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Influence of GA_3 and NAA on Flowering, Fruiting and Yield Attributes of Capsicum cv Indra. under Protected Structures

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ABSTRACT
The experiment was carried in Polly house at Agriculture Farm, School of Agricultural Sciences & Technology, RIMT University, Mandi Gobindgarh, Punjab, India to study the influence of GA_3 and NAA on flowering, fruiting and yield attributes of capsicum cv. Indra under protected structures during 2020-21. Three levels each of GA_3 (25, 50 and 75 ppm) and NAA (50, 100 and 150 ppm) along with a control (distilled water) were applied as foliar application after transplanting. Experiment was laid out in a randomized block design with three replications and all the required parameters were recorded and analysed statistically. Results revealed that application of GA_3 @ 75 ppm resulted with minimum days to flowering (34.33), fruiting (44.33) and longer duration of fruiting (48.27 days) whereas, more number of flowers/cluster (4.73), number of fruits/plant (15.23), fruit setting (65.60%), average fruit weight (45.60 g), fruit yield/plant (0.69 kg), fruit yield/plot (6.95 kg) and fruit yield/ha (43.42 t) while, less days to fruit maturity (60.00) was reported under the application of NAA @ 100 ppm.

KEYWORDS
GA 3, NAA, capsicum and Indra

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INTRODUCTION

Bell pepper or Shimla mirch botanically known as Capsicum annuum and having diploid chromosome number i.e. 2n=24. It was introduced in India by the Britishers in the 19^{th} century in Shimla hills. It is commercially grown in Himachal Pradesh, Jammu Kashmir, Uttrakhand, Arunachal Pradesh and Darjeeling hills of West Bengal during summer months and as autumn crop in Maharashtra, Karnataka, Tamil Nadu and Bihar (Jindal and Dhaliwal, 2019). The bell pepper is a fruit vegetable well known for its high content in bioactive compounds and strong antioxidant capacity. It is one of the most popular fresh vegetable worldwide due to its combination of colour, flavour and nutritional value. The consumption of these bioactive compounds provide beneficial effects in human health due to their antioxidant properties, which protect against the oxidative damage to cells and thus prevent the development of common degenerative diseases such as cancer, cardiovascular diseases, cataracts, diabetes, Alzheimer's, and Parkinson's (Blanco-Rios *et al*, 2013). Fresh peppers have exceptionally high quantities of ascorbic acid and their attractive red color is due to several carotenoid pigments that include B-carotene with provitamin A activity and oxygenated carotenoids such as capsantine, capsorubin and cryptocapsin, which are exclusive to these fruits and have proven to be effective at scavenging free radicals (Deepa *et al*, 2006). Chitwan *et al* (2006) revealed that the application of plant growth regulators in solanaceous vegetable crops is very effective in reducing the flower and fruit drops thereby enhancing production in per unit of area and per unit of time. The plant growth regulators are also known to enhance and stimulate the translocation of photo assimilates thereby helping in better retention of flowers and fruits (Sreenivas *et al*, 2017). Gibberellic acid (GA_3) is a phytohormone that is needed in small quantities at low concentration to accelerate plant plant height, weight of shoot and root of the plant. Gibberellins are often used for promotion of fruit set in some fruit vegetable production including tomatoes and yields can increase dramatically to four times (Singh and Singh, 2019). Pundir *et al* (2020) stated that naphthalene acetic acid (NAA) 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 having beneficial effect like, increased photosynthetic activity, accelerated transport and efficiency of utilizing photosynthetic products resulting in rapid cell elongation and cell division in the meristem which are ultimately responsible for growth, development and higher yield of vegetable crops (Sarker *et al*, 2009). Hence, keeping in view all the facts an experiment was carried out to see the influence of GA_3 and NAA on flowering, fruiting and yield attributes of capsicum cv. Indra under protected structures.

MATERIALS AND METHODS

The current research was conducted with capsicum cv. Indra in Polly house at Agriculture Farm, School of Agricultural Sciences & Technology, RIMT University, Mandi Gobindgarh during 2020-21. Climate of the location is designed as subtropical and semi-arid with hot and dry summer (April-June), hot humid monsoon period (July-September), mild winter (October-November) and cold winter (December-February).

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The maximum temperatures often exceed 40 ^{0}C during summer. Minimum temperatures decreases below 6 ^{0}C with some ice spells during the winter months of December and January. The south-west monsoon during July-September is the major source of rainfall. Scanty rainfall is received during winter months of December, January and February. Total seven treatments i.e. control or distilled water (T_1), GA_3 @ 25 ppm (T_2), GA_3 @ 50 ppm (T_3), GA_3 @ 75 ppm (T_4), NAA @ 50 ppm (T_5), NAA @ 100 ppm (T_6) and NAA @ 150 ppm (T_7) were used for present investigation. Different concentrations of GA_3 and NAA were sprayed to the plants to run-off stage. Control plants were sprayed with distilled water in same manner. The experiment was laid out in a randomized block design with three replications. Observations on various flowering, fruiting and yield parameters were recorded. Results thus obtained, were subjected to statistical analysis.

RESULTS AND DISCUSSION

The outcome of the investigations is cited in Table 1 . Significant variation among different plant growth regulators have noticed. The minimum days from transplanting to flowering (34.33) was found from the treatment T_4 (GA_3 @ 75 ppm) and itwas also statistically significant with all the treatments except T_2 andT_7. This might be increased due to the influencing the timing of anthesis mechanism might be physiological regulation of flower formation by the application of growth regulator (Das *et al*, 2015). Same results are also reported by Hasanuzzaman *et al* (2007). The plants of capsicum when treated with GA_3 @ 75 ppm took minimum number of days to fruiting (44.33 days) ant it was remained statistically significant with all over the treatments except T_1, T_5 and T_6. The mechanism of reduction in days to fruiting due to application of PGR appears to be due to slowing down of cell division and reduction in cell expansion.

Table 1: Influence of GA_3 and NAA on flowering, fruiting and yield attributes of capsicum cv. *Indra* under protected structures

Treatments	Days to flowering	Days to fruiting	No. of flowers per cluster	No. of fruits per plant	Fruit setting (%)	Duration of fruiting (days)	Days to fruit maturity	Average fruit weight (g)	Fruit yield (kg/ plant)	Fruit yield (kg/ plot)	Fruit yield (t/ha)
Control	48.00	58.73	2.33	6.67	50.20	35.93	73.67	26.13	0.17	1.74	10.89
GA3 @ 25 ppm	37.67	46.57	4.30	11.23	53.80	37.80	64.10	35.23	0.40	3.96	24.72
GA3 @ 50 ppm	41.67	48.33	4.33	11.53	56.70	43.83	64.33	35.23	0.41	4.07	25.43
GA3 @ 75 ppm	34.33	44.33	4.07	12.63	59.30	48.27	61.33	38.00	0.48	4.80	29.98
NAA @ 50 ppm	40.33	48.93	4.17	12.77	57.90	38.70	66.33	36.40	0.47	4.65	29.07
NAA @ 100 ppm	41.33	51.37	4.10	12.97	64.10	44.00	60.00	39.20	0.51	5.07	31.70
NAA @ 150 ppm	36.17	44.87	4.73	15.23	65.60	42.03	64.00	45.60	0.69	6.95	43.42
CD at 5%	**4.32**	**4.08**	**1.63**	**1.15**	**0.13**	**3.35**	**4.71**	**1.98**	**0.05**	**0.47**	**2.95**

Thus, the reduced days to fruiting are due to retardation of transverse cell division particularly in cambium, which is the zone of meristematic activity at the base of the internodes (Gollagi *et al*, 2009). NAA @ 150 ppm treated plants have maximum numbers of flowers/cluster (4.73) and also reported as statically at par from all the treatments except T_1. The present findings are accordance with the findings of King *et al* (2006). The maximum number of fruits/plant (15.23) was attained fromT_7 (NAA @ 150 ppm) and T_7 was also remains as statically significant over all the treatments. It was noticed that application of 4-CPA enhance flower and fruit setting by reducing flower and fruit abscission that contributed higher number of flower and fruit plant (Chaudhary *et al*, 2006). This might be ascribed to more efficient utilization of food for reproductive growth (flowering and fruiting), higher photosynthetic efficiency and enhanced source to sink relationship of the plant, reduced respiration, enhanced translocation and accumulation of sugars and other metabolites (Ouzounidou *et al*, 2008). The highest fruit set (65.60%) was observed by application of T_7 (NAA @ 150) which was also found statically at par with all the treatments. This may be increased with the application of growth regulators like

NAA and GA_3 are known to involve in inhibition of cellulose and percentage activities involved in ovary development (Bhalekar *et al*, 2009). This might be occurs due to application of auxin at the time of flowering and resulted lower flowers drop that enhance fruit setting and contributed higher percentage of fruit setting (Hasanuzzaman *et al*, 2007). The maximum duration of fruiting (48.27 days) was observed in treatment T_4 (GA_3 @ 75 ppm) and it was also reported as statically significant over all the treatments. This is might be due to the regulating effect of exogenous application of PGRs that influences early floral initiation, fruit setting and duration to fruiting and helps to early maturity (Hasanuzzaman *et al*, 2007). Treatment T_6 (NAA @ 100 ppm) resulted with minimum number of days to fruit maturity (60.00) it was also reported as statically at par with all other the treatments except T_1 and T_5. The findings were accordance with the results of Hasanuzzaman *et al* (2007). The utmost average fruit weight (45.60 g) was weighted when plants of capsicum were treated with the treatment T_7 (NAA @ 150 ppm). T_7 is statically significant with all the treatments. Auxins are known to improve the capabilities of plants relevant to water economy in such a manner that physiological behavior of plants is modified significantly also reported that, application of plant growth regulators significantly increased single fruit weight of summer tomato (Choudhury *et al*, 2013). The increase in fruit weight in the plants sprayed with NAA might be due to built up of adequate food stock for level bigger sized fruits (Revanappa, 1993) . The utmost average fruit yield/plant (0.69 kg) was recorded with the treatment T_7 (NAA @ 150 ppm). T_7 is statically significant with all other the treatments. This might be due to appropriate growth of plants, control of abscission layer in full bloom stage and acceleration in fruit development by the positive hormonal actions (Balaraj 2012). Maximum fruit yield/plot (6.95 kg) was weighted with the application of T_7 (NAA @ 150 ppm). T_7 is statically significant with all the treatments. This might be occurs due to higher number of fruit setting and single fruit weight so plant yield kg per plot significantly increased by plant hormones (Rajmani *et al*, 1990). Maximum fruit yield/ha (43.42 t) was weighted with the application of T_7 (NAA @ 150 ppm) and it also is statically significant with all the treatments. Higher yield might be due to lesser flower and fruit drop that leading to higher setting of fruit plant G_1 ultimately contributed to yield per hectare (Appireddy *et al*, 2008).

CONCLUSION

On the basis of present study it may be concluded that all the flowering, fruiting parameters and yield attributes of plant were recorded highest when the plants of capsicum treated with treatment T_7 (NAA 2 150 ppm), except days to flowering, fruiting and duration of fruiting which were reported best with the application of T_6 (NAA @ 100 ppm).

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