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Effect of boron and Zinc on economics and nutrient uptake of *Bt* cotton under rainfed condition

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Abstract
A Field experiment was conducted during *kharif* 2017 on the Central farm Balsa. VNMKV Parbhani of clay texture soil. Application of 125% RDF + foliar spraying of 0.5% Zinc+0.2% Boron (T_{11}) twice during flowering (60 DAS) and boll development stage (80 DAS) recorded significantly highest higher gross monetary returns (1,04,356), net monetary returns (62,445) and benefit cost ratio (2.49) but it was at par with the 125% RDF + foliar spraying of 0.2% of Boron (T_8) and 125% RDF +foliar spraying 0.5% Zinc (T_9). Highest uptake of NPK and micronutrients (Zn, Fe, Mn and Cu) were recorded with Application of 125% RDF + foliar spraying of 0.5% Zinc+0.2% Boron (T_{11}) twice during flowering (60 DAS) and boll development stage (80 DAS). The lowest gross monetary returns, net monetary returns and benefit cost ratio uptake of NPK and micronutrients (Zn, Fe, Mn and Cu) were recorded with 100% RDF (120:60:60 NPK kg ha^{-1}) Control (T_1).

Keywords: Zinc and Boron, GMR, NMR, Uptake and B:C ratio

Introduction
Cotton (*Gossypium hirsutum*), the 'White Gold' is one of the most important commercial and industrial crop and plays a key role in Economical and social affairs of the world. It is considered as "King of fibres" and is important cash of this country. There by cotton crop assumes a place of special significance in Indian economy. Agronomic practices like maintenance of, use of optimum dose of fertilizer and use of micronutrient enhancing the productivity. Plant may show better growth and development and give highest yield. Nutrient supply is the most important limiting factor in cotton production. The nutrient management in cotton is a complex phenomenon due to its long duration and in determining growth habit, where simultaneous production of vegetative and reproductive structure during the active growth phase takes place.

Essential micronutrient like Zinc and Magnesium play an important role in physiology of cotton crop being a part of enzyme system or catalyst in enzymatic reactions. They are required for plant activities such as aspiration, meristematic development, chlorophyll formation, photosynthesis, energy system, protein and oil synthesis, gossypol, tannin and phenolic compounds development. Foliar application of micronutrients plays an important role in changing physiological and biochemical processes in cotton (Radhika *et al.* 2013) [8].

Adequate levels of micro-and macro inorganic nutrients are required for optimal growth (Ahmad *et al*. 2009, 2011) [1], and supplements give improvements in yield if only suboptimal levels are otherwise available. Micronutrients (boron, manganese, iron, copper, zinc, and molybdenum) play distinct and vital roles in plant physiology and biochemical processes (Putra *et al*. 2012; Rab and Haq 2012) [6, 7]. The scarcity of any nutrient in the soil can be a barrier to growth, even when all other nutrients are in excess in the soil.

Material and Method
The field experiment conducted during 2017 was conducted at balsa block Central Farm, VNMKV, Parbhani. The experimental field was leveled and well drained. The soil was clay in texture, low in nitrogen, medium in phosphorus and high in potassium and alkaline in reaction. Total rainfall received during crop growing season was 995.01 mm and distributed over 42 rainy days during the process of experimentation. The environmental conditions prevailed during experimental period was favourable for normal growth and maturity of *Bt* cotton.

The experiment was laid out in a Randomized block design with eleven treatments and three replications. *viz.*, T_1–100% RDF (120:60:60 NPK kg ha-1) Control, T_2 –100% RDF +Zinc @ 20 kg ha-1, T_3 –100% RDF+Boron @ 5.0 kg ha-1, T_4 –125% RDF +Zinc @ 20 kg ha-1, T_5–

125% RDF +Boron @ 5.0 kg ha-1, T_6–100% RDF+ foliar spraying of 0.2% Boron, T_7–100% RDF+ foliar spraying of 0.5% Zinc, T_8–125% RDF+ foliar spraying of 0.2% Boron, T_9–125% RDF+ foliar spraying of 0.5% Zinc, T_{10}–100% RDF+ foliar spraying of 0.5% Zinc+0.2% Boron, $T_1$1– 125% RDF+ of 0.5% Zinc+0.2% Boron foliar spraying at flowering (60 DAS) and boll development stage (80 DAS). The biometric observation and post harvest observation were recorded as per the standard procedure to evaluate treatment effects. The recommended cultural practices and preventive plant protection measures were undertaken timely

Table 1: Gross monetary returns (Rs ha^{-1}), Cost of cultivation (Rs ha^{-1}), Net monetary returns (Rs ha^{-1}) and B:C ratio of *Bt.* cotton as influenced by different treatments.

Treatment	Gross monetary returns (Rs ha^{-1})	Net monetary returns (Rs ha^{-1})	B:C ratio
T_1–100%RDF (120:60:60 NPK kg ha^{-1}) Control.	63652	29655	1.87
T_2 –100% RDF +Zinc @ 20 kg ha^{-1}	80034	40501	2.02
T_3 –100% RDF +Boron @ 5kg ha^{-1}	81482	43551	2.15
T_4 –125% RDF +Zinc @ 20 kg ha^{-1}	91429	49077	2.16
T_5–125% RDF +Boron @ 5 kg ha^{-1}	92116	51192	2.25
T_6–100% RDF+0.2% Boron	85058	47944	2.29
T_7–100% RDF+0.5% Zinc	82627	45626	2.23
T_8–125% RDF+0.2% Boron	97245	56907	2.41
T_9–125% RDF+0.5% Zinc	95801	55380	2.37
T_{10} –100% RDF+0.5% Zinc+0.2% Boron	87957	49979	2.32
T_{11}–125% RDF+0.5% Zinc+0.2% Boron	104356	62445	2.49
SE(m) ±	2920	1795.00	-
CD at 5%	4676	5541	-
GM	87432	48387	2.23

Result and Discussion

Effect of Micronutrient on Economics of *Bt* Cotton

Data on gross monetary returns (Rs. ha-1) and net monetary returns (Rs. ha-1) is presented in Table 1. Application of 125% RDF + foliar spraying of 0.5% Zinc+0.2% Boron (T11) twice during flowering (60 DAS) and boll development stage (80 DAS) obtained significantly highest gross monetary returns and net monetary returns, which was at par with application of 125% RDF + foliar spraying of 0.2% of Boron (T8) and 125% RDF + foliar spraying of 0.5% Zinc (T9), followed by application of 125% RDF along with 5.0 ka ha-1 boron (T5). It might be due to higher seed cotton yield and stalk yield. This is in conformation of results represented by Pawar *et al*. (2011) [5] and Santhosh *et al*. (2014) [10].

Highest benefit: cost ratio was recorded with the application of 125% RDF + foliar spraying of 0.5% Zinc+0.2% Boron (T11) twice during flowering (60 DAS) and boll development stage (80 DAS) and followed by application of 125% RDF + foliar spraying of 0.2% of Boron (T8) and 125% RDF + foliar spraying of 0.5% Zinc (T9). Similar results also reported by and Pawar) *et al*. (2011) [5].

Effect of Micronutrient (Zinc and Boron) on uptake

The essential micronutrients requirement is very small they play an important role in physiology of the *Bt* cotton. Being a part of the enzyme system or a catalyst in enzymatic reaction, they are required for plant metabolic activities such as respiration, meristomatic, energy system, protein synthesis, oil content, gossypol, tannin and phenolic, direct role in flowering and fruiting and their deficiency will cause a decrease in fruiting and index.

The application of 125% RDF + foliar spraying of 0.5% Zinc+0.2% Boron (T11) twice during flowering (60 DAS) and boll development stage (80 DAS) recorded significantly higher uptake of nitrogen, potassium and phosphorus over rest of the treatments, but it was at par with application 125% RDF + foliar spraying of 0.2% of Boron (T8) and 125% RDF + foliar spraying of 0.5% Zinc (T9) followed by soil application of 125% RDF along with 5.0 kg ha-1 boron. Similar results were reported earlier by Ravankar *et al.* (1994) [9] Katkar *et al*. (2000) [4] and Waikar *et al*. (2015) [11].

In respect of micronutrients (Zn, Fe, Mg, and Cu) uptake, The uptake of Zn was noticed significantly superior with The application of 125% RDF + foliar spraying of 0.5% Zinc+0.2% Boron (T11) twice during flowering (60 DAS) and boll development stage (80 DAS) recorded significantly higher uptake of Zinc, over rest of the treatments, but it was at par with application 125% RDF + foliar spraying of 0.5% Zinc (T9) and 125% RDF + 20 kg ha-1 of Zinc (T4). These results are further supported by the findings of and Ziaeyan and Rajaie (2009) [12].

The application of 125% RDF + foliar spraying of 0.5% Zinc+0.2% Boron (T_{11}) twice during flowering (60 DAS) and boll development stage (80 DAS) recorded significantly higher uptake of Copper, Iron and Manganese over rest of the treatments, but it was at par with application 125% RDF + foliar spraying of 0.2% of Boron (T_8) and 125% RDF + foliar spraying of 0.5% Zinc (T_9) followed by soil application of 125% RDF along with 5.0 kg ha^{-1} boron. These results are confirmative by the findings of Basavarajappa *et al*. (1992) [2] and Bednarz *et al*., (1998) [3].

Table 2: Uptake N, P, K, Zn, Fe, Cu and Mn by *Bt.* cotton at harvest as influenced by different treatments.

Treatment	kg ha^{-1}			g ha^{-1}			
	N	P_2O_5	K_2O	Zn	Fe	Cu	Mn
(Soil application)							
T_1–100% RDF (120:60:60 NPK kg ha^{-1}) Control.	74.71	15.17	83.64	185	920	80	147
T_2 –100% RDF +Zinc @ 20 kg ha^{-1}	75.86	16.07	83.79	224	949	83	153
T_3 –100% RDF +Boron @ 5kg ha^{-1}	75.99	16.36	84.42	192	977	86	159
T_4 –125% RDF +Zinc @ 20 kg ha^{-1}	79.40	17.14	85.89	228	992	87	160
T_5–125% RDF +Boron @ 5 kg ha^{-1}	80.52	17.18	85.32	205	1073	98	168
(Foliar application)							
T_6–100% RDF+0.2% Boron	79.24	16.75	86.91	208	1056	94	172
T_7–100% RDF+0.5% Zinc	78.18	16.51	86.48	223	1025	91	166
T_8–125% RDF+0.2% Boron	81.54	18.10	90.53	214	1142	107	185
T_9–125% RDF+0.5% Zinc	83.87	17.66	89.29	234	1090	102	177
T_{10} –100% RDF+0.5% Zinc+0.2%Boron	80.12	16.87	86.47	218	1070	95	170
T_{11}–125% RDF+0.5% Zinc+0.2% Boron	85.46	18.65	92.65	250	1172	112	190
SE(m) ±	1.68	0.47	1.82	6.19	32.18	3.95	6.13
CD at 5%	4.99	1.40	5.41	18.39	95.63	11.74	18.20
GM	79.53	16.95	86.85	216.5	1042.35	94.21	168

Conclusion

On the basis of one year data it can be concluded that application of 125% RDF + foliar spraying of 0.5% Zinc+0.2% Boron twice during flowering (60 DAS) and boll development stage (80 DAS) during kharif season of 2017 recorded highest gross monetary returns (Rs. ha^{-1}), net monetary returns (Rs. ha^{-1}) benefit: Cost ratio, highest uptake of NPK and Micronutrient (Zn Cu Mn Fe) and fallowed by treatment 125% RDF + foliar spraying of 0.2% of Boron (T8) and 125% RDF +foliar spraying 0.5% Zinc (T9).

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