Qatar Univ. Sci. J. (1994), 14 (2): 293-297

EFFECT OF "ETHREL" ON COLOUR DEVELOPMENT AND JUICE QUALITY OF SWEET ORANGES AND GRAPEFRUITS

By

S. A. AZAB* and A. M. A. ISMAIL**
* Department of Agricultural and Water Research, Doha, Qatar
** Department of Botany, Faculty of Science, University of Qatar, Doha, Qatar

تأثير « الايثريل » على تلوين وصفات العصير في ثمار البرتقال والجريب فروت

سـعيد أحمـد عـزب و أحمد محمد علي اسماعيل

تم رش اشجار البرتقال والجريب فروت بتركيزات صفر ، ١٢٠ ، ٢٤٠ ، ٤٨٠ جزءاً في المليون من مادة الايثريل في مرحلة اكتمال نمو الثمار وذلك لبيان تأثير هذه المعاملات على التلوين وصفات العصير . ولقد وجدت استجابات معنوية في تغير لون ثمار البرتقال أكثر منها في ثمار الجريب فروت . أما بالنسبة للصفات العصيرية فقد تحسنت معنوياً في ثمار البرتقال ولم يتضح أي تغير معنوي في حالة ثمار الجريب فروت .

وقد أوضحت الدراسة أن أفضل معاملات مادة « الايثريل » لتحسين اللون وصفات العصير في ثمار البرتقال تحت ظروف منطقة الخليج هي رش بتركيزات ١٢٠ أو ٢٤٠ جزءاً في المليون وذلك لتجنب تساقط الأوراق الواضح في حالة التركيز الأعلى (٤٨٠ جزء في المليون) .

Key Words: Ethrel, sweet orange, grapefruit, fruit colour, juice quality.

ABSTRACT

"Ethrel" was sprayed at 0, 120, 420 and 480 ppm on sweet orange and grapefruit trees at fruit maturity stage to improve colouring and juice quality. Changes in fruit colour were observed in both varieties but the results were more conspicuous with oranges than with grapefruits. Following treatment juice quality of oranges was improved significantly, while the effect on grapefruits was not clear. It can be recommended that spraying with "Ethrel" at 120 or 240 ppm on orange trees under the Gulf area conditions may have a profound effect on fruit colouring and juice quality, and may even evade the excessive defoliation resulting from spraying with the highest concentration (480 ppm).

INTRODUCTION

The agroclimatic conditions are the most important factors, in addition to soil management, in affecting ripening and colour development in citrus fruit. The standard natural colour in sweet orange was obtained at night time air temperature of 7°C, day time temperature of 20°C and a soil temperature of 12°C during maturation. This points out that an increase in temperature of one of the above mentioned variables resulted in fruits with less orange colour [1]. However, under subtropical conditions particularly when citrus fruits mature under dry conditions with cool night temperatures, brightly coloured fruits are obtained [2]. When the fruits are at the maturity stage, in the State of Qatar, the minimum air temperature at night, day time and soil are 18°, 23° and 20°C respectively [3]. These temperatures are not suitable for the development of normal orange colour with good fruit quality.

The present investigation was carried out to test the possibility of improving fruit colour by spraying "Ethrel" on vegetative

shoots of sweet orange and grapefruit trees. The fruit juice quality was also evaluated under different treatments.

MATERIALS AND METHODS

This experiment was carried out on sweet orange "*Citrus sinesis* (L) Osbeck" and grapefruit "*Citrus paradisi* Mac." trees located in a private farm in the northern region of the State of Qatar. The trees were 15 years old, grown on sour orange rootstock and planted 5 meters apart in calcareous clay soil. They were sprayed on November 10, 1992 and 1993 with "Ethrel" (2-chlorethyl phosphonic acid) from Amchem. Product Inc., Agriculture Chemicals Division at concentrations of 120, 240 and 480 ppm. The control trees were sprayed with water. At this time the fruits were in mature green stage. A complete randomized design was arranged where each treatment was represented by 6 trees. The fruits were harvested on November 15 and the chemical properties of the juice were determined. Reducing sugars, non-reducing sugars and ascorbic acid (Vitamin C) were determined spectophotometrically using a Technicon Auto Analyzer [4], while titratable acidity was estimated by sodium hydroxide titration. The total soluble salts (TSS) were measured by Zeiss Abbe refractometer Model-A, while sodium and potassium by flame photometer. Iron and manganese were determined using an Atomic Absorption Spectrophotometer [5]. Statistical analysis (ANOVA) was carried out as described earlier [6].

RESULTS AND DISCUSSION

1. Colour development

With an increase in Ethrel concentration, colour development appeared on 14th November in both seasons (Fig. 1a, b) and visually defoliation was clearly apparent. This may be related to the disappearance of chlorophyll, and the increment of carotenoid pigments in the peel. It is possible that Ethrel might have stimulated the activation of enzymes leading to the development of abscission layer in the leaves [7]. The ethylene released from Ethrel enhances cellulase synthesis in the abscission zones of many plants, and appears to be an important factor involved in abscission and subsequent fall of leaves [8]. Thus post-harvest treatment with Ethrel appears to have some advantage over the pre-harvest spray since it eliminated any possible reactions that might occur to the tree from excessive defoliation [9].

Based on respiration (mg CO_2/kg-hr at 5°C) and ethylene production rates (mC_2 H_2/kg-hr 20°C), which significantly affected colour development and ripening process, citrus fruits were classified as having low (5-10) and very low (<0.1) respiration rate and endogenous ethylene production respectively [10]. For these reasons as well as the unsuitable agroclimatic conditions in some citrus cultivated regions, especially at the time of colour differentiation stage, the application of a variety of ethylene releasing chemicals[Ethrel, Alsol, Hydrel, CMNP, Cycloheximide, Salaid, Figaran, benzophenone (N, N-diethylamino) ethoxy and Inshuzhi either as pre-harvest spray (200-500 ppm) or post harvest treatment (500 - 2000 ppm) have proved beneficial in obtaining the standard orange and/or lime colour or degreening in some citrus fruits ([2, 8, 11-19]). The treatment with ethylene is usually made at the start of a harvest season when the fruits are in an advanced maturity stage [20]. There is evidence that ethylene accelerates chlorophyll degradation through the enhancement of chlorophyllase activity [21].

2. Fruit juice quality

A perusal of the fruit juice quality parameters (Table 1) indicates that total, non-reducing sugars and TSS percentages were increased significantly following treatment with Ethrel. At higher concentrations of Ethrel a significant increase was observed in reducing sugars. In contrast the citric content in the juice was reduced significantly due to 120 and 480 treatments of Ethrel, but was insignificantly reduced with 240 ppm in the first season, while in the second season a slight reduction was obtained. Generally TSS/acid ratio increased due to Ethrel treatments. The increment was found to be more related to an increase in TSS percentage than to citric acid content. As compared to control ascorbic acid decreased as a result of Ethrel treatment, although the values obtained were inconsistent in the two seasons. Ethrel treatment did not affect sodium and manganese levels (Table 1), but potassium was increased, and iron level decreased significantly in the fruits treated with the two higher concentrations (240 and 480 ppm) of Ethrel.

The effect of Ethrel on juice quality of grapefruit (Table 2) showed that while the level of reducing sugars decreased except with the intermediate concentration (240 ppm) which gave a significant increase, the non-reducing sugars decreased only with the highest concentration (480 ppm), and increased slightly with the others. Following Ethrel treatment no effect was observed on TSS percentage inspite of the increment in TSS/acid ratio. The ascorbic acid content was also not affected, except with 240 ppm which caused a significant increase.

The effect of Ethrel on juice mineral content showed that potassium content generally increased, but there were no effects on sodium and manganese. On the other hand iron increased significantly with the highest concentration only (Table 2).

Ethylene is known to affect respiratory acceleration and starch conversion [22 and 23]. It also caused a reduction in the activities of citrate-condensing enzymes-more in green orange peel and pulp than in the ripe orange [24]. Possibly by activating the enzymes involved in starch metabolism, it reduces the acidity, which in turn could be ascribed to a fall in mitochondrial activities [25].

Total soluble salts (TSS) percentage was increased and fruit quality and flavour were improved in mandarin (CV. Bendizao) due to Figaran sprays at a range of 50-400 ppm [26], while the acidity was reduced in table grapes "Emperor" by etherphon treatments [27]. Recently Figaran (ethylchlozate) treatment has been reported to advance sugar content and improve fruit quality during storage [19] in "Manju" mandarin.

The increase in potassium content of juice (Table 1 and 2) may be due to the activation centre of the carbohydrate enzyme system by potassium. Hirai [28] suggested a major role of NADP - malic enzyme in decreasing acid during ripening of citrus fruits. This may also decrease other acids such as ascorbic acid.

Fig. 1: Fruit colour development in response to "Ethrel" treatments (A) sweet oranges (B) grapefruits.

Table 1
Quality of orange fruit juice as affected by "Ethrel" Sprays in 1992 & 1993 Season

Treatments	Reducing Sugars (%)	Non reducing sugars	Total Sugar (%)	T.S.S. %	Acidity (%)	T.S.S./Acid Ratio	V.C. mg/ 100 ml Juice	Mineral (ppm)			
								Na	K	Fe	Mn
					1992						
120 ppm	7.3	7.7*	15.0*	15.5*	0.38*	40.8*	41.1	17.0	2600	0.50	0.17
240 ppm	7.3	6.7*	14.0*	14.5*	0.42	34.5*	50.7	18.0	2800*	0.30*	0.09
480 ppm	8.1*	8.1*	16.2*	16.3*	0.36*	45.3	41.1	16.5	2900*	0.30*	0.15
Control	6.7	1.3	8.0	8.5	0.50	16.0	48.0	18.0	2500	0.61	0.14
L.S.D. (P=0.05)	1.2	4.6	5.8	5.5	0.09	16.0	N.S.	N.S.	275	0.27	N.S.
					1993						
120 ppm	7.6	7.5*	15.1*	15.8*	0.48	32.9*	44.1	15.0	2500	0.58	0.14
240 ppm	7.7	7.0	14.7*	15.0*	0.49	30.6	48.2	17.0	2900*	0.40*	0.15
480 ppm	8.48	8.2*	16.6*	16.7*	0.46	36.3	46.0	16.0	2800*	0.30*	0.15
Control	7.0	1.8	8.8	9.0	0.60	15.0	45.0	16.0	2500	0.57	0.15
L.S.D. (P=0.05)	1.1	4.7	5.6	5.8	N.S.	16.0	N.S.	N.S.	250	0.14	N.S.

* Significantly differs from the control.

Table 2
Quality of grapefruit juice as affected by "Ethrel" Sprays in 1992 & 1993 Seasons

Treatments	Reducing Sugars (%)	Non reducing sugars	Total Sugar (%)	T.S.S. %	Acidity (%)	T.S.S./Acid Ratio	V.C. mg/ 100 ml Juice	Mineral (ppm)			
								Na	K	Fe	Mn
					1992						
120 ppm	4.6	7.6	12.2	12.3	1.6	7.5	38.5	17.0	2600*	0.32	0.12
240 ppm	5.1*	7.8	12.9	13.0	1.6	8.0*	46.6*	16.0	2600*	0.45	0.07*
480 ppm	4.2	6.2*	10.4	10.4	1.5*	6.9	32.3	19.0	2600*	0.86*	0.11
Control	4.4	7.4	11.8	11.8	1.7	7.0	34.4	17.5	2300	0.34	0.13
L.S.D. (P=0.05)	0.6	1.1	N.S.	N.S.	0.1	0.7	9.2	N.S.	225	0.41	0.04
					1993						
120 ppm	4.4	7.8	12.2	13.0	1.7	7.6	40.2	18.0	2600	0.38	0.14
240 ppm	5.2*	7.9	13.1	13.2	1.8	7.3	47.0*	17.0	2600	0.44	0.11
480 ppm	4.3	6.3	10.6	11.5	1.4*	8.2*	35.0	19.0	2600	0.70*	0.13
Control	4.0	7.5	11.5	12.0	1.8	6.7	39.8	17.0	2400	0.40	0.14
L.S.D. (P=0.05)	0.5	N.S	N.S	N.S	0.1	1.2	5.1	N.S.	N.S.	0.30	N.S.

* Significantly differs from the control.

It is concluded that spraying with Ethrel at 120 or 240 ppm on orange trees under the Gulf area conditions has a profound effect on fruit colouring and juice quality, and may evade the excessive defoliation resulting from spraying with the high concentration (480 ppm).

ACKNOWLEDGEMENTS

The authors would like to express their heartfelt thanks to Mr. M. Al-Faihani, Assistant Undersecretary of the Ministry of Municipal Affairs & Agriculture for his constructive criticism, Mr. Kyaw Nyein, UNV-Computer Programmer for his help in statistical analysis and Mr. Kumar, typist for typing the manuscript. Our thanks are also extended to the distinguished referee who deciphered most of our experimental observations.

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