSO_4$) at tillering and heading stages. Moreover, Mahrous *et al.,* (2010) in field study under saline soil condition, showed that twice foliar spray with mixture of 0.3g Zn-EDTA+ 0.3g Mn-EDTA+ 0.3g Fe-EDTA + 100 kg N/fed as ammonium nitrate+ 100 kg calcium super phosphate + 50 kg potassium sulfate + 10 m^3 compost/fed recorded the highest values of wheat growth, yield and mineral concentration of N, P, K, Fe, Zn and Mn in grains.

Abd El-Hadi (2015) showed that foliar application of Zn, Mn and Fe-chelates increased wheat grain yield by 0.65 t/fed and straw yield by 1.2 t/fed, however the increases in grain and straw yields were lower by spraying Fe and Mn chelates. Also, he showed that grain yield increases ranged from 3-12 %. Foliar application of plant nutrients especially micro-nutrients proved to be useful for several plants species in soils of high pH values as that in Egyptian soils. Wheat is one of the crops which show a great response to foliar application (Abd El-Hadi, 2015). Bakry *et al.,* (2016) showed that foliar application of 4.5 g/L zinc-chelate gave the best results for wheat grain yield, protein % and harvest index. Also, Ezatollah *et al.,* (2016) showed that foliar spray of zinc sulphate (2 g/L) at different wheat growth stages increased grain yield, number of grains/spike, plant height and grain contents of zinc and ascorbic acid.

Increasing Zn and Fe concentration of food crop plants, resulting in better crop production and improved human health is an important global challenge. Zinc deficiency is currently listed as a major risk factor for human health and causes of death globally. Cereals are the major source of Zn for the world's population chiefly for the poor people of the third world countries (WHO, 2002 and FAO, 2002). Stepien and Wajtkowiak (2016) illustrated that mineral NPK fertilization, combined with micronutrients (Cu +Zn +Mn) increased Cu and Zn content in grain by 22.6 % and 17.7 % respectively.

So, the main objectives of this investigation were to achieve to the balanced fertilization of nitrogen and micronutrients which improve growth and productivity of wheat grown in salt affected soils.

MATERIALS AND METHODS

Two field experiments were conducted at Tag Al-Ezz Agricultural Research Station– Agricultural Research Center *(Latitude 30.9° 68.6′ N, Longitude 31.6° 96.5" E)*- Dakahlia Governorate, Egypt, during winter growing seasons of 2014/2015 and 2015/2016 to evaluate the effect of different N rates and foliar spray of micronutrients in chelated form (Fe-EDTA, Zn-EDTA and Mn-EDTA) at different growth stages for achievement to balanced fertilization which recognize the optimum yield the highest quality and nutrients uptake under salt affected soil.

Data in Table (1) show some soil properties of the experimental field before sowing, according to Jackson (1967) and Page (1982).

Wheat variety Sakha 93 was sown on 20 November 2014, and harvested on 5 May 2015 in 1st season, while it was sown on 15 November 2015 and harvested on 1st May 2016 in 2nd season. The two experiments were designed in split plot design with three replicates; plot area was 10.5 m^2. The main plots were assigned to three N rates i.e. 50, 75 and 100 % of recommended N rate (I,e, N_1: 37.5, N_2: 56.25 and N_3: 75 kg N fed^{-1}). The sub plots were for treatments of foliar micronutrients spraying; F_0: control (without foliar spraying), F_1: two foliar sprays at tillering (after 30 days from sowing) and elongation (after 45-50 days) stages and F_2: three foliar sprays at tillering, elongation and heading (after 70-75 days) stages. Spraying solution volume was 200 L fed^{-1}. Micronutrient concentrations were 0.3 g L^{-1} from each nutrient chelate (Fe-EDTA: 13% Fe, Zn-EDTA: 14% Zn and Mn-EDTA: 13% Mn) with concentration of 39 mg Fe L^{-1}, 42 mg Zn L^{-1} and 39 mg Mn L^{-1}.

Table 1: Some chemical and physical properties of the soil before sowing.

Properties		1st Season	2nd Season	Properties		1st Season	2nd Season
particles size distribution	Sand %	17.75	18.60	**EC (dSm^{-1})		6.06	5.15
	Silt %	36.80	35.15	Soluble Cations (meq L^{-1})	Ca^{++}	14.19	12.85
	Clay %	45.45	46.25		Mg^{++}	10.40	8.60
	Texture	Clay	Clay		Na^{+}	33.45	27.70
SP %		60.0	63.0		K^{+}	2.56	2.35
O.M %		0.43	0.57	Soluble anions (meq L^{-1})	CO_3^{--}	--	--
$CaCO_3$ %		1.35	1.77		HCO_3^{-}	1.98	1.90
*pH		8.28	8.28		Cl^{-}	37.00	30.10
ESP		6.05 %	5.80 %		SO_4^{--}	21.62	19.50
Available N, P and K (mg kg^{-1})				Available Fe, Zn and Mn (mg kg^{-1})			
N		23	25	Fe		2.0	2.0
P		9	10	Zn		0.75	0.80
K		270	280	Mn		1.6	1.7

*pH: determined in 1:2.5 soil : water suspension, ** EC: determined in soil paste extract.

Phosphorus was applied to all plots as calcium super phosphate fertilizer (15% P_2O_5) at the rate of 200 kg fed^{-1} (30 kg P_2O_5 fed^{-1}) before sowing. Potassium was also applied to all plots as potassium sulphate (48% K_2O) at the rate of 50 kg fed^{-1} (24 kg K_2O fed^{-1}) at sowing. N-fertilizer rates (N_1: 37.5, N_2: 56.25 and N_3: 75 kg N fed^{-1}) were applied as ammonium nitrate fertilizer (33.5 % N), at two equal doses with first and second irrigation after sowing.

At harvest, plant height, number of spikes/m^2, spike length, biological yield, 1000-grain weight, grain and straw yield parameters were recorded. Samples of grain and straw were taken for chemical analysis to determine nitrogen, phosphorus, potassium, sodium, iron, zinc and manganese concentrations according to Jackson, (1967), and then the uptake of these nutrients was calculated. The ratio between K and Na in straw and grain (K/Na ratio) was calculated by dividing K % over Na %. Protein was calculated by multiplying "N % in grains × 5.7". Iron, zinc and manganese were determined using atomic adsorption plasma - ULTIMA 2- ICP- OES (Inductively Coupled Plasma Optical Emission Spectrometry) in the Unite of Soil and Water Analysis at Soils, Water and Environment Research Institute, ARC, Egypt.

The statistical analysis was estimated according to Gomez and Gomez (1984), and combined analysis was done over both seasons, then means values were compared against least significant differences test L.S.D. at 5 %.

RESULTS AND DISCUSSION

Plant height and some yield components:

Data in Table 2 show that plant height, spikes No./m^2, spike length and 1000-grain weight were significantly increased with increasing nitrogen rate (NR) up to N_3 (100

% N). The recommended NR (75 kg N fed^{-1}) recorded the highest mean values of plant height (93.3 cm), spike No./m^{2} (289), spike length (13.79 cm) and 1000 grain weight (41.8 g). These results illustrate that the superiority was for the 100 % N (N_3 =75 kg N fed^{-1}), and this result agreea with that obtained by Nassar *et al.,* (2004), Mosaad *et al.,* (2013) and El-Dissoky (2013).

As for the effect of interaction, it is obvious from the results in Table 2 that an integration effect was happened through the interaction between N-rates (NR) and foliar spray of micronutrients. The interaction had a significant effect on 1000-grain weight, plant height, spike length and spike No./m^{2} in one season only, while the averages of the seasons for these parameters except spike length were significantly affected by this interaction. It is clear from the results that interaction between N_3 and F_2 had the highest mean values of plant height (95.6 cm), spikes No./m^{2} (292), spike length (14.33 cm) and 1000-grain weight (42.3 g). Also, these results are in accordance with those obtained by Nassar *et al.,* (2004) and Mahrous *et al.,* (2010) who found that foliar spray with mixture of 0.3 g of each of Zn-EDTA, Mn-EDTA and Fe-EDTA with N-fertilization recorded the highest values of wheat growth.

Table 2: Effect of nitrogen and micronutrients fertilization on plant height and some yield components of wheat grown in salted affected soils.

Characteristics / Treatments		Plant Height (cm)			No. of Spikes/m^{2}			Spike Length (cm)			1000-Grain weight (g)		
		1st season	2nd season	Mean (combine)	1st season	2nd season	Mean	1st season	2nd season	Mean (combine)	1st season	2nd season	Mean (combine)
Nitrogen rates effect:													
N_1		74.8^{c}	86.6^{c}	80.7^{c}	266^{b}	276^{c}	271^{c}	11.98^{c}	12.08^{c}	12.03^{c}	38.5^{c}	38.7^{c}	38.6^{c}
N_2		84.4^{b}	93.8^{b}	89.1^{b}	280^{a}	282^{b}	281^{b}	12.69^{b}	13.19^{b}	12.94^{b}	40.6^{b}	41.2^{b}	40.9^{b}
N_3		87.8^{a}	98.7^{a}	93.3^{a}	287^{a}	292^{a}	289^{a}	13.64^{a}	13.94^{a}	13.79^{a}	41.5^{a}	42.2^{a}	41.8^{a}
Micronutrients effect:													
F_0		78.8^{c}	89.1^{c}	83.9^{c}	270^{b}	277^{b}	274^{c}	12.22^{c}	12.38^{c}	12.30^{c}	39.3^{c}	40.0^{c}	39.6^{c}
F_1		83.1^{b}	93.8^{b}	88.4^{b}	279^{a}	285^{a}	282^{b}	12.87^{b}	13.19^{b}	13.03^{b}	40.3^{b}	40.8^{b}	40.5^{b}
F_2		85.2^{a}	96.1^{a}	90.6^{a}	283^{a}	288^{a}	285^{a}	13.22^{a}	13.64^{a}	13.43^{a}	41.0^{a}	41.2^{a}	41.1^{a}
Interaction effect:													
N_1	F_0	70.8^{f}	83.0	76.9^{f}	253^{e}	267	260^{e}	11.50	11.17^{e}	11.33	36.8g	37.9	37.3^{g}
	F_1	73.7^{e}	86.8	80.3^{e}	269^{d}	280	275^{cd}	12.03	12.37^{d}	12.20	38.8^{f}	38.7	38.7^{f}
	F_2	80.0^{d}	89.8	84.9^{d}	277^{cd}	282	279^{cd}	12.40	12.70^{d}	12.55	39.8^{e}	39.4	39.6^{e}
N_2	F_0	80.5^{d}	89.5	85.0^{d}	274^{d}	277	276^{d}	12.17	12.50^{d}	12.33	40.1^{de}	40.5	40.3^{d}
	F_1	86.8^{bc}	94.8	90.8^{bc}	281^{bc}	283	282^{bc}	12.77	13.17^{c}	12.97	40.6^{cd}	41.4	41.0^{c}
	F_2	85.8^{c}	97.0	91.4^{b}	284^{ab}	286	285^{b}	13.13	13.90^{b}	13.52	41.1^{bc}	41.6	41.4^{c}
N_3	F_0	85.0^{c}	94.8	89.9^{c}	284^{ab}	287	285^{b}	13.00	13.47^{c}	13.23	41.0^{bc}	41.6	41.3^{c}
	F_1	88.7^{ab}	99.8	94.3^{a}	288^{ab}	293	291^{a}	13.80	14.03^{ab}	13.92	41.5^{ab}	42.3	41.9^{b}
	F_2	89.8^{a}	101.3	95.6^{a}	289^{a}	295	292^{a}	14.13	14.33^{a}	14.23	41.9^{a}	42.7	42.3^{a}
LSD at 5%:													
Nitrogen		1.14	1.98	0.54	7.24	1.82	3.16	0.24	0.18	0.17	0.5	0.5	0.42
Micronutrients		1.19	0.78	0.60	3.73	2.84	2.66	0.29	0.20	0.16	0.4	0.2	0.22
Interaction		2.05	Ns	1.05	6.46	Ns	4.61	Ns	0.36	Ns	0.8	Ns	0.38

Wheat Yield:

Data obtained in Table 3 show that application of NR significantly increased wheat biological, grain and straw yields up to N_3, since the differences between values of N_3, N_2 and N_1 were significant in both seasons. On average of the two seasons (combined analysis), grain yield increased by 26.81 and 42.40 % with N fertilization rates N_2 and N_3 (75 and 100 % of the recommended N) compared with N_1 (50 % N), also straw yield increased by 25.09 and 42.73 %, respectively. This result agreed with those obtained by Nassar *et al.,* (2004), Moasad *et al.,* (2013) and El-Dissoky *et al.,* (2013).

Also, data reveal that foliar application of chelated micronutrients; Fe-EDTA, Zn-EDTA and Mn-EDTA had significant effect on wheat yield in both seasons. The highest means of biological yield (7168 kg fed^{-1}), grain yield (16.86 ard. fed^{-1}) and straw yield (4640 kg fed^{-1}) were recorded with three foliar sprays of micronutrient treatment F_2 during the growth stages; tillering, elongation and heading, respectively. This result shows the importance of foliar micronutrient application at heading growth stage, and this may be attributed to improving the flowering and the translocation of carbohydrate and starch to grain which reflected on grain filling, 1000-grain weight and grain yield. These results are in accordance with Zeidan *et al.,* (2010), Abd El-Hadi (2015) and Ezatollah *et al.,* (2016).

Table 3: Effect of nitrogen and micronutrients fertilization on yield of wheat grown in salted affected soils.

Characteristics / Treatments		Biological yield (kg fed^{-1})			Grain yield (ard. fed^{-1})			Straw yield (kg fed^{-1})		
		1st season	2nd season	Mean (combine)	1st season	2nd season	Mean (combine)	1st season	2nd season	Mean (combine)
Nitrogen rates effect:										
N_1		5147^{c}	5703^{c}	5425^{c}	12.27^{c}	13.38^{c}	12.83^{c}	3305^{c}	3697^{c}	3501^{c}
N_2		6336^{b}	7303^{b}	6819^{b}	15.67^{b}	16.86^{b}	16.27^{b}	3984^{b}	4773^{b}	4379^{b}
N_3		7414^{a}	8060^{a}	7737^{a}	17.68^{a}	18.86^{a}	18.27^{a}	4762^{a}	5232^{a}	4997^{a}
Micronutrients effect:										
F_0		5738^{c}	6396^{c}	6067^{c}	13.97^{c}	15.08^{c}	14.53^{c}	3642^{c}	4134^{c}	3888^{c}
F_1		6329^{b}	7163^{b}	6746^{b}	15.41^{b}	16.55^{b}	15.98^{b}	4017^{b}	4681^{b}	4349^{b}
F_2		6830^{a}	7507^{a}	7168^{a}	16.25^{a}	17.47^{a}	16.86^{a}	4393^{a}	4887^{a}	4640^{a}
Interaction effect:										
N_1	F_0	4493^{i}	5144^{h}	4819	10.99	12.08^{i}	11.53^{i}	2845^{g}	3332^{g}	3089
	F_1	5263^{h}	5819^{g}	5541	12.49	13.66^{h}	13.08^{h}	3390^{f}	3770^{f}	3580
	F_2	5683^{g}	6147^{f}	5915	13.35	14.39^{g}	13.87^{g}	3681^{e}	3988^{e}	3835
N_2	F_0	5883^{f}	6561^{e}	6222	14.27	15.44^{f}	14.85^{f}	3743^{e}	4246^{d}	3994
	F_1	6377^{e}	7423^{d}	6900	15.99	16.98^{e}	16.49^{e}	3978^{d}	4876^{c}	4427
	F_2	6747^{dc}	7923^{c}	7335	16.76	18.17^{c}	17.46^{c}	4233^{c}	5198^{b}	4716
N_3	F_0	6837^{c}	7483^{d}	7160	16.66	17.72^{d}	17.19^{d}	4338^{c}	4825^{c}	4581
	F_1	7347^{b}	8247^{b}	7797	17.75	19.00^{b}	18.37^{b}	4685^{b}	5397^{a}	5041
	F_2	8060^{a}	8450^{a}	8255	18.64	19.84^{a}	19.24^{a}	5263^{a}	5473^{a}	5368
LSD at 5 %:										
Nitrogen		192.2	47.7	83.1	0.38	0.35	0.25	175.3	89.6	90.1
Micronutrients		105.8	79.2	65.3	0.22	0.17	0.12	103.3	74.7	61.5
Interaction		183.3	*137.3*	*Ns*	*Ns*	*0.29*	*0.21*	*178.9*	*129.3*	*Ns*

ard. =ardab =150 kg.

Concerning the effect of interaction, data in Table 3 and Fig. 1 show the significant effect of interaction on biological and straw yields in both seasons and grain yield in the 2nd season. As for the combined analysis of the two seasons, it is obvious from the results that interaction between N rates and micronutrient significantly increased the yield of grain up to 19.24 ard. fed^{-1} at N_3×F_2 interaction. The highest values (combined analysis of two seasons) of biological yield (8255 kg fed^{-1}), grain yield (19.24 ard. fed^{-1}) and straw yield (5368 kg fed^{-1}) were recorded under the interaction of N_3 and F_2. So, this result illustrate the integration of N fertilization and and foliar spray of micronutrients chelated Fe-EDTA, Zn-EDTA and Mn-EDTA at plant growth stages; tillering, elongation and heading. This may be attributed to the balance between nitrogen supply and micronutrient nutrition and plant requirements' in salt affected soils, and these results are agreed with El-Fouly *et al.,* (2001), Hu and Schmidhalter (2001), Sairam and Tyagi (2004) and Nassar *et al.,* (2004).

Grain contents of protein, P, Fe and Zn (as grain quality):

Data in Table 4 illustrate that wheat grain contents of protein, P, Fe and Zn significantly improved with application of NR up to N_3 (75 kg N fed^{-1}) and foliar spray of chelated micronutrients Fe-EDTA, Zn-EDTA and Mn-EDTA up to F_2 (3 sprays). It's obvious from the results that values protein %, phosphorus %, and iron and zinc concentrations were the highest with NR-N_3 and F_2. Interaction between NR and treatments of micronutrients significantly affected grain P content while protein, Fe and Zn were insignificantly affected (as shown in Table 4 and Figs, 2 and 3). Application of NR-N_3 (75 kg N fed^{-1}) with 3 foliar sprays of Fe-EDTA, Zn-EDTA and Mn-EDTA had the highest mean values of protein (16.18 %), P (0.428 %), Fe (128 mg kg^{-1}) and Zn (28.7 mg kg^{-1}). These results related with role of N in plant and the role of Fe, Zn and Mn in plant that reflected on translocation of amino acids, protein and Fe and Zn. Nitrogen is Necessary for photosynthesis, formation of amino acids, protein, vitamins, Aids in production and use of carbohydrates; as well as micronutrients are a part of certain enzyme system, carbohydrate and starch formation and seed formation Mengle and Kirkby (2001). These results agreed with Negm and Zahran (2001), Habib (2009), Zeidan *et al.,* (2010) and Ezatollah *et al.,* (2016).

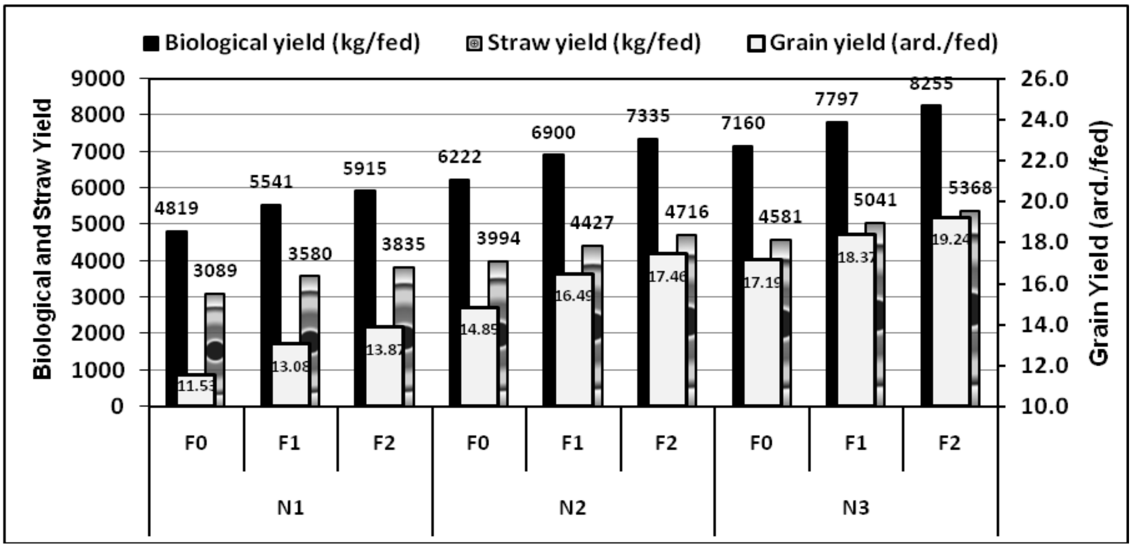

Fig. 1: Effect of interaction between NR and foliar micronutrients on wheat yield.

Table 4: Effect of nitrogen and micronutrients fertilization on grain contents of protein, P, Fe and Zn of wheat grown in salted affected soils.

Characteristics		Protein %			P %			Fe (mg kg^{-1})			Zn (mg kg^{-1})		
		1st season	2nd season	Mean (combine)	1st season	2nd season	Mean (combine)	1st season	2nd season	Mean (combine)	1st season	2nd season	Mean (combine)
Nitrogen rates effect:													
N_1		14.04^{b}	14.89^{c}	14.47^{c}	0.39^{b}	0.40^{b}	0.39^{b}	97^{b}	92^{c}	94^{c}	22.6^{c}	21.5	22.0^{c}
N_2		14.71^{b}	15.26^{b}	14.98^{b}	0.42^{a}	0.42^{a}	0.42^{a}	121^{a}	103^{b}	112^{b}	26.6^{b}	22.4	24.5^{b}
N_3		15.41^{a}	15.94^{a}	15.67^{a}	0.42^{a}	0.43^{a}	0.42^{a}	127^{a}	116^{a}	121^{a}	29.3^{a}	23.4	26.3^{a}
Micronutrients effect:													
F_0		13.72^{b}	14.61^{b}	14.17^{b}	0.40^{c}	0.41^{b}	0.40^{c}	107^{b}	93^{c}	100^{c}	24.0^{c}	17.8^{b}	20.9^{b}
F_1		15.03^{a}	15.67^{a}	15.35^{a}	0.41^{b}	0.42^{a}	0.42^{b}	116^{a}	105^{b}	110^{b}	26.8^{b}	24.8^{a}	25.8^{a}
F_2		15.41^{a}	15.80^{a}	15.61^{a}	0.41^{a}	0.42^{a}	0.42^{a}	121^{a}	113^{a}	117^{a}	27.7^{a}	24.7^{a}	26.2^{a}
Interaction effect:													
N_1	F_0	13.06	14.30	13.68	0.37^{e}	0.38^{e}	0.37^{f}	89	82	85	21.0	16.7	18.8
	F_1	14.35	15.08	14.71	0.39^{d}	0.40^{d}	0.40^{e}	99	94	96	23.3	24.1	23.7
	F_2	14.73	15.30	15.01	0.40^{c}	0.41^{d}	0.40^{d}	103	101	102	23.5	23.7	23.6
N_2	F_0	13.30	14.58	13.94	0.41^{b}	0.42^{c}	0.41^{c}	110	94	102	24.9	17.6	21.3
	F_1	15.20	15.56	15.38	0.42^{ab}	0.43^{ab}	0.42^{b}	122	103	113	27.3	24.8	26.0
	F_2	15.63	15.63	15.63	0.42^{a}	0.43^{a}	0.42^{ab}	129	112	121	27.6	24.9	26.2
N_3	F_0	14.80	14.96	14.88	0.41^{b}	0.42^{bc}	0.42^{c}	122	104	113	26.0	19.2	22.6
	F_1	15.56	16.36	15.96	0.42^{a}	0.43^{a}	0.43^{a}	127	117	122	29.8	25.5	27.7
	F_2	15.87	16.49	16.18	0.42^{a}	0.43^{a}	0.43^{a}	130	126	128	31.9	25.5	28.7
LSD at 5%:													
Nitrogen		0.42	0.26	0.15	0.009	0.007	0.005	6.25	8.38	4.84	0.87	Ns	1.41
Micronutrients		0.38	0.43	0.30	0.004	0.004	0.003	6.85	7.59	5.49	0.97	0.94	0.97
Interaction		*Ns*	*Ns*	Ns	0.007	0.007	0.005	Ns	Ns	Ns	Ns	Ns	Ns

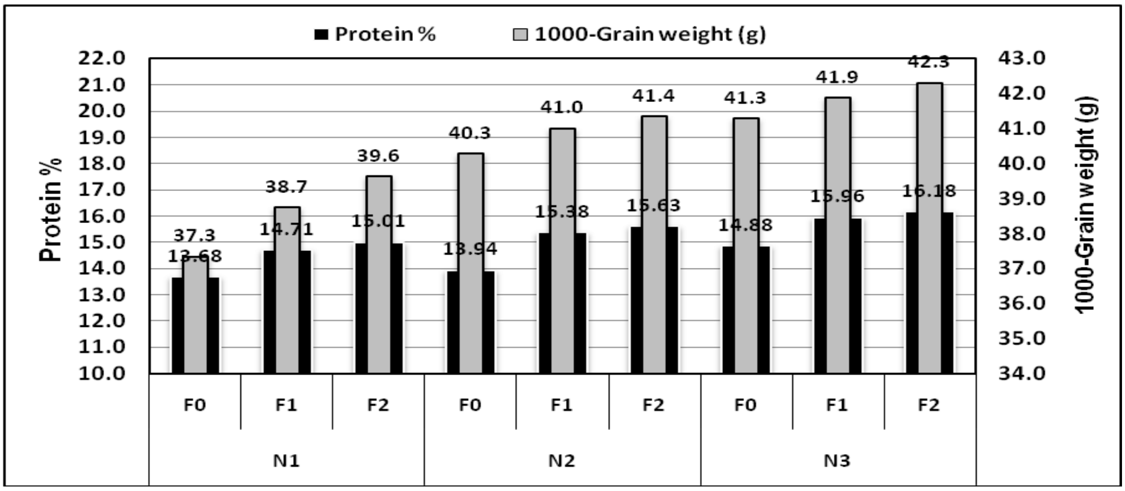

Fig. 2: Effect of interaction between NR and foliar micronutrients on protein % and 1000-grain weight.

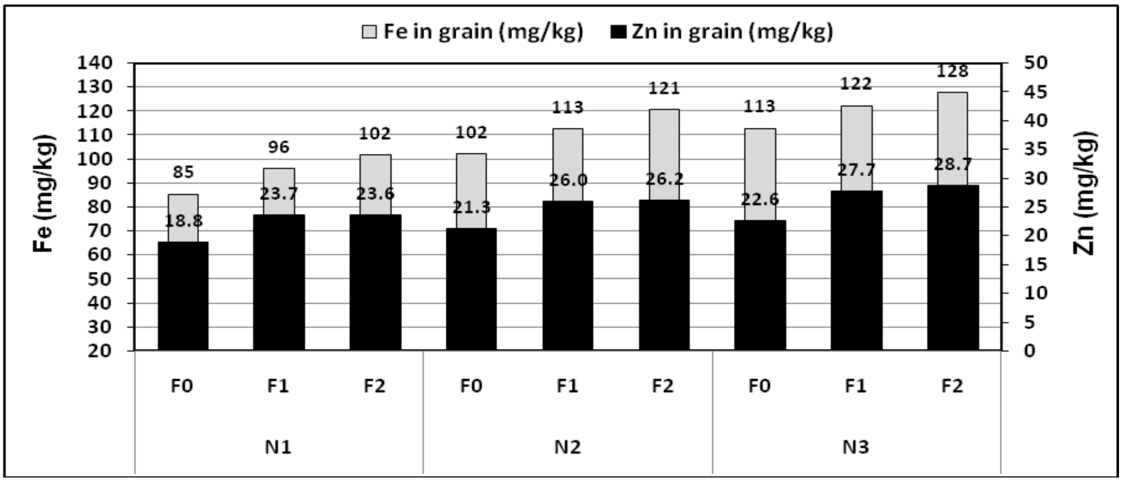

Fig. 3: Effect of interaction between NR and foliar micronutrients on Fe and Zn concentrations in grain.

NPK-uptake (kg fed^{-1}):

Data in Table 5 show that application of NR (N_1, N_2 and N_3) significantly increased N, P and K-uptake in wheat straw and grain yields in both seasons. The highest values of N, P and K- uptake in straw and grain yield were obtained by application of NR-N_3 (75 kg N fed^{-1}). These values of N, P and K-uptake are related with the previous results of growth and yield, which were the highest at NR-N3. These results agreed with Nassar *et al.,* (2004).

Also, data show that foliar application of chelated micronutrients Fe-EDTA, Zn-EDTA and Mn-EDTA significantly increased the uptake of N, P and K in both seasons, by increasing number of sprays, but P and K–uptake by straw were not significantly affected. Generally three foliar sprays (F_2) had significant effects on the uptake of N, P and K for straw and grain, and the highest values of N, P and K uptake were obtained by three foliar sprays of micronutrient. These results showed the importance of foliar spraying of micronutrients at heading stage of wheat which induced further increases in N, P and K uptake by plant. These results are in accordance with El-Fouly *et al.,* (2001), Mahrous *et al.,* (2010) and Zeidan *et al.,* (2010).

Concerning the effect of interaction, data obtained in the same Table (5) reveal that interaction between NR and foliar treatments of micronutrients significantly affected the uptake of N but not P and K uptake. The highest total N, P and K uptake were recorded under the interaction of $N_3 \times F_2$, and this effect agrees with its effect on wheat yield and its studied components. It is obvious from the results that foliar spray of chelated micronutrients Fe-EDTA, Zn-EDTA and Mn-EDTA at tillering, elongation and heading stages with NR fertilization at 75 kg N fed^{-1} (N_3) have integration effect on wheat plants and its productivity, and these may be return to the balance effect between macro and micronutrients and its requirements in plants (Hu and Schmidhalter, 2001). These results are in accordance with El-Fouly *et al*., (2001), Nassar *et al.,* (2004) and Abu El-Fotoh *et al.,* (2006).

Micronutrients Uptake:

Data in Table 6 show that application of NR significantly affected the uptake of Fe, Zn and Mn of wheat grain and straw. The highest uptake of Fe, Zn and Mn were recorded with NR-N_3, but these values of Fe, Zn and Mn-content were decreased with N rates N_2 and N_1. These results may be attributed to synergism correlation between N and these elements. The results are in agreement with those obtained by Nassar *et al.,* (2004).

Also, data in same Table reveal that the uptake of Fe, Zn and Mn of wheat grain and straw were significantly increased with foliar spray of micronutrients, but these increases were the highest with three foliar sprays (F_2), where the differences between F_2 and F_1 were significant for Fe, Zn and Mn-uptake. It is obvious from this result that foliar sprays of micronutrients at heading stage had significant effects on plant growth and its micronutrients contents, and showing the importance of foliar micronutrients at heading stage. This was in accordance with the results obtained by Habib (2009) and Ezatollah *et al.,* (2016) who showed the importance of foliar spray at heading stage.

As for the effect of interaction, data in Table (6) illustrate that values of Fe, Zn and Mn uptake in wheat straw yield, significantly increased with interaction between NR and foliar spray of micronutrients, but Fe-uptake in grain in both seasons, Zn-uptake in grain in 2nd seasons and Mn-uptake in grain in 1st season were insignificant. The highest values of Fe, Zn and Mn uptake in wheat grain and straw were with interaction of $N_3 \times F_2$, and these results show the integration and the balance of fertilizer supplies from N-fertilizer and micronutrients foliar spray on plant. These results agreed with Nassar *et al.,* (2004), Abu El-Fotoh *et al.,* (2006) and Ezatollah *et al.,* (2016).

Table 5: Effect of nitrogen and micronutrients fertilization on the uptake of nitrogen, phosphorus and potassium by wheat plants grown in salted affected soils.

Characteristics / Treatments	1st season						2nd season					
	N-Uptake (kg fed^{-1})		P-Uptake (kg fed^{-1})		K-Uptake (kg fed^{-1})		N-Uptake (kg fed^{-1})		P-Uptake (kg fed^{-1})		K- Uptake (kg fed^{-1})	
	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain
Nitrogen rates effect:												
N_1	55.8^{c}	48.2^{c}	3.5^{c}	7.2^{c}	33.9^{c}	6.8^{c}	53.0^{c}	49.6^{c}	4.2^{b}	8.0^{c}	40.6^{b}	7.7^{c}
N_2	71.9^{b}	63.0^{b}	4.1^{b}	9.8^{b}	40.3^{b}	9.1^{b}	73.9^{b}	65.6^{b}	4.5^{b}	10.8^{b}	47.3^{a}	10.3^{b}
N_3	87.6^{a}	74.3^{a}	4.9^{a}	11.1^{a}	45.2^{a}	10.7^{a}	92.8^{a}	76.5^{a}	5.8^{a}	12.1^{a}	49.7^{a}	12.1^{a}
Micronutrients effect:												
F_0	63.2^{c}	53.9^{c}	4.0^{a}	8.4^{c}	36.4^{c}	7.8^{c}	61.3^{c}	54.8^{c}	4.0^{b}	9.2^{c}	38.6^{b}	8.4^{c}
F_1	72.9^{b}	63.8^{b}	4.2^{a}	9.5^{b}	38.9^{b}	9.1^{b}	77.4^{b}	65.8^{b}	5.3^{a}	10.5^{b}	49.5^{a}	10.4^{b}
F_2	79.2^{a}	67.8^{a}	4.3^{a}	10.2^{a}	44.0^{a}	9.8^{a}	81.0^{a}	71.1^{a}	5.2^{a}	11.1^{a}	49.6^{a}	11.2^{a}
Interaction effect:												
N_1 F_0	45.1^{g}	41.3	3.3	6.1	29.2^{g}	5.8	45.2^{e}	41.5^{g}	3.6	6.8^{f}	35.1	6.4
N_1 F_1	58.9^{f}	49.6	3.8	7.3	32.5^{f}	7.2	55.3^{d}	51.6^{f}	4.6	8.3^{e}	42.7	8.1
N_1 F_2	63.5^{ef}	53.7	3.5	8.1	39.9^{de}	7.5	58.5^{cd}	55.8^{e}	4.5	8.8^{e}	43.9	8.6
N_2 F_0	66.6^{e}	54.8	3.9	8.8	38.4^{e}	8.0	62.8^{c}	54.0^{ef}	3.9	9.7^{d}	38.4	8.4
N_2 F_1	72.4^{d}	65.5	4.0	10.0	40.4^{d}	9.1	77.2^{b}	67.9^{d}	4.7	10.9^{bc}	51.1	10.8
N_2 F_2	76.7^{cd}	68.9	4.3	10.6	42.0^{bc}	10.2	81.7^{b}	74.7^{c}	5.1	11.7^{a}	52.5	11.6
N_3 F_0	78.1^{c}	65.6	4.9	10.3	41.7^{cd}	9.5	76.0^{b}	69.0^{d}	4.7	11.2^{c}	42.3	10.4
N_3 F_1	87.5^{b}	76.4	4.9	11.2	43.7^{b}	10.9	99.6^{a}	77.8^{b}	6.6	12.3^{b}	54.6	12.4
N_3 F_2	97.4^{a}	80.9	5.0	11.8	50.0^{a}	11.7	102.9^{a}	82.8^{a}	6.2	12.9^{a}	52.3	13.4
LSD at 5 %:												
Nitrogen	2.15	2.42	0.23	0.21	0.91	0.66	3.50	2.03	0.41	0.40	3.93	0.48
Micronutrients	2.85	1.91	Ns	0.18	1.07	0.33	3.64	1.68	0.33	0.14	2.56	0.43
Interaction	*4.95*	*Ns*	*Ns*	*Ns*	1.85	Ns	*6.31*	*2.91*	*Ns*	*Ns*	Ns	Ns

Table 6: Effect of nitrogen and micronutrients fertilization on the uptake of iron, manganese and zinc by wheat plants grown in salted affected soils.

Characteristics / Treatments		1st season						2nd season					
		Fe-Uptake (kg fed^{-1})		Mn-Uptake (kg fed^{-1})		Zn-Uptake (kg fed^{-1})		Fe-Uptake (kg fed^{-1})		Mn-Uptake (kg fed^{-1})		Zn-Uptake (kg fed^{-1})	
		Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain
Nitrogen Rates Effect:													
N_1		1.072^{c}	0.179^{c}	0.196^{c}	0.056^{c}	0.106^{c}	0.042^{c}	1.232^{c}	0.186^{c}	0.170^{c}	0.062^{c}	0.084^{c}	0.044^{c}
N_2		1.364^{b}	0.284^{b}	0.249^{b}	0.076^{b}	0.146^{b}	0.063^{b}	1.888^{b}	0.262^{b}	0.248^{b}	0.081^{b}	0.138^{b}	0.057^{b}
N_3		1.868^{a}	0.336^{a}	0.365^{a}	0.091^{a}	0.184^{a}	0.078^{a}	2.214^{a}	0.328^{a}	0.339^{a}	0.106^{a}	0.196^{a}	0.067^{a}
Micronutrients Effect:													
F_0		1.182^{c}	0.229^{c}	0.194^{c}	0.064^{c}	0.105^{c}	0.051^{c}	1.501^{c}	0.214^{c}	0.196^{c}	0.070^{c}	0.104^{c}	0.041^{c}
F_1		1.425^{b}	0.273^{b}	0.266^{b}	0.075^{b}	0.149^{b}	0.063^{b}	1.837^{b}	0.263^{b}	0.258^{b}	0.085^{b}	0.146^{b}	0.062^{b}
F_2		1.698^{a}	0.298^{a}	0.350^{a}	0.083^{a}	0.182^{a}	0.069^{a}	1.995^{a}	0.299^{a}	0.302^{a}	0.094^{a}	0.168^{a}	0.065^{a}
Interaction Effect:													
N_1	F_0	0.830^{f}	0.147	0.132^{g}	0.047	0.065^{g}	0.035^{f}	1.038^{h}	0.148	0.133^{h}	0.053^{f}	0.066^{g}	0.030
	F_1	1.064^{e}	0.185	0.193^{f}	0.057	0.112^{f}	0.044^{e}	1.257^{g}	0.192	0.170^{g}	0.066^{e}	0.088^{f}	0.049
	F_2	1.322^{d}	0.206	0.265^{d}	0.063	0.141^{e}	0.047^{e}	1.401^{f}	0.217	0.206^{e}	0.068^{e}	0.100^{e}	0.051
N_2	F_0	1.225^{e}	0.236	0.191^{f}	0.067	0.109^{f}	0.053^{d}	1.507^{e}	0.217	0.194^{f}	0.067^{e}	0.098^{e}	0.041
	F_1	1.348^{d}	0.293	0.249^{e}	0.077	0.155^{d}	0.065^{c}	1.996^{d}	0.263	0.257^{d}	0.084^{d}	0.146^{d}	0.063
	F_2	1.520^{c}	0.324	0.308^{c}	0.082	0.174^{c}	0.069^{c}	2.161^{c}	0.306	0.295^{c}	0.093^{c}	0.172^{c}	0.068
N_3	F_0	1.489^{c}	0.304	0.260^{de}	0.080	0.140^{e}	0.065^{c}	1.959^{d}	0.276	0.262^{d}	0.091^{c}	0.150^{d}	0.051
	F_1	1.863^{b}	0.339	0.356^{b}	0.091	0.181^{b}	0.079^{b}	2.259^{b}	0.334	0.349^{b}	0.106^{b}	0.205^{b}	0.073
	F_2	2.253^{a}	0.364	0.479^{a}	0.103	0.232^{a}	0.089^{a}	2.423^{a}	0.374	0.405^{a}	0.122^{a}	0.233^{a}	0.076
LSD at 5 %:													
Nitrogen		0.035	0.017	0.021	0.002	0.012	0.002	0.018	0.025	0.005	0.007	0.003	0.004
Micronutrients		0.043	0.018	0.007	0.002	0.005	0.003	0.038	0.019	0.007	0.004	0.006	0.002
Interaction		0.074	Ns	0.012	Ns	0.008	0.005	0.065	Ns	0.011	0.006	0.011	Ns

K and Na % and K/Na ratio:

Data in Table 7 show that applications of NR at 50, 75 and 100 % of recommended dose (75 kg N fed^{-1}) had significant effects on K and Na % in straw and grain, but this effect was insignificant for K% in grain in 1st season. K concentration slightly decreased in straw with increasing N rate, but the total content of straw were significantly increased as shown in Table 7. K % in grain significantly increased with increasing N application rate up to N_3, while, Na concentrations in straw and grain were decreased significantly with increasing NR. As for K/Na ratio, it is clear from Table 7 that the highest ratio of K/Na was 6.31, 6.36 in the 1st season and 7.05 and 4.71 in the 2nd season for straw and grain, respectively with N_3. In this regard, the previous researches showed that increasing K/Na ratio in plant is considered an indicator for improving plant growth and enhancing plant tolerant to salinity (El-Fouly *et al.,* 2001, Ghogdi *et al.,* 2012 and El-Dissoky 2013).

Table 7: Effect of nitrogen and micro nutrients Fe, Mn and Zn fertilization on concentrations of K and Na and K/Na ratio for wheat straw and grain grown in salted affected soils.

Characteristics / Treatments		1st season						2nd season					
		K %		Na %		K/Na Ratio		K %		Na %		K/Na Ratio	
		Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain
Nitrogen rates effect:													
N_1		1.02^{a}	0.37	0.189^{a}	0.112^{a}	5.47^{b}	3.62^{c}	1.10^{a}	0.38^{c}	0.163^{a}	0.102^{a}	6.78	3.43^{c}
N_2		1.01^{a}	0.39	0.171^{b}	0.106^{a}	5.95^{ab}	5.00^{b}	0.99^{b}	0.40^{b}	0.149^{b}	0.078^{b}	6.67	3.84^{b}
N_3		0.95^{b}	0.40	0.151^{c}	0.091^{b}	6.31^{a}	6.36	0.95^{b}	0.43^{a}	0.135^{c}	0.064^{c}	7.05^{a}	4.71^{a}
Micronutrients effect:													
F_0		1.01^{a}	0.37^{c}	0.188^{a}	0.106	5.41^{c}	4.45^{c}	0.95^{b}	0.37^{b}	0.157^{a}	0.086	6.04^{b}	3.53^{c}
F_1		0.97^{b}	0.39^{b}	0.167^{b}	0.104	5.85^{b}	5.10^{b}	1.06^{a}	0.42^{a}	0.149^{b}	0.081	7.20^{a}	4.06^{b}
F_2		1.01^{a}	0.40^{a}	0.156^{c}	0.098	6.48^{a}	5.43^{a}	1.02^{a}	0.42^{a}	0.141^{c}	0.079	7.26^{a}	4.38^{a}
Interaction effect:													
N_1	F_0	1.03^{b}	0.35	0.213^{a}	0.115	4.83^{e}	3.38	1.05	0.35	0.174	0.104	6.11	3.08
	F_1	0.96^{c}	0.38	0.183^{c}	0.113	5.23^{d}	3.74	1.13	0.39	0.165	0.102	6.88	3.49
	F_2	1.08^{a}	0.38	0.171^{d}	0.107	6.36^{b}	3.73	1.10	0.40	0.150	0.101	7.35	3.71
N_2	F_0	1.03^{b}	0.37	0.192^{b}	0.107	5.35^{d}	4.51	0.91	0.36	0.156	0.083	5.80	3.38
	F_1	1.02^{b}	0.38	0.166^{e}	0.109	6.13^{bc}	5.03	1.05	0.42	0.147	0.077	7.15	3.90
	F_2	0.99^{bc}	0.41	0.156^{fg}	0.101	6.37^{b}	5.44	1.01	0.43	0.143	0.075	7.06	4.23
N_3	F_0	0.96^{c}	0.38	0.160^{f}	0.095	6.03^{c}	5.46	0.88	0.39	0.141	0.070	6.22	4.13
	F_1	0.93^{d}	0.41	0.151^{g}	0.091	6.19^{bc}	6.52	1.01	0.44	0.134	0.063	7.56	4.79
	F_2	0.95^{c}	0.42	0.142^{h}	0.087	6.71^{a}	7.10	0.96	0.45	0.130	0.059	7.38	5.19
LSD at 5%													
Nitrogen		0.06	Ns	0.011	0.008	0.59	0.92	0.07	0.01	0.009	0.009	Ns	0.27
Micronutrients		0.03	0.01	0.003	0.005	0.17	0.42	0.06	0.02	0.006	Ns	0.48	0.25
Interaction		0.05	Ns	0.006	Ns	0.29	*Ns*	*Ns*	Ns	Ns	*Ns*	*Ns*	*Ns*

Foliar sprays of chelated micronutrients had a positive effect on K and Na concentrations, where K % was increased but Na % was decreased with foliar spray of Fe-EDTA, Zn-EDTA and Mn-EDTA treatments which consequently reflected on K/Na ratio increments in straw and grain. As for K/Na ratio the superiority was for the three foliar sprays of micronutrients (F_2) compared with control (F_0). Interaction between NR and foliar micronutrients treatments significantly affected K and Na % in straw in 1st season, but it had insignificant effect in the 2nd season (Table 7 and Figs 4 and 5). However, K % in grain was increased and Na % decreased with interaction that reflected on increases K/Na ratio. The highest ratio of K/Na in straw and grain was 6.71 and 7.10 in the 1st season and 7.38 and 5.15 in the 2nd season, respectively with interaction $N_3 \times F_2$. These results agree with Ghogdi *et al*., (2012) and El-Dissoky (2013) who found that soil salinity significantly affected K/Na ratio in straw and grain, where the values of K/Na ratio decreased under saline soil compared with non saline soil.

It can be concluded that application of 100 % RN (75 kg N Fed^{-1}) along with three foliar sprays of chelated micronutrients Fe-EDTA, Zn-EDTA and Mn-EDTA was the optimum for wheat growth, straw and grain yields, where the interaction effect between them was the highest for wheat yield characteristics, grain and straw yields, grain quality, the uptake of N, P, K, Fe, Zn and Mn and K/Na ratio. The results illustrate the importance of balanced fertilization of N and foliar micronutrients for plants grown in salted affected soil.

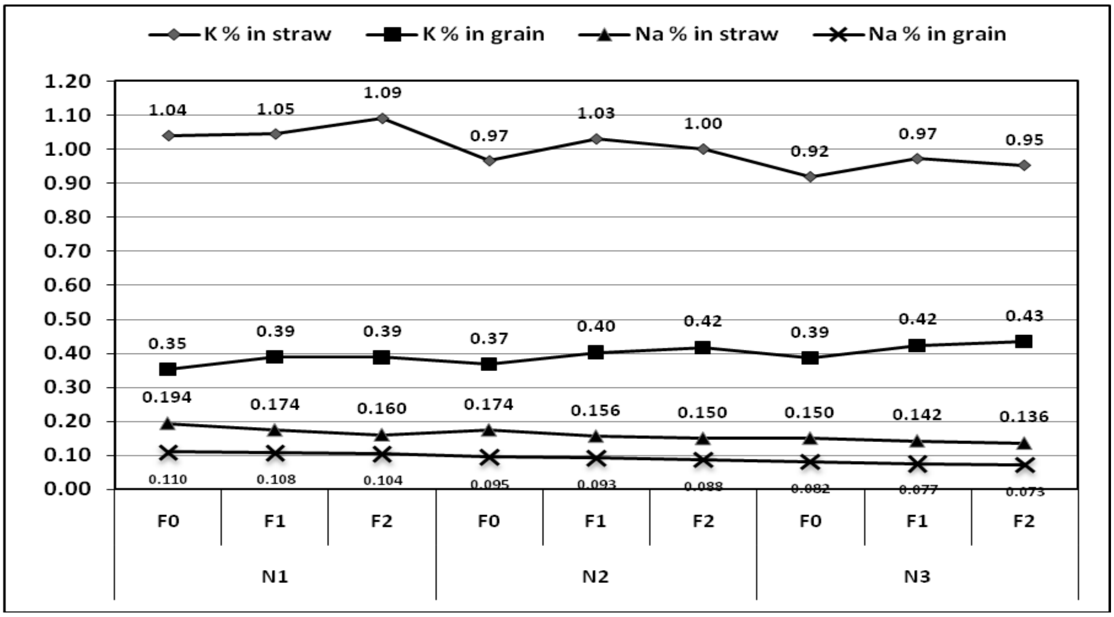

Fig. 4: Effect of interaction between NR and foliar micronutrients on Fe and Zn concentrations in grain.

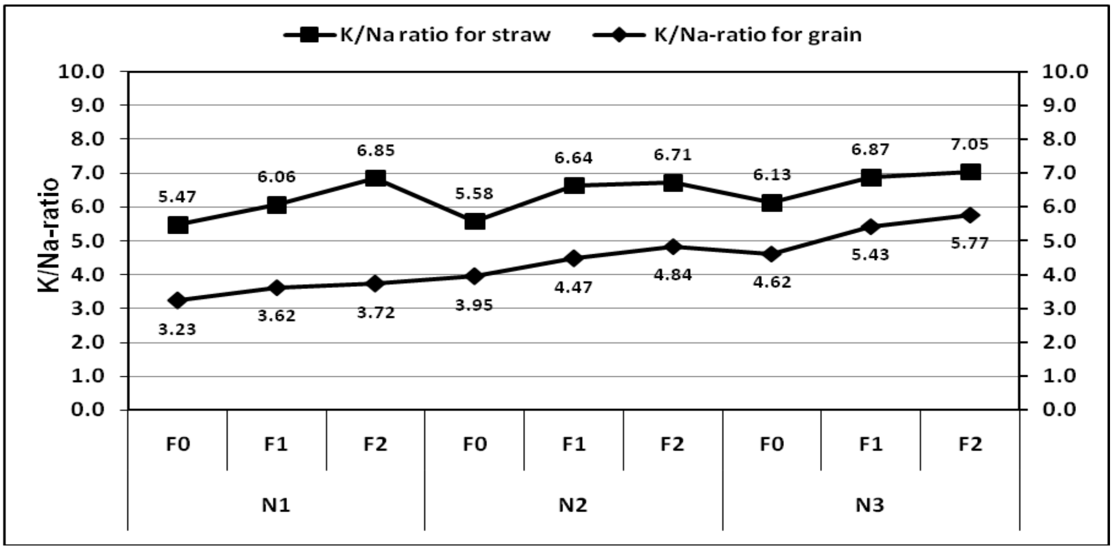

Fig. 5: Effect of interaction between NR and foliar micronutrients on Fe and Zn concentrations in grain.

Conclusion

This study can be recommended by wheat crop fertilization under salt affected soils with N-fertilization at 75 kg N Fed^{-1} (225 kg ammonium nitrate fed^{-1} nearly) with three foliar sprays of chelated micronutrients Fe-EDTA, Zn-EDTA and Mn-EDTA (0.3 g L^{-1} of each chelate) at plant growth stages of tillering, elongation and heading with addition the constant recommended doses of phosphorus and potassium to achieve the highest grain yield with high quality under the same conditions.

REFERENCES

Abd El-Hadi, A. H. (2015). Effect of Zn, Mn and Fe-chelates and some different foliar fertilizers on the production of wheat, potato and sugarcane under Egyptian conditions. Advances in Environ. Biology J., 9(24):229-233.

Abd El-Magid, A. A. (2001). Response of barly to foliar application of some micronutrients under different level of soil salinity. J. Agric. Mansoura Univ., 26(11):7411-7422.

Abu El-Fotoh, H. G., Manal A. Ataya, A. A. Abd El-Magid, M. A. El-Akabawy and Nadia O. Monged (2006). The effectiveness of foliar spraying with putrescine and micronutrients for improving the yield of wheat and rice crops under soil salinity conditions. Egypt J. of Appl. Sci., 21(12A):321-328.

Bakry, A.B., M. H. Taha, M. F. El-Karamany and M. T. Said (2016). Improving productivity and quality of two wheat cultivars using humic acid and zinc foliar application under sandy soil conditions. Res. J. of Pharmaceutical, Biological and Chemical Sci.,7(3):606-616.

El-Dissoky, R. A. (2013). Effect of nitrogen, phosphorus and potassium application as soil and foliar on wheat productivity at soil salinity conditions. J. Soil Sci. and Agric. Eng., Mansoura Univ., 4 (8): 647 – 660.

El-Fouly, M. M., M. M. Zeinab and A. S. Zeinab (2001). Micronutrients spray as a tool to increase tolerance of faba been and wheat plants to salinity. Plant Nutrition J. 92(6):422-423.

Ezatollah, E., M. Abdoli, S. B. Mousavi and B. Sadeghzadeh (2016). Impact of foliar zinc application on agronomic traits and grain quality parameters of wheat grown in zinc deficient soil. Ind. J. Plant Physiol. Published online 30 May 2016.

Faizy, S. E-D. A., M. M. A. Amer and M. M. Ragap (2010). Response of wheat yield and apparent nitrogen recovery of fertilizer to mineral nitrogen and biofertilizer application in salt affected soils. J. Agric. Res. Kafer El-Sheikh Univ., 36 (1):74-96.

FAO (2002). State of Food Insecurity in the World.

Ghogdi, E. A., A. I. Darbandi and A. Borzouei (2012). Effects of salinity on some physiological traits in wheat (Triticum aestivum L.) cultivars. Indian J. Sci. and Technol., 5(1):1901-1906.

Gomez, K.A. and A.A. Gomez (1984). Statistical Procedures for Agriculture Research. 2nd Ed., John Wiley and Sons.

Habib, M. (2009). Effect of foliar application of Zn and Fe on wheat yield and quality. African J. of Biotechnology, 8(24):6795-6798.

Hu, Y. and U. Schmidhalter (2001). Effects of salinity and macronutrient levels on micronutrients in wheat. J. of Plant Nutrition, 24(2):273-281.

Jackson, M. L. (1967). Soil Chemical Analysis. Prentic Hall of land on Private Lim. Indian private Limited, New Delhi.

Ling, F. and M. Silberbush (2002). Response of maize to foliar versus soil application of nitrogen-phosphorus-potassium fertilizers. J. of Plant Nutrition 11:2333-2342.

Mahrous, N. M., Amany M. Sallam, Jaclin G. Sadek and K. A. Shaban (2010). Improving wheat production and grain quality by inorganic, organic and some micronutrients fertilizers under saline condition. Research J. OF Agric. And Biological Sci., 6(6): 1087-1098.

Marschner, H. (1995). "Mineral Nutrition of Higher Plants". 2nd Ed. Academic Press.

Mengel, K. and E. A. Kirkby (2001). "Principles of Plant Nutrition", International Potash Institute, Bern, Switzerland.

Mosaad, I. S. M., E. E. E. Khafagy and R. A. El-Dissoky (2013). Effect of mineral, bio and organic nitrogen fertilization on wheat yield and nitrogen utilization efficiency and uptake at northern delta of Egypt. J. Soil Sci. and Agric. Eng., Mansoura Univ., 4(10): 1101 – 1116.

Nassar, K. E. M., M. M. El-Shouny and E. M. K. Behiry (2004). Improving the quantity and quality of wheat in salt affected soils. Zagazig J. Agric. Res., 31(6):2861-2883.

Negm, A. Y. and F. A. Zahran (2001). Optimizing time of micronutrient application to wheat plants grown on sandy soils. Egypt. J. Agric. Res., 79(3):813-823.

Page, A. L. (ED) (1982). Methods of Soil Analysis. Part2: Chemical and microbiological properties, (2nd Ed). Am. Soc. At Agron. Inc. Soil Sci. Soc. Of Am. Inc., Madison, Wisconsin, VSA.

Sairam, R. K. and A. Tyagi (2004). Physiology and molecular biology of salinity stress tolerance in plants. Current Sci. 86(3): 407-421.

Sharpley, A. N., J. J. Meisinger, J. F. Power and D. L. Suarez (1992). Root extraction of nutrients associated with long-term soil management. In advances in soil Sci. Steward, B., Eid; Springer: New York; 151-217.

Stepien, A. and K. Wajtkowiak (2016). Effect of foliar application of Cu, Zn and Mn on yield and quality indicators of winter wheat grain. Chilean J. of Agric. Res. 76(2): April-June.

WHO (2002). The Report of World Health Organization; Geneva.

Zeidan, M. S., Manal F. Mohamed and H. A. Hamouda (2010). Effect of foliar fertilization of Fe, Mn and Zn on wheat yield and quality in low sandy soils fertility. World J. Agic. Sci., 6(6): 696-699.

التسميد المتوازن من النتروجين والعناصر الصغرى للقمح المنزرع فى الأراضي المتأثرة بالأملاح

رمضان عوض الدسوقي[1] ، رمضان عبد السلام رمضان[2] ، إبراهيم عبد المنعم حجاب[1]

[1] معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر

[2] قسم بحوث القمح – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية – الجيزة– مصر

الملخص العربى

التسميد آلمتوازن من أهم الضروريات للزراعة المستدامة والإنتاج النباتي بالأراضي القديمة والحديثة، علاوة على ذلك فتوازن الإمداد بالأسمدة في حالة الزراعة تحت ظروف الإجهاد المختلفة وبالأخص الملحي أصبح من الأهمية بمكان، فيعاني النبات من امتصاص العناصر الغذائية الصغرى تحت ظروف الأراضي المتأثرة بالأملاح والتي تمثل جزء هاماً في العديد من العمليات الفسيولوجية الحيوية داخل النبات، فالتسميد المتوازن من العناصر الصغرى والنتروجين يعمل على تحسين وزيادة نمو النباتات وإنتاجية وجودة المحصول تحت مثل هذه الظروف، وعليه فقد أجريت تجربتان حقليتان في أرض متأثرة بالأملاح بمحطة بحوث تاج العز بمحافظة الدقهلية– مصر (والواقعة بين خط عرض 30,9° – 68,6" وخط طول 31,6° – 96,5 ") خلال موسمي الزراعة الشتويين 2015/2014 و2016/2015 لتقييم إضافة مستويات مختلفة من النتروجين (50، 75 و100 % من النتروجين الموصي به "75 كجم نتروجين للفدان") مع الرش الورقي بمعاملات العناصر الصغرى (الحديد، الزنك والمنجنيز) في صورتها المخلبية (بدون رش، رش مرتين عند مرحلتي التفريع والاستطالة ورش ثلاث مرات عند مراحل التفريع والاستطالة وطرد السنابل) علي إنتاجية وجودة محصول القمح وكذا الممتص من العناصر الغذائية (النتروجين والفوسفور والبوتاسيوم والحديد والزنك والمنجنيز) ونسبة البوتاسيوم للصوديوم بالنبات وذلك تحت هذه الظروف. وتشير النتائج لزيادة كل من قياسات محصول القمح مع الرش بالعناصر الصغرى عند مراحل التفريع والاستطالة وطرد السنابل والتسميد الأزوتي عند معدل 100 % من الموصي به (75 كجم نتروجين/ للفدان)، كذلك أشارت النتائج لزيادة جودة الحبوب معنويا والمتمثلة في نسب البروتين والفوسفور وتركيز كل من الحديد والزنك وزيادة الممتص من العناصر الكبري (النتروجين ، الفوسفور والبوتاسيوم) و العناصر الصغرى (الحديد ، الزنك والمنجنيز) مع زيادة معدل النتروجين المضاف إلي 75 و 100 % من الموصي به بالمقارنة بال 50%. كما تشير نتائج ارتفاع النبات ومحصول الحبوب والقش وتركيز كل من البوتاسيوم والصوديوم ونسب البوتاسيوم للصوديوم لتحسن نمو النبات تحت ظروف الأرض الملحية مع الرش بالعناصر الصغرى والتسميد بمعدل النتروجين 75 كجم ن/فدان حيث زادت كل القيم السابقة وحقق التفاعل بين معدل تسميد النتروجين 100 % (75 كجم نتروجين/ للفدان) والرش بالعناصر الصغرى عند ثلاث مراحل مختلفة من عمر النبات (التفريع ، الاستطالة وطرد السنابل) أعلي متوسط في محصولي حبوب القمح (19,24 إردب/ للفدان) والقش (5368 كجم /للفدان) لكلا موسمي الزراعة.