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Response of cotton (*Gossypium hirsutum*) to split application of major nutrients

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ABSTRACT

A field experiment was carried out during the summer season of 2000 and 2001, to evaluate the response of summer irrigated cotton (*Gossypium hirsutum* L.) to time of application of nitrogen, phosphorus and potassium. The total dry-matter production at peak flowering stage and boll-bursting stage and seed-cotton yield were higher with the application of recommended level of fertilizers (60, 30 and 30 kg N, P and K/ha) by skipping basal and applying the same in 2 splits at 45 and 60 days after sowing. Extending nutrient application up to 60 days after sowing resulted in increased uptake of nutrients at peak flowering and boll-bursting stage of cotton.

Key words : Cotton, Major nutrients, Split application

In summer irrigated and rice fallow tracts of Tamil Nadu, cotton is sown in the stubbles of rice without land preparation. Under such conditions, application of basal fertilizers is not feasible. Besides, cotton being a slow-growing crop, the applied basal fertilizers, mostly nitrogen, is lost through volatilization and leaching. Oosterhavis *et al.* (1983) reported that inorganic N applied at sowing had little effect on plant N. Hence the present investigation was carried out to study the response of cotton to split application of nutrients, with more emphasis on skipping basal and applying the same as top-dressing.

MATERIALS AND METHODS

The field experiment was carried out at Cotton Research Station, Srivilliputtur, Tamil Nadu, during the summer seasons of 2000 and 2001. The experiment was laid out in randomized complete block design with 4 replications. The experimental field was clay loam with pH 8.2. The soil was medium in available N and P and high in available K (281, 15 and 132 kg N, P and K/ha in 2000; and 284, 13 and 134 kg N, P and K/ha in 2001). The test variety was 'SVPR 2'. The crop was raised with a spacing of 75 cm × 30 cm sown on 15 February during both the years. Need-based plant-protection measures were carried out. The treatments included : T_1, application of recommended dose (RD) of fertilizers (60, 30 and 30 kg N, P and K/ha) by applying 50% N + 100% P and K basal and 50% N at 45 days after sowing (DAS) : T_2, application of 100% P and K basal and N in 2 equal splits at 45 and 60 DAS; T_3, application of 100% P basal and N and K in 2 splits at 45 and 60 DAS; T_4, application of 100% N, P and K by skipping basal and applying the same in 2 splits at 45 and 60 DAS; T_5, application of 75% recommended dose of fertilizers as applied in T_2; T_6 application of 75% RD of fertilizers as applied in T_3; and T_7 and application of 75% RD of fertilizers as applied in T_4.

RESULTS AND DISCUSSION

Dry-matter production

Application of recommended level of fertilizers by skipping basal and applying all the nutrients in 2 splits at 45 and 60 DAS (T_4) registered the highest dry-matter production of cotton at peak flowering stage which was comparable with T_2 and T_3 (Table 1). The results indicated the advantage of splitting N by skipping basal application. Application of N at 45 DAS might have been congenial to meet the peak requirement of cotton. The conventional method (T_1) might have failed to supply the required nutrients since the major portion of the applied N might have been lost through leaching and volatilization (Krishnan and Christopher Lourdhuraj, 1997).

At boll-bursting stage, treatment T_4 registered the highest dry-matter production of cotton and was comparable with those treatments involving top-dressing of potassium along with N. Application of K along with N might have helped in better uptake of nutrients thereby increasing the dry-matter production of cotton. Besides, K application in later stages might have helped in better NK balance in plant system ultimately resulting in better boll retention and bursting.

Growth and yield

There was no significant difference in plant height and monopodia/plant due to various treatments. Application of recommended dose of fertilizers by skipping basal and applying the same in 2 splits on 45 and 60 DAS (T_4) registered the highest number of sympodia/plant and was comparable with most of the treatments involving 2 splits at 45 and 60 DAS. Cotton being an indeterminate crop with long duration, application of fertilizers in later stages might have helped in inducing more number of sympodia despite the reduced level of fertilization in treatments T_5 and T_7.

The mean boll weight was the highest under treatment T_4 and was comparable with that under T_2. The increased boll weight was possible due to higher phosphate content in cotton throughout the boll-development stage (Dastur, 1959). The highest seed-cotton yield of 2,014 kg/ha was recorded in treatment T_4 and was on par with T_2, T_3 and T_7 (Table 1). The yield response was due to the cumulative effect of higher number of bolls/plant, boll weight and continued availability of nutrients in these treatments, ultimately helped in better boll retention and development.

Economic analysis of the returns/rupee invested on total variable cost revealed that skipping basal and applying the same in 2 splits on 45 and 60 DAS was advantageous with the highest benefit : cost ratio of 2.96. Reducing the level of fertilizers resulted in lesser benefit : cost ratio.

Nutrient uptake by cotton

The uptake of N by cotton was significantly higher with the application of recommended dose of fertilizers by skipping basal and applying the same in 2 splits at 45 and 60 DAS and was comparable with T_2 and T_3 at peak flowering and boll-bursting stage of cotton (Table 2). Top-dressing of N by skipping basal application coincides with the peak demand for nutrients, facilitating increased

Table 1. Effect of split application of NPK on dry-matter production, growth and yield of cotton (pooled mean of 2 seasons)

Treatment	Dry-matter production (kg/ha)				Plant height (cm)	Mono-podia/ plant	Sym-podia/ plant	Bolls/ plant	Boll weight (g)	Seed-cotton yield (kg/ha)	Benefit: cost ratio
	2000		2001								
	PF	BBS	PF	BBS							
T_1	3,626	7,542	3,312	6,900	100.0	1.4	16.6	18.4	3.68	1,765	2.45
T_2	3,762	7,828	3,839	7,995	98.0	1.3	15.9	20.3	3.80	1,943	2.47
T_3	3,692	7,678	3,928	8,180	98.0	1.4	16.5	21.0	3.54	1,951	2.44
T_4	3,872	8,048	3,997	8,340	94.1	1.3	17.9	23.1	3.82	2,014	2.96
T_5	3,766	7,841	3,242	6,762	93.8	1.2	16.4	20.0	3.58	1,780	2.42
T_6	3,665	7,625	3,460	7,208	94.3	1.2	16.0	20.0	3.56	1,815	2.40
T_7	3,639	7,572	3,685	7,675	93.3	1.3	16.6	20.1	3.64	1,872	2.38
CD (P=0.05)	180	387	485	722	NS	NS	1.4	2.2	0.12	151	

Details of treatments are given in text
PF, Peak flowering; BBS, boll-bursting stage; NS, non-significant

Table 2. Effect of split application of NPK on nutrient uptake of cotton (pooled mean for 2 seasons)

Treatment	N uptake (kg/ha)		P uptake (kg/ha)		K uptake (kg/ha)	
	PF	BBS	PF	BBS	PF	BBS
T_1	61.1	92.4	10.1	15.9	50.0	91.7
T_2	67.1	101.3	11.0	17.4	54.8	100.4
T_3	67.2	101.6	11.1	17.4	54.9	100.6
T_4	69.6	105.5	11.5	18.5	56.9	104.3
T_5	62.3	93.7	10.2	16.1	50.5	92.4
T_6	62.5	94.3	10.3	16.4	51.4	93.7
T_7	64.5	97.1	10.6	16.9	52.7	95.1
CD (P=0.05)	4.2	6.5	0.8	1.5	4.4	6.9

Details of treatments are given in text
PF, Peak flowering; BBS, boll-bursting stage

uptake at flowering and boll-bursting stage. Application of K along with N resulted in better N uptake due to the reduced fixation of NH_4^{++} due to K and thereby there was higher utilization of N in this form (Sen Gupta *et al.*, 1971).

The phosphorus content was the highest higher under treatment T_4 and was comparable with those treatments involving the application of recommended level of fertilizers. Significant reduction in P uptake was observed with the reduction in the fertilizer level by 25%, corroborating the findings of Mayilsamy and Iruthayaraj (1980). The split application of N and K might have increased the root activity of cotton at peak flowering and boll-bursting stage resulting in the increased P uptake.

Split application of N and K at recommended level of fertilizers resulted in increased uptake of potassium by cotton at peak flowering and boll-bursting stage. Skipping basal application and top-dressing N and K in 2 splits might have supplied adequate quantity of nutrients to coincide with the peak demand for nutrients to cotton. Besides, the external application of K might have increased the quantity of readily available K to cotton thus resulting in higher K uptake.

Thus application of recommended level of fertilizers by skipping basal and applying the same in 2 splits at 45 and 60 DAS was advantageous to cotton in supplying the required quantity of nutrients during the peak demand for nutrients at peak flowering and boll-bursting stage of cotton ultimately resulting in higher seed-cotton yield.

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