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Effect of plant growth regulators on growth, yield and quality of chilli (*Capsicum annuum* L.)

Babu Lal Naga, Deepanshu, Devi Singh and Vijay Bahadur

Abstract

The experiment entitled "Effect of Plant Growth Regulators on Growth, Yield and Quality of Chilli (*Capsicum annuum* L.)" was conducted at Department of Horticulture, Naini Agricultural Institute, SHUATS, Prayagraj during September to January, 2021-22. Experiment was laid out in Randomized Block Design with three replications and thirteen treatment combinations. The results revealed that among the variety studied, variety TMPH-443 resulted better in vegetative growth (Plant height, leaf area, Number of branches per plant, yield parameter Minimum days taken for 50 percent flowering, minimum days to first harvest, length of fruit, fruit girth, weight of fruit, number of chilli fruit per plant, average fruit yield per plant, fruit yield per hectare and quality parameters (total soluble solids). Among different concentrations of growth regulator application T_{11}: GA3 (10 ppm) gave better result in vegetative growth (Plant height, Number of branches per plan, leaf area). yield parameters (Minimum days taken for 50 percent flowering, minimum days to first harvest, length of fruit, fruit girth, weight of fruit, number of chilli fruit per plant, average fruit yield per plant, fruit yield per hectare) and quality parameters (total soluble solids).

Keywords: Chilli, GA3, NAA, triacontanol, RBD

Introduction

Chilli (*Capsicum annuum* L.) is an important vegetable cum spice crop belongs to the family Solanaceae. It is an annual herb, profusely branching bushy plant. It is a rich source of vitamin C. Most of Indian Chilli belongs to the genus Capsicum. India one of the largest producer, consumer and exporter of Chilli in the world, because of favourable soil and climatic conditions prevailing for Chilli production (Anonymous, 2021) [1].

Mexico is said to be the primary centre of origin of chilli with secondary centre in Guatemala and Bulgaria (Salvador, 2002) [18]. It was introduced in Europe by Columbia in 15th century and spread to rest of the globe along the species trading routes to Africa, India, China and Japan. It was introduced in India from Brazil during 1584 by the Portuguese (Thamburaj and Singh, 2003) [23]. There are estimated 1,600 different varieties of pepper throughout the world with five domesticated species including *Capsicum annum* L., *Capsicum frutescens* L., *Capsicum chinense* L., *Capsicum baccatum* L. and *Capsicum pubescens* L. (Bosland and Votava, 2000) [4]. In India, only two species *viz*., *Capsicum annum* L. and *Capsicum frutescence* L. are well known and most of the cultivated varieties belong to *Capsicum annum*. This cultivated species has its unique place in the diet as a vegetable cum spice crop (Gadaginmanth, 1992) [9].

Chilli occupies an area, production and productivity were estimated to be 4.11 lakh hectare, 43.63 lakh tonnes and 10.6 t/ha respectively during 2020-21 in India. However, in Uttar Pradesh chilli is cultivated in 30.84 thousand hectares of area with total annual production of 75.35 thousand tonnes and productivity is 2.44 t/ha of green chilli (Anonymous, 2020-21) [1]. India is the 9 world largest producer, consumer and exporter of chilli.

2,4-Dichlorophenoxyacetic acid (2,4-D) is an 'auxin mimic' or synthetic auxin. This type of herbicide kills the target weed by mimicking the plant growth hormone auxin (indole acetic acid), and when administered at effective doses, causes uncontrolled and disorganized plant growth that leads to plant death.

The growth promoters like naphthalic acetic acid (NAA) enhance the source-sink relationship and hormone modified translocation of photosynthates, which will help in better retention of flowers and fruits and seed filling at the later stages of crop growth. (Pandita *et al*., 1980, and Lata and Singh, 1993) [15]. NAA is a synthetic plant hormone in the auxin family and is an ingredient in many commercial plant rooting horticulture products, it is a rooting agent and used for the vegetative propagation of plants from stem and leaf cutting. Triacontanol is a compound that increases photosynthesis, plant growth, and reproduction. triacontanol (TRIA) is a natural plant growth regulator found in epicuticular waxes. Expectedly, TRIA enhances the physiological efficiency of the cells and, thus, exploits the genetic potential of plant to a large extent. (Hariharan and Unnikrishnan, 1983) [10].

Gibberellic acid (GA3) is a phytohormone that is needed in small quantities at low concentration to accelerate plant growth and development. They are produced in the plant cell's plastids or the double membrane-bound organelles responsible for making food and are eventually transferred to the endoplasmic reticulum of the cell, where they are modified and prepared for use.

Materials and Methods

The experiment was carried out at the department of research field, department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U. P.) during September - February (2021-22), which was situated in the agro climatic zone (sub-tropical belt) of Uttar Pradesh. Prayagraj is located in the south-east part of Uttar Pradesh India. Prayagraj falls under agro-climate zone IV which is named as “middle Gangetic plains” the site of experiment is located at 98 meters from sea level at 25.57º N latitude 81.51º E longitude has a typical subtropical climate with extremes of summer and winter. The maximum temperature of the location reaches up to 46ºC - 48ºC and seldom falls down as low as 4ºC-5ºC during winter the average rainfall in this area is around during winter season especially in the month of December and January the average rainfall in this area is around 1027 mm annually with maximum concentration during July to September with few showers and drizzles in winter also the treatment involving plant growth regulators *viz*. 2-4-D (2.5, 3.5 and 4.5 ppm), NAA (25, 35 and 45 ppm), Triacontanol (2, 4 and 6 ppm) and GA3 (25, 35 and 45 ppm) were imposed variety TMPH-433 at 30 DAT of chilli. The salient features of plant growth regulators used in the experiment. The experiment was laid out in Randomized block design with three replications. The experiment consists of thirteen treatments in which three treatments are 2-4-D, NAA, Triacontanol and three treatments are GA3. Seeds are sown at spacing of 60 cm x 45 cm each plot. The data collected during the course of investigation were subjected to statistical analysis by adopting appropriate method of analysis of variance as described by Fisher (1950).

Results and Discussion

A. Growth parameters

1. Plant height for 30, 45, 60 DAT and at harvest (cm)

Analysis of plant height data shows the significant results. Increase in plant height of chilli was observed in treatment T_{11} (GA3 at 10 ppm) might be due to the fact that, GA3 acts as growth promoter which, increases photosynthetic activities, efficient translocation and utilization of photo synthetics which might be causing rapid cell division in growth portion of the plant or stimulation of growth, besides increase the nutrient and uptake of nutrient thereby resulted is plant height increase. The results are in conformity with the findings of Chaudhary *et al.*, (2006) [6] and Kalshyam *et al.*, (2011) [11] in chilli.

2. Leaf area (cm^2)

Analysis of leaf area data shows the significant results. The leaf area was recorded maximum in T_{11}, GA3 10 ppm (29.75 cm^2) which was statistically at par with T_2, 2,4-D 3.5 ppm (29.65 cm^2) and followed by T_8, Triacontanol 4 ppm (28.25 cm^2) and the minimum leaf area was recorded in T_0, control (25.10 cm^2).

There were increase in the leaf area of chilli crop due to application of GA3 at 10 ppm in the present investigation. Thus, might be due to the fact that, increased photosynthetic metabolic activities and dry matter content in plant was increased due to application of GA3 as compared to other plant growth regulators. The increase in the subsequent increase in plant spread. These results are in line with the findings of Singh and Singh (2019) [21] and Chandini *et al.*, (2016) [5] in chilli.

3. Leaf Area Index (cm)

Analysis of leaf area index data shows the significant results. The leaf area index was recorded maximum in T_{11}, GA3 10 ppm (6.87) which was statistically at par with T_2, 2,4-D 3.5 ppm (6.81) and followed by T_4, NAA 25 ppm (6.55) and the minimum leaf area index was recorded in T_0, control (4.31).

Application of GA3 caused significant increase in leaf area index and was higher than the other growth regulators. There were increase in the leaf area of chilli crop due to application of GA3 at 10 ppm in the present investigation. The increase in the subsequent increase in plant spread. These results are in line with the findings of Singh and Singh (2019) [21] and Chandini *et al.*, (2016) [5] in chilli.

Table 1: Effect of plant growth regulators on plant height (cm) and leaf area (cm^2) of chilli.

Treatments	Plant Height (cm)				Leaf Area (cm^2)	Leaf Area Index (cm)
	30 DAT	60 DAT	90 DAT	At harvest time		
T0- Control	18.34	27.80	38.20	42.30	25.10	4.31
T_1- 2,4-D 2.5ppm spray	25.25	35.00	48.81	57.87	28.10	5.87
T_2- 2,4-D 3.5ppm spray	27.20	40.77	51.37	60.97	29.65	6.81
T_3- 2,4-D 4.5ppm spray	25.80	33.40	44.87	51.93	28.15	6.05
T_4- NAA 25ppm spray	22.80	30.10	43.10	50.37	29.00	6.55
T_5- NAA 35ppm spray	21.50	33.73	43.60	50.80	29.30	6.63
T_6- NAA 45ppm spray	23.00	29.50	41.10	47.97	29.20	6.57
T_7- Triacontanol 2ppm spray	24.70	36.73	46.60	53.83	28.50	6.10
T_8- Triacontanol 4ppm spray	22.70	37.77	48.40	54.30	28.25	6.12
T_9- Triacontanol 6ppm spray	23.39	39.83	48.00	55.87	28.10	5.98
T_{10}- GA_3 8ppm spray	24.32	38.40	50.07	59.73	29.60	6.76
T_{11}- GA_3 10ppm spray	28.10	42.00	51.80	61.80	29.75	6.87
T_{12}- GA_3 12ppm spray	20.45	36.80	45.00	50.40	28.15	6.05

F-test	S	S	S	S	S	S
SE.d (±)	0.531	0.536	1.15	1.036	1.075	0.018
CD $_{0.005}$	1.10	1.57	2.39	2.15	1.09	0.23
C.V.	6.75	8.61	6.05	9.36	5.25	5.14

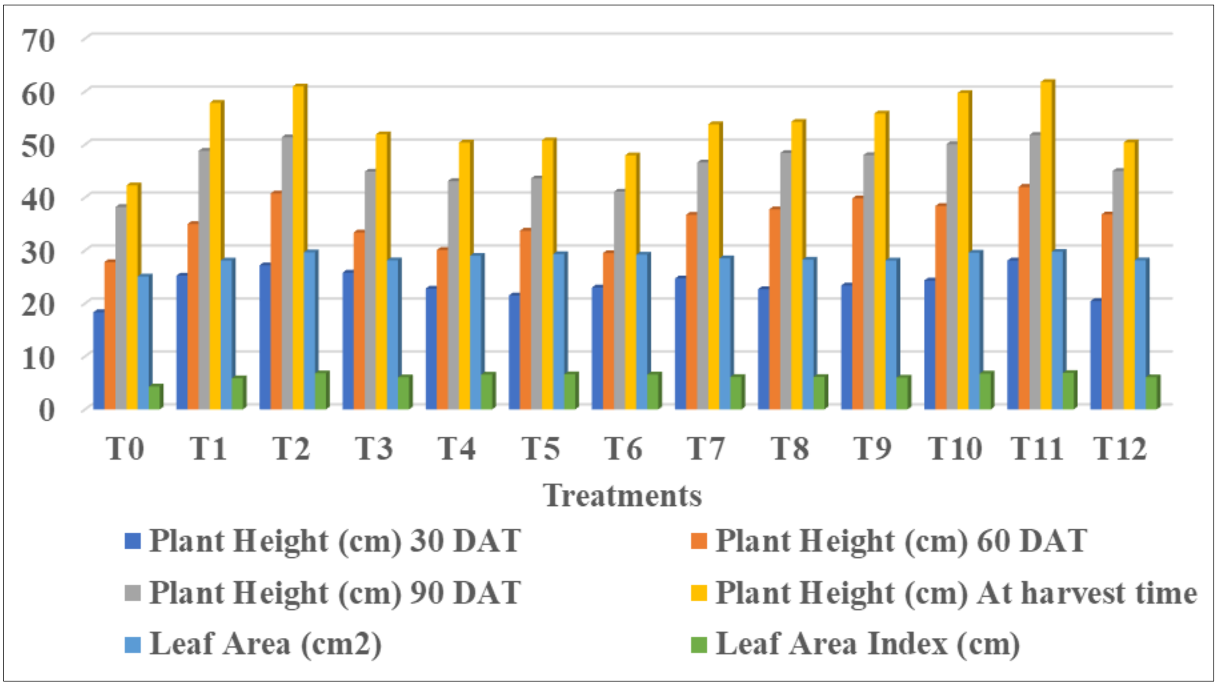

Fig 1: Effect of plant growth regulators on plant height (cm) and leaf area (cm^2) of chilli.

B. Yield parameters

1. Days to first harvest

Analysis of days to first harvest data shows the significant results. The days to first harvest was recorded minimum in T_{11}, GA3 10 ppm (80.50 days) which was statistically at par with T_{10}, GA3 8 ppm (85.67) and followed by T_2, 2,4 –D 3.5 ppm (81.70) and the maximum days to first harvest was recorded in T_0, control (98.33 days).

In the study involving GA3, early fruit harvesting was observed and it was earlier than the application of the other growth regulators. The higher concentration of GA3 had significantly enhanced the number of flowers per plant this might be due to increased production of flower primordial and the growth regulators contributed in regulating the physiological and biochemical process in plant in such a way photosynthetic got transmitted from vegetative parts towards the reproductive organs like flower, fruit which may produce early flowering and fruiting. These results are in conformity with the study of Choudhary *et al.*, (2013) [9], Bharti *et al.*, (2018) [3] and Singh *et al.*, (2019) [20], in chilli.

2. Days to 50% flowering

Analysis of days to 50% flowering data shows the significant results. The days to 50% flowering was recorded minimum in T_{11}, GA3 10 ppm (50.20 days) which was statistically at par with T10, GA3 8 ppm (52.50) and followed by T_4, NAA 25 ppm (52.10) and the maximum days to 50% flowering was recorded in T_0, control (56.43 days).

The minimum days to 50% flowering observed significantly in response to the application of GA3, more than the other growth regulators as well as the control, but was at a similar level to that of 2,4-D. These results are in conformity with the study of Choudhary *et al.*, (2013) [9], Raj *et al.*, (2015) [17] and Balaraj *et al.*, (2002) [2] in chilli.

3. Fruit length (cm)

Analysis of fruit length data shows the significant results. The days to fruit length was recorded maximum in T_{11}, GA3 10 ppm (9.50 cm) which was statistically at par with T_{10}, GA3 8 ppm (9.30 cm) and followed by T_3, 2,4-D 4.5 ppm (8.42 g) the minimum fruit length was recorded in T_0, control (7.70 cm).

The application of GA3 caused a significant increase in fruit length compared to other growth regulators and to the control. Fruit length may increase due to the increased supply of photosynthetic materials and its efficient mobilization in plants giving rise to increased stimulation of fruit growth ultimately resulting in increased fruit length and fruit diameter. These results are in conformity with the study of Choudhary *et al.*, (2013) [9], Raj *et al.*, (2015) [17] and Balaraj *et al.*, (2002) [2] in chilli.

4. Fruit weight (g)

Analysis of fruit weight data shows the significant results. The days to fruit weight was recorded maximum in T_{11}, GA3 10 ppm (4.00 g) which was statistically at par with T_2, 2,4-D 3.5 ppm (3.90 g) and followed by T_3, 2,4-D 2.5 ppm (3.65 g) and the minimum fruit weight was recorded in T_0, control (2.65 g).

There was increase in the fruit weight with an application of GA3 at 10 ppm as against rest of the treatments thus might be due to the probable reason that, GA3 might be responsible for increase in photosynthetic activities within the plant which might be resulted in more production of carbohydrates and related products responsible for increase in growth. fruit size, fruit weight of chilli, ultimately responsible for increased yield of chilli. These results are in agreement with the findings of Sultana *et al.*, (2006) [22] and Shankhwar *et al.*,

(2017) [19] in chilli.

5. Fruit girth (cm)

Analysis of fruit grith data shows the significant results. The fruit grith was recorded maximum in T_{11}, GA3 10 ppm (0.93 cm) which was statistically at par with T_8, Triacontanol 4 ppm spray (0.90 cm) and T_9, Triacontanol 6 ppm spray (0.90 cm) followed by T_7, Triacontanol 4 ppm, T_1, 2,4-D 2.5 ppm (0.89 cm and 0.89 cm) and the minimum fruit grith was recorded in T_0, control (0.79 cm).

A significant increase in fruit grith was caused as a result of the application of GA3, which was higher than any of the other growth regulators and control. The increase in fruit girth may be caused by an increased supply of photosynthetic materials and their efficient mobilization in plants, resulting in increased stimulation of fruit growth. but at par with 2,4-D. These results are in conformity with the study of Choudhary *et al*., (2013) [9], Raj *et al*., (2015) [17] and Balaraj *et al*., (2002) [2] in chilli.

6. No. of fruits/plant

Analysis of number of fruits per plant data shows the significant results. The number of fruits per plant was recorded maximum in T_{11}, GA3 10 ppm (140.67) which was statistically at par with T_{10}, GA3 8 ppm (136.00) and followed by T_9, Triacontanol 6 ppm spray (127.67) and the minimum number of fruits per plant was recorded in T_0, control (101.00).

The application of GA3 resulted in a significant increase in the number of fruits per plant and was higher than the other growth regulators and control but was at par with 2,4-D. The increased number of fruits per plant due to GA3 application is attributed to increased flowers and enhanced vegetative structure of plant which were physiologically more active to produce a greater number of fruits and also might be due to that GA3 facilitated better reproductive development of plant. This is supported with the similar findings of by Ouzounidou *et al*., (2010) [14] and Manna *et al*., (2012) [13] in chilli.

7. Average yield/plant (g)

Analysis of average yield per plant data shows the significant results. The average yield per plant was recorded maximum in T_{11}, GA3 10 ppm (562.68 g) which was statistically at par with T_2, 2,4-D 3.5 ppm (537.85 g) and followed by T_8, GA3 8 ppm (516.80) and the minimum average yield per plant was recorded in T_0, control (267.65 g). There was a significant increase in yield per plant when GA3 was applied, and the yield was higher than that of other growth regulators. The increase in yield due to GA3 application is attributed to the fact that the plant remained physiologically more active to build up sufficient food stocks for developing flowers, fruit and resulted in increased fruit set, which ultimately lead to higher yields. These results are in conformity with the study of Choudhary *et al*. (2013) [9], Raj *et al*., (2015) [17] and Balaraj *et al*., (2002) [2] in chilli.

8. Yield (ton /hectare)

Analysis of average yield per hectare data shows the significant results. The average yield per hectare was recorded maximum in T_{11}, GA3 10 ppm (127.88 q) which was statistically at par with T_2, 2,4-D 3.5 ppm (122.24 q) and followed by T_8, GA3 8 ppm (117.45) and the minimum average yield per hectare was recorded in T_0, control (60.83 q). As a result of the use of GA3, yields per hectare were significantly increased in comparison to the use of other growth regulators. There was increase in the yield per plant per plot and per hectare with an application of GA3 at 10 ppm as against rest of the treatments thus might be due to the probable reason that, GA3 might be responsible for increase in photosynthetic activities within the plant which might be resulted in more production of carbohydrates and related products responsible for increase in growth, fruit size, fruit weight of chilli, ultimately responsible for increased yield of chilli. These results are in agreement with the findings of Sultana *et al*., (2006) [22], Chaudhary *et al*., (2006) [6], Patel *et al*., (2016) [16] and Chandini *et al*., (2016) [5] in chilli.

Table 2: Effect of plant growth regulators on Days to first harvest, Days to 50% flowering, Fruit length (cm), Fruit weight (g), Fruit girth (cm), No. of fruits/plant and Yield (ton /hectare) of chilli.

Treatments	Days to first harvest	Days to 50% flowering	Fruit length (cm)	Fruit weight (g)	Fruit girth (cm)	No. of fruits/plant	Yield (ton /hectare)
T0- Control	98.33	56.43	7.70	2.65	0.79	101.00	267.65
T_1- 2,4-D 2.5ppm spray	90.00	51.10	8.70	3.65	0.89	112.32	409.97
T_2- 2,4-D 3.5ppm spray	81.70	50.90	9.43	3.90	0.91	137.91	537.85
T_3- 2,4-D 4.5ppm spray	85.67	51.50	8.42	3.40	0.87	125.00	425.00
T_4- NAA 25ppm spray	91.00	52.10	8.20	3.20	0.86	115.02	368.06
T_5- NAA 35ppm spray	90.83	51.20	8.35	3.35	0.87	121.79	408.00
T_6- NAA 45ppm spray	92.00	52.50	7.87	2.95	0.86	111.68	329.46
T_7- Triacontanol 2ppm spray	87.17	54.10	8.25	3.15	0.89	131.67	414.76
T_8- Triacontanol 4ppm spray	88.50	53.13	8.50	3.50	0.90	115.35	403.73
T_9- Triacontanol 6ppm spray	89.00	55.30	8.35	3.35	0.90	127.67	427.69
T_{10}- GA_3 8ppm spray	85.67	52.50	9.30	3.80	0.92	136.00	516.80
T_{11}- GA_3 10ppm spray	80.50	50.20	9.50	4.00	0.93	140.67	562.68
T_{12}- GA_3 12ppm spray	83.17	52.03	8.55	3.50	0.87	111.34	389.69
F-test	**S**	**S**	**S**	**S**	**S**	**S**	**S**
SE.d (±)	1.625	1.074	0.215	0.080	0.014	2.565	9.775
CD $_{0.005}$	3.38	2.229	0.447	0.167	0.029	5.326	20.294
C.V.	5.26	4.50	8.09	6.88	4.91	7.57	8.85

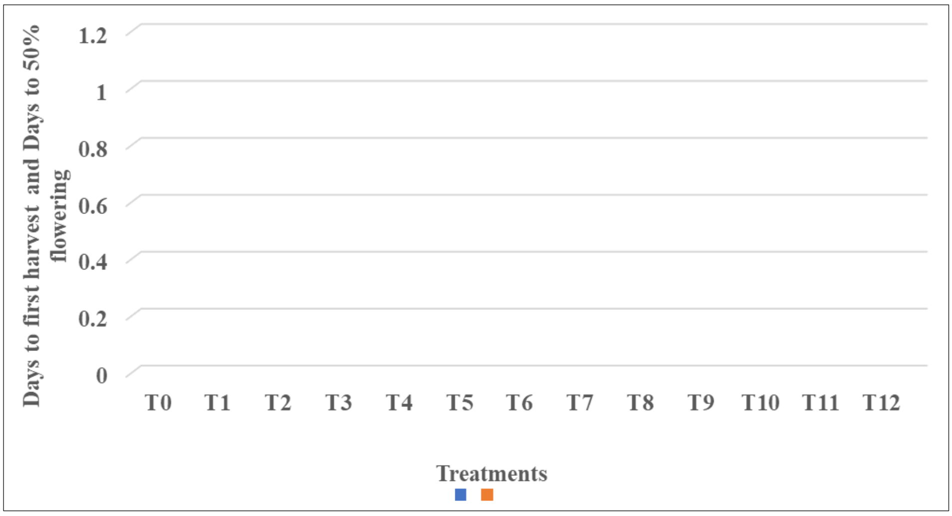

Fig 2: Effect of plant growth regulators on Days to first harvest and Days to 50% flowering of chilli.

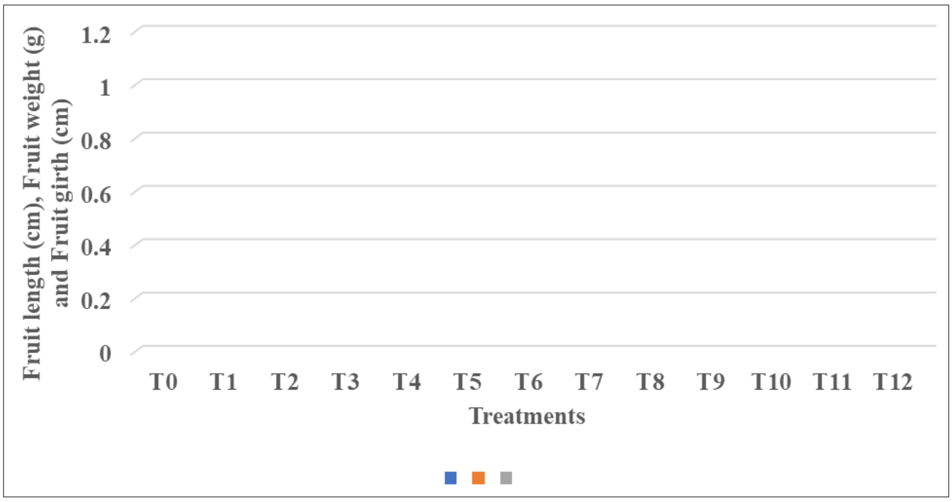

Fig 3: Effect of plant growth regulators on Fruit length (cm), Fruit weight (g) and Fruit girth (cm) of chilli.

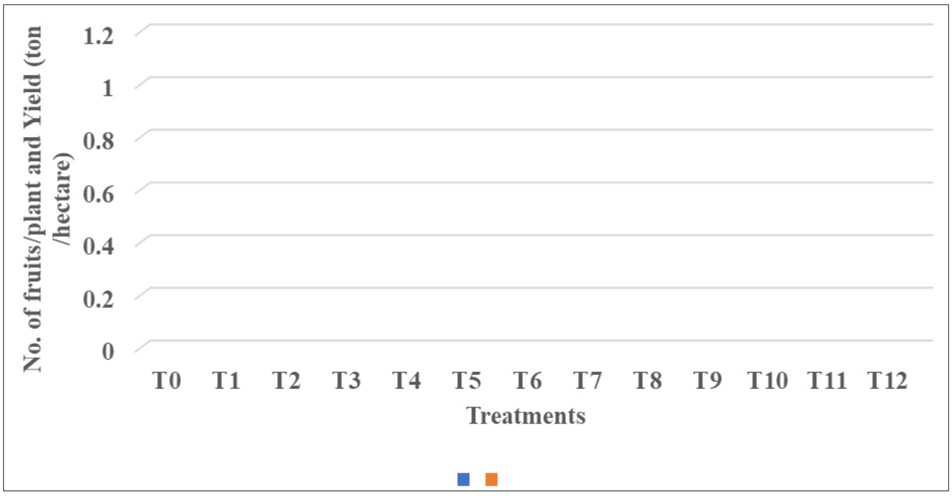

Fig 4: Effect of plant growth regulators on No. of fruits/plant and Yield (ton /hectare) of chilli.

C. Quality parameters

1. Total soluble solids (°Brix)

Analysis of total soluble solids data shows the significant results. The total soluble solids were recorded maximum in T_{11}, GA3 10 ppm (7.8°Brix) which was statistically at par with T_8, GA3 8 ppm (7.5) and followed by T_3, 2,4-D 4.5 ppm (7.3) and the minimum total soluble solids was recorded in T_0, control (6.1°Brix). The use of GA3 caused a significant increase in total soluble solids and was higher than the use of other growth regulators. These results are in agreement with the findings of **Chaudhary *et al.*, (2006)** [6] and **Patel *et al*. (2016)** in chilli.

Table 3: Effect of plant growth regulators on Total soluble solids (°Brix) of chilli.

Treatments	Total soluble solids (°Brix)
T0- Control	6.1
T_1- 2,4-D 2.5ppm spray	7.1
T_2- 2,4-D 3.5ppm spray	7.6
T_3- 2,4-D 4.5ppm spray	7.3
T_4- NAA 25ppm spray	6.4
T_5- NAA 35ppm spray	6.7
T_6- NAA 45ppm spray	6.9
T_7- Triacontanol 2ppm spray	7.1
T_8- Triacontanol 4ppm spray	7.3
T_9- Triacontanol 6ppm spray	7.2
T_{10}- GA_3 8ppm spray	7.5
T_{11}- GA_3 10ppm spray	7.8
T_{12}- GA_3 12ppm spray	7.2
F-test	**S**
SE.d (±)	0.152
CD $_{0.005}$	0.316
C.V.	2.63

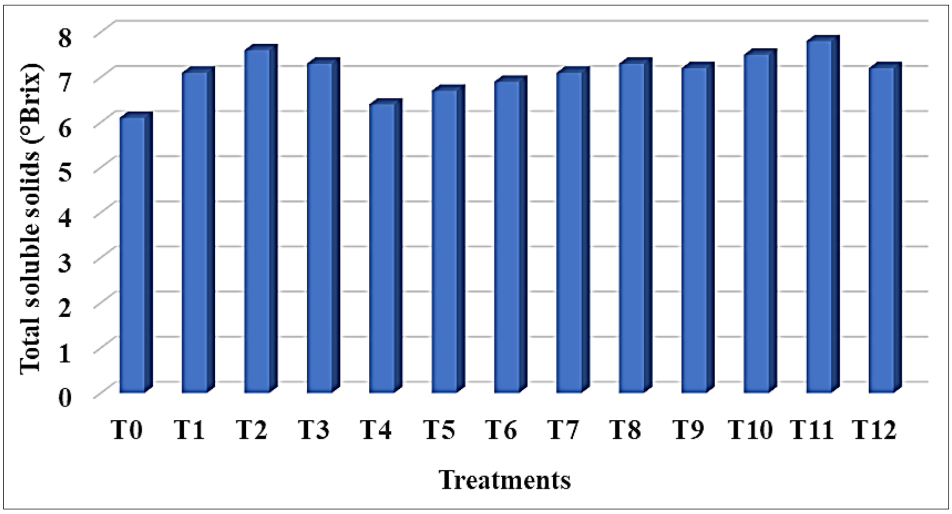

Fig 5: Effect of plant growth regulators on Total soluble solids (°Brix) of chilli.

Conclusion

Based on the results of the present investigation it is concluded that the treatment T_{11} *i.e.* application of 10 ppm gibberellin was found superior in terms of different growth attributes, *viz*., plant height, leaf area and leaf area index, different yield attributes, *viz*., days to 50% flowering, fruit weight, fruit length, fruit grith, number of fruit plant, days to first harvest, fruit yield per plant, fruit yield per hectare and quality attributes like total soluble solids.

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References

1. Anonymous. Horticulture statistics at a glance. Govt. Of India, Ministry of Agriculture and Farmers Welfare, Dept. Of Agriculture, Cooperation and Farmers Welfare, Horticulture Statistics Division; c2020-21.
2. Balraj R, Kurdikeri MB, Revanappa. Effect of growth regulators on growth and yield of chilli (*Capsicum annuum* L.) at different pickings. Indian Journal of Horticulture. 2002;59(1):84-88.
3. Bharti N, Kumar S, Lathiya JB, Chaudhary VK. Effect of exogenous application of plant growth regulators on quality and yield of bell pepper (*Capsicum annuum* L) under NVPH. International Journal of Farm Sciences. 2018;7(2):108-112.
4. Bosland PW, Votava EJ. Peppers: Vegetable and Spice Capsicums. Crop Production Science in Horticulture 12. CAB International Publishing, Wallingford, England, UK; c2000. p. 204.
5. Chandini AR, Holebasappa K, Hore JK, Chattopadyay N. Growth and yield of chilli (*Capsicum annuum*) as Influenced by different growth regulators. Journal of Agricultural Research. 2016;11(1):385-388.
6. Chaudhary BR, Sharma MD, Shakya SM, Gautam DM. Effect of plant growth regulators on growth, yield and quality of chilli (*Capsicum annuum* L.) at Rampur,

Chitwan. Journal of the Institute of Agriculture and Animal Science. 2006;27:65-68.
7. Choudhary MA, Nisha S, Pandey BR. Influence of bio-fertilizes and NAA on growth and yield of chilli (*Capsicum annuum* L.) cv. JM-283. Journal of Vegetable Science. 2013;38(1):101-103.
8. Fisher RA. Statistical methods and scientific induction. Journal of the royal statistical society series. 1955;17(1):69-78.
9. Gadaginmath NB. Studies related to genetics economic and quality traits and exploitation of heterosis in chilli (*Capsicum annuum* L.). Ph.D. Thesis, University of Agricultural Sciences, Dharwad; c1992.
10. Hariharan M, Unnikrishnan K. Enhancement of fruit size in *Capsicum annuum* by NAA treatment. Acta Botanica. 1983;11:161-163.
11. Kalshyam MK, Kumar Mohan BJ, Singh JP, Ram N, Rajbeer. Effect of plant growth hormone and fertilizer on growth and yield parameters in chilli (*Capsicum annum* L.) cv. Pusa Jwala. Journal of Agricultural Research. 2011;6(2):316-318.
12. Lata S, Singh RP. Effect of nitrogen level and growth regulators on growth, yield and quality of chilli (*Capsicum annuum* L.) var. Pant C-l. Journal of Vegetable Science. 1993;20(l):40-43.
13. Manna D, Sarkar A, Maity TK. Impact of biozyme on growth, yield and quality of chilli (*Capsicum annum L.*). Journal of Crop and Weed Sciences. 2012;8(1):40-43.
14. Ouzounidou G, Ilias I, Giannakouula N, Papadopoulou P. Comparative study on the effects of various plant growth regulators on growth, quality and physiology of chilli (*Capsicum annum* L). Journal of Agricultural Research. 2010;42(2):805-814.
15. Pandita ML, Pandey SC, Mangal JL, Singh GI. Effect of various concentrations of planofix as foliar spray on plant growth and fruit yield of chilli. Haryana. Journal of Horticulture. 1980;9(4):170-174.
16. Patel VP, Pall E, John S. Comparative study of the effect of plant growth regulators on growth, yield and physiological attributes of chilli (*Capsicum annum* L.) cv. Kashi Anmol. International Journal of Farm Science. 2016;6(1):199-204.
17. Raj AC, Holebasappa K, Hore J, Chattopadya N. Growth and yield of chilli (*Capsicum annuum* L.) as influenced by different growth regulators. An International Quarterly Journal of Life Sciences. 2015;11(1):385-388.
18. Salvador MH. Genetic resources of chilli (*Capsicum annuum* L.) in Mexico. Proceedings of the 16th International Pepper Conference., Tampico, Tamaulipas, Mexico; c2002 Nov. p. 10-12.
19. Shankhwar B, Nigam AK, Vasure N, Vishvakarma D. Effect of different plant growth regulators on growth of chilli (*Capsicum annuum* L.) cv. Pusa Jwala. Agriculture Update. 2017;12(5):1187-1189.
20. Singh J, Dwivedi AK, Devi P, Bajeli J, Tripathi A, Maurya KS. Effect of plant growth regulators on growth and yield attributes of tomato. International Journal of Current Microbiology and Applied Sciences. 2019;8(1):1635-1641.
21. Singh S, Singh T. Effect of gibberellic acid on growth, yield and quality parameters of chilli (*Capsicum annuum* L.), Journal of Pharmacognosy and Phytochemistry. 2019;8(2):2021-2023.
22. Sultana W, Fattah QA, Islam MS. Yield and seed quality of chilli (*Capsicum annum* L.) as affected by different growth regulators. Bangladesh Journal of Biotechnology Research. 2006;35(2):195-197.
23. Thamburaj S, Singh NA. Chapter written by Despande, A.A. Chilli and Capsicum. In Text book on Vegetable, Tuber Crops and Spices. Published by ICAR; c2003. p. 45- 70.