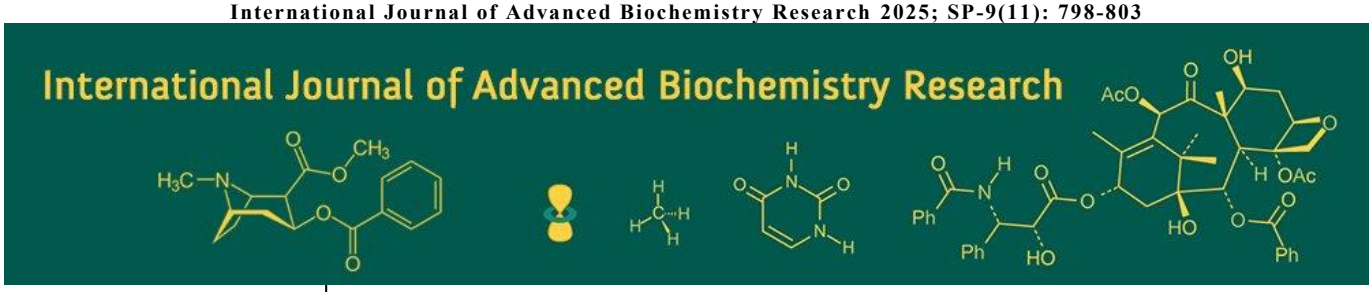

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Effect of plant growth regulator on growth, morphological characters and yield of ridge gourd (*Luffa acutangula*) cv. Arka Vikram under Chhattisgarh plains

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Abstract
The present study entitled "Effect of plant growth regulator on growth, morphological characters and yield of ridge gourd (*Luffa acutangula*) cv. Arka Vikram under Chhattisgarh plains'' was conducted during *Zaid* season 2024-25 at Research Cum Instructional Farm, Mohgaon, Saja, Bemetara (C.G.) under at College of Horticulture and Research Station Saja, Bemetara (C.G.). The field experiment was conducted in randomized block design with three replications and nine treatments consisting a control with one plant growth regulators *i.e.* GA_3@ 25, 50, 100, 150, 200, 250, 300 and 350 ppm, as foliar application at 2 to 4 leaf stage. The interpretations were recorded on various vegetative growth, yield parameter and economic. GA_3 350 ppm performed well vegetative character like maximum length of plant (356.67 cm), length of internode (12.22 cm) number of branches (12.36), minimum days to first male flower (32.45 days) and minimum days to first female flower (34.93 days) also found better in GA_3 350 ppm treated plant. In case of GA_3 350 ppm performed well in flowering parameter like minimum node of first male flower (5.20), node of first female flower (7.20) and 50% flowering in a net plot and gross plot area (46.20 days). Plant growth regulator GA_3 250 ppm gave significantly better performance at yield parameter like maximum number of fruits per plant (32.44), number of fruit per vine (9.21), first harvesting (39.87 days), fruit length (36.16 cm), fruit diameter (9.20 cm), average fruit weight (138.33 gm), fruit yield per plot (12.35) and fruit yield per ha (164.67 q). Also increased benefit cost ratio (2.08) was recorded in GA_3 250 ppm.

Keywords: Ridge gourd, plant growth regulators, growth parameter and yield parameter

Introduction
Vegetables play a very important role in daily human diet, since they are most important source of vitamins and minerals. They also supply carbohydrates for energy and proteinous compounds for muscle building. Out of the various vegetables grown in India cucurbits have a high place in diet as a rich and chief source of minerals, vitamins and carbohydrates. The Cucurbitaceae family consists of about 87 genera and 750 species. It includes a large number of important vegetables such as cucumber/ pumpkins, gourds etc., which are mostly tendril climbers in habits.

Ridge gourd (*Luffa acutangula*), commonly known as angled luffa or turai, belongs to the Cucurbitaceae family and is widely cultivated in tropical and subtropical regions, particularly Ridge gourd (*Luffa acutangula*), commonly known as angled luffa or turai, belongs to the Cucurbitaceae family. It is grown in both season summer and rainy. The name "Luff" or "Loofah" is an Arabic origin and mention to the spongy characteristic of the mature fruit particularly in Asia and Africa. *Turai* is cultivated in Bangladesh, China, Indonesia, Malaysia, Myanmar, Philippines, Srilanka and Taiwan and India is the second-largest producer of ridge gourd after China. (Shukla *et al*., 2023) [18].

In 2023, ridge gourd production in India was approximately 5.2 million metric tons, reflecting a steady increase from previous years. The crop was cultivated across 420 thousand hectares, with an average productivity of 12.38 tons per hectare (Anonymous, 2023) [1].

In Chhattisgarh, ridge gourd farming covered around 35.210 thousand hectares, yielding a total production of 435 thousand metric tons and an average productivity of 12.36 tons per hectare. Within Chhattisgarh, Bemetara district contributed significantly, with ridge gourd cultivation spanning 1.970 thousand hectares, producing 23.512 thousand metric tons, and recording a productivity level of 11.93 tons per hectare (Anonymous, 2023) [1].

Among the vegetables, the cucurbits play a vital role in supply of fresh vegetables and to a certain extent fresh fruits during monsoon as well as summer in the plains of India. Generally, all cucurbitaceous crops are grown all around year except two to three months of heavy winters. They all belong to same family "Cucurbitaceae" but to a number of different genera. These crops constitute the largest group of vegetables and India has been leading in the origin and introduction of number of cultivated cucurbits species. This group includes melons, water melon, round and long melons, pumpkin, cucumber and all gourds including Ridge gourd. They are good source of carbohydrates, vitamin A, vitamin C and minerals.

The chemical composition of ridge gourd fruits include carbohydrates, carotene, fat, protein, phytin, flavonoids,' saponin and amino acid. Fruits contain Moisture (95.2g), Protein (0.5g), Fat (O.lg), Minerals (0,3g), Carbohydrate (3.0g), Energy (20 calories), Calcium (40mg), Magnesium (11 mg), Phosphorus (40mg), Iron (1.6mg), Sodium (2.9 mg), Potassium (50 mg), Copper (0.16mg), Sulphur (13 mg), Chlorine (7.0 mg), Vitamin-A 56 (I.U.), Thiamine (0.07 mg), Riboflavin (0.01 mg), Nicotinic acid (0.2 mg), Vitamin-C (5 mg), Oxalic acid (27 mg) and contains good amount (2.4%) of dietary fiber content per 100 gm of edible portion and thus contribute considerable to a well balanced diet. It also contains about 300 jxg ^carotene and 1,000 pg carotenoids per 100 g of fresh fruits. Besides its nutritional importance, it also has various pharmacological properties like hepatoprotective, antidiabetic, antioxidant, abortifacient and antifungal activity (Kandlakunta *et al,* 2008) [8]. The expression of different sex forms is influenced by genetic factors, the manifestation of which is influenced by environmental conditions (Kubicki, 1972 and Jakubkova Novakova, 1973) [10, 7] like photo-period, temperature (Wien *et al.,* 2004) [19] etc. Besides, exogenous applications of plant hormones play an important role in changing sex tendency in these plants. Subsequently, growth regulating became important tools in this respect. The suppression of male flowers and increasing the number of female flowers by application of plant growth regulators in cucurbits.

Economic factors such as fluctuating market prices, high input costs, and inadequate storage facilities pose significant challenges to ridge gourd farmers. Among the factors influencing crop productivity, plant growth regulators (PGRs) play a crucial role in enhancing plant growth, flowering, fruit set, and overall yield. Growth regulators such as gibberellins are widely used to promote cell elongation, stimulate root and shoot development, and improve fruit retention, ultimately leading to higher productivity and better fruit quality (Kumar *et al.,* 2021) [12].

The method of PGR application significantly influences its effectiveness in modulating plant physiological responses, with seed treatment, foliar spray, and soil application being common methods, each affecting growth and yield attributes differently. Several studies have demonstrated that the application of PGRs enhances vine length, the number of branches, fruit yield, and quality parameters such as fruit weight, shelf life, and nutrient content (Sharma *et al.,* 2020) [16].

The commercial production of Ridge gourd needs adoption of proper agro techniques. The problem of higher sex ratio is of great interest in the most of cucurbitaceous crops which have monoecious plants. Generally, there are more male flowers and less female flowers which bear fruits. An ideal variety is one which has higher female to male flower ratio. The female to male flower ratio is goes on increasingly with age of plants. Lower fertility, higher temperature, lower light period induces maleness. Growth regulators at proper concentration modifies sex ratio.

Material and method

The experiment was carried out during *Zaid* Season of year 2024-25 Research cum instructional farm at College of Horticulture and Research Station Saja, Bemetara (C.G.). The field experiment was conducted in Randomized Block Design with three replications having nine different treatments with one plant growth regulators concentration *i.e*., GA_3 @ 25 ppm (T_1), GA_3 @ 50 ppm (T_2), GA_3 @ 100 ppm (T_3), GA_3 @ 150 ppm (T_4), GA_3 @ 200 ppm (T_5), GA_3 @ 250 ppm (T_6), GA_3 @ 300 ppm (T_7), GA_3 @ 350 ppm (T_8), Control (T_0). The soil was made to fine tilth by continuous cultivator followed by planking after the area had been carefully ploughed, weeds, stubbles, stones etc., were completely removed. Apply complete doses of chemical fertilizers (NPK) were administered at a rate of 150:90:150 kg/ha. The fertilizers were applied in split doses *i.e*., half of the quantity of nitrogen, full amount of phosphorus and potassium applied as basal dose and the remaining amount of nitrogen was given in two split doses at 30 and 45 DAS as top dressing. In spring- summer crop frequent irrigation is very essential. The first irrigation was given after seed sowing in order to improve the seed germination. The crop requires frequent irrigations as high humidity is needed for prolific bearing. During hot and warm weather, irrigation after every fourth or fifth day is needed to maintain proper soil- moisture level. The desired concentrations of plant growth regulators were prepared and 1st spraying was done after 2 leaf stage after sowing and 2nd spray was done 4 leaf stage of ridge gourd. Five plants at random were selected from each plot and tagged in order to record the observations on the length of plant (cm), length of internode (cm), number of branches per vine, node at first male flower (days), node at first female flower (days), 50% flowering in a net plot and gross plot area (days), number of fruits per plant, number of fruits per vine, first harvesting, fruit length (cm), fruit diameter (cm), average fruit weight (gm) fruit yield per plot, fruit yield per ha and B:C ratio.

Results and Discussion

Growth parameter

The study of comparison of concentration of GA_3 various treatments revealed that the application of GA_3 350 ppm showed the better response with respect to the growth parameter length of plant (cm), length of internode (cm), number of branches per vine, node at first male flower (days), node at first female flower (days) and 50% flowering in a net plot and gross plot area (days).The interpretations were recorded on various growth parameter are presented in Table 1.

Length of plant (cm)

At 30 days, T_8 (GA_3 @ 350 ppm) recorded significantly the maximum length of plant (129.34 cm) which was followed by T_5 (GA_3 @ 200 ppm) (124.33 cm). However, T_0 (Control) recorded the minimum length of plant (80.10 cm) among the others.

At 60 days, T_8 (GA_3 @ 350 ppm) recorded significantly the maximum length of plant (240.57 cm) which was statistically at par with treatments T_5 (GA_3 @ 200 ppm) (232.43 cm) and T_7 (GA_3 @ 300 ppm) (228.32 cm). However, T_0 (Control) recorded the minimum length of plant (178.34 cm) among the others.

At 90 days, T_8 (GA_3 @ 350ppm) recorded significantly the length of plant (356.67 cm) which was followed by T_5 (GA_3 @ 200ppm) (333.83 cm). However, T_0 (Control) recorded the minimum length of plant (266.35 cm) among the others.

Remarkable increase in the plant height at 30, 60 and 90 DAS was observed GA_3 350 ppm might be due to increased cell elongation and rapid cell division in the growing portion. The similar finding was also recorded by Das & Das (1973) [5] in cucumber, Dabas *et al.* (2001) [4] in marigold and Cardoso *et al.* (2012) [3] in chrysanthemum.

Length of internode

The T_8 (GA_3 @ 350 ppm) recorded significantly the maximum length of internode (12.22 cm) which was followed by T_7 (GA_3 @ 300 ppm) (11.67 cm) and T_6 (GA_3 @ 250 ppm) (11.50 cm). However, T_0 (Control) recorded the minimum length of internode (8.20 cm) among the others.

The maximum internodal distance was measured in treatment GA_3 (350 ppm) which might be due to cell enlargement and elongation effect of gibberellic acid on main vine as it increases internodal distance in plants. Similar findings were reported by Dabas *et al.* (2001) [4] in marigold and Cardoso *et al.* (2012) [3] in chrysanthemum**.**

Number of branches per vine

The T_8 (GA_3 @ 350 ppm) recorded significantly the maximum number of branches per vine (12.36) which was Statically at par with treatment T_7 (GA_3 @ 300 ppm) (11.55 cm) and T_4 (GA_3 @ 150 ppm) (11.35) However, T_0 (Control) recorded the minimum number of branches per vine (8.76) among the others.

The maximum number of branches per vine was recorded GA_3 (350 ppm) might be due to osmotic driven responses under the influence of gibberellins have attributed to increase in photosynthetic activity, accelerated translocation and efficiency of utilizing photosynthetic products. The similar finding was also recorded by Dabas *et al.* (2001) [4] in marigold, Cardoso *et al.* (2012) [3] in chrysanthemum and Sapkota *et al.* (2020) [15] in cucumber.

Days to first male flower

The earliness of days to first male flower was recorded in treatment T_8 (GA_3 @ 350 ppm) (32.45 days), which was statistically at par with treatments T_7 (GA_3 @ 300 ppm) (33.67 days) and T_4 (GA_3 @ 150 ppm) (34.37 days). However, Control recorded the delayed days to first male flower (40.33 days) among the others.

The variation in the days taken to first male flower might be due to increase the metabolization of GA_3 substance in plants and also reduce sugar thereby bringing a change in the membrane permeability. The similar finding was also recorded by Karim *et al*., (1990) [9] in cucumber**.**

Days to first female flower

The earliness of first female flowering was recorded in treatment T_8 (GA_3 @ 350 ppm) (34.93 days), which was statistically at par with treatments T_7 (GA_3 @ 300 ppm) (36.15 days) and T_4 (GA_3 @ 150 ppm) (36.85 days). However, Control recorded the delayed days to first female flower (40.33 days) among the others.

The variation in the days taken to first female flower might be due GA_3 is flowering hormone and its help initiate the earliness of flower. The similar finding was also recorded by Karim *et al*., (1990) [9] in cucumber.

Node at first male flower

The minimum node at first male flower was recorded in treatment T_8 (GA_3 @ 350 ppm) (5.20), which was statistically at par with treatments T_7 (GA_3 @ 300 ppm) (5.44). However, Control recorded the maximum node at first male flower (8.24) among the others.

The variation in the node at first male flower might be due to increase the metabolization of GA_3 substance in plants and also reduce sugar there by bringing a change in the membrane permeability. The similar finding was also recorded by Rodriguez and Lambeth (1974) [14] in cucumber.

Node at first female flower

Application of T_8 (GA_3 @ 350 ppm) resulted in earliness node at first female flower (7.20) which was Statically at par with treatment T_7 (GA_3 @ 300 ppm) (7.54). However, the maximum node at first female flower (10.23) was recorded in Control.

Growth regulators advanced the first female flower initiation in the present study, which might be due to increase the metabolization of GA_3 substance in plants and also reduce sugar thereby bringing a change in the membrane permeability. The similar finding was also recorded by Karim *et al*., (1990) [9] in cucumber and Rodriguez and Lambeth (1974) [14] in cucumber.

50% flowering in a net plot and gross plot area

The earliness of 50% flowering in a net plot and gross plot area was recorded in treatment T_8 (GA_3 @ 350 ppm) (46.20 days), which was statistically at par with treatments T_7 (GA_3 @ 300 ppm) (48.33 days), T_6 (GA_3 @ 250 ppm) (49.50 days) and T_5 (GA_3 @ 200 ppm) (49.56 days). However, Control recorded the delayed 50% flowering in a net plot and gross plot area **(**56.23 days) among the others.

The earliness of 50% flowering in a net plot and gross plot area might be due to minimum days to first flowering. The similar finding was also recorded by Dabas *et al.* (2001) [4] in marigold and Cardoso *et al.* (2012) [3] in chrysanthemum.

Table 1: Effect of plant growth regulators on vegetative characters of cucumber

Treatment Notation	Treatments	Length of plant (cm)			Length of internode	Number of branches per vine	Days to first male flower	Days to first female flower	Node of first male flower	Node of first female flower	50% flowering in a net plot and gross plot area
		30 days	60 days	90 days							
T_1	GA_3 @ 25 ppm	100.21	195.70	288.35	9.25	10.24	38.67	41.15	7.23	9.24	52.33
T_2	GA_3 @ 50 ppm	105.46	208.56	294.42	9.76	10.77	37.33	39.81	7.44	9.54	51.66
T_3	GA_3 @ 100 ppm	110.24	212.67	307.55	9.85	10.35	36.69	39.17	6.23	8.23	50.33
T_4	GA_3 @ 150 ppm	114.33	218.52	312.56	10.20	11.35	34.37	36.85	7.23	9.05	50.20
T_5	GA_3 @ 200 ppm	124.33	232.43	333.83	10.40	10.42	35.33	37.81	6.45	8.55	49.56
T_6	GA_3 @ 250 ppm	118.25	222.44	316.41	11.50	10.87	34.72	37.2	6.76	8.46	49.50
T_7	GA_3 @ 300 ppm	120.27	228.32	324.66	11.67	11.55	33.67	36.15	5.44	7.54	48.33
T_8	GA_3 @ 350 ppm	129.34	240.57	356.67	12.22	12.36	32.45	34.93	5.20	7.20	46.20
T_0	Control	80.10	178.34	266.35	8.20	8.76	40.33	42.81	8.24	10.23	56.23
	SE(m±)	3.94	8.45	12.77	0.39	0.35	1.32	1.38	0.28	0.32	1.57
	C.D. at	11.82	25.35	38.29	1.18	1.06	3.97	4.13	0.85	0.97	4.70
	CV	6.13	6.81	7.10	6.61	5.70	6.39	6.20	7.40	6.48	5.37

Yield parameter

GA_3 250 ppm showed the, number of fruits per plant, number of fruits per vine, first harvesting, fruit length (cm), fruit diameter (cm), average fruit weight (gm) fruit yield per plot and fruit yield per ha. The interpretations were recorded on various vegetative character are presented in Table 2.

Number of fruits per plant

The highest yield per plot (32.44) recorded T_6 (GA_3 @ 250 ppm) which was statistically at par with treatments T_7 (GA_3 @ 300 ppm) (30.95) and T_8 (GA_3 @ 350 ppm) (29.56), while, it was the lowest (18.20) in Control.

The increase of fruit per plant might be due to increase the number of flower per plant, increase the number of branches and increase the number of fruit per vine. The result was supported by Singh *et al*. (1991) [17] and Naidu *et al*. (2011) [13] in African marigold.

Number of fruits per vine

The highest number of fruits per vine (9.21) recorded T_6 (GA_3 @ 250 ppm) which was statistically at par with treatments T_7 (GA_3 @ 300 ppm) (8.55), while, it was the lowest (4.14) in Control.

The significant improvement in fruit formation might be due to growth regulators increases the metabolic activity of plant, which resulted in enhancement of reproductive phase in ridge gourd. The result was supported by Singh *et al*. (1991) [17] and Naidu *et al*. (2011) [13] in African marigold.

First harvesting

The earliness of first harvesting (39.87 days) recorded T_8 (GA_3 @ 350 ppm) which was statistically at par with treatments T_7 (GA_3 @ 300 ppm) (41.00 day), T_6 (GA_3 @ 250 ppm) (42.17 days), while, it was the maximum (48.90 days) in Control.

The earliness of first harvesting might be significant improvement in fruit formation due to the foliar spray of GA_3 fact that they increase the metabolic activity in plant, which resulted in enhancement of reproductive phase in ridge gourd. The result was supported by Singh *et al*. (1991) [17] and Naidu *et al*. (2011) [13] in African marigold.

Fruit length (cm)

The highest fruit length (36.16 cm) was recorded T_6 (GA_3 @ 250 ppm) which was statically at par with treatment T_7 (GA_3 @ 300 ppm) (33.73 cm), T_8 (GA_3 @ 350 ppm) (33.69 cm) and T_4 (GA_3 @ 150 ppm) (33.33 cm), while, it was the lowest (30.35 cm) in Control.

The fruit length was comparatively more in treatment GA_3 at 250 ppm than control, which was due the impact of gibberellins on photosynthetic activity, quicker translocation and efficiency of utilizing photosynthetic products leading in increased cell elongation and rapid cell division in the growing section. The result was supported by Singh *et al*. (1991) [17], Naidu *et al*. (2011) [13] in African marigold and Sapkota *et al.* (2020) [15] in cucumber.

Fruit diameter (cm)

The highest fruit diameter (9.20 cm) was recorded T_6 (GA_3 @ 250 ppm) which was followed by T_5 (GA_3 @ 200 ppm) (8.55 cm), T_8 (GA_3 @ 350 ppm) (8.18 cm), while, it was the lowest (6.15 cm) in Control.

The increase fruit diameter that the reason for variation on diameter of fruits due to elongation of cells of the fruit by GA_3 is diametric leading to the simultaneous increase in fruit diameter in ridge gourd. The significantly maximum fruit diameter was recorded with the foliar application of GA_3 by Hill *et. al* (2010) [6] in bitter gourd and Kumar *et. al* (2024) [11] in Ridge Gourd.

Average fruit weight (gm)

The highest average fruit weight (138.33 gm) recorded T_6 (GA_3 @ 250 ppm) which was statistically at par with treatments T_7 (GA_3 @ 300 ppm) (134.45 gm), while, it was the lowest (109.33) in Control.

The significant improvement in fruit formation due to the foliar spray of GA_3 in the present study might be because of the fact that they increase the metabolic activity in plant, which resulted in enhancement of reproductive phase in ridge gourd. The result was supported by Singh *et al*. (1991) [17] and Naidu *et al*. (2011) [13] in African marigold.

Fruit yield per plot (kg)

The highest fruit yield per plot (12.35 kg) recorded T_6 (GA_3 @ 250 ppm) which was statistically at par with treatments T_7 (GA_3 @ 300 ppm) (11.90 kg), while, it was the lowest (9.49 kg) in Control.

The increase of fruit yield per plot might be due to increase the number of flower per plant, increase the number of branches, number of fruit per vine, length of fruit, diameter of fruit and increase the number of fruit per plant. The result was supported by Singh *et al*. (1991) [17], Naidu *et al*. (2011)

[13] in African marigold and Sapkota *et al.* (2020) [15] in cucumber.

Fruit yield per ha (q)

The highest fruit yield per ha (164.67 q) recorded T_6 (GA_3 @ 250 ppm) which was statistically at par with treatments T_7 (GA_3 @ 300 ppm) (158.67 q), while, it was the lowest (126.53 q) in Control. The increase of fruit yield per ha might be due to increase the number of flower per plant, increase the number of branches, number of fruit per vine, length of fruit, diameter of fruit, number of fruit per plot. The result was supported by Singh *et al*. (1991) [17], Naidu *et al*. (2011) [13] in African marigold and Sapkota *et al.* (2020) [15] in cucumber.

Table 2: Effect of plant growth regulators on yield parameter of ridge gourd

Treatment Notation	Treatments	Number of fruits per plant	Number of fruits per vine	First harvesting	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (gm)	Fruit yield per plot (kg)	Fruit yield per ha (q)
T_1	GA_3 @ 25 ppm	22.35	7.20	42.87	31.33	7.20	118.23	10.10	134.67
T_2	GA_3 @ 50 ppm	25.44	7.44	43.25	31.16	7.44	122.40	10.38	138.40
T_3	GA_3 @ 100 ppm	27.67	8.13	43.00	32.94	8.23	130.33	10.75	143.33
T_4	GA_3 @ 150 ppm	26.37	7.56	44.13	33.33	7.56	132.33	11.42	152.27
T_5	GA_3 @ 200 ppm	29.22	8.35	42.23	31.93	8.55	128.97	10.54	140.53
T_6	GA_3 @ 250 ppm	32.44	9.21	42.17	36.16	9.20	138.33	12.35	164.67
T_7	GA_3 @ 300 ppm	30.95	8.55	41.00	33.73	8.35	134.45	11.90	158.67
T_8	GA_3 @ 350 ppm	29.56	8.20	39.87	33.69	8.18	130.76	11.59	154.53
T_0	Control	18.20	4.14	48.90	30.35	6.15	109.33	9.49	126.53
	SE(m±)	1.56	0.32	1.56	1.04	0.27	4.49	0.42	5.64
	C.D. at	4.68	0.96	4.68	3.13	0.81	13.47	1.26	16.92
	CV	6.28	7.31	6.28	5.59	6.12	6.12	6.69	6.98

Conclusion

In light of the present experimental findings summarized above, it may be concluded that the application of plant growth regulators enhanced the plant growth, fruit yield and the benefit cost ratio influenced significantly in various plant growth regulator treatments. The study of comparison of concentration of GA_3 various treatments revealed that the application of GA_3 350 ppm showed the better response with respect to the growth parameter length of plant (cm), length of internode (cm), number of branches per vine, node at first male flower (days), node at first female flower (days) and 50% flowering in a net plot and gross plot area (days). GA_3 250 ppm showed the, number of fruits per plant, number of fruits per vine, first harvesting, fruit length (cm), fruit diameter (cm), average fruit weight (gm) fruit yield per plot and fruit yield per ha. The B:C ratio was found better with T_6 (GA_3 250 ppm) than all the treatments.

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