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## Effect of plant growth regulators on flowering and fruit setting of low chilling apple (*Malus domestica*) cv. HRMN-99 under Prayagraj agro climatic conditions

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### Abstract

The present investigation was conducted at the Research farm of Department of Horticulture, SHUATS, Prayagraj, on 40-month-old plant during January 2022 to July 2022 with the objective to find out suitable treatment of GA3 and NAA in relation to plant growth, yield and quality of apple. The statistical design adopted for the experiment was randomized block design (RBD) with three replications and nine treatment combinations. viz, T0 (Control), T1 (GA3 50 ppm), T2 (GA3 100 ppm), T3 (GA3 150 ppm), T4 (GA3 200 ppm), T5 (NAA 10 ppm), T6 (NAA 15 ppm), T7 (NAA 20 ppm), T8 (NAA 25 ppm). The treatments were applied by soil drenching at initiation of experiment, pre-flowering stage and the last one at the fruit setting stage to assess the effect on growth, yield and quality of apple. The results of present investigation revealed that, the treatment T4 (GA3 200 ppm) outstand in all the aspects like maximum plant height (2.96 m), maximum number of Primary and Secondary branches (3.66), (31.33) respectively followed by T3 (GA3 150 ppm). The treatment T5 (NAA 10 ppm) maximum number of flower (258), maximum no. of fruit (36.33), maximum fruit yield/plant (7.6 kg) and quality parameters like maximum TSS (19.7 °Brix) and maximum acidity (0.98%) followed by T7 (NAA 20 ppm). The lowest observation was recorded in T0 (Control). Treatment with GA3 and NAA improved vegetative growth, yield and quality to a lesser extent as compared to the control.

**Keywords:** GA3, NAA, low-chilling apple, subtropical region, HRMN-99

### Introduction

The apple is a pomaceous fruit that grows on an apple tree, *Malus domestica*, a member of the Rosaceae family of plants. It is one of the tree fruits that are grown. Where the tree is thought to have originated, Central America, the tree's wild ancestor is still there. Cultivars vary in production and tree size even when they are planted on the same rootstock. The tree has a broad, frequently heavily twiggy crown and is tiny and deciduous. It can grow to be quite tall. Its beautiful appearance, crispy flesh, pleasant flavour, and sweet taste attract the consumers and fetch high prizes (Ali *et al.*, 2004) <sup>[1]</sup>. The five-petaled, white flowers have a pink undertone that gradually disappears. Apples are available in a number of colours, including red, yellow, orange, and green. Apples are a fantastic source of fibre, healthy vitamins, and minerals. In the past it was generally regarded as a crop of the temperate zones but is increasingly cultivated under sub-tropical and even tropical conditions (Luckwill 1984) <sup>[19]</sup>. It also consists of various phytochemicals including flavonoids (e.g. catechins, flavanols and quercetin) and other phenolic compounds (e.g. epicatechin and procyanidins) found in the skin, core, and pulp of the apple (Hyson 2011) <sup>[12]</sup>. These chemicals aid in free radical neutralisation. The potential for low-chilling apple production in India's subtropical and tropical climates will improve if apple can be grown effectively in India's plains, where the climate is primarily subtropical. The choice of adaptable cultivars, as well as developments in technology and science, have made this possible.

Hariman Sharma discovered the low chilling apple variety HRMN-99 in 1999 after observing an apple plant's tolerance to climate variations. This new type is scab disease resistant. This variety outperforms nearly all low chilling apple varieties in terms of sugar acid ratio, total soluble solids, beautiful colour, and self-life. In the current experiment, four-year-old uniform apple plants that were spaced 3 x 1.5 m apart were collected. In accordance with the apple-recommended package and practises, manure, fertiliser, plant growth regulators, and other orchard management practises were used.

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## Materials and Methods

The present investigation was conducted at Research farm of Department of Horticulture, SHUATS, Prayagraj, on 40-month-old plant during January 2022 to July 2022. The experiment was conducted in randomized block design with three replications and nine treatments (T<sub>0</sub> – Control, T<sub>1</sub> – GA<sub>3</sub> 50 ppm, T<sub>2</sub> – GA<sub>3</sub> 100 ppm, T<sub>3</sub> – GA<sub>3</sub> 150 ppm, T<sub>4</sub> – GA<sub>3</sub> 200 ppm, T<sub>5</sub> – NAA 10 ppm, T<sub>6</sub> – NAA 15 ppm, T<sub>7</sub> – NAA 20 ppm and T<sub>8</sub> – NAA 25 ppm) were applied and data were analyzed statistically.

## Results and Discussion

### Growth Parameters

The data pertaining to effect of GA<sub>3</sub> and NAA on growth parameters of fruit are presented in Table 1 and Graph 1. In case of plant height, the maximum plant height (2.96 m) was recorded in the treatment T<sub>4</sub> (GA<sub>3</sub> 200 ppm) after 4 years of transplanting followed by T<sub>3</sub> (GA<sub>3</sub> 150 ppm) (2.86m) and minimum plant height (2.48 m) was observed in the treatment T<sub>0</sub> (Control) after 4 years of transplanting. Increment in plant height due to effect of GA<sub>3</sub> and NAA. GA<sub>3</sub> and NAA are playing an important role is cell division and cell wall elongation and leads to the increase shoot length. Similar result was given by H. Singh and A. Mirza (2020).<sup>[5]</sup>

The maximum plant spread (11.83 cm) was recorded in the treatment T<sub>4</sub> (GA<sub>3</sub> 200 ppm) followed by T<sub>3</sub> (GA<sub>3</sub> @ 150 ppm) and minimum plant spread (9.43 cm) was observed in the treatment T<sub>0</sub> (Control). Increment in plant spread due to GA<sub>3</sub>. Similar result was given by H. Singh and A. Mirza (2020)<sup>[5]</sup>.

The maximum number of primary branches (3.66) were observed in the treatment T<sub>4</sub> (GA<sub>3</sub> 200 ppm) followed by T<sub>3</sub> (GA<sub>3</sub> 150 ppm) and the minimum number of primary branches (1.66) were observed in treatment T<sub>0</sub> (Control). This might be due to rapid increase in cell division and cell elongation in the meristematic region. Similar result was given by Treder (2007)<sup>[13]</sup> and Padhan *et al.*, (2019)<sup>[9]</sup>.

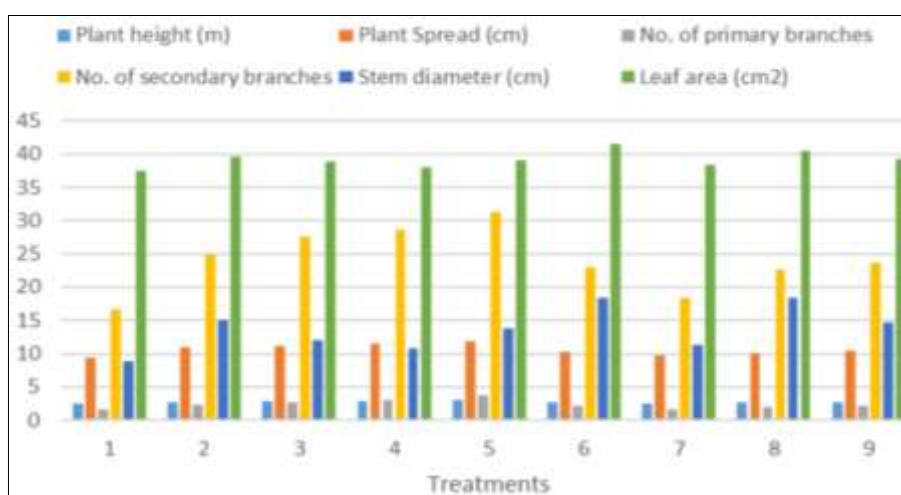
The maximum number of secondary branches (31.33) was observed in the treatment T<sub>4</sub> (GA<sub>3</sub> 200 ppm) followed by T<sub>3</sub> (GA<sub>3</sub> 150 ppm) and the minimum number of secondary branches (16.66) was observed in the treatment T<sub>0</sub> (Control). This might be due to rapid increase in cell division and cell elongation in the meristematic region. Similar result was given by Treder (2007)<sup>[13]</sup> and Padhan *et al.*, (2019)<sup>[9]</sup>.

The maximum stem diameter (18.46 cm) was recorded in the treatment T<sub>5</sub> (NAA 10 ppm) followed by T<sub>7</sub> (NAA 20 ppm) and the minimum stem diameter (8.9 cm) was recorded in the treatment T<sub>0</sub> (Control). GA<sub>3</sub> significantly reduced the vegetative growth in terms of stem diameter and NAA stimulates cell division in plant rooting and shoot systems. Similar result was given by Chandel (2017)<sup>[14]</sup> and Padhan *et al.*, (2019)<sup>[9]</sup>.

The maximum leaf area (41.52 cm<sup>2</sup>) was recorded in the treatment T<sub>5</sub> (NAA 10 ppm) followed by T<sub>7</sub> (NAA 20 ppm) and the minimum leaf area (37.50 cm<sup>2</sup>) was recorded in the treatment T<sub>0</sub> (Control). It was reported that leaf area increased by the application of GA<sub>3</sub> and NAA is a rooting agent and promote rooting from stem and leaf cuttings. Similar result was given by H.A. Hifny, *et al* (2017)<sup>[6]</sup>.

**Table 1:** Effect of plant growth regulators on growth parameters of fruit in apple cv. HRMN-99

Treatment notation	Treatment combinations	Plant height (m)	Plant spread (cm)	No. of primary branches	No. of secondary branches	Stem diameter (cm)	Leaf area (cm <sup>2</sup> )
T <sub>0</sub>	Control(Water Spray)	2.48	9.43	1.6	16.66	8.9	37.50
T <sub>1</sub>	GA <sub>3</sub> (50 ppm)	2.71	11	2.33	25	15.06	39.62
T <sub>2</sub>	GA <sub>3</sub> (100 ppm)	2.80	11.13	2.66	27.66	12.1	38.82
T <sub>3</sub>	GA <sub>3</sub> (150 ppm)	2.86	11.53	3.00	28.66	10.76	37.95
T <sub>4</sub>	GA <sub>3</sub> (200 ppm)	2.96	11.83	3.66	31.33	13.8	38.98
T <sub>5</sub>	NAA (10 ppm)	2.63	10.26	2.1	23	18.46	41.52
T <sub>6</sub>	NAA (15 ppm)	2.57	9.8	1.67	18.33	11.36	38.40
T <sub>7</sub>	NAA (20 ppm)	2.60	10.06	2	22.66	18.33	40.50
T <sub>8</sub>	NAA (25 ppm)	2.66	10.53	2.2	23.66	14.63	39.16
F-test		NS	S	NS	S	S	S
S. Ed		0.186	0.512	0.782	1.527	1.024	0.422
CD at 5%			1.08		3.23	2.17	0.89



**Graph 1:** Effect of plant growth regulators on growth parameters of fruit in apple cv. HRMN-99

### Flowering and Fruiting Parameters

The data pertaining to effect of GA<sub>3</sub> and NAA on physical characteristics of fruit are presented in Table 2 and Graph 2. The maximum bud burst to first flowering (21 days) was recorded from the treatment T5 (NAA 10 ppm) followed by T7 (NAA 20 ppm) and the minimum bud burst to first flowering (13.33 days) was recorded from the treatment T0 (Control). GA<sub>3</sub> decreased the flowers and foliar spray of NAA increases flower production. Similar result was given by S.K. Yadav (2019).

The maximum bud burst to 50% flowering (40.67 days) was recorded from the treatment T5 (NAA 10 ppm) followed by T7 (NAA 20 ppm) and the minimum bud burst to 50% flowering (29.33 days) was recorded from the treatment T0 (Control). GA<sub>3</sub> decreased the flowers and foliar spray of NAA increases flower production. Similar result was given by S.K. Yadav (2019) [16].

The maximum no. of flowers (258) was recorded from the treatment T5 (NAA 10 ppm) followed by T7 (NAA 20 ppm) and the minimum no. of flowers (191) was recorded from the treatment T0 (Control). GA<sub>3</sub> decreased the flowers and foliar spray of NAA increases flower production. Similar result was given by S.K. Yadav (2019) [16].

The maximum no. of fruits per plant (36.33) was recorded from the treatment T5 (NAA 10 ppm) followed by T7 (NAA 20 ppm) and the minimum no. of fruits per plant (10.33) was recorded from the treatment T0 (Control). Application of GA<sub>3</sub> and NAA significantly increased the number of fruits per plant. The increasing number of fruits per plant by GA<sub>3</sub> and NAA treatment might be due to rapid and better nutrient translocation from roots to apical parts of the plant. Similar result was given by Singh *et al.*, (2001) [17].

The maximum fruit weight (110.55 g) was recorded from the treatment T5 (NAA 10 ppm) followed by T7 (NAA 20 ppm) and the minimum fruit weight (72.53 g) was recorded from the treatment T0 (Control). The average fruit weight of fruit were significantly increased with the application of GA<sub>3</sub> and

NAA. This may be attributed to the increased supply of photosynthetic materials and its efficient mobilization in plants giving rise to increased stimulation of fruit growth ultimately resulting in increased fruit weight. Similar result was given by Yadav *et al.*, (2001) [15].

The maximum fruit yield (kg/plant) (7.6 kg/plant) was recorded from the treatment T5 (NAA 10 ppm) followed by T7 (NAA 20 ppm) and the minimum fruit yield (4.10 kg/plant) was recorded from the treatment T0 (Control). The possible reason for increasing in fruit yield per hectare is due to increase in number of fruits per plant, average fruit weight and fruit yield per plant. Similar result was given by Maibangra and Ahmed (2000) [20].

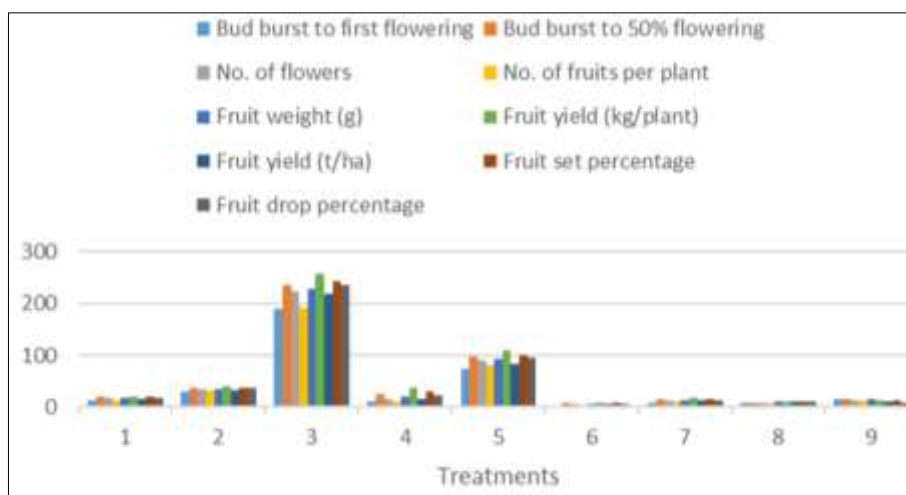
The maximum fruit yield (t/hac) (16.88 t/hac) was recorded from the treatment T5 (NAA 10 ppm) followed by T7 (NAA 20 ppm) and the minimum fruit yield (9.11 t/hac) was recorded from the treatment T0 (Control). The possible reason for increasing in fruit yield per hectare is due to increase in number of fruits per plant, average fruit weight and fruit yield per plant. Similar result was given by Maibangra and Ahmed (2000) [20].

The maximum fruit set percentage (10.9%) was recorded from the treatment T5 (NAA 10 ppm) followed by T4 (GA<sub>3</sub> 200 ppm) and the minimum fruit set percentage (8.25%) was recorded from the treatment T2 (GA<sub>3</sub> 100 ppm). NAA affects the physiological process, hasten maturity and produces better quality fruits that's why NAA increased fruit set compared to GA<sub>3</sub>. Similar result was given by B.T. Hamooh (2014) [18].

The maximum fruit drop percentage (15.08%) was recorded from the treatment T0 (Control) followed by T4 (GA<sub>3</sub> 200 ppm) and the minimum fruit drop percentage (9.25%) was recorded from the treatment T8 (NAA 25 ppm). GA<sub>3</sub> reduced total fruit drop percentage as compared to the control and NAA increasing in photosynthetic activity, fruit set by reducing fruit drop and thereby higher number of fruits. Similar result was given by H.A. Hifny (2017) [6].

**Table 2:** Effect of plant growth regulators on flowering and fruiting parameters of fruit in apple cv. HRMN-99

Treatment notation	Treatment combinations	Bud burst to first flowering	Bud burst to 50% flowering	No. of flowers	No. of fruits per plant	Fruit weight (g)	Fruit yield (kg/plant)	Fruit yield (t/ha)	Fruit set percentage	Fruit drop percentage
T <sub>0</sub>	Control(Water Spray)	13.33	29.33	191	10.33	72.53	2.10	9.11	8.88	15.08
T <sub>1</sub>	GA <sub>3</sub> (50 ppm)	19.33	38	236.33	25.33	98.24	7.20	16	8.70	14.53
T <sub>2</sub>	GA <sub>3</sub> (100 ppm)	17.65	34.33	223.33	16.66	90.13	5.96	13.24	8.25	14.29
T <sub>3</sub>	GA <sub>3</sub> (150ppm)	14.33	31.65	192.3	11.67	80.38	4.72	10.48	8.99	13.95
T <sub>4</sub>	GA <sub>3</sub> (200 ppm)	18.67	34.66	228.66	21.66	93.87	6.10	13.55	10.2	15.03
T <sub>5</sub>	NAA (10 ppm)	21	40.67	258	36.33	110.55	7.6	16.88	10.9	13.25
T <sub>6</sub>	NAA (15 ppm)	16.00	32.67	218.66	15.00	83.52	5.82	12.93	9.85	10.97
T <sub>7</sub>	NAA (20 ppm)	19.66	38.33	243.33	29.00	100.69	7.58	16.84	10.00	13.23
T <sub>8</sub>	NAA (25 ppm)	19.00	36.33	234.66	22.67	96.61	6.29	13.97	9.90	9.25
F-test		S	S	S	NS	S	S	S	S	S
S. Ed		0.866	0.660	3.789	9.007	15.519	0.175	0.427	0.309	0.547
CD at 5%		1.83	1.39	8.03		1.59	0.37	0.90	0.65	1.16



**Graph 2:** Effect of plant growth regulators on flowering and fruiting parameters of fruit in apple cv. HRMN-99

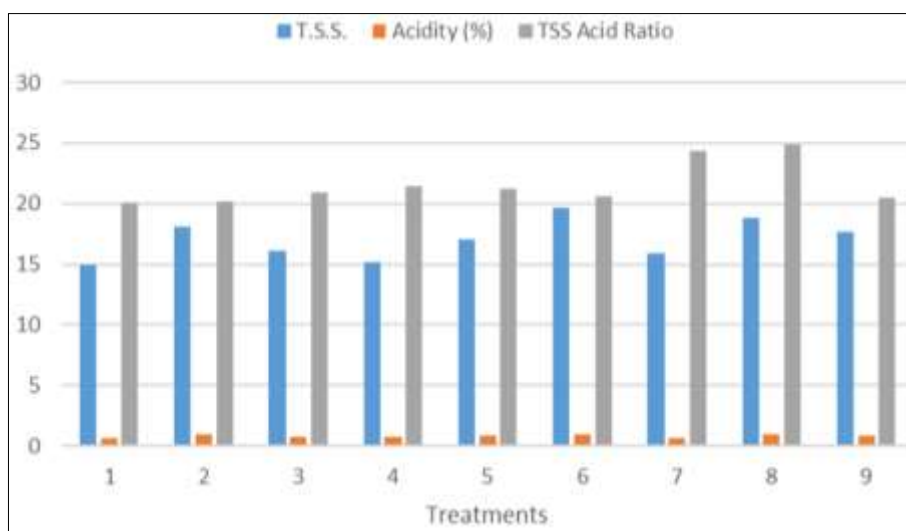
**Chemical Characteristics**

The data pertaining to effect of GA3 and NAA on chemical characteristics of fruit are presented in Table 3 and Graph 3. The maximum total soluble solids (19.7°Brix) was recorded from the treatment T5 (NAA 10 ppm) followed by T7 (NAA 20 ppm) and the minimum total soluble solids (14.98 °Brix) was recorded from the treatment T0 (Control). Similar result was given by H.A. Hifny, *et al* (2017) [6].

The maximum acidity (0.98%) was recorded from the treatment T5 (NAA 10 ppm) and the minimum acidity (0.6%) was recorded from the treatment T0 (Control). Similar result was given by H.A. Hifny, *et al* (2017) [6]. The maximum T.S.S. Acid Ratio (24.9) was recorded from the treatment T7 (NAA 20 ppm) and the minimum T.S.S. Acid Ratio (20.1) was recorded from the treatment T0 (Control). Similar result was given by H.A. Hifny, *et al* (2017) [6].

**Table 3:** Effect of plant growth regulators on chemical characteristics of fruit in apple cv. HRMN-99

Treatment notations	Treatment combinations	T.S.S. (°Brix)	Acidity (%)	TSS Acid Ratio
T <sub>0</sub>	Control (water spray)	14.98	0.6	20.1
T <sub>1</sub>	GA <sub>3</sub> (50 ppm)	18.06	0.89	20.2
T <sub>2</sub>	GA <sub>3</sub> (100 ppm)	16.12	0.77	20.9
T <sub>3</sub>	GA <sub>3</sub> (150ppm)	15.2	0.71	21.4
T <sub>4</sub>	GA <sub>3</sub> (200 ppm)	17.02	0.8	21.2
T <sub>5</sub>	NAA (10 ppm)	19.7	0.98	20.6
T <sub>6</sub>	NAA (15 ppm)	15.9	0.65	24.4
T <sub>7</sub>	NAA (20 ppm)	18.8	0.91	24.9
T <sub>8</sub>	NAA (25 ppm)	17.67	0.86	20.5
F-test		S	NS	S
S.Ed		0.179	0.200	0.517
CD at 5%		0.38		1.09



**Graph 3:** Effect of plant growth regulators on chemical characteristics of fruit in apple cv. HRMN-99



Apple flowers and fruits

### Conclusion

We can come to conclusion that various treatments applied to enhance the vegetative and reproductive growth of apple cv. HRMN-99, according to the above treatment T5 (NAA 10 ppm) is found superior among others, followed by T7 (NAA 20 ppm) and the lowest was T0 (Control). Treatment T4 (GA<sub>3</sub> 200 ppm) is best recommended for overall growth and development of plants like plant height, plant spread, primary and secondary branches. T<sub>5</sub> (NAA 10 ppm) is best for leaf area, stem girth, no of flowers, fruit size, etc. and qualitative parameters like T.S.S and Acidity, also outstand among the others, whereas T7 (NAA 20 ppm) outstand in T.S.S: Acid Ratio. T<sub>0</sub> (Control) is best for fruit drop percentage.

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