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Effect of Pre-Harvest Application of Gibberellic Acid and Ethephon on the Quality of Table Grape

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Abstract

In this study the effects of plant growth regulators including; GA_3 (0 and 50 mg/l) and ethephon (0 and 500 mg/l) were studied on the quality properties of two grape cultivars (Perlette and Yaghuti). At the harvest time, some physicochemical characteristics such as fruit cluster weight, fruit diameter, length, volume and L/D ratio, flesh firmness, fresh weight, TA, pH, TSS and fruit color were measured at the harvest time. Results showed that fruits treats with GA3 had the highest, cluster weight, fruit diameter, length, volume and L/D ratio compared to ethephon, although pH and flesh firmness showed no differences between the treatments. None of treatments affected negatively the quality of the fruit in term of TSS. Using of GA_{3+} Ethephon treatment significantly increased cluster weight, length, volume, L/D ratio and fresh weight in both cultivars. Ethephon had no significant effect on the fruit size, but promoted berry softening and its effect was different for studied quality parameters.

Keywords: Plant growth regulators (PGRs), Titratable acidity (TA), Total soluble solids (TSS).

INTRODUCTION

Grape (*Vitis vinifera* L.) is one of the main fruit crops produced in Iran with over 102,142 tons in 2010 (FAO, 2010). Perlette and Yaghuti are the main seedless grape cultivars grown in south of Iran. Several studies have shown that plant growth regulators (PGRs) are beneficial to improve the yield and fruit quality. Among PGRs gibberellic acid (GA_3) is used widely for improving quality in other horticultural crops such as apple, orange and cherry (Hudson, 2005; Eman *et al*., 2007; Cline, and Trought, 2007). GA_3 is applied to grape cultivars during the fruit set to increase berry size and to achieve commercially acceptable fruit quality (Harrell and Williams, 1987; Wolsoo and Soonju, 2000; Peacock and Beede, 2004; Zoffoli *et al.*, 2008). Ethephon (2 chloroethylphosphonic acid) is a liquid PGR that release ethylene gas after application (Saure, 1990). This chemical has been used since the 1970s to improve color and hasten maturity of grape (Weaver and Pool, 1971; Cirami *et al.*, 1992; Leao and De Assis, 1999). Ethephon can stimulate anthocyanin production and color improvement in the skin of apple and grape berries (Awad and Jager, 2002; Lombard *et al*., 2004). The application of ethephon can reduces berry firmness, particularly when it is applied during fruit ripening. Little information is available about effect of GA_3 and ethephon together. The aim of this study were evaluation of the influence of pre-harvest foliar spray of GA_3 and ethephon on the qualitative characteristics of two grape cultivars i.e. Perlette and Yaghuti grown at Khuzestan province.

MATERIALS AND METHODS

Field experiments were carried out in 2009-10 at the commercial vineyard located in Dezful, Khuzestan province, Iran. The experiments was done on two grapes cultivars Perlette and Yaghuti. The randomized complete block design with three replication was used for statistical analysis. GA_3 was used in two concentrations (0, 50 mg/l) and also ethephon used at 0 and 500 mg/l. GA_3 applied at berry set stage, about 14 days after full bloom and when berries were 4 mm in length. The control treatments were sprayed with distilled water. Ethephon was applied 30 days after full bloom when about 50% of the berries get their normal color.

Immediately after commercial ripening, fruit clusters were harvested and transferred to the laboratory within 3 hours. For each treatment, ten clusters selected for quality analysis. Then cluster weight twenty berries of each cluster randomly selected and used for determination of berry length, diameter, shape index (L/D ratio), firmness, fresh weight, total soluble solid (TSS), titratable acidity (TA), TSS/TA ratio, pH, and skin color (Lightness, hue angle, and chroma).

Fruit firmness was measured using an electronic firmness tester (FG-5020, Lutron). Total soluble solids content and pH were measured by a portable refractometer (IPR-101, Iuchi) and pH meter (Metrohm-691) respecttively. Titratable acidity was determined by titration of fruit extract with 0.1 N NAOH till pH 8.1 and results reported based on tartaric acid.

Surface color traits determined based on L, a, b color spaces and results presented as hue and chroma (Yam *et al*., 2004) (Fig. 1 and Fig. 2). The data were analyzed using MSTATC statistical package and means differences were established by the Duncan's multiple range tests ($P \leq 0.05$).

RESULTS AND DISCUSSION

Fruit Physical Characteristics

The results showed that GA_3 alone or in combination with ethephon, significantly improved physical characteristics of table grape compared to control while other quality parameters such as length, diameter, pH and firmness were not affected by mentioned treatments (Table 1).

Fruit Weight

The weight of clusters is one of the quality factors that influenced on the sale price. Clusters treated with GA_3 and ethephon had the highest weight compared to all other treatments in both cultivars. The lowest fruit weight was belonged to control vines cv. Yaghuti (Fig. 3A). Peacock *et* *al*. (2004) reported that raisin yield and fresh weight yield of cv. Thompson Seedless were greatest when GA_3 was applied 14 days after full bloom. The role of GA_3 in improving the fruit weight may be due to its role in increasing cell enlargement (Pharis and King, 1995).

Fruit Volume

The highest berry volume was related to GA_3 at 50 mg/l and ethephone at 500 mg/l on the Perlette cultivar (Fig. 3B).

Fruit Shape

Some physical properties including fruit length, diameter and shape index (L/D ratio) are considered as fruit shape. Our data showed that quality of some parameters such as length, diameter and firmness were not affected by mentioned treatments (data not shown). It is evident in Fig. 3C. GA_3 significantly increased fruit L/D ratio in both cultivars. Also the lowest significant value of shape index was seen in control vines of Perlette cultivar.

Fruit Flesh Weight

In both cultivars, the highest berry fresh weight was obtained from trees sprayed with GA_3 and ethephon (Fig. 3D).

Fruit Chemical Characteristics

TSS is an important quality factors for attributes for many fresh fruits (Lu, 2004) because of solids include the soluble sugars sucrose, glucose and fructose as well as acids. Among the studied chemical characteristics (Table 2), there was no differences between treatments in terms of TSS. Using of GA_3 and ethephon treatment caused a decrease and increase in the TSS level respectively. The differences of TSS in fruits obtained probably due to the hydrolysis of starch to soluble sugars such as glucose, sucrose and fructose (Tehrani *et al*., 2011).

Our results were in accordance with the results reported by Lambord *et al*. (2004) for Felam and Bonheur grape cultivars. However obtained data indicated that juice acidity was significantly affected by different treatments, except the control and ethephon application treatment in Perlette cultivar, TA was similar to theer other treatments (Table 1 and 2). Spraying of GA_3 and ethephon together significantly increase the juice acidity compared with those sprayed with GA3 or ethephon alone. This may be due to the delaying effect of GA_3 on fruit maturity (Ju *et al*., 1999).

Consequently it can be noticed that TSS/TA was significantly affected by the applied treatments. Highest TSS/TA ratio (2.48) was obtained under 50 mg/l GA3 and 500 mg/l ethephon applying in Perlette cultivar.

Color Measurement

As mentioned above fruit color is considered to be one of the important external factors in determining fruit quality, as the appearance of the fruit greatly influences in view consumers. Surface color parameters of fruit including lightness (L*), chroma and hue angel changed under different applied treatments (Table 3). In this study, the maximum value of L* were seen in Perlette cultivar. This may be due to more shining of Perlette than Yaghuti cultivar.

The value of L* in Perlette cultivar was increased with ethephon. GA_3 and Ethephon showed the highest and lowest value of L* respectively. This results are in agreement with those reported that GA_3 delayed the development of lightness and Ethephon treatment enhanced chlorophyll II degradation in the skin (Usenik *et al*., 2005; Whale *et al*., 2008). Chroma (color saturation) on the fruit surface significantly decreased during fruit maturation in fruit treated with ethephon. It is evident from the data in Table 2 that Hue angle didn't affected by applied treatment while ethephon spraying treatment, Led to the development of the red color in cv. Yaghuti cultivar.

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Tables

Table 1. Analysis of variance for application GA_3 and Ethephon on quantitative and qualitative characteristics of ‘Yaghuti’ and ‘Perllete’ grapes

Hue	Chroma	L*	TA (mg/100ml)	TSS (%)	pH	Firm-ness (N)	Loss Weight (%)	Dry Weight (g)	Flesh Weight (g)	Fruit Volume (cm^3)	Lenght/ Diameter (mm)	Fruit Diameter (mm)	Fruit Length (mm)	Fruit Weight (g)	df	Source
0.00*	5.13*	5.34^{ns}	7434.37**	0.79**	0.00**	0.04**	0.11**	0**	0.014^{ns}	0.02**	1.29*	0.37**	0.13**	7343.13**	2	replication
26.77**	1783.48**	3263.63**	146484.37**	88.16**	0.31**	5.08**	37.87**	0.05**	3.34**	3.60**	7.05*	39.57**	29.63**	90695.29**	1	Cultivar (C)
0.09**	2.819^{ns}	6.11*	144150.00**	10.66*	0.01**	0.84^{ns}	7.22*	0.04**	1.28**	1.88**	23.65**	16.73**	53.01**	224019.24**	1	GA3 (G)
0.03**	18.97**	12.51**	337.500**	0.66**	0.02^{ns}	10.02**	8.29**	0.00^{ns}	0.01**	0**	0.08**	0.99^{ns}	0.74^{ns}	3006.08ns	1	Ethephon (E)
0.07**	0.98^{ns}	53.07**	280584.37**	1.5^{ns}	0.00**	0.40^{ns}	2.08^{ns}	0.01**	0.03**	0.00**	1.21^{ns}	2.17*	1.51*	21074.03**	1	Interaction G x C
0.03**	0.37**	31.9**	11484.37^{ns}	0.16**	0.03^{ns}	0.38^{ns}	4.07^{ns}	0.00^{ns}	0.01**	0.00**	0.08**	0.04**	0.01**	5401.87*	1	Interaction E x C
0**	0.67**	2.96^{ns}	600.00**	6^{ns}	0.07*	0**	0.02**	0.00^{ns}	0.14**	0.17*	2.04^{ns}	4.96**	2.83**	19410.87**	1	Interaction G x E
0.00^{ns}	11.34**	9.84**	459.37**	1.5^{ns}	0.00**	0.28^{ns}	10.20**	0.00^{ns}	0.06*	0.13*	0.20**	1.37^{ns}	1.95*	6974.12*	1	Interaction CxGxC
0.00	0.81	0.89	8963.83	1.36	0.01	0.23	0.89	0.00	0.01	0.02	0.00	0.42	0.24	1072.08	14	Error
-22.21	2.32	2.5	10.21	7.32	3.83	12.42	1.12	16.56	10.49	15.09	4.55	5.51	8.3	10.77		CV%

Means separated by Duncans multiple ranges test at the 5% level

^{ns} Not significant

* Significant at P=0.05

** Significant at P=0.01

Table 2. Effects of different treatments on TSS, TA and TSS/TA.

Treatment	TSS (%)		TA(%)		TSS/TA	
	Perlette	**Yaghuti**	**Perlette**	**Yaghuti**	**Perlette**	**Yaghuti**
Control	14.33 a	18.00 a	10.60 a	9.47 a	1.35 c	2.07 ab
GA_3	12.33 a	17.33 a	6.90 b	10.27 a	1.78 ab	1.68 bc
Ethephon	14.67 a	16.33 a	10.10 a	10.02 a	1.45 c	1.62 bc
GA_3+Ethephon	15.66 a	18.66 a	6.37 a	10.45 a	2.48 a	1.81 bc

Means separated by Duncans multiple ranges test at the 5% level
ns Not significant
* Significant at P=0.05
** Significant at P=0.01

Table 3. Effects of different treatments on Lightness, Chroma and Hue angle.

Treatment	Light		Chroma		Hue angle	
	Perlette	**Yaghuti**	**Perlette**	**Yaghuti**	**Perlette**	**Yaghuti**
Control	49.51 ab	27.10 d	48.15 a	31.63 c	104.99 a	52.80 a
GA_3	48.42 b	29.10 c	48.77 a	30.31 cd	107.20 a	57.60 a
Ethephon	51.25 a	21.37 e	47.83 a	29.06 d	106.47 a	35.49 a
GA_3+Ethephon	48.71 b	27.33 d	45.02 b	29.82 d	105.91 a	50.73 a

Means separated by Duncans multiple ranges test at the 5% level
ns Not significant
* Significant at P=0.05
** Significant at P=0.01

Figures

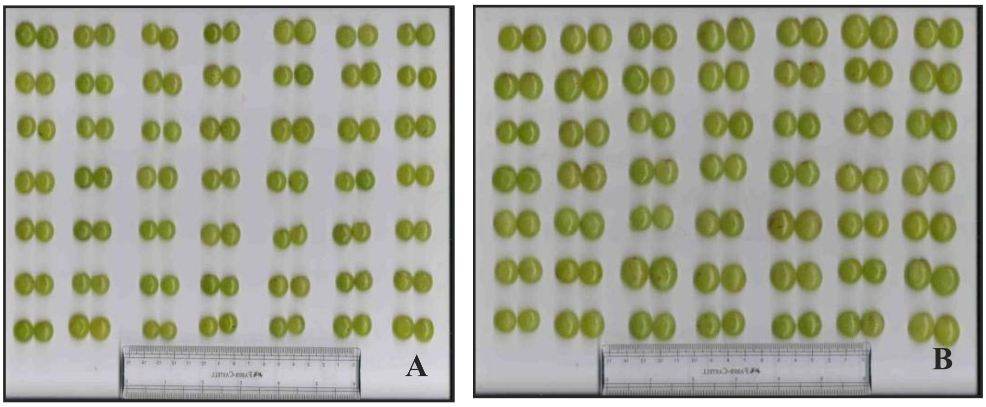

Fig. 1. Samples of scanned Perllet cultivar A) Control treatment B) GA3+Ethephon treatment.

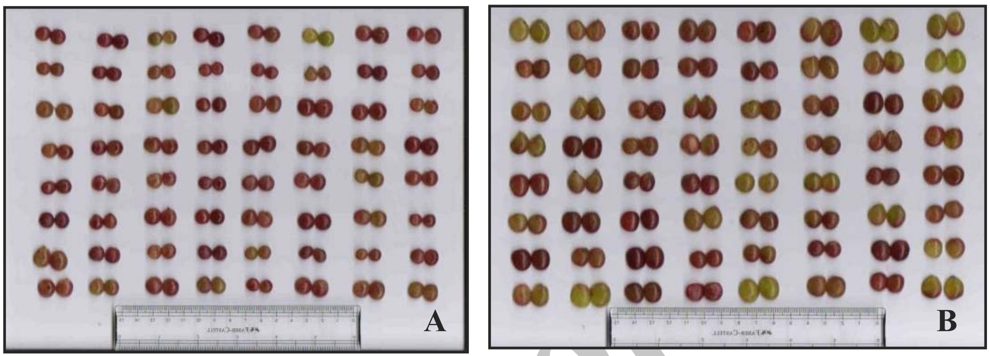

Fig. 2. Samples of scanned Yaghuti cultivar A) Control treatment B) GA_3+Ethephon treatment.

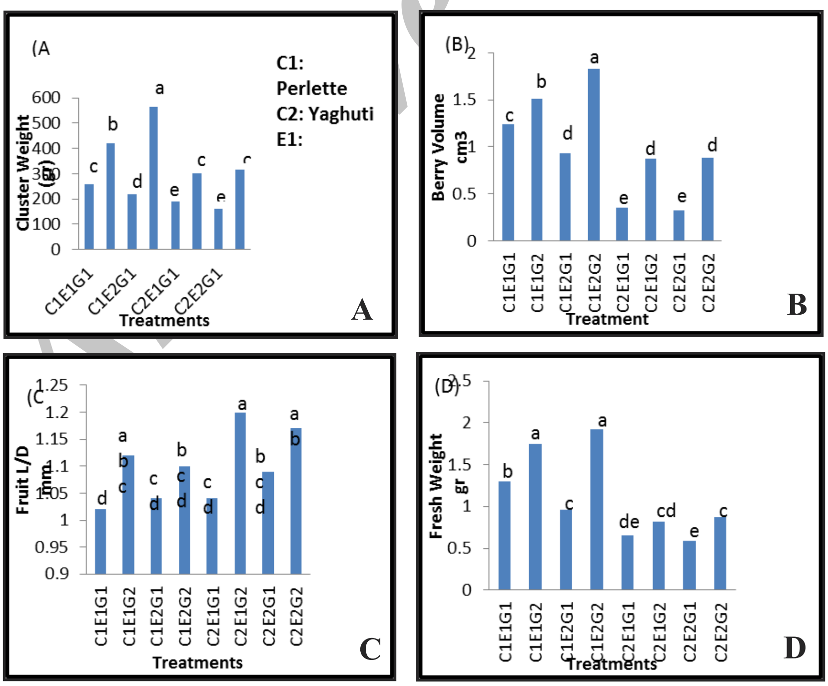

Fig. 3. Effects of different treatments on (A); cluster weight, (B); Berry Volume, (C); Fruit L/D, (D); Fresh Weigh.