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Response of plant growth regulators (NAA) and (GA_3) on growth and yield attributes of Chilli (*Capsicum annuum* L.) at Dehradun valley region

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Abstract
Present investigation entitled "Response of plant growth regulators (NAA) and (GA_3) on growth and yield attributes of chilli (*Capsicum annuum* L.) at Dehradun Valley Region" was conducted at Horticulture Research Block, Shri Guru Ram Rai University, Dehradun, Uttarakhand during summer season from April 2019 - July 2019. The experiment was laid out in Randomized Block Design (RBD) with three replications. The ten treatments comprised following levels of GA_3 concentrations *viz.*10ppm, 25ppm, 50ppm, 100ppm, and NAA 50ppm, 100ppm, 10ppm, 25ppm, 150ppm and control. Among all the treatments it was concluded that for growth as well as yield attributes, NAA @50 ppm gave maximum plant height (34.6 cm), number of branches (51.6), number of leaves(56.3), days to 50% flowering (46.10), flowers per plant (3.6) and fruits per plant(51.6), fruit yield per plant (400.00g), yield per plot (10.56 kg), yield per hectare (146.10 q), fruit length(17.6cm) and fruit breadth(3.9cm). From this experiment, it was concluded that 50 ppm of NAA can be recommended in chilli for its better growth and yield.

Keywords: NAA, GA_3, plant height, flowering, growth, yield attributes

Introduction
Chilli (*Capsicum annuum* L.) is one of the most valuable spice crop as well as important vegetable crop grown in India. It belongs to family solanceae and having chromosome number 2n=24. It is originated from Tropical America and it requires a warm humid climate for good growth. India ranks second next to china in vegetable production the world. The chilli fruit pungency is due to alkaloid capsaicin and its bright red colour is due to the pigment capsathin. The chilli fruit without pungency is popularly known as paprika. It can be grown both in kharif as well as in rabi season. The edible part of a chilli is the fruit. Chilli fruit is rich source of vitamin A and vitamin C. The green chilli contains Rutin which has medicinal value (Singh, 1987). It also contains high amount of vitamin A (292IU) and vitamin C (111mg) according to Singh et al. (1995) and Joshi and Singh (1988) [4]. Its average temperature requirement ranging from 25-35 ^{O}C. In India, chilli can be grown in all the states but mostly grown in Andhra Pradesh, Telangana, Tamil Nadu, Karnataka and Madhya Pradesh. India contributes 36% to the total world production and exporting 20% of total production. Growth hormones are widely used in horticultural crop production all over the world. Growth hormones play a vital role in growth and development of chilli. The plant growth hormones classified into different categories like Auxin, Gibberellins, Cytokinin etc. are involved with the physiological activities in plants. NAA (Naphthalene acetic acid) is a synthetic plant hormone which is used in plant tissue culture, promotes growth and also adds to induce root formation in various plants. NAA is widely used in horticulture for various purposes. Gibberellic acid (GA_3) is a phyto hormone whose occurrence in plant controls their growth and development. Gibberellic acid also increases the plant height, weight of shoot and root of the plant. It also produces in plant cell plastids. Gibberellins stimulate cell division and elongation and seed germinations too. Several experiments were conducted to increase the yield of chilli by using different growth hormones in different parts of the country, but no such experiment was performed in Dehradun region. Therefore, to study the response of NAA and GA_3 in chilli under Dehradun region, the present experiment was conducted to find out the concentration of NAA

and GA_3, best suited in terms of growth and yield and parameters in chilli. Hence, the aim of this study was to maximize the yield of chilli.

Materials and Methods

The present investigation was conducted at the Horticulture Research Block, School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun, Uttarakhand, India. The experiment was laid out in Randomized Block Design (RBD) with three replications. The gross plot size was 2.3m x 2.3m and net plot size was 2m x2m. There were ten different treatment levels of NAA and GA_3 concentrations *viz*. (10, 25, 50, 100, 50, 100, 10, 25,150 and Control). Fully mature seedlings of chilli variety 'Sanaya' were brought from Krishi Vigyan Kendra, Dhakrani, Dehradun and 25 days old seedlings were transplanted in the experimental field with application of recommended doses of N: P_20_5: K_2O: 80-120:60-100: 60-120 kg/ha. Half dose of nitrogen and full dose P_20_5, K_2O were applied at the time of field preparation and remaining dose of nitrogen was given at six weeks after transplanting or time of first earthing up. All the intercultural operations were followed timely in the experimental plots as per the requirement of the crop. From each plot randomly selected five plants and used for taking observations for growth and yield attributes.

Results and Discussion

The findings that were obtained from the execution of the present experiment were recorded and are thoroughly discussed below:

Growth attributes

The treatments used influenced the morphological characters of chilli to a varying extent among which NAA@ 50 ppm gave maximum plant height (34.6cm) at the time of harvesting as mentioned in Table 1 & Figure 1. The other growth characters *viz*; number of branches (51.6), number of leaves (56.3), days of flowering (46.10), flower per plant (3.6) and fruit per plant (51.6) also reported highest with the application of NAA@ 50 ppm. Findings of Pandita et al. (1980) [12], Kannan et al. (2002) [7] and Daddlmani and Panchal (1989) [3] in chilli have also shown similar results in the growth parameters of plants of chilli. The plant height and other growth parameters were significantly increased with application of NAA over control this might be due to the NAA act as a growth promoter which increases photosynthesis activities, affect translocation and utilization of photosynthates which might be causing rapid cell division in growth portion of the plant or stimulation of growth, besides increases the nutrient and uptake of nutrient thereby result in plant height increases. These results are also supported by Chaudhary et al. (2006) [2] and Kalshyam et al. (2011) [6] in chilli.

Yield attributes

Plant growth regulator i.e. NAA and GA_3 contributes significant results in yield attributes and shows increasing effect in the yield per plant, yield per plot and yield per hectare, fruit length and fruit breadth as compared to control. Among all the concentrations of NAA @ 50 ppm gave maximum yield per plant (438.00g), yield per plot(11.56kg) and yield per hectare (146.10q/ha), fruit length(17.6cm) and fruit breadth(3.9cm) as mentioned in Table 2 & Figure 2. This might be due to increases in photosynthesis activities within the plants which might be result in higher production of carbohydrates. Similar findings were also observed by Sultana et al. (2006) [18] in brinjal and Chandni et al. (2016) [1] in chilli. The maximum fruit length (17.6 cm) was also obtained in treatment of NAA@ 50 ppm. This might be due to the cell enlargement and cell elongation, which is caused by the supply of growth regulators within plants (Singh et al. 1994) [15]. The maximum fruit breadth (3.9cm) was too recorded by the application of NAA@ 50 ppm which was maximum than control. This might be due to the higher vegetative growth and physiological activity resulted in buildup assimilates in the plants. (Joshi and Singh 2010) [5].

Table 1: Effect of different NAA ad GA_3 concentrations on growth attributes of chilli

Treatments	Plant height (cm)	Number of branches	Number of leaves	Days of flowering	Flower per plant	Fruit per plant
GA_3 10ppm	0.821	5.230	4.649	4.110	1.367	4.915
NAA 25ppm	0.667	3.379	4.664	4.230	1.433	3.688
GA_3 50ppm	1.348	3.349	3.755	4.110	1.167	3.402
NAA100ppm	1.157	2.551	5.925	4.310	2.031	5.117
NAA 50ppm	0.694	4.352	5.518	4.810	1.400	2.906
GA_3 100ppm	0.371	3.571	3.724	4.610	1.367	2.584
NAA 10ppm	1.267	4.187	6.341	4.730	1.067	3.349
GA_3 25ppm	0.954	4.092	2.849	4.910	1.109	2.887
GA_3 150ppm	1.268	3.758	1.528	4.160	1.133	2.634
CONTROL	1.530	2.675	2.322	4.163	1.400	4.921
C.D.	2.798	9.112	1.615	3.511	1.233	8.297
SE(m)	0.934	3.165	20.456	3.350	0.774	2.771
SE(d)	1.321	4.481	20.11	21.719	11.345	3.919

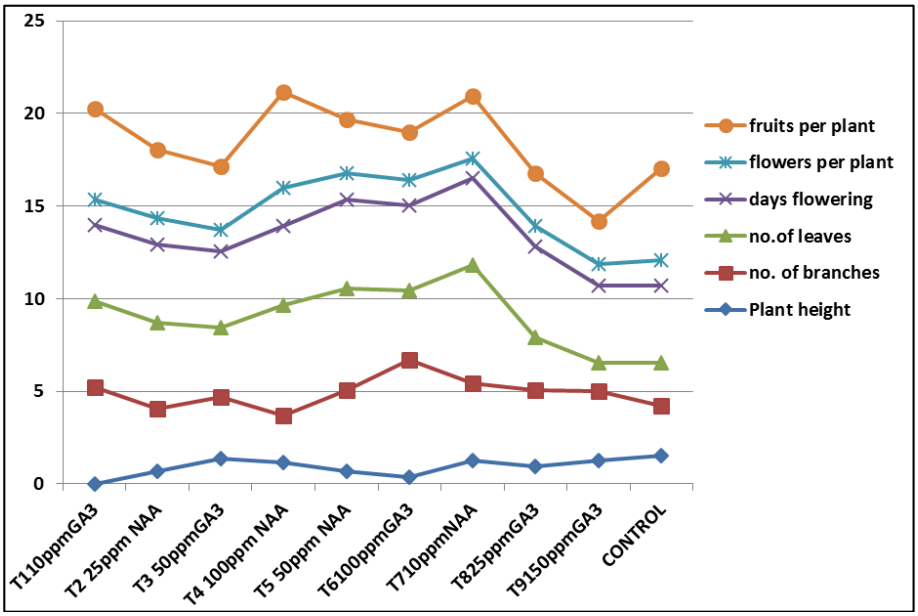

Fig 1: Representation of the growth attributes of chilli due to influence of NAA and GA_3

Table 2: Effect of different NAA and GA_3 concentrations on yield attributes of chilli

Treatment	Yield per plant	Yield per plot	Yield per hectare	Fruit length (cm)	Fruit breadth (cm)
GA_3 10ppm	420.10	9.50	141.10	11.6	2.1
NAA 25ppm	435.10	10.51	142.50	12.3	2.2
GA_3 50ppm	320.40	09.40	130.09	10.1	2.3
NAA100ppm	400.00	09.35	125.74	15.1	1.8
NAA 50ppm	438.10	11.56	146.60	17.6	3.9
GA_3 100ppm	350.10	10.10	141.91	16.6	2.6
NAA 10ppm	360.30	08.30	130.60	16.5	2.5
GA_3 25ppm	333.30	08.60	120.01`	14.3	2.9
GA_3 150ppm	330.10	09.10	129.00	15.6	2.7
CONTROL	333.10	O7.67	120.00	6.469	1.5
C.D.	0.33	0.11	0.16	1.233	2.1
SE(m)	0.11	0.16	0.11	0.868	2.2
SE(d)	0.16	0.14	0.12	1.228	2.3
C.V.	0.33	0.32	0.33	20.520	1.8

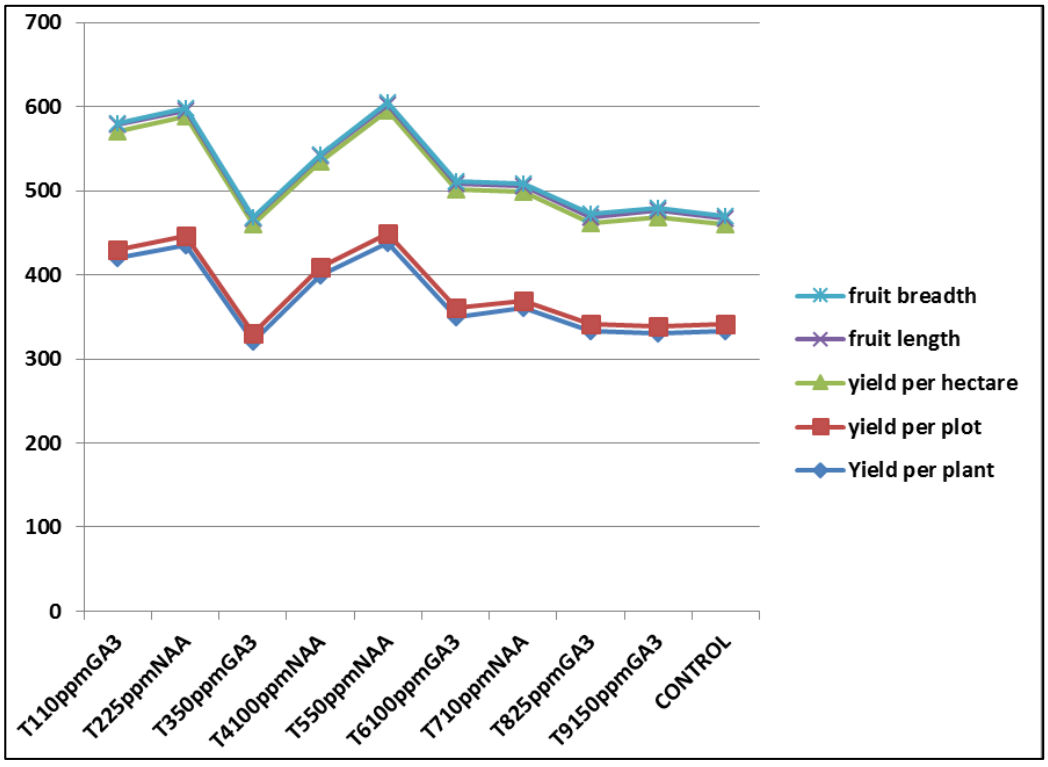

Fig 2: Representation of the yield attributes of chilli due to influence of NAA and GA_3

Conclusion

On the basis of present experiment on response of NAA and GA_3 on growth and yield attributes of chilli cv. Sanaya it can be concluded that the treatment of NAA at 50ppm concentration found to be the most effective for increasing plant height, number of branches, number of leaves, days 50% flowering, fruit per plant, flowers per plant, yield kg per plant, yield per plot, yield q/ha, fruit length and fruit breadth.

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