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Effect of gibberellic acid on different varieties of grape under Northern dry zone of Karnataka

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Abstract
The field experiment was conducted to study the effect of gibberellic acid on different grape varieties under Northern dry zone of Karnataka during October 2017 to March 2018. Two different schedules of gibberellic acid treatment *viz.*, schedule-1 [10 ppm GA_3 at parrot green stage as spray+ 20 ppm GA_3 during 1 week of 1st spray as spray + 30 ppm GA_3 at 3-4 mm berry size stage as bunch dipping + 40 ppm GA_3 at 8-10 mm berry size stage as bunch dipping + 50 ppm GA_3 as bunch dipping during 1 week after 4th treatment] and schedule-2 [20 ppm GA_3 at anthesis stage as dipping + 50 ppm GA_3 at berry set stage as dipping] were applied to four different varities of grape *viz.*, Thompson seedless, Manik Chaman, KR White and 2-A Clone to determine the effect of gibberellic acid on bunch, yield and economics of cultivation in different varieties of grape. The results revealed that, maximum bunch length (22.89 cm), bunch weight (523.14 g), bunch volume (471.06 cm^3), yield (16.63kg/ vine), benefit to cost ratio (2.37:1) and minimum bunch compactness (1.27) was recorded in the grapes treated with schedule-1 set of gibberellic acid treatment compared to that of schedule-2 set of gibberellic acid treatment.

Keywords: grape, gibberellic acid, dipping, schedule-1, schedule-2

Introduction
Grape (*Vitis vinifera* L.) is one of the important sub tropical fruit crops of the country. Though, its origin is temperate region, it is well adopted to sub topical regions of the country. The fruits are rich in sugar, particularly hexose, low caloric output, refreshing and easily digestible. In India it is cultivated in an area of about 1, 36,000 ha with a production of around 26,83,000 MT and with a productivity of 19.7 MT per ha (Anon., 2016)[1] Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu, Punjab, Uttar Pradesh, Haryana and West Bengal are the major grape growing states in India. In Karnataka, it is being cultivated in an area 19,000 ha and with the production 3, 20,000 MT (Anon., 2016) [1] and mainly growing in Northern dry zone of Karnataka especially in Vijayapuar and Bagalkot area.

Various horticultural methods are being practiced in grape cultivation to improve production and quality, which includes nipping, to avoid staggered growth of grape berries. NAA is used to reduce post harvest berry drop, uniform ripening can be achieved through ethrel treatment at berry set stage. Amongst all the growth regulators being used in grape production, gibberellins are much popular and attaining great importance because of its remarked effect. The response of grapes to gibberellin are influenced by many factors like variety, dosage, time, method of application, age of the plant, physiological condition of the plant and prevailing weather conditions during its application. Therefore, it enables to standardize the hormonal schedule for grape varieties in general and the varieties gaining much commercial significance such as Thompson Seedless, Manik Chaman, K R White, 2-A Clone in particular. This study will also standardize hormonal schedule under Northern dry zone of Karnataka as the effect of hormones depends on varieties, environmental parameters and physiological state of the plants.

Materials and Methods
The field experiment was carried out at Main Horticultural Research and Extension Centre, College of Horticulture, University of Horticultural sciences, Bagalkot., during October 2017 to March 2018 by employing four different varities *viz.*, Thompson seedless, Manik Chaman, KR White and 2-A Clone. All the vines are five years old, fairly uniform in their growth and vigour. They were planted at a distance of 3 x 1.5 meters and trained on Y-system of training.

The experiment was set up in a 4 x 2 Factorial randomized block design, (Facor-1 with 4 different varieties and factor-2 is 2 schedules of gibberellic acid treatment), with 4 replications so which comprises 8 Treatment combinations. Hence, the number of plots were 32 (factors interaction that is treatment combination x replication) and 3 vines were selected from each plot (factors interaction), so number of vines selected for this experiment was 96. The two schedules of gibberellic acid treatment was applied for the selected vines in all four varities. Spray material was applied in full coverage with hand sprayer and bunch dipping and number of bunches per vine was counted in each variety and in each treatment. At the ideal stage of ripening (120 days after pruning), three bunches were harvested from each treatment separately and used for taking observation. Bunch length was measured with the scale starting from peduncle to the distal end of the bunch; bunch weight was measured using top loading electronic balance. Bunch volume was measured by water displacement method; bunch compactness was estimated by dividing total number of berries in a bunch by total length of bunch. Yield (kg/ vine) was calculated by multiplying the total number of bunches per vine with the average weight of bunches and the benefit: cost ratio of different treatments was worked out by dividing the net income with total cost of cultivation as described in the table-2. The data obtained from the experiment were statistically analyzed by using excel sheet and compared the means with critical difference (C.D. at 5%).

Results and Discussions

Observations on bunch length are presented in Table-1. Among the varieties, the maximum bunch length was recorded in K R White variety (23.22 cm) and it was on par with all other varieties i.e. Thompson Seedless variety (22.15 cm), Manik Chaman variety (20.69 cm) and 2-A Clone variety (20.37 cm), which recorded lower bunch length over other varieties. Among the two schedules of gibberellic acid treatment, varieties treated with schedule-1 gibberellic acid treatment recorded significantly higher bunch length (22.89 cm) over the varieties treated with schedule-2 gibberellic acid treatment (20.32 cm). But interaction effect of varieties and schedules of gibberellic acid treatment on bunch length did not vary significantly. The increase in bunch length of the grapes due to application of gibberellic acid is might be attributed to increase in length of cells in rachis thus results in increased rachis length, which consequently could have the increased bunch length (Sunita, 2017) [2] The present findings are in accordance with those reported by Ahmad *et al.* (2005) [3] in Perlette grapes; Farooq and Hulamani (2001) [4] in Arkavati grapes.

Observations on bunch weight are presented in Table-1. Significant differences were recorded among the varieties. Among the varieties, the maximum bunch weight was recorded in K R White variety (519.47 g) followed by Thompson Seedless variety (468.16 g), which was on par with Manik Chaman variety (445.47 g) and Manik Chaman Variety was on par with 2-A Clone variety (421.45 g), which recorded least bunch weight over other varieties. In two different schedules of gibberellic acid treatment, bunch weight was significantly higher in the varieties treated with schedule-1 set of gibberellic acid treatment (523.14 g) compared to that of in schedule-2 treatment of gibberellic acid (404.13 g). But, interaction effect of varieties and schedules of gibberellic acid treatment on bunch weight did not vary significantly. This increases in Bunch weight of grape bunches treated with schedule-1 treatment of gibberellic acid compared that of in the grapes treated with schedule-2 treatment of gibberellic acid is due to increase in bunch size and berry size (Habibi, 2009) [5]. The increase in bunch weight of the grapes treated with schedule-1 treatment of gibberellic acid is might be attributed to its higher bunch length, bunch width, berry length, diameter. The present findings are in accordance with those reported by Ahmad *et al.* (2005) [3] in Perlette variety of grape; Kumar and Sharma (2016) [8] in Thompson Seedless cultivar of grape and also by Sunita (2017) [2] in Red Globe grapes (*Vitis Vinifera*) with GA_3 treatment of 5 ppm at pre bloom stage.

Volume of bunches have varied significantly among the varieties (Table-1). Among the varities, maximum bunch volume was recorded in K R White variety (470.75 cm^3) followed by Thompson Seedless variety (416.13 cm^3) which is on par with Manik Chaman variety (388.75 cm^3) and Manik Chaman variety was on par with 2-A Clone variety (368.75 cm^3), which recorded minimum bunch volume over other varieties. Among two different schedules of gibberellic acid treatment, significantly higher bunch volume was found in schedule-1 set of gibberellic acid treatment (471.06 cm^3) compared to that of in schedule-2 treatment of gibberellic acid (351.25 cm^3). But interaction effect of varieties and schedules of gibberellic acid treatment on bunch volume did not vary significantly. The increase in bunch volume due to gibberellic acid application was largely associated with cell elongation of rachis and increase in size of berry and bunch, which resulted in increased bunch volume (Habibi, 2009) [5] Similar results were obtained by Dimovska *et al*. (2014) [6] with double of application of gibberellic acid in Flame Seedless variety of grape, and also by Sunita (2017) [2] with pre bloom application of gibberellic acid in Crimson seedless grape variety.

Observations on bunch appearance are presented in Table-1. Statistically non-significant differences were observed among the varieties. However, the higher bunch compactness was recorded in 2-A Clone variety (1.45) which was on par with all other varieties i.e. Manik Chaman variety (1.42), Thompson Seedless variety (1.39) and K R White variety (1.37) which recorded minimum bunch compactness over other varieties. Among two different schedules of gibberellic acid treatment, significantly higher bunch compactness was noticed in the varieties treated with schedule-2 set of gibberellic acid treatment (1.54) than that of in the varieties treated with schedule-1 treatment of gibberellic acid (1.27). But interaction effect of varieties and Schedules of gibberellic acid treatment on bunch compactness did not vary significantly. This decrease in bunch compactness in the grapes treated with schedule-1 set of gibberellic acid than that schedule-2 set of gibberellic acid treatment is due to the effect of gibberellic acid treatment on reduction of fruit set by lowering pollen germination and pollen tube growth in certain seedless table grapes and higher doses of gibberellic acid causes berry thinning in seedless varieties of grape, which leads to attain lesser number of berries per bunch and reduced bunch compactness (Sunita, 2017) [2] Similar results of reduced bunch compactness with gibberellic acid treatment was obtained by El-Razek *et al.* (2015) [7] with the use of gibberellic acid; Kumar and Sharma (2016) [8] in Thompson Seedless cultivar of grape and also by Sunita (2017) [2] in Crimson Seedless variety of grape.

Significant differences were observed among the varieties with respect to yield (kg/vine) (Table-1). Among the varieties, Manik Chaman recorded the maximum yield (17.20 kg/vine), which was on par with Thompson Seedless (17.10 kg/ vine) followed by K R White (15.60 kg/vine) while, 2-A Clone variety recorded minimum yield (14.60 kg/ vine) over the other varieties. In two different schedules of gibberellic acid treatment, varieties treated with schedule-1 set of gibberellic acid treatment recorded significantly maximum yield (16.63 kg/ vine) compared to that of in the varieties treated with schedule-2 treatment of gibberellic acid (15.47 kg/ vine). But, interaction effect of varieties and schedules of gibberellic acid treatment on yield (kg/ vine) did not vary significantly. The significant increase of yield (kg/ vine) in the grapes treated with schedule-1 set of gibberellic acid compared to that of schedule-2 set of gibberellic acid is attributed to increased number of application of Gibberellic acid, which contributes for cumulative effect of physical characteristic of bunches and berries by promoting growth and development for cell elongation and cell multiplication. The yield increase appears to have indicated through increase in bunch size, as well as berry size and weight (Habibi, 2009) [5]. The differences of yield per vine within the varieties in the same schedule of gibberellic acid treatment is attributed to varied bunch weight and number of bunches per vine. These results are found in close conformity with the earlier findings of those reported by Kumar and Sharma (2016) [8] with combined application of GA_3 with Urea Phosphate and BA in Thompson Seedless cultivar of grape and by Kaplan *et al*. (2017) [9] in “Einset Seedless” grape variety.

Benefit: cost ratio of grape production in schedule-1 and schedule-2 treatment of gibberellic acid in four different varieties of grapes was presented in Table-2. Among the varieties, in schedule-1 set of gibberellic acid treatment, benefit: cost ratio was obtained highest in Manik Chaman (2.37: 1) followed by Thompson Seedless (2.29: 1) and 2-A Clone variety obtained the minimum benefit: cost ratio (1.85: 1) over the other varieties. In schedule-2 set of gibberellic acid treatment, Thompson Seedless recorded higher B: C ratio (2.09: 1), followed by Manik Chaman (2.07: 1) and 2 -A Clone variety obtained minimum benefit: cost ratio (1.62:1) over other varieties. However, in two schedules of gibberellic acid treatment, benefit: cost ratio was found maximum in the grapes treated with schedule-1 set of gibberellic acid treatment compared to that of in the grapes treated with schedule-2 set of gibberellic acid treatment. The maximized B: C ratio in the grapes treated with schedule-1 treatment compared to schedule-2 gibberellic acid treatment is attributed to increased bunch weight and increased number of bunches per vine. As a consequence of which, yield per vine and yield per hectare also increased and finally it led to maximized benefit: cost ratio. The varied B: C ratio within the different varieties of a same schedule of gibberellic acid treatment was also due to varied bunch weight and varied number of average bunches per vine. These findings are found in line with the investigation of those reported by Dutta and Bunik (2007) [10] and they suggested that, the application of urea along with potassium sulphate, zinc and gibberellic acid to obtain better returns to the farmers and Thakur (2017) [11] worked out benefit to cost ratio in pomegranate and her results revealed that, NAA 30ppm recorded the highest benefit cost ratio (2.69) followed by GA_3 75ppm (2.44) and the lowest with control (1.74).

Table 1: Bunch parameters and yield of different grape varieties as influenced by different Schedules of gibberellic acid treatment

Varieties (V)	Bunch length (cm)			Bunch weight (g)			Bunch volume (cm^3)			Bunch appearance (compact/ loose)			Yield (kg/ vine)		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
V_1	23.31	21.00	22.15	526.33	410.00	468.16	476.50	356.25	416.13	1.19	1.59	1.39	17.6	16.50	17.10
V_2	22.13	19.25	20.69	506.25	384.69	445.47	443.75	333.75	388.75	1.32	1.53	1.42	18	16.38	17.20
V_3	24.38	22.06	23.22	576.25	462.69	519.47	536.5	405.00	470.75	1.23	1.51	1.37	16.10	15.00	15.60
V_4	21.75	19.00	20.37	483.75	359.15	421.45	427.50	310.00	368.75	1.35	1.56	1.45	15.3	14.00	14.60
Mean	22.89	20.32		523.14	404.13		471.06	351.25		1.27	1.54		16.63	15.47	
For comparing means of	S. Em. ±		C.D. at 5%	S. m. ±		C.D. at 5%	S. Em. ±		C.D. at 5%	S. Em. ±		C.D. at 5%	S.Em ±		C.D. at 5%
Varieties	1.28		3.77	14.56		42.81	11.14		32.76	0.04		0.13	0.33		0.96
Schedules	0.91		2.66	10.30		30.27	7.88		23.16	0.03		0.09	0.23		0.68
VxS	1.81		NS	20.58		NS	15.75		NS	0.060		NS	0.46		NS

NS- Non Significant V_1- Thompson Seedless V_3- K R White
S_1- Schedule-1 V_2- Manik Chaman V_4- 2-A Clone
S_2- Schedule-2

Table 2: Benefit cost ratio of different varieties of grapes as influenced by different Schedules of gibberellic acid treatment

Treatments	Fruit yield (t/ha)	Gross income (Rs./ha)	Total cost (Rs./ha)	Net return (Rs./ha)	Benefit: cost
V_1S_1	39.02	11,70,600	3,55,520	8,15,080	2.29: 1
V_1S_2	36.66	10,99,800	3,55,180	7,44,620	2.09: 1
V_2S_1	40.00	12,00,000	3,55,520	8,44,480	2.37: 1
V_2S_2	36.38	10,91,400	3,55,180	7,36,220	2.07: 1
V_3S_1	35.83	10,74,900	3,55,520	7,19,380	2.02: 1
V_3S_2	33.33	9,99,900	3,55,180	6,44,720	1.81: 1
V_4S_1	33.89	10,16,700	3,55,520	6,61,180	1.85: 1
V_4S_2	31.11	9,33,300	3,55,180	5,78,120	1.62: 1

Rate per kilogram of grapes is 30 Rupees and Rate per tonnes of grapes is 30,000 Rupees.
NS- Non Significant V_1- Thompson Seedless V_3- K R White
S_1- Schedule-1 V_2- Manik Chaman V_4- 2-A Clone
S_2- Schedule-2

Conclusion

The maximum yield (kg/ vine) and benefit to cost ratio was recorded in Manik Chaman variety, while, 2 -A Clone variety recorded the minimum yield and benefit to cost ratio over the other varieties. In two schedules of gibberellic acid treatment, grapes treated with schedule-1 set of gibberellic acid treatment noticed superiority in bunch parameters, recorded higher yield and benefit to cost ratio compared to that of schedule-2 treatment of gibberellic acid.

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