Characterization of Elite Upland Cotton Genotypes for Earliness and Yield Traits

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Abstract: Short duration cotton genotypes increased the chances to harvest crop before cold and rainy weather conditions. However, earliness in cotton is a difficult character, which is assessed by determining many plant traits. The current experimental was conducted at Cotton Section, A.R.I. Tando Jam, during kharif season 2013. The eight cotton genotypes including CRIS-342, Sindh-I, Haridost, Malmal, Bt-121, Bt-3701, TS-501 and Shahbaz were sown in randomized complete block design with four replications. In a total, seven quantitative traits were measured such as days to first flowering, node number to set first sympodial branch, node number to set first flowering, sympodial branch length (cm), sympodial branches plant^{-1}, number of bolls plant^{-1}, seed cotton yield plant^{-1} (g). The mean squares from analysis of variances showed that genotypes differed significant ($P \leq 0.01$) for all the studied traits, demonstrating a vast genetic variability in tested genotypes. The genotypes, Sindh-1, CRIS-342, Bt-121 and Bt-3701 were characterized as early maturing or short duration cotton varieties. However, the correlation between yield and earliness traits were best criteria for developing the short duration cotton yield varieties.

Keywords: Characterization, earliness, association, yield traits, cotton genotypes.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is an important fiber crop in the world. Its seed is used as raw material in oil and forage industries due to the high percentage of the oil and protein [1]. Early maturing varieties increase the possibility that harvest can be completed before cold and rainy weather. Earliness in cotton is a complex character which is assessed by measuring many plant traits. The traits like node of first fruiting branch, 1st sympodial branch node number on main stem, date of 1st flower and date of 1st open boll are used for assessing earliness in cotton [2]. It is very important in alleviating late season risks of insects/pests (particularly bollworms), diseases, un-favorable weather conditions and increase in economic return by reducing input cost [3]. Another advantage of growing early maturing cotton cultivars is the provision of proper time for rotation of other crops, allowing timely sowing of wheat in cotton- wheat- cotton cropping system as in Pakistan [4]. The early maturing varieties require lesser inputs i.e. use of fertilizer, fewer sprays, irrigation and escape late season pest attack and avoid soil moisture depletion and weathering of open cotton [5]. Due to these reasons, breeding for early maturing cotton varieties has become an important task in cotton breeding. Therefore, the current research was designed to identify selection criteria for the development of early maturing cotton genotypes.

MATERIALS AND METHODS

The present study was conducted in the experimental area of Cotton Section, Agriculture Research Institute. Tando Jam, during 2013. The experimental materials comprised of eight cotton genotypes such as CRIS-342, Sindh-1, Haridost, Malmal, Bt-121, Bt-3701, TS-501 and Shahbaz, which were sown in randomized complete block design with four replications. The row to row and plant to plant space was maintained at 75 and 30 cm, respectively. All the agronomic and cultural practices were performed regularly from sowing till to harvest. Twenty plants were chosen to record the data on days to 1st flowering, node number to set 1st sympodial branch, node number to set 1st flowering, sympodial branch length (cm), sympodial branches plant^{-1}, number of bolls plant^{-1}, seed cotton yield plant^{-1}(g). After taking the raw data from field, the secondary data were analyzed in computer package Statistix 8.1 version to determine analysis of variance and correlation between earliness and yield traits while graphs were draw in MS-excel.

RESULTS AND DISCUSSION

1. Mean Performance

The mean squares from analysis of variance (Table **1**) showed that all the traits for earliness and yield traits

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Table 1: Mean Squares from Analysis of Variance for Earliness and Yield Traits Upland Cotton Genotypes

Source of variation	D.F	Days to first flowering	Node number to set first sympodial branch	Node number to set first flowering	Sympodial branch length	Sympodial branches plant^{-1}	Number of bolls plant^{-1}	Seed cotton yield plant^{-1}
Replications	3	1.03	0.53	0.86	0.20	1.21	1.37	186.10
Genotypes	7	17.50**	8.60**	16.82**	128.17**	45.63**	333.03**	4930.27**
Error	21	1.29	0.56	0.41	1.10	0.76	0.72	53.02

**Significant at 1% probability level.

were significant (P≤0.01) among the evaluated genetic resources, demonstrating that varieties performed differently for the character and these traits are best indicators for developing early maturing cotton varieties with optimum seed cotton yield. Similar results were obtained by [2,3] they also observed significant differences for the earliness and yield traits.

The data regarding the mean performance for all the quantitative traits were presented in Table **2** and Figures **1** and **2**. Number of days taken to flowering is considered as an important determinant of earliness [4]. It is normally assumed that fewer the number of days taken to produce first flower, the earliest is the boll setting and opening; hence earlier the variety. Among the eight cotton genotypes, the Sindh-1 recorded minimum (39.00days) days to first flowering, followed by Bt-121 (40.00 days), whereas TS-501 exhibited maximum (4.00 days) for first flowering, because delay in flowering is the sign of late maturity and susceptible to heat. Similar results were obtained by [6,7] who found positive linkage between first flower

Table 2: Mean Performance for Various Quantitative Traits in Cotton Genotypes

Genotypes	Characters			
	Days to first flowering	Node number to set first sympodial branch	Node number to set first flowering	Sympodial branch length (cm)
CRIS-342	41.25	7.00	5.00	18.75
SINDH-I	39.00	5.00	4.25	14.50
HARIDOST	44.75	9.00	9.75	25.00
MALMAL	41.50	6.00	7.50	19.25
BT-121	40.00	7.50	6.25	8.75
BT-3701	41.50	6.25	8.00	9.50
SHAHBAZ	42.25	9.25	5.50	19.75
TS-501	45.00	7.75	9.50	20.75
L.S.D. at 5%	1.67	1.010	0.94	1.54

Genotypes	Characters		
	Sympodial branches plant^{-1}	Number of bolls plant^{-1}	Seed cotton yield plant^{-1} (g)
CRIS-342	19.25	75.00	256.93
SINDH-I	21.25	77.25	247.15
HARIDOST	24.75	54.00	163.30
MALMAL	19.25	54.75	168.38
BT-121	23.25	73.50	246.20
BT-3701	25.50	74.00	221.98
SHAHBAZ	24.00	70.00	217.03
TS-501	29.25	71.25	217.40
L.S.D. at 5%	1.28	1.25	10.71

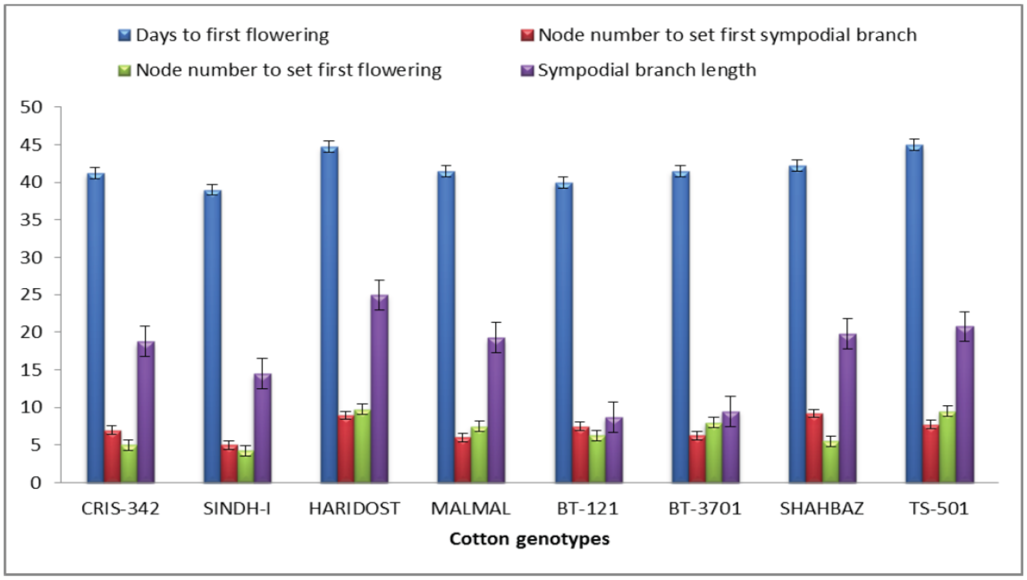

Figure 1: Mean performance of cotton genotypes for days to first flowering, node number to sett first sympodial branch, node number to set first flower and sympodial branch length (cm) for earliness.

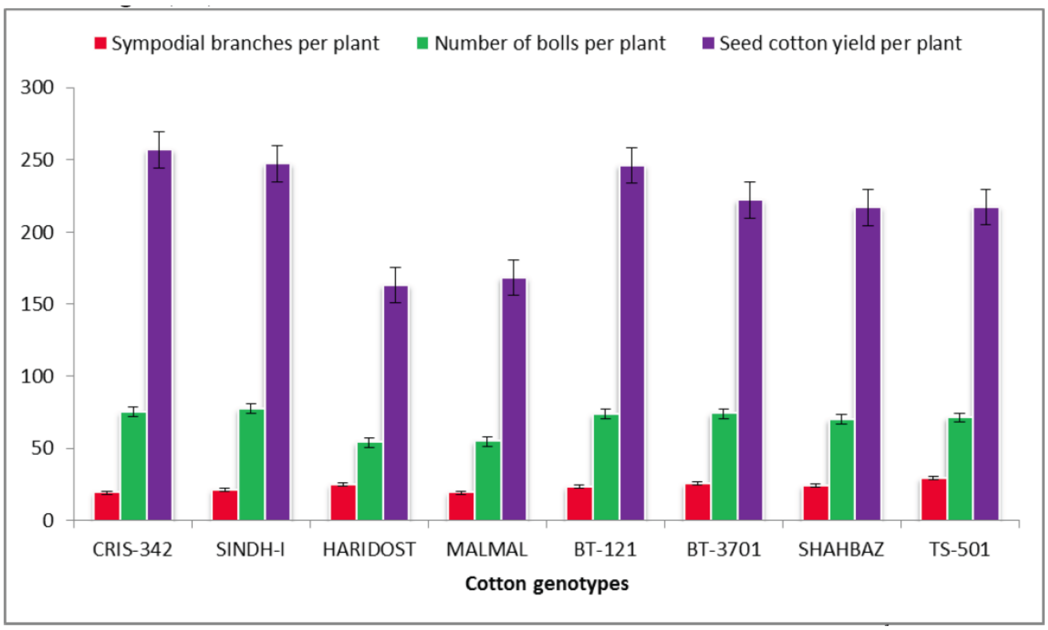

Figure 2: Mean performance of cotton genotypes for sympodial branches plant^{-1}, number of bolls plant^{-1} and seed cotton yield plant^{-1} (g) for earliness.

and earliness and showed that additive gene effects controlled days to flowering.

Node number can be determined early in the season, it can be easily and precisely identified and it is in-dependent of complications arising from shedding of fruit forms. When considered in terms of rate of fruit development and maturity, earliness may be defined. Sindh-1 had the lowest value of 5.00, followed by Bt-3701 with respective value of 6.25 to set node number first sympodial branch, while Shahbaz set first sympodial branch at higher (9.25) node. Several other workers [3,8] have also reported strong relationship between lower sympodial branch node number and early maturity in cotton.

Flowering setting at base of the plant or minimum node number shows early maturity and also tolerance to high temperature. Setting-up of first effective boll on lower sympodial branches can also be regarded as one of the criterion for early maturing varieties. The lowest value of 4.25 was exhibited by Sindh-1, followed by

Shahbaz (5.50), and the highest by Haridost with a value of 9.75 (Table **2**). Strong relationships between early maturity and lower sympodial branch node number with effective boll have been reported by several other cotton breeders [3]. It is also assumed that, closer the distance between the first sympodial branch node and first effective boll setting branch, the earlier the variety would be [9].

The varieties also differed significantly (P≤0.01) for sympodial branch (fruiting branch) length that varied from a minimum length of 8.75 cm to a maximum of 25.00 cm (Table **2**). Short sympodial branches are desirable for early maturing varieties, Bt-121 characterized short (8.75 cm) sympodial branch length and Bt-3701 was next scoring which measured (9.50cm) sympodial branch length. However, Haridost measured long (25.00cm) sympodial branch length. Cotton breeders have been succeeded in developing early maturing varieties with short sympodial branches. Some other workers [3,10] also rated varieties with short sympodial branches as early maturing ones.

Sympodial branches plant^{-1} tends to have direct relationship with bolls plant^{-1} and seed cotton yield. Sympodial, the fruiting branches has important role in managing yield through bolls plant^{-1}. Sympodial branches which set the maximum number of bolls plant^{-1}, more sympodial branches plant^{-1} cannot be sure for maximum boll setting plant^{-1} because it depends upon mode of boll bearing and shading. The genotypes CRIS-342 and Malmal both showed minimum and same value of 19.25, followed by Sindh-1 (21.25) however, TS-501 recorded maximum (29.25) sympodial branch plant^{-1}. Many research workers like [9,11] who also observed similar findings.

Boll number plant^{-1} is related to plant height and sympodial number. Researchers noticed that the cultivar having the highest boll number, also having the highest sympodial number. It has now become a well-recognized fact that, boll size has a strong negative correlation with earliness. Hence, cotton breeders had always been made compromise to evolve varieties with medium boll size, still having an acceptable level of crop maturity and yield. The lowest boll number was taken from Haridost and Mammal (45.00 and 54.75), respectively, for number of bolls plant^{-1}; whereas Sindh-1 set the maximum (77.25) number of bolls plant^{-1} in cotton plant. In the accordance of many researcher of [12,3] who reported that early maturing cottons although had comparatively smaller or moderate bolls but produced better yields, may be due to setting and picking more number of bolls at early stages of boll opening, as compared to late maturing cottons.

Yield is a complex polygenically inherited character, resulting from multiplicative interaction of its contributing characters. It is highly influenced by the environment; hence selection based on yield alone may limit the improvement. Whereas the component characters of yield are less complex in inheritance and are influenced by the environment to a lesser extent. Thus, effective improvement in yield may be brought about through selection for yield component characters. The highest seed cotton yield was obtained CRIS-342 (256.93g), followed by the Sindh-1 of 247.15g and the lowest seed cotton yield produced by the parent Haridost of 163.30g. Similar results were also obtained by [9,5,13] who also recorded optimum yield with early maturing genotypes.

2. Correlation between Earliness and Yield Traits

The correlation coefficient between earliness and yield traits is presented in Table **3** which exhibited that days to initial flowering had significant positive associated with node number to set first flowering (r = 0.55**), node number to set first sympodial branch (r = 0.77**), sympodial branch length (r = 0.65**) and sympodial branches plant^{-1} (r = 0.58**); nevertheless days to initial flowering made significant but negative correlation with number of bolls plant^{-1} (r = -0.46*) and seed cotton yield plant^{-1} (r = -0.41*). The negative correlation revealed that heat susceptible genotypes reduced the number of bolls plant^{-1} and seed cotton yield due to high temperature. If negative association between characters is due to pleiotropic effects it would be very difficult to obtain the desired combinations, while if linkage is involved, special breeding programmes are needed to break these linkage blocks.

Node number to set first flower was significantly and positively associated with sympodial branch length (r = 0.43*) and sympodial branches plant^{-1} (r = 0.37*), while node number to set first sympodial branch was non-significant (r = 0.31^{NS}), number of bolls plant^{-1} (r = -0.28) and seed cotton yield plant^{-1} r = 0.27).

Node number to set first sympodial branch were positively correlated with sympodial branch length (r = 0.35*) and sympodial branch plant^{-1}(r = 0.62**) and significantly and negatively associated with number of bolls plant^{-1} (r = -0.56*) and seed cotton yield plant^{-1} (r =-0.64**). It is suggested that due to high temperature bolls shading were taken place; thus number of bolls

Table 3: Correlation Coefficient (r) between Earliness and Yield Traits

Characters	Days to first flowering	Node number to set first flowering	Node number to set first sympodial branch	Sympodial branch length	Sympodial branches plant^{-1}	Number of bolls plant^{-1}	Seed cotton yield plant^{-1}
Days to first flowering	-	0.55**	0.71**	0.65**	0.58**	-0.46*	-0.410*
Node number to set first flowering		-	0.31	0.43*	0.37*	-0.28	-0.27
Node number to set first sympodial branch			-	0.35*	0.62**	-0.56*	-0.64**
Sympodial branch length				-	0.06	-0.62**	-0.57**
Sympodial branches plant^{-1}					-	0.10	-0.07
Number of bolls plant^{-1}						-	0.94**

**,* = significant at 1 and 5% probability level respectively.

plant^{-1} and seed cotton yield plant^{-1} was negatively associated with node number to set first sympodial branch.

Sympodial branch length was significantly but negatively correlated with number of bolls plant^{-1} (r = -0.62**) and seed cotton yield plant^{-1} (r = -0.64**), which exhibited that increase in sympodial branch length, will cause a significant decrease in number of bolls plant^{-1} and seed cotton yield plant^{-1}.

Sympodial branches plant^{-1} was positively but non-significantly correlated with of bolls plant^{-1} (r = 0.10) and negatively but also non-significantly with seed cotton yield (r = -0.07). It corroborates with the results of [5,13] they reported positive and significant correlations were estimated between yield and earliness characters.

Yield component characters show association among themselves and also with yield. Favorable associations between desirable attributes will help improvement in a joint manner. Whereas, unfavorable associations between the desirable attributes under selection may limit genetic advance. Hence, knowledge of associations between the yield components and also among themselves is essential for planning a sound breeding programme. However, number of bolls plant^{-1} was strongly correlated with seed cotton yield plant^{-1} (r= 0.94**). The importance of number of bolls plant^{-1} towards seed yield has also been reported by [14, 15, 16, 17]. Therefore this trait appears to be most important in influencing seed cotton yield in cotton and selection should be oriented towards high boll number.

CONCLUSION

Among the cultivars, Sindh-1, CRIS-342, Bt-121 and Bt-3701 were characterized as early maturing or short duration cotton varieties. However, the correlation between yield and earliness traits was best criteria for developing the short duration cotton yield varieties.

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