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Improving yield, quality, and shelf life of 2 A clone grapevine by preharvest applications of growth regulators

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ABSTRACT
Five year- old 2A clones grapevines were sprayed during 2016-17 and 2017-18 growing seasons with GA3, 6-BA, CPPU, Salicylic acid, Ethrel, ABA, Brassinosteroid and water spray i.e. Control at two stages of berry development 3-4 mm (85-90 days after pruning) and 6-8 mm (105-110 days after pruning) in order to investigate their influence on yield, berry quality as well as the berry keeping quality. Bunch weight, and berry quality parameters as well as yield per vine were significantly improved by all the growth regulators especially GA3 and CPPU. Increase in berry size resulted in to increase in berry weight, berry volume. In the study, shelf life (keeping quality) was increased by application of GA3, 6-BA, CPPU, Salicylic acid, Ethrel, ABA, Brassinosteroid as they increased berries firmness and decreased the percentage of unmarketable berries after keeping at cold storage (0°C temperature) for seven days after harvest.
Keywords: *Growth Regulators, Yield, Quality Of Grapes And Shelf Life*

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INTRODUCTION

Grape is a commercially important fruit crop of India. The grapes are exported to Europe, UK and Middle East countries. The export suffers because of poor berry quality and noncompliance to quality standards imposed by the importing countries, particularly with respect to the size and sugar content of the berries and shelf life. It is possible to achieve these standards through excellent management practices coupled with the use of growth regulators. In recent years, among the various vineyard practices adopted for table-grape cultivation, there has been a significant use of plant growth regulators to increase berry size and consequent yield [1]. It has been often reported that the Gibberellic acid (GA3) is beneficial in increasing the size of fruits in different crops through cell elongation and it also increases the chlorophyll content and photosynthesis rate. Other growth regulators such as Cytokinins are particularly used for berry enlargement and often applied with gibberellins to stimulate cell division and elongation. In many countries, including the United States, Chile, South Africa, and Italy, the most common cytokinin in viticulture is forchlorfenuron, with the trade name CPPU (N-(2-chloro-4-pyridyl)- N'-phenylurea). The main function of CPPU is to stimulate cell division and promote the enlargement of the berry; it also regulates cellular metabolism by acting on the synthesis of RNA, DNA, and proteins. Forchlorfenuron has various effects on grapes: increasing berry size and weight [2, 3 and 4], delaying maturation [3, 5 and 6], reducing berry skin color [4], and increasing berry pedicel thickness and cuticle content [7]. Considering the importance of growth regulators in berry development yield, berry quality and post-harvest quality in table grapes, the present study was conducted to evaluate the efficacy of growth regulators on 2 A clone under tropical condition of India.

MATERIAL AND METHODS

Experimental conditions and treatments

This experiment was conducted at the experimental vineyard of Maharashtra Rajya Draksh Bagaitdar Sangh, Pune during two growing seasons of 2016-2017 and 2017-2018. Pune is located in Midwest Maharashtra state (India) at an altitude of 559 m above the mean sea level. It lies in 18.32° N latitude and 7.51° E longitude. The vines were grown on calcareous black cotton soil (clay content was 44.5%) exhibiting swelling and shrinkage properties. The average bulk density of the root zone up to a depth of

30 cm was 1.25 g/cm^3. The average electrical conductivity (EC) of the irrigation water during the experimentation was 1.98 dS/m with an average pH value of 7.78. The rainfall during 2016-2017 and 2017 -2018 was 484 and 540 mm respectively. Five year old Clone 2A Seedless grapes grafted on Dogridge rootstock were selected for this study. The vines were planted at a spacing of 2.5 m between rows and 1.2 m between vines within a row.The row orientation was in the direction of North – South. The vines were trained to double cordon T system. The pruning biomass of the vines was in the range of 1 to 1.25 kg. The concept of balanced pruning is not in practice in tropical viticulture of India, where double pruning and single cropping is being practiced. Hence, approximately 40 to 45 shoots are encouraged per vine in a spacing mentioned above. Application of growth regulators was as shown below.
The experiment was conducted in a randomized block designing with three replicates for each treatment; each replicate consisted of six grapevines chosen for similar vigor, number of clusters, and crop load. Treatments consisted of:T1- GA (40 ppm),T2– 6BA (20 ppm), T3 – CPPU (1 ppm),T4 – Salicylic acid (100 ppm), T5- Ethrel (250 ppm), T6 –ABA (200 ppm), T7– Brassinosteroid (1 ppm), T8 – Control. The plant growth regulator was mixed in water and dipping was done as single dip 85 to 90 days after fruit pruning and second dip was done 105-110 days after fruit pruning during both the seasons.

Morphological observations

Morphological observations (Bunch weight, berry weight, berry length, berry size, bunch volume, TSS, Acidity, yield per vine and shelf life) were recorded at harvest. Recommended dose of plant growth regulator as well as crop protection measures were adopted. The observation on berry length and berry diameter derived by averaging 50 berries randomly from each treatment and measured using vernier caliper (0-300 mm, RSK™). Total soluble solids (TSS) were expressed in degree brix (°B). The uniformly ripened grape bunches were harvested in replicate from each treatment.

Shelf life study

The harvested bunches (5 kg/treatment) were placed in cardboard boxes and kept at room temperature (27 to 30° C) for 7 days as per the guidelines of International Standard. Observations were recorded daily up to 7 days (at the same time) for physiological loss in weight (PLW). The initial weight of fresh fruit was recorded and subsequently the weights were taken. The physiological loss in weight was estimated as given below and expressed in percent. The experiment was conducted as randomized block design with three replications and the data was analyzed using SAS Version 9.3. Tukey's test was used for comparing treatment means.

RESULT AND DISCUSSION

Yield and quality parameter

Significant differences were recorded for yield and berry quality parameters presented in 2016- 17 and 2017-18 in Table 1 and 2 respectively. A significant increased in bunch weight was obtained in both seasons by all sprayed substances compared to the control. During 2016-17 and 2017-18 highest bunch weight (370 gm and 351 gm) was recorded with the application of CPPU @ 1 ppm followed by GA_3 @ 40 ppm (361 and 306 gm), while least was recorded with control treatments (255. 47 and 213.27 gm) respectively. The results in hands confirmed the study of [8] who reported that spraying of sitofex (CPPU) and GA_3 significantly increased bunch weight of Thompson Seedless grapes. It is also confirmed that the increased bunch weight might be due to the increase in cell number and cell size also influenced by growth regulators possibly through induced hormonal activities. Data of both seasons showed a significant increase in grapevine yield by the application of growth regulators compared to the control. GA_3 and CPPU treated vines had similar and significantly higher yield than 6-BA, Salicylic acid, Ethrel, ABA, Brassinosteroid. The highest yield per vine was recorded in this study might be due to application of GA_3 and CPPU. The role of exogenous applied polyamines in increasing the yield per vine was previously stated by [9 and 10]. Moreover, data of both seasons showed a significant increase in berry weight and berry volume by all growth regulators compared with the control. GA_3 and CPPU had similar and significantly higher berry weight and berry volume than all other treatments (Table 1 & 2). Furthermore, longer berries than the control were obtained by all growth regulators, with the highest increased in berry length obtained by GA_3 and CPPU. Application of GA_3 and CPPU in seasons, increased berry length and berry size when compared with the control. The increased in berry length and berry size in present study was due to the direct effect of GA_3 on cell division and cell enlargement as reported by [11-13]. However, CPPU has been reported to stimulate both cell division and cell elongation resulting increase in berry size when applied shortly after fruit set to grape berries [14]. Similar increase in berry weight and size by preharvest ethephon spray was previously mentioned by 15 in Beidaneh Ghermez grape. It is suggested that early application of ethephon regulates fruit transmission from cell division to cell enlargement leading to an increase in size and weight of fruits [16].

Table1: Effect of Growth regulators on yield and quality parameters in 2A Clone grapes during 2016-17 seasons

Treatment	Bunch weight (gm)	100 Berry weight (gm)	Berry volume 100b ml	Berry length (mm)	Berry Dia (mm)	Berry length (cm)	Bunch Width (cm)	T.S.S (brix)	Acidity (%)	Yield/ wine (kg)	yield/ acre (ton)	Yield /ha (ton)
1	361.37	217.45	270.67	18.67	16.10	15.23	10.47	21.67	0. 71	18.07	13.55	33.88
2	289.50	291.77	250.33	18.90	16.00	14.93	10.43	22.07	0.73	14.49	10.87	27.17
3	370.90	312.20	189.57	19.70	16.40	14.87	10.87	21.53	0.67	18.55	13.91	34.77
4	243.83	262.17	228.33	18.83	16.03	14.07	10.37	21.20	0.71	12.19	9.14	22.86
5	292.27	222.85	188.33	18.50	16.07	14.23	10.43	22.97	0.67	9.61	7.21	18.03
6	281.37	230.10	194.97	17.20	14.60	14.83	10.13	20.03	0.69	14.07	10.55	26.38
7	295.63	282.07	249.90	18.63	15.73	13.93	10.20	20.50	0.73	14.78	11.09	27.02
8	255.47	203.90	174.90	16.90	14.47	12.53	8.67	22.33	0.71	12.77	9.58	23.95
SEM (±)	**14.71**	**1.85**	**1.71**	**0.45**	**0.34**	**0.49**	**0.54**	**0.55**	**0.05**	**0.74**	**0.55**	**1.38**
C.D @ 5 %	**45.04**	**5.66**	**5.22**	**1.37**	**1.04**	**1.50**	**N/A**	**1.67**	**NA**	**2.25**	**1.69**	**4.22**

Table 2 Effect of Growth regulators on yield and quality parameters in 2A Clone grapes during 2017-18 season.

Treatment	Bunch weight (gm)	100 Berry weight (gm)	Berry volume 100b (ml)	Berry length (mm)	Berry Dia (mm)	T.S.S (Brix)	Acidity (%)	Yield/ wine (kg)	Yield /acre (ton)	Yield /ha (ton)
1	306.03	297.02	285.67	19.07	15.20	19.00	0. 69	15.30	11.48	23.91
2	255.07	288.87	250.67	18.67	15.33	18.67	0.71	15.84	11.88	29.71
3	351.03	308.73	266.00	19.97	16.30	20.02	0.69	17.55	13.16	32.91
4	280.00	238.67	204.33	18.37	15.63	20.00	0.67	14.00	10.50	26.25
5	249.63	247.90	210.33	19.47	15.93	18.00	0.65	12.48	9.36	23.41
6	262.47	224.83	196.33	16.93	15.77	19.00	0.70	13.12	9.84	24.61
7	316.87	242.30	203.67	18.37	15.63	20.00	0.72	12.76	9.57	28.69
8	213.27	213.27	178.00	15.87	13.23	17.33	0.66	10.66	8.00	19.99
SEM (±)	**15.67**	**8.99**	**6.10**	**0.51**	**0.28**	**1.12**	**0.04**	**0.78**	**0.59**	**1.47**
C.D @ 5 %	**47.99**	**27.53**	**18.69**	**1.57**	**0.86**	**N/A**	**NA**	**2.40**	**1.80**	**4.50**

Table 3Effect of Growth regulators on shelf life in 2A Clone grapes during 2016-17 season.

Treatment	5Day	10 Day	15 Day	20 Day	25 Day
	Weight Loss (%)	**Weight Loss (%)**	**Weight Loss (%)**	**Weight Loss (%)**	**Weight Loss (%)**
1	0.83	3.26	4.13	4.89	6.15
2	2.62	3.12	4.04	5.13	6.54
3	0.55	1.59	2.37	3.24	4.37
4	2.11	3.20	4.30	5.42	7.00
5	0.68	2.51	3.69	4.81	6.57
6	1.33	3.25	4.61	6.02	7.90
7	1.73	2.23	3.83	4.45	5.29
8	2.01	4.36	5.56	7.35	9.83
SEM (±)	**0.34**	**0.62**	**0.67**	**0.67**	**0.79**
C.D @ 5 %	**1.03**	**N/A**	**N/A**	**2.05**	**2.42**

Table 4: Effect of Growth regulators on shelf life in 2A Clone grapes during 2018-19 seasons

Treatment	5Day	10 Day	15 Day	20 Day	25 Day
	Weight Loss (%)	Weight Loss (%)	Weight Loss (%)	Weight Loss (%)	Weight Loss (%)
1	1.01	2.06	2.88	3.81	5.24
2	1.07	1.81	3.10	3.91	5.55
3	0.77	1.59	2.76	3.48	4.46
4	1.15	2.14	3.43	4.18	6.06
5	1.21	2.16	3.47	4.50	6.49
6	1.10	2.30	4.48	5.55	8.51
7	1.64	2.82	3.26	4.48	5.09
8	1.60	2.68	5.05	6.26	8.23
SEM (±)	**0.16**	**0.24**	**0.26**	**0.30**	**0.40**
C.D @ 5 %	**0.49**	**0.72**	**0.79**	**0.91**	**1.23**

Berry chemical parameters:

Effect of growth regulators on total soluble solids and acidity at harvest is presented in Table 1 & 2. All the growth regulators treatments influenced total soluble solids (TSS) content in berries comparison with control treatment was obtained in both the seasons. Ethephon treated application vines showed highest TSS contents followed by control while least was recorded with CPPU treated vines in both the seasons. Total acidity contents of berries were not significantly different amongst the growth regulators. The highest TSS obtained with ethephon treatments might be due to ethereal which is known as ripening hormone. Therefore, application of ethephon would increase ethylene content in the fruit at maturity and ripening processes and thus, advances the harvest date. The ripening response observed in this study as a result of ethephon application is in agreement with literature to date (**15**).

shelf life

The data recorded on keeping quality (shelf life) of 2A clone was significantly different within the treatments as were presented in Table 3 & 4. All the treatments are significantly different compared to the control treatment. Among the different treatments minimum weight loss (4.37%) and (4.46%) was recorded with the application of CPPU @ 1 ppm during both seasons respectively. While, the highest loss in weight was recorded with control treatment. The increase in the berry keeping quality (shelf life) obtained in the present study could be explained by the positive influence of the different growth regulators in increasing fruit firmness, reducing ethylene production as well as preventing fungal infection. Positive inhibition of ethylene biosynthesis by putrescine and gibberellic acid is already indicated [17, 18]. Also, salicylic acid is a phenolic compound that regulates a number of processes in plants. It inhibits ethylene biosynthesis [19] and regulates expression of pathogenesis related protein genes, and provides resistance against pathogen attack (**20**). Therefore, exogenous applied salicylic acid has been reported to reduce decay, delay ripening and extend postharvest life of various fruits; bananas [20], Kiwi P19], apples [20]and cherries [22]. This effect might be due to integrity maintained by growth regulators and slowing down water loss [23 and 24].

CONCLUSION

It might be concluded that exogenous application of growth regulators such as GA3, 6-BA, CPPU, Salicylic acid, Ethrel, ABA and Brassinosteroid at fruit development stages of 2 A clone grape had a positive influence in increasing the yield and enhancing the quality parameters of berry as well as extending the shelf life.

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CONFLICT OF INTEREST

No conflict of Interest.

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