International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(3): 722-724

Received: 07-03-2020
Accepted: 09-04-2020

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Response of *Bt* cotton (*Gossypium hirsutum* L.) to varied nitrogen levels in Southern Telangana

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DOI: https://doi.org/10.22271/chemi.2020.v8.i3i.9289

Abstract
Field experiments were conducted during *kharif* 2014 and 2015 at Agricultural Research Institute, Rajendranagar to determine the optimum nitrogen level for Bt cotton in alfisols in Southern Telangana. Significantly more number of days (31, 47 and 94) was taken to attain square initiation, flowering and boll development stage, respectively and higher drymatter production (9.2, 129, 182 and 239 g plant^{-1}) was registered at square initiation stage, flowering, boll development and first picking stages, respectively with application of nitrogen at 225 kg ha^{-1}. Higher earliness index (0.78) was registered when no nitrogen applied over 150 and 225 kg ha^{-1} with earliness index values of 0.75 and 0.74, respectively. Significantly higher seed cotton yield (1714 kg ha^{-1}) was obtained with 225 kg N ha^{-1} and was followed by 150 kg N ha^{-1} (1704 kg ha^{-1}). However, which were comparable with each other and significantly superior over no nitrogen and 75 kg N ha^{-1} application. The rate of increase in seed cotton yield with application of 75, 150 and 225 kg ha^{-1} over no nitrogen application was 54%, 74% and 75%, respectively. It can be concluded that, higher seed cotton yield with higher B:C ratio can be obtained with application of nitrogen at 150 kg ha^{-1} in Bt cotton in alfisols of South Telangana Zone.

Keywords: Cotton, nitrogen, phenology, seed cotton yield

Introduction
Cotton (*Gossypium hirsutum* L.), is one of the major cash crops of India, popularly known as 'White gold' and 'King of fibres' for its role in the national economy in terms of foreign exchange earnings and employment generation. In India, cotton cropping provides 60% of the fiber to textile industries, supplies more than one million metric ton of cooking oil, animal feed and 40 million metric tons of biomass in the form of cotton stalks. In India, cotton is grown in an area of 12.82 million ha with a production of 34.80 million bales and productivity of 462 kg lint ha^{-1}, which is below the world's average of 790 kg ha^{-1} during 2014-15. Telangana is a major cotton growing state cultivated in area of 1.71 million ha mostly under rainfed condition with a production of 3.80 million bales and productivity of the 377 kg lint ha^{-1} during 2014-15. Farmers are using eexcessive nitrogen fertilizers leading to heavy pest incidence in certain pockets whereas in some areas it is below optimum mainly because of the risk associated with the investment under uneven and erratic distribution of rainfall. For obtaining higher seed cotton yields water, nutrients and soils are essential resources, of which water and nitrogen are yield limiting factors.

Nitrogen deficiency in cotton reduces vegetative and reproductive growth and induces premature senescence, there by potentially reduces the yields (Tewiodle and Fernandez 1997) [14], where as high nitrogen availability may shift the balance between vegetative and reproductive growth towards excessive vegetative development thus delaying maturity. Since nitrogen input is costly, judicious and efficient utilisation of nitrogen is essential for higher productivity of Bt cotton grown on alfisols under less rainfall receiving areas of South Telangana Zone. Keeping this in view, an experiment was formulated to study the effect of nitrogen levels on cotton production to optimize the nitrogen level for cotton.

Materials and Methods
The field experiment was carried out at Agricultural Research Institute, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad during *kharif* seasons of 2014 and 2015 to determine the optimum nitrogen level for higher seed cotton yield. The experimental site was sandy loam in texture, neutral in reaction, low in available nitrogen,

phosphorus and high in available potassium. The experiment executed with four nitrogen levels (N_1- 0 kg ha^{-1}, N_2 - 75 kg ha^{-1}, N_3 - 150 kgha^{-1} and N_4 - 225 kg ha^{-1}) using cotton cultivar Mallika BG II sown at a spacing of 90 cm X 60 cm. A uniform dose of 60 kg ha^{-1} P_2O_5 as single super phosphate was applied to all the treatments as basal. Potassium @ 60 kg ha^{-1} as muriate of potash was applied in four equal splits along with nitrogen fertilizer as top dressing. Nitrogen was applied as per the treatments (wherever it was required) in the form of urea (46% N) in four equal splits (1/4th each at 20, 40, 60 and 80 DAS). Observations on plant height, occurrence of phenophases, drymatter production, yield attributes and yield were recorded. Net monetary returns were worked out for different nitrogen levels. The data was analyzed statistically applying analysis of variance technique. The significance was tested by 'F' test (Snedecor and Cochron, 1967) [11]. Critical difference for examining treatment means for their significance was calculated at 5 per cent level of probability (P=0.05).

Results and Discussions

Incremental increase in nitrogen level resulted in significantly advances the days to attain different phenophases of cotton (Table 1). Significantly more number of days (31, 47 and 94) were taken to attain square initiation, flowering and boll development stage, respectively with N_4 (225 kg ha^{-1}) and followed by with N_3 (150 kg ha^{-1}) which were superior over N_2 (75 kg ha^{-1}) and N_1 (0 kg ha^{-1}). The average number of days were taken complete final picking of cotton was 142 days. Howard *et al.* (2001) [7] observed similar results and concluded that higher doses of nitrogen lead to more vegetative growth and causes delay in maturity. The results were in conformity with the findings of Dong *et al.* (2012) [4] and Munir *et al.* (2015) [9].

Table 1: Effect of nitrogen levels on phenology and drymatter production of Bt cotton in alfisols (Pooled)

Treatments	No. of days to attain			Drymatter (g plant^{-1})			
	Square initiation	Flower ing	Boll development	Square initiation	Flower ing	Boll development	1st picking
N_1 - 0 kg ha^{-1}	30	45	92	6.0	64	95	138
N_2 - 75 kg ha^{-1}	30	45	93	7.6	92	125	180
N_3 - 150 kg ha^{-1}	31	46	93	8.6	120	166	224
N_4 - 225 kg ha^{-1}	31	47	94	9.2	129	182	239
S. Em±	-	-	-	0.42	3.3	5.6	5.6
CD (P=0.05)	0.5	0.9	0.48	1.25	9.7	16.6	16.5

Graded levels of nitrogen significantly increased the drymatter production over lower levels of nitrogen at flowering, boll development and first picking stages. Analysis of the data showed that, significantly higher drymatter production (9.2, 129, 182 and 239 g plant^{-1}) was registered with N_4 (225 kg ha^{-1}) at square initiation stage, flowering, boll development and first picking stages, respectively and was not differed significantly with N_3 (150 kg ha^{-1}) which recorded drymatter production of 8.6, 120, 166 and 224 g plant^{-1}, respectively and drymatter production with N_4 (225 kg ha^{-1}) was significantly superior over N_2 (75 kg ha^{-1}) and N_1 (0 kg ha^{-1}). Higher drymatter production is an index of higher photosynthetic capacity of a plant. Relatively higher plant height, leaf area might be contributed by adequate supply of nitrogen with favorable effect on cell elongation leads more plant height, leaf area by enabling the plant to trap higher quantity of radiant energy leading to accumulation of higher photosynthates and dry matter in the plant. Enhanced drymatter production with adequate supply of nitrogen corroborates with the findings of Dadgale *et al.* (2014) [3] and Sunitha *et al.* (2010) [13].

Table 2: Effect of nitrogen levels on yield, nitrogen uptake and economics of Bt cotton in alfisols (Pooled)

Treatments	No. of bolls plant^{-1}	Lint yield (kg ha^{-1})	Ginning (%)	Earliness Index	B:C Ratio	Seed cotton yield (kg ha^{-1})
N_1 - 0 kg ha^{-1}	13	353	36.4	0.78	1.01	977
N_2 - 75 kg ha^{-1}	17	547	36.7	0.76	1.39	1506
N_3 - 150 kg ha^{-1}	19	630	37.1	0.75	1.45	1704
N_4 - 225 kg ha^{-1}	19	636	37.4	0.74	1.39	1714
S. Em±	0.37	19.2	-	-	-	57
CD (p=0.05)	1.1	57	NS	0.027	-	171

Significantly higher number of bolls plant^{-1} (19) was recorded with N_4 (225 kg ha^{-1}) and N_3 (150 kg ha^{-1}) over N_2 (75 kg ha^{-1}) and N_1 (0 kg ha^{-1}) which recorded the lowest bolls plant^{-1} (13). Nitrogen acts as a source for higher retention of bolls and more number of bolls plant^{-1} at higher level of nitrogen application might be due to favourable effect on growth and translocation of photosynthates towards squares. Similar results were reported by Gundlur *et al.* (2013) [5] and Hosamani *et al.* (2013) [6]. It was observed that, nitrogen levels had no significant influence on ginning percentage. Significantly higher earliness index (0.78) was registered with N_1 (0 kg ha^{-1}) over N_3 (150 kg ha^{-1}) and N_4 (225 kg ha^{-1}) with earliness index values of 0.75 and 0.74, respectively, but they were comparable with each other (Table 2). However, earliness index (0.76) found with N_2 (75 kg ha^{-1}) was at par with other higher levels of nitrogen application. The favourable regime of increased nitrogen application in the soil might be resulted in prolonged vegetative phase leads to delayed maturity causes lower earliness index. Similar results were reported by Bandyopadhyay *et al.* (2009) [1]. Higher B:C ratio with N_3 (150 kg ha^{-1}) was might be due to higher seed cotton yield at that particular level of nitrogen application. These results were in conformity with the findings of Srinivasulu *et al.* (2006) [12] and Pandagale *et al.* (2015) [10].

Significantly higher seed cotton yield (1714 kg ha^{-1}) was obtained with N_4 (225 kg ha^{-1}) and was followed by N_3 (150 kg ha^{-1}) with seed cotton yield of 1704 kg ha^{-1}. However, which were comparable with each other and significantly superior over N_2 (75 kg ha^{-1}) and N_1 (0 kg ha^{-1}). The rate of increase in seed cotton yield with N_2 (75 kg ha^{-1}), N_3 (150 kg ha^{-1}) and N_4 (225 kg ha^{-1}) over N_1 (0 kg ha^{-1}) was 54%, 74% and 75%, respectively. Similar results were observed with lint

yield. The substantial increase in seed cotton yield due to application of higher levels of nitrogen might be due to favorable effect of nitrogen on growth attributes like plant height, increased number of bolls plant^{-1}, drymatter accumulation plant^{-1} and its subsequent translocation towards sink improved the seed cotton yield. These results are in conformity with Dadgale *et al.* (2014) [3]. Similar positive response of nitrogen on seed cotton yield was observed by Basavanneppa (2005) [2] and Meena *et al.* (2007) [8].

Conclusion

It can be concluded that, higher seed cotton yield with higher B:C ratio can be obtained with application of nitrogen at 150 kg ha^{-1} in Bt cotton in alfisols of South Telangana Zone

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