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Effect of potassium management through foliar nutrition on yield, quality and economics of *Bt* cotton (*Gossypium hirsutum* L.)

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Abstract

A field experiment entitled “Effect of potassium management through foliar nutrition on yield, quality and economics of *Bt* cotton (*Gossypium hirsutum* L.)” was conducted during the *Kharif* season of 2025 at the Main Agricultural Research Station (MARS), University of Agricultural Sciences, Raichur. The experimental field was laid out in a Randomized Complete Block Design (RCBD) with eleven treatments replicated three times. The treatments consisted of different levels of recommended potassium supplemented with foliar application of potassium sulphate (K_2SO_4) at different concentrations and stages, along with recommended NPK + KNO_3 as the recommended practice and a control treatment without potassium. The results showed that application of 100 per cent recommended NPK + 1 per cent KNO_3 spray at 80 and 100 DAS (T_{10}) recorded significantly higher number of good opened bolls plant⁻¹ (27.5), boll weight (6.00 g), seed cotton yield (165.3 g plant⁻¹) and seed cotton yield (3060 kg ha⁻¹), lint yield (1145 kg ha⁻¹) and ginning percentage of 37.43%. This was followed by application of 75 per cent recommended potassium + 2 per cent K_2SO_4 spray at 50, 75 and 100 DAS (T_5) and 75 per cent recommended potassium + 2 per cent K_2SO_4 spray at 50 and 75 DAS (T_4), which were found *on par* with T_{10} for major yield attributes and seed cotton yield, lint yield and ginning percentage. Economic analysis revealed that T_{10} recorded the higher gross returns (Rs. 2,35,952 ha⁻¹), net returns (Rs. 1,50,287 ha⁻¹) and benefit cost ratio (2.75), followed by T_4 and T_5 . The results indicated that adequate potassium supply through soil and foliar application during critical reproductive stages improved yield attributes, seed cotton yield and economic returns of *Bt* cotton and also 25% of the soil application of potassium can be saved.

Keywords: *Bt* cotton, potassium, foliar nutrition, K_2SO_4 , KNO_3 , seed cotton yield, economics

Introduction

Cotton (*Gossypium hirsutum* L.) is one of the most important commercial fibre crops and plays a major role in the textile and agricultural economy (Malinga, 2021) [8]. India has the largest area under cotton cultivation and ranks second in cotton production. During 2024-25, cotton was cultivated over 114.84 lakh hectares with a production of 297.24 lakh bales (PIB, 2026) [12]. However, cotton productivity remains comparatively low, particularly because of the predominance of rainfed cultivation, erratic climatic conditions, imbalanced nutrient management and other biotic and abiotic stresses (Ministry of Textiles, 2025) [10].

Potassium is an essential macronutrient required in large quantities by cotton, particularly during flowering, boll formation and boll development. It plays an important role in maintaining plant water balance, regulating stomatal activity, activating enzymes, improving photosynthetic efficiency and facilitating the translocation of photosynthates towards developing bolls. Adequate potassium nutrition therefore contributes to better boll development, yield formation and fibre quality.

Foliar application provides an additional approach for supplying nutrients during periods of high crop demand. Potassium nitrate (KNO_3) and potassium sulphate (K_2SO_4) are important potassium sources used for foliar application in cotton. Previous studies have reported improvements in yield attributes and seed cotton yield with foliar application of KNO_3 . Meena *et al.* (2017) [9] recorded higher seed cotton yield with foliar KNO_3 application, while Amarjeet *et al.* (2018) [11] reported

increased seed cotton yield with three sprays of 1 per cent KNO_3 . Similarly, Dhadge *et al.* (2018) [3] observed higher seed cotton yield with four sprays of 3 per cent KNO_3 .

Foliar application of K_2SO_4 has also been reported to improve cotton productivity and profitability. Hussain *et al.* (2020) [5] reported better economic returns with 2 per cent K_2SO_4 compared with foliar application of KNO_3 and KCl , while Basavanneppa *et al.* (2015) [2] observed higher seed cotton yield, net returns and benefit-cost ratio with foliar KNO_3 application. These findings indicate that foliar potassium application can supplement soil-applied potassium during critical reproductive stages and may improve yield and economic returns.

Therefore, the present investigation was undertaken to study “Effect of potassium management through foliar nutrition on yield, quality and economics of *Bt* cotton (*Gossypium hirsutum* L.)”

Material and Methods

A field experiment was conducted during the *Kharif* season of 2025 at the Main Agricultural Research Station (MARS), University of Agricultural Sciences, Raichur. The experimental site was situated in the North-Eastern Dry Zone (Zone 2) of Karnataka at a latitude of $16^{\circ}12' \text{ N}$, longitude of $77^{\circ}20' \text{ E}$ and an altitude of 407 m above mean sea level. The soil of the experimental field was deep black soil. The initial soil available nitrogen, phosphorus and potassium were 223.10, 29.70 and 260.50 kg ha^{-1} , respectively.

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The genotype used was SWCH 4749 BG II (US 7067). The gross plot size was 7.20 m $\times$ 4.80 m and the net plot size was 3.60 m $\times$ 3.60 m, with a spacing of 90 cm $\times$ 60 cm. The recommended fertilizer dose was 180:90:90 kg N: P_2O_5 : $\text{K}_2\text{O ha}^{-1}$, with recommended nitrogen and phosphorus kept common for all treatments.

The treatments were:

T₁: Recommended NPK (100%) (kg ha^{-1})

T₂: 75% recommended potassium + 1% K_2SO_4 spray at 50 and 75 DAS

T₃: 75% recommended potassium + 1% K_2SO_4 spray at 50, 75 and 100 DAS

T₄: 75% recommended potassium + 2% K_2SO_4 spray at 50 and 75 DAS

T₅: 75% recommended potassium + 2% K_2SO_4 spray at 50, 75 and 100 DAS

T₆: 50% recommended potassium + 1% K_2SO_4 spray at 50 and 75 DAS

T₇: 50% recommended potassium + 1% K_2SO_4 spray at 50, 75 and 100 DAS

T₈: 50% recommended potassium + 2% K_2SO_4 spray at 50 and 75 DAS

T₉: 50% recommended potassium + 2% K_2SO_4 spray at 50, 75 and 100 DAS

T₁₀: Recommended NPK (100%) (kg ha^{-1}) + 1% KNO_3 spray at 80 and 100 DAS (recommended practice)

T₁₁: Control (without potassium).

The crop was sown on 3rd July 2025 by dibbling two seeds per hill at a spacing of 60 cm between plants and 90 cm between rows. Seed cotton yield was recorded separately from each net plot at every picking, and the total yield was computed on hectare basis. Yield attributes including number of good opened bolls, boll weight and seed cotton yield plant^{-1} and quality parameters viz. lint yield, ginning outturn, staple length, fibre strength and

micronaire were also recorded as per standard procedure described in the experimental methodology.

The cost of cultivation was calculated by considering the prevailing prices of seed, fertilizers, plant protection chemicals, labour and other inputs. Gross returns were calculated based on seed cotton yield and market price, while net returns were calculated by deducting the cost of cultivation from gross returns. The benefit cost ratio was calculated as the ratio of gross returns to cost of cultivation. The data were statistically analysed as described by Panse and Sukhatme (1978) [11], and critical difference values were calculated when the F-test was significant.

Results and Discussion

Application of different levels of potassium through soil and foliar nutrition significantly influenced the yield attributes and seed cotton yield of *Bt* cotton. Treatment T₁₀, comprising 100 per cent recommended NPK + 1 per cent KNO_3 spray at 80 and 100 DAS, recorded the higher values for major yield attributes, seed cotton yield, lint yield and ginning percentage (%). Whereas treatments T₅ and T₄, involving 75 per cent recommended potassium supplemented with 2 per cent K_2SO_4 sprays, also performed better and were comparable with T₁₀ for the major yield parameters.

Yield attributes and seed cotton yield

Treatment T₁₀ recorded significantly higher number of good opened bolls plant^{-1} (27.5) followed by T₅ (27.0) and T₄ (26.8), which were found *on par* with T₁₀. The control treatment T₁₁ recorded the lower number of good opened bolls plant^{-1} (16.1) as shown in Table 1 and figure 1.

The better performance of T₁₀ may be attributed to adequate potassium availability during the reproductive phase, which supported boll development, retention and translocation of photosynthates towards developing reproductive sinks. The comparable performance of T₅ and T₄ indicated that foliar application of 2 per cent K_2SO_4 could effectively supplement reduced soil-applied potassium during flowering and boll development. Similar improvement in yield attributes with foliar potassium application was reported by Saravanan *et al.* (2012) [15], Sekhon and Singh (2013) [16] and Howard *et al.* (1998) [4].

T₁₀ recorded significantly higher boll weight (6.00 g), seed cotton yield (165.3 g plant^{-1}) and seed cotton yield (3060 kg ha^{-1}). It was followed *on par* by T₅ with 5.96 g boll weight, 161.00 g plant^{-1} seed cotton yield and 2981 kg ha^{-1} seed cotton yield, and T₄ with 5.93 g, 159.00 g plant^{-1} and 2944 kg ha^{-1} , respectively. The control treatment T₁₁ recorded the lower boll weight (5.18 g), 83.7 g plant^{-1} seed cotton yield and seed cotton yield (1551 kg ha^{-1}) as shown in Table 1 and figure 1.

The higher seed cotton yield under T₁₀ may be attributed to the cumulative improvement in yield components, particularly higher boll number, greater number of good opened bolls and higher boll weight together with fewer bad opened bolls. The close performance of T₅ and T₄ indicated that repeated foliar application of K_2SO_4 partially compensated for reduced soil-applied potassium and maintained reproductive productivity. Similar improvement in seed cotton yield with foliar KNO_3 and K_2SO_4 application was reported by Basavanneppa *et al.* (2015) [2], Meena *et al.* (2017) [9], Amarjeet *et al.* (2018) [11] and Hussain *et al.* (2020) [5].

Quality parameters

Lint yield and ginning percentage

Application of different levels of potassium through soil and foliar nutrition significantly influenced lint yield and ginning

percentage, whereas staple length, fibre strength and micronaire value were not significantly influenced. T₁₀ recorded significantly higher lint yield (1145 kg ha⁻¹) and ginning percentage (37.43%), followed by T₅ (1098 kg ha⁻¹ and 36.83%, respectively) and T₄ (1079 kg ha⁻¹ and 36.64%, respectively). The control treatment T₁₁ recorded the lower lint yield (468.00 kg ha⁻¹) and ginning percentage (30.15%) as shown in table 2.

The higher lint yield and ginning percentage under T₁₀ may be attributed to adequate potassium availability during the reproductive phase, which favoured boll development, lint production and greater lint recovery. The comparable performance of T₅ and T₄ indicated that foliar application of 2 per cent K₂SO₄ was effective in supplementing reduced soil-applied potassium. Similar improvement in lint yield with foliar potassium application was reported by Jagdish *et al.* (2011) [6] and higher ginning percentage with foliar application of Polyfeed + Multi-K was reported by Saravanan *et al.* (2012) [15], while Jyothi and Hebsur (2018) [7] recorded higher ginning outturn with soil and foliar potassium application.

Staple length, fibre strength and micronaire

The staple length varied from 29.40 to 30.70 mm, fibre strength from 29.45 to 31.05 g tex⁻¹ and micronaire from 3.55 to 4.20, with T₁₀ recording the higher values for all the three characters (30.70 mm, 31.05 g tex⁻¹ and 4.20, respectively), followed by T₅ (30.65 mm, 30.65 g tex⁻¹ and 4.10, respectively) as shown in table 2. However, the differences were non-significant, indicating that these fibre quality parameters were comparatively stable under the different potassium management practices.

The narrow variation in staple length suggested that foliar potassium application was not sufficient to produce a statistically measurable change in this fibre character. Similarly, the limited variation in fibre strength indicated that the additional KNO₃ and K₂SO₄ applications did not strongly alter this trait. Rajendran *et al.* also reported that foliar nutrition did not significantly influence fibre strength in cotton. The non-significant response of

micronaire indicated comparatively little influence of potassium treatments on fibre fineness under the prevailing conditions. Ratna Kumari *et al.* (2014) [14] reported no significant differences in fibre quality characters with foliar application of urea, DAP and KNO₃ along with RDF, whereas Shanmugam and Bhat (1991) [17] reported improvement in fibre fineness, fibre maturity and strength with adequate potassium concentration in cotton leaves.

Economics

The economic parameters differed with different potassium-management treatments. The higher cost of cultivation was recorded with T₅ (Rs. 90,540 ha⁻¹), while the lower cost was recorded in the control T₁₁ (Rs. 77,865.00 ha⁻¹).

T₁₀ recorded significantly higher gross returns of Rs. 2,35,952 ha⁻¹, followed by T₅ (Rs. 2,29,861 ha⁻¹) and T₄ (Rs. 2,27,008 ha⁻¹) which were found *on par* with each other. The control T₁₁ recorded the lower gross returns of Rs. 1,19,556 ha⁻¹ and T₁₀ recorded significantly higher net returns of Rs. 1,50,287 ha⁻¹, followed by T₄ (Rs. 1,39,418 ha⁻¹) and T₅ (Rs. 1,39,321 ha⁻¹), which were found *on par* with each other. Although T₅ recorded slightly higher gross returns than T₄, its higher cost of cultivation resulted in slightly lower net returns. The control treatment T₁₁ recorded the lowest net returns of Rs. 41,691 ha⁻¹ as shown in table 3 and figure 2.

Significantly higher BC ratio was recorded with T₁₀ (2.75), followed by T₄ (2.59) and T₅ (2.54), which were found *on par* with each other. Whereas control treatment *i.e* T₁₁ recorded lower BC ratio (1.54) as shown in table 3 and figure 2. The higher economic returns under T₁₀ were mainly associated with its higher seed cotton yield, while the favourable economic performance of T₄ and T₅ demonstrated the potential of supplementing reduced soil-applied potassium through foliar K₂SO₄. Similar improvement in economic returns through foliar potassium application was reported by Amarjeet *et al.* (2018) [1] and Hussain *et al.* (2020) [5].

Table 1: Mean of yield attributes and seed cotton yield of *Bt* cotton as influenced by potassium management through foliar nutrition

Treatment	Number of good opened bolls plant ⁻¹	Boll weight (g)	Seed cotton yield (g plant ⁻¹)	Seed cotton yield (kg ha ⁻¹)
T ₁ : Recommended NPK (kg ha ⁻¹) (100%)	21.3	5.74	138.3	2562
T ₂ : 75% recommended potassium + 1% K ₂ SO ₄ spray at 50 and 75 DAS	22.1	5.76	139.2	2578
T ₃ : 75% recommended potassium + 1% K ₂ SO ₄ spray at 50, 75 and 100 DAS	22.5	5.82	140.3	2598
T ₄ : 75% recommended potassium + 2% K ₂ SO ₄ spray at 50 and 75 DAS	26.8	5.93	159.0	2944
T ₅ : 75% recommended potassium + 2% K ₂ SO ₄ spray at 50, 75 and 100 DAS	27.0	5.96	161.0	2981
T ₆ : 50% recommended potassium + 1% K ₂ SO ₄ spray at 50 and 75 DAS	17.9	5.49	98.4	1822
T ₇ : 50% recommended potassium + 1% K ₂ SO ₄ spray at 50, 75 and 100 DAS	20.2	5.55	112.1	2076
T ₈ : 50% recommended potassium + 2% K ₂ SO ₄ spray at 50 and 75 DAS	20.6	5.57	114.9	2128
T ₉ : 50% recommended potassium + 2% K ₂ SO ₄ spray at 50, 75 and 100 DAS	21.0	5.61	125.4	2322
T ₁₀ : Recommended NPK (kg ha ⁻¹) (100%) + 1% KNO ₃ spray at 80 and 100 DAS (rec. practice)	27.5	6.00	165.3	3060
T ₁₁ : Control (Without potassium)	16.1	5.18	83.7	1551
S.E.m.±	1.2	0.05	7.1	131
C.D. at 5%	3.6	0.15	20.9	386

Note: Recommended N and P is common for all the treatments.

RDF-180:90:90 (N: P₂O₅: K₂O kg ha⁻¹)

KNO₃-Potassium nitrate

K₂SO₄-Potassium sulphate

Table 2: Effect of application of potassium through foliar nutrition on lint yield, ginning percentage, staple length, fibre strength and micronaire value of *Bt* cotton

Treatment	Lint yield (kg ha ⁻¹)	Ginning Percentage (%)	Staple length (mm)	Fibre strength (g tex ⁻¹)	Micronaire (Fibre fineness)
T ₁ : Recommended NPK (kg ha ⁻¹) (100%)	859	33.53	30.35	30.15	4.05
T ₂ : 75% recommended potassium + 1% K ₂ SO ₄ spray at 50 and 75 DAS	885	34.31	30.45	30.40	4.05
T ₃ : 75% recommended potassium + 1% K ₂ SO ₄ spray at 50, 75 and 100 DAS	923	35.55	30.50	30.55	4.05
T ₄ : 75% recommended potassium + 2% K ₂ SO ₄ spray at 50 and 75 DAS	1079	36.64	30.55	30.55	4.05
T ₅ : 75% recommended potassium + 2% K ₂ SO ₄ spray at 50, 75 and 100 DAS	1098	36.83	30.65	30.65	4.10
T ₆ : 50% recommended potassium + 1% K ₂ SO ₄ spray at 50 and 75 DAS	558	30.65	29.40	29.60	3.75
T ₇ : 50% recommended potassium + 1% K ₂ SO ₄ spray at 50, 75 and 100 DAS	656	31.58	29.85	29.90	3.80
T ₈ : 50% recommended potassium + 2% K ₂ SO ₄ spray at 50 and 75 DAS	675	31.74	30.00	29.80	3.90
T ₉ : 50% recommended potassium + 2% K ₂ SO ₄ spray at 50, 75 and 100 DAS	775	33.38	30.30	30.10	4.00
T ₁₀ : Recommended NPK (kg ha ⁻¹) (100%) + 1% KNO ₃ spray at 80 and 100 DAS (rec. practice)	1145	37.43	30.70	31.05	4.20
T ₁₁ : Control (Without potassium)	468	30.15	29.80	29.45	3.55
S.E.m.±	42	0.50	0.45	0.45	0.26
C.D. at 5%	125	1.48	NS	NS	NS

Note: Recommended N and P is common for all the treatments.

RDF-180:90:90 (N: P₂O₅: K₂O kg ha⁻¹)

KNO₃-Potassium nitrate

K₂SO₄-Potassium sulphate

Table 3: Effect of application of potassium through foliar nutrition on cost of cultivation, gross returns, net returns and benefit cost ratio of *Bt* cotton

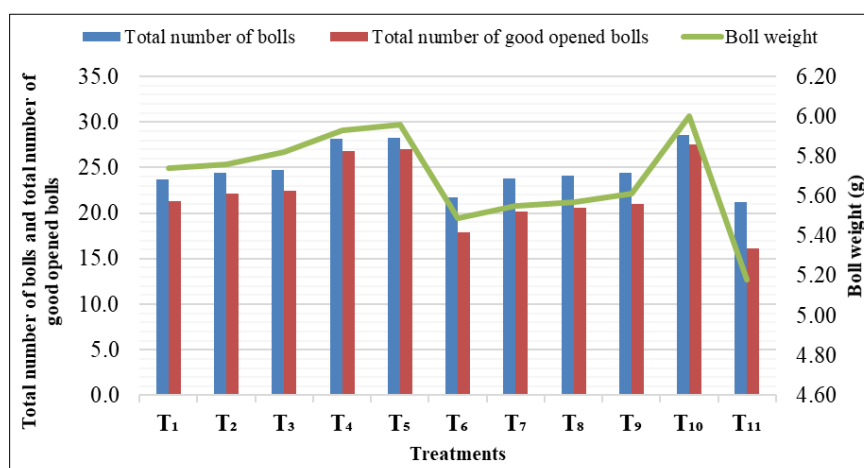
Treatment	Cost of cultivation (Rs. ha ⁻¹)	Gross returns (Rs. ha ⁻¹)	Net returns (Rs. ha ⁻¹)	BC ratio
T ₁ : Recommended NPK (kg ha ⁻¹) (100%)	82965	197505	114540	2.38
T ₂ : 75% recommended potassium + 1% K ₂ SO ₄ spray at 50 and 75 DAS	85090	198790	113700	2.34
T ₃ : 75% recommended potassium + 1% K ₂ SO ₄ spray at 50, 75 and 100 DAS	86790	200280	113490	2.31
T ₄ : 75% recommended potassium + 2% K ₂ SO ₄ spray at 50 and 75 DAS	87590	227008	139418	2.59
T ₅ : 75% recommended potassium + 2% K ₂ SO ₄ spray at 50, 75 and 100 DAS	90540	229861	139321	2.54
T ₆ : 50% recommended potassium + 1% K ₂ SO ₄ spray at 50 and 75 DAS	83815	140476	56661	1.68
T ₇ : 50% recommended potassium + 1% K ₂ SO ₄ spray at 50, 75 and 100 DAS	85515	160111	74596	1.87
T ₈ : 50% recommended potassium + 2% K ₂ SO ₄ spray at 50 and 75 DAS	86315	164069	77754	1.90
T ₉ : 50% recommended potassium + 2% K ₂ SO ₄ spray at 50, 75 and 100 DAS	89265	179026	89761	2.01
T ₁₀ : Recommended NPK (kg ha ⁻¹) (100%) + 1% KNO ₃ spray at 80 and 100 DAS (rec. practice)	85665	235952	150287	2.75
T ₁₁ : Control (Without potassium)	77865	119556	41691	1.54
S.E.m.±	-	10097	10097	0.12
C.D. at 5%	-	29786	29786	0.36

Note: Recommended N and P is common for all the treatments.

RDF-180:90:90 (N: P₂O₅: K₂O kg ha⁻¹)

KNO₃-Potassium nitrate

K₂SO₄-Potassium sulphate

**Fig 1:** Total number of bolls per plant, total number of good opened bolls per plant and boll weight of *Bt* cotton as influenced by application of potassium through foliar nutrition

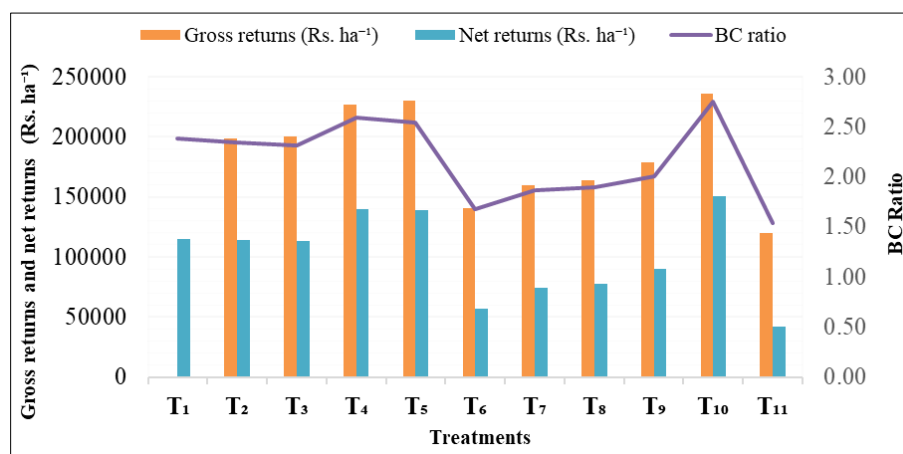


Fig 2: Gross returns, net returns and BC ratio of Bt cotton as influenced by application of potassium through foliar nutrition

Conclusion

The application of 100 per cent recommended NPK + 1 per cent KNO₃ spray at 80 and 100 DAS (T₁₀) recorded significantly higher yield attributes, seed cotton yield, lint yield and economic returns and was superior to the other treatments. It recorded 3060 kg ha⁻¹ seed cotton yield, 1145 kg ha⁻¹ lint yield, Rs. 2,35,952 ha⁻¹ gross returns, Rs. 1,50,287 ha⁻¹ net returns and BC ratio of 2.75. The treatments receiving 75 per cent recommended potassium supplemented with 2 per cent K₂SO₄ spray at 50 and 75 DAS (T₄) and 50,75 and 100 DAS (T₅) also performed well and were comparable with T₁₀ for major yield and economic parameters and T₄ may potentially substitute to reduce 25% of soil applied potassium.

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