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Response of soil and foliar nutrition on *Bt* cotton (*Gossypium hirsutum* L.) quality, yield parameters and economics under irrigation

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ABSTRACT : A field experiment was conducted at Main Agricultural Research Station, Raichur during 2011-2012 to study the response of soil and foliar nutrition on *Bt* cotton (*Gossypium hirsutum* L.) Yield quality parameters and economics under irrigation. The results revealed that application of 150 per cent RDF produced significantly 13.9 per cent higher seed cotton yield, (2940 kg/ha, and 19 per cent higher net returns (Rs.85,504/ha) which inturn was *on par* with 125 per cent RDF (2844 kg/ha) (Rs.80,207/ha). Both 150 per cent RDF and 125 per cent RDF were significantly superior over 100 per cent RDF (2582 kg/ha) (Rs.71,825/ha). Among nutrient management practices soil application of $MgSO_4$+ three foliar sprays of $MgSO_4$(1%) + KNO_3(2%) recorded maximum seed cotton and net returns(3056 kg/ha) and (Rs.84,956/ha) respectively as compared to control (water spray) (2442 kg/ha) (Rs.67,665/ha). However, this combination also resulted in *on par* seed cotton yield and net returns, gross returns with soil application of $MgSO_4$ with three foliar sprays of $MgSO_4$ (1%) + 19:19:19(1%) and soil application of $MgSO_4$+ three sprays of $MgSO_4$ treatments.

Key words : *Bt* cotton, recommended dose of fertilizers, soil and foliar application

Cotton (*Gossypium hirsutum* L.) is the most important of fibre cash crop of India and backbone of textile industries because of its lint and contributing 85 per cent of raw materials to textile industry. It earns 33 per cent of total foreign exchange. India ranks first in area and second in production after China with an average productivity of 494 kg lint/ha which is low as compared to world average of 725 kg lint/ha (Hosmath *et al.,* 2012).

The introduction of *Bt* cotton which is known for resistant against bollworms during last decade in the country has brought a significant change in the cotton cultivation scenario of Indian agriculture. Now more than 90 per cent of the total area under cotton is occupied by *Bt* cotton. The efforts are to be made to improve the existing *Bt* cotton productivity through different means.The maximum yield potential of *Bt* cotton is yet to be trapped under irrigated conditions which is low for various reasons. Of these, monocropping practice, decline in soil fertility status and delayed sowing and imbalanced nutrition are major constraints for low productivity (Vishwanath, 2007). In cotton the yield is strongly influenced by the application of different nutrients indicating role of these chemicals. Basal soil application of $MgSO_4$ along with foliar sprays of $MgSO_4$ + 19:19:19 and $MgSO_4$ are found effective. Most of the previous work was carried out on non *Bt* cotton. Thus, there is a scope of maximizing the yield of *Bt* cotton through soil and foliar application of nutrients either alone or in combination of both. In *Bt* cotton, due to synchronized flowering, retention of most of the first formed bolls and reduced crop duration to an extent of one or two weeks, there is a scope to increase the productivity with foliar nutrition coupled with soil application of the fertilizers under irrigated conditions (Basavanneppa *et al.,* 2009). With this background, the present study was undertaken.

A field experiment was conducted during 2011-2012 at Main Agriculture Research Station, Raichur to study the effect of nutrient management practices on growth and yield of *Bt* cotton (*Gossypium hirsutum* L.) under irrigation. Treatments were replicated thrice in split plot design. There were 18 treatment combinations comprising three fertilizer levels (*viz.,* 100% RDF, 125%RDF and 150% RDF) in main plots and six soil and foliar application of nutrients in sub plots (control, 2 foliar sprays of $MgSO_4$, soil application of $MgSO_4$, soil application of $MgSO_4$ + 3 foliar sprays of $MgSO_4$, soil application of $MgSO_4$ + 3 foliar sprays of $MgSO_4$+ KNO_3, soil application of $MgSO_4$ + 3 foliar sprays of $MgSO_4$ + 19:19:19 at flowering (75-80 DAS), boll formation (90-95 DAS) and boll development stages(105-110 DAS).

The soil was deep black with a pH (8.32). The available N, P K were 208.9, 25.4 139.5 kg/ha and Mg 8.40 (C mol/Kg) respectively. The Cotton hybrid Bunny BG 2 (NCS 145) was sown on 9th July 2011 by giving a spacing of 90 x 60 cm. The crop received the recommended dose of 150:75:75 kg NPK/ha. The major and secondary nutrients containing fertilizers *viz.,* KNO_3, $MgSO_4$ and 19:19:19 were sprayed in combination as per the treatments. The timely plant protection measures for sucking pests (thrips, aphids, leaf hoppers and whiteflies) were adopted. Three hand weedings (20, 45 and 60 DAS) and 2 inter cultivations were at (15 and 50 DAS) were carried out to keep the plots free from weeds. Boll weight (g) and bolls/plants were recorded at harvest. The seed cotton yield in kg/ha was computed. The fibre quality analysis work of lint samples of first picking was done by CIRCOT Quality Analysis Laboratory, Dharwad. The data were analysed statistically.

Growth and yield characters : The data on effect of different soil and foliar nutrient management practices on growth and yield data are presented in (Table 1). the data revealed that among different fertilizer levels, 150 per cent RDF recorded Significantly higher bolls/plant (46.92), boll weight (4.46 g) resulted in 13.9 per cent higher seed cotton yield (2940 kg/ha) and was *on par* with 125 per cent RDF as compare to 100 per cent RDF which records significantly lowest yield parameters and yield level. This increased yield due to from growth characters like higher (140.74 cm), dry matter production (393.39 g/plant), more monopods (3.00) and sympods (30/plant as compared to RDF level. Kumar (2004) and Tyade and Dhobe (2010) also noticed higher dry matter/plant over with higher levels of NPK fertilizers. The increase in boll number is due to adequate supply of nutrients (N, P and K) at critical stages of crop. These results are in compliance with the findings of Kumar (2004), Ram and Giri (2006) who noticed increased growth, yield parameters and seed cotton yield with higher levels of fertilizers.

Among soil and foliar nutrient management levels soil application of $MgSO_4$ @ 25 kg/ha along with 3 foliar spraying of $MgSO_4$ @ 1.0 per cent + KNO_3 @ 2.0 per cent at flowering, boll formation and boll development stages recorded maximum seed cotton yield (3056 kg/ha) and was significantly superior over other treatments except soil application of $MgSO_4$ @ 25 kg/ha + 3 foliar sprays of $MgSO_4$ @ 1.0 per cent + 19:19:19 @ 1.0 per cent and soil application of $MgSO_4$ @ 25 kg/ha + 3 foliar sprays of $MgSO_4$ @ 1.0 per cent (Table 1). All these treatments were *on par* and significantly superior over 2 foliar sprays of $MgSO_4$ @ 1.0 per cent (2605 kg/ha) and control (2442 kg/ha) which inturn were *on par* with each other. Regarding the effect of nitrogen, phosphorus and potassium along with magnesium in plant help in better growth and development of crop plants resulting in higher yields (Upperi and Kuligoud, 2011). Increase in seed cotton yield with soil application of $MgSO_4$ + foliar sprays of $MgSO_4$ + KNO_3, soil application of $MgSO_4$+ foliar sprays of $MgSO_4$ + 19:19:19 and soil application of $MgSO_4$+ foliar sprays of $MgSO_4$ was 25 per cent, 21 and 19

Table 1. Effect of nutrient management practices on different growth and yield parameters of *Bt* cotton

Treatment	Height (cm)	Mono-pods/ plant	Sym-pods/ plant	Drymatter production (g/plant)	Bolls/ plant	Boll weight (g)	Yield/ plant (g)	Yield (kg/ha)	GOT (%)
Fertilizer levels (F) (kg/ha)									
F_1: RDF (150:75:75)	125.17	2.09	23.44	348.54	40.92	3.95	160.88	2582	32.94
F_2: RDF (125%) (25% addition to RDF)	131.48	2.60	27.22	382.12	44.78	4.24	173.82	2844	34.39
F_3: RDF (150%) (50% addition to RDF)	140.74	3.00	30.71	393.39	46.92	4.46	179.77	2940	34.55
S.Em±	1.91	0.04	0.33	5.02	0.53	0.09	3.46	66	0.17
C.D. (p=0.05)	7.51	0.16	1.31	19.73	2.11	0.35	13.61	258	0.69
Soil and foliar application of nutrients (S)									
S_1: Control	126.83	2.38	24.74	346.46	41.38	3.82	153.34	2442	32.18
S_2: $MgSO_4$ (1.0%) (2 foliar sprays)	129.22	2.47	26.57	359.75	42.61	4.03	160.55	2605	34.47
S_3: $MgSO_4$ (25 kg/ha) (SA)	132.77	2.50	26.62	374.51	43.94	4.25	170.09	2761	33.93
S_4: $MgSO_4$ (25 kg/ha) (SA) + $MgSO_4$ (1.0%) (3 foliar sprays)	133.88	2.57	27.81	383.25	45.33	4.49	178.54	2918	34.01
S_5: $MgSO_4$ (25 kg/ha) (SA) + $MgSO_4$ (1.0%) + KNO_3 (2.0%) (3 foliar sprays)	136.46	2.65	28.36	396.52	47.03	4.35	186.03	3056	34.75
S_6: $MgSO_4$ (25 kg/ha) (SA) + $MgSO_4$ (1.0%) +19:19:19 (1.0%) (3 foliar sprays)	135.64	2.81	28.64	387.61	44.94	4.37	180.38	2951	34.44
S.Em±	1.97	0.04	0.52	5.62	0.81	0.10	4.87	93	0.33
C.D. (p=0.05)	5.71	0.14	1.52	16.24	2.36	0.29	14.07	268	0.96

Interactions were non-significant between S and F also between F and S at same levels.

per cent, respectively over control. Several workers have reported increase in seed cotton yield with spraying of $MgSO_4$ (Kumar and Yadav, 2010), $MgSO_4$ + KNO_3, $MgSO_4$ + DAP and soil application of $MgSO_4$ with foliar spray of $MgSO_4$ and soil application of NPK with foliar sprays of KNO_3 +DAP and KNO_3 + 19:19:19, $MgSO_4$ + KNO_3 and $MgSO_4$ + 19:19:19 (Amutha *et al.,* 2009).

Fibre quality and economics : Fibre quality parameters *viz.,* fibre length, fibre fineness, fibre strength and maturity ratio were not significantly influenced by fertilizer levels and spraying of major and secondary nutrients (Table 2). This might be more controlled by genetic makeup of the plant than nutrient status of the plant. These results are in conformity with the findings of experiment conducted at Dharwad. Economic analysis indicated that 150 per cent and 125 per cent RDF recorded resulted in significantly higher net returns (Rs. 82,504/ha and Rs. 80,207/ha) as compared to 100 per cent RDF (Rs.71,825/ha). Soil application of $MgSO_4$+ 3 foliar sprays of $MgSO_4$ + KNO_3, soil application of $MgSO_4$+ 3 foliar sprays of $MgSO_4$ + 19:19:19 and soil application of $MgSO_4$+ 3 foliar sprays of $MgSO_4$ recorded significantly higher net returns (Rs. 84,956/ha ,Rs. 82,333/ha and Rs.82,865/ha, respectively) as compared to control (Rs. 67,665/ha) (Table 2) The higher net returns were mainly because of higher seed cotton yield with these treatments. Net returns realized with soil application of $MgSO_4$ were *on par* with foliar sprays of $MgSO_4$ + KNO_3, $MgSO_4$ +19:19:19 and $MgSO_4$ combined with soil application of $MgSO_4$. This may be

Table 2. Effect of nutrient management practices on fibre quality and economics of *Bt* cotton

Treatment	Lint index	Fibre length (mm)	Fibre fine-ness	Bundle strength (g/tex)	Maturity ratio	Gross returns (Rs./ha)	Net returns (Rs./ha)	Benefit cost ratio
Fertilizer levels (F) (kg/ha)								
F_1: RDF (150:75:75)	4.31	31.92	3.08	24.81	0.66	98,119	71,825	3.73
F_2: RDF (125%) (25% addition to RDF)	4.49	31.71	3.05	24.80	0.66	1,08,090	80,207	3.87
F_3: RDF (150%) (50% addition to RDF)	4.40	31.88	3.03	25.02	0.66	1,11,725	85,504	3.82
S.Em±	0.17	0.16	0.11	0.37	0.08	2499	1837	0.07
C.D. (p=0.05)	NS	NS	NS	NS	NS	9813	7211	NS
Soil and foliar application of nutrients (S)								
S_1: Control	4.06	31.80	3.07	24.91	0.65	92,804	67,665	3.69
S_2: $MgSO_4$ (1.0%) (2 foliar sprays)	4.27	32.01	2.99	25.07	0.65	98,989	72,697	3.75
S_3: $MgSO_4$ (25 kg/ha) (SA)	4.28	31.47	3.04	25.37	0.66	1,04,922	78,555	3.98
S_4: $MgSO_4$ (25 kg/ha) (SA) + $MgSO_4$ (1.0%) (3 foliar sprays)	4.51	32.18	3.16	25.07	0.66	1,10,872	82,865	3.95
S_5: $MgSO_4$ (25 kg/ha) (SA) + $MgSO_4$ (1.0%) + KNO_3 (2.0%) (3 foliar sprays)	4.54	31.71	3.07	24.62	0.66	1,16,131	84,956	3.72
S_6: $MgSO_4$ (25 kg/ha (SA) + $MgSO_4$ (1.0%) +19:19:19 (1.0%) (3 foliar sprays)	4.75	31.86	3.01	24.22	0.66	1,12,151	82,333	3.76
S.Em±	0.12	0.23	0.10	0.39	0.08	3526	3174	0.10
C.D. (p=0.05)	0.36	NS	NS	NS	NS	10183	9166	NS

Interactions were non-significant between S and F also between F and S at same levels

because of lower cost incurred in $MgSO_4$ soil application treatment. Pawar (2010) also records similar results. Soil and foliar application of nutrients did not show any marked influence on B:C ratio (Table 2) on account of higher cost of cultivation associated with the treatments. These results are in accordance with Pawar (2010).

CONCLUSION

From this study it can be concluded that for effective nutrient management in *Bt* cotton and also to get higher seed cotton yields and net returns, it is advocated to follow 125 per cent RDF (25 per cent addition to RDF) fertilizer application with $MgSO_4$ @ 25 kg/ha and 3 foliar sprays of $MgSO_4$ @ 1.0 per cent + KNO_3 @ 2.0 per cent or 125 per cent RDF with $MgSO_4$ @ 25 kg/ha + foliar sprays of $MgSO_4$ @ 1.0 per cent +19:19:19 @ 1.0 per cent at flowering, boll formation and boll development stages found to be more responsive and beneficial.

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