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Prachi
M.Sc. (Hort.), Department of Vegetable Science, College of Agriculture, IGKV, Raipur Chhattisgarh, India

Dr. Deo Shankar
Professor, Department of Vegetable Science, College of Agriculture, IGKV, Raipur, Chhattisgarh, India

Dr. Annu Verma
Professor, Department of Vegetable Science, College of Agriculture, IGKV, Raipur, Chhattisgarh, India

Mrinal Kumar
Ph.D. Scholar, Department of Vegetable Science, College of Agriculture, IGKV, Raipur, Chhattisgarh, India

Ashok Tirkey
M.Sc. (Hort.), Department of Vegetable Science, College of Agriculture, IGKV, Raipur Chhattisgarh, India

Corresponding Author:
Prachi
M.Sc. (Hort.), Department of Vegetable Science, College of Agriculture, IGKV, Raipur Chhattisgarh, India

Effect of plant growth regulators on the growth, yield and yield attributes of French bean (*Phaseolus vulgaris* L.)

Prachi, Deo Shankar, Annu Verma, Mrinal Kumar and Ashok Tirkey

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Abstract
The present investigation entitled "Effect of plant growth regulators on growth, yield and yield attributes of French bean (*Phaseolus vulgaris* L.)." was carried out during *Rabi* (2023- 2024) at the Center of Excellence on Protected Cultivation and Precision Farming Unit, Department of Vegetable Science, College of Agriculture, IGKV, Raipur, Chhattisgarh. There are 13 treatments, each replicated thrice in RBD. The treatments consist of T_0: Control, T_1: NAA@ 10 ppm, T_2: NAA@ 15 ppm, T_3: NAA@ 20 ppm, T_4: GA3@150 ppm, T_5: GA3@200 ppm, T_6: GA3@250 ppm, T_7: CCC@ 250 ppm, T_8: CCC@ 300 ppm, T_9: CCC@350 ppm, T_{10}: Kinetin@ 10 ppm, T_{11}: Kinetin@ 20 ppm and T_{12}: Kinetin@ 40 ppm. Foliar application of PGR was done at 20 DAS and 40 DAS of French beans. The result revealed that T_6 recorded significant maximum plant height (55.06 cm), the maximum number of leaves per plant (33.93), The maximum number of branches per plant (15.47), The maximum leaf area index (0.790), Cycocel 350 ppm (T_9) was recorded the minimum number of days (27.67 days) for first flowering and T_6 recorded the maximum number of days to first flowering (36.87 days), The maximum number of days to 50% flowering (39.80 days) was recorded by T_6 and minimum number of days to 50% flowering (32.53 days) by T_9, The maximum number of pods per plant (53.87) and maximum pod length (13.91 cm) was recorded by T_6, the maximum pod diameter (1.06 cm) was observed in Cycocel 350 ppm (T_9), The maximum weight of 10 pods (64.51 g), maximum yield per plant (340.49 g) and maximum yield per ha (205.00 q) were recorded by T_6. Treatment T_6 also recorded maximum value in quality parameters such as dry matter production (16.426 g) while the maximum nitrogen content (0.497%) and protein content were observed in (T_3) NAA 20 ppm.

Keywords: French bean, PGRs, foliar spray, growth, yield, and quality parameters

Introduction
Among the numerous economically important plant genera in the Leguminaceae family, the self-pollinating annual French bean (*Phaseolus vulgaris* L.) is prized for its seeds as well as its vegetables. Other names include navy bean, string bean, fresh bean, haricot bean, kidney bean, and so on. Except a few semi-pole varieties, which are short-day kinds, the majority of French bean varieties are day-neutral. With 2n = 2x = 22, the French bean (*Phaseolus vulgaris*) is a diploid. *Phaseolus vulgaris*, *P. coccineus*, *P. lunatus*, and *P. acutifolius var. latifolius* are the four species of plant that are grown. Except for *P. coccineus*, which is commonly cross- pollinated, every species is self-pollinating. The crop thrives well in diverse environments around the world, ranging from tropical to temperate regions (Mongi *et al.*, 2016) [1]. In North India, it's a highly appreciated, short-lived vegetable. Depending on the harvest stage, its pods can be eaten as a green vegetable, green-shelled, or dried as pulses. One of the best sources of protein is the French bean. Either fresh or frozen pods are prepared. It is said that French beans have a long history and are native to South America. In tropical and subtropical climates, the crop is sown in two seasons: February–March and September–October. The crop's duration is short.
According to FAOSTAT, the global area of common bean was 34.80 million ha in 2020, and its production was 27.54 million tons. Asia accounts for 43.1% of global bean production, followed by the Americas (29.4%) and Africa (25.5%). After China, India is the world's second-largest producer of vegetables.

It is planted on 20,80,000 hectares in India, where it produces about 2,15,000 million tonnes (NHB, 2019-20). It is mostly farmed in the summer and winter months in hilly regions of Himachal Pradesh, Jammu and Kashmir, and the North- Eastern provinces. A portion of Uttar Pradesh, Maharashtra, Karnataka, and Andhra Pradesh also grow it as an autumn crop. It is grown as an autumn or spring crop on a small scale on the Northern Plains due to its sensitivity to both cold and high temperatures. The function that plant growth regulators play in increasing crop productivity has been recognised. PGRs are organic substances that profoundly modify or regulate a plant's physiological functions. Plant growth regulators play a crucial role in increasing crop yields, and with the advent of low-cost technologies, agricultural production may now be increased at a never-before-seen rate. In addition to poor vegetative development and flowering, it has been noted that during later phases of the crop, photosynthetic synthesis and translocation into the sink are quite poor. Growth hormones which are crucial to control several physiological processes, balance the source and sink, and boost productivity when given in tiny doses.

Materials and Methods

The experiment was conducted at the Center of Excellence on Protected Cultivation and Precision Farming, IGKV, Raipur, (C.G.) during the *rabi* season 2023. The experimental site comes under sub-tropical conditions and was located at 21°14' N latitude and 81°41' E longitude with an altitude of 298.56 meters above the mean sea level. The experiment was laid out in randomized block design (RBD) with three replications consisting of twelve treatments. The variety was selected for the present experiments. The French bean seeds were sown at a spacing of 40x20 (R×P) cm. The size of each experimental field plot was 4 m2. The soil type of the experimental field was clay loam in texture, nearly neutral in soil reaction (pH 7.21), organic carbon (0.38%), available N (176.08 kg/ha), P (14.42 kg/ha), K (380.54 kg/ha), Fe (19.80 mg/kg), Zn (0.81 mg/kg), B (0.62 mg/kg) and Mo (0.15 mg/kg). During field preparation, 10 tons/ha FYM and 10 quintals/ha vermicompost were added and water-soluble fertilizers such as 12:61:0, 0:52:34, 13:0:45, 19:19:19, and 00:00:50 were fertigated with the recommended dose of NPK (80:60:30 kg/ha). Foliar application of each treatment was done at 20 and 40 DAT. Common cultural practices were done for French bean production, such as gap filling, irrigation, fertigation, weeding, etc. The required amounts of plant growth regulators were completely dissolved in the desired amount of water or alcohols as per their solubility to prepare the PGR solution. Carefully applied solutions in different concentrations were used to wet the plant's both surfaces. Five randomly selected plants were tagged in each plot and used for recording observations of growth, yield and quality parameters.

Results and Discussions

Growth parameters

The result of various growth parameters *viz.*, plant height (cm), number of leaves per plant, number of branches, and leaf area index as influenced by foliar spray of PGRs on French beans are presented in Table 1. The effect of foliar spray of PGRs exhibited significant differences concerning plant height, number of leaves per plant, number of branches, and leaf area index. The plant height at 60 days after sowing ranged between 55.06 cm to 26.6 cm. The maximum plant height (55.06 cm) was observed in GA3 250 ppm which was at par with GA3 200 ppm (53.4 cm). The minimum plant height (26;6 cm) was recorded in Cycocel at 350 ppm. Plant height in the rest of the treatments ranged between 31.75 cm (control) to 40.66 cm (GA3 150 ppm). The data collected at 60 days after sowing revealed that the maximum number of leaves per plant (33.93) were recorded in GA3 250 ppm which was at par with GA3 200 ppm (33.2), NAA 20 ppm (33.4), CCC 350 ppm (32.8) and CCC 300 ppm (30.86). A minimum number of leaves per plant (23.33) were observed in NAA 10 ppm. The number of branches per plant at 60 days after sowing ranged between 15.47 to 11.09. The maximum number of branches per plant (15.47) was recorded in GA3 250 ppm which was at par with Kinetin 20 ppm (14.40) and GA3 200 ppm (14.13). The minimum number of branches per plant (11.09) were recorded in NAA at 10 ppm. The number of branches per plant in the rest of the treatments ranged between 13.33 (GA3 at 150 ppm) to 13.13 (CCC 350 ppm). The data on the leaf area index at 60 days after sowing revealed that the leaf area index at 60 DAS ranged between 0.790 to 0.427. The maximum leaf area index (0.790) was recorded in GA3 250 ppm which differed significantly over the other treatments. A minimum leaf area index (0.427) was observed in control. Leaf area index in the rest of the treatments ranged between 0.753 (GA3 200 ppm) to 0.450 (CCC 300 ppm).

Application of different PGRs might have accelerated the rate of metabolic activities in the plant system and might have resulted in increasing growth parameters of the plant GA3 recorded maximum growth in plants followed by Kinetin, NAA, and Cycocel. The maximum growth in plants by GA3 might be due to rapid growth and differentiation. Kinetin helps in rapid cell division which is necessary to lead to the growth of plants. The increase in growth parameters by the application of NAA is due to the active role of NAA in cell division, cell differentiation, and cell elongation (Kokare *et al*., 2006) [11]. NAA may delay senescence through its effect on the mobilization of metabolites to the leaves. The increase in plant growth with a higher concentration of Cycocel might be due to its effectiveness in suppressing apical dominance and diversion of carbohydrates to the lateral buds, thereby promoting the growth of axillary buds into new shoots, so also Cycocel has pronounced effect on the formation of a greater number of nodes and branches. These results are also similar to the results reported by Aurovinda Das and Rajendra Prasad (2003) [3] in Mung bean, Pandey *et al*. (2004) [23] in garden pea, Purbey and Sen (2005) [25] in fenugreek, Kokare *et al*. (2006) [11] in okra, Nawalagatti *et al*. (2008) [19] in French bean, Sharma and Lashkari (2009) [32] and Noor *et al*. (2017) in French bean.

Yield parameters

The results of various yield parameters *viz.*, number of days for first flowering, number of days to 50% flowering, number of pods per plant, pod length (cm), pod diameter (cm), weight of 10 pods (g), yield per plant (g), and yield per ha (q) as influenced by foliar spray of PGRs on French beans are presented in Table 2, 3, and 4. The effect of foliar spray of PGRs exhibited significant differences concerning yield parameters. Data collected on a number of days taken to first flowering ranged between 27.67 to 36.87 days.

Among the treatments studied foliar spray of Cycocel 350 ppm was recorded minimum number of days (27.67 days) for first flowering. The maximum number of days to first flowering (36.87 days) was recorded by GA3 250 ppm which was at par with GA3 200 ppm (36.20 days), NAA 10 ppm (35.40), Kinetin 10 ppm (34.20), GA3 150 ppm (34.06), Kinetin 20 ppm (33.07) and NAA 20 ppm (33.00). The number of days to first flowering in rest of the treatments ranged between 32.40 days (CCC 250 ppm) to 31.13 days (Kinetin 40 ppm). Data collected on number of days taken to 50% flowering ranged between 32.87 to 39.80 days. Among the treatments studied foliar spray of Cycocel 350 ppm was recorded a minimum number of days (32.53 days) for 50% flowering which differed significantly over the other treatments. The maximum number of days to 50% flowering (39.80 days) was recorded by GA3 250 ppm which was at par with GA3 200 ppm (39.60 days), GA3 150 ppm (38.26), NAA 10 ppm (37.80), NAA 15ppm (37.40) and NAA 20 ppm (36.40). The number of days to 50% flowering in the rest of the treatments ranged between 34.40 days (CCC 300 ppm) to 35.87 days (Kinetin 10 ppm). Data collected on the number of pods per plant ranged between 53.87 to 40.73. The maximum number of pods per plant (53.87) was recorded by GA3 250 ppm which was at par with GA3 200 ppm (53.26), GA3 150 ppm (51.73), and CCC 350 ppm (48.67). Among the treatments studied control had recorded a minimum number of pods per plant (40.73). Data collected on pod length ranged between 13.91 cm to 9.78 cm. Among the treatments studied GA3 250 ppm was recorded maximum pod length (13.91 cm) which was at par with GA3 200 ppm (13.32 cm) and GA3 150 ppm (12.87). Cycocel 350 ppm was recorded minimum pod length (9.78 cm). The rest of the treatments were in the order of NAA 20 ppm (11.77 cm) followed by NAA 15 ppm (11.51 cm), kinetin 20 ppm (11.38 cm) and kinetin 40 ppm (11.35cm). Data recorded on pod diameter ranged between 1.06 cm to 0.79 cm. Among the treatments, the maximum pod diameter (1.06 cm) was observed in Cycocel 350 ppm which was at par with GA3 250 ppm (1.04 cm), and CCC 300 ppm (0.98 cm). The minimum pod diameter (0.79 cm) was observed in control. Data collected on the weight of 10 pods ranged between 64.51 g to 36.15 g. The maximum weight of 10 pods (64.51 g) was recorded by GA3 250 ppm which was at par with GA3 200 ppm (62.12 g), and GA3 150 ppm (59.70 g). The minimum weight of 10 pods (36.15 g) was recorded by control. Data collected on yield per ha ranged between 205.00 q to 109.33 q. The maximum yield per ha (205.00 q) was recorded by GA3 250 ppm which is at par with GA3 200 (199.50q) and GA3 150 ppm (195.83q). Minimum yield per ha (109.33 q) was recorded by control treatments.

The decrease in a number of days taken to first flowering by Cycocel application compared to control might be due to the restriction of growth by Cycocel application presumably altered the metabolism and created conditions conducive to early flower formation. The decrease in a number of days taken to first flowering by NAA application compared to control might be due to NAA probably increasing the endogenous auxin content of the plant which hastened the flowering and automatically induced the earliness of flowering. The delayed flowering induced by kinetin in foliar application when compared to other treatments may be due to prolonged vegetative growth. The increase in a number of days taken to first flowering by GA3 application compared to control might be due to the diversion of food material for vegetative growth which leads to the delaying of flowering and fruiting. These results are the results of Aurovinda Das and Rajendra Prasad (2003) [3] in green gram, Patil *et al.* (2005) [24] in Mung bean, Kokare *et al.* (2006) [11] in okra.

Among the different plant growth regulators, GA3 had recorded a maximum number of pods per plant and pod length followed by NAA, kinetin, and Cycocel. The increase in number of pods and length of pods by the application of GA3 might be due to the increased number of branches and fruiting points, which lead to better utilization of sunlight and the plants remained physiologically more active to build up sufficient food material for developing more number of pods. Whereas among the different plant growth regulators Cycocel recorded maximum pod diameter followed by GA3, NAA, and kinetin. The increase in pod diameter by the application of Cycocel might be due to retard cell elongation. The increase in pod diameter with increasing concentrations of GA3, NAA and kinetin might be due to rapid cell division and increased elongation of individual cell. These results were in accordance with the results of Pandey *et al.* (2004) [23] in garden pea, Rai *et al.* (2004) [27] in French bean, Resmi and Gopalakrishnan (2004) [30] in yard long bean, Kokare *et al.* (2006) [11] in okra.

The increase in weight of 10 pods, yield per plant, and yield per hectare by the application of GA3 might be due to the increased size of the photosynthetic apparatus in terms of many leaves which increased the assimilation rate contributing to better pod weight, the application of NAA and kinetin might be attributed to the greater mobilization of metabolites from source (leaves) to sink (pods), the application of Cycocel might be due to greater accumulation of carbohydrates owing to photosynthesis that resulted in increased weight of pods. These results conform with the results reported by Pandey *et al.* (2004) [23] in garden pea, Purbey and Sen (2005) [25] in fenugreek, Kokare *et al.* (2006) [11] in okra, Nawalagatti *et al.* (2008) [19] in French bean, Sharma and Lashkari (2009) [32] and Noor *et al.* (2017) in French bean.

Quality parameters

The result of various quality parameters *viz.*, dry matter (g), nitrogen content (%), and protein content (%) as influenced by foliar spray of PGRs on French beans are presented in Table 5. The dry matter production differed significantly at 60 days after sowing and ranged between 16.426 g to 9.367 g. The maximum dry matter production (16.426 g) was observed in GA3 250 ppm which is at par with NAA 20 ppm (14.441g). The minimum dry matter production (9.367 g) was recorded in Cycocel 350 ppm. Dry matter production in rest of the treatments ranged between 13.877 g (GA3 200 ppm) to 10.443 g (kinetin 40 ppm). Data collected on nitrogen content ranged between 0.497% to 0.423 %. Among the treatments the maximum nitrogen content (0.497%) was observed in NAA 20 ppm which was at par with GA3 250 ppm (0.495%), GA3 200 ppm (0.481%), NAA 15 ppm (0.475%), CCC 350 ppm (0.474%), kinetin 40 ppm (0.468%), CCC 300 ppm (0.466%), kinetin 20 ppm (0.462%), GA3 150 ppm (0.459%) and CCC 250 ppm (0.456%). The minimum nitrogen content (0.423%) was observed in control. Nitrogen content in rest of the treatments ranged between 0.451% (NAA 10 ppm) to 0.442% (kinetin 10 ppm). Data collected on protein content

ranged between 3.108% to 2.641%. Among the treatments the maximum protein content (3.108%) was observed in NAA 20 ppm which was at par with GA3 250 ppm (3.093%), GA3 200 ppm (3.007%), NAA 15 ppm (2.971%), CCC 350 ppm (2.938%), kinetin 40 ppm (2.887%), CCC 300 ppm (2.912%), kinetin 20 ppm (2.887%), GA3 150 ppm (2.866%) and CCC 250 ppm (2.851%). The minimum protein content (2.641%) was observed in control. Protein content in rest of the treatments ranged between 2.816 % (NAA 10 ppm) to 2.762% (kinetin 10 ppm).

Among the different plant growth regulators GA3 recorded maximum dry matter content followed by NAA and kinetin whereas minimum dry matter content was observed with Cycocel. Increase in total dry matter production by the application of GA3 might be due to its effect in stimulating cell division, cell elongation, auxin metabolism, cell wall plasticity and permeability of cell membrane leading to enhanced vegetative growth characters. Significant increase in dry matter production by the application of NAA might be due to enhance source to sink relationship, accumulation of photosynthates and efficient utilization of food reserves for retention of flowers and fruits which resulted into reduced leaf, flower and pod shedding and retention of more number of leaves, flower, and pods. Increase in dry matter due to kinetin may be due to increased plant height, number of branches, number of leaves, leaf area, LAI and pods. Reduction in dry matter production by Cycocel application might be due to reduced vegetative growth which resulted into reduced plant height, intermodal length and leaf size. These results were in tune with the results reported by Medhi (2000) [15] in French bean, Aurovinda Das and Rajendra Prasad (2003) [3] in green gram, Pandey *et al.* (2004) [23] in garden pea, Rai *et al.* (2004) [27] in French bean, Kokare *et al.* (2006) [11] in okra and Nawalagatti *et al.* (2008) [19] in French bean reported similar results.

Among the different plant growth regulators NAA recorded maximum protein content followed by GA3, Cycocel and kinetin. Increase in protein content by the application of plant growth regulators might be due to increased uptake of nutrient particularly nitrogen from the soil and its further assimilation led to the synthesis of protein. Bioregulators are known to promote the metabolism of assimilates or food materials by enhancing the various enzymatic activities leading to the production or conversion into mobile amino acids. Similar results were reported by Jain *et al.* (2000) [8] investigated the seed protein content of cowpeas, Aurovinda Das and Rajendra Prasad (2003) [3], Pandey *et al.* (2004) [23] in garden pea, Purbey and Sen (2005) [25] in Fenugreek and Sharma and Lashkari (2009) [32].

Table 1: Effect of foliar spray of PGRs on plant height (cm), number of leaves per plant, number of branches per plant, and leaf area index

SL.NO.	Treatment	Plant height (cm)	Number of leaves/plants	Number of branches/plants	Leaf area index
T_0	Control	33.13	25.86	11.40	0.427
T_1	NAA @10 ppm	29.3	23.33	11.09	0.517
T_2	NAA@15ppm	30.93	25.46	11.93	0.560
T_3	NAA@20 ppm	32.36	33.4	13.33	0.610
T_4	GA3@150 ppm	41.13	25.8	13.2	0.736
T_5	GA3@200 ppm	53.4	33.2	14.13	0.753
T_6	GA3@250 ppm	55.06	33.93	15.47	0.790
T_7	CCC@250 ppm	31.63	23.86	11.13	0.450
T_8	CCC@300 ppm	30.43	30.86	12.32	0.480
T_9	CCC@350 ppm	26.6	32.8	13.13	0.497
T_{10}	Kinetin@10 ppm	35.13	28.2	12.29	0.613
T_{11}	Kinetin@20 ppm	34.4	27.46	14.40	0.683
T_{12}	Kinetin@40 ppm	30.96	29.06	12.67	0.693
	SE(m)	1.34	1.18	0.63	0.02
	C.D. (5% level)	3.92	3.45	1.98	0.06

NAA-Naphthalene Acetic Acid, GA3 – Gibberellic Acid, CCC- Cycocel, cm- centimetres, SE (m)- Standard error of the mean, C.D.- Critical difference, C.V.- Coefficient of variation

Table 2: Effect of foliar spray of PGRs on days of first flowering, days of first flowering, number of pods/plants, length of pod and pod diameter

Sl. No.	Treatment	Days of first flowering	Days of first flowering	Number of pods/plants	Length of pod (cm)	Pod diameter (cm)
T_0	Control	34.60	37.07	40.73	10.48	0.79
T_1	NAA @10 ppm	35.40	37.80	42.47	10.55	0.82
T_2	NAA@15ppm	32.73	37.40	48.13	11.51	0.86
T_3	NAA@20 ppm	33.00	36.40	49.00	11.77	0.89
T_4	GA3@150 ppm	34.06	38.26	53.26	12.87	0.9
T_5	GA3@200 ppm	36.20	39.60	51.73	13.32	0.95
T_6	GA3@250 ppm	36.87	39.80	53.87	13.91	1.04
T_7	CCC@250 ppm	32.40	34.67	42.27	11.02	0.92
T_8	CCC@300 ppm	28.80	34.40	46.00	10.08	0.98
T_9	CCC@350 ppm	27.67	32.53	48.67	9.78	1.06
T_{10}	Kinetin@10 ppm	34.20	35.87	44.47	10.51	0.81
T_{11}	Kinetin@20 ppm	33.07	35.47	45.53	11.38	0.84
T_{12}	Kinetin@40 ppm	31.13	34.93	42.07	11.35	0.92
	SE(m)	1.16	1.31	1.83	0.6	0.03
	C.D. (5% level)	3.4	3.83	5.34	1.75	0.09
	C.V.	6.09	6.24	6.77	9.05	6.09

NAA-Naphthalene Acetic Acid, GA3 – Gibberellic Acid, CCC- Cycocel, cm- centimetres, SE (m)- Standard error of the mean, C.D.- Critical difference, C.V.- Coefficient of variation

Table 3: Effect of foliar spray of PGRs on weight of 10 pods, yield /plant, and yield /ha

SL. NO.	Treatment	Weight of 10 pods (g)	Yield /plant (g)	Yield /ha (q)
T_0	Control	36.15	146.41	109.33
T_1	NAA @10 ppm	50.50	214.89	146.58
T_2	NAA@15ppm	52.21	251.45	148.83
T_3	NAA@20 ppm	53.97	266.15	153.25
T_4	GA3@150 ppm	59.70	317.39	195.83
T_5	GA3@200 ppm	62.12	321.69	199.50
T_6	GA3@250 ppm	64.51	340.49	205.00
T_7	CCC@250 ppm	36.39	153.70	118.00
T_8	CCC@300 ppm	36.65	169.17	127.25
T_9	CCC@350 ppm	39.41	192.05	139.58
T_{10}	Kinetin@10 ppm	41.25	183.04	129.08
T_{11}	Kinetin@20 ppm	42.35	192.50	140.92
T_{12}	Kinetin@40 ppm	45.97	194.06	141.58
	SE(m)	1.94	11.76	6.061
	C.D. (5% level)	5.67	34.31	17.796
	C.V.	7.04	8.99	6.982

NAA-Naphthalene Acetic Acid, GA3 – Gibberellic Acid, CCC- Cycocel, cm- centimetres, SE (m)- Standard error of the mean, C.D.- Critical difference, C.V.- Coefficient of variation

Table 4: Effect of foliar spray of PGRs on dry matter, nitrogen, and protein

SL.NO.	Treatment	Dry matter (g)	Nitrogen (%)	Protein (%)
T_0	Control	9.627	0.423	2.641
T_1	NAA @10 ppm	9.684	0.451	2.816
T_2	NAA@15ppm	11.284	0.475	2.971
T_3	NAA@20 ppm	14.441	0.497	3.108
T_4	GA3@150 ppm	11.745	0.459	2.866
T_5	GA3@200 ppm	13.877	0.481	3.007
T_6	GA3@250 ppm	16.426	0.495	3.093
T_7	CCC@250 ppm	9.489	0.456	2.851
T_8	CCC@300 ppm	9.409	0.466	2.912
T_9	CCC@350 ppm	9.367	0.474	2.938
T_{10}	Kinetin@10 ppm	10.738	0.442	2.762
T_{11}	Kinetin@20 ppm	10.920	0.462	2.887
T_{12}	Kinetin@40 ppm	10.443	0.468	2.928
	SE(m)	0.6	0.01	0.09
	C.D. (5% level)	1.75	0.04	0.26
	C.V.	9.18	5.09	5.36

NAA-Naphthalene Acetic Acid, GA3 – Gibberellic Acid, CCC- Cycocel, cm- centimetres, SE (m)- Standard error of the mean, C.D.- Critical difference, C.V.- Coefficient of variation.

Conclusion

Based on the results obtained from the present investigation it can be concluded that a foliar application of treatment T_6: GA3 250 ppm at 20 and 40 days after sowing significantly enhanced the vegetative growth as well as yield parameters and T_3: NAA 20 ppm show increment in nitrogen as well as protein content. Hence, it can be concluded that treatment T_6 can be considered the most effective and beneficial for French beans production compared to all other treatments and it can be recommended for production practices to the farmers.

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