EFFECT OF YEAST AND MICRONUTRIENTS FOLIAR APPLICATION ON LEAVES AND RACEMES GROWTH, YIELD AND FRUIT QUALITY OF LOQUAT (*ERIOBOTRYA JAPONICA* LINDL.) TREES.

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ABSTRACTS

To improve the growth, yield and fruit quality of loquat, an experiment was conducted on "Advance" loquat trees grown at Tawfikia village, Damietta Governorate, Egypt, during 1999 and 2000 years. Solutions of active yeast at 1.25 or 2.5 g/l and micronutrients mixture (Fe, Mn and Zn sulphate, 250 ppm of each) either alone or in combinations were foliar applied at both full-bloom (Fb) and after 7 weeks from Fb.

The most tested treatments significantly increased leaf area, raceme length, fruit number/cluster at harvesting, leaf chlorophyll (b and total) and yield/tree compared with the control. Application of yeast at 2.5 g/l alone or with micronutrients significantly surpassed yeast at 1.25 g/l and micronutrients alone in that respect. A significant increase in fruit weight and size, flesh weight/fruit and seeds number/fruit was observed, whereas seed weight showed a significant decrease by the application of both yeast concentrations plus micronutrients compared with the control. However, all the tested applications exhibited significantly lower acidity and higher TSS/acid ratio of fruit juice compared with the control. Foliar application of both yeast concentrations with micronutrients resulted in a significant higher level of vitamin C of fruit juice than control and the same yeast concentrations alone.

The results revealed that fruit protein content and levels of leaf micronutrients and phosphorous were markedly increased by the investigated treatments. However there was a significant decrease in the total reducing sugars concentration in juice of the most treated fruits. The aforementioned results clearly evidenced that foliar application of yeast at 2.5 g/l alone or combined with micronutrients mixture was the most effective treatment to improve vegetative growth, yield and fruit quality of loquat.

Key words: loquat, yeast foliar application, leaf chlorophylls content, leaf micronutrients and phosphorus, growth, yield, fruit quality, total reducing sugars, fruit proteins content.

INTRODUCTION

Loquat (*Eriobotrya japonica* Lindl.,) is a subtropical evergreen fruit tree that blooms in fall and early winter. The tree is cold-hardy down to -10°C (Lin et al., 1999). The origin of loquat is presented in China and extended to other countries specially in Japan (Zhang et al.,, 1990). Loquat fruits represent one of the most important fruits and have a great economic value in China and Japan, since they proceeded the income from citrus and other fruits (Lin et al., 1999). Fruits can be consumed either fresh or processed as jam, juice, syrup, or candied fruits (Liu, 1982). Moreover, leaves and fruits of loquat traditionally have been considered to have high medicinal value. Since, there is evidence that they have pharmaceutically active compounds particularly to treat skin diseases and diabetes mellitus, anti-inflammatory and active to significantly reduce rhinovirus (Duke and Ayensu, 1985; Shimizu et al., 1986; Noreen et al., 1988; DeTommasi, 1992).

In Egypt, it should receive more attention for its important as mentioned above. The cultivated area was 233 feddan and the fruiting area was 154 feddan which produced 803 ton with an average of 5.21 ton/feddan (Ministry of Agriculture, 1998). The harvest period is extended from half of March to nearly end of May, this harvest period gives loquat fruits a high economic value, since they market under no competition with other fruits. Accordingly cultivation of loquat trees in Egypt needs further investigations. To meet the requirements of both local and international markt, yield and quality of fruits should be improved. Application of yeast or/and micronutrients has been used in several fruit trees to improve growth, yield and fruit quality [Nijjar (1985); Hegab, et. al., (1997) with *Citrus sinensis*; Safia, et al., (1999) with pomegranate; Omran (2000) with grape and Attala et al., (2000) with pear]. Therefore, the aim of the present work was to study the possibility of enhancing growth and improving yield and fruit quality of "Advance" loquat trees by using active dry yeast and micronutrients.

MATERIALS AND METHODS

The present study was carried out during two successive seasons, 1999 and 2000, on "Advance" loquat (*Eriobotrya japonica* Lindl.) trees onto quince rootstock in a private orchard, at Tawfikia village, Damietta Governorate, Egypt. The tested trees were selected at previous harvest time (1998 season) at 11-year-old, uniform in vigor and grown in clay loam soil. The trees were cultivated at 5 x 5 m and received the common cultural practices. The selected trees were subjected twice to different foliar applications, 3 l/tree (at full-bloom (Fb) and at 7 weeks from Fb; Swietlik and Faust, 1984) as follows:

Tc = Water alone (control).

T_1 = Yeast solution at 1.25 g/l.

T_2 = Yeast solution at 2.50 g/l.

T_3 = Mixture of micronutrients solution (250 ppm from each of Fe, Mn and Zn sulphate salt).

T_4 = Solution of yeast at 1.25 g/l. + mixture of micronutrients (250 ppm from each of Fe, Mn and Zn sulphate salt).

T_5 = Solution of yeast at 2.50 g/l. + mixture of micronutrients (250 ppm from each of Fe, Mn and Zn sulphate salt).

A complete randomized block design with 3 replicates (one tree each) per treatment was adopted. The yeast solution was prepared by mixing row baker's dry yeast with sugar at the same concentration (1.25 or 2.50 g/l) in hot water (about 35 °C) and kept at room temperature (25 ±1°C) for 12 hr. to allow the release of active substances according to Skoog and Miller (1957).

The chemical composition of the used active baker's dry yeast (*Saccharomyces cerevisiae*) was recorded in Table (1) according to the results obtained by Nagodawitana (1991).

Table 1: Chemical composition of Baker's dry yeast.

Major compositions %		Vitamins contents U/g		Approximate composition of minerals			
				mg/g		μg/g	
Protein	47	Thiamine	60-100	Ca	0.75	Cr	2.2
Carbohydrates	33	Riboflavin	35-50	Fe	0.02	Cu	0.1
Minerals	8	Niacin	300-500	K	21.0	Li	0.17
Nucleic acids	8	Pyridoxine HCl	28	Mg	1.65	Mn	0.02
Lipids	4	Pantothenate	70	Na	0.12	Mo	0.4
		Biotin	1.3	P	13.5	Ni	3.0
		Cholin	4000	S	3.9	Se	0.1
		Folic acid	5.13	Si	0.03	Sn	3.0
		Vit. B12	0.001	Zn	0.17	Va	0.04

In addition, the protein of yeast (*S. cerevisiae*) comprised 18 common amino acids (Abou-Zaid, 1984)

The following measurements in the two successive seasons were studied

A) Leaf characteristics

1- Leaf area : Twelve leaves from the top on non-fruiting shoots (second leaf) of new growth flush at different directions were chosen from each replicate. Leaf area as an average of the selected leaves was measured twice, using Planimeter (Licore 3100 area meter), the first measure was before spray at Fb (leaf area I) and the second one was at the begining of harvest (leaf area II). Percentage of leaf area increase was calculated according the following equation :

$$\text{Leaf area increase (\%)} = \frac{\text{Leaf area II} - \text{Leaf area I}}{\text{Leaf area I}} \times 100$$

2- Leaf minerals content: Twelve leaves/replicate from the top on non-fruiting shoots (third leaf, full mature leaf of current growing season, Picchioni et al., 1995) at different directions were collected at 4 weeks after the second spray time, individually washed with tap water, rinsed twice with distilled water, dried, ground to fine powder and digested with nitric/perchloric (wet ashing) according to Gavlak et al., (1994). Leaf micronutrients content (Fe, Mn and Zn) were determined by Perking-Elmer atomic absorption spectrophotometer, Model 30513.Total phosphorous content of leaf was measured spectrophotometrically as described by Humphries (1956) with some modifications of Hasaneen (1981).

3- Leaf chlorophyll (a, b and total) contents: were extracted with N, N-Dimethylformamide and determined according to Moran (1982). This procedure carried out twice in 10 discs have certain area of full mature third leaves/replicate, before the first spray time at full bloom (chlorophyll level I) and repeated at 4 weeks after the second spray time (chlorophyll level II). The obtained data was recorded as mg chlorophyll per 100 cm^2 of leaf. Increasing % of chlorophyll content over the control was calculated as follow:

$$\text{Increase of chlorophyll content} = \text{Chlorophyll level II} - \text{Chlorophyll level I}$$

$$\text{Chlorophyll increase over the control \%} = \frac{\text{Chlorophyll increase of treatment} - \text{Chlorophyll increase of control}}{\text{Chlorophyll increase of control}} \times 100$$

B) Raceme characters, number of fruits/cluster and yield

1- Raceme length increase (%): Nine racemes about 7 cm length of each/replicate were selected at Fb (average I), marked and at the begining of harvest, their length was recorded (average II). Percentage of raceme length increase was calculated by the following equation :

$$\text{Percentage of raceme length increase} = \frac{\text{Raceme length average II} - \text{Raceme length average I}}{\text{Raceme length average I}} \times 100$$

2- Number of fruits/cluster and yield: At harvest time, twenty cluster were randomly chosen and number of fruits on each was counted to estimate average (Av.) fruits number/cluster. Yield/tree was estimated by using the following equation:

Yield/tree (kg) = Total clusters number/tree X Av. fruits number/cluster X Av. ripe fruit weight g/ 1000

C) Fruit quality

Representative random samples consisted of fifty ripe fruits (orange-yellow color according to Uchino et al., 1994) per replicate were picked at harvest time, and used for determining fruit quality physical and chemical characters.

Physical characteristics measured at harvest time were as follows:

1- Fruit weight (g) 2- Fruit size (cm^3) 3- Seeds number per fruit
4- Average seed weight (g) 5- Flesh weight per fruit (g)

Fruit quality chemical characteristics were determined in the extracted juice and dry flesh as follows:

1- **Total soluble solids (TSS or brix, %):** An Abbe hand refractometer was used.

2- **Titratable acidity % :** Titration against 0.05 N NaOH and phenolephthalene as an indicator was followed (Ranganna, 1979). Titratable acidity was expressed as malic acid percentage.

3- **Total soluble solids/acid ratio:** It was calculated from the data recorded for TSS % and acidity %.

4- **Ascorbic acid content (Vitamin C):** Procedure based on the oxidation of ascorbic acid with 2, 6 dichlorophenol endophenol dye was conducted (Ranganna, 1979). Vitamin C content was calculated as mg/100 ml juice.

5- **Total reducing sugars % (TRS)** : Certain amount of juice was mixed with citric acid and prepared according to method of Ranganna (1979). TRS were determined spectrophotometrically at 700 nm using Spekol II (Carlzesis Jena) as described by Nellson (1944) with some modifications of Naguib (1964).

6- **Total and soluble proteins %:** Total protein (TP) was extracted according to Dure III and Chilan (1981) and Oster et al., (1992). Soluble protein (SP) extraction was prepared as described by Dure III and Chilan (1981) and Mahhou and Dennis (1994) on dry flesh weight basis. The TP and SP contents were measured spectrophotometrically at 595 nm according to Bradford (1976).

D) Statistical analysis

The statistical analysis of the obtained data was carried out according to Norusis (1993) using the new least significant difference (NLSD) at 5% level.

RESULTS

The influence of yeast and micronutrients (Mic.) mixture of foliar application on leaves and racemes growth, yield and fruit quality was presented in Tables (2 to 8).

A) Leaf characters

Data presented in Table (2) showed that applying foliar yeast and Mic. mixture alone or in combinations resulted in a significant increase of leaf area (%) and concentrations of microelements (Fe, Mn & Zn) of leaf compared with the control, except treatment of yeast at 1.25 g/l which didn't significant differ from the control in increase of leaf area (%). The phosphorus (P), Fe, Mn and Zn contents in the leaf increased with the increase of applied yeast dose. While, the P content in leaf did not influenced by spraying yeast at 1.25 g/l or Mic. mixture (Fe, Mn & Zn at 250 ppm of each). Moreover, spraying the combinations of yeast (specially at 2.5 g/l) with Mic. mixture significantly surpassed other tested treatments in that respect.

Concerning chlorophyll b and total contents of leaf, from Tables (3 & 4) it was cleared that all application, in general, resulted in significant higher responses than those of the control in the two studied seasons. The highest levels of leaf chlorophyll a (2.105 mg/100 cm^2) and total (3.360 mg/100 cm^2) were obtained at spraying a combination of yeast (2.5 g/l) with Mic. mixture. In addition, applying yeast at high dose (2.5 g/l) was more effective than the low one (1.25 g/l) in that respect. Since, at high yeast level, averages of leaf chlorophyll (a, b and total) were raised 16.67%, 138.32% and 53.32% over control, respectively.

B) Raceme length, fruit number/cluster and yield

Foliar spray of both yeast and Mic. mixture either alone or in combinations produced significantly more length of raceme compared to control (Table 5). The highest increase in raceme length (66.23%) was recorded under yeast at 2.5 g/l plus Mic. mixture followed by Mic. mixture solely (57.13%). However, No significant differences were observed between

Table 2 : Effect of yeast and some micronutrients foliar application on leaf area and leaf minerals content in loquat tree during 1999 and 2000 seasons.

Treatments	Increase in leaf area (%)			Minerals content in leaf: Phosphorus (P) (mg/g dry wt.)			Microelements (µg/g dry wt.): Fe			Mn			Zn		
	1999	2000	Mean	1999	2000	Mean	1999	2000	Mean	1999	2000	Mean	1999	2000	Mean
Tc = Control	13.68	09.32	11.50	2.70	2.73	2.72	47.50	42.50	45.00	10.50	10.84	10.49	08.00	06.00	07.00
yeast at 1.25g/l	13.30	12.60	12.95	2.86	2.83	2.85	57.50	49.15	53.33	19.00	22.83	20.92	12.00	10.67	11.34
yeast at 2.50g/l	20.16	19.62	19.89	2.98	2.90	2.94	60.00	60.00	60.00	27.50	29.84	28.67	15.00	13.00	14.00
250 ppm Mix.of Mic.*	16.27	19.68	17.98	2.81	2.76	2.79	75.00	71.67	73.33	23.00	23.00	23.00	13.00	12.33	12.67
yeast at 1.25g/l + Mix. of Mic	28.06	21.02	24.54	3.57	3.60	3.59	87.50	79.15	83.33	22.00	25.32	23.66	14.50	18.17	16.34
yeast at 2.50g/l + Mix. of Mic	27.96	23.35	25.65	3.66	3.58	3.62	80.00	80.00	80.00	45.50	42.50	44.00	28.37	25.00	26.69
New LSD at 5%	3.13	2.89	2.72	0.33	0.21	0.20	9.21	4.12	5.25	2.38	3.41	2.23	2.50	2.41	1.81

* Mix. of Mic. = Mixture of micronutrients (250 ppm from each of Fe, Mn and Zn sulphate salts).

Table 3 : Effect of yeast and some micronutrients foliar application on chlorophyll (a & b) contents in loquat leaves during 1999 and 2000 seasons.

Treatments	Chlorophyll (a) content mg/100 cm^2: Level I **		Level II ***		Increase (level II - level I)			Over control (%)	Chlorophyll (b) content mg/100 cm^2: Level I **		Level II ***		Increase (level II - level I)			Over control %
	1999	2000	1999	2000	1999	2000	Mean		1999	2000	1999	2000	1999	2000	Mean	
Tc = Control	1.73	2.13	3.13	3.43	1.40	1.30	1.350	--	1.20	1.36	1.83	1.80	0.63	0.44	0.535	--
yeast at 1.25g/l	1.89	2.16	3.48	3.59	1.59	1.43	1.510	11.85	1.23	1.39	2.30	2.10	1.07	0.71	0.890	66.36
yeast at 2.50g/l	1.85	2.20	3.45	3.76	1.60	1.55	1.575	16.67	1.29	1.48	2.64	2.68	1.35	1.20	1.275	138.32
250 ppm Mix. of Mic. *	1.78	2.14	3.62	4.22	1.84	2.08	1.960	45.19	1.30	1.43	2.49	2.63	1.19	1.20	1.195	123.36
yeast at 1.25g/l + Mix. of Mic	1.66	2.03	3.19	3.41	1.53	1.38	1.455	7.78	1.12	1.29	2.39	2.33	1.27	1.04	1.155	115.89
yeast at 2.50g/l + Mix. of Mic	1.81	2.05	3.82	4.25	2.01	2.20	2.105	55.93	1.23	1.35	2.58	2.52	1.35	1.17	1.260	135.51
New LSD at 5%					0.264	0.313	0.282						0.126	0.192	0.150	

* Mix. of Mic. = Mixture of micronutrients (250 ppm from each of Fe, Mn and Zn sulphate salts).
** Level I = Chlorophyll content at full bloom (before spray).
*** Level I = Chlorophyll content at 4 weeks after the second spray time.

Table 4 : Effect of yeast and some micronutrients foliar application on total chlorophyll contents in loquat leaves during 1999 and 2000 seasons.

Treatments	Total chlorophyll content mg/100 cm²							Over control
	Level I **		Level II ***		Increase (level II - level I)			
	1999	2000	1999	2000	1999	2000	Mean	(%)
Tc = Control	2.93	3.49	4.96	5.23	2.03	1.74	1.885	---
yeast at 1.25g/l	3.12	3.54	5.77	5.69	2.65	2.15	2.400	27.32
yeast at 2.50g/l	3.14	3.68	6.16	6.44	3.02	2.76	2.890	53.32
250 ppm Mix. of Mic. *	3.08	3.57	6.11	6.86	3.03	3.29	3.160	67.63
yeast at 1.25g/l + Mix. of Mic	2.79	3.31	5.59	5.74	2.80	2.43	2.615	38.73
yeast at 2.50g/l + Mix. of Mic	3.04	3.40	6.39	6.77	3.35	3.37	3.360	78.25
New LSD at 5%					0.31	0.40	0.345	

* Mix. of Mic. = Mixture of micronutrients (250 ppm from each of Fe, Mn and Zn sulphate salts)

** Level I = Chlorophyll content at full bloom (before spray).

*** Level I = Chlorophyll content at 4 weeks after the second spray time.

Table 5 : Effect of yeast and some micronutrients foliar application on raceme length, fruits number/cluster and yield/tree of loquat during 1999 and 2000 seasons.

Treatments	Increase in raceme length (%)			Fruit number / cluster at harvest			Fruit yield / tree (kg)		
	1999	2000	Mean	1999	2000	Mean	1999	2000	Mean
Tc = Control	46.75	35.59	41.17	11.0	11.7	11.35	34.65	29.97	32.31
yeast at 1.25g/l	50.81	39.24	45.02	11.1	12.9	12.00	47.39	35.57	41.47
yeast at 2.50g/l	60.25	52.13	56.19	12.8	15.0	13.90	53.40	54.84	54.12
250 ppm Mix. Of Mic. *	61.80	52.47	57.13	12.4	15.3	13.85	53.90	39.36	46.64
yeast at 1.25g/l + Mix. of Mic.	65.95	39.91	52.93	11.9	14.3	13.10	44.91	39.94	42.42
yeast at 2.50g/l + Mix. of Mic.	73.71	58.76	66.23	11.5	14.4	12.95	54.32	52.11	53.21
New LSD at 5%	5.34	5.76	3.65	1.5	0.80	0.90	4.54	3.53	3.58

* Mix. of Mic. = Mixture of micronutrients (250 ppm from each of Fe, Mn and Zn sulphate salts)

high dose of yeast (2.5 g/l) and Mic. mixture, but applying the former one (yeast at high dose) was more effective than yeast at low dose (1.25 g/l) in that respect. A similar trend in case of fruit number/cluster at harvest was recorded under most tested treatments. Moreover, the data presented in the same table showed that all applications of both yeast and Mic. mixture either alone or in combinations had significantly increase in fruit yield/tree when compared with the control (28.4 - 67.5% over the control). The same trend was observed in yield for spraying yeast at the high level (54.12 kg/tree) if compared with the low one (41.47 kg/tree), either alone or in combination with Mic. mixture. Also there were no considered differences in fruit yield/tree between applying yeast solely and it's combinations with Mic. mixture.

C) Fruit quality

1- Physical characteristics

Concerning the behaviour of the physical parameters of treated loquat fruits, data recorded in Table (6) indicated that the combined treatments including yeast and Mic. mixture, in general, gave significantly increment in fruit weight and flesh weight/fruit as compared with either Mic. mixture or with the control. Similar trend was also observed when the same combinations compared with yeast applications solely in weight of both fruit and flesh/ fruit. Also all tested treatments (except yeast at 1.25 g/l) had significantly increase in fruit size when compared with the control. Otherwise, spraying yeast at any used dose did not significantly differ from Mic. mixture treatment in that respect. Although, all tested applications increased seeds number per fruit, they reduced seed weight and therefore cuased increment of flesh weight/fruit comparing with those of the untreated one.

2-Chemical characteristics

The concerned results in Table (7) cleared that TSS in fruit juice as affected by yeast at high dose or Mic. mixture along with their combination had marginal increases over control. While, applying yeast at low dose alone or with Mic. mixture resulted in a significantly higher TSS than those of both yeast at high dose and the control. Data in the same table clearly showed that all tested treatments significantly reduced the acid content in fruit juice (0.37 - 0.47%) compared with control (0.53%). The lowest averages of acid content were recorded by 2.5 g/l yeast (0.40%) and its combination with Mic. mixture (0.37%). On the other hand, all applications induced significantly higher TSS/acid ratio than the cotrol. Concerning vitamin C content in fruit juice (Table 7), spraying yeast at high dose alone or with Mic. mixture produced significantly higher concentration than those of both yeast at 1.25 g/l and Mic. mixture and than that of the contol which did not significantly differ among them.

The results given in Tables (8) emphasized that all foliar applications, except yeast at 1.25 g/l, significantly reduced total reducing sugars in fruit juice (2.78 - 3.16% as a mean) if compared with the control (3.83% as a mean). On the contrary, there were greatly increments in total protein (TP) of fruit as affected by the same foliar applications (6.26 - 11.22g/100g dw.) comparing with the control (4.81g/100g dw.). The superiority was obtained when the tree recived yeast spray at 2.5 g/l which averaged 11.22g of TP/100g dw. of fruit. In addition, both two doses of yeast used gave significantly higher soulble protein in fruit than the control.

Table 6 : Effect of yeast and some micronutrients foliar application on physical characteristics of loquat fruit during 1999 and 2000 seasons.

Treatments	Fruit weight (g)			Fruit size (cm^3)			Seeds number/fruit			Seed weight (g)			Flesh weight/fruit (g)		
	1999	2000	Mean	1999	2000	Mean	1999	2000	Mean	1999	2000	Mean	1999	2000	Mean
Tc = Control	16.91	15.48	16.19	17.84	18.30	18.07	2.63	2.10	2.37	1.05	1.29	1.17	14.15	12.77	13.46
yeast at 1.25g/l	16.58	18.96	17.77	18.58	20.39	19.49	2.61	2.50	2.55	0.97	1.25	1.11	14.05	15.84	14.95
yeast at 2.50g/l	18.14	18.66	18.40	22.05	20.80	21.43	2.85	2.43	2.64	1.16	1.11	1.13	14.83	15.96	15.40
250 ppm Mix. of Mic. *	18.67	15.77	17.22	22.33	20.10	21.22	2.77	2.27	2.52	1.12	1.08	1.10	15.57	13.32	14.45
yeast at 1.25g/l + Mix. of Mic.	19.40	18.94	19.17	21.79	21.50	21.65	3.27	2.62	2.95	1.06	1.01	1.03	16.62	15.64	16.13
yeast at 2.50g/l + Mix. of Mic.	20.19	18.08	19.14	21.49	21.90	21.69	3.22	2.40	2.81	0.97	1.09	1.03	17.07	15.46	16.27
New LSD at 5%	1.24	1.66	1.77	2.40	2.14	0.98	0.45	0.27	0.27	0.14	0.09	0.08	1.30	1.81	1.10

* Mix. of Mic. = Mixture of micronutrients (250 ppm from each of Fe, Mn and Zn sulphate salt).

Table 7 : Effect of yeast and some micronutrients foliar application on chemical characteristics of loquat fruit during 1999 and 2000 seasons.

Treatments	Total soluble solids (TSS%)			Acidity of malic acid (%)			TSS / acid ratio			Vitamin (C) mg/100 juice		
	1999	2000	Mean.	1999	2000	Mean.	1999	2000	Mean.	1999	2000	Mean.
Tc = Control	09.17	10.00	09.59	0.59	0.46	0.53	15.54	21.73	18.64	2.87	1.93	2.40
yeast at 1.25g/l	10.00	11.17	10.59	0.40	0.45	0.43	25.00	24.82	24.91	2.69	1.91	2.30
yeast at 2.50g/l	10.00	10.00	10.00	0.43	0.36	0.40	23.26	27.78	25.52	3.13	2.1	2.61
250 ppm Mix.of Mic.*	09.83	09.67	09.75	0.52	0.38	0.45	18.90	25.45	22.18	2.87	1.95	2.41
yeast at 1.25g/l + Mix. of Mic.	09.83	10.83	10.33	0.49	0.44	0.47	20.06	24.61	22.34	3.13	2.13	2.63
yeast at 2.50g/l + Mix. of Mic.	09.67	09.83	09.75	0.40	0.34	0.37	24.18	28.91	26.55	3.82	2.45	3.14
New LSD at 5%	NS	0.51	0.46	0.06	0.03	0.03	2.75	2.19	1.46	0.17	0.13	0.13

* Mix. of Mic. = Mixture of micronutrients (250 ppm from each of Fe, Mn and Zn sulphate salt).

Table 8 : Effect of yeast and some micronutrients foliar application on reducing sugars of juice and proteins in loquat fruit during 1999 and 2000 seasons.

Treatments	Total reducing sugars (%)			Soluble protein (SP) g/100g dry weight			Total protein (TP) g/100g dry weight		
	1999	2000	Mean	1999	2000	Mean	1999	2000	Mean
Tc = Control	3.84	3.82	3.83	1.80	2.44	2.12	4.50	5.11	4.81
yeast at 1.25g/l	3.75	3.67	3.71	2.44	3.37	2.91	6.42	6.42	6.26
yeast at 2.50g/l	3.08	3.24	3.16	2.62	3.63	3.13	11.62	10.81	11.22
250 ppm Mix. of Mic. *	2.68	2.87	2.78	2.31	2.18	2.25	11.25	10.90	11.08
yeast at 1.25g/l + Mix. of Mic.	3.04	3.21	3.13	1.72	2.27	2.00	11.01	10.32	10.67
yeast at 2.50g/l + Mix. of Mic.	2.92	3.10	3.01	2.62	3.63	3.13	10.81	10.64	10.73
New LSD at 5%	0.36	0.46	0.26	0.62	0.35	0.35	1.13	0.65	0.89

* Mix. of Mic. = Mixture of micronutrients (250 ppm from each of Fe, Mn and Zn sulphate salts)

DISCUSSION

Effect of growth

1. Leaf area, mineral and chlorophyll content

The current data showed that foliar application of yeast or/and Mic. mixture had stimulative effect on leaf area, concentration of minerals (P, Fe, Mn & Zn) and chlorophyll contents of leaves (Tables 2, 3 & 4). Among the treatments, the combination between 2.5g/l yeast and Mic mixture was the most effective. The high level of yeast had more eficiency than the lower level. Such results coincide with those of Ahmed et al., (1997) and Omran (2000) with "Romi Red" grape and Refaat and Balbaa (2001) on lemongrass. The stimulatory effect of yeast application on leaf area could be attributed to its increasing effect on the synthesis of plant growth promoters specially GA_3, IAA and cytokinins which improve cell division and elongation (Tarrow and Nakase, 1975 & Subba Rao, 1984). Mineral constituents of yeast (specially, K and P) are required for synthesis of nucleic acids, ATP and protein as well as formation of membrane lipids which are involved in several bioactivities including leaf expansion. In the same time potassium acts in a complementary manner with reducing sugars to induce the turgor potential required for cell extension (Guardia and Benlloch, 1980). In addition, leaf expansion is strongly related to the extension of epidermal cells and this process might be particularly impaired in phosphorus deficient in plants (Treeby et al., 1987). Moreover, zinc in the used Mic. mixture may be enhances the biosynthesis of IAA which activates cell elongation and thus increases leaf area.

The high level of P, Fe, Mn and Zn in leaves as a result of yeast treatment (Table 2) might be ascribed to the minerals content of yeast or activating biosynthesis of certain growth regulators which transported to the roots, leading to enhancement of nutrients uptake. The superiority of the combined applications (yeast + Mic. mixture) compared with the other tested treatments in that respect confirmed those of Refaat and Balbaa (2001) who found that the highest increment of macro and microelemets content in lemon grass was obtained from the combination of vitamin B_1 and Mic. mixture. Such findings could be attributed to the high content of vitamins in yeast (Nagodawitana, 1991) especially Vit. B which is essential for plant growth and development. Vit. B plays an active role in polar movement of native auxins from the site of their synthesis toward the site of presumed use in roots, and thus nutrients uptake is stimulated (Buchuala and Schimd, 1979). Other suggestion invoke a positive effect of yeast cytokinins content (Ferguson *et al.*, 1987) on cell membrane permeability resulted in more penetration of sprayed minerals into the leaf tissues (Thomas, 1977). Therefore, it is well documented in our study that yeast and micronutrients mixture are senergistic to each other in their uptake.

The obvious increase in chlorophyll contents of the yeast and Mic. mixture treated leaves (Tables 3 & 4) can be interpreted by two functions. At the first, yeast as a source of cytokinins (Ferguson *et al.*, 1987) delays the degradation of chlorophyll via obstructing activity of both chlorophyllase and magnesium-dechelatase enzymes (Langmeier *et al.*, 1993). Secondly, these treatments provide the plant with certain macro and micronutrients which play a direct or indirect role in the biosynthesis of chlorophylls. Yeast can activate magnesium chelatase through providing Mg and P (P is needed for ATP production). This enzyme in turn catalyze insertion of Mg into the prophyrin structure as the first step of chlorophylls biosynthesis (Walker and Weinstein, 1991). In addition, the common precursor of chlorophyll synthesis is α - aminolevulinic acid (ALA), and the rate of ALA formation is controlled by iron (Pushnik and Miller, 1989). Iron (Fe) is also required for the formation of protochlorophyllide from Mg-protophyrin. Furthermore, zinc may be required for chlorophyll production. In that respect, Hu and Sparks (1991) showed that the leaf chlorophyll content of Stuart pecan was adversely affected by zinc deficiency and they suggested that zinc can affect the concentration of nutrients involved in chlorophylls formation or those which are part of the chlorophyll molecule (Fe and Mg).

2. Raceme length

The present results showed a significant increase in raceme length in yeast and Mic. mixture treated trees over the control (Table 5). A similar stimulatory effect of yeast on length of shoot and cluster in grapevine was also observed by El-Mogy et al., (1998) and Omran (2000). This positive effect of yeast could be referred to its content of minerals and cytokinins as well as the activation of GA_3 and IAA synthesis (Tarrow and Nakase, 1975). Meanwhile, such effect play an important role on enhancing cell division and enlargement, consequently a great promotion of vegetative growth was attained.

Effect on yield

1. Fruit number/cluster and yield

The obtained data in Tables (5 & 6) proved a beneficial effect of yeast and Mic. mixture applications on increasing fruits number/cluster, weight and size of fruit along with yield/tree. This increase in yield/tree was mainly due to increasing number of fruits/cluster along with increment of fruit weight. Such result in accordance with those of Ahmed et al., (1997), El-Mogy et al., (1998) and Omran (2000) on grapes and Mansour (1998) on Anna apple. They concluded that foliar or soil drench application of yeast either alone or in combination with mineral nutrients significantly increased fruit set, fruit weight and yield/tree.

2. Fruit quality

The efficiency of yeast and Mic. mixture applications on fruit weight (Table 6) refer to their stimulative effects on leaf area, mineral and chlorophyll contents, which lead to enhancement of photosynthesis and transportation of the produced assimilates to the fruits (specially to the fruit flesh). Wherever, yeast as a source for potassium (Nagodawitana, 1991) activates stomatal regulation, photosynthesis rate, phloem loading and transportation rate of photosynthates from source (leaves) to sink, fruit or other organs (Marschner, 1995). In addition, the flow of electrons required for absorption of light energy (photons) by pigments of two photosystems is derived from the photolysis of water which mediated by a manganese-containing enzyme complex attached to photosystem II (PS II). Cytochromes with their central iron atom also mediate the electron flow between PS II and PS I (Marschner, 1995).

Yeast or/and Mic. mixture treated trees, in general, produced fruits of significantly lower level of the total acidity, slightly higher level of TSS increase and higher value of TSS/acid ratio in the juice, which in turn improve fruit taste. Similar results were reported by Hegab et al., (1997) with Valencia orange and Omran (2000) with "Romi red" grape. The present results also indicated that the combined treatment of yeast at 2.5 g/l and Mic. mixture significantly decreased the acid (%) and total reducing sugars in fruit juice, and simultaneously produced a significant increase in vitamin C content of fruit juice and proteins content in dry fruit flesh

(Tables 7 & 8). These results might due to that yeast as a source of cytokinins (Ferguson *et al.*, 1987) may inhibit protein degradation (Osborne 1962) and also can activate certain hydrolytic enzymes (pyruvate kinase and malate dehydrogenase) are responsible for converting reducing sugars to organic acids. Furthermore, yeast cytokinins content may enhance the conversion of these organic acids (as a carbon skeleton) to new amino acids by activation of transaminase enzymes (El-Dengawy, 1997). Finally , these amino acids were incorporated into protein synthesis. Also, yeast and Mic. mixture are a source of P, Mn and Zn which are required for protein synthesis (Burnell, 1988; Coleman, (1992). The improvement of vitamin C (ascorbic acid) by yeast at 2.5 g/l and Mic. mixture application might be due to stimulating depletion of D-glucose (reducing sugar, a direct precursor of Vit. C) into ascorbic acid biosynthesis (Isherwood and Mapson, 1962).

Referring to the aforementioned results, it could be concluded that spraying loquat trees with combination of yeast (specially at 2.5 g/l) and Mic. mixture (Fe, Mn & Zn sulphate, 250 ppm of each) is recommended to improve vegetative growth, yield and fruit quality.

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الملخص العربى

تأثير الرش الورقى بالخميرة وعناصر صغرى على نمو الأوراق والنورات والمحصول وجودة الثمار فى أشجار البشملة

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أجريت الدراسة فى موسمين متتالين (١٩٩٩ و ٢٠٠٠م)، على أشجار بشملة عمرها ١١ سنة مطعمة على أصل سفرجل ونامية فى تربة رملية . وذلك بهدف دراسة إمكانية تحسين النمو الخضرى والمحصول وجودة الثمار. حيث تم إستخدام محاليل كل من الخميرة النشطة بتركيزين همــا ١,٢٥ و ٢,٥٠ جم/لتر وخليط عناصر صغرى (٢٥٠ جزء فى المليون من كل من الحديد والمنجنيز والزنك) إما منفردة أو فى تداخلات وتم رش المحاليل المذكورة مرتين على الأشجار، وقت التزهير وبعده بسبعة أسابيع.

<u>وتتلخص النتائج المتحصل عليها فى الآتى:</u>

أشجار معظم المعاملات المدروسة أعطت زيادة معنوية مقارنة بالأشجار الغير معاملة فى كل من :

١- مســاحة الورقــة ومحتواها من الكلوروفيل والعناصر المعدنية (فسفور – حديد – منجنيز – زنك).

٢- طول النورة وعدد الثمار بالعنقود عند الحصاد وكذلك كمية المحصول.

٣- صــفات الجودة للثمار (وزن وحجم الثمرة – وزن لحم الثمرة – نسبة المواد الصلبة الكلية الذائبة/الحموضة – فيتامين ج – البروتين الكلى).

- علــى العكــس من ذلك فقد أحدثت كل المعاملات المدروسة نقصا واضحا فى كل من: محــتوى عصير الثمار من السكريات المختزلة الكلية والحموضة الكلية وكذلك متوسط وزن البذرة.
- كمــا إتضح أن رش الخميرة بالتركيز الأعلى (٢,٥٠جم/لتر) كان أفضل تأثيرا مقارنة بالتركيز الأقل (١,٢٥جم/لتر) أو بخليط من العناصر الصغرى.
- وقــد حققت المعاملة المشتملة على الخميرة بالتركيز الأعلى (٢,٥٠جم/لتر) و العناصر الصغرى معا ، أفضل النتائج من حيث تحسين النمو الخضرى (أعلى زيادة فى المساحة الورقــية ومحــتوى الأوراق من العناصر المعدنية والكلوروفيل وأعلى زيادة فى طول الــنورة) ، كمــا أعطت محصولا عاليا (٥٣,٢١كجم/شجرة) وثمارا ذات صفات جودة عالية ، وهذا أدعى للتوصية بتطبيقها.