



## Comparative studies on the physical properties of fibres of *Bt* and non-*Bt* cottons at various stages of growth

A YADAV<sup>1</sup>, G F S HUSSAIN<sup>2</sup> and R P NACHANE<sup>3</sup>

Central Institute for Research on Cotton Technology, Mumbai, Maharashtra 400 019

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### ABSTRACT

The comparative studies pertaining to *Bt* and non-*Bt* cottons assessing quality performances of fibres for 2004–05 and 2005–06 was done from the data collected at various stages of crop growth at Athawa Agricultural Research Farm in Surat (Gujarat). Two varieties of *Bt* cottons, viz. RECH-2 and MECH-184 and their non-*Bt* counterparts (RECH-2 and MECH-184) were selected for the study. Physical parameters of fibers such as micronaire, 2.5% span length, tenacity, maturity ratio, neps count/g and immature fiber content (IFC%) were determined by standard procedures. There was no difference among micronaire, 2.5% span length, immature fibre content, neps/g and maturity ratio at the final stage of fibre development. However, the tenacity encountered some change in the final stage of fibre development.

**Key words:** *Bt* cotton, Maturity, Micronaire, Neps count/g, Tenacity

*Bt* is a genetically engineered cotton form of the natural cotton. It is produced by inserting a gene from the naturally occurred soil bacterium *Bacillus thuringiensis*, into cotton. This is primarily done to induce the plant to produce its own *Bt* toxin to destroy the bollworms (Mayee *et al.* 2004). The gene causes the production of *Bt* toxin in all parts of the plant. *Bt* toxin pierces small intestine of insects and kills. Although India has the world's largest areas of 9.2 million ha representing about one quarter of global area (32.26 million ha) under cotton cultivation (Rajendran *et al.* 2005). The average yield of cotton is 494 kg/ha, which is far below the world average of 677 kg/ha. The production is also only 5.6 million tonnes (about 20%) of the world production of 25.7 million tonnes. Main cause for this reduced production is the 162 species of insects, which are known to devour cotton at various stages of growth, of which 15 are considered to be key pests. Among these insects, cotton bollworms are the most serious pests in India causing an annual loss of at least US Dollar 300 million (Smale *et al.* 2006). The lepidoptera insects are the dreaded pests of cotton, which generally cause crop loss to the level of 70–80%. The available potent chemicals to control these pests are creating havoc to ecosystem, environment and human health. Transgenic cotton

popularly known as *Bt* cotton has given hope that cotton could be grown without/with lesser amount of pesticides. The bacterium *Bacillus thuringiensis* (*Bt*) produces a protein, which is endotoxin in nature causing stomach poison in the caterpillars (Barwale *et al.* 2004). This technology is under practice in global agriculture and year after year the area under *Bt* cotton is vastly growing in many countries. In USA about 70% of the total crop area is under *Bt* cotton. Gujarat state being the top producer of cotton in India had 75–80% of total production under *Bt* cotton during the crop season 2004–05. The beginning of 21<sup>st</sup> century saw many investigations on *Bt* cottons. However, these investigations baring a few focused more on the yield and biological aspects of *Bt* cottons compared to non-*Bt*.

### MATERIALS AND METHODS

The samples of RECH 2 and MECH 184 *Bt* cottons and their non-*Bt* counterparts (RECH 2 and MECH 184) were studied. These cottons were grown at Navsari Agricultural University, Research Farm, Athawa at Surat (Gujarat) in cropping seasons 2004–05 and 2005–06. The cotton fibres were collected on 20, 25, 30, 40 and 45 days at different stages of fibre development. There were 18 rows with 60 dibbles for *Bt* and 18 rows with 15 dibbles for non-*Bt* cottons at the border lines and necessary gap filling were made and inputs were given as per the standard procedures. Physical parameters of fibres like 2.5% span length, tenacity (gm/tex) and micronaire (micro gm/inch), maturity ratio and neps

<sup>1</sup> Scientist (Physics) (e mail: achchheyadav@yahoo.com),

<sup>2</sup> Retired Principal Scientist (Physics) (e mail: gfs@yahoo.com),

<sup>3</sup> Principal Scientist and Head (e mail: drpnachane@hotmail.com)  
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counts/g were determined by the standard procedures. The High Volume Instrument (HVI) was used for the estimation of physical parameters such as 2.5% span length, micronaire and tenacity. High Volume Instrument works on the principle of Constant Rate of Extension (Sundaram *et al.* 2004). The maturity, neps count/g and Immature Fibre Content (IFC) percentage of both types of cottons were estimated by the Advanced Fibre Information System (AFIS). This instrument provides single fibre properties as well as their distribution. The cleaned fibres carry forward through separate pneumatic channels where they are interrupted by a beam of light. Optoelectronic sensors located at appropriate positions to generate voltages proportional to change in intensity of light beam. These voltage changes are converted into meaningful measurement parameters with help of advanced electronics and computation technologies. This instrument consists with Length and Maturity Module, Nep Module and Micro-dust and Trash module.

## RESULTS AND DISCUSSION

Cellulose synthesis in cotton fibre influences the fibre morphological and structural features, which in turn influence the physical, tensile and mechanical parameters of the fibres and their byproduct yarns and fabrics. The physical parameters of *Bt* cottons RECH 2, MECH 184 and their non-*Bt* counterparts (RECH 2 and MECH 184) are summed up in the Tables 1-2. The micronaire (fineness) of cotton fibres is important quality characteristic which plays a prominent part in determining the spinning performance of cotton yarns. Micronaire (fineness) denotes the cross sectional dimensions of the fibres. It may be said that the micronaire development of *Bt* cottons as well as their non-*Bt* counterparts was quite low in the initial stages of growth but latter on it picked up as days progressed (Tables 1, 2). Micronaire of *Bt* cottons RECH 2, MECH 184 and their non-*Bt* counterparts (RECH 2 and MECH 184) fibres were very much similar at the final stage of the fibres development. Value of *t* and on the basis of this evidence we could conclude that there is no significant difference in the micronaire of *Bt* cottons RECH 2 and MECH 184 and their non-*Bt* counterparts. It can be attributed to the consistent and uniform deposition of cellulose on the either cotton fibres.

Among the various parameters which determine the quality of cotton, fibre length occupies a dominant position as it influences to a large extent the spinnability of cotton. Hence, this characteristic of cotton has assumed great importance in commercial transactions and price of cotton. It can be concluded that there is no significant difference in the fibre length of *Bt* cottons RECH 2 and MECH 184 and their non-*Bt* counterparts (RECH 2 and MECH 184) (Tables 1, 2). In addition to fibre length and fineness, fibre tenacity (g/tex) is one of the major factors which influences the strength of yarn spun from staple cotton. In the case of conventional ring spinning, the influence of fibre tenacity becomes more

Table 1 RECH 2 (2004–05 and 2005–06)

RECH-2				
Category	Day	2.5% span length (mm)	Micronaire (microgram/ inch)	Tenacity (g/tex)
2004–05				
<i>Bt</i>	25	29.2	2.3	24.0
Non- <i>Bt</i>		30.9	2.4	23.7
<i>Bt</i>	30	29.0	3.4	24.9
Non- <i>Bt</i>		30.3	3.5	25.0
<i>Bt</i>	35	29.3	4.5	21.3
Non- <i>Bt</i>		30.4	4.4	22.6
<i>Bt</i>	40	31.2	5.0	21.6
Non- <i>Bt</i>		30.8	5.4	20.9
<i>Bt</i>	45	29.0	4.6	22.5
Non- <i>Bt</i>		29.1	4.6	20.9
2005–06				
<i>Bt</i>	25	28.4	2.4	20.9
Non- <i>Bt</i>		29.1	2.7	21.5
<i>Bt</i>	30	28.4	3.1	22.1
Non- <i>Bt</i>		29.1	3.1	22.3
<i>Bt</i>	35	28.7	4.3	19.9
Non- <i>Bt</i>		29.2	4.3	20.8
<i>Bt</i>	40	29.8	4.8	20.8
Non- <i>Bt</i>		30.3	4.6	19.1
<i>Bt</i>	45	29.5	4.8	19.1
Non- <i>Bt</i>		29.7	4.5	20.4

significant. Data summed up (Tables 1, 2) reveal that a change has occurred in the tenacity (strength) of *Bt* cottons and their non-*Bt* counterparts in any stage of development. A cotton fibre consists of a cuticle, a primary layer and secondary layer of cellulose surrounding them lumen or central canal. After the pollination takes place in the flower, some of the epidermal cells of the seed during the first three weeks development the fibre cell is mainly extending longitudinally till its complete length is reached. Although some deposition of cellulose inside the fibre takes place during the elongation period, most of the secondary thickening occurs subsequent to the elongation phase, during the next two to three weeks. If the secondary thickening is proper, the fibre becomes fully mature and lumen width is considerably reduced. All these processes of fibre development influence the maturity of cotton fibres and maturity of fibres determines overall performance of cotton fibres. Analysis of data summed up in the Tables 1, 2 show that the maturity of *Bt* cottons RECH 2 and MECH 184 and their non-*Bt* counterparts (RECH 2 and MECH 184) are increased as days of the growth increased without any definite trend and it became almost the same at the final stage of growth for both the cropping seasons 2004–05 and 2005–06 (Figs 1, 2). Neps are small, entangled clumps

Table 2 MECH 184 (2004–05 and 2005–06)

MECH-184				
Category	Day	2.5% span length (mm)	Micronaire (microgram/ inch)	Tenacity (g/tex)
<i>2004–05</i>				
<i>Bt</i>	25	29.2	2.3	23.6
Non- <i>Bt</i>		28.0	2.4	23.4
<i>Bt</i>	30	28.7	3.3	22.0
Non- <i>Bt</i>		28.6	3.3	23.5
<i>Bt</i>	35	29.1	4.0	22.1
Non- <i>Bt</i>		29.1	4.0	22.6
<i>Bt</i>	40	29.6	4.6	24.0
Non- <i>Bt</i>		30.8	4.6	24.3
<i>Bt</i>	45	29.6	4.5	24.9
Non- <i>Bt</i>		29.7	4.5	25.0
<i>2005–06</i>				
<i>Bt</i>	25	28.7	2.3	22.9
Non- <i>Bt</i>		28.5	2.4	23.0
<i>Bt</i>	30	28.7	3.2	24.0
Non- <i>Bt</i>		28.8	3.2	24.2
<i>Bt</i>	35	29.0	4.9	23.4
Non- <i>Bt</i>		29.0	3.9	23.0
<i>Bt</i>	40	28.8	3.9	24.0
Non- <i>Bt</i>		29.0	4.7	24.1
<i>Bt</i>	45	29.2	4.6	26.0
Non- <i>Bt</i>		29.3	4.6	25.3

of fibres caused by mechanical processing. They are visible as dots or sparks when a thin web of fibres is held to the light or against a dark background. Neps in lint are undesirable because they will appear as defects in yarn and fabrics. The longer and finer cottons tend to have more neps than the shorter and coarser cottons. Lint having a high percentage of thin walled, immature fibres is specially liked to be neppy, which can lead to whitish flicks or specks on the fabric after dyeing. From the analysis of data it could be said that neps counts/g available in *Bt* cottons RECH 2 and MECH 184 and their non-*Bt* counterparts (RECH 2 and MECH 184) were in decreasing trend with the growth and it was almost similar with the crop season of 2005–06 also (Figs 3, 4). Immature fibre content influences the quality of yarn and fabric. It is evident that there is a decreasing trend in the content of immature fibre percentage of both types of cotton but no significant difference was observed between RECH 2, MECH 184 cottons and their non-*Bt* counterparts (RECH 2 and MECH 184) at the final stage of growth (Figs 5, 6).

In general in both types of *Bt* cottons RECH 2 and MECH 184 and non-*Bt* counterparts the fibre length remains fairly constant, micronaire value goes on increasing and gets stabilized at the final stage of fibre development. In tenacity

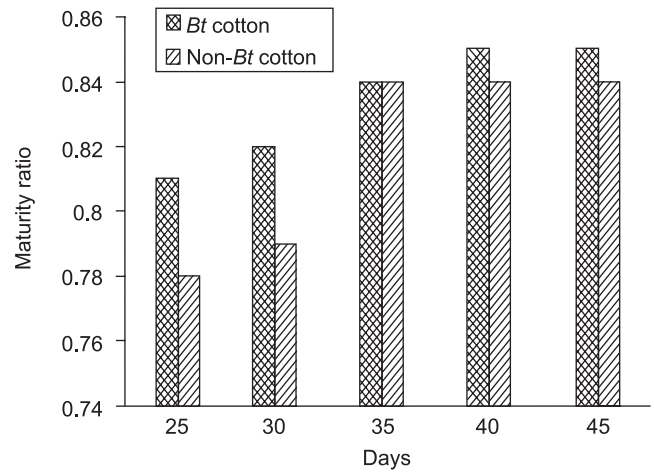


Fig 1 Relation between maturity and days of fibre development of RECH 2 for 2005–06

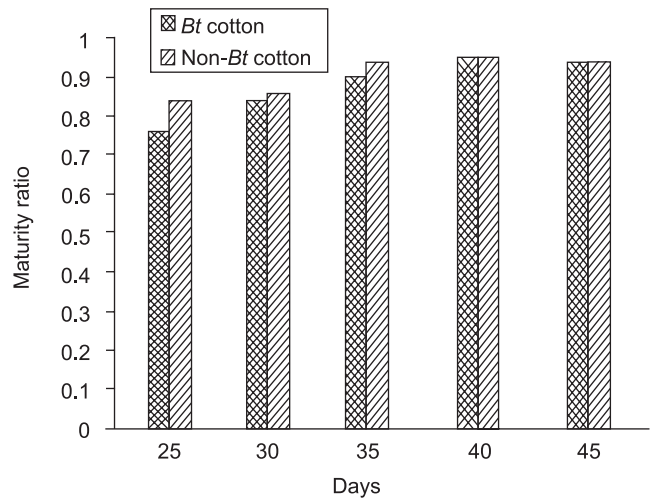


Fig 2 Relation between maturity and days of fibre development of MECH 184 for 2005–06

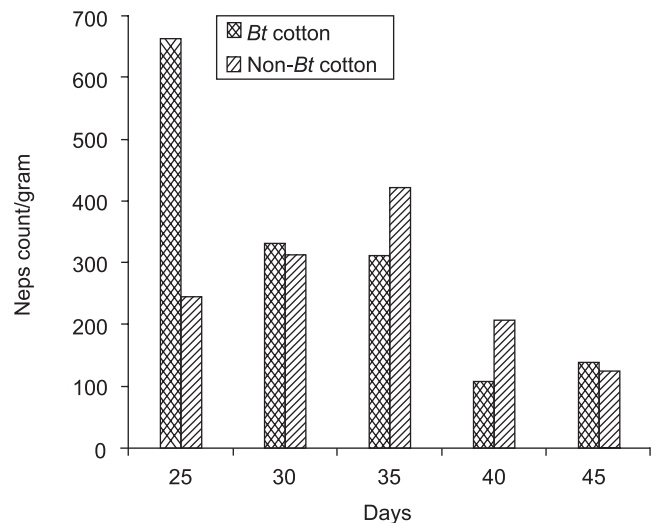


Fig 3 Relation between neps count/g and days of fibre development of RECH 2 for 2005–06

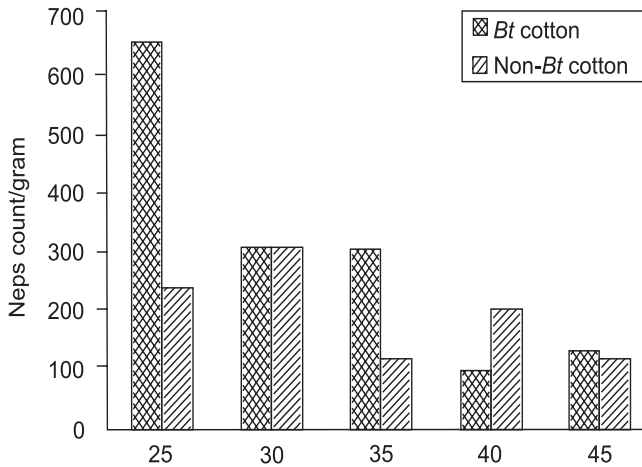


Fig 4 Relation between neps count/g and days of boll development of MECH 184 for 2005-06

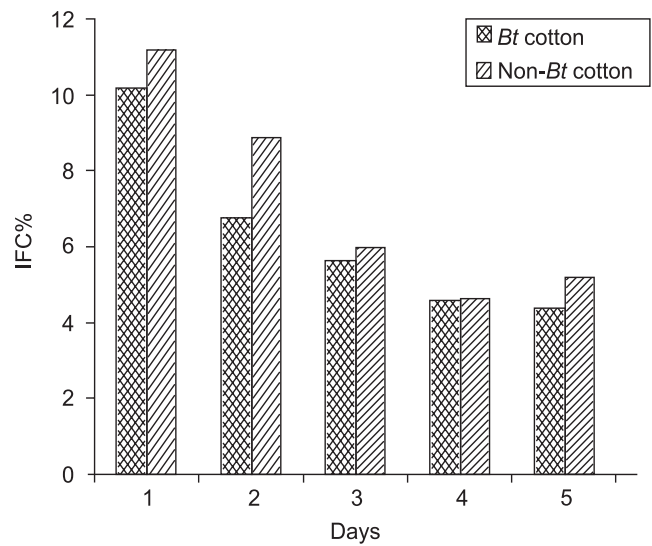


Fig 6 Relation between IFC% and days of boll development of MECH 184 for 2005-06

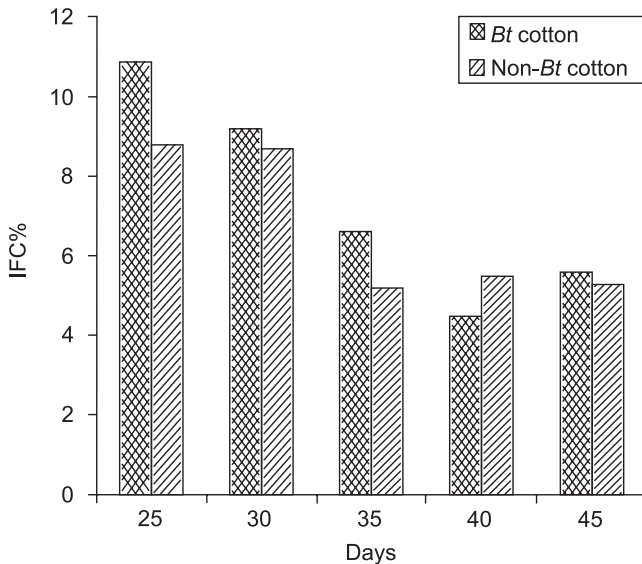


Fig 5 Relation between IFC% and days of boll development of RECH 2 for 2005-06

also the similar trend was seen. It is evident that tenacity of fibres of both *Bt* cottons and their non-*Bt* counterparts on 45<sup>th</sup> day was higher than that of 25<sup>th</sup> day. It can be categorically stated that there was no difference in fibre traits of *Bt* cottons RECH 2 and MECH 184 and their non-*Bt* counterparts at various stages of growth.

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