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Effect of GA and CCC on physical and chemical changes in seedless grapes under cold storage conditions

by

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Einfluß von Gibberellinsäure und CCC auf physikalische und chemische Veränderungen bei samenlosen Trauben während der Kühllagerung

Zusammenfassung. — Es wurde der Einfluß der Wachstumsregulatoren Gibberellinsäure (GS) und CCC auf physikalische und chemische Veränderungen von samenlosen Traubenbeeren während der Kühllagerung untersucht. 50 ppm GS wurden 1 Woche nach der Vollblüte gesprüht. Bei einer anderen Behandlung wurden je 50 ppm GS 3 Wochen vor der Blüte sowie 7 Tage später + 500 ppm CCC 1 Woche vor der Blüte + 50 ppm GS 1 Woche nach der Vollblüte appliziert. Nach allen Behandlungen zeigte sich während der Kühllagerung (90 Tage) eine Verminderung der Beerengröße, die bei den GS-behandelten Trauben am deutlichsten war. Der Anteil an gesamter löslicher Trockensubstanz (TSS) sowie an Gesamtsäure im Beerensaft nahm während der Lagerung zu. Dies dürfte auf einen Wasserverlust zurückzuführen sein, was dadurch bestätigt wird, daß die Menge an Säuren und TSS je Beere während der Lagerung nahezu konstant blieb. Hinsichtlich einer Verfärbung des Beereninneren während der Kühllagerung werden weitere Untersuchungen vorgeschlagen.

Introduction

In recent years plant growth regulators have been established as possible aids in the cultural practices of viticulture. For example, GA was used to increase berry size and decrease berry set, while CCC-application[1]) results in decrease of berry size and increase of berry set (Considine and El-Zeftawi 1971). The response of the seedless grapes varied with concentration of the growth regulator used and the stage of development when treated.

There have been few reports on the effect of these growth regulators on the changes in fruits of "Thompson Seedless" grapes during cold storage (Pool *et al.* 1972, Rizk *et al.* 1974), which might be used for its significance for shipping under marine refrigeration, extending the market period and for relieving suitable market congestion.

In view of this observation it was decided to study the changes that occur during the cold storage of "Thompson Seedless" grape berries previously treated with growth regulators. GA[2]) and CCC were applied to improve the quality of the seedless berries. The study in this work is dealing with the effect of cold storage only.

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[1]) CCC: 2-chloroethyl trimethyl ammonium chloride.

[2]) GA: Aqueous solutions of GA_3, obtained from commercial source, Berilex, ICI Company, was used.

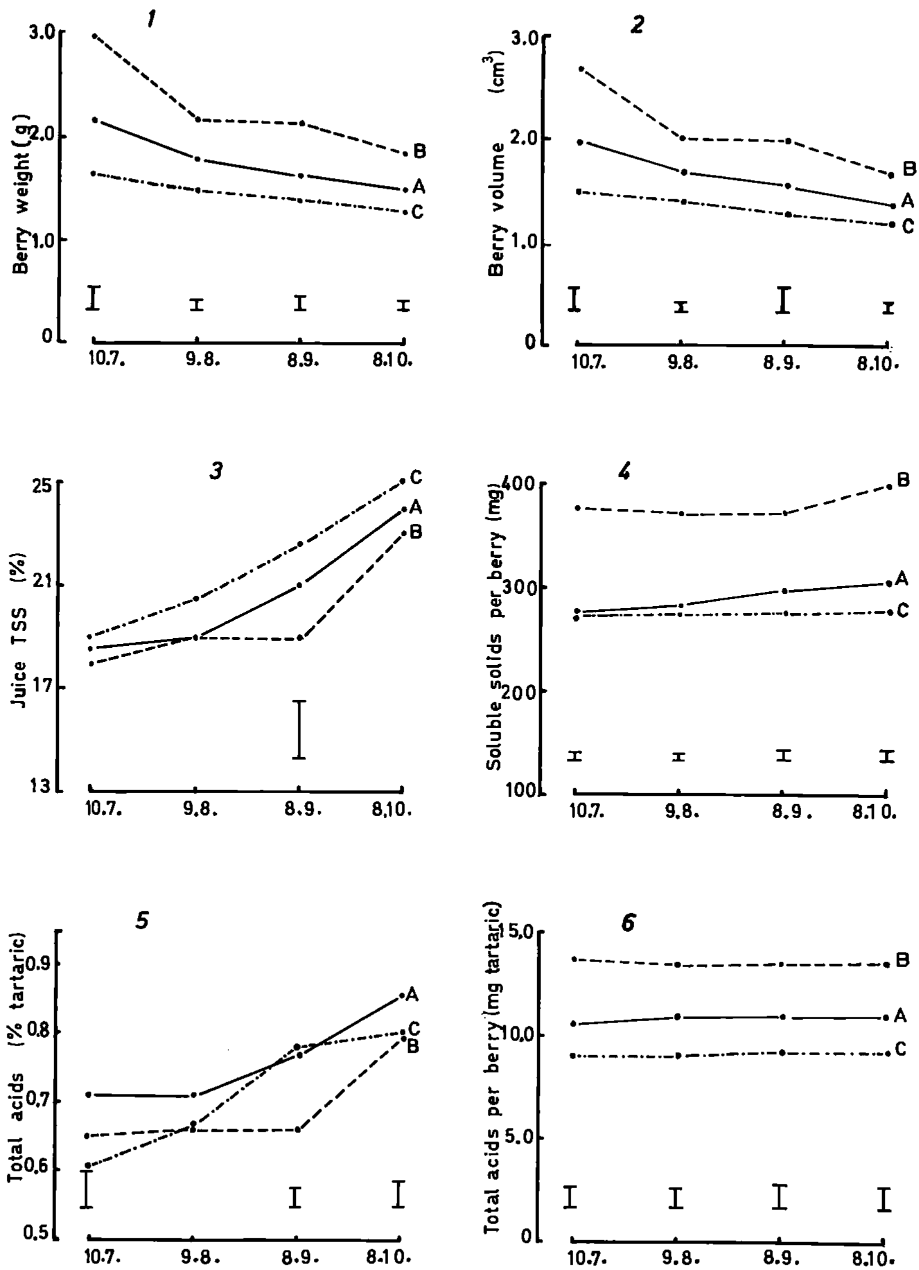

Fig. 1—6: Changes in the berry characters during cold storage. — 1: Berry weight. 2: Berry volume. 3. Concentration of soluble solids in the berry juice. 4: Total amount of soluble solids per berry. 5: Concentration of total acid in the berry juice. 6: Amount of total acid per berry. — A: Control, B: GA 50 ppm, C: 2 × GA 50 ppm + CCC 500 ppm + GA 50 ppm. — Significance level P = 5%.

Veränderungen der Beerenmerkmale während der Kühllagerung. — 1: Beerengewicht. 2: Beerenvolumen. 3: Konzentration der löslichen Substanzen im Beerensaft. 4: Gesamt-

Materials and methods

Mature vines of Thompson Seedless (syn. Banaty) grown in an irrigated vineyard near Cairo named Abo Rgela were used. The seedless variety was head-trained and pruned usually to 7 spurs. In the treatments, clusters were thoroughly wetted with 1.5 l test solution per vine. All sprays contained 0.1% Triton as a wetting agent. Treatments were applied on 4 vines × 3 replicates in randomized blocks. The treatments used were:

A : control (no spray)
B : GA at 50 ppm one week after full bloom
C (1) : GA 50 ppm three weeks before bloom and then repeated after one week, to elongate the rachis as to reduce the compactness
(2) : CCC 500 ppm one week before bloom to increase berry set
(3) : GA 50 ppm one week after full bloom to increase berry size

15 kilograms were obtained at harvest from 12 vines of each treatment. Fruits were firstly fumigated with SO_2 and stored at 0 °C and 90% ± 2% relative humidity. The fumigation was repeated monthly. Weight and volume of 200 berries from each treatment were monthly determined in duplicate. Total acidity expressed as tartaric acid and percentage of total soluble solids were determined in the expressed juice. Soluble solid content and total acid amount per berry were calculated.

Results and discussion

At harvest and before storage, the effect of growth regulators on berry size (weight and volume) was clear in all treatments (Figs. 1 and 2). The increase in berry size for the given concentration of GA was the greatest, while the combined application of GA and CCC reduced the berry size greatly. The additive response of berry size to combined application of GA and CCC can be reconciled to current theories of the mode of action of CCC. The application of CCC one week before bloom depressed the cell division in the first and second phase of berry development, particularly CCC-residual effect lasted about 21 days. This result differs from that obtained by Considine and El-Zeftawi (1971) who used another cultivar, less concentration and different timing for application.

During the cold storage period (90 days) all treatments caused a significant decrease in berry size (volume and weight, Figs. 1 and 2). Maximum decrease was recorded after 30 days of storage. GA-application was found to be more effective in this respect (26.6% reduction in berry size). The co-application of GA and CCC showed the minimum decrease in berry weight (10% reduction) after 30 days of storage. The decrease in berry weight during storage may be mainly due to water loss. The higher rate of moisture loss in the GA-treated fruits may have been due to the higher percentage of free water compared with the fruits of the other treatments and also may reflect the changes in the physical characters of membranes especially at the end of the storage period.

On the other hand, CCC-treated fruits showed the minimum loss in weight, which could be attributed to a minimum decrease in water loss rate. This result may

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menge der löslichen Substanzen je Beere. 5: Konzentration der Gesamtsäure im Beerensaft. 6: Gesamtgehalt der Gesamtsäure je Beere. — A: Kontrolle, B: 50 ppm GS, C: 2 × 50 ppm GS + 500 ppm CCC + 50 ppm GS. — Signifikanzschwelle P = 5%.

be due to higher percentage of hydrophilic colloidal and osmotic substances as sugars, protein ... etc. (LINSER *et al.* 1965; KULL 1972) in the CCC-treated fruits.

All treatments showed a slight increase in the concentration of total soluble solids during 60 days under cold storage (Fig. 3). However, the concentration of TSS increased greatly at the end of the storage period in all treatments. This result is in agreement with the finding of POOL *et al.* (1972). Maximum increase was recorded by the combined application of GA and CCC, while the GA-treated fruits showed the minimum percentage of TSS. This increase in TSS percentage may be due to water loss. In terms of total soluble solid content per berry, the reverse was true and the larger GA-treated berries had more soluble solids than the smaller berries resulting from the GA and CCC treatment. However, the TSS amount per berry was nearly constant during the storage period (90 days) in the individual treatments (Fig. 4).

Before storage, untreated fruits contained higher concentration of total acids than the treated fruits. During storage all treatments showed an increase in acidity with time of storage. This increase was obvious after 60 days except for the GA-treated fruits, which were increased after 90 days.

At the end of the storage period (90 days), GA-treated fruits contained minimum acidity percentage compared with the other treatments (Fig. 5). The apparent increase in total acidity could be attributed to gradual water loss during storage. This was obvious from the fact that the total amount of acids per berry remained nearly constant or slightly increased during the storage period (Fig. 6). The total acid content per berry in the GA-treated fruits was the highest because of their larger size.

POOL *et al.* (1972) found that the malate content per berry increased during 30 days of cold storage. These investigators attributed the rise of malate content to the dark fixation of CO_2 by carboxylating enzymes. MEYNHARDT (1965) and HAWKER (1969) revealed that malic acid is the main product synthesized in the berry and the reaction is catalyzed by phospho-carboxylase. This finding might interprete the slight increase of total acid content per berry under cold storage.

The effect of cold storage on the TSS-acid ratio is summarized in the table. The ratio increased in all treatments during the cold storage. Maximum increase was attained by the additive treatment (GA and CCC).

An internal browning of fruits was also observed during the cold storage. The first appearance of this discoloration was noticed by the growth regulator treatments after 60 days and by the untreated fruits at the end of cold storage period. Hence, the growth regulators might accelerate the discoloration of fruits. Our ob-

Changes in ratios of TSS/acids during the cold storage
Veränderung des Verhältnisses gesamte lösliche Trockensubstanz/ Säure während der Kühllagerung

Treatment	Before storage	After storage
A: control	26.1	27.9
B: GA 50 ppm	27.7	29.1
C: 2 × GA 50 ppm + CCC 500 ppm + GA 50 ppm	30.6	31.3

servation stands in contrary with the findings of Pool *et al.* (1972) who detected the internal browning after 30 to 58 days in the cold stored fruits. More research is needed to interprete this point.

Summary

The effect of the growth regulators GA and CCC on physical and chemical changes in seedless grape fruits under cold storage conditions was studied. GA 50 ppm was sprayed one week after full bloom. The other treatment was as follows: GA 50 ppm 3 weeks before bloom and then repeated after 7 days + CCC 500 ppm one week before bloom + GA 50 ppm one week after full bloom. All treatments caused a decrease in berry size during the cold storage period (90 days). Maximum decrease was attained by GA-treated fruits. TSS and total acidity percentages of juice increased with time of storage, which might be attributed to water loss. This is concluded from the result that the amount of acids and TSS per berry remained nearly constant during the cold storage period. Concerning an internal discoloration of the cold stored fruits, more work is suggested.

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