

Original Research Article

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Effect of Pre-Harvest Application of Hydrogen Cyanamide and Abscisic Acid (ABA) on Time of Ripening and Fruit Quality of Flame Seedless Grape (*Vitis vinifera L.*)

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An experiment was conducted to ascertain the effect hydrogen cyanamide (HCN) @ 2 per cent *a.i* and abscisic acid (ABA) on time of ripening and fruit quality of Flame Seedless grapes. The treatment (T_6 – HCN @ 2% + ABA @ 100 ppm) had advanced the time of ripening by 9-days as compared to untreated (control). Likewise, the maximum bunch weight (384.67 g) was recorded in a treatment in which 2 per cent HCN + 100 ppm of ABA was applied at veraison stage. Grapevines treated with 2 per cent HCN + 100 ppm ABA + 400 ppm ethephon had lowest uneven colour of berries/bunch (16.78 %). The maximum TSS was also recorded in T_3 (HCN 2 % + 100 ppm ABA), while lowest acidity was recorded in treatment T_6 (HCN 2 % + 100 ppm ABA + 400 ppm ethephon). The maximum (41.87 mg/100 g) anthocyanin content was recorded in treatment T_3 i.e. HCN (2 %) + 100 ppm ABA. The present study suggested that pre-harvest treatment of 2 per cent HCN (at end of December) + 100 ppm ABA (at veraison stage) was helpful in advancement of ripening and improvement in fruit quality in Flame Seedless grapes.

Introduction

India has 3.31 per cent share of world grapes production. At present, grapes occupies an area of 122 thousands ha with an annual production 2590 thousand MT (Anonymous 2015-16). Maharashtra is a largest producer of the grapes in the country and contributed 75 per cent of the total domestic production. The cultivars like Thomson Seedless, its clones Tas-e-Ganesh, Manik-Chaman and Sharad Seedless are the major commercial cultivars of this region. In north-western Indian plains the grape cultivation is confined to Punjab, Haryana, parts of Rajasthan and Uttar Pradesh. In this region 'Parlette' variety of grapes has been widely cultivated and it's

occupied about 90 per cent area under grapes. To restrict the monoculture of 'Perlette' in northern states of India, The Punjab Agricultural University, Ludhiana has recommended coloured grape variety 'Flame Seedless' for commercial cultivation in the state. Flame Seedless developed by J. Weinberger and F. Harmon in 1989 (Van der Merwe *et al.*, 1991). This variety has an edge over commercial grape variety Perlette as it has crimson red colour, seedless berries, relatively higher yield, better TSS: acid ratio and bunch is medium and well filled and long shelf life. It ripens a week later than Perlette and reduce market glut due to Perlette.

Although 'Flame Seedless' cultivar of grapes has many advantages over 'Perlette' However, in sub-tropical conditions it exhibits a problem of uneven colour development because high temperature inhibits anthocyanin accumulation in grape berry skin (Spayed *et al.*, 2002; Yamane and Shibayama 2006). Further under subtropical conditions, this variety ripen during 2nd week of June, often this time coincide with pre-monsoon rainfall, which may cause the fear among grape growers. Hence, there is an urgent need to advancement in time of ripening of Flame Seedless grapes, so it can escape from damage of pre-monsoon rainfall. Previously, various attempts have been made to promote early bud burst and ripening by using hydrogen Cyanamide immediately after pruning (Pandey, 1989; Arora *et al.*, 2011). In recent past, efforts have also been made by various worker's to improve the colour of this variety with bunch thinning and foliar application of ethephon (and Kaur *et al.*, 2013). However, the uniform ripening of the berries has not been achieved successfully. Therefore, in the present studies an attempt has been made to advance the time of ripening and improvement in the fruit quality of Flame Seedless grapes by attaining uniform colour with the cumulative application of hydrogen cyanamide and abscisic acid (ABA).

Materials and Methods

The experiment were conducted on 14-years-old own rooted grape vines of *c.v.* 'Flame Seedless' grapes trained on bower's system and planted at 3m × 3m distance at the Fruit Research Farm, Department of Fruit Science, Punjab Agricultural University, Ludhiana, during 2015 fruiting season received uniform cultural practices during the studies period. The various treatment consists of T₁ (Hydrogen Cyanamide 2% + 50 ppm ABA); T₂ (Hydrogen Cyanamide 2% + 75 ppm ABA); T₃ (Hydrogen Cyanamide 2% + 100

ppm ABA); T₄ (Hydrogen Cyanamide 2% + 50 ppm ABA + 400 ppm Ethephon); T₅ (Hydrogen Cyanamide 2% + 75 ppm ABA + 400 ppm Ethephon); T₆ (Hydrogen Cyanamide 2% + 100 ppm ABA + 400 ppm Ethephon); T₇ (Hydrogen Cyanamide 2% + 400 ppm Ethephon); T₈ (75% crop load + 400 ppm Ethephon (Local recommended practice) and T₉ Control (untreated).

The Flame Seedless vines were pruned to 4 buds level during end December (except vines of treatments T₈ and T₉). The hydrogen cyanamide @ 2 per cent active ingredient was sprayed on canes of pruned vines immediately after pruning. In case of treatments T₈ (recommended technology) and T₉ (control), vines were pruned to four buds level during last week of January i.e. recommended time of pruning in grapes under northern Indian conditions. Barring control (T₉), in all the treatments 75-80 bunches were retained at time of bunches emergences. The various concentration of ABA and ethephon was sprayed under different treatments at colour break stage. At time of spray tween-20 @ 1ml/ liter were also added for increasing the effectiveness of growth regulators. At time of ripening, fruit were harvested from all the replication during morning hours & immediately transfer to viticulture laboratory of Department of Fruit Science, PAU, Ludhiana for analysis of fruits by employing standard procedures (AOAC, 1990). The data recorded were analyzed for variance by using SAS (V 9.3, SAS Institute Inc., USA). The treatment means are subjected to mean separation by Least Significant Difference (LSD, p≤0.05).

Results and Discussion

Time of ripening

The data revealed that earliest fruit ripening was observed on 1st June, (advanced time of ripening by 9-days as compared to control) in

the treatment T₃ in which vines were treated with HCN 2 per cent at end of December and 100 ppm ABA at veraison stage (Fig. 1). This was followed by treatments T₁ (HCN 2% + ABA 50 ppm) and T₂ (HCN 2% + ABA 75 ppm) resulted in advancement in ripening by 8 days as compared to control. Whereas, the treatment T₅ (HCN 2% + 75 ppm ABA + 400 ppm ethephon) fruits was ripened 5-days advance as compared to control.

The treatment T₈ (75% crop load + 400 ppm ethephon application) was led to advancement in ripening by two days only as compared to control. In present studies, the advancement of ripening was due to treatment of vines with HCN which is a chemical help in advancement of time of ripening and early bud burst by breaking the dormancy. In treated vines, the treatment with ripening hormone ABA/ Ethepron also caused the synergist effect along with HCN in advancement in ripening as compared to control/ untreated vines. Previously, Pandey, 1989 in Pusa Seedless grapes and Arora *et al.*, (2011) in ‘Perlette’ grapes observed advancement in time of ripening in vines treated with HCN immediately after pruning. Likewise, Singla *et al.*, (1992) found that ethephon at 750 ppm advanced the time of ripening by 7- days in ‘Early Muscat’ and by 8-days in cv. Gold. Similarly, abscisic acid has traditionally been considered as the main triggering signal for the onset of ripening in grapes berries, grapevine showed an increase in ABA concentration in berries just before veraison stage. ABA concentration is very low in unripe fruit, but it increases as a fruit ripens, so it is therefore, considered that ABA plays an important role in regulating the rate of fruit ripening (Setha 2012).

Yield (kg/vine) and marketable yield

The pre-harvest application of HCN, ABA and ethephon significantly affected the fruit

yield in Flame Seedless grapes (Table 1). The treatment T₃ i.e. (HCN 2% + 100 ppm ABA) was recorded highest fruit yield and it was significantly higher yield (32.94 kg/vine) as compared to other treatment. In control the higher fruit yield was recorded due to grapevines were retained with 100 per cent crop load (110-120 bunches/vine).

The treatments T₂ (HCN @ 2%+ ABA @ 75 ppm) and T₈ (75% crop load + 400 ppm ethephon) recorded 28.27 kg and 27.31 kg fruit yield per vine, respectively, which was significantly lower than fruit yield (30.75 kg/vine) recorded in control.

Leao and Silva (2004) studied the effect of hydrogen cyanamide on ‘Italia’ table grape cultivar, in the Sao Francisco River Valley and found that increments of 68 per cent and 84 percent in the yield per plant, respectively in the 1st and 2nd harvest seasons. Quiroga *et al.*, (2009) found that the application ABA on vines of grape cv. ‘Cabernet Sauvignon’, it likely to be enhance bunch per plant by (1.1-to 1.3-fold) across all three harvests.

The highest marketable yield (27.02 kg/vine) was recorded with application of treatment T₃ i.e. (HCN 2% + 100 ppm ABA) which was significantly higher than other treatments (Table 1). This was followed by the treatments T₆ (HCN 2%+ ABA + 100 ppm ABA + 400 ppm ethephon) recorded 25.2 kg marketable yield per vine (Fig. 3).

The lowest marketable yield per vine was recorded with T₉ (control). In present studies, higher marketable yield in vines treated with ABA and ethephon attributed to higher number of uniform bunches in these treatments as compared to control. Likewise, previously Mehta and Chundawat (1979) and Dokoozlian *et al.*, (1995) reported uniform colour development in berries with application of ethephon.

Table.1 Effect of pre-harvest application of hydrogen cyanamide, ABA and ethephon on yield, marketable yield and bunch weight of flame seedless grapes

Treatments		Yield (kg/vine)	Marketable Yield (kg/vine)	Bunch weight (g)
T ₁	HCN 2% + 50 ppm ABA	30.06	22.18	343.60
T ₂	HCN 2% + 75 ppm ABA	28.27	22.79	351.73
T ₃	HCN 2% + 100 ppm ABA	32.94	27.02	384.67
T ₄	HCN 2% + 50 ppm ABA + 400 ppm Ethephon	29.20	23.67	368.90
T ₅	HCN 2% + 75 ppm ABA + 400 ppm Ethephon	29.58	23.11	367.27
T ₆	HCN 2% + 100 ppm ABA + 400 ppm Ethephon	30.28	25.20	371.99
T ₇	HCN 2% + 400 ppm Ethephon	28.76	23.43	362.80
T ₈	75% C.L + 400 ppm Ethephon (Recommended)	27.31	20.60	351.40
T ₉	Control (untreated)	30.75	17.67	283.47
LSD (p ≤ 0.05)		2.06	1.68	28.92

Table.2 Effect of pre-harvest application of hydrogen cyanamide, ABA and ethephon application on total soluble solids and acidity of flame seedless grapes

Treatments		TSS (%)	Acidity (%)
T ₁	HCN 2% + 50 ppm ABA	17.40	0.51
T ₂	HCN 2% + 75 ppm ABA	16.30	0.50
T ₃	HCN 2% + 100 ppm ABA	18.43	0.48
T ₄	HCN 2% + 50 ppm ABA + 400 ppm Ethephon	16.60	0.58
T ₅	HCN 2% + 75 ppm ABA + 400 ppm Ethephon	16.90	0.52
T ₆	HCN 2% + 100 ppm ABA + 400 ppm Ethephon	16.97	0.46
T ₇	HCN 2% + 400 ppm Ethephon	16.77	0.52
T ₈	75% C.P + 400 ppm Ethephon (Recommended)	17.17	0.56
T ₉	Control (untreated)	15.93	0.61
LSD (p ≤ 0.05)		0.86	0.13

Table.3 Effect of pre-harvest application of hydrogen cyanamide, ABA and ethephon application on anthocyanin content (mg/100 g) and uneven colour of berries/bunch (%) of flame seedless grapes

S. No.	Treatments	Uneven colour of berries/bunch (%)	Anthocyanin content (mg/100 g)
T ₁	HCN 2% + 50 ppm ABA	26.22	29.87
T ₂	HCN 2% + 75 ppm ABA	19.41	37.83
T ₃	HCN 2% + 100 ppm ABA	17.97	41.87
T ₄	HCN 2% + 50 ppm ABA + 400 ppm Ethephon	18.93	34.39
T ₅	HCN 2% + 75 ppm ABA + 400 ppm Ethephon	21.86	39.20
T ₆	HCN 2% + 100 ppm ABA + 400 ppm Ethephon	16.78	40.16
T ₇	HCN 2% + 400 ppm Ethephon	18.54	34.80
T ₈	75% C.P + 400 ppm Ethephon (Recommended)	24.59	29.60
T ₉	Control (untreated)	42.52	26.37
LSD (p ≤ 0.05)		1.87	1.04

Fig.1 Effect of pre-harvest application of hydrogen cyanamide, ABA and ethephon on time of ripening of flame seedless grapes

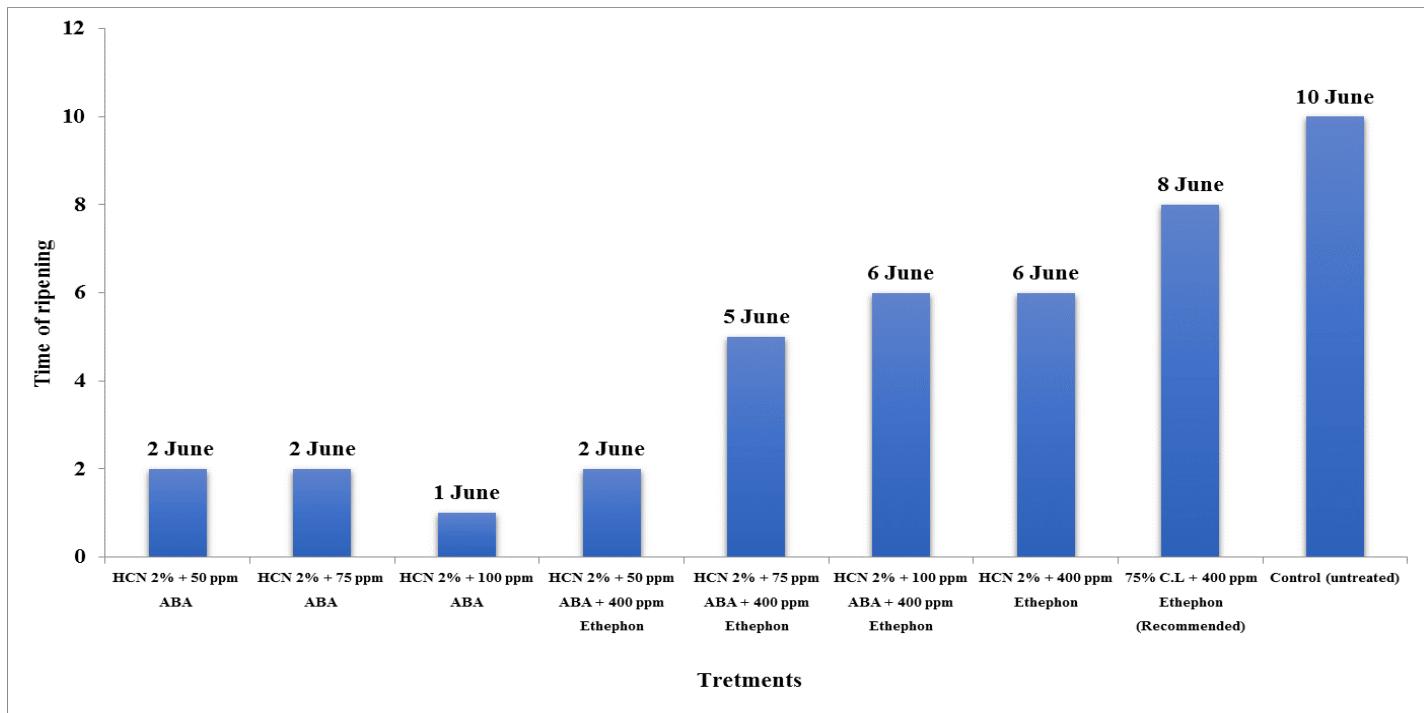


Fig.2 Effect of pre-harvest application of hydrogen cyanamide, ABA and ethephon on anthocyanin and uneven colour of barriers/bunches of flame seedless grapes

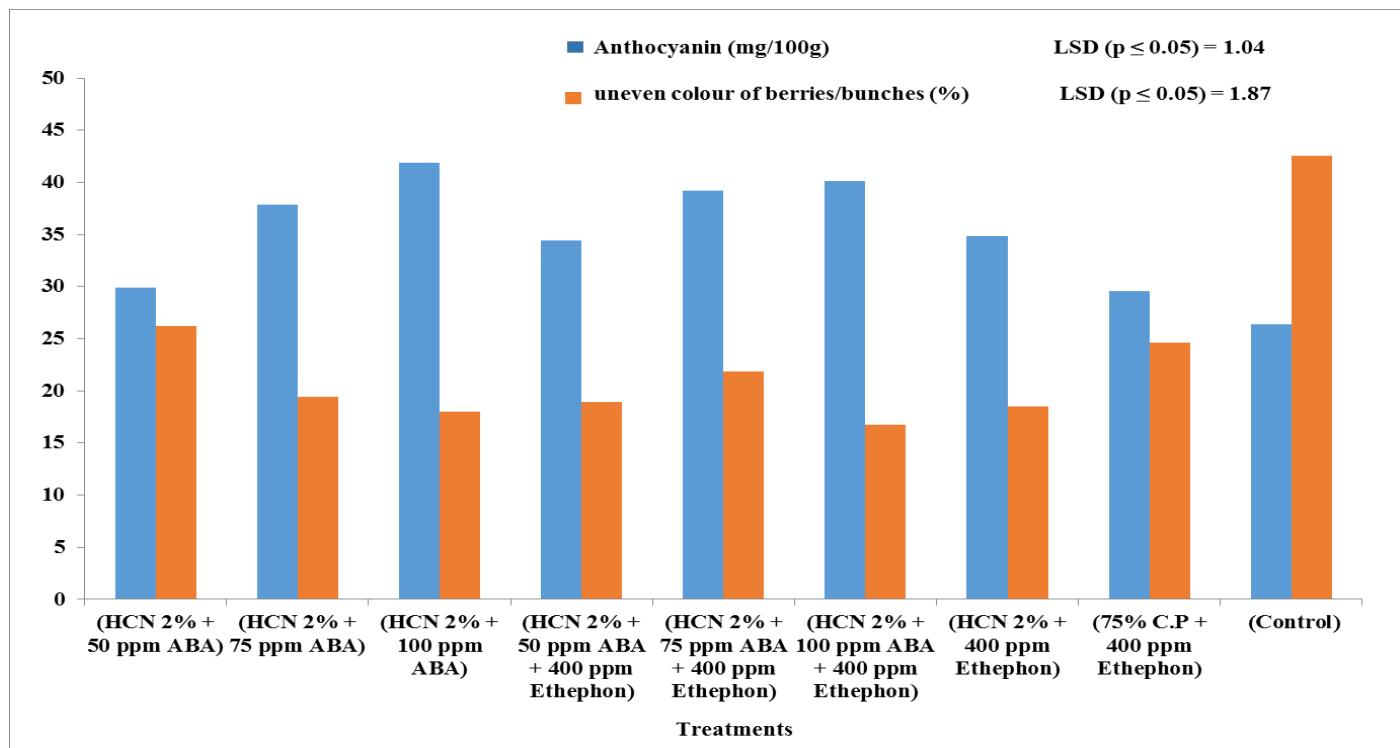
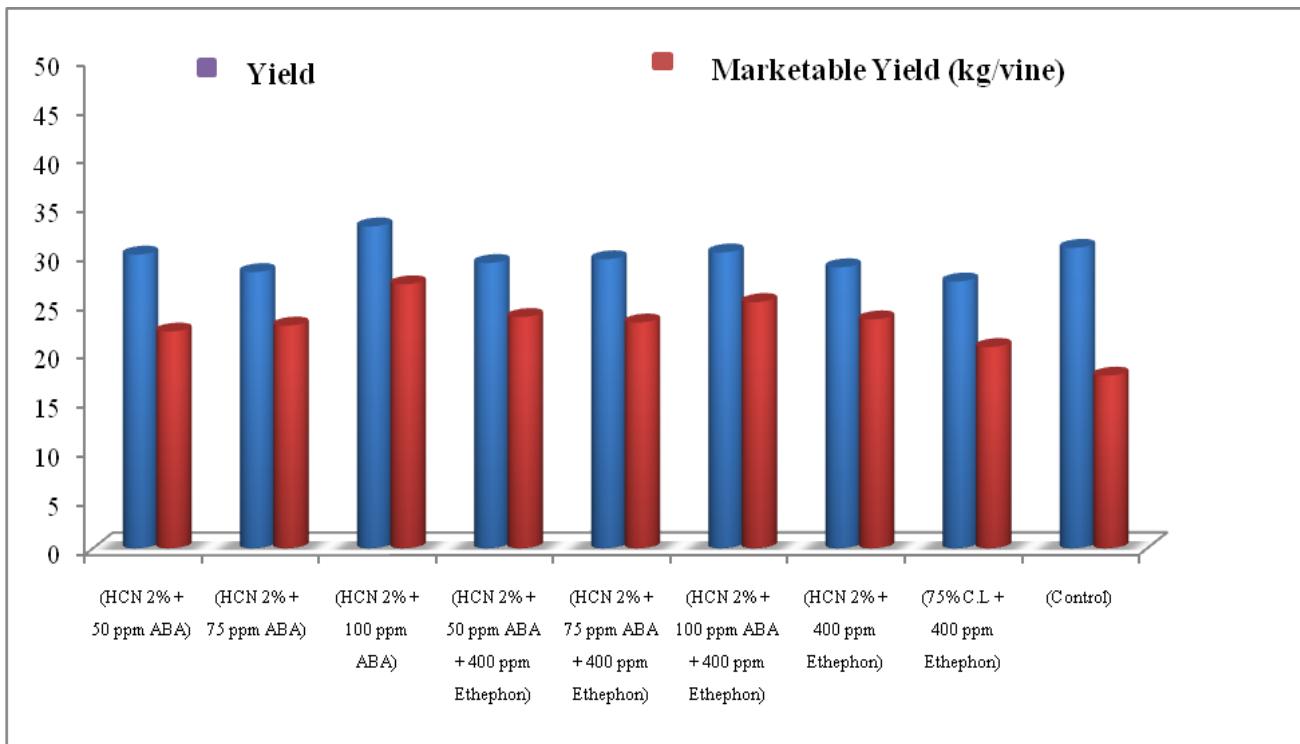


Fig.3 Effect of pre-harvest application of hydrogen cyanamide, ABA and ethephon on yield and marketable yield of flame seedless grapes



Bunch weight (g)

The vines treated with HCN 2 per cent and 100 ppm ABA (T_3) was resulted in a higher bunch weight (384.67 g) as compared to untreated vines (283.47 g) which was statistically at par with T_4 , T_5 and T_7 (Table 1). In case of untreated vines (100 % crop load) minimum bunch weight (283.47 g) was recorded. Previously, Kaur *et al.*, (2013) showed that the application of ethephon @ 500 ppm alone or in combination with 50 per cent crop load leads to highest bunch weight in grape cv. Flame Seedless grapes. Similarly, Hyun *et al.*, (1996) also found the higher bunch weight was recorded with ethephon treatments applied at veraison in 'Kyoho' grapes. Muhtaseb and Ghnaim (2008) studied the effect of time of application of Dormex®. They found that Dormax treated vines had significantly higher fruit weight.

Total soluble solids (%) and acidity (%) contents of fruit

The highest mean TSS (18.43 %) was recorded with treatment T_3 i.e. HCN 2 percent + 100 ppm of ABA (Table 2). In case of untreated vines (control), the least percentage of total soluble solids 15.93 per cent was recorded. This was statistically at par with treatments T_2 , T_4 and T_7 in which 16.3, 16.6, 16.77 total soluble solids with T_9 (15.93) was recorded. The present study revealed that higher TSS was noted in fruits harvested from grapevines maintained with HCN 2 percent, 100 ppm application of ABA. These results are in conformity with the findings of Amiri *et al.*, (2009) and Arora *et al.*, (2011).

The treatment T_6 i.e. (HCN 2% + ABA 100 ppm + 400 ppm ethephon) was recorded lowest mean acidity (0.46 %) which was statistically at par with T_3 i.e. (HCN 2% + 100

ABA) (Table 2). The control (100 % crop load) had highest (0.60 %) mean acidity. The vines under control recorded the highest (0.61 %) fruit acidity per cent which was significantly more than superior treatment (T_6). The results are in conformity with finding of Collalto *et al.*, (1991), Amati *et al.*, (1994) and Gaser *et al.*, (1998). On same line, Peppi *et al.*, (2006) reported that treatment with ABA reduced titratable acidity in 'Flame Seedless' grapes.

Anthocyanin content (mg/100 g)

All the treatments resulted in increase in anthocyanin content as compared to control (Fig. 2). The maximum (41.87 mg/100g) anthocyanin content was recorded in treatment T_3 (HCN 2% + 100 ppm ABA) which was statistically at par with the treatment T_6 i.e. (HCN 2% + 100 ppm ABA + 400 ppm ethephon) recorded 40.16 mg anthocyanin per 100 gm of pulp. The results of present investigations showed that with increase in ABA (100) and ethephon (400 ppm) concentration, anthocyanin content was increased. Similarly, the application of ethephon on grapes during veraison stage results in the highest contents of total anthocyanin which translates into higher visual colour intensities of grapes (Lombard *et al.*, 2004). Amiri *et al.*, (2009) reported that application of ABA was more effective than ethephon for enhancing the colour and total anthocyanin content. Quiroga *et al.*, (2009) observed higher level of anthocyanin relative to control values with ABA application in field-grown grape cv. 'Cabernet Sauvignon'.

Uneven colour of berries/bunch (%)

The significant improvement was observed in uniform coloured berries per bunch under different treatments as compared to control (Fig. 2). The significantly lowest uneven berries per bunch (16.78%) are recorded in

treatment T_6 (HCN 2% + 100 ppm of ABA + 400 ppm ethephon). This was statistically at par with treatments T_3 and T_7 in which 17.97 and 18.54 per cent of uneven berries per bunch were recorded, respectively. The highest 42.52 % uneven berries per bunches was recorded in untreated (control) grapevine (Table 3). Mehta and Chundawat (1979) reported that uniform colour development was observed with 500 ppm ethephon at veraison stage in 'Beauty Seedless' and 'Pinot Noir' grapes. Panwar *et al.*, (1994) also reported that ethephon sprayed at veraison reduced the number of unevenly ripened berries in Beauty Seedless grapes.

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