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Research Article

Using By- Product of Yeast Production (CMS) and Micronutrients for Improving the Yield and Quality of Some Field Crops under Saline Stress Conditions

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Abstract

Background and Objective: The negative effects of using low water irrigation quality on plant growth are the major interest of many researchers. So, the present study aimed to use foliar spray with a by-product of yeast production as condensed molasses soluble (CMS), micronutrients and their interaction to improve growth and yield of faba bean and wheat is grown in a calcareous soil under saline stress conditions. **Materials and Methods:** Two field experiments were carried out at a private farm, in Mariut Sector at Alexandria, Egypt with three replicates by using RCBD design during the 2016/2017 and 2017/2018 seasons. Foliar spraying was applied twice by using (CMS), micronutrients and both of them on faba bean and wheat plants grown in calcareous soil and irrigated with drainage saline water. **Results:** The results indicate that all treatments led to a significant increase in all the character's under study for both faba bean and wheat. The combination of CMS with micronutrients was the best treatment where it gave the highest values of all the studied characters. Also, the results revealed that the percentage increases were 40, 33, 57 and 64% for seed yield, biological yield, protein (%) and Zn content in seeds, respectively for faba bean, however for wheat was 24, 11, 52 and 51% for seed yield, biological yield, protein (%) and Zn content in grains, respectively compared with the control treatment. **Conclusion:** It can be concluded that foliar spray by using CMS with micronutrients may help faba bean and wheat plants to decrease salinity effects and improving growth, quality and yield under salinity stress conditions in calcareous soil.

Key words: Faba bean; wheat, foliar application, by-product of yeast production (CMS), micronutrients, drainage water

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Faba bean (*Vicia faba* L.) is the main major Fabaceae crops that grow in the winter in various types of Egyptian soil. Furthermore, it is regarded as a rich exporter of protein for human exhaustion, therefore it is significant to obtain maximize the yield of faba bean[1]. Thereupon, the shedding phenomena in faba bean plant particularly for its flowers, unripe pods and buds generally took site in critical values resulting in a serious drooping in seed yield of this economic plant. Numerous experiments were done for rising holding flowers, reducing pre- gathering abscission of unripe buds of faba bean especially under stress conditions (water and soil salinity stress) using various factors such as bio-fertilizers, plant outgrowth stimulators (yeast extract) and elements nutrients[2,3].

Wheat (*Triticum aestivum* L.) is the first strategic commodity and it is the main winter cereal crop and as a main exporter of straw for animal feeding in Egypt. Whilst, the whole area planted with wheat around 1.425 million hectares and the gross output override 8.8 million tons with a mean[4] of 6.6 t ha^{-1}. Moreover, it accounted for about 9% of the entire agricultural output[5]. The gap between wheat consumption and production (It is estimated at 40% of the gross domestic product) this deficit can be overcome by importing from abroad. On account of the shortage of freshwater resources, the area planted with wheat should be increased in the reclaimed lands due to the limited area in the Nile Valley and the competition of the essential crops. For that reason, get better both quantitative and qualitative traits of wheat under the deficit of freshwater resources and using low water quality irrigation (saline water) was still the goal of many studies.

The constant use of low-quality irrigation and traditional agricultural practices has added to the problems[6]. In fact, 20 to 30 million hectares of irrigated land is affected by salinity and then 0.25 to 0.50 million hectares of production are lost each year as a result of salt accumulation[7]. Crop productivity varies greatly due to the interaction between genotype and environmental conditions. Ionic toxicity, oxidative stress, nutritional imbalances, decreased cell division and altered metabolic processes such as photosynthesis, respiration and plant membrane disturbance can result from saline stress[8,9], which reflected on decrease plant growth and its output. Vertical expansion that increases crop productivity was achievable by using appropriate agricultural processes. Furthermore, the obvious role of agricultural operations like utilization hopeful varieties and paper utilization of stimulants materials, i.e., yeast extract is of vital importance to the growth of crops and chemical constituents, along with the yield and its component and protective role against different stresses, it was established up to the favorable impact of plant growth which copes the injurious influence of some ecological stress like salinity and dryness[10] and foliar spray of elements is ideal for rectifying nutrient shortage.

Yeast extract is a natural material of cytokinins and has motivational influences on plants. Yeast extract is one of the affluent reasons of high-quality protein, specifically the necessity amino acids like lysine, tryptophan etc., include the macro and micronutrients and the better reason of the B-complex vitamins such as B1, B2, B6 and B12. Where it has a role useful during vegetative and reproductive growths through getting better flower emergence and their set in some plants owing to its rise auxin and cytokinin content and increase carbohydrates accretion[11]. It was mentioned that encourage effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll composition[3,12], furthermore its content of cry preventive agent, i.e. sugars, protein, amino acids and also many vitamins. On the other direction, using of yeast extract in organic farming as biofertilizer is ‘zero impact’ on the environment[13].

Condensed molasses soluble (CMS) is by-products of different fermentation operations in yeast production. Molasses is utilized as a nutrient reactant in many fermentation manufacturers such as yeast production. In these processes, most of the sugar content of the molasses is used by microbiological activity. The output fluid waste has very little remaining sugar content and this waste is condensed, further processed and marketed as CMS[14].

Foliar spraying with micronutrients particularly zinc not only has great effects upon flower composition and increases output[15] but also, wanted for chloroplast composition and sink restriction. Moreover, foliar spray of micronutrient and yeast extract represents the more intense and effective treatments in numerous cases lead to enhance vegetative growth, chemical constituents and yield under stress conditions[16].

Therefore, the present study aimed to evaluate the effects of the by-product of yeast production (CMS), Micronutrients and their interaction on growth, seed and grain quality and yield of faba bean and wheat plants are grown in a calcareous soil under saline stress conditions (drainage water).

MATERIALS AND METHODS

Experiments layout: The present study was carried out in the farmer’s field in Oraby Village in Mariut sector at Alexandria, Egypt (located between latitude 30°58'47"N and longitude 29°48'38"E) to study the effect of foliar applications with a by-product of yeast production as condensed molasses soluble (CMS), micronutrients and both of them on faba bean

(*Vicia faba* L.) and Wheat (*Triticum aestivum* L.) grown in calcareous soil and irrigated with agricultural drainage water (saline water) during two winter seasons 2016/2017 and 2017/2018.

Two field experiments were carried out on faba bean and wheat crops. Before planting, a representative soil sample was taken every season to test physical and chemical properties. Mean physical and chemical characteristics of soil of the experimental site were determined according to Chapman and Pratt[17] and are shown as follow: Texture: Clay loam, pH 8.4, EC 3.4 (dS m^{-1}), $CaCO_3$ (%) 28.6, Organic matter (%) 1.5, N 508, P 19, K 260, Ca 493, Na 842, Fe 3.63, Mn 1.06 and Zn 0.85 (ppm).

Irrigation: In both experiments water used was from agricultural drainage water which was saline water (EC 6.0 dS m^{-1}).

Experiments design: Completely Randomized Blocks Design (CRBD) with 12 plots (four treatments with three replicates) was applied and the area of the plot was 10.5 m^2 (3×3.5 m).

Treatments in both experiments were (control, a by-product of yeast production (CMS) (Table 1), micronutrients in the form of multi chelated micronutrients compound with nitrogen (14% N, 3% Fe, 3% Zn, 3% Mn and 0.5% Cu), micronutrients and CMS were foliar applied 2 g L^{-1} and 6 g L^{-1}, respectively two times after sowing (35 and 60 days-old).

Faba bean experiment: Faba bean seeds were sown on October 24th and October 27th in the first and second season, respectively using faba bean variety Giza Blanka. Planting seeds at 25 cm spacing on both sides of the ridge while the distance between each ridge was 60 cm apart. For all plots, a dose of 200 kg superphosphate (15.5% P_2O_5)/feddan was used before sowing. After emergency 50 kg ammonium nitrate (33.5%N)/feddan were applied. The potassium soil applications at the rate of 50 kg K_2O as potassium sulphate (50% K_2O)/feddan Potassium sulfate were used at 45 days after sowing. The other required culture practices for growing faba bean till harvest as recommended by Legumes Research Department, A.R.C. and Giza, Egypt.

Data collected: A random sample of five plants from each plot was taken at 90 days after sowing where plant height (cm) and several branches/plant were recorded. At harvest, five random plant samples got from the center of each plot to estimate the following agronomic traits: the number of pods per plants, the number of seeds/plant, pods weight (g), 100- seeds weight (g), biological yield and seed yield were estimated as ton/feddan (feddan = 4200 m^2). While Harvest Index (HI) was estimated as follows:

$$HI = \frac{\text{Seed yield}}{\text{Biological yield at maturity}} \times 100$$

Also, nutrient contents in seeds and straw of faba bean plants were determined according to Chapman and Pratt[18]. The percentage of protein was calculated in seeds as (N% in seeds) x6.25.

Wheat experiment: Wheat grains were sowing on 21st November each season using wheat variety, Giza 168.

Recommended doses achieved by the Ministry of Agriculture from Nitrogen (120 kg N/ fed.), Phosphorus (45 kg P_2O_5/fed.) and potassium (48 kg K_2O/ fed.) were applied during the wheat growth stage. Nitrogen fertilizer was added in the form of ammonium nitrate (33.5% N) and was

Table 1: Chemical analysis of by-product of yeast production (CMS)*

Amino acid (g/100 mL)		Nutrient content (%)		Growth regulators (mg L^{-1})	
Aspartic acid	0.58	Total amino acid	20.00	Cytokine	762.6
Threonine	0.14	Free amino acid	7.00	Gibriline	495.2
Serine	0.21	Total-N	4.62	Others (%)	
Glutamic acid	4.80	P_2O_5	0.20	Organic matter	59.75
Glycine	0.25	K_2O	9.80	Organic carbon	34.66
Alanine	0.38	Ca	0.87	-	
Valine	0.17	Mg	0.16	pH	7.23
Isoleucine	0.12	S	10.04		
Leucine	0.17	Nutrient content (mg L^{-1})			
Phenyl alanine	0.10	B	8.5		
Histidine	0.04	Mo	5.3		
Lysine	0.13	Fe	71.0		
Arginine	0.04	Mn	11.3		
Proline	0.14	Zn	483.9		
Cystine	0.03	Cu	5.3		
Methionine	0.06				

*Condensed molasses soluble (CMS) are byproducts of various fermentation processes in yeast production divided into three equal doses; at sowing time, before the first irrigation and before heading stage. Phosphorus does was added in the form of superphosphate (15.5% P_2O_5) and in one dose before planting. Potassium fertilizer was added as potassium sulfate (50% K_2O) and was broadcasted in two installments. The first was added at sowing time and the second was before the first irrigation. The normal agronomic practices of growing wheat were practiced until harvest as recommended by the Agricultural Research Center, Giza, Egypt.

Data collected: A random sample of five plants from each plot was taken at 90 days after sowing to record plant height (cm). At harvest, biological yield and grain yield were determined by cutting plants from 1 m^2 of each plot then weighted in kilograms /plot and recorded in terms of ton/fed. While Harvest Index (HI) was calculated as mentioned earlier. Also, the number of spikes/m^2 was recorded. At the same time, ten random spikes from each plot were sampled and the following traits were measured; plant height, one-hundred kernel weight (g), number of spikelets per spike and spike length (cm). Also at harvest, straw and grains samples of wheat were taken and used to determine nutrient according to Cottenee *et al*.[18]. The percentage of protein in grains was calculated as before.

Economic return: In both experiments, it was calculated by using data of cost of cultivation, return and net return of gross and benefit-cost ratios.

Statistical analysis: Data obtained in this study were statistically analyzed according to Snedecor and Cochran[19] and Steel *et al*.[20]. The means were compare using significant least differences (L.S.D).

RESULTS

Faba bean experiment

- **Growth and yield parameters:** As shown in Table 2, growth parameters, yield and its components of faba bean plants tended to gradually significantly increased as a result of spraying both a by-product of yeast production (CMS) and micronutrients alone or in combination. While the combined treatment of CMS+ micronutrients foliar application was the best treatment because it recorded the highest values of all parameters. It gave a high increase in growth parameters (plant height, number of branches/plant, number of pods/plant, number of seeds/plant, pod weight (g) and 100-seed weight (g)) when compared with control.

  The data also revealed that the combined treatment of CMS+ micronutrients gave the highest values of seed yield (2.49 ton/fed) and biological yield (5.16 ton/fed) with a harvest index of 48.3% as compared to the control. The increasing percentage was 40% for seed yield (ton/fed) and 33% for biological yield (ton/fed). The enhancement effect of the treatments on the growth of faba bean plants may be due to the effect of CMS and micronutrients as growth promoters.
- **Chemical composition of seeds and it's quality:** In general, as shown in Table 3, all treatments increased the chemical composition contents of faba bean seeds. While the combined treatment with CMS+ micronutrients as foliar application gave the highest value of Nitrogen, Phosphorus, potassium, Ca, Mg, Fe, Mn and Cu as compared to the control treatment. On the other hand, the opposite was true with Na content of faba bean seeds where Na content was significantly decreased with

Table 2: Means effect of CMS and micronutrients foliar applications on faba bean growth parameters, yield and its components (combined analysis of two successive seasons)

Treatments	Plant height (cm)	Number of branches/plant	Number of pods/plant	Number of seeds/Plant	Pods weight (g)	100-seed weight (g)	Seed yield (ton/fed)	Biological yield (ton/fed)	Harvest index (%)
Control	86.0	7.67	16.00	71.2	235.3	61.9	1.78	3.88	45.9
CMS	95.3	9.67	19.67	85.1	304.3	73.3	2.13	4.37	48.7
Micronutrients	104.7	10.67	22.30	99.6	456.7	81.7	2.33	4.88	47.7
CMS+Micronutrients	111.7	12.00	29.00	116.1	568.3	85.2	2.49	5.16	48.3
LSD (0.05)	11.3	1.29	2.49	6.1	60.7	3.6	0.15	0.29	1.1

Table 3: Means effect of CMS and micronutrients as foliar applications on nutrient and protein contents in seeds of faba bean (combined analysis of two successive seasons)

	Nutrient contents (%)							Nutrient contents (ppm)			
Treatments	N	P	Protein	K	Ca	Na	Mg	Fe	Mn	Zn	Cu
Control	3.07	0.234	19.25	0.32	0.12	0.56	0.13	64.7	22.3	30.7	5.67
CMS	4.17	0.345	25.94	0.75	0.34	0.32	0.16	90.3	38.7	36.7	7.67
Micronutrients	4.43	0.267	27.56	0.48	0.16	0.42	0.15	118.3	50	46.7	8.33
CMS+Micronutrients	4.83	0.38	30.13	0.7	0.28	0.34	0.17	112	59	50.3	11
LSD (0.05)	0.07	0.021	0.27	0.04	0.05	0.05	0.01	30.4	4.6	4.4	1.88

Table 4: Means effect of CMS and micronutrients as foliar applications on nutrient contents in straw of faba bean (combined analysis of two successive seasons)

	Nutrient contents (%)						Nutrient contents (ppm)			
Treatments	N	P	K	Ca	Na	Mg	Fe	Mn	Zn	Cu
Control	0.69	0.147	0.49	0.18	0.72	0.13	77	9.33	25.67	6
CMS	1.14	0.177	2.47	0.24	0.47	0.17	96.3	17.33	35.67	7.67
Micronutrients	1.29	0.154	0.59	0.22	0.68	0.16	142	26	41.67	7.67
CMS+Micronutrients	1.45	0.162	1.9	0.25	0.65	0.17	142.7	27.33	46.33	9.33
LSD (0.05)	0.05	0.004	0.13	0.02	0.04	0.02	27.1	2.77	1.53	1.6

Table 5: Total Cost of cultivation , total return, net return and benefit: cost ratio of faba bean production (average of two successive seasons)

Treatments	Total cost (LE fed^{-1})	Total return (LE fed^{-1})	Net return (LE fed^{-1})	Additional cost (LE fed^{-1})	Additional return (LE fed^{-1})	Benefit: cost ratio
Control	8520	15346	6826	-	-	1.80
CMS	8850	17908	9058	330	2562	2.02
Micronutrients	8877	19756	10879	357	4410	2.22
CMS+Micronutrients	9107	21021	11914	587	5675	2.31

spraying by combined treatment of CMS+ micronutrients. Regarding the quality of faba bean seeds (protein and zinc content), all treatments significantly increased the quality of faba bean seeds and the combined treatment with CMS+ micronutrients gave the highest percentage of protein (30.13%) and of zinc (50.3 ppm) with increase percent 57% and 64% respectively when compared with control.

- **Chemical composition of straw:** Data in Table 4 presented the nutrients content of faba bean straw. All macro and micronutrients significantly increased as a result of foliar spraying with CMS or micronutrients alone or in combination but the highest increases in N, Ca, Mg, Fe, Mn, Zn and Cu content produced by the combined treatment which recorded the highest value of N, Ca, Mg, Fe, Mn, Zn and Cu as compared to the control treatment. While the highest increase in P and K produced by CMS foliar application which recorded the highest value of P and K comparing with the control treatment. Regarding, Na content was significantly decreased with spraying by CMS and combined treatment of CMS+ micronutrients, respectively compared to the control treatment.
- **The economic return:** The effect of the CMS and micronutrients on the total cost of cultivation, total return, net return and benefit: cost ratios of faba bean under salinity stress are presented in Table 5. Data cleared that additional net return of L.E 2562, 4410 and 5675 resulted from the additional cost of cultivation of LE 330, 357 and 587 for CMS, micronutrients and CMS+micronutrient treatments, respectively. With increasing in benefit: cost ratio of 2.02, 2.22 and 2.31. The net return highest value (11914 LE fed^{-1}) produced by the treatment of CMS+micronutrients also, the ratio of net return / total cost (1.3) (the economic efficiency). This has resulted from increasing seeds production (2.49-ton seeds fed^{-1}) with CMS+micronutrients treatment as a foliar application when compared with control and other treatments.

Wheat experiment:

- **Growth and yield parameters:** As shown in Table 6 growth parameters, yield and its components of wheat plants were significantly increased as a result of spraying CMS or micronutrients alone or in the mix. The combined treatment of CMS+ micronutrients was the best treatment where it gave the highest values of all the studied characters. It exceeds significantly over the control treatment in plant height, spike length (cm), spikelets number/ spike, spike number/m^2 and 100-grain weight (g)

  In addition, the combined treatment of CMS+ micronutrients gave the highest values of grain yield (3.45 ton/fed) and biological yield (8.88 ton/fed) with harvest index 38.9%. The enhancement effect of the treatments on the growth of wheat plants may be due to the promoting effect of CMS and micronutrients on plant growth.
- **Chemical composition of grains and their quality:** As explained in Table 7, all the applied treatments had a significant increase effect on the chemical content of wheat grains. While the combined treatment of CMS+ micronutrients recorded the highest value of N, P, K, Ca, Mg, Fe, Mn and Cu as compared to the control treatment. While Na content seemed to be without effect with these treatments.

  Regarding the quality of wheat grains (protein and zinc content), all treatments have significantly increased

Table 6: Means effect of CMS and micronutrients as foliar applications on wheat growth parameters, yield and its components (combined analysis of two successive seasons)

Treatments	Plant height (cm)	Spike length (cm)	Spikelets No./Spike	Spike number/m^2	100 kernel weight (g)	Grain yield (ton/fed)	Biological yield (ton/fed)	Harvest index (%)
Control	74.7	9.33	12.33	262.3	3.81	2.78	7.98	34.8
CMS	79.7	10.00	14.33	274.0	4.24	2.98	8.48	35.1
Micronutrients	83.3	11.50	15.66	284.3	4.53	3.25	8.48	38.3
CMS+Micronutrients	94.7	13.17	18.66	307.3	4.8	3.45	8.88	38.9
LSD (0.05)	5.2	0.55	1.2	7.9	0.15	0.13	0.42	0.7

Table 7: Means effect of CMS and micronutrients as foliar applications on nutrient and protein contents in grains of wheat (combined analysis of two successive seasons)

	Nutrient contents (%)							Nutrient contents (ppm)			
Treatments	N	P	Protein	K	Ca	Na	Mg	Fe	Mn	Zn	Cu
Control	1.6	0.132	10	1.07	0.22	0.2	0.14	84.3	10.7	43.3	15.7
CMS	1.9	0.143	11.88	1.43	0.25	0.2	0.17	90.3	12	51.3	18.7
Micronutrients	2.33	0.156	14.5	1.6	0.25	0.2	0.19	103.3	14	61.7	22.3
CMS+Micronutrients	2.43	0.163	15.21	1.7	0.27	0.19	0.25	105.3	15	65.3	23.3
LSD (0.05)	0.15	0.007	0.91	0.14	0.03	NS	0.02	3.3	1.9	5.4	2.1

Table 8: Means effect of CMS and micronutrients, as foliar applications on nutrient contents in straw of wheat (combined analysis of two successive seasons)

	Nutrient contents (%)						Nutrient contents (ppm)			
Treatments	N	P	K	Ca	Na	Mg	Fe	Mn	Zn	Cu
Control	0.34	0.116	2.5	1.7	0.49	0.66	272.7	14.7	29.7	12
CMS	0.57	0.126	2.8	1.8	0.45	0.69	308.3	18.3	35.3	13.7
Micronutrients	0.71	0.148	3.13	1.97	0.48	0.78	424.3	22.7	41.3	16
CMS+Micronutrients	0.76	0.156	3.6	2.33	0.45	0.83	427.3	24.7	44.7	16.7
LSD (0.05)	0.05	0.003	0.36	0.2	NS	0.05	26.1	3.3	3.6	1.2

Table 9: Total Cost of cultivation , total return, net return and benefit: cost ratio of wheat production (average of two successive seasons)

Treatments	Total cost (LE fed^{-1})	Total return (LE fed^{-1})	Net return (LE fed^{-1})	Additional cost (LE fed^{-1})	Additional return (LE fed^{-1})	Benefit: Cost ratio
Control	9100	15638	6538	-	-	1.72
CMS	9310	16714	7404	210	1076	1.79
Micronutrients	9410	17489	8079	310	1851	1.86
CMS+Micronutrients	9620	18446	8826	520	2808	1.92

the quality of wheat grains and the combined treatment of CMS+ micronutrients gave the highest percentage of protein (15.21%) with almost 52%increase and of zinc (65.3ppm) with 51% increase as compared to the control.

- **Chemical composition of straw:** Data in Table 8 presented the nutrients content of wheat straw. All macro and micronutrients were significantly increased as a result of foliar spraying of CMS or micronutrients alone or in mixing but the highest increase values produced by the combined treatment of CMS+micronutrients which recorded the highest value of N, P, K, Ca, Mg, Fe, Mn, Zn and Cu as compared to the control treatment. With regard to Na content of wheat straw in Table (8), there were slight variations found in foliar spraying CMS or micronutrients alone or in combination treatments but these differences were not significant.
- **The economic return:** The effect of the CMS and micronutrients under salinity conditions on total cultivation cost, total 3.45-ton grains fed^{-1} return, net return and benefit: cost ratios of wheat production are given in Table 9. Data showed that the additional cost of cultivation of 210, 310 and 520 LE gave an additional net return of 1076, 1851 and2808 LE for CMS, micronutrients and CMS+micronutrients treatments, respectively. With incremental benefit: cost ratio of 1.79, 1.86 and 1.92. The net return highest value (8826LE fed^{-1})produced by the treatment of CMS+ micronutrients also, the ratio of net return / total cost (0.92) (the economic efficiency).This is resulted from increasing wheat grains production (3.45-ton grains fed^{-1}) with CMS+ micronutrients treatment as a foliar application when compared with control and other treatments.

DISCUSSION

The data of this study pointed that treatment with a by-product of yeast production (CMS) or micronutrients alone or in combination resulted in an increase in growth parameters, chemical content of faba bean seeds and wheat grains and their quality which were reflected on increasing their seed and grains yield where the foliar treatments provided the faba bean and wheat plants with CMS growth promoters and micronutrients which reduced salinity effects on growth and increase yield in new soils. From Table 1, it was cleared that the by-product of yeast production (CMS) contains most of the components found in yeast extract, so it largely has the same effect as yeast extract on plants[14].

These findings were agreement with which reported by several researchers, where Marzauk *et al.*[21] found that yeast extract enhanced growth of plants for example, fresh and dry weights (g), plant height (cm) and a number of branches when compared with control and other treatments. These results agree with those found by Abou EL-Yazied and Mady[22] and Mady[1] on bean plants and Mahmoud *et al.*[23] on pea plants who found that the application of yeast extract increased plant growth. El-Hawary *et al.*[4] and Hammad and Ali[24] reported that foliar application of yeast extract increased plant height and growth rate of wheat plants.

Marzauk *et al.*[21] found that pod weight (g), total pods yield per plant and total pods yield (ton/fed.) significantly increased by increasing yeast extract levels. The same findings obtained by Mahmoud *et al.*[23], Abou EL-Yazied and Mady[25,22]. Mady[1] cleared that pod weight, pod yield (g) per plant, the weight of seeds per pod and plant and seed index of faba bean were significantly increased with foliar application of yeast extract and micronutrients. Abou EL-Yazied and Mady[22] illustrated that treatment with yeast extract and micronutrients by foliar application enhanced yield of broad bean plants as a result of improving the decreasing of flowers and pod shedding, flower formation and increasing its content of bio-constituents. Fawzy *et al.*[13] indicated that foliar application of yeast extract increased significantly the weight of 100 seeds (g) of wheat plants. Numerous studies have been evidenced. The enhancing effect of yeast extract also found by Mekki and Ahmed[26], The enhancing in growth and yield components as a result of yeast extract treatment is due to its significant role in increasing available nutrients for plants and amino acids. El-Hawary[4] cleared that yeast extract as foliar application increased spike weight, 1000-grain weight, grain yield and harvest index of wheat. This behavior assigns to the promoting effects of the stimulators materials to decrease salinity stress effects and increased plants' ability to utilize nutrients from soil[27,28].

Marzauk *et al.*[21] Indicated that there was a statistically significant effect for the foliar application treatments of yeast extract on the contents of N and protein % in the seeds of broad bean plants compared to control. On the other hand, foliar application of micronutrients is recommended under Egyptian conditions because of high $CaCO_3$ contents and high pH values. The increases in broad bean yield and the contents of micronutrients in seeds due to the foliar application of micronutrients agree with the findings of Mahmoud, *et al.*[23], Abou EL-Yazied and Mady[25,22]. Mady[1] reported that yeast extract and micronutrients may be enhanced nutrient absorption, translocation and accumulation by roots of plants. The interaction between yeast extract and micronutrients was more important in increasing NPK, crude protein and total carbohydrates content in seeds when compared with alone foliar application. Fawzy *et al.*[13] found that protein contents in grains of wheat plants were significantly increased in response to yeast extract foliar application. The rise in the total soluble protein content could be assigned to yeast extract supplying plants with essential nutrient elements necessary for protein formation[29,30]. El-Hawary *et al.*[4] found that, treatments with yeast extract as foliar application enhanced the ability of wheat varieties to decrease the adverse effects of salinity stress conditions, soil and water salinity. The same results were found by El-Hawary and El-Shafey[27] and Desoky and Merwad[31]. Hammad and Ali[24] illustrated that treatment with yeast extracts decreased the negative effect of stress and significantly improved nutrient content in wheat plants. The application of yeast extract or CMS under stress conditions resulted in a significant increase in N%, P% and K% in pea leaves which due to its carbohydrates, minerals and growth hormone contents. Foliar application with biostimulants such as yeast extract significantly increased total protein and total carbohydrates at the same time decreased total fiber in wheat grains compared to control plants[24].

Marzauk *et al.*[21] cleared that the enhancing in the growth of plants as a result of yeast extract or by-product of yeast production (CMS) foliar application may be due to its contents of macro and micronutrients, i.e. (N, P, K, Mg, Ca, S, Fe, B, Mn and Zn) growth regulators such as cytokine and gibriline, free amino acid and proteins (Table 1) which may play an important role in alleviated stress effects and enhancing growth. Mady[1] found that enhancing the effect of yeast extract or CMS and micronutrients might be due to its role in biological activity, metabolism, stimulating effect on photosynthetic pigments and enzyme activity under stress which resulted in increasing growth and yield of faba bean[3,16]. The positive effect of yeast extract or by-product of yeast production (CMS) with micronutrients may be due to it is a natural source of growth regulators (cytokinins), vitamins and essential nutrients, which improving growth and yield of wheat and alleviated the effects of stress. The obtained results are in agreement with those found by Al-Thabet[32] on wheat and El-Nasharty *et al.*[33] on sunflower.

CONCLUSION

In conclusion, it could be recommended that foliar application with a by-product of yeast production (CMS) + micronutrients is a new technique for enhancing growth, yield and quality of faba bean and wheat. The combined effect of foliar spraying of CMS+micronutrients has an effective combination in enhancing growth parameters, chemical composition and yield under salinity stress conditions when compared with control and other treatments

SIGNIFICANCE STATEMENT

This research will help the researchers to uncover the critical areas of the ameliorative effect of the by-product of yeast production (CMS) as a foliar application in alleviating the opposite effects of salinity stress on faba bean and wheat production when foliar applied with micronutrients as a combination. Therefore, a new vision of production may be reached under salinity conditions.

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