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GENETIC VARIATION AND HERITABILITY FOR COTTON SEED, FIBER AND OIL TRAITS IN *GOSSYPIUM HIRSUTUM* L.

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Abstract

The research work pertaining to the study of genetic variability, heritability, genetic gain and correlation for cottonseed, fiber and cottonseed oil % in *Gossypium hirsutum* cultivars was conducted during 2005 at NWFP Agricultural University Peshawar, Pakistan. Analysis of variance manifested highly significant differences among the genotypes for all the traits except seeds per locule. Genetic potential range of eight cotton cultivars for different parameters was recorded i.e. seeds locule^{-1} (6.33 to 6.60), seeds boll^{-1} (26.10 to 28.47), seed index (8.61 to 9.69 g), lint index (5.35 to 6.05 g), lint % (35.17 to 38.13 %), seed cotton yield (1200 to 2450 kg ha^{-1}) and cottonseed oil % (27.52 to 30.15%). Genetic variances were found almost greater than the environmental variances for all the traits except seeds locule^{-1} and seed index. High broad sense heritability and selection response were also formulated for seeds boll^{-1} (0.67, 0.84), seed index (0.77, 0.47 g), lint index (0.96, 0.33 g), lint % (0.96, 1.66 %), seed cotton yield (0.98, 643.16 kg) and cottonseed oil % (0.87, 1.28 %), respectively. Correlation of yield with other traits was found positive for majority of traits except seeds locule^{-1} and cotton seed oil %. Seed cotton yield is our ultimate goal in growing cotton besides lint %. Highest seed cotton yield was recorded in CIM-499 followed by CIM-473, CIM-496 and CIM-506 and were also found as the 2nd and 3rd top scoring genotypes for seeds per boll, seed index, lint % and cottonseed oil %. Cultivar SLH-279 performed better for lint index, lint % and oil %. This type of correlation is rarely found and ultra desirable by the cotton breeders and a little genetic gain in seed and lint traits, and oil content is a great accomplishment.

Introduction

In Pakistan, the cotton research work has been started since independence and a large number of cultivars acquiring melodious combination of characters were evolved. But our per unit seed cotton yield and fiber quality is still low as compared to other cotton growing countries. During 2007-08, the 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). Seed cotton yield being a complex character, is the product of interplay between its attributes coupled with varying environmental conditions (Khan, 2003; Ahmad *et al*., 2008; Khan *et al*. 2009a & b).

Quantitative trait like yield being polygenic is a total sum of genetic illustration of all the yield components (Larik *et al*., 1997) and is significantly affected by environmental factors (Khan *et al*., 2007). The overall performance of a genotype may vary due to changes in environment and the higher the heritability, the simpler the selection process and greater the response to selection (Larik *et al*., 1997 & 2000; Soomro *et al*., 2008). In addition, a thorough knowledge about the mean performance, extent of relationship and correlation of yield with various agronomic characters is indispensable for breeder to tackle the problem of yield increase successfully. The correlation analysis also reflects the correlated response of a particular character with its counterpart and also provides a good index to predict the corresponding change which occurs in one character at the expanse of the proportionate change in the other (Khan, 2003; Ahmad *et al*., 2008).

Suinaga *et al*., (2006), Taohua & Haipeng (2006), Khan *et al*., (2007) and Meena *et al*., (2007) studied the stability and adaptability of *G. hirsutum* cultivars and observed varied values for different agronomic, morphological and yield related traits. Genetic variability and positive correlation were observed for yield traits in *G. hirsutum* (Iqbal *et al*., 2003; Wang *et al*., 2004). Arshad *et al*., (1993) also executed mean performance and observed positive correlation of yield with yield attributing traits in upland cotton. Khan *et al*., (1999) and Khan (2003) studied upland cotton genotypes and found high genetic variability for yield and cottonseed traits. The primary objectives of this study were to determine the genetic potential and variability, heritability broad sense (bs), genetic advance and correlation in upland cotton cultivars in form of their expressions and association for different traits. Such information can usefully be subjugated in articulating efficient selection programme for synthesis and development of new cotton genotypes with improved yield, cottonseed oil and fiber quality traits and having broad genetic base.

Materials and Methods

Genetic material: Breeding material comprised of six different *Gossypium hirsutum* genotypes having broad genetic base and varied by date of release, pedigree, seed cotton and fiber yield as well as fiber quality traits. The cultivars were CIM-466, CIM-473, CIM-496, CIM-499, CIM-506, CIM-538, CIM-707 and SLH-279.

Experimental design and field procedures: The experimental work comprised of to study the genetic variability and potential of genotypes, heritability, genetic gain and correlation of seed cotton yield with seed traits, fiber and cottonseed oil % in upland cotton was carried out during 2005 under the prevailing environmental conditions of NWFP Agricultural University, Peshawar, Pakistan. Peshawar lies between 34°, 02′ North latitude and 71°, 37′ East longitude. Breeding material comprised of eight different upland cotton genotypes were hand sown during mid of May, 2005 with intra- and inter-row spacing of 30 and 75 cm, respectively in a randomized complete block (RCB) design with four replications. Each sub-plot of a cultivar was having four rows with eight meter length. Thinning was performed twice after 15 and 25 days of germination when the plant height was 10 and 20 cm, respectively to ensure single plant per hill. All the 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, 2005 on single plant basis and ginning was made with eight saw-gins.

Traits measurement: The data were recorded on individual plant basis for the following parameters i.e. seeds per boll, seeds per locule, seed index (g), lint index (g), lint (%), seed cotton yield (kg ha^{-1}) and cottonseed oil (%). For seeds per boll, 20 bolls were separated and after counting the number of seeds in each boll, the average number of seeds per boll was calculated for each genotype. The seeds per locule were counted in each locule of the 10 bolls per plant to have average seeds per locule. For seed index, after ginning the hundred cottonseeds free from lint, disease or any other insect pest were weighed on electronic balance and hundred seed weight in gram (g) was treated as seed index. Lint index means the weight of lint obtained from one hundred seeds in grams; however, lint index of each plant was calculated by applying the below given formula. For lint %, clean and dry seed cotton picked from bolls of each plant was weighed and then ginned separately with 8-saw gins. The lint obtained from each plant was weighed and the ginning outturn (G.O.T) was worked out by the formula given below. For cottonseed oil content %, after ginning the seed samples were acid-delinted and were oven dried at 40°C for 24 hours and oil analysis was carried out by wide line Nuclear Magnetic Resonance (NMR, 4000).

$$\text{Lint index} = \frac{\text{Seed Index x Lint \%}}{100 - \text{Lint \%}}$$

$$\text{Lint \% (G.O.T.)} = \frac{\text{Weight of lint in a sample}}{\text{Weight of seed cotton sample}} \text{ x } 100$$

$$\text{Genetic variance } (Vg) = \frac{\text{Genotypes mean squares (GMS)} - \text{Error mean squares (EMS)}}{\text{Number of replications (r)}}$$

$$\text{Environmental variance } (Ve) = \text{Error mean squares (EMS)}$$

Phenotypic variance (Vp) = $Vg + (Ve/\text{r})$

Heritability broad sense (H^2) on entry mean basis was calculated as:

$$H^2 = \frac{Vg}{Vp}$$

The expected response to selection (Re) for each trait was calculated as under:

$$\text{Re} = k\sqrt{vp}H^2$$

Where:
k = 1.40 at 20% selection intensity for a trait
vp = Phenotypic variance for a trait
H^2 = Broad sense heritability for a trait

Statistical analyses: All the recorded data were subjected to analysis of variance (ANOVA) technique for a RCB design as outlined by Steel & Torrie (1980) through Mstatc computer programme for all the traits to test the null hypothesis of no differences among the cotton genotypes. The genotypes means for each parameter were further separated and compared by using the least significant difference (LSD) test at 5% level of probability. For each trait the genetic, environmental and phenotypic variances, broad sense heritability (H^2) and expected response to selection (Re) were further estimated from the ANOVA mean squares according to Burton (1951). The simple correlation coefficient (r) of seed cotton yield with other seed and fiber traits was also worked out according to Kwon & Torrie (1964).

Results and Discussion

According to analysis of variance (Table 1), the mean values for 8 cotton genotypes manifested highly significant differences ($p \leq 0.01$) for seeds per boll, seed index, lint index, lint %, seed cotton yield and cottonseed oil %, while observed nonsignificant differences for seeds per locule.

Seeds per boll: Overall seeds per boll (Fig. 1) managed by 8 different genotypes were 26.10 to 28.47. However, the highest and statistically at par seeds per boll were obtained in CIM-473 (28.47) and CIM-506 (28.17), and were found statistically at par with four other cultivars (CIM-496, CIM-499, CIM-707 and CIM-538) ranged from 27.50 to 28.02. Minimum number of seeds per boll was obtained in the cultivar CIM-446 (26.10). Seeds per boll are directly contributing to seed cotton yield. Genetic variance for seeds per boll was 0.53, while environmental variance was 0.78 (Table 2). H^2 estimation for seeds per boll was 0.67 and the expected selection response was 0.84. Correlation was observed positive and highly significant (r = 0.688) for the said trait with seed cotton yield (Table 3). The seed per boll is an important yield component and manage boll weight, seed cotton yield, lint yield and cottonseed oil content. CIM-473 and CIM-506 by having larger number of seeds per boll also proved as second top scoring genotypes for seed cotton yield as contributing to seed cotton yield in combination with other yield components. Seeds per boll also have close correlation with seeds per locule and seed cotton yield, and contribute to seed cotton yield through addition to boll weight. Thus cultivars having high seeds per boll have relatively good yield potential in comparison with cultivars have less number of seeds per boll. Heritability (H^2) estimates with expected selection response for seed per boll were moderate and desirable with presence of significant positive correlation, revealed that the cultivars have the genetic potential to boost up the seeds per boll.

Krishnarao & Mary (1990), Iqbal *et al*., (2003) and Wang *et al*., (2004) derived information on genetic variability and positive correlation between seeds per bolls and seed cotton yield including other yield characters in *G. hirsutum*. Khan *et al*. (2009a) also executed positive correlation of seed cotton yield with yield attributes including seeds per boll in upland cotton. Rao & Mary (1996) studied upland cotton genotypes and found high genetic variability for seeds per boll and seed cotton yield. In the said studies, results 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.

Seed index: Average seed index (Fig. 2) varied from 8.61 to 9.69 g for eight cotton genotypes. CIM-707 excelled all other genotypes having highest 100 seed weight (9.59 g) by having bigger seeds. It was also found statistically at par with two other cultivars CIM-538 (9.50 g) and CIM-506 (9.46 g). The cultivars CIM-473 and CIM-499 were also found at par with later cultivars. The lowest and at par seed index was observed in two cultivars CIM-496 and CIM-446 having seed index of 8.61 and 8.81 g, respectively. Genetic and environmental variations for seed index were 0.14 and 0.13, respectively (Table 2). H^2 for the said trait was 0.77 and the expected selection response for seed index was 0.47 g. Positive correlation (r = 0.185) observed for the said trait with seed cotton yield (Table 3).

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

Parameters	Mean squares		F. Ratio's	CV %
	Genotypes	Error		
Seeds per boll	2.372	0.779	3.04**	3.20
Seed index	0.561	0.128	4.39**	3.92
Seeds per locule	0.047	0.069	0.68 N.S.	4.03
Lint index	0.180	0.007	26.53**	1.44
Lint % (G.O.T)	4.577	0.179	25.58**	1.16
Seed cotton yield	654542.411	10792.411	60.65**	4.92
Cottonseed oil %	3.288	0.421	7.81**	2.30

** Significant at $p \leq 0.01$, N.S. = Non-significant, CV = Coefficient of variation

Table 2. Genetic, environmental and phonotypic variances, and heritability with selection response for various traits of upland cotton.

Parameters	Vg	Ve	Vp	H^2	Re
Seeds per boll	0.53	0.78	0.79	0.67	0.84
Seed index	0.14	0.13	0.19	0.77	0.47
Lint index	0.06	0.07	0.06	0.96	0.33
Lint %	1.47	0.18	1.53	0.96	1.66
Seed cotton yield	214583.33	10792.41	218180.80	0.98	643.16
Cottonseed oil %	0.96	0.421	1.10	0.87	1.28

Vg= Genetic variance, Ve= Environmental variance, Vp= Phonotypic variance, H^2 = Heritability broad sense, Re= Selection response

Table 3. Correlation of seed cotton yield with various traits of upland cotton.

Parameters	Correlation (r)	Std. Error
	Seed cotton yield	
Seeds per boll	0.668**	58.959
Seed index	0.185	151.402
Seeds per locule	-0.022	186.939
Lint index	0.405*	307.736
Lint %	0.202	65.235
Cottonseed oil %	-0.077	68.954

*, ** = significant at $p \leq 0.05$ and $p \leq 0.01$.

Seed index is also an important yield factor and plays imperative role in increasing seed cotton yield and cottonseed oil %. Heritability estimation for the said trait was high with valuable expected selection response and positive correlation with yield, exhibited that the seed size was administered through genetic variance and there is space for improvement in seed size. Dani (1991) studied the mean performance of *G. hirsutum* for seed index and observed significant variations among cultivars for seed index. Suinaga *et al*., (2006), Taohua & Haipeng (2006) and Meena *et al*., (2007) studied the yielding capacity of *G. hirsutum* cultivars and observed varied values for seed index. Hassan *et al*., (2005) studied the performance of Egyptian cotton cultivars and found positive and significant correlation between seed index and seed cotton yield. Abouzaid *et al*., (1997) and Iqbal *et al*., (2003) mentioned in their studies conducted on *G. hirsutum* for seed index, yield and other yield related traits and observed that yield attributes also varied significantly between cultivars. The inconsistent views of past researchers about the said trait might be due to genotypic and environmental differences and due to diverse genetic background of the breeding material used in various environmental conditions.

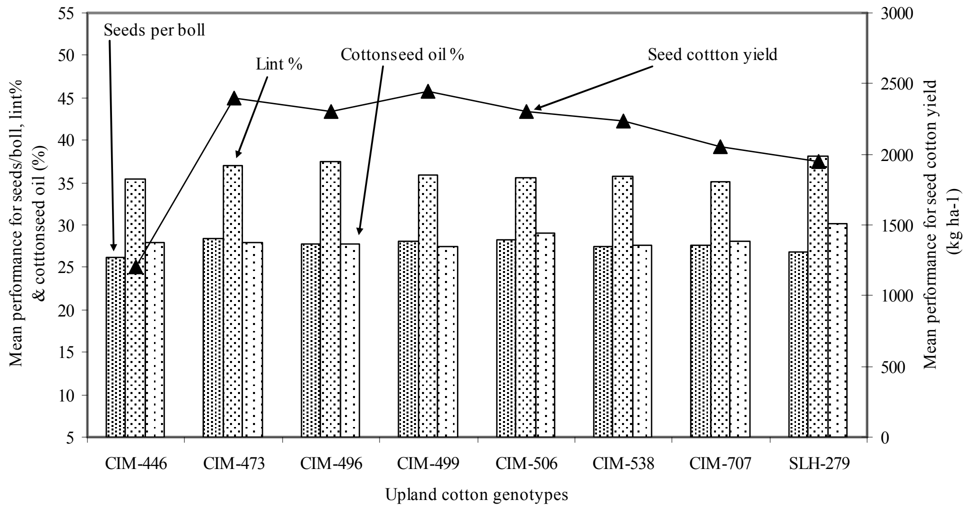

Fig. 1. Mean performance for seeds per boll, lint%, seed cotton yield and cottonseed oil% in upland cotton.

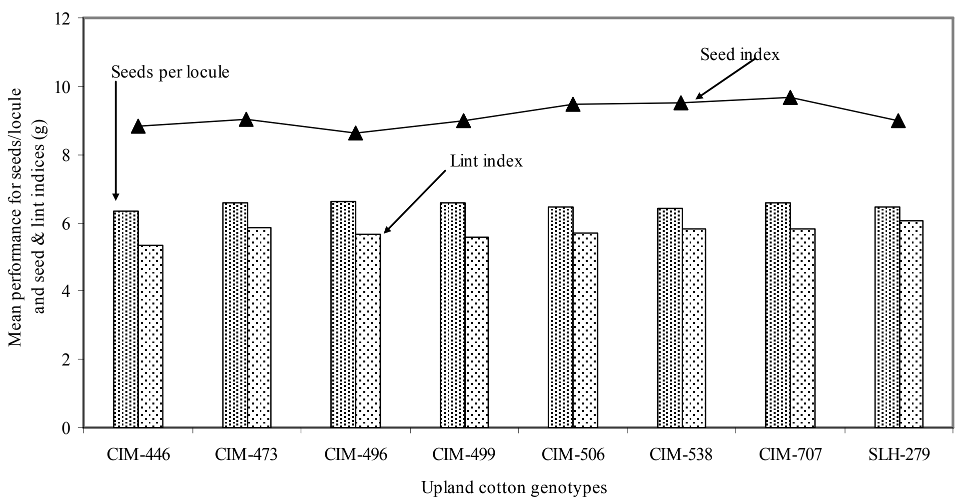

Fig. 2. Mean performance for seeds per locule, seed and lint indices in upland cotton.

Seeds per locule: Mean values revealed that the genotypes were having nonsignificant differences for seeds per locule (Fig. 2). The seeds per locule ranged from 6.33 to 6.63 among the genotypes. However, numerically the highest seeds per locule were recorded in cultivars CIM-496, CIM-707, CIM-473 and CIM-499 ranged from 6.58 to 6.63. The lowest value (6.33) for said trait was recorded in the cultivar CIM-446. Seed per locule is an important yield component and play important role not only in manifesting seed cotton yield but also cottonseed oil %. Seeds per locule have also direct correlation with seed cotton yield, so the cultivars having more number of seeds per locules have higher seed cotton yield and oil %. Seeds per locule also manage the lint% as fibers directly originating from cotton seeds. For seeds per locule, the means differences were non-significant and due to which the said trait has no association with seed cotton yield and to play role for variation and correlation. The environmental variances play some role and were found greater than genetic variances for the said trait, hence, the H^2 and selection response could not be work out as well and the same response obtained about correlation of the said trait with seed cotton yield which was negative but non-significant also, otherwise we may get positive correlation for said trait with yield but if genotypes vary also for the said trait.

Khan *et al*. (2009a & b) also derived information on correlation between seeds per locule and seed cotton yield. Seed cotton yield was significantly and positively associated with seeds per locule. They also mentioned that traits like seeds per locule contributed 70% of the total variability for seed cotton yield. Khan *et al*. (2009a) mentioned that seeds per boll and other yield components had positive correlation with seed cotton yield. Krishnarao & Mary (1990) and Wang *et al*., (2004) derived information on genetic variability and noted positive yield correlations with seeds per locule and other yield traits in *G. hirsutum*. The conflicting findings and different views of past researchers about the said trait might be due to genotypic and environmental differences.

Lint index: On average, the lint index ranged from 5.35 to 6.05 g (Fig. 2). Maximum lint index was noticed in cultivar SLH-279 (6.05 g) and was followed by three other cultivars CIM-473, CIM-707 and CIM-538 ranged from 5.80 to 5.86 g. The lowest lint index (5.25) was recorded in CIM-446. Genetic and environmental variances were (0.06, 0.07), respectively (Table 2). H^2 for the said trait was 0.96 and the expected selection response for lint index was 0.33 g. Positive and significant correlation (r = 0.405) was obtained for the said trait with seed cotton yield (Table 3). Lint index is the key trait and has major contribution in increasing the lint % and seed cotton yield. Due to close association of lint index with lint %, the promising cultivars also showed maximum lint %. The cultivars having medium lint index have also exhibited increased seed cotton yield. The Cultivar (CIM-446) having least lint index also demonstrated lowest lint %. Heritability was high with desired expected selection response, along with positive correlation manifested that the inheritance of the said trait was controlled by genetic variance and there is room for further improvement in lint index.

Rao & Mary (1996) and Afiah & Ghoneim (2000) mentioned that the genetic variability was high for yield components including lint index and yield. Positive association between lint index and yield suggested that increase in lint index will lead to increased seed cotton yield and lint %. Suinaga *et al*., (2006), Taohua & Haipeng (2006) and Meena *et al*., (2007) studied the performance of *G. hirsutum* and perceived varied values for lint index. Abouzaid *et al*., (1997) and Iqbal *et al*., (2003) also cited that *G. hirsutum* cultivars varied significantly for lint index and other yield related traits.

Lint percentage: On average, lint % was recorded from 37.28 to 40.22% (Fig. 1) among eight cultivars. The highest lint % was noticed in cultivar SLH-279 (38.13%) and was followed by two other cultivars CIM-473 and CIM-496 having 37.03% and 37.42%, respectively. Cultivar CIM-707 revealed lowest lint % (35.17%), but was found statistically at par with three other cultivars (CIM-446, CIM-506 and CIM-538) ranged from 35.47 to 35.72%. The genetic and environmental variances were 1.47 and 0.18, in which genetic variance was found eight times greater than the environmental variance (Table 2). H^2 for the said trait was 0.96 and the expected selection response for lint % was 1.66%. Positive correlation (r = 0.202) was observed for the said trait with seed cotton yield (Table 3). Lint % is the focal trait and major output after ginning the seed cotton, as cotton is mainly grown for lint (fibers) and cottonseed oil is extracted as byproduct. Arshad *et al*., (1993) and Iqbal *et al*., (2003) also studied agronomic characteristics of upland cotton cultivars using correlation and mentioned that ginning out-turn percentage had a negative direct effect on seed cotton yield. However, in present studies, the cultivars CIM-473 and CIM-496 having second leading GOT also exhibited high seed cotton yield under the said environmental conditions, which is extra desirable as it rarely found that a cultivar have both qualities. Cultivar CIM-446 with lowest GOT also showed lowest seed cotton yield and showing some signs of positive correlation.

Afiah & Ghoneim (2000) used phenotypic and genotypic correlation and showed that lint yield was the major contributor to yield, and it was followed by lint percentage and boll weight. However, other traits were found to have minor contributions towards the variations in seed cotton yield. The genetic variances were found greater than environmental variances and the heritability was also high with desired genetic gain and in presence of positive correlation, authenticated that the cultivars have the potential to enhance the lint %. Taohua & Haipeng (2006) and Meena *et al*., (2007) studied the stability and adaptability of *G. hirsutum* and observed varied values for lint percentage. Cook & El-Zik (1993) noticed that cultivars differed significantly for lint yield. Reid *et al*., (1989) also assessed the fibre yield of promising cultivars in all major Australian cotton growing areas and mentioned highest rate of genetic gain in lint yield. Khan *et al*. (2009a) confirmed through study of upland that bolls per plant had the most important effect on lint yield. The inconsistent findings and different views of past researchers about the said trait might be due to genotypic and environmental differences. Therefore, it is suggested to breed cotton cultivars with higher lint yield based on synchronous selection of more bolls per plant.

Seed cotton yield: Overall seed cotton yield ranged from 1200 to 2450 kg ha^{-1} among the eight upland cotton genotypes (Fig. 1). Maximum and statistically at par seed cotton yield was observed in CIM-499 (2450 kg ha^{-1}) and CIM-473 (2400 kg ha^{-1}). These cultivars were found also at par with two other cultivars CIM-506 and CIM-496 with yield of 2300 kg ha^{-1}, followed by CIM-538 (2238 kg ha^{-1}). Lowest seed cotton yield per hectare was gained in CIM-446 (1200 kg ha^{-1}). The cultivars having more number of bolls per plant like CIM-499 and CIM-473 have also shown maximum yield as both traits have a strong positive correlation. Genetic and environmental variances were 214583.33 and 10792.41, respectively and genetic variance was 20 times greater in magnitude than environmental variance (Table 2). Consequently, the H^2 estimate for seed cotton yield was 0.98 and the resultant expected selection response was 643.16 kg for seed cotton yield.

Seed cotton yield is an ultimate goal in growing cotton besides lint %. Highest seed cotton yield was observed in CIM-499 and CIM-473 followed by CIM-496, CIM-506 and were also found as the 2nd and 3rd top scoring genotypes for lint% and cottonseed oil %. The yield also manifested strong correlation with important 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 Arshad *et al*., (1993), Cook & El-Zik (1993) and Khan (2003). Genetic variances were greater in magnitude than environmental variances; hence, the heritability estimation was also high with desired expected selection response. It revealed that the seed cotton yield was mainly controlled by genetic variance and 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. Ahmad *et al*., (2008) evaluated different *G. hirsutum* cultivars for yield and other economic characters and observed significant variations for seed traits and positive effect on yield. Khan (2003) and Ahmad *et al*., (2008) reported significant correlation, which indicated that any improvement in seed traits would have a positive effect on seed cotton yield. Afiah & Ghoneim (2000), Khan *et al*., (2007) and Soomro *et al*., (2008) also mentioned that seed cotton yield was significantly positively correlated with seed traits. The results obtained also revealed that seed cotton yield and lint % were interdependent and major contributors to one another. However, other traits were considered and found to have minor contributions to seed cotton yield variance.

Cottonseed oil %: In present studies, overall cottonseed oil % ranged from 27.52 to 30.15% among eight upland cotton cultivars (Fig. 1). Maximum cottonseed oil % was noted in the genotype SLH-279 (30.15%). It was closely followed by cultivar CIM-506 having 29.10% cottonseed oil. All the remaining six cultivars showed at par cottonseed oil % (27.52 to 28.08%). However the cultivar CIM-499 manifested lowest cottonseed oil content (27.52%). The genetic variance was 0.96 (Table 2) and was found two times greater than the environmental variance (0.42). H^2 for the said trait was 0.87 with expected selection response for cottonseed oil % (1.28%). Correlation was found negative but non-significant (r = -0.077) for the said trait with seed cotton yield (Table 3). As we are well aware that cotton is of great economic importance due to textile industry, but in developing countries like Pakistan it is also the main source of edible oil. Its contribution amounts to 65-70% in the local edible oil industry (Khan *et al*., 1999; Khan, 2003) but less attention has been paid by breeders to cottonseed oil improvement. Maximum cottonseed oil % was observed in the genotypes SLH-279 and CIM-506. Cultivar CIM-506 also observed as the 3rd top scoring genotype for increased seed cotton yield, which is a nice combination of both capabilities in one genotype. Genetic variances were greater than environmental variances, and heritability was also high with preferred expected selection response, revealed that there are better chances of improvement in cottonseed oil. However, correlation of the said trait with seed cotton yield was negative but non-significant also.

Hassan *et al*., (2005) studies exhibited the performance of Egyptian cotton cultivars for cottonseed oil % and found significant mean differences. Kohel (1980) also investigated the inheritance of cottonseed oil % and exhibited significant variability for cottonseed oil % and the heritability based on parental cultivars ranged from 42-66%. Hossain (1983) studied mean performance and heritability for cottonseed oil and yield in two pure line cultivars and their hybrids of upland cotton and observed that high oil content was a continuously varying character, which differentiated the parents into relatively high and low oil types and the heritability (42%) was moderate for cottonseed oil %. Dani (1989) and Dani (1991) studied the mean performance of *G. hirsutum* cultivars for cottonseed oil % and observed significant variations among genotypes for cotton seed oil. Khan (2003) and Khan *et al*. (2009b) observed variable cottonseed oil % in the *G. hirsutum* cultivars, which varied from 27.55% (BH-36) to 29.32% (CIM-240). Some of the incompatible views of past researchers about the said trait might be due to genotypic and environmental variations and due to different genetic ambiance of the cultivars used in various environmental conditions.

Conclusion

On the basis of the above studies, it is concluded that the cultivars CIM-499, CIM-473, CIM-496 and CIM-506 have larger genetic potential for seed cotton yield and were also found as the 2^{nd} and 3^{rd} top scoring genotypes for seed and lint traits, and cottonseed oil %. However, cultivar SLH-279 performed better and exceeded all the cultivars for lint index, lint % and cottonseed oil % under the prevailing environmental conditions of Peshawar, Pakistan. So for tangible results in yield, seed and fiber traits, and cottonseed oil, due consideration may be given to the above genotypes in the future cotton breeding programmes.

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