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Short communication

Effect of plant growth regulators on fruit drop and quality of *Bael* under *Tarai* conditions of Uttarakhand

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ABSTRACT

Present investigation was carried to study the role of plant growth regulators on fruit drop in *bael* (*Aegle marmelos* Correa). Treatments consists of sprays of NAA (10, 20 and 30 ppm), 2,4-D (5, 10 and 20 ppm), GA_3 (25, 50 and 50 ppm) and ethrel (50,100 and 150 ppm) in *bael* cv. Pant Shivani. All the growth substances sprayed, proved beneficial in minimizing drop and enhancing quality characters of *bael* fruits. Maximum fruit set (78.48%) was recorded with NAA 30 ppm, while minimum fruit drop (90.64%) and maximum fruit retention (9.36%) were recorded with NAA 20 ppm. Highest fruit length and breadth was recorded with NAA 30 ppm. Fruits sprayed with NAA 20 ppm estimated highest fruit weight, volume, pulp content and ascorbic acid but least acidity. Maximum TSS was recorded with GA_3 50 ppm.

Key words: *Aegle marmelos*, fruit drop, plant growth regulators.

Bael (*Aegle marmelos* Correa) is the one of the most important indigenous fruit of India. The importance of *bael* fruit lies in its curative, pesticidal and nutritive properties. It is vary hardy, drought tolerant and thrives well on marginal and poor fertility soils and gives good economic return even without much care and inputs. Problem of fruit drop is the most important limiting factors in its cultivation. There is very heavy initial fruit set in *bael* but final retention is very low due to premature fruit drop. Low auxin content in the fruits has been reported to be the major cause of fruit abscission. Plant growth regulators have been reported to be useful for control of fruit drop in fruits crop. Foliar application of 2,4-D (10 mg/l) + Zn (0.25%) + K (0.25%) is effective in improving fruit yield, quality and providing the maximum control on excessive drop of premature Kinnow fruit (Ashraf *et al.*, 3). Application of NAA at 20 and 30 ppm during the fruit set and again one month after the first spray proved effective in reducing fruit drop in *ber* (Bal and Randhawa, 4). 2,4-D (20 ppm) proves to be the most effective measures for the control of physiological fruit drop of Nagpur mandarin (Ansari *et al.*, 2). Ethrel (100 ppm) applied during fourth week of March was the most effective treatment to reduce the pre-harvest drop in plum (Gupta and Kaur, 6). But the work done on this aspect on *bael* is scanty in literature. The present studies, therefore, were conducted to find out the suitable remedial measures to minimize the pre-harvest fruit drop in *bael* cv. Pant Shivani under *Tarai* conditions of Uttarakhand.

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Present investigation was carried out at Horticultural Research Centre, Patharchatta and Department of Horticulture, GBPUA&T, Pantnagar during 2009-2011 in 15-year-old trees of *bael* cv. Pant Shivani planted at 8 m × 8 m spacing. The trees of uniform age, size and vigour were selected. Plant growth regulators containing Tween-20® (0.1%) were sprayed twice on the whole tree. First spray was done on 7th June after seven days of initiation of growth and second spray on 21st June. Treatments consist of sprays of NAA (10, 20 and 30 ppm), 2,4-D (5, 10 and 20 ppm), GA_3 (25, 50 and 50 ppm), ethrel (50, 100 and 150 ppm) and control (water spray). There were 13 treatments, which were replicated thrice in a randomized block design with one tree per replication. Twenty branches spread over four directions in all the treatments were tagged to study the fruit set. Numbers of flower buds were counted on each branch in June. Fruits were considered to have set when their ovaries started swelling after 20 days. Fruit drop at monthly interval were calculated by counting the number of fruits in each month and subtracting it from the number of fruits at previous month. Final retention was recorded at the time of harvest by counting the number of remaining fruits in tagged branches. Fruits samples from each treatment were collected at harvest and analysed for physico-chemical characteristics as per standard methods. Fruit size was recorded by measuring length and diameter of fruits. The fruits were weighed and volume of fruits was determined by water displacement method (Majid *et al.*, 8). Peel, pulp, fibre, mucilage and non-edible portion were separated, weighed and calculated in per cent on fresh weight basis. The seeds were removed, counted and weighed. The TSS of fruit pulp was determined with the help of Zeiss hand refractometer. The total titratable acidity and ascorbic contents of fruit pulp were estimated as per standard methods (AOAC, 1) and expressed as per cent citric acid on fresh weight basis and milligrams of ascorbic acid per 100 g of fresh pulp weight, respectively. The TSS: acid ratio was calculated by dividing the TSS of fruit pulp by its acid content. The per cent data were angularly transformed before statistical analysis.

Fruit set was significantly increased from control by the sprays of plant growth regulators during both the years of experiment (Table 1). The maximum fruit set was recorded in NAA 30 ppm followed by GA_3 100 ppm and NAA 20 ppm. Similar results on the effect of NAA and GA_3 on fruit set was reported in *ber* (Singh *et al.*, 13) and plum (Saini and Sharma, 12). It is clear from the data that effect of plant growth regulators on fruit drop and fruit retention percentage was superior from control. Minimum fruit drop and maximum fruit retention were observed in NAA 20 ppm followed by 2,4-D 20 ppm. Similar results have been reported in ber (Bal and Randhawa, 4), Nagpur mandarin (Patil *et al.*, 10; Ansari *et al.*, 2) and oranges (Modise *et al.*, 9). It might be due to the fact that developing fruits needs auxin in higher quantity and fruit drop occur when auxin level goes down by exogenous application the deficiency of auxin is met and thus it checks fruit drop. Improvement in fruit retention percentage might be attributed to the reduction in fruit drop percentage. The maximum fruit length, diameter, weight and volume were observed in NAA 30 ppm followed by spray of NAA 20 ppm during both the years of experiment. These results are in conformity with the effects of NAA in *ber* (Bal and Randhawa, 4). The increase in fruit size, weight and volume by application of NAA were probably due to cell enlargement and accelerated rate of fruit growth. A direct correlation between endogenous auxins, gibberellins and cytokinins of the developing fruits and their rate of growth has been established (Krishnamurthy, 7). Treated fruits gained more weight and volume due to increase in cell volume and greater accumulation of water and food materials.

Physical parameters of fruits were significantly improved from control by the sprays of plant growth regulators during both the years of experiment (Table 2). A significant reduction in percentage of fruit peel content was observed by different sprays of plant growth regulators during both the years of experiment. Minimum fruit peel (skull) content was observed in NAA 20 ppm and maximum in control. Fruits treated with plant growth regulators have thinner peel due to cell expansion (Rani and Brahmachari, 11). Fruit pulp content was significantly varied by the application of plant growth regulators. The maximum fruit pulp content was observed in NAA 20 ppm and minimum fruit pulp content in ethrel 50 ppm. Similar effect of NAA was reported in ber (Singh *et al.*, 13) and Nagpur mandarin (Ansari *et al.*, 2). The increase in pulp weight might be due to accumulation of more water and food substances in the aril along with increase

Table 1. Effect of plant growth regulators on fruit set, fruit drop, fruit retention and physical parameters of *bael*.

Treatment	Fruit set (%)	Fruit drop (%)	Fruit retention (%)	Fruit length (cm)	Fruit dia. (cm)	Fruit wt. (kg)	Fruit volume (l)
NAA 10 ppm	71.41 (57.68)	93.76 (75.54)	6.24 (14.47)	17.35	17.07	2.01	2.08
NAA 20 ppm	77.81 (61.90)	90.64 (72.19)	9.36 (17.81)	17.96	17.12	2.08	2.09
NAA 30 ppm	78.48 (62.36)	92.72 (74.36)	7.28 (15.65)	17.99	17.77	2.23	2.33
2,4-D 5 ppm	72.35 (58.28)	94.03 (75.85)	5.98 (14.15)	16.38	16.02	1.98	2.04
2,4-D 10 ppm	75.70 (60.47)	92.40 (74.01)	7.60 (16.00)	17.04	16.71	2.01	2.10
2,4-D 20 ppm	71.00 (57.42)	91.12 (72.66)	8.88 (17.34)	17.47	16.99	2.06	2.13
GA_3 25 ppm	74.25 (59.50)	95.01 (77.09)	5.00 (12.92)	15.63	14.95	1.98	2.07
GA_3 50 ppm	76.82 (61.22)	93.07 (74.74)	6.94 (15.27)	16.52	16.03	2.03	2.10
GA_3 100 ppm	78.02 (62.04)	94.96 (77.02)	5.04 (12.98)	17.76	17.17	2.07	2.12
Ethrel 50 ppm	71.79 (57.92)	96.47 (79.18)	3.53 (10.83)	15.24	15.03	2.00	2.02
Ethrel 100 ppm	75.06 (60.04)	95.15 (77.27)	4.86 (12.73)	16.72	16.10	2.00	2.03
Ethrel 150 ppm	70.16 (56.88)	94.07 (75.94)	5.93 (14.07)	17.06	16.86	2.02	2.04
Control	67.82 (55.44)	98.06 (82.00)	1.94 (8.00)	15.00	14.87	1.99	2.01
$CD_{(0.05)}$	(0.61)	(0.76)	(0.75)	0.41	0.24	0.21	0.23

Table 2. Effect of plant growth regulators on physical parameters of *bael* fruits.

Treatment	Fruit skull (%)	Fruit pulp (%)	Fruit fibre (%)	Fruit mucilage (%)	Fruit non-edible portion (%)	No. of seeds per fruit	Weight of seeds per fruit (g)
NAA 10 ppm	18.94 (25.80)	61.44 (51.61)	9.96 (18.40)	7.47 (15.86)	2.20 (8.53)	146.17	32.67
NAA 20 ppm	17.59 (24.80)	63.64 (52.92)	10.11 (18.54)	6.73 (15.04)	1.93 (7.99)	142.67	29.83
NAA 30 ppm	18.91 (25.78)	62.23 (52.08)	10.08 (18.51)	6.63 (14.92)	2.16 (8.44)	144.83	31.00
2,4-D 5 ppm	18.67 (25.60)	60.99 (51.35)	10.09 (18.53)	7.98 (16.42)	2.27 (8.66)	144.00	33.17
2,4-D 10 ppm	18.67 (25.60)	61.99 (51.94)	10.06 (18.49)	7.45 (15.84)	1.85 (7.82)	144.83	34.33
2,4-D 20 ppm	17.86 (25.00)	62.29 (52.11)	9.97 (18.41)	7.44 (15.82)	2.45 (9.01)	143.50	34.67
GA_3 25 ppm	19.07 (25.89)	61.11 (51.42)	10.11 (18.54)	7.82 (16.24)	1.89 (7.92)	144.17	30.67
GA_3 50 ppm	18.59 (25.54)	62.14 (52.03)	10.29 (18.71)	7.33 (15.71)	1.64 (7.34)	140.83	28.50
GA_3 100 ppm	19.02 (25.86)	61.47 (51.63)	10.12 (18.55)	6.86 (15.18)	2.54 (9.17)	138.67	27.00
Ethrel 50 ppm	19.07 (25.90)	60.86 (51.27)	10.26 (18.68)	7.64 (16.04)	2.19 (8.50)	143.33	35.17
Ethrel 100 ppm	19.23 (26.01)	60.93 (51.31)	10.15 (18.58)	8.26 (16.70)	1.43 (6.85)	147.17	32.50
Ethrel 150 ppm	18.98 (25.83)	60.97 (51.34)	10.35 (18.77)	8.25 (16.69)	1.45 (6.90)	145.67	34.67
Control	19.30 (26.06)	60.99 (51.35)	9.99 (18.43)	8.40 (16.84)	1.32 (6.60)	149.17	36.00
$CD_{(0.05)}$	(0.24)	(0.35)	(0.26)	(0.56)	(0.73)	2.40	2.20

in size of cells and intercellular spaces. Significant differences were observed for fruit fibre, mucilage and non-edible portion of fruit by application of plant growth regulators. Maximum fruit fibre was found in ethrel 50 ppm and minimum fruit fibre was found in NAA 10 ppm. While maximum fruit mucilage and minimum non-edible portion of fruit were recorded in control. The results on number of seeds per fruit and weight of seeds per fruit clearly indicate that there were significant reduction in number and weight of seeds per fruit by application of plant growth regulators in comparison to control. Among the different sprays of plant growth regulators, GA_3 100 ppm was most effective in reducing number and weight of seeds per fruit. Similar findings have been reported in litchi (Brahmachari and Rani, 5). GA_3 has been found very effective in inducing parthenocarpy or reducing the size and weight of seeds.

The chemical compositions of fruits were significantly affected by different sprays of plant growth regulators (Table 3). Maximum TSS was recorded in GA_3 50 ppm followed by NAA 20 ppm and minimum TSS were observed in control. Spray of NAA 20 ppm resulted in minimum titratable acidity and maximum TSS: acid ratio and ascorbic acid content of the fruit. These results are in conformity with the results obtained by spray of NAA in *ber* (Singh *et al.*, 13; Bal and Randhawa, 4). The increase in TSS may be attributed to the fact that application of GA_3 and NAA might have increased the α-amylase activity and thus there was conversion of starch into sugars and hence improved total solids content. The lower acidity might be due to degradation of organic acids. The increase in the contents of ascorbic acid might be due to catabolic influence of growth substances on its biosynthesis from its precursor, glucose 6-phosphate.

Table 3. Effect of plant growth regulators on chemical parameters of *bael* fruits.

Treatment	TSS (%)	Total titratable acidity (%)	TSS: acid ratio	Ascorbic acid (mg/ 100 g)
NAA 10 ppm	35.21	0.73	48.46	17.25
NAA 20 ppm	38.00	0.58	65.35	19.65
NAA 30 ppm	37.05	0.62	59.60	19.08
2,4-D 5 ppm	34.40	0.83	41.46	16.69
2,4-D 10 ppm	35.28	0.71	49.54	17.55
2,4-D 20 ppm	37.16	0.70	52.99	18.23
GA_3 25 ppm	35.95	0.68	53.19	17.87
GA_3 50 ppm	38.12	0.61	62.54	19.21
GA_3 100 ppm	37.50	0.67	55.86	18.92
Ethrel 50 ppm	34.88	0.80	43.42	18.15
Ethrel 100 ppm	36.24	0.74	49.31	17.87
Ethrel 150 ppm	37.11	0.78	47.91	18.31
Control	34.19	0.89	38.42	16.73
$CD_{(0.05)}$	(0.35)	(0.10)	2.42	0.38

Increase in TSS: acid ratio is directly due to increase in sugar content and decrease in acidity of fruits. From, the present study, it can be conclude that the spray of NAA @ 20 ppm after seven days of initiation of growth, 7th June and second spray on 21st June, were found effective in reducing fruit drop and increasing the physico-chemical characters of fruits in *bael*.

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