Biological and Clinical Sciences Research Journal
eISSN: 2708-2261; pISSN: 2958-4728
www.bcsrj.com
DOI: https://doi.org/10.54112/bcsrj.v2023i1.297
*Biol. Clin. Sci. Res. J., Volume, **2023**: 297*
Original Research Article

GERMPLASM POTENTIAL FOR DIFFERENT ADVANCE LINES OF *GOSSYPIUM HIRSUTUM* FOR WITHIN BOLL YIELD COMPONENTS

SHAFIQUE MT[1], BANO M[1], *KHALID MN[1], RAZA A[2], SHAHID M[2], HUSSNAIN H[2], IQBAL M[2], HUSSAIN M[3], ABBAS Q[3], IQBAL MM[4], AHMAD HR[5], AQEEL M[6]

[1]Department of Plant Breeding and Genetics, University of Agriculture Faisalabad, Pakistan
[2]Cotton research Institute Multan, Pakistan
[3]Entomological Research Sub-Station Multan, Pakistan
[4]Agronomy, Forage Production Section Faisalabad, Pakistan
[5]Soil Fertility Lahore, Pakistan
[6]Maize and Millets Research Institute, Yousafwala Sahiwal, Pakistan
**Correspondence author email address: noumankhalidpbg@gmail.com*

(Received, 10th December 2022, Revised 24th April 2023, Published 30th April 2023)

Abstract: *Cotton production per hectare is low in Pakistan due to many biotic and abiotic factors. As boll is the basic determinant for yield in cotton crop, a study on within boll yield parameters was carried out using 24 cotton bulk and 2 check varieties to check their variability for within boll yield components. The experiment was performed in the research area of the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. The genotypes were seeded in two replications following a randomized complete block design. Data were subjected to analysis of variance to check significance among different genotypes. Genotypes were significantly different. The genotype PB-132 performed best for most parameters including GOT, lint index, lint mass per seed, and seed density. Correlation analysis was applied to find out the association of these parameters. Seed cotton yield was positively associated with the GOT, boll weight and number of seeds per boll while it negatively correlated with fiber fineness, seed volume, and seed surface area. The first principal component showed 26.37%, the second component showed 17.93%, the third component showed 14.88%, and the fourth component showed 14.40% of total variation. PCA analysis showed the genetic diversity among cotton genotypes. The current study's findings revealed the potential of different bulks of cotton for developing high-yielding varieties. This information may be used to develop breeding strategies to enhance cotton production and variety.*

Keywords: Cotton, PCA, Correlation, Within boll yield, High yielding

Introduction

The most basic factors affecting cotton seed cotton and lint yield are within-boll components (*Gossypium hirsutum* L.). Boll serves as the foundation for seed cotton production, therefore within-boll yield components may be the most fundamental factors affecting cotton productivity on a per-unit-land-area (Zhi et al., 2016). Studying the genetic process behind the inheritance of any characteristic is necessary before attempting to improve it. Seed cotton yield, seeds per boll, lint mass per boll, and GOT% directly affect cotton yield (Imran et al., 2012).

The correlation analysis forecasts the change that occurs in one attribute by the change in the other (Hampannavar et al., 2020). Correlation analysis is an effective tool to identify the association between the yield-related attributes in genetically diverse populations that will be used in the future breeding program for crop improvement (Komala et al., 2018). All yield contributing traits are correlated with one another. Therefore, it is important to have information about their association for the selection of suitable breeding. To start any breeding program information about genotypic and phenotypic correlation is helpful. If the correlation between two different traits of a plant is positive, then it means by improving one trait other traits will have significant positive results, while if the correlation is negative then it means by increasing or improving one character another trait will show negative or non-significant results. Magnitude and direction of correlation among yield and yield-related attributes must be considered for selecting the superior genotypes for the highly diverse genetic breeding program (Abbas et al., 2015).

Utilization of available diversity regarding morphological features is required to initiate a well-planned breeding program (Mugheri et al., 2017). Boll

[Citation Shafique, M.T., Bano, M., Khalid, M.N., Raza, A., Shahid, M., Hussnain, H., Iqbal, M., Hussain, M., Abbas, Q., Iqbal, M.M., Ahmad, H.R., Aqeel, M. (2023). Germplasm potential for different advance lines of *Gossypium hirsutum* for within boll yield components. *Biol. Clin. Sci. Res. J.*, **2023***: 297*. doi: https://doi.org/10.54112/bcsrj.v2023i1.297]

weight, seed cotton yield, and lint yield are positively correlated; an increase in boll weight enhances seed cotton yield and lint production. The most important trait and the ultimate goal of the breeder for any crop is the yield. Yield is a quantitative trait which means multiple genes control it. Cotton yield is an inclusive trait, factors such as lint yield, lint percentage, lint index, seed index, seed yield, boll number, boll size, and weight affect the total yield (Constable et al., 2015). Considering the importance of population in the cotton breeding program, the research was designed to study correlation analysis to set selection criteria in the different advance lines of cotton. This study may be helpful for the selection of other plants in the bulk populations.

Objectives

- To evaluate the best-performing lines based on within boll yield components.

MATERIALS AND METHODS

The material comprised 24 advanced cotton lines (table 1) developed by cotton research group, department of Plant Breeding and Genetics. The research was conducted in the cotton field area of the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, during the regular cotton planting season in 2021. Twenty-six genotypes were sown in a randomized complete block design with two replications. At the time of sowing, the recommended row-to-row distance (75cm) and plant-to-plant distance (30cm) were maintained. Proper agronomic practices were applied from sowing to picking, like weeding, thinning, hoeing, proper irrigation, and plant protection by using different pesticides as recommendations.

Ten plants of each genotype from each replication were chosen at random for data collection for the following traits.

Attributes

1. Seed cotton yield (g)
2. Boll weight (g)
3. Seed index (g)
4. Lint index (g)
5. Seed number per boll
6. Seed mass per boll (g)
7. Seed volume per 100 seeds
8. Seed density (g/cm^3)
9. Seed surface area (cm^2)
10. GOT (%)
11. Lint mass per boll (g)
12. Fiber fineness (µg/inch)
13. Fiber strength (g/tex)
14. Fiber length (mm)

Table 1: Genotypes Name

1. PB-106	2. PB-99
3. FLD-490	4. PB-100
5. PB-114	6. PB-136
7. PB-95	8. PB-116
9. PB-97	10. PB-131
11. PB-101	12. LALAZAR
13. PB-94	14. PB-130
15. PB-129	16. PB-126
17. PB-134	18. PB-135
19. NOOR-21	20. PB-96
21. PB-93	22. PB-137
23. PB-123	24. PB-132
25. PB-133	26. PB-128

Traits Evaluation

At the time of maturity 20 plants were selected from two replications. Ten from replication one and 10 from replication two. Ten effective bolls were picked from axial, terminal, and middle part of the plant to study seed and lint-related traits. Data were recorded from selected plants individually for the following parameters.

Statistical analysis

The collected data was exposed to the analysis of variance and correlation by using Statistix 8.1. PCA determined diversity among genotypes with the help of XLSTAT.

Results and discussion

Analysis of Variance

Analysis of variance manifested that the bulk population exhibited significant variation for all the attributes like boll weight, lint index, seed index, ginning outturn (%), seeds boll^{-1}, fiber length, fiber length, fiber strength, fiber fineness, seed volume, seed density and seed surface area while seed cotton yield was highly significant (Table 2).

Table 2. Analysis of variance of cotton genotypes for various traits under study

Source	DF	SCY	S/B	BW	GOT	SM/B	LM/B	SI	LI	FS	FF	FL	SV	SSA	SD
Replication	1	84.992	24.923	1.13723	1.72463	0.28062	0.04043	1.05023	0.99139	2.08	0.013	0.00085	0.30769	0.00007	0.0055
Genotypes	25	834.394**	25.15**	0.143**	3.880*	0.045*	0.023**	0.30**	0.276*	8.97**	0.135*	1.090**	4.390**	0.015**	0.042**
Error	25	59.526	1.9231	0.00622	1.5278	0.01191	0.00623	0.0715	0.11157	0.8488	0.03718	0.19588	0.34769	0.0028	0.00064
Total	51														

*Significant Values = * Highly Significant Values = ** SCY= seed cotton yield, S/B= seed per boll, BW= boll weight, GOT%= ginning out turn percentage, SM/B= seed mass per boll, LM/B= lint mass per boll, FF=fiber fineness, FL = fiber length, FS= fiber strength, SI= seed index, SV= seed volume, LI= lint index, SD= seed density, SSA= seed surface area*

[Citation Shafique, M.T., Bano, M., Khalid, M.N., Raza, A., Shahid, M., Hussnain, H., Iqbal, M., Hussain, M., Abbas, Q., Iqbal, M.M., Ahmad, H.R., Aqeel, M. (2023). Germplasm potential for different advance lines of *Gossypium hirsutum* for within boll yield components. *Biol. Clin. Sci. Res. J.*, **2023***: 297*. doi: https://doi.org/10.54112/bcsrj.v2023i1.297]

Correlation

Correlation analysis studied the magnitude and type of association among the attributes under study and which attribute should be selected to increase the seed cotton yield. It determined traits that may be able to increase the value of the crop. A correlation study is an important factor in developing a selection strategy for the breeding program. The information of association among characters is crucial for the selection procedure. This association may be due to genetic or environmental factors (Hampannavar et al., 2020). Correlation is usually studied to find out the association between different traits. The correlation values lie between -1.0 to +1.0 if the value is 0 to 1.0 then the trait is positively correlated, and if the values of the results are between -1.0 to 0 then the trait is negatively correlated. The results of correlation analysis of the current study are presented in table 3.

Seed Per Boll

Seeds per boll positively correlated with seed cotton yield per plant and boll weight. It showed significant positive correlation with GOT%. Seeds per boll showed a negative association with seed volume, seed surface area, lint index, and seed index and highly significant negative association with lint index. Positive correlation of seeds per boll with seed cotton yield per plant was observed (Malik, 2018). A highly significant correlation was observed between numbers of seeds per boll, lint yield and cotton yield per plant.

Positive association was observed between the number of seeds per boll and boll weight observed by Desalegn *et al*. (2009). Seeds per boll positively correlated with lint percentage and cotton yield per plant (Batool *et al.*, 2010). Positive association of seeds per boll with seed cotton yield, fiber strength and fiber length by Bibi *et al.* (2011). Seeds per boll positively associated with seed cotton yield per plant by Tang and Xio. (2014).

Boll Weight

Boll weight per plant positively associated with seeds per boll and seed cotton yield per plant and seed index. It showed highly significant positive correlation with seed mass per boll and lint mass per boll. Boll weight per plant showed negative association with lint percentage and seed volume. Boll weight per plant positively associated with lint percentage reported by Azhar *et al*. (2004). Significant results of boll weight with seed cotton yield per plant were reported by Afiah and Ghoneim (2000). Hussain et al. (2010) reported the same results according to our research work. Positive linkage between boll weight and seed index was studied by Killi*et al*. (2005). Different cotton varieties were assessed for a positive association between boll weight and seed cotton yield. Boll weight per plant showed positive correlation with seed cotton yield per plant. Positive association between boll weight and seed cotton yield was observed by Ahmad *et al*. (2008). Boll weight per plant positively associated with seed cotton yield per plant Abbas *et al.* (2008). Positive correlation between boll weight and number of seeds per boll was stated by Karademir *et al.* (2009). Boll weight per plant positively associated with seed cotton yield per plant Desalegn *et al.*, (2009). Boll weight per plant positively correlated with 62 seed cotton yields per plant (Bibi *et al*., 2011; Alkuddsi *et al*., 2013). Boll weight per plant positively correlated with seed cotton yield per plant (Erande *et al.*, 2014; Ahsan *et al.*, 2015).

GOT%

Ginning out turn showed a significant positive association with seeds per boll. It showed a highly positive correlation between lint index and seed density. Ginning out turn, showed a significant negative association with seed volume and a highly significant negative association with seed surface area. Positive and significant association of ginning out turn with seed index was investigated by Yaqoob *et al.* (2016). Negative association between GOT and seed mass per boll was studied by Zeng *et al.* (2009). A positive association of plant GOT% was observed with seed cotton yield per plant and the Lint index (Djaboutou *et al.*, 2005). Positive correlation of ginning out turn with a yield of seed cotton and fiber fineness while studying F_2 population of upland cotton (Yaqoob *et al.*, 2016).

Seed Mass per Boll

Seed mass per boll depicted a highly significant positive correlation with boll weight per plant and lint mass per boll. It showed a negative association with fiber fineness. It showed a significant positive association with seeds per boll and seed cotton yield per plant. Seed mass per boll showed a positive association with boll weight. Seed mass/boll positively and significantly associated with seeds/boll. Within boll seed yield components per boll depicted positive and significant results i.e., seed mass per boll and number of seeds depicted positive association Tang and Xiao (2013).

Lint Mass Per Boll

The amount of lint per boll was found to be highly significant positive association with boll weight, seed mass per boll. The negative association was observed with GOT% which means that if we increase lint percentage then GOT% decrease which is not desirable for us. A significant negative correlation was detected for fiber fineness.

Positive association of lint weight with plant height was reported by Kumar *et al.* (2017). The findings align with Zeng *et al.* (2009) and Tang and Xiao (2013) who revealed a positive significant association between lint mass per boll and seed mass per boll.

Lint index

[Citation Shafique, M.T., Bano, M., Khalid, M.N., Raza, A., Shahid, M., Hussnain, H., Iqbal, M., Hussain, M., Abbas, Q., Iqbal, M.M., Ahmad, H.R., Aqeel, M. (2023). Germplasm potential for different advance lines of *Gossypium hirsutum* for within boll yield components. *Biol. Clin. Sci. Res. J.,* **2023***: 297*. doi: https://doi.org/10.54112/bcsrj.v2023i1.297]

Lint index depicted a highly significant positive association with seed cotton yield and GOT%. It showed a positive association with lint mass per boll and lint percentage. It showed a negative association with seeds per boll and seed mass per boll. It showed a significant negative correlation with seed per boll and seed index. A significant correlation of lint index with boll weight was observed by Ahmad *et al.* (2019).

Seed index

Seed index showed a highly significant and negative correlation with lint index. Seed index showed a positive correlation with seeds per boll, seed cotton yield per plant, boll weight per plant, seed mass per boll and. Seed index showed negative association with fiber fineness and significant and positive association with fiber strength. Results are following Kale *et al*. (2007) that seed index is positively associated with boll weight. Seed index is positively correlated with number of bolls per plant Do Thi *et al*. (2008). Hinza et al. (2011) stated a negative correlation between lint index and seed index in a diallel mating system of seven parents. Positive correlation between seed index and the number of sympodial branches per plant was reported by Kumar *et al.* (2017). Seed index positively associated with boll weight (Deshmukh *et al*., 2019).

Seed Volume

Seed volume highly significant and positively correlated with seed surface area. It showed a highly significant but negative correlation between seed density and GOT%. A negative correlation was found with seed cotton yield and seed per boll.

Seed Density

Seed density showed a significant and positive correlation with seed index. A positive correlation was found with seed cotton yield, seed per boll and seed mass per boll. Seed density showed a highly significant negative association with seed volume and seed surface area. Its mean that seed density is inversely proportional to seed volume and seed surface area. If seed density increases seed surface area of cotton seed will decrease.

Seed Surface Area

Seed surface area was found positively correlate with seed volume and showed a significantly negative association with seed cotton yield, seed per boll and boll weight. A positive correlation was found with seed index while having a negative association with seed density.

If the seed index will be high seed surface area also increase as compared to seed density because it showed a negative correlation with each other.

Fiber Fineness

Fiber Fineness is positively associated with GOT%, fiber length, seed volume, and lint index. While fiber fineness shows a highly significant and negative association with boll weight and seed density. Fiber fineness positively correlated with fiber length (Hussain *et al*., 2010).

Fiber Length

Fiber length showed a highly significant positive association with fiber strength and a negative association with Boll weight and GOT%. Mei *et al*. (2013) and Imran *et al*. (2012) found that Fiber length is positively associated with fiber fineness and uniformity. Dinakaran *et al*. (2012), Ahuja *et al*. (2006), Nateera *et al*. (2012) and Rasheed *et al*. (2009) also revealed that fiber length directly affected seed cotton yield.

Fiber Strength

Fiber strength showed a positive association with seed cotton yield, seed per boll, seed mass per boll, lint mass per boll and showed a negative association boll weight and GOT% and fiber fineness. Fiber strength is positively linked with seed per boll for the overall population. Karademir *et al.* (2010) also indicated that fiber strength is positively linked with seed per boll.

Seed Cotton Yield

Seed cotton yield per plant showed a positive, important, and strong positive association with seed per boll, boll weight, GOT%, fiber length, fiber strength, lint index and seed density while having a negative association with seed mass per boll, lint mass per boll, fiber fineness, seed index, seed volume and seed surface area. Seed cotton yield positively associated with seed traits (Afiah and Ghoneim, 2000). Positive association of seed cotton yield per plant was observed with plant GOT% and Lint index. (Djaboutou *et al*., 2005). Khan et al. (2010) observed a positive correlation with the number of seeds per boll. Seed cotton yield positively correlated with lint percentage (Salhuddin *et al.*, 2010). Positive association of seed cotton yield with number of seeds per boll was observed by Raza *et al.* (2016). Seed cotton yield positively correlated with fiber length and fineness (Hussain *et al.*, 2010). Positive association of seed cotton yield with boll weight was observed by Ahsan *et al*. (2015). Positive association of seed cotton yield with the boll weight was reported by Baloch *et al.* (2015).

Table 3: Correlation matrix among yield related traits of upland cotton

	S/B	BW	GOT%	SM/B	LM/B	FF	FL	FS	SI	SV	LI	SD	SSA
BW	0.239												

[Citation Shafique, M.T., Bano, M., Khalid, M.N., Raza, A., Shahid, M., Hussnain, H., Iqbal, M., Hussain, M., Abbas, Q., Iqbal, M.M., Ahmad, H.R., Aqeel, M. (2023). Germplasm potential for different advance lines of *Gossypium hirsutum* for within boll yield components. *Biol. Clin. Sci. Res. J.*, **2023***: 297*. doi: https://doi.org/10.54112/bcsrj.v2023i1.297]

GOT%	*0.288	-0.071											
SM/B	0.222	**0.425	0.176										
LM/B	-0.226	**0.471	-0.072	**0.658									
FF	-0.069	**-0.366	0.143	-0.152	*-0.343								
FL	0.081	-0.013	-0.197	0.023	0.139	*0.289							
FS	0.112	-0.023	-0.128	0.062	0.065	-0.093	**0.508						
SI	0.151	0.181	0.057	0.218	*-0.276	-0.165	0.251	**0.358					
SV	-0.188	-0.076	*-0.329	-0.041	0.119	0.25	0.012	-0.065	0.181				
LI	**-0.371	0.117	**0.438	-0.024	0.018	0.029	0.08	0.181	**-0.61	0.009			
SD	0.216	0.162	**0.366	0.136	0.015	*-0.29	0.088	0.134	0.207	**-0.903	0.249		
SSA	-0.16	-0.098	*-0.343	-0.146	0.106	0.186	0.092	-0.024	0.196	**0.908	0.067	**-0.789	
SCY/P	0.173	0.068	0.101	0.045	0.211	*-0.355	0.249	0.003	-0.113	*-0.286	0.015	0.269	*-0.277

*Significant Values = *   Highly Significant Values = ***

SCY= seed cotton yield, S/B= seed per boll, BW= boll weight, GOT%= ginning out turn percentage, SM/B= seed mass per boll, LM/B= lint mass per boll, FF=fiber fineness, FL = fiber length, FS= fiber strength, SI= seed index, SV= seed volume, LI= lint index, SD= seed density, SSA= seed surface area

Principal component analysis

Principal component analysis is most frequently used statistical technique in environmental studies (Yongming *et al*., 2006). Principal component analysis is a multivariate statistical technique used to describe the data set and extract important information from data set (Tokalioglu and Kartal, 2006). Principal component analysis was performed on 14 characters of 26 genotypes to check Eigen value, proportion of variation and cumulative variation among all genotypes and their studied traits. Fourteen yield contributing traits were studied i.e., Seed cotton yield, boll weight, seed index, lint index, seed number per bolls Seed mass per boll, seed volume, seed density, seed surface area, GOT (%), lint mass per boll, fiber fineness, fiber strength and fiber length. Out of 14 principal components 5 components showed Eigen value of greater than I (Eigen value > 1), which represents significant results (table 4). The first principal component contributed 26.37 % to the total variation, mainly due to lint mass per boll, seed mass per boll, seed index, and boll weight, seed cotton yield and lint index. The second principal component showed 17.93 % of total variation due to bool weight, seed mass per boll, lint mass per boll, fiber length, seed volume and seed surface area (Table 5). Third component represented 14.88 % variability to the total variation attributed by seeds per boll GOT percentage, boll weight per plant, lint mass, seed mass and fiber strength. 4th principal component showed 14.40 % of total variation which is depicted by seed cotton yield, GOT%, seeds per boll, seed index. Fifth principle component showed 7.211% of total variation due to seed mass per boll, lint mass per boll, fiber fineness, fiber strength and seed density.

First component showed 26.37 % cumulative variation, second 44.31 %, third showed 59.19%, 4th component represented 73.60 % and 5th components represented 80.81% cumulative variation (Table 6). These attributes should be emphasized for improving cotton genotypes for future breeding program. Results of these aspects have shown their contribution towards cumulative variability and cotton programs for future (Latif *et al*., 2015; kaleri *et al*., 2015).

Genotypes PB-106, G.FLD-490, PB-114, PB-95, PB-97, PB-101, PB-94, PB-129, PB-134, NOOR, PB-93, PB-123, PB-133, PB-99, PB-100, PB-136, PB-116, PB-131, LALAZAR, PB-130, PB-126, PB-135, PB-96, PB-137, PB-132 and PB-128. Score plot scattered the genotypes based on variation (Rana *et al*., 2013).

Distance from plot origin has depicted the level of variation among genotypes. Greater the distance from origin greater will be variation Greater distance from origin among genotypes had displayed greater variation (Rana *et al*., 2013) principal component analysis and cluster analysis were used to group winter genotypes of wheat (Salihu *et al*., 2006). Present research results were in great accordance with Latif *et al*. (2015). Therefore, the present study was carried out to access PCA to find the association among various yield-contributing traits in upland cotton genotypes. Present results were in favor of the findings of Saeed *et al.* (2014). Kaleri *et al*. (2015) and Gunasegaram (2019) Maximum yield components were observed in principal component 1 (Jarwar *et al*., 2019). Maximum contribution of yield and sympodial branches per plant was observed in principal component 1. Results favor Farooq *et al*. (2017), who accounted maximum contributions of ginning out turn percentage and boils per plant in principal component II.

Table 4: Principle Components Analysis

	Eigenvalue	Variability (%)	Cumulative (%)
	3.6920	26.3716	26.3716
II.	2.5115	17.9391	44.3107
III.	2.0837	14.8835	59.1942

IV.	2.0170	14.4073	73.6015
V.	1.0096	7.2117	80.8131
VI.	0.7921	5.6576	86.4707
VII.	0.6143	4.3882	90.8589
VIII.	0.5275	3.7680	94.6269
IX.	0.3429	2.4496	97.0765
X.	0.2158	1.5418	98.6183
XI.	0.1665	1.1891	99.8073
XII.	0.0189	0.1350	99.9424
XIII.	0.0077	0.0547	99.9971
XIV.	0.0004	0.0029	100.000

Table. 5: Principal Component Analysis for 14 characters in 26 genotypes of upland Cotton.

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
SYC/P	0.206	-0.082	-0.270	0.244	-0.518	0.473	-0.205	0.196	-0.343	-0.091
S/B	0.212	-0.050	0.296	0.277	-0.312	-0.099	0.767	-0.031	0.075	-0.282
B/W	0.110	0.244	-0.368	-0.252	-0.117	-0.274	0.130	0.751	0.170	-0.052
GOT%	0.319	-0.10	0.339	-0.296	-0.218	0.244	0.028	0.081	0.015	0.567
SM/B	0.128	0.313	-0.071	-0.431	0.0724	0.506	0.136	-0.191	-0.153	-0.423
LM/B	0.022	0.471	-0.190	-0.325	0.0024	-0.039	0.243	-0.300	0.037	0.221
FF	-0.188	-0.214	0.399	-0.226	0.305	0.317	-0.023	0.3651	0.212	-0.315
FL	0.079	0.320	-0.130	0.446	0.053	0.320	-0.121	-0.064	0.73	-0.001
FS	0.094	0.257	0.053	0.372	0.551	0.227	0.260	0.290	-0.406	0.322
SI	0.165	0.431	0.332	0.138	-0.0018	-0.288	-0.319	0.039	-0.160	-0.325
SV	-0.444	0.226	0.168	0.014	-0.237	0.087	-0.008	0.134	0.0154	-0.004
LI	0.325	0.235	0.4335	-0.080	-0.135	-0.049	-0.228	0.084	-0.0024	0.109
SD	0.485	-0.071	-0.053	0.003	0.184	-0.154	-0.178	-0.112	0.0128	-0.157
SSA	-0.404	0.2944	0.190	0.074	-0.239	-0.004	-0.058	-0.037	-0.129	0.112

Table 6: Contribution of genotypes in PC1 and PC2

Sr. no	Genotypes	PC1	PC2
1	PB-106	1.3077	2.1071
2	G.FLD-490	0.1818	4.1700
3	PB-114	-1.7446	0.0832
4	PB-95	-2.1729	1.3899
5	PB-97	1.1582	-1.8490
6	PB-101	0.1900	0.9965
7	PB-94	0.1292	-1.8917
8	PB-129	-0.6043	-1.6655
9	PB-134	-4.0385	-0.6939
10	NOOR	-0.1305	0.5912
11	PB-93	-0.4882	-1.0044
12	PB-123	-2.3018	0.9489
13	PB-133	0.8000	-0.4388
14	PB-99	0.9908	2.8764
15	PB-100	0.8967	-0.9358
16	PB-136	-1.0050	-0.5344
17	PB-116	-0.4044	1.2611
18	PB-131	-2.3347	-1.0162
19	LALAZAR	-0.6948	1.5807
20	PB-130	0.0253	-1.9708
21	PB-126	2.0711	-2.6400
22	PB-135	-1.2202	-0.6257
23	PB-96	-1.6476	-0.6710
24	PB-137	2.6588	0.5779
25	PB-132	5.3448	0.3980
26	PB-128	3.0331	-1.0438

[Citation Shafique, M.T., Bano, M., Khalid, M.N., Raza, A., Shahid, M., Hussnain, H., Iqbal, M., Hussain, M., Abbas, Q., Iqbal, M.M., Ahmad, H.R., Aqeel, M. (2023). Germplasm potential for different advance lines of *Gossypium hirsutum* for within boll yield components. *Biol. Clin. Sci. Res. J.*, **2023***: 297*. doi: https://doi.org/10.54112/bcsrj.v2023i1.297]

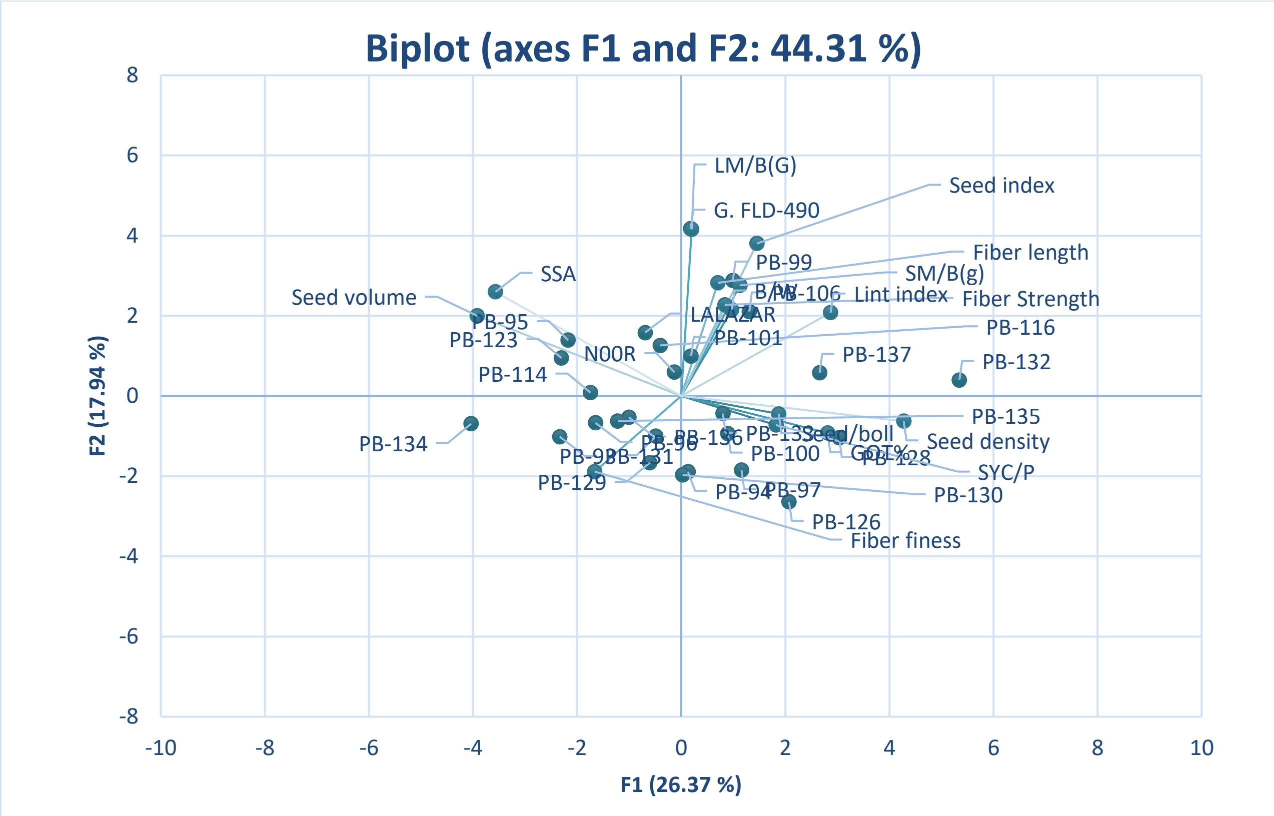

Figure 1: Biplot orientation of 26 genotypes on principal components axis 1 and 2

Figure 1 showed Biplot between 1st and 2nd component which displays contribution of yield contributing traits of cotton genotypes concerning variation. Traits represented with vectors and genotypes as dots. Distance of traits for first and second components depicted the contribution of genotypes and their traits in variation. Genotype PB-106 showed high potential for boll weight, seed mass per boll and fiber length. Genotypes G.FLD-490 represented high yielding cultivar for lint mass per boll, PB-99 illustrated seed index, PB-130 represented high yielding cultivar for seed cotton yield.

Conclusion

All lines performed well in different traits, but bulk PB-132 performed well for most traits like GOT%, Lint index, and lint mass per boll. It showed good seed cotton yield value as compared to other lines. In short, PB-132 showed good results, and can contribute to the next breeding programs.

Conflict of interest

Authors have no conflict of interest.

References

Abbas, A., Ali, M., & Khan, T. (2008). Studies on gene effects of seed cotton yield and its attributes in five American cotton cultivars. *Journal of Agriculture and Social Sciences (Pakistan)*.

Abbas, H. G., Mahmood, A., & Ali, Q. (2015). Genetic variability and correlation analysis for various yield traits of cotton (Gossypium hirsutum L.). *Journal of Agricultural Research* **53**, 481-491.

Afiah, S., & Ghoneim, E. (2000). Correlation, stepwise and path coefficient analysis in Egyptian cotton under saline conditions. *Arab Universities Journal of Agricultural Sciences* **8**, 607-618.

Ahmad, S., Iqbal, M. Z., Hussain, A., Sadiq, M. A., & Jabbar, A. (2003). Gene action and heritability studies in cotton (Gossypium hirsutum L). *Online J Biol Sci* **4**, 443-450.

Ahmad, W., Khan, N., Khalil, M., Parveen, A., Saeed, M., & Shah, S. (2008). Genetic variability and correlation analysis in upland cotton. *Sarhad Journal of Agriculture (Pakistan)*.

Ahsan, M. Z., Majidano, M. S., Bhutto, H., Soomro, A. W., Panhwar, F. H., Channa, A. R., & Sial, K. B. (2015). Genetic variability, coefficient of variance, heritability and genetic advance of some Gossypium hirsutum L. accessions. *Journal of agricultural science* **7**, 147.

Alkuddsi, Y., Patil, S., Manjula, S., & Patil, B. (2013). Correlation Studies on Yield and its Components in inter specific cotton hybrids (G. hirsutum x G. barbadense) for developing heterotic box. *Molecular Plant Breeding* **4**.

Azhar, F., Naveed, M., & Ali, A. (2004). Correlation analysis of seed cotton yield with fiber characteristics in Gossypium hirsutum L. *International Journal of Agriculture and Biology* **4**, 656-658.

Baloch, M., Baloch, A., Baloch, M., Mallano, I., Baloch, A., Baloch, N., & Abro, S. (2015). Association and heritability analysis for yield and fiber traits in promising genotypes of cotton (Gossypium hirsutum L.). *Sindh University Research Journal-SURJ (Science Series)* **47**.

Batool, S., Khan, N. U., Makhdoom, K., Bibi, Z., Hassan, G., Marwat, K. B., Farhatullah, F., Mohammad, R., & Khan, I. (2010). Heritability and genetic potential of upland cotton genotypes for morpho-yield traits. *Pak. J. Bot* **42**, 1057-1064.

Bibi, M., Khan, N. U., Mohammad, F., Gul, R., Khakwani, A. A., & Sayal, O. U. (2011). Genetic divergence and association among polygenic characters in Gossypium hirsutum L. *L. Pak. J. Bot* **43**, 2751-2758.

Constable, G., Llewellyn, D., Walford, S. A., & Clement, J. D. (2015). Cotton breeding for fiber quality improvement. *Industrial crops: Breeding for bioenergy and bioproducts*, 191-232.

Desalegn, Z., Ratanadilok, N., & Kaveeta, R. (2009). Correlation and heritability for yield and fiber quality parameters of Ethiopian cotton (Gossypium hirsutum L.) estimated from 15 (diallel) crosses. *Agriculture and Natural Resources* **43**, 1-11.

Erande, C., Kalpande, H., Deosarkar, D., Chavan, S., Patil, V., Deshmukh, J., Chinchane, V., Kumar, A., Dey, U., & Puttawar, M. (2014). Genetic variability, correlation and path analysis among different traits in desi cotton (Gossypium arboreum L.). *African Journal of Agriculture Research* **9**, 2278-2286.

Farooq, J., Rizwan, M., Sharif, I., Saleem, S., Chohan, S. M., & Kainth, R. A. (2017). Genetic diversity studies in some advanced lines of Gossypium hirsutum L. for yield and quality related attributes using cluster and principle component analysis. *Advances in Agriculture & Botanics* **9**, 111-118.

Hampannavar, M. R., Patil, B., Katageri, I., Kumar, B. A., & Janagoudar, B. (2020). Genetic variability and correlation analysis for agronomic and fibre quality traits in intra-specific cotton (G. hirsutum× G. hirsutum) recombinant inbred lines (RILs). *Int. J. Curr. Microbiol. Appl. Sci* **9**, 493-503.

Hussain, A., Azhar, F., Ali, M., Ahmad, S., & Mahmood, K. (2010). Genetic studies of fiber quality characters in upland cotton. *The Journal of Animal & Plant Sciences* **20**, 234-238.

Imran, M., Shakeel, A., Azhar, F., Farooq, J., Saleem, M., Saeed, A., Nazeer, W., Riaz, M., Naeem, M., & Javaid, A. (2012). Combining ability analysis for within-boll yield components in upland cotton (Gossypium hirsutum L.). *Genetics and Molecular Research* **11**, 2790-2800.

Jarwar, A. H., Wang, X., Iqbal, M. S., Sarfraz, Z., Wang, L., Ma, Q., & Shuli, F. (2019). Genetic divergence on the basis of principal component, correlation and cluster analysis of yield and quality traits in cotton cultivars. *Pak. J. Bot* **51**, 1143-1148.

Kaleri, A., Rajput, S., Kaleri, G., Kaleri, M., & Marri, J. (2015). Analysis of Genetic diversity in genetically modified and non-modified cotton (Gossypium hirsutum L.) genotypes. *IOSR Journal of Agriculture and Veterinary Science* **8**, 70-76.

Karademir, C., Karademir, E., Ekinci, R., & Gencer, O. (2009). Correlations and path coefficient analysis between leaf chlorophyll content, yield and yield components in cotton (Gossypium hirsutum L.) under drought stress conditions. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca* **37**, 241-244.

Karademir, E., Karademir, Ç., EKININCI, R., & Gençer, O. (2010). Relationship between yield, fiber length and other fiber-related traits in advanced cotton strains. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca* **38**, 111-116.

Komala, M., Ganesan, N. M., & Kumar, M. (2018). Genetic variability, heritability and correlation analysis in F2 populations of ratoon upland cotton hybrids. *International Journal of Agriculture, Environment and Biotechnology* **11**, 815-827.

Latif, A., Bilal, M., Hussain, S. B., & Ahmad, F. (2015). Estimation of genetic divergence, association, direct and indirect effects of yield with other attributes in cotton (Gossypium hirsutum L.) using biplot correlation and path coefficient analysis. *Tropical Plant Research* **2**, 120-126.

Malik, T. A. (2018). Correlation for economic traits in upland cotton. *ACTA Sci. Agric* **2**, 59-62.

Mugheri, M., Baloch, A., Baloch, M., Yasir, T., Gandahi, N., Jatoi, G., Baloch, A., Ali, M., & Baloch, I. (2017). Genetic diversity analysis through phenotypic assessment in Bt-cotton germplasm. *Sindh University Research Journal-SURJ (Science Series)* **49**, 739-742.

Rana, R. M., Rehman, S. U., Ahmed, J., & Bilal, M. (2013). A comprehensive overview of recent advances in drought stress tolerance research in wheat (Triticum aestivum L.). *Asian Journal of Agriculture and Biology* **1**, 29-37.

Saeed, F., Farooq, J., Mahmood, A., Hussain, T., Riaz, M., & Ahmad, S. (2014). Genetic diversity in upland cotton for cotton leaf curl virus

[Citation Shafique, M.T., Bano, M., Khalid, M.N., Raza, A., Shahid, M., Hussnain, H., Iqbal, M., Hussain, M., Abbas, Q., Iqbal, M.M., Ahmad, H.R., Aqeel, M. (2023). Germplasm potential for different advance lines of *Gossypium hirsutum* for within boll yield components. *Biol. Clin. Sci. Res. J.,* **2023***: 297*. doi: https://doi.org/10.54112/bcsrj.v2023i1.297]

disease, earliness and fiber quality. *Pakistan Journal of Agricultural Research* **27**.
Salihu, S., Grausgruber, H., & Ruckenbauer, P. (2006). Agronomic and quality performance of international winter wheat genotypes grown in Kosovo. *Cereal Research Communications* **34**, 957-964.
Tang, F., & Xiao, W. (2014). Genetic association of within-boll yield components and boll morphological traits with fibre properties in upland cotton (G ossypium hirsutum L.). *Plant Breeding* **133**, 521-529.
Tokalıoğlu, Ş., & Kartal, Ş. (2006). Multivariate analysis of the data and speciation of heavy metals in street dust samples from the Organized Industrial District in Kayseri (Turkey). *Atmospheric environment* **40**, 2797-2805.
Yongming, H., Peixuan, D., Junji, C., & Posmentier, E. S. (2006). Multivariate analysis of heavy metal contamination in urban dusts of Xi'an, Central China. *Science of the total environment* **355**, 176-186.
Zhi, X.-y., Han, Y.-c., Li, Y.-b., Wang, G.-p., Du, W.-l., Li, X.-x., Mao, S.-c., & Lu, F. (2016). Effects of plant density on cotton yield components and quality. *Journal of Integrative Agriculture* **15**, 1469-1479.

[Citation Shafique, M.T., Bano, M., Khalid, M.N., Raza, A., Shahid, M., Hussnain, H., Iqbal, M., Hussain, M., Abbas, Q., Iqbal, M.M., Ahmad, H.R., Aqeel, M. (2023). Germplasm potential for different advance lines of *Gossypium hirsutum* for within boll yield components. *Biol. Clin. Sci. Res. J.*, **2023***: 297*. doi: https://doi.org/10.54112/bcsrj.v2023i1.297]