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THE EFFECTS OF BERRY THINNING AND GIBBERELLIN ON RECEL UZUMU TABLE GRAPES

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This study was carried out to determine the effects of berry thinning and gibberellin (GA_3) on yield and fruit quality of 'Reçel Üzümü' table grapes. A combined six treatments of gibberellin (control and 40 ppm) and cluster tipping (control, 1/3 and 1/2) were applied at the 3-5 mm berry size stage. Gibberellin was the main factor for the increase in berry size, berry and cluster weight, and yield. Crushing resistance of berries was higher for gibberellin sprayed clusters. Fruit maturity was delayed with gibberellin and it significantly decreased fruit color. Maturity levels of Reçel Üzümü berries increased with the amount of berry thinning. Lengths of tipped clusters were shorter than control while there were no differences between 1/3 and ½ berry thinning. Removing parts of clusters did not influence berry and cluster sizes. The total sensory evaluation scores were the highest for thinned grapes that had not been treated with gibberellin.

Keywords: Grapes, Reçel Üzümü, berry thinning, GA_3, quality, yield, maturity, coloration

INTRODUCTION

A total of 4,255,000 tons of grapes were produced on a 477,785.6 ha vineyard area in Turkey in 2010 (Turkey Statistical Institute, 2011). With these figures Turkey is the fifth largest grape grower country and ranks sixth in world grape production. Table grapes differ from wine grapes in the structure of the berries and clusters. The appearance of table grapes must primarily attract consumers. Attractive factors for table grapes are berry and cluster size, shape and compactness of clusters, and color of berries. Characteristic flavor and aroma and the presence of seeds are the other important reasons for the choice of table grape cultivar. As well as these factors, suitability for handling and storage, ripening time, cluster structure for packaging, and productivity are additional features for table grapes. Many more cultural practices are needed for table grapes than for wine grapes in order to increase consumer preference. Girdling, berry and cluster thinning to increase berry size; girdling and ethephon to hasten ripening and coloration of berries are widely used practices in countries that dominate the table grape market. The effectiveness of these practices can vary according to cultivar, growing system, rootstock and ecology.

Consumers prefer seedless grapes because of the ease of eating, traditional grape cultivars such as Sultanina, Afuzali and Rozaki are under competitive pressure from the new hybrid grape cultivars like Redglobe, Autumn Royal, and Flame Seedless. Therefore, the majority of new hybrid genotypes are seedless. Color, aroma, early or late ripening, resistance biotic or abiotic stress condition are complementary elements for these grapes. Naturally, berries of stenospermic seedless grapes are usually smaller than seeded ones. Especially for seedless grapes, gibberellins are applied at full bloom to decrease berry set and at berry set to increase the size of the remaining berries.

Gibberellin applications levels and period may vary according to cultivar, ecology, and growing system. GA_3 stimulates both cell division and cell elongation, especially for seedless varieties (Shiozaki *et al*., 1998). In Chile, for example, 10 to15 ppm GA_3 is used for thinning and 80 to120 ppm for improving the size of berries of Thompson Seedless, while less GA_3 (5 to 7.5 ppm for thinning and 20 to 30 ppm for increasing berry size) is sufficient for Flame Seedless (Pérez-Harvey, 1994). Thompson Seedless bunches are thinned by a 10–15 ppm gibberellic acid spray at full bloom in Israel (Lavee, 1994). Berry sizing is induced by two to three repeated gibberellic acid sprays, seven to 10 days apart, using a concentration of 20 to 40 mg/L (Lavee, 1994). Among the seedless varieties, only Sultanina is treated with two sprays of 10 mg/L gibberellic acid in South Africa (Orth, 1994). Gibberellin is applied at bloom to Thompson Seedless and Flame Seedless to reduce berry set in California. Two sprays for berry enlargement, one at fruit set and the other five to seven days later, are commonly performed for Thompson Seedless, Flame Seedless, and Perlette grapes (Jensen, 1994). Gibberellin is intensively used for Sultanina grapes in the Aegean Region of Turkey. Table grape growers use this hormone at full bloom and fourteen days later at 25 to 30 ppm concentration to improve berry size and bunch structure.

The dimensions of berries and clusters were increased in several studies with gibberellin at bloom and berry set (Khanduja and Chaturvedi, 1979; Saad *et al*., 1979; Thilak, 1983; Qadir *et al*., 1989; Sing *et al*., 1994; Colapietra *et al*., 1995a,b; Uzun and Ceyhan, 1995; Samancı 1998; Kara and

Ecevit, 1998; Wali *et al*., 1990; El-Hodairi *et al*., 1995; ShuFen *et al*., 2011). The repetition of gibberellin spraying ten days after berry set application generally increased berry weights of Reçel Üzümü grapes. Gibberellin doses of 10+20+20 ppm GA_3 and 20+40+40 ppm GA_3, respectively at full bloom, berry set and ten days after berry set gave the highest berry weights (Özer *et al*., 2008). It has been determined in several previous studies that gibberellin can decrease sugar accumulation in berries and this causes a delay in harvest in some cases (Jensen *et al*., 1994; Uzun and Ceyhan, 1995; Colapietra *et al*., 1996; Samancı, 1998). Otherwise, a decline in total acidity and advancing maturity has been reported by some scientists (Moti, 1971; Thilak, 1983; Sing *et al*., 1994; Colapietra *et al*., 1996; ShuFen *et al*., 2011). Soluble solids of Reçel Üzümü grapes did not differ significantly due to gibberellin or girdling (Özer *et al*., 2008).

There is some information that gibberellin increases berry drops on grapes (Badr and Ramming, 1994; Jensen *et al*., 1994). On the other hand, unexpected phenomena were observed, such as berry attachment to the pedicel of Thompson Seedless grapes being increased with gibberellin and berry shatter decreased (Retamales and Cooper, 1993). Bunches can be looser with gibberellin spray before or after berry set (Sing *et al*., 1994; El-Hodairi *et al*., 1995).

Berry or cluster thinning treatments have a direct effect on the source/sink ratio; having less sinks (fruits), photosynthetic assimilation might be improved, increasing grape quality (Reynolds *et al*., 1994). Table grapes are hand thinned to achieve uniform, medium sized, loose clusters of uniformly large, perfect berries with a characteristic color, pleasing flavor and good texture. Growers use different styles of berry thinning. Partial removal of clusters or berries is made at one time or several times after berry set. The level of the berry thinning must be synchronized with genotype and crop load (Jensen, 1994; Liuni *et al*., 1994; Orth, 1994). Combined treatments of gibberellin and berry thinning generally increase berry and cluster weights (Yadav and Pandey, 1974; Mor, 1983; Colapietra *et al*., 1995a). Higher levels of berry thinning reduces bunch weight and bunches become loose and straggly. Berry thinning increases soluble solids, especially at the 50% level (Nangia and Bakhshi, 1971).

Table grapes represent 52.86% while raisins represent 36.28% of the total production. Gibberellin sprayed Sultanina grapes have been sold in domestic and foreign markets in addition to raisin grapes. Alternative early or late table grape cultivars have been developed by hybridization program. Reçel Üzümü is a late maturing table grape released by the Tekirdağ Viticulture Research Institute in Turkey. This red seedless table grape variety resulted from a cross between Elhamra and Perlette. Vines of this cultivar are vigorous and fruitful. The clusters are so long that they are suitable for trimming applications. Response to various gibberellin and girdling applications were determined for newly released table grape cultivars, including Reçel Üzümü, based on a two year study. The purpose of this study was to examine the interaction between gibberellin and berry thinning on the quality, yield and maturity of Reçel Üzümü.

MATERIALS AND METHODS

***Plant material and experimental design*:** This study was carried out on a 15 year old vineyard located in the Tekirdağ Viticultural Research Institute. The experimental vineyard was established with Reçel Üzümü grafted vines on Kober 5BB. The distance between rows and within rows was 2.50 and 1.50 m, respectively. Trunk height was 65 cm for bilateral guyot pruned vines. Shoots from canes bearing 7 to 8 buds were trained vertically. Cultural practices were uniform for experimental vines.

A combined six treatments of gibberellin (control and 40 ppm) and berry thinning (control, 1/3 removal of the base part of the cluster and 1/2 removal of the base part of the cluster) were applied at the 3–5 mm berry size stage. The experimental design was randomized split block replicated three times and an experimental unit consisted of three vines. Berry thinning treatments were connected with subparcels. The individual clusters were hand sprayed with 40 mg/L gibberellin (Hek-Gibb® tablets containing 1 g GA_3) to run off while protecting all other parts of the vine. An adjuvant, Supervet® (Alkylarylpolyglycol Ether) was added at a rate of 25 mL/100L.

***Climate and soil characteristics of experimental area*:** The soil type of experimental vineyard was sandy loam and clayish loam for 0-60 and 60-120 cm soil depths respectively.

Detailed information about the characteristics of climate and soil are given in Table 1.

***Determination of yield and quality parameters of grape berries*:** Fruit samples were collected and the vines harvested on 28 September, 2010. The following parameters were evaluated: berry width, berry length, berry weight, cluster width, cluster length, cluster weight, cluster density, grape yield, ^{o}Brix, titratable acid content, maturity index, total anthocyanin content, berry removal force and berry crushing resistance. Fifty randomly selected berry samples were collected from each experimental unit at harvest and used to determine berry weight, soluble solids and titratable acid content. The juice was used to determine percent soluble solids and titratable acidity. Percent soluble solids were determined with temperature–compensated hand refractometer. Titratable acidity was determined by titrating a 10 mL juice with 0.1N NaOH to pH 8.1. The measurements of berry diameter and berry length were performed on 20 berries with a compass. The anthocyanin concentrations were measured by the pH-differential method, which relies on the structural transformation of the

Table 1. Climate characteristics of experimental area in vegetation period

	April	May	June	July	August	September
Average temperature (°C)	11.9	17.6	21.5	24.3	26.5	20.3
Maximum temperature (°C)	20.7	32.9	32.3	34.0	34.8	29.1
Minimum temperature (°C)	1.8	4.0	11.7	15.3	15.8	11.7
Monthly rain (mm)	31.0	16.8	31.7	33.0	1.5	44.2
Rainy days	8	6	8	8	1	5

Soil characteristics of the experimental area

Depth (cm)	Saturation (%)	Salinity (%)	$CaC0_3$ (%)	Organic matter (%)	P (kg/da)	K (kg/da)	Structure			Field capacity (%)	Wilting Point (%)
							Clay (%)	Silt (%)	Sand (%)		
0-30	57	0,069	4,13	1,09	8,93	120,6	30,2	31,4	38,3	23,8	11,6
30-60	59	0,082	4,45	1,09	8,93	116,8	32,3	27,1	40,6	24,4	11,8
60-90	60	0,076	3,18	0,80	4,01	90,3	38,5	31,2	30,2	25,3	12,9
90-120	61	0,075	2,54	0,80	1,55	77,3	42,7	33,3	23,2	26,9	14,7

anthocyanin chromophore as a function of pH as measured using optical spectroscopy (Cemeroğlu, 2007). Two dilutions of the sample were prepared, one with potassium chloride buffer pH=1.0 and the other with sodium acetate buffer pH=4.5. The absorbance of each dilution was measured at 520 and 700 nm by an UV/vis spectrophotometer (Shimadzu®, UV Mini-1240).

Berry removal force and berry crushing resistance was determined with a modified digital balance. Ten berries were placed on the test platform longitudinally and pressure was applied to the equatorial zone until berry crushing. The fixed value on the screen of the balance was recorded. Afterwards, ten berries (pedicels attached) were placed on the platform vertically to determine berry removal force. The fixed force at the time of berry detachment from the pedicel was recorded. The effects of treatment on cluster density were determined using a scale ranging from 1 to 5, resembling very loose and very compact clusters, respectively (Çelik, 1998).

Sensory analysis**:** The effects of the treatments on taste and appearance of grapes were also determined by sensory analysis based on the OIV General Form for the Sensory Analysis of Table Grapes (OIV, 2011).

Statistical analysis**:** The data from trials was subjected to analysis of variance. Significant differences between the means of treatments were determined using Students t-LSD test.

RESULTS AND DISCUSSION

Yield and quality parameters of grape berries**:** The effect of berry thinning and gibberellin on yield and fruit quality parameters of Reçel Üzümü grapes are presented in Table 2. The simple width of clusters was not influenced by treatments, either alone or in interaction. A difference was found for bunch density and berry removal force with six treatments from a combination of berry thinning and gibberellin while only one factor was affected by the other parameters. Detailed explanations of these results are presented in the text below. When an evaluation is made from the figures, it can be seen that the yield is less for thinned vines, with or without gibberellin. There was a very high grape yield for non-thinned and gibberellin sprayed vines. Berry size and crushing resistance of gibberellin sprayed grapes were higher than for control grapes. There was a tendency to decrease the maturity index of grapes because of a decline in soluble solids and acidity. Reduction in the length of the clusters with the dose of berry thinning was an expected result. Finally, it is noteworthy that anthocyanin content of gibberellin sprayed grapes was less than for non-sprayed vines. Clear assessments with significance factors or interaction are presented below.

Berry size, cluster weight and grape yield were significantly increased by gibberellin sprays at berry set (Table 3). The berry weight increased to 3.16 g with 40 ppm gibberellin, while natural berries weighed 2.62 g. This is a typical effect of gibberellin application at berry set that has been determined from several previous studies (Khanduja and Chaturvedi, 1979; Saad *et al*., 1979; Thilak, 1983; Qadir *et al*., 1989; Sing *et al*., 1994; Colapietra *et al*., 1995a,b; Uzun and Ceyhan, 1995; Samancı, 1998; Kara and Ecevit, 1998; Wali *et al*., 1990; El- Hodairi *et al*., 1995; ShuFen *et al*., 2011). Resistance to crushing was found to be high with 1637 g for berries that sized to 21 mm length and 17 mm width with gibberellin application. In a previous study (Özer *et al*., 2008), the same concentration of gibberellin increased resistance to crushing of Reçel Üzümü berries, but a significant increase was obtained from a total of 80 ppm gibberellin. A similar result was found for Flame Seedless for gibberellin sprays before bloom (El-Hammady *et al.*, 1998). There is a significant correlation between berry weight and resistance to crushing (Özer and Kiracı, 2002). The reason for higher resistance to crushing of the berries can be an increase of berry size with GA_3. An increase of berry weight led to an increase of cluster weight and yield with a confidence of 99%. Positive effects of GA_3 on the

Table 2. Effect of berry thinning and gibberellin on yield and fruit quality of Reçel Üzümü table grapes

	Control			**40 ppm GA_3**		
	Control	**1/3 Berry Thinning**	**1/2 Berry Thinning**	**Control**	**1/3 Berry Thinning**	**1/2 Berry Thinning**
Yield (kg/vine)	5,47	4,23	4,57	8,90	6,67	5,12
Berry wt (g)	2,39	2,84	2,62	3,13	3,11	3,24
Berry width (mm)	15,17	16,03	15,27	16,83	16,83	17,20
Berry length (mm)	18,23	19,67	18,53	20,70	20,57	21,00
Resistance to crushing (g)	1086,33	1291,33	1384,67	1635,67	1562,00	1713,667
Berry removal force (g)	157	236,33	197,33	243	191	179,67
Soluble solids (^{o}Brix)	18,13	18,60	19,50	14,70	15,73	16,00
Acidity (g/100mL)	0,68	0,62	0,61	0,58	0,55	0,52
SS/Acidity	26,74	30,14	32,23	25,67	28,60	30,81
Cluster wt (g)	262,46	235,03	280,18	419,20	348,82	222,43
Cluster width (cm)	9,93	11,17	11,42	12,67	14,75	12,95
Cluster length (cm)	28,45	18,83	15,88	28,83	19,33	18,48
Cluster density	4,37	3,50	5,1	3,93	4,50	3,53
Anthocyanin content (mg/kg)	46,81	71,35	43,71	27,92	31,02	64,86

Table 3. Effect of gibberellin on yield and fruit quality of Reçel Üzümü table grapes

	Control	40 ppm GA_3	Significance level	LSD (5%)
Berry wt (g)	2,62 b	3,16 a	0,05	0,28
Berry width (mm)	15,49 b	16,96 a	0,05	1,14
Berry length (mm)	18,81 b	20,76 a	0,05	1,61
Resistance to crushing (g)	1254,11 b	1637,11 a	0,05	358,06
Cluster wt (g)	259,22 b	330,15 a	0,05	65,35
Yield (kg/vine)	4,76 b	6,89 a	0,01	0,16
Anthocyanin content (mg/kg)	53,95 a	41,26 b	0,01	4,59
Soluble solids (^{o}Brix)	18,74 a	15,48 b	0,01	0,93
Acidity (g/100mL)	0,64 a	0,55 b	0,01	0,03
SS/Acidity	44,56 a	42,54 b	0,01	0,79

Means within a line followed by different letters are significantly different.

yield components caused a negative impact on maturity components and colorization of Reçel Üzümü table grapes. The anthocyanin content, soluble solids and acidity for gibberellin sprayed grapes decreased from 53.95 to 42.26 mg/kg, from 18.74 to 15.48 ^{o}Brix and from 0.64 to 0.55 g/100 ml, respectively. These findings support previous studies that indicate gibberellin delays sugar accumulation in berries (Jensen *et al*., 1994; Uzun and Ceyhan, 1995; Colapietra *et al*., 1996; Samancı, 1998). Similarly, gibberellic acid application after full bloom has led to a decrease in anthocyanin content of Kyoho grapes (Lee Changhoo *et al.*, 1996).

While the maturity of berries decreased with gibberellin, a rise was observed in thinning levels (Table 4). Fruit soluble solids at harvest increased, from 16.42 to 17.77 Brix with 1/2 berry thinned vines. There was a similar decline in acidity for thinning treatments compared to unthinned grapes. The maturity index increased in proportion to thinning level. Soluble solids of Perlette and Centennial Seedless grapes were similarly affected by thinning (Nangia and Bakhshi, 1971; Colapietra *et al*., 1995a). Berry thinning at berry set reduced cluster length, as expected; however, there was no difference between 1/3 and 1/2 thinning operations. Berry thinning did not improve berry and cluster weight as in Perlette and Centennial Seedless grapes (Nangia and Bakhshi, 1971; Colapietra *et al*., 1995 a).

Interaction between gibberellin and berry thinning was found to have an effect on berry removal force for pedicel attachment to berries. Berry shatters at harvest show that pedicel and berry connection is weak for this cultivar. An increase of berry removal force with gibberellin can be accepted as an advantage. Removal of one third of the basal part of clusters increased the berry removal force compared to unthinned and non-gibberellin sprayed vines. It can be said that there was a decline in removal force with increase of berry thinning levels for grapes treated with gibberellin (Fig. 1).

Interaction between two factors also had an effect on bunch density. Bunches of non-sprayed and 1/2 berry thinned vines were too compact, while thinning did not affect the density of bunches with gibberellin (Fig. 2).

Table 4. Effect of berry thinning on maturity components and cluster length of Reçel Üzümü table grapes

	Soluble solids (^{o}Brix)	Acidity (g/100mL)	SS/Acidity	Cluster length (cm)
Control	16,42 b	0,63 a	39,31 c	28,64 a
1/3 Cluster Trimming	17,16 ab	0,59 b	44,05 b	19,08 b
1/2 Cluster Trimming	17,75 a	0,56 b	47,28 a	17,18 b
Significance level	0,05	0,05	0,01	0,01
LSD at the 5% level	0,92	0,039	1,65	2,41

Means within a row followed by different letters are significantly different.

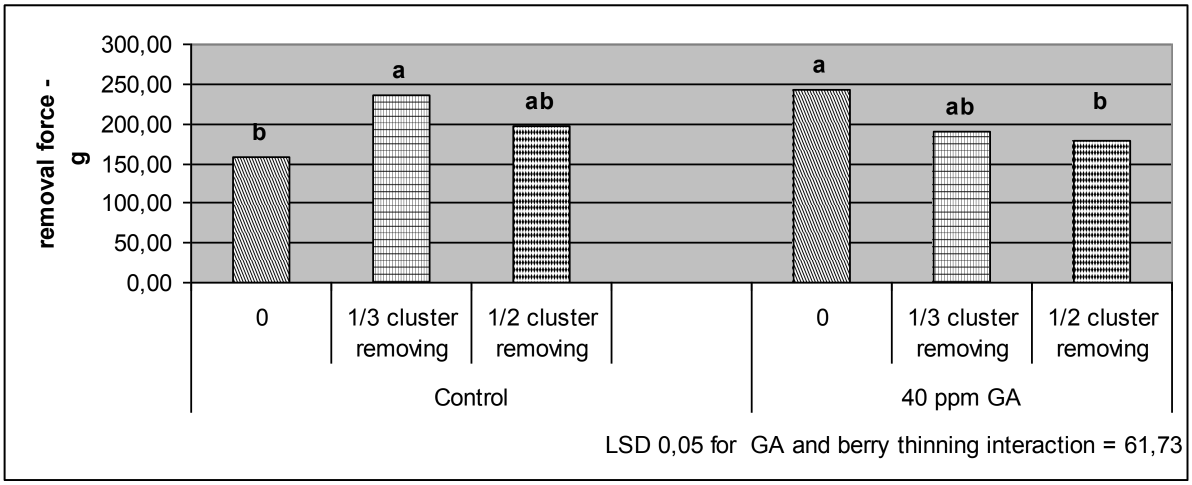

Figure 1. Effect of interaction between berry thinning and gibberellin on berry removal force of Reçel Üzümü table grapes

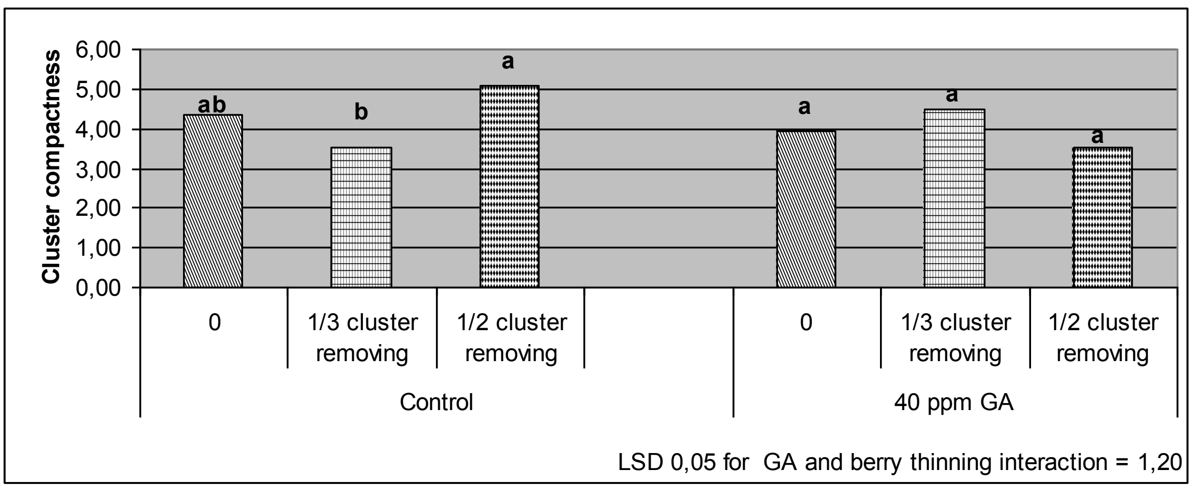

Figure 2. Effect of interaction between berry thinning and gibberellin on cluster density of Reçel Üzümü table grapes

The clusters showing the treatments can be seen in Fig. 3. The first striking feature is less coloration for gibberellin applications and little increase of color with thinning within this group. Coloration was less on berries of thinned clusters from vines without gibberellin. Very large clusters from gibberellin sprayed and unthinned vines are noteworthy. Even though not reflected in the statistical analysis, it can be seen that the top ranked thinned clusters in the photo are a little larger than the control.

***Sensory analysis*:** Effects of the treatments mentioned above were reflected in the sensory analysis scores, especially the visual evaluations (Table 5). The highest scores for general appearance were given to thinned clusters without gibberellin. The higher force required to detach the berry

Table 5. Sensory analysis scores of berry thinning and gibberellin combinations at Reçel Üzümü grapes (B0=control, B1= 40 ppm GA_3; A0= control, A1= 1/3 berry thinning; A2= ½ berry thinning)

	Descriptors -Scale and Values	B0A0	B0A1	B0A2	B1A0	B1A1	B1A2
I	Cluster – General appearance (1=badly shaped; 10=well shaped)	8	10	9	4	6	4
	Cluster – Detachment of berries from pedicels (1=low resistance; 10=high resistance)	2	5	9	3	4	7
	Cluster – Uniformity of colour (1= ≥ to 30% of berries with colour defects; 10=all	8	7	5	1	4	4
	Stalk - Colour (1=Brown; 10= bright green)	9	9	10	10	10	10
	Stalk – Turgidity (1=shriveled; 10=turgid)	8	10	10	10	10	10
	Stalk – Presence of rot and/or lesions (1=all rotten; 10=all healthy)	10	10	10	10	10	10
	Stalk – Browning of the peduncle (1=all brown; 10 all green)	10	10	10	10	10	10
	Berry – Uniformity of colour (1= < to 30% of the surface coloured; 10=all coloured)	8	8	6	1	6	4
	Berry – Presence of shriveling (1=all shriveled; 10=all healthy)	10	10	10	10	10	10
	Berry – Ease of detachment from the pedicel (1=low resistance; 10=very resistant)	1	4	9	1	5	5
	Skin - marks of pesticide residues or black mould (1= completely covered ; 10= no marks)	10	10	10	10	10	10
	Skin – Browning of the skin (1=clearly visible; 10= browning not visible)	10	10	10	10	10	10
	Bloom: distribution (1= irregular ; 10=uniform)	10	10	10	10	10	10
	Flesh – Browning of the flesh (1=clearly visible; 10= browning not visible)	10	10	10	10	10	10
	Flesh - Presence of seeds (in dissected berry) (1=clearly visible; 10=not visible)	10	10	10	10	10	10
II	Intensity of aromas (in dissected berry) (1=neutral; 10=many aromas)	1	1	1	1	1	1
III	*Berry - Crispness (1=low; 10=very crisp)*	*7*	*8*	*9*	*8*	*6*	*5*
	Flesh - Consistency (1=deliquescent; 10=very firm)	7	8	8	8	8	7
	Flesh – Intensity of aromatic sensation (1=not very intense; 10=very intense)	1	1	1	1	1	10
	Flesh – Gustative balance (sweet/acid) (1=not very well balanced; 10=very well balanced)	7	9	6	1	4	4
	Skin - Thickness (1=thick; 10=thin)	5	7	7	1	3	4
	Skin - Astringency (1=astringent; 10=not tannic)	10	10	10	10	10	10
	Skin – Persistence of skin in mouth (1=very persistent; 10= little persistent)	5	7	6	3	3	5
	General assessment (1=minimum; 10=maximum)	7	9	7	4	6	4
	Total score	174	193	193	147	167	174

I= Visual examination; II= Olfactive examination; III= Gustative and tactile examination

from the pedicel could be seen for thinned grapes. Scores of uniformity of colour were less for gibberellin treated clusters. A striking difference could not be identified between treatments according to stalk. Uniformity of color scores from berries was highest for control or 1/3 thinned with no gibberellin treatment. Detachment from the pedicel for a berry was observed to be easy for grapes of nonsprayed vines. Berries of gibberellin treated and thinned grapes were evaluated as crisper. Intensity of aromatic sensation was felt strongly for gibberellin sprayed and 1/2 thinned grapes. The most gustative balanced berries were found for 1/3 thinned grapes without hormone. A thin skin of the berries was perceived with hormone application. Grapes with gibberellin had lower scores in general gustative assessment. All scores were summed to make a final assessment and the highest figure was observed for thinned and non-gibberellin sprayed grapes.

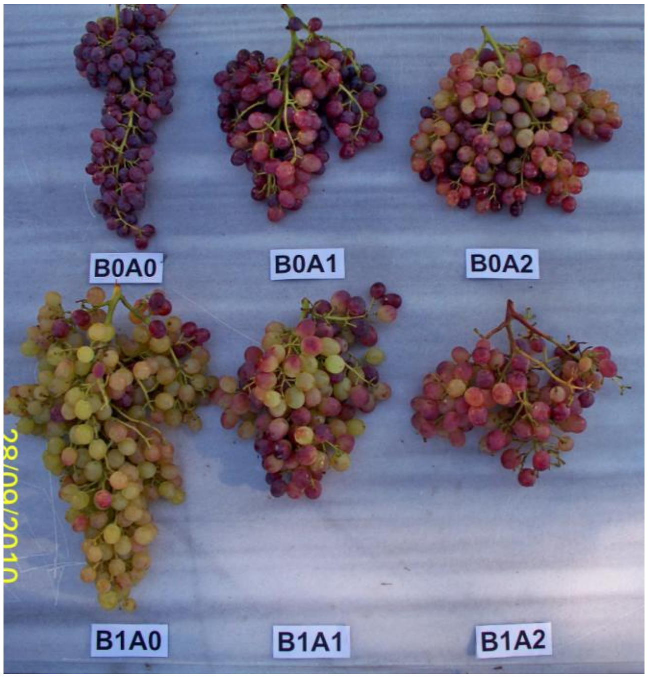

Figure 3. General appearance of berry thinning and gibberellin combinations at Reçel Üzümü grapes (B0=control, B1= 40 ppm GA_3; A0= control, A1= 1/3 berry thinning; A2= ½ berry thinning)

CONCLUSION

Depending upon gibberellin and berry thinning treatments are more effective alone as compared to combined applications for Reçel Üzümü vines. Larger berries and clusters can be achieved with gibberellin while advanced mature berries are achieved with berry thinning. Growers must be cautious because of the delayed effect of gibberellin on coloration and maturity of Reçel Üzümü grapes. In such cases, practices such as girdling and ethephon spray can enhance coloration and maturity level. Berries can be thinned to advance maturity level in this late season cv. Reçel Üzümü. Growers should prefer removal of 1/2 of a cluster for this purpose since there is no difference between thinning levels for cluster length and sensorial analysis.

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