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GENETIC APTITUDE AND CORRELATION STUDIES IN *GOSSYPIUM HIRSUTUM* L.

KHADIJAH MAKHDOOM[1*], NAQIB ULLAH KHAN[1], SUNDAS BATOOL[1], ZARINA BIBI[2], FARHATULLAH[1], SIRAJ KHAN[1], FIDA MOHAMMAD[1], DILDAR HUSSAIN[1], RAZIUDDIN[1], MUHAMMAD SAJJAD[1] AND NAUSHAD KHAN[1]

[1]*Khyber Pakhtunkhwa Agricultural University, Peshawar 25130, Pakistan*
[2]*Department of Soil and Environmental Sciences, Faculty of Agriculture, Gomal University, Dera Ismail Khan, Pakistan.*

Abstract

The experiment for determining genetic potential of different cotton genotypes and correlation studies among different yield traits in cotton (*Gossypium hirsutum* L.) was conducted during 2008 at the NWFP Agricultural University Peshawar, Pakistan. The breeding material consisted of eight upland cotton genotypes i.e. CIM-446, CIM-473, CIM-496, CIM-499, CIM-506, CIM-554, CIM-707 and SLH-284. The experiment was carried out in a randomized complete block (RCB) design with three replications. Data were recorded on plant height, bolls plant^{-1}, boll weight, seeds locule^{-1}, seeds boll^{-1} and seed cotton yield plant^{-1}. Significant ($p\leq0.01$) variations were observed among the genotypes for all the parameters. The cultivar CIM-506 performed well by having maximum bolls, seed cotton yield with short stature plants and medium boll weight, seeds locule^{-1} and seeds boll^{-1}. The cultivars CIM-707, CIM-554 and CIM-496 also showed appreciable genetic potential. Major yield components (bolls plant^{-1}, boll weight, seeds locule^{-1} and seeds boll^{-1}) were also found to have positive correlation with seed cotton yield. However, plant height (due to lodging) was noticed negatively correlated with yield.

Introduction

Gossypium hirsutum L., plays a major role in boosting our national economy by earning huge amount of foreign exchange and that's why called as the backbone of the economy of Pakistan. Being an important cash and industrial crop, also termed as white gold and grown on 12% of the total cultivated area. Beside fiber, it also produces edible oil and cotton seed cake for human and animal consumption, respectively. During 2007-08, cotton crop was grown on 3.054 million hectares and seed cotton production was 11.655 million bales with average seed cotton yield of 649 kg ha^{-1} (Anon., 2008). Our national yield is still low as compared to other cotton growing countries due to low yielding genotypes, cotton leaf curl virus (CLCuV), insect pests, rains and floods etc.

Before initiating any cotton improvement program, the precise knowledge about the nature and genetic potential of existing germplasm, and extent of relationship and association of different morphological and yield contributing traits with the seed cotton yield is of vital importance (Badr, 2003; Soomro *et al*., 2005 & 2008; Batool *et al*., 2010; Khan *et al*., 2009a & 2010). From such studies the corresponding change and improvement in a particular character can be predetermined at the expense of the proportionate improvement in the other (Khan, 2003; Khan *et al*., 2007; Ahmad *et al*., 2008). Rao & Mary (1996) and Meena *et al*., (2007) evaluated different upland cotton cultivars for yield and other economic traits and observed significant variations. Khan *et al*., (2009a & b) mentioned that genetic variances were found almost greater than the environmental variances and correlation of seed cotton yield with other different traits was found significantly positive for majority of traits.

*E-mail: dijah_mak@yahoo.com

Vast information on the genetic potential of genotypes, genotypic and phenotypic correlation between different plant characters is available in literature. The studies of Khan (2003) showed that the seed cotton yield was found positively correlated with bolls per plant and bolls weight. Further studies in this respect also indicated that seed and lint indices were positively associated with seed cotton yield. Genetic variability and positive correlation were observed for yield traits in *G. hirsutum* (Iqbal *et al*., 2003; Wang *et al*., 2004; Batool *et al*., 2010). The principle objectives in the cotton breeding are higher production of seed cotton and lint yields with better fiber quality, early maturity and resistance to diseases and insect pests (Khan *et al*., 2009a, 2009c & 2010). For achieving these objectives, a comprehensive study of the genetic procedure of the management of cotton plant traits under different environmental conditions is also a compulsion. In light of the above, a research project was planned to study the genetic capability of different genotypes and correlation studies of different cotton yield traits under climatic conditions of Peshawar, Pakistan.

Materials and Methods

Genetic material and field procedure: The experimental work to study the genetic ability of genotypes and association of seed cotton yield with yield contributing traits in *Gossypium hirsutum* was carried out during 2008 at NWFP Agricultural University, Peshawar, Pakistan. The breeding materials comprised of eight upland cotton cultivars i.e., CIM-446, CIM-473, CIM-496, CIM-499, CIM-506, CIM-554, CIM-707 and SLH-284. Cultivars were sown with intra- and inter-row spacing of 30 and 75 cm, respectively in a RCB design with three replications on May 15, 2008. Each sub-plot had four rows with eight meters length. Thinning was performed twice after 20 days of germination when the plant height was 15 cm, respectively to ensure single plant per hill. Recommended cultural practices and inputs including fertilizer, hoeing, irrigation and pest control were applied same for all the entries from sowing till the harvesting and the crop was grown under uniform conditions to minimize environmental variability to the maximum possible extent. Picking was made during the months of November-December, 2008 on single plant basis.

Traits measurement and statistical analysis: At maturity ten plants were randomly selected from central two rows. The data were recorded on plant height, bolls per plant, boll weight, seeds per locule, seeds per boll and seed cotton yield per plant (g). Data were subjected to analysis of variance as outlined by Steel and Torrie (1980) to compare the mean differences among cotton genotypes for seed cotton yield and its components. The mean values of genotypes for each parameter were further compared by using the least significant difference (LSD). The simple correlation coefficient (r) of seed cotton yield with other seed and yield traits was also worked out according to Kwon and Torrie (1964).

Results and Discussion

The mean values for eight cotton genotypes manifested highly significant differences ($p \leq 0.01$) for plant height, bolls per plant, boll weight, seed per locule, seeds per boll and seed cotton yield (Table 1). The highest plant height (145.43 cm) was observed in CIM-554 (Fig. 1). It was also found statistically at par with cultivar CIM-446 (136.30 cm). Minimum and at par plant height of 109.10 cm, 109.73 cm, 112.17 cm and 112.27 cm was observed in cultivars CIM-506, CIM-473, CIM-707 and CIM-499, respectively. All other cultivars showed medium plant height. Plant height was found negatively correlated ($r = -0.106$) with the seed cotton yield (Table 2) and it may be due to lodging effect of cotton crop, which adversely affect the bolls per plant and ultimately seed cotton yield.

Table 1. Mean squares and CV for various traits of upland cotton.

Parameters	Mean squares	CV (%)
Plant height	602.657**	4.57
Bolls plant^{-1}	37.577**	5.62
Boll weight	0.152**	2.06
Seeds locule^{-1}	0.455**	3.07
Seeds boll^{-1}	8.66**	3.67
Seed cotton yield plant^{-1}	500.946**	8.11

** Significant at $p \leq 0.01$, CV = Coefficient of variation.

Table 2. Correlation of various traits with seed cotton yield in upland cotton.

Parameters	Correlation (r) with seed cotton yield	Std. Error
Plant height	-0.106	0.192
Bolls plant^{-1}	0.877	0.374
Boll weight	0.294	11.674
Seeds locule^{-1}	0.407	6.031
Seeds boll^{-1}	0.302	1.373

Cotton breeders are mostly interested in short stature plants due to lodging threat and found also easy in picking as manual or by machine. In the present studies the plant height was negatively correlated due to lodging. However, Khan (2003) and Khan *et al*., (2009b) and Batool *et al*. (2010) noted that plant height was found positively correlated with boll number and seed cotton yield. They also reported the genetic variability for plant height among different upland cotton cultivars and mentioned that plant height was positively correlated with bolls and seed cotton yield if lodging didn’t occur. Taohua & Haipeng (2006), Khan (2003) and Khan *et al*., (2009b) concluded that plant height was positively correlated with yield and boll number. Murthy (1999) observed positive correlation between plant height and yield and noted that plant height contributed 70% of the total variability for seed cotton yield. Therefore, it is concluded that in cotton crop, plant height is desirable if no lodging occurred. The contradictory views of past researchers about the said trait might be due to different genetic background of the breeding material used under various environmental conditions.

In case of bolls per plant (Fig. 2) maximum bolls per plant were picked from CIM-506 (29). It was followed by four cultivars viz., CIM-707, CIM-554, CIM-496 and CIM-499 ranged from 24 to 25 bolls per plant. The lowest bolls per plant were recorded in the cultivar CIM-446 (18) and SLH-284 (20). Bolls per plant have a direct influence on the seed cotton yield and was found significantly ($p \leq 0.01$) positively correlated ($r = 0.877$) with seed cotton yield (Table 2). Thus variability for this trait among different cultivars is a good sign and selection in the breeding material for high boll number will have a significant effect on the seed cotton yield. Abouzaid *et al*., (1997) and Khan *et al*., (2009b) also reported variable number of bolls per plant in upland genotypes and positive correlation with yield. Bolls per plant is the key independent yield component and play prime role in managing seed cotton yield. Bolls per plant have a direct influence on the yield and positively correlated with seed cotton yield.

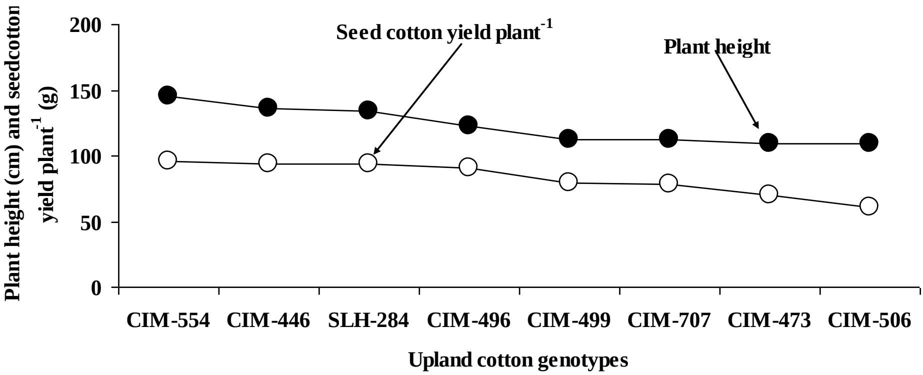

Fig. 1. Genetic potential of upland cotton genotypes for seed cotton yield plant^{-1} and plant height.

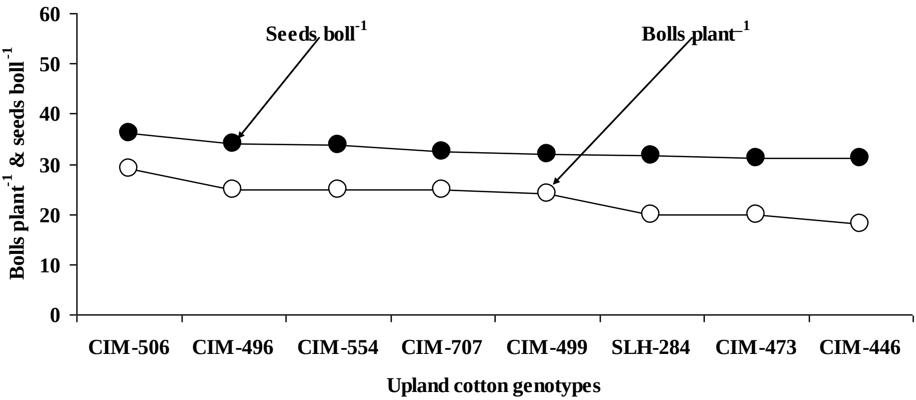

Fig. 2. Genetic potential of upland cotton genotypes for seeds boll^{-1} and bolls plant^{-1}.

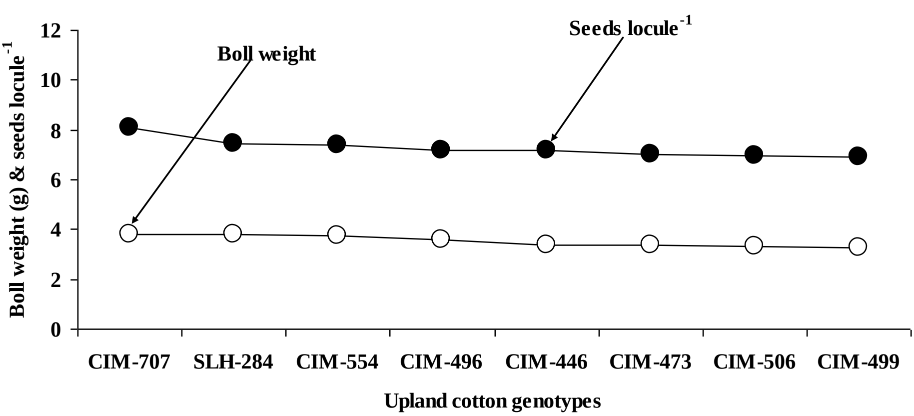

Fig. 3. Genetic potential of upland cotton genotypes for boll weight and seeds locule^{-1}.

G. hirsutum cultivars evaluated and observed varied values for bolls per plant (Meena *et al*., 2007; Ahmad *et al*., 2008). Soomro *et al*., (2005) compared the yield and yield components of cotton cultivars and observed significant differences for bolls per plant and other yield attributes. Rao & Mary (1996) evaluated different *hirsutum* cultivars for yield and other economic traits and observed significant variations for bolls number and observed positive impact on yield. Murthy (1999), Sultan *et al*., (1999) and Soomro *et al*., (2008) enunciated the positive genotypic correlation of bolls per plant with yield. Degui *et al*., (2003) and Iqbal *et al*., (2003) also revealed the effects of genetic transformation on the yield and bolls per plant of cotton cultivars. Results also revealed that bolls per plant should receive greater emphasis and selection should be made for larger number of bolls per plant for breeding cotton with high seed cotton yield.

Maximum and at par boll weight was observed in three cultivars (CIM-707, SLH-284 and CIM-554) ranged from 3.74 to 3.83 g (Fig. 3). Minimum and at par boll weight was manifested by four cultivars viz., CIM-499, CIM-506, CIM-473 and CIM-446 ranged from 3.28 to 3.40 g. Boll weight was also found positively correlated (r = 0.294) with seed cotton yield (Table 2). Ivanova and Stovanova (1996), Terziev *et al*., (1996), Abouzaid *et al*., (1997) and Khan *et al*., (2009b) also obtained similar results for boll weight in different cotton genotypes. Boll weight is second major yield component after bolls per plant and have a greater contribution in enhancement of yield. By having bigger bolls, the cultivars CIM-707, SLH-284 and CIM-554 proved to be the top promising genotypes followed by CIM-496 with the same criteria. The least boll weight holder cultivar (CIM-446) also produced lowest seed cotton yield, as boll weight has direct association with seed cotton yield after bolls per plant.

Similar proportions for boll weight in relation to seed cotton yield were observed in different cotton genotypes (Ahmad *et al*., 2008; Batool *et al*., 2010). Taohua & Haipeng (2006) and Meena *et al*., (2007) observed varied values for boll weight. Rao & Mary (1996) also observed significant variations for boll weight and showed positive effect on yield. Afiah & Ghoneim (2000), Badr (2003), Khan (2003) and Soomro *et al*., (2008) reported highly significant correlation which indicated that any improvement in boll weight would have a positive effect on yield. Iqbal *et al*., (2003) and Wang *et al*., (2004) observed that genotypic correlation was higher than the corresponding phenotypic correlation for all traits. The current results also revealed that bolls number followed by boll weight have positive effect on yield.

Maximum seeds per locule (Fig. 3) were recorded in the cultivar CIM-446 (8.11). It was followed by CIM-506 having 7.46 seeds per locule and was found at par with cultivars CIM-496 (7.40), SLH-284 (7.19) and CIM-473 (7.17). Other genotypes showed medium number of seeds per locule. The lowest mean value for said trait was recorded in CIM-499 (6.91) and CIM-554 (6.96). Seeds per locule were positively correlated (r = 0.407) with seed cotton yield (Table 2). Khan (2003) and Khan *et al*., (2010) also noted that seeds per locule was significantly and positively associated with seed cotton yield and contributed 70% of the total variability for seed cotton yield. Murthy (1999) and Wang *et al*., (2004) derived information on genetic variability and observed positive yield correlations with seeds per locule and other yield traits.

The highest seeds per boll (Fig. 2) were obtained in CIM-446 (36.16) and it was closely followed by three cultivars i.e., CIM-506 (33.83), SLH-284 (32.57) and CIM-473 (31.97). Minimum and at par number of seeds per boll were obtained in the cultivars CIM-499 (31.31) and CIM-554 (31.19). Other genotypes showed medium number of seeds per boll. Seeds per boll were positively correlated (r = 0. 0.302) with seed cotton yield as contributing to seed cotton yield through addition in the boll weight (Table 2). Genetic variability and positive correlation between seeds per bolls and seed cotton yield was derived in *G. hirsutum* (Iqbal *et al*., 2003; Wang *et al*., 2004). Rao & Mary (1996) and Khan *et al*., (2010) found high genetic variability for seeds per boll and seed cotton yield. Results also revealed that correlation showed positive associations between seed cotton yield and all other yield traits including seeds per boll. However, the direct effects of other yield traits on yield were of minor significance.

The maximum and at par seed cotton yield ranged from 91.00 to 96.00 g per plant was revealed by four cultivars viz., CIM-506, CIM-554, CIM-707 and CIM-494 (Fig. 1). These cultivars were followed by SLH-284 (78.00 g) and CIM-473 (70.00 g). The lowest seed cotton yield was observed in cultivar CIM-446 (61.00 g) which also having low number of bolls per plant and boll weight. The seed cotton yield was found positively correlated with bolls per plant and boll weight. Khan *et al*., (2009b) mentioned positive correlation of yield with yield components in *Gossypium hirsutum* cultivars.

Seed cotton yield is an eventual goal in growing cotton besides lint %. Highest yielding cultivars (CIM-506, CIM-707, CIM-554 and CIM-496) were also found as the 2nd and 3rd top scoring genotypes for other traits. The yield also manifested strong correlation with important yield and seed traits and this type of correlation is rarely found and mostly desirable in cotton breeding. Same genetic variability for seed cotton yield was also reported by Khan (2003), Khan *et al*., (2009b, 2009c) and Batool *et al*. (2010). There is an opportunity in the said genotypes for further enhancement in yield as most of yield attribute have positive correlation with seed cotton yield. Khan (2003) and Ahmad *et al*., (2008) observed significant variations for seed traits and reported significant correlation, which indicated that any improvement in seed traits would have a positive effect on seed cotton yield. Afiah & Ghoneim (2000), Badr (2003), Khan *et al*., (2007 & 2010) and Soomro *et al*., (2008) also mentioned that seed cotton yield has strong positive association with seed traits.

Conclusion

Genetic potential of genotypes and correlation of different yield traits revealed that the cultivars showed highly significant differences for most of the traits. The promising cultivars CIM-506, CIM-707, CIM-554 and CIM-496 with high genetic potential for majority of the traits can safely be used in future cotton breeding for further exploitation of their genetic variability.

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