International Journal of Agriculture, Environment and Biotechnology
Citation: *IJAEB*: **14**(04): 489-494, December 2021
DOI: 10.30954/0974-1712.04.2021.1

ASSOCIATION FOR AGRICULTURE ENVIRONMENT AND BIOTECHNOLOGY

HORTICULTURE

Pre-harvest Application of Ethrel and Potassium Schoenite on Yield, Quality, Biochemical Changes, and Shelf-life in Crimson Seedless Grapes

Sahadeo Dasharath Ramteke[1], Sharad Rajendra Bhagwat[2*], Appaso Haridas Gavali[1], Amruta Langote[1], Snehal Madhukar Khalate[1] and Jeevan Nandram Kalbhor[2]

[1]ICAR-National Research Centre for Grapes, Pune, Maharastra, India
[2]R&D Unit, Maharashtra Grape Growers Association, Pune, Maharastra, India

*Corresponding author: sharadbhagwat55@gmail.com (**ORCID ID:** 0000-0003-1067-8723)

Paper No. 935 **Received:** 20-07-2021 **Revised:** 28-09-2021 **Accepted:** 12-12-2021

ABSTRACT

The study was conducted to investigate the effect of potassium schoenite and ethrel on yield, quality, biochemical changes, and physiological loss in the weight of grapevines. Crimson Seedless vines grafted on dog ridge rootstocks at ICAR – NRC for grapes, Pune under the tropical condition of India was selected for this study. The grapevines were planted by adapting a 3.3m × 1.6 m and trained on the Y system. Pre-harvest spray of potassium scheonite (2.50 g/L and 5.00 g/L) and ethrel (300 and 600 ppm) along with control untreated vines was carried out at the veraison stage. The grapes bunches were harvested after attaining harvestable maturity with TSS of 17.50° Brix. The highest bunch weight (287.16 g), berry weight (3.70 g), and yield per vine (11.25 kg/vine) were recorded in treatment with potassium schoenite 5.00 g/L. In terms of quality parameters viz., TSS (18.43 ° Brix), total acidity (0.604 %) were recorded with the pre-harvest spray potassium schoenite at 5.00 g/L. Among the different treatments, ethrel at 600 ppm enhances total anthocyanins, total tannins, and total berry flavonoids. It was increased in the shelf life of Crimson Seedless by decreases in physiological weight in loss (10.96 %), Fallen berries (1.36 %), and Rotten berries (0.68 %) on 7th day of observation in this investigation.

HIGHLIGHTS

- Application of potassium schoenite increases berry weight, cluster weight and yield per vine.
- Physiological loss in weight (%). Fallen berries (%) and Rotten berries (%) were reduced in this study.
- Total anthocyanins, total tannins, and flavonoids increased by ethrel at 600 ppm.
- Application of potassium at 5.00 g/L and ethrel at 600 ppm were beneficial to increasingberry quality, yield, biochemical changes, and achieving best shelf life in Crimson Seedless vines.

Keywords: Pottasium schoenite, ethrel, yield, anthocyanins, and physiological loss in weight

Grape (*Vitis vinifera* L.) belongs to the family Vitaceae, is originated in Armenia near the Black and Caspian seas in Russia. It was introduced into India during 1300 AD by the Moghul invaders. It is believed to be one of the essential commercial fruit crops of temperate to tropical regions(Gowda *et al*. 2008). The significant grapes growing countries globally are Italy, France, Australia, China, Russia, and USA. Grape cultivation in India assumes excellent significance due to its high productivity compared to many other producing countries. One of the most remunerative farming enterprises has created interest among Indian growers. Grape berries are attractive for their unique flavor and

How to cite this article: Ramteke, S.D., Bhagwat, S.R., Gavali, A.H., Langote, A., Khalate, S.M. and Kalbhor, J.N. 2021. Pre-harvest Application of Ethrel and Potassium Schoenite on Yield, Quality, Biochemical Changes, and Shelf-life in Crimson Seedless Grapes. *Int. J. Ag. Env. Biotech.*, **14**(04): 489-494.

Source of Support: None; **Conflict of Interest:** None

are utilized in many ways, so their cultivation is becoming more popular. India's major grape grape-growing states are Maharashtra, Karnataka, Andhra Pradesh, Telangana, and Tamil Nadu. Among the grape-growing states, Karnataka stands second in the area after Maharashtra.

The Crimson Seedless (*Vitis vinifera* L.) grape is a late-season, attractive, red seedless grape cultivar, introduced in 1989 as a Seedless alternative to Emperor. Vines were received favorably by consumers due to their elongated, firm berries and crisp eating quality (Ramming, Tarailo and Badr 1995). The popularity of 'Crimson Seedless' can be ascribed to the following: it has elongated, firm berries, crisp eating quality, late maturing, a red seedless grape which is not susceptible to berry crack, thus allowing for a more extended ripening period. Another reason for its popularity could be that 'Crimson Seedless' was released as a public cultivar, with no restrictions on its propagation.

However, some of the main problems with 'Crimson Seedless' production are related to its color and size. A further problem with the 'Crimson Seedless' color is that with increased yields and practices used to increase berry size, color is further decreased. Applications of some plant growth regulators (PGRs), such as gibberellic acid (GA_3) and forchlorfenuron (CPPU), may be needed to increase berry size, but they can further inhibit coloring (Dokoozlian *et al.* 1995). Even with all of the favorable characteristics of this cultivar, the problem remains a lack of adequate color intensity and uniformity (Human and Bindon 2010).

The severe problems crimson seedless cv. Grown in the tropical environment of India are the poor berry setting, small berries, and uneven coloration of berries in clusters. It is advised to use compounds that are responsible for enhancing the biosynthesis of plant pigments and carbohydrates such as boron, magnesium, potassium, and phosphorous, as well as materials such as silicon that are responsible for protecting the vines from higher temperatures. In addition, using compounds such as ethrel is beneficial in enhancing enzymes that break down complex nutrients to soluble ones. Anthocyanins are considered critical components in Crimson seedless grapevine cv grapes that greatly governed the coloration of the berries. This pigment is negatively affected by air temperature, solar, and temperature differences between day and night (Downey *et al.*, 2006).

Ethrel is considered a promoting compound responsible for enhancing the coloration and ripening of some fruits. This is attributed to its action in releasing ethylene that activates hydrolytic and oxidative enzymes involved in maturation, increasing the degradation of chlorophylls and the appearance of anthocyanins, xanthophylls, and carotenoids (Morre, 1979). The beneficial effects of silicon (Si) and Potassium (K) on fruit trees are mainly associated with enhancing trees' resistance to biotic and abiotic stresses, especially temperature, by stimulating defense reaction mechanisms. It is essential to use K during fruit development to protect the vine from the higher temperature that negatively affects berries coloration. Considering the importance of growth regulators and nutrients for improving yield and yield attributing parameters, increasing anthocyanins composition and enhancing shelf-life in grapevines the present investigation was carried out to evaluate the effect of ethephon & potassium schoenite at preharvest application in Crimson Seedless vines.

MATERIALS AND METHODS

Experimental Design and Treatments

Experimental layout

The experiment was carried out at ICAR- National Research Center for Grapes during the fruiting season of 2020. Pune (18.32 °N and 73.51°E) has a tropical wet and dry climate with an average temperature of 20 to 28 °C. The experiment was laid out in Randomized Block Design (RBD) with five treatments and four replications. Crimson Seedless vines grafted on dog ridge rootstock were selected for this investigation. The vines were planted in N-S direction with a spacing of 2.66 mtr between the rows and 1.33 meter between the vines. The vines were trained to mini-Y- trellises with a single cordon placed in horizontal orientation. The vines were 7-year-old, uniform grows in sandy soil on wire trills system and under drip irrigation. The treatment impositions were done at the berry softening stage (90 days after fruit pruning). All the good agricultural practices were followed to keep the vines healthy. The vine received the treatment at veraison (15-20% berries coloration) (23th Jan 2021). All the treatments application was made with a high-volume pneumatic knapsack sprayer fitted with a hollow cone nozzle using spray fluid @ 500 liters/ha. The recent research work includes the following treatments details:

Table 1: Treatment Details

T_1	Ethrel (ethephon 39%) at 300 ppm
T_2	Ethrel (ethephon 39%) at 600 ppm
T_3	Potassium schoenite 2.5g/lit
T_4	Potassium schoenite 5g/lit
T_5	Control(untreated vines)

Observations recorded

Yield per vine (Kg)

At harvest, average berry pedicel (mm), diameter, berry length (mm), and berry diameter (mm) were measured by using the digital Vernier caliper (RSK™, China). Average berry weight bunch weight and yield per vine were recorded. Hundred berry samples were randomly selected from each replicate, processed in a blender and strained through two layers of muslin cloth. Soluble solids concentration was determined from the juice using a digital refractometer (model ERMA of Japan). The titratable acidity was calculated by using the titration method. 5 ml of fruit juice from each replication was titrated with sodium hydroxide solution of known normality (NaOH N =0.1N) using phenolphthalein as an indicator as suggested by (A.O.A.C 1985). The results of these titrations were converted to percent of titratable acidity using the following equation;

Percent of titratable acidity =

$$\frac{(N.NaOH \times ml.NaOH \times 0.075^{*} \times 100)}{(Juice\ in\ ml)}$$

*0.075 = Equivalent weight of tartaric acid.

Biochemicals study

The total phenol, tannin contents of the fruit extract was determined using the Folin- Ciocalteu method (Singleton and Rossi 1965) using gallic acid as the standard. Total anthocyanins were estimated as suggested by Sondheimer and Kertesz (1948) and total flavonoids by (Sahoo *et al.* 2019). All biochemicals were estimated using UV spectrometer. The standard reference chemicals were obtained from the s. d. OK chemicals Ltd., Mumbai (India). All other buffers and chemicals were of AR grade and obtained from Merck Pvt. Ltd., Mumbai.

Physiological loss in weight (PLW)

The PLW was calculated on an initial weight basis. The physiological loss in weight of grape bunches was recorded based on the initial fresh weight of the fruit and subsequent loss in weight which occurred during post-harvest storage and was expressed as a percentage value.

PLW (%) =

$$\frac{\text{Initial weight of fruit} - \text{Finial weight of fruit}}{\text{Initial weight of fruit}} \times 100$$

Fallen berry (%)

Fallen berry percentage was recorded from each box by dividing the weight of fallen berries and the total weight of packed bunches.

Fallen berries (%) =

$$\frac{\text{Weight of free berries inside each box}}{\text{Total bunch weight}} \times 100$$

Rotten berry (%)

Rotten berry percentage was recorded from each box by dividing the weight of fallen berries and the total weight of packed bunches.

Rotten berries (%) =

$$\frac{\text{Total weight of bunch} - \text{bunch weight after removing defective berries}}{\text{Total weight of the bunch}} \times 100$$

STATISTICAL ANALYSIS

The experiment was conducted in randomized block design consisting of five treatments with four replications. All the calculations were performed using the GLM procedure of SAS System software (version 9.3).

RESULTS AND DISCUSSION

YIELD AND QUALITY PARAMETERS

Significant differences were recorded on yield and yield attributing parameters of Crimson Seedless and were presented in Table 2. The highest bunch weight (287.16 g) and berry weight (3.70 g) and yield per vine (11.25 kg) were recorded with potassium schoenite 5.00 g/lit followed by its lower dose potassium schoenite 2.50 g/lit bunch weight (282.43), berry weight (3.02 g) and yield per vine (9.82 kg) while minimum bunch weight (202.23 g), berry weight (2.13 g) and yield per vine (7.14 kg) with untreated control. The results obtained in this investigation might be due to the application of Potassium schoenite with its higher dose in an increase in cluster weight, berry weight, and yield per vine. The results confirm the finding of Ahmed, M. K. Abdel Aal (2013). While working on Crimson seedless, they reported that the beneficial effects of K, P, Mg, B, and Si on enhancing growth and vine nutritional status indeed reflected on enhancing berry set, yield, and cluster weight. These results are in agreement with those obtained by Farag *et al.* (2012 a and 2012 b) and Mohamed-Ebtesam (2012) on ethrel; Abdel Hameed (2012) on silicon (Si); Er *et al.* (2011). There were No significant differences were recorded for berry length and berry diameter during the application of all the treatments in Crimson Seedless vines.

The data recorded on total soluble solids, acidity, and T.S.S./acidity ratio was significantly influenced by all the treatments (Table 2). The highest T.S.S. (18.43 °Brix) with most minor Acidity (0.60 %) and highest T.S.S./acidity ratio (30.89) were obtained with application potassium schoenite 5.00 g/L. In contrast, lease T.S.S. (16.85) with the highest acidity (0.75 %) and minimum T.S.S./acidity ratio (22.39) were obtained with untreated vines. The results obtained in this investigation might be due to the potassium schoenite might promote the maturity in Crimson seedless vines through biosynthesis and translocation of sugar. The result is hands confirms the findings of Amin (2007) in P, K, and Mg.

Biochemical parameters

The data recorded on biochemical changes of Crimson Seedless vines were presented in Table 3. The significant differences were recorded with all the treatments studied. The highest total phenol (1.98 mg/ g) was recorded with Potassium schoenite at 5.00 g/L, which on par (1.96 mg/g) with its lower dose potassium schoenite at 2.50 g/L followed by ethrel at 600 ppm (1.83 mg/g) and ethrel at 300 ppm recorded (1.52 mg/g). In comparison, most minor (1.45 mg/g) total phenols were recorded with untreated control. This investigation's increased in total phenols might be due to agronomical practices and environmental conditions. This study supports the findings of Tomas-Barberan and Espin (2001), who reported the phenolic contents of the plants depend on several agronomic and environmental factors. The results for total anthocyanins (56.93 mg/l), total tannins (3.58 mg/g), and total flavonoids (119.97 mg/g) were obtained with the application of ethrel at 600 ppm followed by total anthocyanins (33. 55 mg/l) total tannins (2.92 mg/g) and total flavonoids (118.66 mg/g) potassium schoenite ar 5.00 g/L while total anthocyanins (21.74 mg/l) total tannins (1.95 mg/g) and total flavonoids (99.07 mg/g) were recorded with untreated control vines. The application of ethrel at 600 ppm significantly influenced the total anthocyanin, tannins, and flavonoids in this investigation. The results obtained in this investigation ethrel might be broken down total chlorophyll contents and carotenoids and stimulate the maturity in Crimson Seedless vines. The result confirms the finding of Jindal and Naik (1994) also recorded that application of Ethephon at 750 ppm increased anthocyanin pigments in colored grapevines. Similarly, Ferrer and Gonzalez (2002) reported that high anthocyanin content was observed with the application of Ethephon at veraison in Tannat grapes.

Physiological loss in weight

The data recorded on PLW (%), Fallen berries (%), and Rotten berries (%) in Table 4. were significantly influenced by all the treatments studied. Data revealed that reduced PLW (%), Fallen berries (%), and Rotten berries (%) were observed with the application potassium schoenite at 5.00 g/L, which was on par with its lower dose i.e., potassium schoenite at 2.50 g/L. Ethrel at 600 ppm significantly reduced PLW (%), Fallen berries %, and Rotten berries (%) over control untreated vines. The results obtained in this investigation might be due to the application of potassium schoenite at pre-harvest

Table 2: Effect of Ethrel and Potassium schoenite on yield and quality parameters of Crimson seedless grapes

Treatments	Bunch Weight	Berry Weight	Berry diameter	Berry length	TSS	Acidity	TSS/Acidity ratio	Yield/Vine
	(g)	(g)	(mm)	(mm)	(°Brix)	(%)		(kg)
T1 - Ethrel @300 ppm	219.31	2.30	14.70	18.40	17.28	0.724	23.90	7.53
T2 - Ethrel @600 ppm	238.79	2.40	14.63	19.19	17.23	0.716	23.95	8.81
T3 - P.Schoenite @ 2.5 g/Lit	282.43	3.02	13.73	17.70	18.15	0.663	27.57	9.82
T4 - P.Schoenite @ 5 gr/Lit	287.16	3.70	14.00	17.30	18.43	0.604	30.89	11.25
T5 – Control	202.23	2.13	14.80	19.40	16.85	0.755	22.39	7.14
SEm ±	24.868	0.164	0.244	0.116	0.26	0.030	1.624	1.214
C.D @ 0.5%	54.19	0.36	0.53	0.25	0.57	0.07	3.54	2.64

Table 3: Effect of Ethrel and Potassium schoenite on Biochemical changes of Crimson seedless grapes

Treatments	Phenol	Tannin	Flavonoids	Anthocyanin (Fresh wt.)
	(mg/g)	(mg/g)	(mg/g)	(mg/l)
T1 - Ethrel @300 ppm	1.52	2.80	101.82	47.87
T2 - Ethrel @600 ppm	1.83	3.58	119.97	56.93
T3 - P.Schoenite@2.5 gr/Ltr	1.96	2.54	101.54	28.87
T4 - P.Schoenite @5 gr/Ltr	1.98	2.92	118.66	33.55
T5 Control	1.45	1.95	99.07	21.74
SEm ±	0.063	0.189	2.788	0.371
C.D @ 0.5%	0.14	0.41	6.08	0.84

Table 4: Effect of Ethrel and Potassium schoenite on PLW (%), Fallen beery (%) and Rotten berry (%), at room temperature of Crimson seedless grapes

Treatments	PLW	Fallen berries	Rotten berries
	(%)	(%)	(%)
T1 - Ethrel @300 ppm	11.06	3.27	0.85
T2 - Ethrel @600 ppm	10.72	1.94	0.41
T3 - P.Schoenite@2.5 gr/Ltr	10.41	2.10	0.24
T4 - P.Schoenite @5 gr/Ltr	10.96	1.36	0.68
T5 Control	12.29	2.08	1.39
SEm ±	0.404	0.195	0.147
C.D @ 0.5%	0.88	0.43	0.32

reduces water loss in berries after post-harvest storage. These studies confirm the findings of Ronan *et al.* (2018), who reported that Potassium bicarbonate treatments showed an increase in the Soluble Solid content after 50 days of cold storage, mainly when applied only at pre-harvest.

The positive and negative correlations between different morphological parameters due to the use of different concentrations of ethrel and potassium schoenite. Among all parameters, bunch weight has a highly positive relationship with yield per vine. The TSS was negatively correlated with total acidity. In biochemical studies, phenol showed a positive correlation with tannin and anthocyanin. Berry length showed highly negative correlations with berry diameter and length. PLW (%) positively correlated with fallen and rotten berry (%).

CONCLUSION

It can be concluded that the application of potassium schoenite increases berry weight, cluster weight, and yield per vine. While, PLW (%). Fallen berries (%)

and Rotten berries (%) were reduced in this study. However, it increases total anthocyanins, tannins, and flavonoids by ethrel at 600 ppm**.** Application of potassium at 5.00 g/L and ethrel at 600 ppm were beneficial to increasingberry quality, yield, biochemical changes, and achieving best shelf life in Crimson Seedless vines.

ACKNOWLEDGEMENTS

The authors are incredibly thankful to the Director, ICAR – National Research Center for Grapes, Pune, for providing all the field and laboratory facilities for conducting this experiment.

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