J. Cotton Res. Dev. **29** (1) 71-75 (January, 2015)

Effect of nutrient management practices on leaf reddening of *Bt* cotton (*Gossypium hirsutum* L.) under irrigated conditions

U.N. SANTHOSH*, SATYANARAYANA RAO, B.K.DESAI, A.S.HALEPYATI AND B.G.KOPPALKAR

Department of Agronomy, University of Agricultural Sciences, Raichur-584104
**Email: santhu2032@rediffmail.com*

ABSTRACT : Among the treatments, LRI was significantly reduced with higher NPK fertilizers and also with foliar sprays of $MgSO_4$+KNO_3, $MgSO_4$+19:19:19 NPK and $MgSO_4$ thrice combined with initial soil application of $MgSO_4$ @ 25 kg /ha. The extent of reduction in LRI with 125 and 150 per cent RDF over 100 per cent RDF, was 15.4 and 30.1 per cent, respectively at 135 DAS and 11.3 and 23.8 per cent at harvest, respectively. Whereas 3 foliar sprays of $MgSO_4$+KNO_3 and $MgSO_4$+19:19:19 along with soil application of $MgSO_4$ during flowering, boll formation and boll development stages, reduced the LRI by 18.7 and 16.2 per cent at 135 DAS and 12.7 and 11.5 per cent at harvest growth stages, respectively as compared with control (2.40 and 2.59). The leaf chlorophyll, nitrogen and magnesium contents were increased at all the stages, with higher fertilizer levels and foliar application of nutrients.

Key words: Foliar sprays, leaf reddening, soil application

Cotton is an important commercial fibre crop of India and contributes 85 per cent of raw materials to textile industries. In India the annual area under this crop was 11.16 m ha, with annual production of 31.20 m bales and average productivity of 494 lint kg/ha (Hosmath *et al.,*2012). *Bt* cotton is intensively cultivated on black clay soil under irrigated areas of Tungabhadra and Upper Krishna Command areas (TBP and UKP). The area under cotton in these command areas has been increased distinctly over the past decade and occupied an area of more than 1.6 lakh ha. Average cotton yield is around 20 q/ha, which is less than the potential yield. The maximum yield potential of *Bt* cotton has been not tapped due to monocropping, declined in soil fertility, delayed sowing, imbalanced nutrition, attack of sucking pests and physiological disorders mainly leaf reddening of leaves.

Among the production constraints, leaf reddening has become major physiological problem in *Bt* cotton cultivation. Hosmath *et al.,* (2012) observed that *Bt* cotton genotypes recorded significantly higher red leaf index (1.82) as compared to non *Bt* cotton genotypes (1.63). The malady is observed during peak flowering and boll development stages or later on but occasionally during squaring to flowering stages. The yield losses due to reddening of leaves may be as high as 60-75 per cent. Usually reddening occurs after boll formation stage where the losses could be 15-25 per cent depending upon severity of the disease. The principle cause of reddening as reported, is due to nitrogen and magnesium deficiencies. Increased in nitrogen along with phosphorus and potassium increased the supply of nitrogen to leaf and reduced the formation of anthocyanin at the cost of chlorophyll. It showed the importance of plant nutrition in management of leaf reddening in cotton (Upperi and Kuligoud, 2011).

A field experiment was conducted to study the effect of nutrient management practices on chemical composition and leaf reddening of *Bt* cotton during 2011-2012 at Main Agricultural Research Station, Raichur. The soil of experimental site had pH of 8.32. The available N, P and K respectively were 208.9, 25.4 and 139.5 kg/ha, whereas Mg was 8.40 (C mol/kg). There

were 18 treatment combinations comprised of three fertilizer levels (*viz.,* 100, 125 and 150% RDF) in main plots and 6 soil and foliar application of nutrients in sub plots(control, 2 foliar sprays of $MgSO_4$ at 90 and 105 DAS, soil application of $MgSO_4$@ 25 kg/ha, 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). The foliar sprays were taken at flowering, boll formation and boll development stage. Treatments were replicated thrice in split plot design. The cotton hybrid Bunny BG II (NCS145) was sown on 9th July 2011 at a distance 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 (15 and 50 DAS) were carried out to keep the plots free from weeds. Chlorophyll content of the green leaves (3rd leaf from top) of each 5 tagged plants was recorded with the help of chlorophyll meter (Modal, SPAD 502), nitrogen and magnesium content in leaves were estimated at 90, 135 DAS and at harvest. Nitrogen was estimated by Modified Micro, Kjeldhal Method whereas, magnesium content in leaves was estimated using sample test solution by EDTA titration using Mg indicator. For the quantitative estimation of degree of leaf reddening, an index was worked out. The basis of this method is the number of leaves showing the signs of reddening at a given time. Leaves turned red partly or wholly, were divided into 5 categories as follows: Grade ´zero´-when all the leaves were green or less than 3 leaves showed signs of reddening ; Grade ´one´ - when 3 leaves showed reddening ; Grade ´two´ - when more than three leaves were showing signs of reddening but young leaves were green ; Grade ´three´ - when all the leaves were showing reddening in patches and Grade ´four´ - when the whole plant turned red. Before harvesting mean boll weight recorded in grams and individual plant yield was also recorded in and total yield expressed in kg/ ha.

Seed cotton yield: Application of 150 per cent RDF produced 2940 kg/ha of seed cotton yield which was significantly higher than the application of 100 per cent RDF (2582 kg/ha) but was *on par* with 125 per cent RDF application (2844 kg/ha). Application of 125 per cent RDF also produced significantly superior seed cotton yield to 100 per cent RDF. Yields recorded with 125 per cent RDF and 150 per cent RDF, were *at par*. Increased in seed cotton yield with 150 per cent RDF was 13.9 and 3.4 per cent over 100 and 125per cent RDF, respectively (Table 1). These results are in conformity with the findings of Vishwanath (2007). Among foliar nutrition practices, 3 foliar sprays of $MgSO_4$ + KNO_3 recorded maximum seed cotton yield (3056 kg/ ha) and was significantly superior to all other treatments except 3 foliar sprays of $MgSO_4$ (2918 kg/ha) and three 3 sprays of $MgSO_4$ + 19:19:19 along with soil application of $MgSO_4$ (2951 kg/ ha) when compared to control (water spray) (2442 kg/ha). Several workers have reported increased in seed cotton yields because of development of optimum canopy as a result of lower leaf reddening index which was attributed due to higher leaf nitrogen, magnesium and chlorophyll contents and thus leading to higher photosynthetic efficiency with spraying of $MgSO_4$ (Setty *et al.,* 2002 and Kumar and Yadav, 2010), $MgSO_4$ + KNO_3, $MgSO_4$ + DAP (Setty *et al.,* 2002) 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.

Leaf chemical composition and leaf reddening index : During the present study, higher yields due to application of 150 per cent RDF and 125 per cent RDF might be attributed to the development of optimum canopy as a result of lower leaf reddening index and higher nitrogen, magnesium and chlorophyll contents leading to higher photosynthetic efficiency. Application of 150 per cent RDF and 125 per cent RDF resulted

Table 1. Yield attributes and yield of seed cotton as influenced by nutrient management practices for leaf reddening

Treatments	Bolls/ plant	Boll weight (g)	Seed cotton yield (g/plant)	Seed cotton yield (kg/ha)
Fertilizer levels (kg/ha)				
F_1: RDF (150:75:75)	40.92	3.95	160.88	2582
F_2: RDF (125%)	44.78	4.24	173.82	2844
F_3: RDF (150%)	46.92	4.46	179.77	2940
S.Em±	0.53	0.09	3.46	66
C.D. (p=0.05)	2.11	0.35	13.61	258
Soil and foliar application of nutrients				
S_1: Control	41.38	3.82	153.34	2442
S_2: $MgSO_4$ (1.0%) (two foliar sprays)	42.61	4.03	160.55	2605
S_3: $MgSO_4$ @ 25 kg/ha (SA)	43.94	4.25	170.09	2761
S_4: $MgSO_4$ @ 25 kg/ha (SA) + $MgSO_4$ (1.0%) (three foliar sprays)	45.33	4.49	178.54	2918
S_5: $MgSO_4$ @ 25 kg/ha (SA) + $MgSO_4$ (1.0%) + KNO_3 (2.0%) (three foliar sprays)	47.03	4.35	186.03	3056
S_6: $MgSO_4$ @ 25 kg/ha(SA) + $MgSO_4$ (1.0%) + 19:19:19 (1.0%)(three foliar sprays)	44.94	4.37	180.38	2951
S.Em±	0.81	0.10	4.87	93
C.D. (p=0.05)	2.36	0.29	14.07	268

RDF– Recommended dose of fertilizer SA– Soil application
*Interactions were non-significant between S and F also between F and S at same levels

in significantly lower leaf reddening index (0.56 and 0.73 at 90 DAS and 1.76 and 2.13 at 135 DAS respectively) as a result of higher leaf N (2.79 and 2.76 per cent at 90 DAS and 2.20 and 2.19 per cent at 135 DAS, respectively), leaf magnesium (2.01 and 1.87 per cent at 90 DAS and 1.66 and 1.56per cent at 135 DAS, respectively) and chlorophyll contents (47.38 and 43.31 SPAD values at 91 to 135 DAS as compared to 100 per cent RDF (Table 2). At 90 and 135 DAS, the application of 100 per cent RDF showed higher values of leaf reddening index (1.03 and 2.52) and lower values of leaf nitrogen (2.68 and 2.14), magnesium (1.57 and 1.34) and chlorophyll contents (36.67 and 38.59). At higher fertilizer levels, increased in nitrogen along with phosphorus and potassium might have increased the supply of nitrogen to leaf and reduced the formation of anthocyanin at the cost of chlorophyll. Findings of this study are also in conformity with those of Vishwanath (2007), Brar *et al.*, (2009) and Upperi and Kuligoud (2011), who reported increased contents of nitrogen and chlorophyll due to higher levels of NPK fertilizers.

Among soil and foliar application of nutrients, higher yields due to combined initial soil application of $MgSO_4$ with foliar sprays of $MgSO_4$ + KNO_3, $MgSO_4$ + 19:19:19 and $MgSO_4$ might be attributed to the development of optimum canopy as a result of lower leaf reddening index (LRI) which was attributed due to higher leaf nitrogen, magnesium and chlorophyll contents and thus leading to higher photosynthetic efficiency. Foliar spraying of $MgSO_4$+ KNO_3, $MgSO_4$ + 19:19:19 and $MgSO_4$ combined with initial soil application of $MgSO_4$ resulted in significantly lower leaf reddening index (0.43, 0.57 and 0.65 at 90 DAS and 1.95, 2.01 and 2.08 at 120 DAS) as a result of higher nitrogen contents (2.81, 2.80 and 2.78% at 90 DAS and 2.41, 2.43 and 2.28 % at 120 DAS) and magnesium contents in leaves (1.92, 1.97 and 1.85% at 90 DAS and 1.63, 1.67 and 1.56% at 120 DAS) at different growth stages. The higher nitrogen and magnesium content in leaves in these treatments might be resulted in higher chlorophyll content in leaves (38.62, 38.83 and 36.78 at 90 DAS and 42.62, 42.61 and 41.26 at 120 DAS). The beneficial effect of $MgSO_4$ was higher when foliar spray was combined with KNO_3 and 19:19:19 NPK. This might be due to growth promoting effect of N, P and K nutrients

Table 2. Effect of nutrient management practices on chemical composition of *Bt* cotton at different growth stages

Treatments	Leaf reddening index (DAS)			Nitrogen content in leaves (DAS)			Magnesium content in leaves (DAS)			Crop growth rate (g^2/day) 46 to 91 DAS	Chlorophyll content spad values 91 to 135 DAS
	90	135	At Harvest	90	135	At Harvest	90	135	At Harvest		
Fertilizer levels (kg/ha)											
F_1 RDF (150:75:75)	1.03	2.52	2.72	2.68	2.14	1.97	1.57	1.34	1.18	6.13	38.59
F_2 RDF (125%)	0.73	2.13	2.41	2.76	2.19	1.97	1.87	1.56	1.32	6.58	43.31
F_3 RDF (150%)	0.56	1.76	2.07	2.79	2.20	1.99	2.01	1.66	1.37	6.90	47.38
S.Em±	0.02	0.02	0.05	0.01	0.05	0.07	0.02	0.07	0.06	0.08	1.06
C.D. (p0.05)	0.07	0.08	0.20	0.07	NS	NS	0.09	NS	NS	0.31	4.17
Soil and foliar application of nutrients											
S_1 Control	1.27	2.40	2.59	2.64	1.94	1.75	1.63	1.35	1.11	5.99	40.68
S_2 $MgSO_4$ (1.0%) (2 foliar sprays)	0.88	2.23	2.48	2.64	1.96	1.77	1.73	1.43	1.16	6.66	43.43
S_3 $MgSO_4$ @ 25 kg/ha (SA)	0.84	2.14	2.42	2.77	2.03	1.82	1.78	1.48	1.24	6.25	42.18
S_4 $MgSO_4$ @ 25 kg/ha (SA) + $MgSO_4$ (1.0%) (3 foliar sprays)	0.65	2.08	2.35	2.78	2.28	1.93	1.85	1.56	1.35	6.37	44.12
S_5 $MgSO_4$ @ 25 kg/ha (SA) + $MgSO_4$ @ (1.0%) + KNO_3 (2.0%) (3 foliar sprays)	0.43	1.95	2.26	2.81	2.41	2.33	1.92	1.63	1.42	7.08	43.97
S_6 $MgSO_4$ @ 25 kg/ha(SA) + $MgSO_4$ @ (1.0%) +19:19:19 (1.0%) (three foliar sprays)	0.57	2.01	2.29	2.80	2.43	2.26	1.97	1.67	1.46	6.86	44.20
S.Em±	0.04	0.03	0.03	0.03	0.07	0.07	0.03	0.04	0.07	0.11	1.59
C.D. (p=0.05)	0.13	0.09	0.09	0.10	0.22	0.22	0.09	0.12	0.22	0.33	NS

RDF – Recommended dose of fertilizerSA – Soil application.

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

supplied through KNO_3 and 19:19:19 sprays might has promoted the retention and development of the bolls on account of adequate supply of the nutrients (N and K) at critical stages resulted into better growth of the crop besides the role of magnesium in growth and development of the plant with minimizing the leaf reddening incidence. Further, it might be due to the fact that nutrients (N and K) supplied through KNO_3 and 19:19:19 sprays might have helped in redistributing dry matter within the plant thus bringing an improvement in yield. Similar results of beneficial effect of nitrogen, phosphorus and potassium along with magnesium on plant growth and development of the crop plants were reported by Upperi and Kuligoud (2011).

On the basis of this study, it could be infered that for effective control of leaf reddening and also to get higher seed cotton yields, it is advocated to follow 25 per cent extra fertilizer dose *i.e.*, 125 per cent RDF along with $MgSO_4$ @ 25 kg/ ha soil application and 3 foliar sprays of $MgSO_4$ @ 1.0 per cent + KNO_3 @ 2.0 per cent or $MgSO_4$ @ 1.0 per cent +19:19:19 @ 1.0 per cent at flowering, boll formation and boll development stages, respectively in irrigated *Bt* cotton.

REFERENCES

Brar, M. S., Gill, M. S., Sekhan, K. S., Sidhu, B. S., Sharma, P. and Singh, A. 2009. Effect of soil and foliar application of nutrients on yield and nutrient concentration in *Bt* cotton. *J. Res., Punjab Agric. Univ.,* **45** : 126-31.

Hosmath, J.A., Biradar, D.P., Patil, V.C., Palled, Y.B., Malligawad, L.H., Patil,S.S., Alagawadi and Vastrad, A.S. 2012. Performance of *Bt* and non *Bt* cotton genotypes under leaf reddening malady situation. *Karnataka J. Agric. Sci.*, **25**: 36-38.

Kumar, J. and Yadav, M. P. 2010. Effect of foliar application of nutrients on seed cotton yield and economics in *hirsutum* cotton. *J. Cotton Res. Dev.*, **24** : 71-72.

Setty, R. A., Satyanarayana Rao and Koppalkar, B. G. 2002. Integrated foliar nutrition studies for yield maximization in hybrid cotton under irrigation. *J. Cotton Res. Dev.*, **16** : 196-98.

Upperi, S.N. and Kuligoud, V.B. 2011. Effects of prolonged and integrated use of organics and inorganics on the performance of cotton. . World Cotton Research Conference on *"Technologies for Prosperity – 5"*, Mumbai, 7-11 November 2011, *Book of Papers*, pp. 359-63.

Vishwanath, 2007. Response of late sown *Bt* cotton (*Gossypium hirsutum* L.) to plant spacings, fertilizer levels and NAA applications under irrigation. *M.Sc. (Agri.) Thesis,* UAS, Dharwad.

Recieved for publication : June 13 2013
Accepted for publication : January 13, 2014