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## Evaluation of foliar micronutrients for enhanced seed cotton yield and fibre quality in cotton (*Gossypium hirsutum* L.)

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### Abstract

An investigation was conducted during the *kharif*, 2025 at the Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra to evaluate the influence of foliar application of micronutrients on growth, reproductive development, seed cotton yield, fibre quality and biochemical characteristics of cotton. The experiment was laid out in a Randomized Block Design with three replications. Eight treatments comprised recommended dose of fertilizer (RDF) + water spray as control (T<sub>0</sub>), PDKV Micro Grade-XI (T<sub>1</sub>), New PDKV Micro Grade-A (T<sub>2</sub>), New PDKV Micro Grade-B (T<sub>3</sub>), New PDKV Micro Grade-C (T<sub>4</sub>), New PDKV Micro Grade-D (T<sub>5</sub>), New PDKV Micro Grade-E (T<sub>6</sub>) and New PDKV Micro Grade-F (T<sub>7</sub>). Foliar application of micronutrient significantly influenced plant height at 60, 90 and 120 days after sowing (DAS), sympodial branches plant<sup>-1</sup>, number of bolls plant<sup>-1</sup> at 90 and 120 DAS, seed cotton yield, seed index, lint index, harvest index, fibre strength and fibre elongation. New PDKV Micro Grade-E (T<sub>6</sub>) recorded the highest plant height at 90 DAS (134.91 cm) and 120 DAS (138.53 cm), sympodial branches plant<sup>-1</sup> at 60, 90 and 120 DAS (4.79, 8.51 and 10.87, respectively), seed cotton yield plot<sup>-1</sup> (3.43 kg), seed cotton yield (16.30 q ha<sup>-1</sup>), seed index (12.75), lint index (7.03) and harvest index (43.00%). It also recorded the highest fibre strength (31.40 g tex<sup>-1</sup>) and fibre elongation (13.01%). The highest numerical values for micronaire (4.40) and fibre uniformity index (87.66%) were also recorded with New PDKV Micro Grade-E (T<sub>6</sub>) although these traits were statistically non-significant. The findings demonstrated that foliar application of New PDKV Micro Grade-E was the most promising treatment for improving seed cotton productivity and selected fibre-quality attributes under the conditions of the present investigation.

**Keywords:** Cotton, foliar application, micronutrients, seed cotton yield, fibre quality, New PDKV Micro Grade-E

### Introduction

Cotton (*Gossypium hirsutum* L.) is an important commercial fibre crop and a major contributor to India's agricultural and textile economy. Cottonseed also has considerable value as a source of oil, livestock feed and industrial products. Cotton productivity and fibre quality are influenced by genotype, environment and crop management, with balanced plant nutrition playing an important role.

Cotton requires substantial quantities of nutrients throughout its prolonged vegetative and reproductive growth. Although nitrogen, phosphorus and potassium are the major nutrients, micronutrients such as zinc, iron, boron, manganese, copper and molybdenum are essential for photosynthesis, enzyme activity, hormonal regulation, reproductive development and assimilate partitioning. Their deficiency can adversely affect plant growth, boll retention, seed development and fibre production.

Foliar application offers an effective supplementary method of supplying micronutrients directly to the crop canopy during critical growth and reproductive stages. Timely foliar nutrition during flowering, boll setting and boll development may improve nutrient availability and influence seed cotton yield and fibre quality. However, the response to foliar micronutrients varies with nutrient formulation, concentration, application timing, genotype and environmental conditions.

Since fibre development involves elongation, secondary cell-wall deposition and maturation, adequate nutrient supply is important for achieving desirable fibre characteristics such as length, strength, micronaire, uniformity and elongation. Therefore, the present investigation was undertaken to evaluate the effect of different foliar micronutrient formulations on growth, reproductive traits, seed cotton yield and fibre quality of cotton.

### Materials and Methods

The field experiment was conducted during the *kharif*, 2025 at the Cotton Research Unit, Dr. PDKV, Akola, Maharashtra, India. The experimental site is situated in the Vidarbha region of Maharashtra at 22°42' N latitude and 77°02' E longitude, with an altitude of 307.42 m above mean sea level. Akola experiences a semi-arid tropical climate and receives the major proportion of its annual rainfall during the southwest monsoon. Cotton hybrid 'Ajeet-155' was grown in a Randomized Block Design (RBD) with three replications. The crop was sown at a seed rate of 2.5-3.0 kg ha<sup>-1</sup> with a spacing of 90 × 30 cm. The gross plot size was 7.20 × 4.50 m, while the net plot size was 5.40 × 3.90 m. Eight treatments comprising different foliar micronutrient formulations were evaluated viz., T<sub>0</sub>: RDF + water spray (Control), T<sub>1</sub>: PDKV Micro Grade-XI, T<sub>2</sub>: New PDKV Micro Grade-A, T<sub>3</sub>: New PDKV Micro Grade-B, T<sub>4</sub>: New PDKV Micro Grade-C, T<sub>5</sub>: New PDKV Micro Grade-D, T<sub>6</sub>: New PDKV Micro Grade-E and T<sub>7</sub>: New PDKV Micro Grade-F. All treatments received the recommended dose of fertilizers, and the respective foliar micronutrient formulations were applied as per the treatment schedule.

Five representative plants were selected and tagged from each net plot for recording observations on growth and reproductive attributes. Plant height was recorded at 30, 60, 90 and 120 days after sowing (DAS), while the number of sympodial branches plant<sup>-1</sup> was recorded at 60, 90 and 120 DAS. Number of bolls plant<sup>-1</sup> and boll weight were recorded following standard field procedures. Seed cotton yield was recorded from successive pickings and expressed as kg plot<sup>-1</sup> and q ha<sup>-1</sup>. Seed index, lint index and harvest index were calculated using standard procedures. Fibre quality parameters, including fibre strength, micronaire, fibre uniformity index and fibre elongation were evaluated. Fibre length, strength, micronaire, uniformity and elongation were determined using a High-Volume Instrument (HVI).

### Results and Discussion

#### Growth and reproductive development

Foliar application of micronutrients significantly influenced plant height at 60, 90 and 120 DAS, whereas treatment differences were non-significant at 30 DAS. At 30 DAS, plant height ranged from 27.39 to 31.72 cm, with the highest value under T<sub>6</sub> (31.72 cm) and the lowest under T<sub>0</sub> (27.39 cm). At 60 DAS, T<sub>1</sub> recorded the highest plant height (96.97 cm), while T<sub>6</sub> recorded the highest values at 90 DAS (134.91 cm) and 120 DAS (138.53 cm). The enhanced plant height under T<sub>6</sub> during the later stages may be associated with improved nutrient availability, photosynthetic activity, enzyme activation and cellular growth. Similar favourable effects of foliar micronutrient nutrition on cotton growth have been reported by Radhika *et al.* (2013) and Rajendran *et al.* (2019) [17, 27].

**Table 1:** Performance of cotton for growth traits as influenced by foliar application of micronutrients

| Treatment                                     | Plant height (cm) |        |        |         | Sympodial branches plant <sup>-1</sup> |        |         |
|-----------------------------------------------|-------------------|--------|--------|---------|----------------------------------------|--------|---------|
|                                               | 30 DAS            | 60 DAS | 90 DAS | 120 DAS | 60 DAS                                 | 90 DAS | 120 DAS |
| RDF + Water spray (Control) (T <sub>0</sub> ) | 27.39             | 78.97  | 90.45  | 110.84  | 3.15                                   | 5.58   | 6.91    |
| PDKV Micro Grade-XI (T <sub>1</sub> )         | 30.76             | 96.97  | 104.05 | 117.68  | 3.54                                   | 6.63   | 8.66    |
| New PDKV Micro Grade-A (T <sub>2</sub> )      | 28.41             | 81.06  | 111.67 | 118.61  | 3.56                                   | 6.98   | 8.64    |
| New PDKV Micro Grade-B (T <sub>3</sub> )      | 29.48             | 70.82  | 120.14 | 129.71  | 3.66                                   | 6.84   | 9.09    |
| New PDKV Micro Grade-C (T <sub>4</sub> )      | 28.45             | 72.47  | 108.26 | 119.75  | 3.40                                   | 6.74   | 8.51    |
| New PDKV Micro Grade-D (T <sub>5</sub> )      | 28.89             | 76.02  | 119.17 | 133.53  | 3.84                                   | 7.22   | 8.61    |
| New PDKV Micro Grade-E (T <sub>6</sub> )      | 31.72             | 70.29  | 134.91 | 138.53  | 4.79                                   | 8.51   | 10.87   |
| New PDKV Micro Grade-F (T <sub>7</sub> )      | 29.28             | 75.80  | 129.03 | 135.28  | 3.93                                   | 7.79   | 10.34   |
| SE(m)±                                        | 1.535             | 4.766  | 6.251  | 6.006   | 0.275                                  | 0.349  | 0.471   |
| CD at 5%                                      | NS                | 14.456 | 18.961 | 18.217  | 0.834                                  | 1.060  | 1.430   |

NS - Non significant

The number of sympodial branches plant<sup>-1</sup>, however, was significantly influenced at 60, 90 and 120 DAS. T<sub>6</sub> recorded the highest number of sympodial branches at all three stages, with 4.79, 8.51 and 10.87 branches plant<sup>-1</sup>, respectively. The progressive increase in sympodial branching under T<sub>6</sub> suggests favourable vegetative and reproductive development and provides a greater number of fruiting sites for boll formation. These findings are in agreement with the beneficial effects of foliar micronutrient nutrition reported by Radhika *et al.* (2013) and Rajendran *et al.* (2019) [17, 27].

#### Reproductive traits

The number of bolls plant<sup>-1</sup> was significantly affected by treatments at 90 and 120 DAS but not at 60 DAS. At 60

DAS, T<sub>6</sub> recorded the highest number of bolls (4.93 plant<sup>-1</sup>). At 90 DAS, T<sub>6</sub> recorded the maximum number of bolls (15.25 plant<sup>-1</sup>), whereas at 120 DAS T<sub>7</sub> recorded the highest number (25.81 plant<sup>-1</sup>), followed by T<sub>6</sub> (25.17). The control consistently recorded the lowest boll number. Improved boll production under micronutrient treatments may be associated with improved nutritional status and physiological activity during flowering and boll formation. Boll weight was not significantly influenced by foliar micronutrient application. The values ranged from 5.16 to 5.29 g, with the highest value under T<sub>0</sub> (5.29 g) and the lowest under T<sub>2</sub> (5.16 g). The narrow range suggests that individual boll weight was comparatively less responsive to the treatments under the prevailing conditions.

**Table 2:** Performance of cotton for reproductive traits as influenced by foliar application of micronutrients

| Treatment                                     | Number of Bolls plant <sup>-1</sup> |        |         | Boll weight (g) |
|-----------------------------------------------|-------------------------------------|--------|---------|-----------------|
|                                               | 60 DAS                              | 90 DAS | 120 DAS |                 |
| RDF + Water spray (Control) (T <sub>0</sub> ) | 4.07                                | 11.87  | 18.75   | 5.29            |
| PDKV Micro Grade-XI (T <sub>1</sub> )         | 4.87                                | 14.50  | 24.18   | 5.25            |
| New PDKV Micro Grade-A (T <sub>2</sub> )      | 4.13                                | 12.93  | 21.36   | 5.16            |
| New PDKV Micro Grade-B (T <sub>3</sub> )      | 4.47                                | 13.83  | 22.86   | 5.20            |
| New PDKV Micro Grade-C (T <sub>4</sub> )      | 4.20                                | 12.10  | 19.85   | 5.18            |
| New PDKV Micro Grade-D (T <sub>5</sub> )      | 4.27                                | 13.93  | 23.09   | 5.26            |
| New PDKV Micro Grade-E (T <sub>6</sub> )      | 4.93                                | 15.25  | 25.17   | 5.25            |
| New PDKV Micro Grade-F (T <sub>7</sub> )      | 4.60                                | 14.97  | 25.81   | 5.18            |
| SE(m)±                                        | 0.219                               | 0.647  | 1.275   | 0.031           |
| CD at 5%                                      | NS                                  | 1.963  | 3.867   | NS              |

NS - Non significant

**Seed cotton yield and yield components**

Seed cotton yield plot<sup>-1</sup> was significantly influenced by foliar micronutrient application. Yield ranged from 2.29 to 3.43 kg plot<sup>-1</sup>. T<sub>6</sub> recorded the highest yield (3.43 kg plot<sup>-1</sup>), followed by T<sub>7</sub> (3.26 kg), T<sub>5</sub> (2.80 kg) and T<sub>4</sub> (2.57 kg), whereas T<sub>0</sub> recorded the lowest yield (2.29 kg plot<sup>-1</sup>). The higher yield under T<sub>6</sub> may be attributed to its favourable effects on sympodial branching and boll production, which increased the effective reproductive sink.

On a hectare basis, seed cotton yield ranged from 10.85 to 16.30 q ha<sup>-1</sup>. T<sub>6</sub> recorded the highest yield (16.30 q ha<sup>-1</sup>) followed by T<sub>7</sub> (15.50 q ha<sup>-1</sup>) and T<sub>5</sub> (13.34 q ha<sup>-1</sup>), while T<sub>0</sub> recorded the lowest yield (10.85 q ha<sup>-1</sup>). The increase in productivity under T<sub>6</sub> was associated with improved nutrient availability, physiological activity, sympodial branching and boll formation. The present findings support earlier observations of Radhika *et al.* (2013) and Rajendran *et al.* (2019) [17, 27] regarding the beneficial contribution of foliar micronutrient nutrition to cotton productivity.

**Table 3:** Performance of cotton for yield traits as influenced by foliar application of micronutrients

| Treatment                                     | Seed cotton yield plot <sup>-1</sup> (kg) | Seed cotton yield (q ha <sup>-1</sup> ) | Seed index | Lint index | Harvest index (%) |
|-----------------------------------------------|-------------------------------------------|-----------------------------------------|------------|------------|-------------------|
| RDF + Water spray (Control) (T <sub>0</sub> ) | 2.29                                      | 10.85                                   | 10.01      | 5.43       | 33.00             |
| PDKV Micro Grade-XI (T <sub>1</sub> )         | 2.30                                      | 10.92                                   | 10.73      | 6.20       | 36.00             |
| New PDKV Micro Grade-A (T <sub>2</sub> )      | 2.34                                      | 11.14                                   | 10.30      | 5.90       | 38.00             |
| New PDKV Micro Grade-B (T <sub>3</sub> )      | 2.43                                      | 11.58                                   | 10.23      | 6.24       | 41.00             |
| New PDKV Micro Grade-C (T <sub>4</sub> )      | 2.57                                      | 12.20                                   | 10.58      | 5.86       | 37.00             |
| New PDKV Micro Grade-D (T <sub>5</sub> )      | 2.80                                      | 13.34                                   | 10.50      | 6.26       | 40.00             |
| New PDKV Micro Grade-E (T <sub>6</sub> )      | 3.43                                      | 16.30                                   | 12.75      | 7.03       | 43.00             |
| New PDKV Micro Grade-F (T <sub>7</sub> )      | 3.26                                      | 15.50                                   | 11.05      | 6.80       | 41.00             |
| SE(m)±                                        | 0.050                                     | 0.237                                   | 0.500      | 0.342      | 0.551             |
| CD at 5%                                      | 0.152                                     | 0.718                                   | 2.065      | 1.413      | 1.671             |

Seed index was significantly influenced by foliar micronutrient application. T<sub>6</sub> recorded the highest seed index (12.75), followed by T<sub>7</sub> (11.05), while the control recorded the lowest value (10.01). The higher seed index under T<sub>6</sub> may be related to improved nutrient availability, assimilate production and translocation towards developing seeds.

Lint index also showed a significant response. T<sub>6</sub> recorded the highest lint index (7.03), followed by T<sub>7</sub> (6.80), while the control recorded the lowest value (5.43). Improved nutrient availability and enhanced assimilate translocation during fibre development may have contributed to the superior response of T<sub>6</sub>.

Harvest index was significantly influenced by foliar micronutrient application. T<sub>6</sub> recorded the highest harvest index (43.00%) followed by T<sub>3</sub> and T<sub>7</sub> (41.00% each), while

T<sub>0</sub> recorded the lowest value (33.00%). The higher harvest index under T<sub>6</sub> reflects comparatively efficient partitioning of biomass towards economic yield.

**Fibre quality**

Fibre strength was significantly influenced by foliar micronutrient application. T<sub>6</sub> recorded the highest fibre strength (31.40 g tex<sup>-1</sup>) followed by T<sub>5</sub> (29.36 g tex<sup>-1</sup>), whereas T<sub>0</sub> recorded the lowest value (27.96 g tex<sup>-1</sup>). Improved fibre strength under T<sub>6</sub> may be associated with enhanced nutrient availability, physiological activity, carbohydrate metabolism and cell-wall development during fibre formation. The findings are consistent with the broader role of foliar micronutrients in improving physiological processes and fibre-related characteristics reported by Radhika *et al.* (2013) and Rajendran *et al.* (2019) [17, 27].

**Table 4:** Effect of foliar application of micronutrients on fibre quality of cotton

| Treatment                                     | Fibre strength (g tex <sup>-1</sup> ) | Micronaire | Fibre uniformity index (%) | Fibre elongation (%) |
|-----------------------------------------------|---------------------------------------|------------|----------------------------|----------------------|
| RDF + Water spray (Control) (T <sub>0</sub> ) | 27.96                                 | 4.00       | 82.33                      | 7.60                 |
| PDKV Micro Grade-XI (T <sub>1</sub> )         | 28.53                                 | 4.16       | 86.66                      | 9.27                 |
| New PDKV Micro Grade-A (T <sub>2</sub> )      | 28.12                                 | 4.11       | 85.33                      | 8.83                 |
| New PDKV Micro Grade-B (T <sub>3</sub> )      | 28.50                                 | 4.10       | 83.66                      | 9.54                 |
| New PDKV Micro Grade-C (T <sub>4</sub> )      | 28.59                                 | 4.13       | 84.33                      | 9.13                 |

|                                          |       |       |       |       |
|------------------------------------------|-------|-------|-------|-------|
| New PDKV Micro Grade-D (T <sub>5</sub> ) | 29.36 | 4.20  | 84.66 | 11.27 |
| New PDKV Micro Grade-E (T <sub>6</sub> ) | 31.40 | 4.40  | 87.66 | 13.01 |
| New PDKV Micro Grade-F (T <sub>7</sub> ) | 28.53 | 4.26  | 85.00 | 8.84  |
| SE(m)±                                   | 0.576 | 0.140 | 0.462 | 0.698 |
| CD at 1%                                 | 2.381 | NS    | NS    | 2.883 |

NS - Non significant

Micronaire value was not significantly influenced by the treatments. The highest numerical value was recorded under T<sub>6</sub> (4.40) followed by T<sub>7</sub> (4.26), whereas the control recorded the lowest value (4.00). Similarly, fibre uniformity index was non-significant, although T<sub>6</sub> recorded the highest numerical value (87.66%) compared with 82.33% under the control.

Fibre elongation was significantly influenced by foliar micronutrient application. T<sub>6</sub> recorded the highest fibre elongation (13.01%) followed by T<sub>5</sub> (11.27%), while T<sub>0</sub> recorded the lowest value (7.60%). The favourable response under T<sub>6</sub> may be related to improved nutrient availability, enzyme activity, carbohydrate metabolism and cell-wall development during fibre growth.

### Conclusion

The present study revealed that foliar application of micronutrients significantly influenced several important growth, reproductive, yield and fibre-quality attributes of cotton. Among the treatments, New PDKV Micro Grade-E (T<sub>6</sub>) exhibited the most favourable and consistent performance. It recorded the highest plant height at 90 and 120 DAS, sympodial branches plant<sup>-1</sup> at 60, 90 and 120 DAS, seed cotton yield plot<sup>-1</sup> (3.43 kg), seed cotton yield (16.30 q ha<sup>-1</sup>), seed index (12.75), lint index (7.03) and harvest index (43.00%). It also produced the highest fibre strength (31.40 g tex<sup>-1</sup>) and fibre elongation (13.01%). New PDKV Micro Grade-E (T<sub>6</sub>) additionally recorded the highest numerical values for micronaire and fibre uniformity index although these traits were statistically non-significant. Thus, New PDKV Micro Grade-E emerged as the most promising foliar micronutrient treatment for enhancing seed cotton productivity and some fibre-quality attributes of cotton.

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