

# EFFECT OF MICRONUTRIENT APPLICATION UNDER DIFFERENT FERTILIZER PRESCRIPTION METHODS ON GROWTH AND YIELD ATTRIBUTES OF BT-COTTON

## Abstract

An experiment was conducted to study the effect of ~~micronutrient~~ micronutrients application under different fertilizer prescription methods on growth and yield of Bt cotton ~~on~~ at KVK farm, Chamarajanagar district, Southern Dry Zone of Karnataka (Zone 6). The experiment was laid out in randomised complete block design with thirteen treatments and three replications during *Kharif* 2016 and *Kharif* 2017. The micro-nutrients were given as soil application and foliar spray under UAS B and SSNM dose of NPK fertilizers prescription. The soil was slightly alkaline in reaction (pH: 7.95), low in zinc ( $0.32 \text{ mg kg}^{-1}$ ) and boron ( $0.18 \text{ mg kg}^{-1}$ ). The results indicated ~~significants~~ significantly higher plant height and number of sympodial branches ~~with~~ within UASB Package, UASB + Micro-nutrients, SSNM and SSNM + Micro-nutrients. However, significantly higher seed cotton yield ( $2179 \text{ kg ha}^{-1}$ ) was recorded with NPK as per SSNM + MNM foliar application at 80 and 100 DAS followed by NPK as per UASB package + MNM foliar application at 80 and 100 DAS ( $2127 \text{ kg ha}^{-1}$ ) and NPK as per SSNM + MNM soil application ( $1956 \text{ kg ha}^{-1}$ ) treatments as compared to control. The supplementation of micronutrients with ~~the~~ optimized major nutrients application can bring about an overall augmentation in crop performance both in terms of growth and yield attributes, thereby resulting in a significantly higher yield. Application of micronutrients through foliar spray has a significant and positive effect on the growth and yield in Bt cotton under black soils of Chamarajanagar district.

**Keywords:** Bt-Cotton, Micronutrients, Foliar application and Seed cotton yield, SSNM

## 1. Introduction

Cotton (*Gossypium hirsutum* L.) is one of the most important fiber crops worldwide because of its adaptability, good fiber quality and higher yield. Cotton, also known as white gold and king of fiber crops, is an important cash crop and foremost source of raw material for textile industries. It earns about 33 per cent of total foreign exchange. The yield of cotton is affected due to many reasons *viz.*, flower and boll shedding associated with imbalanced nutrition, hormones, etc. The area under Bt cotton is increasing continuously but productivity is decreasing over the years. The reasons for decreasing productivity are due to decreasing

soil fertility, especially micronutrients, imbalanced application of fertilizers and occurrence of physiological disorders like square dropping, square drying, leaf reddening etc. Among these, imbalanced use of major and micro nutrients is the major problem. These nutrients are more important because, in Bt cotton, synchronized boll development altered the source-sink relationship due to rapid translocation of saccharides and nutrients from the leaves to the developing bolls (Hebbbar *et al.*, 2007).

Cotton yield in Chamarajanagar district noticed a 4.62 per cent negative growth rate and the production reduced by 27.66 per cent (Pavithra and Kunnal, 2013). The yield of cotton is 430 kg ha<sup>-1</sup> for Karnataka state and it is very low for Chamarajanagar district (282 kg ha<sup>-1</sup>). Hence, the present experiment was taken up to study the effect of different methods of application of micronutrients under different fertilizer prescription on growth, yield and quality parameters of Bt cotton.

## 2. Material and methods

A field experiment was conducted during *Kharif* 2016 and *Kharif* 2017 at ICAR Krishi Vigyan Kendra, Haradanahally Farm, Chamarajanagara (latitude 11° 53' N and 76° 57' E longitude and altitude 714 m) to study the effect of application of micronutrients under different fertilizer prescription on growth and yield of Bt cotton grown with NPK recommendation by UAS B and SSNM. Bt cotton hybrid, Jadu (Kaveri seeds) was the test crop taken up at a spacing of 90 cm X 60 cm with 13 treatments replicated thrice under Randomised Complete Block Design in medium black soil. Recommended FYM was applied to all the plots, NPK as per the UAS B recommendation (150:75:75 kg N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O ha<sup>-1</sup>) and SSNM recommendations taking into consideration the crop uptake – 44.5:29.3:74.7 kg N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O per ton produce (Das *et al.*, 1991 and Fauconnier, 1973) and 2 tons target yield. The treatments comprised of the combination of UAS B recommended dose of fertilizers and site specific nutrient management with foliar and soil application of varied levels of different micronutrients. The details are given in Table 1.

The soil of the experiment site was medium black. A composite soil sample was collected from the experimental site before the start of the experiment. The soil was air-dried, powdered and passed through a 2 mm sieve and was analysed for physical and chemical properties. The results are furnished in Table 2.

The soil physico-chemical properties were analysed using standard procedures. The growth and yield parameters like plant height (at harvest), number of monopodial & sympodial branches, total dry matter, harvested bolls plant<sup>-1</sup>, boll weight, seed index, seed cotton yield and stalk yield were recorded at different interval of crop life cycle.

**Table 1: List of treatments**

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Treatment	Details
T <sub>1</sub>	Absolute control
T <sub>2</sub>	UAS (B) Recommended nutrient management
T <sub>3</sub>	T <sub>2</sub> + MNM foliar application at 80 & 100 days after sowing (ZnSO <sub>4</sub> , Fe SO <sub>4</sub> , MnSO <sub>4</sub> , CuSO <sub>4</sub> @ 0.3% each and Borax @ 0.2%)

T <sub>4</sub>	T <sub>2</sub> + Zinc Sulphate (0.5%) and Borax (0.2%) foliar application at 80 & 100 DAS
T <sub>5</sub>	T <sub>2</sub> + Zinc Sulphate (15 kg ha <sup>-1</sup> ) and Borax (10 kg ha <sup>-1</sup> ) soil application
T <sub>6</sub>	T <sub>2</sub> + MNM soil application (15kg ZnSO <sub>4</sub> + 10kg Borax + 15kg FeSO <sub>4</sub> + 20kg MnSO <sub>4</sub> + 10kg CuSO <sub>4</sub> ha <sup>-1</sup> )
T <sub>7</sub>	T <sub>2</sub> + MNM soil application (7.5kg ZnSO <sub>4</sub> + 5kg Borax + 7.5kg FeSO <sub>4</sub> + 10kg MnSO <sub>4</sub> + 5kg CuSO <sub>4</sub> ha <sup>-1</sup> )
T <sub>8</sub>	Site specific nutrient management
T <sub>9</sub>	T <sub>8</sub> + MNM foliar application at 80 & 100 days after sowing (ZnSO <sub>4</sub> , FeSO <sub>4</sub> , MnSO <sub>4</sub> , CuSO <sub>4</sub> @ 0.3% each and Borax @ 0.2%)
T <sub>10</sub>	T <sub>8</sub> + Zinc Sulphate (0.5%) and Borax (0.2%) foliar application at 80 & 100 DAS
T <sub>11</sub>	T <sub>8</sub> + Zinc Sulphate (15 kg ha <sup>-1</sup> ) and Borax (10 kg ha <sup>-1</sup> ) soil application
T <sub>12</sub>	T <sub>8</sub> + MNM soil application (15kg ZnSO <sub>4</sub> + 10kg Borax + 15kg FeSO <sub>4</sub> + 20kg MnSO <sub>4</sub> + 10kg CuSO <sub>4</sub> ha <sup>-1</sup> )
T <sub>13</sub>	T <sub>8</sub> + MNM soil application (7.5kg ZnSO <sub>4</sub> + 5kg Borax + 7.5kg FeSO <sub>4</sub> + 10kg MnSO <sub>4</sub> + 5kg CuSO <sub>4</sub> ha <sup>-1</sup> )

SSNM – Site Specific Nutrient Management

MNM – Micronutrient mixture

DAS – Days after sowing

**Table 2: Initial soil characteristics**

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Parameter	Value	Parameter	Value
Soil reaction (pH)	7.95	Exchangeable Calcium (meq 100 g <sup>-1</sup> )	21.50
Electrical Conductivity (dSm <sup>-1</sup> )	0.452	Exchangeable Magnesium (m-eq 100 g <sup>-1</sup> )	6.00
Organic Carbon (g kg <sup>-1</sup> )	4.24	DTPA Iron (mg kg <sup>-1</sup> )	3.75
Available Nitrogen (kg ha <sup>-1</sup> )	193.00	DTPA Zinc (mg kg <sup>-1</sup> )	0.32
Available P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> )	55.10	DTPA Manganese (mg kg <sup>-1</sup> )	2.70
Available K <sub>2</sub> O (kg ha <sup>-1</sup> )	376.50	DTPA Copper (mg kg <sup>-1</sup> )	2.10
Available Sulphur (mg kg <sup>-1</sup> )	8.49	Hot water extractable Boron (mg kg <sup>-1</sup> )	0.18

### 3. Results and discussion

The results of an experiment revealed that, all the treatments showed significantly better growth attributes than the control (Table 3). Higher plant height, monopodial branches, sympodial branches and dry matter was noticed with the treatment T<sub>9</sub> receiving foliar spray of all micronutrients with SSNM (138.94 cm, 3.35, 20.17, 361.09 g plant<sup>-1</sup>, respectively) followed by treatment T<sub>3</sub> receiving foliar spray of all micronutrients with UAS B package (135.02 cm, 3.45, 20.42, 351.9 g plant<sup>-1</sup>, respectively). Application of micro nutrients showed improved crop growth compared to non-application of micro nutrients irrespective of the fertilizer recommendation adopted. Christos Dordas (2006) in his experiment found that plant height was increased by an average of 9 to 10 per cent compared to control after the application of

micronutrients in cotton crop. Further, among the soil and foliar methods of application of micronutrients, foliar application was found better in improving growth parameters compared to soil application of micro-nutrients under both UAS (B) and SSNM practice. Accordingly, adequate absorption and utilization of micronutrients is essential to accelerate plant growth and result in higher yield, Sangh Ravikiran (2012), and Kulvir Singh *et al.* (2015). The efficiency of improving plant growth was higher due to foliar application of a solution containing micronutrients when compared with soil application of the micronutrient fertilizers.

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Spraying of micronutrients increased plant height, number of sympodial branches significantly in plants compared to untreated plants. Supply of micronutrients through foliar spray led to higher uptake of boron and zinc that promotes the synthesis of growth promoting hormones, especially the production of auxins that may have resulted in enhanced growth and increased the number of internodes that promoted the development of main shoot as well growth of sympodial branches. Dale G. Blevins and Krystyna M. Lukaszewski (1998) explained that boron plays a pivotal role in nitrogen metabolism, membranes functioning, photosynthesis and cell division. The application of micronutrients improved all these physiological processes, resulting in improved growth due to enhanced protein synthesis and efficient supply of metabolites. Manganese acts as an activator for many enzymes, which promotes plant growth, number of nodes and flower production. Also, these increases may be due to the influence of zinc on auxin level. As for iron, it is an essential element for plant growth, photosynthesis and other light dependant processes. All these factors are collectively responsible for increased growth attributes.

The data presented in Table 4 revealed that the application of micronutrients along with inorganic fertilizers as UAS (B) and SSNM recommendations recorded significantly increased yield parameters of Bt-cotton. Significantly more bolls per plant, higher boll weight and seed index were recorded in the treatment T<sub>9</sub> (32.58, 4.43 g and 14.17 respectively) in pooled data which was on par with T<sub>3</sub> (31.33 g, 4.26 and 13.95, respectively). Seed cotton yield was also recorded higher in treatment T<sub>9</sub> (127.59 g plant<sup>-1</sup>) and T<sub>3</sub> (121.12 g plant<sup>-1</sup>). The improvement in yield attributes is a manifestation of better growth, higher photosynthetic activity and transport of photosynthates from source to sink. The improvement in growth as a result of improved physiological processes in the plant might be due to enhanced supply of nutrients by application of micronutrients along with macro nutrients.

**Table 3: Growth attributes of Bt-cotton as influenced by different nutrient management practices**

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Treatments	Plant height (cm)	Monopodial	Sympodial	Total dry matter (g plant <sup>-1</sup> )
T <sub>1</sub>	60.72	1.75	10.10	216.48
T <sub>2</sub>	96.38	2.42	14.16	255.55
T <sub>3</sub>	135.02	3.45	20.42	351.90
T <sub>4</sub>	107.71	2.69	15.79	279.80
T <sub>5</sub>	104.92	2.62	15.39	274.26

T <sub>6</sub>	126.26	3.13	18.46	322.50
T <sub>7</sub>	110.77	2.76	16.23	289.96
T <sub>8</sub>	101.50	2.54	14.89	266.90
T <sub>9</sub>	138.94	3.35	20.17	361.09
T <sub>10</sub>	110.22	2.75	16.91	285.33
T <sub>11</sub>	105.18	2.63	15.42	275.01
T <sub>12</sub>	127.98	3.17	18.71	326.70
T <sub>13</sub>	115.06	2.86	16.85	298.56
S.Em±	3.91	0.10	0.55	10.25
CD (P=0.05)	11.11	0.28	1.56	29.12

**Table 4: Yield attributes and yield of Bt-cotton as influenced by different nutrient management practices.**

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Treatment s	Harvested bolls plant <sup>-1</sup>	Boll weight (g)	Seed cotton yield (g plant <sup>-1</sup> )	Seed index	Seed cotton yield (kg ha <sup>-1</sup> )	Stalk yield (kg ha <sup>-1</sup> )
T <sub>1</sub>	18.32	2.39	60.55	9.04	989	2169
T <sub>2</sub>	20.92	2.84	80.93	11.53	1521	2410
T <sub>3</sub>	31.33	4.26	121.12	13.95	2215	3450
T <sub>4</sub>	23.63	3.21	91.40	12.22	1665	2665
T <sub>5</sub>	22.96	3.12	88.83	11.92	1617	2611
T <sub>6</sub>	28.07	3.82	108.56	13.06	1982	3139
T <sub>7</sub>	24.36	3.31	94.24	12.62	1717	2801
T <sub>8</sub>	22.15	3.01	85.67	11.64	1559	2533
T <sub>9</sub>	32.58	4.43	127.59	14.17	2329	3507
T <sub>10</sub>	24.23	3.30	93.86	12.31	1708	2725
T <sub>11</sub>	23.02	3.13	91.54	12.00	1622	2620
T <sub>12</sub>	28.48	3.87	98.92	13.25	2012	3187
T <sub>13</sub>	25.39	3.45	104.56	12.84	1791	2887
S.Em±	0.88	0.12	3.43	0.51	62.09	99.01
CD (P=0.05)	2.51	0.34	9.75	1.41	176.37	281.23

The results are in conformity with those of Hallikeri *et al.* (2002). It has been observed previously by Ratnavel *et al.* (1999) that the number of bolls per plant and number of cotton seeds per boll was increased in plants given combined soil application of zinc and boron. Though application of NPK for of 2 tonnes per hectare target yield through SSNM recommendation resulted in better yield parameters than UAS(B) practice, both the treatments were on par with each other corresponding to the results of Vinayak Hosamani *et al.* (2013) who found that 75 per cent and 100 per cent of RDF application performed similarly.

Lower values for the yield parameters was obtained in T<sub>2</sub> with UAS (B) practice alone (2.84 g, 20.92 and 11.53 of boll weight, bolls per plant and seed index, respectively) and T<sub>8</sub> (SSNM alone; 3.01 g, 22.15 and 11.64 of boll weight, bolls per plant and seed index,

respectively) apart from absolute control plot that showed the lowest values of 2.39 g, 18.32 and 9.04 for boll weight, bolls per plant and seed index, respectively.

Seed Cotton yield and stalk yield in absolute control were 989 and 2169 kg ha<sup>-1</sup>, respectively, which increased significantly ~~to~~in 1521 and 2410 kg ha<sup>-1</sup> in treatment T<sub>2</sub> with UAS(B) practice alone and 1559 and 2533 kg ha<sup>-1</sup> respectively in treatment T<sub>8</sub> ~~with~~to SSNM practice alone.

The extent of increase in seed and stalk yield was higher with the application of micro nutrients under both UAS (B) and SSNM practices. However, seed cotton yield and stalk yield was higher (2329 and 3507 kg ha<sup>-1</sup>, respectively) in the treatment T<sub>9</sub> with site specific nutrient management + MNM foliar application at 80 and 100 days after sowing (ZnSO<sub>4</sub>, Fe SO<sub>4</sub>, MnSO<sub>4</sub>, CuSO<sub>4</sub> @ 0.3% each and Borax @ 0.2%). It was on par (2215 and 3450 kg ha<sup>-1</sup>, respectively) with T<sub>3</sub> treatment (UAS B practice + MNM foliar application at 80 & 100 days after sowing (ZnSO<sub>4</sub>, Fe SO<sub>4</sub>, MnSO<sub>4</sub>, CuSO<sub>4</sub> @ 0.3% each and Borax @ 0.2%) and T<sub>12</sub> treatment (2012 and 3187 kg ha<sup>-1</sup>, respectively) with specific nutrient management + MNM soil application (15kg ZnSO<sub>4</sub> + 10kg Borax + 15kg FeSO<sub>4</sub> + 20kg MnSO<sub>4</sub> + 10kg CuSO<sub>4</sub> ha<sup>-1</sup>).

The significant increase in cotton yield due to application of micronutrients along with macronutrients might be attributed to improvement in growth parameters (Table 3) and yield attributes (Table 4). The yYield of a crop is an outcome of improvement in growth and yield attributing parameters. The improved growth and yield components observed in the present investigation might be due to higher uptake of nutrients due to enhanced supply of nutrients with addition especially through foliar application. The supply of all essential nutrients in adequate amount might have helped ~~for~~in the improvement in photosynthesis and translocation of photosynthates from source to sink. Ahmad *et al.* (2009) have reported that the balanced use of macro and micronutrients resulted in a significant increase in yield and cotton quality.

According to Korzeniowska (2008) and Liew *et al.* (2012), infertility of flowers and premature falling of flowers ~~are~~is the consequence of Zn and B insufficiency in plants and ultimately a reduction in yield occurs. The lower yields in absolute control treatment followed by UAS (B) alone and SSNM alone treatments showed that no application of micronutrients is one of the foremost factors that brings down the potential of high yielding Bt cotton. For that reason, foliar feeding of micronutrients is highly advisable for cotton regions with micronutrient deficit soils. Thereby, foliar application of micronutrients, particularly of Zn, B, Fe, Mn, and Cu is an effective technology for increasing the yield of cotton.

The lower yields obtained in the treatments without micronutrients application may be because the cotton yield and quality is adversely affected by the boron deficiency as it has a primary role in regulating lint quality and boll development Khan *et al.* (2007). The deficiency of zinc is also a well-documented issue that decreases the crop yields by significantly decreasing plant performance. These micronutrients are involved in indispensable functions like translocation and incorporation of sugar compounds and nitrogen in complex carbohydrates (fiber) and proteins as reported by Khan *et al.* (2007).

Wojcik *et al.* (2008) reported that boron and zinc application improved the transport and deposition of assimilates in fruiting body resulting in enhanced fruit yield and quality.

Though application of micronutrients resulted in better yield, foliar application was found to perform better than the soil application of micronutrients. Similar results were reported by Basavanneppa *et al.* (2016) who reported that foliar application of nutrients, especially micronutrients at critical stages (at flowering and boll development stage) registered significantly higher seed cotton yield compared to other methods of application. The highest seed cotton yield was obtained from the combined application of the recommended NPK rate with one percent Micnelf MS – 16, a micronutrient mixture. Application 0.2 to 0.4 % solution of Fe, Zn and Mn or 0.2 % solution of two or all the three elements at 75 DAS as a foliar spray gave a significantly higher yield in cotton. Zn, Fe and Mn with the concentration of 0.2 % gave the highest seed cotton yield (Rajendran *et al.*, 2010, Sangh Ravikiran, 2012).

The practice of foliar application of plant nutrients gives quick benefits and economizes nutrient element as compared to soil application. Foliar application is often effective when roots are unable to absorb sufficient nutrients from the soil due to high soil pH, high degree of fixation, losses from leaching, low soil temperature and lack of soil moisture.

SSNM recommendation could be considered as a balanced dose of N, P and K. However, imbalanced fertilizer application, possibly shifts the balance between the vegetative and reproductive growth, thus delaying maturity, promotes boll shedding and reducing yield (Praharaaj and Rajendran, 2007).

#### 4. Conclusion

On the basis of present investigation, it can be concluded that micronutrient application plays a vital role in improvement of growth and yield of cotton. Further, foliar application of micronutrients has a great effect in improving the efficiency and utilisation of nutrients and, thereby, improves the growth and seed cotton yield. And hence, foliar nutrition in cotton can be considered as a viable practice for enhancing production and productivity of cotton in Southern Dry Zone of Karnataka. Further, the micronutrients supplementation with the optimized major nutrients application can bring about an overall augmentation in crop performance both in terms of growth and yield attributes, thereby resulting in a significantly higher yield.

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