Journal of American Pomological Society 54(3):130-133 2000

Gibberellic Acid Sprays Increase Berry Size and Reduce Shot Berry of 'Vanessa' Grapevines

THOMAS J. ZABADAL[1] AND THOMAS W. DITTMER[1]

Abstract

'Vanessa,' a red seedless table grape, is often recommended for planting in cool climates because berries have excellent color, crisp texture, and flavor. However, in its natural condition 'Vanessa' clusters tend to be loose with small berries and frequent shot berries. The application of gibberellic acid (GA) to correct these deficiencies was evaluated for four growing seasons at concentrations of 25 and 50 ppm when berry diameters averaged 3, 5, 7 and 9 mm. GA increased yield, cluster weight, berry weight, fruits soluble solids and juice pH and decreased the number of shot berries per cluster and cluster compactness. Applications of GA at 50 ppm when berries averaged 5 mm in diameter were most effective for increasing berry weight and fruit soluble solids while reducing the occurrence of shot berry. Cane pruning weights recorded for vines over the 4-year period indicate no reduction in vine size as a result of GA applications made directly to clusters.

Introduction

Table grape production in cool, temperate climates offers great potential to produce flavorful, high quality fruit. However, the efforts of several breeding programs since the late 1940's have yet to produce a red seedless table grape that has been widely adopted commercially. Named red seedless table grape cultivars for temperate climates include 'Canadice,' 'Challenger,' 'Einset,' 'Reliance,' 'Saturn' and 'Suffolk Red.' However, significant defects have been identified in each of these cultivars (10). 'Vanessa,' another red seedless table grape cultivar, has several excellent qualities, especially with its well-colored, crisp-textured, flavorful berry. It has often been recommended for planting (1, 2, 5, 7, 10). However, the relatively small berry size of 'Vanessa' combined with the frequent occurrence of shot berries in the cluster make this cultivar unattractive for commercial production.

Gibberellic acid (GA) can increase berry size in seedless grapes (6). However, the seedless characteristic of 'Vanessa' is somewhat variable (4, 9). Perhaps for this reason the response of this variety to GA has been uncertain. Applications of GA at bloom to 'Vanessa' werc ineffective for either thinning or berry sizing but post-bloom GA applications to 'Vanessa' increased berry weight and reduced the incidence of shot berry (8). Unfortunately, that previous study measured time of GA application only in relation to days-after-bloom. GA applications need to be made in relation to the stage of berry development to obtain reproducible, reliable results (6). Therefore, this study was undertaken to establish that relationship for the 'Vanessa' cultivar.

Materials and Methods

Self-rooted, four-year-old 'Vanessa' grapevines were pruned to four 10-node canes and trained to a modified-Munson training system. Cane pruning weights were recorded annually. Fruiting canes were tied on two parallel wires at the top of a 1.8 m trellis. Side arms, which were attached at the top of the trellis post on both sides, supported catch wires for shoot growth. These were offset 50 cm from the plane of the trellis. Shoots were positioned over these catch wires. Vines were crop thinned to 25 basal clusters per vine prior to bloom. GA was applied when berries averaged 3, 5, 7, or 9 mm in diameter on their smallest dimension. GA concentrations of 0, 25 or 50 ppm were applied to runoff directly to clusters only with a hand

[1]Associate Professor and former Research Technician, Dept. of Horticulture, Michigan State University, E. Lansing, MI 48824.

sprayer. Total yield per vine was recorded at harvest. Ten clusters per vine were randomly chosen and measured for weight, compactness, total weight of berries, number of berries, number of shot berries and weight of damaged berries. Cluster compactness was rated as follows: 1 = rigid – unable to move berries on cluster; 2 = some movement of berries; 3 = able to manually separate berries; 4 = loose – occasional berries not touching others; 5 = uniformly loose with many berries not touching each other, able to see some gaps through the cluster; 6 = large holes or gaps visible in the cluster. Ten berries were randomly sampled from each of the 10 clusters. Juice from these berries was analyzed for soluble solids, pH and titratable acidity. The experiment was a factorial of three levels of GA (0, 25 and 50 ppm) and four times of GA application. The experimental design was a randomized complete block with whole vines as experimental units and six replicates per treatment. Data are the average of four years. Data were analyzed using SAS statistical software for analysis of variance.

Results and Discussion

GA applications had several positive influences on the performance of 'Vanessa' vines. They increased yield (Table 1) which was due to an increase in cluster weight (Table 2) which in turn was caused by an increase in berry weight (Table 2). GA increased fruit soluble solids and juice pH (Table 1) and decreased cluster compactness (Table 2). GA applications made at later stages of berry development increased yield but they reduced fruit soluble solids (Table 1). There was a significant interaction between the GA concentration and when it was applied on fruit soluble solids accumulation (Table 1). This was apparently due to the dual action of GA (3), which when applied close to bloom, can reduce berry set as well as increase berry size. Later applications only

Table 1. Yield, fruit quality as measured by fruit soluble solids, juice pH and juice titratable acidity, and cane prunings per vine for 'Vanessa' grapevines subjected to varying rates and times of gibberellic acid application. Data are the average of four years.

Variable	Yield (kg/vine)	Fruit soluble solids (%)	Juice pH	Juice titratable acidity (g/liter)	Cane prunings (kg/vine)
GA conc[1] (ppm)					
0	3.55	19.01	3.36	0.58	1.27
25	4.25	19.26	3.42	0.58	1.54
50	4.06	19.46	3.44	0.58	1.54
Berry diameter[2] (mm)					
3	3.53	19.54	3.45	0.56	1.45
5	3.66	19.29	3.41	0.57	1.47
7	4.47	19.11	3.40	0.57	1.53
9	4.05	19.03	3.38	0.61	1.33
F significance[3]					
Year (Y)	***	***	***	***	***
GA conc (G)	*	***	***	NS	***
Y x G	NS	NS	NS	***	***
Berry diameter (B)	**	***	*	***	NS
G x B	NS	**	NS	***	NS
Y x B	NS	NS	NS	***	*
Y x G x B	NS	NS	NS	***	

[1]GA conc. = application of gibberellic acid directly to clusters to runoff.
[2]Berry diameter = average diameter of berries in their smallest dimension at time of gibberellic acid application.
[3]NS, *, ** or *** = non-significant or significant at P<= 0.05, 0.01 or 0.001, respectively.

increase berry size. GA application at earlier stages of berry development produced fewer berries per cluster and smaller clusters (Table 2), which contributed to smaller yields, increased fruit soluble solids, higher juice pH and reduced titratable acidity (Table 1). GA applications at later stages of berry development increased berry weight but did not reduce the number of berries per cluster or yield. Therefore, these later GA applications resulted in somewhat lower fruit soluble solids accumulation, probably in response to the larger yields associated with those treatments.

GA applied at 50 ppm when berry diameter averaged 5 mm was most effective for fruit soluble solids accumulation with a 4-year average of 19.8%. The greatest berry thinning occurred when the highest rate of GA (50 ppm) was applied when berries were 3-5 mm in diameter with a 4-year average of 63 berries per cluster. The largest berry weight was achieved when 50 ppm of GA was applied when the berries averaged 5-7 mm in diameter with a 4-year average of 2.36. GA applied at 50 ppm when berries averaged 5 mm in diameter was also most effective for reducing the occurrence of shot berry (Table 2).

Although the largest yields were achieved when GA was applied at later stages of berry development (Table 1), this is not the highest priority for table grape production. Fruit quality, as influenced by reducing the number of berries and shot berries per cluster and increasing berry size and fruit soluble solids, is more important than yield. Therefore, the best overall rate and time of GA application for

Table 2. Cluster weight, berries per cluster, berry weight, number of shot berries per cluster, percent of damaged fruit and cluster compactness for 'Vanessa' grapevines subjected to varying times and rates of gibberellic acid application. Data are the average of four years.

Variable	Cluster wt (g)	Berries/ cluster	Berry wt (g)	Shot berries/ cluster	Damaged[1] fruit (%)	Cluster compactness[2]
GA conc[3] (ppm)						
0	139	75	1.79	4.5	0.96	4.58
25	164	73	2.20	1.3	0.71	4.55
50	161	71	2.26	1.1	0.70	4.73
Berry diameter[4] (mm)						
3	141	69	1.63	2.2	0.78	4.73
5	153	70	1.93	1.7	0.74	4.62
7	167	77	1.80	2.3	0.81	4.56
9	157	76	1.77	2.9	0.82	4.56
F significance[5]						
Year (Y)	***	***	***	***	***	***
GA conc (G)	***	NS	***	***	NS	***
Y x G	NS	***	**	**	**	***
Berry diameter (B)	***	***	***	***	NS	**
G x B	NS	**	**	NS	NS	***
Y x B	*	***	**	**	NS	***
Y x G x B	NS	NS	NS	NS	NS	NS

[1]Damaged fruit = percent of fruit by weight with unhealthy berry tissue at harvest.
[2]Cluster compactness = visual rating as follows: (1) = rigid – unable to move berries on cluster; (2) = some movement of berries; (3) = able to manually separate berries; (4) = loose – occasional berries not touching others; (5) = uniformly loose with many berries not touching each other, able to see some gaps through the cluster; (6) = large holes or gaps visible in the cluster.
[3]GA conc. = application of gibberellic acid directly to clusters to runoff.
[4]Berry diameter = average diameter of berries in their smallest dimension at time of gibberellic acid application.
[5]NS, *, ** or *** = non-significant or significant at P <= 0.05, 0.01 or 0.001, respectively.

the 'Vanessa' variety was 50 ppm GA when berries averaged 5 mm in diameter.

'Vanessa' berries are subject to cracking and rotting in wet harvest periods. Reduced cluster compactness can reduce the risk of berry cracking in some varieties. GA reduced cluster compactness in 'Vanessa' (Table 2) but it reduced the amount of damaged fruit on clusters only in some years (Table 2).

Although the GA applications resulted in 4-year average cane pruning weights that were larger than the control (Table 1), by the end of the experiment all treatments resulted in insignificantly different, large vines with average cane pruning weights of 1.6 kg/vine. Therefore, the application of GA directly to clusters in this experiment had no long-term negative impact on vine size. However, the impact of applications of GA to all tissues of the vine would be uncertain.

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IAA Transport as Affected by Apple Rootstocks

IAA transport was greater in June and July (faster shoot growth period) than in August (slower shoot growth). M.9 and M.27 showed smaller uptake and less transport of IAA than MM.111 and MM.104. In June and July all stocks showed transport but in August only the vigorous rootstocks showed transport. From Kamboj et al. 1997. J. Hort. Sci. 72(5):773-780.

Fruit Color – Orchard and Post Harvest Factors

Fruit color was strongly correlated with firmness and sugar content, where as starch and acid content correlations were not consistent from green to intermediate and yellow fruit of 'Mutsu.' Fruit collor was poorer with higher yields. No correlations were found between ratings for tree density, tree vigor and tree openness vs fruit color, whereas crop load was highly correlated to both green, intermediate and yellow fruit color. Leaf N ($r = -.53$) and K ($r = -.50$) were correlated with color. From Daugaard and Grauslund. 1999. J. HortSci Biotech 74(3):283-287.