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Effect of Micronutrients Application and Spraying Yeast Extract on Yield and Yield Components of Wheat (*Triticum aestivum* L.)

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Abstract: A field experiment was conducted during winter season of 2018-2019, at Al-Qurna district (75 km north of Basrah city centre). The aim of experiment was studding the effect of five levels of micronutrients (MN), Fe, Zn, Mn, Cu, B, and Mo: 0, 2 and 4 kg. ha^{-1} (soil application), 500 and 1000 ppm (foliar application), and three levels of activated yeast extract (AYE): 0, 3 and 6 g. L^{-1}, in the yield and qualitative characteristics of wheat. The experiment was carried out using randomized completely block design in a split arrangement with three replicates. The main plots contained fertilizer levels. While the sub-plot occupied by Yeast levels. The results showed that spraying 1000 ppm from the solution of MN significantly increase the number of spikes per m^2 , the number of grains in the spike, grain yield and biological yield with an increase by 15.4%, 18%, 27.5 % and 35% respectively compared to the control treatment, while the concentration of 500 ppm significantly increase protein yield with an increase of 35% compared to the control treatment. The results also showed that spraying 6 g. L^{-1} of AYE differ significantly and gave the highest values of spikes number per m^2 , number of grains per spike , grain yield , biological yield and protein yield, with an increase by 5.84%, 7.1%, 11.4% , 11.1% and 10.9% respectively compared to the control treatment. The interaction between application of 4 kg. MN ha^{-1} and the level of 6 g. L^{-1} AYE gave a significant superiority in the number of spikes (333.9 spike m^{-2}), while the spraying of 1000 ppm + 6 g. L^{-1} AYE gave the highest grain yield (8.891 ton. ha^{-1}) and biological yield (31.827 ton. ha^{-1}).

Keywords: *Triticum aestivum* L., Yield components, Seed yield, Protein yield.

Introduction:

Wheat (*Triticum aestivum* L.) is one of the most important strategic crops for its high nutritional value. Iraq is one of the first places for the emergence of wheat crop because of the availability of production factors such as soil, water and suitable climatic conditions, but the productivity of the crop fluctuates from year to year. In general, there is a gap between the amount of production and the actual need of the population. Most soils of the central and southern regions of Iraq tend to be alkaline with a pH ranging from 7.5-8.2 depending on their lime content (Khalaf *et al*., 2017). This makes micronutrients such as iron, manganese, zinc,

and copper precipitate in the form of complex compounds and become unavailable for the plant (Abu-Dahi, 1995). Numerous researches have shown that the best method to add MN to the plant to obtain a good quantitative and qualitative production is by spraying it on the vegetative part. Abu-Dahi & Shati (2009) found that the use of chelated fertilizer containing a combination of micronutrients led to an increase in dry weight, weight of thousand grain and grain yield of wheat. Al-Zergawy (2016) obtained an increase in the number of spikes and weight of 1000 grains and the grain yield of wheat when spraying with micronutrients (N 40% , P 10% , K 0.10% , Mg 0.25%, Ca 0.10% , S 1% , Fe 700 ppm , Zn 700 ppm, Cu 600 ppm, Mo 80 ppm and B 30 ppm) at a concentration of 0.01 g. L^{-1}. Al-Tameme (2013) found significant increase in number of spike m^{-2}, weight of 1000 grains, grain yield and biological yield of two cultivars of wheat (Iba 99 and Buhooth 7) when sprayed in combination (50 mg Fe and 50 mg Zn. l^{-1}).

Some research has been done on the use of AYE as biofertilizer for some crops. Yeast (*Saccharomyces cerevisiae*) is a living organism (fungi) that contains many important nutrients for plants such as iron, calcium, magnesium, potassium, nitrogen, sodium, phosphorus, zinc and silicon (Table 2). It is rich in growth regulators such as gibberellins and oxins (De Wedar & Ibrahim, 2016). It was found that AYE increase vegetative growth such as plant height and leaf area (Ezz El-Din & Hendawy, 2010). El-Desouky *et al*. (2007) noted that yeast extract has a role in encouraging cells to grow, divide, elongate and increase plant height and leaf area because of the nutrients they contain. Al-Maeini & Al-Isawi (2017) observed that the concentration exceeded 15 g. L^{-1} of AYE significantly increased the number of grains in the head and grain yield for sorghum which reached 11.72 ton. ha^{-1}. It was also observed that spraying with AYE on maize plants at levels 10, 20 and 30 g. L^{-1} showed significant differences and increases for most growth and yield characteristics compared to no spraying in both spring and autumn seasons (Al-Ani & Al-Obeidi, 2017).

Due to unavailability of micronutrients in the soil of southern of Iraq, and the lack of studies on the addition methods, as well as the scarcity of studies on spraying plants with AYE, this study was carried out, aimed to knowing the response of wheat to applying micronutrient (in different quantities concentration and different methods) and the effectiveness of spraying plants with AYE.

Materials & Methods

A field experiment was carried out during the winter season of 2018-2019, in order to study the impact of five levels of micronutrients (MN), Fe, Zn, Mn, Cu, B, and Mo: 0, 2, 4 kg. ha^{-1} (soil application) and 500 and 1000 ppm (foliar application), and three levels of activated yeast extract (AYE): 0, 3 and 6 g. L^{-1}; in the yield and qualitative characteristics of wheat. The experiment was carried out using randomized completely block design in a split arrangement with three replicates. The main plots occupied by fertilizer levels. The sub-plots occupied by yeast levels. The field of experiment was prepared by (plowing and leveling). Thereafter, five random soil samples were taken from the soil to determine some physical and chemical properties, shown in

table (1) (Salim & Ali, 2017). Field was divided into three blocks (replicates), each block into five main plots, and each main plot to three sub-plots (experimental units) with dimensions of (2 × 3) m^2, A distance of 1.5 m has been left between each blocks. Each experimental unit included 13 rows which were opened manually, the distance between the rows was 15 cm with 3 m length. The seeds of wheat cv. Buhooth 22 were sown at 1/12/2018 with a seeds rate of 120 kg ha^{-1}. The five levels of MN symbolized by F_0, F_1, F_2, F_3 and F_4, respectively.

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

	P (mg kg^{-1})	K (mg kg^{-1})	pH	E.Ce (dSm^{-1})
69	17	182	7.56	4.12
		Soil particles (gm. kg^{-1})		
Clay loam	Soil texture	Clay	Silt	Sand
		401.6	391.7	272.7

Table (2): Some components of activated yeast (mg per 100 g dry yeast) cited from Neama *et al*. (2014).

Arginine	1.99	Serine	1.59	Inositol	0.26
Histidine	2.63	Aspartic acid	1.33	Biotin	0.09
Isoleucine	2.31	Cysteine	0.23	Nicotinic acid	39.90
Lucien	3.09	Proline	1.53	Pantothenic acid	19.60
Lysine	2.95	Tyrosine	1.49	Folic acid	4.36
Methionine	0.72	Vit. B_1	2.23	Pyridoxine	2.90
Phenylalanine	2.01	Vit. B_2	1.33	Total carbohydrates	23.20
Threonine	2.09	Vit. B_6	1.25		
Tryptophan	0.45	Vit. B_{12}	0.15	Glucose	13.30
Valine	2.19	Glutamic acid	2.00	Cobalamine	153.0
Fe	50.00	Cu	50.00	Zn	50.00
Ca	100	Mg	2000	Co	5.00
Na	5600	P	38000	K	30000

Soil application of MN (F_1 & F_2) was applied at sowing time, while the MN solution was sprayed at deferent timing one, two, and three months after sowing. The three levels of AYE solution had the symbols: Y_0, Y_1, and Y_2 respectively. The solution of AYE was prepared in the laboratory of College of Agriculture, University of Basrah, according to the method described by Spencer *et al*. (1983). Some components of activated yeast illustrated in table (2). The AYE was sprayed after 35, 70, and 105 days after sowing. The compound fertilizer NPK (20-20-20) was evenly added to all experimental units by 200 kg. ha^{-1} in one batch before sowing (when preparing the field). Before flowering, 60 kg N. ha^{-1} as urea (46% N) were applied. The plants were harvested after reaching full maturity at 16/4/2019. Data were collected and analyzed using SPSS program ver. 17 for analysis of variance and the least significant difference at 0.05 level was used to compare the means of treatments. Random samples were taken from the field to determine their physical and chemical properties, (table 1). Number of spikes. m^{-2}, number of grain per spike, weight of 1000 grains, grain yield, biological yield and protein yield were studied. The composition of MN solution is shown in table (3).

Table (3): Micronutrient concentration(%) in spraying solution.

Element	Fe	Zn	Mn	Cu	B	Mo
%	33.3	25.0	16.7	13.3	8.3	3.3

Results & Discussion

Number of spikes m^{-2}

The results in table (4) indicated a significant increase in the number of spikes per square meter when using MN in spraying method. Concentration of 1000 ppm (F_4) gave the highest number of spikes of 326.8 m^{-2} (which was not significantly differed from treatment F_3) with an increase by 15.4% compared to the control treatment, which gave the lowest average of 283.2 spike m^{-2}. This may be due to the active and positive role of some MN in transporting carbohydrates from sources to sinks, providing them in the suitable time (critical stage) to modern and efficient growth centers, which gave an opportunity for the growth and development of fertile tillers. These processes reflected on the increase in the number of spikes (Rawashdeh & Sala, 2014), in addition, iron and manganese takes an important role in building good roots (Abu-Dahi & Shati, 2009). This leads to an increase in the number of spikes per unit area, due to the strong and positive correlation between them (Al-Alusi, 2002). From result of table (4) we also noted the significant effect of spraying with AYE in increasing the number of spikes, where the level of 6 g. L^{-1} (Y_2) gave the highest number of spikes (319.9 m^{-2}) with an increase by 5.84 and 4.10% compared to Y_0 and Y_1 respectively. This may be due to the containing of yeast extract on various nutrients mineral elements that have a role in encouraging plant

cells to grow, divide, elongate and increase the leaf area, resulting in more efficient photosynthesis and consequently increasing the number of tiller carrying spikes (Al-Hamdani *et al*., 2014; Mohamed *et al*., 2018) This result was agreed with Ismail & Amin, (2014).

The interaction between MN and spraying with AYE showed a significant effect on the number of spikes m^{-2}. Treatment F_0Y_0 gave the lowest number of spikes (271.1 m^{-2}). The heights number obtained by F_2Y_2, F_2Y_3 and F_2Y_4. Here, the contribution of both of the two factors to increase indicatory of growth, including the leaf area, may encourage the other factor to increase the area of foliar spray and the greater response of the plant in absorbing a larger amount of MN or AYE.

Table (4): Effect of micronutrients, spraying with AYE and their interaction on number of spikes m^{-2} for wheat.

Yeast levels	Micronutrients levels					Mean for Yeast
	F_0	F_1	F_2	F_3	F_4	
Y_0	271.1	301.6	312.2	308.3	317.6	302.2
Y_1	274.5	295.0	308.8	327.1	330.9	307.3
Y_2	304.0	298.0	333.9	331.6	331.8	319.9
Mean for Micronutrients	283.2	298.3	318.3	322.3	326.8	
L.S.D. (P<0.05)	Micronutrients		Yeast		Interaction	
	19.01		6.17		13.79	

The number of grain per spike

Results in table (5) indicated a significant increase in grains number in the spike by applying F_4, which gave the highest number of grains in spike (80.3), with a significant increase by 18% over the control treatment (F_0), which gave the lowest value (68.0 grain per spike). This is due to the role of MN, including the importance of boron in increasing pollen germination and reducing the fatigue of ovule, the fact that the fertility rate in flowers is affected by nutrition in addition to being affected by genetic makeup (Al-Hassan, 2017), and this result agreed with (Al-Jumailly, 2011). The results of table (5) also indicate the significant effect of spraying AYE on the number of grains in the spike. This is due to the active role of yeast in vegetative growth by

Table (5): Effect of micronutrients, spraying with AYE and their interaction on the number of grains in spike for wheat.

Yeast levels	Micronutrients levels					Mean for Yeast
	F_0	F_1	F_2	F_3	F_4	
Y_0	68.3	65.0	65.0	75.0	79.0	70.5
Y_1	63.7	74.0	70.3	75.0	82.0	73.0
Y_2	72.0	73.7	79.0	73.0	80.0	75.5
Mean for Micronutrients	68.0	70.9	71.4	74.3	80.3	
L.S.D. (P<0.05)	Micronutrients		Yeast		Interaction	
	3.78		2.68		6.00	

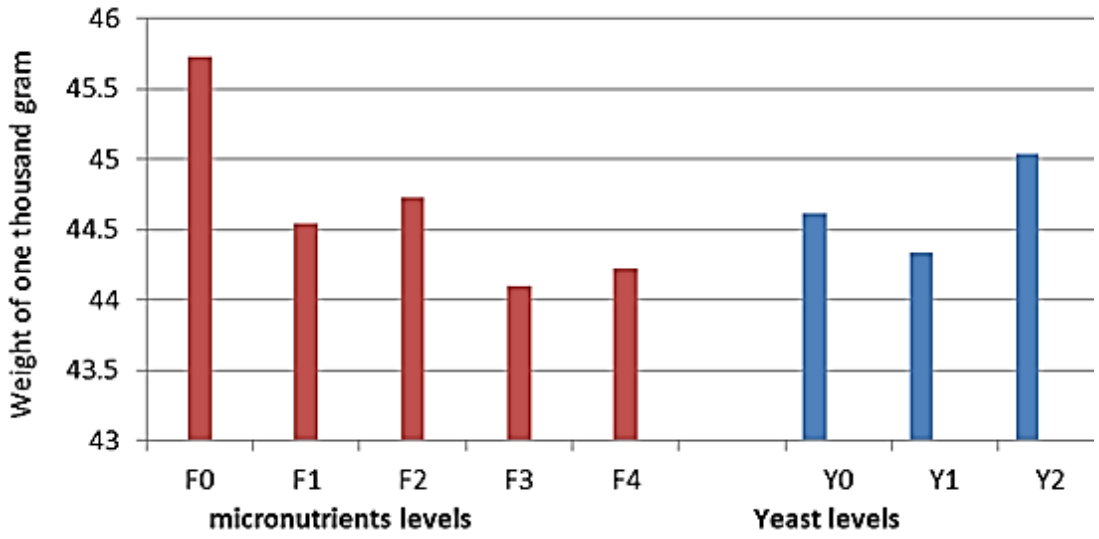

Fig. (1): Effect of micronutrients and spraying with AYE on weight of 1000 grains (gm) of wheat.

absorbing it from the leaves and the fact that the leaves are an and the lowest value was obtained (no significant difference) at F_3 and F_4 (44.1 and 44.2 g) respectively. The yield components cannot take the same trend of increase or decrease at the same time. As the increase in the number of spikes m^{-2} (table 4) and the increase in the number of grains in the spike (table 5) were offset by the unaffected weight of the grain or there may be a decrease in weight (fig. 1).

Grain yield

The results in table (6) showed that the grain yield had been found to been increased progressively irrespective of MN application. The highest amount of grain yield of wheat being reached 8.596 ton. ha^{-1} by foliar application (F_4), with an increasing percentage by 27.5 % compared to F_0 which gave the lowest value (6.740 ton. ha^{-1}). This increase might be due to the increase in the number of spikes per m^2 and the number of grains in the spike, which positively lead to the increase grain yield (tables 4 & 5).

Table (6): Effect of micronutrients, spraying with AYE and their interaction on grain yield of wheat (ton. ha^{-1}).

Yeast levels	Micronutrients levels					Mean for Yeast
	F_0	F_1	F_2	F_3	F_4	
Y_0	6.663	6.678	6.958	7.841	8.349	7.298
Y_1	6.156	7.284	7.493	7.887	8.549	7.474
Y_2	7.401	7.484	8.729	8.186	8.891	8.138
Mean for Micronutrients	6.740	7.149	7.726	7.971	8.596	
L.S.D. ($P<0.05$)	Micronutrients		Yeast		Interaction	
	0.644		0.267		0.599	

The results in table (6) also showed the positive and significant effect of AYE in an increasing wheat grain yield. The highest yield observed was 8.138 ton. ha^{-1} recorded by using Y_2 treatment with an increase of 11.4% as compared to the non-sprayed yeast treatment (Y_0) which gave the lowest yield (7.294 ton. ha^{-1}). This may be due to the nutrient and another content of AYE, which reflected positively in an increasing the vegetative growth through the development of the plant and leaf area (Sarhan *et al*., 2011). These lead to increase photosynthesis and biological processing reflected on increasing the number of spikes and the number of grains in the spike and then increase the total grain yield (Al-Ani & Al-Obeidi, 2017). The finding of Sarhan *et al*. (2011) supported these results. The effect of the interaction between the two factors was significant in this parameter. The highest value obtained by using F_4Y_2 and F_2Y_2 (8.891 and 8.729 ton. ha^{-2} respectively), while the lowest value obtained by using F_0Y_1 (6.156 ton. ha^{-2}). Such increase in grain yield might be due to the high effect of spraying MN which increase leaf area and then resulted in receive more amount of AYE causing relatively greater effect on

yield components reflected on giving the highest yield of wheat grain.

Biological yield (BY)

Results of table (7) indicated the positive significant effect of spraying with MN on biological yield. The highest biological yield (BY) (30.670 ton. ha^{-1}) was obtained when the plants sprayed by 1000 ppm (F4) of MN solution, while the lowest (22.711 ton. ha^{-1}) was obtained when the plants sprayed by F_0. This is due to the role of MN in an increasing the weight of the vegetative parts and grain yield and thus lead to increase the biological yield (Khalaf *et al*., 2017). This result was in agreement with results of Meghana *et al*. (2019). The results also showed the positive effect of spraying AYE, where the BY increased with increasing the AYE concentration. The highest weight of BY being obtained (28.214 ton. ha^{-1}) by using Y_2 treatment with an increase by 11.1% compared to Y_0 which gave the lowest BY (25.398 ton. ha^{-1}). This is due to the role of AYE in an increasing some of biological processes which reflected in increasing vegetative growth, tillering, leaf area and grain yield leading to increased biological yield (Ismail & Amin, 2014) This finding was in agreement with results of Sarhan e*t al.* (2011). The interaction between the two factors had a significant effect in this characteristic. The combinations of F_4Y_2 and F_2Y_2 gave the highest BY reached to31.827 and 31.247 ton. ha^{-1} respectively; while the lowest value obtained at the combination F_0Y_1 which reached to 20.427 ton. ha^{-1}.

Protein yield (kg. ha^{-1})

The results of the statistical analysis and the data of fig. (2) showed that spraying of MN and AYE had a significant effect on the protein yield of wheat , while the interaction have no significant effect on this parameter. The highest protein yield was 1064.8 kg. ha^{-1} obtained by using F_3 treatment, which did not differ significantly from F_4 treatment, which gave a protein yield of 1053.2 kg ha^{-1} with an increase of 35 and 34%, respectively, compared to the control treatment (F_0). This may be due to the role of MN, especially the role played by iron and molybdenum in an increasing the effectiveness of Nitrate (No_3) reductase enzyme

Table (7): Effect of micronutrients and spraying with AYE and their interaction on biological yield (ton. ha^{-1}) for wheat.

Yeast levels	Micronutrients levels					Mean for Yeast
	F_0	F_1	F_2	F_3	F_4	
Y_0	22.367	23.177	23.931	28.189	29.359	25.405
Y_1	20.427	25.034	26.143	27.883	30.823	26.062
Y_2	25.339	26.199	31.247	27.598	31.827	28.442
Mean for Micronutrients	22.711	24.803	27.107	27.890	30.670	
L.S.D. (P<0.05)	Micronutrients		Yeast		Interaction	
	2.971		1.182		2.644	

and consequently increase the nitrogen content in the seeds and then increase the protein yield (Al-Jubouri, 2015). Such increase of protein yield is due to the increase in grain yield and nitrogen concentration at this level. The protein yield exhibits behavior as that of the seed (Meghana *et al*., 2019).

The results of fig. (2) also indicate the significant effect of spraying with AYE.Y_2 treatment gave the highest protein yield of 1017.3 kg. ha^{-1} compared to the no-spray treatment (Y_0) which gave the lowest protein yield of 917.1 kg. ha^{-1}, with an increase by 10.9% as compared to the control treatment. This may be due to the different contents of yeast like: acids, vitamins, growth regulators and nutrients that have an active role in anincreasing the protein yield. This is consistent with what Al-Shammary & Salman (2011) found.

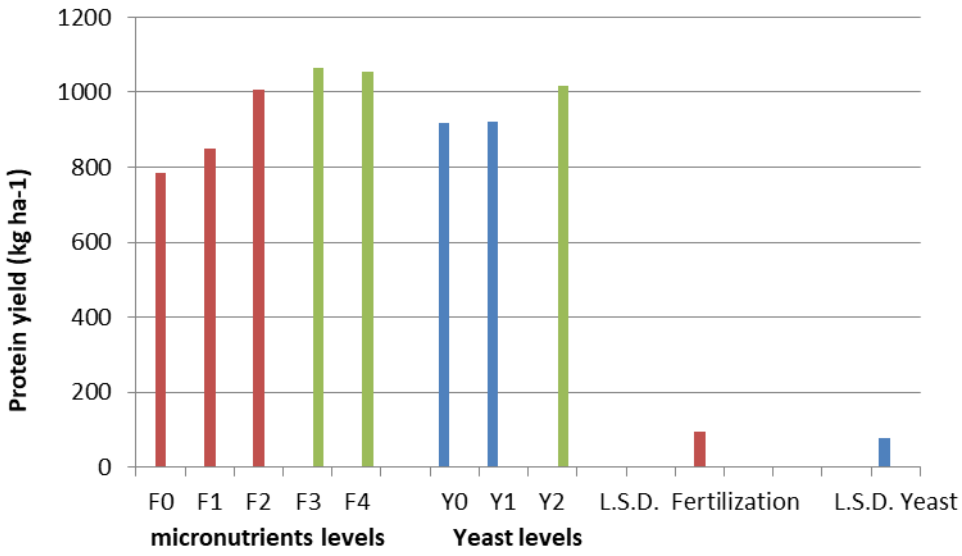

Fig. (2): Effect of micronutrients and spraying with AYE on protein yield (kg ha^{-1}) for wheat.

Conclusions

It can concluding that spraying of micronutrients in concentration of 1000 ppm and using 6 gm yeast.l^{-1} affected significantly and gave the highest grain, biological and protein yield. The interaction between the two factors (F_4Y_2) recorded the highest grain yield reached to 8.891 ton ha^{-1} with an increasing percent by 33.4 % compared to control (F_0Y_0).

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