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Short communication

Post-harvest chemical manipulation in strawberry regeneration under Jammu sub-tropics

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ABSTRACT

The present investigation on postharvest chemical manipulation in strawberry (*Fragaria* × *ananassa* Duch.) regeneration under Jammu sub-tropics was carried out to standardize the dose and time of application of chemicals for optimising the runner production. Application of plant growth regulators enhanced the runner production in strawberry cultivar Chandler under Jammu sub-tropics. The maximum number of runners/ mother plant (13.53), number of trains/ mother plant (4.10), number of runners/ train (3.30), plant spread per mother plant (34.02 cm), plant spread per runner plant (10.83 cm), number of leaves per mother plant (22) and number of leaves per runner plants (7.29) of strawberry cv. Chandler was recorded with the application of 300 ppm GA_3 + 150 ppm BA. The maximum plant height per mother plant (23.29 cm), plant height per runner (10.88 cm), petiole length per mother plant (19.1 cm), petiole length per runner plant (10.70 cm) and root length per runner plant (5.90 cm) were recorded under application of GA_3 100 ppm. Whereas, control treatment recorded the maximum crown diameter (6.92 mm), crown weight (0.66 g) and leaf area (16.57). The findings indicated that the application of GA_3 (300 ppm) + BA (150 ppm) enhanced the regeneration capacity of strawberry runners under Jammu sub-tropics.

Key words: 6-Benzyladenine, gibberellins, regeneration, runner production, strawberry.

Strawberry is one of the important temperate fruit crops of India but also being grown in sub-tropical and tropical climates. It is propagated commercially by runners. As the strawberry growers of the subtropical region are entirely dependent on hilly areas for their planting material requirements, which make its cultivation in plains less remunerative. The runners, which are received from hilly areas have very limited growth due to short growing season as compared to plains and thus give weak runners. Gibberellic acid (GA_3) is a growth regulator which stimulate the effect of long day lengths in short day plants by improving vegetative development and increasing runner production. Gibberellic acid progressively increased the plant height, canopy spread, leaf area, number of leaves, petiole length and induces stem elongation when applied exogenously to strawberry plants (Kasim *et al.*, 5; Paroussi *et al.*, 10; Sharma and Singh, 8). Cytokinin has been found to increase runner formation when it was used in long days and moderate temperatures between 15°C at night and 30°C at day (Hasse *et al.*, 4). Spraying GA, BA and their combination increases plantlet production (Dale *et al*., 3). It also enhanced the number of runners in all strawberry varieties by specifically stimulating the stolon forming systems during long days. It is also responsible for increasing the number of runners per crown at higher rates of application. Keeping in view the above mentioned problems the present experiment was carried out to ascertain the treatment, which can increase its runner production and provide opportunity to the farming community to grow it commercially.

The present investigation was carried out at the Research Farm, Faculty of Agriculture, SKUAST Jammu, Udheywalla, Jammu during 2012-2013. Udheywalla is situated in the sub-tropical zone at 32.73°N and longitude of 74.87°E at an elevation of 327 m from the mean sea level with annual precipitation of about 1,200 mm (about 70 percent rains are received during July to October). The mean annual maximum and minimum temperature are 29.60°C and 16.70°C, respectively. Summer months are hot with temperature and humidity ranging from 23.50 to 35.50°C and 53.0 to 73.50 per cent, respectively. The experiment was laid out in randomized block design with 16 treatments, *viz.*, T_1 (GA_3 100 ppm), T_2 (GA_3 200 ppm), T_3 (GA_3 300 ppm), T_4 (BA 50 ppm), T_5 (BA 100 ppm), T_6 (BA 150 ppm), T_7 (GA_3 100 ppm + 50 ppm), T_8 (GA_3 100 ppm + BA 100 ppm), T_9 (GA_3 100 ppm + BA 150 ppm), T_{10} (GA_3 200 ppm + BA 50 ppm), T_{11} (GA_3 200 ppm + BA 100 ppm), T_{12} (GA_3 200 ppm + BA 150 ppm), T_{13} (GA_3 300 ppm + BA 50 ppm), T_{14} (GA_3 300 ppm + BA 100 ppm), T_{15} (GA_3 300 ppm + BA 150 ppm) and T_{16} (control). All the treatments were replicated thrice.

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The runners of equal size and vigour were transplanted during evening hours at a spacing of 45 x 30 cm and size of plots was 1.2 × 1.4 m. The watering was done for seven continuous days with watering cane and gap filling was done up to one week after transplanting of runners. The treatments were given 150 days after transplanting. The gibberellic acid, benzyl adenine and their combination were sprayed on the plants till the solution began to run-off. To avoid mixing of these chemicals, spraying was performed carefully by covering the adjacent beds with polythene sheets. The height of three representative plants was recorded with a scale from vertical distance to the highest point of the tallest leaf to the ground level without stretching out and average was calculated. The total number of leaves of three randomly selected plants were counted and divided by the number of plants and average was calculated. The petiole length of five leaves selected at random from each of the marked plants was measured from the base of the conjunction of the lamina. The spread of three randomly selected plants were measured from north to south and east to west and expressed as a mean of the two measurements. Leaf area of five leaves of three randomly selected plants was recorded at the end of growing season. The root length of three randomly selected runner plants were measured with the help of scale. The data on number of runners/ mother plant and number of trains/ mother plant were recorded by counting the total number of runners per train and number of trains per mother plants of three randomly selected mother plants and divided by number total number of selected mother plants. Total number of runners of three randomly selected mother plants were counted and divided by the total number of train at the end of growing season. The crown weight of the runners were recorded with electronic balance. All the observations were subjected to statistical analysis as per the method suggested by Panse and Sukhatme (7). Economics of different treatment combinations was calculated as per the existing market prices. The gross return from each treatment was calculated after deducting the crop loss at 10%. The net profit from each treatment was calculated separately by subtracting cost of cultivation from gross return. The benefit : cost ratio for each treatment was calculated.

There were significant differences among the treatments of gibberellic acid, benzyl adenine and their combinations on vegetative growth of runner

Table 1. Effect of benzyladenine, gibberellic acid and their combinations on plant height, plant spread, root length, petiole length of strawberry cv. Chandler.

Treatment	Plant height/ mother plant (cm)	Plant height/ runner plant (cm)	Root length/ runner plant (cm)	Plant spread/ mother plant (cm)	Plant spread/ runner plant (cm)	Petiole length/ mother plant (cm)	Petiole length/runner plant (cm)
T_1	23.29	11.88	6.90	24.11	8.13	19.1	11.20
T_2	22.40	10.71	5.87	23.79	7.19	18.3	10.46
T_3	22.74	10.55	5.34	24.67	7.19	18.4	10.17
T_4	20.46	8.88	4.55	24.37	7.49	18.3	7.07
T_5	20.2	9.73	4.82	25.25	7.51	17.2	7.32
T_6	21.6	9.38	4.62	25.83	7.63	17	7.49
T_7	19.41	8.83	4.09	26.02	7.7	18.6	8.41
T_8	16.93	10.44	5.28	25.67	7.96	16.7	8.28
T_9	15.39	9.66	4.65	29	8.74	16.4	8.57
T_{10}	17.15	9.95	5.00	28.51	7.95	15.7	9.16
T_{11}	14.73	9.41	4.64	27.67	7.96	17.9	9.54
T_{12}	14.07	9.20	5.07	27.11	8.96	15.79	7.45
T_{13}	14.65	9.90	4.83	28.7	8.14	12.3	9.99
T_{14}	13.52	10.00	5.17	32.73	9.38	13.4	7.43
T_{15}	13.64	10.20	5.27	34.02	10.83	11.1	7.24
T_{16}	12.56	8.24	4.05	22.33	6.96	9.4	7.01
$CD_{0.05}$	3.70	1.21	0.91	5.39	1.50	4.43	2.40

T_1 (GA_3 100 ppm), T_2 (GA_3 200 ppm), T_3 (GA_3 300 ppm), T_4 (BA 50 ppm), T_5 (BA 100 ppm), T_6 (BA 150 ppm), T_7 (GA_3 100 ppm + 50 ppm), T_8 (GA_3 100 ppm + BA 100 ppm), T_9 (GA_3 100 ppm + BA 150 ppm), T_{10} (GA_3 200 ppm + BA 50 ppm), T_{11} (GA_3 200 ppm + BA 100 ppm), T_{12} (GA_3 200 ppm + BA 150 ppm), T_{13} (GA_3 300 ppm + BA 50 ppm), T_{14} (GA_3 300 ppm + BA 100 ppm), T_{15} (GA_3 300 ppm + BA 150 ppm) and T_{16} (control).

production in Chandler strawberry (Table 1). In the present investigations, the application of gibberellin and benzyladenine significantly influenced the plant height per mother, plant height per runner and root length of strawberry plant. Maximum plant height per mother plant (23.29 cm), plant height per runner plant (11.88 cm) and root length per runner plant (6.90 cm) were obtained with the application of GA_3 (100 ppm) as compared to other treatments. This increase in plant height and root length of strawberry might be due to fact that gibberellins causing cell elongation in plant system. These results are in conformity with the findings of Qureshi *et al.* (9), Paroussi *et al*. (8), Asrey *et al*. (2) and Kumar *et al*. (6) who reported stimulation of plant growth in strawberry with gibberellic acid application. The application of gibberellic acid and benzyladenine significantly influenced the plant spread per mother and plant spread per runner in strawberry plants. Maximum plant spread per mother plant (34.02 cm) and plant spread per runner plant (10.83 cm) were obtained with the application of GA_3 (300 ppm) + BA (150 ppm). The application of plant growth regulators effectively influenced the petiole length per mother plant and petiole length per runner plant in the present study. Petiole length per mother plant (19.10 cm) and petiole length per runner plant (11.20 cm) were found to be maximum with the application of GA_3 (100 ppm).

Application of gibberellic acid and benzyladenine effectively influenced the number of leaves per mother plant, number of leaves per runner plant and leaf area per runner plants in the present study (Table 2). Maximum number of leaves per mother plant (22.00) and number of leaves per runner plant (7.29) were observed in plants treated with GA_3 (300 ppm) and BA (150 ppm). The treated plants had less leaf area than the control. The maximum leaf area (16.57 cm^2) was recorded under control treatment. In this study, higher concentration of GA and BA increased the leaf number but decreased leaf area, therefore, hormone treated plants had smaller leaves and these treatments decreased vegetative growth in favour of runner production. The research findings are in line with the results obtained by Tripathi and Shukla (11) and Ali *et al.* (1). Decreased leaf area by GA_3 application was reported by Hasse *et al*. (4) and Dale *et al*. (3). The maximum crown diameter (6.92

Table 2. Effect of benzyladenine, gibberellic acid and their combinations on number of leaves, leaf area, crown diameter and crown weight of strawberry cv. Chandler.

Treatment	No. of leaves/ mother plant	No. of leaves/ runner plant	Leaf area/runner plant (cm^2)	Crown dia. (mm)	Crown weight (kg)
T_1	14.07	5.23	12.10	5.49	0.21
T_2	14.00	4.55	11.97	5.31	0.21
T_3	15.00	4.20	11.69	5.15	0.18
T_4	15.51	4.97	13.00	5.69	0.27
T_5	15.00	5.07	13.53	5.67	0.22
T_6	18.73	5.26	13.56	5.64	0.22
T_7	16.00	5.41	13.68	5.9	0.37
T_8	16.28	5.48	14.05	5.97	0.33
T_9	17.41	5.59	14.43	6.04	0.32
T_{10}	17.26	5.84	13.81	6.25	0.42
T_{11}	19.00	6.14	14.32	6.23	0.42
T_{12}	19.00	5.94	15.05	6.15	0.37
T_{13}	19.33	6.09	13.92	6.38	0.52
T_{14}	20.00	6.22	15.30	6.31	0.50
T_{15}	22.00	7.29	15.34	6.30	0.50
T_{16}	9.00	3.28	16.57	6.92	0.66
$CD_{0.05}$	2.66	1.17	1.52	0.36	0.12

T_1 (GA_3 100 ppm), T_2 (GA_3 200 ppm), T_3 (GA_3 300 ppm), T_4 (BA 50 ppm), T_5 (BA 100 ppm), T_6 (BA 150 ppm), T_7 (GA_3 100 ppm + 50 ppm), T_8 (GA_3 100 ppm + BA 100 ppm), T_9 (GA_3 100 ppm + BA 150 ppm), T_{10} (GA_3 200 ppm + BA 50 ppm), T_{11} (GA_3 200 ppm + BA 100 ppm), T_{12} (GA_3 200 ppm + BA 150 ppm), T_{13} (GA_3 300 ppm + BA 50 ppm), T_{14} (GA_3 300 ppm + BA 100 ppm), T_{15} (GA_3 300 ppm + BA 150 ppm) and T_{16} (control).

mm) and crown weight (0.66 g) per runner plant were observed in control. Average crown diameter and crown weight decreased significantly by hormonal treatments. The findings are in conformity with the result of Dale *et al*. (3). In the present investigations, the application of gibberellin and benzyladenine significantly influenced the number of runners per mother plant, number of trains per mother plant and number of runners per train (Table 3). Maximum runners per mother plant (13.53), trains per mother plant (4.10) and runners per train (3.10) were obtained with the application of GA_3 (300 ppm) + BA (150 ppm), respectively as compared to other treatments. The maximum increase in number of runners per mother plant, number of trains per mother plant and number of runners per train of cv. Chandler might be due to the synergistic effect of GA_3 and BA which consistently enhanced the runner production in day neutral strawberries. Growth regulators induce runners to form either by stimulating dormant buds to grow or by preventing flower bud initiation. GA_3 has been reported to promote runners production and inhibit flowers formation in strawberry plants. These results are in accordance with Dale *et al*. (3). This might also be due to the application of gibberellins increases the vegetative growth in the form of height, number of leaves and leaf area, which facilitates accumulation of more photosynthates leading to production of more number of runners per plant. It is concluded from the present investigation that application of GA_3 (300 ppm) + BA (150 ppm) enhanced the regeneration capacity of strawberry runners under Jammu sub-tropics.

Table 3. Effect of benzyl adenine, gibberellic acid and their combinations on number of runners per mother plant, number of train per mother plant and number of runner per train of strawberry cv. Chandler.

Treatment	No. of runners/ mother plant	No. of trains/ mother plant	No. of runners/train
T_1	9.08	3.11	2.92
T_2	8.60	3.15	2.73
T_3	8.07	3.11	2.60
T_4	4.28	2.11	2.03
T_5	4.76	2.30	2.07
T_6	4.89	2.33	2.10
T_7	9.95	3.20	3.11
T_8	10.21	3.22	3.17
T_9	10.49	3.28	3.20
T_{10}	10.26	3.36	3.15
T_{11}	10.72	3.33	3.22
T_{12}	10.85	3.36	3.23
T_{13}	11.01	3.38	3.26
T_{14}	11.15	3.40	3.28
T_{15}	13.53	4.10	3.30
T_{16}	3.290	1.96	1.67
$CD_{0.05}$	1.35	0.57	0.12

T_1 (GA_3 100 ppm), T_2 (GA_3 200 ppm), T_3 (GA_3 300 ppm), T_4 (BA 50 ppm), T_5 (BA 100 ppm), T_6 (BA 150 ppm), T_7 (GA_3 100 ppm + 50 ppm), T_8 (GA_3 100 ppm + BA 100 ppm), T_9 (GA_3 100 ppm + BA 150 ppm), T_{10} (GA_3 200 ppm + BA 50 ppm), T_{11} (GA_3 200 ppm + BA 100 ppm), T_{12} (GA_3 200 ppm + BA 150 ppm), T_{13} (GA_3 300 ppm + BA 50 ppm), T_{14} (GA_3 300 ppm + BA 100 ppm), T_{15} (GA_3 300 ppm + BA 150 ppm) and T_{16} (control).

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