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Research Note

Assessment of yield and yield related traits to determine earliness in Egyptian cotton (*Gossypium barbadense*, L).

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Abstract

A field experiment was conducted to identify elite early maturing *G. barbadense* genotypes by evaluating morphological and fibre quality traits advanced genotypes developed at CICR, Regional Station, Coimbatore. Ten advanced genotypes of *G. barbadense* genotypes *viz*., CCB-5, CCB-11, CCB-17, CCB-26, CCB-27, CCB-28, CCB-29, CCB-30, CCB-33 and CCB-36 were used in this study. In the present study, analysis of variance of genotypes was highly significant for all the traits studied. Three genotypes *viz,*. CCB-29, CCB-36 and CCB-5 were found to be early maturing in terms of days to first flower, lower node no to first sympodial branch, boll formation in 90, 120 and 150 days after sowing and opening of bolls in 120 and 150 days after sowing. Regarding yield traits, maximum number of bolls per plant and higher seed cotton yield were recorded in the genotypes CCB-29, CCB-36 and CCB-5. It was also observed that maximum staple length, strength and desirable micronaire were registered in CCB-29, CCB-36, CCB-5 and CCB-11. The correlation coefficients showed that the days taken to first flower, number of nodes in lower first sympodial branch, bolls formed at 150 days, number of bolls per plant have significant positive correlations with seed cotton yield. The positive correlations of yield components with seed cotton yield are reliable and more effective and efficient indicators for selecting early maturing genotypes in Egyptian cotton.

Keywords

Gossypium barbadense, genotypes, traits, staple length, earliness

Globally India has the largest area of cotton cultivation that contributes 23% to the cotton production. It occupies a unique position in Indian economy in terms of income generation in the agricultural and industrial sectors. Upland cotton, *Gossypium hirsutum* L., is the world's leading Fibre producing crops and grown more than 80 countries in an annual production of 20 million tons (Dutt et al. 2004) and another 8-9 % constitutes the share of the *G. barbadense* cotton varieties. In India, research on *G. barbadense* has been neglected as compared to other cultivated species (Alkuddsi et al. 2013). However, in the recent past, the Egyptian cotton, *G. barbadense* gains lot of importance as it possesses high fibre quality traits than *G. hirsutum* and it is known for extra long staple cotton. No sufficient progress has been achieved in improving the yield and yield related characters of *G. barbadense as G. hirsutum* species. Various efforts have been taken to improve the yield and yield related characters without sacrificing fibre quality parameters of *G. barbadense* cotton. Earliness is an important trait providing for timely harvesting of high quality cotton. It is a complex and polygenic trait, a result of interaction of a large number of genes. Cotton, a kharif crop requires 6 to 8 months for maturity. Moist weather and heavy rainfall at the time of boll opening and picking are detrimental to cotton as the plant becomes vulnerable to pests and diseases. Early maturing cotton genotypes are highly preferable as it could avoid yield losses as the crop escapes from the late season pest attacks and also to fit the other suitable rotation crops. Short duration cotton cultivars are desirable since they have lower requirements of fertilizer, irrigation water and labour. In Uzbekistan, Pima cottons were found to be very early, short duration and dwarf (Abdel Bary and Bishr 1995).

Assessing earliness in cotton is cumbersome as its maturity is determined by the complex quantitative trait influenced by the number morphological, physiological, phonological and environmental and genotypic influences (Kausar Nawas Shah *et al*. 2010). In cotton, earliness depends up on the square initiation, flower occurrence, boll formation and complete boll opening in relation to time of sowing under certain set of environments. The damage from pink bollworm (*Pectinophora gossypiella*) can also be avoided by growing early maturing cotton genotypes than long duration cultivars (Chu *et al.* 1992). Most of the studies on earliness were carried out in upland cotton (*G. hirsutum*). The Egyptian cotton species *Gossypium barbadense,* L., is generally long duration crop that takes more than 200 days for maturity. The available information regarding earliness and the traits involved for earliness is limited in *G. barbadense* cotton. The present study was therefore taken up to assess the advanced genotypes for earliness and also determine the interrelationship between early maturity, yield and yield related traits. The main objective of the study was to identify suitable early maturing *G. barbadense* genotypes without sacrificing the yield which may use for the future exploitation in crop improvement programmes.

The experiments were conducted during 2011-2012 & 2012-2013 Kharif Season at New Area farm, Central Institute for Cotton Research, Regional Station, Coimbatore. Ten advanced genotypes from segregating population of *G. barbadense* viz., CCB-5, CCB-11, CCB-17, CCB-25, CCB-26, CCB-28, CCB-29, CCB-30, CCB-33 and CCB-36 were taken in the present study to determine the earliness based on their morphological and fibre quality traits. The experiment was laid out in a Complete Randomized Block (CRB) design with three replications. Normal package of practice was followed and all intercultural operations and irrigation and pesticides were applied in time. Ten plants were randomly tagged per genotype from each replication for recording the data on earliness, yield and yield related characters including days taken to first flower, number of first lower node sympodial branch, bolls formed at 90,120 & days after sowing (DAS), bolls opened at 120 & 150 days (DAS), number of bolls per plant at harvest, seed cotton yield, fibre quality parameters viz., 2.5% staple length (mm), strength (g/tex) and micronaire (µ/inch). The data were subjected to Statistical analysis (Gomez and Gomez 1984).

Earliness is a main feature of a short duration cotton system. Several plant features contribute to earliness viz., fruiting branch starting from the first lower nodes, days to first flower, rapid boll maturity, boll opening etc. All these parameters of earliness are highly influenced by the genotypes, growing environment and management practices. In the present study, ten advanced genotypes of *Gossypium barbadense*, L. were assessed for earliness by measuring days taken to first flowering, lower node number of first sympodial branch, boll formation at 90, 120 & 150 days after sowing respectively, bolls opening at 120 and 150 days after sowing respectively, bolls per plant at harvest, 2.5% span length (mm), strength (g/tex) and micronaire (µ/inch). The results of analysis of variance (Table 1) showed highly significant ($p \leq 0.01$) differences among the genotypes for all the traits under study. Similar significant variations have been reported in upland cotton by several cotton workers (Baloch et al. 2004), Shakeel *et al.* 2008, Panhwar *et al.* 2010, and Ali *et al.* 2013.

The main component of earliness is the formation of first sympodia at the main stem and the number of fruiting points in it. It is one of the most reliable and practical morphological measures of earliness in cotton genotypes. The mean data on number of nodes on first sympodial branch of different genotypes is presented in Table-2. Observations on this character revealed that the maximum number of nodes on lower first sympodial branch was noticed in CCB-29 (7.4), CCB-5 (7.2) and CCB-36 (7.1), the minimum number was recorded in CCB-26 (2.5). Earlier reports of Baloch and Veesar (2007) revealed that the number of node in the first sympodial branch highly correlated with earliness as well as heat tolerance. It was also noted from the reports of Kairon and Singh (1996), Iqbal et al. (2003) and Soomro et al. (2015), that there is a strong correlation between early maturity and lower sympodial node number. In the present study, the genotype which set higher number of fruiting nodes in the first sympodia proved to be early in terms of maturity while others with less number of nodes have extended growth and delay in harvest was observed as presented in Fig.1. The finding of present study, the genotypes CCB-29, CCB-5 and CCB-36 were found to have early maturity which was in agreement with Baloch & Baloch (2004) who found a strong relationship between earliness and lower sympodial branch node number in an extensive study.

The minimum number of days taken to initiation of first flowering from the date of sowing leads to the early maturity of the cotton crop. It is evident from the present study that the genotypes CCB-29, CCB-5 and CCB-11 have taken 39, 42 and 49 days, respectively to yield the first flower and the rest have taken more number of days (Table-2). The genotypes, CCB-29 and CCB-36 exhibited higher potential for maximum bolls per plant and have taken minimum days to bear the first flower followed by boll opening at 150 days which indicate the earliness. Similar results were obtained in upland cotton varieties by Ahmad et al. (2008), Soomro et al. (2015). The genotypes that open the first flower facilitate the boll formation; earlier boll opening that leads to identification of the early maturing genotypes. Baloch et al. (2014) opined that, though the days to first flowering may not be directly connected with the yield components, it is indirectly influencing the earlier opening of the bolls thereby helping the earliness of the crop. The genotypes, CCB-29, CCB-5 and CCB-11 have been identified as early maturing genotypes since they have taken 39, 42 and 49 days, respectively for first flower formation, while maximum number of days have been taken by the genotype CCB-27 (62 days) (Fig.1). The manifestation of first flowering is easily identifiable and can be used as an indicator for identification of early maturing genotypes in breeding programmes.

A boll set in early growth period ultimately leads to early maturity thereby helping to go for early picking. As per the classification given by Kairon and Singh (1996), the short duration cotton crop matures in 125 to 145 days, medium duration (145 to 165 days) and long duration matures from 170 to 190 days after sowing. In *G. barbadense* the crop generally matures from 175 to 200 days after sowing which is considered as very long crop duration. The observations on number of fully formed bolls taken at 90 days after sowing showed that the genotypes, CCB-29 (17.4), CCB-36 (16.9) and CCB-33 (15.5) exhibited the maximum number of bolls when compared to rest of the cultures. Similar trend of observation for this trait was recorded when taken at 120 and 150 days after sowing (Fig 2). Identical results of present study were reported in *G. hirsutum* cultivars by Soomro et al. (2002), Chang et al. (2005), Bloch et al. (20014) and Soomro *et al.* (2015). According to their studies, the boll formation at 90 and 120 days after sowing was considered one of the effective selection criteria for the earliness in cotton.

Among the ten *G. barbadense* genotypes, CCB-36 (66) and CCB-29 (61) maximum number of bolls at 150 days after sowing was recorded (Fig.3). A range between 21.0 to 42.5 bolls/ plant was recorded at 120 days after sowing among the ten genotypes. As per the results presented in Table 2, the genotypes CCB-36 and CCB-29 have been identified as early maturing *G. barbadense* genotypes which can be utilized in further cotton improvement programmes.
The mean data on opened boll recoded at 120 and 150 days after sowing are presented in Table 2, indicates that boll opening at 120 days after sowing in genotypes CCB-29 (17.4) and CCB-36 (16.9) were the maximum (Fig. 3) followed by in CCB-30 (14) and CCB-5 (13.6), where as minimum number of opened bolls was recorded in CCB-26 (8.4) and CCB-28 (7.5). The observation taken at 150 days after sowing also indicated that the maximum number of opened bolls obtained in CCB-36 (42.5) and CCB-29 (41.3) and minimum in CCB-17 (21) and CCB-26 (23.4).

In both the cases, the results indicated that the genotypes having the maximum opened bolls/plant are being considered as early maturing types and possession of minimum number of bolls/plant reflects medium or late maturity. Soomro et al. (2002) and Soomro et al. (2015) evaluated several upland cotton genotypes for earliness using the tool, boll opening at various stages of crop improvement. It was also suggested by Baloch et al. (2014), that boll opening percentage at various stages play crucial role in exploring the earliness of cotton genotypes.

The data on number of bolls per plant is presented in Table 3 and Fig. 4, the maximum number of bolls was recorded in CCB-36 (77), CCB-29 (71) and CCB-5 (69) and minimum was observed in CCB-CCB-26 (38), CCB-27 (38) and 17(39). The number of bolls per plant character is directly proportional to the seed cotton yield. Baloch et al. 2014 also considered boll number /plant as an important yield component, having strong relationship with seed cotton yield. Similar results reported in upland cotton *G. hirsutum* by Sakeel (2008), Baloch et al. (2014) and Soomro et al. (2015). They opined that an increase in boll number would ultimately increase the seed cotton yield.The inference made from the results shows that the genotype CCB-36, CCB-29 and CCB-5 are superior in terms of boll production per plant.

The highest seed cotton yield was recorded in CCB-29, CCB-36 and CCB-5 followed by CCB-30 and CCB-33 (Table-3). The genotypes CCB-29 and CCB-36 have been identified as early maturing and also bearing maximum number of bolls (Fig. 4). The total number of bolls produced by each plant determines the yield potential of a genotype. Similar findings were reported by Soomro *et al.* (2015) in upland cotton. Ahmed et al. (2008) reported that some of the upland cotton cultures consistently performed well in terms of days taken to first flower, first sympodial lower node branch number, boll opening and seed cotton yield per plant. Ahmed et al. (2008) observed that optimum seed cotton yield and earliness may be enhanced by decreasing the days to flowering and first boll opening and by lowering the node to the first fruiting branch in upland cotton. Earliness in *G. hirsutum* was worked out by several breeders (Kairon and Singh 1996, Shakeel *et al.*2008, Bloch *et al.*2014, Soomro *et al.* 2015). They suggested that the time to first square, open flower or the nodal position of the first fruiting branch are important measures of earliness in cotton. Those identified genotypes using the above criteria may be successfully utilized in further breeding programmes to develop cultivars with high yield, early maturity in *G. barbadense* species.

Fibre qualities are the most important parameters in cotton, which determines the national and international market value. In *G. barbadense* cotton, the staple length is the most important fibre traits. The fibre length recorded in the CCB-29 (39.2) and

CCB-36 (37.5) was the maximum followed by CCB-30 (37.4) and CCB-33 (36.8). The minimum was recorded in CCB-26 (32.6) and CCB-27 (33.1). The superior genotypes thus identified (CCB-29 and CCB-36) from the present study exhibits high length of 39.2 mm and 37.4 mm respectively falls under the extra long staple category. Similarly, higher fibre strength and micronaire were noticed in the identified genotypes (Fig 5). The results also showed not much of variation in fibre properties of the other genotypes studied.

The present study revealed that CCB-29 and CCB-36 have taken minimum number of days for formation of lower sympodial branch, lesser days to first flowering, first boll formation, first boll opening and boll maturity which are considered major criteria for the selection of early maturing *G. barbadense* genotypes. The overall performance of 10 genotypes evaluated in field experiment culminated that cultures CCB-29 and CCB-36 are superior in terms of yield components such as Number of first sympodial nodes, days to first flowering, green matured bolls at 90, 120 and 150 days after sowing, bolls opening at 120 and 150 days after sowing and fiber properties such as 2.5% span length, fibre strength and fibre fineness (micronaire). Efforts for promotion of these cultures for cultivation under extra long staple category in the southern cotton growing zone is in progress.

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Table 1. ANOVA for morphological, yield and fibre properties of *G .barbadense* genotypes

SOV	D.F	No of first sympodial Branch node	Days to first flowering	Boll formation days after sowing			Boll opening days after sowing		Bolls/ plant	Seed Cotton yield	Fibre characters		
				90	120	150	120	150			SL	ST	MIC
Replication	3	0.2	35.4	1.8	3.2	37.2	6.0	8.06	2.6	32387.2	0.9	1.0	0.06
Genotypes	9	100.2	1835	354	1395	5047.6	1887.2	1632.8	6013.3	799637.3	194.7	36.6	1.59
Error	27	0.8	141.8	6.9	24.0	712.0	72.6	45.2	40.0	292520.7	62.7	23.2	0.23
S Ed		0.1	2.2	0.5	0.9	5.1	1.6	1.2	1.2	104.0	1.5	0.9	0.09
CD @5%		0.3	4.8	1.0	1.9	10.7	3.4	2.7	2.5	218.6	3.2	1.9	0.19
CV%		4.2	5.3	4.9	3.9	13.2	5.7	3.98	2.7	11.9	5.2	4.0	3.44

SL-2.5% staple length, ST- Fibre strength, MIC-Micronaire

Table 2. Mean performance of morphological characters of ten early maturing genotypes of *Gossypium barbadense*, L.

Genotypes	No. of nodes in first sympodial branch	Days to first flowering	Boll formation at different periods			Opening of bolls at different periods	
			90 DAS	120 DAS	150 DAS	120 DAS	150 DAS
CCB-5	7.2a	41.3f	12.7c	27.5d	55.7bc	37.3b	43.0c
CCB-11	6.4b	48.0e	13.4c	28.1cd	45.7cde	35.3bc	37.3d
CCB-17	3.7d	58.0bc	9.1de	21.0f	34.3f	30.3d	32.3fg
CCB-26	2.6f	57.0bc	8.4ef	23.9e	33.0f	26.0e	30.7g
CCB-27	3.3de	65.0a	9.5d	23.9e	36.3ef	24.3e	34.3ef
CCB-28	6.3b	50.7de	7.6f	23.8e	39.3def	30.7d	36.7de
CCB-29	7.5a	37.7f	17.7a	41.5a	61.0b	49.7a	37.7d
CCB-30	3.1e	58.3b	13.6c	32.0b	48.7cd	37.0b	47.0b
CCB-33	5.4c	54.0bcd	15.6b	29.9c	45.7cde	32.7cd	42.7c
CCB-36	7.3a	53.3cd	16.8a	41.5a	76.7a	47.7a	56.7a
LSD (0.05%)	0.38	4.8159	1.064	1.9838	10.7893	3.4451	2.7203

DAS-days after sowing

Table 3. Mean performance of yield and fibre quality parameters of ten early maturing genotypes of *Gossypium barbadense*, L.

Genotypes	No. of bolls / plants at harvest	Seed cotton yield (kg/ha)	Fibre characters		
			2.5% Span length (mm)	Fibre strength (g/tex)	Micronaire (µ/inch)
CCB-5	68.7bc	1084bc	35.2bcde	28.1ab	3.2de
CCB-11	44.7g	1005c	34.6cde	27.4ab	3.4bc
CCB-17	39.0h	976c	32.2e	26.4bce	3.5b
CCB-26	37.0hi	993c	33.3de	25.1de	3.3cde
CCB-27	36.3i	958c	33.5de	26.2ce	3.1ef
CCB-28	50.7f	894c	35.9bcd	27.3abc	3.0f
CCB-29	72.3a	1489a	40.8ad	29.5a	3.5b
CCB-30	54.7e	1024abc	38.1ab	28.2a	3.4bcd
CCB-33	60.7bcd	1049bc	37.2bc	26.4bc	3.1ef
CCB-36	76.0a	1231ab	38.3ab	27.6abc	3.9a
LSD (0.05%)	**2.5593**	**218.6818**	**3.2025**	**1.9478**	**0.1978**

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Fig.1

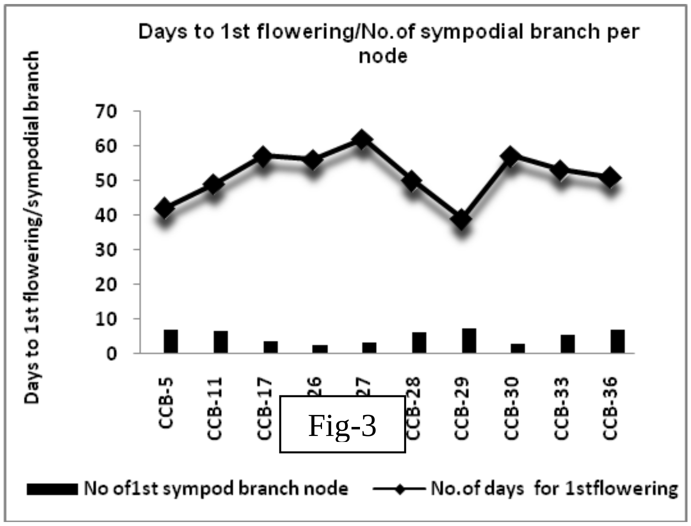

Fig.2

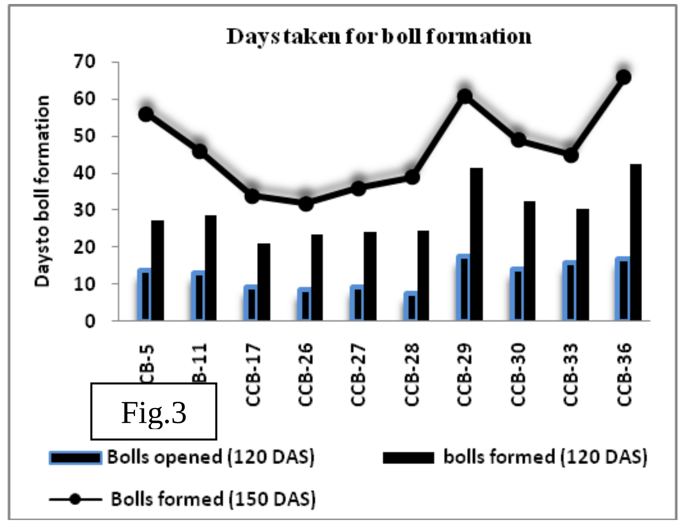

Fig.3

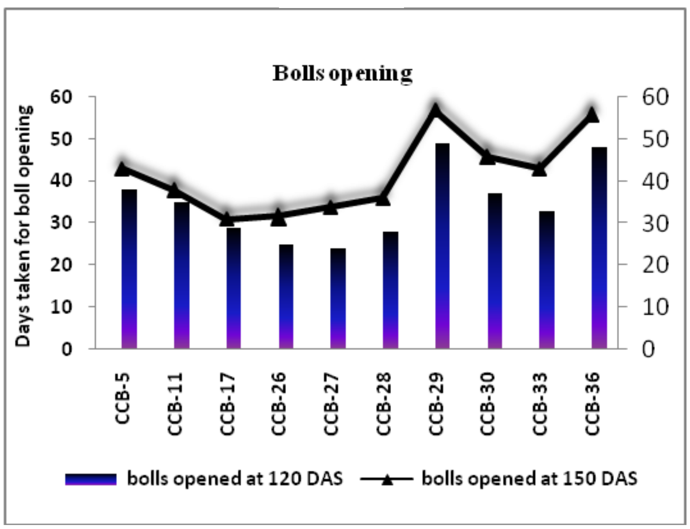

Fig.4

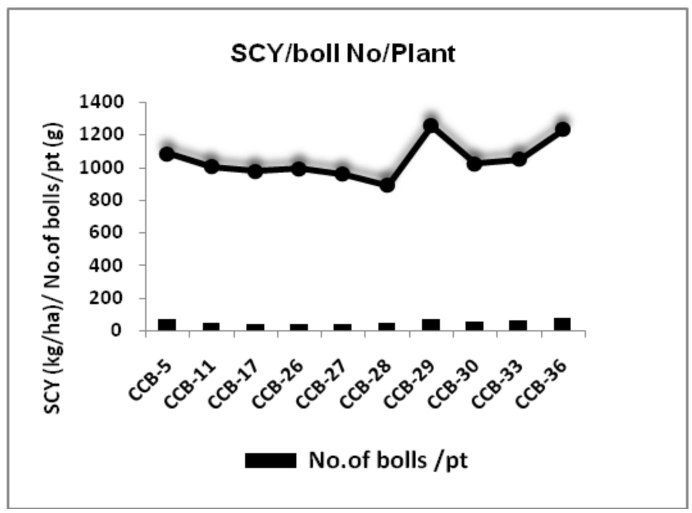

Fig.5