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ORIGINAL ARTICLE

Effect of Various Growth Regulators on Vegetative parameters of strawberry (*Fragaria x ananassa* Duch.) Cv. Sujatha

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ABSTRACT

A field experiment was conducted to know the effect of the growth regulators on vegetative parameters of strawberry at College of Horticulture, Mudigere, Karnataka during 2014-2015. Four growth regulators namely NAA (15 and 20 ppm), GA_3 (100 and 125 ppm), CCC (1000 and 1250 ppm) and BA (100 and 125 ppm) were tested during the course of experimentation. Among the various treatments imposed 125 ppm GA_3 proved to be best with respect to plant height (22.39 cm), number of trifoliate leaves per plant (28.33), length of trifoliate leaves (11.64 cm), breadth of trifoliate leaf (15.88 cm), plant spread (29.70 cm east- west and 24.63 cm north- south) and number of runners per plant (5.87). Whereas, all the above mentioned parameters were found to be minimum with the application of CCC 1250 ppm. The maximum leaf area (128.53 cm^2), leaf area index (3.70), absolute growth rate (0.43 g/plant/ day), crop growth rate (4.77 g/m^2/day) was observed with the spraying of 125 ppm GA_3 ,whereas maximum net assimilation ratio (0.250 mg/ cm^2/ day) was recorded with the spraying of 1000 ppm CCC. The maximum total chlorophyll content (2.29 mg/g of fresh weight) was recorded in the treatment CCC (1000 ppm).

***Key words**: Strawberry, growth regulators, vegetative, AGR and Chlorophyll.*

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INTRODUCTION

The modern cultivated strawberry (*Fragaria x ananassa* Duch.) is a man made hybrid crop evolved by crossing two species, *Fragaria chilonensis* and *Fragaria virginiana.* Strawberry (*Fragaria x ananassa* Duch.) a member of family Rosaceae with an octaploid chromosome number of 2n= 56 is one of the most delicious and nutritious among soft fruits of the world. It is one of the most widely distributed fruit crops due to its generic diversity, high heterozygosity and broad range of environmental adaptations. The strawberry is a typical short day plant which presently is cultivated in more than 75 countries of world. In the early decades the cultivation of strawberry was confined to temperate regions of world rendering it to price hiking. In recent years, breeding of new varieties suitable for subtropical climate and accordingly the development of agro-techniques has resulted in boosting the strawberry cultivation even in nontraditional areas.

Apart from several agronomic practices followed in strawberry the application of plant growth regulators plays an important role in improving both vegetative and reproductive growth. In the studies conducted earlier it has been observed that the application of growth regulators has significant effect on vegetative characters of strawberry plants. The application of gibberellic acid (GA_3) is reported to increase leaf size, petiole length, whereas the application of auxins is also known to impart similar effects. On the contrary the application of growth retardants improves fruit characters on the cost of reducing vegetative growth. Therefore it is necessary to investigate the effect of various growth regulators which regulates the bio chemical changes in strawberry plants. Keeping this point in view an experiment was conducted to know the effect of different growth regulators on vegetative growth of strawberry plants which would in turn help the farmers to increase the yield and quality of fruits.

MATERIALS AND METHODS

The present study was conducted to know the effect of growth regulators on vegetative growth of Strawberry (*Fragaria X ananassa* Duch.*)* cv. Sujatha. The experiment was carried out in College of Horticulture, Mudigere, UAHS, Shivamogga during 2014-2015. Mudigere is located in hilly zone of

Karnataka 13^0 25' N latitude and $75^0$25 E longitude with an altitude of 982 m above mean sea level. The runners used for planting were of uniform age and size as per standards mentioned in package of practices. The runners were planted at the spacing of 30 x 30 cm on raised beds and each treatment had 18 plants which were replicated thrice in randomized complete block design.

The plant growth regulators viz., NAA (15, 20 ppm), GA_3 (100 , 125 ppm), CCC (1000, 1250 ppm), BA (100, 125 ppm), were used for experimentation along with water spray as control. The strawberry cultivar "Sujatha" was used for experimentation which was maintained in fruit orchard of Fruit Science Department, College of Horticulture, Mudigere. The recommended dose of fertilizers and manures were applied as per package of practices.

Five plants were selected at random and tagged in each treatment for the purpose of recording observations. Observations on growth parameters viz., plant height, number of trifoliate leaves, length and breadth of leaves and plant spread were recorded at 30, 60, and 90 and 120 days after planting whereas, number of runners per plant was recorded one month after final harvesting of the fruits. The growth parameters like Leaf area, leaf area index, absolute growth rate, crop growth rate and net assimilation rate were recorded using standard formula. The leaf area was calculated by using digital leaf area meter (LAM - 211). Leaf area index was computed using the formula suggested by Watson [1]. Absolute growth rate (AGR) was calculated by the formula suggested by Briggs *et al*. [2] and is expressed in g/plant/day. Crop growth rate (CGR) was calculated by using the formula suggested by Watson [1] and expressed in g/m^2/day. Net assimilation rate (NAR) was calculated by applying the formula suggested by Gregory [3] and is expressed in g/cm^2/day. Chlorophyll content of leaf was estimated by collecting the healthy fully matured leaf at peak vegetative stage. Chlorophyll-a, Chlorophyll-b and total chlorophyll contents of leaf tissue were determined by using Dimethyl Sulfoxide (DMSO) method as suggested by Shoaf and Lium [4] and is expressed in mg/g fresh weight. The data on all the growth parameters were subjected to statistical analysis using method of analysis of variance (ANOVA) for Complete Randomized Block Design (CRBD) as suggested by Fisher and Yates [5].

RESULTS AND DISCUSSION

The application of growth regulators resulted in significant difference in vegetative growth of strawberry plants. The maximum vegetative growth in terms of plant height (22.39 cm), number of trifoliate leaves per plant (28.33 cm), length and breadth of trifoliate leaves (11.64 cm and 15.88 cm, respectively) and plant spread (29.70 cm and 24.63 cm in north-south and east-west directions, respectively) at 120 days after planting were observed in the plants sprayed with 125 pm of gibberellic acid followed by T_3 (GA_3 100 ppm). The maximum increase in plant height might be due to the fact that gibberellins regulate the growth of Strawberry plants by causing cell elongation and increased cell division. This might also be due to the fact that gibberellins cause the elongation in mature petiole of Strawberry and also gibberllins enhance the endogenous level of auxins in the plants. The results are in accordance with the findings of Akath and Singh [6]. The maximum increase in number of leaves and length and breadth might be due to the corresponding increase in length of epidermal and parenchyma cells, higher rate of cell division and cell elongation in sub-apical meristems of Strawberry shoots which might lead to production of higher number of leaves with bigger size. The research findings are in line with the results obtained by Tripathi and Shukla [7], Akath and Singh [6] and Ali *et al.* [8].

The maximum number of runners (5.87) was recorded in the plants sprayed with 125 ppm gibberellic acid followed by T_3 (GA_3 100 ppm). This might be due to the application of gibberellins increases the vegetative growth in the form of height, number of leaves and leaf area which facilitates accumulation of more photosynthates leading to production of more number of runners per plant. This is in close conformity with the findings of Braun and Kender [9], Adam *et al.* [10] and Ali *et al.* [8] in Strawberry crop.

The strawberry plants sprayed with 125 ppm gibberellic acid recorded the maximum leaf area (128.53 cm^2), leaf area index (3.70), absolute growth rate (0.43 g/plant/day) and crop growth rate (4.77 g/m^2/day) followed by T_3 (GA_3 100 ppm), whereas maximum net assimilation ratio was recorded in the plants sprayed with 1000 ppm CCC. The increase in number and length and breadth of leaves with the application of 125 ppm gibberellic ultimately leads to increase in leaf area index, absolute growth rate and crop growth rate. These results are in line with the findings of Akath and Singh [6], Rajesh *et al.* [11], Khalid *et al.* [12] and Saima *et al*. [13] in strawberry.

The maximum chlorophyll content in the form of chlorophyll 'a' (1.67 mg/g of fresh weight) and total chlorophyll (2.29 mg/g of fresh weight) was observed in the leaves of plants sprayed with 1000 ppm CCC. The increased chlorophyll content of Cycocel treated plants could be referred to hormonal effects as it has been noted earlier that ancymidol stimulate chlorophyll biosynthesis through acceleration of chloroplast

differentiation and stimulating photosynthetic enzymes [14]. The result is in conformity with the findings of Abhay *et al.* [15] in soybean crop.

Hence it can be concluded from the experiment that the strawberry plants sprayed with 125 ppm GA_3 produced maximum vegetative growth followed by plants sprayed with 100 ppm GA_3.

Table 1. Effect of plant growth regulators on growth parameters of strawberry

Treatments	Plant height (cm) at 120 DAP	Number of trifoliate leaves at 120 DAP	Length of trifoliate leaf (cm) at 120 DAP	Breadth of trifoliate leaf (cm) at 120 DAP	Plant spread (cm) at 120 DAP		Number of runners per plant
					N-S	E-W	
T_1 NAA 15 ppm	17.36	22.40	9.82	12.88	21.60	17.67	2.60
T_2 NAA 20 ppm	18.21	23.80	10.16	13.56	25.30	19.40	3.40
T_3 GA_3 100 ppm	19.64	26.27	11.12	15.10	28.37	21.83	4.40
T_4 GA_3 125 ppm	22.39	28.33	11.64	15.88	29.70	24.63	5.87
T_5 CCC 1000 ppm	14.43	22.53	9.12	11.24	18.17	16.53	3.13
T_6 CCC 1250 ppm	14.27	21.35	8.22	10.24	17.57	15.40	2.53
T_7 BA 100 ppm	17.83	22.80	10.34	13.12	21.53	17.40	4.20
T_8 BA 125 ppm	19.10	23.67	10.86	13.86	22.37	18.47	4.60
T_9 Control	15.61	22.05	9.68	12.85	20.30	17.63	3.60
S.Em±	0.41	0.86	0.37	0.63	0.69	0.81	0.18
CD @ 5%	1.24	2.58	1.10	1.88	2.08	2.43	0.53

DAP- Days After Planting; N-S- North – South ; E-W- East – West

Table 2. Effect of plant growth regulators on LA, LAI, AGR, CGR and NAR of strawberry at 105 DAP

Treatments	LA (cm^2)	LAI	AGR (g/plant/ day)	CGR (g/m^2/day)	NAR (mg/ cm^2/ day)
T_1 NAA 15 ppm	106.78	2.55	0.32	3.55	0.191
T_2 NAA 20 ppm	109.34	2.76	0.33	3.66	0.178
T_3 GA_3 100 ppm	120.64	3.18	0.40	4.44	0.189
T_4 GA_3 125 ppm	128.53	3.70	0.43	4.77	0.174
T_5 CCC 1000 ppm	99.48	2.41	0.38	4.22	0.254
T_6 CCC 1250 ppm	96.73	2.22	0.32	3.55	0.250
T_7 BA 100 ppm	111.64	2.94	0.34	3.77	0.184
T_8 BA 125 ppm	118.71	3.21	0.38	4.22	0.168
T_9 Control	102.37	2.49	0.26	2.88	0.152
S.Em±	3.29	0.21	0.01	0.15	0.006
CD @ 5%	9.86	0.64	0.04	0.44	0.017

LA- Leaf Area LAI- Leaf Area Index
AGR- Absolute Growth Rate CGR – Crop Growth Rate
NAR- Net Assimilation Rate

Table 3. Effect of plant growth regulators on chlorophyll content (mg/g of fresh weight) of strawberry leaves

Treatments	Chlorophyll a	Chlorophyll b	Total chlorophyll
T_1 NAA 15 ppm	1.24	0.54	1.79
T_2 NAA 20 ppm	1.45	0.58	2.04
T_3 GA_3 100 ppm	1.36	0.48	1.86
T_4 GA_3 125 ppm	1.27	0.79	2.06
T_5 CCC 1000 ppm	1.67	0.62	2.29
T_6 CCC 1250 ppm	1.56	0.64	2.20
T_7 BA 100 ppm	1.32	0.56	1.88
T_8 BA 125 ppm	1.55	0.58	2.13
T_9 Control	1.28	0.49	1.77
S.Em±	0.03	0.02	0.05
CD @ 5%	0.10	0.05	0.15

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