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Uptake pattern of nutrients and yield of *Bt* Cotton as influenced by different nutrient management practices in a vertisol

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Abstract

The field experiment of *Bt* cotton to evaluate different nutrient management practices was conducted on Vertisol during *khari*f 2016. The experiment was laid out in RBD design and replicated three times. The experiment consisted of eight treatments involving STCR, modified STCR and STL approaches, blanket recommendation and control.

The soil of the experimental site was alkaline in reaction, non saline and low in available nitrogen and high in available phosphorus and potassium.

Uptake of major, secondary and micronutrients at 75, 115 and harvest was higher with 100 per cent application of nutrients through STCR equation to attain target yield of 40 q ha⁻¹ compared to STL approaches and blanket recommendation and the former was on par with those recorded under modified STCR approach (application of 50% P, full dose of N and K of STCR equation). The higher uptake of these nutrients by cotton crop reflected on higher seed cotton yield (36.2 q ha⁻¹) compared to other treatment combinations.

Keywords: Nutrient management practices, nutrient uptake pattern, *Bt* cotton, vertisol

Introduction

In Karnataka, cotton is grown over an area of 8.69 m ha with production of 0.34 m tones and productivity of 430 kg per hectare in 2014-15 according to Ministry of Textiles, Govt. of India. The productivity, however, is much lower than the world average of 766 kg ha⁻¹. Among the cotton growing states, Karnataka ranks fifth in area with 5.94 lakh ha⁻¹ and fourth in production with 20.90 lakh bales of lint and fifth in productivity with an average lint productivity of 630 kg ha⁻¹ (Anon., 2014) ^[1]. *Bt* cotton is intensively cultivated in the North Eastern Dry Zone and Northern Dry Zone of the state (Zone 2 and 3) covering partly the Tungabhadra and Upper Krishna irrigation Commands (TBP and UKP) on black soil. The area under this crop in these commands has been increasing over the past half decade.

It has been found that *Bt* cotton needs 25 per cent extra nutrients than non-*Bt* hybrids: 100: 50: 50, N: P₂O₅: K₂O Kg ha⁻¹, in rainfed condition and 150: 75: 75, N, P₂O₅ and K₂O kg ha⁻¹, under irrigated condition than non-*Bt* hybrids. Cotton being deep rooted crop removes large quantities of nutrients from the soil profile. Application of optimum dose of NPK nutrients is essential in cotton for maximum yield. Excess or inadequate fertilizers reduce the cotton yield. Several factors responsible for crop production among them, fertilizers play an important role. *Bt* cotton being highly exhaustive crop with regard to plant nutrients, fairly large quantities of nutrients are required (Satyanarayana Rao and Setty, 2002) ^[12].

The productivity of seed cotton is largely dependent on its nutrient management and soil fertility status. Proper nutrient management is an important aspect in its production management systems. Applying the required quantities of nutrient at all stages of growth and understanding the soil ability to supply those nutrients is critical in profitable crop production. The effective fertilizer recommendation should consider crop needs and nutrients already available in the soil. Considering these points in view, a study was initiated to know uptake pattern of *Bt* cotton and yield as influenced by different nutrient management approaches in a Vertisol.

Materials and Methods

A field experiment was carried out during *kharif* 2016, at KVK Farm, University of Agriculture Sciences, Raichur to study the "Influence of different nutrient management practices on growth and yield of *Bt* cotton" on medium deep black soil. The soil of the experimental site belongs to Vertisol and clay in texture. The soils were alkaline in reaction, non saline, low in available N (240.0 kg/ha), high in available phosphorus and potassium (61.6 & 429.5 kg/ha). The experiment was laid out in a Randomized Block Design (RBD) and treatments were replicated thrice. Treatment details of experiment are: T₁: Absolute control; T₂: RDF (150:75:75, N: P₂O₅: K₂O kg ha⁻¹); T₃: Soil Test Based (STL) NPK (L, M and H); T₄: Soil test based (STL) NPK ± 25%; T₅: Soil test based NK ± 50% & ± 25% P; T₆: STL-NK ± 25% & ± 50% STL-P; T₇: STCR-NPK for targeted yield of 40 q ha⁻¹; T₈: STCR-NK & 50% STCR-P.

STCR equation for calculating the fertilizer nutrient requirement

FN: 11.33 T - 0.59 SN; FP₂O₅: 6.45 T - 4.4

SP; FK₂O: 4.71 - 0.41 SK FN = Fertilizer nitrogen;

FP₂O₅ = Fertilizer phosphorus; FK₂O = Fertilizer K

T = Target yield; SN = Soil available N;

SP = Soil available P; SK = Soil available K

Fertilizers (NPK) were applied as per the treatment details. Half of the nitrogen and potassium and entire dose of phosphorus were applied in the form of diammonium phosphate (DAP), urea and muriate of potash (MOP) as per the treatments. Soil application of MgSO₄ @ 25 kg ha⁻¹ and foliar spray of MgSO₄ and 19:19:19 @ 1 per cent at 60 and 90 DAS is common for Treatment T₂ to T₈. Recommended cultural practises for cotton were carried out as per Package of Practises developed by UAS, Raichur. Yield obtained from the net plot area was converted to quintals per hectare, analysed statistically and interpreted (Gomez and Gomez, 1984)^[4]. Uptake of nutrients was computed based on concentration of nutrients multiplied by total dry matter yield. Nutrient elements were analysed following the standard procedure as mentioned by Piper (1966)^[11].

Results and Discussion

Uptake of nitrogen, phosphorus and potassium by *Bt* cotton

Uptake of nutrients is associated with the metabolic activities of plants and with the concentration and distribution of ions in the external medium. It has been proved that, application of nutrients at optimum dose improves the absorption and utilization of nutrients. The treatment (T₇) receiving nutrients based on STCR equation, namely, STCR-NPK for targeted yield of 40 q ha⁻¹ recorded significantly higher uptake of nitrogen, phosphorus and potassium at different growth stages of crop when compared to other treatments (Table 1 & fig. 1, 2 & 3).

Uptake of NPK by cotton at different growth stages as influenced by the different nutrient recommendation techniques revealed that higher uptake by *Bt* cotton at 75, 115 DAS and at harvest, respectively (N: 148.7, 175.5 and 212.1 kg ha⁻¹; P: 22.7, 24.4 & 28.2 kg ha⁻¹ & K: 138.1, 169.6 & 194.2 kg ha⁻¹) was observed with the application of nutrients according to STCR equation in treatment T₇ and was on par with treatment T₈: STCR-NK & 50% STCR-P. The lower uptake of N: 80.8, 97.8 and 126.7 kg ha⁻¹; P: 11.9, 15.4 & 18.9 kg ha⁻¹ and K: 91.7, 132.3 and 144.5 kg ha⁻¹ respectively at 75, 115 DAS and at harvest was registered in treatment (T₂)

receiving RDF @ 150:75:75 kg ha⁻¹. The increase in uptake of N in T₇ treatment over T₂ was 84.0, 79.6 and 67.4 per cent, respectively, at 75, 115 DAS and at harvest. The significant variation in uptake of nutrients was due to variation in dry matter accumulation of plant and soil available nutrient status. It was observed that uptake of nutrients increased with increasing crop growth. The uptake of nutrients increased from 75 DAS to harvest of the crop, which was mainly to meet the nutrient needs of developing branches, leaves, flowers and bolls. Under high level of fertilizers, plants extract more nutrients from soil as compared to low level of fertilizer. Nutrient uptake increases with increase in fertilizer level which might be related to increase in dry matter accumulation and their respective content in plant with increase in fertilizer levels. These results are also supported by the finding of Gundlur *et al.* (2013)^[5]. The increase in levels of K enhanced the K availability in the soil and thus higher uptake of K by maize. Besides, potassium has a role in enzyme activation, photosynthesis, and protein and starch synthesis. It regulates stomatal activity, enhances the transport of sugars, water and nutrients, and maintains crop quality. The continuous availability of K and higher efficiency resulted in more uptake of potassium as compared to lower levels as reported by Lei *et al.* (2000)^[8], Sharanappa (2001)^[13], Manoj Kumar and Singh (2003)^[10] and Arun Kumar *et al.* (2007)^[2].

Uptake of secondary nutrients

At 75, 115 DAS and harvest, respectively, the higher uptake of Ca (27.3, 32.2 & 40.2 kg ha⁻¹) Mg (11.8, 13.9 & 16.3 kg ha⁻¹) and S (16.5, 22.1 & 26.4 kg ha⁻¹) by cotton was registered in treatment T₇: STCR-NPK for targeted yield of 40 q ha⁻¹ and was on par with treatment T₈: STCR-NK & 50% STCR-P (Table 2). Among STL treatments, the higher uptake of secondary nutrients was noticed in treatment T₅: STL-NK ± 50% & ± 25% P.

The uptake of nutrients was higher at harvest when compared to 75 and 115 DAS might be due to progression of the crop growth increased the dry matter content with uptake of higher nutrients at higher NPK fertilizer levels. The present findings are in line with the report of Mamatha and Ramesh, (2015)^[9] and Basavarajappa (1992)^[3].

Uptake of micronutrients

Uptake of micronutrients (Table 3) such as copper, iron, manganese and zinc showed an increasing trend in uptake from 75 DAS towards harvest of the crop. The higher uptake of Cu, Fe, Mn and Zn, respectively (117.7, 1196.2, 374.1 and 194.1 g ha⁻¹) was recorded due to application of nutrients according to STCR equation which was superior to all other treatments except treatment T₈: STCR-NK & 50% STCR-P (114.1, 1193.1, 372.8 and 188.1 g ha⁻¹ at 75 DAS). Among STL treatments, the higher uptake of Cu, Fe, Mn and Zn was noticed in treatment T₅: STL-NK ± 50% & ± 25% P (91.0, 995.3, 311.7 and 154.3 g ha⁻¹ at 75 DAS). At harvest, among fertilizer applied treatments, the highest uptake of Cu, Fe, Mn and Zn, respectively (169.6, 1977.5, 599.8 and 280.1 g ha⁻¹) were noticed in treatment receiving nutrients based on STCR equation for targeted yield of 40 q ha⁻¹ (T₇) and application of RDF @ 150:75:75 kg ha⁻¹, registered the lower uptake (114.2, 1587.6, 472.3 and 213.6 g ha⁻¹) of these micronutrients. Variation in uptake of micronutrients was due to higher dry matter accumulation and yields are in conformity with the findings of Ishaq *et al.* (1992)^[7] and Waikar *et al.* (2015)^[14].

Seed cotton Yield

The higher seed cotton yield (Table 4) per plant (189.4 g plant⁻¹) and seed cotton yield per hectare (36.2 q ha⁻¹) was

recorded with application of major nutrients based on STCR equation for the targeted yield 40 q ha⁻¹ (T7) and was superior to all other treatments except treatment T₈: STCR-NK and 50% STCR-P (185.0 g plant⁻¹ & 34.1 q ha⁻¹). Among the STL treatment combinations, higher seed cotton yield was registered in treatment T₄: STL-NPK ± 25% (28.7 q ha⁻¹) and lower in STL-NPK (low, medium and high category) (27.7 q ha⁻¹). The seed cotton yield (25.5 q ha⁻¹) registered with application of RDF @ 150:75:75 kg ha⁻¹ was low compared to STL and STCR treatments. Higher seed cotton yield recorded with STCR equation and soil test level (STL) fertilizer recommendation is because, application of fertilizers based on general recommendation may be insufficient to meet nutrient demand by the crop to obtain sustained yield levels. The higher yield realized in treatment consisting of STCR and

STL was due to balanced supply of nutrients, efficient utilization of applied NPK fertilizer nutrients and the synergistic effect of addition of various sources of nutrients. Application of fertilizer doses based on soil test values probably helped in providing balanced nutrition to the crop which further helped in building up of higher dry matter accumulation, through higher bio-chemical process and higher photosynthetic rate and higher leaf area with subsequent better translocation of photosynthates from source to sink for improving all the growth and yield components and in turn to put forth higher yield. A similar variation in yield components of *Bt* cotton was also reported by the Gudadhe *et al.* (2011)^[6] who obtained maximum seed cotton yield, stalk yield and biological yield with the application of fertilizer dose according to soil test crop response approach.

Table 1: Uptake of major nutrients by *Bt* cotton as influenced by different nutrient management practices at different crop growth stages

Treatment	Nitrogen uptake (kg ha ⁻¹)			Phosphorus uptake (kg ha ⁻¹)			Potassium uptake (kg ha ⁻¹)		
	75 DAS	115 DAS	At harvest	75 DAS	115 DAS	At harvest	75 DAS	115 DAS	At harvest
T ₁ : Absolute control	49.1	66.5	81.7	6.1	10.2	13.3	43.6	63.3	77.9
T ₂ : RDF (150: 75: 75, N: P ₂ O ₅ : K ₂ O kg ha ⁻¹)	80.8	97.8	126.7	11.9	15.4	18.9	91.7	132.3	144.5
T ₃ : Soil test based (STL) NPK (L, M & H)	88.5	106.0	132.9	12.3	16.3	18.6	87.9	112.6	129.0
T ₄ : Soil test based (STL) NPK ± 25%	99.6	112.6	141.8	12.4	15.6	18.4	98.1	118.3	134.8
T ₅ : Soil test based NK ± 50% & ± 25% P	105.2	117.7	147.4	12.6	16.1	19.0	85.1	97.7	107.8
T ₆ : STL-NK ± 25% & 50% STL- P	98.9	110.6	140.5	12.1	14.6	17.7	97.9	115.7	134.0
T ₇ : STCR - NPK for targeted yield of 40 q ha ⁻¹	148.7	175.5	212.1	22.7	24.4	28.2	138.1	169.6	194.2
T ₈ : STCR-NK & 50% STCR-P	147.8	171.3	208.1	17.0	18.8	21.7	136.7	165.5	192.2
Mean	102.3	119.8	148.9	13.3	16.4	19.5	97.4	121.9	139.3
S.Em±	2.49	3.67	3.78	1.11	1.37	1.68	2.80	3.98	4.25
CD at 5%	7.54	11.15	11.48	3.36	4.16	5.10	8.49	12.07	12.88

Table 2: Uptake of secondary nutrients by *Bt* cotton as influenced by different nutrient management practices at different crop growth stages

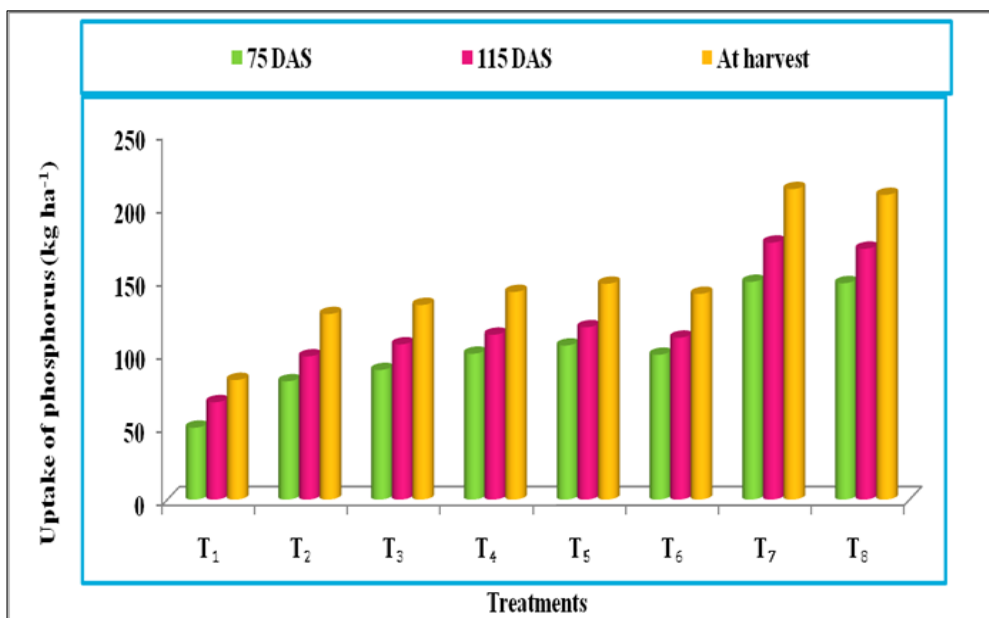
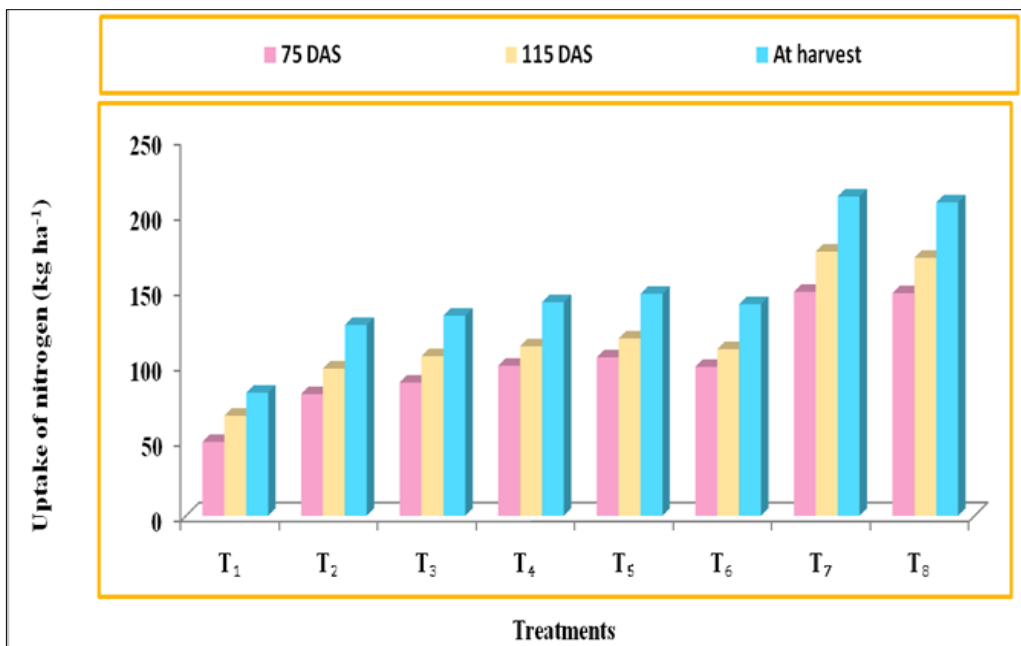
Treatment	Calcium uptake (kg ha ⁻¹)			Magnesium uptake (kg ha ⁻¹)			Sulphur uptake (kg ha ⁻¹)		
	75 DAS	115 DAS	At harvest	75 DAS	115 DAS	At harvest	75 DAS	115 DAS	At harvest
T ₁ : Absolute control	8.1	13.3	19.5	3.4	5.3	7.4	4.7	8.7	11.5
T ₂ : RDF (150: 75: 75, N: P ₂ O ₅ : K ₂ O kg ha ⁻¹)	13.7	19.0	24.2	6.4	8.7	10.3	9.8	12.4	15.3
T ₃ : Soil test based (STL) NPK (L, M & H)	15.1	21.5	25.6	7.4	9.8	11.3	10.3	14.4	16.5
T ₄ : Soil test based (STL) NPK ± 25%	18.0	23.6	27.9	8.8	11.7	13.6	12.0	16.2	18.3
T ₅ : Soil test based NK ± 50% & ± 25% P	18.5	23.5	27.7	8.7	11.6	13.3	12.8	17.9	20.4
T ₆ : STL-NK ± 25% & 50% STL- P	17.9	22.6	26.9	9.5	11.6	13.7	12.9	15.7	18.2
T ₇ : STCR - NPK for targeted yield of 40 q ha ⁻¹	27.3	32.2	40.2	11.8	13.9	16.3	16.5	22.1	26.4
T ₈ : STCR-NK & 50% STCR-P	26.8	31.3	39.2	11.7	13.5	16.2	16.3	20.0	24.5
Mean	18.2	23.4	29.0	8.5	10.8	12.8	11.9	15.9	18.9
S.Em±	1.12	1.45	1.70	0.54	1.4	2.19	0.84	1.03	1.65
CD at 5%	3.40	4.41	5.16	1.64	4.15	6.65	2.53	3.14	5.01

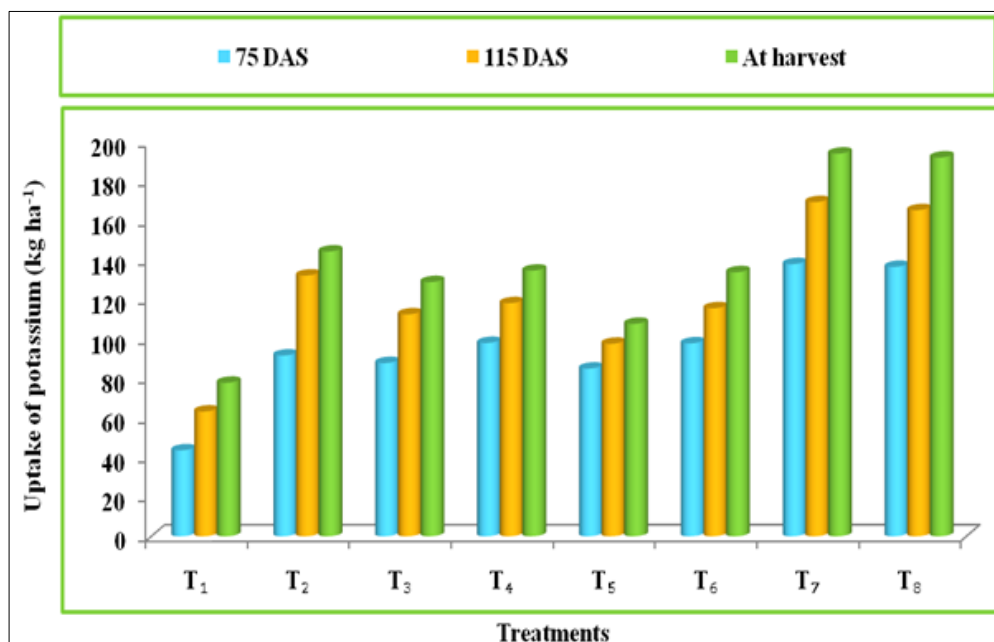
Table 3: Uptake of micronutrients by *Bt* cotton as influenced by different nutrient management practices at different growth stages of crop.

Treatment	Copper (g ha ⁻¹)			Iron (g ha ⁻¹)			Manganese (g ha ⁻¹)			Zinc (g ha ⁻¹)		
	75 DAS	115 DAS	At harvest	75 DAS	115 DAS	At harvest	75 DAS	115 DAS	At harvest	75 DAS	115 DAS	At harvest
T ₁ : Absolute control	41.2	66.5	90.5	499.0	900.9	1396.6	156.5	274.9	417.5	74.9	129.4	179.5
T ₂ : RDF (150: 75: 75, N: P ₂ O ₅ : K ₂ O kg ha ⁻¹)	71.2	92.8	114.2	789.4	1174.9	1587.6	246.4	357.9	472.3	119.6	169.3	213.6
T ₃ : Soil test based (STL) NPK (L, M & H)	78.0	101.4	126.4	856.3	1279.9	1662.8	270.1	389.6	494.2	130.7	185.2	223.5
T ₄ : Soil test based (STL) NPK ± 25%	84.5	110.5	136.9	964.9	1345.7	1726.4	299.7	413.1	525.0	148.7	193.9	234.9
T ₅ : Soil test based NK ± 50% & ± 25% P	91.0	114.9	139.2	995.3	1401.7	1790.4	311.7	427.3	541.2	154.3	203.9	240.8
T ₆ : STL-NK ± 25% & 50% STL- P	84.4	108.8	135.8	956.5	1318.3	1711.2	296.4	405.7	515.5	147.6	188.7	233.2
T ₇ : STCR - NPK for targeted yield of 40 q ha ⁻¹	117.7	141.5	169.6	1196.2	1522.9	1977.5	374.1	473.4	599.8	194.1	229.8	280.1
T ₈ : STCR-NK & 50% STCR-P	114.1	134.2	161.4	1193.1	1481.7	1943.3	372.8	459.8	590.4	188.1	222.3	275.5
Mean	85.3	108.8	134.3	931.3	1303.2	1724.5	291.0	400.2	519.5	144.7	190.3	235.1
S.Em±	1.7	5.7	3.1	21.5	35.8	45.9	6.7	10.6	12.6	3.0	5.9	5.7
CD at 5%	5.3	17.2	9.4	65.3	108.5	139.2	20.4	32.1	38.2	9.0	18.0	17.3

Table 4: Cotton yield as influenced by different nutrient management practices

Treatment	Cotton yield (g plant ⁻¹)	Cotton yield (q ha ⁻¹)
T ₁ : Absolute control	97.6	16.2
T ₂ : RDF (150: 75: 75, N: P ₂ O ₅ : K ₂ O kg ha ⁻¹)	147.4	25.5
T ₃ : Soil test based (STL) NPK (L, M & H)	153.1	27.7
T ₄ : Soil test based (STL) NPK ± 25%	158.7	28.7
T ₅ : Soil test based NK ± 50% & ± 25% P	156.1	28.4
T ₆ : STL-NK ± 25% & 50% STL- P	156.0	28.3
T ₇ : STCR - NPK for targeted yield of 40 q ha ⁻¹	189.4	36.2
T ₈ : STCR-NK & 50% STCR-P	185.0	34.1
Mean	155.4	28.3
S.Em±	4.46	0.80
CD at 5%	13.51	2.43



**Legend**

- | | |
|-------------------------------------|---|
| T ₁ : Absolute control | T ₅ : STL-NK± 50% & ± 25% P |
| T ₂ : RDF | T ₆ : STL-NK± 25% & 50% STL-P |
| T ₃ : STL-NPK (L, M & H) | T ₇ : STCR-NPK for targeted yield of 40 q ha ⁻¹ |
| T ₄ : STL-NPK ± 25% | T ₈ : STCR-NK & 50% STCR-P |

Fig 1: Uptake of nutrients by Bt cotton at different growth stages as influenced by different nutrient management approaches.

References

- Anonymous. Annual report. Cotton Advisory Board, 2014.
- Arun Kumar MA, Gali SK, Hebsur NS. Effect of different levels of NPK on growth and yield parameters of sweet corn. *Karnataka J Agric. Sci.* 2007; 20(1):41-43.
- Basavarajappa R. Response of cotton cv. Abaditha (*Gossypium hirsutum* L.) to soil and foliar application of micronutrients under rainfed conditions. MSc. (Ag.) Thesis, University of Agricultural Sciences, Dharwad (Karnataka) India, 1992.
- Gomez KA, Gomez AA. Statistical procedures for agricultural research 2nd Edn. A Willey Interscience Pub., New York (USA), 1984, 680.
- Gundlur SS, Rajkumara S, Neelkanth JK, Ashoka P. Water and nutrient requirement of Bt cotton under vertisols of Malaprabha command. *Karnataka J Agric. Sci.* 2013; 26(3):368-371.
- Gudadhe NN, Khang VT, Thete NM, Lambade BM, Jibhkate SB. Effect of different INMS treatments on growth, yield, quality, economics and nutrient uptake of hybrid cotton: Phule-492 (*Gossypium hirsutum* L.). *Omonrice.* 2011; 18:137-143.
- Ishaq HM. Effect of foliar micronutrient fertilizer on the yield of irrigated cotton Vertisol of the Sudan, Gezirel. *Experimental Agriculture.* 1992; 28:265-271.
- Lei Y, Zhang B, Zhang M, Zhao K, Qio W, Wan X. Corn response to potassium in Liaoning province. *Better Crops.* 2000; 14(1):6-9.
- Mamatha N, Ramesh HS. Effect of sulphur and micronutrients (zinc and iron) on nutrient uptake, availability, yield and quality of cotton. *Asian J Soil Science.* 2015; 10(1):63-67.
- Manoj Kumar, Singh M. Effect of nitrogen and phosphorus levels on yield and nutrient uptake in maize (*Zea mays* L.) under rainfed condition of Nagaland. *Crops Res.* 2003; 25(1):46-49.
- Piper CS. Soil and Plant Analysis, Hans Publishers, Bombay, 1966, 368.
- Satyanarayana Rao, Setty RA. Response of hybrid cotton to levels and times of nitrogen and potash application under irrigated condition. *J Cotton Res. Dev.* 2002; 16(2):188-189.
- Sharanappa. Effect of recommended dose of fertilizer on nutrient content and chlorophyll of maize. *Current Res.* 2001; 34(1):17-21.
- Waikar SL, Dhamak AL, Meshram NA, Patil VD. Effect of specialty fertilizers on soil fertility, nutrient uptake, quality and productivity of cotton in vertisol. *IOSR J of Agric. and Veterinary Sci. (IOSR-JAVS).* 2015; 8(2):76-79.