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INCREASING 'HASS' AVOCADO FRUIT SIZE BY CPPU AND GA APPLICATION

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Abstract

The main limiting factor to 'Hass' avocado production is the high rate of undersized fruits. Small fruits could be identified already from time of set. The length/diameter ratio was lower for the small fruits. GA3 have been applied in order to elevate this ratio and to improve fruit size. Fruit length and diameter were increased, L/D ratio was elevated and significant higher rate of fruits was suitable for export in response to GA application on the whole tree and on individual twigs as well. Different pH of the spraying solution as modified by BB-5 and L-77 surfactants did not affect the GA activity. However the rate of the fruit size improvement was not consistent. CPPU has been proved to improve fruit size of some fruit crops. It was assumed that this compound strengthen directly the fruit sink. 'Hass' fruit size was significantly increased and accordingly much more fruits were suitable for export following the CPPU application on the whole tree. The fruit size increment was evident at various fruit number per tree. The use of antitranspirant Antistress showed a positive effect on fruit size. The precise conditions for optimizing the activity of the used bioregulating chemicals should be more elaborated.

Additional index words:

antitranspirant, cytokinin, fruit quality, *Persea americana* , plant growth regulator, surfactant.

1.Introduction

The main limiting factor to 'Hass' avocado (*Persea americana*) production is the high rate of undersized fruits. Small fruits could be identified already from time of set (Zilkah and Klein, 1987). The length/diameter ratio was lower for the small fruits (Greene, 1991, Zilkah and Klein, 1987). GA has been found to induce elongation (Jones, 1979; Curry and Williams, 1983, Buban et al., 1993) and to improve fruit size of some crops (Christodoulou, 1968; Facteau et al., 1992; Takagi et al., 1993; Wolf and Loubser, 1992). Therefore GA application aimed to elevate L/D ratio and hence to improve avocado fruit size.

CPPU (N-(2-chloro-4-pyridyl)-N-phenylurea) has a cytokinin like activity. Foliar treatment of this compound caused increase of fruit size (Antognozzi and Proietti, 1995; Blank et al., 1992; Iwahori et al., 1988; Tartarini et al., 1993). Young 'Hass' avocado fruits dipped in CPPU

developed into larger fruits (Köhne and Schutte, 1991). However, when the whole tree was treated with CPPU the effect on fruit size was not definite (Köhne et al., 1993). The small fruit problem is more profound when avocado trees are grown under warm conditions. At those conditions the content and composition of cytokinins in fruits were different from fruits grown at cool conditions (Cutting, 1993).

The objective of the present presentation was to examine the effect of GA_3 and CPPU on avocado fruit size.

2. Materials and methods

1990 experiment (Table 1) - GA_3 (10% a.i. in Pro-Gibb commercial product of CZT Co., Israel) was sprayed with gun sprayer, 10 liters per tree, in concentrations of 0, 100, 200 and 400 ppm, on 11 years old 'Hass' avocado trees. The solution contained 0.04% L-77 surfactant. Five replicates of single trees were sprayed, in a completely randomized block design. 30-50 fruits were randomly sampled, tagged and numbered. The application was carried out at the beginning of fruit set (14 May) and on 4 June, when fruitlets were stabilized after the first wave of abscission. The fruit measurements and weight were calculated for the same fruits (Zilkah and Klein, 1987). The fruit dimensions (average of the 4 treatments) of the first measurement (M1) at 4 June, 1990 were 34.4 +03 mm, 22.9+0.3 mm, and 12.3+0.7 g for length, diameter and calculated weight, respectively. Added growth (%) was calculated as (M2-M1)/M1. M2 values were taken from measurement of 27 July.

1992 experiment (Table 2, Figs. 1, 2) - Five replicates of single tree were sprayed with a gun sprayer, 17 liters per tree, in a completely randomized block design. The spraying solutions were: 1- 200 ppm GA_3, 0.15% BB-5 surfactant (CZT Co., Israel). 2- 10 ppm CPPU (Forchlorfenuron, was cordially donated by Agan Co., Israel), 0.1% B-1956 surfactant. 3- 3% of the antitranspirant Anti-stress (Polimer AG Inc. USA), 0.15% BB-5 surfactant. Triple applications of each compound were carried out on 18 June, 23 July and 27 August. The harvest was on 26 Jan., 1993. Fruits per each tree were weighed and counted. Fruits for each treatment were sorted in packinghouse for size and quality.

Effect of pH/surfactant on GA activity (Table 3) - Comparison has been made between spraying solution containing 200 ppm GA_3 and 0.04% L-77 surfactant to solution containing the same GA concentration in addition to 0.45% BB-5 surfactant. The pH was 7.4 and 5.8 for the L-77 and BB-5 solutions, respectively. 25-40 twigs of 60 cm in length were sprayed for each treatment. Each twig bore only a single fruit. Double applications of each solution were carried out on 3 July and 5 July, 1990. All fruits in the experiments were measured (length and diameter) in several time-points along their development. The presented data (Table 3) taken from the last measurement of 26 December, 1990. Percent added growth (see above) was calculated only for fruits that had the first and the last measurements.

3. Results and discussion

The effect of GA_3

Several approaches could be taken for improving fruit size. Selective pickings (Lahav and Atsmon, 1979), fruit thinning (Köhne and Schutte, 1991) and application of bioregulating chemicals (Looney, 1993).The approach of using GA based on the previous finding that small fruits of 'Hass' differ from the larger fruit in their reduced length/diameter ratio (Zilkah and

Klein, 1987). The gape in L/D ratio was distinguished shortly after fruit set. GA was applied in order to stimulate the fruit elongation.

Growth of the same fruits were determined between 2 time-points of fruit development (Table 1). Growth was calculated as added growth relative to the initial fruit size. By this kind of accurate measurements variability could be reduced. At that measured period the fruit length was increased in a higher rate than the diameter. Fruit growth in all the GA treatments was in a higher rate than control fruits. This was true for all measured and calculated parameters. There was an insignificant tendency of inducing more the length rather than the diameter growth. Accordingly, the ratio of added L/added D was higher for the GA treatments compared to the control. The 200 ppm GA treatment was more efficient (Table 1).

When the whole fruits per tree were weighed and counted, the average fruit weight of the GA treatment was not significantly different from that of control (Table 2). Nevertheless, the percentage of the GA treated fruits that were not suitable for export (<133 g) was almost half of that of the control fruits (Fig. 1). Addition of 17.2% of the yield to export, as a result of the GA treatment, has a significant economic advantage.

The efficiency of GA treatment for increasing fruit size probably depends on parameters of timing, concentration, environmental and tree conditions. All these parameters probably have some impact on GA uptake into the different plant tissues and organs. One of the means that found advantageous in increasing GA efficiency is the higher acidity of the spraying solution (Shulman et al., 1987). The comparison between the lower (BB-5) and the higher (L-77) pH solutions of GA showed no significant different between them (Table 3). Both solutions showed a meaningful increase in length and diameter dimensions. The added L/D ratio was higher in the treated fruits compared to control fruits. The difference of 32% in length growth between GA treated and untreated fruits was not statistically significant. Although the presented results show a solid tendency that could support the original hypothesis of the GA potentiality to increase fruits, undoubtedly that more factors have to be studied and determined for optimizing the GA treatment efficiency.

The effect of CPPU

CPPU as a cytokinin like hormone found to strengthen sinks (Blank et al., 1992; Neri et al., 1993; Sugiyama et al., 1993) that eventually resulted in fruit size increment some fruit crops such as kiwifruit (Iwahori et al., 1988) apple (Biasi et al., 1993), loquat (Takagi et al., 1994) and grapes (Reynolds et al., 1992). Dipping 'Hass' fruits into CPPU solution caused stimulation of fruit size growth, fact that supports the hypothesis of sink-strengthening. Avocado might be problematic in fruit growth response due to the close competition between the vegetative and the reproductive sinks in determinate inflorescences. Therefore, timing of CPPU application should be in particular important for avocado. Triple application of CPPU to the whole tree caused a significant increase of fruit weight (Table 2). In principle, fruit size could be increased also due to a low bearing fruits per tree. When fruit size was plotted as function of fruit number per tree, the CPPU treated fruits were larger than the control fruits for various yield level on tree (Fig. 2). The significant effect of CPPU on the average fruit weight (Table 2) was well expressed in the amount of fruits that were unsuitable for export (Fig. 1). The CPPU treated fruits were only 1/3 of the amount of low-quality control fruits.

It was hypothesized that improvement of water balance in fruits might improve fruit size. Application of the antitranspirant Antistress showed some improvement (Table 2, Fig. 1). This treatment should be examined in combination with the effect of bioregulating chemicals.

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Table 1. The effect of GA_3 on length and diameter growth of 'Hass' avocado fruits.

Treatment	Application date	Added growth (%)			
		Length	Diameter	Calculated wt. (g)	ΔL/ΔD
Control		111	92	481	1.21
% of control		100	100	100	100
100 ppm	14.5	128	97	595	1.32
% of control		115	105	124	109
200 ppm	4.6	141	111	686	1.27
% of control		127	121	143	105
400 ppm	4.6	130	105	568	1.24
% of control		117	114	118	102

Table 2. Effect of CPPU and GA_3 on avocado 'Hass' fruit size.

	Fruit wt. (g)	% of control	Fruits/tree	Kg tree
Control	131+3	100	584+25	77+4
CPPU (10 ppm X 3)	160+4	122	435+92	66+12
GA3 (200 ppm X 3)	139+6	105	454+134	60+9
Antistress	142+8	108	481+83	69+14

Table 3. The effect of pH solution/surfactant on GA3 activity on length and diameter growth of 'Hass' avocado fruits.

Treatment	Added growth (%)		
	Length	Diameter	ΔL/ΔD
Control	66+2.7	65+2.6	1.03+0.03
% of control	100	100	100
BB5	84+11.6	72+6.5	1.15+0.09
% of control	127	111	112
L-77	87+11.0	77+7.2	1.12
% of control	132	118	109

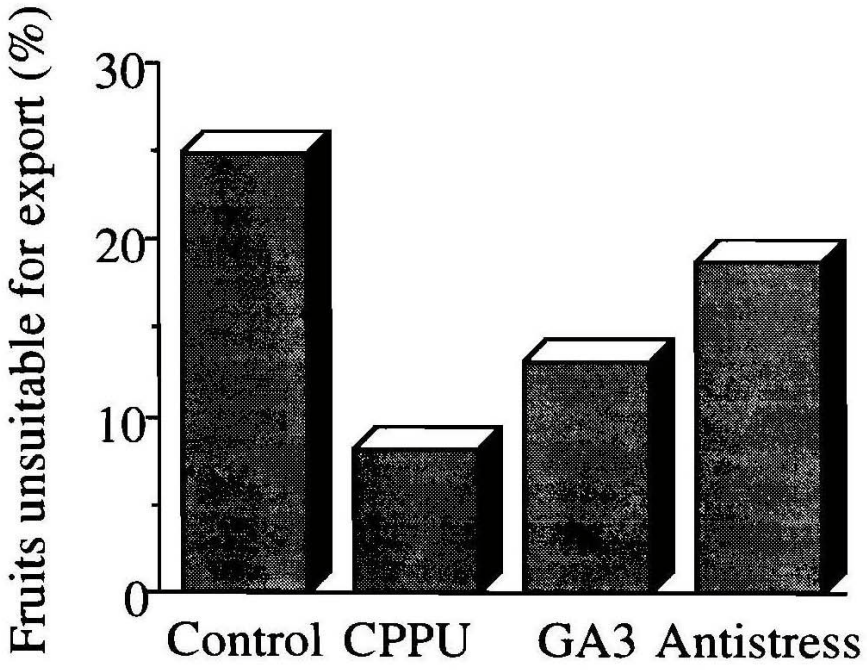

Figure 1. Effect of CPPU, GA_3 and Antistress on 'Hass' fruits unsuitable for export.

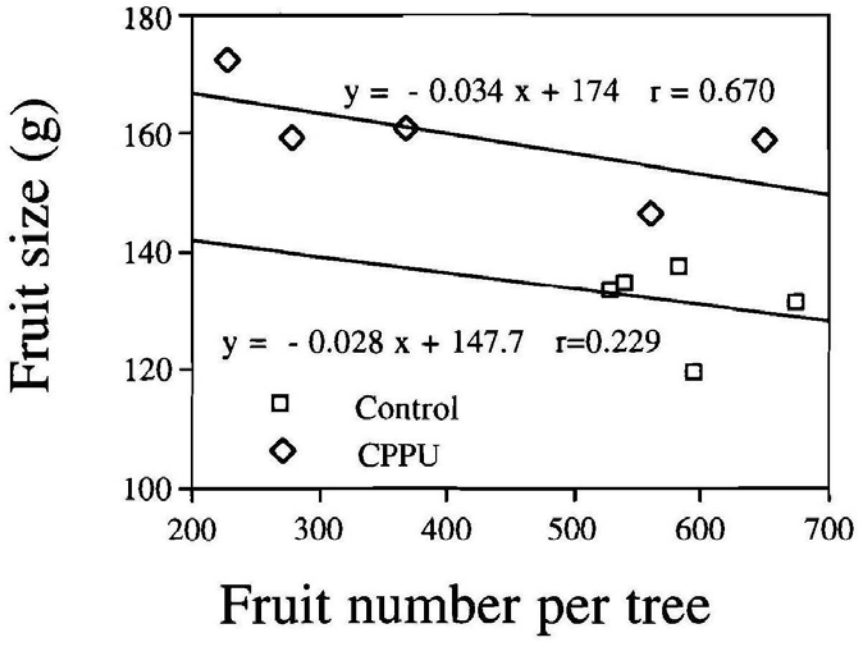

Figure 2. Effect of CPPU on 'Hass' avocado fruits as function of tree yield.