

Impact of Plant Growth Regulators on Growth, Yield and Quality of Strawberry (*Fragaria × ananassa* Duch.) cv. Winter Dawn.

Abstract

An investigation was carried out at the Horticulture Research Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology & Science, Prayagraj, (U.P.) - 211007 during the year 2022. The experiment was consisting of winterdawn variety of Strawberry with each comprising of ten treatments replicated thrice. Source of variables were NAA ; GA₃ ; BA (benzyl adenine) and combination of them with control treatment taken as eleven treatments. The experiment was laid out in randomized block design by randomizing treatments in each replication. As far as the vegetative growth, flowering, fruit yield and quality of fruit is concerned, application of different treatment of plant growth regulators significantly enhanced the Plant height, Number of leaves per plant, Petiole length, Plant spread, Days taken to first flower, Number of flowers /plant, Fruit length, Fruit width, Number of fruits/plant, Fruit set(%), Yield per plot, Total soluble solids, Total acidity, Ascorbic acid and Fruit weight at all successive stages. Maximum Plant height (24.50cm), Number of leaves per plant (20.66), Petiole length (13.83cm), Plant spread (27.16) (E-W), (26.16) (N-S) ,were recorded in successive year with T₆ (GA₃ 100ppm) Days taken to first flower (40.00 days), Number of flowers /plant (19.33), Fruit length (61.43mm), Fruit width (38.33 mm), Number of fruits/plant (16.66), Fruit set (87.66%), Yield per plot (Kg.) (2.33 Kg) Total soluble solids (TSS) (10.17), Total acidity (%) (1.33%), Ascorbic acid (58.66 mg/ 100 g) and Fruit weight (g) (41.33 g) were recorded in successive year with T₉ (BA 75ppm) and minimum vegetative growth, flowering, fruit yield and quality of fruit were observed in T₀.

Keywords:- Strawberry, PGR, Growth, Quality.

Introduction

Strawberry (*Fragaria x ananassa* Duch.) is one of the most fascinating fruits of the world. It is a cross between two species of American wild strawberry: a large fruited species, *Fragaria chiloensis*, originally from Chile and *Fragaria virginiana*, originally from Virginia, USA. The chromosome no. of strawberry is $2n=2x= 56$. Strawberry belongs to the family Rosaceae. The commercially cultivated strawberry is an octaploid species. The United States is the world's largest producer of strawberries accounting for about 30 percent of the world strawberry production (Morgan, 2012). Strawberry is a popular soft fruit in India, cultivated in plains as well as in the hills up to an elevation of 3000 m in humid or dry regions. Its main center of cultivation is Nainital and Dehradun in Uttarakhand, Mahabaleshwar (Maharashtra), Kashmir Valley, Bangalore and Kalimpong (West Bengal). In recent years, strawberry is being cultivated successfully in plains of Maharashtra (around Pune, Nashik and Sangali towns), Haryana and Uttar Pradesh. The wide variation in climates within these regions and the wide adaptation of the strawberry plant permit harvesting and marketing, the fruit during greater part of the year.

Strawberry is a short-lived (3-5 yrs.), perennial, vigorous, stoloniferous herb growing to 10-20cm height with a spread of about 0.3-1.0m. Leaves are trifoliate on stalks which grow out from a central crown. Its crown is compacted stem, where many leaves are formed very close together. The leaflets are oval-egg shaped, deep green with coarse serrations. Flowers are white, 1-2cm wide, bisexual with approximately 30 stamens and approximately 300 pistils on a swollen, conical, yellowish

receptacle. The first flower opens at the top and centre of the crown and produces the bigger fruits. Flowers that open later produce the small fruits. The true fruit of the strawberry is an achene, which is a small, dry seed loosely attached to the swollen ovary wall (receptacle). The roots are shallow so plants need regular moisture but not water logging (Vishal et al. 2016).

There are many factors which influence plant health. PGRs and micronutrients are such type of input factors. Plant Growth Regulators (PGRs) have proven their role in augmenting yield and quality in many fruits. PGR are either synthetic or natural compounds or that modify plant physiological processes at very minute concentrations. Use of plant bio-regulators have plays an important role in vegetative growth, flowering, yield and quality.

Materials and Methods

The area of Prayagraj district comes under subtropical belt in the south east of Uttar Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46° C-48° C and seldom falls as low as 4°C- 5°C. The relative humidity ranges between 20 to 94 %. The average rainfall in this area is around 1013.4 mm annually. However, occasional precipitation is also not uncommon during winter months.

The experiment was laid out in randomized block design by randomizing treatments in each replication with the objectives to find the best treatment for growth, yield and quality of strawberry. The treatments were T_0 (Control), T_1

(NAA@ 50 ppm), T₂ (NAA@ 75 ppm), T₃ (NAA@ 100 ppm), T₄ (GA3@ 50 ppm), T₅ (GA3@ 75 ppm), T₆ (GA3@ 100 ppm), T₇ (BA (6-benzyladenine) @ 25 ppm), T₈ (BA (6-benzyladenine) @ 50 ppm), T₉ (BA (6-benzyladenine) @ 75 ppm), T₁₀ (NAA + GA + BA@ 50 + 50 + 25 ppm).

Results and Discussion

The maximum plant height at 30, 60, 90 days was recorded as 9.50 cm, 16.33 cm and 24.50 cm with treatment T₆ (GA3@100 ppm) and it was followed by 8.50 cm, 14.66 cm and 22.66 cm in T₅ (GA3@75 ppm). The minimum plant height of 5.46 cm, 9.16 cm and 15.00 cm are recorded under T₀ (control). The maximum increase in plant height of strawberry due to treatment might be due to fact that gibberellins regulate the growth by causing cell division and cell elongation in plant system. These results are in conformity with Rademabher (2000).

The maximum plant spread at 30, 60, 90 days was recorded as 13.50 cm, 22.00 cm, 27.16 cm (E-W), 13.00 cm, 22.66 cm and 26.16 cm (N-S) with treatment T₆ (GA3@100 ppm) and it was followed by 12.33 cm, 21.33 cm, 24.5 cm (E-W) 11.66 cm, 20.66 cm and 23.33 cm (N-S) in T₅ (GA3@75 ppm). The minimum plant height of 7.5 cm, 14.33 cm, 19.50 cm (E-W) 7.83 cm, 15.83 cm and 19.50 cm (N-S) are recorded under T₀ (control). GA₃ has a great influence on over all plant growth and development and had a promoting effect on growth parameters. The reason responsible for this augmentation of growth is its effect on cell division and cell enlargement (O'Neil and Ross 2002).

The maximum number of leaves at 30, 60, 90 days was recorded as 8.00 cm, 12.66 cm and 20.66 cm with treatment T₆ (GA3@100 ppm) and it was followed by 7.33 cm, 12.33 cm and 16.33 cm in T₅ (GA3@75 ppm). The minimum number of leaves of 2.66 cm, 5.33 cm and 9.66 cm are recorded under T₀ (control). The maximum increase in plant height of strawberry due to treatment might be due to fact that gibberellins regulate the growth by causing cell division and cell elongation in plant system. These results are in conformity with Rademabher (2000). Qureshi *et al.* (2013).

The maximum petiole length at 30, 60, 90 days was recorded as 6.66 cm, 10.66 cm and 13.83 cm with treatment T₆ (GA3@100 ppm) and it was followed by 5.66 cm, 10.00 cm and 12.83 cm in T₅ (GA3@75 ppm). The minimum petiole length of 2.66 cm, 5.33 cm and 8.33 cm are recorded under T₀ (control).

The maximum increase in petiole length of strawberry due to treatment might be due to fact that gibberellins regulate the growth by causing cell division and cell elongation in plant system. These results are in conformity with Tripathi (2010).

Earliest flowering at 40.00 days was recorded in with treatment T₉ (BA@75 ppm) followed by treatment T₈ (BA@50 ppm) in 40.66 days. The maximum number of days taken by the plants treated with T₀ (control) in 55.00

Minimum days required to initiate flower with treatment BA@ 75 ppm may be due to its effect to cause rapid growth of flower primordium. Its role has been well proven in enhancing flowering in short day plants growing

under inductive conditions (Singh, 2012). The synthesis of florigen is mediated through BA and also minimizing the days required opening first flower. Similar results were observed by many researchers who found early flowering in strawberry following spray of BA (Tripathi and Shukla (2008), Sharma and Singh, 2009, Yadav *et al.* (2017).

In relation of number of flowers Treatment T₉ (BA @ 75ppm) recorded the maximum number of flowers [19.33] over all other treatments and it was followed by [18.66] in T₈ (BA@50ppm) where as T₀ (Control) treatment had the minimum number of flowers [11.66]. Increase in number of flowers per plant with the use of BA might be due to fact that benzyle adenine causes the production of large number of flowers with rapid elongation of peduncle, leading to full development of flower buds having all reproductive parts functional which increases the fruit set and number of berries per plant. It could also be due to the fact that BA application accelerates the development of differentiated inflorescence. Similar results have been reported by Tripathi and Shukla (2008); Prasad *et al.* (2012) and Saima *et al.* (2014).

In relation of number of fruits Treatment T₉ (BA @ 75ppm) recorded the maximum number of fruits [16.66] over all other treatments and it was followed by [15.33] in T₈ (BA@50ppm) where as T₀ (Control) treatment had the minimum number of fruits [8.66]. Increase in number of fruits per plant with the use of BA might be due to fact that benzyle adenine causes the production of large number of fruits with rapid elongation of peduncle, leading to full development of flower buds having all reproductive parts functional

which increases the fruit set and number of berries per plant. It could also be due to the fact that BA application accelerates the development of differentiated inflorescence.

In relation of fruit set (%) Treatment T₉ (BA @ 75ppm) recorded the maximum number of fruits set (%) [87.66] over all other treatments and it was followed by [83.10] in T₈ (BA@50ppm) where as T₀ (Control) treatment had the minimum number of fruits set (%) [63.83]. It is mainly due to the positive effect of the combination of BA on metabolic activity of plant. Similar findings were reported by Qureshi *et al.* (2013) and Bhople *et al.* (2019).

In relation of yield per plot Treatment T₉ (BA @ 75ppm) recorded the highest yield per plot (kg) [2.33] over all other treatments and it was followed by [2.13] in T₈ (BA@50ppm) whereas T₀ (Control) treatment had the lowest yield per plot (kg) [0.80]. Above findings corroborate the results in strawberry Yadav *et al.* (2017); Ahire and Gaikwad (2018). The increase in yield might be due to increased fruit set/plant, berry size and berry weight. Similar findings were also reported by Rajbhar *et al.* (2015) with the application of gibberellic acid (BA) @ 100ppm.

In relation of fruit length (mm) Treatment T₉ (BA @ 75ppm) recorded the maximum fruit length (mm) [61.43] over all other treatments and it was followed by [60.66] in T₈ (BA@50ppm) where as T₀ (Control) treatment had the minimum fruit length [37.10]. Increase in fruit length (mm) following use of BA might be due to its effect in cell division and cell elongation. BA is also reported to promote growth by increasing

plasticity of cell wall followed by hydrolysis of starch into sugar which reduces cell wall potential, resulting in the entry of water into the cell and causing its elongation (Richard, 2006).

In relation of fruit width Treatment T₉ (BA @ 75ppm) recorded the maximum fruit width (mm) [38.33] over all other treatments and it was followed by [37.00] in T₈ (BA@50ppm) where as T₀ (Control) treatment had the minimum fruit length [30.16]. Increase in fruit diameter following use of BA might be due to its effect in cell division and cell elongation. BA is also reported to promote growth by increasing plasticity of cell wall followed by hydrolysis of starch into sugar which reduces cell wall potential, resulting in the entry of water into the cell and causing its elongation (Richard, 2006).

In relation of fruit weight (gm) Treatment T₉ (BA @ 75ppm) recorded the maximum fruit weight (gm) [41.33] over all other treatments and it was followed by [38.66] in T₈ (BA@50ppm) where as T₀ (Control) treatment had the minimum fruit weight (gm) [13.33]. Increment in fruit weight (g) in Treatment T₉ (BA 75 ppm) might be due to its role in plant metabolism (Chaturvedi *et al.* (2005) in terms of better supply of water, nutrients and other compounds vital for their proper growth and development (Datta and Banik, 2007).

In relation of TSS(Brix) Treatment T₉ (BA@75ppm) recorded Maximum TSS [10.17 Brix] over all treatments and it was followed by [9.50] in T₈ (BA@50ppm) where-as T₀ (Control) treatment had the Minimum TSS [5.33 Brix]. Maximum TSS in treatment- BA might be attributed to rapid mobilization of sugars and other soluble solids to developing fruits Singh and

Singh (2009).

Treatment T₉ (BA@75ppm) recorded highest acidity[1.33] over all treatments and it was followed by [1.06] in T₈ (BA@50ppm) where-as T₀ (Control) treatment had the lowest. The decrease in acidity in boron treated plants (Treatment- BA 75 ppm) might be due to their better utilization in respiration and rapid metabolic transformation of organic acids into sugars Kumar *et al.* (2012) and Tripathi *et al.* (2011).

Conclusion

From the above experiment finding it may be concluded that the treatment T₆ (GA3@ 100 ppm) was found to be best in the terms of Vegetative growth viz., Plant height, Plant Spread, Petiole length, No. of leaves per plant .

The treatment T₉ (BA @ 75 ppm) was found to be best in the terms of Floral characters, Yield Parameters and quality parameter viz., Days to first flowering, No. of fruits, No. of flowers, Fruit set, Yield per plot, Fruit weight, Fruit Length, Fruit Width, T.S.S, Acidity, Ascorbic acid.

The treatment T₉ (BA @ 75 ppm) gave highest net profit with highest B:C ratio.

Table 1 Impact of plant growth regulators on plant height, plant spread, no. of leaves, petiole length, days to flowering and no. of flower/plant in strawberry .

Treatment	Plant Height (cm)			Plant Spread (cm)						No. of leaves			Petiole Length			Days to flowering	No. of flower/plant.
	30 DAP	60 DAP	90 DAP	30 DAP		60 DAP		90 DAP		30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP		
				E-W	N-S	E-W	N-S	E-W	N-S								
T ₀	5.46	9.16	15	7.50	7.83	14.33	15.83	19.83	19.50	2.66	5.33	9.66	2.66	5.33	8.33	55	11.66
T ₁	5.5	10.66	16.1	9.16	9.50	16.50	18.83	22.13	20.66	4.33	8.66	12.33	3.5	7.33	9.33	45.66	15.00
T ₂	6	11.06	15.86	9.50	10.50	16.83	19.66	23.66	21.16	5.33	10.66	13.33	3.83	7.66	9.66	44.66	15.33
T ₃	6.36	11.56	16.66	10.16	10.66	17.83	18.33	23.33	21.00	5.33	10	14.33	4.33	8.33	10.83	45.33	16.33
T ₄	6.83	12.5	18.5	11.50	11.33	20.16	19.50	23.16	22.66	5.66	11.66	15.33	5.33	9.33	11.66	43.66	16.33
T ₅	8.5	14.66	22.66	12.33	11.66	21.33	20.66	24.50	23.33	7.33	12.33	16.33	5.66	10	12.83	44.66	16.00
T ₆	9.5	16.33	24.5	13.50	13.00	22.00	22.66	27.16	26.16	8.00	12.66	20.66	6.66	10.66	13.83	46	17.33
T ₇	7.33	14.06	17.5	10.00	8.66	16.50	17.50	22.50	21.00	5.33	10.66	12.66	4.5	8	10	43	18.00
T ₈	8.9	14.23	17.93	11.16	9.66	16.83	17.66	22.83	21.33	6.00	11.33	13.33	4.66	8.33	11.5	40.66	18.66
T ₉	8	14	18.33	11.5	10.00	17.33	17.00	23.83	21.66	6.33	11.00	14	5.16	8.66	12	40	19.33
T ₁₀	7.9	14.5	19.66	12.16	11.66	17.33	19.00	25.00	22.66	6.66	11.33	16.66	5.33	9.33	12.16	44	17.33
F – Test	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
S.E. (M)	0.58	0.4	0.47	0.28	0.39	0.44	0.49	0.29	0.86	0.35	0.4	0.49	0.29	0.4	0.42	1.18	0.81
C.D.	1.74	1.18	1.4	0.85	1.17	1.33	1.46	0.86	2.31	1.04	1.19	1.46	0.88	1.21	1.25	2.2	2.03

Table 2 Impact of plant growth regulators on no. of fruit/plants, fruit set %, fruit length, fruit width, fruit weight, TSS, and B:C ratio in strawberry .

Treatment	No of fruit /plants	Fruit set %	Yield/plot (kg)	Fruit length (mm)	Fruit width (mm)	Fruit weight (g)	TSS (^o B)	Acidity %	Ascorbic acid (mg/100g)	B:C Ratio
T ₀	8.66	63.83	0.80	37.1	30.16	13.33	5.33	0.6	51.5	2.14
T ₁	11.33	66.33	1.08	38.8	31.06	17.33	8.33	0.6	53.83	2.89
T ₂	13	77.93	1.30	40.8	31.50	18.66	8.33	0.83	53.83	3.46
T ₃	14	80.86	1.83	41.5	32.16	22.66	8.50	0.9	54.5	4.9
T ₄	11	75	1.80	51.5	32.66	24.66	7.67	0.86	54.83	4.66
T ₅	12	81.66	1.86	52.33	34.50	27.33	7.83	1.03	56.16	4.74
T ₆	12.66	76.66	2.00	51.83	35.16	27.33	8.50	0.86	56.83	5.01
T ₇	14	82	2.10	54.5	36.16	37.33	9.50	0.8	56	5.62
T ₈	15.33	83.1	2.13	60.66	37.00	38.66	9.50	1.06	57.16	5.7
T ₉	16.66	87.66	2.33	61.43	38.33	41.33	10.17	1.33	58.66	6.21
T ₁₀	12.66	63.83	0.80	51.43	36.33	37.33	8.00	0.6	56.83	4.16
F – Test	S	S	S	S	S	S	S	S	S	
S.E. (M)	0.90	5.04	0.21	1.12	0.55	1.21	0.63	0.19	0.56	
C.D.	1.89	10.6	0.45	2.37	1.97	2.56	1.32	NA	1.19	

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