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INFLUENCE OF DIFFERENT PLANT GROWTH REGULATORS ON VEGETATIVE GROWTH AND PHYSICO-CHEMICAL PROPERTIES OF STRAWBERRY (*FRAGARIA X ANANASSA* DUCH.) cv. CHANDLER

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Abstract

An experiment was laid out in Randomized Block Design (RBD) comprising of thirteen treatments and each replicated thrice. The allocation of treatments to the individual plots was done randomly in each replication. The results of the investigation, regarding the influence of different plant growth regulators *viz*., NAA, GA_3, Triacontanol (TRIA) and Cycocel (CCC) on vegetative growth, fruit yield and fruit quality of strawberry was observed. On the basis of the results obtained during the course of present investigation, it is concluded that foliar spray of treatment $\mathbf{T_6}$ *i.e.* (GA_3 @ 200 ppm at 30, 60, 90 and 120 days after transplanting) was found most suitable plant growth regulators (PGR's) in respect of maximum physiological parameters *viz*. plant height (17.52 cm) and number of leaves per plant (8.55) whereas combination of treatment $\mathbf{T_5}$ *i.e.* (GA_3 @ 150 ppm) was found most effective plant growth regulators (PGR's) in terms of maximum bio-chemical parameters *viz*., total soluble solids (TSS) content (9.60^0 Brix), total acidity (0.65%), ascorbic acid (53.43 mg/100 g fruit pulp) and pH (3.06) while treatment $\mathbf{T_0}$ (Control) pertained the results minimum in both physiological and bio-chemical parameters. Hence, on the basis of overall findings of present investigation, it is stated that foliar spray of GA_3 were significantly showed the maximum effect on vegetative growth and physico-chemical properties of strawberries cv. Chandler.

Key words : Strawberry, NAA, GA_3, Cycocel (CCC) and Triacontanol (TRIA).

Introduction

Strawberry (*Fragaria* X sp.) is a native of temperate regions, but varieties are available which can be cultivated in subtropical climate (Suga *et al.,* 2013). It was estimated that the global strawberry production in 2012 was 4,516,810 tons, according to Food and Agriculture Organization (FAO) statistics (Mirmajlessi *et al.,* 2015). The genus *Fragaria* includes at least 17 other species (diploid, tetraploid, hexaploid and octaploid). The strawberry is an attractive, luscious, tasty, aggregate, nutritious fruit. It has a unique place among cultivated berry fruits. Fruit of strawberry is complete fruit with 98% edible portion. It is used for the preparation of various value added products. Strawberry thrives best in temperate climatic regions and it is grouped into short day plants on the basis of their behavior and life-cycle. The fruit quality is found excellent in hills as compared to plains. Similarly, the colour and flavor development is not proper in plains as compare to hilly varieties. Strawberry consumption can reduce the risk of cancer by 50% due to high level of vitamin – C content *i.e.* (30 - 100 mg/100 g of fruit pulp) foliate and photo-chemical compound such as the ellagic acid present in the fruits.

Strawberry is an important fruit crop of India and its commercial production is possible in temperate and sub-tropical areas of the country. The main objective of this research is to present a bankable one-acre model for high quality commercial cultivation of the crop. The growth and quality of fruits depends on different attributes which are closely associated with nutrient uptake by the plant and also with PGR's. Although, the use of Cycocel

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(CCC) was reported to reduce plant height by which fruit yield is positively increased (Benoit and Aerts, 1975). Triacontanol (TRIA) treated plants increased number of root which causes plants to take up more nutrients from soil and increased production per plants (Blarke and Lenz, 1983). The application of NAA was delayed ripening and Anthocyanin accumulation of strawberry fruits Villrreal *et al.,* 2009). TSS and Acidity were increased by GA_3 (Singh and Singh, 1979). Keeping in view all the above mentioned facts and importance of strawberry having the aim of the present study is to evaluate the effective and acute dose of plant growth regulators (PGR's) on Physico-chemical properties and quality of strawberry. We have also studied the vegetative feasibility and yield of the various treatments.

Material and Methods

An experiment entitled "Influence of different plant growth regulators on vegetative growth and physico-chemical properties of strawberry (*Fragaria X ananassa* Duch.*)* cv. Chandler" was carried out at Research field, Department of Horticulture, Allahabad school of Agriculture, Sam Higginbottom Institute of Agriculture, Technology & Sciences, (Deemed To-Be University), Allahabad during the year (2015 -2016). The experiment was laid out in Randomized Block Design (RBD) composed by 13 treatments and each replicated thrice. Allahabad is situated at an elevation of 98 m from the sea level at 25.87^0 North latitude and 81.15^0 East longitudes. This region has typical sub-tropical climate prevailing in the south-east part of the Uttar Pradesh, with both the extreme in temperature *i.e.* the winter and the summer. The purpose of study is to assess the impact of different treatment combinations of plant growth regulators (PGR's) on vegetative growth, fruit yield and quality of strawberry fruits. The data recorded in the year (2015-2016), during the course of experimental investigation were subjected to statistical analysis "Analysis of variance"- ANOVA technique (Fisher and Yates, 1963) through Randomized Block Design (RBD) for drawing the conclusion. The significance and non-significance of the treatments were judged with the help of 'F- test' (Variance ratio) test the significant differences between the means were tested with the critical differences at 5% probability level. For bio-chemical test *viz.* Ascorbic acid, TSS (Refractometer- Erma, Japan), Reducing & Non- reducing sugar and pH and Acidity. The total soluble solids (TSS) were measured according to the A.O.A.C. (2000); Gould (1978).

Treatment details

S. no.	Treatment Symbol	Treatment Combination
1.	T_0	Control
2.	T_1	NAA @ 100 ppm
3.	T_2	NAA @ 150 ppm
4.	T_3	NAA @ 200 ppm
5.	T_4	GA_3 @ 100 ppm
6.	T_5	GA_3 @ 150 ppm
7.	T_6	GA_3 @ 200 ppm
8.	T_7	Triacontanol @ 100 ppm
9.	T_8	Triacontanol @ 150 ppm
10.	T_9	Triacontanol @ 200 ppm
11.	T_{10}	Cycocel @ 50 ppm
12.	T_{11}	Cycocel @ 75 ppm
13.	T_{12}	Cycocel @ 100 ppm

Method of application

Plant growth regulators were sprayed according to various treatment combinations during layout of experimental plots thirty days before transplanting. GA_3 and Triacontanol (TRIA) were dissolved in a small volume of alcohol (5-10 ml). GA_3 solution was slighltly heated to improve solubility. Then it was mixed in 1.0 liter of good quality water along with liquid hand wash soap 1-5 drops. It was best to shake before each spray. It was aimed to coat the upper surface of the plant leaves thoroughly. Spray enough to allow drip down from the leaves, stems and shoots also. Spraying with GA_3 and Cycocel (CCC) was done 30 days after transplanting but Tricontanol (TRIA) and NAA were sprayed 45 days after transplanting. The quantity was measured by measuring cylinder and the chemical were sprayed with the help of small hand sprayer.

Results and Discussion

Vegetative growth parameters

The treatment combination T_6 (GA_3 @ 200 ppm) was recorded maximum plant height (17.52cm) and the minimum plant height (11.95cm) was recorded with treatment T_{11} (Cycocel @ 75 ppm).

The treatment combination T_6 (GA_3 @ 200 ppm) recorded maximum number of leaves per plant (8.55) while the minimum number of leaves per plant (7.24) was found with treatment T_{11} (Cycocel @ 75 ppm). Similar trend was observed at subsequent growth stages also. The highest number of leaves per plant and leaf area was found with Triacontanol (TRIA) and Anthocyanin content was increased with Cycocel (CCC) treated plant (Thakur *et al.*, 1991).

Table 1 : Influence of different plant growth regulators on vegetative growth of Strawberry (*Fragaria X ananassa* Duch.) cv. Chandler.

Treatments	Plant height (cm)	Number of leaves per plant	Number of fruit per plant	Average fruit weight per plant (g)
T_0 (Control)	13.91	7.47	2.55	11.26
T_1 (NAA @ 100ppm)	13.13	7.50	3.51	26.76
T_2 (NAA @ 150ppm)	13.34	8.00	4.28	31.75
T_3 (NAA @ 200ppm)	16.34	8.45	5.50	46.43
T_4 (GA_3 @ 100 ppm)	17.52	8.33	5.04	34.90
T_5 (GA_3 @ 150 ppm)	13.42	8.08	6.02	53.62
T_6 (GA_3 @ 200 ppm)	13.91	8.38	5.39	44.47
T_7 (Triacontanol @ 100 ppm)	13.01	7.63	3.59	24.40
T_8 (Triacontanol @ 150 ppm)	16.91	8.55	2.93	19.43
T_9 (Triacontanol @ 200 ppm)	13.26	7.72	3.35	21.61
T_{10} (Cycocel @ 500 ppm)	14.87	7.43	4.35	32.72
T_{11} (Cycocel @ 750 ppm)	11.95	7.24	4.83	37.71
T_{12} (Cycocel @ 1000 ppm)	12.36	7.44	5.70	49.50
F-test	**S**	**S**	**S**	**S**
C. D. at 0.05%	1.920	0.313	0.355	6.255
S.Ed (±)	0.930	0.645	0.172	3.031

Table 2 : Influence of different plant growth regulators on physico-chemical properties of Strawberry fruit (*Fragaria X ananassa* Duch.) cv. Chandler.

Treatments	TSS (^{0}Brix)	pH	Acidity (%)	Ascorbic acid (mg/ 100g fruit pulp)
T_0 (Control)	7.24	1.30	0.82	49.47
T_1 (NAA @ 100ppm)	8.35	1.85	0.72	49.80
T_2 (NAA @ 150ppm)	8.53	1.95	0.70	52.23
T_3 (NAA @ 200ppm)	9.43	2.71	0.70	50.90
T_4 (GA_3 @ 100 ppm)	9.05	2.62	0.63	52.10
T_5 (GA_3 @ 150 ppm)	9.62	3.06	0.65	53.43
T_6 (GA_3 @ 200 ppm)	9.17	2.50	0.64	50.30
T_7 (Triacontanol @ 100 ppm)	8.09	1.71	0.70	51.33
T_8 (Triacontanol @ 150 ppm)	7.78	1.67	0.76	53.33
T_9 (Triacontanol @ 200 ppm)	7.48	1.47	0.79	52.77
T_{10} (Cycocel @ 500 ppm)	8.76	2.12	0.71	52.47
T_{11} (Cycocel @ 750 ppm)	8.89	2.17	0.76	53.13
T_{12} (Cycocel @ 1000 ppm)	9.60	2.85	0.69	52.17
F-test	**S**	**S**	**S**	**S**
C. D. at 0.05%	0.212	0.257	0.110	0.796
S.Ed (±)	0.103	0.125	0.053	0.386

Two enzymes (Amylase and Protease) induced by GA_3 treatment arise through de-novo synthesis. These enzymes participate in the breakdown of the stored starch to simple sugar. The sugars are then translocated to the growing embryo where they provide energy for growth and development of plants. Singh and Kaul (1969) and Khokhar *et al.* (2004) were also reported that increased in plant height with treatment T_6 (GA_3 @ 200 ppm). GA_3 stimulate cell division or cell enlargement or both. Spraying with GA_3 exert significant effect on vegetative growth and fruit characters. Wang (1989) were also significantly showed that increased in maximum number of leaves per plant with treatment T_6 (GA_3 @ 200 ppm).

Physico-chemical parameters

Maximum Total soluble solids (TSS) content (9.60

^{0}Brix) was recorded with treatment **T_5** (GA_3 @ 150 ppm), whereas pH (3.06), Total acidity (0.65%) and Ascorbic acid content (53.43 mg/100 g of fruit pulp) was also reported maximum. The treatment T_0 (Control) recorded the minimum respectively. Similar findings were also reported by Kumar *et al.* (2012). Ascorbic acid content was increased with Cycocel (CCC) treated strawberry plants (Singh and Phogat, 1983). TSS and Acidity were increased by GA_3 (Singh and Singh, 1979). The highest fruit diameter, weight, volume, acidity per cent (as citric acid equivalent) and the lowest sugar: acid ratio was reported with 400 ppm NAA treated strawberry plant (Techawongstein, 1989).

Conclusion

On the basis of present experimental findings, it is concluded that foliar spray of (GA_3 @ 200 ppm) at 30, 60, 90 and 120 days after transplanting was found most suitable plant growth regulators (PGR'S) in respect of vegetative growth parameters; while (GA_3 @ 150 ppm) was found best in terms of fruit quality for cultivation of strawberry under Allahabad agro-climatic condition. However, since these results are based on one year experimental findings for further improvement more trails may be needed to substantiate the same.

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