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# Effect of pre-harvest treatment on yield, maturity and quality of Flame Seedless grape (*Vitis vinifera* L.)

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## ABSTRACT

**To improve fruit quality in grape cv. Flame Seedless, application of Ethephon (400 and 500 ppm) and trunk girdling was done at veraison stage. Cluster thinning was done by retaining 100, 75 and 50% of total number of bunches on the vines, and, the rest were removed immediately after full bloom. Highest yield was obtained in the treatment 100% Crop load + 500ppm Ethephon, followed by 75% Crop load + 500ppm Ethephon. The treatment of 50% Crop load + 500ppm Ethephon resulted in maximum bunch weight, lowest percentage of uneven coloured berries, maximum TSS, minimum acidity and maximum TSS:acid ratio, maximum anthocyanin content, advanced maturity by 9 days and had maximum sensory rating. But, in this treatment, yield was significantly lower than in treatments where either 75% or 100% Crop load was retained. Thus, considering yield as well as quality parameters, the treatment 75% Crop load + 500ppm Ethephon was found to be the best.**

**Key words:** Flame Seedless grape, Ethephon, girdling, thinning, crop load

## INTRODUCTION

In grape production, India is next only to USA, with annual production of 18,78,100 MT from an area of 80,000 ha (FAO, 2009). Peninsular India accounts for 90% area under grapes. India holds the distinction of highest productivity of grapes in the world. The major grape growing states in India are Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu. Grape is also grown in small pockets of Punjab, Haryana and Uttar Pradesh. In Punjab, grapes are grown on an area of 457 ha with annual production of 12,942 MT (Anon., 2011).

More than 90% of area under grape in Punjab is under cv. Perlette alone. Monoculture of this variety leads to market glut during a short span of 15-20 days in Punjab and adjoining states. Moreover, due to fear of pre-monsoon rains, there is panic harvest of poor quality grapes by growers.

Grape cv. Flame Seedless has recently been recommended by Punjab Agricultural University for commercial cultivation in the state. This variety has an edge over the commercial cv. Perlette as it is coloured and seedless, has relatively higher yield and better TSS/acid ratio. Due to excellent fruit quality and earliness, this cultivar has a potential for acquiring an important position in Northern India. Berries of Flame Seedless are also lesser than Perlette and are light purple in colour at maturity (Gill, 2003). Superiority of this variety is compromised by uneven colour development in berries and occurence of water berries. Uneven ripening results in poor fruit quality due to presence of unattractive, sour and green berries in a bunch.

Crop regulation with use of cultural practices like thinning, girdling, ringing and application of growth regulators has shown some promise in quality improvement in grapes (Dhillon *et al*, 1990). In the recent past, efforts have been made to improve colour of this variety with foliar application of Ethephon. However, uniform ripening of berries has not been achieved successfully. Ethylene-releasing compounds like Ethephon, applied at veraison, have been used successfully in many *Vitis vinifera* L. cultivars to improve colour in red grapes (Gallegos *et al*, 2006; Yahuaca *et al*, 2006). Human and Bindon (2008) also found that Ethephon exerted a strong influence on anthocyanin production in grape skin in this cultivar and is, therefore, a more likely solution to overcome poor colour development in production of this cultivar. Girdling has been practiced for years to produce large berries in Thompson seedless grapes intended for table use, and to enhance fruit quality by enhancing accumulation of sugars (Roper and Williams, 1989; Williams and Ayars, 2005).

## MATERIAL AND METHODS

The present investigation was undertaken in the new orchard of Department of Horticulture, Punjab Agricultural University, Ludhiana, during 2007-2008. There were twelve treatments in the experiment, with three replications. The experiment was laid out in Randomized Block Design (RBD). Flame Seedless cultivar planted at 3m X 3m spacing on Bower (Overhead) system of training was selected for the study. Thirty-six vines of uniform vigour were selected and these received uniform cultural practices during the course of the investigation. In the treatment of 100% Crop load, 120-130 bunches were retained on the vines. Likewise, in the treatment of 75% and 50% Crop load, 90-98 bunches and 60-65, bunches respectively, were retained on the vines while the rest were removed immediately after full bloom. All the treatments of Ethephon and girdling were applied at the veraison stage. Trunk girdling was done with a 2mm wide girdler.

| Treatment | Details |
|---|---|
| $T_1$ | 100% Crop load |
| $T_2$ | 75% Crop load |
| $T_3$ | 50% Crop load |
| $T_4$ | 100% Crop load + 400ppm Ethephon |
| $T_5$ | 100% Crop load + 500ppm Ethephon |
| $T_6$ | 100% Crop load + girdling |
| $T_7$ | 75% Crop load + 400ppm Ethephon |
| $T_8$ | 75% Crop load + 500ppm Ethephon |
| $T_9$ | 75% Crop load + girdling |
| $T_{10}$ | 50% Crop load + 400ppm Ethephon |
| $T_{11}$ | 50% Crop load + 500ppm Ethephon |
| $T_{12}$ | 50% Crop load + girdling |

Observations on bunch characters were recorded in 10 bunches at random from each vine. Bunch length, breadth and weight were recorded in these bunches. On attaining uniform purple colour by the berries, maturation date was recorded. Berry weight was recorded in 50 randomly-selected berries. Bunches from each treatment were evaluated for organoleptic qualities by a panel of five judges on the basis of external appearance of the fruit, its texture, taste and flavor. However, observations on uneven colored berries were recorded from 10 bunches selected at random from each vine. Berry skin showing less than 50% area without color development was counted as uneven colored berry and percentage of uneven coloured berries per bunch was calculated. Anthocyanin content was recorded by macerating the pulp in aqueous methanolic HCL solvent prepared by mixing methanol (95%) 85 parts+15 parts 1.5N hydrochloric acid. The extracts were centrifuged and OD recorded at 530nm and 657nm in a UV-visible spectrophotometer (Systronic, 108). Anthocyanin content was calculated based on a standard formula as follows (Mahadeven and Sridhar, 1986):

$$\text{Anthocyanin (mg/100g of tissue)} = \frac{(OD530) - 0.33(OD657)}{W} \times 100$$

W = Weight of sample in grams

Total soluble solids were recorded as °Brix using Bausch and Lamp Hand Refractometer at room temperature. Subsequent corrections in the readings were made at 20°C using a temperature correction chart. Acidity was determined by titrating 2ml of juice against 0.1 N NaOH solution using phenolphthalein as an indicator. Appearance of light-pink colour marked the end point of titration. Percentage tartaric acid was calculated and expressed as anhydrous malic acid using the following formula:

$$\text{Per cent acidity} = \frac{0.0075 \times 0.1\ \text{N NaOH used (ml)}}{\text{Volume of juice (ml)}} \times 100$$

## RESULTS AND DISCUSSION

Treatment $T_5$ (Crop load 100% + 500ppm Ethephon) resulted in significantly higher yield (25.37 kg/vine), followed by treatment $T_8$ (Crop load 75% + 500ppm Ethephon (23.07 kg/vine) compared to other treatments (Table 1). However, with decreased crop load (from 100 to 50%), there was a

**Table 1. Effect of various treatments on yield, bunch weight and bunch size (length and breadth) in Flame Seedless grape**

| Treatment | Yield (kg/vine) | Bunch wt. (g) | Bunch length (cm) | Bunch breadth (cm) |
|---|---|---|---|---|
| $T_1$ Crop load (100%) | 24.79 | 316.33 | 17.80 | 9.13 |
| $T_2$ Crop load (75%) | 19.46 | 342.83 | 18.26 | 9.26 |
| $T_3$ Crop load (50%) | 14.52 | 341.16 | 18.63 | 9.59 |
| $T_4$ Crop load (100%)+ 400 ppm Ethephon | 22.91 | 353.00 | 18.13 | 9.80 |
| $T_5$ Crop load (100%)+ 500 ppm Ethephon | 25.37 | 358.00 | 18.80 | 9.83 |
| $T_6$ Crop load (100%)+ Girdling | 23.76 | 326.66 | 19.76 | 9.96 |
| $T_7$ Crop load (75%)+ 400 ppm Ethephon | 20.43 | 375.00 | 19.53 | 9.82 |
| $T_8$ Crop load (75%)+ 500 ppm Ethephon | 23.07 | 379.66 | 19.73 | 9.86 |
| $T_9$ Crop load (75%)+ Girdling | 19.26 | 340.33 | 20.10 | 10.56 |
| $T_{10}$ Crop load (50%)+ 400 ppm Ethephon | 13.12 | 363.00 | 19.26 | 9.93 |
| $T_{11}$ Crop load (50%)+ 500 ppm Ethephon | 17.28 | 423.86 | 19.90 | 10.33 |
| $T_{12}$ Crop load (50%)+ Girdling | 14.21 | 341.33 | 20.20 | 11.46 |
| CD ($P= 0.05$) | 0.15 | 2.08 | 0.38 | 1.06 |

reduction in yeild. Chadha and Shikamany (1999) reported yield of grapevine to be a mean function of number of clusters and their mean weight. Fracaro and Boliani (2001) reported that Ethephon at 7500ppm, applied 20 days before pruning, resulted in greater yield.

All the treatments increased bunch weight compared to Control (Table 1). Treatment $T_{11}$ (Crop load 50% + 500ppm Ethephon) resulted in higher bunch weight (423.86g) compared to Control. This was followed by $T_8$ (Crop load (75%) + 500ppm Ethephon), which recorded 379.66g. Increase in bunch weight observed in the study can be attributed to the effect of cluster-thinning by increased amount of carbohydrates available for growth and development of the bunches. Hyun *et al* (1996) also reported higher bunch weight with Ethephon treatment at veraison in Kyoho grapes. Panwar *et al* (1994) found that Ethephon at 500ppm increased bunch weight by reducing berry drop. Similarly, Cheema *et al* (2003) reported greater cluster weight in 50% cluster-thinning along with canopy management in Perlette grapes. Hameed *et al* (2004) found that trunk girdling and cluster/berry thinning improved cluster and berry weight. JinYong *et al* (2005) reported that trunk girdling done when fruits were 15-16mm in diameter increased fruit weight by 10%.

Maximum bunch length (20.20cm) was recorded in treatment $T_{12}$ (Crop load 50% + girdling) followed by treatment $T_9$ (crop load (75%) + girdling). Jawanda and Vij (1971) and Bhujbal and Wavhal (1972) also found an increase in bunch length due to girdling in Perlette and Beauty Seedless grapes.

Maximum bunch breadth was recorded in treatment $T_{12}$ (Crop load 50% + girdling) (11.46cm), followed by treatment $T_9$ (Crop load 75% + girdling) (10.56cm). Fawzi and Moniem (2003) reported increase in bunch breadth with girdling alone, or in combination with cluster-thinning, in Black Monukka grapes.

Significant reduction in percentage of uneven coloured berries was recorded in all the treatments over Control (Crop load 100%, Table 2). However, treatment $T_{11}$ (Crop load 50% + 500ppm Ethephon) at veraison resulted in lowest percentage of uneven-coloured berries (14.02%), followed by treatment T-11 (Crop load 75% +500ppm Ethephon). It was concluded that uneven berry percentage decreased with decrease in crop load (50%). Also, with increase in concentration of Ethephon (500ppm) and low crop load (50%), there was a reduction in uneven berry percentage. Girdling treatment also decreased uneven berry colour, along with low crop load (50%). Enhanced fruit colour in coloured cvs. Karanchi Gulabi and Kandhari with Ethephon was reported by (Singh and Chundawat, 1978). Uniform color development with ethephon 500 ppm at veraison in Beauty Seedless and Pinot Noir grapes has also been reported (Mehta and Chundawat 1979; Powers *et al* 1980). Panwar *et al* (1994) also reported that Ethephon sprayed at veraison reduced the number of unevenly ripened berries in Beauty Seedless grape. Kitamura *et al* (2005) found that by controlling crop load, proper coloration of 'Aki Queen' fruits can be obtained through regulation of anthocyanin concentration.

It is clear from the data (Table 2) that all treatments resulted in significant increase in anthocyanin content compared to crop load at 100% (Control). Maximum anthocyanin content (23.06 mg/100g) was recorded in treatment $T_{11}$ (Crop load 50% + 500ppm Ethephon), followed by treatment $T_8$ (Crop load 75% +500ppm Ethephon).These results show that decrease in crop load and increase in Ethephon concentration can increase anthocyanin concentration. Girdling, with decreasing crop load, also increases anthocyanin content, but less than that with Ethephon and decreasing crop load. Jindal and Naik (1994) also found that application of Ethephon at 750ppm resulted in increase in anthocyanin pigments in coloured

**Table 2. Effect of various treatments on % uneven coloured berries in Flame Seedless grape**

| Treatment | Uneven coloured berries (%) | Anthocyanin content (mg/100g) | Berry wt.(g) |
|---|---|---|---|
| $T_1$ Crop load (100%) | 85.51 | 7.07 | 2.08 |
| $T_2$ Crop load (75%) | 69.36 | 10.55 | 2.17 |
| $T_3$ Crop load (50%) | 56.24 | 11.36 | 2.38 |
| $T_4$ Crop load (100%)+ 400 ppm Ethephon | 28.28 | 11.55 | 2.54 |
| $T_5$ Crop load (100%)+ 500 ppm Ethephon | 23.84 | 12.38 | 2.58 |
| $T_6$ Crop load (100%)+ Girdling | 39.05 | 9.52 | 2.62 |
| $T_7$ Crop load (75%)+ 400 ppm Ethephon | 18.32 | 17.62 | 2.56 |
| $T_8$ Crop load (75%)+ 500 ppm Ethephon | 15.63 | 21.72 | 2.59 |
| $T_9$ Crop load (75%)+ Girdling | 33.21 | 13.01 | 2.97 |
| $T_{10}$ Crop load (50%)+ 400 ppm Ethephon | 16.66 | 18.01 | 2.66 |
| $T_{11}$ Crop load (50%)+ 500 ppm Ethephon | 14.02 | 23.06 | 2.69 |
| $T_{12}$ Crop load (50%)+ Girdling | 28.38 | 15.84 | 2.99 |
| CD (*P=0.05*) | 2.37 | 1.71 | 0.47 |

grapes. Likewise, high anthocyanin content was observed with application of Ethephon at veraison in Tannat grapes (Ferrer and Gonzalez, 2002). Kitamura *et al* (2005) found in grape that controlling crop load resulted in proper coloration of 'Aki Queen' fruits through regulation of anthocyanin concentration. Anthocyanin content and soluble contents in the skin of grape were higher with girdling in combination with low crop load, compared to girdling with higher crop load (Yamane and Shibayama, 2006).

Maximum berry weight (2.99g) was significantly higher in treatment $T_{12}$ (Crop load 50% + girdling), followed by treatment $T_9$ (Crop load 75% + girdling). Increase in berry weight with trunk girdling and lower crop load might be due to higher availability of photosynthates to the bunches. Dookoozlian *et al* (1995) also reported increase in berry weight with girdling at fruit set in Crimson Seedless. However, Singh (1995) found highest berry weight with cluster-thinning in Perlette and Beauty Seedless grapes. Increase in weight and size of berry, cluster and rachis occurred as a result of girdling (Kalil *et al*, 1999). Josan *et al* (2001) found that trunk girdling along with brushing increased berry size. Tarricone (2007) reported that cane girdling at veraison stage increased berry and bunch mass compared to Control.

Data on effect of various treatments on fruit maturity (Table 3) indicated that in treatment $T_{11}$ (Crop load 50% + 500ppm Ethephon), maturity advanced by nine days compared to Control, followed by treatment $T_8$ (Crop load 75% + 500ppm Ethephon) and treatment T-10 (Crop load 50% + 400ppm Ethephon), where maturity advanced by eight days. Other treatments advanced maturity by 3-7 days over Control. Advancement of maturity with Ethephon was possible due to release of ethylene - a ripening hormone, resulting in early ripening. Ethephon has also been reported to hasten maturity of many grape cultivars when applied at veraison (Jensen *et al*, 1975; 1980; 1982; Peacock *et al*, 1977; Metha and Chundawat, 1979).

Results showed that maturation date advanced with low crop load (50%) But, with increased Ethephon concentration (500ppm) and low crop load (50%), greater advancement in maturation date was observed, compared to low crop-load alone. Girdling also advanced maturity date with low crop-load (50%) compared to low crop-load alone, but maturity was delayed compared to Ethephon treatment and low-crop load. Ethrel at 250ppm advanced ripening by about 10 days in Gulabi grape (Reddy and Prakash, 1989). Al-Dujaili (1989) reported that girdling advanced fruit ripening by 3-4 days in Buhurzy grape. Cheema *et al* (2003) found that cluster-thinning advanced maturity by nine days in Perlette. Advancement in maturity may be attributed to the reduced crop load per vine.

Maximum sensory score (8.97) was recorded with treatment $T_{11}$ (Crop load 75% + 500ppm Ethephon) at veraison, followed by treatment $T_8$ (Crop load 75% + 500ppm Ethephon) which had a sensory score of 8.59 (Table 3). Control, however, got lowest sensory score (3.32).

It is clear from the data (Table 2) that all the treatments resulted in significant increase in total soluble solids (TSS) compared to 100% crop load (Control). There was incremental increase in total soluble solids with increase in Ethephon concentration and decrease in crop load. Highest total soluble solids 17.30$^0$Brix were recorded in treatment $T_{11}$ (Crop load 50% + 500ppm Ethephon), followed by treatment $T_8$, (Crop load 75% + 500ppm Ethephon) which recorded 17.10$^0$Brix. Data (Table 3) on total acidity revealed that all treatments reduced acidity significantly compared to Control. Minimum acidity was recorded in

**Table 3. Effect of various treatments on maturation, palatability rating and chemical traits (TSS and acidity) in Flame Seedless grape**

| Treatment | Date of maturation | Palatability rating | TSS ($^0$Brix) | Acidity (%) | TSS/ Acidity ratio |
|---|---|---|---|---|---|
| $T_1$ Crop load (100%) | 30/5 | 5.32 | 14.00 | 0.60 | 23.33 |
| $T_2$ Crop load (75%) | 28/5 | 5.75 | 14.80 | 0.52 | 28.46 |
| $T_3$ Crop load (50%) | 27/5 | 5.94 | 14.93 | 0.48 | 31.10 |
| $T_4$ Crop load (100%)+ 400 ppm Ethephon | 26/5 | 6.54 | 15.06 | 0.48 | 31.37 |
| $T_5$ Crop load (100%)+ 500 ppm Ethephon | 25/5 | 6.84 | 15.36 | 0.41 | 37.46 |
| $T_6$ Crop load (100%)+ Girdling | 27/5 | 6.13 | 15.00 | 0.52 | 28.84 |
| $T_7$ Crop load (75%)+ 400 ppm Ethephon | 23/5 | 7.92 | 16.43 | 0.41 | 40.07 |
| $T_8$ Crop load (75%)+ 500 ppm Ethephon | 22/5 | 8.59 | 17.10 | 0.37 | 46.21 |
| $T_9$ Crop load (75%)+ Girdling | 25/5 | 7.15 | 15.70 | 0.48 | 32.70 |
| $T_{10}$ Crop load (50%)+ 400 ppm Ethephon | 22/5 | 8.50 | 16.63 | 0.37 | 44.94 |
| $T_{11}$ Crop load (50%)+ 500 ppm Ethephon | 21/5 | 8.97 | 17.30 | 0.36 | 48.05 |
| $T_{12}$ Crop load (50%)+ Girdling | 24/5 | 8.01 | 16.90 | 0.45 | 37.55 |
| CD (*P=0.05*) | — | 0.03 | 0.35 | 0.09 | 3.3 |

treatment $T_{11}$ (Crop load 50% + 500ppm Ethephon) at 0.36%, followed by treatment $T_8$ (Crop load 75% + 500ppm Ethephon) (0.37%). Reduction in acidity as a result of Ethephon application could be due to effect of this chemical in increasing membrane permeability (which permits acids, stored in cell vacuoles, to respire at a faster rate) (Hardy, 1968; Kliewer, 1971). It is evident from the data (Table 3) that all the treatments influenced TSS/acid ratio in fruits. Maximum TSS/acid ratio was recorded in treatment $T_{11}$ (Crop load 50% + 500ppm Ethephon) (48.05), followed by treatment $T_8$ (Crop load 75% + 500ppm Ethephon) (46.21). Increase in total soluble solids with Ethephon applications is in support with findings of Sharma and Jindal (1983) who found increase in total soluble solids by Ethrel application in Beauty Seedless grape. Amutha and Rajendran (2001) found that Ethephon at 500ppm produced fruits of superior quality in terms of increased sugar content and decreased acidity. Godara *et al* (2002) also found that Ethrel (Ethephon) at 500ppm at veraison stage increased total soluble solids (TSS) and decreased acidity in Thompson Seedless grape. Likewise, Ahmad and Zargar (2005) found that Ethephon treatment (500ppm) with or without girdling at veraison stage increased TSS and accumulation of sugars. Girdling and ethanol also increased total soluble solids, berry colouration and hastened ripening. In the present study it observed that treatment 75% Crop load + 500ppm Ethephon (T8) is the best combination improving yield, fruit maturity and quality of grape *cv.* Flame Seedless.

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