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Original Research Article

Effect of Split Application of Fertilizers on Growth, Yield and Economics of *Bt* Cotton Hybrid under Rainfed Condition

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Keywords

Bt cotton, Split application of fertilizers, Nitrogen, Potassium, Seed cotton yield

A B S T R A C T

A field experiment was carried out to study the effect of split application of fertilizers on growth, yield and economics of *Bt* cotton under rainfed condition at Cotton Research Station, Nanded, Maharashtra during the *kharif* season of 2009-11. The results indicated that split application of K_2O (50% as basal + 50% 4 WAS) was significantly superior over 100% basal application of K_2O. However, 100% K_2O as basal was equally profitable as its splitting in terms of NMR and B: C ratio. Four splits of nitrogen (20% as basal + 30% at 4 WAS + 30% at 8 WAS + 20% at 4 WAS) was resulted 13.02 per cent higher seed cotton yield (2075 kg ha^{-1}) and it was found significantly superior over two splits of nitrogen. Splitting of nitrogen has improved boll weight with increase in number of bolls $plant^{-1}$, gross and net monetary returns. Application of Nitrogen in three splits (40% as basal + 30% at 4 WAS + 30% at 8 WAS) was found to be remunerative in terms of B: C ratio over two splits of nitrogen.

Introduction

There is tremendous change observed in area, production and productivity of cotton after the introduction of *Bt* technology in India. Various agronomic parameters are responsible for low yield in India among which inappropriate fertilizer management is major one. The nutrient management in *Bt* cotton is big challenge to enhance production and productivity as cotton growing soils are losing their fertility level due to depletion of nutrients from the soil (Blaise and Prasad, 2005). The optimum requirement of NPK nutrients for achieving the maximum yield of *Bt* cotton varies from location to location in consideration with soil moisture, temperature, cropping pattern followed by crop cultivars. For timely and judiciously supply of nutrients to the *Bt* cotton crop, split application of nutrients get importance. Nitrogen is the nutrient, which is easily lost in soil under various processes. Need for potassium increases in reproductive stage and especially as bolls are sinks for fibre elongation. Hence, there is need to enhance nitrogen and potassium use efficiency from the applied fertilizers. Split application is likely to be one of the best ways to enhance the nutrient use efficiency in cotton crop. As N requirement is more and losses of N are higher and cause of potential to environment pollutant. Nitrogen and potassium uptake efficiency was increased when were applied in splits (Bhati and Manpreet, 2015). Inappropriate application delays cotton maturity (Rochester *et al.,* 2001). To optimize the best time of fertilizer application for getting higher seed cotton yield, it is necessary to split the optimum dose. Hence, the current study was carried out to determine effect of nitrogen and potassium fertilizer split application timing and proportion on seed cotton yield and its economics.

Materials and Methods

An experiment was conducted for three years during *kharif* season of 2009, 2010 and 2011 at Cotton Research Station, Nanded (Maharashtra). The experimental site soil was vertisol with pH range in 8.11 to 8.21.

Experiment was conducted in Randomized Block Design with factorial concept. Two factors *viz.*, splits of K_2O – two levels (K_1 - 100% K_2O as basal; and K_2 - 50% K_2O at sowing + 50 % K_2O at 4 WAS) and splits of Nitrogen - three levels (N_1 - 50% N as basal + 50% N at 4 WAS; N_2 - 40% N as basal + 30% N at 4 WAS + 30% N at 8 WAS; and N_3 - 20% N as basal + 30% N at 4 WAS + 30 % N at 8 WAS + 20% N at 10 WAS) were evaluated in four replications. Intra *hirsutum Bt* cotton hybrid Bunny was sown with spacing of 90 x 60 cm after receipt of sufficient monsoon rains.

The soil of experimental fields was low in N, average on P_2O_5 and high in K_2O content. Recommended dose of fertilizers *i.e.* 120:60:60 NPK kg ha^{-1} was applied to *Bt* Cotton. Full dose of P_2O_5 was applied as basal and splitting of N and K_2O were done as per treatment schedule. Plant protection measures were adopted for management of sucking pests. Data pertaining to plant growth and yield attributes were recorded from randomly selected five plants. Seed cotton yield per ha was recorded from net plot. Data were statistically analyzed by standard procedure of Panse and Sukhatme (1967).

Results and Discussion

Effect on plant growth and yield

The plant height of cotton was found to increased significantly due to splitting of K_2O at basal and 4 weeks after sowing (WAS). Number of monopodial and sympodial branches remained unaltered due to potassium splits. The splitting nitrogen at four stages (N_3) recorded significantly higher number of monopodial branches over two splits only. On pooled mean basis, numbers of bolls $plant^{-1}$ were found increased significantly due to two splits of K_2O over basal application (Table 1). However, boll weight was not influenced due to potassium splits. Increase in boll number $plant^{-1}$ (36.71) in two splits of K_2O depicted to significant increase in yield $plant^{-1}$ (113.07 g) and seed cotton yield (2013 kg ha^{-1}). Higher yields along with biomass and improved nutrients uptake with application of potassium at ploughing and square formation were reported by Khalifa (2012).

Application of nitrogen in four splits (basal, at 4, 8 and 10 WAS) treatment recorded significantly taller plants than two splits (Table 1). Four splits of N recorded highest number bolls $plant^{-1}$ (37.29) and boll weight (3.38 g) and were significantly higher than two splits (zonal recommendation for rainfed cotton) and were at par with three splits. The boll weight differences observed in N split application treatments might be due to higher availability of N at boll development stages which increased the boll weight. Hallikeri *et al.,* (2010) reported that three splits of N significantly increased boll weight in cotton.

Table.1 Plant growth, yield contributing characters and seed cotton yield (pooled mean) as influenced by split application of nitrogen and potassium

Treatment	Plant height (cm)	Mono podia plant^{-1}	Symp odia plant^{-1}	Yield plant^{-1} (g)	Bolls plant^{-1}	Boll weight (g)	Seed cotton yield (Kg/ha)			
							Year I	Year II	Year III	Pooled mean
A) Potassium splits										
K_1: 100 % Basal	114.46	1.82	21.77	105.85	34.43	3.11	2164	2022	1605	1930
K_2: 50 % Basal + 50 % 4 WAS	116.77	2.00	21.88	113.07	36.71	3.24	2262	2097	1681	2013
S.E.$\pm$	1.36	0.05	0.79	1.65	0.71	0.05	58.67	49.24	27.85	16.51
C.D. at 5 %	3.76	N.S.	N.S.	4.58	1.97	N.S.	N.S.	N.S.	N.S.	51.96
B) Nitrogen splits										
N_1: 50 % Basal + 50 % 4 WAS	113.72	1.73	21.35	98.47	33.40	2.94	2081	1884	1542	1836
N_2: 40 % as basal + 30 % 4 WAS + 30 % 8 WAS + 30 % 8 WAS	115.90	1.89	21.28	111.44	36.03	3.20	2245	2096	1671	2004
N_3: 20 % as basal + 30 % 4 WAS + 30 % 8 WAS + 20 % 10 WAS	117.22	2.12	22.85	118.46	37.29	3.38	2312	2198	1715	2075
S.E.$\pm$	1.66	0.06	0.34	2.02	0.87	0.06	71.85	60.31	34.11	20.23
C.D. at 5 %	N.S.	0.17	N.S.	5.61	2.42	0.19	216.21	181.48	102.65	63.63
Interaction K X N splits										
S.E.$\pm$	2.35	0.08	0.49	2.86	1.23	0.09	101.62	85.29	48.24	28.60
C.D. at 5 %	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Grand mean	115.61	1.91	21.82	109.46	35.57	3.17	2213	2060	1643	1972
C.V. (%)	7.05	16.15	7.85	9.07	12.04	10.67	9.18	8.28	7.87	7.64

Table.2 Economics as influenced by split application of fertilizers

Treatment	GMR (Rs./ha)				NMR (Rs./ha)				B:C ratio			
	Year I	**Year II**	**Year III**	**Pooled Mean**	**Year I**	**Year II**	**Year III**	**Pooled Mean**	**Year I**	**Year II**	**Year III**	**Pooled Mean**
A) Potassium												
K_1: 100 % Basal	64920	77772	58314	67002	37990	42675	25794	35481	2.41	2.21	1.79	2.14
K_2: 50 % Basal + 50 % 4 WAS	67875	80660	61071	69869	40945	45338	28322	38203	2.51	2.28	1.86	2.22
S.E.±	1760	1894	1011	674	1760	1746	928	584	0.06	0.04	0.03	0.03
C.D. at 5 %	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
B) Nitrogen												
N_1: 50 % Basal + 50 % 4 WAS	62449	72478	56049	63659	36269	38793	24482	33176	2.38	2.15	1.78	2.10
N_2: 40 % as basal + 30 % 4 WAS + 30 % 8 WAS	67372	80631	60706	69570	40442	45311	27955	37903	2.50	2.28	1.85	2.21
N_3: 20 % as basal + 30 % 4 WAS + 30 % 8 WAS + 20 % 10 WAS	69371	84540	62322	72078	41691	47915	28737	39448	2.50	2.31	1.85	2.22
S.E.±	2155	2319	1239	825	2155	2138	1137	715	0.08	0.05	0.03	0.03
C.D. at 5 %	6486	6979	3728	2595	N.S.	6435	3420	2249	N.S.	N.S.	N.S.	N.S.
Interaction K X N splits												
S.E.±	3048	3280	1752	1166	3048	3024	1607	1011	0.14	0.07	0.04	0.05
C.D. at 5 %	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Grand mean	66398	79216	59693	68436	39468	44006	27058	36842	2.46	2.24	1.83	2.18
C.V. (%)	9.18	8.28	5.87	8.11	15.44	13.74	11.88	13.78	9.30	6.80	5.10	7.14

More number of fruiting bodies with splitting of nitrogen has resulted in more number of bolls plant^{-1} ultimately resulting into higher seed cotton yield. These results are in close conformity with Deepa and Aladakatti (2016). Nitrogen splitting resulted in significant increase in seed cotton yield. Splitting of nitrogen in three splits (2004 kg ha^{-1}) and four splits (2075 kg ha^{-1}) recorded 9.15 per cent and 13.02 per cent increase in yield over two splits (1836 kg ha^{-1}) during all the years and on pooled analysis. The highest seed cotton yield with regard to split N applications seems due to higher number of boll and boll weight in that treatment. Tang *et al.,* (2011) reported similar results as highest biomass and yield was obtained when the N was applied in split doses at different growth stages of cotton crop. Sankat *et al.,* (2013) recorded that application of nitrogen in five splits at 30, 60, 75, 90 and 105 DAS increased significantly higher number of bolls per plant and seed cotton yield on black cotton soil. Anjum *et al.,* (2007) revealed that split application of N (25 % at sowing + 25 % as first irrigation + 50 % at flowering) increases leaf area index, number of branches plant^{-1} and bolls plant^{-1} to a significant level compared to lower splits.

Interaction effect of split application of K_2O and N were found non-significant for seed cotton yield during all the years and pooled mean basis.

Economics

The mean NMR of K_2O in two splits (₹ 38,203/- per ha) was 7.67 per cent more than 100 per cent K_2O as basal dose (Table 2). However, the differences in GMR and NMR due to split application of K_2O were non-significant during all the years of experimentation and on pooled mean basis. Four splits of nitrogen resulted in highest GMR (₹ 72,078/- ha^{-1}) and NMR (₹ 39,448/- ha^{-1}) during all the years and on pooled analysis. Three splits of nitrogen were found equally profitable in terms of NMR with four splits of N during all the years. Four splits and three splits of nitrogen was proved to be remunerative treatments for Bt cotton in regards of B: C ratio (2.22) during all the years under rainfed condition. Three and four splits of N recorded 14.25 per cent and 18.90 per cent additional NMR over two splits, respectively. Srinivasan (2003) reported higher B: C ratio with application of nitrogen in splits up to 60 DAS. Higher gross and net returns as well as B:C ratio were obtained with split application of nutrients to Bt cotton was reported by Bhalerao *et al.,* (2012).

Split application of Potassium was not found profitable over basal application in *Bt* cotton. Application of Nitrogen to *Bt* cotton in three splits (40 % as basal + 30 % 4 WAS + 30 % 8 WAS) was found to be most profitable in terms of yield and NMR over two splits of nitrogen.

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