



Short Note

Growth, Yield, Nutrient Uptake and Economics of Bt Cotton as Influenced by Foliar Nutrition

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A field experiment was conducted from August 2008 to January 2009 at Tamil Nadu Agricultural University, Coimbatore to find out the influence of foliar nutrition on growth, yield, nutrient uptake and economics of Bt cotton. The experiment was laid out in a randomized block design (RBD), replicated thrice. The treatments were T₁- Urea - (1.5 %), T₂- Diammonium phosphate (DAP) - (2 %), T₃- Potassium chloride (KCl) - (2 %), T₄- Potassium nitrate (KNO₃) - (3 %), T₅- Potassium sulphate (K₂SO₄) - (1.5 %), T₆- Polyfeed – (1.5 %) + Multi K - (1.5 %), T₇- Zinc Sulphate (ZnSO₄) – (0.5 %), T₈- Boron (solubar) - (0.2 %), T₉- Control. The results revealed that foliar application of Polyfeed (1.5 %) + Multi K (1.5 %) recorded significantly higher growth, yield (2758 kg ha⁻¹), nutrient uptake and economics.

Key words: Foliar application, Polyfeed, Multi k, Yield, Nutrient uptake.

Cotton, the 'white gold' or the 'king of the fibre', as it is often referred to, still holds its position high. India is the second largest producer of cotton in the world after China. The cotton acreage in 2010-11 has increased by 8% to reach a record level of 111.61 lakh hectares as against 103.10 lakh hectares in the previous year. Acreage under Bt cotton in the country constant to increase year after year. In 2010-11, out of total 111.42 lakh hectares area, 98.54 lakh hectares area was covered under Bt cultivation, constituting around 88% of the total acreage as compared to 78% in the previous year (CCI, 2011).

Among the various production constrains, imbalanced and inadequate nutrition to cotton crop is considered to be one of the important factors. Due to early and semi-determinate habit of these Bt Cotton Hybrids, the rate of growth and rejuvenation capacity of the plant after first flush of flowering is slow. First formed squares and bolls are retained up to 90 per cent in Bt cotton. When there is need to have more nutritional requirement after first bearing, the plant could not cope up with the nutritional requirements and necessitates additional nutrition. Soil-applied nutrients depend on the moisture to dissolve the fertilizer, and much of those nutrients become unavailable due to strong adsorption to soil particle. To overcome these constraints, additional nutrition through foliar feeding is required over and above the normal fertilizer recommendation. By foliar feeding the plant, the nutrients are available to the growing crop at key growth stages. Considering this the experiment was conducted to find out the appropriate foliar feeding fertilizers for Bt cotton to increase the growth, yield, nutrient uptake and economics.

Materials and Methods

Field experiment was conducted from August 2008 to January 2009 at Tamil Nadu Agricultural University, Coimbatore. The soil was sandy clay loam in texture with pH 8.49. The fertility status of the soil was low, medium and high in the available N, P₂O₅, and K₂O, the values were 212, 20 and 575 kg ha⁻¹, respectively. The experiment was laid out in a randomized block design (RBD) with three replications. The treatments, T₁- Urea - (1.5 %), T₂-Diammonium phosphate (DAP) - (2 %), T₃-Potassium chloride (KCl) - (2 %), T₄-Potassium nitrate (KNO₃) - (3 %), T₅- Potassium sulphate (K₂SO₄) - (1.5 %), T₆- Polyfeed – (1.5 %) + Multi K - (1.5 %), T₇- Zinc Sulphate (ZnSO₄) – (0.5 %), T₈-Boron (solubar) - (0.2 %), T₉- Control were taken up for the experiment. Foliar spraying was given at stray flowering (75 DAS) and boll formation stage (90 DAS) as per different treatments. The spacing adopted was 90 cm between rows and 60 cm between plants. A fertilizer dose of 150:60:60 kg NPK ha⁻¹ was applied uniformly for all the treatments. Out of this full dose of P and 25 per cent of N and K (37.5:60:15 kg NPK ha⁻¹) was applied as basal dose at sowing and the balance 75 per cent of N and K was applied as top dressing at 40, 50 and 65 DAS in equal splits. Other cultural practices and plant, protection measures were given according to the recommendation of TNAU, Coimbatore. Data on growth, yield parameters and yield were recorded.

Results and Discussion

Growth attributes

Among the foliar treatments application of Polyfeed (1.5 %) + Multi K (1.5 %) recorded taller

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Table 1. Effect of foliar nutrition on growth and SPAD values of Bt cotton

Treatment	Plant		Dry matter		Leaf area index		SPAD reading	
	height (cm)		production (kg ha ⁻¹)		120 Harvest		120 Harvest	
	120	Harvest	120	Harvest	120	Harvest	120	Harvest
	DAS	DAS	DAS	DAS	DAS	DAS	DAS	DAS
T ₁ - Urea - (1.5 %)	109	135	5025	5612	2.92	2.25	47.1	50.2
T ₂ - Diammonium phosphate (DAP) - (2 %)	116	143	5227	5672	3.07	2.35	48.4	52.2
T ₃ - Potassium chloride (KCl) - (2 %)	103	125	4874	5421	2.73	2.03	43.3	47.3
T ₄ - Potassium nitrate (KNO ₃) - (3 %)	104	130	4747	5552	2.78	2.17	42.2	45.3
T ₅ - Potassium sulphate (K ₂ SO ₄) - (1.5 %)	106	122	4721	5293	2.61	1.94	40.3	42.1
T ₆ - Polyfeed – (1.5 %) + Multi K - (1.5 %)	123	149	5443	6100	3.22	2.53	51.1	56.8
T ₇ - Zinc Sulphate (ZnSO ₄) – (0.5 %)	102	119	4641	5298	2.52	1.84	38.6	40.1
T ₈ - Boron (solubar) - (0.2 %)	101	113	4575	5290	2.40	1.68	36.7	38.9
T ₉ - Control	97	105	4405	5232	2.21	1.27	34.4	37.7
SEd	5	6	241	273	0.13	0.11	2.1	2.3
CD (P=0.05)	11	13	512	580	0.29	0.23	4.5	4.8

plants height of 123 and 149 cm at 120 DAS and harvest respectively (Table 1). This might be due to the reason that the better utilisation of foliar nutrients by plant, which in turn increased the photosynthetic rate and faster mobilization of nutrients to the growing parts of cotton. Similar report concluded by Jeyabal *et al.* (2000) foliar spray of Polyfeed (1.5 %) + Multi K (1.5 %) produced significantly taller plants.

Polyfeed (1.5 %) + Multi K (1.5 %) registered the maximum DMP of 5443 and 6100 kg ha⁻¹ at 120 DAS and harvest respectively. The maximum leaf area index (Table 1), higher number of bolls per plant, more number of monopodia, sympodia branches (Table 2) might have contributed for the highest DMP at harvest.

Table 2. Effect of foliar nutrition on Number of bolls plant⁻¹, Monopodial branches plant⁻¹ and sympodial branches plant⁻¹ and yield of Bt cotton (kg ha⁻¹) at 120 DAS

Treatment	Number of bolls plant ⁻¹	Monopodial branches plant ⁻¹	Sympodial branches plant ⁻¹	Yield (kg ha ⁻¹)
T ₁ - Urea - (1.5 %)	25.4	1.8	18.5	2445
T ₂ - Diammonium phosphate (DAP) - (2 %)	26.0	2.0	20.5	2506
T ₃ - Potassium chloride (KCl) - (2 %)	24.5	1.6	18.0	2358
T ₄ - Potassium nitrate (KNO ₃) - (3 %)	24.7	1.7	18.2	2376
T ₅ - Potassium sulphate (K ₂ SO ₄) - (1.5 %)	24.0	1.6	17.7	2315
T ₆ - Polyfeed – (1.5 %) + Multi K - (1.5 %)	28.7	2.2	22.6	2758
T ₇ - Zinc Sulphate (ZnSO ₄) – (0.5 %)	24.6	1.5	17.4	2308
T ₈ - Boron (solubar) - (0.2 %)	24.4	1.5	16.3	2297
T ₉ - Control	22.3	1.3	14.7	2269
SEd	1.2	0.1	0.9	119
CD (P=0.05)	2.6	0.2	1.9	253

With respect to leaf area index, application of Polyfeed (1.5 %) + Multi K (1.5 %) recorded significantly higher LAI of 3.22 and 2.53 at 120 DAS and harvest, respectively reported higher LAI

recorded with the soil application of 150 per cent RDF combined with TNAU MN mixture followed by 150 per cent RDF combined with Polyfeed (1.5 per cent) + Multi K (1.5 per cent) application.

Table 3. Effect of foliar nutrition on uptake of major and micro nutrient by Bt cotton

Treatment	N (kg ha ⁻¹)		P (kg ha ⁻¹)		K (kg ha ⁻¹)		Mn (g ha ⁻¹)		Zn (g ha ⁻¹)		Fe (g ha ⁻¹)	
	90	At	90	At	90	At	100	At	100	At	100	At
	DAS	harvest	DAS	harvest	DAS	harvest	DAS	harvest	DAS	harvest	DAS	harvest
T ₁ - Urea - (1.5 %)	83.4	154	25.3	37.3	65.4	118	372	720	162	330	2601	2845
T ₂ - Diammonium phosphate (DAP) - (2 %)	85.6	166	26.4	40.1	69.3	122	381	750	167	325	2654	2900
T ₃ - Potassium chloride (KCl) - (2 %)	80.1	153	21.1	35.3	67.4	120	366	710	153	301	2341	2715
T ₄ - Potassium nitrate (KNO ₃) - (3 %)	82.3	149	20.4	32.3	68.4	115	359	685	145	295	2356	2740
T ₅ - Potassium sulphate (K ₂ SO ₄) - (1.5 %)	80.2	150	21.7	36.4	60.3	118	367	651	155	287	2478	2690
T ₆ - Polyfeed – (1.5 %) + Multi K - (1.5 %)	89.4	174	27.4	43.2	74.2	127	424	814	179	346	2782	3100
T ₇ - Zinc Sulphate (ZnSO ₄) – (0.5 %)	80.2	143	25.3	33.2	62.1	101	347	697	145	310	2578	2650
T ₈ - Boron (solubar) - (0.2 %)	74.2	140	20.1	38.4	59.4	108	348	690	130	270	2207	2600
T ₉ - Control	69.4	129	17.5	27.5	50.2	92	320	590	126	250	1986	2550
SEd	4.0	7	1.2	1.8	3.2	5.7	18	35	7	15	122	136
CD (P=0.05)	8.5	16	2.4	3.8	6.8	12.1	38	74	16	32	259	289

Foliar feeding of plant nutrients influenced the SPAD readings at 90 and 120 DAS. Application of Polyfeed (1.5 %) + Multi K (1.5 %) was recorded higher SPAD readings of 51.1 and 56.8 at 90 and 120 DAS, respectively. Application of MgSO₄ was also

found to reduce reddening of cotton leaves even in rainfed areas. These results implied that foliar sprays of macro and micro nutrients helped to retain the greenness of leaves through increasing chlorophyll contents.

Yield

Foliar application had a pronounced effect on the yield of Bt cotton. Polyfeed (1.5 %) + Multi K (1.5 %) recorded higher yield of 2758 kg ha⁻¹ followed by DAP (2 %) (2506 kg ha⁻¹) and urea (1.5 %) (2445 kg ha⁻¹) (Table 2). This might be due to the reason that when nutrients are applied through foliar spray, the nutrients are supplied directly to where they are required and foliar application may increase the utilization of applied nutrient by enhancing the translocation of nutrients into the boll which increases the number and size of the boll. This result was in accordance with the findings of Majid Rashidi and Mohammad Gholami (2011). Spraying ZnSO₄ (0.5 %) recorded a seed cotton yield of 2308 kg ha⁻¹ and spraying of boron registered 2297 kg ha⁻¹

of seed cotton yield. Foliar application of nutrients increased seed cotton yield, the yield increase due

Table 4. Effect of foliar nutrition on economics of Bt cotton

Treatment	Gross income (Rs. ha ⁻¹)	Cost of cultivation (Rs. ha ⁻¹)	Net income (Rs. ha ⁻¹)	B:C ratio
T ₁ - Urea - (1.5 %)	6357	31552	32018	2.01
T ₂ - Diammonium phosphate (DAP) - (2 %)	65156	31677	33479	2.06
T ₃ - Potassium chloride (KCl) - (2 %)	61308	31577	29731	1.94
T ₄ - Potassium nitrate (KNO ₃) - (3 %)	61776	32677	29099	1.89
T ₅ - Potassium sulphate (K ₂ SO ₄) - (1.5 %)	60190	32497	27693	1.85
T ₆ - Polyfeed – (1.5 %) + Multi K - (1.5 %)	71708	32714	38994	2.19
T ₇ - Zinc Sulphate (ZnSO ₄) – (0.5 %)	60008	31627	28381	1.90
T ₈ - Boron (solubar) - (0.2 %)	59722	31877	27845	1.87
T ₉ - Control	58994	30837	28157	1.91

fertilizers may get fixed up in the soil but up to 80 percent of the foliar-added phosphorus is directly absorbed (Baloch *et al.*, 2008). The higher uptake during early stages of crop growth might be due to the application major nutrients in conjunction with micronutrients which helped in the better translocation of nutrients. Further due to the higher vegetative growth in the early stage (dry matter) the uptake was found to be higher.

Micro nutrients

Application of foliar nutrients influenced the Mn, Zn and Fe uptake at 100 and 120 DAS. Polyfeed (1.5 %) + Multi K (1.5 %) application recorded a maximum Mn uptake of 424 and 814 g ha⁻¹, Zinc uptake of 179 and 346 g ha⁻¹, and Fe uptake of 2782 and 3100 g ha⁻¹ respectively (Table 3). The uptake of Cu was not increased throughout the period of observation. The uptake of micronutrients were in the order of Cu < Zn < Mn < Fe.

Economics

The highest net return of Rs.38,994 ha⁻¹ was recorded with Polyfeed (1.5 per cent) + Multi K (1.5 per cent) sprays at stray flowering and boll formation stages. This treatment also gave the highest B: C ratio of 2.19 (Table 4). The higher net returns observed in the above treatments was mainly due to the application of foliar nutrients that improved the yield attributing characters ultimately led to

to the application of Polyfeed (1.5 %) + Multi K (1.5 %) was 21.5 per cent over the control. The increase in seed cotton yield was due to increased plant height and LAI and resulted in increase in photosynthetic activity and plant DMP.

Nutrients uptake

Major nutrients

Foliar application significantly altered the nutrients uptake of Bt cotton on 90 DAS and at harvest. Polyfeed (1.5 %) + Multi K (1.5 %) application recorded higher N uptake of 89.4 and 174 kg ha⁻¹, P uptake of 27.4 and 43.2 kg of P₂O₅ ha⁻¹, and K uptake of 74.2 and 127 kg ha⁻¹ at 90 DAS and at harvest stage, respectively (Table 3). Foliar fertilizers are known to immediately deliver nutrients to the tissues and organs of the crop. For instance, 80 per cent of the phosphorus applied through conventional

higher net return and B:C ratio. The lowest net return Rs. 28, 157 kg ha⁻¹ and B: C ratio (1.91) was observed under control.

Conclusion

Spraying Polyfeed (1.5 %) + Multi K (1.5 %) could be considered as a better foliar spray option for increased plant height, LAI, dry matter production, nutrient uptake and economics of Bt cotton hybrid under winter irrigated conditions.

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