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RESPONSE OF *BT* COTTON (*GOSSYPIUM HIRSUTUM*) TO FOLIAR NUTRITION IN IRRIGATED ECOSYSTEM

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ABSTRACT
A field experiment was conducted to study the response of *Bt* cotton (Cv. NCH 145 BG II) to foliar nutrition under irrigated condition at Agricultural Research Station, Siruguppa, Karnataka on black cotton soil during growing seasons of 2008-09 and 2009-10. The soil of the experimental plot has pH 8.41 and available N, P and K content of the soil was 456, 19.3 and 443.5 kg/ha respectively. Boron (0.1 %), $ZnSO_4$ (0.5 %), $MnSO_4$ (1.0 %), $MgSO_4$ (1.0 %), $MgSO_4$ (1.0 %) + $ZnSO_4$ (0.5 %), $FeSO_4$ (0.5 %), $FeSO_4$ (0.5 %) + $ZnSO_4$ (0.5 %), and urea (2 %) followed by (fb) DAP (2%) were sprayed twice at flowering and at boll development stages. Crop in common was supplied with 120:60:60 kg NPK/ha + FYM @ 10 t/ha. Among all, $MgSO_4$ registered higher seed cotton yield (1757 kg/ha) followed by boron (1654 kg/ha), $FeSO_4$ + $ZnSO_4$ (1659 kg/ha) and $MgSO_4$ + $ZnSO_4$ (1588 kg/ha). The percent increase with the former treatment was to the extent of 32 and 37 over water spray (1281 kg/ha), and urea fb DAP, respectively. Further, the highest net returns (Rs. 23338/ha) and B: C ratio (2.17) were also realized with $MgSO_4$ while water spray and urea fb DAP recorded lower net returns (Rs. 12506/ha: Rs.13700/ha) and B: C ratio (1.62: 1.67, respectively). Thus experiment, revealed need for micronutrients supply during reproductive stages in *Bt* cotton on black cotton soils of TBP irrigation command.

KEY WORDS: *Bt* cotton, foliar nutrition, major and micronutrients, seed cotton yield and economics.

INTRODUCTION

The cultivation of *Bt* cotton hybrids is most popular these days in irrigation commands and rainfed areas as well for their high productivity, economic returns and Tunga Bhadra irrigation command in Karnataka is not exception. However, at present yield levels are declining and yields are not sustainable probably due to increasing trend of monocropping and declining soil fertility particularly of micronutrients. Most of the *Bt* cotton hybrids bear fruiting parts by 20 to 25 days and also mature early in comparison to the erstwhile interspecific hybrids and hence need for good nutrition begins from the beginning in cotton otherwise there would be flower and/or boll drop, early leaf reddening *etc*. which greatly affect overall crop production. Being early and semi-determinate nature the rate of growth and rejuvenation **c**apacity of the plant after first flush of flowering is slow and therefore there is more nutritional requirement after first bearing and this necessitates additional nutrition (Mamatha *et al.,* 2009). Further, the deficiency of micronutrients has become major constraint to productivity, stability and sustainability of cotton ecosystem now than ever before (Yadav and Meena, 2009). Besides, zinc and boron are key in plant metabolism such as photosynthesis, translocation, enzyme activation as well as water retention. In many instances, cotton production is constrained by soil fertility and its ability to accumulate nutrients (Dorahy *et al.,* 2004). Therefore, balanced nutrition and additional care through foliar nutrition assume significance to augment any real time nutritional requirement of crop and hence the study. Besides, foliar feeding is one of the most efficient ways of supplying essential nutrients to a growing crop plant.

MATERIALS & METHODS

The investigation was carried out at Agricultural Research Station, Siruguppa, Karnataka falling in the prestigious Tunga Bhadra irrigation command of the state on black cotton soils for two consecutive growing seasons of 2008-09 and 2009-10. The soil of the experimental plot has pH 8.41 and available N, P and K content of the soil was 456, 19.3 and 443.5 kg/ha respectively. The experiment consisted of nine treatments *viz*., control (water spray), foliar spray of boron (0.1 %), $ZnSO_4$ (0.5 %), $MnSO_4$ (1.0 %), $MgSO_4$ (1.0 %), $MgSO_4$ (1.0 %) + $ZnSO_4$ (0.5 %), $FeSO_4$ (0.5 %), $FeSO_4$ (0.5 %) + $ZnSO_4$ (0.5 %), and urea (2 %) followed by (fb) DAP (2%) twice at flowering and at boll development stages. The experiment was laid out in a Randomized Complete Block Design with three replications. The fertilizer dose of 120:60:60 kg NPK/ha with FYM @ 10 t/ha was commonly applied to all the treatments. The seeds *Bt* cotton hybrid Bunny BT (Cv. NCH 145 BG II) were dibbled at a spacing of 90 X 60 cm. Data on growth and yield parameters were recorded from 5 randomly selected plants in each treatment plot measuring 34.56 m^2. Seed cotton yield (kg/ha) was calculated from whole plot. The all other recommended practices were uniformly followed as per the university's manual of Package of Practices. Economics was worked out using prevailing prices of inputs and products.

RESULTS & DISCUSSION

Foliar application of $MgSO_4$ @ 1.0% twice at flowering and boll development stage registered significantly higher seed cotton yield (1757 kg/ha) compared to other nutrients sprays (Table 1). It was closely followed by foliar sprays of boron (1654 kg/ha), $FeSO_4$ + $ZnSO_4$ (1659 kg/ha) and $MgSO_4$ + $ZnSO_4$ (1588 kg/ha).

TABLE 1. Seed cotton yield and yield parameters as influenced by foliar nutrition under irrigated ecosystem

Treatments	No. of Bolls / plant		Boll weight(g)				Cotton yield (g/plant)			Cotton yield (g/plant)		
	2008-2009	2009-2010	2008-2009	2008-2009	2008-2009	2008-2009	2008-2009	2009-2010	Pooled	2008-2009	2009-2010	Pooled
T_1 Control	21.8	28.1	106	106	106	1626	21.8	28.1	25.0	4.43	3.95	4.19
T_2 Spray of boron (0.1%)	22.5	33.8	118	118	118	1943	22.5	33.8	28.2	4.57	4.08	4.30
T_3 Spray of $ZnSO_4$ (0.5%)	24.3	29.9	118	118	118	1810	24.3	29.9	27.1	4.83	3.86	4.35
T_4Spray of $MnSO_4$(1.0%)	23.4	32.5	117	117	117	1883	23.4	32.5	28.0	4.48	4.00	4.24
T_5Spray of $MgSO_4$ (1.0%)	26.9	36.2	139	139	139	2066	26.9	36.2	31.5	4.65	4.01	4.33
T_6 Spray of $MgSO_4$ (1.0%)+ $ZnSO_4$ (0.5%)	25.0	32.6	132	132	132	1093	25.0	32.6	28.8	4.92	4.00	4.46
T_7 Spray of $FeSO_4$(0.5%)	21.7	30.4	115	115	115	1872	21.7	30.4	26.0	4.35	4.10	4.22
T_8 Spray of $FeSO_4$ (0.5%)+ $ZnSO_4$(0.5%)	28.3	34.6	115	115	115	1990	28.3	34.6	30.0	4.59	3.91	4.25
T_9 Spray of 2% each of urea fb DAP	23.6	29.8	120	120	120	1791	23.6	29.8	26.7	4.59	3.83	4.18
SEm+/-	1.54	2.79	4.19	4.19	4.19	64	1.54	2.79	2.26	0.07	0.12	0.10
CD @ 5%	4.63	8.38	12.58	12.58	12.58	194	4.63	8.38	6.15	0.22	0.38	0.40

Note: Foliar spray was given twice at flowering and boll development stages, urea was sprayed at flowering and DAP was sprayed at boll development stage

TABLE 2: Growth attributes *Bt* cotton as influenced by foliar nutrition under irrigated ecosystem

Treatments	No. of Sympodia/plant			No. of Monopodia / plant			Plant height (cm)		
	2008-09	2009-10	Pooled	2008-09	2009-10	Pooled	2008-09	2009-10	Pooled
T_1 Control	44.6	17.8	31.2	1.86	0.66	1.26	148.8	94.8	121.8
T_2 Spray of boron (0.1%)	49.7	19.9	34.8	2.06	0.93	1.50	149.8	103.5	126.7
T_3 Spray of $ZnSO_4$ (0.5%)	59.2	18.6	38.9	2.06	1.00	1.53	152.2	98.7	125.4
T_4Spray of $MnSO_4$(1.0%)	53.4	18.8	36.1	1.66	0.66	1.16	150.0	100.0	125.4
T_5Spray of $MgSO_4$ (1.0%)	62.2	20.2	41.2	2.06	0.66	1.36	144.8	107.0	125.9
T_6 Spray of $MgSO_4$ (1.0%)+ $ZnSO_4$ (0.5%)	50.7	19.6	35.1	1.86	0.46	1.16	147.0	102.4	124.9
T_7 Spray of $FeSO_4$(0.5%)	50.3	18.8	34.5	2.06	0.60	1.33	138.8	99.5	119.1
T_8 Spray of $FeSO_4$ (0.5%)+ $ZnSO_4$(0.5%)	52.3	20.1	26.2	1.66	0.73	1.20	139.5	104.3	121.9
T_9 Spray of 2% each of urea fb DAP	52.4	18.6	35.5	2.00	0.46	1.23	141.4	98.6	120.0
SEm+/-	2.23	1.36	1.85	0.31	0.13	0.24	2.95	4.07	3.54
CD @ 5%	6.70	4.08	5.33	0.95	0.41	0.70	8.86	12.23	10.21

Note: Foliar spray was given twice at flowering and boll development stages, urea was sprayed at flowering and DAP was sprayed at boll development stage

The percent increase in yield was to the extent of 32 and 37 over water spray (control), and urea fb DAP, respectively. Results are in agreement with Sankaranarayanan *et al.* (2010) who obtained 26, 30 and 27 % higher boll weight over control with single foliar application of MgSO4 @ 0.5 % at 60, 75 and 90 days after planting which they attributed to increased leaf area index and bolls/plant and dry weight. Similarly, Eweida *et al*. (1979) reported increased seed cotton yield with the foliar application of magnesium and zinc separately and also with combination of sulphate of zinc and magnesium. Significantly lower seed cotton yield was recorded with water spray alone (1281 kg/ha). Higher seed cotton yield with foliar spray of $MgSO_4$@ 1.0% twice at flowering and boll development stage greatly influenced seed cotton yield per plant (114g), boll weight (4.46 g), number of bolls per plant (28) and more number of sympodials branches per plant (41.2). While, Meshram et al. (2013) obtained significantly higher cotton yield and uptake of N, P, K, Zn and B with the combined application of zinc and boron along with 125 per cent RDF and application of boron alone along with 125 per cent RDF owing higher availability and uptake of these critical nutrients Further, significantly higher gross returns (Rs.44962), net returns (Rs.23338) and B:C ratio (2:17) were obtained with foliar spray of 1% $MgSO_4$ at flowering and boll development stages over water spray and foliar spray of 2% each of Urea and DAP at flowering and boll development stages (Table 3). However, again foliar spray of $FeSO_4$ + $ZnSO_4$, boron, $MgSO_4$ + $ZnSO_4$ were on par with the former treatment. Significantly lower net returns (Rs. 12506/ha: Rs.13700/ha) and B: C ratio (1.62: 1.67, respectively) were observed with control (water spray) and foliar spray and spray of 2% each of Urea fb DAP at flowering and boll development stages, respectively. Similarly, Yaseen *et al.* (2013) also reported 20 - 30% more economic benefit over NPK fertilizers alone with foliar application of Zn, B, Mn, Cu and Fe. From the study, it is inferred that *Bt* cotton responds to foliar nutrition of micronutrient particularly $MgSO_4$ sprayed twice at flowering and boll development stages on black cotton soils of Tunga Bhadra irrigation command. Other micro nutrients solely or in

combination though were instrumental in enhancing yield over water spray need to be provided based on soil analysis data of individual holding.

TABLE 3. Economics of *Bt* cotton as influenced by foliar nutrition under irrigated condition

Treatments	Gross Returns (Rs/ha)			Net Returns (Rs/ha)			B : C ratio		
	2008-09	2009-10	Pooled	2008-09	2009-10	Pooled	2008-09	2009-10	Pooled
T_1 Control	42323	23408	32865	22023	2989	12506	2.08	1.15	1.62
T_2 Spray of boron (0.1%)	50559	34150	42354	29967	13433	21700	2.48	1.65	2.05
T_3 Spray of $ZnSO_4$ (0.5%)	47077	29400	38238	26457	11372	18915	2.28	1.41	1.85
T_4Spray of $MnSO_4$ (1.0%)	48975	30675	29825	28055	9139	18957	2.34	1.46	1.90
T_5Spray of $MgSO_4$ (1.0%)	53724	36200	44962	33104	13572	23338	2.60	1.94	2.17
T_6 Spray of $MgSO_4$ (1.0%) + $ZnSO_4$ (0.5%)	49218	32116	40667	28448	9872	19160	2.37	1.53	1.95
T_7 Spray of $FeSO_4$ (0.5%)	46672	30325	39498	28052	11031	19451	2.36	1.46	1.91
T_8 Spray of $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%)	51748	33191	42470	30975	8307	19643	2.49	1.59	2.04
T_9 Spray of 2% each of urea fb DAP	46574	23555	35064	25684	1715	13700	2.22	1.12	1.67
SEm+/-	1605	1522	1555	1755	1523	1687	0.07	0.07	0.07
CD @ 5%	4625	4564	4480	5056	4566	4862	0.22	0.21	0.21

Note: Foliar spray was given twice at flowering and boll development stages, urea was sprayed at flowering and DAP was sprayed at boll development stage, Market price of the cotton Rs 2600/q (2008-09) and Rs.2500/ha(2009-10)

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