# Interaction between $GA_3$ and CCC on growth, chlorophyll content, yield and oil content of sesamum (*Sesamum indicum* L.)

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**SUMMARY**

Sesamum (*Sesamum indicum* L.) is an important oilseed crop grown widely in India during *kharif* and summer seasons. An experiment was conducted with plant growth regulators ($GA_3$ and CCC) to examine the effect on growth and development, chlorophyll content, oil content and yield of sesamum, var. ST 1683 with 20 treatment combinations in randomized block design. Recommended package and practices for sesamum were followed and treatments were made 15 days after sowing. Among all the applied treatment combinations $GA_3$ 250 + CCC 500 µg/ml gave the best results on plant growth, yield attributes and chlorophyll content of leaves. These results were closely followed by the treatment combination $GA_3$ 250 + CCC 250, $GA_3$ 250 + CCC 100 and $GA_3$ 100 + CCC 250 µg/ml. Highest oil content (54.85 per cent) was recorded at the combination of $GA_3$ 250 µg/ml plus CCC 500 µg/ml.

**Key words :** Sesamum, Plant growth regulators, Growth, Yield, Chlorophyll content

Sesammum (*Sesamum indicum* L.) is one of the ancient crops cultivated in India as oilseed crop for using in religious ceremonies. The crop produces low yield in the north-eastern region of India and one of the reasons of low productivity is that no definite nutrient management programme is followed for this region. This is not because of its inability to make good use of the added nutrients but it can be grown with less amount of expensive fertilizers than many other tropical crops (Ninan, 1989). The introduction of chemical growth regulators have added a new dimension to the possibility for modifying plant growth. The potential uses of effective growth retardants are almost as numerous and valuable as those for growth promoters. Beneficial effect of growth regulators on growth and productivity of different crop has been reported by several workers (Sontakey *et al.*, 1991, Devi Sharma and Sarma, 1997). But the information of combined effect of growth promoter ($GA_3$) and growth retardant (CCC) on growth and yield of sesamum has been rather meagre. Hence, the present investigation was planned.

## MATERIALS AND METHODS

The present experiment was carried out during *kharif* season at Botanical garden of Gawahati University, Assam. The soil for the experiment is well drained and slightly acidic (pH5.8-6.5) with high water holding capacity. As per recommendation for this zone, fertilizers doses of 30 kg N (as urea), 20 kg $P_2O_5$ (as single super phosphate), 20 kg $K_2O_5$ (as murate of potash) per hectare were mixed together and applied to experimental field. The experiment was laid out with 20 treatment combinations in randomized block design with three replications. Normal package of practices for the cultivation of sesamum were followed. Four level of gibberellic acids (0, 100, 250, 500 µg/ml) and five levels of CCC (0, 100, 250, 500, 1000 µg/ml) were taken for different treatments. The concentration of individual chemicals was prepared by adding required quantity of water to measured quantity of chemicals. The prepared solutions were sprayed uniformly during morning hours at 15 days after sowing and in control distilled water was sprayed. Observation on shoot length and number of leaves per plant was made at different growth stages. Chlorophyll content was estimated in the laboratory following the method of Arnon (1949). Numbers of capsules per plant, seed weight per plant, seed yield were recorded at maturity. Oil content was estimated following the method of Kartha and Sethi (1975). The pooled data were analyzed statistically.

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## RESULTS AND DISCUSSION

All the treatments of $GA_3$+ CCC increased the shoot length, while the different concentrations of CCC had reduced the shoot length (Table 1). The highest 38.10 cm and 105.07 cm shoot elongation was achieved at 500 µg/ml of $GA_3$ after 30 and 60 DAS, respectively. On the other hand, CCC retarded the shoot length with increasing concentration. The interaction between both the chemicals

**Table 1 : Effect of interaction between $GA_3$ and CCC on length of shoots, number of branches and number of leaves of sesamum plants (cv. ST-1683) (Mean of 3 replications)**

| Concentration combinations (µg/ml) | Length of shoots (cm) | | | Number of branches | | | Number of leaves | | |
|---|---|---|---|---|---|---|---|---|---|
| | Time in days after sowing | | | Time in days after sowing | | | Time in days after sowing | | |
| | 30 | 45 | 60 | 30 | 45 | 60 | 30 | 45 | 60 |
| $GA_3$ 0 + CCC 0 | 32.22 | 53.18 | 92.86 | 1.13 | 2.21 | 3.10 | 12.66 | 23.17 | 27.44 |
| $GA_3$ 0 + CCC 100 | 31.11 | 52.75 | 92.15 | 1.22 | 2.26 | 3.12 | 13.78 | 23.75 | 29.36 |
| $GA_3$ 0 + CCC 250 | 30.26 | 51.63 | 90.98 | 1.31 | 2.57 | 3.30 | 14.77 | 25.47 | 32.59 |
| $GA_3$ 0 + CCC 500 | 29.98 | 49.08 | 90.50 | 1.56 | 2.74 | 3.56 | 13.72 | 24.30 | 30.19 |
| $GA_3$ 0 + CCC 1000 | 29.07 | 47.60 | 90.04 | 1.47 | 2.90 | 3.46 | 12.80 | 22.64 | 28.31 |
| $GA_3$ 100 + CCC 0 | 34.35 | 56.25 | 96.25 | 1.22 | 2.12 | 3.06 | 15.53 | 24.73 | 31.68 |
| $GA_3$ 100 + CCC 100 | 33.79 | 55.61 | 96.01 | 1.27 | 2.48 | 3.64 | 17.41 | 26.10 | 33.37 |
| $GA_3$ 100 + CCC 250 | 33.19 | 54.42 | 95.38 | 1.48 | 2.76 | 4.04 | 18.38 | 27.16 | 35.56 |
| $GA_3$ 100 + CCC 500 | 32.50 | 53.85 | 94.92 | 2.04 | 3.03 | 4.27 | 16.74 | 25.80 | 36.38 |
| $GA_3$ 100 + CCC 1000 | 32.05 | 53.02 | 94.20 | 1.76 | 2.88 | 4.17 | 16.10 | 25.12 | 34.60 |
| $GA_3$ 250 + CCC 0 | 37.55 | 66.92 | 104.76 | 1.37 | 2.35 | 3.20 | 15.67 | 24.25 | 32.14 |
| $GA_3$ 250 + CCC 100 | 36.46 | 64.67 | 102.58 | 1.63 | 2.66 | 3.47 | 16.60 | 26.70 | 35.65 |
| $GA_3$ 250 + CCC 250 | 37.07 | 66.14 | 102.32 | 2.12 | 3.15 | 4.13 | 18.72 | 27.23 | 38.14 |
| $GA_3$ 250 + CCC 500 | 36.05 | 65.09 | 101.14 | 2.32 | 3.49 | 4.40 | 18.31 | 28.42 | 37.00 |
| $GA_3$ 250 + CCC 1000 | 35.13 | 63.94 | 99.23 | 2.52 | 3.05 | 3.25 | 16.85 | 26.26 | 36.27 |
| $GA_3$ 500 + CCC 0 | 38.10 | 67.14 | 105.07 | 1.16 | 2.17 | 3.32 | 14.90 | 23.64 | 33.11 |
| $GA_3$ 500 + CCC 100 | 36.61 | 62.12 | 102.15 | 1.35 | 2.37 | 3.55 | 15.85 | 27.13 | 34.37 |
| $GA_3$ 500 + CCC 250 | 35.64 | 60.54 | 100.26 | 2.04 | 2.69 | 3.55 | 16.96 | 27.52 | 36.58 |
| $GA_3$ 500 + CCC 500 | 35.03 | 58.07 | 99.23 | 1.87 | 2.81 | 3.50 | 18.18 | 26.39 | 33.42 |
| $GA_3$ 500 + CCC 1000 | 34.63 | 56.76 | 97.50 | 1.61 | 2.55 | 3.19 | 15.81 | 25.80 | 32.20 |
| C.D. for $GA_3$ (P=0.05) | 0.185 | 0.404 | 0.414 | 0.054 | 0.051 | 0.178 | 0.439 | 0.452 | 0.509 |
| C.D. for CCC (P=0.05) | 0.205 | 0.205 | 0.463 | 0.060 | 0.057 | 0.199 | 0.484 | 0.506 | 0.569 |

GA- Gibberellic acid, CCC- (2-chloroethyl) trimethylammonium chloride

also emerged as highly significant confirming the counteracting effect of each other. $GA_3$ induced elongation growth of shoots was not completely reversed by CCC at low concentrations. However, significant retardation in shoot growth was evident with the increase of CCC concentration. The retardation of plant height may be due to the prevention of $GA_3$ biosynthesis by CCC (Cleland and Zeevart, 1970). Salisbury and Ross (1986) reported that $GA_3$ has an ability among many plant hormones to promote extensive growth of intact plants. GA induced growth may be either due to cell elongation or cell division or both. CCC lowers the diffusible auxin level resulting in growth retardation (Kuraishi and Muir, 1963). After 60 days, the number of branches and leaves per plant were found highest (4.40) at $GA_3$ 250 µg/ml plus CCC 500 µg/ml and (38.14) at $GA_3$ 250 µg/ml plus CCC 250 µg/ml, respectively (Table 1). The individual effects of $GA_3$ and CCC as well as their combinations emerged as highly significant indicating the superiority of their combinations over the control on increasing number of branches and leaves per plant. Growth regulator was responsible for rapid cell multiplication resulting in vigorous growth by increasing plant height and branch production (Ghosh and Mohiuddin, 2000). It is very clear that, height of stem gave rise to number of branches and leaves resulting in more number of flowers, buds and capitulum on the plant.

The highest chlorophyll a and chlorophyll b content were estimated as 1.149 and 1.425 mg/g at $GA_3$ 250 mg/ml plus CCC 500 µg/ml. Chlorophyll content was higher in all the $GA_3$ and CCC interactions compared to control (Table 2). All the concentrations of CCC increased the chlorophyll content. The effect of CCC in increasing chlorophyll contents may be due to the reduction in cell size resulting in dense cytoplasm (Appleby *et al*., 1966). There was an increase in chlorophyll content of leaves at lower concentrations of $GA_3$, while at higher concentrations of the content of chlorophyll gradually came down (Hazarika and Sarma, 1999). The inhibitory effect of $GA_3$ on chlorophyll synthesis was reduced to some extent in combination with CCC. Identical observation was made by Sarma (1987) on interaction between $GA_3$ and CCC in radish.

The highest number of capsules per plant and seed yield was worked out as 37.19 and 8.50 q/ha at $GA_3$ 250 µg/ml plus CCC 250 µg/ml (Table 2). In all the combinations of $GA_3$, CCC and their interactions the yield

**Table 2 : Effect of interaction between $GA_3$ and CCC on chlorophyll content of leaves, yield parameters and oil content of sesamum plants (cv. ST-1683) (Mean of 3 replications)**

| Concentration combinations (µg/ml) | Chlorophyll Content (mg/g ± SE) | | Yield parameters | | | Percentage of oil content (± SE) |
|---|---|---|---|---|---|---|
| | Chlorophyll a | Chlorophyll b | Number of capsules/plant | Seed weight per plant (g) | Seed yield (q/ha) | |
| $GA_3$ 0 + CCC 0 | 0.821 ± 0.026 | 0.972 ± 0.015 | 28.48 | 3.24 | 5.82 | 46.43 ± 0.620 |
| $GA_3$ 0 + CCC 100 | 0.908 ± 0.008 | 1.102 ± 0.022 | 31.54 | 3.38 | 6.08 | 49.17 ± 0.339 |
| $GA_3$ 0 + CCC 250 | 0.986 ± 0.002 | 1.136 ± 0.006 | 33.35 | 3.45 | 6.21 | 50.25 ± 0.301 |
| $GA_3$ 0 + CCC 500 | 1.036 ± 0.008 | 1.151 ± 0.013 | 33.70 | 3.56 | 6.40 | 50.98 ± 0.346 |
| $GA_3$ 0 + CCC 1000 | 1.006 ± 0.011 | 1.192 ± 0.019 | 32.23 | 3.33 | 5.96 | 48.72 ± 0.327 |
| $GA_3$ 100 + CCC 0 | 0.865 ± 0.012 | 1.002 ± 0.031 | 33.20 | 3.31 | 5.90 | 49.34 ± 0.546 |
| $GA_3$ 100 + CCC 100 | 0.959 ± 0.034 | 1.204 ± 0.020 | 34.60 | 4.14 | 7.45 | 52.13 ± 0.398 |
| $GA_3$ 100 + CCC 250 | 1.002 ± 0.017 | 1.273 ± 0.005 | 35.65 | 4.47 | 8.05 | 52.43 ± 0.222 |
| $GA_3$ 100 + CCC 500 | 1.014 ± 0.021 | 1.232 ± 0.026 | 34.28 | 3.68 | 7.61 | 53.30 ± 0.531 |
| $GA_3$ 100 + CCC 1000 | 1.054 ± 0.022 | 1.225 ± 0.020 | 33.53 | 3.62 | 6.67 | 51.92 ± 0.369 |
| $GA_3$ 250 + CCC 0 | 0.785 ± 0.026 | 0.908 ± 0.011 | 34.47 | 3.74 | 6.12 | 51.65 ± 0.663 |
| $GA_3$ 250 + CCC 100 | 1.084 ± 0.009 | 1.234 ± 0.031 | 36.31 | 4.02 | 7.72 | 53.17 ± 0.663 |
| $GA_3$ 250 + CCC 250 | 1.117 ± 0.022 | 1.323 ± 0.009 | 37.19 | 4.73 | 8.50 | 53.60 ± 0.534 |
| $GA_3$ 250 + CCC 500 | 1.149 ± 0.026 | 1.425 ± 0.023 | 36.70 | 4.50 | 8.12 | 54.85 ± 0.313 |
| $GA_3$ 250 + CCC 1000 | 1.011 ± 0.009 | 1.413 ± 0.027 | 35.17 | 3.47 | 6.73 | 54.26 ± 0.631 |
| $GA_3$ 500 + CCC 0 | 0.729 ± 0.030 | 0.884 ± 0.009 | 30.61 | 3.30 | 5.86 | 47.62 ± 0.415 |
| $GA_3$ 500 + CCC 100 | 0.886 ± 0.021 | 0.982 ± 0.030 | 33.22 | 3.95 | 7.11 | 49.18 ± 0.729 |
| $GA_3$ 500 + CCC 250 | 0.902 ± 0.017 | 1.042 ± 0.023 | 32.59 | 3.57 | 6.42 | 53.55 ± 0.312 |
| $GA_3$ 500 + CCC 500 | 0.954 ± 0.021 | 1.121 ± 0.024 | 31.27 | 3.48 | 6.26 | 51.87 ± 0.780 |
| $GA_3$ 500 + CCC 1000 | 0.986 ± 0.023 | 1.149 ± 0.008 | 30.34 | 3.38 | 6.08 | 50.18 ± 0.382 |
| C.D. for $GA_3$ (P = 0.05) | | | 0.591 | 0.378 | 0.400 | |
| C.D. for CCC (P =0.05) | | | 0.660 | 0.422 | 0.450 | |

was higher than control. The present findings are in agreement with the earlier findings of Arora *et al*. (1998) and Dey and Srivastava (2004). Subbaiah (1983) found that foliar applications of growth regulators helped in translocation of photosynthates to the head resulting in higher seed yields. The combinations of various types of growth regulators are more beneficial for sunflower yield improvement (Kamraj *et al.,* 1999). Devi Sharma and Sarma (1997) found that yield of radish can be increased significantly by using suitable combinations of $GA_3$ and CCC.

Percentage of oil content was stimulated by the treatment of both the chemicals. In combinations they exhibited an additive effect. At the combination of $GA_3$ 250 µg/ml plus CCC 500 µg/ml, highest 54.85 per cent of oil content was recorded (Table 2). Chakrabortty and Sarma (2004) also reported that $GA_3$ and CCC in combination increased the fat content in groundnut.

### *Conclusion:*

Plant growth regulators (PGRs) have found wide application in modern agriculture and horticulture. The introduction of chemical growth promoters has added a new dimension to the possibility for modifying plant growth. The potential uses of effective growth retardants are almost as numerous and valuable as those for growth promoters. The findings in the present study establish the fact that the combined effect of $GA_3$ and CCC was more responsive than both of the chemicals individually.

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