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EFFECT OF ALGAE EXTRACT AND MONO POTASSIUM PHOSPHATE ON GROWTH AND FRUITING OF BALADY ORANGE TREES

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ABSTRACT

Growth, nutritional status of the trees, yield as well as physical and chemical properties of Balady orange fruits as affected by spraying Algae extract at 0.125 to 0.50% and/or mono potassium phosphate at 0.5 to 2.0%, were investigated during 2002 and 2003 seasons.

Results showed that single or combined applications of Algae extract at 0.125 to 0.50 % and mono potassium phosphate at 0.5 to 2.0 % were effective in improving the leaf area, percentages of N, P, and K in the leaves, yield , fruit weight , total soluble solids% , total and reducing sugars and vitamin C content and in reducing both fruit peel thickness and total acidity % compared to the check treatment. The promotions on growth aspects, nutrient concentrations, yield and fruit quality were associated with increasing the concentrations of each material. Mono potassium phosphate was preferable than Algae extract in improving yield and fruit quality. Meaningless effect on the studied parameters was detected among the two higher concentrations of each material. Combined application of Algae extract and mono potassium phosphate was favourable rather than using each material alone in all the previous parameters.

The best results with regard to yield and fruit quality of Balady orange trees were due to foliar application of Algae extract at 0.25 %

plus mono potassium phosphate at 1.0 %, three times at spring flush cycle start, just after fruit set and at one month later.

Key words: *algae , algae extract, amino acids, blue green algae, compositions of algae extract , cytokinins .*

1. INTRODUCTION

Because of the importance of citrus production in Egypt, it is natural for the citrus growers to be mindful of the factors which may positively influence the productivity such as biofertilization and application of compounds containing K and P nutrients. This study was established for overcoming poor cropping of Balady orange trees grown under the middle Egypt conditions using the biofertilizer Algae instead of auxins for reducing pollution and producing organic fruits.

The Soil Microbiology Section, Soil Water and Environment Research Institute started a series of trials as early as 1960, to study the possibility of using blue green algae (El-Nawawy *et al.*,1958). The promising results of these trials open a new route to further examination of algalization on a somewhat large scale in pomology fields.

Biofertilization is considered an important tool to enhance the yield of citrus trees and recently it became a positive alternative to chemical fertilizers. Biofertilizers are safe for human, animal and environment and using them is accompanied with lowering the great pollution occurred in our environment. Producing organic or healthy citrus fruits was not achieved without using biofertilizers. They may help in improving crop productivity by increasing the biological N fixation, the availability and uptake of nutrients and stimulation of natural hormones. (Subbo Rao, 1984; Abd El-Moumen, 1994, Boutrous *et al.*, 1995a and 1995b; El-Sayed, 1996; Hegab *et al.*, 1997; Abd El-Wahab, 1999; Ebrahiem *et al.*, 2000 and Kannaiyan, 2000).

Algae extract is a biofertilizer having a promotive effect on growth through the secretion of natural hormones (cytokinins, vitamin B_{12} and essential amino acids such as tyrosine and phenylalanine (Venkataraman and Neelakantan , 1963).

Phosphorus is an essential nutrient and it plays an important role in the biosynthesis and translocation of carbohydrates and is

necessary in stimulating cell division and the formation of DNA and RNA (Nijjar, 1985).

Potassium is an essential element in many plant metabolic processes. Inspite, K is not becoming a part of plant compounds, it plays many important regulatory roles in development. The functions of potassium in plants can be outlined under the following main topics.

1.It activates at least about 46 different enzymes involved in plant growth.
2. It regulates the opening and closing of stomata essential for photosynthesis, water nutrient transport and plant uptake.
3. It increases root growth and improves drought resistance.
4. It maintains turgor, reduces water loss and wilting.
5. It reduces respiration and prevents energy losses.
6. It enhances translocations of sugars and starch.
7. It increases protein content of plant.
8. It builds cellulose and reduces lodging.
9. It helps in reducing crop diseases.
10. It improves the shelf life of fruits.
11. Under high K levels, starch efficiently moves from sites of production to storage organs.

Foliar nutrition is suggested to be one of the important fertilization methods for fruit trees to overcome the disadvantages of nutrient application to soil. One of the problems that faces citrus grower is the high leaching of K due to the excessive use of irrigation water(Nijjar, 1985).

The role of K and P on improving growth, nutritional status of the trees, yield and fruit quality of citrus fruits was reviewed by many workers. (Franciosi *et al.* 1985), Mohamed (1991); El-Dawwey and Ahmed (1991); Ebrahiem *et al.*, (1993); Erner *et al.*,(1993); Lavon *et al.*, (1995); Dass and Srivestava (1997); Farahat, (2000) and Abd El-Latief (2002).

Balanced nutrition is defined as the continuous availability of all the essential elements to growing plants, with none in excess and non in deficient amounts. For several decades Nile alluvial soils were considered as rich in potassium and in many sites potassium was removed from the nutritional regime. Exchangeable and non exchangeable potassium are declining at an annoying rate and in most sites crops responded well to K – fertilization. Though, the nutrient

is not balanced with potassium deffecincy in Nile alluvial soils and high addition of nitrogen gives a significant insufficiency for potassium. (Wiebel, 1996).

This study aimed at throwing light on the effects of the biofertilizer Algae extract and mono potassium phosphate on growth and fruiting of Balady orange trees.

2.MATERIALS AND METHODS

This experiment was performed in 2002 and 2003 seasons on thirty uniform vigorous 15 year old Balady orange on sour orange rootstock in a private orchard situated at El-Fashen district , Beni Suef Governorate . The trees were planted at 5x5 meters apart.

The texture of the orchard soil is silty clay. The analysis of the soil (according to Chapman and Pratt , 1961) is shown in Table (1).

Table (1): Analytical data of the tested soil.

Sand %	: 9.0
Silt %	:74.0
Clay %	: 17.0
Texture	Silty clay
pH(1:2.5 extract)	: 8.22
E.C. (1: 2.5 extract) mmhos/cm	: 0.71
O.M. %	: 1.93
Total CaCO3%	: 1.83
Total N %	: 0.10
Available P (ppm. Olsen)	: 11.2
Available K (ppm, ammonium acetate)	: 370.9

The experiment included the following ten treatments:

1. Control (untreated trees).
2. Spraying Algae extract at 0.125 %.
3. Spraying Algae extract at 0. 25 %.
4. Spraying Algae extract at 0.50 %
5. Spraying mono potassium phosphate (MPK) at 0.5 %.
6. Spraying mono potassium phosphate at 1.0 %.
7. Spraying mono potassium phosphate at 2.5 %.
8. Spraying Algae extract at 0.25 % + MPK at 0.5 %.

9. Spraying Algae extract at 0.25 % + MPK at 1.0 %.
10. Spraying Algae extract at 0.25 % + MPK at 2.0 %.

Each treatment was replicated three times, one tree per each. Completely randomized block design was followed. Algae extract and mono potassium phosphate were sprayed three times, when spring flush cycle starts, just after fruit setting and at one month later. Triton B as a wetting agent at 0.05 % was added to all spraying solutions and each tree was sprayed with these solutions till run off. The treated trees received the basal fertilizers of 4.0 kg ammonium sulphate (20.6% N) as well as 600 g of calcium superphosphate (15.5 $\%P_2O_5$) and 600 g of potassium sulphate (48 % K_2O) per each. Regular horticultural practices were carried out as usual.

Samples of twenty mature leaves 7-month old (Nijjar, 1985) were selected from fruiting shoots of the spring growth cycle (1st week of September) to measure their area (cm^2) according to Ahmed and Morsy (1999). Leaf contents of N, P and K (as percentages) were determined by the method of Chapman and Pratt (1961), where all calculations were carried out on dry weight basis.

Table (2): Composition of algae extract.

Inorganic Matter			Organic Matter		Growth Regulators	
Essential major elements: (macro-nutrients)			Protein	8%	Adenin (cytokinins)	0.02%
			Carbohydrates	35%	Indole acetic acid	0.03%
Total nitrogen	N	1.5%	Alginic acid	20%	Indole butyric acid	0.01%
Phosphorus	P	0.05%	Mannitol	7%	Betaines	0.04%
Potassium	K	1.0%				
Calcium	Ca	1.0%				
Sulphur	S	9%				
Magnesium	Mg	0.9%				
Copper	Cu	6 ppm				
Iron	Fe	200 ppm				
Manganese	Mn	12 ppm				
Boron	B	100 ppm				
Zinc	Zn	100 ppm				
Molbdenum	Mo	5 ppm				

At commercial harvesting date (2nd week of November) and when T.S.S./acid exceeded 8:1, the yield of each tree was recorded (kg). Samples of 20 fruits were taken from each replicate for

measuring their weight (gm) and peel thickness (cm by vernier caliper). The following characters were also determined in the juice (according to A.O.A.C., 1985):-

1. Total soluble solids % by Galleleo handy refractometer.
2. Total and reducing sugars % by using Lane and Eynon procedure.
3. Total acidity %, (expressed as g citric acid per 100 ml juice) by titration with 0.1 N of NaOH using phenolphthalein as an indicator.
4. Vitamin C content (as mg 100 ml juice) by the use of 2,6 dichloro phenol endophenol method.

The obtained data were statistically analyzed according to Snedecor and Cochran (1980) using L.S.D. parameter for comparing the differences between the studied treatment means.

3. RESULTS AND DISCUSSION

3.1. Leaf area and NPK leaf content

It is clear from the data in Tables (3 & 4) that a single or combined application of Algae extract at 0.125 to 0.50 % and mono potassium phosphate at 0.5 to 2.0 % significantly increased the leaf area and its content of N, P and K compared to the control. The increment was associated with increasing Algae extract and mono potassium phosphate concentrations. Combined application of Algae extract and mono potassium phosphate was favorable for stimulating the leaf area and its content of N, P and K rather than using each material alone. Insignificant effect on such growth and chemical characters was observed among the two higher concentrations (between 0.25 and 0.50 % for Algae extract and between 1.0 and 2.0 % for mono potassium phosphate). The maximum values were detected on the trees sprayed with 0.25% Algae extract plus 2.0% mono potassium phosphate. The untreated trees recorded the minimum values. These results are in agreement with those obtained by Abd El-Moumen (1994) who showed that fertilization with phosphorus and magnesium gave the best results with regard to fruit quality of Balady orange trees. Similarly, El-Sayed (1996) demonstrated that the addition of mycorrhizal fungi to the soil improves the absorption and available phosphorus in the soil. Recently, Ebrahiem *et al.* (2000) worked on biofertilizers and proved that foliar sprays with different forms and concentrations of potassium

in sandy soil produced favorable fruit quality and enhanced yield. Moreover, Farahat (2000) who worked on nutrition of Washington Navel orange trees, reported that potassium and phosphorus increased leaf area and its contents of N, P and K. Other workers proved that fertilization of Balady mandarin with some macro and micro nutrients increased the yield (Mohamed,1991& El-Dawwey and Ahmed, 1991).

3.2.Yield / tree

It is clear from the data in Table (4) that spraying Algae extract at the rate of 0.125 to 0.50 and / or mono potassium phosphate at 0.5 to 2.0 % improved significantly the yield of Balady orange trees compared to unspraying ones. The increment of the yield was associated with increasing the concentrations of each material. Spraying the trees with mono potassium phosphate at 0.5 to 2.0 % was preferable in increasing the yield than using Algae extract. Raising the concentrations of Algae extract from 0.25 to 0.50 % and mono potassium phosphate from 1.0 to 2.0 % had a slight and insignificant effect on the yield. Spraying both materials together was favourable in improving the yield than using each alone. The maximum yield (73.9 and 78.3 kg in both seasons, respectively) was obtained on the trees that received three sprays of Algae extract at 0.25 % plus mono potassium phosphate at 1.0 % , since non-significant increase in the yield was obtained by using the same previous treatment and the treatment of Algae extract at 0.25 % + mono potassium phosphate at 2.0 % . The untreated trees recorded the minimum values (56.2 and 60.1 kg in both seasons). These results were the same in both seasons.

The results of Hegab *et al.*(1997) showed that spraying Valencia orange trees by active dry yeast at 0.25 to 0.75 either once on March or August or twice at both dates was favorable in improving growth, fruit set and the number of fruits, yield as well as fruit weight and volume while reduced June drop percentage. Also, Abd El-Wahab (1999) who worked on biofertilizers recorded that foliar spraying with magnesium, boron and vitamins B compounds increased vegetative and fruiting characters of Washington Navel oranges. Mohamed (1991) showed that the fertilization with some macro and micro nutrients on Balady mandarin was preferable in increasing the yield. El-Dawwey and Ahmed (1991), and Ahmed and El-Dawwey (1992)

Table (3): Effect of spraying Algae extract and mono potassium phosphate on leaf area (cm^2), and some mineral contents of Balady orange leaves (%) during 2002 and 2003 seasons.

Treatment	Leaf N %		Leaf P %		Leaf K %	
	2002	2003	2002	2003	2002	2003
Control	1.62	1.69	0.12	0.13	1.10	1.08
Algae extract at 0.125 %	1.69	1.79	0.16	0.16	1.18	1.15
Algae extract at 0.25 %	1.79	1.89	0.20	0.19	1.25	1.23
Algae extract at 0.50 %	1.80	1.91	0.21	0.20	1.26	1.24
Mono potassium phosphate (MPK) at 0.5 %	1.89	1.98	0.24	0.24	1.33	1.32
Mono potassium phosphate at 1.0 %	1.96	2.10	0.28	0.27	1.41	1.40
Mono potassium phosphate at 2.0 %	1.97	2.12	0.29	0.28	1.42	1.41
Algae extract at 0.25% + (MPK) at 0.5 %	2.10	2.23	0.31	0.33	1.48	1.48
Algae extract at 0.25% + (MPK) at 1.0 %	2.22	2.31	0.35	0.36	1.53	1.57
Algae extract at 0.25% + (MPK) at 2.0 %	2.23	2.32	0.36	0.37	1.54	1.58
L.S.D. at 5 %	0.04	0.05	0.03	0.02	0.05	0.06

Table (4): Effect of spraying Algae extract and mono potassium phosphate on yield / tree (kg) and some physical fruit properties of Balady orange during 2002 and 2003 seasons.

Treatment	Leaf area (cm^2)		Yield / tree (kg)		Fruit weight (gm)		Fruit peel thickness (cm.)	
	2002	2003	2002	2003	2002	2003	2002	2003
Control	36.6	37.0	56.2	60.1	110.0	118.2	0.33	0.35
Algae extract at 0.125 %	37.8	38.5	58.9	62.8	118.0	127.0	0.30	0.33
Algae extract at 0.25 %	39.0	40.0	62.3	65.3	125.0	135.9	0.30	0.32
Algae extract at 0.50 %	39.3	40.3	62.5	65.5	125.5	136.0	0.29	0.32
Mono potassium phosphate (MPK) at 0.5 %	40.8	41.8	65.0	68.0	133.0	145.0	0.29	0.32
Mono potassium phosphate at 1.0 %	42.0	43.0	67.9	71.0	141.0	154.0	0.29	0.32
Mono potassium phosphate at 2.0 %	42.3	43.2	68.0	71.2	142.0	155.0	0.29	0.32
Algae extract at 0.25% + (MPK) at 0.5 %	44.0	45.8	71.0	75.5	149.9	164.0	0.29	0.32
Algae extract at 0.25% + (MPK) at 1.0 %	45.5	48.2	73.9	78.3	157.5	168.0	0.28	0.32
Algae extract at 0.25% + (MPK) at 2.0 %	45.8	48.5	74.2	79.0	158.0	168.5	0.28	0.32
L.S.D. at 5 %	1.1	1.3	1.9	2.0	7.0	8.0	0.02	0.02

Table (5): Effect of spraying Algae extract and mono potassium phosphate on some chemical fruit properties of Balady oranges during 2002 and 2003 seasons.

Treatment	Reducing sugars %		Total sugars %		T.S.S. %		Total acidity %		T.S.S. / AC		Vitamin C (mg 100 ml juice)	
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
Control	3.11	3.20	7.20	7.40	11.20	11.30	1.201	1.202	9.33	9.40	48.2	46.9
Algae extract at 0.125 %	3.30	3.40	7.50	7.70	11.40	11.50	1.160	1.170	9.83	9.83	49.9	48.9
Algae extract at 0.25 %	3.45	3.60	7.85	8.00	11.80	11.75	1.122	1.130	10.52	10.40	51.2	51.0
Algae extract at 0.50 %	3.50	3.64	7.90	8.10	11.85	11.80	1.100	1.127	10.77	10.47	51.3	51.2
Mono potassium phosphate (MPK) at 0.5 %	3.80	3.92	8.20	8.60	12.20	12.40	1.060	1.091	11.51	11.37	52.5	52.8
Mono potassium phosphate at 1.0 %	4.25	4.15	8.50	8.82	12.50	12.65	1.030	1.060	12.14	11.93	53.6	54.0
Mono potassium phosphate at 2.0 %	4.30	4.18	8.60	8.85	12.55	12.70	1.027	1.057	12.22	12.02	53.8	54.3
Algae extract at 0.25% + (MPK) at 0.5 %	4.55	4.40	9.00	9.10	13.25	13.00	0.970	1.026	13.66	12.67	55.0	55.6
Algae extract at 0.25% + (MPK) at 1.0 %	4.80	4.50	9.25	9.30	13.50	13.50	0.940	0.994	14.36	13.58	56.2	57.2
Algae extract at 0.25% + (MPK) at 2.0 %	4.83	4.52	9.30	9.33	13.55	13.55	0.938	0.991	14.45	13.67	56.3	57.5
L.S.D. at 5 %	0.11	0.12	0.22	0.19	0.15	0.18	0.030	0.028	0.048	0.035	1.0	1.2

supported the previous results, as the application of potassium nitrate and phosphorus on Balady orange trees increased the yield and fruit quality.

3.3. Physical and chemical properties of the fruits

It is evident from the data in Tables (3, 4& 5) that spraying Algae extract at 0.125 to 0.50 % and mono potassium phosphate at 0.5 to 2.0 % either singly or in combinations significantly improved fruit quality in terms of increasing fruit weight, total soluble solids %, total and reducing sugars % and vitamin C content and in reducing fruit peel thickness and total acidity % and total soluble solids / acid ratio compared to unspraying. Increasing the concentration of both materials was followed by a gradual increment in fruit quality. Fruit quality was significantly affected in response to the application of mono potassium phosphate rather than from using Algae extract. A slight promotion in fruit quality was detected by using the two higher concentrations of each material. Combined application of Algae extract with mono potassium phosphate was superior in improving fruit quality than using each alone. Foliar fertilizing with a mixture containing Algae extract at 0.25 + mono potassium phosphate at 1.0 % gave the best results with regard to fruit quality of Balady orange trees, since no material promotion was observed when using 1.0 and 2.0 % mono potassium phosphate. The untreated trees produced unfavorable fruit quality. Similar trends were detected in both experimental seasons. These results are in accordance with those obtained by Abd El-Moumen (1994); Hegab *et al.* (1997); Abd El-Wahab (1999) and Ebrahiem *et al.* (2000) who used biofertilizers and Mohamed (1991); El-Dawwey and Ahmed (1991); Ahmed and El-Dawwey (1992); Lavon *et al.* (1995) and Abd El-Latif (2002) who worked on P and K.

The previous beneficial effects of P and K on growth , yield and fruit quality were attributed to their vital role in stimulating both cell division as well as the biosynthesis and translocation of organic foods in favour of enhancing growth and fruiting of the trees(Nijjar , 1985). The positive action of biofertilizers in supplying the trees with elements especially N, vitamins, natural hormones and antibiotics could result in stimulating growth and make a good balance between it and fruiting (Subbo-Rao , 1984).

As a final conclusion, supplying Balady orange trees three times *via* foliage with 0.25 % Algae extract plus 1.0 % mono potassium sulphate is suggested for improving the nutritional quality of the tree and subsequently increasing the yield and fruit quality.

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تأثير مستخلص الطحالب وفوسفات البوتاسيوم الأحادية على النمو والاثمار فى البرتقال البلدى

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ملخص

أجرى هذا البحث في حديقة خاصة بمركز الفشن – محافظة بني سويف حيث تمت دراسة تأثر النمو والحالة الغذائية والمحصول لاشجار البرتقال البلدى والخصائص الطبيعية والكيميائية لثمار البرتقال البلدى برش مستخلص الطحالب بتركيز من ٠,١٢٥ الى ٠,٥ % ومركب فوسفات البوتاسيوم الأحادية من ٠,٥ – ٢ % إما بصورة فردية أو بصورة مشتركة وذلك خلال موسمى٢٠٠٢ / ٢٠٠٣.

أشارت نتائج الدراسة الى أن الاستخدام الفردى او المشترك لمستخلص الطحالب بتركيز ٠,١٢٥ – ٠,٥ % أو مادة فوسفات البوتاسيوم الأحادية بتركيز ٠,٥ – ٢ % كان فعالا فى تحسين مساحة الورقة والنسبة المئوية للنيتروجين والفوسفور والبوتاسيوم فى الأوراق، كمية المحصول، وزن الثمرة، النسبة المئوية للمواد الصلبة الذائبة الكلية والنسبة المئوية للسكريات الكلية والمختزلة، ومحتوى الثمار من فيتامين C وتقليل كل من سمك قشرة الثمار، النسبة المئوية للحموضة الكلية وذلك بالمقارنة بعدم الرش.

وكان التحسن فى مساحة الورقة، وتركيز العناصر، المحصول وجودة الثمار مرتبطا بزيادة التركيز المستخدم من كل مادة ولقد تفوق استخدام مادة فوسفات البوتاسيوم الأحادية عن مستخلص الطحالب فى تحسين المحصول وخصائص الجودة، وكان التأثير طفيفا على الصفات تحت الدراسة ما بين التركيزين الأعلى من كل مادة، وكانت التوليفة المشتركة منهما مفيدة مقارنة بالاستخدام الفردى لأى منهما على كل الصفات السابقة.

أمكن الحصول على أفضل النتائج من المحصول وخصائص الجودة فى أشجار البرتقال البلدى عند الرش الورقى لمستخلص الطحالب بتركيز ٠,٢٥ % مع مادة فوسفات البوتاسيوم الأحادية بتركيز ١% ثلاثة مرات فى بداية دورة نمو الربيع ، بعد العقد مباشرة ثم بعد العقد بشهر.

المجلة العلمية لكلية الزراعة - جامعة القاهرة - المجلد (٥٦) العدد الأول (يناير ٢٠٠٥):١٠٧-١٢٠.