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Growth Behaviour of *Bt* (*Bacillus thuringiensis*) Cotton as Influenced by Mepiquat Chloride under Varying Nitrogen Levels

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

Cotton is indeterminant and long duration crop. For synchronising in growth and to prevent heavy shedding of bolls different growth regulators used in cotton field. The present field experiment was conducted at National Seed Production Area of Choudhary Charan Singh Haryana Agricultural University, Hisar, India during *kharif* season 2018. The experiment comprised of three levels of nitrogen (100%, 125% and 150% Recommended Dose Fertilizer) and three spray of mepiquat chloride (control, single spray at 60 Days After Sowing and two spray at 60 and 75 DAS) was conducted in factorial randomized complete block design replicated thrice. Based on the research investigation, it was found that different phenological stages were delayed by 3 to 4 days with application of 150% RDF, while twice spray of mepiquat chloride resulted in 6 to 7 days earlier completion of these stages. Ginning out turn was statistically at par with different levels of nitrogen, while 100% RDF has shown maximum span length with lowest micronaire value. With single

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mepiquat chloride spray at 60 DAS ginning percentages decreases by 6.80% over control, it maybe seen beacause of shortened growth period. While span length reduces with two sprays of mepiquat chloride at 60 and 75 DAS by 0.62% over the control and single spray of mepiquat chloride at 60 DAS. However finest fibre (4.23 x 10^{-6}g/inch micronaire value) obtained with single spray of mepiquat chloride. The result of present study reveals that, 100% RDF in Bt cotton along with single spray of mepiquat chloride at 60 DAS gives finest fibre with more span length by completing all phenological stages earlier than others.

Keywords: Bt cotton; mepiquat chloride; ginning percentages; micronaire value; span length.

1. INTRODUCTION

Cotton is a major cash crop around the world. Cotton crops experience significant vegetative growth due to high soil fertility, as well as the timing of vegetative growth with the rainy season and high humidity. Thick crop canopy hinders light penetration, as well as shading of bolls and the use of plant energy on vegetative stature building, resulting in the loss of flower buds, blooms, and immature bolls. Excessive vegetative development often comes at the price of reproductive growth, and many squares and small bolls on the lower sympods shed or open poorly, resulting in reduced yield [1]. Cotton is used as raw material in textile industry and this industry contributes about 14% to the industrial production and 4% of the GDP [1]. Cotton is used as major raw material in this sector. Around 35 million people are directly dependent on this sector for their employment. The hand loom sector consumes around 12.50 % of raw cotton and power loom sector around 62.70 %. Mills and Hosiery sector consume nearly 3.40 % and 21.40 % of total raw cotton respectively in India [1]. It is also the source of edible oil, cotton seed oil cake, linters, and huge biomass as dried cotton stalk used as fuel. It has the important character of high lint production and long staple length. Lint is the most important economical product, provides a source of quality fiber for textile industry and cotton seeds which is the primary by-product of lint production, is an important source of oil for human consumption and also used as livestock feed. Cotton plants must have a harmonic balance between vegetative and reproductive growth for adequate photosynthates supply for healthy boll development leading to better productivity [2]. The use of mepiquat chloride increases the N uptake resulting into higher seed cotton yield [2]. Quality parameters *viz.,* ginning percent, lint index, fiber length, bundle strength and fiber fineness were not affected significantly by N management practices [3]. A field experiment on effect of different nitrogen levels (50, 100, 150 kg N/ha) on cotton shows that application of 150 kg N/ha gave significantly higher ginning out turn [4]. Sometimes with higher levels of nitrogen, rotting of lower bolls also occurs. The loss of reproductive structures alters the physiological growth and development of the plant by redirecting assimilates which normally are incorporated into these abscised organs to other plant parts. Most source sink research has focused on leaf boll relationships (harmonic balance) with little study of vegetative storage reserves.

Source-sink balance can be altered by using plant growth regulator such as mepiquat chloride (MC) [5]. The best way to prevent excessive vegetative growth is to manage for early and high fruit set. If early fruit are not set, the crop may compensate by setting fruit at higher nodes and at outer fruiting positions leading to delayed crop maturity. Growth retardants such as mepiquat chloride (MC) have been shown to diminish inter nodal length, lowering plant height and increasing photosynthetic translocation to reproductive sinks (growing cotton bolls), all of which lead to higher yields. Plant growth regulators (PGRs) may improve yield by enhancing photosynthate retention in developing bolls. In industrialised countries, PGRs have been widely employed to increase cotton production by regulating plant growth and improving lint yield and fibre quality. To control plant growth and enhance output and quality, mepiquat chloride (MC) is used in cotton cultivation all over the world. Application of MC at squaring stage or at both squaring and flowering stages significantly improved cotton quality parameters like fiber length (1.7%) and fiber strength (2.8%) without significant loss of yields [6]. Fiber strength increased by 1.5 to 2.8 g/tex with MC [7]. Application of MC increased fiber strength by 3.8% [8]. MC did not significantly affect fiber qualities [9,10] but micronaire increased with MC application [11]. Cycocel and Alar did not affect cotton fiber quality, as they both are also used as a growth retardant [12-14].

The main objective of this study was to find out the effect of nitrogen and mepiquat chloride on duration and fiber quality parameter of *Bt* cotton under semi-arid condition.

2. MATERIALS AND METHODS

2.1 Experimental Site

The study was conducted at National Seed Production Area of Choudhary Charan Singh Haryana Agricultural University, Hisar, during *kharif* season 2018. Hisar is situated in the sub-tropics at 75º46'E, 29º10'N and altitude of 215.2 m in Haryana, India. Hisar has semi-arid climate with very hot summers (temperature rises up to ≥45˚C) and extremely cool winter (temperature falls up to ±1-2˚C). The initial soil characteristics of experimental sites like pH, soil texture, electrical conductivity, organic carbon, available NPK are presented in Table 1.

2.2 Experimental Details

The experiment was carried out during the 2018 kharif season by using *Bt* cotton genotype RCH 650 at CCS Haryana Agricultural University, Hisar. The experiment comprised of three levels of nitrogen (100%, 125% and 150% RDF) and three spray of mepiquat chloride (control, single spray @ 20g *a.i.*/ha at 60 DAS and two spray @ 20g *a.i.*/ha at 60 and 75 DAS) was conducted in Factorial Randomized Complete Block Design replicated thrice. Recommended dose of fertilizer 100% and 125%, 150% was applied as one third of N and full dose of P, K was applied at the time of seed bed preparation. Remaining dose of N was applied after 1st irrigation and at flowering stage. Recommended dose of fertilizer for RCH 650 are 175 kg N, 60 kg P_2O_5 and 60 kg K_2O per hectare.

2.3 Phenological Stages

Phenological stages like days to squaring, 50% flowering, 50% boll opening and maturity was the total number of days noted after the sowing in which 50% of plants initiate squaring, flowering, boll opening and shows maturity.

2.4 Quality Parameters

2.4.1 Ginning out turn (GOT), %

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

2.4.2 Micronaire value

It measures the fiber weight in 10^{-6} g/inch length of fiber. Fineness denotes the size of cross-sectional diameter of the fibre. A sample of 100g lint was taken and measure micronaire value by using Precitronic Digital Mic Tester at CICR, Sirsa.

2.5 Statistical Analysis

Data used in the study are the mean values of the replicated observations. For the statistical analysis of all the research field data, online computer programme OPSTAT (http://hau.ernet.in/sheoranop/) was used.

3. RESULTS AND DISCUSSION

3.1 Phenological Stages

There was significant difference on phenological growth observed with different levels of nitrogen (Table 2). Higher dose of nitrogen *i.e* 150% RDF were significantly delayed the duration of each phenological stages compared to 100% RDF. It might be due to more vegetative growth which delays the maturity *i.e.,* it has taken more number of days to reach boll development stage at higher levels of nitrogen application [20,21]. Earliness in phenological stages was significantly enhanced by MC application (Table 2). Improved earliness may be linked to the MC effect on biomass partitioning (inhibiting growth of branches and stems, expanding leaves, and extending stem internodes and petioles), which resulted in the development of a more compact canopy structure, which provides a better microclimate, particularly better light conditions, resulting in earlier maturity [22].

3.2 Quality Parameters

3.2.1 Ginning out turn (%)

Ginning out turn was not affected with different levels of nitrogen (Table 3) [23]. But mepiquat chloride significantly effects the ginning out turn, it was decreases with mepiquat chloride application. Significantly higher ginning out turn was recorded in control compared to other two treatments of mepiquat chloride. While ginning out turn was at par with twice and single application of mepiquat chloride. It might be due to high seed cotton yield with mepiquat chloride [11].

Table 1. Initial physico-chemical analysis of experimental field soil

Soil property	values	Method of determination
Sand (%)	73.8	International pipette method [15]
Silt (%)	15.9	
Clay (%)	10.3	
pH	7.9	Glass electrode pH meter [16]
Electrical conductivity (ds/m)	0.23	Solubridge conductivity meter 1:2 soil-water suspension [17]
Organic carbon (%)	0.44	Walkley and Black rapid titration method [16]
Available nitrogen (Kg/ha)	160	Alkaline permanganate method [18]
Available phosphorus (Kg/ha)	16	Olsen method [19]
Available potassium (Kg/ha)	280	Flame photometer method [17]

Table 2. Effect of different nitrogen levels and mepiquat chloride dose on phenological stages of *Bt* (*Bacillus thuringiensis*) cotton hybrid

Treatments	Days to squaring	Days to 50% flowering	Days to 50% boll opening	Days to maturity
Nitrogen levels				
N_1 (100% RDF)	50	81	108	174
N_2 (125% RDF)	52	80	109	177
N_3 (150% RDF)	53	80	111	179
CD	1.01	0.91	1.01	1.01
Mepiquat chloride dose				
G_1 (Control)	51	84	112	182
G_2 (MC@ 20g a.i./ha at 60 DAS)	52	80	109	176
G_3 (MC@ 20g a.i./ha at 60 and 75 DAS)	51	77	106	171
CD	1.01	0.90	1.01	1.01

Table 3. Effect of different nitrogen levels and mepiquat chloride dose on quality parameters of *Bt* (*Bacillus thuringiensis*) cotton hybrid

Treatments	Ginning out turn (%)	Span Length (mm)	Micronaire Value (10^{-6}g/inch)
Nitrogen levels			
N_1 (100% RDF)	34	28.84	4.3
N_2 (125% RDF)	34.78	28.55	4.44
N_3 (150% RDF)	34.21	28.64	4.37
CD	NS	0.08	0.05
Mepiquat chloride dose			
G_1 (Control)	36.16	28.74	4.47
G_2 (MC@ 20g a.i./ha at 60 DAS)	33.7	28.74	4.23
G_3 (MC@ 20g a.i./ha at 60 and 75 DAS)	33.13	28.56	4.41
CD	1.87	0.08	0.05

3.2.2 Span length (mm)

Span length significantly differ with different levels of nitrogen and mepiquat chloride (Table 3). 100% RDF shows significantly higher span length followed by 150% and 125% RDF. Span length was significantly higher in control and single application of mepiquat chloride as compared to twice spray. Span length was reduced with higher levels of nitrogen but this decrement was too small to affect the quality of fiber like it's fineness. Span length not affected with mepiquat chloride, but twice of mepiquat chloride application decreases span length [11].

3.2.3 Micronaire value (10^{-6}g/inch)

Micronaire value was significantly vary with different levels of nitrogen and mepiquat chloride. Significantly higher value of micronaire recorded with 125% RDF which was close to 150% RDF followed by 100% RDF (Table 3). This showed that excess application of N can reduce fiber quality. Nitrogen rate had no effect on fiber

uniformity [23]. Excess application of N than the required for optimum crop performance can reduce fiber quality. With mepiquat chloride, significantly higher value of micronaire was recorded in control followed by twice spray of mepiquat chloride and single spray. Twice application of mepiquat chloride gave almost closer micronaire value to control. Very low effect of mepiquat chloride on micronaire value was observed.

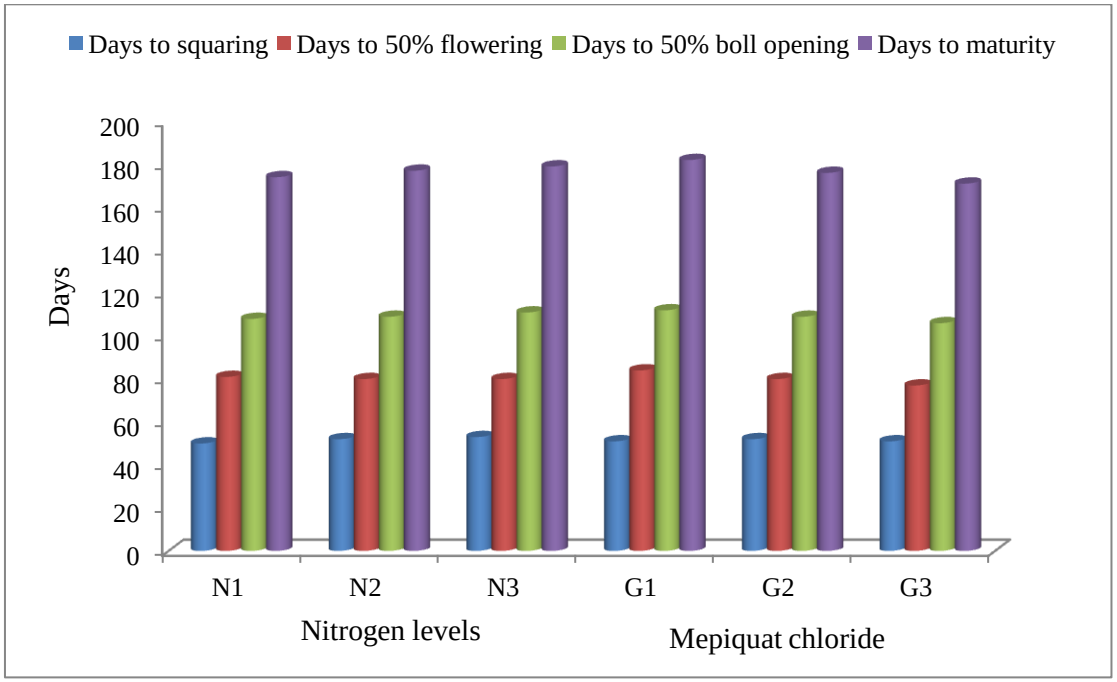

Fig. 1. Effect of different nitrogen levels and mepiquat chloride dose on phenological stages of *Bt* (*Bacillus thuringiensis*) cotton hybrid

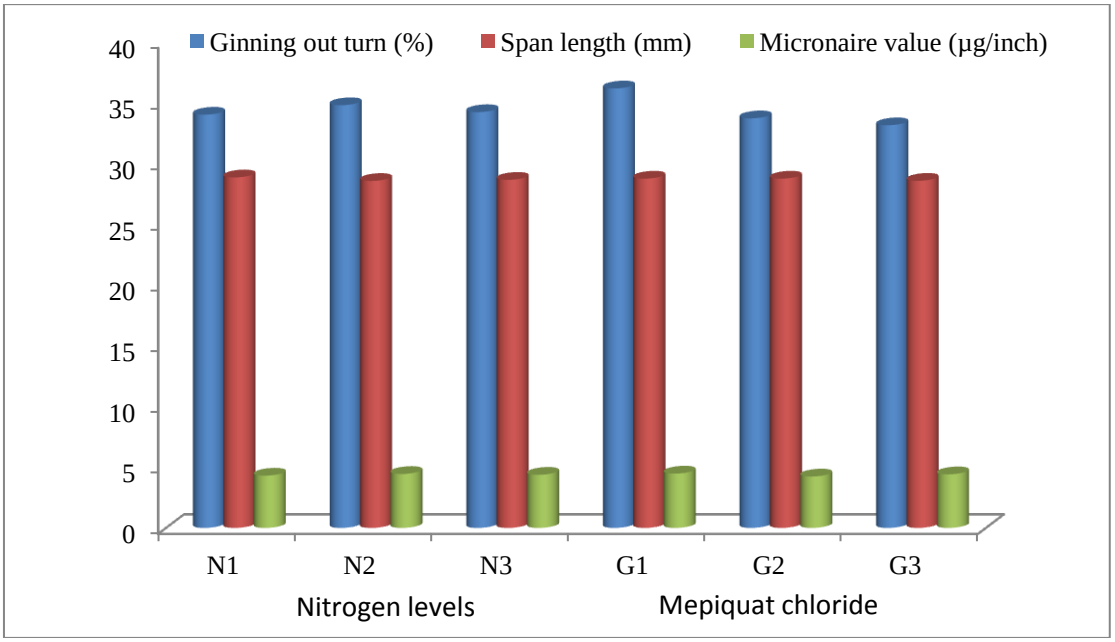

Fig. 2. Effect of different nitrogen levels and mepiquat chloride dose on quality parameters of *Bt* (*Bacillus thuringiensis*) cotton hybrid

4. CONCLUSION

Phenological stages of *Bt* cotton like days to squaring, boll formation and maturity extended by 2 to 5 days with increasing nitrogen dose from 175 kg per ha (100% RDF) to 218.75 kg per ha (125% RDF), 262.5 kg per ha (150% RDF). However, flowering occurs 4 and 7 days earlier with single and two spray of mepiquat chloride respectively than no spray. Also, the boll opening and maturity was 3 to 11 days earlier with spray of mepiquat chloride than no spray. Finest quality fibre was recorded with 125% RDF which was 0.69% and 0.70% more fine than 150% RDF and 100% RDF respectively. Maximum lint yield was gained (36.16% ginning percent) by without mepiquat chloride spray, while finest fibre was recorded with single spray of mepiquat chloride at 60 DAS with 4.26 x 10^{-6}g/inch micronaire value. The results reveal that, for getting fine quality fibre single spray of mepiquat chloride at 60 DAS with 100% RDF is recommended in *Bt* cotton growing areas in semi-arid region.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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