J. of Soil Sciences and Agricultural Engineering, Mansoura Univ., Vol 11 (12):863 - 872, 2020

Journal of Soil Sciences and Agricultural Engineering

Journal homepage: www.jssae.mans.edu.eg
Available online at: www.jssae.journals.ekb.eg

Sustain Wheat Production and Avoid Saline Water decline by using Stimulation Substances and Foliar Application of Micronutrients under North Sinai Soils Condition

Cross Mark

Rasha E. El-Mahdy*; Riham M. N. Faiyad and Eman M. Rashwan

Soil Fertility and Plant Nutrition Research Department, Soils, Water and Environment Research Institute, Agriculture Research Centre, Giza, Egypt.

ABSTRACT

To maximize the beneficial effect of using some stimulation substances (Potassium Fulvate and Yeast) along with foliar application of micronutrients on wheat crop productivity and properties of sandy soils under irrigation with saline ground water. Two field trials were conducted during two successive winter growing seasons of 2016/17and 2017/18 in Agricultural Experimental Research Station at Al-Arish, Agricultural Research Centre (ARC), Al-Arish Province, North Sinai Governorate, Egypt. The main treatments were Stimulants substants included four treatments (i. e. control, Potassium Fulvate (KFv), Yeast (Yst) and KFv+Yst) whereas the subplot treatments were micronutrients foliar application included three treatments (i.e. control, chelated form (Fe+Zn+Mn-EDTA) and mineral form (Fe+Zn+Mn-SO_4). The treatments were layout in split plot design with three replicates. The results indicated that application of (KFv+Yst) with foliar application of micronutrients was the best treatment for vegetative growth traits i.e. fresh and dry weight (FW and DW), plant height (PH), chlorophyll content (Chl) and chemical constituents in above ground parts (N, P and K as macronutrients and Fe, Zn and Mn as Micronutrients) as well as grains yield, while the sodium (Na) content of grains was decreased. The highest values of soil available nutrients were recorded with the treatment of (KFv+Yst) and foliar application with micronutrients in the mineral form. Thus, it could be concluded that, the fertilization with potassium fulvate and yeast along with foliar application of micronutrients in mineral sulfate form was considered the most suitable treatment for obtaining the highest grains yield of wheat plants.

Key words: Potassium Fulvate, Yeast, Micronutrients, Wheat, Saline water

INTRODUCTION

Sandy soils were characterizes with low water holding capacity, high sand and low organic matter content and high N leaching applets in addition to alkalinity and accordingly, there were very poor in fertility. So, to overcome these problems, soil fertility must be buildup especially when using saline water for irrigation. Water salinity was a global problem that adversely affects 20 % of irrigated land and reduces crop yields. Salinity stress was a major factor reduces cereal yield by 50 %. Also, salinity limits soil fertility in irrigated regions of the world.

The addition of supplemental organic matters of different sources acts as an ameliorative agent against salinity stress Walker and Bernal (2008).

The exchange capacity of fulvic acids was high, due to the total number of carboxyl (COOH) groups present. Because of the relatively small size of fulvic acid molecules they can readily enter plant roots, stems, and leaves. As they enter these plant parts they carry trace minerals from plant surfaces into plant tissues Pettit, (2008). Akinci and Ongel, (2011) mentioned that fulvic acid have high ion exchange and hydrolysis capacity and resulting in excess amounts of amino acids and organic acids increase the soil Cation exchange capacity, decrease soil loss and increase soil fertility and facilitates the transfer of mineral nutrients from the soil to plants.it can function as a plant hormone. Rashwan-Eman, et.al., (2020) found that the plants treated with soil addition of potassium fulvate (at a rate of 2 kg fed-1) and potassium humate (at a rate of 2 kg fed-1)and its combinations enhance the growth and seeds quality of kidney bean and resulted the highest yield and also, increased the residual soil N, P and K after harvesting.

Yeast was considered as a promising plant growth promoting for different crops. Yeast extract was a natural source of many growth substances (thiamine, riboflavin, niacin, pyridoxine and vitamins B1, B2, B3 and B12), cytokines and many of the nutrient elements as well as organic compounds i.e., protein, carbohydrates, nucleic acid and lipids Barnett *et al*., (1990). Hassanein, et. al. (2018) and Mohamed, et .al (2019) revealed that application of yeast as biofertilizer has superior promoting effect on yield and yield components as well as nutrient content of the wheat grains than chemical fertilizers.

Micronutrients were a part of many crucial physiological plant processes. Modaihsh, (1997) Application of the micronutrients Fe, Mn, Zn and Cu in sulphate form generally resulted in higher concentrations of these elements in grain than when the chelated forms were applied. Foliar application of the micronutrients in the form of sulphate at higher application rates may be more effective than the chelates due to lower cost despite the higher application rates.

Seadh et. al. (2009) stated that foliar application with the combination of Cu, Mn, Fe and Zn at the rate of 500

* **Corresponding author.**
E-mail address:rashaelmahdy1982@gmail.com
DOI: 10.21608/jssae.2020.160934

ppm of each one resulted in the maximum averages of grains yield and its components, chemical composition and parameters of quality for wheat grains. Foliar spraying of plants with micronutrient increased plant tolerance under salinity stress as Van Bockhaven *et al*. (2013). Zain , et .al. (2015) showed that foliar application of micronutrients substantially improved plant height, spike length, spikelets /spike, grains/spike weight, Tillers, grains and biological yield as well as harvest index of wheat. Among treatments, foliar application of FeSO4 + ZnSO4 + MnSO4 remained comparatively better regarding yield related attributes of wheat.

Aziz, et. al. (2019) found that foliar application with Zn, Cu, Mn, Fe and B on wheat crop increased tillering ability, spike length, grains yield and the contents of Zn, Cu, Mn, Fe and B in wheat flour. Therefore, foliar feeding of micronutrients could be an effective approach to enrich wheat grains with essential nutrients for correcting malnutrition.

Egypt imported about 12 million tons of wheat in 2016/2017, this estimation about 1.3 million tons above the average for the last five years FAO, (2016). In order to fill the gap between production and consumption and contribute in food problem solves, efforts should be directed toward increasing the cultivated area of wheat it is necessary to go to newly reclaimed lands and avoiding problem of saline water.

Therefore, the objective of this work was to:

1- Assessing the role of potassium fulvate (KFv) and yeast (Yst) under foliar application of micronutrients on alleviating the deleterious effect of saline water on wheat growth and productivity and sustain soil fertility.

2-Detect the effect of salinity stress and the shortage of irrigation water on wheat growth and yield.

MATERIALS AND METHODS

Field Experiments:

Two field experiments were conducted on sandy soil at Al-Arish Agricultural Research Station, Agricultural Research Centre (ARC), Al-Arish Province, North Sinai Governorate, Egypt during two consecutive winter growing seasons of 2016/17 and 2017/18 using wheat plants (Triticum aestivum L.; variety sids 12). The experiment was laid out in a split-plot design arranged in a complete randomized block design (CRBD) with three replications. Stimulation substance included four treatments (i.e., control, KFv, Yst and KFv+Yst) randomly arranged in the main plots and the sub plot treatments were foliar micronutrients application included three treatments (i.e., control, Fe+Zn+Mn-EDTA and Fe+Zn+Mn-SO4). The average of soil chemical and physical characteristics before planting and the chemical characteristics of the irrigation water shown in Table (1) and (2).

Table 1. Some physical and chemical properties of experimental soil

Particle size distribution, (%)			Textural Class	*EC, µmhos/cm	**pH	CaCO3, (%)	O.M, (%)
sand	Silt	Clay					
68.17	15.26	13.26	Sand	760	8.6	1.00	1.71

Soluble cations (meq l^{-1})					Soluble anions (meq l^{-1})			Available microelement, mg kg^{-1}					
Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}	N	P	K	Fe	Zn	Mn
1.84	1.79	3.8	0.17	00	1.76	3.86	1.98	19	7.9	146	2.2	0.69	1.13

*** Soil Electrical Conductivity (EC) and soluble ions were determined soil solution (1:5).**
**** Soil pH was determined in soil suspension (1: 2.5).**

Table 2. Chemical properties of the experimental ground irrigation water:

Properties	EC	pH	TDS	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}	Ca^{++}	Mg^{+}	Na^{+}	K^{+}	N	P	K
	dsm^{-1}		Ppm				meq l^{-1}						mg kg^{-1}	
Value	4.9	7.96	3161.6	00	23.6	1008.4	45.9	56.4	21.0	992.6	7	6.3	0.095	11.2

Stimulation Substances (KFv), (Yst) and Micronutrients:

Potassium Fulvate (KFv) was applied three times with irrigation water at 15, 30 and 60 days at a rate of 2 kg fed^{-1}.Yeast was added three times with irrigation water at 15, 30 and 60 days at a rate of 800 g fed^{-1}. Micronutrients were sprayed twice after germination and before boating at the rate of 1000:500:500 ppm ferrous sulfate: zinc sulfate: manganese sulfate as mineral form or Fe-EDTA: Zn-EDTA: Mn-EDTA as chelated form.

Table 3. Some characteristic of Potassium Fulvate (KFv):

substances	HA* %	FA** %	Solubility, %	Moisture %	pH	Total macro elements		
						N%	P%	K%
Potassium fulvate.	3.70	65.0	100	5.75	5.61	0.55	2.97	8

***HA: Humic Acid **FA: Fulvic Acid**

Cultivation Practices:

Wheat grains variety sids 12 were sown at the recommended cultivation rate at 75 kg fed^{-1} during last week of November in both growing seasons of 2016/17 and 2017/18. The grains were obtained from wheat Crop Research Department, Field Crop Research Institute, Agriculture Research Centre, Giza, Egypt. The grains were sown in plots at ridges (3m length×3.5m width). The recommended cultural practices for wheat cultivation were followed according to the instruction laid down by the Ministry of Agriculture and Land Reclamation (MALR). The experiment was installed under drip irrigation system.

Organic and Mineral Fertilizers Application Rates:

Farm yard manure (FYM) was incorporated with soil surface in the rate of 20 m^{3}fed (26.25 kg / plot) before cultivation. The P fertilizer rate (as super phosphate 12.5 % P_2O_5) was (200 kg fed^{-1}), 525 g plot^{-1} applied as recommended rate during land preparation, K fertilizer was applied in a rate of (50 kg fed^{-1}) as potassium sulphate (50 % K_2O), 131.25 g plot^{-1} at two doses fertigated throw irrigation water. 100 kg N fed^{-1} was applied as ammonium nitrates (33.5 % N) in a rate of 298.5 kg fed^{-1} (783.5 g plot^{-1}) at ten times for all treatments throw irrigation water. Plants were irrigated using drip irrigation system, irrigation stop before harvest nearly 10-15 day.

Plant Growth Parameters Data:

Vegetative growth stage: During vegetative growth stage up to 60 days after planting, plants were taken randomly to determine: plant height (PH, cm), fresh and dry weight (FW, DW, g plant^{-1}) also pigments, chlorophyll a, b and carotenoid contents in leaves were determined according to Sumanta *et al.* (2014). Pigments were determined in fresh weight samples. The samples of leaves were dried at 70^{0} c to determined N % according to the methods described by Jones *et al.* (1991) and both P, K and Na % according to Peters *et al.* (2003).

Wheat yield, its Components, Quality and Chemical constituents:

Wheat yield and its components: At harvesting time (145-150 days after planting), plants were taken randomly to determine: plant height (PH, cm), The whole plot was harvested weigh to determine the biological yield then threshed to determine grains and straw yield (Ton fed^{-1}) and 1000 grain weight as grains quality were determined (g).

Chemical composition of grains and straw at harvest:

Grains and straw samples were collected then oven-dried at 70 °C and finely ground and wet digested using concentrated sulfuric acid and perchloric acid according to (Cottenie, *et. al.* 1982).

Concentration of macronutrients (N, P and Na) and micronutrients (Fe, Zn and Mn) in wheat grains and straw samples were determined as formerly mentioned in leaves. Proline was determined according to Bates *et al*. (1973). Crude protein content was calculated by multiplying the total N by the factor 5.70 as described by A.O.A.C., (2007).

Soil analysis: Soil texture, physical and chemical analyses were determined using the methods described by Piper, (1950), Hesse, (1971) and Hillel, (1972). After harvest, soil samples from each experimental sub plot were taken to determine available N, P, and K, and soluble Na according to Reeuwijk (2002) wears' Fe, Zn and Mn was measured using the Atomic absorption spectrophotometer (AAS).

Statistical analysis: Appropriate analysis of variance was performed using COSTATE Computer Software. The significant differences among the mean of various treatments were established by the Least Significant Differences method (LSD) according to Gomez and Gomez, (1984). The displayed parameters values are mean of the two seasons.

RESULTS AND DISSCUSSION

Growth Parameters and Photosynthetic Pigments during Vegetative Growth Stage:

The obtained results in Table (4) show effect of (KFv) and (Yst) as soil application and micronutrients as foliar application on vegetative growth characters (PH, FW and DW) and photosynthetic pigments (Chl a, b, a+b and carotenoids)..

Table 4. Effect of Stimulation substances, foliar application of micronutrients, and its combinations on wheat plants vegetative growth and photosynthetic pigments parameters at 45 days after planting.

Character		Plant Weight		Plant height	Chlorophyll content (mg g FW^{-1})			Carotene
Treatments		Fresh W. (Kg)	Dry W. (Kg)	(cm)	A	B	a+b	(mg g FW^{-1})
Stimulation substances	Control	1.26	0.211	74.67	0.295	0.085	0.380	0.089
	KFv	1.42	0.235	80.00	0.311	0.090	0.402	0.094
	Yst	1.50	0.248	83.22	0.327	0.102	0.429	0.100
	KFv+Yst	1.56	0.252	85.67	0.345	0.108	0.453	0.107
F test		***	***	***	***	***	***	***
LSD 5%		0.04	0.006	0.74	0.001	0.001	0.002	0.001
Foliar application of microelements	Control	1.29	0.213	76.00	0.289	0.087	0.376	0.087
	Chelated	1.41	0.230	82.00	0.320	0.096	0.417	0.098
	Mineral	1.61	0.266	84.67	0.349	0.105	0.455	0.108
F test		***	***	***	***	***	***	***
LSD 5%		0.04	0.006	0.49	0.001	0.001	0.001	0.001
Control	Control	1.10	0.189	68.67	0.256	0.075	0.331	0.083
	Chelated	1.26	0.210	75.67	0.298	0.086	0.385	0.089
	Mineral	1.43	0.235	79.67	0.331	0.095	0.426	0.096
KFv	Control	1.29	0.212	74.33	0.277	0.080	0.357	0.085
	Chelated	1.40	0.231	81.33	0.314	0.090	0.404	0.093
	Mineral	1.58	0.261	84.33	0.343	0.102	0.445	0.105
Yst	Control	1.36	0.225	79.00	0.301	0.092	0.393	0.088
	Chelated	1.47	0.240	84.00	0.327	0.102	0.429	0.101
	Mineral	1.68	0.279	86.67	0.354	0.112	0.466	0.113
KFv+Yst	Control	1.40	0.228	82.00	0.322	0.101	0.423	0.091
	Chelated	1.53	0.240	87.00	0.344	0.109	0.453	0.110
	Mineral	1.75	0.289	88.00	0.370	0.114	0.484	0.120
F test		Ns	Ns	***	***	***	***	***
LSD 5%		0.07	0.012	0.98	0.002	0.001	0.002	0.002

The data reveal that, all vegetative growth and photosynthetic pigments were significantly increased under stimulation substances compared to control (without treatment). In addition, the maximum stimulatory effect existed in plants those treated with combination of (KFv+Yst). Yousif et al., (2019) referred that positive significant effect when using humic acid and bread yeast caused increase in photosynthetic pigments and vegetative growth characters it may due to the role of humic acid improving the soil fertility and increasing the availability of elements and consequently increased plant growth as well as the ability of yeast to increase the production of stimulants for plant growth, especially Gibberellins, Auxins and Cytokinins which work to improves the plant cell division and its growth

Also, foliar applications of micronutrients in chelated or mineral form were significantly increased all aforementioned traits (PH, FW and DW) and (Chl a, b, a+b and carotenoids) with the superiority of the mineral form. Modaihsh, (1997) and Patil and Chetan (2018) who stated that Chelated sources, while valuable for soil application, have been shown to be generally unfavorable for foliar application, because most chelating agents have a molecular size too large to be effectively absorbed by leaf tissue.

The interaction between the stimulation substances combined with foliar application of micronutrients treatments (Table 4) found to be insignificant at wheat FW and DW. While plant height (PH), Chl a, b, a+b and carotenoids show a significant response. The potassium fulvate + yeast (KFv+Yst) along with foliar application of micronutrients in mineral form (Fe+Zn+Mn-SO_4) were the best treatment.

The results indicated that PH, FW and DW of wheat plants increased due to application of potassium fulvate (KFv) which increased the organic matter of the soil consequently reflect on the growth of wheat plants also, yeast (Yst) which increased roots growth and increased nutrients uptake generally increased wheat plant growth. Different photosynthetic pigments as chlorophyll a, b, a+b and carotenoids as well as total pigments shows positively significance responses to potassium fulvate and yeast along with foliar application of micronutrients. This increase might be attributed to activating chlorophyll biosynthesis and/or preventing its degradation.

Chemical Constituents of wheat during Vegetative Growth Stage:

Results in table 5 cleared that stimulation substants or foliar application of micronutrients increased significantly all the nutrients concentrations of wheat plants at vegetative growth period at 45 days after planting. A gradual increasing in plant contents of N, P, K, Fe, Zn and Mn % combined with a gradual decreasing in Na % absorption in above ground parts were found by application potassium fulvate (KFv) and yeast (Yst) along with foliar application of micronutrients specially in the mineral form. The decreasing in Na % was 8.09 % at (KFv+ Yst) treatment and reached 13.54 % at foliar application of micronutrients in the mineral form treatment (Fe+Zn+Mn-SO_4).

Table 5. Effect of Stimulation Substances, Foliar Application of Micronutrients, and its Combinations on Wheat Plants Chemical Constituents at 45 Days after Planting.

Character Treatments		N %	P %	K %	Na %	Fe $mgkg^{-1}$	Zn $mgkg^{-1}$	Mn $mgkg^{-1}$
Stimulation substances	Control	2.38	0.35	2.63	0.187	113.89	19.33	21.22
	KFv	2.54	0.40	2.71	0.182	125.22	22.67	23.11
	Yst	2.69	0.45	2.78	0.177	135.44	25.89	27.44
	KFv+Yst	2.85	0.49	2.85	0.173	145.56	29.11	30.67
F test		***	***	***	***	***	***	***
LSD 5%		0.03	0.01	0.02	0.001	1.57	1.30	0.71
Foliar application of microelements	Control	2.37	0.34	2.63	0.192	94.58	15.17	16.58
	Chelated	2.61	0.42	2.72	0.181	132.92	24.67	25.92
	Mineral	2.87	0.51	2.88	0.166	162.58	32.92	34.33
F test		***	***	***	***	***	***	***
LSD 5%		0.03	0.01	0.03	0.001	1.22	0.99	1.06
Control	Control	2.10	0.30	2.55	0.199	73.33	10.33	14.33
	Chelated	2.35	0.35	2.60	0.188	119.67	20.00	20.00
	Mineral	2.68	0.41	2.73	0.176	148.67	27.67	29.33
KFv	Control	2.30	0.32	2.59	0.194	95.00	14.00	15.00
	Chelated	2.53	0.40	2.69	0.183	123.33	23.00	24.33
	Mineral	2.80	0.49	2.85	0.168	157.33	31.00	30.00
Yst	Control	2.46	0.36	2.65	0.190	101.00	17.00	18.00
	Chelated	2.70	0.45	2.75	0.179	140.00	26.67	28.33
	Mineral	2.91	0.54	2.93	0.162	165.33	34.00	36.00
KFv+Yst	Control	2.60	0.38	2.72	0.186	109.00	19.33	19.00
	Chelated	2.86	0.49	2.84	0.174	148.67	29.00	31.00
	Mineral	3.08	0.59	3.00	0.159	179.00	39.00	42.00
F test		*	***	ns	***	***	Ns	***
LSD 5%		0.05	0.02	0.05	0.002	2.44	1.98	2.12

Concerning the interaction between the treatments, the chemical constituents of wheat plants during the vegetative growth stage showed significant effect on all nutrients concentration except K and Zn, The highest values of nutrients were recorded when plants treated with combined treatment of soil application by (KFv+Yst) combined with foliar application by (Fe+Zn+Mn-SO4), While the lowest value of Na were recorded with the same treatment with 20.01% decrease as compared to control.

Increasing the absorption of the N, P, Fe and Mn consequently enhance alleviating the negative effects of Na might be attributed to potassium fulvate (KFv) has a low molecular weight, high oxygen content and has many (-OH) and (-COOH) group, which increase its exchange capacity. In addition to the reduction of soil pH in the rhizosphere, so increased the availability of nutrients in the soil consequently plant uptake. This results were confirmed with those obtained by Pettit (2008). Akinci and Ongel, (2011). Also, yeast (Yst) used as plant biostimulants to increased nutrients uptake. In addition foliar application of micronutrients also increased uptake of Fe, Zn and Mn. These results were in harmony with those of Modaihsh, (1997) who reported that foliar application of micronutrients in sulphate form resulted in higher concentrations of elements in grain than chelated form. And as mentioned by Van Bockhaven et al. (2013), Zain , et .al. (2015) and Aziz et. al.(2019).

Yields and Its components at Harvest Time

Listed data presented in Table 6 illustrate that at harvesting time, stimulation substance or foliar micronutrient application increased significantly the traits of wheat plants in terms of plant height (PH), straw, grains and biological yields, (Ton fed^{-1}) and 1000 grains weight (g). The increase in plant height (PH), straw, grains and biological yields, (Ton fed^{-1}) and 1000 grains weight (g) with combined potassium fulvate and yeast (KFv+Yst) was 12.43 %, 25 %, 22.91 %, 23.84 % and 11.94 % respectively. And ranged to 10.84 %, 20.16 %, 18.61 %, 19.12 % and 9.59 % with treatment of foliar application of micronutrients in the mineral form (Fe+Zn+Mn-SO_4).

Plant height (PH, cm), straw, grains, biological yield (Ton fed^{-1}) and 1000- grains weight (g) of wheat slightly affected by the interaction between the treatments, however this effect was insignificant only in PH; but the other demonstrated yield parameters and 1000 grains weight exhibit a highly significant increase. The highest values were recorded with combined treatment of potassium fulvate and yeast (KFv+Yst) combined with foliar application of micronutrients in the mineral form(Fe+Zn+Mn-SO_4), where The increase in plant height (PH), straw, grains and biological yields, (Ton fed^{-1}) and 1000 grains weight (g) was 25.98%, 37.66 %, 42.8 %, 37.96 % and 24.31 % respectively. The highest wheat grains yield might be due to the stimulation effect between potassium fulvate and yeast as a bio-fertilizer on improving the soil fertility by increasing the availability of many nutrients to plant uptake, which in turn on improved the yield and its components of wheat plants. These results were in harmony with those obtained by Hassanein, et. al. (2018) and Mohamed, et .al (2019). Also Zain, et .al. (2015) and Aziz, et. al. (2019).

Table 6. Effect of Stimulation Substances, Foliar Application of Micronutrients, and its Combinations on wheat PH, Yield and its Components at harvest Time.

Character Treatments		PH, (cm)	Yields (Ton fed^{-1}) Straw	Grains	Biological yield	1000-Grain W,(g)
Stimulation substances	Control	90.22	2.52	2.88	5.41	38.10
	KFv	96.56	2.79	3.13	5.92	40.97
	Yst	98.78	2.99	3.35	6.35	42.18
	KFv+Yst	101.44	3.15	3.54	6.70	42.64
F test		***	***	***	***	***
LSD 5%		0.730	0.024	0.017	0.018	0.288
Foliar application of microelements	Control	91.42	2.48	2.74	5.23	39.20
	Chelated	97.50	2.72	2.99	5.70	41.50
	Mineral	101.33	2.98	3.25	6.23	42.96
F test		***	***	***	***	***
LSD 5%		0.460	0.016	0.020	0.020	0.332
Control	Control	84.67	2.31	2.51	4.82	36.60
	Chelated	91.00	2.51	2.72	5.23	38.13
	Mineral	95.00	2.75	2.98	5.73	39.00
KFv	Control	91.33	2.45	2.76	5.22	39.50
	Chelated	97.67	2.68	3.01	5.69	39.7.0
	Mineral	100.67	2.93	3.26	6.19	41.30
Yst	Control	93.67	2.61	2.97	5.59	41.40
	Chelated	99.67	2.77	3.18	5.91	42.60
	Mineral	103.00	3.05	3.39	6.44	42.60
KFv+Yst	Control	96.00	2.63	3.02	5.55	43.90
	Chelated	101.67	2.89	3.29	6.04	44.30
	Mineral	106.67	3.18	3.57	6.65	45.50
F test		ns	***	***	***	**
LSD 5%		0.910	0.031	0.052	0.055	0.864

Chemical constituents of wheat plants at harvesting Time:

As shown in Tables 7 and 8 main effects and interaction between stimulation substances and foliar micronutrients application increased significantly nutrients concentrations of wheat straw and grains at harvesting time. The same trend of data as mentioned previously during the vegetative growth stage due to soil application of (KFv and Yst) and foliar application with micronutrients were located. The grains concentrations increase of the nutrients N, P, K, Fe, Zn and Mn was 19.48 %,32.43 %, 74.13 %, 29.77 %,31.87 % and 48.20 % respectively, while Na decrease was 14.11% with combined treatment of potassium fulvate and yeast (KFv+Yst). The grains concentrations increase of the nutrients N, P, K, Fe, Zn and Mn was 24.34 %, 41.66 %, 72.41 % 57.03 %, 62.55 % and 133.92 % respectively, while Na decrease was22.72 % with treatment foliar application of micronutrients in the mineral form(Fe+Zn+Mn-SO_4). With respect to the interaction between the tested treatments had a significant effect on nutrients concentrations except Mn % in straw and P, Zn and Mn % in wheat grains. The results indicated that application of combined treatment of potassium fulvate and yeast (KFv+Yst) with foliar application of micronutrients in the mineral form (Fe+Zn+Mn-SO_4) gave the highest concentrations increase of the nutrients N, P, K, Fe, Zn and Mn 46.80 %, 90.32 %, 80.35 %, 107.14 %, 126.31% and 280 % with decrease in Na concentration33.33 %.

These results were in agreement with those obtained by El-Ghamry et. al., (2009) who stated that foliar application of micronutrients led to an increase in concentrations of macro and micronutrients in both of wheat grains and straw yield and this effect might be attributed mainly to the vital physiological roles in plant cells which promote the uptake of plant nutrients. Seadh et. al. (2009), Yassen et. al. (2010) and Aziz, et. al. (2019) indicates the same discussions about the beneficial effect of foliar application of micronutrients on wheat grains and straw chemical constituents.

Table 7. Effect of Stimulation substances, foliar application of micronutrients, and its Combinations on wheat straw chemical constituents at harvest time

Character **Treatments**		**N** **%**	**P** **%**	**K** **%**	**Na** **%**	**Fe** **$mgkg^{-1}$**	**Zn** **$mgkg^{-1}$**	**Mn** **$mgkg^{-1}$**
Stimulation substances	Control	0.45	0.27	2.81	0.728	91.11	13.33	14.78
	KFv	0.50	0.33	2.90	0.704	99.44	15.67	17.56
	Yeast	0.55	0.39	3.00	0.686	106.78	17.56	20.11
	KFv+Yst	0.60	0.42	3.05	0.670	113.33	20.33	23.22
F test		***	***	***	***	***	***	***
LSD 5%		0.01	0.01	0.02	0.001	1.28	0.79	0.99
Foliar application of microelements	Control	0.45	0.25	2.82	0.751	84.08	8.50	10.00
	Chelated	0.53	0.35	2.94	0.691	104.50	16.92	19.83
	Mineral	0.61	0.45	3.06	0.648	119.42	24.75	26.92
F test		***	***	***	***	***	***	***
LSD 5%		0.01	0.01	0.01	0.001	0.92	0.76	1.13
Control	Control	0.36	0.20	2.69	0.799	68.33	6.00	6.33
	Chelated	0.44	0.27	2.82	0.726	96.00	12.00	16.00
	Mineral	0.55	0.35	2.93	0.669	109.00	22.00	22.00
KFv	Control	0.42	0.23	2.80	0.761	82.00	8.00	9.00
	Chelated	0.50	0.32	2.91	0.697	102.00	15.00	18.00
	Mineral	0.59	0.44	3.00	0.654	114.33	24.00	25.67
Yst	Control	0.48	0.28	2.86	0.733	89.00	9.00	11.00
	Chelated	0.56	0.39	3.00	0.683	108.00	17.67	20.33
	Mineral	0.62	0.49	3.13	0.641	123.33	26.00	29.00
KFv+Yst	Control	0.54	0.31	2.94	0.721	97.00	11.00	13.67
	Chelated	0.60	0.43	3.02	0.660	112.00	23.00	25.00
	Mineral	0.67	0.53	3.20	0.628	131.00	27.00	31.00
F test		**	**	***	***	***	***	Ns
LSD 5%		0.02	0.02	0.03	0.002	1.84	1.53	2.25

Table 8. Effect of Stimulation substances, foliar application of micronutrients, and its Combinations on wheat grains chemical constituents at harvest time

Character **Treatments**		**N** **%**	**P** **%**	**K** **%**	**Na** **%**	**Fe** **$mgkg^{-1}$**	**Zn** **$mgkg^{-1}$**	**Mn** **$mgkg^{-1}$**
Stimulation substances	Control	1.54	0.37	0.58	0.085	91.78	27.89	18.67
	KFv	1.66	0.42	0.99	0.080	102.78	31.67	20.67
	Yeast	1.76	0.45	1.00	0.077	111.67	33.78	23.78
	KFv+Yst	1.84	0.49	1.01	0.073	119.11	36.78	27.67
F test		***	***	***	***	***	***	***
LSD 5%		0.01	0.01	0.00	0.002	0.96	1.47	1.00
Foliar application of microelements	Control	1.52	0.36	0.58	0.088	81.67	24.25	13.50
	Chelated	1.69	0.43	1.00	0.079	109.08	33.92	23.00
	Mineral	1.89	0.51	1.00	0.068	128.25	39.42	31.58
F test		***	***	***	***	***	***	***
LSD 5%		0.01	0.01	0.00	0.0008	1.33	1.00	0.93
Control	Control	1.41	0.31	0.56	0.093	70.00	19.00	10.00
	Chelated	1.52	0.37	0.59	0.087	94.33	29.00	19.00
	Mineral	1.70	0.43	0.59	0.075	111.00	35.67	27.00
KFv	Control	1.50	0.34	0.97	0.090	79.33	23.00	12.00
	Chelated	1.65	0.42	0.99	0.082	106.00	33.00	21.00
	Mineral	1.84	0.48	1.00	0.070	123.00	39.00	29.00
Yst	Control	1.54	0.39	1.00	0.088	86.33	26.33	15.00
	Chelated	1.77	0.44	1.00	0.077	114.67	35.00	24.00
	Mineral	1.96	0.52	1.01	0.066	134.00	40.00	32.33
KFv+Yst	Control	1.63	0.41	1.00	0.084	91.00	28.67	17.00
	Chelated	1.82	0.48	1.00	0.073	121.33	38.67	28.00
	Mineral	2.07	0.59	1.01	0.062	145.00	43.00	38.00
F test		***	Ns	***	***	***	Ns	Ns
LSD 5%		0.03	0.03	0.00	0.0006	2.67	2.00	1.86

Wheat Grains Quality and K/Na ratio at harvest time:

Data presented in table 9, obvious that the individual effect of stimulation substants or foliar micronutrients application induce highly significant increase in protein content and K/Na ratio, grains and straw, on the other hand while the data showed decrease in proline concentration of wheat at harvest which reflect the effect treatments in ignoring the negative effect of saline water and disaccumulation of Na ion. As well as, the interaction between the treatments the highest values were recorded with combined treatment of potassium fulvate and yeast (KFv+Yst) with foliar application of micronutrients in the mineral form. The total content of proteins ranged from 8.06 % to 11.82 % and proline 95.56 to 120.85 (mg/100g dry weight) in the wheat grains was significantly different regardless of the applied of micronutrients. These results were a harmony with those of Yassen *et. al.* (2010) who showed that additional nitrogen foliar spraying mixture of micronutrients (Fe, Zn, Mn) gave significant increases in thousand grain weight, grains and straw yield, nitrogen and protein percentage. The highest value of proline concentration was recorded with control treatment. Substantial increase of K:Na ratio in vegetative stage, grain and straw at harvest of wheat that found with the application of stimulation substances, might be due to the effect of these substances in encourage roots growth, reduce soil pH and increase nutrients uptake and alleviate the hazard effect of Na ion. These results were in agreement with Tester and Davenport (2003) who reported that metabolic toxicity of Na is largely a result of its ability to compete with K for binding sites essential for cellular function.

Table 9. Effect of Stimulation substances, foliar application of micronutrients, and its combinations on wheat grains quality and K/Na ratio at harvest time.

Character Treatments		Protein content (%)	Proline content in grains(mg/100g dry weight)	K/Na vegetative	K/Na grain	K/Na straw
Stimulation substances	Control	8.80	110.94	14.04	4.50	3.89
	KFv	9.47	106.86	14.97	4.87	4.14
	Yeast	10.03	102.84	15.77	5.27	4.38
	KFv+Yst	10.50	98.89	16.57	5.63	4.57
F test		***	***	***	***	***
LSD 5%		0.15	1.70	0.318	0.178	0.041
Foliar application of microelements	Control	8.67	113.56	13.66	4.30	3.76
	Chelated	9.64	102.76	15.02	4.97	4.25
	Mineral	10.80	98.34	17.33	5.95	4.73
F test		***	***	***	***	***
LSD 5%		0.08	0.80	0.168	0.130	0.025
Control	Control	8.06	120.85	12.81	3.86	3.40
	Chelated	8.66	110.60	13.80	4.44	3.89
	Mineral	9.69	101.39	15.51	5.20	4.38
KFv	Control	8.55	116.85	13.32	4.13	3.67
	Chelated	9.39	104.48	14.64	4.76	4.17
	Mineral	10.49	99.27	16.95	5.74	4.57
Yst	Control	8.78	112.08	13.94	4.47	3.89
	Chelated	10.11	99.31	15.38	5.16	4.38
	Mineral	11.19	97.14	18.01	6.20	4.88
KFv+Yst	Control	9.29	104.48	14.59	4.74	4.07
	Chelated	10.39	96.64	16.26	5.53	4.58
	Mineral	11.82	95.56	18.87	6.64	5.08
F test		***	***	***	*	*
LSD 5%		0.15	1.70	0.318	0.178	0.041

Some traits and nutrients concentration in soil at harvesting time:

As illustrated in Figs.1 Electrical Conductivity (EC) µmhos/cm at harvesting time of wheat plants as affected by studied treatments were decreased. The present data indicated beneficial effect of potassium fulvate and Yeast where the most effective treatments in decreasing soil was combination of potassium fulvate and Yeast (KFv+Yst) Such decrease might be due to potassium fulvate (KFv) improves soil physical property, ion exchange capacity, water holding capacity, salinity tolerance ability.

Average concentrations of available macro NPK and micro Fe, Zn and Mn nutrients and Na, in soil (mg kg^{-1}) (combined data over both seasons) at harvesting time as affected by soil application of stimulation substances under foliar application of micronutrients were showed in Figs. 2:8 respectively where the concentrations of N, P, K, Fe, Zn and Mn (mg kg^{-1}) in the soil after harvesting generally increased over that before planting, as shown in table 1 it could attributed due application of FYM during land preparation and due to potassium fulvate (KFv) and yeast (Yst) which produce chelating substances and maintain soil fertility buildup. Potassium fulvate was an organic water-soluble humid substance. It was a good plant growth stimulant acting on soil and plants. It improves soil physical property, ion exchange capacity, water holding capacity, salinity tolerance ability and increases soil microorganisms activity, reflecting in increasing organic matter decomposition and enhance availability of N, P, K and microelements in the roots zone area. This also prevents loss of nutrients from soil and act as a storehouse by keeping plant nutrients in soil. It increased crop growth and yield, soil fertility status and reduced the use of chemical fertilizers.

Conversely, Na concentration in the soil after harvesting generally decreased over that before planting as shown in fig. 5. This result might be due to potassium fulvate and yeast alleviation the harmful effects of the Na where potassium fulvate and yeast had amount of potassium which compete sodium in soil solution as mentioned by Tester and Davenport (2003).

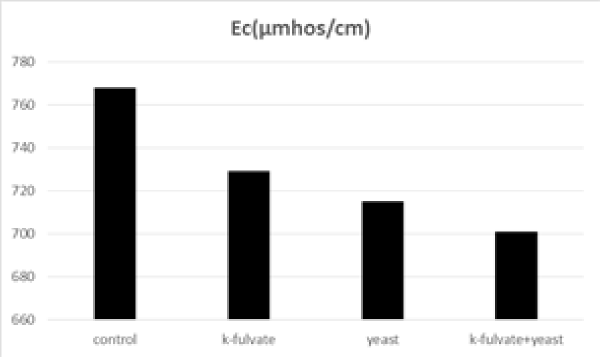

Fig .1. Electrical Conductivity (EC) (µmhos/cm) in soil after harvesting as affected by soil application of (KFv and Yst) .

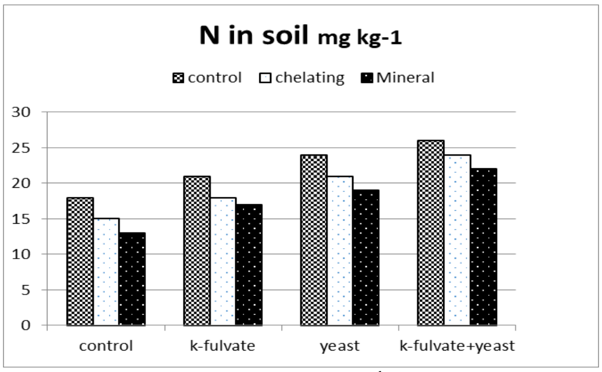

Fig. 2. Available N in soil (mg kg^{-1}) after harvesting as affected by soil application of (KFv and Yst) under foliar application of micronutrients.

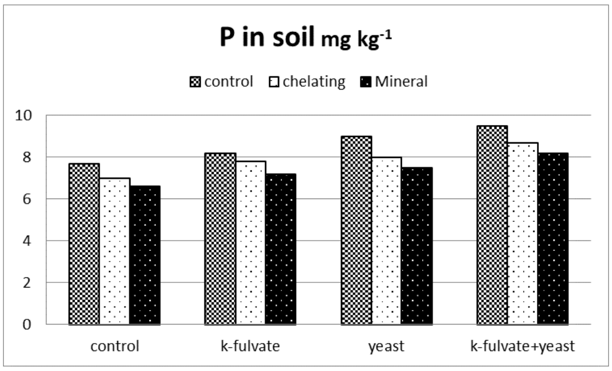

Fig. 3. Available P in soil (mg kg^{-1}) after harvesting as affected by soil application of (KFv and Yst) under foliar application of micronutrients.

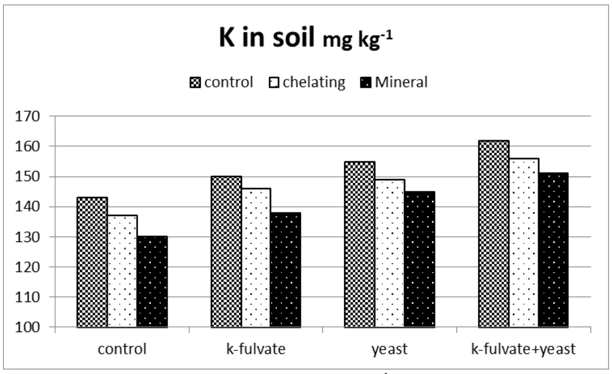

Fig. 4. Available K in soil (mg kg^{-1}) after harvesting as affected by soil application of (KFv and Yst) under foliar application of micronutrients.

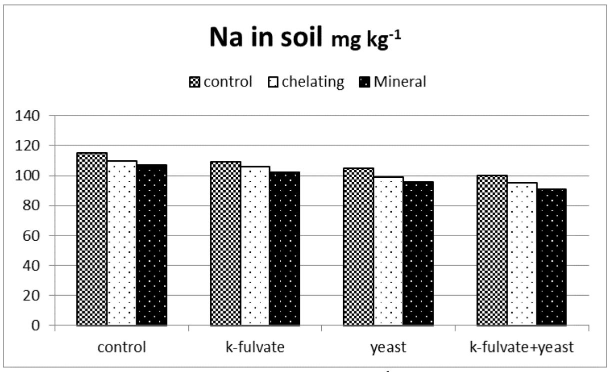

Fig. 5. Available Na in soil (mg kg^{-1}) after harvesting as affected by soil application of (KFv and Yst) under foliar application of micronutrients.

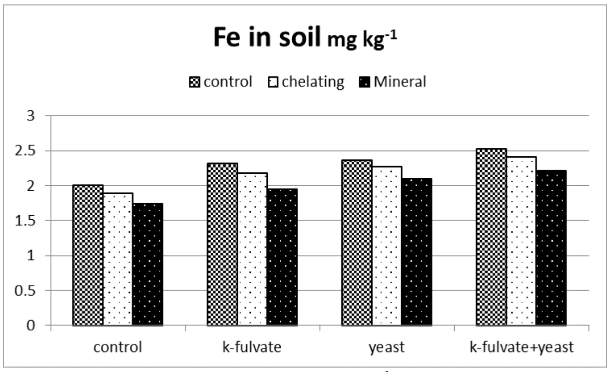

Fig. 6. Available Fe in soil (mg kg^{-1}) after harvesting as affected by soil application of (KFv and Yst) under foliar application of micronutrients.

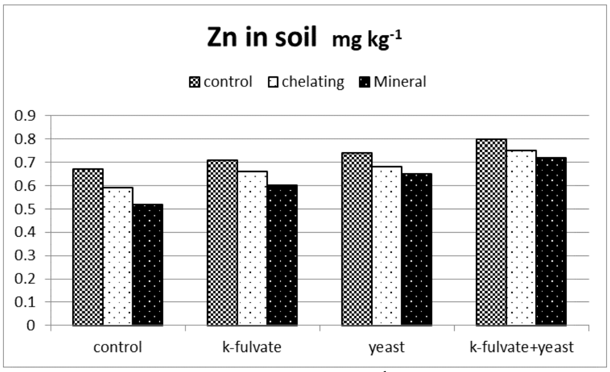

Fig.7. Available Zn in soil (mg kg^{-1}) after harvesting as affected by soil application of (KFv and Yst) under foliar application of micronutrients.

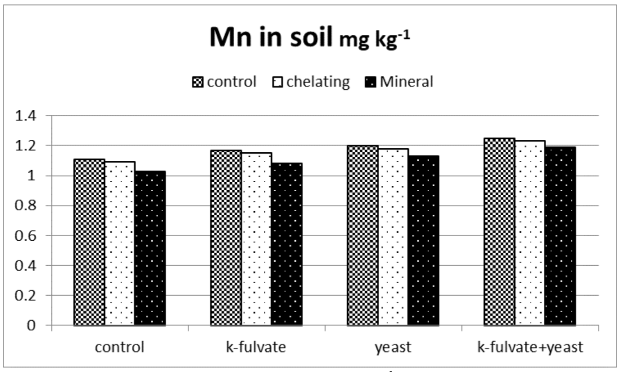

Fig. 8. Available Mn in soil (mg kg^{-1}) after harvesting as affected by soil application of (KFv and Yst) under foliar application of micronutrients.

On the other hand, foliar application of micronutrients treatment leads to decreased the average concentration of available N, P, K, Fe, Zn and Mn (mg kg^{-1}) in the soil after harvesting wheat plants it might be due to the role of micronutrients in improving plant status, increasing vegetative growth of plant and consequently, a greater absorption of nutrients by plants with foliar application of micronutrients with the superpass to mineral form more than untreated plants. These results were in agreement with Barnett *et al*., (1990), Akinci and Ongel, (2011) and Rashwan-Eman, *et. al*., (2020).

CONCLUSION

Finally, it could be concluded that, for sustain wheat growth and maximize production in sandy soils, avoid decline effect of irrigation water salinity, it recommended that to enhances management of wheat cultivation it should be treated with stimulation substances like potassium fulvate and yeast together with foliar nutrition by micronutrients in the mineral form. Which can be used as a promising alternative to improve soils fertility and mitigate salinity stress-induced damage in wheat production and helping to decrease the economical wheat production costs under the same conditions of this study.

REFERENCES

A. O.A.C. (2007). Official Methods of Analysis. 18th Ed. Association of Official Analytical Chemists, Inc., Gaithersburg, MD, Method 04.

Akinci, I. E and O. Ongel, (2011). Nikelin fasulye (*phaseolus vulgaris*) fide gelisimi uzerindeki toksisitesinin humik asite ile azaltilmasi. Ekoloji. 20: 29-37.

Aziz, M. Z.; M. Yaseen; T. Abbas; M. Naveed; A. Mustafa;

Barnett, J. A.; R. W. Payne and D. Yarrow, (1990). Yeast Characteristics and Identification, second ed. Press, Cambridge Univ., London, UK, 012 p.

Bates, L.S. (1973). Rapid determination of free proline for water –stress studies. Plant Soil 39. 205-7.

Cottenie, A.; M. Verloo; L. Kiekens and R. Canerlynck (1982).Chemical Analysis of Plants and Soil. Laboratory of Analysis and Agrochemistry, State Univ. Ghent, Belgium.

El-Ghamry, A. M.; A. M. Abd El-Hamid and A. A. Mosa (2009). Effect of Farmyard Manure and Foliar Application of Micronutrients on Yield Characteristics of Wheat Grown on Salt Affected Soil. American-Eurasian J. Agric. & Environ. Sci., 5 (4): 460-465. ISSN 1818-6769.

FAO (Food and Agriculture Organization). (2016). FAO GIEWS Country Brief on Egypt. www. fao. org/giews/countrybrief/country. jsp? code= EGY.

Gomez, K. A. and A. A. Gomez. (1984). "Statistical procedures for Agriculture Research".2nd Ed. John Willey and Sons Inc. New York.

Hassanein, M. S., A. G. Ahmed and N. M. Zaki, (2018). Effect of nitrogen fertilizer and bio-fertilizer on yield and yield components of two wheat cultivars under sandy soil. Middle East Journal of Applied Sciences. 8(1):37-42.

Hesse, P. R. (1971). "A Text Book of Soil Chemical Analysis". John Murry (Publishers) Ltd, 50 Albemarle Street, London.

Hillel. (1972).Optimizing the soil physical environment toward greater crop yields. Symp Soil Water Physics and Technology.

Jones, J.; B. J. B. Wolf, and H. A. Mills, (1991). Plant analysis Handbook: A Practical Sampling, Preparation, Analysis, and Interpretative Guide. Micro-Macro Publishing, Athens, Ga.

Modaihsh, A. S. (1997). Foliar Application Of Chelated And Non-Chelated Metals for Supplying Micronutrients to Wheat Grown on Calcareous Soil. Experimental Agriculture , Vol. 33 (2): 237 – 245.

Mohamed, M. F.; A. T. Thalooth; T. A. Elewa and A. G. Ahmed, (2019). Yield and nutrient status of wheat plants (Triticum aestivum) as affected by sludge, compost, and biofertilizers under newly reclaimed soil. . Bulletin of the National Research Centre. 43:31 https://doi.org/10.1186/s42269-019-0069-y.

Patil, B. and H. T. Chetan, (2018). Foliar Fertilization of Nutrients. Marumegh: 3(1): 49-53.

Peters, J.; S. Combs; B. Hoskins; J. Jarman; J. Kovar; M. Watson and N. Wolf, (2003). Recommended methods of manure analysis. Univ. of Wisconsin Coop. Ext. Publ. A3769, Univ. of Wisconsin, Madison. Recommended methods of manure analysis. Univ. of Wisconsin Coop. Ext. Publ. A3769, Univ. of Wisconsin, Madison.

Pettit, R. E. (2008). Organic Matter, Humus, Humate, Humic Acid, Fulvic Acid and Humin: Their Importance In Soil Fertility And Plant Health. Emeritus Associate Professor Texas A&M University cdc. Chemistry.

Piper, C. S. (1950). "Soil and Plant Analysis". Inter Science Publishers Inc. New York.

Rashwan-Eman, M.; M. N. Fayaid-Riham and E. Elmahdy-Rasha, (2020). Sustainable Management of Kidney Bean Plants by Soil Application of Humic Substances and Foliar Application of Molybdenum. Environment, Biodiversity and Soil Security.4: 381-390

Reeuwijk, L. P. (2002).″ Procedures for soil analysis″. Inter. Soil Ref. and Info. Center. Food and Agric. Organization of the United Nations.

Seadh, S. E.; M. I. El-Abady; A. M. El-Ghamry and S. Farouk, (2009). Influence of micronutrients foliar application and nitrogen fertilization on wheat yield and quality of grain and seed. J. Biol. Sci., 9 (8): 851-858.

Sumanta, N.; C. I. Haque; J. Nishika and R. Suprakash, (2014). Spectrophotometric analysis of chlorophylls and carotenoids from commonly grown fern species by using various extracting solvents. Res. J. Chem. Sci., 4(9), 63-69.

Tester, M. and R. Davenport, (2003). Na tolerance and Na transport in higher plants. Annals of Botany, 91: 503-527.

Van Bockhaven J; D. De Vleesschauwer and M. Hofte, (2013). Towards establishing broad-spectrum disease resistance in plants: silicon leads the way. Journal of Experimental Botany 64: 1281–1293.

Walker, D.J. and M. P. Bernal, (2008). The effects of olive mill waste compost and poultry manure on the availability and plant uptake of nutrients in a highly saline soil. Bioresour. Technol. 99, 396-403.

Y. Hamid; Q. Saeed, and Xu. Ming-gang, (2019). Foliar application of micronutrients enhances crop stand, yield and the biofortification essential for human health of different wheat cultivars. Journal of Integrative Agriculture, 18(6): 1369–1378.

Yassen, A.; E.A.A. Abou El-Nour and S. Shedeed, (2010). Response of wheat to foliar spray with urea and micronutrients. J. of Amer. Sci., 6(9): 14-22.

Yousif, S. H.; K. H. Yousif and S. M. Salih (2019). Effect of Bread Yeast and Humic Acid on Growth and Yield Traits on Broad Bean (Vicia Faba L.). Journal of University of Duhok., Vol. 22, No.1 (Agri. and Vet. Sciences):98-106

Zain, M.; I. Khan; R. Qadri; U. Ashraf; S. Hussain; S. Minhas; A. Siddique; M. Jahangir and M. Bashir, (2015). Foliar Application of Micronutrients Enhances Wheat Growth, Yield and Related Attributes. American Journal of Plant Sciences. 6, 864-869.

تعظيم إنتاجية القمح و تلافى التأثير السلبى لملوحة المياه بواسطة المواد المستحثة للنمو والرش الورقى للعناصر الصغرى تحت ظروف أراضى شمال سيناء

رشا السيد المهدى ، ريهام محمد نجيب فياض وإيمان محمود رشوان

قسم بحوث خصوبة الأراضى وتغذية النبات – معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية – الجيزة –مصر.

لتعظيم الأثر النافع لاستخدام بعض المواد المنشطة (فولفات البوتاسيوم والخميرة) إلى جانب الرش الورقى بالعناصر الصغرى على إنتاجية محصول القمح وخصائص التربة الرملية المروية بالمياه الجوفية المالحة. أجريت تجربتان حقليتان خلال موسمي زراعة شتويتين متتاليين ٢٠١٦-٢٠١٧ و ٢٠١٧ - ٢٠١٨ في محطة بحوث التجارب الزراعية بالعريش ، مركز البحوث الزراعية ، مدينة العريش ، محافظة شمال سيناء ، مصر. كانت المعاملات الرئيسية هي المواد المنشطة والتي اشتملت على أربع معاملات }بدون إضافة ، فولفات البوتاسيوم ، الخميرة وفولفات بوتاسيوم +الخميرة {بينما كانت المعاملات الفرعية عبارة عن الرش الورقى بالعناصر الصغرى واشتملت على ثلاث معاملات }بدون رش ، الصورة المخلبية(حديد وزنك ومنجنيز-اديتا) والصورة المعدنية (سلفات حديد وزنك ومنجنيز) {كانت المعاملات في تصميم القطع المنشقة بثلاث مكررات ، وأظهرت النتائج أن معاملة فولفات بوتاسيوم + الخميرة مع الرش الورقى بالعناصر الصغرى كانت أفضل معاملة لصفات النمو الخضرى مثل الوزن الطازج والجاف ، طول النبات ، محتوى الكلوروفيل والمكونات الكيميائية في الأجزاء فوق سطح الأرض (نيتروجين و فوسفور وبوتاسيوم كمغذيات كبرى ، والحديد والزنك والمنغنيز كمغذيات صغرى) وكذلك محصول الحبوب ، بينما انخفض محتوى الصوديوم للحبوب ، وسجلت أعلى قيم للعناصر الغذائية المتاحة في التربة مع معاملة فولفات البوتاسيوم +الخميرة والرش الورقي بالعناصر الصغرى في الصورة المعدنية. وبذلك يمكن إستنتاج أن التسميد بفولفات البوتاسيوم + الخميرة معا" مع الرش الورقي بالعناصر الصغرى في الصورة المعدنية كبريتات هى الأنسب للحصول على أعلى محصول حبوب لنباتات القمح.