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Assessment of planting dates, GA_3 concentrations and *Azotobacter* on Chandler strawberry

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ABSTRACT

The present three-factor experiment consisting of 08 treatments on strawberry cultivar Chandler at four different dates viz., 15th August, 5th September, 25th September and 15th October with the application of four GA_3 concentrations viz., no GA_3 (without application), 50 ppm GA_3, 75 ppm GA_3 , 100 ppm GA_3, with and without *Azotobacter* (bio fertilizer) were carried out during 2018-19. The treatment under 15th October planting date, 75 ppm GA_3 concentration and plant treated with *Azotobacter* (bio fertilizer) was found the most effective for majority traits *viz.,* plant height (33.11 cm), number of runners/plant (8.25), days taken to first flower initiation (54.23), fruit setting % (88.66), fruit length (34.47 mm), fruit diameter (23.12 mm), fruit volume (15.25 ml), fresh wt. of fruit (15.34 g), fruit yield/plant (298.56 g), T.S.S. (8.52^{0}Brix), vitamin C (66.51 mg/100g), and sugar content (6.970 %) whereas the minimum values for most of the characters was noted with 15th August planting date and without application of GA_3 and *Azotobacter*.

Key words: *Fragaria* × *ananassa*, quantitative, qualitative traits.

INTRODUCTION

Fruits are not only good source of food; they are serving as medicine and treat ailments. India provides ample opportunity to grow a variety of fruit crops with diverse soil and climate comprising several agro-ecological regions. After grapes, strawberry (*Fragaria* × *ananassa* Duch.), an aggregate fruit, has attained the status of being one of the most important soft fruit of the world (Umar *et al.*, 12). Botanically it is an octaploid (2n=8x=56), dicotyledonous, low growing herb grown in most arable regions of the world and millions of people are enjoyed this in all kinds of climates (Kumar *et al.,* 7). In the global fruit production, India become largest producer of fruit by producing 94383 thousand MT under an area of 6523 thousand hectare. India accounts four thousand MT productions from an area of one thousand hectare, in strawberry (NHB, 6).

Strawberry displays a wide variation in adaptation to environmental conditions. Early efforts to popularize its cultivation in Uttarakhand received a setback on account of poor return per unit area. A major back through was seen with the introduction of few cultivars from America, some of which like Chandler, Tioga and Torrey displayed high yield of excellent quality berries in the late seventies. From different parts of the world several new strawberry cultivars have been introduced recently, in the state, which could be exploited for bringing about improvement in strawberry production. For the production of fruits as well as runners, the climatic conditions of the state are congenial. The runner production in strawberry cultivar Chandler does not take place in warm areas (Tanuja & Rana, 11).

Plant growth regulators are the chemical substances modify the growth of plants usually by stimulating part of natural growth regulatory system which when applied in small amounts. The growth regulators include both growth promoters and retardants which modify the canopy structure and other yield attributes. Among growth regulators, in the development of morphological characters of plants and their fruits, gibberellic acid plays a vital role. To influence the seed germination, plant growth, development, flowering and fruit characters, gibberllins is used. The senescence of fruits is delayed by Gibberellic acid (Alam and Khan, 2).

In place of chemical fertilizers, the beneficial microorganisms are used, they are not only able to improve the plant growth but also maintain the environmental health and productivity of the soil. A number of species of bacteria mainly associated with the rhizosphere of plants are beneficial to the growth, yield and crop quality (Agronet, 1). Looking the low fruit yield and scope of improvement in yield by optimization of cultural operations, this experiment was designed and conducted.

MATERIALS AND METHODS

The experiment was conducted in strawberry cv. Chandlerr at the Horticultural Research Centre of H N B Garhwal University, Srinagar (Garhwal) situated in the Alaknanda valley (78° 47' 30" E longitude and

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30° 13' 0" N latitude and at an elevation of 540 m above msl), a semi-arid, subtropical climate with dry summer and rigorous winters with occasional dense fog in the morning hours from mid December to mid February. The experiment was laid out in three-factor experimental design consisting of four date of planting viz., 15th August, 5th September, 25th September and 15th October applied with four GA_3 concentration viz., no GA_3 concentration, 50 ppm, 75 ppm and 100 ppm GA_3 concentration and plant with and without treatment with *Azotobacter* (bio fertilizer).

All the recommended agronomical practices under irrigated condition were followed to raise the healthy crop. GA_3 was applied thrice; first spray after 30 days of planting and rest of the spray was applied at 15 days interval as per treatment combinations. The runners were cultured with *Azotobacter* before planting. The *Azotobacter* was diluted in jaggery solution and then the runners were dipped in the solution. The observations were recorded on five randomly selected plants from each treatment to assess the effect of date of planting, growth regulator and bio fertilizer on growth, yield and quality of strawberry.

The recorded data for each parameter on plant height (cm), plant spread (cm^2), number of runners/ plant, days taken to first flower initiation, fruit setting %, fruit length (mm), fruit diameter (mm), fruit volume (ml), fresh weight of fruit (g), fruit yield/plant (g), TSS (°Brix), vitamin C (mg/100g) and sugar content (%) from the experiment was analyzed statistically according to procedure given by (Cochran and Cox, 4) to find out the variation resulting from experimental treatments.

RESULTS AND DISCUSSION

The data presented in Table 1&2 and depicted in Fig. 1 & 2 strongly revealed that there was a significant ($P<0.05$) effect of date of planting, GA_3 concentrations and *Azotobacter* on quantitative and qualitative traits of strawberry plants.

The maximum number of qualitative and quantitative traits of strawberry Cv. Chandler were observed during 15th October planting date. Planting time has direct effect on day and night temperature, day light intensity and photoperiod, which affect the floral induction, fruit size, quality and production. Because 90 to 95% of a plant's dry weight is derived from photosynthesis (Biscoe and Gallagher, 3). Similar results were also found by Rahman *et al*., (8) in his experiment, they reported that October planting was suitable for strawberry cultivation in terms of yield and yield attributes and quality parameters of fruits.

The performance of strawberry with respect to GA_3 application proved that 75 ppm GA_3 was recorded superior for most of the quantitative and qualitative

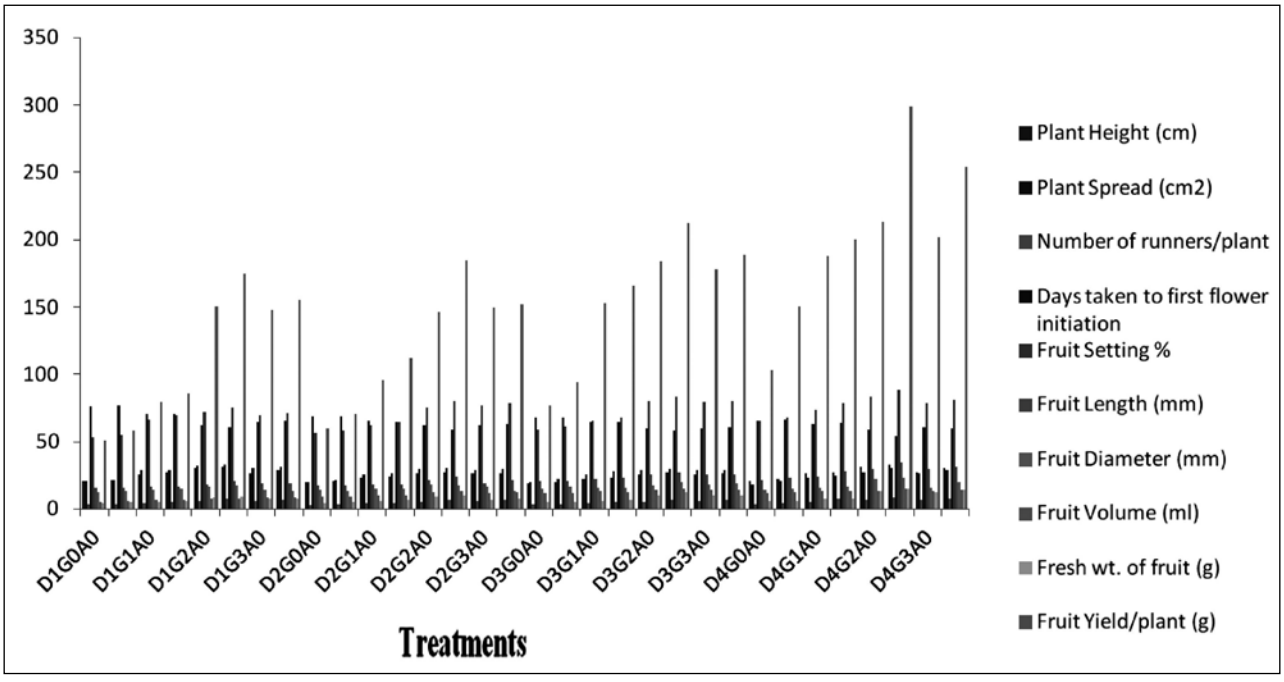

Fig. 1. Assessment of Planting Dates, GA3 Concentrations and *Azotobacter* on Quantitative Characters of Strawberry Cv. Chandler.

Table 1. Assessment of planting dates, GA_3 concentrations and *Azotobacter* on quantitative characters of Chandler strawberry.

Treatments		Plant Height (cm)	Plant Spread (cm^2)	Number of runners/ plant	Days taken to first flower initiation	Fruit Setting %	Fruit Length (mm)	Fruit Diameter (mm)	Fruit Volume (ml)	Fresh wt. of fruit (g)	Fruit Yield/ plant (g)
	G_0A_0	20.41	20.77	3.49	75.89	53.33	15.41	12.25	5.02	4.18	50.52
	G_0A_1	21.49	21.72	3.82	76.59	55.26	15.97	13.11	6.12	4.92	58.19
	G_1A_0	25.37	28.76	4.22	70.78	66.64	16.26	14.32	6.98	5.23	79.12
D_1	G_1A_1	27.51	28.89	4.85	70.17	69.76	16.87	14.66	6.97	5.77	86.25
(15^{th}	G_2A_0	30.7	31.74	6.12	62.61	72.14	18.39	16.22	7.52	8.20	150.24
August)	G_2A_1	31.60	32.71	7.59	60.32	75.74	20.91	17.18	7.99	9.10	174.67
	G_3A_0	26.35	30.63	5.85	64.87	69.42	18.82	14.15	8.23	7.52	148.12
	G_3A_1	29.14	31.60	6.69	65.15	71.25	19.22	13.12	8.57	7.52	155.25
	G_0A_0	19.91	19.93	3.00	69.18	56.75	17.47	14.48	9.01	4.54	60.13
	G_0A_1	20.48	21.81	3.62	69.09	58.50	17.55	13.11	9.12	5.14	70.12
	G_1A_0	23.18	25.42	4.75	65.46	62.35	18.35	15.19	10.13	6.29	95.55
D_2	G_1A_1	23.74	26.48	4.72	65.08	64.92	18.47	14.66	10.36	6.98	112.13
(5^{th}	G_2A_0	26.76	29.48	5.59	62.59	75.66	21.55	18.15	12.14	9.25	146.38
September)	G_2A_1	27.28	30.41	6.88	59.07	80.27	23.64	17.18	13.57	10.05	184.52
	G_3A_0	26.28	28.71	6.00	62.24	77.21	19.25	16.26	12.01	7.22	149.54
	G_3A_1	26.68	29.55	6.44	62.79	78.51	21.33	13.12	12.57	7.62	152.23
	G_0A_0	19.22	19.52	3.28	67.89	59.27	20.42	15.17	12.02	5.15	77.14
	G_0A_1	20.26	22.64	3.75	68.00	61.32	20.98	16.35	11.99	5.29	94.37
	G_1A_0	22.49	25.46	4.36	64.48	65.64	22.67	16.15	13.01	6.35	152.56
	G_1A_1	23.52	28.30	5.05	64.34	68.31	22.95	15.87	12.58	6.94	165.75
D_3	G_2A_0	25.84	29.10	5.59	59.50	80.44	25.22	17.30	14.51	10.47	184.14
(20^{th}	G_2A_1	27.30	29.52	7.07	58.23	83.46	27.26	20.14	14.99	12.21	212.32
September)	G_3A_0	25.28	28.58	5.88	60.08	79.40	25.28	18.31	14.01	9.98	178.16
	G_3A_1	26.17	28.49	6.72	60.88	80.20	25.420	18.92	14.05	10.31	189.12
	G_0A_0	20.45	18.59	3.52	65.61	65.29	21.39	14.14	11.92	5.64	103.34
	G_0A_1	22.66	21.01	4.11	66.69	68.26	22.93	14.79	12.53	6.01	150.12
	G_1A_0	26.52	23.08	5.34	63.24	73.50	24.29	16.16	12.97	7.85	187.67
D_4	G_1A_1	27.61	24.54	7.30	63.85	78.34	27.62	16.95	13.08	8.03	200.37
(5^{th}	G_2A_0	31.12	27.54	6.85	59.21	83.88	29.94	22.52	13.69	13.53	213.18
October)	G_2A_1	33.11	30.75	8.25	54.23	88.66	34.47	23.12	15.25	15.34	298.56
	G_3A_0	27.32	26.22	7.18	60.25	78.89	29.47	16.14	13.40	12.51	202.16
	G_3A_1	30.27	28.95	7.54	59.58	81.20	31.27	20.12	14.01	14.04	253.64
S.Em±		0.06	0.06	0.15	0.33	0.18	0.14	0.25	0.03	0.05	2.76
C.D. at 5%		0.16	0.16	0.45	0.93	0.50	0.41	0.71	0.09	0.14	7.80

traits. Gibberellic acid (GA_3) improves the plant height, canopy spread, leaf area, number of leaves, petiole length and also induces stem elongation when exogenously applied to strawberry plants. It initiates early flowering, fruit development and early harvesting of berries in strawberry crop. It also increases the number of flowers per crown, fruit set percentage, total number of fruits per plant (Sharma

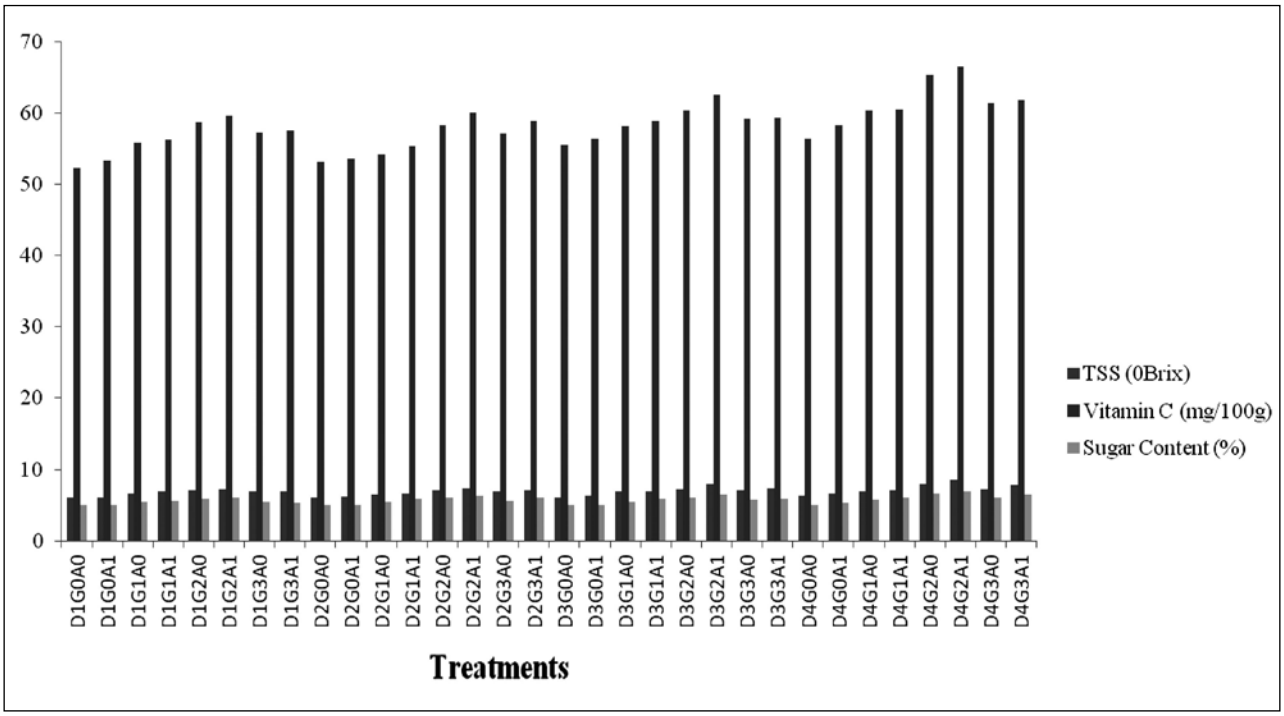

Fig. 2. Assessment of planting dates, GA_3 concentrations and *Azotobacter* on qualitative characters of Chandler strawberry.

Table 2. Assessment of planting dates, GA_3 concentrations and *Azotobacter* on qualitative characters of Chandler strawberry.

Treatments		TSS (°Brix)	Vitamin C (mg/100g)	Sugar Content (%)
D_1 (15^{th} August)	G_0A_0	6.02	52.28	5.02
	G_0A_1	6.12	53.30	5.05
	G_1A_0	6.58	55.78	5.51
	G_1A_1	7.00	56.24	5.55
	G_2A_0	7.01	58.69	5.97
	G_2A_1	7.25	59.67	5.99
	G_3A_0	6.87	57.22	5.48
	G_3A_1	6.91	57.55	5.37
D_2 (5^{th} September)	G_0A_0	6.03	53.22	5.03
	G_0A_1	6.15	53.64	5.04
	G_1A_0	6.47	54.15	5.51
	G_1A_1	6.67	55.38	5.92
	G_2A_0	7.04	58.34	6.00
	G_2A_1	7.37	60.12	6.34
	G_3A_0	6.87	57.13	5.54
	G_3A_1	7.02	58.92	5.98
D_3 (20^{th} September)	G_0A_0	6.06	55.57	5.05
	G_0A_1	6.38	56.34	5.09
	G_1A_0	6.94	58.14	5.47
	G_1A_1	6.99	58.96	5.92
	G_2A_0	7.23	60.32	6.04
	G_2A_1	7.97	62.53	6.55
	G_3A_0	7.03	59.17	5.82
	G_3A_1	7.34	59.31	5.93
D_4 (5^{th} October)	G_0A_0	6.37	56.34	5.09
	G_0A_1	6.59	58.32	5.35
	G_1A_0	6.89	60.34	5.81
	G_1A_1	7.05	60.58	6.05
	G_2A_0	7.98	65.37	6.62
	G_2A_1	8.52	66.51	6.97
	G_3A_0	7.27	61.38	6.01
	G_3A_1	7.81	61.89	6.51
S.Em±		2.76	0.03	0.02
C.D. at 5%		7.80	0.09	0.06

and Singh, 9). Similar findings were also reported by Jamal Uddin *et al.,* (5) in their experiment.

Plant treated with *Azotobacter* significantly found best over non treated plants. Bio fertilizer use atmospheric nitrogen for the synthesis of the cellular proteins. Cellular protein is mineralized after the death of the cell, thus contributing to the availability of nitrogen for wild plants and crops **(**Agronet, 1). Results obtained in the present experiment were in accordance to the findings of Verma *et al.,* (13) they reported that best performance in terms of maximum fruit yield of strawberry was found with bio fertilizer.

Planting on 15th October (D_4) proved to be superior to all other GA_3 and *Azotobacter* treatments by achieving the highest values of plant height (33.11 cm), plant spread (32.71 cm^2), number of runners/plant (8.25), fruit setting % (88.66), fruit length (34.47 mm), fruit diameter (23.12 mm), fruit volume (15.25 ml), fresh weight of fruit (15.34 g), fruit yield/plant (298.56 g), TSS (8.52 ^{0}Brix), vitamin C (66.51 mg/100g), sugar content (6.97 %), whereas the maximum plant spread was found (32.71 cm) in planting on 15th August (D_1) and the minimum days taken to first flower initiation was observed (54.23) in planting on 15th October (D_4) whereas the maximum days was found (76.59) in D_1 (15th August) planting. On the other hand, D_1 (15th August planting) showed minimum values for most of the quantitative and qualitative characters viz., fruit setting % (53.33), fruit length (15.41 mm), fruit diameter (12.25 mm), fruit volume (5.02 ml), fresh weight of fruit (4.18 g), fruit yield/plant (50.52 g), TSS (6.02 ^{0}Brix), vitamin C (52.28 mg/100g), sugar content (5.02 %). Obtained results from the present experiment were in the line of experiment conducted by Singh and Singh (10) on strawberry.

From the above mention findings it could be concluded that the treatment combination i.e., $D_4G_2A_1$ (15th October planting, 75 ppm GA_3 and with *Azotobacter*) was found most effective to obtain the highest values for most of the quantitative and qualitative contributing characters under subtropical conditions of Garhwal Himalaya.

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