Response of plant growth regulators (NAA) and (GA₃) 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 (GA₃) 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 GA₃ 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(146.10 q), fruit breadth(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, GA₃, 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 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). Its average temperature requirement ranging from 25-35 °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, Cytokinins 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. Gibberelic acid (GA₃) is a phyto hormone whose occurrence in plant controls their growth and development. Gibberelic 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 GA₃ in chilli under Dehradun region, the present experiment was conducted to find out the concentration of NAA.
and GA₃, 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 x 2m. There were ten different treatment levels of NAA and GA₃ concentrations viz., (10, 25, 50, 100, 50, 10, 25, 150, and Control). Fully mature seedlings of chilli variety ‘Sanaya’ were brought from Krishi Vigyan Kendra, Dakshin, Dehradun and 25 days old seedlings were transplanted in the experimental field with application of recommended doses of N: P₂O₅: K₂O: 80-120:60-100: 60-120 kg/ha. Half dose of nitrogen and full dose P₂O₅, K₂O 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) and Kannan et al. (2002) and Daddlmani and Panchal (1989) 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) and Kalshyam et al. (2011) in chilli.

Yield attributes
Plant growth regulator i.e. NAA and GA₃ 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) in brinjal and Chandani et al. (2016) in chilli. The maximum fruit length (17.6 cm) was also obtained in treatment of NAA@ 50 ppm. Findings of Pandita et al. (2006) in chilli have also shown similar results in the growth and physiological activity resulted in buildup assimilates in the plants. (Joshi and Singh 2010)

| Treatments  | Plant height (cm) | Number of branches | Number of leaves | Days of flowering | Flower per plant | Fruit per plant |
|-------------|-------------------|--------------------|-----------------|------------------|-----------------|----------------|
| GA10ppm     | 0.821             | 5.230              | 4.649           | 4.110            | 1.367           | 4.915          |
| NAA25ppm    | 0.667             | 3.379              | 4.664           | 4.230            | 1.433           | 3.688          |
| GA50ppm     | 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          |
| NAA50ppm    | 0.694             | 4.352              | 5.518           | 4.810            | 1.400           | 2.906          |
| GA100ppm    | 0.371             | 3.571              | 3.724           | 4.610            | 1.367           | 2.584          |
| NAA10ppm    | 1.267             | 4.187              | 6.341           | 4.730            | 1.067           | 3.349          |
| GA25ppm     | 0.954             | 4.092              | 2.849           | 4.910            | 1.109           | 2.887          |
| GA150ppm    | 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          | 13.350           | 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 GA₃

Table 2: Effect of different NAA and GA₃ concentrations on yield attributes of chilli

| Treatment   | Yield per plant | Yield per plot | Yield per hectare | Fruit length (cm) | Fruit breadth (cm) |
|-------------|-----------------|----------------|-------------------|-------------------|-------------------|
| GA₃ 10ppm   | 420.10          | 9.50           | 141.10            | 11.6              | 2.1               |
| NAA 25ppm   | 435.10          | 10.51          | 142.50            | 12.3              | 2.2               |
| GA₃ 50ppm   | 320.40          | 09.40          | 130.09            | 10.1              | 2.3               |
| NAA 100ppm  | 400.00          | 09.35          | 125.74            | 15.1              | 1.8               |
| GA₃ 100ppm  | 438.10          | 11.56          | 146.60            | 17.6              | 3.9               |
| NAA 50ppm   | 350.10          | 10.10          | 141.91            | 16.6              | 2.6               |
| GA₃ 25ppm   | 360.30          | 08.30          | 130.60            | 16.5              | 2.5               |
| GA₃ 150ppm  | 333.30          | 08.60          | 120.01            | 14.3              | 2.9               |
| CONTROL     | 333.10          | 07.67          | 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 GA₃

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Conclusion
On the basis of present experiment on response of NAA and GA3 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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