

## **Effect of Plant Growth Regulators on Yield and Quality of Chilli (*Capsicum annuum* L.) cv. Bidhan Chilli-4**

### **ABSTRACT**

Present experiment entitled "Effect of plant growth regulators on yield and quality of chilli (*Capsicum annuum* L.) cv. Bidhan Chilli-4" was conducted at experimental farm of Horticulture and Post-harvest Technology, Palli Siksha Bhavana, Palli Shiksha Bhavana Visva Bharati West Bengal during rabi season of 2020. The experiment was laid out in randomized block design (RBD) with three replications and ten treatments. The concentrations of treatments were T<sub>1</sub> = NAA 25 ppm, T<sub>2</sub> = NAA 50 ppm, T<sub>3</sub> = NAA 75 ppm, T<sub>4</sub> = GA<sub>3</sub> 5 ppm, T<sub>5</sub> = GA<sub>3</sub> 15 ppm, T<sub>6</sub> = GA<sub>3</sub> 30 ppm, T<sub>7</sub> = CCC 200 ppm, T<sub>8</sub> = CCC 400 ppm, T<sub>9</sub> = CCC 600 ppm and T<sub>10</sub> Control. The result of the study revealed that maximum plant height (30.96, 44.40, 54.06 and 67.01 cm at 30, 60, 90 and 120 DAT respectively), number of branches per plant (8.96, 13.43, 18.00 and 23.53 at 30, 60, 90 and 120 DAT respectively), plant spread (19.50, 30.96, 40.10 and 54.73 cm at 30, 60, 90 and 120 DAT respectively), flowers per plant (400.20), fruits per plant (144.33), fruit length (9.63 cm), breadth of fruit (1.93 cm), yield per plant (399.43 g), yield per plot (98.74 kg/plot), yield per hectare (134.53 q/ha), ascorbic Acid (190.76 mg/100g), capsaicin (0.38%), capsanthin content (296.109 ASTA Unit), Oleoresin content (11.57%) and minimum days required to 50% flowering (41.68 DAT), were recorded in treatment T<sub>3</sub> - NAA (75 ppm). Therefore, it is recommended to employ the NAA 75 ppm to chilli growing farmers to enhance growth and maximize yield.

Keywords: Chilli, plant growth regulator, NAA, GA<sub>3</sub> and CCC.

### **INTRODUCTION**

Chilli (*Capsicum annuum* L.) is an important vegetable cum spice crop grown in almost all parts of tropical and subtropical regions of the world. It belongs to the family Solanaceae and originated from South America or Mexico. Where, it was domesticated around 7000 BC. The genus *Capsicum* includes 30 species, five of which are cultivated: *Capsicum annuum* L., *C. frutescens* L., *C. chinense* J., *C. pubescens* R. and *C. baccatum* L. (Patelet al. 2016). Despite being planted across the nation in a variety of agro-climatic zones, dry chilli is primarily grown in southern states. It is produced in large quantities throughout the nation, both under rainfed and irrigated conditions, on an area of 377 thousand hectares (NHB, Final Estimate 2018-19). The majority of the world's export of chillies comes from India. India exports chilli in the form of dry pods, chilli powder, and oleoresins to the USA, UK, Russia, Canada, Italy, Netherlands, Singapore, Saudi Arabia, UAE, and Germany. Major chilli producing states are Andhra Pradesh, Karnataka, Maharashtra, Odisha, Rajasthan, Tamil Nadu, and Madhya Pradesh.

The pungency of the chilli fruits is due to the presence of capsaicin content. The size of fruit ranges between 1 to 20 cm and has a variety of shapes, including thin, long, conical, and blocky with thick flesh. The majority of the cultivars grown in the nation have strong to mildly strong flavours. Chilli is employed in the food and beverage industries in the form of oleoresin, which allows for improved flavour and colour distribution in food. The vitamins C, B and K are abundant in green chillies. It is frequently used in the preparation of sauces, soups, pickles, curry paste, and curry powder. No other spice has possibly gained as much popularity or has become as essential to the everyday diet of the majority of people in the globe as the chilli. Chaudhary *et al.*, (2006).

After fertilizers, insecticides, and herbicides, plant growth regulators are called next generation agro-chemicals since they help achieve this. Plant growth regulators may be able to boost vegetable productivity. Premature bloom and fruit drop in chilli is a major issue in hot regions like Vidarbha. One of the main production bottlenecks for chillies is poor fruit set caused by hormonal imbalance brought on by a fast increase in atmospheric temperature, which has a direct impact on yield, (Vijayaraghavan, H., and Tamilselvi, C. 2014).

Moreover, PGRs have been shown to mitigate the effects of biotic and abiotic stresses in chilli plants. For example, salicylic acid and abscisic acid are involved in enhancing resistance to drought and pathogen attacks by modulating the plant's stress response mechanisms (Rao *et al.*, 2021; Singh *et al.*, 2022). The strategic application of these regulators can lead to improved stress resilience and yield stability, particularly in regions prone to climatic variability.

The growth regulators NAA, GA<sub>3</sub>, and CCC all have positive effects on various crops. There is a dearth of knowledge regarding the effects of CCC, NAA, and GA<sub>3</sub> on chilli in Vidarbha. Hence, the suggested experiment was designed to examine the impact of NAA, GA<sub>3</sub>, and CCC on chilli plant growth, yield, and quality enhancement, (Pandita *et al.*, 1980).

## **MATERIALS AND METHODS**

The trial was performed during *Rabi* season of 2022-23 at experimental farm department of Horticulture, Palli Shiksha Bhavana Visva Bharati West Bengal, The experiment's was laid out in randomised block design (RBD) with three replications and ten treatment combinations *viz.* T<sub>1</sub>= NAA 25 ppm, T<sub>2</sub> = NAA 50 ppm, T<sub>3</sub>= NAA 75 ppm, T<sub>4</sub>= GA<sub>3</sub> 5 ppm, T<sub>5</sub> = GA<sub>3</sub> 15 ppm, T<sub>6</sub> = GA<sub>3</sub> 30 ppm, T<sub>7</sub>= (CCC 200 ppm), T<sub>8</sub>= CCC 400 ppm, T<sub>9</sub> = (CCC 600 ppm), and T<sub>10</sub>= Control. The treatments were applied foliar at 30 DAT, 60 DAT, and 90 DAT. The crop

was raised at the spacing of 60×30 cm in plot size of 2 ×1.75m. Standard culture practices recommended for chilli were followed uniformly in all experimental plots.

The following parameters were observed

### **Growth and yield parameters**

Plant height, Numberofbranchesperplant, Plantspreads (cm), Plantspreads (cm), Flowers per plant, Fruits per plant, Lengthof fruit (cm), Breadth of red fruit Yield per plant (kg), Yield per plot(kg/ plot), Yield perhectare(q/ha).

**Quality Parameters**-Ascorbic Acid (mg/100g), capsaicin (%),capsanthin content(ASTA Unit) and oleoresin (%).

### **Statistical Analysis-**

Experimental data was subjected to biometrical analysis as per the standard as procedure given by Gomez and Gomez (1984).

## **RESULTS AND DISCUSSION**

### **A. Growth parameters**

The plant height was measured at 30, 60, 90, and 120 days after transplanting. Application of plant growth regulators were found statistically significant at 30 DAT 60 DAT, 90 and 120 DAT. Treatment T<sub>3</sub> (NAA at 75 ppm) produced the highest plant height (30.96, 44.40, 54.06 and 67.01cm at 30,60, 90 and 120 DAT respectively.), followed by treatment T<sub>6</sub> (GA<sub>3</sub> at 15 ppm), (25.83, 37.73, 51.26and 56.96cm at 30,60, 90 and 120 DAT respectively), and the lowest plant height (24.73, 28.53, 42.00, and 48.53cm at 30,60, 90 and 120 DAT respectively) was recorded in treatment T<sub>9</sub> (CCC at 600 ppm). These findings are similar to Anolisaet *al.*, 2020., Table 1and Fig 1.

A significant difference was recorded in number of branches with the application of various plant growth regulatorsat 30, 60, 90 and 120 DAT.maximum number of branches(8.96, 13.43, 18.00 and 23.53 at 30, 60, 90 and 120 DAT respectively)in T<sub>3</sub> (NAA at 75ppm)followed by treatment T<sub>6</sub> (GA<sub>3</sub> (30 ppm), (7.33, 11.13, 12.30 and 21.96 at 30, 60, 90 and 120 DAT respectively.)Lowest number of branches in T<sub>10</sub> (control) 6.86, 10.86, 15.53, 19.20 at 30, 60, 90 and 120 DAT respectively).

The spread of plant was recorded at 30, 60, 90 and 120 DAT, and showedsignificantdifferencesduetoapplicationof theplantgrowthregulators. Maximum plantspread(19.50, 30.96, 40. 10 and 54.73 cmat 30, 60, 90 and 120 DAT respectively) wasfound intreatmentT<sub>3</sub>(NAAat75 ppm), which was found at par T<sub>6</sub>(17.85, 28.86, 32.83 and 50.30 cm at 30, 60, 90 and 120 DAT respectively)cm.whereas, minimum (9.76, 19.0, 28.30

and 37.73cm) in plant spread was recorded in application of treatment T<sub>10</sub> (Control). These results are in line with the findings of Kalshyama *et al.*, (2011) and Chandini *et al.*, (2016) in chilli.

Significantly the minimum days (39.06) were required to 50% flowering in chilli plant was recorded in the treatment T<sub>3</sub> (NAA 75 ppm), followed by 40.43 with treatment T<sub>1</sub> (NAA 25 ppm). Whereas, the maximum 43.90 days were required to 50% flowering was recorded due to application of treatment T<sub>7</sub> (NAA 75 ppm). Similar results were also reported by Singh and Mukherjee (2000) in chilli, (Table 1.)

### **Yield and yield attributes.**

Significantly the maximum number of flowers 400.20 per plant in chilli was recorded in the treatment T<sub>3</sub> (NAA 75 ppm), and followed by 390.96 treatment T<sub>5</sub> (GA<sub>3</sub> 15 ppm). However, the minimum 261.66 number of flowers per plant was recorded with treatment T<sub>10</sub> (Control).

Analysis of number of fruits per plant data have been shown in Table 2. Significantly the maximum 144.53 number of fruits per plant in chilli crop was recorded in the treatment T<sub>3</sub> (NAA 75 ppm), and followed by 129.20 with treatment T<sub>4</sub> (GA<sub>3</sub> 5 ppm), and the minimum 111.66 number of fruits per plant was observed in treatment T<sub>10</sub> (Control). Application of Naphthalene Acetic Acid at 50 ppm concentration and also the GA<sub>3</sub> at 30 ppm recorded significantly maximum number of fruits per plant. Similar results were also reported by Singh and Mukherjee (2000) in chilli

The data in respect of length of fruit indicated significant differences in respect of length of chilli fruit. The data from Table 2 clearly depicted that, significantly the maximum fruit length 9.63 cm length of fruit was obtained in the treatment T<sub>3</sub> and minimum 6.63 cm length of chilli fruit was recorded in treatment T<sub>10</sub> (Control).

The data from Table 2 clearly indicated that, significantly the maximum 1.93 cm breadth of fruit was recorded in the treatment T<sub>3</sub> (NAA 75 ppm), and minimum 1.13 cm breadth of chilli fruit was recorded in treatment T<sub>10</sub> (Control).

The information in table 2 showed that the treatment T<sub>3</sub> (NAA at 75 ppm) produced the significantly highest yield per plant (399.43 g), yield per plot (9.74 kg), and yield per hectare (134.53 q) in the chilli crop. However, it was noted that treatment T<sub>10</sub> (Control) produced the lowest yield of chilli fruit per plant (399.43 g), yield per plot (9.47 kg), and yield per hectare (134.53 q). This might be because NAA might be responsible for increasing photosynthetic

activities within the plant, which may have led to more production of carbohydrates and related products, which are responsible for the increase in growth. These findings concur with those of Sultana *et al.*,(2006) studied in chilli.

### **Quality Parameters**

Among the quality parameters, maximum ascorbic acid(190.76mg/100gm),capsaicin (0.38%), capsanthin (296.10 ASTA unit), and oleoresin (11.57%) were reported with the application of T<sub>3</sub>- NAA (75 ppm) followed by T<sub>6</sub>- GA3(30 ppm), (ascorbic acid 175.65 mg/100gm, capsaicin 0.31 %, capsanthin content 250.50 ASTA unit, oleoresin 10.21%)and T<sub>9</sub>- CCC (600 ppm) (ascorbic acid 160.74 mg/100gm, capsaicin 0.30 %, capsanthin content 213.94 ASTA unit,oleoresin 9.85 %). Whereas these all-qualitative parameters were minimum in T<sub>10</sub> (ascorbic acid 110.22 mg/100gm, capsaicin 0.25 %, capsanthin content 201.16 ASTA unit and oleoresin 7.75 %), (Table 2.)

UNDER PEER REVIEW

**Table1. Effect of plant growth regulators on growth parameters**

Treatments	Plantheight (cm)				Numberofbranchesperplant				Plantspread(cm)				Days required to 50%flowering
	30 DAT	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT	
T <sub>1</sub> - NAA (25 ppm)	24.96	37.63	50.66	63.20	6.10	10.53	15.87	19.33	15.86	27.20	36.20	39.96	40.43
T <sub>2</sub> - NAA (50 ppm)	25.30	37.10	49.10	59.53	6.00	10.53	14.20	16.76	16.06	25.63	31.33	49.10	42.86
T <sub>3</sub> - NAA (75 ppm)	30.96	44.40	54.06	67.10	8.96	13.43	18.00	23.53	19.50	30.96	40.10	54.73	39.06
T <sub>4</sub> - GA <sub>3</sub> (5 ppm)	24.96	37.76	47.96	58.30	5.66	9.50	12.10	16.20	16.33	26.20	34.20	49.40	41.68
T <sub>5</sub> - GA <sub>3</sub> (15ppm)	25.43	38.33	50.26	61.53	6.66	9.43	14.53	19.10	13.10	26.63	35.20	52.20	43.50
T <sub>6</sub> - GA <sub>3</sub> (30ppm)	25.83	37.73	51.26	56.96	7.33	11.13	12.30	21.96	17.85	28.86	32.83	50.30	42.53
T <sub>7</sub> - CCC(200ppm)	27.33	34.20	47.96	52.10	6.01	9.35	13.50	18.09	12.56	20.45	28.56	43.01	43.90
T <sub>8</sub> - CCC(400ppm)	19.66	30.96	45.76	50.30	6.10	9.65	14.00	22.43	13.00	21.30	30.86	45.53	42.36
T <sub>9</sub> - CCC (600ppm)	24.73	28.53	42.00	48.53	6.86	10.63	15.53	19.20	13.63	22.20	32.86	46.63	42.38
T <sub>10</sub> - Control	17.83	30.96	47.20	54.33	5.86	8.40	12.53	15.06	9.76	19.00	28.30	37.73	40.63
<b>CV%</b>	<b>3.30</b>	<b>3.60</b>	<b>3.70</b>	<b>4.67</b>	<b>5.50</b>	<b>2.74</b>	<b>3.18</b>	<b>4.94</b>	<b>2.78</b>	<b>6.09</b>	<b>4.98</b>	<b>3.76</b>	<b>2.09</b>
<b>CD%</b>	<b>1.40</b>	<b>2.12</b>	<b>1.40</b>	<b>2.15</b>	<b>2.90</b>	<b>1.90</b>	<b>1.67</b>	<b>2.52</b>	<b>0.87</b>	<b>3.15</b>	<b>2.87</b>	<b>2.20</b>	<b>2.53</b>

**Table 2. Effect of plant growth regulators on yield and quality parameters**

Treatments	Yield							Quality			
	Flowers per plant	Fruits per plant	Length of fruit (cm)	Breadth of fruit	Yield per plant (g)	Yield per plot (kg/plot)	Yield per hectare (q/ha)	Ascorbic Acid (mg/100g)	Capsaicin (%)	Capsanthin Content (ASTA Unit)	Oleoresin (%)
T <sub>1</sub> - NAA (25 ppm)	318.16	126.46	8.06	1.30	380.6	8.55	126.16	186.98	0.37	285.01	10.10
T <sub>2</sub> - NAA (50 ppm)	333.86	126.56	7.86	1.63	359.61	7.35	129.48	189.98	0.37	290.28	10.76
T <sub>3</sub> - NAA (75 ppm)	400.20	144.53	9.63	1.93	399.43	9.74	134.53	190.76	0.38	296.10	11.57
T <sub>4</sub> - GA <sub>3</sub> (5 ppm)	324.20	129.20	8.03	1.30	376.21	7.96	120.68	170.80	0.28	241.91	9.43
T <sub>5</sub> - GA <sub>3</sub> (15ppm)	390.96	127.81	8.33	1.36	369.68	6.26	125.65	172.60	0.29	247.98	9.96
T <sub>6</sub> - GA <sub>3</sub> (30ppm)	351.73	128.96	8.40	1.56	390.61	8.71	117.48	175.65	0.31	250.50	10.21
T <sub>7</sub> - CCC(200ppm)	281.40	121.76	7.43	1.23	350.58	6.50	107.23	165.74	0.27	218.67	8.75
T <sub>8</sub> - CCC(400ppm)	297.96	124.30	8.43	1.60	363.85	8.11	120.30	158.90	0.28	222.82	8.17
T <sub>9</sub> - CCC (600ppm)	329.83	129.03	8.20	1.36	375.51	7.43	116.36	160.74	0.30	213.94	9.85
T <sub>10</sub> - Control	261.66	111.66	6.63	1.13	330.58	6.25	100.88	110.22	0.25	201.16	7.75
<b>CV%</b>	<b>5.91</b>	<b>4.20</b>	<b>3.05</b>	<b>1.09</b>	<b>2.43</b>	<b>2.09</b>	<b>3.61</b>	<b>4.09</b>	<b>3.54</b>	<b>3.14</b>	<b>2.94</b>
<b>CD @5%</b>	<b>3.09</b>	<b>2.56</b>	<b>1.48</b>	<b>0.87</b>	<b>1.65</b>	<b>2.45</b>	<b>2.43</b>	<b>2.65</b>	<b>1.28</b>	<b>1.39</b>	<b>1.10</b>

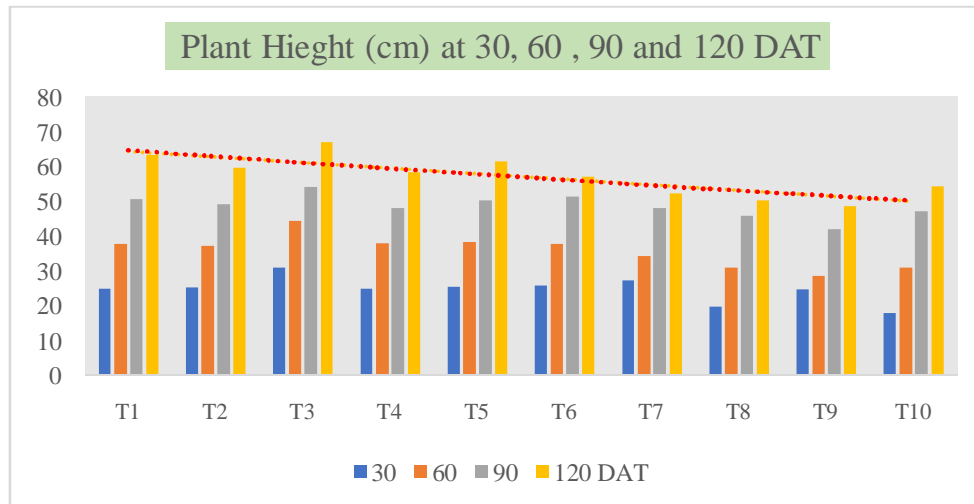


Fig. 1.: Plant Height (cm) at 30, 60, 90 and 120 DAT

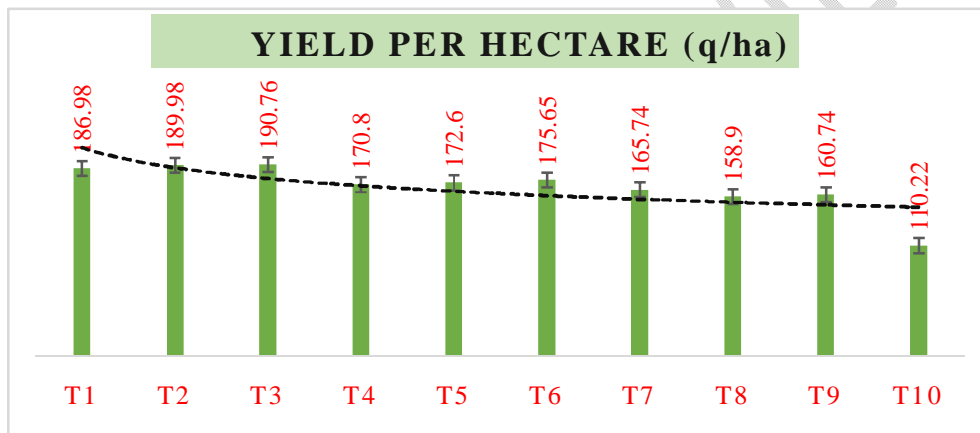


Fig 2.: Yield per hectare (q/ha)

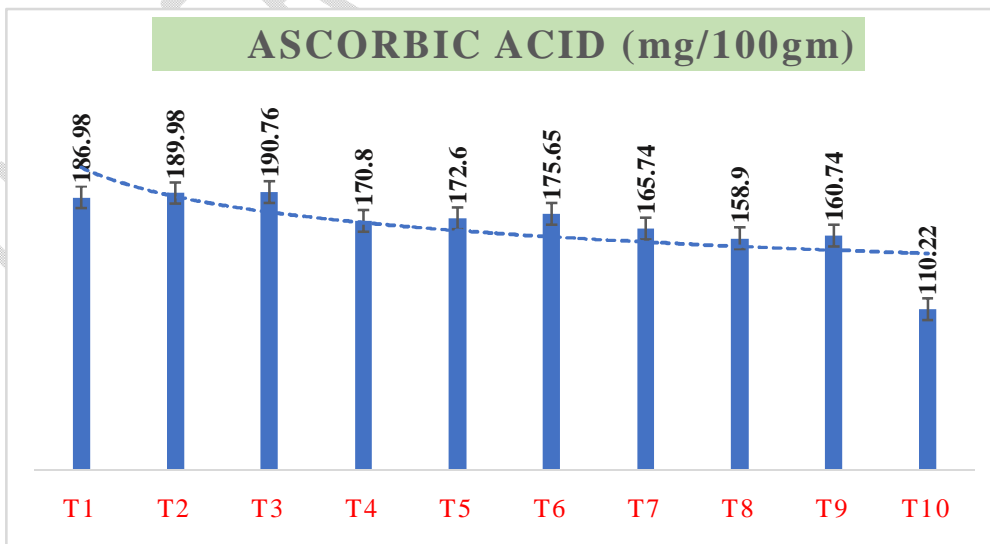


Fig 3.: Yield per hectare (q/ha)

## CONCLUSION

Based on this study, it can be concluded that application of plant growth regulators significantly influenced the growth, yield, and quality parameters of chilli plants. Treatment T<sub>3</sub> (NAA at 75 ppm) consistently produced the highest plant height, number of branches, plant spread, number of flowers, and number of fruits per plant across all measured intervals. Additionally, T<sub>3</sub> resulted in the shortest time to 50% flowering. This treatment also achieved the highest fruit length, breadth, and yield per plant, per plot, and per hectare. Based on the results of this study, we recommend that chili growers use T<sub>3</sub> (NAA at 75 ppm) to improve growth, yield, and quality.

### Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc have been used during writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

- 1.
- 2.
- 3.

## REFERENCES

- Anolisa, M., Al-Imran, R. H., ATM, R. I., & Subroto, K. D. (2020). Effect of plant growth regulators on growth and yield of chili (*Capsicum annuum* L.). *Journal of Phytology*, 12, 117-120.
- Chaudhary, B. R., M. D. Sharma, S. M. Shakya and D. M. Gautam. (2006). Effect of plant growth regulators on growth, yield and quality of chilli (*Capsicum annuum* L.). *J. of Agril. Res.* 27:65-68.
- Chandini, A.R., K. Holebasappa, J.K. Hore and N. Chattopadhyay. (2016). Growth and yield of chilli (*Capsicum annuum*) as influenced by different growth regulators. *J. of Agril. Res.* 11(1):385-388.

Gomez, K.A. and Gomez, A.A. (1984) Statistical Procedures for Agricultural Research . 2<sup>nd</sup> Edition, John Wiley and Sons , New York , 680p.

Indian Horticulture Database. NHB. www.nhb.gov.in. 2019-20 Final estimate

Kalshyam, M.K., J. Kumar, B. Mohan, J.P. Singh, N. Ram and Rajbeer. (2011). Effect of plant growth hormone and fertilizer on growth and yield parameters in chilli (*Capsicum annum* L.) cv. Pusa Jwala. *J. of Agril Res.* 6(2):316-318.

Patel, V.P., E. Pall and S. John. (2016). Comparative study of the effect of plant growth regulators on growth, yield and physiological attributes of chilli (*Capsicum annum* L.) cv. Kashi Anmol. *Int J. of Farm Sci.* 6(1):199-204.

Pandita, M.L., S.C. Pandey, J.L. Mangal and G.P. Singh. 1980. Effect of various concentrations of planofix as foliar spray on plant growth and fruit yield of chillies. *Haryana J. Hort. Sci.* 9:170-174.

Rao, V., Kumar, S., & Reddy, M. (2021). Salicylic acid and its role in enhancing stress resistance in plants. *Plant Science Today*, 8(2), 102-110.

Singh, L. and S. Mukherjee. (2000). Effect of foliar application of urea and NAA on yield and yield attributes of chili. *J. of Agril. Sci.* 20 (2):116-117.

Singh, R., Bhattacharya, S., & Kaur, N. (2022). Abscisic acid and its role in drought tolerance in *Capsicum annum*. *Journal of Plant Physiology*, 259, 151-160.

Sultana, W., Q.A. Fattah and M.S. Islam. (2006). Yield and seed quality of chilli (*Capsicum annum* L.) as affected by different growth regulators. *Bangladesh J. of Biotechnology Res.* 35(2):195-197.

Vijayaraghavan, H. (2014). Impact of plant growth regulators and formulations on growth of chilli (*Capsicum annum* L.). *Plant Gene and Trait*, 5(8).

Tamilselvi, C and H. Vijayaraghavan. 2014. Impact of plant growth regulators and formulations on growth of chilli (*Capsicum annum* L.), *Plant Gene and Trait*. 5: 1-3.