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Influence of PGRs on growth parameters and plant growth analysis of cluster bean cv. Pusa Navbahar

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Abstract
A field experiment was carried out, with a view to study the influence of PGRs on growth parameters and plant growth analysis of cluster bean cv. Pusa Navbahar at the Vegetable Research Scheme, Regional Horticultural Research Station of the Navsari Agricultural University, Navsari, Gujarat, India during Summer 2016 and 2017. The experiment was conducted in randomized block design with three replications, which included 13 treatments. The results revealed that application of GA_3 20 mg l^{-1} recorded higher values for growth characters namely, plant height; number of leaves $plant^{-1}$; fresh weight of plant, dry matter content of plant and stem diameter on pooled analysis basis. Results of plant growth analysis *viz.*, leaf area; leaf area index and crop growth rate found significant on pooled basis except net assimilation rate. Under all plant growth analysis, treatment T_4 (GA_3 20 mg l^{-1}) was found best treatment.

Keywords: Cluster bean, PGRs, growth and plant growth analysis

Introduction
Technological breakthrough in Indian agriculture has brought about rapid increase in the productivity levels of crops. In agricultural scenario of different countries, vegetable farming is given precedence attention in view of the great importance of these crops due to a good source of income to the growers and forms a vital part of human diet in terms of nutrition such as leguminous vegetables which are the rich source of protein, fibres, mineral and vitamins. Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] is grown for its young tender green immature pods, which are used as a nutritive vegetable. In spite of commercial importance of cluster bean crop in our daily diet and wide spread cultivation; availability of good quality cluster bean is not satisfactory. Several attempts have been made to increase the yield potential of pulses, but they are primarily concerned with the use of fertilizers, pesticides and better management practices coupled with genetic improvement. But, very little attention has been given to the physiological processes, which limit the crop productivity. Application of growth promoting hormones *i.e.*, Plant Growth Regulators (PGRs) is a recent technique in this direction. Plant growth regulators are known to influence growth and development at very low concentrations but inhibit plant growth and development at high concentration (Ibrahim *et al.*, 2007) [5]. Such substances are therefore potentially useful in horticulture, because suitable concentrations applied at appropriate times will increase the yield either by altering dry matter distribution in the plant or by regulating growth. Thus, application of plant growth substances on various leguminous crops which were found effective for increasing growth and yield parameters. Therefore, an attempt has been made to study the influence of PGRs on growth parameters and plant growth analysis of cluster bean cv. Pusa Navbahar.

Materials and Methods
The experiment was undertaken at the Vegetable Research Scheme, Regional Horticultural Research Station of the Navsari Agricultural University, Navsari, Gujarat, India during Summer 2016 and 2017 on cv. Pusa Navbahar to investigate the influence of PGRs on growth parameters and plant growth analysis of cluster bean cv. Pusa Navbahar. The experiment was conducted in randomized block design (RBD), which included 13 treatments namely, T_1: NAA 20 mg l^{-1}, T_2: NAA 40 mg l^{-1}, T_3: NAA 60 mg l^{-1}, T_4: GA_3 20 mg l^{-1}, T_5: GA_3 40 mg l^{-1}, T_6: GA_3 60 mg l^{-1}, T_7: Thiourea 250 mg l^{-1}, T_8: Thiourea 500 mg l^{-1}, T_9: Thiourea 750 mg l^{-1}, T_{10}:

NAA 20 mg l^{-1} + GA_3 20 mg l^{-1}, T_{11}: NAA 20 mg l^{-1} + Thiourea 250 mg l^{-1}, T_{12}: GA_3 20 mg l^{-1} + Thiourea 250 mg l^{-1} and T_{13}: Control. The experiment included three replications. At the time of 50% flowering, foliar sprays were made at early hours of morning to avoid dehydration effect at mid-day.

For recording different field observations, five plants of cluster bean from each net plot area were selected randomly in the beginning and tagged with the labels. For destroyable character *viz.,* fresh weight of plant, dry matter content of plant, leaf area, leaf area index, crop growth rate and net assimilation rate at 60 DAS and at 90 DAS one plant was selected which was uprooted by keeping border plants. Observations were recorded as per characters. Plant growth analysis was done with the method given by Gardner *et al.* (2003) [3]. Leaf area was measured by leaf area meter (image analyzer), in which leaves from randomly selected one plant was used and after computing the result, it was worked out in centimetre square per plant at 60 and 90 DAS. Leaf area per plant was used to work out leaf area index at 60 and 90 DAS using equation given by (Watson, 1947) [12]. Crop growth rate is the gain in dry matter production on a unit of land in a unit of time. It was computed at 60-90 DAS. Net assimilation rate is the rate of dry weight increase per unit leaf area per unit time. NAR directly indicates the rate of net photosynthesis. It was calculated at 60-90 DAS by using formula and expressed as weight area^{-1} time^{-1} *i.e.*, g cm^{-2} day^{-1}. The collected data were subjected to statistical analysis as per Panse and Sukhatme (1967) [8].

Results and Discussion

A perusal of the data revealed that the plant height was significantly influenced by different treatments under study. In pooled analysis, application of GA_3 20 mg l^{-1} (T_4) recorded the maximum plant height (95.10 cm) at 60 DAS and was at par with the plants fed through T_1, T_{11}, T_7 and T_2. At 90 DAS, application of GA_3 20 mg l^{-1} (T_4) recorded the maximum plant height (142.83 cm) and was at par with the plants fed through T_1, T_{11}, T_7 and T_2. This might be due to increasing cell wall extensibility by GA_3. Gibberellins increasing cell elongation as well as division and decreased the minimum force in tissue levels that will cause cell wall extension. It was also reported that GA_3 increasing plasticity of the cell wall followed by hydrolysis of starch to sugars which lowers the water potential of cell, resulting in the entry of water into the cell causing elongation. These results are in accordance with other researchers *viz.,* Meena *et al*. (2014) [6] and Patel, Priyanka *et al*. (2015) [9] in cluster bean; Nabi *et al.* (2014) [7] and Golakiya *et al.* (2017) [4] in cowpea; Rathod *et al.* (2015) [10] in french bean; Singh *et al*. (2015) [11] in pea; Ibrahim *et al.* (2007) [5], Zewail *et al.* (2011) [13] and Amin *et al.* (2014) [2] in faba bean. (Table 1)

In Pooled analysis, application of GA_3 20 mg l^{-1} (T_4) recorded the maximum number of leaves plant^{-1} (18.50) at 60 DAS and was at par with the plants fed through T_1 only. However, the values of number of leaves plant^{-1} under different treatments varied from 14.07 to 18.50. At 90 DAS, application of GA_3 20 mg l^{-1} (T_4) recorded the maximum number of leaves plant^{-1} (30.03) and was at par with the plants fed through T_1 and T_{11}. The increase in number of leaves per plant is mainly due to enhanced cell elongation and cell division. It enhanced the photosynthesis, respiration and catalyse activites in plant, hence enhanced the number of leaves per plant. Similar results were obtained by Patel, Priyanka *et al.* (2015) [9] in cluster bean; Nabi *et al.* (2014) [7] in cowpea; Rathod *et al.* (2015) [10] in french bean; Singh *et al*. (2015) [11] in pea; Ibrahim *et al.* (2007) [5], Zewail *et al.* (2011) [13] and Amin *et al.* (2014) [2] in faba bean.

With regard to pooled analysis, the fresh weight of plant at 60 DAS, ranged from 6.99 to 8.57 t ha^{-1}. Application of GA_3 20 mg l^{-1} (T_4) was found superior treatments recording the highest fresh weight of plant (8.57 t ha^{-1}). Although, treatment T_1, T_{11} and T_7 were at par with it. At 90 DAS, the fresh weight of plant ranged from 16.01 to 18.48 t ha^{-1}. Application of GA_3 20 mg l^{-1} (T_4) was recording the highest fresh weight of plant (18.48 t ha^{-1}). Although, treatment T_1, T_{11}, T_7, T_2, T_{12}, T_5 and T_{13}were at par with it. (Table 2)

On the basis of pooled analysis, it was observed that the dry matter content of plant at 60 DAS of cluster bean plant ranged between 1.15 and 1.58 t ha^{-1}. Treatment T_4 (consisting of GA_3 20 mg l^{-1}) recorded higher dry matter (1.58 t ha^{-1}) which was found to be statistically at par with the treatment T_1, T_{11}, T_7, T_2 and T_{12}. On the other hand, treatment T_{10} having NAA 20 mg l^{-1} + GA_3 20 mg l^{-1} recorded the lower value of dry matter (1.15 t ha^{-1}) and it was at par with treatment T_9.

At 90 DAS, significantly the highest dry matter (2.90 t ha^{-1}) was recorded with the treatment T_4 consisting GA_3 20 mg l^{-1}. The next best treatment was T_1 and it was at par with treatment T_{11} and T_7. The lower dry matter (1.58 t ha^{-1}) was noticed under the T_{10}, which was at par with the treatments T_9. This was obviously due to better vegetative growth in terms of plant height, inclusive of whole canopy which was reflected through fresh weight and dry matter contents. GA_3 stimulate various physiological processes governed under plant levels which ultimately reflected in the increase in plant fresh and dry matter which was attributed to the increase in leaf area and leaf number per plant. Large amounts of dry matter are produced when cluster bean plants maintain relatively large and healthy leaf areas for prolonged periods. The research results are in conformity with some early reports *viz.,* Meena *et al*. (2014) [6] and Patel, Priyanka *et al*. (2015) [9] in cluster bean; Nabi *et al.* (2014) [7] in cowpea; Ibrahim *et al.* (2007) [5] and Amin *et al.* (2014) [2] in faba bean.

Looking at the pooled analysis, the results were significant. The stem diameter was recorded between 1.34 and 1.79 cm. Higher stem diameter (1.79 cm) was observed under the treatment of T_4 and was near to treatment T_1 and T_{11}. Treatment T_{10} recorded minimum stem diameter (1.34 cm) and it was at par with T_9. The increase in stem diameter (cm) with treatment T_4 (GA_3 20 mg l^{-1}) might be due to plant growth regulators role in plant growth and development because they acts on all developmental plant processes, ultimately enhanced the photosynthesis, respiration and catalyse activites in plant, hence enhanced the stem diameter. The results are in agreement with the findings of Ahmadi *et al.* (2017) [1] in cluster bean crop with humic acid experiment also. (Table 3)

It is evident from the data that leaf area was found to be significant under various treatments. The perusal of pooled data indicated that leaf area at 60 DAS varied from 1286.53 to 3402.07 cm^2 plant^{-1}. The maximum leaf area was recorded under the treatment of T_4 and similar trend observed as in second year trial. At 90 DAS also similar trend observed as in 60 DAS. But it was varied from 1544.40 to 4429.58 cm^2 plant^{-1}. The perusal of pooled data indicated that leaf area index at 60 DAS varied from 0.95 to 2.52. The maximum leaf area index was recorded under the treatment of T_4. It was significantly superior treatment. And similar trend observed as in second year trial (Table 4). At 90 DAS also similar trend observed as in 60 DAS. But it was varied from 1.14 to 3.28.

Increased leaf area due to increase in photosynthetic activity, accelerated translocation and efficiency of utilizing photosynthetic products, thus resulting in increasing cell division and plasticity of the cell wall followed by hydrolysis of starch to sugars which lowers the water potential of cell, resulting in the entry of water into the cell causing elongation leading to enhanced leaf growth. Similar views in the direction of present findings were also expressed by Patel, Priyanka *et al*. (2015) [9] in cluster bean; Nabi *et al.* (2014) [7] in cowpea; Ibrahim *et al.* (2007) [5], Zewail *et al.* (2011) [13] and Amin *et al.* (2014) [2] in faba bean.

The results of the pooled analysis of the data on CGR showed that treatment T_4 observed significantly the highest CGR (4.37 g m^{-2} day^{-1}); whereas, the lower CGR (1.44 g m^{-2} day^{-1}) was noticed under the treatment T_{10} which was at par with T_9. The range was from 1.44 to 4.37 g m^{-2} day^{-1}. The rapid increase in CGR observed under the effect of growth regulators which had significant and positive correlation with bio-chemical and physiological processes that increased the size of photosynthetic area coupled with increased cell multiplication which leads to higher production of dry matter that enhance CGR. These results are in accordance with other researchers *viz.*, Patel, Priyanka *et al*. (2015) [9] in cluster bean, Nabi *et al.* (2014) [7] in cowpea and Amin *et al.* (2014) [2] in faba bean.

Another important growth parameter apart from CGR was net assimilation rate (NAR). Here, NAR at 60-90 DAS found to be non-significant during cropping period and in pooled analysis also. Similar result was obtained in cluster bean by Patel, Priyanka *et al*. (2015) [9]. (Table 5)

Table 1: Effect of different treatments on growth characters *viz.*, Plant height (cm) at 60 DAS, Plant height (cm) at 90 DAS and Number of leaves $plant^{-1}$ at 60 DAS of cluster bean cv. Pusa Navbahar

Treatments	Plant height (cm) at 60 DAS			Plant height (cm) at 90 DAS			Number of leaves $plant^{-1}$ at 60 DAS		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
T_1: NAA 20 mg l^{-1}	95.13	94.13	94.63	139.47	138.07	138.77	17.73	16.93	17.33
T_2: NAA 40 mg l^{-1}	87.80	87.53	87.67	134.53	134.40	134.47	16.27	16.40	16.33
T_3: NAA 60 mg l^{-1}	75.40	74.40	74.90	122.00	122.80	122.40	15.07	14.73	14.90
T_4: GA_3 20 mg l^{-1}	95.53	94.67	95.10	143.67	142.00	142.83	18.87	18.13	18.50
T_5: GA_3 40 mg l^{-1}	86.67	85.40	86.03	131.60	130.27	130.93	15.60	15.73	15.67
T_6: GA_3 60 mg l^{-1}	78.27	79.13	78.70	126.60	126.13	126.37	15.27	15.33	15.30
T_7: Thiourea 250 mg l^{-1}	90.87	89.00	89.93	134.93	136.73	135.83	16.60	16.47	16.53
T_8: Thiourea 500 mg l^{-1}	76.53	77.40	76.97	125.47	125.93	125.70	15.20	14.87	15.03
T_9: Thiourea 750 mg l^{-1}	73.33	74.13	73.73	117.67	118.67	118.17	14.60	14.53	14.57
T_{10}: NAA 20 mg l^{-1} + GA_3 20 mg l^{-1}	71.80	71.60	71.70	112.60	113.13	112.87	14.27	13.87	14.07
T_{11}: NAA 20 mg l^{-1}+Thiourea 250 mg l^{-1}	93.87	92.33	93.10	138.47	137.13	137.80	16.60	16.93	16.77
T_{12}: GA_3 20 mg l^{-1} +Thiourea 250 mg l^{-1}	86.93	86.20	86.57	132.47	132.87	132.67	16.20	16.33	16.27
T_{13}: Control	81.20	81.67	81.43	129.13	129.40	129.27	15.33	15.40	15.37
Year Mean	84.10	83.66	83.88	129.89	129.81	129.85	15.97	15.82	15.89
S.Em. ±	4.54	4.36	2.82	5.54	5.28	3.43	0.73	0.69	0.46
C.D. at 5%	13.25	12.73	7.98	16.17	15.40	9.70	2.12	2.02	1.29
C.V. %	9.35	9.03	9.19	7.38	7.04	7.21	7.89	7.59	7.74
YT: S.Em. ±			4.45			5.41			0.71
YT: C.D. at 5%			NS			NS			NS

Table 2: Effect of different treatments on growth characters *viz.*, Number of leaves $plant^{-1}$ at 90 DAS, Fresh weight of plant (t ha^{-1}) at 60 DAS and Fresh weight of plant (t ha^{-1}) at 90 DAS of cluster bean cv. Pusa Navbahar

Treatments	Number of leaves $plant^{-1}$ at 90 DAS			Fresh weight of plant (t ha^{-1}) at 60 DAS			Fresh weight of plant (t ha^{-1}) at 90 DAS		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
T_1: NAA 20 mg l^{-1}	29.40	29.33	29.37	8.52	8.56	8.54	18.44	18.44	18.44
T_2: NAA 40 mg l^{-1}	26.80	26.20	26.50	7.82	7.85	7.84	18.27	18.29	18.28
T_3: NAA 60 mg l^{-1}	22.00	22.53	22.27	7.42	7.35	7.39	16.05	16.08	16.06
T_4: GA_3 20 mg l^{-1}	30.07	30.00	30.03	8.54	8.59	8.57	18.47	18.49	18.48
T_5: GA_3 40 mg l^{-1}	23.53	24.93	24.23	7.76	7.79	7.78	18.16	18.19	18.18
T_6: GA_3 60 mg l^{-1}	23.00	23.27	23.13	7.53	7.51	7.52	16.40	16.43	16.42
T_7: Thiourea 250 mg l^{-1}	27.33	26.33	26.83	8.32	8.32	8.32	18.40	18.41	18.40
T_8: Thiourea 500 mg l^{-1}	22.87	23.00	22.93	7.49	7.42	7.46	16.30	16.33	16.31
T_9: Thiourea 750 mg l^{-1}	21.20	21.07	21.13	7.32	7.34	7.33	16.02	16.05	16.04
T_{10}: NAA 20 mg l^{-1} + GA_3 20 mg l^{-1}	19.87	20.47	20.17	6.98	6.99	6.99	16.00	16.03	16.01
T_{11}: NAA 20 mg l^{-1}+Thiourea 250 mg l^{-1}	29.27	28.13	28.70	8.41	8.40	8.41	18.42	18.44	18.43
T_{12}: GA_3 20 mg l^{-1} + Thiourea 250 mg l^{-1}	25.33	25.00	25.17	7.82	7.79	7.80	18.25	18.28	18.26
T_{13}: Control	23.40	24.40	23.90	7.59	7.59	7.59	17.08	17.10	17.09
Year Mean	24.93	24.97	24.95	7.81	7.81	7.81	17.41	17.43	17.42
S.Em. ±	1.07	1.19	0.74	0.33	0.34	0.21	0.71	0.71	0.45
C.D. at 5%	3.13	3.48	2.08	0.97	0.98	0.60	2.08	2.08	1.27
C.V. %	7.45	8.27	7.87	7.34	7.46	7.40	7.09	7.07	7.08
YT: S.Em. ±			1.13			0.33			0.71
YT: C.D. at 5%			NS			NS			NS

Table 3: Effect of different treatments on growth characters *viz.*, Dry matter content of plant (t ha^{-1}) at 60 DAS, Dry matter content of plant (t ha^{-1}) at 90 DAS and Stem diameter (cm) of cluster bean cv. Pusa Navbahar

Treatments	Dry matter content of plant (t ha^{-1}) at 60 DAS			Dry matter content of plant (t ha^{-1}) at 90 DAS			Stem diameter (cm)		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
T_1: NAA 20 mg l^{-1}	1.52	1.52	1.52	2.55	2.58	2.56	1.69	1.67	1.68
T_2: NAA 40 mg l^{-1}	1.48	1.47	1.48	2.23	2.23	2.23	1.58	1.60	1.59
T_3: NAA 60 mg l^{-1}	1.28	1.29	1.29	1.83	1.83	1.83	1.47	1.46	1.46
T_4: GA_3 20 mg l^{-1}	1.59	1.58	1.58	2.87	2.92	2.90	1.79	1.80	1.79
T_5: GA_3 40 mg l^{-1}	1.41	1.40	1.41	2.18	2.18	2.18	1.57	1.58	1.58
T_6: GA_3 60 mg l^{-1}	1.34	1.33	1.34	2.08	2.07	2.08	1.52	1.51	1.51
T_7: Thiourea 250 mg l^{-1}	1.49	1.49	1.49	2.45	2.44	2.45	1.65	1.64	1.64
T_8: Thiourea 500 mg l^{-1}	1.30	1.32	1.31	1.91	1.95	1.93	1.48	1.49	1.48
T_9: Thiourea 750 mg l^{-1}	1.19	1.18	1.18	1.63	1.65	1.64	1.35	1.36	1.36
T_{10}: NAA 20 mg l^{-1} + GA_3 20 mg l^{-1}	1.15	1.15	1.15	1.58	1.58	1.58	1.34	1.35	1.34
T_{11}: NAA 20 mg l^{-1}+Thiourea 250 mg l^{-1}	1.51	1.51	1.51	2.45	2.44	2.45	1.67	1.65	1.66
T_{12}: GA_3 20 mg l^{-1} + Thiourea 250 mg l^{-1}	1.41	1.42	1.42	2.23	2.22	2.23	1.57	1.58	1.58
T_{13}: Control	1.36	1.36	1.36	2.11	2.10	2.11	1.57	1.53	1.55
Year Mean	1.39	1.39	1.39	2.16	2.17	2.17	1.56	1.55	1.56
S.Em. ±	0.08	0.08	0.05	0.09	0.10	0.06	0.07	0.07	0.05
C.D. at 5%	0.23	0.24	0.14	0.25	0.28	0.16	0.21	0.21	0.13
C.V. %	9.95	10.09	10.02	7.00	7.65	7.33	8.16	8.16	8.16
YT: S.Em. ±			0.08			0.09			0.07
YT: C.D. at 5%			NS			NS			NS

Table 4: Effect of different treatments on plant growth analysis characters *viz.*, Leaf area (cm^2 $plant^{-1}$) at 60 DAS, Leaf area (cm^2 $plant^{-1}$) at 90 DAS and Leaf area index at 60 DAS of cluster bean cv. Pusa Navbahar

Treatments	Leaf area (cm^2 $plant^{-1}$) at 60 DAS			Leaf area (cm^2 $plant^{-1}$) at 90 DAS			Leaf area index at 60 DAS		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
T_1: NAA 20 mg l^{-1}	2698.43	2682.73	2690.58	3701.80	3686.40	3694.10	2.00	1.99	1.99
T_2: NAA 40 mg l^{-1}	2369.00	2405.76	2387.38	3457.03	3451.34	3454.18	1.75	1.78	1.77
T_3: NAA 60 mg l^{-1}	1742.18	1745.85	1744.01	2346.26	2360.11	2353.19	1.29	1.29	1.29
T_4: GA_3 20 mg l^{-1}	3401.10	3403.04	3402.07	4432.57	4426.59	4429.58	2.52	2.52	2.52
T_5: GA_3 40 mg l^{-1}	2274.41	2338.55	2306.48	3199.24	3203.93	3201.58	1.69	1.73	1.71
T_6: GA_3 60 mg l^{-1}	2229.27	2231.93	2230.60	2940.98	2942.44	2941.71	1.65	1.65	1.65
T_7: Thiourea 250 mg l^{-1}	2466.43	2472.80	2469.61	3546.59	3555.95	3551.27	1.83	1.83	1.83
T_8: Thiourea 500 mg l^{-1}	2157.05	2126.51	2141.78	2593.32	2609.42	2601.37	1.60	1.57	1.59
T_9: Thiourea 750 mg l^{-1}	1534.83	1636.93	1585.88	2108.91	2096.91	2102.91	1.14	1.21	1.18
T_{10}: NAA 20 mg l^{-1} + GA_3 20 mg l^{-1}	1281.06	1292.00	1286.53	1541.77	1547.03	1544.40	0.95	0.96	0.95
T_{11}: NAA 20 mg l^{-1}+Thiourea 250 mg l^{-1}	2694.91	2627.55	2661.23	3672.06	3667.66	3669.86	2.00	1.95	1.97
T_{12}: GA_3 20 mg l^{-1} + Thiourea 250 mg l^{-1}	2338.76	2344.07	2341.41	3456.81	3439.61	3448.21	1.73	1.74	1.74
T_{13}: Control	2274.33	2266.77	2270.55	3041.45	3043.85	3042.65	1.69	1.68	1.68
Year Mean	2266.29	2274.96	2270.63	3079.91	3079.33	3079.62	1.68	1.69	1.68
S.Em. ±	99.70	101.72	64.38	142.71	142.38	90.19	0.07	0.07	0.05
C.D. at 5%	291.01	296.90	182.08	416.57	415.61	255.09	0.22	0.22	0.13
C.V. %	7.62	7.74	7.68	8.03	8.01	8.02	7.61	7.70	7.66
YT: S.Em. ±			100.71			142.55			0.07
YT: C.D. at 5%			NS			NS			NS

Table 5: Effect of different treatments on plant growth analysis characters *viz.*, Leaf area index at 90 DAS, Crop growth rate (g m^{-2} day^{-1}) at 60-90 DAS, Net assimilation rate (g cm^{-2} day^{-1}) at 60-90 DAS of cluster bean cv. Pusa Navbahar

Treatments	Leaf area index at 90 DAS			Crop growth rate (g m^{-2} day^{-1}) at 60-90 DAS			Net assimilation rate (g cm^{-2} day^{-1}) at 60-90 DAS		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
T_1: NAA 20 mg l^{-1}	2.74	2.73	2.74	3.41	3.53	3.47	1.47 x 10^{-4}	1.53 x 10^{-4}	1.50 x 10^{-4}
T_2: NAA 40 mg l^{-1}	2.56	2.56	2.56	2.49	2.51	2.50	1.17 x 10^{-4}	1.17 x 10^{-4}	1.17 x 10^{-4}
T_3: NAA 60 mg l^{-1}	1.74	1.75	1.74	1.83	1.78	1.80	1.22 x 10^{-4}	1.18 x 10^{-4}	1.20 x 10^{-4}
T_4: GA_3 20 mg l^{-1}	3.28	3.28	3.28	4.28	4.46	4.37	1.48 x 10^{-4}	1.53 x 10^{-4}	1.51x 10^{-4}
T_5: GA_3 40 mg l^{-1}	2.37	2.37	2.37	2.56	2.58	2.57	1.28 x 10^{-4}	1.28 x 10^{-4}	1.28 x 10^{-4}
T_6: GA_3 60 mg l^{-1}	2.18	2.18	2.18	2.47	2.46	2.46	1.29 x 10^{-4}	1.29 x 10^{-4}	1.29 x 10^{-4}
T_7: Thiourea 250 mg l^{-1}	2.63	2.63	2.63	3.20	3.18	3.19	1.45 x 10^{-4}	1.45 x 10^{-4}	1.45 x 10^{-4}
T_8: Thiourea 500 mg l^{-1}	1.92	1.93	1.93	2.02	2.11	2.06	1.15 x 10^{-4}	1.21 x 10^{-4}	1.18 x 10^{-4}
T_9: Thiourea 750 mg l^{-1}	1.56	1.55	1.56	1.48	1.57	1.53	1.11 x 10^{-4}	1.14 x 10^{-4}	1.13 x 10^{-4}
T_{10}: NAA 20 mg l^{-1} + GA_3 20 mg l^{-1}	1.14	1.14	1.14	1.44	1.44	1.44	1.36 x 10^{-4}	1.35 x 10^{-4}	1.36 x 10^{-4}
T_{11}: NAA 20 mg l^{-1}+Thiourea 250 mg l^{-1}	2.72	2.72	2.72	3.12	3.10	3.11	1.33 x 10^{-4}	1.34 x 10^{-4}	1.34 x 10^{-4}
T_{12}: GA_3 20 mg l^{-1} + Thiourea 250 mg l^{-1}	2.56	2.55	2.56	2.71	2.68	2.70	1.28 x 10^{-4}	1.27 x 10^{-4}	1.27 x 10^{-4}
T_{13}: Control	2.25	2.26	2.25	2.50	2.48	2.49	1.28 x 10^{-4}	1.26 x 10^{-4}	1.27 x 10^{-4}
Year Mean	2.28	2.28	2.28	2.58	2.61	2.59	1.30 x 10^{-4}	1.31 x 10^{-4}	1.30 x 10^{-4}
S.Em. ±	0.11	0.11	0.07	0.32	0.37	0.22	0.14 x 10^{-4}	0.16 x 10^{-4}	0.10 x 10^{-4}
C.D. at 5%	0.31	0.31	0.19	0.94	1.08	0.62	NS	NS	NS
C.V. %	8.02	8.01	8.01	21.52	24.52	23.09	19.09	21.68	20.43
YT: S.Em. ±			0.11			0.35			0.15 x 10^{-4}
YT: C.D. at 5%			NS			NS			NS

Conclusion

From the research results of two years study, it was inferred that foliar spray of GA_3 20 mg l^{-1} at the time of 50% flowering stage under south Gujarat Agro-climatic conditions gave better influence on growth characters and plant growth analysis.

References

1. Ahmadi S, Hatamzadeh A, Biglueii MH, Sahraroo A. Effect of humic acid on some morphological traits of guar (*Cyamopsis tetragonoloba*) in Karaj region. J. Biodiversity and Env. Sci. 2017; 11(1):287-295.
2. Amin AA, Abouziena HF, Abdelhamid MT, Rashad El-Sh M, Fatma Gharib AE. Improving Growth and Productivity of Faba Bean Plants by Foliar Application of Thiourea and Aspartic Acid. Int. J. Plant and Soil Sci. 2014; 3(6):724-736.
3. Gardner FP, Pearce RB, Mitchell RL. Physiology of crop plants, Scientific Publishers, Jodhpur, 2003, 187-207.
4. Golakiya PD, Saravaiya SN, Patel CR, Habibullah. Evaluation of GA_3 on performance of cowpea (*Vigna unguiculata* (L.) Walp.). Trends Biosci. 2017; 10(13):2429-2433.
5. Ibrahim ME, Bekheta MA, El-Moursi A, Gaafar NA. Improvement of Growth and Seed Yield Quality of *Vicia faba* L. Plants as Affected by Application of Some Bioregulators. Australian J. Basic and Applied Sci. 2007; 1(4):657-666.
6. Meena VK, Kaushik MK, Meena RS, Meena VS, Meena BP. Effect of growth regulators on cluster bean [*Cyamopsis tetragonoloba* (L.)] growth under aravali hills environment in Rajasthan. Bioscan. 2014; 9(2):547-550.
7. Nabi AJMN, Hasan MM, Alam MS, Islam MS, Islam MR. Responses of Gibberelic Acid (GA_3) on Growth and Yield of Cowpea cv. BARI Falon-1 (*Vigna unguiculata* L.). J. Env. Sci. and Nat. Resources. 2014 ; 7(2):7-12.
8. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers, Indian Council of Agricultural Research, New Delhi, India, 1967, 152-161.
9. Patel Priyanka, Saravaiya SN, Ahlawat TR, Patel NB. Effect of decapitation and PGRs on parameters of plant growth analysis of cluster bean (*Cyamopsis tetragonoloba* Taub.) cv. Pusa Navbahar. Multilogic Sci. 2015; 5(13):155-159.
10. Rathod RR, Gore RV, Bothikar PA. Effect of Growth Regulators on Growth and Yield of French bean (*Phaseolus vulgaris* L.) Var. Arka Komal. IOSR J. Agric. and Vet. Sci. 2015; 8(5):36-39.
11. Singh M, John SA, Rout S, Patra SS. Effect of GA_3 and NAA on growth and quality of garden pea (*Pisum sativum* L.) cv. Arkel. Bioscan. 2015; 10(3):381-383.
12. Watson DJ. Comparative physiological studies on the growth of field crops. I. Variation in net assimilation rate and leaf area between species and varieties, and within and between years. Annl. Botany. 1947; 11(1):41-76.
13. Zewail RMY, Khder ZMA, Mady MA. Effect of potassium, some antioxidants, phosphoric acid and napthalen acetic acid (NAA) on growth and productivity of faba bean plants (*Faba vulgaris*). Annals Agric. Sci. 2011; 49(1):53-64.