International Journal of Agriculture Innovations and Research
Volume 2, Issue 5, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy) :
Received : 10/04/2014 | Accepted on : 29/04/2014 | Published : 03/05/2014

Growth, Yield and Quality of *Bt* Cotton (*G. Hirsutum*) as Influenced by Nitrogen Application under South Gujarat Condition

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Abstract – **A field experiment was conducted at Main Cotton Research Station, Surat with the object to study the effect of different levels, split and methods of application of nitrogen on growth, yield and quality of *Bt* cotton during *kharif* season of 2012-13. Results revealed that increasing level of nitrogen from 180 to 240 and further to 300 kg N ha^{-1} significantly increased seed cotton yield by 9.14 and 7.31%, respectively. Application of N with 5 and 6 splits were equally effective for production of seed cotton yield. Neem coated urea significantly produced 124 kg more seed cotton yield per hectare. In *Bt* cotton, nitrogen @ 240 kg ha^{-1} applied in 5 equal splits at 25 days intervals through neem coated urea recorded higher number of sympodial branches, number of bolls, boll weight, seed cotton and stalk yields as well as nitrogen use efficiency and economics as compared to other treatments. However, the quality of *Bt* cotton did not influence significantly due to nitrogen application.**

Keywords – ***Bt* Cotton, Neem Coated Urea, Nitrogen Levels, Split Application.**

I. Introduction

Cotton is a king of fiber crops due to its industrial importance, it is known as "*White Gold*". Nitrogen is most essential nutrient for plant growth needs to be supplied at proper time and appropriate quantity. *Bt* cotton differs in its requirement either by total or part of it in the different growth stages of crop. Thus, nitrogen use efficiency (NUE) can be increased and better use to attain higher production. Cotton is a long duration crop with an indeterminate growth habit. It provides long time nitrogen supplementation from square formation to boll development. Low efficiency of nitrogen applied to soil is a major problem to farmers especially in the context of increasing fertilizer prices. Nitrogen is subjected to leaching, denitrification and volatilization losses, which makes it unavailable to crop. Therefore, it is essential to introduce such fertilizer practices as would ensure maximum efficiency of applied nitrogen and these relate to placement, split application, appropriate rates and use of nitrification inhibitor for *Bt* cotton. Hence, critical stages of nitrogen requirement can be met with split application. Information on these aspects in *Bt* cotton is meager. Therefore, to standardize nitrogen level, it's scheduling and to find response of method of application is need of the hours.

II. Materials and Methods

The field experiment was carried out during 2012-13 at Main Cotton Research Station, Navsari Agricultural University, Surat, Gujarat (India). The soil was clayey in texture with slightly alkaline in reaction (pH 7.8), organic carbon 0.46% and EC 0.48 dSm^{-1}. The soil was low in available nitrogen (207 kg ha^{-1}) and medium in available phosphorus (49 kg ha^{-1}) but high in available potassium (528 kg ha^{-1}). The experiment was conducted in factorial randomize block design replicated three times on *Bt* cotton variety Guj. Cot. Hy.- 6 BG-II keeping a spacing of 120 cm x 45 cm. The experiment comprising three levels of nitrogen (180, 240 and 300 kg N ha^{-1}); three split application (4 splits at 30 days intervals, 5 splits at 25 days intervals and 6 splits at 20 days intervals) and two levels of nitrification inhibitors (neem coated urea and prilled urea). Cotton was sown in 1st week of July and 40 kg P_2O_5 applied as basal from Single Super Phosphate. In order to minimize weed competition, pre-emergence application of Pendimethalin @ 1.0 kg ha^{-1} followed by one hand weeding and two interculturing were done. The crop was irrigated at an interval of 20 days after cessation of rainfall. The observations related to growth and yields were recorded and subjected to statistical analysis. The fibre quality parameters were evaluated at Cotton Research Laboratory as HIV.

III. Results and Discussion

Growth attributes

Application of 300 kg N ha^{-1} significantly increased sympodial branches over 240 and 180 kg N ha^{-1} at harvest (Table 1). Nitrogen played its part in the exuberant vegetative growth of plant and increased sympodial branches per plant with levels of nitrogen application. Nitrogen levels also showed better response increased sympodial branches.

Number of sympodial branches was significantly affected due to splits application. Application of nitrogen in 6 splits recorded significantly higher number of sympodial branches (21.4) than other levels (Table 1). Cotton being an indeterminate plant with long duration, so application of nitrogen in splits might have helped in inducing more number of sympodial branches by timely supply of nitrogen in its growth period. Similarly, Anjum *et al.* (2007) observed increased in sympodial branches with increase split application of nitrogen.

Neem coated urea treatment exhibited significantly its superiority over prilled urea (Table 1). It might be due to slow release of nitrogen in soil, thereby plant uptake of nitrogen efficiently by cotton and fewer losses due to leaching and volatilization. These results are in accordance with those reported by Kumar *et al.* (2010).

Yield and yield attributes

Yield attributes of *Bt* cotton showed marked improvement with successive increase in nitrogen levels up to 300 kg N ha^{-1}, consequently highest seed cotton and stalk yields were recorded under 300 kg N ha^{-1} which was significantly higher over 180 kg N ha^{-1}, but it was remained at par with 240 kg N ha^{-1} (Table 1). Increased nitrogen level increased leaf photosynthetic rate, which might have resulted in higher accumulation of metabolites thus impacted number of bolls and boll weight and ultimately effect on yields. Significant increase in yield attributes and cotton yields with application of nitrogen up to 300 kg ha^{-1} was reported by Seilsepour and Rashidi (2011).

Application of nitrogen in 6 splits significantly increased most of yield attributing characters *viz.,* seed cotton and stalk yields over 4 splits, but it was at par with 5 splits (Table 1). These is due to maximum utilization of nitrogen, resulted in adequate food supply to sink and ultimately reflected on yield attributes and yields. The results of present investigation are in conforming to those of Hallikeri *et al.* (2010).

Significantly the highest number of bolls, boll weight and seed cotton as well as stalk yields were registered in neem coated urea (Table 1). These might be due to reduced losses of nitrogen by inhibiting the activities of nitrifying bacteria and slow release of nitrogen over prolonged periods, which helps to increase availability of nitrogen for developed vigorous growth of plant. Jain (1984) also reported similar results.

Quality parameters

The data indicated that application of 300 kg N ha^{-1} significantly increased the chlorophyll content in cotton leaves at 60 and 90 DAS, but it was at par with 240 kg N ha^{-1}(Table 1). The increase in chlorophyll content was ascribed to the fact that nitrogen is an important constituent of chlorophyll; increases in the levels of nitrogen may increase the availability of nitrogen and its concentration in leaves, which increase the chlorophyll content in leaves.

Application of nitrogen in 6 splits recorded significantly higher chlorophyll content of 35.3 and 36.7 µg cm^{-2} at 60 and 90 DAS, respectively being it remained at par with 5 splits. The treatment of neem coated urea significantly superior in chlorophyll content at all growth stages, over uncoated urea (Table 1).

Ginning percentage of cotton was failed to get the level of significance due to nitrogen levels, split application and nitrification inhibitor (Table 1).

Nitrogen use efficiency

Nitrogen use efficiency was remarkably influenced due to nitrogen levels. Application of 300 kg N ha^{-1} recorded higher NUE over 240 and 180 kg N ha^{-1}, whereas, nitrogen applied in 6 splits registered higher value of NUE than 4 and 5 splits. Further, it indicated that neem coated urea noted more effect on NUE over uncoated urea. It might be due to more nitrogen was taken up and effective utilization by the cotton crop. The present findings are in close agreement with those reported by Nadeem *et al.* (2010).

Interaction effect

Seed cotton yield was remarkably higher under treatment combination $N_2S_3M_1$ (240 kg N ha^{-1} + 6 splits + neem coated urea), but it was at par with combination $N_3S_2M_1$ (300 kg N ha^{-1} + 5 splits + neem coated urea), $N_3S_3M_1$ (300 kg N ha^{-1} + 6 splits + neem coated urea), $N_3S_3M_2$ (300 kg N ha^{-1} + 6 splits + prilled urea), $N_2S_2M_1$ (240 kg N ha^{-1} + 5 splits + neem coated urea), $N_2S_1M_1$ (240 kg N ha^{-1} + 4 splits + neem coated urea), $N_3S_1M_2$ (300 kg N ha^{-1} + 4 splits + prilled urea) and $N_2S_3M_2$ (240 kg N ha^{-1} + 6 splits + prilled urea) (Table 2).

Economics

The maximum net realization of Rs. 65875 ha^{-1} was accrued under application of 300 kg N ha^{-1} with BCR of 3.16, however 240 kg N ha^{-1} occupied second position with the net realization of Rs. 65072 ha^{-1} and BCR of 3.19. In case of splits, the highest net return of Rs. 69021 ha^{-1} with BCR value of 3.52 was noted under 6 splits. Neem coated urea treatment secured more net monetary return of Rs. 64700 ha^{-1} with BCR value of 3.07 (Table 1). Neem coated urea hold considerable promise and its low production cost and it involves an indigenous raw material which produced higher yield of *Bt* cotton.

It can be concluded that for getting economical production of *Bt*-cotton (G. Cot. Hy. 6, BG-II); nitrogen applied at 240 kg ha^{-1} in 5 equal splits at 25 days intervals (0, 25, 50, 75 and 100 DAS) through neem coated urea. Moreover, it was observed that nitrogen applied through neem coated urea in *Bt* cotton could be economized 60 kg N ha^{-1} and yielded more or less equal seed cotton yield under south Gujarat condition.

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International Journal of Agriculture Innovations and Research
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Table 1: Effect of different levels of nitrogen, split and nitrification inhibitor on growth, yield and economics on Bt cotton

Treatment	**Sympodial branches plant^{-1}**	**Bolls plant^{-1}**	**Boll weight (g)**	**Yields (kg ha^{-1})**		**Chlorophyll content (µg cm^{-2})**		**Ginning percentage (%)**	**NUE (kg/kg)**	**Net realization (Rs. ha^{-1})**	**BCR**
				Seed cotton	**Stalk**	**60 DAS**	**90 DAS**				
Nitrogen levels (kg ha^{-1})											
N_1 : 180	19.1	34.7	3.37	1968	3651	34.2	34.8	32.31	7.15	59395	3.05
N_2 : 240	20.6	37.3	3.65	2112	3898	34.9	36.2	32.56	8.79	65072	3.19
N_3 : 300	21.1	39.2	3.92	2148	3990	35.7	37.4	32.65	10.92	65875	3.16
S. Em. ±	0.43	0.91	0.03	44.6	93.4	0.20	0.24	0.24	-	-	-
C. D. (P = 0.05)	1.23	2.64	0.09	128.1	268.5	0.59	0.69	NS	-	-	-
Split application of nitrogen (S)											
S_1 : 4 splits (30 days intervals)	19.6	33.9	3.47	1973	3648	34.5	35.4	32.27	8.55	61481	3.27
S_2 : 5 splits (25 days intervals)	19.9	36.9	3.71	2108	3908	35.0	36.4	32.61	9.10	67431	3.48
S_3 : 6 splits (20 days intervals)	21.4	38.7	3.75	2146	3983	35.3	36.7	32.63	9.23	69021	3.52
S. Em. ±	0.43	0.91	0.03	44.6	93.4	0.20	0.24	0.24	-	-	-
C. D. (P = 0.05)	1.23	2.64	0.09	128.1	268.5	0.59	0.69	NS	-	-	-
Nitrification inhibitor (M)											
M_1 : Neem coated urea	20.8	39.1	3.77	2138	3965	35.3	36.9	32.59	9.23	64700	3.07
M_2 : Prilled urea	19.8	34.8	3.52	2014	3728	34.6	35.5	32.42	8.68	60185	2.98
S. Em. ±	0.35	0.75	0.02	36.5	76.3	0.17	0.20	0.19	-	-	-
C. D. (P = 0.05)	1.00	2.15	0.07	104.7	219.3	0.48	0.56	NS	-	-	-
Interaction											
N x S	NS	Sig.	NS	Sig.	NS	NS	NS	NS	-	-	-
N x M	NS	Sig.	NS	Sig.	NS	NS	NS	NS	-	-	-
S x M	NS	NS	NS	NS	NS	NS	NS	NS	-	-	-
N x S x M	NS	NS	NS	Sig.	NS	NS	NS	NS	-	-	-
C. V. %	8.94	11.00	3.85	9.11	10.30	2.49	2.84	3.09	-	-	-

Sig.- Significant NS-Non-significant

Table 2: Interaction effect of different levels of nitrogen, split and nitrification inhibitor on seed cotton yield of *Bt* cotton (kg ha^{-1})

Treatment	**Split application (S)**					
	S_1 (4 splits)		**S_2 (5 splits)**		**S_3 (6 splits)**	
	Nitrification inhibitor (M)		**Nitrification inhibitor (M)**		**Nitrification inhibitor (M)**	
Nitrogen levels (N) (kg ha^{-1})	**Neem coated urea (M_1)**	**Prilled urea (M_2)**	**Neem coated urea (M_1)**	**Prilled urea (M_2)**	**Neem coated urea (M_1)**	**Prilled urea (M_2)**
N_1 (180)	2092	1928	1950	2010	1959	1858
N_2 (240)	2168	1628	2196	2088	2425	2155
N_3 (300)	1846	2168	2338	2054	2250	2220
S. Em. ±	109					
C. D. (P = 0.05)	313					