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# Impact of Planting Density and Growth Regulators on Bt Cotton (*Gossypium hirsutum* L.) Hybrid Yield and Component Traits

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**ABSTRACT**

*Agronomic investigation has been taken up to assess the impact of chemical growth regulator sprays and planting densities on Bt cotton hybrid yield, yield components and phenological traits in kharif 2015 under rainfed and irrigated condition. In order to study both two variables at time, split plot design was considered with three replicates, wherein five growth regulators sprays and three planting density treatments assigned to main plots and sub plots respectively. Pooled statistical analysis revealed that two sprays of chloro mepiquat chloride @ 60DAS + 90DAS treatment exerted significant favorable effect of plant height, number of bolls per plant and boll weight, leading to highest seed cotton yield (kg/ha). Whereas, high density planting (HDP) of 37037 plants/ha with 90X30 cm spacing found to be optimal to achive higher seed cotton yield (Kg/ha) with supplementary sprays of growth regulators to minimize the inter plant competition by restricting the excessive plant height. From this study it is quite evident that combination of high density planting (HDP) and two sprays of chloro mepiquat chloride could be explored to increase the productivity levels in Bt cotton hybrids with semi open plant architecture.*

***Key words:*** *Bt cotton, split plot design, HDP, cholo mepiquat chloride, plant architecture*

## INTRODUCTION

American cotton, *Gossypium hirsutum* L. is one of the most important industrial crop species contributing significantly to economy directly and indirectly. In India, cotton is cultivated in an area of 10.5 million hectares with a production of 32.1 million bales of cotton lint (170 kg per bale) during 2016 - 17[1]. With large scale cultivation of hybrid cultivars from mid-90´s and adoption of boll worm insect resistance Bt technology since 2002 aided for achieving current average productivity of 520 kg of lint per hectare. But still our productivity is low compared to world average (765 kg lint per ha). In spite of introduction of improved hybrids over the years we have started witnessing the plateauing of yield levels. One of the alternative options to break this plateauing and to increase the productivity levels is through exploring higher planting densities.

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Cotton is a sub-tropical plant with Indeterminate to semi determinate growth habit with simultaneously vegetative and reproductive growth. The growth habit of present hybrids coupled with high availability of nutrients and assured moisture can encourage excessive vegetative growth. This can lead to severe production problems like fruit abortion, delayed maturity, boll rot and difficulty in harvesting.

The physiological efficiency of a plant can be improved by prolonging photosynthesis, reducing photorespiration, better partitioning of photo assimilates, improving mineral ions uptake and stimulating nitrogen metabolism. All these processes are inter-linked through several interactions leading to influence on growth and productivity. Plant growth regulators have been found to influence these processes in one or the other way and also known to minimize the interplant competition by arresting the excess vegetative growth.

By considering potential impact of above factors investigation was carried out to identify optimum planting density and complementary growth regulator spays to realize higher productivity in Bt cotton hybrid with exsisting plant architecture.

## MATERIAL AND METHODS

Agronomic experiment was carried out in kharif 2015 season at the research farm of department of Botany, Pratishthan Mahavidyalaya, Paithan, Aurangabad with deep black cotton soil, situated at latitude 19°44' N, longitude 73°59' E. The experiment was laid out in split plot design with three replication to assess the impact of growth regulators and planting densities at a time. Five treatments of regulator sprays viz., G1: control, G2: one spray of mepiquat chloride (Chamatkar® 2ml/litre of water) @ 60DAS, G3: two sprays of mepiquat chloride (Chamatkar® 2ml/litre of water) @ 60DAS + 90DAS, G4: one spray of chloro mepiquat chloride (Lihocin® 0.2ml/litre of water) @ 60DAS and G5: two sprays of chloro mepiquat chloride (Lihocin® 0.2ml/litre of water) @ 60DAS + 90DAS were assigned to main plots to facilitate the spraying. Whereas, three planting densities treatments viz., D1: 18518 plants/ha @ 90x60cm spacing, D2:24691 plants/ha @ 90X45cm spacing and D3: 37037 plants/ha @ 90X30 cm spacing with gross plot area of 21.6 square meters assigned to sub plots. As cotton is grown under diverse moisture regimes the whole experiment with the same design was examined under rainfed and irrigated conditions to know the wide scale adaptability of the findings. Accordingly standard package of practices of the region were followed raise the crop.

Widely cultivated Bt cotton hybrid Mallika® with semi open plant architecture was considered for the study. In order to assess the impact of the treatments on growth and development, phenological traits such as plant height, number of monopodial and number of sympodial branches which are directly influencing the crop management practices were measured. Along with this seed cotton yield (kg/ha) and yield component traits such as boll number and boll weight were collected and subjected for statistical analysis.

## RESULTS AND DISCUSSION

**Phenological traits:**

Through the pooled analysis of data from irrigated and rainfed conditions it is clearly evident that growth regulators sprays had (Table 1) effect on plant height resulting in significant of reduction of height with all mepiquat chloride treatments as compared to the no spray control. These findings are in agreement with Siebert and Stewart[7]. Whereas number of sympodial and monopodial branches were unaffected by the growth regulator sprays which has resulted in compact

plant architecture with shorter internodal distance to overcome the interplant competition in high density planting treatments. Among the planting densities (Table 1) signicant differences were observed for plant height and number of monopodial branches, maximum proliferation of plant height and restriction of monopodial branches were recorded with highest density of planting (37037 plants/ha), the same phenomenon was observed by Manjunath[4]. None of the phenological traits under the investigation experienced interaction effects (Table 1).

**Yield components:**

Number of bolls per plant and boll weight is considered as major yield components determining the final seed cotton yield, in this particular study both growth regulator and planting density (Table 2) treatments exhibited significant differences. Out of growth regulator treatments, two sprays of chloro mepiquat chloride @ 60DAS + 90DAS registered maximum number of bolls per plant and boll weight whereas highest planting density treatment (37037 plants/ha) recorded the lower values for the same traits due to the competition for space and other resources. The results are in conformity with the studies of Shekar *et al.*[6] Neverthless, by virtue of higher number of plants per unit area compensated boll number per plant and resulted in higher seed cotton yield per unit area. Except for boll numbers per plant in irrigated condition (Table 3) interaction effects found to be non-significant for yield component traits.

**Seed cotton yield (kg/ha)**

Cotton bolls with burst open fibers with seeds is considered as economic yield and referred as seed cotton yield or kapas yield, expressed as kilo grams per hectare of land. In this particular investigation significant differences were observed among the growth regulator sprays and planting density treatments (Table 2). Two sprays of chloro mepiquat chloride @ 60DAS + 90DAS recorded highest seed cotton yield of 4974 Kg/ha due to the better boll retention with varying plant densities as well as improvement in boll weight which corroborates with studies from earlier workers[3,5,6]. Plating density treatments had relatively high impact on determining final seed cotton yield compared to growth regulator treatments. Among the three treatments (Table 2), highest planting density of 37037 plants per hectare gave raise to highest seed cotton yield of 5470 kg/ha which is in agreement with the study of Bhalerao *et al*.[2] As far as interaction effects (Table 3) as concerned, significant effects were observed for irrigated and rainfed conditions separately due to the synergistic effect of growth regulator sprays on higher planting density by minimizing the interplant competition as well as per se favorable influence on yield component traits. Owing to the vast differances in the potential yield levels in rainfed and irrigated conditions, pooled analysis revealed only numerical progressive increments (Graph 1) accross treatment combinations. Wherein combination of 2 sprays of chloro mepiquat chloride @ 60DAS + 90DAS and highest density planting (37037 plants/ha) registered highest seed cotton yield (kg/ha).

## CONCLUSION

Through the present investigation it is quite evident that seed cotton yield in cotton can be potentially increased by the adoption of HDP of 37037 plants/ha with 90X30 cm spacing. Two sprays of chloro mepiquat chloride @ 60DAS + 90DAS found to be effective to minimize the interplant competition in HDP with modified architecture and to have favorable effect on yield component traits like boll number and boll weight. The findings from the present study has to be confirmed in large scale multi environment trials involving most prevalent hybrids.

**Table 1: Effect of growth regulator sprays and planting densities on phenological traits**

| Treatments | Plant height (cm) | | | Monopodia branches | | | Sympodial branches | | |
|---|---|---|---|---|---|---|---|---|---|
| | Rainfed | Irrigated | Pooled | Rainfed | Irrigated | Pooled | Rainfed | Irrigated | Pooled |
| Growth regulator sprays (G) | | | | | | | | | |
| G1 | 121.5 | 127.2 | 124.4 | 2.8 | 2.7 | 2.8 | 15.6 | 21.7 | 18.7 |
| G2 | 119.0 | 114.3 | 116.7 | 2.9 | 3.0 | 3.0 | 16.7 | 21.8 | 19.3 |
| G3 | 117.0 | 105.4 | 111.2 | 3.0 | 2.6 | 2.8 | 16.6 | 20.4 | 18.5 |
| G4 | 117.4 | 112.0 | 114.7 | 3.1 | 2.8 | 3.0 | 16.7 | 20.8 | 18.7 |
| G5 | 117.6 | 110.0 | 113.8 | 3.0 | 2.7 | 2.8 | 17.4 | 20.7 | 19.1 |
| Sem± | 1.21 | 2.09 | 1.79 | 0.14 | 0.19 | 0.12 | 0.60 | 0.42 | 0.41 |
| CD (P=005) | NS | 6.92 | 5.32 | NS | NS | NS | NS | NS | NS |
| Planting densities (D) | | | | | | | | | |
| D1 | 115.7 | 114.1 | 114.9 | 3.8 | 3.2 | 3.5 | 15.6 | 21.6 | 18.6 |
| D2 | 119.5 | 112.2 | 115.8 | 3.0 | 2.9 | 3.0 | 17.0 | 21.3 | 19.2 |
| D3 | 120.3 | 115.1 | 117.7 | 2.0 | 2.2 | 2.1 | 17.2 | 20.4 | 18.8 |
| Sem± | 0.63 | 1.06 | 0.65 | 0.09 | 0.11 | 0.08 | 0.63 | 1.06 | 0.65 |
| CD (P=005) | 1.87 | NS | 1.86 | 0.27 | 0.33 | 0.23 | 0.90 | 0.62 | NS |
| Combined effects (GXD) | | | | | | | | | |
| Sem± | 1.41 | 2.38 | 1.46 | 0.21 | 0.25 | 0.18 | 0.68 | 0.68 | 0.50 |
| CD (P=005) | NS | NS | NS | NS | NS | NS | NS | NS | NS |

G1: control, G2: one spray of mepiquat chloride (Chamatkar® 2ml/litre of water) @ 60DAS, G3: two sprays of mepiquat chloride (Chamatkar® 2ml/litre of water) @ 60DAS + 90DAS, G4: one spray of chloro mepiquat chloride (Lihocin® 0.2ml/litre of water) @ 60DAS and G5: two sprays of chloro mepiquat chloride (Lihocin® 0.2ml/litre of water) @ 60DAS + 90DAS, D1: 18518 plants/ha @ 90x60cm spacing, D2:24691 plants/ha @ 90X45cm spacing and D3: 37037 @ 90X30cm

**Table 2: Effect of growth regulator sprays and planting densities on yield and yield components**

| Treatments | Number of bolls per plant | | | Boll weight (g) | | | Seed cotton yield (kg/ha) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Rainfed | Irrigated | Pooled | Rainfed | Irrigated | Pooled | Rainfed | Irrigated | Pooled |
| G1+D1 | 37.3 | 55.9 | 46.6 | 5.40 | 5.44 | 5.42 | 2349 | 3120 | 2735 |
| G1+D2 | 33.6 | 46.8 | 40.2 | 5.33 | 5.35 | 5.34 | 2790 | 3891 | 3341 |
| G1+D3 | 26.7 | 37.0 | 31.9 | 5.19 | 5.17 | 5.18 | 3304 | 5103 | 4203 |
| G2+D1 | 46.1 | 69.5 | 57.8 | 5.85 | 5.82 | 5.84 | 2570 | 3891 | 3231 |
| G2+D2 | 41.5 | 69.4 | 55.5 | 5.74 | 5.64 | 5.69 | 3194 | 4552 | 3873 |
| G2+D3 | 34.8 | 44.5 | 39.7 | 5.54 | 5.50 | 5.52 | 3855 | 6461 | 5158 |
| G3+D1 | 47.6 | 82.1 | 64.9 | 5.96 | 6.03 | 6.00 | 2937 | 4626 | 3781 |
| G3+D2 | 41.3 | 73.0 | 57.2 | 5.92 | 5.90 | 5.91 | 3194 | 5396 | 4295 |
| G3+D3 | 36.6 | 50.2 | 43.4 | 5.78 | 5.75 | 5.77 | 4185 | 7526 | 5855 |
| G4+D1 | 49.2 | 78.0 | 63.6 | 6.29 | 6.12 | 6.21 | 3084 | 4075 | 3579 |
| G4+D2 | 45.3 | 71.6 | 58.5 | 6.15 | 5.95 | 6.05 | 3671 | 4919 | 4295 |
| G4+D3 | 39.3 | 45.0 | 42.2 | 6.03 | 5.90 | 5.97 | 4148 | 7305 | 5727 |
| G5+D1 | 50.8 | 90.6 | 70.7 | 6.50 | 6.22 | 6.36 | 3120 | 4626 | 3873 |
| G5+D2 | 44.7 | 75.9 | 60.3 | 6.25 | 6.07 | 6.16 | 3708 | 5580 | 4644 |
| G5+D3 | 39.6 | 50.7 | 45.2 | 6.19 | 6.02 | 6.10 | 4589 | 8223 | 6406 |
| Sem± | 1.13 | 2.95 | 2.86 | 0.05 | 0.24 | 0.03 | 64 | 171 | 221 |
| CD (P=005) | NS | 9.13 | NS | NS | NS | NS | 210 | 540 | NS |

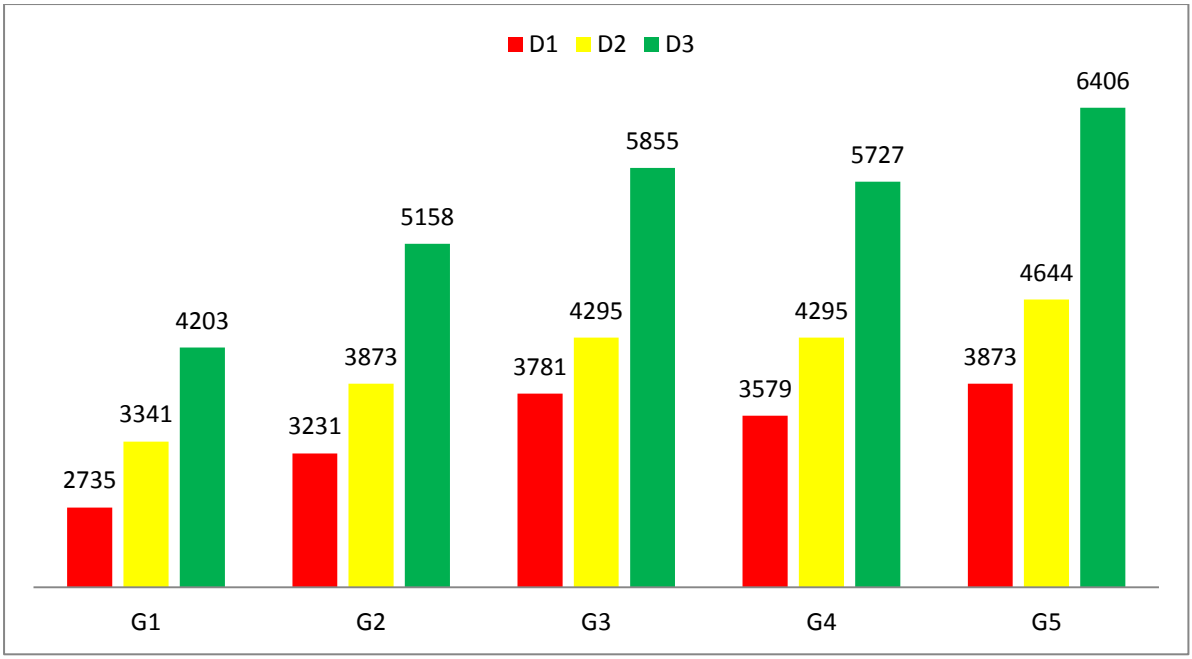
G1: control, G2: one spray of mepiquat chloride (Chamatkar® 2ml/litre of water) @ 60DAS, G3: two sprays of mepiquat chloride (Chamatkar® 2ml/litre of water) @ 60DAS + 90DAS, G4: one spray of chloro mepiquat chloride (Lihocin® 0.2ml/litre of water) @ 60DAS and G5: two sprays of chloro mepiquat chloride (Lihocin® 0.2ml/litre of water) @ 60DAS + 90DAS, D1: 18518 plants/ha @ 90x60cm spacing, D2:24691 plants/ha @ 90X45cm spacing and D3: 37037 @ 90X30cm

**Table 3: Combined effect of growth regulator sprays and planting densities on yield and yield components**

| Treatments | Number of bolls per plant | | | Boll weight (g) | | | Seed cotton yield (kg/ha) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Rainfed | Irrigated | Pooled | Rainfed | Irrigated | Pooled | Rainfed | Irrigated | Pooled |
| Growth regulator sprays | | | | | | | | | |
| G1 | 32.6 | 46.6 | 39.6 | 5.31 | 5.32 | 5.31 | 2814 | 4038 | 3426 |
| G2 | 40.8 | 61.1 | 51.0 | 5.71 | 5.65 | 5.68 | 3206 | 4968 | 4087 |
| G3 | 41.9 | 68.4 | 55.2 | 5.89 | 5.90 | 5.89 | 3439 | 5849 | 4644 |
| G4 | 44.6 | 64.9 | 54.7 | 6.16 | 5.99 | 6.08 | 3634 | 5433 | 4534 |
| G5 | 45.1 | 72.4 | 58.7 | 6.31 | 6.10 | 6.21 | 3806 | 6143 | 4974 |
| Sem± | 0.90 | 1.85 | 1.53 | 0.04 | 0.04 | 0.04 | 146 | 156 | 144 |
| CD (P=005) | 6.6 | 8.86 | 12.52 | 2.01 | 2.12 | 2.48 | 484 | 517 | 429 |
| Planting densities | | | | | | | | | |
| D1 | 46.2 | 75.2 | 60.7 | 6.00 | 5.93 | 5.96 | 2812 | 4068 | 3440 |
| D2 | 41.3 | 67.3 | 54.3 | 5.88 | 5.78 | 5.83 | 3311 | 4868 | 4090 |
| D3 | 35.4 | 45.5 | 40.5 | 5.75 | 5.67 | 5.71 | 4016 | 6924 | 5470 |
| Sem± | 0.51 | 1.32 | 1.28 | 0.02 | 0.01 | 0.01 | 29 | 76 | 99 |
| CD (P=005) | 1.51 | 3.92 | 3.64 | 0.07 | 0.03 | 0.04 | 85 | 227 | 282 |

G1: control, G2: one spray of mepiquat chloride (Chamatkar® 2ml/litre of water) @ 60DAS, G3: two sprays of mepiquat chloride (Chamatkar® 2ml/litre of water) @ 60DAS + 90DAS, G4: one spray of chloro mepiquat chloride (Lihocin® 0.2ml/litre of water) @ 60DAS and G5: two sprays of chloro mepiquat chloride (Lihocin® 0.2ml/litre of water) @ 60DAS + 90DAS, D1: 18518 plants/ha @ 90x60cm spacing, D2:24691 plants/ha @ 90X45cm spacing and D3: 37037 @ 90X30cm

**Graph 1: Impact of growth regulator sprays and planting densities on seed cotton yield (kg/ha)**




G1: control, G2: one spray of mepiquat chloride (Chamatkar® 2ml/litre of water) @ 60DAS, G3: two sprays of mepiquat chloride (Chamatkar® 2ml/litre of water) @ 60DAS + 90DAS, G4: one spray of chloro mepiquat chloride (Lihocin® 0.2ml/litre of water) @ 60DAS and G5: two sprays of chloro mepiquat chloride (Lihocin® 0.2ml/litre of water) @ 60DAS + 90DAS, D1: 18518 plants/ha @ 90x60cm spacing, D2:24691 plants/ha @ 90X45cm spacing and D3: 37037 @ 90X30cm

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