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Yield and fiber qualities of hybrid cotton (*Gossypium hirsutum*) as influenced by soil and foliar application of potassium

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Abstract : Field experiments were carried out on medium black soils at Agricultural Research Station, Dharwad during 2004-05 and 2005-06 under rainfed conditions to study the effect of soil and foliar application of potassium on seed cotton yield (SCY) and fibre qualities of cotton. Potassium applied as basal dose @ 40 kg/ha along with recommended nitrogen (80 kg/ha), phosphorus (40 kg/ha) and foliar potassium sprays each at early and peak boll formation stage with 1.0 % Muriate of Potash (MOP) resulted in higher SCY. Treatment with RDF + Foliar sprays with 1.0 % MOP each at early (90 DAS) and peak boll formation stage (110 DAS) recorded higher SCY of 1806 kg/ha which was significantly higher over without potassium application (1482 kg/ha). Higher net returns (Rs.19,960/ha) and B:C ratio (2.24) were obtained with RDF + twice K foliar sprays each at early and peak boll formation stage as compared to the application of N P (Rs.13,960/ha) and RDF only (Rs.17,780/ha). Higher K accumulation in different plant parts of cotton and higher K uptake was found in K applied treatments. Influence of potassium on fiber length, uniformity ratio, micronaire value was found non significant but fibre tenacity was influenced significantly. Higher fiber tenacity of 23.4 g/tex was recorded with RDF + K foliar sprays each at early (90 DAS) and peak boll formation stage (110 DAS) as compared to the treatment without potassium (22.2 g/tex) during 2005-06.

Key words: Cotton, potassium, foliar nutrition, fibre quality

Introduction

Cotton is an important commercial crop extensively grown in India and Karnataka. India has the largest acreage (10.5 m.ha) under cotton and ranks second in production (310 lakh bales) after China. India ranks second in cotton productivity (553 kg lint/ha) as against a world average of 733 kg lint/ha (Choudhary and Gaur, 2009). Cotton is grown in an area of 3.71 lakh hectares in Karnataka, with an average productivity is 367 kg lint/ha (Anon., 2009). Potassium is a major nutrient for cotton apart from nitrogen and phosphorus. Cotton crop removes 75 kg of potassium from the soil to produce one tonne of seed cotton, but the quantity of potassium applied to the crop is less than its removal, resulting in mining of potassium from the soil (www.ipni.net). Adequate potassium in the soil is essential to optimize seed cotton yield, quality and net profit in cotton production. Even mid to late season foliar nutrition of potassium to cotton under rainfed condition can increase yield, as the uptake of potassium from soil slows down beyond 120 days. In view of this, a field study was undertaken to study the effect of soil and foliar application of potassium with recommended dose of nitrogen and phosphorus on seed cotton yield and fibre qualities.

Material and methods

Field studies were carried out at Agricultural Research Station, Dharwad Farm under rainfed conditions during 2004-05 and 2005-06 to study the effect of soil and foliar application potassium on yield and quality of intra hirsutum hybrid cotton. The location falls under transition region having an average annual rainfall of 755 mm and majority of the rainfall is received from July to September. The total rainfall received during the crop season was 850 mm and 900 mm during 2004-05 and 2005-06 respectively. The soil of the experimental site belonged to vertisols having montmorillonite as dominant clay. The soil was medium deep black having neutral pH (7.2) with medium available N (280 kg/ha) and P_2O_5 (21.2 kg/ha), while the available K_2O was in high range (545 kg/ha).Promising cotton hybrid DHH-11 was sown at a spacing of 90x30 cm. The experiment consisted of five treatments viz., T_1- N P only; T_2 - N P K (RDF); T_3 - NPK + K-Foliar spray with 1% MOP at early boll formation (90 DAS) ; T_4 - NPK + K- foliar sprays with 1% MOP at peak boll formation (110 DAS) and T_5 - NPK + twice K- foliar sprays with 1% MOP each at early (90 DAS) and peak boll formation stage (110 DAS). The experiment was laid out in a randomized complete block design with four replications. Entire recommended dose of phosphorous and potassium along with 50 per cent N was band placed at sowing as basal dose followed by top dressing of remaining 50 per cent N at 50 DAS. Muriate of potash (MOP) was used for the foliar sprays and the sprays were given by using knapsack sprayer with a spray volume of 500 l/ha. Water spray was taken in the treatments without foliar potassium application. Recommended crop management practices including plant protection remained common to all the treatments. Plant samples were collected from each plot at peak boll bursting stage and separated in to leaf, stem, bur and seed, oven dried at 60 °C and powdered to pass through a 0.5 mm sieve. Potassium content in the plant samples was assessed on a flame photometer. Seed cotton from each treatment plot (300g)was ginned for working out ginning out turn (GOT) and the lint was analysed for its fiber qualities by High Volume Instrument (CIRCOT, Sub-Center at ARS, Dharwad).

Results and discussion

Results of the study revealed that soil and foliar application of K had significant effect on number of monopodia and sympodia per plant, total number of bolls per plant and boll weight (Table1).

Table 1. Effect of soil and foliar application of potassium on growth and yield parameters of cotton

Treatments	No. of monopodia/plant		No. of sympodia/plant		Number of bolls/plant			Boll weight (g)		
	04-05	05-06	04-05	05-06	04-05	05-06	Pooled	04-05	05-06	Pooled
T_1 - N P only (No K)	1.5	1.4	17.1	19.3	18.0	12.5	15.3	4.9	4.6	4.75
T_2 - N P K (RDF)*	2.2	2.2	19.2	21.9	19.2	15.8	17.5	4.8	5.2	5.03
T_3 - N P K + K-foliar spray at early boll formation	1.7	2.1	18.4	22.5	21.7	15.9	18.8	5.2	5.4	5.30
T_4 - N P K + K-foliar spray at peak boll formation	1.8	2.4	19.6	23.0	21.6	15.9	18.8	5.3	5.4	5.35
T_5 - N P K + K- twice foliar sprays each at early and peak boll formation	1.9	2.6	19.2	23.9	21.7	19.5	20.6	5.4	5.6	5.48
S Em$\pm$	0.15	0.24	0.76	0.61	0.66	0.89	0.57	0.2	0.13	0.10
CD at 5 %	0.47	0.73	NS	1.87	2.0	2.8	1.75	NS	0.4	0.32

*NPK (Recommended dose of fertilizer): 80:40:40 N, P, K kg/ha NS: Non significant

Higher number of bolls (20.6) were produced with NPK + twice foliar sprays of potassium each at early and peak boll formation stages (T5) as compared to treatment with only N and P (15.3) and NPK (17.5) Similar trend was also seen in individual year. Potassium application had a significant effect on single boll weight with a maximum of 5.5 g in the treatment NPK + twice foliar sprays of potassium at early and peak boll formation stages (T5) as against 4.8 g in the treatment with N and P only (T_1), followed by NPK (5 g). More number of bolls per plant and higher boll weight in the treatment NPK + foliar K sprays might have contributed to higher yields. Potassium requirement of developing bolls is higher as bolls are the highest sinks of potassium (Oosterhuis, 2002). The results are in line with the earlier research findings (Abaye, 1998). Increase in boll number and boll weight with the application of potassium was reported under loamy soil in Punjab (Brar and Brar, 2004) Pooled data revealed that application of potassium along with N and P had significant effect on seed cotton yield (SCY) and economics of cotton (Table 2). Potassium, either soil application or both soil and foliar applications resulted in significantly higher seed cotton yield (SCY) over the soil application of N and P alone. Significantly highest SCY of 1806 kg/ha was obtained with RDF + twice foliar sprays of potassium each at early (90 DAS) and peak boll formation stages (110 DAS) (T_5) as against the application of only N and P (1482 kg/ha) (T1), but remained on par with RDF soil applied (1689 kg/ha), and with NPK + foliar spray of potassium at early boll formation (1717 kg/ha) and RDF + foliar spray of potassium at peak boll formation stage (1775 kg/ha). Significantly lowest SCY was recorded with the treatment (T1) without potassium application (1482 kg/ha).The trend was similar in individual year of experimentation (Table 2). Donald and Owen (1998) also reported higher seed cotton yield with potassium foliar sprays. Higher seed cotton was reported with plots applied with either soil or foliar K as compared to the plots applied with N and P alone (Blaise *et al.,* 2009). Higher SCY in RDF and RDF with foliar sprays of potassium was due to higher number of bolls per plant and boll weight. As uptake of K in cotton plant slows down beyond 120 days due to moisture stress in the soil, foliar applied K might have met the crop need resulting in higher SCY. Response to application of K (RDF)and RDF with twice foliar sprays over application of N and P alone was 21.9 per cent and 5.2 per cent respectively. Soil and foliar application of potassium revealed a higher net returns and B:C ratio of ` 19,960/ha and 2.24 respectively with NPK + twice foliar sprays of potassium each at early and peak boll formation stages ($T_5$) as compared to the application of N and P alone (`.13,960/ha) and NPK (`.17,780/ha)

Table 2. Effect of soil and foliar application of potassium on seed cotton yield and economics.

Treatments	Seed cotton yield (kg/ha)			Economics (Pooled)		
	04-05	05-06	Pooled	Gross returns (` /ha)	Net returns (` /ha)	B: C ratio
T_1 - N P only (No K)	1785	1173	1482	29,640	13,960	1.87
T_2 - N P K (RDF)*	1912	1460	1689	33,780	17,780	2.11
T_3 - N P K + K-foliar spray at early boll formation	2000	1429	1717	34,340	18,240	2.13
T_4 - N P K + K-foliar spray at peak boll formation	2063	1482	1775	35,500	19,400	2.20
T_5 - N P K + K- twice foliar sprays each at early and peak boll formation	2055	1552	1806	36,120	19,960	2.24
S Em$\pm$	60.4	72.5	46.3	-	-	-
CD at 5 %	186	223	143	-	-	-

*NPK (Recommended dose of fertilizer): 80:40:40 N, P, K kg/ha NS: Non significant

Table 3. Total dry matter, potassium content in plant parts of cotton and uptake as influenced by soil and foliar application of potassium

Treatments	Total dry matter (g/plant)	Potassium content (%) Leaf	Stem	Bur	Seed	Average K content in whole plant	Potassium uptake (kg/ha)
T_1 - N P only (No K)	152.7	1.57	1.40	2.70	1.30	1.74	98.5
T_2 - N P K (RDF)*	187.5	1.78	1.65	3.20	1.35	1.99	138.2
T_3 - N P K + K-foliar spray at early boll formation	198.1	1.90	1.30	3.80	1.40	2.10	154.0
T_4 - N P K + K-foliar spray at peak boll formation	196.6	1.85	2.00	3.20	1.40	2.11	153.6
T_5 - N P K + K- twice foliar sprays each at early and peak boll formation	215.3	1.90	1.70	3.50	1.40	2.13	169.8
Mean	190.0	1.80	1.61	3.28	1.37	2.01	142.8

*NPK (Recommended dose of fertilizer): 80:40:40 N, P, K kg/ha

Potassium application had significant effect on production of total dry matter at harvest. Average higher total dry matter of 215 g/plant was obtained with RDF + twice foliar sprays of potassium with 1.0 per cent MOP each at early and peak boll formation stages (T_5) as compared to the treatment with only N and P (152.7 g/plant). Treatments with application of potassium (K) either soil or both soil and foliar, recorded higher K content in leaf, stem, bur and seed as compared to the treatments with out application of potassium (T_1). The highest average K content in whole plant was 2.13% in the treatment of RDF + K- twice K foliar sprays and the lowest K content was in the recommended N, P only (1.74%) (Table 3). Brar and Brar (2004) earlier reported an increase in K concentration of cotton plant parts with the application of potassium. The average potassium uptake was higher (169.8 kg/ha) with RDF + twice foliar sprays of potassium with 1.0 per cent MOP each at early and peak boll formation stages (T_5) as compared to the treatment with only N and P (98.5 kg/ha). Blaise *et al.*(2009) reported significantly higher K uptake in K applied plots than the plots applied with no K.

Soil and foliar application of potassium had significant effect on ginning out turn (GOT). Pooled data indicated that higher GOT of 39.4 per cent was possible with treatment of NPK + twice foliar sprays of potassium each at early and peak boll formation stages (T_5) followed by NPK (38.2%) and least GOT was recorded with N and P alone (37.1 %). Effect of potassium on fiber quality parameters *viz.* fiber length, uniformity ratio, micronaire value was found to be non significant during both the years. Application of RDF + twice foliar sprays of K each at early and peak boll formation stage (T5) recorded higher fiber strength (23.4g/tex) as compared to the application of only N, P and no K (22.2 g/tex), NPK (22.5 g/tex) and NPK + once foliar spray of K at early or peak boll formation stage (22.2 and 22.4 g/tex) during 2005-06 (Table 4). Potassium has its role in fiber development and hence the foliar application of potassium at later stages of cotton crop might have helped in improving the fiber qualities of cotton. Shanmugham and Bhat (1991) reported the improvement of fiber length, uniformity ratio, fiber strength and fineness through foliar application of K at flowering. It was also found that limited supply of potassium during active fiber growth period may cause reduction in the turgor pressure of the fiber, resulting in less cell elongation and shorter fibers at maturity (Oosterhuis, 1994).

Based on the two years study it can be concluded that basal soil application of potassium (40 kg/ha) with recommended N and P (80 & 40 kg/ha) is essential for higher seed cotton yield

Table 4. Effect of soil and foliar application of potassium on quality parameters of cotton

Treatments	GOT (%) 04-05	05-06	Pooled	Quality parameters 2004-05 2.5 % SL (mm)	UR %	Micronaire value	Tenacity (g/tex)	2005-06 2.5 % SL (mm)	UR %	Micronaire value	Tenacity (g/tex)
T_1 - N P only (No K)	38.8	35.3	37.1	28.9	49.0	3.7	22.4	28.50	49.0	4.2	22.2
T_2 - N P K (RDF)*	38.5	37.9	38.2	28.3	48.5	3.6	22.7	28.28	48.8	4.3	22.5
T_3 - N P K + K-foliar spray at early boll formation	39.5	38.9	39.2	28.6	49.5	3.7	22.7	28.2	49.0	4.3	22.2
T_4 - N P K + K-foliar spray at peak boll formation	38.9	39.4	39.1	28.3	48.5	3.7	22.5	28.4	48.3	4.5	22.4
T_5 - N P K + K- twice foliar sprays each at early and peak boll formation	39.3	39.4	39.4	28.3	49.3	3.8	23.2	28.7	49.8	4.3	23.4
S Em±	3.9	0.7	0.48	0.4	0.5	0.06	0.35	0.37	0.35	0.08	0.26
CD at 5 %	NS	2.2	1.4	NS	NS	NS	NS	NS	NS	NS	0.8

*NPK (Recommended dose of fertilizer): 80:40:40 N, P, K kg/ha NS: Non significant and better quality fiber. Further, application of recommended N, P, K (80:40:40 kg/ha) + twice foliar sprays of K with 1 % MOP each at early (90 DAS) and peak boll formation stage (110 DAS) can increase seed cotton yield and net returns with marginal improvement in fiber qualities.

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