EFFECT OF CITRINE AND ACTIVE DRY YEAST AS FOLIAR APPLICATION ON GROWTH, YIELD AND SOME CHEMICAL CONSTITUENTS OF ROSELLE PLANTS (*Hibiscus sabdariffa* L.) GROWN UNDER A SALINE CALCAREOUS SOIL.

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ABSTRACT:

A field experiments were carried out during the two successive seasons of 2007 and 2008 in the Experimental Farm at Demo (a newly reclaimed soil with a moderately salinity level), Faculty of Agriculture, Fayoum University to investigate the effect of foliar application of citrine (15% citric acid, 2% Fe, 2% Mn and 2% Zn) at the rates of 0, 0.3, 0.4, and 0.5% and active dry yeast at the rates of 0, 1, 1.5 and 2 g / L, each alone or together on growth, yield and some chemical constituents of roselle plants (*Hibiscus sabdariffa* L. var. sabdariffa). The studied growth characters were plant height, number of branches/ plant, number of leaves/plant, leaf area and dry weight of leaves /plant, as well as yield and its components, (i.e. number of flowers /plant, fresh and dry weights of sepals/ plant, yield of dry sepals/fed). The chemical constituents of leaves included total chlorophyll, carotenoids & antioxidants enzyme activity and those of sepals, i.e., pH, anthocyanin and total carbohydrates. The obtained results indicated that, all studied characters were affected positively by the foliar application of citrine and active dry yeast at all applied different rates either alone or together (except, pH values that were decreased by the applied treatments). The best results were obtained by the application of the highest rates of citrine (0. 5%) or active dry yeast (2 g / L) alone or together. At the same time, the oxidative enzyme activities such as peroxidase and catalase were recorded the highest values when spraying with the highest rates of citrine or active dry yeast alone or together.

In view of these results, it could be recommended that foliar spraying roselle plants (*Hibiscus sabdariffa* L. var. sabdariffa) with citrine or active dry yeast should be counteracted the adverse conditions, particularly at salinity condition of the soil, and consequently producing an economic yield.

Key words: Calcareous soil, roselle, salinity hazard, citrine and active dry yeast.

INTRODUCTION

Roselle plants (*Hibiscus sabdariffa* L.) is an annual plant belongs to family Malvaceae and known in Egypt as "Karkade". It is grown in tropical and subtropical regions of the World for its dry sepals (calyx and epicalyxes) that are used to make cold and hot beverages. Also, roselle is used in folk medicinal to treat a number of diseases such as blood pressure. It contains pigments especially, anthocyanin, mixture of organic acids such as malic, citric, tartaric and hibiscus acid. Extraction drinkable has antibacterial effect, fungal and diuretic activities (**Caceres *et al.*, 1987).** Also, roselle seeds contain fixed oils (17%), which are easily refinable and have good cooking properties. Antioxidants such as citrine have an auxinic action due to their own citric acid and hence they have a synergistic effect on growth, yield and

some chemical constituents of many crops as well as controlling the incidence of most fungi on many crops, **i.e., Ahmed *et al.*(2002), Ahmed** and **Abd El-Hameed (2004)** and **Gaser *et al.* (2007)** on grapevine, **Ahmed *et al.*(20030** on banana, **Zaghlool *et al.* (2006)** on wheat, **Rady(2006)** on sunflower, **El Yazal (2007)** on onion, **El Yazal (2008) on** tuberose plants and **Maksoud ,*et al.* (2009)** on olive trees. The beneficial effect of micronutrients on growth, yield and some chemical constituents of many crops plants was reported by several workers **such as Rehan *et al.* (2003)** and **Seaf El-Yazal & Sayim (2004)** on faba bean, **Seaf El-Yazal (2004)** and **Rahimizadeh *et al.* (2007)** on sunflower, **El-yazal (2008)** on tuberose, **Hanafy (2009)** on roselle and **Hanafy *et al.* (2009)** on rosemary plants) The various positive effect of spraying with active dry yeast was attributed to its own contents of different nutrients, high percentage of protein, large amounts of vitamin B and natural plant growth regulators such as cytokinins. In addition, soluble phosphate, which it contains a pronounced content of readily combine with cations in soil solution to form low solubility substance called phosphate fixation, especially at high soil pH and greater percentage of calcium carbonate. Soil microorganisms, which convert the non-soluble form of phosphorus to soluble one, play an important role in supplying the plants with available phosphorus (**Ahmed *et al.*, 1997).**

Fertilizer application affects plant growth through increasing plant height, number of branch, number of fruit/plant, fresh weight of sepals/plant (gm), air-dried weight of sepals/plant (gm), chlorophyll (a), chlorophyll (b), carotenoids, and acidity values of the water extract of sepals. N, P and K % and total carbohydrates. Active dry yeast as a natural source of cytokinin had stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation (**Shalan *et al.*, 2001** and **Nagiub and Khalil (2002); Mohamed (2005); Somida *et al.* (2005) and Mostafa (2006)** on different plant species including (*Hibiscus sabdariffa* L.).

This investigation aimed to study the effect of citrine and active dry yeast as foliar application on growth, yield and some chemical constituents of roselle plants (*Hibiscus sabdariffa* L.) under a saline calcareous soils.

MATERIAL AND METHODS

The present investigation was carried out during the two successive seasons of 2007 and 2008 at the Experimental Farm, Fac. of Agric., Fayoum Univ. Some physical and chemical properties of the experimental soil, which was used in the current study are determined according to the standard methods described by **Klute (1986) and Page *et al.* (1982)** and are presented in Table (1).

Table (1) Some physical and chemical properties of the experimental soil.

Particle size distribution %				ECe (dS/m)	PH (1:2.5)	$CaCO_3$%	Availaple macro nutrient (mg/kg) Soil			Availaple micro nutrient (mg/kg) Soil			
Sand	Silt	Clay	Texture grade				N	P	K	Fe	Mn	Zn	Cu
77.1	14.2	8.7	Loamy sand	8.91	7.65	12.7	38	4.8	74.5	5.2	1.6	0.9	0.8

Seeds and planting: Seeds of roselle (*Hibiscus sabdariffa* L.) var. sabdariffa were obtained from the Research Center of Medicinal and Aromatic Plants, Ministry of Agriculture, Cairo, Egypt. Seeds were sown in rows on 15th May in the studied two successive seasons. Spacing between rows was 50 cm and 30 cm for hills, four seeds were sown in each hill. One month later from sowing the seedlings were thinned to one plant/ hill. The plants were irrigated regularly according to its needs and hand weeding was carried out regularly.

Mineral fertilizers as soil application: Plants received mineral fertilizer at the rates of 300 kg N/fed as ammonium nitrate, 23 kg P_2O_5/fed as calcium super phosphates and 50 kg K_2 O/fed as potassium sulphate/ fed. Nitrogen was added in two equal doses at 30 and 90 days after planting, potassium fertilizer was added with the first of nitrogen dose and calcium super phosphate was added during preparing the soil for planting.

Foliar application:-

a-Citrine

The plants were sprayed with tap water (as a control) or citrine solution (containing 15% citric acid, 2% Fe, 2% Zn, 2% Mn, 3% adhesive sugar substances and 76% water) at two times; i.e., 30 days after thinning and three weeks later with a volume of 150 L /fed for each time. Citrine was applied at the rates of 0, 0.3, 0.4 and 0.5% as foliar spraying out till runoff. Triton B as a wetting agent at 0.1% was added to the antioxidant solutions..

b-Active dry yeast preparation:

Active dry yeast (*Saccharomyces cerevisiae*) was dissolved in warm water (38C) followed by adding sugar at a ratio 1 : 1 to activate growth and reproduction of yeast and left stand for two hours before spraying. The yeast was applied at the rates of 0, 1,0 1.5 and 2.0 g/L and sprayed twice, each one after 4 days after the foliar spray of citrine. The plants were sprayed till run off, and the control plants were sprayed with tap water.

Morphological parameters: At the flowering stage (aged 140 days), 10 plants from each plot were randomly chosen to study the parameters of plant height (cm), number of branches/ plant, number of leaves / plant, leaf area / plant (cm^2), and dry weight of leaves /plant (g) .

Yield and its components: At harvest (aged 180 days), 10 plants from each plot were randomly chosen to study the parameters of number of flowers /plant , fresh weight of sepals / plant (g), dry weight of sepal's / plant (g) and yield of dry sepals / Fadden (kg).

Chemical constituents:

The chemical constituents were determined in powdered dry leaves and roselle sepals (the samples were dried in an electric oven at 70 °C ± 2 till constant weight, then ground).

- Total carbohydrates (%) were determined calorimetrically according to the method described by **Herbert *et al.* (1971).**
- pH was determination in sepales extracts, which were prepared by boiling 3g dry sepales in a distilled water for a period of 10 minutes. The pH was measured using pH meter **(Diab, 1968).** Anthocyanin was determined according to the method described by **Due and Francis (1973).**
- At age of 140 days (in both seasons) samples of fresh leaves were taken for the following determinations (a) total chlorophyll and carotenoids which extracted by acetone and determined according to **Welburn and Lichtenthaler, (1984),** (b)Peroxidase activity was determined by the method described by **Maehly and Chance (1954),** as follows: Half gram of fresh leaves homogenating in polytron with 4ml phosphate buffer (pH 6.0), extracts were centrifuged for 15 minutes at 4000rpm, and Peroxidase activity was measured in the supernatants using a reaction mixture consisted of 1.5ml of phosphate buffer (pH6.0), 1.5ml of H_2O_2 (20 volume), 1.5ml of 0.04M catechol solution as substrates and 0.1 ml of extract. Enzyme activities were expressed as changes in the optical density (O.D.) at 470 nm 60 to 120 seconds after the substrate was added.
  (c) Catalase activity was determined by the method described by Beers and Sizer (1952), as follows: Half gram of fresh leaves homogenating in polytron with 4ml phosphate buffer (pH 7.0), extracts were centrifuged for 15 minutes at 4000rpm. Catalase activity was measured in the supernatants using 1.9 ml of reagent grade water, 1.0 ml of H_2O_2 and 0.1ml of extract and the changes in the optical density (O.D.) at 240 nm were recorded for 1-2 minutes.

The experiment included 16 treatments, each with 3 replicates, in a complete randomized block design, and the results were statistically analyzed using the LSD at probability level of 5% for comparisons (**Gomez and Gomez, 1983**).

RESULTS AND DISCUSSION

Growth parameters:

Data presented in Table (2) show that the treated rosella plants with (citrine compound) as foliar spray gave the best results on the growth parameters, i.e., plant height, number of branches/ plant, number of leaves/plant, leaf area/ plant and dry weight of leaves /plant as compared to the control plants. Also, the data cleared that the increments in these characters were more related with increasing the applied rates of citrine, up to the highest rate of 0.5%. The greatest increase percentage were found to be, 18.08 % for plant height; 38.74% for number of branches/ plant; 54.94% for number of leaves/ plant; 21.97% for leaf area / plant and 33.95 % for dry weight of leaves /plant, as compared to the control plants at the first season.

Regarding the effect of active dry yeast (*Saccharomyces cerevisiae*), the data show pronounced increases in vegetative growth parameters with increasing the applied, rates especially at the highest one (2 g/L). The relative increase percetage reached, 40.2 % for plant height; 108.96% for number of branches/plant; 14.09% for number of leaves/ plant; 14.09% for leaf area/ plant and 44.10 % for dry weight of leaves /plant, as compared to the control plants at the first season.

Table (2): Effect of applied citrine and active dry yeast as foliar spray and their combination on growth parameters of roselle plants grown under saline calcareous soil condition.

Seasons	First season					Second season				
	Active dry yeast					Active dry yeast				
Treatment	0	1%	1.5 %	2 %	Mean	0	1%	1.5%	2%	Mean
Citrine	Plant height (cm)									
Control	71.63	113.6	123.2	125.2	108.4	105.6	118.0	126.5	130.8	120.2
0.3%	98.92	122.3	130.3	132.3	120.9	110.5	125.7	130.2	133.9	125.1
0.4 %	100.96	127.3	131.2	135.5	123.7	113.6	130.1	134.5	136.0	128.6
0.5 %	106.02	133.3	136.3	136.3	128.0	117.8	135.0	137.8	139.5	132.5
Mean	94.36	124.1	130.2	132.3		111.9	127.2	132.3	135.1	
LSD 5%	C= 2.00 Y= 1.14 C x Y= 2.28					C= 2.30 Y= 2.10 C x Y= 5.00				
	Number of branches / plant									
Control	3.28	8.59	9.09	9.59	7.64	4.50	8.75	9.52	9.59	8.09
0.3%	4.54	9.33	10.6	10.8	8.82	5.50	9.80	10.50	10.50	9.08
0.4 %	6.05	9.59	11.2	11.6	9.59	6.00	10.0	11.70	12.55	10.10
0.5 %	7.58	10.1	12.1	12.6	10.6	7.55	10.5	12.50	12.85	10.90
Mean	5.36	9.40	10.7	11.2		5.89	9.76	11.10	11.37	
LSD 5%	c= 0.05 Y= 0.04 C x Y= 1..0					C= 0.7 Y= 0.65 Cx Y= 1.50				
	No. of leaves/ plant									
Control	30.5	40.6	46.5	50.1	41.9	38.5	44.2	48.8	52.4	46.0
0.3%	35.4	46.7	52.4	53.3	47.0	43.5	48.5	50.3	55.5	49.4
0.4 %	42.5	50.6	59.4	65.9	54.6	46.6	49.7	59.5	60.1	53.7
0.5 %	45.3	55.3	63.5	68.5	58.1	50.2	56.7	65.0	69.5	60.4
Mean	38.4	48.3	55.5	59.5		44.4	49.8	55.9	59.4	
LSD 5%	C= 2.05 Y= 1.08 Cx Y= 3.2					C= 2.5 Y= 1.2 C x Y= 3.00				
	Leaf area (cm^2)									
Control	45.7	46.7	50.0	52.3	48.7	48.7	49.5	53.2	56.5	52.0
0.3%	49.6	50.3	53.1	55.5	52.1	49.9	55.7	56.0	59.4	55.3
0.4 %	53.5	56.5	57.0	59.8	56.8	55.3	59.9	60.8	65.1	60.3
0.5 %	55.6	56.8	59.7	65.4	59.4	57.2	64.8	65.9	69.5	64.3
Mean	51.1	52.6	54.9	58.3		52.8	57.5	59.0	62.6	
LSD 5%	C= 1.15 Y= 2.00 C x Y= 2.95					C= 2.10 Y= 3.0 C x Y= 4.98				
	Dry weight of leaves / plant (g)									
Control	35.6	48.3	54.8	55.6	48.6	43.6	50.3	53.1	56.3	50.8
0.3%	42.3	53.6	56.7	58.8	52.9	46.7	55.8	58.9	60.3	55.4
0.4 %	49.5	60.2	65.9	69.3	61.2	49.9	58..5	65.4	66.5	60.1
0.5 %	52.3	65.0	68.3	74.9	65.1	56.5	60.7	70.4	75.8	65.8
Mean	44.9	56.8	61.4	64.7		49.2	56.3	61.9	64.7	
LSD 5%	C= 1.08 Y= 1.66 Cx Y= 3.01					C= 1.30 Y= 1.98 C x Y= 3.12				

A combination between citrine and active dry yeast resulted in markedly increases for the previous parameters, especially at the highest rates that caused the greatest increases reached, 90.28; 284.14; 124.59; 43.1 and 110.39% for plant height, number of branches/ plant, number of leaves/plant, leaf area/ plant and dry weight of leaves /plant, respectively, as compared with the control plants. A similar trend was obtained in the second one.

The beneficial effect of the applied active dry yeast on growth parameters of rosella plants may be due to that yeast (*Saccharomyces cerevisiae*), as a natural source for cytokinins, had stimulatory effects on cell division as well as enlargement, protein and nucleic acid synthesis, besides chlorophylls formation **(Spencer *et al.*, 1983).** Also, yeast was found to contain carbohydrates, amino acids and lipids as well as several vitamins and most nutritional elements i.e Na, Ca, Fe, Mg, K, P, S, Zn and Si **(Nagodawithana, 1991).** These results are in agreement with those obtained by, **Tartoura (2001)** on pea; **Mekhemar and Al-Kahal (2002)** on bean plants; **Mohamed (2005)** on bean plants and **Somida *et al.*, (2005)** on roselle plants.

The positive effect of the antioxidants on growth might be attributed to their positive action on enhancing cell divisions and protecting plant cells from free radicals that is responsible for plant senescence. Also the benefits of these antioxidants are more attributed to their effect on counteracting drought, salinity and diseases stresses as well as they have an auxinic action, consequently enhancing plant growth characters **(Raskin, 1992).** Moreover, micronutrients used in this study (Zn, Fe and Mn) also have an improving effects on vegetative growth parameters, due to their essential role of Zn in synthesis of tryptophan amino acid and consequently formation of auxin, i.e. IAA which act as growth regulator especially in prolonging height of plants **(Devendra *et al.*, 1999).** The stimulating effect of the used micronutrients on plant growth may be due to their role in transmission of the electron from water to chlorophyll and producing oxygen gas in the photosynthesis, in addition to their role in the nitrogen metabolism through activated nitrite reductase enzyme **(Baza, 1984).**

Yield and its components:

Data tabulated in Table (3) indicated that the yield and its components (i.e. number of fruits /plant, fresh weight of sepals / plant , dry weight of sepals /plant and yield of dry sepals / fed) were increased by increasing the applied rates of citrine as foliar spray, especially when the applied increased from 0.3 up to 0.5%. The relative increase percentages obtained at the highest rate of citrine (0.5%) were, 38.64% for number of fruits /plant, 16.44%for fresh weight of sepals /plant, 19.22 % for dry weight of sepals/ plant and 20.99 % for yield of dry sepals/ fed . A similar trend was observed for treated plants with the different rates of active dry yeast, especially, at the highest rate of 2 g/ L which gave the greatest increases in yield and its components. The corresponding relative increases were, 101.12; 53.31; 66.24 and 61.46%, respectively, and consequently for the mentioned previous characters at the first season, as compared to the control plants.

The interaction between citrine and active dry yeast at all different rates increased yield and its components. The best results were obtained at the highest rates of citrine (0.5 %) in combination with that of active dry yeast (2 g/ L,). The relative increases due to their combinations were, 178.96% for number of fruits /plant, 83.69% for fresh weight of sepals/ plant, 97.46% for dry weight of sepals/ plant and 98.07% for yield of dry sepals / fed in the first

season as compared to the control plants. The same trend was observed in the second season.

Table (3): Effect of applied citrine and active dry yeast as foliar spray and their combination on yield and its components of roselle plants grown under saline calcareous soil condition.

Seasons	First season					Second season				
	Active dry yeast					Active dry yeast				
Treatments	0	1 %	1.5 %	2 %	Mean	0	1 %	1.5 %	2%	Mean
Citrine	**Number of fruits / plant**									
Control	9.08	14.65	18.16	18.68	15.14	10.50	15.75	19.71	19.90	16.47
0.3%	9.59	16.76	20.69	21.19	17.04	13.50	16.89	20.20	21.60	18.05
0.4 %	12.13	18.57	20.70	21.29	18.17	14.0	20.05	22.50	22.80	19.95
0.5 %	12.18	21.21	25.24	25.33	20.99	14.1	21.50	22.90	23.00	20.38
Mean	10.75	17.78	21.20	21.62		13.03	18.66	21.33	21.83	
LSD 5%	C= 0.45 Y= 0.65 C x Y= 1.10					C= 2.00 Y= 1.5 C x Y= 4.00				
Fresh weight of sepals/ plant (g)										
Control	27.47	38.39	44.72	45.43	39.00	32.85	39.95	45.55	45.72	41.02
0.3%	28.78	42.51	46.49	47.43	41.30	36.75	43.68	47.81	47.95	44.05
0.4 %	33.97	43.92	47.65	47.65	43.30	38.41	43.86	48.20	49.81	45.07
0.5 %	34.32	46.86	49.97	50.46	45.41	40.20	49.88	50.60	52.5	48.29
Mean	31.14	42.92	47.21	47.74		37.05	44.34	48.04	48.99	
LSD 5%	C= 0.40 Y= 0.35 C x Y= 0.81					C=0.8 Y= 1.10 C x Y= 2.0				
Dry weight of sepals/ plant (g)										
Control	3.55	4.94	5.94	5.95	5.10	3.85	4.99	6.00	6.08	5.23
0.3%	3.68	5.33	6.03	6.06	5.28	4.21	5.85	6.11	6.18	5.58
0.4 %	4.02	5.40	6.46	6.36	5.61	4.93	5.98	6.25	6.39	5.89
0.5 %	4.26	6.08	6.98	7.01	6.08	5.00	6.10	6.75	6.92	6.19
Mean	3.88	5.44	6.35	6.45		4.50	5.73	6.15	6.27	
LSD 5%	C= 0.13 Y= 0.09 C x Y= 0.18					C= 0.25 Y= 0.35 C x Y= 0.69				
Yield of dry sepals / fed (kg)										
Control	114.0	157.9	186.7	185.7	161.1	115.5	159.0	188.2	189.9	163.2
0.3%	117.9	170.7	192.8	193.8	168.8	118.5	173.5	195.7	196.7	171.1
0.4 %	128.6	173.8	194.3	197.5	173.3	128.9	174.9	198.0	199.6	175.4
0.5 %	136.5	194.4	223.2	225.8	194.9	138.1	196.1	226.0	230.9	197.8
Mean	124.3	174.0	199.3	200.7		125.3	175.9	201.9	204.3	
LSD 5%	C= 0.95 Y= 1.41 C x Y= 2.82					C= 1.00 Y= 1.95 Cx Y= 3.08				

The enhancing effect of active dry yeast on roselle yield and its components may be due to that yeast via its cytokinins content and the high content of vitamin B and nutrient elements as well as organic compounds

(**Nagodawithana, 1991**). In addition it plays a role in distribution and translocation of metabolites from leaves towards the reproductive organs. All of these occurrences and attributes might lead to the improvement of roselle yield. These results are in harmony with those obtained by **Mohamed (2005)** on bean plants and **Somida *et al.* (2005)** on roselle plants. The positive effect of citric acid and micronutrients on yield and its components was mainly attributed to its positive action on enhancing growth parameters (Table 2) and photosynthetic pigments of plants leaves (Table 4). In this respect, **Al-Qubaie (2002)** stated that antioxidant has an auxinic action and also synergistic effect on the biosyntheses of carbohydrate and controlling the incidence of most fungi on plants makes them in vigorous states which consequently is reflected on seed yield. Moreover, the increase in yield and its components may be attributed to the metabolic role of Zn, Fe and Mn in plant, which might be attributed to the increase in photosynthetic pigments concentration (**Price *et al.*, 1972**) as well as enzyme activity, which enhancing plant metabolism (**Boardman, 1975**). Also, zinc has essential role in carbohydrate metabolism, protein synthesis, tryptophan and IAA synthesis, since it activates number of enzymes for photosynthesis (**Gardner *et al.*, 1985** and **Marschner, 1986**). The obtained results were in agreement with those obtained by, **El-Sherbeny and Hussein (1990)**; **Hanafy (1994)** and **Somida *et al.* (2005)** on roselle plants.

Chemical constituents of leaves:-

1 –Chlorophylls and carotenoide concentrations

Data recorded in Table (4) show that the total chlorophylls and carotenoide concentrations in roselle leaves greatly increased by treated plants with citrine or active dry yeast treatments either alone or in combination with each other at all different rates as compared to control plants. Generally, the greatest increases of total chlorophylls and carotenoide concentrations were obtained by treatment of 0.5% citrine as foliar fertilizers, which reached, 12.75 and 13.27%, respectively, as compared to the control plants in the first season. Moreover, the greatest increases of total chlorophylls and carotenoide concentrations were obtained by the highest rate of active dry yeast (2 g/ L.), and reached, 41.18 and 40.91 %, respectively, at the first season as compared with control plants.

A combination between the highest rate of citrine (0.5 %.) and active dry yeast (2 g/ L) gave the greatest increases of total chlorophylls and carotenoide in roselle leaves, which reached 54.70 and 62.79%, respectively, at the first season as compared to the control plants. Similar trend was observed in the second season. The promotive effect of citrine on leaf pigments concentration might be attributed to the enhancing effect of antioxidants and micronutrients on the nutritional status of roselle plants .In this respect, **Farag (1996)** stated that most antioxidants were responsible for accelerating the biosynthesis of various pigments leading to the increase in biosynthesis of sugars. Moreover, the stimulating effect of micronutrients on chlorophyll formation was reported by **Mohr and Schopfer (1995)** who stated that this increase may be due to the enhancing effect of Fe, Mn and Zn on chlorophyll formation and consequently photosynthesis.

The stimulatory effect of active dry yeast on pigment concentration might be due to that yeast as a source of cytokinins delays the degradation of chlorophyll via the inhibition of chlorophyllase (**Ben, 1986**) and enhances the

synthesis of protein and RNA that are closely related with delaying the aging of leaves (**Natio *et al.*, 1981**).

Table (4): Effect of applied citrine and active dry yeast as foliar spray and their combination on total chlorophyll and carotenoid concentrations of roselle plants grown under saline calcareous soil condition.

Seasons	First season					Second season				
	Active dry yeast					Active dry yeast				
Treatments	0	1 %	1.5 %	2 %	Mean	0	1 %	1.5 %	2%	Mean
Citrine	Total chlorophyll (mg/ g F.W.)									
Control	0.808	1.004	1.133	1.135	1.020	0.809	1.010	1.142	1.136	1.024
0.3%	0.833	1.010	1.196	1.198	1.060	0.835	1.053	1.199	1.198	1.071
0.4 %	0859	1.201	1.222	1.226	1.130	0865	1.232	1.252	1.230	1.145
0.5 %	0.901	1.207	1.232	1.250	1.150	0.910	1.251	1.240	1.268	1.167
Mean	0.850	1.110	1.190	1.200		0854	1.137	1.208	1.208	
LSD 5%	C= 0.012 Y= 0.011 C x Y= 0.022					C=0.03 Y= 0.02 Cx Y= 0.06				
Carotenoids (mg/ g F.W.)										
Control	0.258	0.333	0.379	0.385	0.339	0.258	0.335	0.381	0.388	0.341
0.3%	0.284	0.343	0.399	0.399	0.356	0.295	0.346	0.409	0.415	0.366
0.4 %	0.293	0.365	0.403	0.409	0.368	0.299	0.375	0.410	0.420	0.376
0.5 %	0.308	0.395	0.414	0.420	0.384	0.315	0.398	0.425	0.435	0.393
Mean	0.286	0.359	0.399	0.403		0.292	0.364	0.406	0.416	
LSD 5%	C= 0.004 Y= 0.003 C x Y= 0.007					C= 0.002 Y= 0.003 C x Y= 0.005				

2- Antioxidant enzymes activity:

Data recorded in Table (5) clearly indicated that peroxidase and catalaes activity in roselle leaves greatly increased by spraying plants with citrine or active dry yeast either alone or together at all different rates as compared to the control plants. The greatest increase of peroxidase and catalaes activity were obtained by citrine at the rate of 0.5%, which reached, 29.66 and 27.11 %, respectively, as compared to the control plants in the first season. Moreover, the greatest increases in peroxidase and catalaes activity were obtained at the highest rate of active dry yeast (2 g/ L.) which reached, 3.78 and 11.34 %, respectively, at the first season as compared with control plants.

The data also showed that the combination between the highest rate of citrine (0.5 %.) and active dry yeast (2 g/ L) gave the greatest increases of peroxidase and catalaes activity in roselle leaves which reached 37.00 and 34.00 %, respectively, at the first season as compared to the control plants. A similar trend was observed in the second season. The promotive effect of citrine and active dry yeast on enzyme activity might be attributed to the enhancing effect of antioxidants and micronutrients on enzyme activity of roselle plants .In this respect, **Burris (1960)** reported that catalase functions in ensuring the removal of H_2O_2, supplying free O_2, and detoxifying harmful metabolic products. The mode peroxidase action on the H_2O_2 substrate differs from catalase action in that peroxidase liberates free radicals rather than oxygen. These free radicals are highly phytotoxic and the use of antioxidant were diminishing free radical formation. The accumulation of H_2O_2 may be caused changes in plant

metabolism, however, it may oxidize sulfhydryl groups and inactivate IAA **(Omran 1977).** Moreover, the ability to defend plant cells against oxidative damager resulting from salinity stress is directly correlated with the level of antioxidants such as ascorbate, glutathione and a-tocopherol **(Wise and Naylor, 1987).**

Table (5): Effect of applied citrine and active dry yeast as foliar spray and their combination on antioxidants enzyme activity of roselle plants grown under saline calcareous soil condition.

Seasons	First season					Second season				
Treatments	Active dry yeast					Active dry yeast				
	0	1 %	1.5 %	2 %	Mean	0	1 %	1.5 %	2%	Mean
Citrine	Peroxidase activity									
Control	100.0	104.0	106.0	108.0	104.5	100.0	104.0	107.0	107.0	104.5
0.3%	119.0	120.0	122.0	122.0	120.8	121.0	121.0	124.0	124.0	122.5
0.4 %	124.0	124.0	126.0	127.0	125.2	125.0	126.0	126.0	128.0	126.2
0.5 %	133.0	136.0	136.0	137.0	135.5	132.0	137.0	137.0	137.0	135.8
Mean	119.0	121.0	122.5	123.5		119.5	122.0	123.5	124.0	
LSD 5%	C= 12.21 Y= 3.86 C x Y= 14.33					C=10.15 Y= 4.66 Cx Y= 12.18				
Catalase activity										
Control	100.0	105.0	105.0	106.0	104.0	100.0	106.0	106.0	106.0	104.5
0.3%	125.0	126.0	126.0	128.0	126.3	127.0	127.0	129.0	129.0	128.0
0.4 %	129.0	129.0	130.0	130.0	129.5	130.0	130.0	131.0	132.0	130.8
0.5 %	131.0	132.0	132.0	134.0	132.2	132.0	133.0	133.0	133.0	132.7
Mean	121.3	123.0	123.2	124.5		122.3	124.0	124.8	125.0	
LSD 5%	C= 15.35 Y= 4.65 C x Y=11.46					C= 13.33 Y= 5.16 C x Y= 14.58				

3 - Chemical constituents of sepals:

Data presented in Table (6) show that pH values of roselle plants were decreased by increasing the rates of citrine or active dry yeast application each alone or in combination with each other at all different rates as compared to control plants, Generally, the pronounced decreases of pH value were obtained at the highest rates of citrine (0.5 %) and active dry yeast,(2 g/ L,) that reached (6.72 % and 6.17 %) ,respectively . While the interaction between both two treatments gave the greatest decrease of pH value (4. 27 %) at the first season as compared to the control plants. A similar trend was observed in the second season..

On the contrary, spraying plants with the highest rate of citrine or active dry yeast significantly increased anthocyanin by, 9.9 and 15.0%; and total carbohydrates by 47.63 and 14.48%, respectively, at the first season as compared to the control plants. While, the combination between the highest rates of citrine (0.5 %) and active dry yeast (2 g/ L) gave the greatest increases in anthocyanin and total carbohydrates concentrations which reached 66.08 and 86.88%, respectively, at the first season as compared to the control plants. A similar trend was observed in the second season. The stimulating effect of micronutrients on total carbohydrates and anthocyanin concentration were reported by **Mohr and Schopfer (1995)** who stated that such increase may be due to the enhancing effect of Fe, Mn and Zn on chlorophyll formation and

consequently photosynthesis. In this respect, **Price *et al.*, (1972)** reported that the basic function of zinc in plant was related to its role in carbohydrates metabolism. Moreover, increasing total carbohydrates by active dry yeast or citrine application was more attributed to increasing the absorption of macro and micronutrients which, resulted in vigorous vegetative growth, i.e., leaves number and area, and consequently increasing photosynthesis production and carbohydrates. In this respect, **El-Fouly and Fawzi (1996)** recorded that the use of micronutrients as foliar spray led to an increase in root growth and thereby higher uptake of macro and micronutrients. Concerning the effect of the tested antioxidants on total carbohydrates and anthocyanin data showed that the used antioxidants significantly increased these components. In this respect, **Farag (1996)** pointed out that most antioxidants were responsible for accelerating the biosynthesis of various pigments that leading to the increase in biosynthesis of sugars

Table (6): Effect ofapplied citrine and active dry yeast as foliar spray and their combination on some chemical constituents of roselle plants grown under saline calcareous soil condition.

Seasons	First season					Second season				
	Active dry yeast					Active dry yeast				
Treatments	0	1%	1.5%	2 %	Mean	0	1%	1.5 %	2%	Mean
Citrine	Total carbohydrates (mg / g)									
Control	86.1	129.5	141.4	141.8	124.7	100.0	130.5	142.6	142.8	129.0
0.3%	89.7	140.3	150.6	158.5	134.8	101.2	148.6	159.5	160.2	142.4
0.4 %	94.4	147.1	154.1	158.9	138.6	104.7	150.4	160.3	163.5	144.7
0.5 %	101.1	152.1	159.6	160.9	143.4	108.5	158.9	168.2	170.1	151.4
Mean	135.4	142.2	151.4	155.0		103.6	147.1	157.7	159.2	
LSD 5%	C= 1.36 Y= 1.17 Cx Y= 2.35					C= 2.02 Y= 2.10 C x Y= 4.08				
pH										
Control	3.98	3.04	3.59	3.68	3.57	3.98	3.05	3.68	3.69	3.59
0.3%	4.03	3.15	3.62	3.72	3.63	4.00	3.19	3.62	3.74	3.65
0.4 %	4.04	3.28	3.68	3.82	3.71	4.14	3.32	3.70	3.80	3.74
0.5 %	4.15	3.28	3.84	3.96	3.81	4.22	3.38	3.91	3.96	3.87
Mean	4.05	3.19	3.68	3.80		4.09	3.24	3.73	3.80	
LSD 5%	C= 0.02 Y= 0.03 C x Y= 0.07					C= 0.10 Y= 0.23 C x Y= 0.50				
Anthocyanin										
Control	6.84	10.05	10.31	10.35	9.39	6.88	10.10	10.33	10.35	9.42
0.3%	7.28	10.18	10.65	10.84	9.74	7.31	10.21	10.65	10.84	9.75
0.4 %	7.46	10.58	11.05	11.10	10.05	7.55	10.66	11.29	11.35	10.21
0.5 %	7.96	10.93	11.14	11.36	10.32	7.99	10.89	11.45	11.46	10.45
Mean	7.39	10.41	10.79	10.91		7.43	10.47	10.93	11.00	
LSD 5%	C= 0.09 Y= 0.1 C x Y=0.18					C= 0.05 Y= 0.03 C x Y= 0.10				

Finally, from the present results, it could be concluded that the application of citrine (citric acid, Fe, Zn, and Mn) greatly increased roselle

growth and its yield as well as improved sepals quality and their chemical constituents. These elements participate in the different metabolic processes, which increased syntheses of chlorophyll, carbohydrates, and absorption of essential nutrients. Moreover the increase in chemical constituents by active dry yeast, which is a natural source of cytokinins, had stimulatory effects on cell division and cell enlargement so far increasing the leaf area surface as well as enhancing the accumulation of soluble metabolites **(Muller and Leoped, 1966)**. Also, yeast is a natural source of many growth substance, i.e., thiamine, riboflavin, niacin, pyridoxine, panthothenate, bioten, cholin, folic acid and vit.B12 as well as most nutritional elements (Na, Ca,Fe, Mg, K, P,S, Zn and Si) and organic compounds (portion, carbohydrate, nucleic acid and lipids) **Nagodawithana (1991).** So that, the used active dry yeast, micronutrients and antioxidants could be increase roselle productivity with high quality for sepals.

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تأثير الرش الورقى بمركب السترين والخميره النشطة على النمو والمحصول وبعض المكونات الكيميائية لنباتات الكركديةالنامية تحت ظروف اراض جيرية ملحية

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أجريت هذا الدراسة بمزرعة كلية الزراعة بدمو جامعة الفيوم (أرض ملحية مستصلحة حديثا ذات طبيعة جيرية) خلال موسمي ٢٠٠٧ ، ٢٠٠٨ وذلك لدراسة تأثير رش النباتات بمركب السترين بمعدلات ٠، ٠,٣، ٠,٤، ٠,٥% المحتوى على (حامض الستريك بنسبة ١٥% وكل من الحديد بنسبة ٢% والزنك بنسبة ٢% والمنجنيز بنسبة ٢%) وكذالك الرش بالخميرة النشطة بمعدلات صفر، ١، ١,٥، ٢ جرام/لتر كأضافة منفرده أو مشتركة على حالة النمو الخضرى والمحصول وبعض المكونات الكيميائية لنباتات الكركدية. وقد تم دراسة كل الصفات الخضرية (طول النبات، عدد الأفرع للنبات، عدد الأوراق/ نبات ومساحة الورقة والوزن الجاف للاوراق/ نبات) وايضا صفات المحصول (عدد الثمار/ نبات والوزن الطازج للسبلات/ نبات والوزن الجاف للسبلات/ نبات ومحصول السبلات الجافة/الفدان) وكذلك محتوى الاوراق من الكلوروفيلات الكلية والكاروتين والسبلات من الحموضة والأنثوسيانين والكربوهيدرات الكلية. **ولقد أوضحت** النتائج المتحصل عليها بصفة عامة أن قيم كل الصفات المدروسة قد زادت نتيجة الرش بالمعدلات المختلفة من السترين والخميرة النشطة كأضافة منفرده أو مشتركة حيث سجلت أعلى القيم للقياسات السابقة عند استخدام المعدل العالى من كلأ المركبين المستخدمين (٠,٥% من السترين ، ٢ جرام/ لتر من الخميرة النشطة) كإضافة منفرده أو مشتركة. كذلك زيادة نشاط انزيمات الاكسدة مثل انزيم البيروكسيديز والكتااليز. وعلى العكس من ذلك فقد أدت كل المعاملات الى نقص محتوى السبلات من الحموضة مقارنة بمعاملة الكنترول.

في ضوء تلك النتائج، يمكن التوصية برش نباتات الكر كدية بمركب السترين او الخميرة النشطة للتغلب على الظروف البيئية المعاكسة، خاصة التأثيرات الضارة لملوحة التربة في الأراضي المستصلحة حديثا وبالتالي الحصول على إنتاج اقتصادي في ظل تلك الظروف المعاكسة.