



## Influence of paclobutrazol and summer pruning on growth and vigour of apple cv. Red Delicious

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Received 4 January 2015, accepted 22 March 2015.

### Abstract

Twenty-five years old apple trees cv. Red Delicious on seedling rootstock, uniform in vigour and health were selected during 2011 and 2012 at experimental orchard of Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar (J & K) situated at between 34.01°N latitude and 79.89°E longitude at an elevation of 1685 m above mean sea level. The trees under investigation were subjected to foliar spray of paclobutrazol (250, 500 and 750 ppm), two timings of summer pruning (8 and 12 weeks after full bloom) and their combinations. The experiment was laid down in a randomized block design with 16 treatments and 3 replications. Results revealed that trees treated with 750 ppm paclobutrazol + summer pruning (I and II) resulted in minimum vegetative growth and vigour in terms of tree height, trunk diameter, annual shoot extension growth, tree spread and leaf area in comparison to control and other treatments during both years of study.

**Key words:** Apple, paclobutrazol, summer pruning, quality.

### Introduction

Apple is the most important temperate fruit crop grown in India. Jammu and Kashmir is the leading state in apple cultivation and Red Delicious is the most commercial variety grown in the state. One of the most important elements in apple orchard management is growth control. Excessive vigour reduces light penetration, yield and fruit quality and increases cost of pruning and pest control <sup>9</sup>. On the other hand, many apple cultivars may set very large number of fruits with unacceptably smaller size and often serious reduction in return bloom and fruit set may occur in the following year leading to biennial bearing. Various chemicals are used in horticulturally advanced countries to reduce the amount of pruning. Among the various growth control chemicals tested, paclobutrazol (PB) is one of the most successful and widely used in fruit trees that can retard tree growth <sup>3</sup>. Besides, it also increases fruit set the years following application as a carryover effect. For vigour control, pruning is the most important operation conducted in dormant season, when the leaf fall takes place. It is the means of diverting a portion of plant water and nutrients from one part of growing point to another. The pruning is done to restrict excessive vegetative growth and to maintain a balance between leaf/fruit ratio, fruit size, fruit colour and other quality attributes. Excessive tree vigour can reduce flower bud formation, fruit set and result in reduced fruit quality. Pruning of fruit trees directly or indirectly affects many physiological processes and hormonal activity is increased. It increases auxin activity by about 60%, gibberellin by 90% and cytokinin by 90% <sup>6</sup>. Therefore, the study was undertaken to investigate the influence of paclobutrazol and summer pruning on growth and vigour of apple cv. Red Delicious.

### Materials and Methods

The present investigation was carried out in the Division of Fruit Science, SKUAST-K, Shalimar during the years 2011 and 2012. Twenty-five years old apple trees cv. Red Delicious on seedling rootstock, uniform in vigour and health were selected for the study. The orchard had proper soil and air drainage and was on the southern aspect. The trees were spaced at 18 × 18 feet distance and received uniform cultural treatments. The experiment was laid in a completely randomized block design with three replications. The selected trees were sprayed with paclobutrazol (PP<sub>333</sub>) at (250, 500 and 750 ppm) 4 weeks after full bloom followed by summer pruning (I and II) eight and twelve weeks after full bloom, respectively. The spray was given 4 weeks after full bloom. The control plants were sprayed with water only. The foliage was completely drenched to slightly run off by spraying first in clockwise and then in anti-clockwise directions. First summer pruning (SPI) was performed 8 weeks after full bloom by thinning out water sprouts and unwanted branches. Second summer pruning (SPII) was performed 12 weeks after full bloom by heading back from upper, middle and lower canopy area to the extent of 25% only of current season's growth. Observations in terms of tree height were recorded with the help of measuring tape using a long bamboo stick from ground to the top at the beginning and end of the growing season and expressed in metres. Tree trunk diameter was measured with the help of measuring tape, 10 cm above bud union. Four shoots were randomly selected from each quadrant of the experimental tree, the average annual extension growth of the current season was recorded, and the average was expressed in cm. Tree spread was recorded in metres with the help

of measuring tape by measuring the outer periphery from the tree trunk up to the canopy area from four sides at the beginning and end of the growing season and was averaged. In the first week of March, trunk cross sectional area of each tree was taken by measuring tree girth at 10 cm above bud union and accordingly was calculated by using the formula given by Westwood<sup>13</sup>. Fully developed leaves were randomly detached from all the directions of each tree periphery during early July. Among these, 10 leaves were selected randomly and their area was measured with the help of automatic leaf area meter (221 Systronics) having a sensor and read out unit and expressed in cm<sup>2</sup><sup>10</sup>. Data recorded was subjected to statistical analysis.

### Results and Discussion

**Tree height:** The results revealed that the treatment with 750 ppm paclobutrazol + summer pruning I + summer pruning II (T<sub>15</sub>) resulted in minimum tree height (6.69 and 6.60 m) during 2011 and 2012, respectively (Table 1). However, the maximum tree height of (7.12 and 7.23 m) was observed under control (T<sub>0</sub>) in both the years. Pooled data recorded minimum tree height (6.64 m) with treatment of 750 ppm paclobutrazol + summer pruning I + summer pruning II and maximum tree height (7.23 m) under control, which was significantly superior to all other treatments. Reduction in growth is attributed to paclobutrazol, which is a triazol that inhibits gibberellin biosynthesis<sup>8</sup>. Gupta and Bist<sup>7</sup> also noticed that application of paclobutrazol inhibited the vegetative growth in high density pear plantation. These results are in line with Pant and Kumar<sup>11</sup> in ‘Red Delicious’ apple.

**Trunk diameter:** Lowest trunk diameter (58.00 and 58.15 cm) was noticed under the treatment of 750 ppm paclobutrazol + summer pruning I + summer pruning II, whereas the highest trunk diameter (60.11 and 60.17 cm) was recorded under control during the years 2011 and 2012. Pooled data also recorded the lowest trunk diameter (58.07 cm) in treatment 750 ppm paclobutrazol + summer pruning I + summer pruning II and maximum trunk diameter (60.17 cm) under control, which was significantly higher than all other treatments. These results are in accordance with Demirtas *et al.*<sup>4</sup> in apricot.

**Annual shoot extension growth:** Summer pruning and paclobutrazol significantly influenced annual shoot extension

growth. The lowest annual shoot extension growth was recorded in treatment of 750 ppm paclobutrazol + summer pruning I + summer pruning II (35.00 and 31.04 cm); however, the highest annual shoot extension growth (60.02 and 60.25 cm) was observed under control in both years of study. Pooled data recorded the lowest (33.02 cm) annual shoot extension growth in treatment T<sub>15</sub>, which was significantly lower than all the treatments, whereas the highest annual shoot extension growth (60.13 cm) was observed under control. Wani *et al.*<sup>12</sup> also observed decreased tree limb girth, shoot extension, length, breadth, L/D ratio and pedicel length in ‘Red Delicious’ apples with paclobutrazol application.

**Tree spread:** Different treatments of paclobutrazol and summer pruning had non-significant influence on tree spread during the years 2011 and 2012 (Table 2). However, the lowest tree spread (4.52 and 4.36 m) was observed under treatment 750 ppm paclobutrazol + summer pruning I + summer pruning II during the years 2011 and 2012, respectively, whereas the highest tree spread (5.21 and 5.40 m) was recorded under control in 2011 and 2012, respectively. The pooled data recorded the lowest (4.44 m) tree spread in treatment T<sub>15</sub>, which was significantly followed by treatment T<sub>14</sub> (4.55 m) and T<sub>13</sub> (4.68 m). However, the highest tree spread (5.30 m) was recorded in control, which was significantly superior to all other treatments. Paclobutrazol reduced tree spread. These results are in line with Wani *et al.*<sup>12</sup> in ‘Red Delicious’ apples and Abdollahi *et al.*<sup>1</sup> in strawberry.

**Trunk cross sectional area:** The combination of summer pruning and paclobutrazol resulted in the lowest trunk cross sectional area (267.83 and 269.22 cm<sup>2</sup>); however, the trees receiving no treatment (control) recorded the highest (287.67 and 288.29 cm<sup>2</sup>) trunk cross sectional area in both years of study. Similarly, the lowest (268.52 cm<sup>2</sup>) trunk cross sectional area was noticed under the treatment T<sub>15</sub>, whereas the highest (288.29 cm<sup>2</sup>) trunk cross sectional area was observed in control (T<sub>0</sub>) in pooled data, which was significantly different from other treatments. Similar results were obtained by Faizan *et al.*<sup>5</sup> in litchi, Pant and Kumar<sup>11</sup> in ‘Red Delicious’ apple and Arzani and Roosta<sup>2</sup> in apricot with paclobutrazol application.

**Table 1.** Effect of paclobutrazol and summer pruning on vegetative characteristics of apple cv. Red Delicious.

Treatments	Tree height (m)			Trunk diameter (cm)			Annual shoot extension growth (cm)		
	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled
T0 Control	7.12	7.34	7.23	60.11	60.24	60.17	60.02	60.25	60.13
T1 250 ppm PP333	7.01	6.97	6.99	60.04	60.08	60.06	49.93	45.99	47.96
T2 500 ppm PP333	6.98	6.92	6.95	60.00	60.03	60.01	49.19	44.66	46.92
T3 750 ppm PP333	6.94	6.86	6.90	59.97	59.99	59.98	48.84	43.02	45.93
T4 SP I	7.03	7.00	7.01	60.02	60.07	60.04	49.95	46.01	47.98
T5 250 ppm PP333 + SP I	6.99	6.93	6.96	59.98	60.02	60.00	47.86	43.30	45.58
T6 500 ppm PP333 + SP I	6.97	6.90	6.93	59.92	59.95	59.93	46.68	39.80	43.24
T7 750 ppm PP333 + SP I	6.94	6.85	6.89	59.87	59.89	59.88	43.28	35.06	39.17
T8 SP II	6.96	6.91	6.93	59.99	60.02	60.00	49.46	44.87	47.16
T9 250 ppm PP333 + SP II	6.92	6.86	6.89	59.94	59.97	59.95	46.26	42.02	44.14
T10 500 ppm PP333 + SP II	6.90	6.84	6.87	59.89	59.92	59.90	44.15	37.66	40.90
T11 750 ppm PP333 + SP II	6.86	6.78	6.82	59.84	59.86	59.85	42.38	34.02	38.20
T12 SP I + SP II	6.88	6.82	6.85	59.96	60.00	59.98	48.62	41.06	44.84
T13 250 ppm PP333 + SP I + SP II	6.83	6.75	6.79	57.82	57.88	57.85	40.26	36.02	38.14
T14 500 ppm PP333 + SP I + SP II	6.78	6.70	6.74	57.86	57.92	57.89	38.02	34.09	36.05
T15 750 ppm PP333 + SP I + SP II	6.69	6.60	6.64	58.00	58.15	58.07	35.00	31.04	33.02
CD (p ≤ 0.05)	NS	0.22	0.11	0.25	0.22	0.05	0.11	0.09	0.10

SP I = summer pruning I and SP II = summer pruning II.

**Table 2.** Effect of paclobutrazol and summer pruning on vegetative characteristics of apple cv. Red Delicious.

Treatments	Tree spread (m)			Trunk cross sectional area (cm <sup>2</sup> )			Leaf area (cm <sup>2</sup> )		
	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled
T0 Control	5.21	5.40	5.30	287.67	288.92	288.29	23.96	24.06	24.01
T1 250 ppm PP333	4.93	4.88	4.90	287.00	287.39	287.19	23.44	22.94	23.19
T2 500 ppm PP333	4.84	4.79	4.81	286.62	286.91	286.76	23.08	22.51	22.79
T3 750 ppm PP333	4.77	4.71	4.74	286.33	286.52	286.42	22.14	21.81	21.97
T4 SP I	5.11	5.02	5.06	286.81	287.29	287.05	23.51	23.21	23.36
T5 250 ppm PP333 + SP I	4.89	4.83	4.86	286.43	286.81	286.62	23.21	22.51	22.86
T6 500 ppm PP333 + SP I	4.80	4.74	4.77	285.86	286.14	286.00	22.15	20.89	21.52
T7 750 ppm PP333 + SP I	4.71	4.65	4.68	285.38	285.57	285.47	20.97	20.35	20.66
T8 SP II	4.90	4.84	4.87	286.52	286.81	286.66	23.24	22.99	23.11
T9 250 ppm PP333 + SP II	4.86	4.79	4.82	286.05	286.34	286.19	22.02	21.23	21.62
T10 500 ppm PP333 + SP II	4.75	4.67	4.71	285.57	285.86	285.71	21.09	20.71	20.90
T11 750 ppm PP333 + SP II	4.64	4.56	4.60	285.09	285.28	285.18	20.78	20.17	20.47
T12 SP I + SP II	4.86	4.78	4.82	286.24	286.62	286.43	21.00	20.69	20.84
T13 250 ppm PP333 + SP I + SP II	4.72	4.64	4.68	266.17	266.73	266.45	19.94	19.64	19.79
T14 500 ppm PP333 + SP I + SP II	4.61	4.5	4.55	266.54	267.09	266.81	19.50	19.23	19.36
T15 750 ppm PP333 + SP I + SP II	4.52	4.36	4.44	267.83	269.22	268.52	19.12	18.03	18.57
CD (p ≤ 0.05)	NS	NS	0.09	2.37	2.11	0.54	0.10	0.12	0.11

SP I = summer pruning I and SP II = summer pruning II.

**Leaf area:** Perusal of data given in Table 2 revealed that all the treatments significantly influenced the leaf area. Reduced leaf area was recorded under treatment T<sub>15</sub> (19.12 and 18.03 cm<sup>2</sup>) which was statistically significant to treatment T<sub>14</sub> (500 ppm PP333 + SP I + SP II) (19.50 and 19.23 cm<sup>2</sup>) and T<sub>13</sub> (250 ppm PP333 + SP I + SP II) (19.94, 19.64 cm<sup>2</sup>) in 2011 and 2012, respectively. However, higher leaf area (23.96 and 24.06 cm<sup>2</sup>) was observed in control during 2011 and 2012, respectively, which was significantly superior to all other treatments. Pooled data recorded the lowest (18.57 cm<sup>2</sup>) leaf area in treatment T<sub>15</sub>, which was significantly lower than treatment T<sub>14</sub> (19.36 cm<sup>2</sup>) and treatment T<sub>13</sub> (19.79 cm<sup>2</sup>), respectively, whereas the higher leaf area (24.01 cm<sup>2</sup>) was observed in control. Similar results were obtained by Pant and Kumar<sup>11</sup> in 'Red Delicious' apple and by Gupta and Bist<sup>7</sup> in pear by paclobutrazol application.

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