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Effect of cytokinin and yeast extract foliar application on wheat yield and its components (*Triticum aestivum L.)* under different levels of zinc

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ABSTRACT

Microelements and plant growth regulators are essential to sustain the crop production of traditional and organic farming systems. Thus, a 2–year field experiment was conducted the Experimental Farm, Faculty of Agriculture, Fayoum University at "Demo" district, Fayoum Governorate, Egypt during the two successive seasons of 2018-2019 and 2019-2020 The study aimed to examine the effects of zinc sulfate, cytokinin rates and yeast extract concentrations and their interactions on yield and yield attributes of wheat plants. Along the two seasons, yeast extract concentrations had statistically significant effect on plant height, spikes number per plant, 1000 grain weight, grain yield, straw yield and crud protein percentage. Wheat plants treated with 0.50 ml/liter cytokinin rate surpassed to untreated plants on plant height, spikes number per plant, 1000 grain weight, grain yield and straw yield in two seasons (2018-2019) and (2019-2020). A significant effect in 1000 grain weight, grain yield, straw yield and crud protein percentage were obtained by spraying wheat plants with zinc sulfate concentrations in both seasons. Interaction between zinc sulfate (1 g/liter) x cytokinin rate (0.50 ml/liter) and yeast extract concentration (5 or 10 g/liter) showed that producing the highest values of grain yield (ton/fed) and straw yield (ton/fed). Also, the data reflect appositive result of this chemical substance on maximization wheat productivity under these experimental conditions.

Key words: wheat, zinc sulfate, cytokinin, yeast extract, plant growth regulators.

INTRODUCTION

Globally wheat as a cereal crop is a staple food for about one third of the world's population **(Hussain and Shah, 2002)** and it provides 20% of energy in human diets **(Ahmadi et al., 2004).** Thus, there is continuously a dire need for increasing its productivity. In Egypt, improving the productivity of wheat is a main task due to its short supply which mandated importing about 50% of the needed wheat grains from outside the country.

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Zinc is considered of these essential nutrients. Zinc is considered one of the top responsible essential micronutrients for vital crop growth. It is a substantial element and activator of various enzymes engaged in the metabolic process such as energy production, protein synthesis, and growth regulation. Moreover, zinc is an ingredient that directly influences yield and quality because of its activity in biological membrane stability, enzyme activation ability, and auxin synthesis **(Marschner, 1997).** Many studies have been shown that one of the effective and productive ways to improvement in cereal grains is application of zinc fertilizer either to the soil or foliar application **(El-Metwally et al., 2012)**. **Hassanein et al. (2019)** in Egypt, use four treatments of zinc foliar fertilizer (control without zinc foliar application, 0.4%, 0.6% and that 0.8% Zn SO_4/fed) with two cultivars (Sids-12 and Misr 2). They indicated that zinc foliar increased significantly growth characters under study at 90 and 105 days from sowing.

Plant hormones play a vital role in coordination of many growth and behavioral processes in the plant life. Cytokinins as a hormonal group, has been strongly implicated in many aspects affecting yield, particularly grain number and size **(Jameson and Song, 2016)**. Cytokinins regulate cell division and differentiation in certain plant tissues and participate in many developmental processes e.g. senescence, photosynthesis, flower formation and photosynthate partitioning etc. Yeast is considered as a new promising plant growth promoting for different crops. Yeast extract is a natural source of many growth substances (thiamine, riboflavin, niacin, pyridoxine and vitamins B1, B2, B3 and B12), cytokinins and many of the nutrient elements as well as organic compounds i.e., protein, carbohydrates, nucleic acid and lipids **(Barnett et al., 1990)**. **Mohamed (2005)** also found that active dry yeast as foliar application had a beneficial effect on growth, yield and chemical constituents of plants.The present study was conducted to evaluate the effects of cytokinin, yeast extract, zinc and their interaction on growth and yield of wheat cv.

MATERIALS AND METHODS

Experimental site and plant materials:

Two field experiments were conducted at Experimental Station Farm, Faculty of Agriculture, Fayoum University, Fayoum Governorate Egypt, during the two successive seasons of 2018/2019 (SI) and /2019/2020 (SII). The representative soil samples (0-30 cm depth) were taken before adding fertilizers and during soil preparation for assessing physical and chemical properties of the experimental soil in (Table 1).

Layout and experimental design:

The experiments were lay out in a split – split plot design in RCBD, three replications.,The treatments of the experimental factors were allocated as follows: Three zinc concentration i.e. spraying tap water (Z_w), 1g/L^{-1} (Z_2) and 2g/L^{-1} (Z_3) was added at 45 and 60 days after sowing (DAS) in the main plots., While three foliar spraying with cytokinin concentrations i.e. spraying tap water (C_w), 0.25ml/L^{-1} (C_2) and 0.50 ml/L^{-1} (C_3) at 30 and 45(DAS) in the sub – plots. Moreover,, the yeast extract (Y_L) was foliage sprayed with three concentrations [spraying water as a control (Y_w), 5 g/L^{-1} (Y_2), and 10 g/L^{-1} (Y_3)] at 30 and 45 (DAS) in the sub-sub-plots. The (Y) treatments were applied using a hand-operated compressed air sprayer with a rate of 200 L/fed^{-1}. According to Spencer et al. (1983), the extract of dry bread yeast scientifically known as Saccharomyces cerevisiae, was freshly prepared using a technique that enables yeast cells (pure active dry yeast 100 g L^{-1}) to be grown and effectively multiplied during aerobic and nutritional conditions. These optimal conditions allow producing useful components such as total carbohydrates, soluble sugars, total proteins,

amino acids, fatty acids, hormones, etc. These chemical components could be released from yeast cells in readily form by two freezing cycles. The net size of the experimental unit was 3×3.5 m, resulted an area of 10.5 m^2 (1/400 fed). Wheat grains cv. Giza 171 were obtained from the wheat Department, Field Crops Institute Research, Agricultural Research Center, Giza, Egypt. Sowing dates was done on 22 November in both seasons. While seeding rate was 50 kg/fed. The preceding summer crop was maize (*Zea mays, L.*) in both seasons.

Table 1. The mechanical and chemical analysis of the experimental soil in both growing seasons of 2018/2019 and /2019/2020.

2018/2019 (SI)				2019/2020(SI)			
Mechanical analysis							
Sand, %	**Silt, %**	**Clay, %**	**Texture Class**	**Sand, %**	**Silt, %**	**Clay, %**	**Texture Class**
80.00	9.50	10.50	Sandy loam	77.43	11.20	11.37	Sandy loam
Chemical analysis							
Organic M %	**CaCo3 %**	**PH**	**EC (dS/m)**	**Organic M %**	**CaCo3 %**	**PH**	**EC (ds/m)**
1.33	6.57	7.42	3.56	1.33	10.43	7.76	7.66

Cultural practices:

Nitrogen fertilizer in the form of ammonium nitrate (33.5% N) at rate of 75 kg N/fed., was added in three doses, (15 kg N/fed.) at sowing (30 kg N /fed.) before the first irrigation (21 DAS) and (30 kg N / fed.) at (42 DAS). Calcium super-phosphate at a rate of 150 kg; (15.5% P_2O_5) was added during the soil preparation. Potassium fertilizer was applied before sowing (during seedbed preparation) at rate of 50 kg/fed., in the form of potassium sulphate (48% K_2O). The first Irrigation was applied at 21 DAS then plants were irrigated every 21 days till the dough stage. All other agricultural treatments for wheat production were carried out as recommended by the Ministry of Agriculture, Egypt.

Data recorded:

At harvest time, five guarded plants were taken at random from each sub- sub plot of the three replications to determine some agronomic data including:

1- Plant height (cm),
2- Spikes number per plant,
3- 1000 grain weight (g).

At harvest, one meter square in each plot was randomly selected to assess the following measurements:

1- Grain yield (ton/fed),
2- Straw yield (ton/fed),
3- Crud protein percentage in grains according to **Granland and Zimmerman (1975)**.

All data obtained in both seasons were subjected to analysis of variance (ANOVA) by GenStat Statistical computer software (version12). Treatment means were compared using the least significant difference (LSD) test according to **(Gomez and Gomez, 1984)** at the 5% level of significance.

RESULTS

Effect of zinc sulfate concentrations:

The available data in Table (2) indicated that zinc sulfate concentrations had a significant impact on plant height (cm), spikes number / plant, 1000 grain weight (g), grain yield (ton/fed), straw yield (ton/fed) and crude protein

(%) at harvest of wheat during 2018/2019 and 2019/2020 seasons. All traits did not increase significantly by spraying wheat plants with zinc sulfate concentrations (1 g/liter or 2 g/liter) in the two seasons. Whereas, spraying water was the superior treatment and spraying wheat plants with 1 g/liter of zinc sulfate came in the second order with a non-significant result in this respect. Otherwise, 2 g/liter zinc sulfate treatment revealed significant decreases in all studied traits.

A- Effect of cytokinin rates:

Except of crud protein percentage in two seasons and grain yield (ton/fed) in the two season were affected significantly by spraying with cytokinin rates as shown in table 3. The best values in plant height (cm), spikes number / plant, 1000 grain weight (g), grain yield (ton/fed), straw yield (ton/fed) and crude protein (%) were obtained by spraying with 0.50 ml/liter dose of cytokinin in both seasons.

B- **Effect of yeast extracts concentrations:**

Plant height (cm), spikes number / plant, 1000 grain weight (g), grain yield (ton/fed), straw yield (ton/fed) and crude protein (%) in the two season responded significantly to foliar application of yeast extract concentrations (Table 4). All traits increased by spraying wheat plants with yeast extract 5 g/liter or 10 g/liter doses respectively in the two studied seasons. Whereas, spraying 10 g/liter dose was the superior treatment followed by spraying wheat plants with 5 g/liter of yeast extract with a non-significant result in this respect which reflect that 5 g/liter treatment was the effective dose for producing high values in compare with cost.

C- Effect of interaction between zinc sulfate concentrations and cytokinin rates:

Plant height (cm), spikes number / plant, 1000 grain weight (g), grain yield (ton/fed), straw yield (ton/fed) and crude protein (%) in both seasons affected significantly by foliar application of zinc sulfate concentrations and cytokinin rates (Table 5). Combinations between three levels of cytokinins under zinc sulfate 1 g/liter dose gave the highest values in all studied traits in the two seasons. Whereas, spraying 0.50 ml/liter dose of cytokinin along with 1 g/liter zinc sulfate was the effective combination for producing the highest values in compare with any combinations in this respect under two seasons in all traits which reflect positive interaction between [zinc sulfate**]** and **[**cytokinins]. It's noticed from data that combination between three levels of cytokinins under zinc sulfate 2 g/liter dose gave the lowest values in all studied traits in the two seasons(because of the toxic dose of zinc sulfate).

D- Effect of interaction between zinc sulfate concentrations and yeast extracts concentrations:

As shown in Table 6 all studied traits in the two seasons, markedly affected by foliar application between zinc sulfate concentrations and yeast extract concentrations. Combinations between three levels of yeast extract concentrations under zinc sulfate 1 g/liter dose came in the first order surpassing all other combinations in all studied traits in the two studied seasons. Whereas, foliar application of 10 g/liter dose of yeast extract along with 1 g/liter zinc sulfate was the effective combination for producing highest values which reflect positive interaction between [zinc sulfate**]** and **[**yeast extract].

E- Effect of interaction between yeast extracts concentration and cytokinin rates:

A significant upgrade on plant height per cm, spikes number / plant, 1000 grain weight per gram, grain yield per ton/fed, straw yield per ton/fed and crude protein percentage of wheat plants were achieved in the two seasons by the interaction between spraying yeast extract concentrations and cytokinins rates (Table 7). Combinations between three levels of cytokinins under yeast extract 10 g/liter dose came in the first order surpassing all combinations, While three levels of cytokinins along with 5 g/liter yeast extract dose came in the second order in this respect. Foliar application of 10 g/liter dose of yeast extract along with 0.50 ml/liter

cytokinins was the effective combination for producing highest values compared any combinations reflecting the positive interaction between [cytokinins] and [yeast extract].

F- Zinc sulfate concentration X cytokinin rates X yeast extracts concentrations interaction:

Figures from 1 to 4 show the effect of the interaction between zinc sulfate concentrations, cytokinin rates and yeast extracts concentration on wheat grain and straw yield (ton / fed). Results revealed clearly that the interaction effect was significant. This significant effect of the above interaction means that the tested zinc sulfate concentrations and cytokinin rates levels do not take the same behavior under the different treatments of yeast extract.

As shown in Figure 1, (wheat plants were treated with 1 g/liter zinc sulfate, zero cytokinin and 5 g/liter yeast extract) and (wheat plants treated with zero zinc sulfate plus , 0.25 ml/liter plus cytokinin and plus 10 g/liter yeast extract) scored the highest means values of grain yield (3.43 and 3.32 ton/fed respectively) in 2018-2019 season. On the other hand, figure (1) refer to non-significant results between those treatments and other interactions which can be consider promising treatments like (Z_2 X C_w X Y_3), (Z_w X C_3 X Y_3), (Z_2 X C_2 X Y_3) and (Z_2 X C_3 X Y_3) all gave 3,21 ton/fed grain yield. As shown from figure (2) in the same season spraying wheat plants with combinations between (Z_2 X C_3 X Y_2), (Z_2 X C_2 X Y_3) and (Z_2 X C_3 X Y_3) surpassing of all combinations which recorded 7.32, 7.13 and 7.06 ton/fed straw yield respectively. In this respect, it should not be forget the combinations between (Z_w X C_2 X Y_2), (Z_w X C_2 X Y_3) and (Z_3 X C_2 X Y_2) as promising treatments.

Wheat plants were treated with 1 g/liter zinc sulfate, 0.50 cytokinin and 10 g/liter yeast extract reflectpositive result of these chemical substances in maximization values of grain yield ton per feddan on season 2019-2020 (figure 3). In this context, combinations (Z_w X C_2 X Y_3), (Z_w X C_3 X Y_3) and (Z_w X C_2 X Y_2) came in the second order. Otherwise, figure (4) show the highest values of straw yield ton/fed were obtained from combinations between (Z_w X C_3 X Y_w), (Z_2 X C_3 X Y_w) and (Z_2 X C_w X Y_w). The other combinations came in the descending orders. These findings explain the great role of these chemical substances in maximization grain and straw yield.

DISCUSSION

Aforementioned results concerned to the response of wheat yield and its components as affected by zinc sulfate concentrations, cytokinin rates and yeast extracts concentrations can be discussed as follow:

Data in tables 2, 5, 6 and figures from 1-4 revealed the effect of zinc sulfate concentrations as an individual factor, second interaction and third interaction. Data reflected a significant effect of zinc sulfate levels in all studied traits in the two studied seasons. 1 g/liter dose of zinc sulfate as an individual factor did not enough to reach the 5% level of significance in compare with spraying water (control treatment) on plant height per cm, spikes number / plant, 1000 grain weight per gram, grain yield per ton/fed, straw yield per ton/fed and crude protein percentage in the two studied seasons. While, in second and third interactions in the two seasons data showed a significant increases in plant height (cm) and number of spikes per plant because of the vital role of zinc in biological membrane stability, enzyme activation ability and auxin synthesis. Zinc is a substantial element and activator of various enzymes engaged in the metabolic process such as energy production, protein synthesis, and growth regulation. Accordingly, 1000 grain weight per gram affected by spraying

with 1 g/liter dose of zinc sulfate. As a respond to the upgrade of plant height (cm), number of spikes per plant and 1000 grain weight per gram great increases a great increases occurred in grain yield (ton/fed) and straw yield (ton/fed). In this context, crud protein percentage significantly increased may be due to the improvement role of zinc in protein synthesis. On the other hand, 2 g/liter zinc sulfate dose as an individual factor, second and third interactions achieved a significant decreases in all traits under the two studied seasons, may be due to the 2 g/liter zinc sulfate considered a high toxic level dose. **(Marschner, 1997), Khan et al. (2009), Gomaa et al. (2015), Arif et al. (2017), Abbas et al. (2018)** and **Mohamed et al. (2019).**

As shown in tables 3, 5, 7 and figures from 1- 4, data responded markedly significant effects of two treatments of cytokinins (0.25 and 0.50 ml/liter) on yield and yield components of wheat plants in compare with spraying water (control treatment) as an individual factor, second and third interactions under the two studied seasons. Cytokinins regulate cell division and differentiation in certain plant tissues which reflected on plant height (cm) and spikes number per plant, and participate in many developmental processes e.g. senescence, photosynthesis, flower formation and photosynthetic partitioning etc, which inverted on 1000 weight grain per gram arriving to maximization of grain yield and straw yield ton/fed. **(Jameson and Song, 2016), El-Shafey et al. (2016), Huthily et al., (2020)** and **Kamar et al. (2020).**

A significant increases on plant height (cm), spikes number per plant and 1000 grain weight per gram of wheat plants affected by the two treatments of yeast extract (5 and 10 g/liter) in compare with spraying water (control treatment) as an individual factor, second and third interactions under the two seasons, which may be attribute to yeast extract contains many growth substances (thiamine, riboflavin, niacin, pyridoxine and vitamins B1, B2, B3 and B12), cytokinins and many of the nutrient elements as well as organic compounds i.e., protein, carbohydrates, nucleic acid and lipids. In this concern, a great relationship between increases in grain, straw yield and yield components (plant height (cm), spikes number per plant and 1000 grain weight per gram) in this respect. On the other hand, increases in crud protein percentage may be due to yeast extract contains organic compounds i.e., protein and nucleic acid. **(Barnett et al., 1990), Abo-El-Hamd et al. (2015), Barakat et al (2015), El-Tohamy et al. (2015), El-Hawary *et al.* (2019)** and **Abdel-Rahman et al. (2020).**

Table 2 .Effect of zinc sulfate concentrations on plant height (cm), spikes number / plant, 1000 grain weight (g), grain yield (ton/fed), straw yield (ton/fed) and crude protein (%) at harvest of wheat during 2018/2019 and 2019/2020 seasons.

Table 3.Effect of cytokinin rates on plant height (cm), spikes number / plant, 1000 grain

Traits	Plant height (cm)		Spikes number / plant		1000 grain weight (g)		Grain yield (ton/fed)		Straw yield (ton/fed)		Crude protein (%)	
Seasons	Season **2018-2019**	Season **2019-2020**	Season **2018-2019**	Season **2019-2020**	Season **2018-2019**	Season **2019-2020**	Season **2018-2019**	Season **2019-2020**	Season **2018-2019**	Season **2019-2020**	Season **2018-2019**	Season **2019-2020**
Spraying water	109.41	104.93	3.21	2.95	58.11	55.56	3.02	2.53	5.04	2.87	10.49	10.78
0.25 ml/liter	112.88	109.87	3.23	3.19	59.06	56.60	3.03	2.76	5.63	2.58	10.79	10.95
0.50 ml/liter	111.39	111.05	3.30	3.44	59.80	58.69	2.98	2.84	5.27	3.04	10.85	11.21
LSD 5%	**N.S**	**4.04**	**N.S**	**0.20**	**1.43**	**1.56**	**N.S**	**0.09**	**0.29**	**0.45**	**N.S**	**N.S**

weight (g), grain yield (ton/fed), straw yield (ton/fed) and crude protein (%) at harvest of wheat during 2018/2019 and 2019/2020 seasons.

Traits	Plant height (cm)		Spikes number / plant		1000 grain weight (g)		Grain yield (ton/fed)		Straw yield (ton/fed)		Crude protein (%)	
Seasons	Season **2018-2019**	Season **2019-2020**	Season **2018-2019**	Season **2019-2020**	Season **2018-2019**	Season **2019-2020**	Season **2018-2019**	Season **2019-2020**	Season **2018-2019**	Season **2019-2020**	Season **2018-2019**	Season **2019-2020**
Spraying water	107.36	105.33	3.15	2.90	57.34	55.90	2.87	2.39	4.72	3.12	10.49	10.78
5 g/liter	112.90	110.06	3.19	3.33	59.76	56.92	3.05	2.84	5.64	2.52	10.73	11.02
10 g/liter	113.39	110.46	3.42	3.36	59.87	58.03	3.11	2.90	5.58	2.84	10.91	11.20
LSD 5%	**3.09**	**3.26**	**0.13**	**0.24**	**1.00**	**1.35**	**0.08**	**0.09**	**0.33**	**0.35**	**0.33**	**0.32**

Table 4.Effect of yeast extracts concentrations on plant height (cm), spikes number / plant, 1000 grain weight (g), grain yield (ton/fed), straw yield (ton/fed) and crude protein (%) at harvest of wheat during 2018/2019 and 2019/2020 seasons.

Traits	Plant height (cm)		Spikes number / plant		1000 grain weight (g)		Grain yield (ton/fed)		Straw yield (ton/fed)		Crude protein (%)	
Seasons	Season **2018-2019**	Season **2019-2020**	Season **2018-2019**	Season **2019-2020**	Season **2018-2019**	Season **2019-2020**	Season **2018-2019**	Season **2019-2020**	Season **2018-2019**	Season **2019-2020**	Season **2018-2019**	Season **2019-2020**
Spraying water	109.01	105.39	3.35	2.90	58.28	57.27	3.09	2.88	5.14	3.05	11.04	11.20
Zinc sulfate 1 g/liter	111.82	109.45	3.20	3.27	59.45	56.57	3.05	2.72	5.98	2.81	10.57	10.95
Zinc sulfate 2 g/liter	113.34	111.00	3.21	3.42	58.11	55.56	2.89	2.53	4.88	2.62	10.52	10.78
LSD 5%	**N.S**	**N.S**	**N.S**	**0.29**	**1.05**	**1.82**	**0.13**	**0.10**	**0.63**	**0.35**	**N.S**	**0.39**

Table 5. Effect of interaction between zinc sulfate concentrations and cytokinin rates on plant height (cm), spikes number / plant, 1000 grain weight (g), grain yield (ton/fed), straw yield (ton/fed) and crude protein (%) at harvest of wheat during 2018/2019 and 2019/2020 seasons.

Traits		Plant height (cm)		Spikes number / plant		1000 grain weight (g)		Grain yield (ton/fed)		Straw yield (ton/fed)		Crude protein (%)	
Zinc	Cytokinin	Season 2018-2019	Season 2019-2020	Season 2018-2019	Season 2019-2020	Season 2018-2019	Season 2019-2020	Season 2018-2019	Season 2019-2020	Season 2018-2019	Season 2019-2020	Season 2018-2019	Season 2019-2020
Spraying water	Spraying water	107.67	101.33	3.16	2.71	56.47	55.56	3.06	2.60	4.66	2.95	10.96	11.18
	0.25 ml/liter	109.26	108.64	3.28	2.80	59.18	57.71	3.09	3.07	5.78	2.53	11.23	11.29
	0.50 ml/liter	110.11	106.18	3.60	3.18	59.18	58.56	3.14	2.97	4.97	3.68	10.92	11.14
Zinc sulfate 1 g/liter	Spraying water	108.45	107.50	3.00	3.05	59.55	53.90	3.20	2.35	5.62	2.77	10.42	10.72
	0.25 ml/liter	115.42	112.02	3.38	3.31	59.09	57.59	3.03	2.73	5.99	2.73	10.44	10.83
	0.50 ml/liter	111.58	108.82	3.22	3.44	59.72	58.21	2.91	3.08	6.33	2.93	10.84	11.31
Zinc sulfate 2 g/liter	Spraying water	112.11	105.94	3.49	3.09	58.32	57.21	2.80	2.64	4.84	2.88	10.09	10.43
	0.25 ml/liter	113.97	112.49	3.07	3.45	58.92	54.49	2.97	2.49	5.12	2.47	10.68	10.72
	0.50 ml/liter	113.94	114.59	3.06	3.71	60.49	59.31	2.89	2.47	4.69	2.50	10.79	11.18
LSD 5%		7.05	7.00	0.31	0.38	2.48	2.71	0.16	0.15	0.50	0.78	0.85	0.79

Table 6 .Effect of interaction between zinc sulfate concentrations and yeast extracts concentrations on plant height (cm), spikes number / plant, 1000 grain weight (g), grain yield (ton/fed), straw yield (ton/fed) and crude protein (%) at harvest of wheat during 2018/2019 and 2019/2020 seasons.

Traits		Plant height (cm)		Spikes number / plant		1000 grain weight (g)		Grain yield (ton/fed)			Straw yield (ton/fed)	Crude protein (%)	
Zinc	Yeast	Season 2018-2019	Season 2019-2020	Season 2018-2019	Season 2019-2020	Season 2018-2019	Season 2019-2020	Season 2018-2019	Season 2019-2020	Season 2018-2019	Season 2019-2020	Season 2018-2019	Season 2019-2020
Spraying water	Spraying water	104.87	101.56	3.36	2.56	56.36	55.54	2.97	2.48	4.75	3.76	10.85	11.06
	5 g/liter	110.96	105.98	3.29	3.18	59.40	57.82	3.09	3.04	5.31	2.59	10.70	10.91
	10 g/liter	111.20	108.62	3.39	2.96	59.07	58.46	3.23	3.12	5.35	2.81	11.57	11.64
Zinc sulfate 1 g/liter	Spraying water	107.09	105.04	3.15	3.07	58.87	55.16	2.83	2.38	5.17	2.89	10.10	10.54
	5 g/liter	113.49	111.31	3.18	3.27	59.69	56.53	3.28	2.84	6.27	2.54	10.79	11.07
	10 g/liter	114.88	112.02	3.27	3.47	59.80	58.01	3.02	2.94	6.50	3.01	10.82	11.26
Zinc sulfate 2 g/liter	Spraying water	110.13	109.39	2.93	3.07	56.80	56.99	2.80	2.31	4.38	2.72	10.52	10.74
	5 g/liter	114.25	112.90	3.09	3.54	60.20	56.41	2.79	2.63	5.32	2.43	10.69	11.09
	10 g/liter	115.63	110.73	3.60	3.64	60.73	57.61	3.08	2.67	4.94	2.69	10.34	10.69
LSD 5%		5.37	5.66	0.23	0.42	1.74	2.34	0.15	0.16	0.58	0.62	0.58	0.56

plant height (cm), spikes number / plant, 1000 grain weight (g), grain yield (ton/fed), straw yield (ton/fed) and crude protein (%) at harvest of wheat during 2018/2019 and 2019/2020 seasons.

Table 7. Effect of interaction between yeast extract concentrations and cytokinin rates on plant height (cm), spikes number / plant, 1000 grain weight (g), grain yield (ton/fed), straw yield (ton/fed) and crude protein (%) at harvest of wheat during 2018/2019 and 2019/2020 seasons.

Traits		Plant height (cm)		Spikes number / plant		1000 grain weight (g)		Grain yield (ton/fed)		Straw yield (ton/fed)		Crude protein (%)	
Yeast	Cytokinin	Season 2018-2019	Season 2019-2020	Season 2018-2019	Season 2019-2020	Season 2018-2019	Season 2019-2020	Season 2018-2019	Season 2019-2020	Season 2018-2019	Season 2019-2020	Season 2018-2019	Season 2019-2020
Spraying water	Spraying water	106.00	101.00	3.00	2.76	54.90	52.96	2.88	2.26	5.06	3.07	10.40	10.75
	0.25 ml/liter	108.84	107.83	3.07	2.80	58.57	56.21	2.85	2.36	4.68	2.73	10.58	10.77
	0.50 ml/liter	107.24	107.16	3.38	3.13	58.56	58.52	2.87	2.55	4.55	3.57	10.49	10.82
5 g/liter	Spraying water	110.16	104.94	3.11	2.93	60.01	55.90	3.08	2.60	4.94	2.82	10.31	10.60
	0.25 ml/liter	115.66	110.89	3.11	3.29	58.89	56.41	3.08	3.04	6.06	2.23	10.91	11.23
	0.50 ml/liter	112.89	114.36	3.33	3.76	60.39	58.46	3.00	2.87	5.90	2.51	10.96	11.23
10 g/liter	Spraying water	112.08	108.84	3.53	3.16	59.42	57.81	3.10	2.73	5.12	2.71	10.76	10.98
	0.25 ml/liter	114.14	110.89	3.51	3.47	59.73	57.17	3.17	2.89	6.14	2.77	10.87	11.10
	0.50 ml/liter	115.49	111.64	3.18	3.44	60.44	59.10	3.06	3.09	5.54	3.03	11.10	11.51
LSD 5%		5.37	5.66	0.23	0.42	1.74	2.34	0.15	0.16	0.57	0.62	0.58	0.55

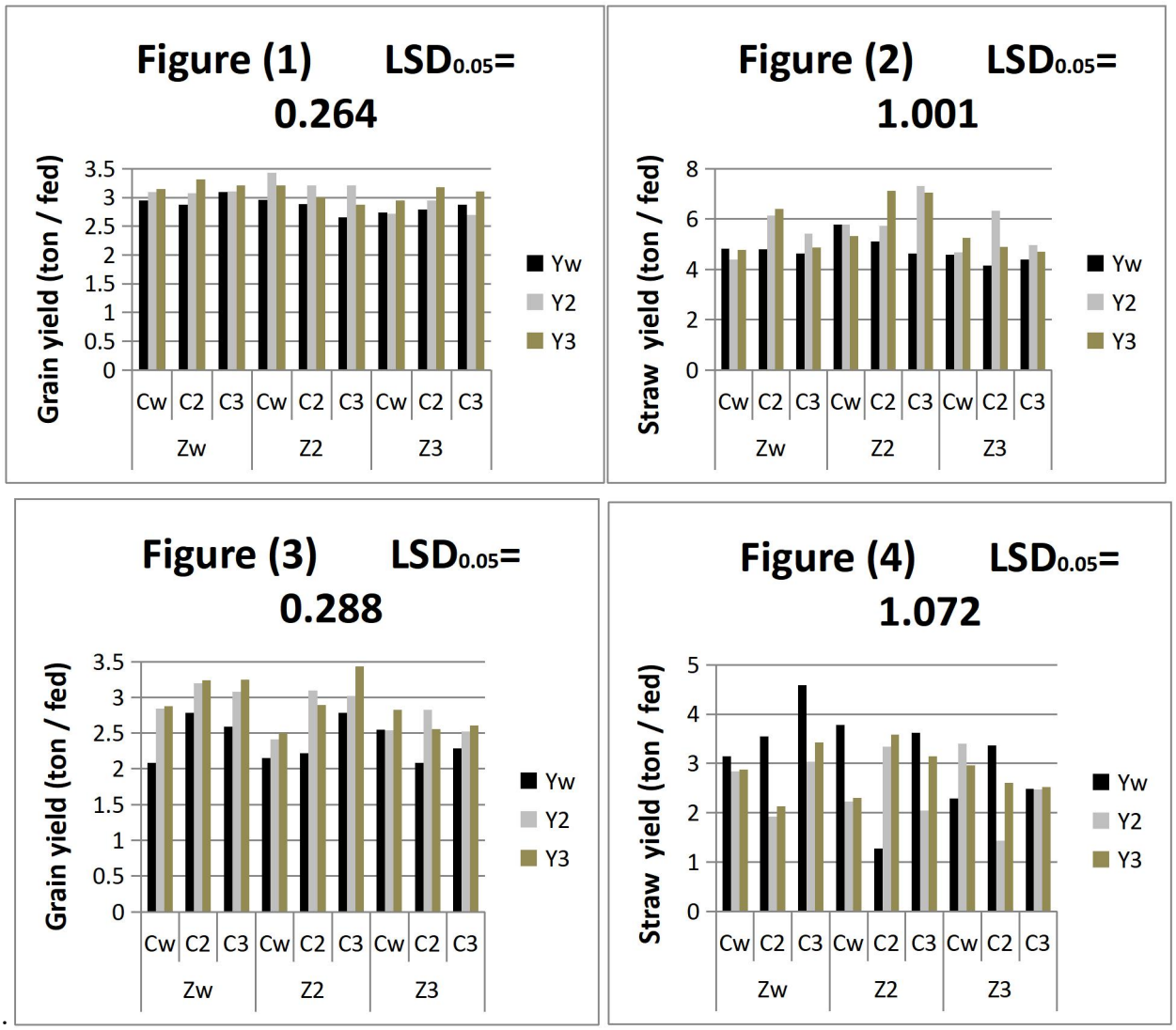

Figure 1, 2, 3, 4 [The significant interaction along with zinc sulfate concentrations (Zw spraying water, Z2 1 g/liter and Z3 2 g/liter), cytokinin rates (Cw spraying water, C2 0.25 ml/liter and C3 0.50 ml/liter) and yeast extracts concentrations (Yw spraying water, Y2 5 g/liter and Y3 10 g/liter) of wheat grain and straw yield (ton / fed) on 2018-2019 and 2019-2020 seasons, respectively].

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الملخص العربى

تأثير الرش الورقى بالسيتوكينين ومستخلص الخميرة على محصول قمح الخبز ومكوناته تحت مستويات مختلفة من الزنك

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العناصر الغذائية الصغرى ومنظمات نمو النباتات ضرورية لأستدامة الانتاجية فى نظم الزراعات القديمة والعضوية. وبناءا عليه، أقيمت تجربتان حقليتان بالمزرعة التجريبية بكلية الزراعة جامعة الفيوم (بدمو) خلال موسمى 2019/2018 و 2020/2019 لدراسة تأثير الرش الورقى للسيتوكينين، مستخلص الخميرة وتركيزات مختلفة من سلفات الزنك والتفاعلات بينهم على محصول القمح ومكوناته. ويمكن تلخيص أهم النتائج فيما يلى :-

1- تأثير مستخلص الخميرة

أدت الاضافة الورقية للتركيزات المختلفة من مستخلص الخميرة الى زيادة معنوية فى جميع الصفات التالية: (أرتفاع النبات بالسنتيمتر، عدد السنابل للنبات، وزن الألف حبة بالجرام، محصول الحبوب بالطن للفدان، محصول القش بالطن للفدان، النسبة المئوية للبروتين الخام في الحبوب) فى الموسمين 2018-2019 و 2019-2020 تحت الدراسة.

2- تأثير نسب السيتوكينين

تفوق الرش الورقى لنباتات القمح بتركيز 0.50 مل/لتر من السيتوكينين على المعاملة الكنترول (رش بالماء) فى صفات (أرتفاع النبات بالسنتيمتر، عدد السنابل للنبات، وزن الألف حبة بالجرام، محصول الحبوب بالطن للفدان، محصول القش بالطن للفدان) فى الموسمين 2018-2019 و 2019-2020 تحت الدراسة.

3- تأثير الرش بالزنك

تأثر كل من (، وزن الألف حبة بالجرام، محصول الحبوب بالطن للفدان، محصول القش بالطن للفدان، النسبة المئوية للبروتين الخام في الحبوب) معنويا بالرش بتركيزات مختلفة من الزنك فى الموسمين 2018-2019 و 2019-2020 تحت الدراسة.