DEGREENING AND REDUCING BERRY SHATTER OF THOMPSON SEEDLESS GRAPES BY USING SAFE AGRICULTURAL CHEMICALS

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ABSTRACT

Berry color is one of the main fruit attributes that affect the marketability of Thompson seedless grapes. Yellowish berries are more desired by consumers especially at the beginning of the season. Consumers in many European countries have been demanding yellowish berries of "Thompson" seedless grapes. Ethrel was found to enhance the breakdown of chlorophylls and the formation of carotenes. However, Ethrel spray on Thompson grapes caused berry pinkishnes, loss of acidity and increased berry shatter. In this study, some safe chemicals, that have been already used in agriculture, were sprayed to increase yellowish-colored berries. Treatments included EDTA alone or bound with either Cu, Zn, K in addition to diluted sulphuric acid, copper sulphate, potassium sulphate, zinc sulphate and the control (water spray). All treatments were applied to the run off at a concentration 0.05% (w/v). The non-ionic surfactant Tergitol (at 0.1%, v/v) was added to all treatments. Bunches were harvested ten days after spray for the determination of some physical and chemical characteristics. Another group of bunches were exposed to precooling then stored at 1.0°C for 55 days for the assessment of berry shatter. The data revealed that various treatments did not significantly affect fruit weight or length while some reduced juice volume such as zinc sulphate, Zn EDTA, potassium sulphate, K EDTA and diluted sulphuric acid when compared with the control. Berry shatter after cold storage was not, generally, affected except with Cu EDTA that caused an increase in such shatter as compared with the control especially in the first season. Total soluble solids in the berries increased significantly by some treatments such as zinc sulphate, Zn EDTA and diluted sulphuric acid in both seasons. Furthermore, Zn EDTA caused a significant increase in carotenes in the berry skin without a significant change in chlorophylls a and b in both seasons. The present study provided evidence about the possibility of utilizing some already used agricultural chemicals for other purposes such as accelerating yellowish color formation of grape berries by Zn EDTA.

INTRODUCTION

Thompson seedless is on of the most demanded grape cultivars for consumers in Egypt and many other countries. Berry color at harvest is an important quality attribute that affects marketability. Consumers are attracted to yellowish "Thompson" seedless grapes especially at the beginning of the marketing seasons. Some European countries have been demanding yellowish berries of such cultivars as in England and Greece with balanced total soluble solids to acidity. Moreover, reduction of berry shatter is a main concern for grape exporters and importers. Enhancing berry quality must take into consideration such shatter. Wet shatter of Thompson would enhance the infection by gray mold caused by *Botrytis cinerea*. Ethrel (ethephon) is an ethylene-releasing compound that enhances the breakdown of chlorophylls and formations of carotenes but caused berry pinkishness, loss of acidity and increased berry shatter (Nelson, 1985). On the other hand, sulphur-containing compounds are known to stimulate chlorophyllase acidity which leads to higher rate of chlorophyll breakdown (Musselman *et al.,* 1985).

Furthermore, the chelating agent EDTA either alone or with other nutrients were found to stimulate ethylene production in plant tissues (Cooper *et al*., 1968) while potassium has been reported to increase fruit size. This size was reported to be in proportion to the percentage of potassium in the tissue (Ryugo, 1988).

Thus, the objectives of this study were to investigate safe means that enhance the degreening of Thompson seedless grapes or increase carotene content by preharvest treatments without increasing berry shatter after cold storage. It was also aimed at enhancing fruit quality parameters which would reflect on better marketability and higher export opportunities.

MATERIAL AND METHODS

This study was carried out during the two successive seasons 1996 and 1997 using "Thompson" seedless grapevines grown in private orchard at Sadat city. Grape vines were healthy, uniform, free of defects and seven years old. Vines were grown in sandy soil and under fertigation system, cane pruned and the trellis system was in Y shape. Grapevines were sprayed to the run off using a hand sprayer. Treatments included: the control (water), EDTA, Cu sulphate, Cu EDTA, Zn sulphate, Zn EDTA, Potassium Sulphate, potassium EDTA, diluted sulphuric acid (all mentioned treatments were used at 0.05%(w/v). The non-ionic surfactant Tergitol at 0.1% (v/v) was added to all treatments. Vines were sprayed on June 11 in both seasons.

Berry diameter at the spray time was about 14-15 mm. Bunches were harvested after ten days of spray and five bunches were randomly selected per each replication for the determination of various fruit parameters at harvest. Four vines represented four replications per each treatment. Another group of five bunches per replication was exposed to the standard practices before cold storage. Bunches were transferred to the packing line, defected berries were sorted out, packed, exposed to precooling then stored at 1.0°C and 85% RH for 55 days. Packing was done in carton boxes by using perforated plastic bags.

At harvest, various physical and chemical characteristics were determined. A random sample of 40 berries was taken from the bunches of each replication. These berries were used to determine berry weight, berry length and diameter and juice volume. Total soluble solids were determined by using a hand refractometer, titratable acidity by titration against NaOH (A. O. A. C., 1984), chlorophylls a, b and carotenes

by the method of Wintermann and Mots (1965). Shattered berries in stored grapes were weighed at the end of cold storage. Magnitude of such shatter was expressed as percentage of the initial weight of the bunch at the initiation of cold storage. The design of the experiment was completely randomized with 4 replications (each vine represented one replication) per treatment. Statistical analyses were performed by using Costat computer software and the least significant difference at 0.05 level was used to compare the means.

RESULTS AND DISCUSSION

The data in Table 1 indicated to the effect of various treatments on some physical characteristics of "Thompson" seedless grapes at harvest and percentage of berry shatter after cold storage. The data revealed that fruit weight was not significantly influenced by all treatments when compared with the control in both seasons except with CuSO4 in the second season that resulted in a significant increase in fruit weight. Similar trend of results was found when fruit length of various treated berries was compared with the control since non of the treatments were able to significantly change fruit length in both seasons.

Fruit diameter values had inconsistent trend in both seasons. The general trend was a tendency to a reduction in fruit diameter by various used chemicals.

With regard to juice volume of the berries at harvest, the data in Table 1 indicated to a significant reduction caused by many treatments in both seasons such as Zinc sulphate, Zn EDTA, potassium sulphate, potassium EDTA, and diluted sulphuric acid. However, treatments such as EDTA, Cu EDTA and Cu sulphate in both seasons were not consistent in the magnitude of such reduction in juice volume when compared with the control in both seasons but also tended to reduce juice volume.

On the other hand, berry shatter after cold storage was not affected by most treatments when compared with the control. However, Cu EDTA resulted in a significant increase in berry shatter in the first season and tended to cause higher shatter than the control and many other treatments such as zinc sulphate and potassium EDTA in the second season.

Responses of chemical characteristics of Thompson seedless grapes were shown in Table 2. The data indicated to a significant increase in TSS by zinc suphate , Zn EDTA or diluted sulphuric acid when compared with the control. Berries treated with either the chelating agent EDTA alone or Cu EDTA did not vary in their TSS content in both seasons. Moreover, the three chelated nutrients, namely Zn EDTA, Cu EDTA, and potassium EDTA, resulted in similar TSS in the berries in a consistent manner.

Fruit acidity was not generally affected by various treatments in both seasons. Even in the berries sprayed with diluted sulphuric acid which did not significantly vary in their juice acidity when compared with the control. Regarding the changes in TSS to acidity ratio (Table 2) in response to the treatments, it was found that Zn sulphate caused a consistent increase in such ratio in both seasons as compared to the control. This increase could be mainly attributed to the increase in TSS rather by the change in acidity as reported above. Moreover, there was a general trend of a similar TSS to acidity ratio caused by Cu EDTA, K EDTA, Potassium sulphate or even diluted sulphuric acid and the control.

Chlorophylls a and b in the berry skin were not significantly influenced by various treatments when compared with the control. However, there was a general trend of lower chlorophyll values by almost all treatments than that obtained by the control. Furthermore, carotenes in the skin of berries took a different trend. It was found that Zn EDTA treatment resulted in a significant increase in carotenes when compared with the control in both seasons. However, other chelated nutrients such as Cu EDTA or potassium EDTA did not significantly vary from that found with Zn EDTA in skin carotenes.

The present study represented an attempt to degreen "Thompson" seedless grapes by using safe chemicals, that have been already used in agriculture for other purposes. The rate of chlorophyll loss was found to be influenced by various plant hormones where cytokinins, gibberellins and light retarded chlorophyll loss, whereas ethylene and ABA accelerated the loss of chlorophyll (Lipton, 1987). Thus, some chemicals which were reported to stimulate ethylene production were used in this study in an attempt to accelerate the loss of chlorophyll or to increase carotene content in grape berries skin. One of these chemicals was copper that was used in the form of copper sulphate. It was found by Rousos *et al*., (1986) that when cabbage leaf disks were floated (adaxial side up) in copper sulphate solutions (0, 0.16 and 0.40 mM) for 1 – 4 days in light, total chlorophyll, chlorophyll a and chlorophyll b and the ratio of chlorophyll a / b declined linearly with increasing exposure duration and Cu^{2+} concentrations.

In this study, even though most treatments resulted in a general trend of higher carotene content in the skin, but the consistent and significant effect on increasing carotenes in the berry skin was obtained with the use of Zn EDTA. Thus, further study might be needed to try using more than one spray to increase the efficacy of those treatments that tended to reduce chlorophylls and increase carotenes but in a nonsignificant way. Furthermore, Zn EDTA is not expensive, and could increase Zn content in the vine which prevent the formation of shot-green berries (Christensen *et al*., 1978). Moreover, Zn EDTA treatment resulted in a significant increase in TSS, TSS to acidity ratio but reduced juice volume. It was also found that EDTA was able to stimulate ethylene production in many fruit tissue and increased the efficacy of auxins in inducing fruit abscission (Cooper *et al*., 1968).

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Table 1. Some physical characteristics at harvest and percentage of berry shatter of "Thompson" seedless grapes after cold storage as influenced by preharvest treatments of safe chemicals during the two seasons 1996 and 1997.

Treatments	Fruit Weight (40 berries) (gm)		Fruit Length (cm)		Fruit Diameter (cm)		Juice Volume (cm^3)		Berry Shatter (%)	
	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997
Control	99.67* a	101.50 b	1.92 ab	1.88 a	1.53 a	1.41 bc	48.0 a	43.00 ab	1.62 b	2.10 ab
EDTA	98.27 a	112.70 ab	2.04 a	1.99 a	1.40 ab	1.47 ab	40.67 ab	34.67 bc	1.73 b	0.56 b
Cu SO_4	97.33 a	133.57 a	1.83 ab	2.10 a	1.44 ab	1.56 a	29.67 bc	49.33 a	2.09 ab	2.63 ab
Cu EDTA	86.73 a	97.53 b	1.74 ab	1.83 a	1.38 b	1.40 bc	23.33 c	30.67 bcd	4.73 a	4.29 a
Zinc sulphate	73.70 a	86.63 b	1.66 b	1.84 a	1.32 b	1.38 bc	22.00 c	28.00 cd	2.83 ab	1.03 b
Zn EDTA	98.60 a	89.57 b	1.80 ab	1.80 a	1.41 ab	1.37 bc	27.00 c	20.00 d	0.912 b	2.30 ab
Potassium sulphate	88.23 a	88.20 b	1.68 b	1.86 a	1.33 b	1.39 bc	20.33 c	27.00 cd	2.38 ab	2.42 ab
K EDTA	88.77 a	90.50 b	1.75 ab	1.83 a	1.37 b	1.40 bc	23.00 c	22.67 cd	2.18 ab	1.34 b
Diluted sulphuric acid	98.00 a	98.53 b	1.88 ab	1.82 a	1.41 ab	1.32 c	26.67 c	29.67 cd	1.38 b	2.89 ab

* Values, within a column, of similar letters were not significantly different according to using the least significant difference (LSD) at 0.05 level to compare the means.

Table 2. Some chemical characteristics of "Thompson" seedless grapes at harvest as influenced by preharvest treatments of safe chemicals during the two seasons 1996 and 1997.

Treatments	TSS (%)		Acidity (%)		TSS/Acidity (%)		Chlorophyll A (mg/100g)		Chlorophyll B (mg/100g)		Carotenes (mg/100g)	
	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997
Control	16.40* c	17.73 de	1.30 abc	1.31 b	12.69 b	13.65 bc	0.325 a	0.266 bc	0.312 ab	0.230 b	0.135 b	0.154 b
EDTA	17.40 bc	15.93 f	1.35 abc	1.49 a	12.97 b	10.78 d	0.239 a	0.297 b	0.145 b	0.199 b	0.337 ab	0.199 b
Cu SO_4	18.20 abc	16.67 ef	1.35 abc	1.39 ab	13.57 ab	12.01 cd	0.313 a	0.420 a	0.402 a	0.442 a	0.399 ab	0.237 b
Cu EDTA	17.33 bc	17.53 def	1.32 abc	1.37 ab	13.10 ab	12.77 bcd	0.420 a	0.275 bc	0.304 ab	0.317 ab	0.252 ab	0.862 ab
Zinc sulphate	19.33 ab	20.93 a	1.25 bc	1.25 b	15.53 a	16.95 a	0.284 a	0.195 bc	0.225 b	0.220 b	0.326 ab	0.437 ab
Zn EDTA	19.20 ab	18.93 bcd	1.38 abc	1.36 ab	13.90 ab	13.92 bc	0.249 a	0.204 bc	0.265 ab	0.207 b	1.560 a	1.216 a
Potassium sulphate	18.07 abc	19.67 abc	1.41 ab	1.49 a	13.00 b	13.24 bc	0.224 a	0.260 bc	0.268 ab	0.152 b	0.574 ab	0.926 ab
K EDTA	19.00 ab	18.13 cde	1.22 c	1.36 ab	15.54 a	13.38 bc	0.216 a	0.170 c	0.147 b	0.207 b	0.290 ab	0.857 ab
Diluted sulphuric acid	19.93 a	20.20 ab	1.43 a	1.37 ab	13.93 ab	14.75 ab	0.272 a	0.238 bc	0.144 b	0.165 b	0.878 ab	0.321 ab

* Values, within a column, of similar letters were not significantly different according to using the least significant difference (LSD) at 0.05 level to compare the means.

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الملخص العربى

إزالة اللون الأخضر وتقليل فرط حبات العنب البناتى تومسون باستخدام كيماويات زراعية آمنة

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يعتبر لون الحبات أحد الخصائص الهامة التى تؤثر على تسويق العنب البناتى تومسون. هناك طلباً متزايداً على حبات العنب المصفرة من هذا النوع خاصة فى بداية الموسم، كذلك هناك طلباً لبعض المستهلكين فى دول أوربية للعنب التومسون المصفر الحبات. ولقد وجد أن مركب الإيثريل يمكن أن يسرع من إزالة اللون الأخضر للحبات ويزيد من تكوين الكاروتينات لكن يسبب تكوين خطوط وردية أو محمرة على الحبات ويؤدى لنقص الحموضة ويزيد من فرط الحبات فى ذلك الصنف. تم فى هذه الدراسة استخدام بعض الكيماويات الزراعية التى تستخدم فعلياً فى مجال زراعة الفاكهة، وقد اشتملت المعاملات على استخدام المركب المخلبى EDTA وحده أو مرتبطاً مع النحاس أو الزنك أو البوتاسيوم بالإضافة لاستخدام حمض الكبريتيك المخفف، كبريتات النحاس، كبريتات البوتاسيوم، وكذلك الكنترول (رش الماء)، وتم رش كل المعاملات حتى نقطة الجريان السطحى وكانت كلها بتركيز 0.05٪ (وزن إلى حجم) مع استخدام المادة الناشرة ترجيتول (بتركيز 0.1٪ حجم إلى حجم)، وقد تم جمع العناقيد بعد عشرة أيام من الرش لتقدير بعض الصفات الطبيعية والكيماوية، كذلك حفظت عينة أخرى على درجة 1°م لمدة 55 يوماً بعد إجراء التبريد الأولى لها وذلك لتقدير نسبة فرط الحبات. أوضحت النتائج عدم تأثير المعاملات المختلفة على وزن أو طول الثمار بينما أدى بعضها لخفض نسبة العصير بالحبات مثل معاملات كبريتات الزنك والزنك المخلوب بواسطة EDTA وكبريتات البوتاسيوم، والبوتاسيوم المخلوب بواسطة EDTA ، وحمض الكبريتيك المخفف وذلك بالمقارنة مع الكنترول، ولم تتأثر نسبة فرط الحبات بصفة عامة، بواسطة المعاملات المختلفة ما عدا فى حالة استخدام Cu EDTA والذى أدى إلى زيادة الفرط بعد التخزين المبرد خاصة فى الموسم الأول. أدت بعض المعاملات لحدوث زيادة معنوية فى نسبة المواد الصلبة الذائبة فى كلا الموسمين مثل معاملات كبريتات الزنك، Zn EDTA وحمض الكبريتيك المخفف. كذلك أدى رش Zn EDTA إلى حدوث زيادة معنوية فى محتوى جلد أو قشرة الثمار من الكاروتينات دون حدوث تغير معنوى فى محتواها من كلوروفيل أ ، ب . مما سبق فقد أثبتت تلك الدراسة أنه يمكن الاستفادة ببعض الكيماويات الزراعية لتحقيق أغراض أخرى مفيدة مثل إسراع اصفرار حبات العنب البناتى تومسون بمعاملة مثل Zn EDTA.