ANALYSIS VOL. 5, 2019

ISSN 2347–3819 EISSN 2347–386X

DISCOVERY Agriculture

Performance of new Bt-cotton strains for yield and fiber traits

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Article History
Received: 14 July 2019
Accepted: 28 August 2019
Published: September 2019

Citation
Zaheer Ahmed Jatoi, Saifullah Abro, Dongyi Huang, Wenqiang Wu, Haider Bux Jatoi, Faizan Mahmood Halo, Muhammad Tahir Jatoi, Sajjad Ali Panhwar, Mir Hazar Khan Jatoi, Mir Muhammad Nizamani. Performance of new Bt-cotton strains for yield and fiber traits. *Discovery Agriculture*, 2019, 5, 189-202

ABSTRACT

A field experiment was conducted during Kharif 2018 to ascertain the performance of twelve newly evolved advanced elite lines of Bt-cotton strains i.e. Silkee, Neelam-131, RCA, KZ-181, RCA-2, KZ-191, KZ-389, SB-149, Sitara-009, Sitara-10M, Sitara-11M and AA-

904 along with two check verities i.e. IR-3701 and AA-802 were evaluated under field conditions for yield and fiber traits. Among the strains, Sitara-10M and Silkee recorded good performance for almost all the yield traits studied while on the basis of fiber traits, new Bt-cotton strain Silkee measured relatively longer staple length, Sitara-10M gave highest lint percentage, KZ-181 recorded the lowest micronaire value indicating fiber fitness, Sitara-009 measured maximum fiber strength. Among twelve new Bt-cotton strains, two strains Sitara-10M and Silkee proved better for fiber, yield and bollworm resistance traits while KZ-181 and Sitara-009 performed better for micronaire and fiber strength. These strains could be utilized in future breeding programs for the development of high yielding, bollworm resistant and good fiber quality Bt-cotton cultivars. High heritability estimates in a broad sense for plant height, monopodial branches plant^{-1}, sympodial branches plant^{-1}, bolls plant^{-1}, boll weight, seed cotton yield plant^{-1}, GOT, staple length, seed index, micronaire, fiber strength, and bollworm infestation indicated that the traits under study are highly heritable.

Keywords: Analysis, replications, variance, strength, heritability, bollworm infestation, resistant, heritable

1. INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is the most important economic crop and plays an important role in the Pakistani economy, not only providing raw materials for the entire textile industry, but also earning valuable foreign exchange. Cotton fiber is the main raw material for the development of the modern national textile industry, including public and private factories and the home weaving department, which is mainly produced in traditional clothing. As cottonseed oil is used in cooking and cottonseed cakes are increasingly popular as livestock and fishery feed, cotton is increasingly recognized as an important food and feed crop. Cotton also provides employment opportunities. More than one-fifth of people directly or indirectly obtain livelihoods from cotton cultivation, ginning, by-product processing and trade (Memon et al., 2007).

At present, Pakistan's cotton crop faces a series of constraints, including low yield per mu, high agricultural input prices (seeds, fertilizers, pesticides, etc.), high-intensity episodes of insects and pests, high-yield and high-quality seed shortages, and insufficient irrigation water and lack of information on advanced production techniques, lack of understanding of genetically modified varieties, adulteration of agriculture and adulteration of agricultural inputs. Flexible weather conditions also lead to early crop growth and increased incidence of pests during flowering and boll formation, thereby reducing the number and weight of cotton bolls (Rao, 2007). In order to increase the competitiveness of cotton, it is necessary to increase cotton production. Varieties vary widely in potential yields. Input requirements and agronomic practices should be adjusted experimentally, depending on the variety. Promising genotypes and fertilizer management are important aspects of yield development. Seed cotton yield and lint yield are significantly different due to different fertilizer management (Tomar et al., 2000). The added value of cotton crops in agriculture increased by 8.6% and was 40% of the employment rate in rural communities. Through the surplus of exportable cotton fiber and fiber products, it also obtained a large amount of foreign exchange of 60%, accounting for about 1.8% of GDP (Anonymous, 2009).

Bt (*Bacillus thuringiensis*) is a transgenic cotton variety that produces toxins that kill cotton bollworms, which are responsible for most of the damage to cotton crops worldwide. These varieties have significant multiple benefits, including increased yield, reduced pesticide costs, reduced environmental benefits from pesticide use, reduced fungal contamination, and reduced labor requirements (Huang et al., 2002; Bennett et al., 2004; Huesing & English) , 2004; Purcell & Perlak, 2004 and Bennett et al., 2006). A major issue regarding the long-term use of Bt. Diversity is their potential vulnerability to the adaptation of cotton bollworm to Bt. toxin. The continuous existence of Bt toxins exert a strong selection pressure on cotton bollworms, which ultimately leads to insect resistance to toxins. Sensitivity to Bt if most pest populations develop resistance. Toxins are reduced, which reduces the control of Bt cotton against pests; this leads to reduced yields and increased insect control costs (Qaim et al., 2003).

Considering the geographical conditions and farming systems of cotton breeding in Pakistan, to promote precocity, heat tolerance and low input requirements, the development of CLCuV, pest population resistance and high-quality characteristics is the main target. These breeding goals help protect the environment, increase cotton productivity, and make cotton production a profitable business. Most cotton growers in Pakistan are poor and unable to pay for large amounts of fertilizers, pesticides and irrigation water. Varieties with deeper roots and higher body size require less irrigation water and therefore meet the needs of farmers. Similarly, varieties with the Bt gene provide resistance to cotton bollworm, thus reducing the cost of insecticide control of these insects (Gouse et al., 2005).

Some studies based on semi-structured questionnaires and informal interviews have initially compared the performance of existing Bt varieties in Pakistan with recommended non-Bt varieties (Hayee, 2004; Sheikh et al., 2008; Arshad et al., 2009). These studies have found that the performance of existing Bt cotton is relatively poor compared to the recommended conventional varieties. These preliminary results raise two main questions: If profitability is low, why will the adoptions of Bt varieties increase over time? Moreover, what is the impact of Bt cotton on the health of farmers? Only two studies have systematically and positively evaluated the current effects of Bt cotton adoption in Pakistan (Kouser and Qaim, 2012). Therefore, the current study was conducted to evaluate new Bt-cotton strains in order to develop promising cotton cultivars for commercial cultivation.

Objectives

1. To determine the fiber quality of newly evolved Bt-cotton strains
2. To investigate the impact of the bollworm population on Bt-cotton
3. To estimates heritability in a broad sense of various yield and fiber traits

2. MATERIALS AND METHODS

A field experiment was conducted at the Kharif season 2018, in order to investigate the performance of new Bt-cotton strains for yield and fiber traits. Twelve newly evolved advanced elite lines of Bt-cotton strains i.e. Silkee, Neelam-131, RCA, KZ 181, RCA-2, KZ-191, KZ-389, SB-149, Sitara-009, Sitara-10M, Sitara-11M and AA-904 along with two check verities i.e. IR-3701 and AA-802 were evaluated under field conditions. The experiment was laidout in a Randomized Complete Block Design (RCBD) with three replications. The distances between plant to plant and row to row were kept at 30 and 75 cm respectively. The collected data were analyzed according to Gomez and Gomez (1984) and broad sense heritability estimated according to Burton (1951) on entry mean basis.

Observations recorded

1. Plant height (cm)
2. Monopodial branches plant $^{-1}$
3. Sympodial branches plant $^{-1}$
4. Bolls plant $^{-1}$
5. Boll weight (g)
6. Seed cotton yield plant $^{-1}$
7. Ginning outturn (GOT) (%)
8. Staple length (mm)
9. Seed index (100 seed weight g)
10. Micronaire value
11. Fiber strength
12. Bollworm infestation

3. RESULTS

The experiment was conducted to evaluate the mean performance of new Bt-cotton strains for yield and fiber traits during the cotton growing season 2012. The experiment was laid out at the experimental field of Nuclear Institute of Agriculture (NIA) Tandojam, for assessing a range of traits such as plant height (cm), monopodial branches plant^{-1},sympodial branches plant^{-1},bolls plant^{-1}, boll weight (g), seed cotton yield plant^{-1} (g), ginning outturn (GOT%), staple length (mm), seed index (100 seed weight g), micronaire value (μg/inch), fiber strength (lbs inch^{-2}) and bollworm infestation (%) in twelve new Bt-cotton strains along with two check.

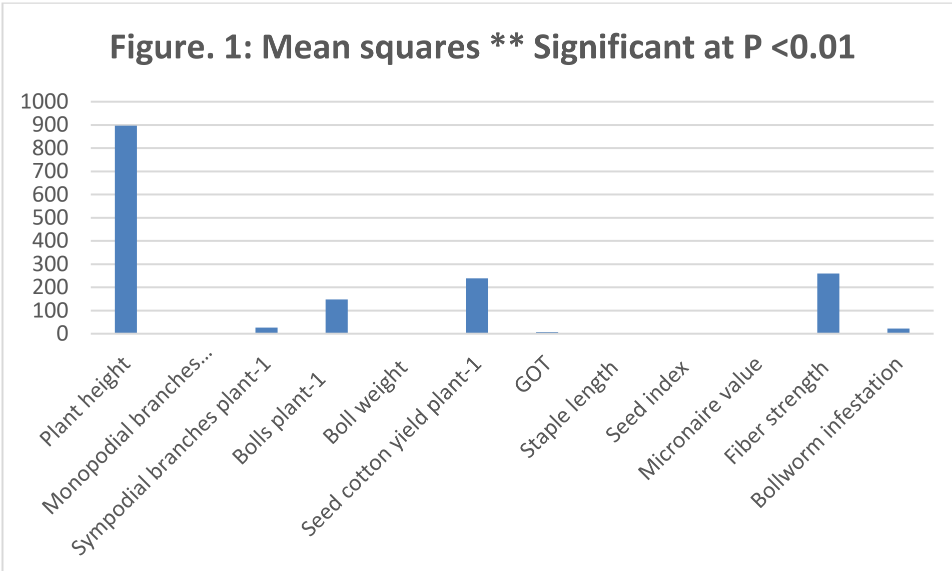
Analysis of variance

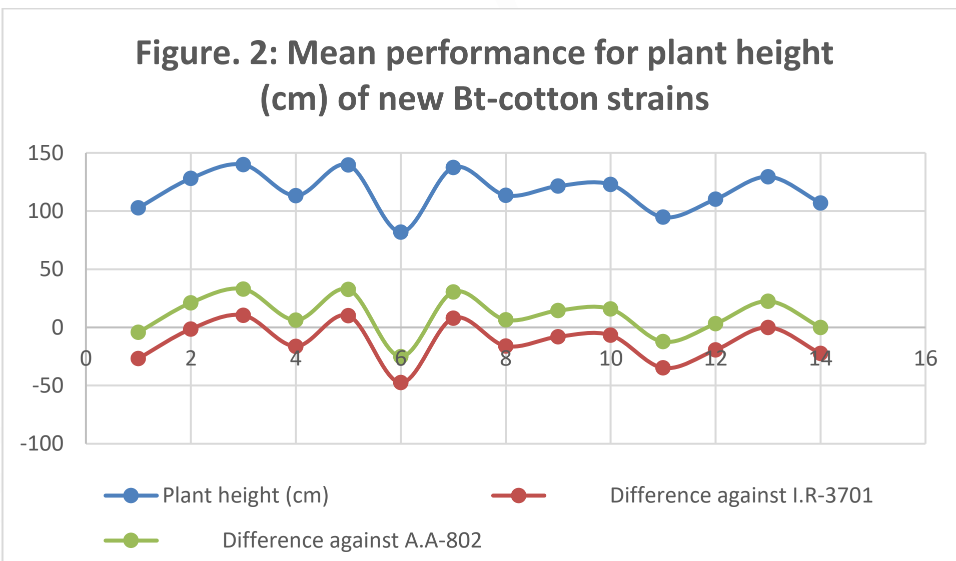
Mean squares from analysis of variance (figure 1) revealed that all the traits viz. plant height, monopodial branches plant$^{-1,}$ sympodial branches plant$^{-1,}$ bolls plant^{-1}, boll weight, seed cotton yield plant^{-1}, ginning outturn, staple length, seed index, micronaire value, fiber strength and bollworm infestation studied were significantly different, which indicated that strains performed variably for all the studied traits. The results are described in the following paragraphs as under:

Mean Performance of new Bt. strains for yield and fiber traits

Plant height (cm)

Plant height is a quantitative trait and a major plant growth indicator and it is generally influenced by inputs and environment. The average plant height presented in figure 2 revealed that new Bt-cotton strain KZ-191 (82.0 cm) produced the shortest plants as compared to commercial check I.R-3701 (129.5 cm) and A.A-802 (106.9 cm). The tallest plants were observed in a new Bt-cotton strain RCA (139.9 cm) and were comparatively resulted taller than standard checks i.e. I.R-3701 (129.5 cm) and A.A-802 (106.9 cm), respectively.

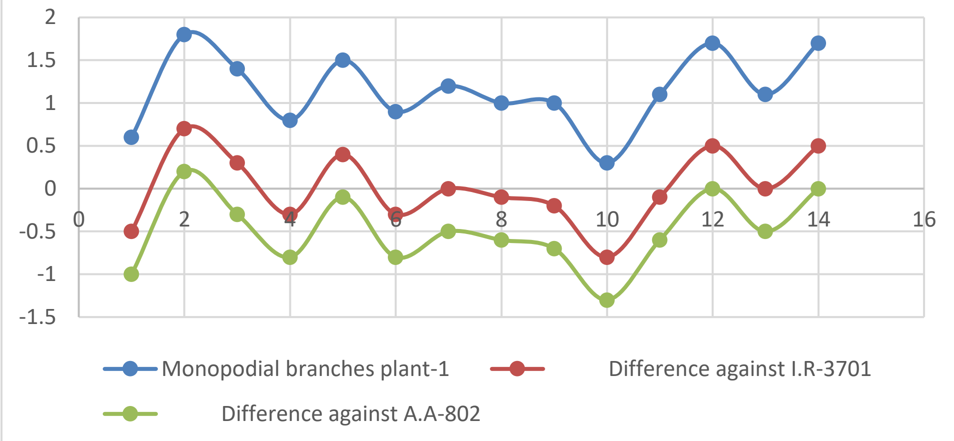




Monopodial branches plant^{-1}

The cultivars have a low number of monopodial branches plant^{-1} with higher seed cotton yield. Therefore, breeding for higher yields preference should be given to less vegetative branches per plant. The average number of monopodial branches plant^{-1} shown in figure 3 showed that maximum number (1.8) of monopodial branches plant^{-1} was recorded in new Bt-cotton strain Neelum-131 which is 1.1 and 1.6 higher than the check verities I.R-3701 (0.7) and A.A-802 (0.1), respectively. Whereas Sitara-10M produced minimum (0.3) number of monopodial branches plant^{-1} which is -0.8 and-1.3 lower than check varieties I.R-3701 (1.1) and A.A-802 (1.6) respectively.

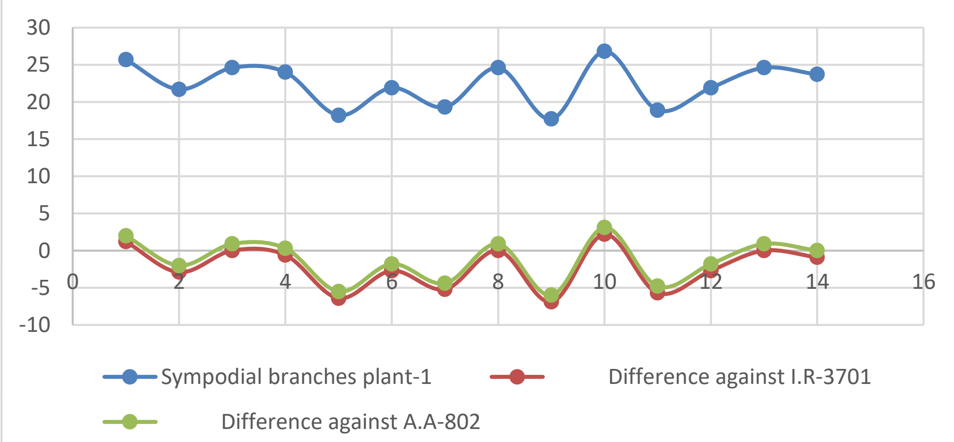
Figure. 3: Mean performance for monopodial branches per plant of new Bt-cotton strains



Sympodial branches plant^{-1}

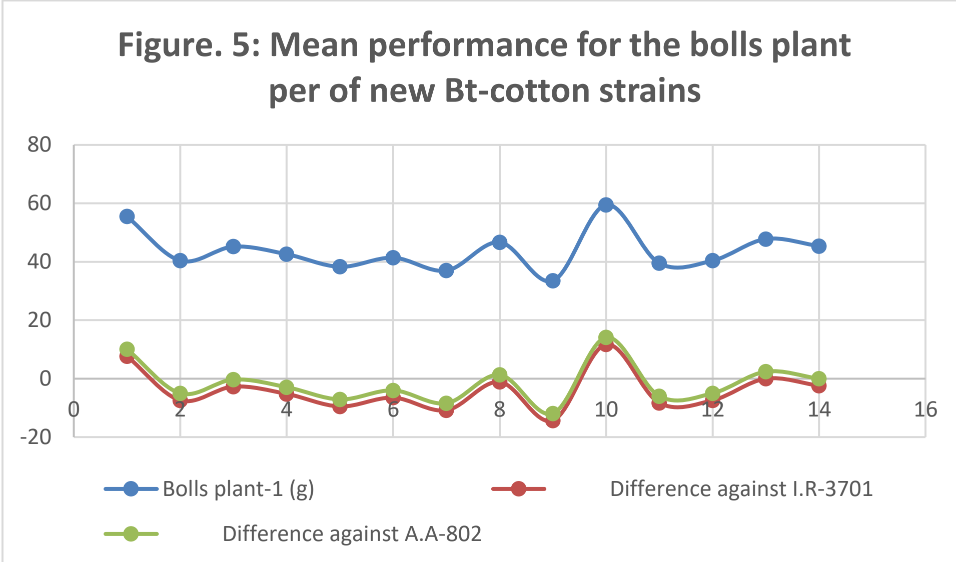
Sympodial branches are the main fruiting branches and linearly affect final yield. Figure 4 indicated that the lowest (17.7) number of sympodial branches plant^{-1} was recorded in a Bt-cotton strain Sitara-009 which is -6.9 and -5.9 lower than commercials i.e. I.R-3701 (24.6) and A.A-802 (23.7), respectively. While Sitara-10M produced maximum (26.8) number of sympodial branches plant^{-1} which is 2.2 and 3.1 higher than checks I.R-3701 (24.6) and A.A-802 (23.7) varieties, respectively, among all the new Bt-cotton strains, studied.

Figure. 4: Mean performance for the sympodial branches per plant of new Bt-cotton strains



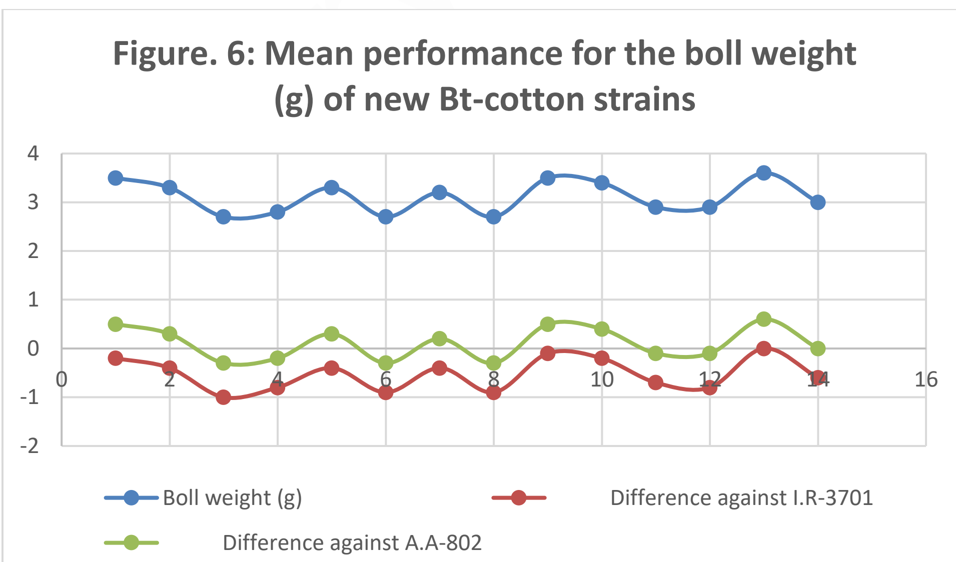
Bolls plant^{-1}

The results regarding a number of bolls plant^{-1} presented in figure 5 revealed that new Bt-cotton strains Sitara-10M set maximum number of bolls plant^{-1} (59.5 bolls) followed by Silkee (55.5) which is comparatively higher than standard check varieties i.e. I.R-3701 and A.A-802, both produced 47.8 and 45.4 bolls plant^{-1} respectively. While Bt-cotton strains Sitara-009 set a minimum number of bolls plant^{-1} (33.5 bolls) which is -14.3 and -11.9 bolls lower than I.R-3701 (47.8) and A.A-802 (45.4) respectively. It can be suggested that new Bt-cotton strains Sitara-10M and Silkee may be utilized in breeding programmes for the exploitation of varieties producing a higher number of bolls plant^{-1}.



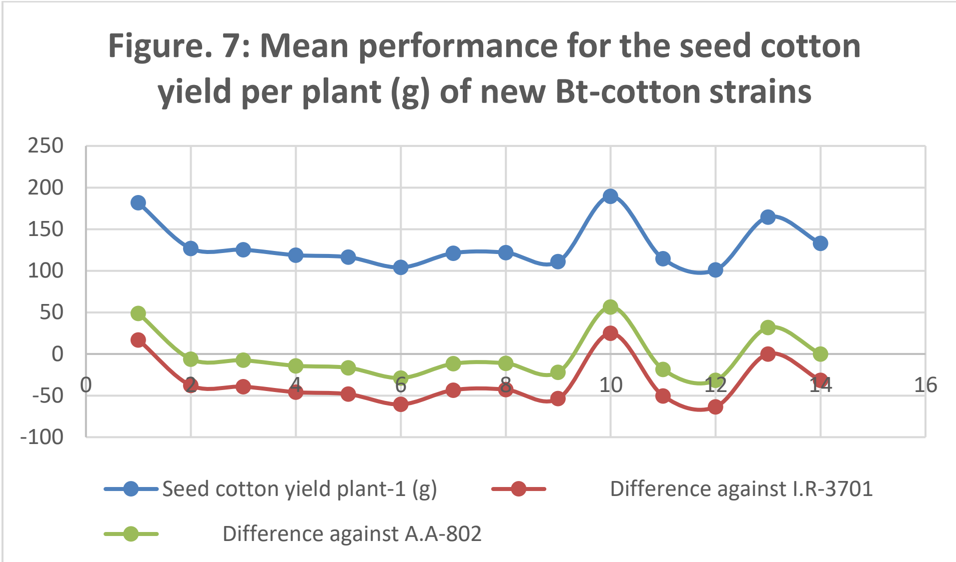
Boll weight (g)

It is assumed that as the boll weight increases, the seed cotton yield will also increase, thus boll weight has a direct influence on seed cotton yield. The results regarding boll weight presented in figure 6 showed that minimum boll weight with 2.7g was weighed by RCA which is -0.9 and -0.3 g comparatively lower than check varieties I.R-3701 and A.A-802 which weighed 3.6 and 3.0 g respectively. Whereas, the new Bt-cotton strain Sitara-009 (3.5g) and Silkee (3.5g) produced higher boll weight which is about equal to check varieties I.R-3701 and A.A-802 (3.6, 3.0).



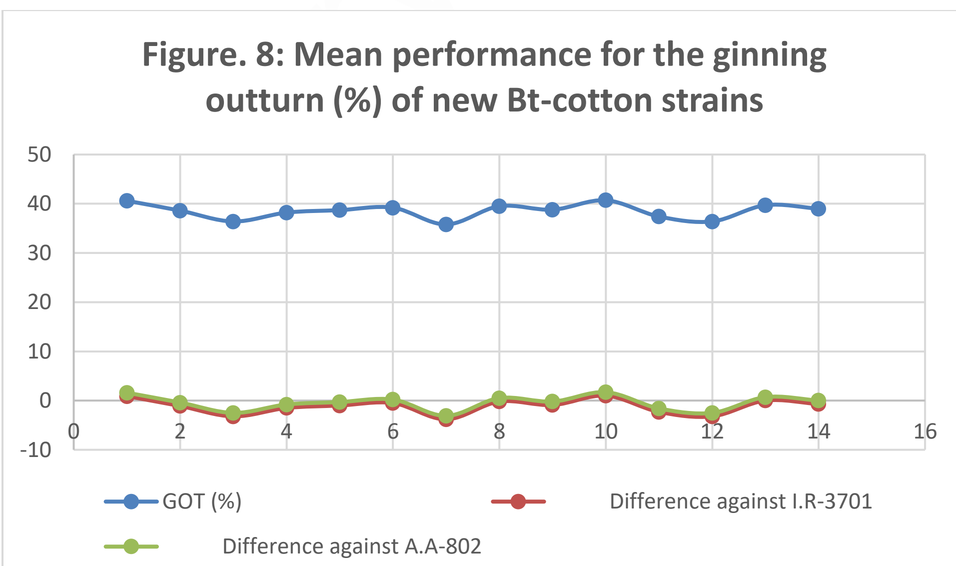
Seed cotton yield plant^{-1} (g)

The results regarding seed cotton yield plant^{-1} presented in figure 7 showed that new Bt-cotton strain Sitara-10M produced the highest seed cotton yield plant^{-1} (189.4 g) followed by Silkee (181.6 g), whereas new Bt-cotton strain A.A-904 gave the lowest (101.1 g) seed cotton yield plant[1]. As compared to check varieties i.e. I.R-3701 and A.A-802 produced seed cotton yield of 164.6 and 132.9 g, respectively.



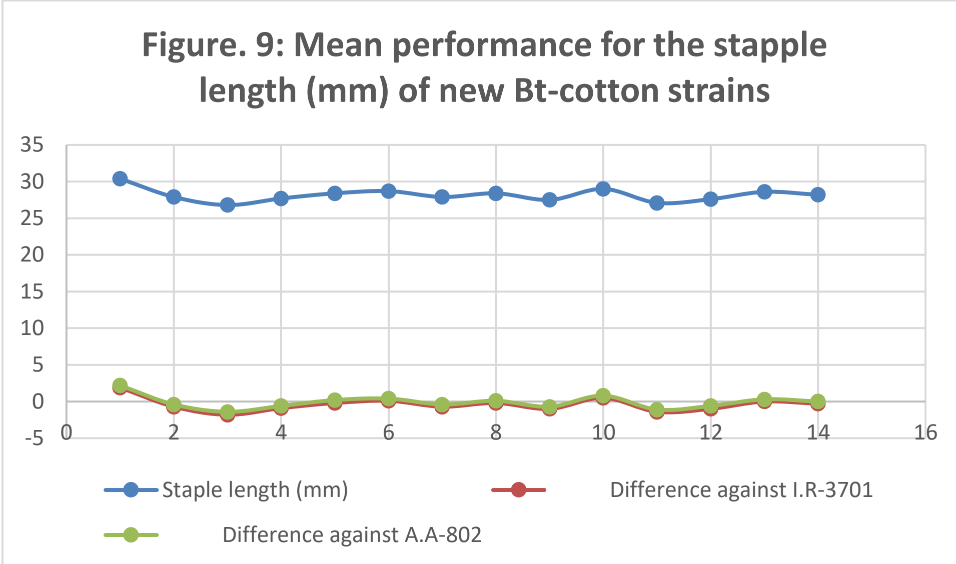
GOT (%)

The mean performance regarding GOT% is represented in figure 8 which depicted that the new Bt-cotton strain Sitara-10M ginned significantly highest lint percentage (40.7%) which is 1.0% and 1.7% higher than standard checks I.R-3701 (39.6%) and A.A-802 (38.9%), respectively. While a new Bt-cotton strain KZ-389 gave the lowest lint percentage (35.8%) which is -3.8 and -3.1% lower than both the commercial check varieties I.R-3701 (39.6%) and A.A-802 (38.9%), respectively. Results suggested that new Bt-cotton strains Sitara-10M may be utilized in breeding programs for exploitation of varieties producing higher ginning outturn percentage.



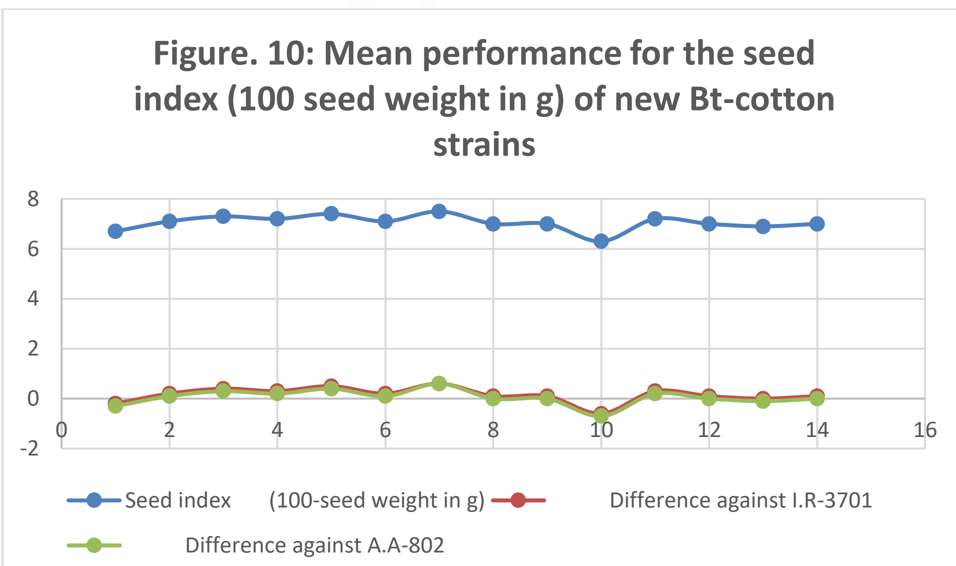
Staple length (mm)

The mean performance regarding this character is presented in figure 9 revealed that the new Bt-cotton strain Silkee measured the longest staple length (30.4mm) as compared to standard checks I.R-3701 (28.6mm) and A.A-802 (28.2mm) which showed that new Bt-cotton strain Silkee gave 1.9 and 2.2mm higher staple length than both the checks. While RCA produced shorter staple length of 26.8mm, as compared to check varieties I.R-3701 (28.6 mm) and A.A-802 (28.2 mm) staple length.



Seed index (100-seed weight g)

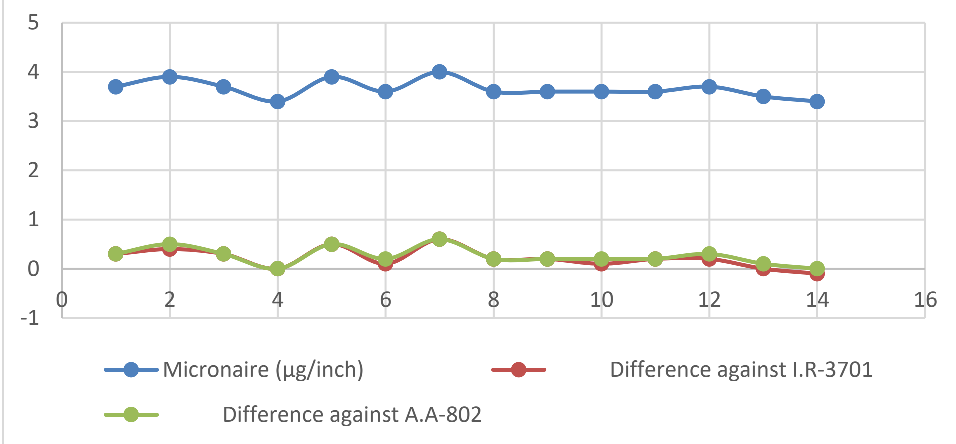
The data with respect to seed index presented in figure 10 revealed that the new Bt-cotton strain KZ-389 gave the maximum 100-seed weight (7.5g) which is comparatively 0.6 and 0.5g higher than I.R-3701 (6.9g) and A.A-802 (6.9g). Whereas RCA-2 ranked at second by producing (7.4g) 100-seed weight after KZ-389; however, the minimum seed index value of 6.3g was obtained from strain Sitara-10M as compared to check varieties I.R-3701 (6.9g) and A.A-802 (6.9g).



Micronaire (µg/inch)

The results regarding micronaire values are presented in figure 11 which indicated that the new Bt-cotton strains gave significantly variable micronaire value. On the basis of mean performance, the strain KZ-389 showed the highest micronaire value (4.0µg/inch) followed by RCA-2 (3.9µg/inch). Nonetheless, KZ-181 measured the lowest micronaire value (3.4µg/inch) which is at par with check varieties I.R-3701 and A.A-802 with micronaire values 3.4 and 3.4µg/inch, respectively.

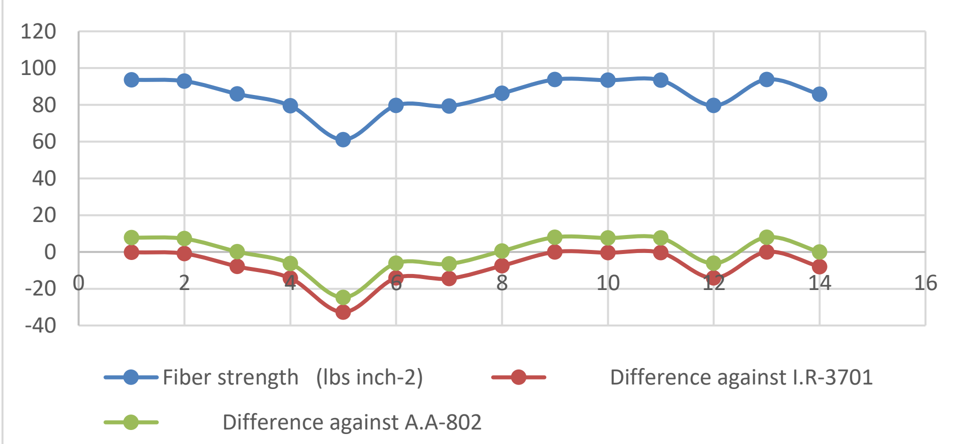
Figure. 11: Mean performance for the micronaire (ug/inch) of new Bt-cotton strains



Fiber strength (lbsinch^{-2})

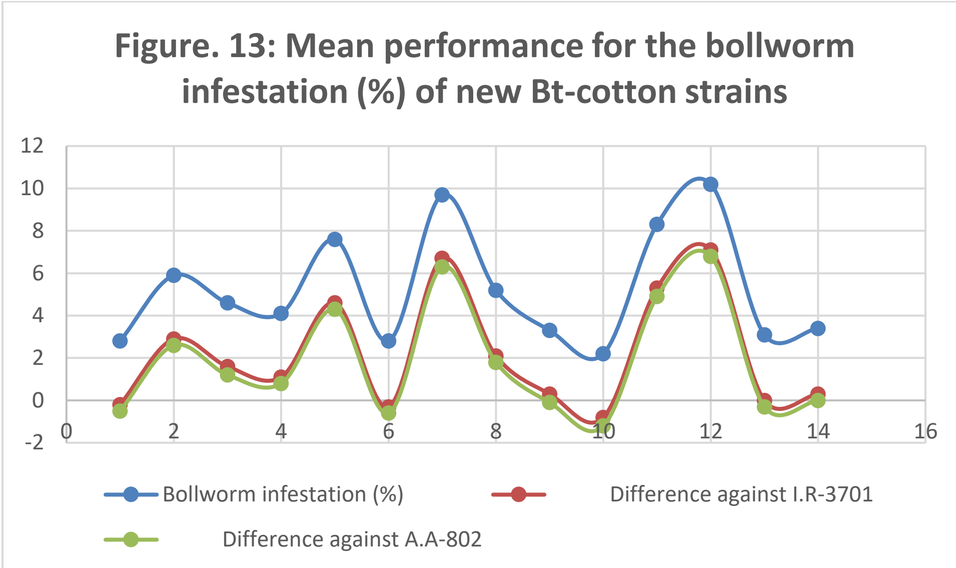
The results regarding to fiber strength (lbs inch^{-2}) are mentioned in figure 12 which show that the new Bt-cotton strain Sitara-009 resulted in highest fiber strength (93.8 lbs inch^{-2}) but more or less followed by the new strain Silkee (93.5 lbs inch^{-2}) whereas strain RCA-2 resulted in lowest fiber strength (61.0 lbs inch^{-2}) as compared to check varieties I.R-3701 (93.8 lbs inch^{-2}) and A.A-802 (85.8 lbs inch^{-2}).

Figure. 12: Mean performance for the fiber strength (lbs inch-2) of new Bt-cotton strains



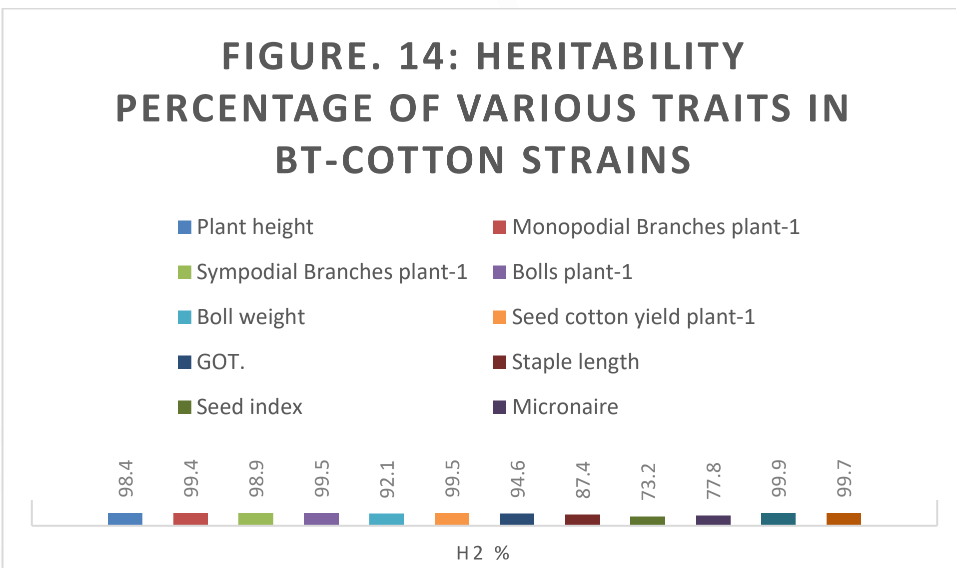
Bollworm infestation (%)

The average number of infested bolls plant^{-1} presented in figure 13 showed that maximum infested bolls (10.2%) were recorded in the new Bt-cotton strain A.A-904, whereas Sitara-10Mresulted in the minimum number of infested bolls plant^{-1} (2.2 bolls). However, both the check varieties I.R-3701 and A.A-802 showed the infested bolls plant^{-1} of 3.0 and 3.4, respectively. Among all the strains studied, A.A-904 resulted highly susceptible to bollworm may be due to do not created genetic alterations in this genotype, whereas Sitara-10M was observed as tolerant against bollworm infestation may be due to genetic alterations created in this genotype.



Heritability estimates in a broad sense (h²%)

The yield and fiber traits recorded higher heritability estimates in broad sense for plant height (h^2 = 98.4%), monopodial branches plant^{-1} (h^2 = 99.4%), sympodial branches plant^{-1} (h^2 = 98.9%), bolls plant^{-1} (h^2 = 99.5%), boll weight (h^2 =9.1%), seed cotton yield plant^{-1} (h^2 =99.5%), GOT. (h^2 = 94.6%), staple length (h^2 = 87.4%), seed index (h^2 = 73.2%), micronaire (h^2= 77.8%), fiber strength (h^2= 99.9%) and bollworm infestation h^2= 99.7% (Figure 14).



4. DISCUSSION

Cotton fiber is more challenging than synthetic fiber; increasing cotton yield per unit area is inevitable to meet the basic human needs for clothing, and biotechnology is one of the best methods in developed countries. Bt cotton has performed equally well in countries such as Pakistan. Although the main controlling factor is the availability of real seed seeds, there is an urgent need to develop new packaging production techniques for Bt. Variety and create awareness among farmers. The aim of conducting, the present studies deal with those objectives. The present study was carried out to evaluate the performance of new Bt. cotton strains for yield and fiber traits. Twelve newly evolved advanced lines of Bt-cotton strains i.e. Silkee, Neelam-131, RCA, KZ-181, RCA-2, KZ-

191, KZ-389, SB-149, Sitara-009, Sitara-10M, Sitara-11M and AA-904 along with two check varieties i.e. IR-3701 and AA-802 were evaluated under field conditions.

The analysis of variance revealed that all the strains and check varieties performed significantly different for plant height, monopodial branches plant^{-1}, sympodial branches plant^{-1},bolls plant^{-1}, boll weight, seed cotton yield plant^{-1}, GOT, staple length, seed index, micronaire value, fiber strength, and bollworm infestation. The character wise results are discussed as under:

Mean performance of yield and fiber parameters

Plant height (cm)

Plant height is an important trait that enables crops to compete specifically with weeds and often competes with other pests for light intercepting and photosynthesizing. The plant height of cotton varieties is significantly different. The maximum plant height (139.9 cm) was observed in the case of strain RCA, which was statistically equivalent to strain RCA-2 (139.6 cm). The minimum plant height (82.0 cm) was observed in the cultivar KZ-191. The differences in plant height observed in Bt-cotton lines can be attributed to changes in the genetic composition of crop plants. The current results are consistent with the study by Naveed et al. (2006), Nisar et al. (2007) and Jatt et al. (2007).

Monopodial branches plant^{-1}

The cultivars have a low number of monopodial branches plant^{-1} have higher seed cotton yield. Therefore, in breeding for higher yield preference should be given to less vegetative branches plant^{-1}. The monopodial branches plant^{-1} varied from 0.3 to 1.8 among all the Bt-cotton genotypes. The lowest monopodial branches plant^{-1} was recorded in Sitara-10M followed by Silkee and KZ-181 which was also lower than both the check varieties IR-3701 and AA-802. These findings are similar to those obtained by Jatt et al. (2007).

Sympodial branches plant^{-1}

Data on the number of common branches of plant-1 revealed significant differences between Bt-cotton strains. The strain Sitara-10M produced the highest number of symbiotic branching plants^{-1} (26.8) and was statistically equivalent to the strain Silkee (25.7). The minimum number of plants^{-1} was produced by Sitara-009 (17.7). The difference in many common branches of plant-1 can be attributed to differences in the genetic makeup of the strain. Copur (2006) also reported significant differences between strains of many Sympodial branches plant^{-1}.

Bolls plant^{-1}

A number of total bolls formed by each plant determines the yield potential of a variety and is considered as a major yield component and having a strong relationship with seed cotton yield. Through breeding for improvement of this trait, it is generally believed that an increase in boll numbers in cotton would ultimately increase the seed cotton yield. The new Bt-cotton strain Sitara-10M (59.5 bolls) produced the maximum number of bolls plant^{-1} followed by Silkee (55.5), while Sitara-009 formed a minimum number of bolls (33.5). It can be suggested that varieties Sitara-10M and Silkee may be utilized in further breeding programmes in order to develop new high yield cultivars. Similar results were also obtained by Azhar et al. (1999).

Boll weight (g)

Boll weight has a direct impact on seed cotton yield, as it is assumed that seed cotton yield will increase as bell weight increases. The results of the bell weight showed that Sitara-009 was then Silkee (3.5 g) producing a medium weight (3.5 g) boll, while strain RCA produced a smaller boll (2.7 g). Our results indicate that Silkee and Sitara-009 can be evolved as potential parents to new Bt cotton with ideal boll size. Ahmad et al. obtained similar results (2008) and Saadabadi and Tahmasebi (2008).

Seed cotton yield plant^{-1} (g)

Our results show a significant difference in this trait, and the strain Sitara-10M produces the highest seed cotton yield plant-1 (189.4 g), followed by Silkee (181.6 g), while AA-904 produces the smallest seed cotton yield plant^{-1} (101.1g). The current results are consistent with the results of Panhwar et al. (2008) and Baloch and Veesar (2007). Breeders have successfully developed high-yield and high-quality varieties in the world, such as C-6037, Termeze-14, Termeze-16, Termeze-24 and Karshan-8.

Ginning outturn percentage (GOT%)

The percentage of ginning exports is a complex polygenic trait that is largely influenced by environmental factors. It depends mainly on the weight of the lint, which has a direct impact on the seed cotton yield. Choosing a higher ginning yield usually results in an increase in production plant^{-1} and unit area. The results in figure 8 show significant differences between the varieties, and it is also observed that the new Bt-cotton variety Sitara-10M significantly increased the highest percentage of lint (40.7%), while the strain KZ-389 provided the lowest Percentage of cotton wool (35.8%). Azhar et al. (1999) obtained similar results. Current results indicate that RCA-2 and Sitara-10M can be used in breeding programs to increase the percentage of lint.

Staple length (mm)

The length of the staples directly contributes to the quality of the yarn. Changes in fiber length were found within the strain or even in a single boll. The uniformity of the length of the staple fibers improves the spinning performance. The maximum fiber length (30.4 mm) was observed in the strain Silkee and it was consistent with the results obtained by Azhar et al. (1999) and Hussian et al. (2007).

Seed index (100 seed weight in g)

The seed index is also an important yield factor and plays an important role in increasing seed cotton yield. Dani (1991) studied the average performance of seed index of upland cotton varieties and observed significant changes in seed index between varieties. Suinaga et al. (2006), Taohua and Haipeng (2006) and Meena et al. (2007) studied the yield of upland cotton varieties and observed changes in seed index. The seed index (figure 10) in the current study was 6.3 to 7.5 g for 12 Bt-cotton varieties and two commercial tests. Due to the more biliary seeds, KZ-389 is superior to all other genotypes with a maximum of 100 grain weight (7.5 g). It was also found statistically that it was identical to the other strains, RCA-2, and produced a second stage by producing (7.4 g). The lowest seed index was observed in the seed index (6.3 g) of the Sitara-10M strain.

Micronaire (µg/inch)

Fiber fineness is related to fiber diameter and fiber wall thickness. The micronaire value determines the spinning quality of the cotton variety. In this experiment, the LSD comparison showed a significant difference between the new Bt-cotton strains, indicating that the new Bt-cotton strain KZ-181 had the largest fiber fineness (3.4 µg/inch) compared to the other strains. Naveed et al. reported very similar changes in micronaire values for different Bt cotton strains (2006) and Nisar et al. (2007).

Fiber strength (lbs inch^{-2})

Fiber strength is an important parameter that determines the yarn spinning value. It is difficult to obtain high fiber strength without sacrificing yield. A comparison of LSD showed that all Bt-cotton strains differed significantly from each other in fiber strength. The Bt-cotton strain Sitara-009 produced very strong fibers (93.8 lb-in-2), but its seed cotton yield was the lowest, indicating that this quality trait may be affected by the yield potential of the strain. These results were confirmed by the results of the study by Asad et al. (2002), Hussain et al. (2007), Nasir et al. (2007).

Bollworm infestation (%)

Helicover paarmigera infection is a major obstacle to the increase of cotton crop yield. Compared with sensitive varieties, strains resistant to cotton bollworm infection are preferred for general cultivation (Khan et al., 1993). The new Bt-cotton Sitara-10M showed tolerance to cotton bollworm infection, probably due to genetic changes in this genotype. This argument was supported by Azhar et al. (1999) and Asad et al. (2002). Who also described the low sensitivity of Bt cotton to cotton bollworm.

Heritability estimates in a broad sense (h^2%)

Traits with high heritability are more likely to improve than those with lower heritability. Yield and fiber traits show high heritability estimates in a broad sense, ie plant height, single-branched plant^{-1}, symbiotic shoot plant^{-1}, cotton boll plant^{-1}, boll weight, seed cotton yield plant^{-1}, GOT, major length, seed index, micronaire value, fiber strength and cotton bollworm infection. Our results are consistent with the results of Batool et al. (2010) and Dhivya et al. (2014) also reported high heritability of characteristic plant height, parthenocarp^{-1}, rhizome^{-1}, boll weight, seed index, micronaire value and seed cotton yield-1. Other researchers such as Farooq et al. (2013) Estimated fiber strength, fiber fineness, yield kg/ha, boll weight, plant height and heredity of boll botanical^{-1} (generalized) were higher.

Funding: This study has not received any external funding.

Conflict of Interest: The authors declare that there are no conflicts of interests.

Peer-review: External peer-review was done through double-blind method.

Data and materials availability: All data associated with this study are present in the paper.

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