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Short communication

Effect of exogenous application of plant growth regulators on vine growth, yield and quality attributes in kiwifruit cv. Hayward

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ABSTRACT

Present investigation was carried out on 11-year-old vines of kiwifruit cv. Hayward trained on a T bar trellis system for two years. Four different plant growth regulators *viz*., GA_3 (25 & 50 mg l^{-1}), BA (10 & 20 mg l^{-1}), 2,4-D (10 & 25 mg l^{-1}), TRIA (10 & 20 mg l^{-1}) and a natural extract (4 g ml^{-1}) were sprayed four weeks after full bloom. All the growth regulators proved effective in improving vine growth, yield and physico-chemical characteristics of fruits as compared to control. Maximum shoot growth (157.27 & 153.49 cm) was observed with the application of 50 mg l^{-1} GA_3. Maximum leaf area (190.25 & 188.34 cm^2) was obtained with 25 mg l^{-1} of GA_3. The highest fruit retention (86.19 & 81.06%) and yield per vine (57.98 & 54.82 kg) was recorded with 10 mg l^{-1} 2,4-D. Advancement in harvest maturity was noted with 10 mg l^{-1} TRIA. Among all the treatments, application of 25 mg l^{-1} GA_3 followed by 10 mg l^{-1} 2,4-D proved to be more effective in improving fruit physical characteristics *viz*., fruit weight, fruit length & fruit diameter; and chemical characteristics *viz*., total soluble solids and total sugars.

Key words: Plant growth substances, kiwifruit, physical parameters, chemical parameters.

Kiwifruit (*Actinidia deliciosa* Chev.) has emerged as a success story in temperate fruit growing areas in India. Kiwifruit is very much acclaimed for its nutritive and medicinal values. Of few cultivars, the most common kiwifruit cv. Hayward accounts for 75 per cent of the global kiwifruit production due to its attractive green colour pulp, superior flavour and storage-life. Use of synthetic growth regulators and natural plant extract are known to influence various plant activities. Triacontanol (TRIA), a primary alcohol, is reported to cause increased uptake of water and nutrients and results in increased growth of the plants and improved CO_2 exchange (Mishra and Srivastava, 6). Gibberellic acid plays a major role in stimulating cell division and cell elongation, benzyl adenine, a cytokinin in cell division, whereas 2,4-D an auxin is known to promote size and control fruit drop. Therefore, the present study was undertaken to standardize the best growth regulators for improving vine growth, yield and quality of kiwifruit.

The investigations were carried out on 11-year-old Hayward kiwifruit vines planted at a spacing of 6 m × 5 m. Canopies of the vines were trained on T-bar system. The vines were irrigated using drip irrigation system and managed giving uniform agronomic practices. There were 10 treatments, *viz*. gibberellic acid @ 50 (T_1) and 25 mg/l (T_2); benzylaminopurine (6-BA) @ 20 (T_3) and 10 mg/ l (T_4); 2,4-D @ 25 (T_5) and 10 mg/l (T_6); triacontanol (TRIA) @ 20 (T_7) and 10 mg/l (T_8); Natural extract (auxin + cytokinin + GA_3) (T_9) and control (water spray) (T_{10}). The treatments were applied as spray 4-weeks after full bloom on a plot size of 2 plants/ treatment in three replications. Data on annual shoot extension growth were recorded during the last week of November. Leaf area was measured in July (LiCor-Model 3100). The total number of fruits retained on the tagged branches was counted at the time of harvest (Westwood, 9). Fruits were taken as mature stage when TSS was around 6.2^0Brix. Other parameters recorded were days from full bloom to maturity, total fruit weight, average yield per vine, fruit weight, fruit length & diameter. Fruit firmness was recorded using digital fruit pressure tester (Toshiba-India). Amongst the quality parameters TSS, titratable acidity and total sugars content were also determined as per the standard methods. The data generated were analysed randomized block design.

Annual shoot extension growth, leaf area, fruit retention and days taken to maturity of kiwifruit cv. Hayward were significantly influenced by exogenous application of plant growth regulators (Table 1). Maximum shoot length was recorded with the application of 50 mg l^{-1} GA_3 (T_1) (157.27 cm during first year and 153.49 cm during 2nd year), which was significantly superior over rest of the treatments. Lowest shoot growth was recorded in control (T_{10}). Maximum leaf area (190.25 and 188.34 cm^2) was recorded in vines, which received 25 mg $l^{-1}$$GA_3$ (T_2) in comparison to other treatments. However, lowest leaf area was observed in control (T_{10}) (170.57 and 173.62

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Table 1. Effect of exogenous application of plant growth regulators on annual shoot growth, leaf area, fruit retention and days taken to maturity in kiwifruit cv. Hayward.

Treatment	Annual shoot extension growth (cm)		Leaf area (cm^2)		Fruit retention (%)		Days taken to maturity	
	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr
T_1	157.27	153.49	185.77	183.82	81.32	72.12	183.34	185.21
T_2	150.76	151.21	190.25	188.34	85.43	78.75	181.21	182.97
T_3	142.32	137.04	177.17	176.42	76.23	73.10	180.65	181.56
T_4	139.77	140.14	179.18	177.23	78.64	70.04	178.86	180.29
T_5	145.17	143.19	180.14	179.19	83.12	76.34	180.13	184.01
T_6	148.36	148.97	184.07	182.46	86.19	81.06	176.10	180.16
T_7	141.14	141.01	173.03	173.98	79.32	64.19	177.11	175.21
T_8	139.23	134.15	175.13	174.84	84.19	78.72	174.27	174.43
T_9	146.23	143.65	181.27	179.37	73.39	70.26	177.67	179.36
T_{10}	125.91	129.31	170.57	173.62	63.71	60.92	177.11	178.13
$CD_{0.05}$	2.41	2.23	1.41	1.39	2.01	2.21	0.57	1.21

cm^2). The promotion of growth in terms of increase in shoot length and leaf area has been attributed to increasing plasticity of the cell wall followed by hydrolysis of starch to sugars, which lowers the water potential of cell, resulting in the entry of water into the cell causing elongation.

Fruit retention was highest with 10 mg l^{-1}2,4-D (T_6) (86.19 and 81.06%) in comparison to other treatments. However, lowest per cent fruit retention was recorded in control (T_{10}) (63.71 and 60.92%). Reduction in fruit drop as a response of gibberellic acid may also be due to an increase in initial growth of ovaries which ultimately reduce the magnitude of peak of abscission (Agusti, 1). The results are also in conformation to the findings of Rani and Brahmachari (7). Fruits of the vines treated with a foliar spray of 10 mg l^{-1} of TRIA (T_8) took minimum time (174.27 and 174.43 during 2012) to reach maturity. It advanced the date of maturity by 3-4 days over control (T_{10}). However, treatment with 50 mg l^{-1} GA_3 (T_1) delayed harvesting by about 6-7 days as compared to control (T_{10}). This advancement in harvest maturity might have occurred due to stimulated ethylene production as a result of TRIA treatment. The rate of photosynthesis gradually increased with the advancement of growth (Mishra and Srivastava, 6).

Maximum yield per vine was noticed with 10 mg l^{-1} 2,4-D (T_6) (57.98 and 54.82 kg $vine^{-1}$) followed by 25 mg l^{-1} 2-4-D (T_5) (56.18 and 52.63 kg $vine^{-1}$) (Table 2). The significantly lower fruit yield was recorded in control (T_{10}), *i.e.* 40.95 and 39.79 kg $vine^{-1}$. Increased number of fruits per tree and increased fruit size and weight might have contributed towards increase in yields due to growth regulators application. 2,4-D treatments have also known to increase total yields in other fruits like Nagpur mandarin (Ansari *et al.*, 2).

Fruit weight was significantly more in vines treated with 25 mg l^{-1} GA_3 (T_2) (87. and 89.94 g) in comparison to other treatments (Table 2). However minimum fruit weight was recorded in control (T_{10}) (66.96 and 68.43 g). Maximum increase in fruit length was observed with the application of 25 mg l^{-1} GA_3 (T_2) (7.54 7.20 cm) and maximum fruit diameter was recorded with 10 mg l^{-1} 2,4-D (T_6) (5.29 and 5.36 cm). Exogenous application of GA_3 is known to increase cell size thus increased fruit length (Zhang *et al.*, 10).

Fruit firmness was higher with the application of 25mg l^{-1} GA_3 (T_2) (7.76 N and 7.55) (Table 3). The lowest firmness was recorded in untreated fruit (T_{10}) (7.01 and 7.04 N). Choi *et al.* (3) also reported that GA_3 increased fruit firmness at harvest and decreased the rate of fruit softening. Total soluble solids was found to be highest with foliar application of 25 mg l^{-1} GA_3 (T_2) (12.91° and 13.32°B). Increase in total soluble solids might be due to conversion of carbohydrates into simple sugars with GA_3 application (Rub *et al.*, 8). Earlier, Clayton *et al.* (4) also reported that GA_3 spray increased fruit soluble solids in sweet cherry.

Minimum acidity was recorded with 25 mg l^{-1} GA_3 (T_2) (0.85 and 0.77%) followed by 50 mg $l^{-1}$$GA_3$ (T_1) and 10 mg l^{-1} 2,4-D (T_6), respectively. These treatments were at par with one another. Maximum acidity was recorded with 25 mg l^{-1} 2,4-D (T_5) (1.41 and 1.35). Maximum total sugars were recorded with the application of 25 mg l^{-1} GA_3 (T_2) (12.76 and

Table 2. Effect of exogenous application of plant growth regulators on fruit yield, fruit weight, fruit length and fruit diameter in kiwifruit cv. Hayward.

Treatment	Yield per vine (kg)		Fruit wt. (g)		Fruit length (cm)		Fruit dia. (cm)	
	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr
T_1	51.45	48.13	79.84	81.82	7.11	7.09	5.19	5.20
T_2	53.29	49.08	87.39	89.94	7.54	7.20	5.03	5.22
T_3	47.89	44.73	79.21	81.11	6.54	6.74	5.13	5.15
T_4	48.15	46.99	78.34	78.74	6.38	6.64	5.11	5.16
T_5	56.18	52.63	84.75	84.97	7.01	7.02	5.15	5.27
T_6	57.98	54.82	86.24	87.11	7.39	7.13	5.29	5.36
T_7	44.79	41.13	80.79	81.24	6.57	6.59	5.16	5.14
T_8	46.14	43.29	78.30	79.99	6.23	6.41	4.88	4.95
T_9	46.28	43.12	79.11	74.86	6.85	6.80	5.06	5.11
T_{10}	40.95	39.79	66.96	68.43	5.85	5.73	5.01	4.50
$CD_{0.05}$	1.33	1.09	0.11	0.04	0.17	0.14	0.11	0.19

Table 3. Effect of exogenous application of plant growth regulators on fruit firmness, TSS, titrable acidity and total sugars in kiwifruit cv. Hayward.

Treatment	Fruit firmness (N)		TSS (^{0}B)		Titrable acidity (%)		Total sugars (%)	
	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr
T_1	7.69	7.50	12.80	13.11	0.93	0.78	12.65	11.67
T_2	7.76	7.55	12.91	13.32	0.85	0.77	12.76	12.01
T_3	7.34	7.13	12.29	12.45	1.17	1.13	11.32	11.31
T_4	7.46	7.25	12.42	12.84	1.16	1.01	12.05	11.58
T_5	7.64	7.46	12.65	12.98	1.41	1.35	8.65	9.21
T_6	7.53	7.32	12.78	13.23	0.95	0.89	8.91	9.36
T_7	7.32	7.37	12.11	12.65	1.40	1.31	11.21	11.28
T_8	7.05	7.07	11.93	12.87	1.21	1.04	10.32	11.34
T_9	7.23	7.29	11.10	12.11	1.09	1.11	11.20	11.18
T_{10}	7.01	7.04	11.25	11.32	1.35	1.27	9.05	9.17
$CD_{0.05}$	0.08	0.04	0.51	0.07	0.06	0.11	0.01	0.32

12.01%), while was in 25 mg l^{-1} 2,4-D (T_5) (8.65 and 9.21%). The increase in the content of total sugars in fruits may be due to degradation of polysaccharides into simple sugars by metabolic activities, conversion of organic acids into sugars, and loss of moisture with growth regulators application (Kumar *et al.*, 5).

From the above discussion it may be concluded that growth regulators, *viz*., 25 mg/l GA_3 and 10 mg/l 2,4-D may be used for enhancing the plant growth and yield of better quality fruits in cv Hayward.

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