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Effect of application methods and nitrogen scheduling on growth and quality of *Bt* (*Bacillus thuringiensis*) cotton

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ABSTRACT : The present investigation was carried out at cotton research area of CCS Haryana Agricultural University, Hisar, during *kharif* season 2018 to study the effect of application method and scheduling of nitrogen on growth and quality of *Bt* cotton. The result revealed that the treatment T_2, T_6 and T_7 are statistically *at par* in case of plant height, dry matter accumulation, leaf area index and span length. Lowest Micronaire value observed in T_6 treatment whereas there was no significant difference found in ginning out turn of cotton among various treatments.

Keywords: Cotton, growth, nitrogen, quality

Cotton (*Gossypium hirsutum* L.), also known as “White Gold” is one of the most important commercial cash crops grown under diverse agro-climatic conditions in semi-arid regions of India. The area, production and productivity of cotton in India is 12.23 m ha, 36.1 m bales, 501 kg/ha, respectively and the productivity in world is 797 kg/ha which is higher than that of India (Anonymous, 2019).

Synchronizing crop demand with fertilizer N application plays inducible role in plant photosynthesis activities, canopy development and reproductive growth In contrast, surplus N application encourages excessive vegetative growth, resulting in poor boll setting, higher pest incidence and delayed maturity (Leghari *et al.*, 2016).

Nitrogen requirement of crops is usually more than P and K, yet N has higher losses (leaching, volatilization etc.) resulting in lower use efficiency and greater environment pollution (Jan *et al.*, 2007). Inadequate supply of nitrogen affect the growth and development of cotton, results in a reduction of leaf area index (LAI), chlorophyll concentration in leaves, photosynthetic rate, and biomass production (Zhao and Oosterhuis, 2000)

Nitrogen is one of the decisive as well as expensive input, which is applied for increasing the crop production. It shows quickest effect on plant growth. Over-fertilization results in excessive vegetative growth, decreased lint turn out, increased wilt-disease incidence, delay in maturity which may results in immature fiber, adversely affects lint yield and fiber quality (Main *et al.*, 2011).

The present study was conducted on *Bt* cotton hybrid (RCH 650) at Cotton Research Area, CCS Haryana Agricultural University, Hisar. There were seven treatments as T_1- Control, T_2- (100% RDN) (band application in 2 splits at sowing and flowering), T_3- (75% RDN) (band application in 2 splits at sowing and flowering), T_4 - (75% RDN) + Placement(spot application in 2 splits at sowing and flowering), T_5 - (75% RDN) + Placement (spot application in 4 splits at sowing, squaring, flowering and boll development), T_6- T_5+ foliar application of (1%) urea (3 times at squaring, flowering and boll development) and T_7 -T_5+ raising of *moong* between rows incorporated before flowering (50-55 DAS). The experiment was conducted in RBD design along with three replications. Sowing was done on 20 April, 2018 by dibbling method on well prepared bed with row to row spacing of 90

Table 1. Effect of various treatments on plant height (cm) at different growth stages of *Bt* cotton hybrid

Treatments	Days after sowing				At
	45	75	105	135	harvest
T_1- Control	37	85	166	180	183
T_2- (100% RDN) (band application in 2 splits at sowing and flowering)	38	92	184	211	214
T_3- (75% RDN) (band application in 2 splits at sowing and flowering)	40	104	182	208	210
T_4 - (75% RDN) + Placement (spot application in 2 splits at sowing and flowering)	40	105	184	212	214
T_5 - (75% RDN) + Placement (spot application in 4 splits at sowing, squaring, flowering and boll development)	42	106	183	215	218
T_6- **T_5** + foliar application of (1%) urea (3 times at squaring, flowering and boll development)	40	100	183	214	215
T_7 - **T_5** + raising of *moong* between rows incorporated before flowering (50-55 DAS)	39	109	186	214	215
SEm±	1.67	2.64	2.88	2.94	3.65
CD (p = 0.05)	NS	8.21	8.98	9.17	11.39

cm and plant to plant spacing of 45cm. thinning was done to keep the good crop stand. All the recommended package of practices was followed to raise a health crop.

Observations were recorded as per standard procedures. Height of five tagged plants in each plot was measured periodically at 45, 75, 105,135 DAS and at maturity. It was measured from the main stem to the tip of fully opened leaf at the top and expressed in cm.

Two plants/plot were uprooted at ground level. For the measurement of dry matter accumulation at 45, 75, 105,135 DAS and at maturity, the samples were first dried in air and then oven dried at a temperature of 70°C till constant weight was obtained. Dry weight was recorded on/plant basis and expressed in g/plant.

Leaf area index (LAI) was recorded 45, 75, 105 and 135 DAS by uprooting two plants/plot at ground level and leaves of these plants were used for the measurement of LAI by using LI-3000 Leaf Area Meter, LICOR Ltd., Nebraska, USA.

$$\text{LAI} = \frac{\text{Leaf area}}{\text{Ground area}}$$

100 g sample of seed cotton was taken from each plot and then ginned to get lint and cotton seed. It was calculated by using following formula.

$$\text{GOT (\%)} = \frac{\text{Weight of lint}}{\text{Weight of seed cotton}} \times 100$$

Micronaire value is a measurement of cotton fibre quality which is a reflection of both fineness and maturity. Low values indicate fine fiber and high values indicate coarse fiber. It measures weight per unit length of fiber. Fineness denotes the size of cross-sectional diameter of the fibre. A sample of 100 g. lint was taken and measure micronaire value by using Precitronic Digital Mic Tester at CICR, Sirsa.

Span length is the distance spanned by specified (%) of fibers in test beard or distance from clamp on fiber beard. It is expressed in mm. A sample of having weight 100 g lint was taken to measure span length by Statex Electrospan automatically measures span length taken from sample blowroom, cards, draw frames and combers. Optic principle is used to test the span length, and also provides uniformity ratio, short fibre percentage, mean length, upper half mean length, uniformity index and fibrogram at CICR, Sirsa

Table 2. Effect of various treatments on dry matter (g/plant) at different growth stages of *Bt* cotton hybrid

Treatments	Days after sowing				At
	45	75	105	135	harvest
T_1- Control	4.3	24	71	103	365
T_2- (100% RDN) (band application in 2 splits at sowing and flowering)	5.5	37	103	159	565
T_3- (75% RDN) (band application in 2 splits at sowing and flowering)	4.7	33	84	140	545
T_4 - (75% RDN) + Placement (spot application in 2 splits at sowing and flowering)	4.9	35	94	149	560
T_5 - (75% RDN) + Placement (spot application in 4 splits at sowing, squaring, flowering and boll development)	5.0	33	90	149	549
T_6- T_5+ foliar application of (1%) urea (3 times at squaring, flowering and boll development)	4.9	36	103	163	594
T_7 -T_5+ raising of *moong* between rows incorporated before flowering (50-55 DAS)	5.0	34	96	148	553
SEm±	0.10	0.62	2.58	10.37	11.25
CD (p = 0.05)	0.30	1.94	8.04	32.32	35.04

Plant height is a genetically controlled character and ultimate height of a crop and/or genotype is dependent on its genetic makeup. The result showed that method of application and N scheduling had a significant effect on plant height. It was monitored at different growth stages and at 45DAS, all the treatments are statistically *at par* with each other. Similar results have been reported by Jagvir Singh *et al.*, (2003). However, at 75 DAS, significantly higher plant height was obtained in T_7 (T_5+ raising of *moong* between rows incorporated before flowering (50-55 DAS) treatment as compared to control.

At 105,135 DAS and at harvest, all the treatments have significantly higher plant height over control. This might be due to timely availability of nitrogen in adequate amount for the cell division and elongation as nitrogen is one of the major component for the growth of plant. The results also confirm the finding of Bibi *et al.*, (2011).

The dry matter accumulation is one of the most important parameter that reflects the crop growth. Method of application and N scheduling had a significant influence on the dry matter accumulation at all the crop growth stages. The data presented in Table 2 indicated that there was continuous increase in dry matter accumulation up to maturity.

At 45 DAS, significantly higher dry matter accumulation was found in T_2 (100% RDN) band application in 2 splits at sowing and flowering) treatment which might be due to vigorous growth of plant by higher rate of nitrogen application. The result also confirms the finding of Mahatale *et al.*, (2003). At 75 DAS, highest dry matter accumulation was obtained in T6 (T_5+ foliar application of (1%) urea 3 times at squaring, flowering, boll development) treatment which was *at par* with T_2 (100% RDN) band application in 2 splits at sowing and flowering) and significantly higher as compare to other treatments. At 105 DAS, highest dry matter accumulation obtained in T_2 (100% of RDN) band application in 2 splits at sowing and flowering), T_6 (T_5 + foliar application of (1%) urea 3 times at squaring, flowering, boll development) treatment which were *at par* with T_7 (T_5+ raising of *moong* between rows incorporated before flowering (50-55 DAS) and significantly higher than other treatments.

At 135 DAS, all the treatments accumulate significantly higher dry matter over

Table 3. Effects of various treatments on Leaf area index at different growth stages of *Bt* cotton

Treatments	Days after sowing				At
	45	75	105	135	harvest
T_1- Control	0.13	0.52	1.28	1.48	0.42
T_2- (100% RDN) (band application in 2 splits at sowing and flowering)	0.16	0.72	2.20	2.50	0.62
T_3- (75% RDN) (band application in 2 splits at sowing and flowering)	0.15	0.65	1.80	2.05	0.55
T_4 - (75% of RDN) + Placement (spot application in 2 splits at sowing and flowering)	0.15	0.62	1.80	2.08	0.52
T_5 - (75% of RDN) + Placement (spot application in 4 splits at sowing, squaring, flowering and boll development)	0.16	0.68	1.85	2.10	0.58
T_6- **T_5**+ foliar application of (1%) urea (3 times at squaring, flowering and boll development)	0.14	0.71	1.98	2.23	0.61
T_7 -**T_5**+ raising of *moong* between rows incorporated before flowering (50-55 DAS)	0.16	0.75	2.30	2.60	0.65
SEm±	0.01	0.01	0.03	0.04	0.01
CD (p = 0.05)	0.02	0.04	0.11	0.12	0.03

control. It may be the effect of availability of nitrogen. At maturity, highest dry matter accumulation was observed in T_6 (T_5+ foliar application of (1%) urea 3 times at squaring, flowering, boll development) treatment which was at par with T_2 (100% RDN) band application in 2 splits at sowing and flowering), T_4 (75% RDN) + Placement spot application in 2 splits at sowing and flowering) and significantly higher as compare to other treatments. The increased drymatter accumulation might be due to the fact that nitrogen fertilization made at right time with suitable method, helps the plants more efficient in photosynthetic activity by enhancing the carbohydrate metabolism resulting in increased drymatter accumulation. Similar results have been reported by Sisidia and Khamparia (2007).

Leaf area index is a common index of plant growth which directly affects the solar radiation interception, photosynthesis and

Table 4. Effect of various treatments on fiber quality parameters of cotton

Treatments	Span length (mm)	Micronaire (µg/inch)	GOT (%)
T_1- Control	27.1	4.8	35.7
T_2- (100% RDN) (band application in 2 splits at sowing and flowering)	28.2	4.8	36.5
T_3- (75% RDN) (band application in 2 splits at sowing and flowering)	27.2	4.8	37.4
T_4 - (75% RDN) + Placement (spot application in 2 splits at sowing and flowering)	27.2	4.7	37.9
T_5 - (75% RDN) + Placement (spot application in 4 splits at sowing, squaring, flowering and boll development)	27.4	4.9	37.3
T_6- **T_5**+ foliar application of (1%) urea (3 times at squaring, flowering and boll development)	28.0	4.2	36.9
T_7 -**T_5**+ raising of *moong* between rows incorporated before flowering (50-55 DAS)	28.2	4.8	37.9
SEm±	0.07	0.03	1.1
CD (p = 0.05)	0.23	0.10	NS

ultimately the yield. Method of application and N scheduling had a significant effect on the LAI at all the crop growth stages (Table 3). At 45 DAS, lowest LAI was recorded in control as compared to other treatments. At 75 DAS, maximum LAI was obtained T_7 (T_5+ raising of *moong* between rows incorporated before flowering (50-55 DAS)) treatment which was *at par* with T_2 (100% RDN) band application in 2 splits at sowing and flowering), T_6 (T_5+ foliar application of (1%) urea 3 times at squaring, flowering, boll development) and significantly higher than other treatments.

At 105, 135 DAS and at harvest, higher LAI was found in T_7 (T_5+ raising of *moong* between rows incorporated before flowering (50-55 DAS) treatment which was *at par* with T_2 (100% RDN) band application in 2 splits at sowing and flowering) and significantly higher as compared to other treatments. It might be because of trapping higher quantity of radiant energy. Similar results have been reported by Singh *et al.*, (2014).

The results indicated that different treatments had a significant effect on span length. Higher span length recorded in T_2 (100% RDN) band application in 2 splits at sowing and flowering),T_7 (T_5+ raising of *moong* between rows incorporated before flowering (50-55 DAS)) treatment which were statistically *at par* with T_6 (T_5+ foliar application of (1%) urea 3 times at squaring, flowering, boll development) and significantly higher as compared to other treatments. This might be due to availability of adequate amount of nitrogen at the boll development stage as it helps in increasing the span length of fiber. These findings were in close agreement with Das *et al.*, (2006).

Micronair value of cotton is a fiber quality parameter that reflects a combination of fiber maturity and fiber linear density (often referred to as fineness). Lower the micronair value, better the quality of fibre. In comparison to other treatments, significantly lower micronair value was obtained in T_6 (T_5+ foliar application of (1%) urea 3 times at squaring, flowering, boll development) treatment. Similar was the findings of Das *et al.*, (2006).

The results indicated that various treatments did not differed significantly among themselves for ginning out turn. Similar was the findings of Das *et al.*, (2006).

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