FORCHLORFENURON (CPPU) INCREASES THE BERRY SIZE AND DELAYS THE MATURITY OF THOMPSON SEEDLESS TABLE GRAPES

N.K. Dokoozlian, M.M. Moriyama, and N.C. Ebisuda
Department of Viticulture and Enology, University of California, Davis

ABSTRACT

A study was initiated in 1993 to determine the effects of CPPU (forchlorfenuron) on the fruit growth and composition of Thompson Seedless table grapes. CPPU (5, 10 or 15 mg/L) was applied to vines alone at fruit set, in combination gibberellic acid (GA_3) at fruit set, or at berry softening to vines treated with GA_3 at fruit set. The berry weight of vines treated with CPPU at fruit set was approximately 40% greater than those of the untreated control, and similar to those of vines receiving two, 40 mg/L GA_3 applications. The berry weight of vines receiving CPPU + GA_3 at berry set were approximately 16% greater than vines receiving either material alone. Berry diameter increased as the concentration of CPPU applied at berry set was increased, while berry length reached its maximum when vines were treated with 5 mg/l CPPU. The berry length:diameter ratios for CPPU and GA_3 treated fruits were 1.43 and 1.53, respectively, indicating that CPPU applications resulted in a more spherical berry shape compared to GA_3 applications. CPPU applied at fruit softening had no significant effect on berry growth. CPPU applied at both berry set and berry softening delayed fruit maturation. A two-week delay in harvest was obtained when 15 mg/L CPPU was applied in combination with GA_3 at berry set. CPPU had no significant effect on vine yield components in 1993, or on subsequent vine fruitfulness in 1994.

INTRODUCTION

CPPU (forchlorfenuron or N-(2-chloro-4-pyridyl)-N'-phenylurea) is a plant growth regulator which has significant physiological activity on many fruits, including grapes (1, 2, 7, 8, 9). The compound's mode of action is similar to that of a cytokinin (4). When applied prior to anthesis, CPPU significantly increases the berry set of both seedless and seeded grape cultivars (4). When applied to clusters following fruit set, CPPU increases berry size (2, 3, 4, 7). In addition to their larger size, berries treated with CPPU at fruit set commonly exhibit delayed maturity and reduced color (2, 7).

Multiple applications of gibberellic acid (GA_3) are currently used to increase the berry size of Thompson Seedless table grapes in California. The chemical and application costs associated with these treatments (normally between 100 to 150 grams GA_3 per hectare) represent are a significant portion of the total production expenses for this cultivar. Due to its high physiological activity, the amount of CPPU required for enlarging the berries of seedless table grapes is much lower compared to GA_3. Diaz and Maldonado recently found that a single application of CPPU (approximately 20 grams per hectare) provided similar efficacy for increasing the berry size of Flame Seedless as two, 200 gram per hectare GA_3 applications (2). Previous studies have also reported that combined applications of CPPU and GA_3 have

synergistic effects on berry growth (2, 4, 7). The purpose of this study was to examine the interaction between CPPU and GA_3 applications on the berry growth and fruit composition of Thompson Seedless table grapes. The results show that CPPU applied at berry set, both alone and in combination with GA_3, increased the berry size and delayed the maturity of this cultivar. Preliminary results also indicate that CPPU has no effect on vine fruitfulness the year following its application.

MATERIALS AND METHODS

Growing conditions and cultural practices. The study was conducted on mature, own-rooted Thompson Seedless grapevines grown at the University of California Kearney Agricultural Center in Parlier, CA (approximately 40 km southeast of Fresno, CA, USA). The vines were planted in a fine sandy loam soil, and spaced 2.4 m (between vines) x 3.7 m (between rows). The vines were head trained and cane pruned. The trellis system consisted of a stake (1.8 m above ground), and a 1.2 m cross-arm at each vine. Five wires, spaced 0.24 m apart, were attached to each cross-arm. The three inside wires were used to tie canes, and the two outside wires were used for foliage support. Six canes and approximately five spurs were retained on each vine at pruning in January of 1993. The vines were drip irrigated. Cultural operations were performed in accordance with standard commercial production practices for Thompson Seedless table grapes in this region. Gibberellic acid (GA_3) was applied to the vines twice during anthesis to reduce berry set (30 g per ha for each application). GA_3 bloom applications were performed using a dilute sprayer and approximately 1500 L of spray solution per hectare. Girdles were applied to the vine trunk following fruit set (8 to 9 mm berry diameter) using a 6 mm girdling knife to increase berry size.

Experimental treatments and design. Experimental vines were selected several weeks prior to anthesis on the basis of uniformity of foliage and cluster development. All data vines were adjusted to the same cluster number (30) prior to anthesis. The treatments evaluated in the trial are presented in Table 1. Vines treated with GA_3 (Pro-Gibb 4%, Abbott Laboratories, Chicago, IL) received two applications following berry set. The first application was performed when berries were 4 to 5 mm in diameter, and the second application was performed six days thereafter (7-8 mm berry diameter). CPPU berry set applications were performed on the same date as the second GA_3 sizing application. CPPU berry softening treatments were applied at the initiation of fruit softening (5-10% of the berries soft). All treatments were applied to clusters and foliage with a hand-held spray wand, using approximately 2000 L of spray solution per hectare. Each treatment was replicated 6 times using three vine plots arranged in a randomized complete block design. The middle vine in each replicate was used for data collection.

Berry sampling and analyses. Berry samples were collected from each replicate at two-week intervals beginning at berry softening and concluding at harvest. Samples were taken by removing a single berry from the top, middle, and bottom of 12 randomly selected clusters on each vine (48 berries removed per vine at each sampling). Care was taken to sample an equal number of widely distributed clusters on each cane. The fruit was transported to the laboratory immediately after sampling, and the berry number and fresh weight of each sample recorded. The berries were then ground in an electric blender for 20 seconds, or until completely

macerated, and the juice and pulp was filtered through a paper towel. The filtrate was allowed to settle for approximately 30 minutes, after which aliquots of the clear juice were used to determine juice soluble solids content and titratable acidity. Soluble solids content was determined using a hand-held, temperature compensated refractometer (American Optical, Buffalo, NY) to the nearest 0.1 °Brix. Acidity was determined by titrating a 5 ml aliquot of juice with 0.1 N NaOH to a pH endpoint of 8.2 using a automatic titrator (Radiometer America Inc., Westlake, OH). Prior to performing compositional analyses at harvest, fruit length and diameter was determined by placing the berries single-file in a specially designed trough so that their ends (berry length) or equators (berry diameter) gently touched. The cumulative length and diameter of the berries was recorded, then divided by the number of berries in the sample to determine mean berry length and diameter.

Vine yield components and rachis dry weight determinations. All clusters were removed from each vine at harvest, counted, and weighed. Fruit quality defects were not present at harvest, thus all fruit was deemed suitable for market as table grapes. Following harvest, 10 clusters were randomly selected from Treatments 1-4 (Table 1) to determine rachis dry weight. All berries were removed from the cluster rachis, and the rachis dried in paper bags at 60° C for 72 hours. The dry weight of the rachis was recorded after the clusters cooled to room temperature.

RESULTS

The effects of fruit set applications of CPPU and CPPU+GA_3 on the berry growth of Thompson Seedless table grapes are presented in Figure 1. The results show that little additional increase in berry weight was obtained, for either GA_3 treated or untreated vines, when CPPU concentration exceeded 5 mg/L The berry weight of the 5 mg/L CPPU treatment was approximately 40% greater than the control (vines girdled with no chemical treatment), and similar to that of the GA_3 treatment. The berry weight of the GA_3+5 mg/L CPPU treatment was 65% greater than the control, while the berry weight of the combined treatment was 16% greater than when either material was applied alone. Berry length was greatest for the 5 mg/L CPPU treatment, for both GA_3 treated and untreated fruit, and declined as CPPU concentration exceeded this level. The berry length of fruit treated with CPPU+GA_3 was approximately 5% greater compared to fruit treated with CPPU alone. Berry diameter increased, from 17.8 to 18.4 mm, as the CPPU concentration was raised from 5 to 15 mg/L. The berry diameter of fruit treated with CPPU+ GA_3 was approximately 4% greater than fruit treated with CPPU alone. CPPU had no significant effect on berry growth when applied at fruit softening (data not presented).

The influence of CPPU on the maturation rate of Thompson Seedless table grapes is presented in Figure 2. The upper graphs in Figure 2 compare the effects of GA_3 and CPPU applied at berry set on fruit soluble solids and titratable acidity during ripening. Fruit composition was similar for the 5 mg/L CPPU and GA_3 treatments throughout ripening. However, the maturation of the 10 and 15 mg/L CPPU treatments was delayed compared to the GA_3 treatment. The number of days after berry set required for fruit maturation (17 °Brix) was 73 for both the GA_3 and 5 mg/L CPPU treatments, 78 for the 10 mg/L CPPU treatment, and 83 for the 15 mg/L