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Influence of foliar application of plant growth regulators on crop growth and seed yield of paprika chilli (*Capsicum annuum* L.)

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Abstract
The field experiment was conducted in nethouse during *Rabi*, 2022 at AICRP on Seed (Crops), NSP, UAS, GKVK, Bengaluru, to study the effect of foliar application of plant growth regulators on crop growth and seed yield of paprika chilli. The experiment consists of 12 different plant growth regulators with paprika chilli variety OAL-1 planted in RCBD with 3 replications. Significant differences were noticed between the treatments for crop growth and seed yield parameters. Among the treatments, crop sprayed with Homobrassinolide @ 0.6 ml/l (T_6) recorded higher growth and yield parameters *viz*., plant height at harvest (106.56 cm), number of branches per plant at harvest (17.03), fruit length (15.22 cm), number of fruits per plant (25.79), fruit yield (39.56 q/ha), number of seeds per fruit (63.65), seed yield (333.54 kg/ha) compared to control (78.56 cm, 12.27, 11.86 cm, 20.17, 28.63 q/ha, 51.52, 242.55 kg/ha), respectively. Highest B:C ratio (2.64) was noticed with Homobrassinolide @ 0.6 ml/l compared to control (1.92).Hence, it can be concluded that spraying of Homobrassinolide @ 0.6 ml/l at 30, 60, 90 DAT could be employed to enhance crop growth and seed yield of paprika chilli.

Keywords: Crop growth, Homobrassinolide, paprika chilli, plant growth regulators, seed yield

Introduction
Chilli (*Capsicum annuum* L.) belongs to the family Solanaceae, with chromosome number 2n=24. It is an important vegetable cum spice crop rich in vitamins and capsaicin. It includes all the commercially important types *viz*., red pepper, paprika chilli and sweet pepper. Capsicum is derived from Greek word "Kapto" meaning "To bite". Among five cultivated species *viz*., *Capsicum annuum*, *Capsicum frutescens*, *Capsicum chinense*, *Capsicum baccatum* and *Capsicum pubescens*, most of the commercially cultivated chilli types including paprika belonging to the species *Capsicum annuum*. The origin of paprika chilli is in Mexico with secondary centers are Guatemala and Bulgaria (Abdel-Kader *et al*., 2011) [1].

Paprika chilli is one of the most lucrative commercial annual spice crops growing in India. Vitamins A and C are abundant in it. Paprika chilli fruits are deep red in colour and have no pungency. The main factor for judging its excellence is colour. 100 grams of fresh raw edible capsicum contain 93 percent water, 20 kilo calories of energy, 4.64 grams of carbohydrates, 0.86 grams of protein, 1 to 2 grams of fiber, 0.17 grams of fat, 10 milligrams of calcium, 3 milligrams of sodium, 0.34 milligrams of iron, 20 milligrams of phosphorus, 80.4 milligrams of ascorbic acid and 0.057 milligrams of thiamine (Anon., 2018) [2].

In world, the production of paprika is around 4.03 Mmt. The major paprika producers in the world are India (42.24%), followed by Thailand (8.01%), China (7.63%), Ethiopia (7.3%), Bangladesh (3.91%), Pakistan (3.51%), Myanmar (3.50%) and Ghana (2.69%). In India the production of paprika is 1.70 Mmt (Anon., 2022) [2]. Major paprika producing states in India are Andhra Pradesh, Telangana, Madhya Pradesh, Karnataka. Arka Abir and Kt-Pl-19 are released paprika varieties and bydagi is a local type mainly grown in Karnataka which has got geographical indication.

The increased fruit drop, decreased percentage of fruit set and delay in flowering and lower productivity are major issues lead to low productivity in paprika (Kannan *et al*., 2009) [8]. The plant growth regulators are known as new generation of agro-chemicals after fertilizers, pesticides and herbicides to increase seed yield and quality. The use of plant growth regulator is common horticultural practice to improve yields (Vandana and Varma., 2014) [12].

Foliar spray of PGRs are regularly used to develop fruit set, decrease fruit drop or to avoid pre-harvest drop to increase yield. Due to their broad range of benefits for all aspects of plant development, even a small increase of 10–15% might result in an increase in gross annual output of 10–15 million tonnes. By using various growth regulators, it is possible to enhance the fruit set percentage in paprika chilli, which will enhance the yield.

The growth regulators or promoters like Brassinosteroids are known for their role in growth and yield enhancement in different crops. Homobrassinolide is known to promote seed germination, cell elongation, cell division, root growth, photo-morphogenesis, vascular differentiation and reproduction in plants (Wei and Li., 2016) [14]. In the cambium, GA_3 and NAA promote vegetative development and play a role in the onset of cell division, while ABA controls water status and stomatal mobility. These plant growth regulators induce osmotic uptake of water absorption, which keeps swelling force against the softening of cell wall (Arora *et al*., 1985) [4]. Keeping all these points the experiment was conducted.

Materials and Methods

The experiment was conducted at AICRP on Seed (Crops), NSP, UAS, GKVK, Bengaluru during *Rabi*, 2022. Experiment was conducted under nethouse, where seedlings were directly transplanted in to Growbags containing cocopeat. The seeds of paprika chilli variety OAL-1 were collected from Omni Activa Pvt. Ltd., Bangalore used for the present study. The collected seeds of paprika chilli were fresh and untreated, stored under ambient conditions. The experiment was laid out in randomized complete block design with 3 replications. For this experiment, 11 different plant growth regulators along with control were applied in the form of foliar spray at three different stages *viz*., at 30, 60 and 90 days after transplanting. Treatments were, T_1: Control, T_2: NAA @ 50 ppm, T_3: GA_3 @ 50 ppm, T_4: CCC @ 600 ppm, T_5: 2, 4-D @ 5 ppm, T_6: Homobrassinolide @ 0.6 ml/l, T_7: Nitro Benzene @ 0.2%, T_8: Mepiquat Chloride @ 50 ppm, T_9: Ascorbic acid @ 50 ppm, T_{10}: Ortho Salicylic acid @ 1 ml/l, T_{11}: Triacontanol @ 1.5 ml/l, T_{12}: Zinc oxide @ 1.5 ml/l. The growth and yield parameters *viz.*, plant height at harvest (cm), number of branches per plant at harvest, crop duration (days), fruit length (cm), number of fruits per plant, fruit yield (q/ha), number of seeds per fruit, seed yield (kg/ha) and B: C ratio. These parameters were recorded timely. The experiment data collected on various growth and yield parameters of plants were subjected to Fisher's method of Analysis of variance technique as outlined by Gomez and Gomez., 1984 [5]. The level of significance used in 'F' and 'T' tests was at P=0.05. Whenever F-test was significant for comparison amongst the treatments an appropriate value of critical difference (CD) was worked out. Otherwise against CD values abbreviation NS (Non-significant) was indicated.

Results and Discussion

The data on growth and yield parameters *viz.*, plant height at harvest (cm), number of branches per plant at harvest, crop duration (days), fruit length (cm), number of fruits per plant, fruit yield (q/ha), number of seeds per fruit, seed yield (kg/ha) and B: C ratio as influenced by foliar spray of different growth regulators were presented in Table 1.

Significantly maximum plant height at harvest (106.56 cm) was recorded in T_6 (Homobrassinolide @ 0.6 ml/l) while the lowest plant height at harvest (78.56 cm) was recorded in control. Increased plant height with homobrassinolide foliar spray might be due to induction of broad spectrum of responses, including stimulation of longitudinal growth of young tissues *via* cell elongation and cell division and vascular differentiation, which is a developmental process critical for plant growth (Zurek *et al*., 1994) [15]. At harvest, the highest number of branches per plant (17.03) was recorded in T_6 (Homobrassinolide @ 0.6 ml/l) compared to all other treatments this might be due to its positive effect on meristematic tissues of plant as well as in increasing number and size of cell (Prakash *et al*., 2008) [9].

No significant differences were detected in crop duration between the treatments. Among the treatments, T_6 (Homobrassinolide @ 0.6 ml/l) recorded lower crop duration (163.65 days). Whereas, highest crop duration (177.78 days) was recorded in control. Significantly highest fruit length (15.22 cm) was observed in T_6 (Homobrassinolide @ 0.6 ml/l) compared to all other treatments. Vivency (1998) [13] observed the increased average berry length due to application of GA_3 25 ppm + Homobrssinolide 1 ppm. The growth induced by brassinosteroids may be related to the increase in RNA and DNA and improvement in the assimilation efficiency of photosynthetic assimilation and protein biosynthesis (Hayat *et al*., 2012) [6]. Foliar application of

Table 1: Effect of foliar spray of plant growth regulators on growth and yield attributing characters and seed yield of paprika chilli

Treatments (T)	Plant height (cm) at harvest	No. of branches per plant At harvest	Crop duration (days)	Fruit length (cm)	Number of fruits per plant	Fruit yield (q/ha)	Number of seeds per fruit	Seed yield (kg/ha)	B: C ratio
T_1: Control	78.56	12.27	177.78	11.86	20.17	28.63	51.52	242.55	1.92
T_2: NAA @ 50 ppm	95.21	16.28	165.41	15.00	24.26	37.25	61.75	305.61	2.42
T_3: GA_3 @ 50 ppm	92.09	15.40	167.49	14.34	24.86	35.99	60.45	297.43	2.35
T_4: CCC @ 600 ppm	81.15	14.68	169.94	12.93	21.33	34.98	50.65	268.74	2.13
T_5: 2, 4-D @ 5 ppm	85.27	14.61	168.94	13.66	21.96	33.82	58.38	266.42	2.11
T_6: Homobrassinolide @ 0.6 ml/l	106.56	17.03	163.65	15.22	25.79	39.56	63.65	333.54	2.64
T_7: Nitro Benzene @ 0.2%	85.48	15.06	175.91	13.23	22.62	35.45	54.58	260.87	2.07
T_8: Mepiquat Chloride @ 50 ppm	82.63	13.26	174.14	12.46	21.66	33.48	57.31	272.19	2.16
T_9: Ascorbic acid @ 50 ppm	89.35	13.88	172.68	11.97	22.35	31.75	55.98	265.17	2.10
T_{10}: Ortho Salicylic acid @ 1 ml/l	80.90	13.23	173.49	13.27	22.34	34.86	54.64	257.58	2.04
T_{11}: Triacontanol @ 1.5 ml/l	90.14	13.91	167.56	13.63	23.43	34.07	56.01	267.24	2.12
T_{12}: Zinc oxide @ 1.5 ml/l	80.97	13.83	168.89	13.14	22.58	33.18	60.06	281.57	2.23
S.Em±	5.24	0.79	7.70	0.70	1.05	1.75	2.60	14.12	-
CD (P=0.05)	15.37	2.31	NS	2.06	3.07	5.15	7.63	41.40	-
CV (%)	10.39	9.45	7.82	9.09	7.96	8.83	7.89	8.84	-

Homobrassinolide @ 0.6 ml/l (T_6) recorded the highest number of fruits per plant (25.79), fruit yield per hectare (39.56 q). Application of homobrssinolide improved the fruit yield of the tomato as brassinosteroids are known to delay the senescence process thereby a greater number of productive flowers will be retained in the plant for longer duration which ultimately enhances the fruit development in the crop (Iwahori *et al*., 1990) [7].

Highest number of seeds per fruit (63.65) and seed yield per hectare (333.54 kg) were observed in Homobrassinolide @ 0.6 ml/l (T_6). While the lowest number of seeds per fruit (51.52) and seed yield per hectare (242.55 kg) were recorded in control. Similar results of increased seed yield have been reported by Sairam (1994) [10] in wheat by foliar spraying foliar of homobrassinolide, Sridhara *et al*. (2021) [11] in tomatoes with foliar spray of homobrassinolide @ 0.04%. The treatment T_6 (Homobrassinolide @ 0.6 ml/l) recorded highest B: C ratio (2.64) and lowest B: C ratio (1.92) was recorded in control (T_1).

Conclusion

The foliar application of Homobrassinolide @ 0.6 ml/l has shown promising influences on growth and seed yield parameters of paprika chilli and It is also proved most economical with higher B: C ratio of (2.64). Thus, to obtain higher seed yield and more profit, it is advised to grow paprika chilli varieties with foliar application of Homobrassinolide @ 0.6 ml/l, which is one of best plant growth regulator among all treatments and it is nontoxic, non-Genotoxic, Biosafe and eco-friendly.

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