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# FRESH AND DRY WEIGHT OF SEED GUAR CULTIVARS INFLUENCED BY PLANT GROWTH REGULATORS UNDER MAHANANDI CONDITIONS OF ANDHRA PRADESH, INDIA

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## Abstract

The seed cluster bean exhibited significant variations in the fresh and dry weight due to spray of growth regulators. At 90 DAS, the highest fresh weight of whole plant was recorded by HG 365. Among the growth regulators, maximum fresh weight of whole plant was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm. The lowest fresh weight of whole plant was observed by the spray of MC 500 ppm preceded by MC 1000 ppm. The seed yield per plot differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons. The highest seed yield per plot was recorded by HG 365. Among the growth regulators, maximum seed yield per plot was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm.

***Key words :*** Fresh and dry weight, seed guar cultivars and plant growth regulators.

## Introduction

Plant growth regulators (PGR) are known to improve physiological efficiency including photosynthetic ability of plants and 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. Unlike the seeds of other legumes, guar seeds contains sufficient amount of galactomannan gum, which form a viscous gel in cold water. Guar gum has 5-8 times the thickening power of starch. It is used in textile, paper manufacture, stamps, cosmetics, pharmaceuticals, food products, *e.g.* bakery products, ice cream, stabilizer for cheeses and meat binder. Also it is used recently in oil wells, mining industries, explosives, and other industrial applications (Undersander *et al*., 2006). 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

Seed guar cultivars HG 365 and HG 563 were applied with growth regulating chemicals in a factorial experiment under Mahanandi conditions both during *Kharif* and *Rabi* in the year 2015-16. Foliar sprays of chemicals *viz.,* cycocel, Mepiquat chloride and triacontenol 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 plants were 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

### Fresh weight of different plant parts

The fresh weight of leaf (table 1a, 1b) differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons. At 90 DAS, the highest fresh weight of leaf (*kharif* 6.83 g; *rabi* 6.33 g) was recorded by HG 365. Among the growth regulators, maximum

**Table 1 a :** Fresh weight (g) of different plant parts at 90 DAS as influenced by growth regulators in cluster bean varieties during *kharif* 2015-16.

| Growth regulators (ppm)(B) | Variety (A) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Leaf | | | Stem | | | Pod | | |
| | HG 365 | HG 563 | *Mean* | HG 365 | HG 563 | *Mean* | HG 365 | HG 563 | Mean |
| CCC 500 | 7.28 | 7.19 | **7.23** | 18.19 | 17.97 | **18.08** | 40.02 | 39.54 | **39.78** |
| CCC 1000 | 8.27 | 8.17 | **8.22** | 20.67 | 20.42 | **20.55** | 45.48 | 44.93 | **45.21** |
| CCC 1500 | 8.40 | 8.30 | **8.35** | 21.00 | 20.75 | **20.87** | 46.20 | 45.65 | **45.92** |
| MC 500 | 5.90 | 5.83 | **5.86** | 14.75 | 14.57 | **14.66** | 32.45 | 32.06 | **32.25** |
| MC 1000 | 6.30 | 6.23 | **6.26** | 15.76 | 15.57 | **15.66** | 34.67 | 34.25 | **34.46** |
| MC 1500 | 6.59 | 6.51 | **6.55** | 16.46 | 16.27 | **16.36** | 36.22 | 35.79 | **36.00** |
| TRIA 500 | 6.28 | 6.21 | **6.24** | 15.70 | 15.51 | **15.61** | 34.54 | 34.13 | **34.34** |
| TRIA 1000 | 6.67 | 6.59 | **6.63** | 16.68 | 16.48 | **16.58** | 36.69 | 36.25 | **36.47** |
| TRIA 1500 | 6.79 | 6.70 | **6.75** | 16.97 | 16.76 | **16.86** | 37.32 | 36.88 | **37.10** |
| Control | 5.84 | 5.77 | **5.81** | 14.61 | 14.44 | **14.52** | 32.15 | 31.76 | **31.95** |
| **Mean** | **6.83** | **6.75** | **6.79** | **17.08** | **16.87** | **16.98** | **37.57** | **37.12** | **37.35** |
| ***Factor*** | ***S Em±*** | ***CD*** | | ***S Em±*** | ***CD*** | | ***S Em±*** | ***CD*** | |
| *Variety (A)* | *0.012* | *0.03* | | *0.030* | *0.09* | | *0.065* | *0.19* | |
| *Growth regulators (B)* | *0.059* | *0.17* | | *0.149* | *0.43* | | *0.327* | *0.95* | |
| *Interaction (A x B)* | *-* | *NS* | | *0.169* | *0.49* | | *-* | *NS* | |

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

**Table 1 b :** Fresh weight (g) of different plant parts at 90 DAS as influenced by growth regulators in cluster bean varieties during *rabi* 2015-16.

| Growth regulators (ppm)(B) | Variety (A) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Leaf | | | Stem | | | Pod | | |
| | HG 365 | HG 563 | *Mean* | HG 365 | HG 563 | *Mean* | HG 365 | HG 563 | Mean |
| CCC 500 | 6.75 | 6.67 | **6.71** | 16.87 | 16.66 | **16.76** | 37.10 | 36.66 | **36.88** |
| CCC 1000 | 7.67 | 7.57 | **7.62** | 19.16 | 18.93 | **19.05** | 42.16 | 41.66 | **41.91** |
| CCC 1500 | 7.79 | 7.69 | **7.74** | 19.47 | 19.24 | **19.35** | 42.83 | 42.32 | **42.57** |
| MC 500 | 5.47 | 5.40 | **5.44** | 13.67 | 13.51 | **13.59** | 30.08 | 29.72 | **29.90** |
| MC 1000 | 5.84 | 5.77 | **5.81** | 14.61 | 14.43 | **14.52** | 32.14 | 31.75 | **31.94** |
| MC 1500 | 6.11 | 6.03 | **6.07** | 15.26 | 15.08 | **15.17** | 33.58 | 33.18 | **33.38** |
| TRIA 500 | 5.82 | 5.75 | **5.79** | 14.56 | 14.38 | **14.47** | 32.03 | 31.64 | **31.83** |
| TRIA 1000 | 6.18 | 6.11 | **6.15** | 15.46 | 15.28 | **15.37** | 34.02 | 33.61 | **33.81** |
| TRIA 1500 | 6.29 | 6.22 | **6.25** | 15.73 | 15.54 | **15.63** | 34.60 | 34.19 | **34.39** |
| Control | 5.42 | 5.35 | **5.39** | 13.55 | 13.38 | **13.47** | 29.80 | 29.45 | **29.62** |
| **Mean** | **6.33** | **6.26** | **6.30** | **15.83** | **15.64** | **15.74** | **34.83** | **34.42** | **34.63** |
| ***Factor*** | ***S Em±*** | ***CD*** | | ***S Em±*** | ***CD*** | | ***S Em±*** | ***CD*** | |
| *Variety (A)* | *0.011* | *0.03* | | *0.028* | *0.08* | | *0.061* | *0.18* | |
| *Growth regulators (B)* | *0.055* | *0.16* | | *0.138* | *0.40* | | *0.303* | *0.88* | |
| *Interaction (A x B)* | *-* | *NS* | | *0.157* | *0.45* | | *-* | *NS* | |

fresh weight of leaf (*kharif* 8.35g; *rabi* 7.74g) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (*kharif* 8.22 g; *rabi* 7.62 g). The lowest fresh weight of leaf was observed by the spray of MC 500 ppm (*kharif* 5.86 g; *rabi* 5.44 g) preceded by MC 1000 ppm (*kharif* 6.26 g; *rabi* 5.81 g) whereas, TRIA 1500 ppm resulted in moderate values (*kharif* 6.75 g; *rabi* 6.25 g). The control recorded a fresh weight of leaf of 5.81g in *kharif* and 5.39 g in *rabi* at 90 DAS.

**Fresh weight of stem per plant (g)**

The spray of growth regulators during *kharif* and *rabi* seasons resulted in significant differences in the fresh weight of stem (Table 1a, 1b). At 90 DAS, the highest fresh weight of stem (*kharif* 17.08 g; *rabi* 15.83 g) was recorded by HG 365. Among the growth regulators, maximum fresh weight of stem (*kharif* 20.87 g; *rabi* 19.35 g) was recorded by the application of CCC at 1500 ppm, which was on par with CCC 1000 ppm (*kharif* 20.55 g; *rabi* 19.05 g). The lowest fresh weight of stem was observed by the spray of MC 500 ppm (*kharif* 14.66 g; *rabi* 13.59 g) preceded by MC 1000 ppm (*kharif* 15.66 g; *rabi* 14.52 g). TRIA1500 ppm resulted in the moderate fresh weight of stem during both the seasons (*kharif* 16.86 g, *rabi* 15.63 g) at 90 DAS. The control recorded a fresh weight of stem of 14.52 g in *kharif* and 13.47 g in *rabi* at 90 DAS.

**Fresh weight of pods per plant (g)**

The fresh weight of pods (Table 1a, 1b) differed significantly due to spray of growth regulators during both *kharif* and *rabi* seasons. At 90 DAS, the highest fresh weight of pod (*kharif* 37.57 g; *rabi* 34.83 g) was recorded by HG 365. Among the growth regulators, maximum fresh weight of pod (*kharif* 45.92 g; *rabi* 42.57 g) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (*kharif* 45.21 g; *rabi* 41.91 g). The lowest fresh weight of pod was observed by the spray of MC 500 ppm (*kharif* 32.25 g; *rabi* 29.90 g) preceded by MC 1000 ppm (*kharif* 34.46 g; *rabi* 31.94 g) whereas, TRIA 1500 ppm resulted in intermediate values of fresh weight of pods per plant (*kharif* 37.10 g, *rabi* 34.39 g). The control recorded a fresh weight of pods at 31.95 g in *kharif* and 29.62 g in *rabi* at 90 DAS.

**Fresh weight of whole plant (g)**

The spray of growth regulators brought significant differences in the fresh of whole plant (table 2) during *kharif* and *rabi* seasons at various growth stages. At 90 DAS, the highest fresh weight of whole plant (*kharif* 61.48 g; *rabi* 57.00 g) was recorded by HG 365. Among the growth regulators, maximum fresh weight of whole plant (*kharif* 75.15 g; *rabi* 69.67 g) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm ((*kharif* 73.97 g; *rabi* 68.58 g). The lowest fresh weight of whole plant was observed by the spray of MC 500 ppm (*kharif* 52.78 g; *rabi* 48.93 g) preceded by MC 1000 ppm (*kharif* 56.38 g; *rabi* 52.27 g). Whole plant fresh weight was moderate due to the spray of TRIA 1500 ppm (*kharif* 60.71 g; *rabi* 56.28 g). The control recorded a fresh weight of whole plant of 52.29 g in *kharif* and 48.48 g in *rabi* at 90 DAS.

**Dry weight of leaf per plant (g)**

The dry weight of leaf (Table 3a, 3b) differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons. At 90 DAS, the highest dry weight of leaf (*kharif* 3.25 g; *rabi* 3.02 g) was recorded by HG 365. Among the growth regulators, maximum dry weight of leaf (*kharif* 3.98g; *rabi* 3.69 g) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (*kharif* 3.91 g; *rabi* 3.63 g). The lowest dry weight of leaf was observed by the spray of MC 500 ppm (*kharif* 2.79 g; *rabi* 2.59 g) preceded by MC 1000 ppm (*kharif* 2.98 g; *rabi* 2.77 g), whereas, TRIA 1500 ppm resulted in moderate values (*kharif* 3.21 g; *rabi* 2.98 g). The control recorded a dry weight of leaf of 2.77 g in *kharif* and 2.56 g in *rabi* at 90 DAS.

**Dry weight of stem per plant (g)**

The dry weight of stem (table 3a, 3b) differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons. At 90 DAS, the highest dry weight of stem (*kharif* 8.13 g; *rabi* 7.54 g) was recorded by HG 365. Among the growth regulators, maximum dry weight of stem (*kharif* 9.94 g; *rabi* 9.22 g) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (*kharif* 9.78 g; *rabi* 9.07 g). The lowest dry weight of stem was observed by the spray of MC 500 ppm (*kharif* 6.98 g; *rabi* 6.47 g) preceded by MC 1000 ppm (*kharif* 7.46 g; *rabi* 6.91 g). TRIA resulted in the moderate dry weight of stem during both the seasons (*kharif* 8.08 g, *rabi* 7.49 g) at 90 DAS. The control recorded a dry weight of stem of 6.92 g in *kharif* and 6.41 g in *rabi* at 90 DAS.

**Dry weight of pods per plant (g)**

The spray of growth regulators resulted in significant differences in respect of dry weight of pods (table 3a, 3b) during *kharif* and *rabi* seasons. At 90 DAS, the highest dry weight of pod (*kharif* 20.09 g; *rabi* 17.74 g) was recorded by HG 365. Among the growth regulators, maximum dry weight of pods per plant (*kharif* 22.49 g; *rabi* 21.20 g) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (*kharif* 22.28 g; *rabi* 21.00 g). The lowest dry weight of pod was observed by the spray of MC 1500 ppm (*kharif* 16.60 g; *rabi* 15.66 g) preceded by MC 1000 ppm (*kharif* 16.95 g; *rabi* 15.97 g) whereas, TRIA 1500 ppm resulted in intermediate values of dry weight of pods per plant (*kharif 18.18* g, *rabi* 17.13 g). The control recorded a dry weight of pod of 11.48 g in *kharif* and 10.85 g in *rabi* at 90 DAS.

**Dry weight of whole plant (g)**

The dry weight of whole plant (table 3c, 3d) differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons at 30, 60, and 90 DAS. At 90 DAS, the highest dry weight of whole plant (*kharif* 31.48 g; *rabi* 28.29 g) was recorded by HG 365. Among the growth regulators, maximum dry weight of whole plant

**Table 2 :** Fresh weight (g) of whole plant at 90 DAS as influenced by growth regulators in cluster bean varieties during *kharif* & *rabi* 2015-16.

| Growth regulators (ppm)(B) | Variety (A) | | | | | |
|---|---|---|---|---|---|---|
| | ***Kharif*** | | | ***Rabi*** | | |
| | **HG 365** | **HG 563** | ***Mean*** | **HG 365** | **HG 563** | ***Mean*** |
| CCC 500 | 65.49 | 64.70 | **65.10** | 60.71 | 59.99 | **60.35** |
| CCC 1000 | 74.42 | 73.53 | **73.97** | 68.99 | 68.17 | **68.58** |
| CCC 1500 | 75.60 | 74.69 | **75.15** | 70.09 | 69.25 | **69.67** |
| MC 500 | 53.10 | 52.46 | **52.78** | 49.23 | 48.63 | **48.93** |
| MC 1000 | 56.72 | 56.04 | **56.38** | 52.59 | 51.96 | **52.27** |
| MC 1500 | 59.27 | 58.56 | **58.91** | 54.95 | 54.29 | **54.62** |
| TRIA 500 | 56.53 | 55.85 | **56.19** | 52.41 | 51.78 | **52.09** |
| TRIA 1000 | 60.04 | 59.32 | **59.68** | 55.66 | 54.99 | **55.33** |
| TRIA 1500 | 61.07 | 60.34 | **60.71** | 56.62 | 55.94 | **56.28** |
| Control | 52.60 | 51.97 | **52.29** | 48.77 | 48.18 | **48.48** |
| **Mean** | **61.48** | **60.75** | **61.12** | **57.00** | **56.32** | **56.66** |
| ***Factor*** | ***S Em±*** | ***CD*** | | ***S Em±*** | ***CD*** | |
| *Variety (A)* | *0.107* | *0.31* | | *0.099* | *0.29* | |
| *Growth regulators (B)* | *0.535* | *1.55* | | *0.496* | *1.43* | |
| *Interaction (A x B)* | - | *NS* | | - | *NS* | |

(*kharif* 36.41 g; *rabi* 34.10 g) was recorded by the application of CCC at 1500 ppm, which was on par with CCC 1000 ppm (*kharif* 35.98 g; *rabi* 33.70 g). The lowest dry weight of whole plant was observed by the spray of MC 500 ppm (*kharif* 26.88 g; *rabi* 25.18 g) preceded by MC 1000 ppm (*kharif* 26.89 g; *rabi* 25.65 g). Whole plant dry weight was moderate due to the spray of TRIA 1500 ppm (*kharif* 29.42 g; *rabi* 27.56 g). The control recorded a dry weight of whole plant of 21.17 g in *kharif* and 19.83 g in *rabi* at 90 DAS.

It is inferred from the results on fresh and dry weights of all plant parts as well as whole plant that since the weights were taken at 90 DAS, the difference between fresh weight and dry weight was less in magnitude. In case of leaf and stem, there was a more weight reduction compared to pods since the pods started drying by that stage. Regarding the influence of growth regulator sprays, both the varieties were significantly influenced by all the three chemicals *i.e.* CCC, traiacontanol and mepiquat chloride in order of decreasing effect. Foliar spray of CCC was found to be the most powerful in the enhancement of fresh and dry weights of different plant parts in both the cultivars of cluster bean and exhibited maximum assimilation at 1500 ppm strength as compared to lower strengths. However, it was not significantly superior to the spray of same chemical at 1000 ppm strength. The difference between 1000 and 1500 ppm was tested non-significant in case of all the three chemicals with respect to majority of the weight observations.

The greatest influence of CCC was followed by traicontenol; but even the highest concentration of traicontenol (1500 ppm) could not show the values on par with the lowest concentration of CCC with respect of weights of different plant parts at both fresh and dry states. However, traicontanol along with mepiquat chloride, though brought about significant increase in the fresh and dry weights of plants over control, they were apparently less effective as compared to CCC at varied concentrations. However, triacontenol was significantly different from mepiquat chloride at respective concentrations regarding their influence on fresh and dry weights of various plant parts. Such differences may be attributed to the corresponding differences in leaf area and spad values. The chemical sprays those exhibited higher leaf areas with thicker chlorophyll contents also recorded higher quantities of dry matter assimilation.

The beneficial effect of tricontanol could be due to its cytokinin like activity which could therefore increase the assimilation of photosynthetic carbon products in the plant parts (Kumar and Kaushik, 2014). Poor translocation of photo-assimilates to the growing reproductive parts was found to be the major constraint in cluster bean. This constraint can be overcome by applying synthetic plant growth regulators which improve the canopy structure and increase the productivity through the manipulation of source-sink relationship (Sahu *et al.*, 1993).

Thus the present study, it was noticed that the dry matter accumulation in the different parts increased from 30 to 90 DAS due to the spray of all the growth regulators over control. This could be due to better translocation of stored photo-assimilates towards the development of various organs, the higher leaf dry weight with the application of mepiquat chloride could be attributed to it is beneficial effect on leaf development (Prabhavathi, 2005).

Similarly, application of CCC lead to increased leaf dry weight which was also observed in greengram (Shah

**Table 3 a :** Dry weight (g) of different plant parts at 90 DAS as influenced by growth regulators in cluster bean varieties during *kharif* 2015-16.

| Growth regulators (ppm)(B) | Variety (A) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Leaf | | | Stem | | | Pod | | |
| | HG 365 | HG 563 | *Mean* | HG 365 | HG 563 | *Mean* | HG 365 | HG 563 | Mean |
| CCC 500 | 3.47 | 3.42 | **3.44** | 8.66 | 8.56 | **8.61** | 21.83 | 17.55 | **19.69** |
| CCC 1000 | 3.94 | 3.89 | **3.91** | 9.84 | 9.73 | **9.78** | 24.70 | 19.86 | **22.28** |
| CCC 1500 | 4.00 | 3.95 | **3.98** | 10.00 | 9.88 | **9.94** | 24.94 | 20.04 | **22.49** |
| MC 500 | 2.81 | 2.78 | **2.79** | 7.02 | 6.94 | **6.98** | 18.92 | 15.29 | **17.11** |
| MC 1000 | 3.00 | 2.97 | **2.98** | 7.50 | 7.41 | **7.46** | 18.79 | 15.10 | **16.95** |
| MC 1500 | 3.14 | 3.10 | **3.12** | 7.84 | 7.75 | **7.79** | 18.45 | 14.75 | **16.60** |
| TRIA 500 | 2.99 | 2.95 | **2.97** | 7.48 | 7.39 | **7.43** | 20.77 | 16.83 | **18.80** |
| TRIA 1000 | 3.18 | 3.14 | **3.16** | 7.94 | 7.85 | **7.89** | 19.44 | 15.60 | **17.52** |
| TRIA 1500 | 3.23 | 3.19 | **3.21** | 8.08 | 7.98 | **8.03** | 20.16 | 16.20 | **18.18** |
| Control | 2.78 | 2.75 | **2.77** | 6.96 | 6.87 | **6.92** | 12.90 | 10.07 | **11.48** |
| **Mean** | **3.25** | **3.21** | **3.23** | **8.13** | **8.04** | **8.08** | **20.09** | **16.13** | **18.11** |
| ***Factor*** | ***S Em±*** | ***CD*** | | ***S Em±*** | ***CD*** | | ***S Em±*** | ***CD*** | |
| *Variety (A)* | *0.006* | *0.02* | | *0.014* | *0.04* | | *0.042* | *0.12* | |
| *Growth regulators (B)* | *0.028* | *0.08* | | *0.071* | *0.20* | | *0.209* | *0.60* | |
| *Interaction (A x B)* | - | *NS* | | - | *NS* | | *0.238* | *0.69* | |

**Table 3 b :** Dry weight (g) of different plant parts at 90 DAS as influenced by growth regulators in cluster bean varieties during *rabi* 2015-16.

| Growth regulators (ppm)(B) | Variety (A) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Leaf | | | Stem | | | Pod | | |
| | HG 365 | HG 563 | *Mean* | HG 365 | HG 563 | *Mean* | HG 365 | HG 563 | Mean |
| CCC 500 | 3.21 | 3.17 | **3.19** | 8.03 | 7.93 | **7.98** | 19.28 | 17.84 | **18.56** |
| CCC 1000 | 3.65 | 3.61 | **3.63** | 9.13 | 9.02 | **9.07** | 21.82 | 20.18 | **21.00** |
| CCC 1500 | 3.71 | 3.66 | **3.69** | 9.27 | 9.16 | **9.22** | 22.02 | 20.37 | **21.20** |
| MC 500 | 2.60 | 2.57 | **2.59** | 6.51 | 6.43 | **6.47** | 16.73 | 15.50 | **16.11** |
| MC 1000 | 2.78 | 2.75 | **2.77** | 6.96 | 6.87 | **6.91** | 16.59 | 15.35 | **15.97** |
| MC 1500 | 2.91 | 2.87 | **2.89** | 7.27 | 7.18 | **7.22** | 16.28 | 15.03 | **15.66** |
| TRIA 500 | 2.77 | 2.74 | **2.76** | 6.93 | 6.85 | **6.89** | 18.38 | 17.04 | **17.71** |
| TRIA 1000 | 2.95 | 2.91 | **2.93** | 7.36 | 7.27 | **7.32** | 17.16 | 15.87 | **16.52** |
| TRIA 1500 | 3.00 | 2.96 | **2.98** | 7.49 | 7.40 | **7.44** | 17.80 | 16.47 | **17.13** |
| Control | 2.58 | 2.55 | **2.56** | 6.45 | 6.37 | **6.41** | 11.32 | 10.38 | **10.85** |
| **Mean** | **3.02** | **2.98** | **3.00** | **7.54** | **7.45** | **7.49** | **17.74** | **16.40** | **17.07** |
| ***Factor*** | ***S Em±*** | ***CD*** | | ***S Em±*** | ***CD*** | | ***S Em±*** | ***CD*** | |
| *Variety (A)* | *0.005* | *0.02* | | *0.013* | *0.04* | | *0.039* | *0.11* | |
| *Growth regulators (B)* | *0.026* | *0.08* | | *0.066* | *0.19* | | *0.197* | *0.57* | |
| *Interaction (A x B)* | - | *NS* | | - | *NS* | | *0.224* | *0.65* | |

and Prathapsenan, 1991). Wasnik and Bagga (1996) reported that the application of mepiquat chloride increased the leaf dry weight in chickpea over control. The stem dry weight and pod dry weight along with leaf dry weight were increased significantly due to application of mepiquat chloride (1000 ppm) at all the stages studied (Prabhavathi, 2005).

Dry matter accumulation, particularly in reproductive parts is an important yield contributing character. However, a productive vegetative phase is essential for the development of reproductive organs. Although, the dry matter production in general is an indication of the efficiency of any treatment, the pattern in which it is distributed in different plant parts would give a better understanding about the effect of such treatment. In the present study, CCC maintained higher dry weight of reproductive parts. Among the growth regulators this might be probably due to better source sink relationship.

**Table 3 c :** Dry weight (g) of whole plant as influenced by growth regulators in cluster bean varieties during *kharif* 2015-16.

| 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 | 10.51 | 9.17 | 9.84 | 25.08 | 19.64 | 22.36 | 33.96 | 29.54 | 31.75 |
| CCC 1000 | 11.42 | 9.96 | 10.69 | 26.91 | 21.07 | 23.99 | 38.49 | 33.47 | 35.98 |
| CCC 1500 | 11.14 | 10.12 | 10.63 | 26.82 | 21.36 | 24.09 | 38.94 | 33.87 | 36.41 |
| MC 500 | 9.17 | 8.01 | 8.59 | 19.39 | 15.20 | 17.29 | 28.75 | 25.01 | 26.88 |
| MC 1000 | 8.38 | 8.20 | 8.29 | 18.66 | 15.41 | 17.03 | 28.29 | 25.48 | 26.89 |
| MC 1500 | 8.43 | 8.24 | 8.33 | 18.74 | 15.47 | 17.10 | 28.43 | 25.60 | 27.02 |
| TRIA 500 | 9.64 | 8.41 | 9.02 | 21.19 | 16.59 | 18.89 | 31.25 | 27.17 | 29.21 |
| TRIA 1000 | 10.44 | 9.11 | 9.77 | 22.39 | 17.54 | 19.96 | 30.56 | 26.58 | 28.57 |
| TRIA 1500 | 10.62 | 10.32 | 10.47 | 22.94 | 17.96 | 20.45 | 31.47 | 27.37 | 29.42 |
| Control | 8.65 | 7.55 | 8.10 | 17.88 | 14.00 | 15.94 | 22.64 | 19.69 | 21.17 |
| **Mean** | **9.84** | **8.91** | **9.37** | **22.00** | **17.42** | **19.71** | **31.48** | **27.38** | **29.43** |
| ***Factor*** | ***S Em±*** | ***CD*** | | ***S Em±*** | ***CD*** | | ***S Em±*** | ***CD*** | |
| *Variety (A)* | *0.014* | *0.04* | | *0.040* | *0.11* | | *0.060* | *0.17* | |
| *Growth regulators (B)* | *0.069* | *0.20* | | *0.199* | *0.57* | | *0.299* | *0.87* | |
| *Interaction (A x B)* | *-* | *NS* | | *-* | *NS* | | *0.341* | *0.99* | |

**Table 3 d :** Dry weight (g) of whole plant as influenced by growth regulators in cluster bean varieties during *rabi* 2015-16.

| 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 | 9.22 | 8.24 | 8.73 | 23.79 | 20.46 | 22.13 | 30.52 | 28.95 | 29.74 |
| CCC 1000 | 10.02 | 8.95 | 9.49 | 25.53 | 21.96 | 23.75 | 34.59 | 32.81 | 33.70 |
| CCC 1500 | 10.18 | 9.08 | 9.63 | 25.87 | 22.25 | 24.06 | 35.00 | 33.19 | 34.10 |
| MC 500 | 8.05 | 7.19 | 7.62 | 18.40 | 15.83 | 17.11 | 25.84 | 24.51 | 25.18 |
| MC 1000 | 8.24 | 7.36 | 7.80 | 18.66 | 16.05 | 17.35 | 26.33 | 24.97 | 25.65 |
| MC 1500 | 8.28 | 7.40 | 7.84 | 18.73 | 16.11 | 17.42 | 26.45 | 25.09 | 25.77 |
| TRIA 500 | 8.46 | 7.55 | 8.00 | 20.10 | 17.29 | 18.69 | 28.08 | 26.63 | 27.36 |
| TRIA 1000 | 9.17 | 8.18 | 8.67 | 21.25 | 18.27 | 19.76 | 27.47 | 26.05 | 26.76 |
| TRIA 1500 | 9.33 | 10.31 | 9.82 | 21.77 | 18.71 | 20.24 | 28.29 | 26.82 | 27.56 |
| Control | 7.59 | 6.77 | 7.18 | 16.97 | 14.59 | 15.78 | 20.35 | 19.30 | 19.83 |
| **Mean** | **8.85** | **8.10** | **8.48** | **21.11** | **18.15** | **19.63** | **28.29** | **26.83** | **27.56** |
| ***Factor*** | ***S Em±*** | ***CD*** | | ***S Em±*** | ***CD*** | | ***S Em±*** | ***CD*** | |
| *Variety (A)* | *0.012* | *0.04* | | *0.039* | *0.11* | | *0.056* | *0.16* | |
| *Growth regulators (B)* | *0.062* | *0.18* | | *0.193* | *0.56* | | *0.279* | *0.81* | |
| *Interaction (A x B)* | *-* | *NS* | | *0.220* | *0.64* | | *0.319* | *0.92* | |

Maintained by the external application of CCC such a better source sink relationship might have be due to increased translocation of assimilates from leaf and stem to the reproductive parts. Similar effects were found in mungbean and chickpea due to application of CCC (Singh *et al*., 1993 and Brar *et al*., 1993). The application of cycocel was found to increase the RuBP carboxylase enzyme activity, net photosynthesis and drymatter partitioning in to pods in groundnut (Dashora and Jain, 1994), while the combination of triacontanol with other chemicals (paras or planofix) increased the dry matter accumulation in whole plants of mustard (Ghosh *et al*., 1991). These findings are in conformity with the results obtained in the present study.

### Absolute Growth Rate (AGR)

The absolute growth rate (table 4a, 4b) differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons at various growth stages. At 30-60 DAS, the highest absolute growth rate (*kharif* 40.53; *rabi* 40.84) was recorded by HG 365. Among the

**Table 4 a :** Absolute growth rate (centi gram day$^{-1}$) as influenced by growth regulators in cluster bean varieties during *kharif* 2015-16.

| Growth regulators (ppm) (B) | Variety (A) | | | | | |
|---|---|---|---|---|---|---|
| | 30-60 DAS | | | 60-90 DAS | | |
| | HG 365 | HG 563 | *Mean* | HG 365 | HG 563 | *Mean* |
| CCC 500 | 48.56 | 34.90 | **41.73** | 29.61 | 32.99 | **31.30** |
| CCC 1000 | 51.64 | 37.05 | **44.35** | 38.60 | 41.32 | **39.96** |
| CCC 1500 | 52.26 | 37.48 | **44.87** | 38.91 | 41.70 | **40.31** |
| MC 500 | 34.07 | 23.95 | **29.01** | 31.19 | 32.71 | **31.95** |
| MC 1000 | 34.25 | 24.04 | **29.15** | 32.10 | 33.57 | **32.84** |
| MC 1500 | 34.35 | 24.10 | **29.23** | 32.31 | 33.78 | **33.04** |
| TRIA 500 | 38.51 | 27.30 | **32.91** | 33.52 | 35.25 | **34.39** |
| TRIA 1000 | 39.85 | 28.09 | **33.97** | 27.23 | 30.14 | **28.69** |
| TRIA 1500 | 41.04 | 25.48 | **33.26** | 28.45 | 31.36 | **29.90** |
| Control | 30.78 | 21.52 | **26.15** | 15.87 | 18.97 | **17.42** |
| **Mean** | **40.53** | **28.39** | **34.46** | **30.78** | **33.18** | **31.98** |
| ***Factor*** | ***S Em±*** | ***CD*** | | ***S Em±*** | ***CD*** | |
| *Variety (A)* | *0.091* | *0.26* | | *0.085* | *0.25* | |
| *Growth regulators (B)* | *0.454* | *1.31* | | *0.426* | *1.23* | |
| *Interaction (A x B)* | - | *NS* | | *0.486* | *1.41* | |

**Table 4 b :** Absolute growth rate (centi gram day$^{-1}$) as influenced by growth regulators in cluster bean varieties during *rabi* 2015-2016.

| Growth regulators (ppm) (B) | Variety (A) | | | | | |
|---|---|---|---|---|---|---|
| | 30-60 DAS | | | 60-90 DAS | | |
| | HG 365 | HG 563 | *Mean* | HG 365 | HG 563 | *Mean* |
| CCC 500 | 48.57 | 40.75 | **44.66** | 22.42 | 28.29 | **25.36** |
| CCC 1000 | 51.69 | 43.36 | **47.53** | 30.20 | 36.16 | **33.18** |
| CCC 1500 | 52.32 | 43.88 | **48.10** | 30.43 | 36.48 | **33.45** |
| MC 500 | 34.49 | 28.79 | **31.64** | 24.80 | 28.94 | **26.87** |
| MC 1000 | 34.72 | 28.97 | **31.84** | 25.57 | 29.74 | **27.66** |
| MC 1500 | 34.82 | 29.05 | **31.93** | 25.75 | 29.93 | **27.84** |
| TRIA 500 | 38.81 | 32.46 | **35.64** | 26.59 | 31.14 | **28.87** |
| TRIA 1000 | 40.28 | 33.65 | **36.97** | 20.73 | 25.93 | **23.33** |
| TRIA 1500 | 41.46 | 28.01 | **34.74** | 21.74 | 27.03 | **24.38** |
| Control | 31.27 | 26.07 | **28.67** | 11.27 | 15.70 | **13.48** |
| **Mean** | **40.84** | **33.50** | **37.17** | **23.95** | **28.93** | **26.44** |
| ***Factor*** | ***S Em±*** | ***CD*** | | ***S Em±*** | ***CD*** | |
| *Variety (A)* | *0.094* | *0.27* | | *0.075* | *0.22* | |
| *Growth regulators (B)* | *0.471* | *1.36* | | *0.377* | *1.09* | |
| *Interaction (A x B)* | - | *NS* | | *0.429* | *1.24* | |

growth regulators, maximum absolute growth rate (*kharif* 44.87; *rabi* 48.10) was recorded by the application of CCC at 1500 ppm, which was on par with CCC 1000 ppm (*kharif* 44.35; *rabi* 47.53). The lowest absolute growth rate was observed by the spray of MC 500 ppm (*kharif* 29.01; *rabi* 31.64) preceded by MC 1000 ppm (*kharif* 29.15; *rabi* 31.84) whereas, TRIA 1500 ppm resulted in intermediate values of AGR (*kharif* 33.26 g, *rabi* 34.74 g). The control recorded an absolute growth rate of 26.15 in *kharif* and 28.67 in *rabi* at 30-60 DAS.

The absolute and crop growth rates indicating the accumulation of additional dry matter per unit time and unit ground area were found to be more during the first growth phase between thirty and sixty days after sowing as compared to the later growth phase which could be attributed to the early vigour of the crop. As compared to control, the spray of growth regulating chemicals significantly boosted the early growth rate of crop between 30 DAS and 60 DAS and eventually accumulated more dry matter at the end of first growth phase laying a strong foundation for the second growth phase where lot of economic parts developed. During second growth phase also, the plants sprayed with chemicals were found to show meritorious accumulation of dry matter and eventually could have exhibited the greatest biomass production. CCC spray was found to be superior in terms of growth rate since it had shown maximum amount of photosynthetic surface followed by triacontenol and mepiquat chloride. The growth rates of mepiquat chloride and triacontenol were falling numerically in comparable range but the spray of CCC showed a conspicuous lead in elevating the growth rates per unit time and unit ground area. However, the AGR values were in the clear decreasing order from CCC to triacontenol to mepiquat chloride.

### Crop duration

The crop duration (table 5) differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons. The highest crop duration (*kharif* 110.82; *rabi* 101.95) was recorded by HG 365. Among the growth regulators, maximum crop duration (*kharif* 110.17; *rabi* 101.36) was recorded by the

**Table 5 :** Crop duration (days) as influenced by growth regulators in cluster bean varieties during *kharif* and *rabi* 2015-16.

| Growth regulators (ppm)(B) | Variety (A) | | | | | |
|---|---|---|---|---|---|---|
| | *Kharif* | | | *Rabi* | | |
| | HG 365 | HG 563 | *Mean* | HG 365 | HG 563 | *Mean* |
| CCC 500 | 109.79 | 103.43 | **106.61** | 101.00 | 95.16 | **98.08** |
| CCC 1000 | 107.95 | 101.71 | **104.83** | 99.32 | 93.57 | **96.45** |
| CCC 1500 | 106.67 | 100.51 | **103.59** | 98.13 | 92.47 | **95.30** |
| MC 500 | 111.47 | 104.26 | **107.87** | 102.55 | 95.92 | **99.24** |
| MC 1000 | 112.61 | 105.32 | **108.96** | 103.60 | 96.89 | **100.25** |
| MC 1500 | 113.86 | 106.48 | **110.17** | 104.75 | 97.96 | **101.36** |
| TRIA 500 | 112.17 | 105.01 | **108.59** | 103.20 | 96.61 | **99.91** |
| TRIA 1000 | 111.83 | 104.74 | **108.29** | 102.89 | 96.36 | **99.62** |
| TRIA 1500 | 111.23 | 104.21 | **107.72** | 102.33 | 95.88 | **99.10** |
| Control | 110.58 | 103.49 | **107.04** | 101.74 | 95.21 | **98.47** |
| **Mean** | **110.82** | **103.92** | **107.37** | **101.95** | **95.60** | **98.78** |
| ***Factor*** | ***S Em±*** | ***CD*** | | ***S Em±*** | ***CD*** | |
| *Variety (A)* | *0.026* | *0.08* | | *0.024* | *0.07* | |
| *Growth regulators (B)* | *0.131* | *0.38* | | *0.120* | *0.35* | |
| *Interaction (A x B)* | *0.149* | *0.43* | | - | *NS* | |

**Table 6 :** Seed yield per plot (kg) as influenced by growth regulators in cluster bean varieties during *kharif* and *rabi* 2015-16.

| Growth regulators (ppm)(B) | Variety (A) | | | | | |
|---|---|---|---|---|---|---|
| | *Kharif* | | | *Rabi* | | |
| | HG 365 | HG 563 | *Mean* | HG 365 | HG 563 | *Mean* |
| CCC 500 | 1.92 | 1.73 | **1.82** | 1.82 | 1.64 | *1.73* |
| CCC 1000 | 2.08 | 1.87 | **1.98** | 1.98 | 1.78 | *1.88* |
| CCC 1500 | 2.11 | 1.90 | **2.01** | 2.01 | 1.81 | *1.91* |
| MC 500 | 1.68 | 1.51 | **1.60** | 1.60 | 1.44 | *1.52* |
| MC 1000 | 1.72 | 1.55 | **1.63** | 1.63 | 1.47 | *1.55* |
| MC 1500 | 1.73 | 1.55 | **1.64** | 1.64 | 1.48 | *1.56* |
| TRIA 500 | 1.76 | 1.58 | **1.67** | 1.67 | 1.50 | *1.59* |
| TRIA 1000 | 1.92 | 1.73 | **1.82** | 1.82 | 1.64 | *1.73* |
| TRIA 1500 | 1.95 | 1.76 | **1.85** | 1.85 | 1.67 | *1.76* |
| Control | 1.60 | 1.40 | **1.50** | 1.52 | 1.33 | 1.42 |
| **Mean** | **1.85** | **1.66** | **1.75** | **1.76** | **1.57** | **1.67** |
| ***Factor*** | ***S Em±*** | ***CD*** | | ***S Em±*** | ***CD*** | |
| *Variety (A)* | ***0.00*** | ***0.01*** | | ***0.00*** | ***0.01*** | |
| *Growth regulators (B)* | ***0.01*** | ***0.03*** | | ***0.01*** | ***0.03*** | |
| *Interaction (A x B)* | ***0.01*** | ***0.04*** | | ***0.01*** | ***0.04*** | |

application of MC at 1500 ppm followed by MC 1000 ppm (*kharif* 108.96; *rabi* 100.25). The lowest crop duration was observed by the spray of CCC 1500 ppm (*kharif* 103.59; *rabi* 95.30) preceded by CCC 1000 ppm (*kharif* 104.83; *rabi* 96.45). Foliar application of TRIA 1500 ppm resulted in medium crop duration (*kharif* 107.72; *rabi* 99.10). The control recorded the crop duration of 107.04 days in *kharif* and 98.47 days in *rabi*.

With respect to crop duration, the differences observed among the treatments were due to the corresponding differences with regard to days to flower initiation, 50% flowering, complete flowering coupled with the duration of flowering to pod drying. In spite of the fact that CCC spray led to an enlarged time spent in pod maturity, the plants had lesser crop duration perhaps due to the fact that the CCC spray was early to initiate flowering. On the other hand, mepiquat chloride though late to flower initiation constricted the period of pod maturity and exhibited summarily little more crop duration as compared to control. In case of triacontenol, there was an extended duration of crop period beyond the control more significantly because it had a prolonged period of pod maturity.

It can be pointed out here that it is not important to have more crop duration in to but it is more important to have more period spent in the reproductive phase which was significantly differing with growth regulator sprays and probably the same might lead to enhanced growth of reproductive organs. The florifeours nature of the crop may be a probably reason for not to have distinct difference in the flowering phases and could complete flower initiation in all the plants very quickly and therefore the marginal increase or decrease in different treatments in earliness or delayedness in respect of flowering could not exhibit a highly prominent difference in overall crop duration. Similar observations were also noted by Resmi and Gopalakrishnan (2004).

**Seed yield per plot (Kg)**

The seed yield per plot (table 6) differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons. The highest seed yield per plot (*kharif* 1.85 kg; *rabi* 1.76 kg) was recorded by HG 365. 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). The lowest seed yield per plot was observed by the spray of MC 500 ppm (*kharif* 1.60 kg; *rabi* 1.52 kg), which was on par with MC 1000 ppm (*kharif* 1.63 kg; *rabi* 1.55 g). Application of TRIA 1500 ppm recorded a moderate seed yield per plot during both *kharif* (1.85 kg) and *rabi* (1.76 kg). The control recorded a seed yield per plot of 1.50 kg in *kharif* and 1.42 kg 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 photoassimilates 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 morpho-physiological 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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