**Abstract**

The seed cluster bean exhibited significant variations in the growth and yield due to spray of growth regulators during kharif and rabi seasons at 30, 60 and 90 days after sowing (DAS). At 90 DAS, the highest plant height (kharif 63.99 cm; rabi 59.32) was recorded by HG 365. Among the growth regulators, maximum plant height (kharif 85.13 cm; rabi 78.92 cm) was recorded by the application of triacontanol at 1500 ppm which was on par with 1000 ppm (kharif 82.63 cm; rabi 76.60 cm). The earliest occurrence of 50% flowering (kharif 24.65; rabi 22.68) was observed in the var. HG 563. Among the growth regulators, the lowest number of days to 50% flowering (kharif 23.09; rabi 21.24) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (kharif 23.71; rabi 21.81). Among the growth regulators, maximum seed yield per plot (kharif 2.01 kg; rabi 1.91 kg) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (kharif 1.98 kg; rabi 1.88 kg).

**Keywords**

Plant Growth Regulators, Growth and Yield and seed guar

**Introduction**

The physiological efficiency including photosynthetic ability of plants are improved by plant growth regulating chemicals and therefore offer a significant role in realizing higher crop yields. The PGR’s are also known to enhance the source-sink relationship and stimulate the translocation of photo-assimilates, thereby increasing the productivity. Though, the plant growth regulators have great potential, its application and assessment etc. have to be judiciously planned in terms of optimal concentration, stage of application, species specificity and seasons. In their wide spectrum of effectiveness on every aspect of plant growth, even a modest increase of 10-15 per cent could bring about an increment in the gross annual productivity by 10-15 m tons. The effect of PGRs particular new compounds on cluster bean has not been evaluated and hence the data on this aspect is scarce. Under these conditions, the spray of growth regulating chemicals on partitioning of dry weight among different parts and ultimately the seed yield is studied in the present study.
Materials and Methods

The present experiment was conducted on seed guar cultivars HG 365 and HG 563 by applying with growth regulating chemicals in a factorial experiment under Mahanandi conditions both during Kharif and Rabi seasons of two years from 2015 to 2017. Foliar sprays of chemicals viz., cycocel, mepiquat chloride and triacontanol were given twice at 20 and 40 days after sowing. Each of these chemicals was tried at three different concentrations i.e. 500, 1000 and 1500 ppm. The crop was spaced at 30 cm x 10 cm and applied with a uniform nutrient dose of N at 30 kg ha\(^{-1}\) + P at 40 kg ha\(^{-1}\) + K at 40 kg ha\(^{-1}\) + S at 20 kg ha\(^{-1}\).

Results and Discussion

Plant height (cm)

The plant height differed significantly due to spray of growth regulators during kharif and rabi seasons at 30, 60 and 90 days after sowing (DAS). The mean plant height (Table 1 and 2) increased from 23.92 cm and 22.18 cm (30 DAS) to 63.19 cm and 58.58 cm (90 DAS) during kharif and rabi seasons, respectively. At 90 DAS, the highest plant height (kharif 63.99 cm; rabi 59.32) was recorded by HG 365. Among the growth regulators, maximum plant height (kharif 85.13 cm; rabi 78.92 cm) was recorded by the application of triacontanol at 1500 ppm which was on par with 1000 ppm (kharif 82.63 cm; rabi 76.60 cm). The lowest plant height was observed by the spray of MC 1500 ppm (kharif 47.32 cm; rabi 43.87 cm) preceded by MC 1000 ppm (kharif 50.45 cm; rabi 46.77 cm). The control recorded a plant height of 62.85 cm in kharif and 58.26 cm in rabi at 90 DAS, whereas CCC 1500 has shown intermediate values for plant height (kharif 49.58 cm; rabi 45.96 cm).

The height of plant was found to increase throughout the growth period in both the varieties and under the influence of all the growth regulators studied in the present investigation at various concentrations. The foliar spray of growth regulators in early stages (20 and 40 DAS) significantly influenced the plant height and resulted in either increase or decrease in plant height depending on the chemical used in the spray. Significant increase in plant height was observed when the plants were sprayed with triacontanol from 500 ppm to 1000 ppm whereas further increase in concentration of triacontanol did not show significant increase in plant height. Foliar spray of CCC and mepiquat chloride was found to decrease plant height with every increase in the concentration from 500 ppm to 1500 ppm when compared to control.

An increase in the plant height due to application of triacontanol could be attributed to an increase in the meristematic activity of apical tissues. Triacontanol was also said to increase photosynthetic activity and improve the efficiency of translocation and utilization of photosynthates causing rapid cell elongation and cell division at growing region of the plant leading to stimulation of growth, besides increasing the uptake of nutrients (Dicks, 1980). Similar beneficial effect of growth promoters on plant height was also reported by Dashora and Jain (1994) in soybean and Neelam et al., (1995) in lentil.

The lower plant height in CCC (cycocel) and mepiquat chloride applied plants may be due to retardation of transverse cell multiplication particularly in combium, which was the zone of meristematic activity at the base of the internode as reported by (Arun kumar and Uppar, 2007). The results of the present study are in agreement with the findings of Grossman (1990) who opined that the cycocel is an antigibberellin dwarfing agent, leading
to a deficiency of gibberellin in the plant and reduced the growth. Mepiquat chloride also was found to show antigibberellin like activity leading to reduced plant height as observed in case of some pulses (Jeyakumar and Thangaraj, 1996).

**Number of branches per plant**

The number of branches differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons at various growth stages. The mean number of branches (Table 3 and 4) increased from 10.69 and 9.91 (30 DAS) to 22.50 and 26.78 (90 DAS) during *kharif* and *rabi* seasons, respectively. At 90 DAS, the highest number of branches (*kharif* 22.79; *rabi* 27.12) was recorded by HG 365. Among the growth regulators, maximum number of branches (*kharif* 28.74; *rabi* 34.20) was recorded by the application of CCC at 1500 ppm followed by CCC 1000 ppm (*kharif* 25.86; *rabi* 30.78).

The lowest number of branches was observed by the spray of TRIA 1500 ppm (*kharif*: 16.74; *rabi* 19.91) which was on par with TRIA 1000 ppm (*kharif*: 17.24; *rabi* 20.52). Foliar application of mepiquat chloride resulted in intermediary values among which the highest (*kharif* 26.41; *rabi* 31.43) was recorded by MC 1500 ppm. The control recorded 22.67 branches in *kharif* and 26.98 branches in *rabi* at 90 DAS.

Foliar spray of cycocel as well as mepiquat chloride was found to increase the number of branches significantly over the control plants. At 90 days after sowing, an increased number of branches were recorded in the plants supplied with every incremental concentration of cycocel from 500 ppm to 1500 ppm *i.e.* maximum increase was noted from the spray of 1500 ppm cycocel. Among the different concentrations of cycocel, 500 ppm was found to be significantly the least effective in increasing the number of branches. However, the concentration of 1000 ppm was on par with 1500 ppm. On the contrary, the triacontanol sprays were found to reduce the number of branches per plant with increase in its concentration. Application of triacontanol, at 500 ppm exhibited the lowest influence in reducing the number of branches *i.e.* in other words it had the highest number of branches when compared to the foliar application of the same chemical at 1000 and 1500 ppm concentrations. This effect of triacontanol might be due to its positive influence an elongation of plant in vertical axis. With increase in concentration, it increased plant height but reduced number of branches.

The anti-gibberellin activity of cycocel (CCC) and mepiquat chloride might have lowered the growth in vertical axis and therefore, growth correlation mechanism could have boosted more axillary growth by elongating the axillary sprouts into branches (Grossman, 1990). The association of minimum plant height with maximum number of branches under the influence of CCC was also reported by Rathod *et al.*, (2015).

The mechanism of reduction in plant height due to application of CCC and mepiquat chloride appears to be due to slowing down of cell division and reduction in cell expansion. It has been suggested that CCC and mepiquat chloride are antigibberellin dwarfing agents, leading to a deficiency of gibberellins in the plant and reduce the growth by blocking the conversion of geranyl pyrophosphate to capalyl pyrophosphate which happens to be the first step of gibberellin synthesis (Moore, 1980). Similarly, Garai and Datta (2003), Jeyakumar and Thangaraj (1996) also reported decreased plant height and increased number of branches in greengram and groundnut, respectively due to application of growth retardants, *i.e.* CCC and mepiquat chloride.
The application of CCC and mepiquat chloride increased the number of branches significantly and the increase was more pronounced at higher concentrations of the respective chemicals. The increase in the number of branches could be due to the suppression of auxin mediated apical dominance due to the application of growth retardants, thereby diverting the polar transport of auxins towards the basal buds leading to increased branching. Another probable reason could be the oxidative decarboxylation of auxins triggered by the application of these chemicals in the plant system. Such a suppression of auxin activity could have led to dwarfing of plants (Reinecke and Bunderski, 1987). Similarly, Mandal et al., (1997) and Dhaka and Anamika (2003) reported that the application of CCC and mepiquat chloride increased the number of branches in greengram and broad bean, respectively.

**Number of leaves per plant**

The number of leaves differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons at 30, 60 and 90 DAS. The mean number of leaves (Table 5 and 6) increased from 35.75 and 31.81 (30 DAS) to 61.13 and 53.99 (90 DAS) during *kharif* and *rabi* seasons, respectively. At 90 DAS, the highest number of leaves (*kharif* 61.49; *rabi* 54.31) was recorded by HG 365. Among the growth regulators, maximum number of leaves (*kharif* 75.61; *rabi* 66.78) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (*kharif* 73.99; *rabi* 65.34). The lowest number of leaves was observed by the spray of MC 500 ppm (*kharif* 52.79; *rabi* 46.62) preceded by MC 1000 ppm (*kharif* 56.39; *rabi* 49.81). Tricontanol concentrations recorded medium values among which the highest being recorded at TRIA 1500 ppm both in *kharif* (60.72) and *rabi* (53.63) seasons. The control recorded still lesser number of leaves both in *kharif* (52.30 cm) and in *rabi* (46.19 cm) at 90 DAS.

**Days to 50% flowering**

The days to 50% flowering (Table 7) differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons. The earliest occurrence of 50% flowering (*kharif* 24.65; *rabi* 22.68) was observed in the var. HG 563. Among the growth regulators, the lowest number of days to 50% flowering (*kharif* 23.09; *rabi* 21.24) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (*kharif* 23.71; *rabi* 21.81). The highest delay to 50% flowering was noticed by the spray of MC 1500 ppm (*kharif* 29.02; *rabi* 26.70) which was on par with MC 1000 ppm (*kharif* 28.41; *rabi* 26.14). Foliar spray of TRIA 1500 ppm resulted in intermediary values for days to 50% flowering during both the seasons (*kharif* 24.39; *rabi* 22.44). The control recorded 26.97 days to 50% flowering in *kharif* and 24.81 days in *rabi*.

**Dry pod yield per plant (g)**

The spray of growth regulators influenced the weight of dry pods per plant (Table 8) significantly during *kharif* and *rabi* seasons. The highest weight of dry pods per plant (*kharif* 26.19 g; *rabi* 24.10 g) was recorded by HG 365. Among the growth regulators, maximum weight of dry pods per plant (*kharif* 28.44 g; *rabi* 26.17 g) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (kharif 28.01 g; rabi 25.77 g).

The lowest weight of dry pods per plant was observed by the spray of MC 500 ppm (*kharif* 22.62 g; *rabi* 20.81 g) which was on par with MC 1000 ppm (*kharif* 23.16 g; *rabi* 21.31 g) whereas, TRIA 1500 ppm resulted in medium weight of dry pods per plant (*kharif* 26.29 g;...
The control recorded a weight of dry pods per plant of 21.25 g in kharif and 19.55 g in rabi.

The pod yield is the most essential parameter contributing to the seed yield because the only difference lies in pericarps encircling the seeds. The effect of growth regulators was found significant on the pod yield per plant and per plot in both the varieties. As it was observed in case of growth, flowering and quality parameters, the pod yield was found to be highest in case of spray of CCC at 1500 ppm being significantly superior to the same chemical at 1000 ppm. This merit is also revealed from the standpoint of corresponding superiority in having highest duration of pod maturity and bold sized pods and seeds ultimately leading to the highest individual weight of pods per plant with growth regulator sprays.

The next chemicals in the order were triacontanol and mepiquat chloride above the control. The highest concentration of both these chemicals was at parity with 1000 ppm concentration of the corresponding chemicals. The highest concentration of mepiquat chloride (MC 1500 ppm) was found on par with the lowest concentration of triacontanol (TRIA 500 ppm) and similarly the highest of triacontanol (TRIA 1500 ppm) was at parity with the lowest concentration of CCC (cycocel 500 ppm).

The additional concentration beyond 1000 ppm in mepiquat chloride and triacontanol was not resulting in significant superiority in the weight of dry pods per plant as well as per plot. This was not true in case of CCC. The differences in the pod yield or weight of dry pods per plant can be attributed to the similar differences in growth parameters, growth rates and flowering periods as well as pod maturity duration.

Similar observations were made by Prabhavathi (2005) who reported that the application of lihocin (1000 ppm) resulted in significantly higher pod yield followed by miraculan @ 1000 ppm and mepiquat chloride @ 1000 ppm as compared to control in cluster bean. These effects were attributed to their corresponding effect on growth parameters and growth rates as also evident in the present study.

Seed yield per plant (g)

The seed yield per plant (Table 9) differed significantly due to spray of growth regulators during kharif and rabi seasons. The highest seed yield per plant (kharif 16.88 g; rabi 16.04 g) was recorded by HG 365. Among the growth regulators, maximum seed yield per plant (kharif 18.33 g; rabi 17.42 g) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (kharif 18.05 g; rabi 17.15 g). The lowest seed yield per plant was observed by the spray of MC 500 ppm (kharif 14.58 g; rabi 13.85 g) which was on par with MC 1000 ppm (kharif 14.93 g; rabi 14.18 g). TRIA 1500 ppm produced moderate quantities of seed per plant during both kharif (16.94 g) and rabi (16.10 g). The control recorded a seed yield per plant of 13.70 g in kharif and 13.01 g in rabi.

Seed yield per ha (q)

The seed yield per hectare (Table 10) differed significantly due to spray of growth regulators during kharif and rabi seasons. The highest seed yield per hectare (kharif 21.38 q; rabi 20.31 q) was recorded by HG 365. Among the growth regulators, maximum seed yield per hectare (kharif 23.22 q; rabi 22.06 q) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (kharif 22.87 q; rabi 21.73 q).
Table 1. Plant height (cm) as influenced by growth regulators in cluster bean varieties during *kharif*

| Growth regulators (ppm) (B) | Variety (A) |
|---------------------------|-------------|
|                           | 30 DAS | 60 DAS | 90 DAS |
|                           | HG 365 | HG 563 | Mean  | HG 365 | HG 563 | Mean  | HG 365 | HG 563 | Mean  |
| CCC 500                   | 24.00  | 23.40  | 23.70 | 51.12  | 49.84  | 50.48 | 63.39  | 61.80  | 62.60 |
| CCC 1000                  | 21.12  | 20.59  | 20.86 | 44.99  | 43.86  | 44.42 | 55.78  | 54.39  | 55.08 |
| CCC 1500                  | 19.01  | 18.53  | 18.77 | 40.49  | 39.47  | 39.98 | 50.20  | 48.95  | 49.58 |
| MC 500                    | 22.00  | 21.45  | 21.73 | 46.87  | 45.70  | 46.28 | 58.11  | 56.66  | 57.39 |
| MC 1000                   | 19.34  | 18.86  | 19.10 | 41.20  | 40.17  | 40.69 | 51.09  | 49.81  | 50.45 |
| MC 1500                   | 18.14  | 17.69  | 17.92 | 38.65  | 37.68  | 38.16 | 47.92  | 46.72  | 47.32 |
| TRIA 500                  | 30.24  | 29.48  | 29.86 | 64.41  | 62.80  | 63.61 | 79.87  | 77.87  | 78.87 |
| TRIA 1000                 | 31.68  | 30.89  | 31.28 | 67.48  | 65.79  | 66.63 | 83.67  | 81.58  | 82.63 |
| TRIA 1500                 | 32.64  | 31.82  | 32.23 | 69.52  | 67.79  | 68.85 | 86.21  | 84.05  | 85.13 |
| Control                   | 24.10  | 23.49  | 23.79 | 51.32  | 50.04  | 50.68 | 63.64  | 62.05  | 62.85 |
| Mean                      | 24.23  | 23.62  | 23.92 | 51.60  | 50.31  | 50.96 | 63.99  | 62.39  | 63.19 |

| Factor                  | S Em+ | CD   | S Em+ | CD   | S Em+ | CD   |
|-------------------------|-------|------|-------|------|-------|------|
| Variety (A)             | 0.071 | 0.21 | 0.152 | 0.44 | 0.189 | 0.55 |
| Growth regulators (B)   | 0.357 | 1.03 | 0.761 | 2.20 | 0.944 | 2.73 |
| Interaction (A x B)     | -     | NS   | -     | NS   | 1.076 | 3.11 |

CD: CD at 5% level of significance DAS; Days after sowing CCC: Cycocel MC: Mepiquat chloride TRIA: Triacontanol

Table 2. Plant height (cm) as influenced by growth regulators in cluster bean varieties during *rabi*

| Growth regulators (ppm) (B) | Variety (A) |
|---------------------------|-------------|
|                           | 30 DAS | 60 DAS | 90 DAS |
|                           | HG 365 | HG 563 | Mean  | HG 365 | HG 563 | Mean  | HG 365 | HG 563 | Mean  |
| CCC 500                   | 22.25  | 21.69  | 21.97 | 47.39  | 46.21  | 46.80 | 58.77  | 57.30  | 58.03 |
| CCC 1000                  | 19.58  | 19.09  | 19.34 | 41.71  | 40.66  | 41.18 | 51.71  | 50.42  | 51.07 |
| CCC 1500                  | 17.62  | 17.18  | 17.40 | 37.53  | 36.60  | 37.07 | 46.54  | 45.38  | 45.96 |
| MC 500                    | 20.40  | 19.89  | 20.14 | 43.45  | 42.36  | 42.91 | 53.88  | 52.53  | 53.20 |
| MC 1000                   | 17.93  | 17.49  | 17.71 | 38.20  | 37.24  | 37.72 | 47.37  | 46.18  | 46.77 |
| MC 1500                   | 16.82  | 16.40  | 16.61 | 35.83  | 34.93  | 35.38 | 44.43  | 43.32  | 43.87 |
| TRIA 500                  | 28.04  | 27.33  | 27.68 | 59.71  | 58.22  | 58.97 | 74.05  | 72.19  | 73.12 |
| TRIA 1000                 | 29.37  | 28.64  | 29.00 | 62.56  | 60.99  | 61.78 | 77.57  | 75.63  | 76.60 |
| TRIA 1500                 | 30.26  | 29.50  | 29.88 | 64.45  | 62.84  | 63.65 | 79.92  | 77.92  | 78.92 |
| Control                   | 22.34  | 21.78  | 22.06 | 47.58  | 46.39  | 46.99 | 59.00  | 57.53  | 58.26 |
| Mean                      | 22.46  | 21.90  | 22.18 | 47.84  | 46.65  | 47.24 | 59.32  | 57.84  | 58.58 |

| Factor                  | S Em+ | CD   | S Em+ | CD   | S Em+ | CD   |
|-------------------------|-------|------|-------|------|-------|------|
| Variety (A)             | 0.066 | 0.19 | 0.141 | 0.41 | 0.175 | 0.51 |
| Growth regulators (B)   | 0.331 | 0.96 | 0.706 | 2.04 | 0.875 | 2.53 |
| Interaction (A x B)     | -     | NS   | -     | NS   | -     | NS   |

CD: CD at 5% level of significance DAS; Days after sowing CCC: Cycocel MC: Mepiquat chloride TRIA: Triacontanol
### Table 3
Number of branches per plant as influenced by growth regulators in cluster bean varieties during kharif

| Growth regulators (ppm) (B) | Variety (A) | 30 DAS | 60 DAS | 90 DAS |
|----------------------------|-------------|--------|--------|--------|
|                            | HG 365  | HG 563 | Mean   | HG 365 | HG 563 | Mean   |
| CCC 500                    | 10.94   | 10.67  | 10.81  | 21.34  | 20.81  | 21.07  |
| CCC 1000                   | 12.44   | 12.13  | 12.28  | 24.25  | 23.64  | 23.95  |
| CCC 1500                   | 13.82   | 13.47  | 13.65  | 26.95  | 26.27  | 26.61  |
| MC 500                     | 10.47   | 10.21  | 10.34  | 20.42  | 19.91  | 20.16  |
| MC 1000                    | 11.91   | 11.61  | 11.76  | 23.23  | 22.65  | 22.94  |
| MC 1500                    | 12.70   | 12.38  | 12.54  | 24.76  | 24.14  | 24.45  |
| TRIA 500                   | 8.69    | 8.47   | 8.58   | 16.94  | 16.51  | 16.73  |
| TRIA 1000                  | 8.29    | 8.08   | 8.19   | 16.17  | 15.76  | 15.97  |
| TRIA 1500                  | 8.05    | 7.85   | 7.95   | 15.69  | 15.30  | 15.50  |
| Control                    | 10.90   | 10.63  | 10.76  | 21.26  | 20.72  | 20.99  |
| Mean                       | 10.82   | 10.55  | 10.69  | 21.10  | 20.87  | 20.84  |

Factor: $S_{Em^+}$, $CD$

| Variety (A)     | 0.026  | 0.08  | 0.051  | 0.15  | 0.055  | 0.16 |
|-----------------|--------|-------|--------|-------|--------|------|
| Growth regulators (B) | 0.130  | 0.38  | 0.254  | 0.73  | 0.274  | 0.79 |
| Interaction (A x B) | -      | NS    | -      | NS    | 0.312  | 0.90 |

CD: CD at 5% level of significance
DAS: Days after sowing
CCC: Cycocel
MC: Mepiquat chloride
TRIA: Triacontanol

### Table 4
Number of branches per plant as influenced by growth regulators in cluster bean varieties during rabi

| Growth regulators (ppm) (B) | Variety (A) | 30 DAS | 60 DAS | 90 DAS |
|----------------------------|-------------|--------|--------|--------|
|                            | HG 365  | HG 563 | Mean   | HG 365 | HG 563 | Mean   |
| CCC 500                    | 10.15   | 9.89   | 10.02  | 22.12  | 21.57  | 21.84  |
| CCC 1000                   | 11.53   | 11.24  | 11.39  | 25.13  | 24.51  | 24.82  |
| CCC 1500                   | 12.81   | 12.49  | 12.65  | 27.93  | 27.23  | 27.58  |
| MC 500                     | 9.71    | 9.46   | 9.59   | 21.16  | 20.63  | 20.90  |
| MC 1000                    | 11.04   | 10.77  | 10.90  | 24.07  | 23.47  | 23.77  |
| MC 1500                    | 11.77   | 11.48  | 11.63  | 25.66  | 25.02  | 25.34  |
| TRIA 500                   | 8.05    | 7.85   | 7.95   | 17.55  | 17.12  | 17.33  |
| TRIA 1000                  | 7.69    | 7.49   | 7.59   | 16.76  | 16.34  | 16.55  |
| TRIA 1500                  | 7.46    | 7.27   | 7.37   | 16.26  | 15.86  | 16.06  |
| Control                    | 10.11   | 9.85   | 9.98   | 22.03  | 21.48  | 21.75  |
| Mean                       | 10.03   | 9.78   | 9.91   | 21.87  | 21.32  | 21.59  |

Factor: $S_{Em^+}$, $CD$

| Variety (A)     | 0.024  | 0.07  | 0.053  | 0.15  | 0.065  | 0.19 |
|-----------------|--------|-------|--------|-------|--------|------|
| Growth regulators (B) | 0.121  | 0.35  | 0.263  | 0.76  | 0.326  | 0.94 |
| Interaction (A x B) | -      | NS    | -      | NS    | 0.371  | 1.07 |

CD: CD at 5% level of significance
DAS: Days after sowing
CCC: Cycocel
MC: Mepiquat chloride
TRIA: Triacontanol
**Table 5** Number of leaves per plant as influenced by growth regulators in cluster bean varieties during *kharif*

| Growth regulators (ppm) (B) | Variety (A) 30 DAS | Mean | Variety (A) 60 DAS | Mean | Variety (A) 90 DAS | Mean |
|----------------------------|--------------------|------|--------------------|------|--------------------|------|
|                            | HG 365             | HG 563 |                      | HG 365 | HG 563 |                      | HG 365 | HG 563 |                      |
| CCC 500                    | 38.30              | 37.84 | 38.07               | 68.95 | 68.12 | 68.53               | 65.50 | 64.71 | 65.11               |
| CCC 1000                   | 43.53              | 43.00 | 43.27               | 78.35 | 77.41 | 77.88               | 74.43 | 73.54 | 73.99               |
| CCC 1500                   | 44.22              | 43.69 | 43.95               | 79.59 | 78.64 | 79.12               | 75.61 | 74.71 | 75.16               |
| MC 500                     | 31.06              | 30.68 | 30.87               | 55.90 | 55.23 | 55.57               | 53.11 | 52.47 | 52.79               |
| MC 1000                    | 33.18              | 32.78 | 32.98               | 59.72 | 59.00 | 59.36               | 56.73 | 56.05 | 56.39               |
| MC 1500                    | 34.67              | 34.25 | 34.46               | 62.40 | 61.65 | 62.02               | 59.28 | 58.57 | 58.92               |
| TRIA 500                   | 33.06              | 32.67 | 32.86               | 59.51 | 58.80 | 59.16               | 56.54 | 55.86 | 56.20               |
| TRIA 1000                  | 35.12              | 34.70 | 34.91               | 63.21 | 62.45 | 62.83               | 60.05 | 59.33 | 59.69               |
| TRIA 1500                  | 35.72              | 35.29 | 35.51               | 64.30 | 63.53 | 63.91               | 61.08 | 60.35 | 60.72               |
| Control                    | 30.77              | 30.40 | 30.58               | 55.38 | 54.72 | 55.05               | 52.61 | 51.98 | 52.30               |
| **Mean**                   | 35.96              | 35.53 | 35.75               | 64.73 | 63.95 | 64.34               | 61.49 | 60.76 | 61.13               |

| Factor | S Em | CD | S Em | CD | S Em | CD |
|--------|------|----|------|----|------|----|
| Variety (A) | 0.063 | 0.18 | 0.113 | 0.33 | 0.107 | 0.31 |
| Growth regulators (B) | 0.313 | 0.90 | 0.563 | 1.63 | 0.535 | 1.55 |
| Interaction (A x B) | - | NS | - | NS | 0.610 | 1.76 |

CD: CD at 5% level of significance DAS: Days after sowing CCC: Cycocel MC: Mepiquat chloride TRIA: Triacontanol

**Table 6** Number of leaves per plant as influenced by growth regulators in cluster bean varieties during *rabi* 2015-16

| Growth regulators (B) | Variety (A) 30 DAS | Mean | Variety (A) 60 DAS | Mean | Variety (A) 90 DAS | Mean |
|-----------------------|--------------------|------|--------------------|------|--------------------|------|
|                       | HG 365             | HG 563 |                      | HG 365 | HG 563 |                      | HG 365 | HG 563 |                      |
| CCC 500               | 34.09              | 33.68 | 33.89               | 61.36 | 60.63 | 60.99               | 57.85 | 57.16 | 57.50               |
| CCC 1000              | 38.74              | 38.27 | 38.51               | 69.73 | 68.89 | 69.31               | 65.74 | 64.95 | 65.34               |
| CCC 1500              | 39.35              | 38.88 | 39.12               | 70.84 | 69.99 | 70.41               | 66.78 | 65.98 | 66.38               |
| MC 500                | 27.64              | 27.31 | 27.47               | 49.75 | 49.15 | 49.45               | 46.90 | 46.34 | 46.62               |
| MC 1000               | 29.53              | 29.17 | 29.35               | 53.15 | 52.51 | 52.83               | 50.11 | 49.51 | 49.81               |
| MC 1500               | 30.85              | 30.48 | 30.67               | 55.53 | 54.87 | 55.20               | 52.35 | 51.73 | 52.04               |
| TRIA 500              | 29.43              | 29.07 | 29.25               | 52.97 | 52.33 | 52.65               | 49.93 | 49.33 | 49.63               |
| TRIA 1000             | 31.25              | 30.88 | 31.07               | 56.26 | 55.58 | 55.92               | 53.04 | 52.40 | 52.72               |
| TRIA 1500             | 31.79              | 31.41 | 31.60               | 57.23 | 56.54 | 56.88               | 53.95 | 53.30 | 53.63               |
| Control               | 27.38              | 27.05 | 27.22               | 49.29 | 48.70 | 48.99               | 46.47 | 45.91 | 46.19               |
| **Mean**              | 32.01              | 31.62 | 31.81               | 57.61 | 56.92 | 57.27               | 54.31 | 53.66 | 53.99               |

| Factor | S Em | CD at 5% | S Em | CD at 5% | S Em | CD at 5% |
|--------|------|----------|------|----------|------|----------|
| Variety (A) | 0.058 | 0.17 | 0.126 | 0.37 | 0.157 | 0.45 |
| Growth regulators (B) | 0.290 | 0.84 | 0.632 | 1.83 | 0.784 | 2.27 |
| Interaction (A x B) | - | NS | - | NS | 0.894 | 2.58 |

CD: CD at 5% level of significance DAS: Days after sowing CCC: Cycocel MC: Mepiquat chloride TRIA: Triacontanol
Table 7 Days to 50% flowering as influenced by growth regulators in cluster bean varieties during *kharif* and *rabi*

| Growth regulators (ppm) (B) | Variety (A) | Kharif | Rabi |
|----------------------------|-------------|--------|------|
|                            |             | HG 365 | HG 563 | Mean | HG 365 | HG 563 | Mean |
| CCC 500                    |             | 25.47  | 23.43  | 24.45 | 23.43  | 21.56  | 22.49 |
| CCC 1000                   |             | 24.70  | 22.72  | 23.71 | 22.72  | 20.90  | 21.81 |
| CCC 1500                   |             | 24.05  | 22.13  | 23.09 | 22.13  | 20.36  | 21.24 |
| MC 500                     |             | 29.36  | 26.42  | 27.89 | 27.01  | 24.31  | 25.66 |
| MC 1000                    |             | 29.90  | 26.91  | 28.41 | 27.51  | 24.76  | 26.14 |
| MC 1500                    |             | 30.55  | 27.49  | 29.02 | 28.10  | 25.29  | 26.70 |
| TRIA 500                   |             | 27.62  | 24.86  | 26.24 | 25.41  | 22.87  | 24.14 |
| TRIA 1000                  |             | 26.65  | 23.98  | 25.31 | 24.52  | 22.06  | 23.29 |
| TRIA 1500                  |             | 25.67  | 23.10  | 24.39 | 23.62  | 21.26  | 22.44 |
| Control                    |             | 28.48  | 25.46  | 26.97 | 26.20  | 23.42  | 24.81 |
| Mean                       |             | 27.24  | 24.65  | 25.95 | 25.06  | 22.68  | 23.87 |

Factor: $S_{Em}^+$ CD  
Variety (A) 0.028 0.08 0.025 0.07  
Growth regulators (B) 0.138 0.40 0.127 0.37  
Interaction (A x B) 0.157 0.46 - NS  
CD: CD at 5% level of significance  
CCC: Cycocel  
MC: Mepiquat chloride  
TRIA: Triacontanol

Table 8 Dry pod yield per plant (g) as influenced by growth regulators in cluster bean varieties during *kharif* and *rabi*

| Growth regulators (ppm) (B) | Variety (A) | Kharif | Rabi |
|----------------------------|-------------|--------|------|
|                            |             | HG 365 | HG 563 | Mean | HG 365 | HG 563 | Mean |
| CCC 500                    |             | 27.23  | 24.49  | 25.86 | 25.05  | 22.53  | 23.79 |
| CCC 1000                   |             | 29.49  | 26.53  | 28.01 | 27.13  | 24.41  | 25.77 |
| CCC 1500                   |             | 29.95  | 26.94  | 28.44 | 27.55  | 24.78  | 26.17 |
| MC 500                     |             | 23.82  | 21.43  | 22.62 | 21.92  | 19.71  | 20.81 |
| MC 1000                    |             | 24.39  | 21.94  | 23.16 | 22.44  | 20.18  | 21.31 |
| MC 1500                    |             | 24.50  | 22.04  | 23.27 | 22.54  | 20.28  | 21.41 |
| TRIA 500                   |             | 24.96  | 22.45  | 23.70 | 22.96  | 20.65  | 21.81 |
| TRIA 1000                  |             | 27.23  | 24.49  | 25.86 | 25.05  | 22.53  | 23.79 |
| TRIA 1500                  |             | 27.68  | 24.90  | 26.29 | 25.46  | 22.90  | 24.18 |
| Control                    |             | 22.69  | 19.82  | 21.25 | 20.87  | 18.24  | 19.55 |
| Mean                       |             | 26.19  | 23.50  | 24.85 | 24.10  | 21.62  | 22.86 |

Factor: $S_{Em}^+$ CD  
Variety (A) 0.032 0.09 0.029 0.08  
Growth regulators (B) 0.160 0.46 0.147 0.42  
Interaction (A x B) - NS - NS  
CD: CD at 5% level of significance  
CCC: Cycocel  
MC: Mepiquat chloride  
TRIA: Triacontanol
### Table 9
Seed yield per plant (g) as influenced by growth regulators in cluster bean varieties during *kharif* and *rabi*

| Growth regulators (B) | Variety (A) |  
|----------------------|-------------|
|                      | Kharif      | Rabi       |
|                      | HG 365      | HG 563     | Mean | HG 365 | HG 563 | Mean |
| CCC 500              | 17.55       | 15.78      | **16.67** | 16.67 | 14.99 | 15.83 |
| CCC 1000             | 19.01       | 17.10      | **18.05** | 18.06 | 16.24 | 17.15 |
| CCC 1500             | 19.30       | 17.36      | **18.33** | 18.34 | 16.49 | 17.42 |
| MC 500               | 15.35       | 13.81      | **14.58** | 14.59 | 13.12 | 13.85 |
| MC 1000              | 15.72       | 14.14      | **14.93** | 14.93 | 13.43 | 14.18 |
| MC 1500              | 15.79       | 14.20      | **15.00** | 15.00 | 13.49 | 14.25 |
| TRIA 500             | 16.09       | 14.47      | **15.28** | 15.28 | 13.74 | 14.51 |
| TRIA 1000            | 17.55       | 15.78      | **16.67** | 16.67 | 14.99 | 15.83 |
| TRIA 1500            | 17.84       | 16.05      | **16.94** | 16.95 | 15.24 | 16.10 |
| Control              | 14.62       | 12.78      | **13.70** | 13.89 | 12.14 | 13.01 |
| **Mean**             | **16.88**   | **15.15**  | **16.01** | **16.04** | **14.39** | **15.21** |

| Factor               |  
|----------------------|-------------|
| Variety (A)          | *S Em*+ | CD | *S Em*+ | CD |
| Growth regulators (B)| 0.10     | 0.30 | 0.10    | 0.28 |
| Interaction (A x B)  | 0.12     | 0.34 | 0.11    | 0.32 |

CD: CD at 5% level of significance
CCC: Cycocel
MC: Mepiquat chloride
TRIA: Triacontanol

### Table 10
Seed yield per hectare (q) as influenced by growth regulators in cluster bean varieties during *kharif* and *rabi*

| Growth regulators (ppm) (B) | Variety (A) |  
|-----------------------------|-------------|
|                            | Kharif      | Rabi       |
|                            | HG 365      | HG 563     | Mean | HG 365 | HG 563 | Mean |
| CCC 500                    | 22.23       | 19.99      | **21.11** | 21.12 | 18.99 | 20.05 |
| CCC 1000                   | 24.08       | 21.66      | **22.87** | 22.87 | 20.58 | 21.73 |
| CCC 1500                   | 24.45       | 21.99      | **23.22** | 23.23 | 20.89 | 22.06 |
| MC 500                     | 19.45       | 17.49      | **18.47** | 18.48 | 16.62 | 17.55 |
| MC 1000                    | 19.91       | 17.91      | **18.91** | 18.92 | 17.01 | 17.96 |
| MC 1500                    | 20.00       | 17.99      | **19.00** | 19.00 | 17.09 | 18.05 |
| TRIA 500                   | 20.37       | 18.33      | **19.35** | 19.36 | 17.41 | 18.38 |
| TRIA 1000                  | 22.23       | 19.99      | **21.11** | 21.12 | 18.99 | 20.05 |
| TRIA 1500                  | 22.60       | 20.33      | **21.46** | 21.47 | 19.31 | 20.39 |
| Control                    | 18.52       | 16.18      | **17.35** | 17.60 | 15.37 | 16.48 |
| **Mean**                   | **21.38**   | **19.19**  | **20.29** | **20.31** | **18.23** | **19.27** |

| Factor               |  
|----------------------|-------------|
| Variety (A)          | *S Em*+ | CD | *S Em*+ | CD |
| Growth regulators (B)| 0.13     | 0.38 | 0.12    | 0.36 |
| Interaction (A x B)  | 0.15     | 0.43 | 0.14    | 0.41 |

CD: CD at 5% level of significance
CCC: Cycocel
MC: Mepiquat chloride
TRIA: Triacontanol
The lowest seed yield per hectare was observed by the spray of MC 500 ppm (kharif 18.47 q; rabi 17.55 q) which was on par with MC 1000 ppm (kharif 18.91 q; rabi 17.96 q) whereas, TRIA 1500 ppm resulted in a medium seed yield per ha (kharif 21.46 q; rabi 20.39 q). The control recorded a seed yield per hectare of 17.35 q in kharif and 16.48 q in rabi.

Crop yield depend not only on the accumulation of photosynthates during the crop growth and development, but also on its partitioning into the desired storage organs. These in turn, are influenced by the efficiency of metabolic processes within the plant. The growth retardants are capable of redistribution of dry matter in the plant thereby bringing about improvement in yield (Chetti, 1991 and Chandrababu et al., 1995). The pod yield in cluster bean depends on the accumulation of photo assimilates and partitioning in different plant parts. The yield in cluster bean was found to be strongly influenced by the application of different growth regulators and thus indicating the importance of these compounds in increasing the yield potential through their effect on various morphophysiological and biochemical traits.

Similar opinion was expressed by Prabhavathi (2005) who reported that the application of lihocin (1000 ppm) resulted in significantly higher pod yield followed by miraculan @ 1000 ppm and mepiquat chloride @ 1000 ppm as compared to control in cluster bean. The increased yield was attributed to higher dry matter production and its accumulation in reproductive parts, higher AGR, CGR and enhanced chlorophyll and nitrate reductase activity.

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