Effect of Gibberellic acid and Cytokinin on growth,quality and yield of French bean (*Phaseolus vulgaris* L.) cv. Ellora No. 11

ABSTRACT

The experiment was conducted during Rabi season November – March, 2022-2023 at the Vegetable Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, and Prayagraj (UP). The experiment was laid out in Randomized Block Design with 10 treatments and 3 replication to study the "Effect of GA3 and Cytokinin on growth, quality and yield of French bean (*Phaseolus vulgaris L.*) cv. Ellora No 11." The treatments which areT0: Control, T1:GA3@200ppm, T2: GA3@400ppm, T3:GA3@600ppm,T4:GA3@800ppm,T5:GA3@1000ppm,T6Cytokinin@250ppm,T7Cytokinin@500ppm,T8Cytokinin@750ppm, T9Cytokinin@1000ppm. The growth regulators were sprayed at 10 D.A.S in French bean. from the above experiment finding it is conclude that all the character viz., growth parameter, earliness parameter yield parameter, qualitative parameters varied significantly.Further, The result showed that the minimumdays to first flowering(42.33DAS), first picking (63.33DAS) anddays to 50% flowering(53.67 DAS) while the maximum plant height(52.07cm), no. of branches(13.57), no. of leaves(214.93), number of pod per plant(21.67),pod length(16.50), pod girth(2.63cm)1 pod weight(5.70g), yield per ha(12.35t/ha), total soluble solids (6.37°BRIX), protein (1.52%), fiber (3.89%), ascorbic acid (11.77mg)and BC ratio (3.1) was found maximum in T1:GA3@200ppm

Keyword French bean; GA3; Cytokinin; growth; quality and yield

1. INTRODUCTION

French bean (*Phaseolus vulgaris L.*)(2n=22) is most important and one of the widely grown vegetable leguminous vegetable crops of North eastern region. It is cultivated for the tender vegetable, shelled green beans and dry beans (Rajma). It is very rich in protein, vitamins and minerals. French bean is popular as a dietary food, because it containsvitamins and rich source of nutrient and minerals viz., protein content 17.5-28.7% in dry seeds and 1.0-2.5% in green pods, 3.2-5.0% mineral matter, 4.2-6.3% crude fiber, 1.2-2.0% crude fat and 340-450 K cal energy, 0.16 mg iron, 1.76 mg calcium and 3.43 mg zinc per 100 g of the edible part Sardana*et al*., (2000). French bean is a short duration crop and farmers get more profit in a short period. In this region, it is cultivated in rice fallow during spring summer and on hill slopes during autumn winter season. It has possibility to be grown round the year in this region where irrigation facilities are available during dry period.The optimum mean temperature for French bean is 20-25 °C for its growth and better productivity. Extreme high temperature interfere pod filling, while low temperature is unfavorable for vegetative growth Dhakal et al., (2020). It is also an important pulsecrop, with high yielding ability as compared to gram and pea. It is grown in Maharashtra, Himachal Pradesh, Uttar Pradesh, Jammu and Kashmir and NE states. This is also known as kidney bean, snap bean, navy bean, haricot bean and common bean originated in the central and South America. It is extensively grown commercially and also in the home garden. In our country it is known as Farash bean. The role of growth regulator in crop production plant growth regulator is developed at very low concentration but inhibits plant growth and development at high concentration. Moreover, response of plant PGR may vary in different environmental conditions, physiological and nutritional status stages of development and endogenous hormonal balance. The use of plant growth regulator such as GA3,Cytokinin,auxin on their synthetic compound is becoming popular to ensure the efficient production .It has been reported that application of PGR enhance plant growth and crop yield PGR modified growth and development in various ways under normal and stress environmental conditions .Gibberellins are plant growth regulators that facilitate cell elongation and help the plants to grow taller .They also help in germination ,stem elongation , flowering and fruit

ripening. Cytokinin promotes cell division and increase cell expansionresponse of plant to PGRs may vary with species, varieties, environmental conditions, physiological and nutritional status, stage of development and endogenous hormonal balanceVerma and Sen., (2008).

2. MATERIAL AND METHOD

The present investigation entitles "Effect of Gibberellic acid and cytokinin on growth, quality and yield of Frenchbean (*Phaseolus vulgaris* L.) cv. Ellora No 11 carried out during the winter season. The experiment was conducted in the Central Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P) during 2022 – 2023.The experiment was laid out in randomized block design (R.B.D.) with 10 treatments including control in three replications. the experiment material consists of French bean variety Ellora No 11 from Ellora natural seeds Pvt. Ltd.Maharastraand10 treatments were tried and replicated thrice vizT0: Control, T1:GA3@200ppm, T2: GA3@400ppm,T3:GA3@600ppm,T4:GA3@800ppm,T5:GA3@1000ppm,T6Cytokinin@250ppm,T7Cytokinin@500ppm, T8Cytokinin@750ppm, T9Cytokinin@1000ppmwere applied at 10 D.A.S.The sowing was done on open field condition, ridges with spacing of 60 X 15cm in plot of 1.8 × 1.55 m adopting the recommended cultivation practices for raising a healthy crop .The cultural practices such as irrigation, weeding and plant protection measure were carried out uniformly as and when required. Observations were recorded at different stages of growth periods and studied for growth parameters like plant height (cm), number of branches,number of leaves per plant, earliness parameters like, days to first flowering(DAS), days to 50% flowering(DAS), first picking(D.A.S), yield parameters like number of fruits per plant, fruit length(cm), fruit girth(cm), average fruit weight(g), pod per plant, yield per hectare (t/ha) and quality parameters total soluble solid(BRIX), protein(%), fiber(%) and ascorbic acid(mg) content. The data were statistically analyses by the method suggested by Fisher and Yates, 1963. The total soluble solids of the fruit were determined with the help of Portable Hand refractometer. The observed value of T.S.S. was recorded from the scale of the instrument (0-32 range). Vitamin C content or Ascorbic acid content was estimated by using 2, 6 dichlorophenol indophenolsdye. Five plants were randomly selected for recording observation for growth yield and quality parameter.The data collected during course of investigation was subjected to statically analysis of variance (ANOVA) as described byFisher (1950).

Results and discussion

4.1 Growth parameter

4.1.1. Effect of GA3 and Cytokinin on Plant height

Effect of GA3 and cytokinin plant height showed the significant result as effected by various treatments,the maximum plant height recorded at 80 D.A.S in T1GA3 @200ppm (52.07cm) followed by T6 (50.13cm), T7(50.67cm), T9 (50.13cm) where as minimum plant height recorded in T0 control (45.73cm) in table 2 GA3 and Cytokinin effectively increased the formation of photosynthetic productsand vegetative growth of plant, promote the cell division and cell elongation. Similar findings were reported by Noori. (2014) and Thomson *et al*,. (2015).

4.1.2. Effect of GA3 and Cytokinin on number of Branches

Effect of GA3 and cytokinin number of branches showed the significant result as affected by various treatments. The maximum number of branches recorded at 80 D.A.S in T1GA3 @200ppm (13.57) followed by T7 Cytokinin@500ppm (12.47), T3GA3@600ppm (12.53), T6Cytokinin@250ppm(12.47), and T9 Cytokinin @1000ppm (12.57) where as minimum recorded in T0 Control (10.00) in table 2.The variationinnumber of branches appears might have been duethe growth regulators can enhance the formation of photosynthetic products which improves the plant growth and increase the growth attributes like shoot, number of leaves and plant height by seed treatment Similar findings were reported by reported by El Karamany*et al*., (2019).

4.1.3 Effect of GA3 and Cytokinin on Number of leaves

Effect of GA3 and cytokinin number of leaves showed the significant result as affected by various treatments. The maximum number of branches recorded at 80 D.A.S inT1GA3 @200ppm214.93) followedbyCytokinin500ppm (187.13),T3GA3 @600ppm (183.00), T4GA3@800ppm188.07), T6 (186.80) where as minimum no. of leaves recorded in T0 (177.87) in table 2. The variationinnumber of leavesappears might have been due the growth regulators can enhance the formation of photosynthetic products which improves the plant growth and increase the growth attributes like shoot, number of leaves and plant height by seed treatment reported by El Karamany*et al*., (2019).

4.2 Earliness parameter

4.2.1 Days to 1st flowering on treatment of GA3 and cytokinin (DAS)

Effect of GA3 and cytokinin day to first flowering showed the significant result as affected by various treatments. The minimum day to first flowering recorded in T1 GA3 @200ppm(42.33DAS) followed by cytokinin @500ppm(45.33DAS), T3(46.3DAS) ,T5(45.33DAS),T8(46.00DAS), where as maximum data recorded in T0 control(52.00DAS) in table 3. Growth regulators can enhance the vegetative as well as reproductive growth of plants. The variationinnumber of leavesappears might have been dueGA3 play a major role in all growth processes like seed germination and development, seed germination rate, stimulating stem and root growth and early flowering similar findings were reported by Yamaguchi. (2008) and Taiz & Zeiger.,(2010).

4.2.2 Effect of GA3 and Cytokinin on Day of 1st pickling (DAS)

Effect of GA3 and cytokinin day to first flowering showed the significant result as affected by various treatments. The minimum day to first flowering recorded in T1 GA3 @200ppm(42.33DAS) followed by cytokinin @500ppm(53.67 DAS),T5(55.67 DAS),T8(54.00 DAS),T9(54.3 DAS) where as maximum day recorded in T0 control(64.33 DAS) in table 3.

4.2.3 Effect of GA3 and Cytokinin on Day of 50% flowering (DAS)

Effect of GA3 and cytokinin on day to first picking showed the significant result as affected by various treatments. The minimum day to first flowering recorded in T1 GA3 @200ppm (63.33) followedbycytokinin@500ppm(65.37 DAS), T4(65.37 DAS) T5(65.4 DAS),T6(66.20 DAS) where as maximum data recorded in T0 control(76.33) in table 3The variationinnumber of leavesappears might have been dueGA3 can enhance the vegetative as well as reproductive growth of plants. GA3 play a major role in all growth processes like seed germination and development, seed germination rate, stimulating stem and root growth and early flowering similar findings were reported by Yamaguchi., (2008) and Taiz & Zeiger., (2010)

4.3 Yield parameter

4.3.1 Effect of GA3 and Cytokinin on Av. Pod length (cm)

Effect of GA3 and cytokinin pod length showed the significant result as affected by various treatments. The maximum pod length recorded in T1 GA3 @200ppm (16.50cm) followed by cytokinin@500ppm (16.33), T3 (16.00 cm), T4 (16.20 cm), where as maximum data recorded in T0 control (15.37cm) in table 3.The variationinaverage pod weightappears might have been dueapplication of GA3 have promoted rapid cell division and increased elongation of individual cell that resulted in increase in pod length. Similar findings were reported by Pandey *et al*., (2004).

4.3.2 Effect of GA3 and Cytokinin on Av pod girth (cm)

Effect of GA3 and cytokinin pod girth showed the significant result as affected by various treatments. The maximum pod girth recorded in T1GA3@200ppm (2.67 cm) followed by cytokinin @500ppm (2.37),T3 (2.33 cm),T4 (2.37cm),where as maximum data recorded in T0 control(2.13 cm) in table 3.The variationinpod girthappears might have been dueapplication of GA3 increase in pod diameter by retarded the cell elongation. These findings are in conformity with Kokare*et al.*, (2006)

4.3.3 Effect of GA3 and Cytokinin on Pod weight (g)

Effect of GA3 and cytokinin pod weight showed the significant result as affected by various treatments. The maximum pod weight recorded in T1 GA3 @200ppm (5.70g) followed by T3cytokinin@500ppm (5.53g), where as minimum data recorded in T8(5.07g) in table 3.The variationinpod weight appears might have been dueGA3 increased the rate of photosynthesis activity, accelerated translocation and efficiency of utilization of photosynthetic, thus resulting in the cell elongation and rapid cell division in the growing portion which increase fruit weight. Similar findings were reported by Kadi *et al*., (2018) and Shafeek *et al*., (2016).

4.3.4 Effect of GA3 and Cytokinin on pod per plant

Effect of GA3 and cytokinin pod per plant showed the significant result as affected by various treatments. The maximum pod per plant recorded in T1 GA3 @200ppm (21.67) followed by cytokinin @500ppm (19.90),T2 (18.53), T8 (19.13),T9 (17.63) where as maximum data recorded in T0 control (15.23) in table 3.The variationinpod per plantappears might have been due GA3 increased the number of branches and fruiting points, which lead to better utilization of sunlight and higher current photosynthesis which resulted developing more number of pods per plant.

4.3.5Effect of GA3 and cytokinin yield per ha (t/ha)

Effect of GA3 and cytokinin yield per ha showed the significant result as affected by various treatment. The minimum day to first flowering recorded in T1 GA3 @200ppm(12.35t) followedby,cytokinin@500ppm(10.80t), T3(46.33t), T5(45.33t),T8(46.00t), where as maximum data recorded in T0 control(52.00t) in table 3.The variationinyield per haappears might have been dueplant growth regulators can improve the physiological efficiency including photosynthetic ability and thereby helping in effective flower formation, fruit and seed development and ultimately enhance productivity of the crops. Similar findings were reported byKumar *et al*., (2018) and WadahunlangKharsahnoh*et al*., (2021)

4.4quality parameter

4.4 .1 Effect of GA3 and cytokinin on TSS [°Brix]

Effect of GA3 and cytokinin TSS showed the significant result as affected by various treatments. The TSS recordedinT1 GA3@200ppm (6.37Brix) followed by cytokinin @500ppm (5.73Brix), T3 (5.63),T4 (5.53), T5 (5.57),where as maximum data recorded in T0 control (5.13) in table 4.The variationinTSS of leavesappears might have been dueGA3 concentration might be due to quick metabolic transformation of starch and pectin into soluble compounds and rapid translocation of sugars from leaves to developing fruits. Similar findings were reported byChaurasiya *et al.,* (2016), [16] and [27].

4.4.2 Effect of GA3 and cytokinin on Vitamin Ccontent (mg)

Effect of GA3 and cytokinin vitamin C showed the significant result as affected by various treatments. The maximum vitamin C recorded in T1 GA3 @200ppm (11.77mg) followed by cytokinin@500ppm (11.60 mg), T2 (11.57 mg), T6 (11.57 mg), T8 (11.57 mg) where as minimum data recorded in T0 control (11.13 mg) in table

4concentration might be due to quick metabolic transformation of starch and pectin into soluble compounds and rapid translocation of sugars from leaves to developing fruits.

4.4.3Effect of GA3 and cytokinin on Protein content (%)

Effect of GA3 and cytokinin Protein showed the significant result as affected by various treatments. The maximum Protein recorded in T1 GA3@200ppm (1.52%) followed by cytokinin @500ppm (1.50%),T5(1.49%),T6(1.49%), T8(1.48%) where as maximum data recorded in T0 control(1.45%) in table 4plant growth hormone that stimulates cell division and enlargement as well as the synthesis of protein, nucleic acid and chlorophyll.

4.4.4 Effect of GA3 and cytokinin fibercontent (%)

Effect of GA3 and cytokinin fiber showed the significant result as affected by various treatments. The maximum fiber recorded in T1 GA3@200ppm(11.60%) followed by T7 cytokinin @500ppm (11.43%)where as maximum data recordedinT0control(11.13%) in table4

Table1. Benefit cost ratio (B: C)

Name of treatment	Yield (Tone/ha)	Gross return (Rs/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	Benefit cost ratio
Control	8.04	321600	120000	201600	1.6
GA3@200	**12.35**	494000	120000	374000	**3.1**
GA3@400	10.24	409600	120000	289600	2.4
GA3@600	9.35	374000	120000	254000	2.1
GA3@800	8.48	339200	120000	219200	1.8
GA3@1000	8.34	333600	120000	213600	1.7
Cytokinin@250	8.60	344000	120000	224000	1.8
Cytokinin@500	10.80	432000	120000	312000	2.6
Cytokinin@750	9.69	387600	120000	267600	2.2
Cytokinin@1000	9.32	372800	120000	252800	2.1

Table2. Mean performance of French bean on growth parameter

Notation	Name of treatment	Day to germination	Plant height (80D.A.S)	No. of branches (80 D.A.S)	No. of Leaves (80 D.A.S)
T0	**Control (water spray)**	11.00	45.73	10.00	177.87
T1	**GA3@200ppm**	**7.37**	**52.07**	**14.47**	**214.93**
T2	**GA3@400ppm**	9.87	49.33	12.20	170.07
T3	**GA3@600ppm**	9.30	49.07	12.53	183.00
T4	**GA3@800ppm**	9.70	49.73	11.57	188.07
T5	**GA3@1000ppm**	8.33	47.73	11.17	182.67
T6	**Cytokinin@250ppm**	10.00	50.13	12.47	186.80
T7	**Cytokinin@500ppm**	8.33	50.67	13.57	187.13
T8	**Cytokinin@750ppm**	9.00	49.60	11.53	182.33
T9	**Cytokinin@1000ppm**	8.33	50.13	12.57	153.73
	F Test	S	S	S	S
	SE(d)±	0.15	1.10	0.23	3.64
	CD(5%)	0.32	2.31	0.48	7.65
	CV	2.02	2.72	2.27	2.44

Table 3. Mean performance of French bean on yield parameter

Notation	Name of treatment	Day of 1st flowering (D.A.S)	Day of 50% flowering (D.A.S)	First picking (D.A.S)	Pod length (cm)	Pod Girth (cm)	Average 10 Pod weight(g)	1 Pod weight (g)	pod per plant	Yield/ha (Tone)
T0	**Control (waterspray)**	52.00	64.33	76.33	15.37	2.13	52.80	5.28	15.23	8.04
T1	**GA3@200ppm**	**42.33**	**53.67**	**63.33**	**16.50**	**2.63**	**57.63**	**5.70**	**21.67**	**12.35**
T2	**GA3@400ppm**	46.67	57.00	67.50	15.87	2.33	55.33	5.53	18.53	10.24
T3	**GA3@600ppm**	46.67	56.67	66.77	16.00	2.37	54.00	5.40	17.33	9.35
T4	**GA3@800ppm**	48.00	56.33	65.37	16.20	2.37	55.07	5.50	15.43	8.48
T5	**GA3@1000ppm**	45.33	55.67	65.43	15.83	2.20	52.40	5.24	15.93	8.34
T6	**Cytokinin@250ppm**	47.33	55.67	66.20	16.33	2.17	52.77	5.27	16.33	8.60
T7	**Cytokinin@500ppm**	45.33	53.67	65.37	15.80	2.37	54.30	5.43	19.90	10.80
T8	**Cytokinin@750ppm**	46.00	53.00	66.90	15.70	2.20	50.73	5.07	19.13	9.69
T9	**Cytokinin@1000ppm**	46.33	54.33	69.20	15.63	2.13	52.97	5.29	17.63	9.32
	F Test	S	S	S	S	S	S	S	S	S
	SE(d)±	0.53	1.10	1.30	0.22	0.05	1.58	0.32	0.32	0.09
	CD(5%)	1.12	2.32	2.74	0.46	0.10	4.54	0.68	0.68	0.18
	CV	1.40	2.41	2.37	1.70	2.51	3.59	2.25	2.25	1.79

Table 4. Mean performance of French bean on Quality parameter

Notation	Name of treatment	TSS(°Brix)	Protein (%)	Fiber (%)	Vit C (mg)
T0	**Control (waterspray)**	5.13	1.45	3.82	11.13
T1	**GA3@200ppm**	**6.37**	**1.52**	**3.89**	**11.77**
T2	**GA3@400ppm**	5.30	1.46	3.86	11.57
T3	**GA3@600ppm**	5.73	1.48	3.86	11.43
T4	**GA3@800ppm**	5.53	1.47	3.84	11.43
T5	**GA3@1000ppm**	5.57	1.49	3.85	11.37
T6	**Cytokinin@250ppm**	5.47	1.49	3.85	11.57
T7	**Cytokinin@500ppm**	5.63	1.50	3.88	11.60
T8	**Cytokinin@750ppm**	5.13	1.45	3.82	11.13
T9	**Cytokinin@1000ppm**	6.37	1.52	3.89	11.77

CONCLUSION

Based on the results of the present investigation, itwas concluded that cultivation of French bean with application of GA3@200ppm recorded significantly higher in term of growth, quality, yield(12.35t/ha) and benefit-cost ratio (3.1)as compare to other treatments

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Fig.1.production scenario

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