J. Cotton Res. Dev. **38**(1), 52-57 (January, 2024) **ISSN No. 0972-8619**

Effect of Foliar Application of Micronutrients on Dry Matter Accumulation, Quality and Economics of *Bt* cotton

KALU RAM, MEENA SEWHAG, KARMAL SINGH*, RAM PRAKASH AND POOJA KUMARI
Department of Agronomy, CCS Haryana Agricultural University, Hisar-125004
**Email : karmalsingh@gmail.com*

Abstract : An experiment entitled "Response of *Bt* cotton (*Gossypium hirsutum* L.) to the foliar spray of nutrients" was carried out during crop season *kharif* 2021-22 at Cotton Research Area of Chaudhary Charan Singh Haryana Agricultural University, Hisar. The experiment was laid out in Randomized Block Design (RBD) replicated thrice with eight treatments of foliar application of nutrients *viz.* T_1: Control, T_2:$MgSO_4$ (0.5%), T_3: $ZnSO_4$ (0.5%), T_4: $FeSO_4$ (0.5%), T_5: Borax (0.5%), T_6: $ZnSO_4$ (0.5%) +Urea (2%), T_7: DAP (1%), T_8: Urea (2%) applied at 60, 75, 90 DAS. The results revealed that (T_6) being *at par* with T_5 and T_8 produced significantly higher value of ginning outturn (38.9%) than rest all. The Micronaire value (u/g)of *Bt* cotton did not differ significantly with different foliar spray of nutrients although highest value of 4.77was attained withT_6followed by T_4. The highest net returns was found with the treatment T_2. The net return varied from 51579 Rs/ha (Control) to 77939 Rs/ha (T_2). Thus, there is an additional benefit to tune of Rs. 26360 ha^{-1} with T_2 over control. The benefit: cost ratio ranged from 1.98 (Control) to 2.47 (T_2). The gross returns were found highest with the treatment $T_6$and lowest in control treatment.

Keywords: Borax, *Bt* cotton, DAP, foliar spray, $MgSO_4$, $ZnSO_4$, urea

Cotton (*Gossypium hirsutum*L.) is a perennial plant that belongs to the Malvaceae family and the genus *Gossypium*. It is also known as as "King of Fibers". Cotton is also used to make food and animal feed. Lint is the most significant cost-effective product, as it offers high quality fibre for the textile industry. Cotton seeds, which are a byproduct of lint manufacture, are an important source of oil for human use and are also utilized as a feed for livestock. Cotton is a heavy feeder crop and removes large quantities of nutrients from the soil. Among the various factors of cotton production method of sowing and fertilizer application plays a significant role. Secondary (Ca, Mg, S) and micronutrients especially Zn, B are essential for higher productivity of cotton. Besides increasing nutrient use efficiency, Magnesium is essential for the production of the green pigment in chlorophyll, which is the driving force of photosynthesis and also essential for the metabolism of carbohydrates (sugars). It also facilitates the translocation of carbohydrates (sugars and starches), enhances the production of oils and fats. Micronutrient deficiencies not only hamper crop productivity but also deteriorate produce quality. Micronutrients requirement though small, act as catalyst in the uptake and use of macronutrients. Nutritional status of plants has a considerable impact on partitioning of carbohydrates and dry matter between plant shoots and roots. The increasing deficiencies of these nutrients affect the crop and low response to their applications are being noticed. Boron plays an essential role in the growth and development of new cells in the growing meristem and also required for protein synthesis where nitrogen and carbohydrates are converted into protein. It also plays an essential role in plant cell formation, integrity of plasma membranes, pollen tube growth and increases pollination and seed development. Zinc has important functions in carbohydrate and protein metabolism. Full potential of cotton can be exploited by applying fertilizer with appropriate method along with suitable sowing method. Soil

application of Zn, B, Fe, Mn, and Cu on calcareous soils is less efficient, as these nutrients remain inaccessible to plant roots due to the higher soil pH (Rashid and Ryan, 2004). However, an alternative approach under such circumstances is foliar application of nutrients (Rab and Haq , 2012) as it eliminates the effects of soil pH on the availability of these nutrients (Ali, 2012) and it is more effective and less costly (Ali *et al.*, 2007). External supplementation of nutrients needs to be therefore emphasized keeping in view their role in improving crop yield. Quantum of micronutrient deficiencies of Zn (49%), B (37%), Fe (12%), Mn (4%) and Cu (30%) reported in Indian soils demand urgent attention (Singh, 2009). Foliar spray of nutrients also improved the nutrient status of leaves compared to soil applied fertilizers alone which resulted in an increase in the number of flowers, number of bolls, and ultimately seed cotton yield. Since little information is available on application of aforesaid nutrients through foliar sprays and consequently their effect on growth and yield of *Bt* cotton. Keeping the point in view, the present investigation has been planned with the objective to study the effect of foliar application of micronutrients on dry matter accumulation, quality and economics of *Bt* cotton.

A field experiment was conducted during conducted at Cotton Research Area of Chaudhary Charan Singh Haryana Agricultural University, Hisar, during the year 2021. Hisar is situated in the sub tropics at longitude 75°46'E, latitude 29°10'N and altitude of 215.2 m above mean sea level in Haryana state of India. The total rainfall received during the *kharif* crop growing period was 770.6 mm. Weekly maximum and minimum temperature remained under a suitable range for different crop growth stages, mean weekly maximum and minimum temperature ranged between 28.9-41.4°C and 11.8-28.1°C, during *kharif* 2021. The experiment was laid out in Randomized Block Design replicated thrice with eight treatments of foliar

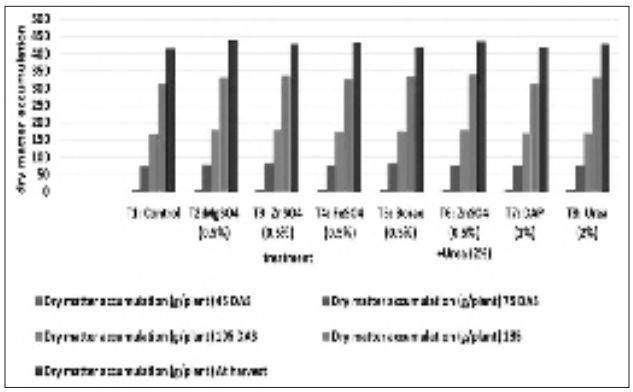

Fig. 1. Dry matter accumulation of *Bt* cotton at different crop growth stages as influenced by various foliar spray of nutrients.

application of nutrients *viz.*T_1: Control, T_2: $MgSO_4$ (0.5%), T_3: $ZnSO_4$ (0.5%), T_4: $FeSO_4$ (0.5%), T_5: Borax (0.5%), T_6: $ZnSO_4$ (0.5%) +Urea (2%), T_7: DAP (1%), T_8: Urea (2%) applied at 60, 75, 90 DAS. Pre sowing irrigation was done with canal water 5-6 days before on 21st April 2021 and sowing of cotton was done by dibbling method on 27th April 2021. Gap filling was done five days after crop emergence. Two post sown irrigations were applied on 3rd June and 19th August 2021. Two hand pickings were performed on 8th October and 3rd November, 2021 .Weeds were removed by hand pulling from time to time in all the plots throughout the crop season. Full dose of P and half dose of N as per treatments were applied to the field before sowing and rest of N was top dressed after first irrigation. Five representative plants from each plot were selected randomly and tagged for recording the effect of different treatments on dry matter accumulation. All yield attributes were recorded periodically on these randomly selected and tagged plants. Span length is the distance spanned by specified % of fibers in test beard or distance from clamp on fiber beard. It is expressed in mm. A sample of having weight 100 g lint was taken to measure span length by Statex Electrospan automatically measures span length taken from sample blow room, cards, draw frames and combers. Optic principle is used to test the span length, and also provides uniformity ratio, short fibre percentage, mean length, upper half mean length, uniformity

index and fibrogram at CICR, Sirsa. Seed cotton sample of 100 gm weight was taken from each plot and then ginning was performed to get lint and cotton seed. Micronaire value measures the fiber weight in 10^{-6} g/inch length of fiber. Fineness denotes the size of cross-sectional diameter of the fibre. A sample of 100gram lint was taken and measure micronaire value by using Precitronic Digital Mic Tester at CICR, Sirsa.

Dry matter accumulation

Results showed that among various foliar sprays of nutrients, T_3 ($ZnSO_4$ (0.5%) being at par with T_5 (Borax (0.5%) resulted in significantly higher dry matter accumulation than rest all foliar sprays of nutrients at 75 DAS. The treatment T_2 ($MgSO_4$ (0.5%) and T_8 (Urea (2%) resulted in significantly higher dry matter accumulation than control treatment at 75 DAS. While treatment T_1,T_4,T_6 and T_7 were *at par* with each other with respect to dry matter accumulation at 75 DAS. At 105 DAS treatment T_6 ($ZnSO_4$ (0.5%) +Urea (2%) being at par with treatment T_3,T_4,T_5 and T_8 recorded significantly higher dry matter accumulation than rest all foliar sprays of nutrients and control. While at 135 DAS treatment T_3 ($ZnSO_4$ (0.5%) being *at par* with treatment T_4,T_5,T_6 and T_8 recorded significantly higher dry matter accumulation than rest all the treatments. At harvest stage treatment T_6 ($ZnSO_4$ (0.5%) +Urea (2%) being *at par* with treatment T_2 to T_8 recorded significantly higher dry matter accumulation than control treatments. Foliar application of micronutrients enhances uptake and use of macronutrients which results in better growth of plants as they have major role in determining the growth and development of cotton crop. Similar result has been reported by Swetha *et al.,* (2020). Several previous studies had determined the positive effect of foliar applied nutrients on dry matter accumulation of *Bt* cotton. Similar result has been reported by Eleyan *et al.*, (2014) and More *et al.*, (2018).

Quality parameters

In the present study foliar spray of any nutrients fails to bring any significant variation in the span length of *Bt* cotton. Span length of *Bt* cotton were between 26.8- 28.9. But ginning out turn (%) of *Bt* cotton significantly increasing by spraying various foliar sprays of nutrients over control. Application of $ZnSO_4$ (0.5%) +Urea (2%) (T_6) being *at par* with T_5 and T_8 produced significantly higher value of ginning out turn (38.9%) than rest all treatments. The reason for which is due to the fact that foliar application of nutrients in cotton increased the uptake of nitrogen, phosphorus and potassium significantly compared to the unsprayed treatments. Lowest ginning outturn (%) of *Bt* cotton was recorded in control treatment (34.8 %) followed by treatment T_2 (35.6 %). Kailash and Tamgadge (2016) also reported better quality parameter of cotton with application of 75 percent RDF + 2.5 t FYM + 2 per cent Urea + 2

Table 1. Dry matter accumulation of *Bt* cotton at different crop growth stages as influenced by various foliar spray of nutrients

Treatment	Dry matter accumulation (g/plant)				
	45 DAS	75 DAS	105 DAS	135 DAS	At harvest
T_1: Control	5.2	74	167	312	414
T_2: MgSO4 (0.5%) as foliar spray at 60, 75 and 90 DAS	5.1	80	177	331	437
T_3: ZnSO4 (0.5%) as foliar spray at 60, 75 and 90 DAS	5.3	82	177	336	428
T_4: FeSO4 (0.5%) as foliar spray at 60, 75 and 90 DAS	4.6	75	172	326	430
T_5: Borax (0.5%) as foliar spray at 60, 75 and 90 DAS	5.2	81	176	334	419
T_6: ZnSO4 (0.5%) +Urea (2%) as foliar spray at 60, 75 and 90 DAS	4.8	75	178	338	436
T_7: DAP (1%) as foliar spray at 60, 75 and 90 DAS	4.9	76	170	314	421
T_8: Urea (2%) as foliar spray at 60, 75 and 90 DAS	5.0	77	171	332	428
S.E (m) ±	0.24	1.02	2.21	4.33	9.72
CD (p=0.05)	N.S.	2.96	6.76	13.02	19.20

Table 2. Quality parameters of *Bt* cotton as influenced by various foliar spray of nutrients

Treatment	Span length (mm)	Ginning outturn (%)	Micronaire value (u/g)
T_1: Control	26.8	34.8	4.69
T_2: MgSO4 (0.5%) as foliar spray at 60, 75 and 90 DAS	27.1	35.6	4.58
T_3: ZnSO4 (0.5%) as foliar spray at 60, 75 and 90 DAS	27.9	35.7	4.72
T_4: FeSO4 (0.5%) as foliar spray at 60, 75 and 90 DAS	28.3	36.4	4.75
T_5: Borax (0.5%) as foliar spray at 60, 75 and 90 DAS	28.1	38.0	4.59
T_6: ZnSO4 (0.5%) +Urea (2%) as foliar spray at 60, 75 and 90 DAS	28.9	38.9	4.77
T_7: DAP (1%) as foliar spray at 60, 75 and 90 DAS	28.0	36.4	4.62
T_8: Urea (2%) as foliar spray at 60, 75 and 90 DAS	28.8	37.6	4.67
S.E (m) ±	0.28	0.46	0.22
CD (p=0.05)	N.S.	1.41	N.S.

Table 3. Economics of *Bt* cotton as influenced by various foliar spray of nutrients

Treatment	Gross returns (Rs/ha)	Net returns (Rs/ha)	Benefit cost ratio
T_1: Control	104154	51579	1.98
T_2: $MgSO_4$ (0.5%) as foliar spray at 60, 75 and 90 DAS	131014	77939	2.47
T_3: $ZnSO_4$ (0.5%) as foliar spray at 60, 75 and 90 DAS	120143	64069	2.14
T_4: $FeSO_4$ (0.5%) as foliar spray at 60, 75 and 90 DAS	108072	52664	1.95
T_5: Borax (0.5%) as foliar spray at 60, 75 and 90 DAS	130950	65377	2.00
T_6: $ZnSO_4$ (0.5%) +Urea (2%) as foliar spray at 60, 75 and 90 DAS	131140	74276	2.31
T_7: DAP (1%) as foliar spray at 60, 75 and 90 DAS	122734	68560	2.27
T_8: Urea (2%) as foliar spray at 60, 75 and 90 DAS	123493	70128	2.31

percent DAP spray. The Micronaire value (u/g)of *Bt* cotton varies from 4.58to 4.77 among treatments (Table 2). It did not differ significantly with different foliar spray of nutrients although highest value of 4.77 was attained with treatment T_6 ($ZnSO_4$ (0.5%) +Urea (2%) followed by T_4 ($FeSO_4$ (0.5%). Eleyan *et al.*, (2014); Sriharsha *et al.*, (2017)*;* Sangh *et al.*, (2012) obtained similar trend with foliar application of nutrients in cotton. However, our findings contradict the results of Rajendran *et al.*, (2011) who concluded that foliar application of micronutrients had non-significant effect on lint turnout which might be due to genetic character of cotton.

Economics

The higher cost of cultivation was recorded with application foliar spray of borax (0.5%) followed by $ZnSO_4$ (0.5%) + urea (2.0%) of *Bt* cotton during the respective crop seasons (Tables 3). The cost of cultivation was lower in control when compared to all other treatments. The higher cost of cultivation was mainly due to high input cost on foliar spray leading to higher combined total cost. The highest gross returns were recorded with foliar spray of $ZnSO_4$ (0.5%) + Urea (2.0%).

The lowest gross returns were obtained with control. The increase in gross returns in these treatments was due to higher seed cotton yield. These results are in line with findings of Rajendran *et al.*, (2011); Shivamurthy and Biradar (2014) who reported significantly increased gross returns in foliar application of nutrients. Highest net return of Rs. 77939/ha was recorded in the treatment T_2 ($MgSO_4$ (0.5%) which is because of higher yield in this treatment. The profitability of any crop is measured in terms of profit/rupee invested (B:C ratio) and net returns. Among various foliar spray of nutrients, the highest benefit: cost ratio was found with the treatment T_2 ($MgSO_4$ (0.5%). The net return varied from 51579 Rs/ha (Control) to 77939 Rs/ha (T_2).Thus, there is an additional benefit to tune of Rs. 26360/ha with foliar spray of $MgSO_4$ (0.5%) over control. The practice of foliar spray of nutrients gives quick

benefits and economizes nutrient element as compared to soil application. Foliar feeding is quite effective in increasing the yield of cotton crop and economically superior to not applying nutrients as foliar spray. These results are in conformity with the findings of Hosmani *et al.,* (2013) and Yaseen *et al.*, (2013). Singh *et al.*, (2015) reported that higher net returns (Rs 100760/ha) and a higher B:C (4.06) ratio was found with the application of $MgSO_4$ 1.0 percent+$ZnSO_4$ 0.5 per cent in cotton. The benefit: cost ratio in the present study ranged from 1.98 in control treatment to 2.47 in treatment T_2 where foliar spray of $MgSO_4$ (0.5%) was done clearly indicated its application benefits to achieve higher cotton yield. Again, gross return was computed highest in the treatment T_6 ($ZnSO_4$ (0.5%) +Urea (2%) which is Rs. 131140/ha followed by treatment T_2 ($MgSO_4$ (0.5%) in which gross return calculated was Rs. 104154/ha. The gross return recorded was lowest in control treatment (T_1) which is only Rs. 104154/ha. It means monetary returns of *Bt* cotton can be increased by foliar feeding of nutrients as yield recorded were significantly higher with application of foliar spray of nutrient. Raju *et al.* (2008) also reported that foliar application of DAP recorded higher B: C ratio with 7 per cent higher boll numbers over soil application alone. Similar result has been reported by Katkar *et al.* (2005) and Kaur *et al.*, (2008).

CONCLUSION

It may be concluded that in *Bt* cotton at 75 and 135 DAS foliar spray of $ZnSO_4$ (0.5%) +Urea (2%) at 60, 75 and 90 DAS recorded significantly higher dry matter accumulation than rest all foliar sprays of nutrients and at harvest $MgSO_4$ (0.5%) recorded significantly higher dry matter accumulation than control treatment. Application of $ZnSO_4$ (0.5%) +Urea (2%) (T_6) produced significantly higher value of ginning out turn (38.9%) than rest all treatments. The highest Micronaire value (u/g) of *Bt* cotton was attained with foliar spray of $ZnSO_4$ (0.5%) +Urea (2%) followed by $FeSO_4$ (0.5%).

REFERENCES

Eleyan, S., Abodahab, E.D., Abdall A.A., Amany M. and Rabeh, H. A. 2014. Foliar application of Boron and Zinc effects on growth, yield and fiber properties of some Egyptian cotton cultivars (*Gossypium barbadense* L.) *Internat. J. Agricul. Crop Sci.* **7** : 1274-82.

Hosamani, V., Halepyati, A.S., Desai, B.K., Koppalkar, B.G. and Ravi, M.V. 2013. Effect of macro nutrients and liquid fertilizers on the growth and yield of irrigated *Bt* cotton (*Gossypium hirsutum* L.). *Karnataka J Agricul. Sci.*, **26** : 200-04.

Kailash, M., and Tamgadge, D.B. 2016. Response of cotton to foliar application of nutrients under rainfed condition. *J. Cotton Res. Deve.*, **30** : 210-13.

Katkar, R.N., Turkhede, A.B., Wankhede, S.T. and Lambe, S.P. 2005. Effect of foliar application of nutrients on production of cotton. *J. Cotton Res. Deve.*, **16** : 89-92.

Kaur, M., Kaur, M. and Brar, A.S. 2008. Effect of NPK with and without farm yard manure on the growth and yield of *hirsutum* cotton (*Gossypium hirsutum* L.). *J. Cotton Res. Deve.*, **22**: 34-37.

More, V.R., Khargkharate, V.K., Yelvikar, N.V., and Matre, Y.B. 2018. Effect of boron and zinc on growth and yield of *Bt* cotton under rainfed condition. *Internat. J. Pure Appl. Biosci.*, **6** : 566-70.

Rab, A., and Haq, I.U. 2012. Foliar application of calcium chloride and borax influences plant growth, yield, and quality of tomato (*Lycopersicon esculentum Mill.*) fruit. *Turkish J. Agricul. Forestry*, **36** : 695-701.

Rajendran, K., Mohamed Amanuallah, M., and Vaiyapuri, K. 2011a. Influence on growth, yield attributes and yield of *Bt* cotton by soil and foliar application of nutrients. *Madras Agricul. J.*, **98** : 67-68.

Raju, A.R., Pundareekakshudu, R., Majumdar, G., and Uma, B. 2008. Split application of N, P, K, S and foliar spray of DAP in rainfed *hirsutum* cotton. *J. Soils Crops*, **18**: 305-16.

Shivamurthy, D., and Biradar, D.P. 2014. Effect of foliar nutrition on growth, yield attributes and seed cotton yield of *Bt* cotton. *Karnataka J. Agricul. Sci.*, **27**: 5-8.

Singh, K., Buttar, G.S., Singh, S., Sarlach, R.S., Brar, A.S., and Rathore, P. 2015. Productivity enhancement in *Bt* cotton (*Gossypium hirsutum*) through foliar feeding of nutrients in north-western India. *Internat. J. Agricul. Statistical Sci.*, **11** : 419-24.

Swetha, D., Laxminarayana, P., Vidyasagar, G. E. C. H., Reddy, S. N. and Sharma, H. K. 2020. Impact of secondary and micronutrients on productivity and quality of *Bt* Cotton: A review. *Internat. J. Eco. Plants*, **7**: 91-93.

Yaseen, M., Ahmed, W. and Shahbaz, M. 2013. Role of foliar feeding of micronutrients in yield maximization of cotton in Punjab. *Turkish J. Agricult. Forestry*, **37**: 420-26.

Received for publication : October 11, 2023
Accepted for publication : November 10, 2023