

Full Length Research Paper

Effect of plant bio-regulators on vegetative growth, yield and quality of strawberry cv. Chandler

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The results of effect of plant bio-regulators on yield and yield attributing characters of strawberry CV. Chandler showed that at 75 DAT the plant height attained maximum of 20.50 cm, spread (25.53 cm) leaf number per plant (23.00), petiole length (0.20 cm), leaf area (136.30 cm²) and yield (356.56 g/plant) respectively, of strawberry was obtained highest with the application of GA 75 mg/L while, cycocel 750 mg/l resulted in minimum days taken to first flowering (61.66 DAT) and fruit formation (66.66 DAT). The maximum number of flowers per plant were recorded as 30.22 and number of berries (24.80) with application of GA 75 mg/L.

Key words: Chandler, *Fragaria x ananassa*, bio-regulators, physico-chemical, yield.

INTRODUCTION

The cultivated octaploid strawberry (*Fragaria x ananassa* Duch.) belongs to family Rosaceae and it is one of the most delicious, refreshing and nutritious among soft fruits of the world. Strawberry is basically a fruit plant of temperate climate, but during the recent years, there has been phenomenal increase in its area, production and cultivation in the non-traditional regions of India (Sharma and Sharma, 2004). It has happened because of standardization of modern agro-techniques and introduction of many subtropical cultivars which unprecedently returns higher capitals under subtropical conditions as well (Asrey and Jain, 2003). In India, higher return per unit area and short duration (six months) of crop have attracted large number of Indian farmers of Punjab, Haryana, Delhi, Uttarakhand and Jammu and Kashmir states.

Under Jammu sub-tropics, strawberry has recently come out as one of the most favored and profitable crop for cultivation (Bhat et al., 2005). A key point in fruit production is the manipulation of flowering to fruit production and to increase the productivity of the crops. There is a lot of information that shows how plant bio-regulators elicit biochemical changes in plants, which in turn induce vegetative and reproductive responses. Therefore, it is imperative to assess the effect of plant bio-regulators which modifies various physiological processes with the advantage to increase strawberry production. Keeping in view the need to enhance the strawberry production, the present investigation was conducted to find out the efficacy and optimum concentration of plant bio-regulators on vegetative growth and yield of strawberry cv. Chandler.

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Table 1. Initial status of soil in the experimental orchard.

Particulars	Contents
Mechanical analysis	
Sand (%)	60.0
Silt (%)	19.0
Clay (%)	21.0
Chemical analysis	
pH	6.7
Electrical conductivity (dsm ⁻¹)	0.20
Organic Carbon (%)	0.51
Available Nitrogen (Kg ha ⁻¹)	225.5
Available Phosphorus (Kg ha ⁻¹)	13.84
Available Potassium (Kg ha ⁻¹)	138.0

MATERIALS AND METHODS

The present investigation on the effect of plant bio-regulators on vegetative growth, quality and yield of strawberry (*Fragaria x ananassa* Duch.) cv. Chandler was carried out in the experimental farm of Fruit Science Division, Faculty of Agriculture, SKUAST-J, Udheywalla, Jammu during 2009 to 2010. Udheywalla is situated in the sub-tropical zone at latitude of 32.40°N and longitude of 74.54°E. The altitude of the place is 300 m from mean sea level. The winter months experience mild to severe cold and temperature ranges from 6.5 to 21.70°C. December is the coldest month and minimum temperature goes low as 4.0°C, however, the maximum, minimum temperature and evaporation rate rises from March onwards. Before the commencement of this study, the plot remained fallow in the last and previous year. The fertilizers dose for strawberry was applied uniformly as per recommendation in package and practices for fruit crops by SKAUST-Jammu (Anonymous, 2006). A total of ten treatments replicated thrice were executed in randomized block design viz. T₁ - Gibberellic acid 50 ppm, T₂ - Gibberellic acid 75 ppm, T₃ - Gibberellic acid 100 ppm, T₄ - Naphthalene acetic acid 25ppm, T₅ - Naphthalene acetic acid 50ppm, T₆ - Naphthalene acetic acid 75 ppm, T₇ - Cycocel 500 ppm, T₈ - Cycocel 750 ppm, T₉ - Cycocel 1000 ppm, T₁₀ - Control (Distilled water). The observations were recorded on plant height, spread, number of leaves and petiole length at 30, 45, 60 and 75 days after transplanting.

The observations on days taken to first flowering, days taken to fruit formation, average number of flowers per plant were recorded as floral characteristics and fruit yield was calculated in grams per plant.

RESULTS

The application of plant bio-regulators significantly influenced the plant height and spread of strawberry. In Figure 1, at 45, 60, 75 days after transplanting plant height (12.23, 17.50 and 20.50 cm) and in Figure 2, plant spread (18.80, 22.23, 25.53 cm) were obtained maximum with the application of GA 75 ppm as compared to other treatments.

Perusal of the data in Figure 3, showed that leaf numbers per plant (14.50, 20.66, 23.00 cm) was found highest with the application of GA 75 ppm at 45, 60, 75 days after transplanting, whereas, in Figure 4, petiole

length was also observed highest with GA 75 ppm (6.15, 8.76 and 10.20 cm) at 45, 60, 75 DAT. The data depicted Table 2 showed that with the application of GA 75 ppm, leaf area of strawberry plants was also found maximum (136.30 cm²) as compared to other treatments. Table 2 also showed that the application of cycocel 750 ppm effectively influenced the days taken to flowering (61.66 DAT) and fruit formation (66.66 DAT) which was statistically at par with GA 75 ppm (62.33 DAT) and (67.63 DAT) respectively (Table 1). It was observed from present investigations, that application of GA 75 ppm significantly increased the average number of flower per plant at primary, secondary and tertiary stages (7.00, 12.11 and 11.11) respectively, while total number of flower per plant (30.22) and number of berries (24.80) were recorded highest with GA75 ppm (Table 3). An inquisition of the data in the study revealed that the concentration of GA 75 ppm (356.5 g/plant) resulted in maximum fruit yield of strawberry cv. Chandler (Table 5). Based on the experimental results obtained, it may be concluded that GA 75 ppm applied at 30 days and repeated on 45 days after transplanting was found best in increasing growth and yield of strawberry cv.Chandler.

DISSCUSION

The maximum increase in plant height and spread of strawberry cv. Chandler in these treatments might be due to fact that gibberellins regulate the growth of strawberry plants by causing cell elongation in plant system (Figures 1 and 2). These results are in conformity with Pathak (1971) . This could be due to the fact that gibberellins increased the cell division, cell elongation and a corresponding increase in epidermal and parenchyma's cell length (Figure 3). These findings are in accordance with those of Guttridge and Thompson (1959) and Pathak and Singh (1976).

In Figure 4, which might be due to the fact that gibberellins cause the elongation in mature petiole of strawberry. Similar results were reported by Arney and

Table 2. Effect of plant bio-regulators on leaf area, days taken to first flowering and fruit formation of strawberry CV. Chandler.

Concentrations (ppm)	Leaf area(cm ²) per plant	Days taken (DAT)	
		First flowering	Fruit formation
GA 50	132.77	64.66	70.26
GA 75	136.30	62.33	67.63
GA 100	130.46	66.33	72.63
NAA 25	119.38	68.66	75.26
NAA 50	120.42	68.33	74.93
NAA 75	118.87	69.66	76.66
Cycocel 500	104.83	62.66	67.66
Cycocel 750	102.80	61.66	66.66
Cycocel 1000	107.83	65.33	70.33
Control	99.84	70.33	77.33
CD (0.05)	3.14	1.75	1.70

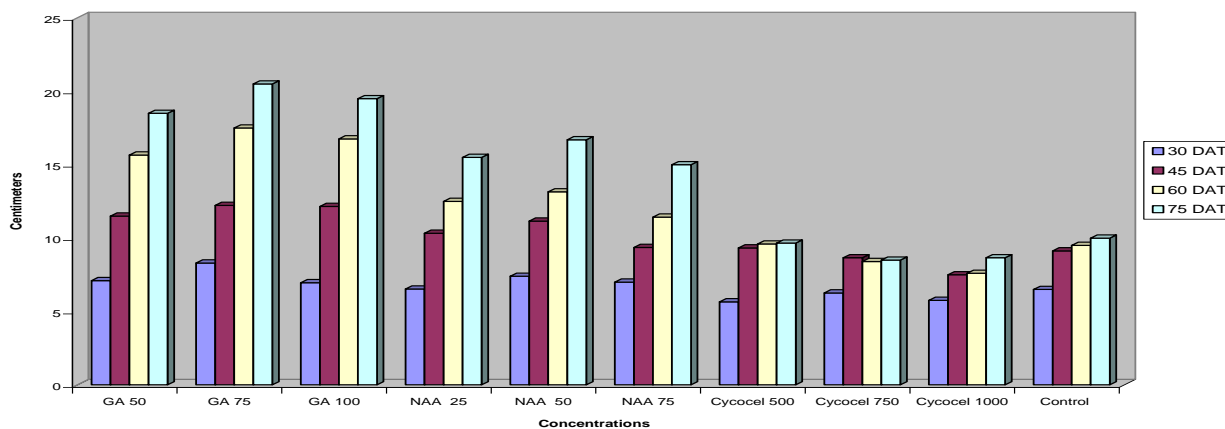


Figure 1. Effect of plant bio-regulator on plant height (cm) of straw berry.

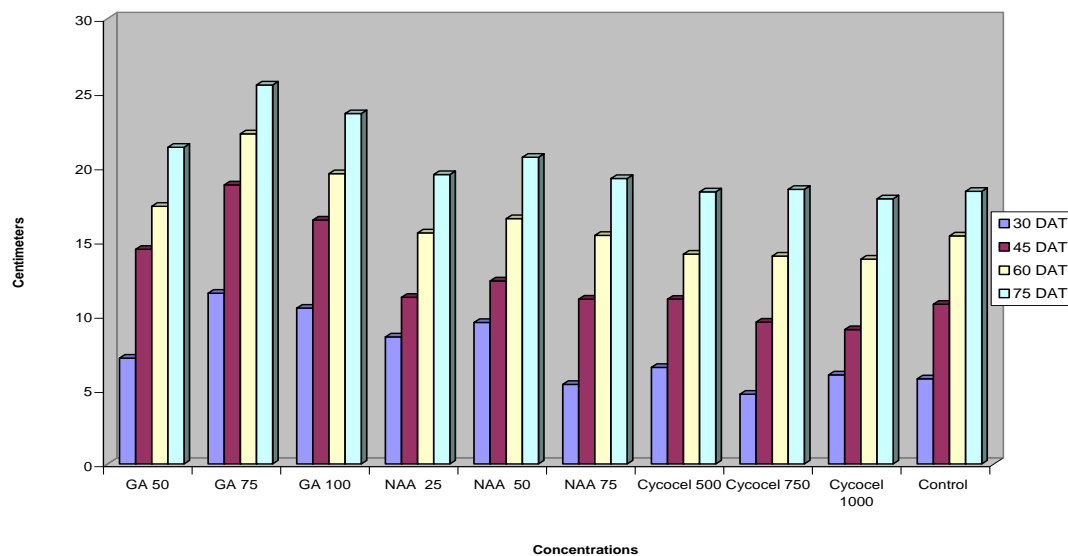


Figure 2. Effect of plant bio-regulator on plant spread (cm) of strawberry.

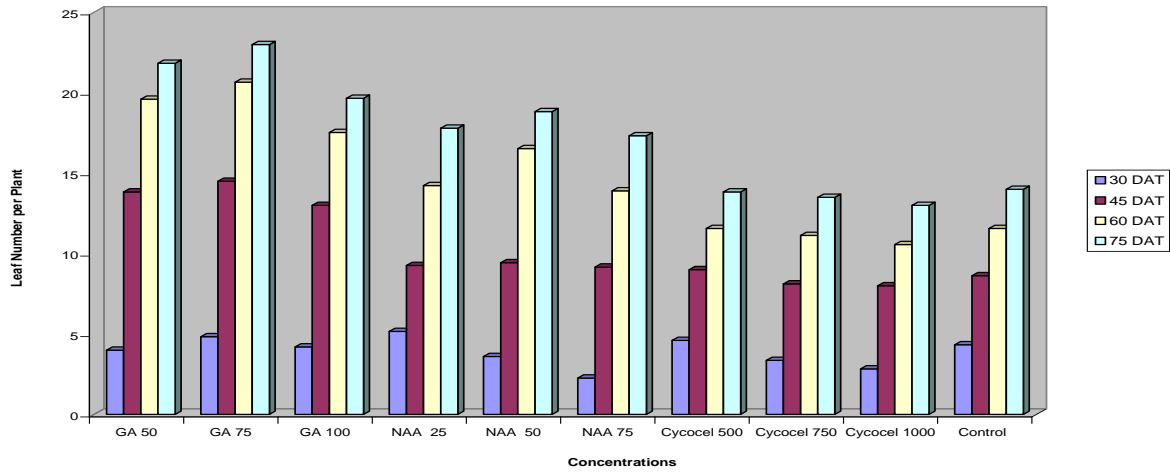


Figure 3. Effect of plant bio-regulator on leaf number per plant of strawberry.

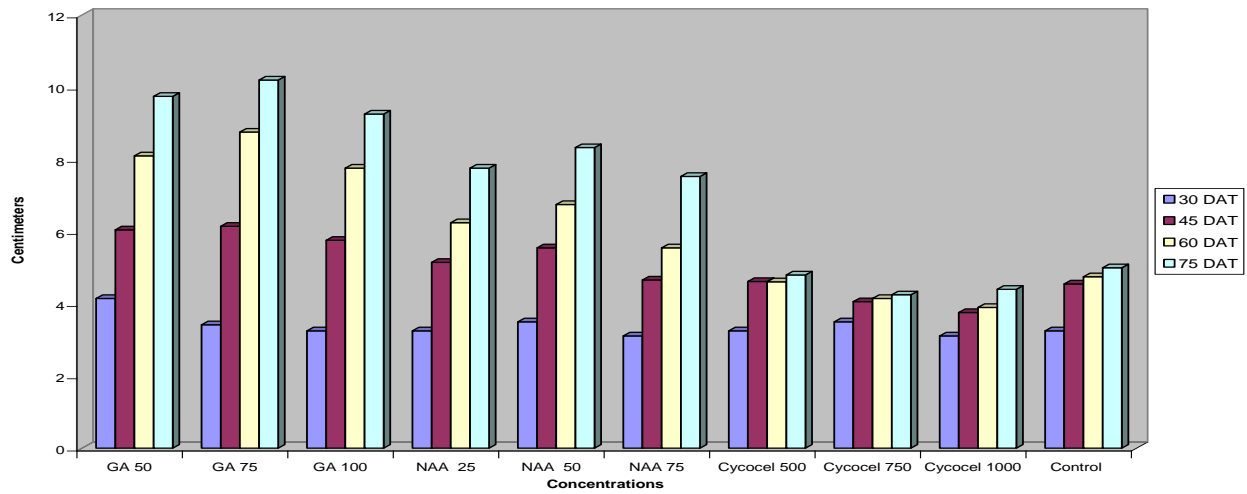


Figure 4. Effect of plant bio-regulator on petiole length (cm) of strawberry.

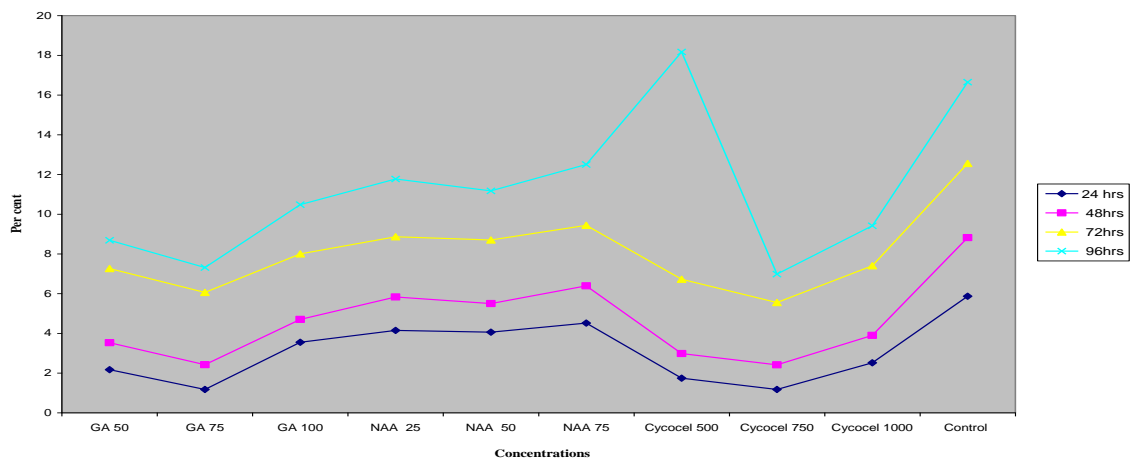


Figure 5. Effect of plant bio-regulator on percent physiological loss in weight of strawberry.

Table 3. Effect of plant bio-regulators on flowering, fruit set, number of berries/plant and fruit yield of strawberry CV. Chandler.

Concentrations (ppm)	Average number of flowers per plant			Total flowers per plant	Fruit Set (%)	No. of berries per plant	Fruit yield (gram per plant)
	Primary	Secondary	Tertiary				
GA 50	6.70	11.11	10.85	28.65	78.98	22.63	338.45
GA 75	7.00	12.11	11.11	30.22	82.06	24.80	356.56
GA 100	5.60	10.50	9.45	25.55	80.35	20.53	311.21
NAA 25	5.00	10.55	10.00	25.55	77.10	19.70	216.80
NAA 50	5.30	10.25	9.50	25.05	79.28	19.86	220.90
NAA 75	4.70	11.00	9.40	24.40	76.36	18.63	211.40
Cycocel 500	4.43	11.00	9.10	24.30	71.93	17.48	175.93
Cycocel 750	4.20	10.94	8.45	23.59	76.13	17.96	183.53
Cycocel 1000	4.03	10.32	8.00	22.35	77.49	17.32	150.70
Control	6.20	7.60	5.08	18.88	66.73	12.60	112.53
CD (0.05)	0.09	0.77	0.51	3.91	2.02	0.09	0.84

Table 4. Effect of plant bio-regulators on physical characteristics of strawberry fruits CV.Chandler.

Concentrations (ppm)	Size (mm)		Fruit weight (g)	Fruit volume (cc)	Specific gravity	No. of achene's	Juice content (%)
	Fruit length	Fruit diameter					
GA 50	37.25	27.25	16.15	16.21	0.99	381.85	94.12
GA 75	38.95	28.95	17.06	17.11	0.98	385.31	94.92
GA 100	35.87	24.44	16.05	16.12	0.99	372.61	93.08
NAA 25	32.74	22.18	15.65	15.70	0.99	335.41	92.25
NAA 50	31.79	21.78	15.53	15.59	0.99	351.72	92.89
NAA 75	30.45	20.45	15.25	15.31	0.99	319.72	92.15
Cycocel 500	37.45	27.45	16.65	16.71	0.99	382.51	94.45
Cycocel 750	39.19	29.15	17.12	17.25	0.98	385.50	95.00
Cycocel 1000	36.66	26.96	16.25	16.29	0.99	375.52	93.65
Control	29.35	20.33	12.44	12.45	0.94	291.92	85.59
CD (0.05)	0.32	0.55	1.73	1.76	0.03	0.82	0.55

Orenden (1965). It might be due to increase in cell division and cell elongation in sub-apical meristems of strawberry (Table 2). These results are in line to that of Pathak and Singh (1976).

The effect may be due to the early flowering and fruiting by blocking gibberellic synthesis. Similar results are in accordance with Sachs and Kofranek (1963) and Pathak and Singh (1976).

In Table 3, Gibberellins applied at either time have affected the initiation and duration of flowering season. Duration of flowering largely depends on the time of application of plant bio-

Table 5. Effect of plant bio-regulators on chemical characteristics of strawberry fruits CV.Chandler.

Concentrations (ppm)	TSS (%Brix)	Titrateable acidity (%)	TSS/Acid ratio	Ascorbic acid (mg/100g pulp)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)
GA 50	6.61	0.78	8.47	64.08	7.08	4.37	2.57
GA 75	7.06	0.80	8.82	66.03	7.82	4.51	3.14
GA 100	6.41	0.81	7.91	63.21	6.92	4.45	2.34
NAA 25	6.19	0.84	7.30	60.07	6.75	4.28	2.34
NAA 50	6.26	0.83	7.50	60.46	6.81	4.31	2.37
NAA 75	6.11	0.84	7.20	59.23	6.71	4.21	2.37
Cycocel 500	6.92	0.75	9.20	64.76	7.47	4.46	2.85
Cycocel 750	7.08	0.75	9.40	71.36	7.87	4.56	3.14
Cycocel 1000	6.51	0.76	8.50	63.47	6.96	4.41	2.42
Control	6.09	0.75	8.12	58.29	6.15	4.08	1.96
CD (0.05)	0.02	0.02	0.72	2.18	0.02	0.02	0.56

regulators which hastened the flowering period when applied about a month before the appearance of flower buds and showed an increase in secondary flowering because of temperature rise.

These findings are substantiated with the observations of Singh and Singh (2006) and Kappel and Donald (2007). Gibberellic acid 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 GA application accelerated the development of differentiated inflorescence (Table 5). Similar results are reported by Ozgven and Kaska (1990) and Parouissi et al. (2002). The yield attributes on the sink capacity of crop is determined by its vegetative growth throughout the life cycle of plants. Vigorous growth is associated with higher sink capacity of a crop. The higher yield might be due to formation of more metabolites by large leaves in these plants resulting in bumper

flowering, fruit setting besides better vegetative growth. These results are in agreement with Sharma and Singh (1990) and Anwar et al. (1990).

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