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Research Paper

Effect of nutrient management on FUE, red leaf, fibre properties of Bt hybrid cotton (*Gossypium hirsutum*)

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ABSTRACT

A field experiment was conducted during 2008, 2009 to study the effect of nutrient management on fertilizer use efficiency (FUE), red leaves and fibre quality in multiple pickings of Bt hybrid cotton (*Gossypium hirsutum* L.) at Central Institute for Cotton Research, Nagpur (21° 09' N, 79° 09' E). Senescence was faster in Bt hybrid cotton in mid-October, 2008 with deficient rainfall in shallow soils. Soil application of $MgSO_4$ @ 25 kg/ha **/**3year in shallow soils significantly reduced the formation of red leaves in October. Cell sap sucking jassids and thrips on Bt hybrid cotton (Bunny) leaves caused N deficiency and accumulation of anthocyanin in August month. Higher FUE was observed in non Bt hybrid cotton compared to Bt hybrid cotton. Fertilizer response, FUE and profitability was significantly improved by application of 150% RDF or $ZnSO_4$ @ 25 kg/ha**/**3year **+** $MgSO_4$ @ 25 kg/ha **/**3year **+** borax @10 kg/ha **/**3year + sulphur @ 20 kg/ha**/**2 year together. Bt hybrid cotton was significantly not profitable with lesser returns and lower yields than non Bt isogenic line of NCS 145 under adverse weather conditions and resurgence of sucking pests. Bundle strength tenacity (g/tex) at 3.2 mm guage and fineness were not significantly affected across pickings, both were 15%-18% shortage of spinning norms.

Key words: Bt hybrid cotton, Bundle strength, FUE, Micronaire, Non Bt. hybrid, Red leaves

Bt hybrid cotton in India gave a yield advantage of 0.237-0.502 t/ha with early boll retention over non Bt cotton hybrids (Naik, 2001). Early and higher boll retention was due to insect resistance in Bt hybrid cotton with higher reported seed cotton yields were advocated with 125% to 150% recommended dose of fertilizers (RDF) along with micro and secondary nutrients with early application in their absence or delay caused leaf reddening and decline in seed cotton yield (CICR, 2008; Sankarnarayanan *et al*., 2010; ISIS, 2010). Severe incidence of jassids on 'RCH-2' and Bunny Bt hybrid cotton with leaf reddening and reduction in boll number was reported by CSA, 2005, which was ignored in general by the researchers but later it was noticed in all Bt hybrid cottons backcrossed with 'Cocker-312'. Very low incidence of boll worms during the decade and record highest fertilizer nutrients consumption (Sharma and Thaker, 2009) in cotton reached highest productivity in 2007 in major cotton growing countries after that decline in productivity in Indian sub continent was due to lower fertilizer consumption, expansion of Bt cotton to non conventional areas besides adverse climatic conditions (CCI, 2010).

Leaf reddening was observed in Bunny Bt hybrid cottons only when jassids/thrips were attacked, which could not be recovered by fresh green leaves due to moisture or nutrition stress in shallow soils, therefore it was mistakenly concluded that Bt hybrid cotton was not suitable for shallow soils, but the fact largest area was adopted in these soils of Maharashtra during 2005-2007 (Chaudhary and Kadambini Gaur, 2010; VJAS, 2009). Reddening before the boll formation, results in a 25% drop in seed cotton yield. Resurgence of jassids, thrips and resistance to imidachloprid insecticide was noticed on Bt hybrid cotton genotypes converted through 'Cocker-312' (TMC, 2010).

Fibre properties were unaffected by transgenic commercial cotton varieties in USA compared to their parents (Perlak *et al*., 2001). Bronson *et al*. (2006) observed that nitrogen management effect on lint yields was highly significant. Read *et al*. (2006) indicated that N stress indirectly influenced fibre quality, N deficiency in cotton leaf N < 25 g/kg and a relatively high boll load combined to produce low quality fibre. RDF 100% produced significantly better uniformity and micronaire compared to higher doses but seed cotton yields were better realized at 150% RDF (Aruna and Reddy, 2009). Commercial Bt hybrid cotton have significantly lower fineness and tenac-

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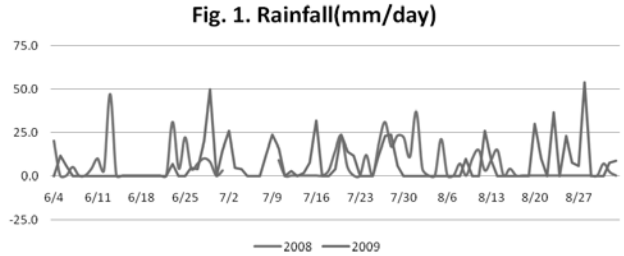
ity values than required quality norms (CIRCOT, 2004, Kelly and Constable, 2011). Serious attention is needed in up gradation of fibre tenacity to suit modern processing system for realization of better quality yarn (Chakraborty, 2010). A research programme was conducted to look into the deterioration of micronaire in later pickings and red leaf in Bt hybrid cotton whether can be improved by suitable nutrition management.

MATERIALS AND METHODS

A field experiment was conducted during 2008 and 2009 seasons to find out remedy for red leaf, deterioration in micronaire and fibre strength over pickings in insect resistant Bt II hybrid cotton. A field experiment consists of 4 fertilizer levels in main plots viz., 75, 100, 125 and 150% recommended dose of fertilizers (RDF) of non Bt hybrid cotton to bunny Bt NCS 145 in combination with secondary and micronutrients viz., Control, $ZnSO_4$ @ 25 kg/ha/3year, $MgSO_4$ @ 25 kg/ha/3 year, borax @ 10 kg/ha/3 year, $ZnSO_4$, $MgSO_4$, borax together, sulphur @ 20 kg/ha/2 year applied in sub plots as split annual applications and foliar spray of 2% Urea/DAP + 0.5% of $MgSO_4$. Bt hybrid cotton was planted on June 27 both the years in 5 rows at 0.75 x 0.75 m a part bordered with one line of near isogenic line of non Bt hybrid cotton as un sprayed refugea as sub sub plot in the split plot design with 3 replications. The soil of the experimental site was shallow to medium deep, *Panjri* series. The soil organic carbon status was 0.45% and pH 8.1, available N 280 kg/ha, available P 12 kg/ha and available K 300 kg/ha, available Zn 0.58 ppm, Mn 2.52 ppm, hot water soluble B 0.25 ppm. Recommended package of practices were followed with pre emergence application of Pendimethalin 1.0 kg a.i./ha followed by three hoeings and two hand weeding. Deficit rainfall in July and August, months of year 2008 where nitrogen was applied in two splits and year 2009 was excess rains in July and August and October months (Fig. 1), where 3 split application of N fertilizers were followed. Continuous rains in 2009 caused uncontrolled weed growth in the absence of timely interculture operations. The red leaves were collected from Bt hybrid cotton in shallow soils 16 October, 2008, 16 August, 2009, to represent terminal and mid season red leaf syndrome, respectively. Red leaves were classified into sucking insect damaged, disease infested, nutrients deficient and compared with normal green leave for their critical nutrients. Leaf nutrients N, P, K, Mg content for their sufficiency with standard procedure were analyzed (AESL, 2011) and the results were subjected to ANOVA technique. Seed cotton yield was estimated by picking seed cotton once i.e. composite (mixed pickings) sample in 2008 and in three separate pickings in 2009. Lint was analyzed for fibre properties on HVI from CIRCOT as per international cotton classing standards. Profitability was calculated from the prevailing input and out prices.

Fig. 1. Rainfall(mm/day)



RESULTS AND DISCUSSION

Seed cotton yield

Non Bt hybrid cotton NCS 145 (Bunny) produced 0.32 t/ ha (22%) higher seed cotton yield more than Bt hybrid cotton NCS 145 during 2008-09 year. Absence of boll worms, deeper root system and longer crop duration without any red leaves are major factor behind non Bt hybrid cotton higher performance despite of deficit rainfall. Bt hybrid cotton produced 21% higher boll load per plant at first picking and subsequently less due to reduced duration and faster senescence than non Bt hybrid cotton, which resulted in 35% lower yield per plant in 2008 (Table 1). Seed cotton yields/plant and net plot yields were significantly improved with 150% recommended dose of fertilizers (RDF) over 75% RDF in 37% deficit rainfall year, 2008 (Table 1) in both Bt and its counterpart Non Bt hybrid cotton NCS 145 due to significantly higher number of open bolls picked per plant. Similar results were also observed by Manjunatha *et al*., 2010 in Bt hybrid cotton with major and micronutrient supply.

Higher rainfall during July, August and October months of year 2009 (Fig.1) resulted non-significant response for variable rate of fertilizer application 75 to 150% RDF (Table 1) due to leaching of nitrogen beyond root zone despite of 3 split application, which reduced growth, development and biomass of Bt hybrid cotton. Abnormal weather conditions reduced yield per plant 45% in Non Bt hybrid cotton and 36% in Bt hybrid cotton (Table 1). Prevailing anaerobic conditions in rhizosphere suffocated cotton which is known to be sensitive to oxygen deficiency in swell shrink soils. The higher air humidity during this period also had higher foliar diseases such as *Alternaria* and *Myrothecium* leaf spots caused shedding of fruiting bodies and pre mature boll rot (Fig.1). Continuous rains >30-50 mm/ day encouraged excess weed growth due to delayed hoeing and hand weedings. These results were in agreements with Hebbar *et al*., 2007 as Bt hybrid cotton in particular in the absence of compensatory

Table 1. Seed cotton yield, biomass, fertilizer use efficiency (FUE) and profitability as influenced by nutrient supply

Treatment	Open bolls 1st picking		2nd .3rd picking 2009		Seed cotton yield kg/plant		Seed cotton yield (t/ha)		FUE kg cotton/ kg fertilizer		Net returns (×10³ ₹/ha)		B:C Ratio		Biomass t/ha	
	2008	2009	bolls	kg/plant	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
NPK																
75% RDF	30	13	10.8	0.035	0.11	0.058	1.49	0.97	11.1	5.1	25.0	11.6	2.52	1.73	2.64	2.52
100% RDF	30	13	10.6	0.060	0.12	0.099	1.55	1.03	8.6	4.1	26.2	12.8	2.56	1.78	2.27	2.30
125% RDF	29	13	11.3	0.062	0.12	0.105	1.47	0.99	6.5	3.1	23.8	11.7	2.42	1.71	2.8	2.49
150% RDF	34	15	11.7	0.065	0.13	0.107	1.90	1.12	7.0	3.1	34.2	14.0	2.88	1.78	2.46	2.02
SEm±	1	1	1.1	0.004	0.01	0.008	0.11	0.05	0.5	0.3	2.6	1.4	0.12	0.08	0.22	0.28
CD (P=0.05)	2	NS	NS	0.008	0.02	0.016	0.21	NS	1.0	0.7	5.2	NS	0.25	NS	NS	NS
Control	31	12	10.4	0.054	0.11	0.092	1.44	0.95	7.4	3.5	23.5	10.8	2.43	1.69	2.24	2.20
Secondary and micronutrients																
Zn 8.3 kg/ha	29	14	11.3	0.060	0.13	0.098	1.57	1.04	8.1	3.7	26.3	12.9	2.54	1.76	2.52	2.32
Mg 8.3 kg/ha	30	15	12.0	0.070	0.11	0.111	1.44	1.09	7.4	4.2	23.4	14.9	2.42	1.92	2.53	2.23
B 3 kg/ha	32	14	11.0	0.059	0.12	0.099	1.70	0.97	8.9	3.5	29.9	10.8	2.75	1.64	2.64	2.18
Zn, Mg, B, S	31	14	11.3	0.070	0.14	0.113	1.79	1.19	9.4	4.7	31.5	16.3	2.77	1.92	2.61	2.64
S 6.6 kg/ha	29	13	11.4	0.061	0.12	0.103	1.67	1.01	8.6	3.8	29.0	12.0	2.70	1.71	2.56	2.50
FS N, Mg	33	12	10.1	0.055	0.11	0.093	1.62	0.94	8.4	3.4	27.6	10.0	2.59	1.60	2.68	2.26
SEm±	2	1	1.0	0.006	0.01	0.010	0.14	0.07	0.8	0.4	3.5	2.2	0.18	0.12	0.31	0.18
CD (P=0.05)	NS	NS	NS	0.012	NS	0.021	0.29	0.15	1.7	0.8	7.1	4.4	0.37	0.28	NS	NS
Cotton type																
Bt	34	13	9.2	0.064	0.11	0.097	1.44	1.02	7.5	3.8	22.9	12.2	2.34	1.74		
N Bt	28	14	12.9	0.058	0.13	0.104	1.76	1.04	9.2	3.8	31.7	12.8	2.85	1.77		
SEm±	0	1	0.6	0.003	0.00	0.05	0.01	0.04	0.1	0.2	0.4	1.0	0.02	0.06		
CD (P=0.05)	1	1	1.2	0.010	0.01	0.01	0.03	NS	0.1	NS	0.8	NS	0.04	NS		

mechanism due to shorter duration was very sensitive for abnormal weather conditions.

Nutrient uptake

The N uptake results shows (Table 4) that there is impeded uptake in both the years either by deficit or excess rains. Therefore under adverse climatic conditions judicious application fertilizers beyond 100% RDF is to be followed with fine tuning of other agronomic limiting factors. The P and K uptake were non significantly responded by major nutrient supply (Table 4). Similar results for major nutrients application for Bt hybrid cotton were observed by Aruna and Reddy, 2009

Fertilizer use efficiency

Seed cotton yield response kg fertilizer added (FUE) was significantly highest with 'NCS-145' Non Bt hybrid cotton 9.2 kg seed cotton kg fertilizer nutrient added compared to 7.5 kg seed cotton kg fertilizer nutrient added for Bt hybrid cotton in 2008 due to its healthy more number of leaves and deeper root system with longer crop duration. FUE was non significant for both Bt and Non bt hybrid cottons in 2009 a year of excess rains (Table 1). FUE was significantly influenced in both the years for variable rate of fertilizer application with higher response in deficit rainfall year to less than half in excess rain years. The highest response was at sub optimal fertilizer dose with decline in yield response with every addition of 25% fertilizers, followed law of diminishing returns (Table 1) but significance was found upto 150% RDF. Similar results were observed by Reddy and Kumar,

(2010) at Warangal (A.P) and Sree Rekha and Pradeep, (2012) at Adilabad (A.P.) in Bt hybrid cotton. It is clearly indicating that adjusting 2-3 split application of N fertilizer as per soil moisture is not enough, fine tuning other agronomic practices such as soil moisture conservation and drainage are equally important for realizing better FUE. FUE was significantly improved by addition of $MgSO_4$ @ 25 kg/ha/3 year or $ZnSO_4$ @ 25 kg/ha/3 year + $MgSO_4$ @ 25 kg/ha/3 year + borax @ 10 kg/ha/3 year + Sulphur @ 20 kg/ha/2 year together in 2009 with 17.3% higher seed cotton yield. Similar response was observed in 2008 with 24% higher realization of seed cotton yield (Table 1). These results were in agreement with those observed by Sankaranarayana *et al,* (2010) with Mg and B application in cotton for yield and fibre quality improvement.

Economics

There is significantly higher returns and profitability due to application of 150% RDF which are in agreement with those observed by Reddy and Kumar, (2010) and Seee Rekha and Pradeep, (2012). The profitability of Bt hybrid cotton under adverse climatic condition with resurgence of sucking pests was raised by many researchers but went un noticed as results clearly shows the significant profitability for non Bt hybrid cottons in 2008 season (Table 1). Micro and secondary nutrients together application in both the seasons found to be profitable as they improved FUE and put fresh green leaves, thereby reducing the impact of red leaves (Table 2).

Red leaf of cotton

Red leaves were 9-17/plant only in 2008 due to nutritional deficiency on 16 October, 2008 (Table 2) which were not significantly reducing the seed cotton yields if compensated by producing more green leaves with sufficient soil moisture or nutrients. The plant analysis found significant deficiency of N, P, in red and disease affected leaves upto 100% RDF above this P was not a deficient but N was less than critical limits shows the need for multiple application of N in both soil and foliar form (AESL, 2011). These results were in conformity with those observed as 2.5% leaf N as critical by Read *et al*. (2006). Mean leaf Mg and K were not limiting confirms to sufficiency range observed by AESL, 2011. Soil application of Sulphur @ 20 kg/ha and foliar spray of Urea 2% and $MgSO_4$ 0.5% both significantly doubled leaf Mg status. There is no significant influence of micronutrients on improved availability of NPK in disease affected leaves (Table 3). Red leaf analysis on 16 August, 2009 found non-significant influence of major nutrients through soil application and the red leaves were by insect, disease and nutrient deficiency caused damage to green leaves (Table 3). Nutrient deficient leaves had significantly lower nitrogen compared to insect damaged and normal leaves which was significantly improved with foliar application but far less than critical requirement. Cell sap sucking jassids and thrips damaged leaves were also shown very low N compared to normal leaves but their differences were non-significantly influenced by N supply. The differences between N deficient leaves and insect damaged leaves were significantly lower (Table 3) but both of them were in insufficient range (AESL, 2011). Soil application of all micro and secondary nutrients shown significantly highest leaf potassium only in normal leaves.

Table 2. Number of leaves deficient in nutrients (red) and disease infected with their nutrient status on 16 October, 2008.

	Abnormal leaves (%)		Red (Nutrition) deficient leaves				Disease infected leaves		
Treatment	Nutrition	Diseased	Mg (%)	N (%)	P (%)	K (%)	N (%)	P (%)	K (%)
NPK									
75% RDF	13.2	15.2	0.41	2.5	0.4	1.8	2.6	0.1	0.92
100% RDF	12.3	14.7	0.77	2.6	0.5	1.8	2.3	0.1	1.01
125% RDF	13	15	0.53	2.3	0.4	1.9	3.4	0.4	0.9
150% RDF	12.7	16.1	0.44	2.2	0.4	2	3.7	0.4	0.99
SEm±	1.29	1.3	0.17	0.1	0.4	0.1	0.2	0.0	1
CD (P=0.05)	NS	NS	NS	0.2	0	NS	0.4	0.1	NS
Control	11.8	13.9	0.48	2.3	0.4	1.9	2.6	0.2	0.96
Secondary and micronutrients									
Zn 8.3 kg/ha	14	16	0.39	2.4	0.4	1.9	2.9	0.3	0.84
Mg 8.3 kg/ha	8.9	12	0.45	2.6	0.4	1.9	3.4	0.3	0.92
B 3 kg/ha	13.4	16.7	0.32	2.6	0.4	1.9	3.2	0.2	0.87
Zn, Mg, B, S	16.9	17.6	0.6	2.2	0.5	1.8	3.1	0.2	1.06
S 6.6 kg/ha	12.4	15.5	0.83	2.4	0.5	1.9	2.9	0.3	0.96
FS N, Mg	12.1	15.3	0.72	2.3	0.5	2	3.1	0.3	1.07
SEm±	2.0	2.0	0.1	0.2	0.4	0.1	0.2	1	0.13
CD (P=0.05)	4.3	4.3	0.3	NS	NS	NS	NS	NS	NS

Table 3. Red leaf nutrient status percent on 16 August, 2009 as influenced by nutrient supply

	Abnormal leaves/plant				Magnesium			Nitrogen				Phosphorus				Potassium			
	D*	I	ND	Total	D	I	ND	N	D	I	ND	N	D	I	ND	N	D	I	ND
NPK																			
75% RDF	2.7	2.4	2.6	7.5	0.4	0.7	0.2	4.2	3.8	1.7	0.9	0.4	0.7	0.7	0.5	1.9	1.5	1.5	0.9
100% RDF	2.6	2.8	2.5	7.2	0.4	0.5	0.3	4.7	4.3	1.3	1.6	0.4	0.7	0.7	0.7	1.9	1.8	1.4	1.6
125% RDF	3.3	3.2	2.0	7.1	0.6	0.7	0.3	4.0	4.0	1.5	1.0	0.5	0.7	0.7	0.4	1.9	1.7	1.3	0.9
150% RDF	2.7	2.9	1.9	5.8	0.5	0.6	0.3	4.0	3.7	1.6	0.8	0.5	0.6	0.7	0.4	2.0	1.6	1.4	0.9
SEm±	0.8	0.4	0.4	1.1	0.2	0.3	0.2	0.2	0.6	0.1	0.5	0.0	0.1	0.1	0.3	0.1	0.2	0.2	0.5
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Secondary and micronutrients																			
Control	3.5	3.4	1.7	7.2	0.5	0.5	0.2	4.2	3.9	1.4	0.7	0.5	0.7	0.6	0.3	1.9	1.6	1.4	0.7
Zn 8.3 kg/ha	2.3	2.5	2.0	5.6	0.7	0.6	0.3	4.3	3.8	1.5	0.8	0.4	0.6	0.7	0.4	1.9	1.7	1.3	0.9
Mg 8.3 kg/ha	2.9	2.3	2.2	6.5	0.6	0.5	0.4	4.3	4.2	1.5	1.3	0.4	0.7	0.7	0.5	1.9	1.6	1.3	1.3
B 3 kg/ha	2.8	2.7	2.7	8.2	0.4	0.7	0.3	4.3	2.8	1.4	1.0	0.5	0.6	0.6	0.5	1.9	1.2	1.3	1.0
Zn, Mg, B, S	2.4	2.5	2.1	6.1	0.4	0.8	0.2	4.2	4.4	1.7	1.2	0.4	0.8	0.7	0.5	2.0	1.8	1.5	1.1
S 6.6 kg/ha	2.9	3.4	2.2	7.5	0.5	0.6	0.4	4.1	4.1	1.5	1.4	0.4	0.7	0.7	0.6	1.9	1.8	1.6	1.4
FS N, Mg	3.2	2.9	2.8	7.3	0.4	0.6	0.3	4.2	4.5	1.8	1.3	0.4	0.7	0.8	0.6	2.0	1.7	1.5	1.3
SEm±	0.6	0.8	0.5	0.8	0.1	0.2	0.1	0.2	0.4	0.2		0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	0.8	NS	0.4	NS	NS	NS	NS	0.1	NS	NS	NS

Note: *D=Diseased; I=Insect damaged; ND = Nutritional deficiency

Fibre properties

Fertilizers application: Variable rate of fertilizers application 75% to 150% neither improved 2.5% span length mm or bundle strength tenacity (g tex) at 3.2 mm guage in both composite/multiple pick sample of Bt hybrid cotton "Bunny" 'NCS-145' (Table 5). These results were in conformity with those observed on fibre properties in Bt hybrid cotton by Aruna and Reddy, (2009). Application of RDF @ 75% significantly reduced uniformity ratio (%) and fineness micronaire 10^{-6} g/ inch over application of RDF @ 100% due to higher number of immature fibres in the latter formed bolls. Similarly, application of RDF @ 150% also significantly produced more number of late formed bolls with immature fibres or lower uniformity ratio (%) but relatively higher fineness micronaire 10^{-6} g/ inch over application of RDF @ 125% due to reduced span length in less rainfall year (Bradow and Davidonis, 2000, Aruna and Reddy, 2009). Similar results were also observed in a year of higher rainfall with multiple pickings for fineness micronaire 10^{-6} g/ inch reduced in 100 and 150% RDF soil application.

Micro and secondary nutrients application

None of the fibre properties significantly influenced by micro and secondary nutrients soil / foliar application except $ZnSO_4$ @25 kg ha soil application reduced span length by 1 mm in composite sample relatively less rainfall year (Table 5).

Pickings

Variation in the ginning percentage and other fibre properties across pickings were not significantly influenced in samples of multiple pickable Bt hybrid cotton. There is no significant differences across pickings on the bundle strength tenacity (g tex) at 3.2 mm guage in this genotype may be due to determinate type of Bt hybrid cotton plant.

Thus it can be concluded that the primary cause of red leaves before senescence was insect and disease damage rather nutrient deficiency of major, secondary and micronutrients which could not be controlled with their supply. Therefore, present recommendations of N, P, K micro and secondary nutrients in both soil and foliar application are not giving any concluding results with Indian cotton farms for red leaves manage-

Table 4. Nutrient uptake of Bt hybrid cotton as influenced by nutrient management

Treatment	N uptake (kg/ha)			P uptake (kg/ha)			K uptake (kg/ha)		
Nutrient	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean
NPK									
75% RDF	42.4	62.9	52.7	7.3	21.5	14.4	49.6	70.9	60.3
100% RDF	63.3	70.4	66.9	9.7	21.8	15.8	69.4	81.8	75.6
125% RDF	54.1	48.1	51.1	10.5	18.7	14.6	68.7	52.7	60.7
150% RDF	63.9	47.3	55.6	11	16.4	13.7	70.8	50.8	60.8
SEm±	4.6	5.2		1	2.1		7.8	13	
CD (P=0.05)	10	11.3		NS	NS		NS	NS	
Secondary and micronutrients									
Control	49.7	49.5	49.6	9.1	17.7	13.4	64.3	54.8	59.6
Zn 8.3 kg/ha	57	57.4	57.2	11.2	22.3	16.8	62.4	59.3	60.9
Mg 8.3 kg/ha	58.6	59.8	59.2	9	18.5	13.8	61.8	63.9	62.9
B 3 kg/ha	55.2	58.6	56.9	8.8	18.8	13.8	67.2	74.3	70.8
Zn, Mg, B, S	53.1	54.5	53.8	9.5	19.7	14.6	57.3	53.6	55.5
S 6.6 kg/ha	63.4	63.1	63.3	10	20.3	15.2	69.1	58.6	63.9
FS N, Mg	54.7	57.3	56	9.8	20	14.9	70.3	83.8	77.1
SEm±	4.7	4.8		0.9	1.9		8.5	16.6	
CD (P=0.05)	NS	NS		NS	NS		NS	NS	

Table 5. Fibre quality of Bt hybrid cotton in composite and multiple pickings

Treatment	Ginning (%)	2.5% Span length (mm)		Uniformity Ratio (%)		Fineness Micronaire 10^{-6} (g/inch)		Bundle strength Tenacity (g/tex at 3.2 mm guage)	
	2009	2008	2009	2008	2009	2008	2009	2008	2009
NPK									
75% RDF	33.5	30.3	29.8	44.2	47.3	3.22	3.19	21.9	23.1
100% RDF	32.7	30.9	29.9	45.2	47.3	3.33	3.07	22	23
125% RDF	32.2	30.3	29.6	45.3	47.2	3.26	3.2	22.8	22.6
150% RDF	32.7	30.6	29.1	44.5	47.2	3.45	3.07	22.3	23.1
SEm±	0.6	0.28	0.38	0.4	0.39	0.05	0.04	0.51	0.09
CD (P=0.05)	NS	NS	NS	0.77	NS	0.1	0.09	NS	0.20
Control	33.2	31	29.6	44.3	47.3	3.22	3.11	22	23.1
Secondary and micronutrients									
Zn 8.3 kg/ha	33.4	30	29.8	44.4	47.4	3.28	3.19	22.5	23.1
Mg 8.3 kg/ha	32.7	30.4	29.5	45	47.1	3.21	3.18	22	22.9
B 3 kg/ha	32.1	30.7	29.4	45.2	46.9	3.48	3.06	22.6	22.8
Zn, Mg, B, S	33.5	30.1	29.6	44.5	47.1	3.42	3.19	21.2	22.6
S 6.6 kg/ha	32.2	30.3	29.6	44.7	47.4	3.43	3.06	22.4	22.9
FS N, Mg	32.5	31.2	29.7	45.5	47.4	3.16	3.17	23.1	23.3
SEm±	0.6	0.44	0.26	0.65	0.32	0.16	0.06	0.61	0.26
CD (P=0.05)	NS	0.96	NS	NS	NS	NS	NS	NS	NS
Picking									
Picking 1	30.3		29.6		47.2		3.11		23
Picking 2	33.3		29.5		47.3		3.13		22.8
Picking 3	34.8		29.7		47.2		3.17		23.3
SEm±	0.4		0.14		0.2		0.02		0.16
CD (P=0.05)	0.8		NS		NS		NS		NS

ment. Soil application of $MgSO_4$ @ 25 kg/ha/3 year as basal dose can significantly reduce red leaves during boll formation stage in shallow soils.

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