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## Influence of land configuration methods and osmoprotectant sprays on growth, yield attributes and yield of HDPS cotton under rainfed Alfisols

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### Abstract

A field experiment was conducted at the College farm, College of Agriculture, Rajendranagar, Hyderabad, during the *khari*f season of 2022-23. The experiment investigated the effect of land configuration methods (L1: flatbed, L2: ridge and furrow at sowing, L3: ridge and furrow at 30 DAS) and osmoprotectant sprays (T<sub>1</sub>: Glycine betaine (0.01%), T<sub>2</sub>: Salicylic acid (0.01%), T<sub>3</sub>: Multi K (1%), T<sub>4</sub>: Water spray (500 L ha<sup>-1</sup>), T<sub>5</sub>: Control (No spray) in split plot design replicated thrice on growth and yield of cotton under rainfed Alfisols. Ridge and furrow at 30DAS produced significantly taller plants (102.6 cm) and dry matter production (4837 kg ha<sup>-1</sup>), which was on par with ridge and furrow at sowing (101 cm and 4372 kg ha<sup>-1</sup>). Ridge and furrow at 30DAS resulted in significantly more sympodial branches plant<sup>-1</sup> (18.6) and number of bolls plant<sup>-1</sup> (12). Adoption of ridge and furrow at 30DAS (2312 kg ha<sup>-1</sup>) and ridge and furrow at sowing (1987 kg ha<sup>-1</sup>) resulted in higher seed cotton yield. Among osmoprotectant sprays, glycine betaine (0.01%) resulted in significantly greater plant height (98.7 cm) and dry weight (4610 kg ha<sup>-1</sup>), which was on par with salicylic acid (0.01%) and multi-K (1%). Further, glycine betaine (0.01%) applied crop had higher boll weight (11.7g) and seed cotton yield (2365 kg ha<sup>-1</sup>), which was on par with multi-K (2195 kg ha<sup>-1</sup>), outperforming the control (no spray) (1240 kg ha<sup>-1</sup>).

**Keywords:** Cotton, Land configuration methods, osmoprotectant sprays, high density planting system, rainfed, Alfisols, Telangana

### 1. Introduction

Cotton (*Gossypium hirsutum*) is a commercial crop of global importance and it has retained its unique name and fame as the “King of Fibers” and “White gold” because of its higher economic importance. Further, cotton is the primary raw material (60%) for Indian textile mills. The Indian textile industry contributes 5% to India's GDP, 14% to industrial production, and 11% to total export earnings. This industry is the second largest employer in India, providing direct employment to 51 million people and indirect employment to 68 million people (Annual report, Ministry of textile, 2020-2021) [1]. Globally, India ranks 1st in cultivated area (12.96 M ha) followed by the USA (3.52 M ha), China (3.17 M ha), and Pakistan (2.19M ha). India has recorded the highest cotton production (6.05 MT), accounting for 26% of global cotton production (cotcorp.gov.in) [2]. In India, during 2020-21, the highest area (4.2 M ha) and production (1.47 MMT) were recorded in Maharashtra, while the highest productivity was recorded in Gujarat (1.64 MMT). Further, Telangana ranked third in area (2.25 M ha) with a production of (0.94 MMT) during 2020-21 ((indiastat.com) [3].

The demand for cotton continues to grow due to increasing demand from the domestic apparel industry. This necessitates the need for enhancing production and productivity in the future too. However, cotton cultivation in India is hindered by several challenges like drought, incessant rains, insect pests and disease incidence, indiscriminate use of fertilizers and pesticides, labour shortage, climate change, etc. Drought is considered the most important abiotic stress limiting growth and productivity of cotton under rainfed conditions in this era of global climate change. Occurrence of prolonged dry spells during initial or mid-season or terminal stages of crop

growth leads to partial or complete failure, which in turn leads to a decline in productivity. Telangana state experienced drought conditions in 6 years (1999, 2002, 2004, 2009, 2014, and 2015) in the last 20 years. Rainfall variation in 2004 appears to be higher compared to other drought years.

Telangana state is a significant contributor to India's cotton production. The area under the high-density planting system (HDPS) is steadily increasing in the state of Telangana. Further, the cotton crop is largely grown on Alfisols, which are characterized by shallow depth, light texture, low water-holding capacity, and low organic carbon. Thus, the effects of drought stress are expected to be more pronounced in HDPS cotton grown in light-textured soils due to an increase in plant density by 3-6 times. Telangana is prone to droughts and other climate-related stresses. Enhancing cotton quality and yield can augment export opportunities, leading to higher incomes and livelihoods. Several approaches have been tried by various authors to overcome the effects of drought or prolonged dry spells.

Land configuration methods can store and conserve as much rainfall as possible in-situ by reducing runoff and increasing the storage capacity of the soil, thus helping to overcome low moisture stress. By adopting these techniques, farmers can enhance drought resilience, increase water productivity, and reduce soil erosion.

Foliar spray of osmoprotectant is indeed an effective way to overcome drought stress in crops (Wyn Jones *et al.*, 1984) [4]. Osmoprotectant are small molecules that protect osmotically stressed cells by raising osmotic pressure and shielding enzymes and membranes from damage. They include sugars, sugar alcohols (polyols), mannitol, proline, choline, glycine, and quaternary ammonium compounds (betaines) (Roy and Basu, 2009) [5]. These compounds have been reported to alleviate the adverse effects of salinity by enhancing ion uptake and transport, membrane permeability, and antioxidative enzymes. However, studies on the combined effect of land configuration and osmoprotectant on HDPS cotton is meager. Hence, the field investigation was taken up.

## 2. Materials and Methods

A field experiment was conducted at the College farm, College of Agriculture, Rajendranagar, Hyderabad, during the *kharif* season of 2022-23, located at Latitude 17°19' N, Longitude 78°23' E, Altitude 542.3 m above Mean Sea Level (MSL). The experimental soil was sandy loam, alkaline in reaction (pH 7.48), low in organic carbon (0.53%), low in available N (230 kg ha<sup>-1</sup>), medium in available P (20.6 kg ha<sup>-1</sup>), and available K (270.6 kg ha<sup>-1</sup>). There were fifteen treatment combinations consisting of three land configuration methods and five osmoprotectant sprays. The land configuration treatments consisted of three methods of cotton sowings viz., L1: flatbed, L2: ridge and furrow at sowing, L3: ridge and furrow at 30 DAS. Osmoprotectant sprays consisted of five treatments: T<sub>1</sub>: Glycine betaine (0.01%), T<sub>2</sub>: Salicylic acid (0.01%), T<sub>3</sub>: Multi K (1%), T<sub>4</sub>: Water sprays (500 L ha<sup>-1</sup>), T<sub>5</sub>: Control (No spray). The experiment was laid out in a split plot design (SPD) with three replications. Cotton

Bt hybrid RCH-665 (BG II) was sown by dibbling on 21st July 2022. The crop was harvested in two pickings up to the last week of November. The recommended dose of 120-60-60 NPK kg ha<sup>-1</sup> was applied to the crop. The total rainfall received during the crop growth period was 687.6 mm in 2022.

**Plant height:** Five tagged plants were used for recording plant height. Plant height (cm) was measured from the ground surface

to the topmost growing point in cm at harvest.

**Dry matter production (kg ha<sup>-1</sup>):** In all the replications, five plants plot-1 were selected from the second border row and uprooted at harvest. These uprooted plants were carefully placed in labelled brown paper bags. Subsequently, the plants were dried in the shade initially for 2-3 days, followed by further drying in a hot air oven maintained at a temperature of 60-65-°C until a constant weight was achieved. The weight of the oven-dried plants was then measured using an electronic balance with a precision of 0.001 g, and the mean value was recorded as the dry matter accumulation per plant for cotton. To obtain the dry matter ha<sup>-1</sup>, this value was multiplied by the plant population ha<sup>-1</sup>.

**No. of sympodial branches plant<sup>-1</sup>:** Sympodial branches are the branches that arise above the developing shoots and expand horizontally while bearing flowers at each node. At harvest, these were counted from the labelled plants, and the average number of sympodial branches was calculated. The monopodial branches were also included in the total number of sympodial branches plant<sup>-1</sup>.

**No. of bolls plant<sup>-1</sup>:** The total number of bolls present in boll development and opened bolls at picking from the five tagged plants from the net plot were counted, averaged, and expressed as no. of bolls plant<sup>-1</sup>.

**Boll weight (g boll<sup>-1</sup>):** The seed cotton yield obtained from bolls of tagged plants in each plot was weighed, averaged, and expressed as boll weight in g boll<sup>-1</sup>.

**Seed cotton yield (kg ha<sup>-1</sup>):** After picking, seed cotton obtained from each treatment in the net plot was weighed on an electronic balance. The yield of seed cotton from picking of net plots in each treatment was weighed in g plot-1 and yield was converted to kg ha<sup>-1</sup>.

The data was statistically analyzed by adopting standard analysis of variance (ANOVA) as described by Gomez and Gomez. The significance of difference was tested using 'F' value at 5% level of significance. The value of critical difference (C.D.) for examining treatment means for their significance was done at 5% level.

## 3. Results and Discussion

### 3.1 Effect of land configuration methods and osmoprotectant sprays on Growth Component of Cotton

The results showed that growth parameters like plant height and dry matter production were significantly influenced by land configuration methods (Table 1). However, taller plants (102.6 cm) and dry matter production (4837 kg ha<sup>-1</sup>) were observed with ridge and furrow at 30 DAS, which was on par with ridge and furrow at sowing (101 cm and 4372 kg ha<sup>-1</sup>). Flatbed sowing recorded the least (87.4 cm and 3659 kg ha<sup>-1</sup>). According to Anusha *et al.* (2023) [6], among in-situ moisture conservation practices, raised beds recorded a significantly higher plant height (100.8 cm), which was on par with conservation furrows at sowing (99.0 cm), and the lowest was recorded in the flat bed method (89.8 cm). These findings were in agreement with those of (Allolli *et al.*, 2008[7]; Paslawar and Deotalu, 2015[8]; Gabhane *et al.*, 2017[9]) Among osmoprotectant sprays, glycine betaine (0.01%) resulted in significantly greater plant height (98.7 cm) and dry weight (4610 kg ha<sup>-1</sup>), which was on par with salicylic acid (0.01%) (98.6 cm and 4443 kg ha<sup>-1</sup>) and multi-K

(1%) (998.6 cm and 4486 kg ha<sup>-1</sup>). Control (no spray) recorded least (93.6 cm and 3599 kg ha<sup>-1</sup>). The positive effect of glycine betaine (0.01%) on plant height can be attributed to its osmo-protective, antioxidant, and ion-regulating properties, which enhanced plant growth and stress tolerance. These findings were in agreement with previous studies by Patil *et al.* (2009) <sup>[10]</sup>, and

Aziz *et al.* (2018) <sup>[11]</sup>. Pande (2012) <sup>[12]</sup> concluded that the glycine betaine treatment (5% GB seed treatment + 2% GB foliar spray at 15 DAG) was found to be superior among all the treatments, which recorded a high plant height (81.3 cm) and might have helped in alleviating the negative effects of moisture stress in cotton compared to the control (70.3 cm).

**Table 1:** Plant height (cm), dry weight (kg ha<sup>-1</sup>), sympodial branches plant<sup>-1</sup>, no. of bolls plant<sup>-1</sup>, kapas yield (kg ha<sup>-1</sup>) of *Bt* cotton as influenced by land configuration methods and osmoprotectant sprays under rainfed HDPS (*khari* 2022-23)

| Treatments                                                               | Height (cm) | Dry weight (kg ha <sup>-1</sup> ) | Sympodial branches plant <sup>-1</sup> | No. of bolls plant <sup>-1</sup> | Kapas yield (kg ha <sup>-1</sup> ) |
|--------------------------------------------------------------------------|-------------|-----------------------------------|----------------------------------------|----------------------------------|------------------------------------|
| <b>Land configuration methods</b>                                        |             |                                   |                                        |                                  |                                    |
| L1: Flat bed                                                             | 87.4        | 3659                              | 15.45                                  | 10.1                             | 1658                               |
| L2: Ridge and furrow at sowing                                           | 101.2       | 4372                              | 17.17                                  | 10.9                             | 1987                               |
| L3: Ridge and furrow at T <sub>3</sub> 0DAS                              | 102.6       | 4837                              | 18.63                                  | 12.0                             | 2312                               |
| SEm+                                                                     | 1.1         | 56                                | 0.26                                   | 0.25                             | 61                                 |
| CD(p=0.05)                                                               | 4.4         | 220                               | 1.02                                   | 1.00                             | 238                                |
| <b>Osmoprotectant sprays</b>                                             |             |                                   |                                        |                                  |                                    |
| T <sub>1</sub> : Glycine betaine (0.01%)                                 | 98.7        | 4610                              | 17.80                                  | 11.7                             | 2365                               |
| T <sub>2</sub> : Salicylic acid (0.01%)                                  | 98.6        | 4443                              | 16.57                                  | 11.3                             | 2167                               |
| T <sub>3</sub> : Multi K (1%)                                            | 98.6        | 4486                              | 18.59                                  | 11.2                             | 2196                               |
| T <sub>4</sub> : Water spray (500l ha <sup>-1</sup> )                    | 95.4        | 4307                              | 16.88                                  | 11.4                             | 1960                               |
| T <sub>5</sub> : Control                                                 | 93.6        | 3599                              | 15.60                                  | 9.4                              | 1239                               |
| SEm+                                                                     | 0.8         | 87                                | 0.84                                   | 0.33                             | 63                                 |
| CD(p=0.05)                                                               | 2.3         | 253                               | NS                                     | 0.96                             | 184                                |
| <b>Interaction</b>                                                       |             |                                   |                                        |                                  |                                    |
| <b>Land configuration methods at same level of osmoprotectant sprays</b> |             |                                   |                                        |                                  |                                    |
| SEm+                                                                     | 2.1         | 188                               | 1.70                                   | 0.74                             | 148                                |
| CD(p=0.05)                                                               | NS          | NS                                | NS                                     | NS                               | NS                                 |
| <b>Osmoprotectant sprays at same level of land configuration methods</b> |             |                                   |                                        |                                  |                                    |
| SEm+                                                                     | 1.4         |                                   | 1.45                                   | 0.57                             | 109                                |
| CD(p=0.05)                                                               | NS          | NS                                | NS                                     | NS                               | NS                                 |

### 3.2 Effect of land configuration methods and osmoprotectant sprays on yield attributing characters of cotton

A perusal of data in Table 1 indicated that yield parameters like sympodial branches plant<sup>-1</sup> and number of bolls plant<sup>-1</sup> were significantly different due to varied land configuration methods. Significantly higher sympodial branches plant<sup>-1</sup> (18.6) and number of bolls plant<sup>-1</sup> (12) were recorded with ridge and furrow at 30 DAS. Adoption of ridge and furrow at 30 DAS (2312 kg ha<sup>-1</sup>) and ridge and furrow at sowing (1987 kg ha<sup>-1</sup>) resulted in higher seed cotton yield. The superior performance of ridge and furrow sowing can be attributed to the higher moisture availability, which helps maintain optimal soil moisture in the root zone and prevents water logging. Consistent moisture availability was crucial during branch initiation and development stages. Furthermore, ridge and furrow sowing reduces soil compaction, facilitating easier root expansion and better shoot development, including branching.

Boll weight was not significantly affected by varied osmoprotectant sprays. Glycine betaine (0.01%) also led to higher boll weight (11.7 g) and seed cotton yield (2365 kg ha<sup>-1</sup>), on par with multi-K (2195 kg ha<sup>-1</sup>), outperforming the control (no spray) (1240 kg ha<sup>-1</sup>). The increase in number of monopodia and sympodia in cotton under moisture stress was recorded when glycine betaine was exogenously applied. It might be attributed to increased plant height which provides site for nodes and internodes from where monopodial and sympodial branches emerge (Eaton, 1955) <sup>[13]</sup>. Morphological characters like numbers of monopodial and sympodial branches were associated with increase in seed cotton yield (Basu and Bhatt, 1987) <sup>[14]</sup>. Similar results were observed by Patil *et al.* (2009) <sup>[15]</sup>.

### 3.3 Effect of land configuration methods and osmoprotectant sprays on kapas yield (kg ha<sup>-1</sup>)

The impact of land configuration methods and osmoprotectant sprays on kapas yield of cotton was presented in Table 1. The results reveal significant effects of both land configuration methods and osmoprotectant sprays on kapas yield. Among the land configuration methods, ridge and furrow at 30 DAS resulted in the highest kapas yield (2312 kg ha<sup>-1</sup>) at final harvest (150 DAS), while the flatbed method recorded the lowest (1658 kg ha<sup>-1</sup>).

Osmoprotectant sprays also significantly influenced kapas yield. Spraying of glycine betaine (0.01%) at 106, 120, 134 DAS yielded the highest kapas yield (2365 kg ha<sup>-1</sup>) at final harvest (150 DAS), which was on par with multi-K (1%) and salicylic acid (0.01%) sprayed at 106, 120, 134 DAS (2196 and 2167 kg ha<sup>-1</sup>). The control (no spray) treatment recorded the lowest kapas yield (1240 kg ha<sup>-1</sup>).

The differences in seed cotton yield can be attributed to various yield attributes, including boll weight, number of bolls per plant, number of seeds per plant, and seed weight per plant, as well as characters like the number of monopodial and sympodial branches and plant height. These findings were consistent with previous research (Patel *et al.* (2009) <sup>[16]</sup>; Ambika *et al.* (2017)) <sup>[17]</sup>.

The exogenous application of glycine betaine likely improved these aspects, collectively enhancing cotton yield. Naidu *et al.* (1995) <sup>[18]</sup> revealed that glycine betaine seed treatment produced stronger stems, improved branching, and more bolls per plant, increasing yield by 22% over control under rainfed conditions. Gorham *et al.* (1998) <sup>[19]</sup> reported highest seed cotton yields with

soil application of 3–6 kg ha<sup>-1</sup> glycine betaine at squaring, along with more bolls per plant and more nodes at maturity than control. Mottaram (1999) <sup>[20]</sup> found glycine betaine under water deficit improved boll number and yield. Sarwar *et al.* (2006) <sup>[21]</sup> observed positive correlation between glycine betaine accumulation and boll weight, boll number, and seed cotton yield under water deficit. Patil *et al.* (2009) <sup>[22]</sup> noted that 0.3% glycine betaine spray increased monopodia, sympodia, bolls per plant, and seed cotton yield per plant over control under drought. Ahmad *et al.* (2014) <sup>[23]</sup> recorded higher seed cotton yield with exogenous glycine betaine at 2264 kg ha<sup>-1</sup> compared to 1861 kg ha<sup>-1</sup> in control, with no interaction between land configuration and osmoprotectant sprays.

#### 4. Conclusion

The results of foregoing discussion suggested adoption of ridge and furrow at 30 DAS and foliar spray of glycine betaine (0.01%) can effectively improve cotton productivity in rainfed Alfisols under rainfed conditions in HDPS cotton.

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