

## Effect of Plant Growth Regulators on Fruit Set, Yield Efficiency, Fruit Size and Russet Formation in Apple cv. Scarlet Spur II

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### ABSTRACT

The field experiment was conducted during 2017 and 2018 to study the effect of GA<sub>4+7</sub>+BA and CPPU on fruit set, fruit retention, yield efficiency, fruit size and russet control in apple cv. Scarlet Spur II. Experimental trees were subjected to ten treatments viz., T<sub>1</sub>: GA<sub>4+7</sub>+BA at 1ppm (2 sprays: PF+ 10 days later), T<sub>2</sub>: GA<sub>4+7</sub>+BA at 1ppm (3 sprays: PF+ later at 10 days intervals), T<sub>3</sub>: GA<sub>4+7</sub>+BA at 2.5ppm (2 sprays), T<sub>4</sub>: GA<sub>4+7</sub>+BA at 2.5ppm (3 sprays), T<sub>5</sub>: GA<sub>4+7</sub>+BA at 5ppm (2 sprays), T<sub>6</sub>: GA<sub>4+7</sub>+BA at 5ppm (3 sprays), T<sub>7</sub>: CPPU at 2.5ppm (single spray at PF), T<sub>8</sub>: CPPU at 5ppm (spray at PF), T<sub>9</sub>: CPPU at 10ppm (spray at PF), and T<sub>10</sub>: control (no spray). Among different treatments, GA<sub>4+7</sub>+BA at 5ppm when applied thrice was most effective in reducing the russet formation and increasing fruit shape index (L/D ratio). However, higher increase fruit set, fruit retention, yield efficiency, fruit diameter and fruit weight observed with the treatments of CPPU at 10ppm applied at petal fall stage. Therefore, multiple application of GA<sub>4+7</sub>+BA at 5ppm seems to be useful for controlling russetting and improving the fruit shape whereas single application of CPPU at 10ppm was most effective for increasing yield efficiency and fruit weight in apple.

**Key words:** Apple, Promalin, CPPU, Petal fall stage, Russetting

### INTRODUCTION

Apple (*Malus × domestica* Borkh.) is one of the most important temperate fruit crop of world. Due to quality fruit production, Himachal Pradesh has been recognised as an “Apple State of India”. In the state, apple alone constitutes about 49% of the total area under fruit crops, which is being grown mainly in the districts of Shimla, Kinnaur, Kullu, Mandi, Chamba, some parts of Sirmour and

Lahaul-Spiti. The “Scarlet Spur II” is one of the newer members of Red Delicious which are believed by many fruit growers to be one of the prettiest apples produced. However, Scarlet Spur II is very much susceptible to ‘Russetting’ which reduces its market value. The incidence of russetting increases under high air humidity, rain, and temperature fluctuation at the beginning of the fruit development period.

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Since their discovery, a lot of information has emerged regarding the effects of gibberellins and cytokinins on fruit development and growth<sup>2</sup>. ‘Promalin’ is a growth regulator that contains the gibberellins GA<sub>4+7</sub> (1.8%) and benzyladenine (1.8%). It is used to improve apple fruit quality in terms of fruit shape and size, and to reduce the incidence of russeting. Eccher and Maffi<sup>4</sup> found that promalin 16 mgL<sup>-1</sup> reduced the incidence of russeting and increased the fruit length / diameter (L/D) ratio. GA<sub>4+7</sub>+BA applied at flowering have been shown to increase fruit size and the fruit L/D ratio, and reduce russeting<sup>10,12</sup>. The fruit size increase is a consequence of the induction of cell division and elongation, and the increase in fruit length<sup>15</sup>. The mode of action in russeting reduction is related to the control of the epidermis cell elongation, resulting in a fruit cuticle less prone to cracks<sup>5</sup>. Ginzberg and Stern<sup>9</sup> found that spraying a mixture of GA<sub>4+7</sub> and 6-benzyl adenine (BA) at cell division stage of apple fruit development resulted in reduced incidence of skin cracking by maintaining a higher number of epidermal cells compared to untreated fruit. Mehraj *et al.*<sup>16</sup>, reported that foliar application of gibberellins reduces russeting on “Golden Delicious” apple and “Bartlett” pear. Application of CPPU at 10ppm increased the fruit size in terms of length (29.88 mm) and breadth (30.51 mm), fruit weight (16.20 g) and volume (14.93 cc) in apricot<sup>11</sup>. Keeping in view this, the present investigation was therefore, carried out to evaluate the influence of plant growth regulators such as Promalin (GA<sub>4+7</sub>+BA) and CPPU on fruit set, fruit retention, yield efficiency, fruit size and russet control in apple cv. Scarlet Spur II.

#### MATERIAL AND METHODS

The present investigation was carried out at the experimental orchard of Regional Horticultural Research and Training Station, Mashobra, Dr YS Parmar University of Horticulture and Forestry, Nauni- Solan, Himachal Pradesh, during the years 2017 and 2018. Thirty trees apple cultivar Scarlet Spur II/ MM 106 rootstocks which are 8-year old

having uniform vigour and size, planted at a spacing of 2.5m x 2.5m were selected for the study. All the trees were maintained under uniform cultural practices during the course of investigation. The experiment was laid in a factorial randomized block design with three replications. Experimental trees were subjected to ten treatments *viz.*, T<sub>1</sub>: GA<sub>4+7</sub>+BA at 1ppm(2 sprays: PF+ 10 days later), T<sub>2</sub>: GA<sub>4+7</sub>+BA at 1ppm (3 sprays: PF+ later at 10 days intervals), T<sub>3</sub>: GA<sub>4+7</sub>+BA at 2.5ppm (2 sprays), T<sub>4</sub>: GA<sub>4+7</sub>+BA at 2.5ppm (3 sprays), T<sub>5</sub>: GA<sub>4+7</sub>+BA at 5ppm (2 sprays), T<sub>6</sub>: GA<sub>4+7</sub>+BA at 5ppm (3 sprays), T<sub>7</sub>: CPPU at 2.5ppm (single spray at PF), T<sub>8</sub>: CPPU at 5ppm(spray at PF), T<sub>9</sub>: CPPU at 10ppm(spray at PF), and T<sub>10</sub>: control (no spray). The data of fruit set and fruit retained was taken as per standard method. Yield efficiency was worked out in yield of tree per trunk cross sectional area of the trees. Data on fruit size and russet formation of five fully mature fruits in each replication were recorded. In this study, two years (2017 and 2018) data have been pooled analyzed.

#### RESULTS AND DISCUSSION

All the treatments of growth regulators significantly increased the fruit set as compared to control (Table 1), however, the highest increase was achieved with the application of 10ppm CPPU. Application of ‘Promalin’ at petal fall stage + 2 applications at 10 days interval however, did not exerted as additional influence on fruit set compared to single application of CPPU given at petal fall stage. Higher fruit set with CPPU treatments can be attributed to its ability to enhance mobilization of carbohydrates from leaves to the developing fruits<sup>23</sup>. These results were in accordance with those obtained by Fathi *et al.*<sup>8</sup>, in “LeConte” pear trees, Taha and El-Ghany<sup>20</sup> in apple cv. Anna (Table 1). In this study, CPPU when applied as a single application at petal fall stages caused higher increase in fruit retention followed by 3 sprays of ‘Promalin’ at 2.5 and 5ppm as compared to control. It might be due to cytokinin’s (CPPU) action on inhibition of abscission zone

formation<sup>13</sup>. The present results concerning the effect of CPPU on the fruit retention are in accordance with those obtained by Banyal *et al.*<sup>1</sup>, in apple and Singh *et al.*<sup>19</sup>, in pear (Table 1). Present results revealed that combined application of CPPU considerably increased the yield efficiency as compared to control. The maximum yield efficiency (0.51 kg cm<sup>2</sup>) was observed following the application of 10ppm CPPU treatment, followed by 5ppm CPPU and 2.5ppm CPPU. Increased yield efficiency under these treatments may be attributing to increased fruit set, fruit retention (Table 1) and fruit size (Table 2). During the course of present study, application of 'Promalin' at 5ppm (thrice) significantly increased fruit length and L:D ratio followed by the application of 'Promalin' at 5ppm (twice) (Table 2). These results confirm the earlier findings that combined application of GA<sub>4+7</sub>+BA altered fruit shape index (L/D ratio) by stimulating elongation and development of the calyx lobes in apple<sup>14,21</sup>. In this study, CPPU applied once at petal fall stage at 10ppm increased fruit weight and

volume (Table 3). The CPPU has been shown to expand fruit size through cell expansion and division<sup>22</sup>. Patterson *et al.*<sup>17</sup>, reported that CPPU stimulated cell expansion in the pericarp sufficiently to explain the measured increase in total fruit volume. The present results concerning the effect of CPPU on the fruit dimensions are in accordance with those obtained by Sharma and Belsare<sup>18</sup> in pomegranate and Hota *et al.*<sup>11</sup>, in apricot. In the present study it was found that pre-harvest application of plant growth regulators influenced the extent of russet formation. Treatments with GA<sub>4+7</sub>+BA significantly decreased the incidence of resetting on fruit surface, however, most distinct response was obtained when it was applied three times at 2.5- 5.0ppm (T<sub>4</sub> & T<sub>6</sub>) as compared to control (Table 3). These results are in conformity with the findings<sup>7,16</sup>, that GA<sub>4+7</sub> reduced the fruit russetting on apples. Lesser russet formation occurred also with the application of CPPU at 5ppm.

**Table 1: Effect of plant growth regulators on fruit set, fruit retention and yield efficiency of apple**

Treatments	Fruit set (%)			Fruit retention (%)			Yield efficiency (kg/cm <sup>2</sup> )		
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
Promalin (GA <sub>4+7</sub> +BA) @ 1ppm	38.82	47.53	43.17	66.00	73.24	69.62	0.25	0.29	0.27
Promalin (GA <sub>4+7</sub> +BA) @ 1ppm	40.35	50.41	45.38	72.62	76.10	74.36	0.27	0.32	0.30
Promalin (GA <sub>4+7</sub> +BA) @ 2.5ppm	43.66	55.45	49.55	75.72	82.75	79.24	0.32	0.37	0.35
Promalin (GA <sub>4+7</sub> +BA) @ 2.5ppm	41.34	51.19	46.26	83.27	85.18	84.22	0.36	0.43	0.40
Promalin (GA <sub>4+7</sub> +BA) @ 5ppm	42.31	55.48	48.90	73.17	80.12	76.64	0.34	0.38	0.36
Promalin (GA <sub>4+7</sub> +BA) @ 5ppm	50.35	59.98	55.16	82.64	88.54	85.59	0.42	0.43	0.42
CPPU @ 2.5ppm	51.94	60.33	56.14	77.76	86.03	81.89	0.43	0.45	0.44
CPPU @ 5ppm	49.90	61.16	55.53	82.15	88.23	85.19	0.45	0.49	0.47
CPPU @ 10ppm	57.41	65.14	61.28	83.59	91.34	87.47	0.49	0.54	0.51
Control (no spray)	26.13	31.89	29.01	50.87	66.13	58.50	0.22	0.25	0.24
<b>CD<sub>0.05</sub></b>	<b>7.21</b>	<b>5.44</b>	<b>4.21</b>	<b>6.74</b>	<b>6.47</b>	<b>4.95</b>	<b>0.10</b>	<b>0.09</b>	<b>0.08</b>

**Table 2: Effect of plant growth regulators on fruit size of apple**

Treatments	Fruit length (mm)			Fruit diameter (mm)			Fruit shape index(L/D ratio)		
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
Promalin (GA <sub>4+7</sub> +BA ) @ 1ppm	63.28	64.95	64.12	62.11	62.22	62.17	1.02	1.04	1.03
Promalin (GA <sub>4+7</sub> +BA ) @ 1ppm	64.21	65.48	64.85	62.36	62.07	62.22	1.03	1.05	1.04
Promalin (GA <sub>4+7</sub> +BA ) @ 2.5ppm	65.86	66.79	66.33	63.50	63.02	63.26	1.04	1.06	1.05
Promalin (GA <sub>4+7</sub> +BA ) @ 2.5ppm	67.14	68.19	67.66	64.17	63.88	64.02	1.05	1.07	1.06
Promalin (GA <sub>4+7</sub> +BA ) @ 5ppm	67.87	68.55	68.21	64.70	64.15	64.43	1.05	1.07	1.06
Promalin (GA <sub>4+7</sub> +BA ) @ 5ppm	68.71	69.15	68.93	65.00	63.73	64.37	1.06	1.08	1.07
CPPU @ 2.5ppm	64.02	63.71	63.87	67.72	68.35	68.04	0.95	0.93	0.94
CPPU @ 5ppm	65.70	64.40	65.05	68.65	69.14	68.90	0.96	0.93	0.94
CPPU @ 10ppm	66.64	65.67	66.16	70.17	71.60	70.89	0.95	0.92	0.93
Control (no spray)	60.86	61.37	61.12	62.74	63.15	62.95	0.97	0.97	0.97
CD <sub>0.05</sub>	<b>1.00</b>	<b>1.56</b>	<b>1.06</b>	<b>2.19</b>	<b>1.31</b>	<b>1.24</b>	<b>0.04</b>	<b>0.04</b>	<b>0.03</b>

**Table 3: Effect of plant growth regulators on fruit weight, fruit volume and russet formation of apple**

Treatments	Fruit weight (gm)			Fruit volume (cc)			Russet formation (10 point scale basis)		
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
Promalin (GA <sub>4+7</sub> +BA ) @ 1ppm	139.32	141.63	140.47	157.36	158.71	158.03	3.33	2.00	2.67
Promalin (GA <sub>4+7</sub> +BA ) @ 1ppm	140.38	142.63	141.51	160.78	162.59	161.69	2.67	1.61	2.14
Promalin (GA <sub>4+7</sub> +BA ) @ 2.5ppm	142.77	144.31	143.54	164.59	166.17	165.38	2.00	1.33	1.67
Promalin (GA <sub>4+7</sub> +BA ) @ 2.5ppm	145.54	146.00	145.77	167.40	168.44	167.92	1.33	1.00	1.17
Promalin (GA <sub>4+7</sub> +BA ) @ 5ppm	143.38	144.73	144.06	166.53	166.66	166.59	1.33	1.33	1.33
Promalin (GA <sub>4+7</sub> +BA ) @ 5ppm	144.57	145.88	145.23	165.77	167.52	166.65	1.33	1.00	1.17
CPPU @ 2.5ppm	148.81	149.53	149.17	175.89	177.10	176.50	2.67	2.33	2.33
CPPU @ 5ppm	150.15	155.40	152.78	177.13	180.58	178.85	1.33	1.33	1.33
CPPU @ 10ppm	154.11	157.02	155.56	182.05	182.08	182.07	2.00	2.67	2.33
Control (no spray)	125.87	127.52	126.70	141.32	145.30	143.31	5.67	6.33	6.00
CD <sub>0.05</sub>	<b>4.12</b>	<b>3.58</b>	<b>2.82</b>	<b>4.08</b>	<b>3.37</b>	<b>2.49</b>	<b>1.17</b>	<b>1.00</b>	<b>0.81</b>

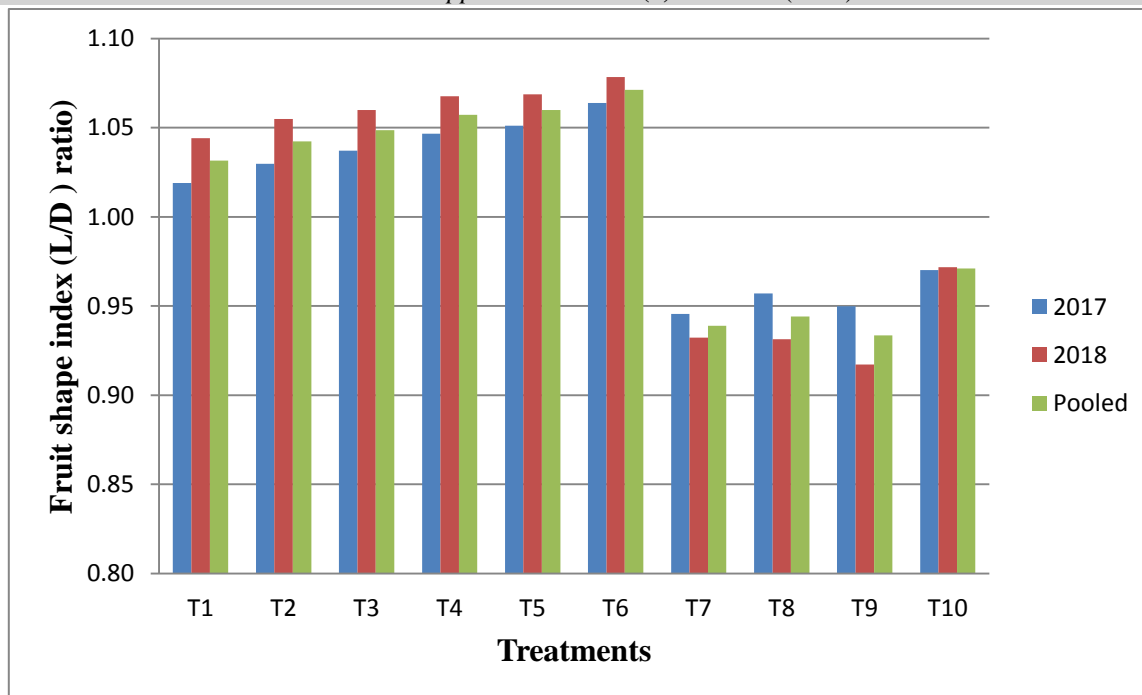


Figure 1: Graphical representation of Fruit shape index (L/D ratio) as influenced by different treatments

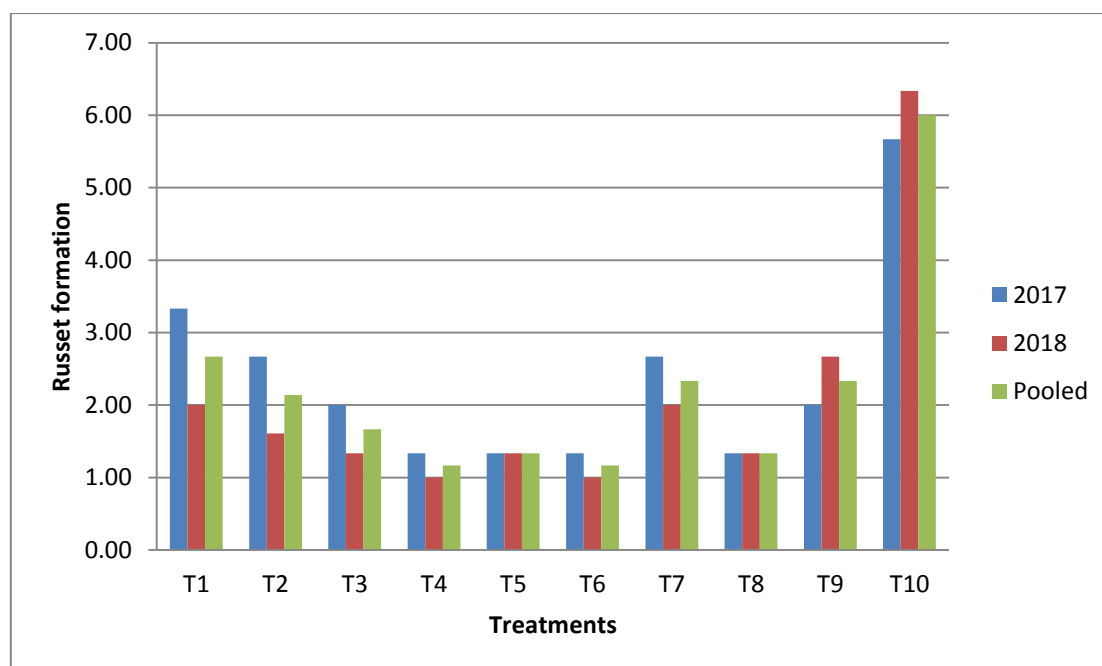


Figure 2: Graphical representation effect of GA<sub>4+7</sub>+BA and CPPU on russet formation

### CONCLUSION

Foliar applications of Promalin (GA<sub>4+7</sub>+BA) at 2.5 and 5ppm when given at petal fall and two times later at 10 days interval can be useful for the control of russet formation, increasing fruit shape index (L/D ratio) apple cv. Scarlet Spur II. However, CPPU at 10ppm when applied at petal fall stage increased improved fruit set, fruit retention and yield efficiency. The CPPU further resulted in a

positive increase in fruit size, fruit weight and fruit volume.

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