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Original Research Article

EVALUATION OF GENETIC VARIABILITY FOR DIFFERENT FIBER AND YIELD RELATED COMPONENTS IN COTTON (*GOSSYPIUM HIRSUTUM* L.)

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Abstract: *Cotton (Gossypium hirsutum.) is a vital commodity, and fiber and cash crop grown as an important part of cropping systems around the globe. However, Pakistan's production has not been according to its potential for many years. Its production and yield have decreased in Pakistan due to the loss of genetic diversity and lack of empirical research. Therefore, the current research was performed to evaluate the genetic diversity for sixteen yield components among 19 local and one exotic cotton (Gossypium hirsutum L.) genotypes. The experiment was conducted at the experimental site of the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. The experiment was performed under the Randomized complete block design (RCBD) with two replications. Analysis of variance revealed significant differences among all traits for available genotypes. The mean value for seed cotton yield ranged from 106.8 to 35.5 g. Genotype ZB-18026 displayed the maximum mean value, whereas genotype ZB-18032 showed the minimum mean value for this particular trait. High heritability coupled with high genetic advance was calculated for most traits. Lint mass per seed showed the highest heritability value (99.99%). Lint mass per boll showed the lowest value of heritability coupled with genetic advance. The phenotypic coefficient of variance (PCV) was higher than most traits' corresponding genotypic coefficient of variance (GCV). Boll weight manifested the highest PCV (68.7088%) and GCV (61.0473%). While traits, such as seed index and fiber strength, showed low values of GCV and PCV. The information related to the genetic variability of genotypes for various traits can be utilized as a basis for further genetic evaluations for future breeding programs.*

Keywords: Cotton, genetic variability, heritability, genetic advance

Introduction

Being an agricultural country, cotton constitutes one of the most important crops for the stable growth of Pakistan's economy (Zafar et al., 2022). Cotton is the backbone of Pakistan's textile industry which is a major industry, contributing about 60% to the country's exports. Its shares 0.8 percent of the GDP and contributes 4.5% in agriculture value addition. However, the country has gradually declined cotton yield and production. Cotton production witnessed a sharp decline of 6.9% (Razzaq et al., 2021). There are many reasons behind this decline, but the most prominent among them is the changing climate, weather and soil conditions. It includes growing temperature, fluctuations in rainfall patterns and increased extreme weather conditions (Farooq et al., 2022; Manan et al., 2022; Zafar et al., 2022). Expected changes are projected to have a negative effect on cotton production in Pakistan, especially in areas with arid to semi-arid conditions (Zafar et al., 2021). The growth of cotton crops and seed cotton

[Citation: Iqbal, Z., Ullah, M.I., Chohan, S.M., Iqbal, J., Farooq, M.S., Sarwar, M.K.S., Khan, R.A.R., Latif, A., Nazar, M.Z.K., Saleem, M., Majeed, T., Ahmad, M.I., Bano, T. (2023). Evaluation of genetic variability for different fiber and yield related components in cotton (*Gossypium hirsutum* L.). *Biol. Clin. Sci. Res. J.*, **2023***: 177*. doi: https://doi.org/10.54112/bcsrj.v2023i1.177]

yield highly sensitive to temperature variations, decreasing the yield dramatically (Zafar et al., 2022). The boll growth period becomes short with high temperatures, leading to smaller bolls resulting in a lower cotton yield (Saleem et al., 2021). Further, climate change will increase the vulnerability of cotton crop to CLCuV (Abbas, 2020; Khalid et al., 2022). Taking into account the economic architecture of the country, it is necessary to develop promising cotton varieties with a better adaptation that can fulfill the demand for high yield for producers and good quality for processors at the same time (Sahar et al., 2021). Plant scientists have worked extensively to study the morphological, physiological and genetic causes of the yield and related attributes to identify the different features which can effectively contribute to the ultimate goal i.e., yield. Seed cotton yield is dependent upon various morphological traits which can interact with each other (Khalid and Amjad, 2018; Khalid and Amjad, 2019; Malik and Rasheed 2022). Hence, the phenotypic outlook of the plant is the consequence of environmental interaction with the genotype. So, it becomes necessary to decipher the environmental effect of variation and thus investigate its impact on genetic variability, eventually helping to select desirable plants, which is preliminary to any breeding model (Farooq et al., 2022). To develop an effective breeding program, genetic variability for various agronomic traits in the gene pool is essential. The selection option is fruitful only when there is enough variability in the breeding population (Manonmani et al., 2019; Rao et al., 2021). This study helped evaluate genetic variability among 20 genotypes, which will assist in selecting desirable genotypes in future breeding programs.

Material and methods

The present research was conducted in the Department of Agriculture, Faisalabad field experimental site during the kharif season of 2019-2020. The experimental material included 19 exotic genotypes and one local cultivar. The seeds of the exotic and local genotypes were sown in June 2020. The experiment was performed under the randomized complete block design (RCBD) with 3 replications. Plant-to-plant and row-to-row distances of 33cm and 75cm were maintained, respectively. All agronomic practices, such as irrigation, hoeing and plant safety measures, were executed following the plant requirements to ensure the maintenance of proper plant health.

Table 1: Genotypes were used as experimental material

Sr. no	Genotypes	Sr. no	Genotypes
1	ZB-18021	**11**	ZB-18031
2	ZB-18022	**12**	ZB-18032
3	ZB-18023	**13**	ZB-18033
4	ZB-18024	**14**	ZB-18034
5	ZB-18025	**15**	53
6	ZB-18026	**16**	1808
7	ZB-18027	**17**	18079
8	ZB-18028	**18**	18081
9	ZB-18029	**19**	18082
10	ZB-18030	**20**	40-FH LALAZAR

Experimental conditions during crop season (June – Nov) 2020

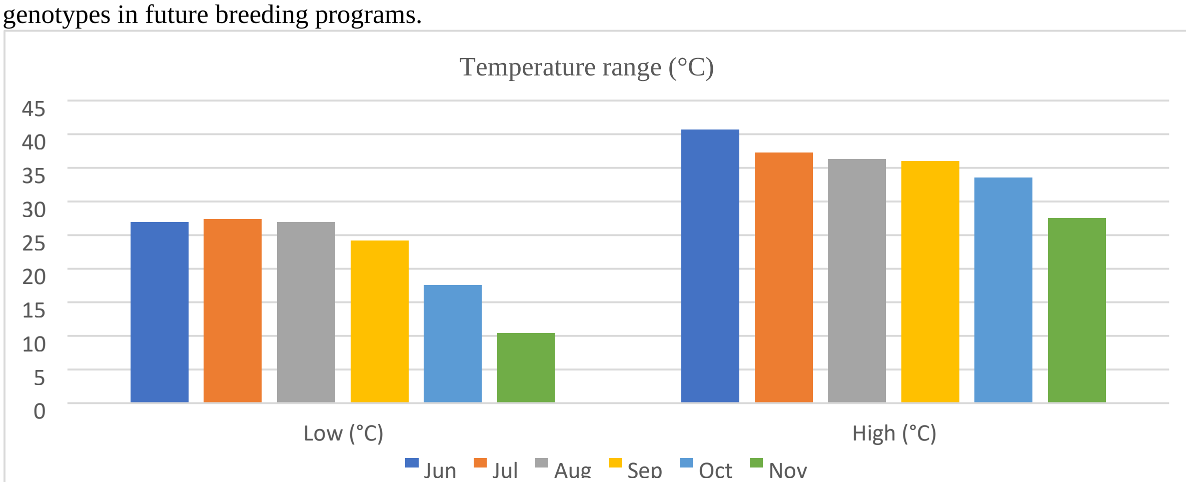

Fig. 1: Temperature during crop season (Jun-Nov) 2020

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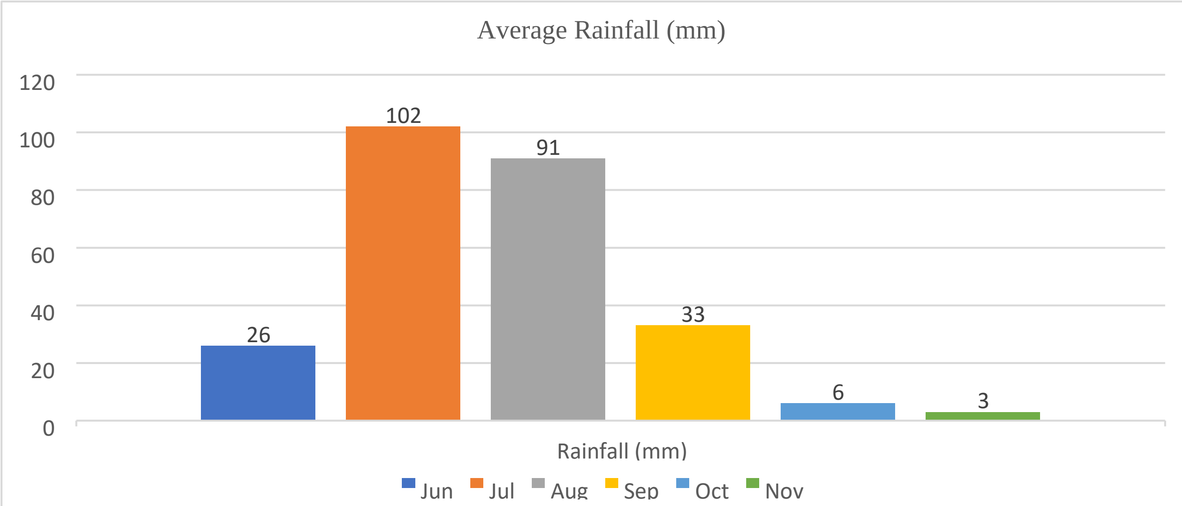

Fig 2: Average rainfall during crop season (Jun-Nov) 2020

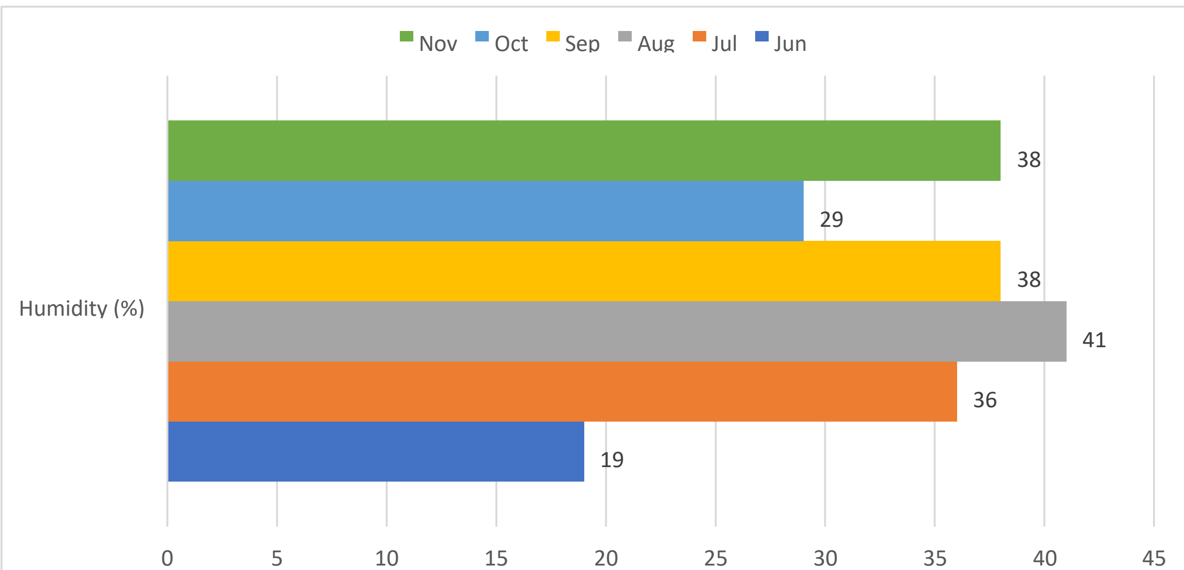

Fig 3: Average humidity% during crop season (Jun-Nov) 2020

Data recorded

The following traits were recorded at the time of maturity.

Number of bolls per plant, Boll weight (g), Seed index (g), Seeds per boll, Lint index (g), Seed surface area (cm^2), Seed mass per boll (g), Lint mass per seed (g), Lint mass per boll (g), Lint percentage (%), Seed volume (mm^3), Seed density ($kg\ m^{-3}$), Seed cotton yield (g), Fiber length (mm), Fiber strength (g/tex) and Fiber fineness (µg/inch).

Statistical Analysis

The recorded data were subjected to analysis of variance by using Statistix 8.1 to find out the significance of the data. Heritability, genetic advance, percentage mean, PCV, and GCV were calculated using R software and XLSTAT.

Results and discussion

Analysis of variance was performed for 16 different yields, and fiber-related traits, which exhibited that mean squares of these traits were significant and suggested significant differences among 20 genotypes under study (Table 2).

Mean performance of 20 cotton genotypes under study

The mean value for the number of bolls per plant ranged from 59.4-13. The genotype ZB-18026 displayed the maximum mean value (59.4), whereas genotype ZB-18032 showed the minimum mean value (13) for this particular trait (Fig. 4). The mean value for boll weight ranged from 9.76-1.11 g. The genotype ZB-18025 displayed the maximum mean value (9.76 g), whereas genotype 1808 showed the minimum mean value (1.11 g) for this particular trait

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(Fig. 5). The mean value for seed index ranged from 8.94-5.82 g. The genotype ZB-18028 displayed the maximum mean value (8.94 g), whereas genotype 18081 showed the minimum mean value (5.82 g) for this particular trait (Fig. 6). The mean value for seeds per boll ranged from 87.984-10.955. The genotype ZB-18025 displayed the maximum mean value (87.984), whereas genotype ZB-18029 showed the minimum mean value (10.955) for this particular trait (Fig. 7). The mean value for the lint index ranged from 6.961-3.174 g. The genotype ZB-18029 displayed the maximum mean value (6.961 g), whereas genotype ZB-18022 showed the minimum mean value (3.174 g) for this particular trait (Fig. 8). The mean value for fiber length ranged from 31.12-24.5 mm. Genotype 18082 displayed the maximum mean value (31.12 mm), whereas genotype ZB-18022 showed the minimum mean value (24.5 mm) for this particular trait (Fig. 9). The mean value for fiber strength ranged from 31.456-21.3 g/tex. Genotype 18081 displayed the maximum mean value (31.456 g/tex), whereas genotype 53 showed the minimum mean value (21.3 g/tex) for this particular trait (Fig. 10). The mean value for fiber fineness ranged from 7.33-4.33 µg/inch. The genotype ZB-18026 displayed the maximum mean value (7.33 µg/inch), whereas genotype ZB-18030 showed the minimum mean value (4.33 µg/inch) for this particular trait (Fig. 11). The mean value for seed surface area ranged from 1.983-0.889 cm^2. Genotype 1808 displayed the maximum mean value (1.983 cm^2), whereas genotype ZB-18027 showed the minimum mean value (0.889 cm^2) for this particular trait (Fig. 12). The mean value for lint mass per boll ranged from 1.424-0.528 g (Fig. 13). The mean value for seed mass per boll ranged from 4.45-1.123 g. Genotype 53 displayed the maximum mean value (4.45 g), whereas genotype ZB-18026 showed the minimum mean value (1.123 g) for this particular trait (Fig. 14). The mean value for lint mass per seed ranged from 0.123-0.0242 g. The genotype ZB-18029 displayed the maximum mean value (0.123 g), whereas genotype ZB-18030 showed the minimum mean value (0.0242 g) for this particular trait (Fig. 15). The mean value for lint percentage ranged from 43.94-32.01 %. The genotype 40-FH-LALAZAR displayed the maximum mean value (43.94 %), whereas genotype ZB-18022 showed the minimum mean value (32.01 %) for this particular trait (Fig. 16). The mean value for seed volume ranged from 16.8-5.2 mm^3. Genotype 1808 displayed the maximum mean value (16.8 mm^3), whereas genotype ZB-18081 showed the minimum mean value (5.2 mm^3) for this particular trait (Fig. 17). The mean value for seed density ranged from 2.471-1.069 kg m^{-3}. Genotype 18082 displayed the maximum mean value (2.471 kg m^{-3}), whereas genotype ZB-18079 showed the minimum mean value (1.069 kg m^{-3}) for this particular trait (Fig. 18). The mean value for seed cotton yield ranged from 106.8-35.5 g. Genotype ZB-18026 displayed the maximum mean value (106.8 g), whereas genotype ZB-18032 showed the minimum mean value (35.5 g) for this particular trait (Fig. 19).

Parameters of genetic variability and heritability for various yield and fiber-related attributes:

Results of genetic variability parameters and heritability for various yield and fiber-related attributes are presented in table 3. Genotypic, phenotypic and environmental variances for the number of bolls per plant were 128.69, 147.089 and 18.41, respectively. Heritability for this trait was 87.49%, and the genetic advance of mean was 64.8154% which showed that this trait was suitable for breeding programs due to high heritability coupled with high genetic advance (Abdelmoghny et al., 2021). Genotypic, phenotypic and environmental variances for bolls weight were 4.3895, 5.5604 and 1.1790, respectively. Coefficients of genotypic, phenotypic and environmental variances were 61.0473, 68.7088 and 31.5292, respectively. GCV and PCV values have not shown many differences for boll weight which showed that the influence of environment is not more than genetic components. Therefore, both equally contribute to the phenotypic expression. Boll weight showed high genetic advance as % of the mean, which showed similarity with the work of Ishaq et al. (2021); Kumar et al. (2019). Boll weight depicted high PCV and GCV values which were in agreement with the work of Nawaz et al. (2019) and Sahar et al. (2021).

The seed index showed moderate heritability (40.15 %). The seed index registered low PCV, GCV and ECV values. These results showed close similarity with the work of Yehia et al. (2022). Low ECV similarity showed close similarity with the work of Sahar et al. (2021). GCV and PCV values have not shown many differences for seeds per boll which showed that the influence of the environment is not more than genetic components. Therefore, both equally contribute to the phenotypic expression. Seeds per boll showed high genetic advance as % of the mean, which closely matched the work of Yar et al. (2020) and Sahar et al. (2021). The lint index's genotypic, phenotypic and environmental variances were 0.5241, 0.6967 and 0.1726, respectively. Coefficients of genotypic, phenotypic and environmental variances were 15.115, 17.427 and 8.674, respectively. The lint index depicted moderate GCV and PCV values which showed close agreement with the work of Parre & Patil, (2021). Fiber length showed moderate broad sense heritability (48.50%) for this trait. Fiber strength depicted moderate genetic advance as % of the mean (16.126%), which exhibited close agreement with the work of Kumar et al. (2019).

GCV and PCV values have not shown many differences in fiber fineness. Heritability for this trait was 33.63%, and the genetic advance of mean was 7.306%. Heritability for lint mass per boll was 20.13%, and genetic advance of mean was 7.35%. Genotypic, phenotypic and environmental variances for seed mass per boll were 0.3843, 0.4027 and 0.0184, respectively. Coefficients of genotypic, phenotypic and environmental variances were 37.8276, 38.7226 and 8.269, respectively. The lint percentage exhibited high broad sense heritability (85.62%). These results showed close similarity with the work of Nawaz et al. (2019); Parre & Patil, (2021); Rao et al. (2021). Lint percentage showed moderate genetic advance as % of the mean (11.9045%), which closely resembles the results of Nawaz et al. (2019). Seed volume showed high heritability (88.77%), which closely resembles the work of Abdelraheem et al. (2020).

Genotypic, phenotypic and environmental variances for seed cotton yield were 307.2060, 365.4642 and 58.2582, respectively. Coefficients of genotypic, phenotypic and environmental variances were 25.0122, 27.2809 and 10.89, respectively. GCV and PCV values have no differences in seed density, which showed that the influence of the environment is not more than genetic components. Therefore, both equally contribute to the phenotypic expression. Heritability for this trait was 84.06%, and the genetic advance of mean was 47.2401%. This showed that this trait could be considered for breeding programs due to high heritability coupled with high genetic advance (Abdelmoghny et al., 2021). The high range of variability in mean values demonstrated a high amount of variability among genotypes for seed density. We can use these genotypes for this particular trait in future breeding programs. Seed cotton yield depicted high broad sense heritability (84.06%). Similar results were found in the work of Balci et al. (2020). Seed cotton yield showed high genetic advance as % of the mean (47.24%). These findings showed close similarity with the results of Abro et al. (2022); Jamil et al. (2020), and Rao et al. (2021).

Conclusion:

The genotype ZB-18026 displayed the maximum mean value for seed cotton yield among all the studied genotypes. The high range of variability in mean values of various traits under study demonstrated that a high amount of variability is present among genotypes. So, we can use these genotypes in future breeding programs.

Table 2: Analysis of variance for various yield and fiber related attributes in 20 *Gossypium hirsutum* genotypes

SOV	Df	NBP	BW	SI	SPB	LI	FL	FS	FF	SSA	LMPB	SMPB	LMPS	LP	SV	SD	SCY
Block	1	23.4	0.01	0.78	23.03	1.1	4.4	2.59	2.65	0.02	0.04	0.00	0.01	0.59	0.59	0.02	48.1
Genotype	19	275.7**	9.9**	1.58*	851.7*	1.22**	6.83**	9.90*	4.46*	0.14**	0.06**	0.78**	0.02**	13.20**	12.60**	0.32**	672.6**
Error	19	18.4	1.17	0.25	49.75	0.17	1.33	0.53	0.23	0.04	0.02	0.01	0.01	1.02	0.74	0.01	58.26
Total	39																

Table 3: Parameters of genetic variability and heritability for various yield and fiber related attributes in 20 *Gossypium hirsutum* genotypes

	NBP	BW	SI	SPB	LI	FL	FS	FF	SSA	LMPB	SMPB	LMPS	LP	SV	SD	SCY
Mean ± SEM	33.72 ± 3.03	3.43 ± 0.76	7.36 ± 0.3	31.32 ± 4.98	4.79 ± 0.29	27.78 ± 0.81	26.20 ± 0.51	5.60 ± 0.34	1.30 ± 0.14	0.98 ± 0.11	1.63 ± 0.09	0.06 ± 0.03	39.51 ± 0.71	10.20 ± 0.61	1.60 ± 0.00	70.07 ± 5.40
Genotypic variance	128.6	4.3	0.16	401	0.52	1.25	4.68	0.11	0.05	0.00	0.38	0.05	6.09	5.92	0.16	307.2
Phenotypic variance	147	5.5	0.42	450.7	0.69	2.58	5.22	0.34	0.09	0.03	0.40	0.06	7.11	6.70	0.16	365.4
Environmental variance	18.4	1.1	0.2	49.75	0.17	1.33	0.53	0.23	0.04	0.02	0.01	0.01	1.02	0.74	0.00	58.25
GCV %	33.6	61.0	5.5	63.9	15.1	4.02	8.26	6.11	17.3	7.95	37.82	0.05	6.24	23.9	25.2	25.0
PCV %	35.9	68.7	8.8	67.78	17.42	5.78	8.72	10.54	23.25	17.71	38.72	0.06	6.75	25.23	25.21	27.28
ECV %	17.7	31.5	6.8	22.5	8.67	4.15	2.78	2.78	15.4	15.84	8.26	0.01	2.56	8.47	0.00	10.8
Broad sense heritability % (h^2BS)	87.4	78.9	40.1	88.96	75.23	48.5	89.78	33.63	55.86	20.13	95.43	99.99	85.62	88.77	99.99	84.06
Genetic advance	21.8	3.8	0.5	38.90	1.29	1.60	4.22	0.4	0.34	0.07	1.24	0.04	4.70	4.22	0.83	33.10
Genetic advance as % of mean	64.8	111.7	7.2	124.2	27.0	5.77	16.12	7.3	26.76	7.35	76.12	76.81	11.90	46.25	51.93	47.24

[Citation: Iqbal, Z., Ullah, M.I., Chohan, S.M., Iqbal, J., Farooq, M.S., Sarwar, M.K.S., Khan, R.A.R., Latif, A., Nazar, M.Z.K., Saleem, M., Majeed, T., Ahmad, M.I., Bano, T. (2023). Evaluation of genetic variability for different fiber and yield related components in cotton (*Gossypium hirsutum* L.). *Biol. Clin. Sci. Res. J.*, **2023***: 177*. doi: https://doi.org/10.54112/bcsrj.v2023i1.177]

Fig 4: Mean performance of 20 *Gossypium hirsutum* L. genotypes for number of bolls per plant

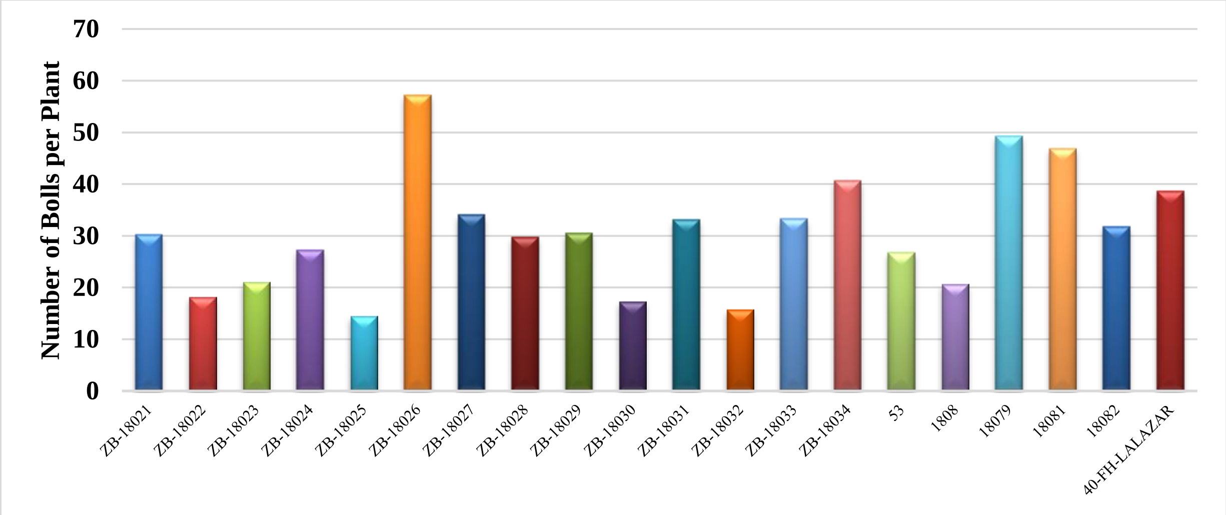


Fig 5: Mean performance of 20 *Gossypium hirsutum* L. genotypes for boll weight

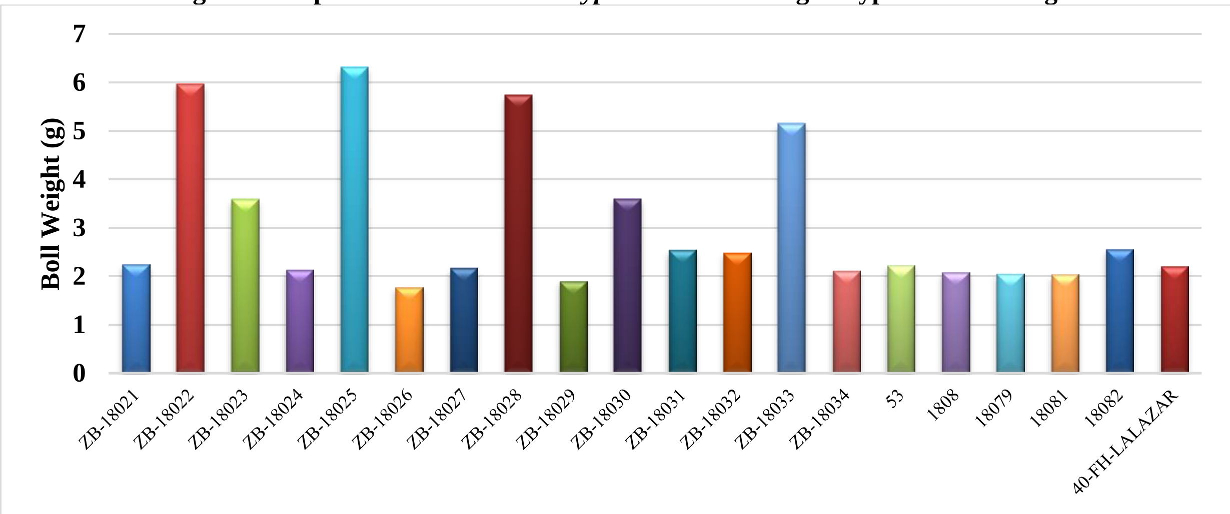


Fig 6: Mean performance of 20 *Gossypium hirsutum* L. genotypes for seed index

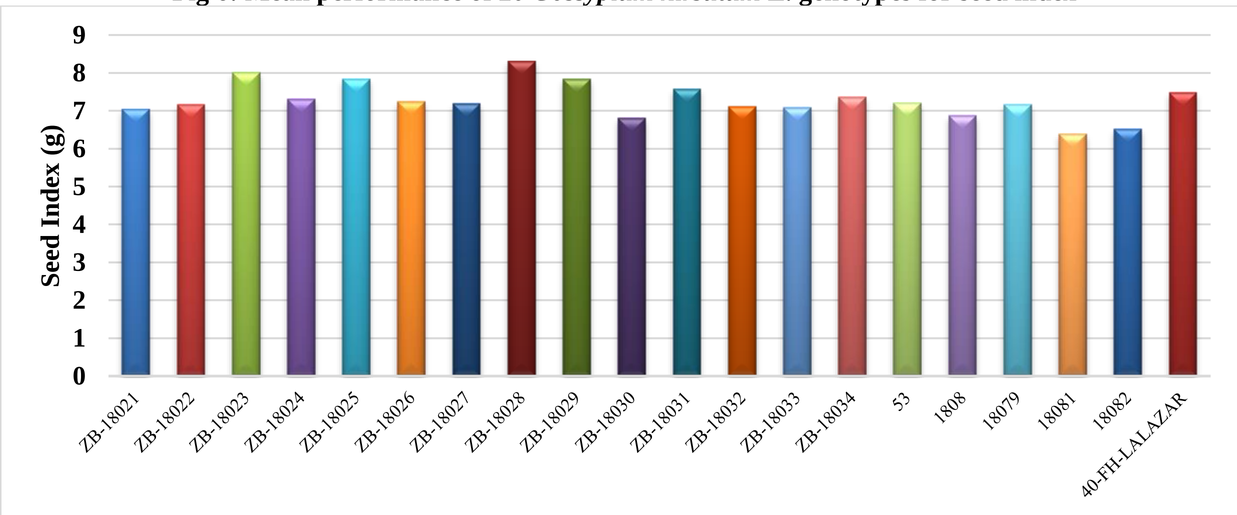


Fig 7: Mean performance of 20 *Gossypium hirsutum* L. genotypes for seeds per boll

[Citation: Iqbal, Z., Ullah, M.I., Chohan, S.M., Iqbal, J., Farooq, M.S., Sarwar, M.K.S., Khan, R.A.R., Latif, A., Nazar, M.Z.K., Saleem, M., Majeed, T., Ahmad, M.I., Bano, T. (2023). Evaluation of genetic variability for different fiber and yield related components in cotton (*Gossypium hirsutum* L.). *Biol. Clin. Sci. Res. J.*, **2023***: 177*. doi: https://doi.org/10.54112/bcsrj.v2023i1.177]

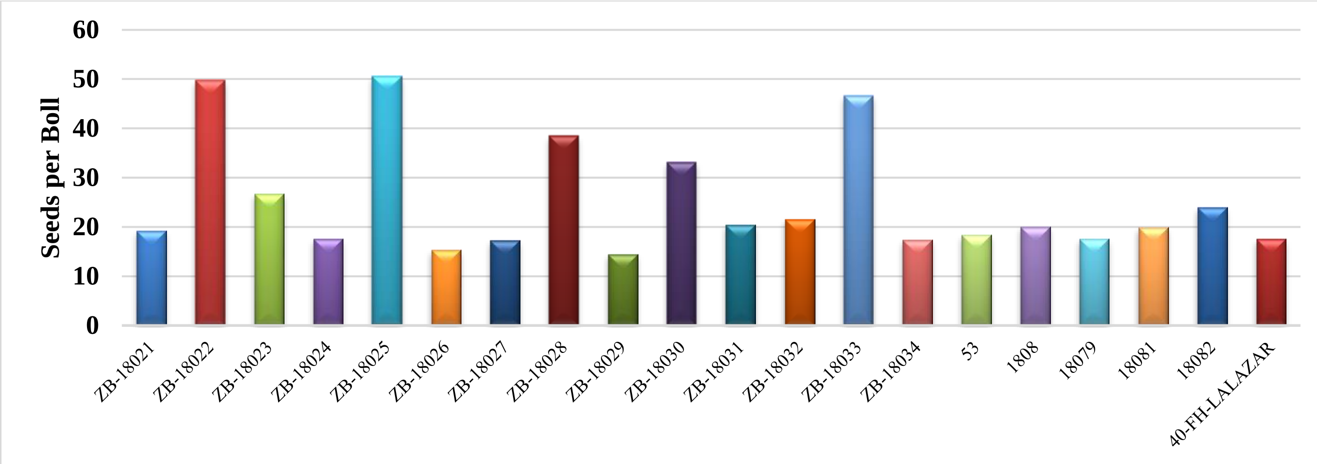


Fig 8: Mean performance of 20 *Gossypium hirsutum* L. genotypes for lint index

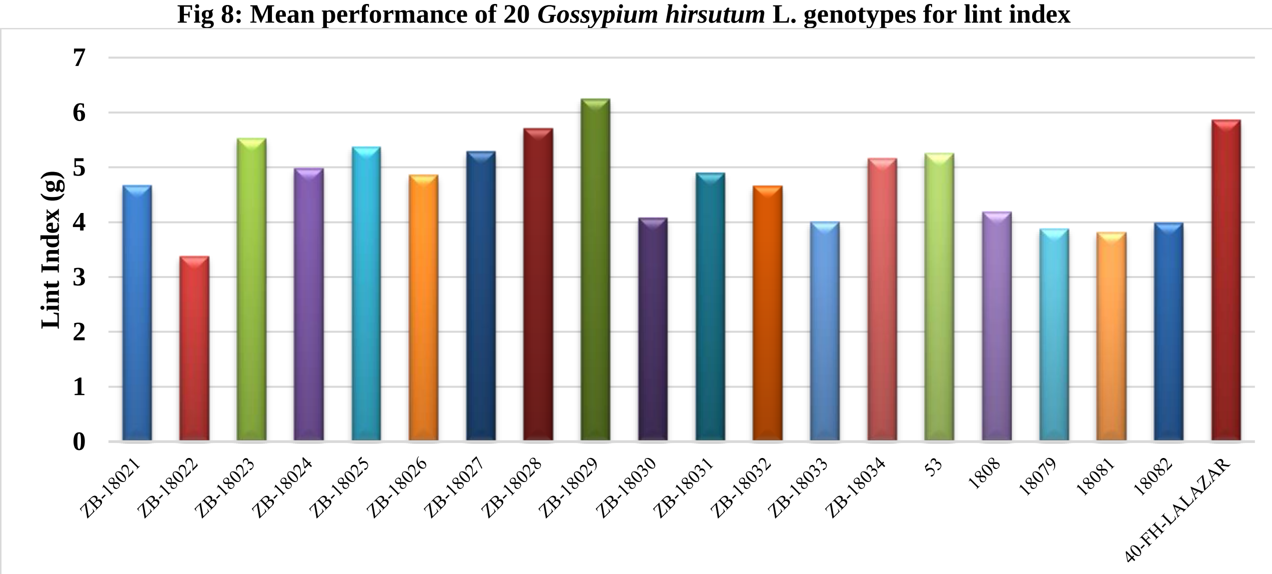


Fig 9: Mean performance of 20 *Gossypium hirsutum* L. genotypes for fiber length

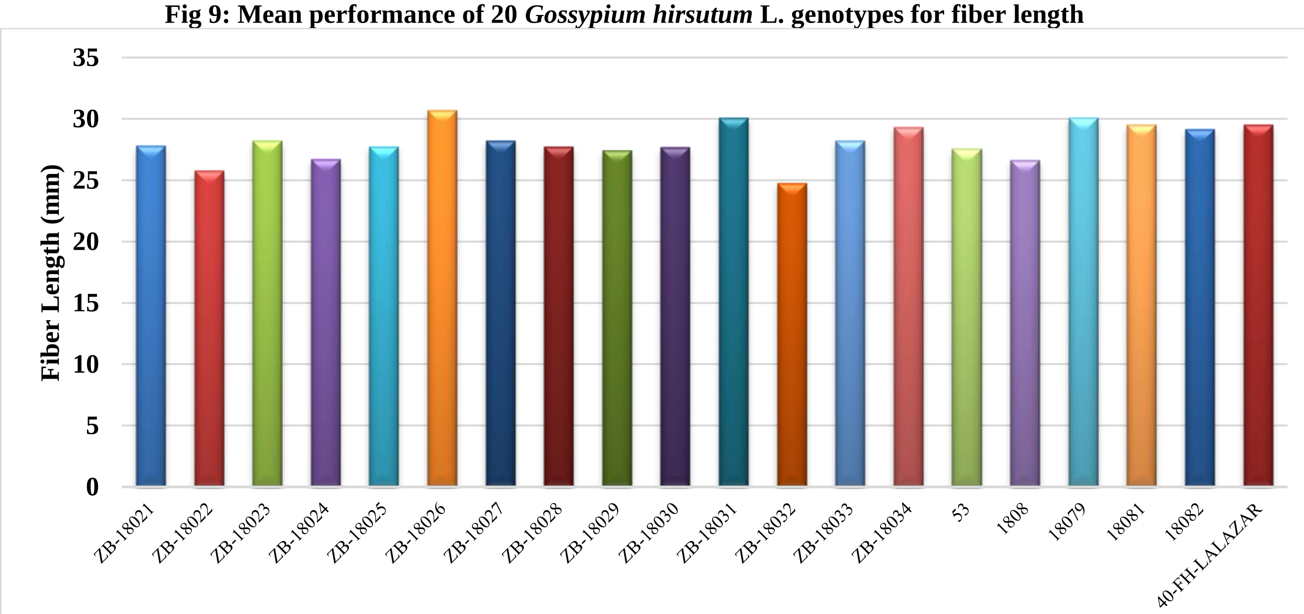


Fig 10: Mean performance of 20 *Gossypium hirsutum* L. genotypes for fiber strength

[Citation: Iqbal, Z., Ullah, M.I., Chohan, S.M., Iqbal, J., Farooq, M.S., Sarwar, M.K.S., Khan, R.A.R., Latif, A., Nazar, M.Z.K., Saleem, M., Majeed, T., Ahmad, M.I., Bano, T. (2023). Evaluation of genetic variability for different fiber and yield related components in cotton (*Gossypium hirsutum* L.). *Biol. Clin. Sci. Res. J.*, **2023***: 177*. doi: https://doi.org/10.54112/bcsrj.v2023i1.177]

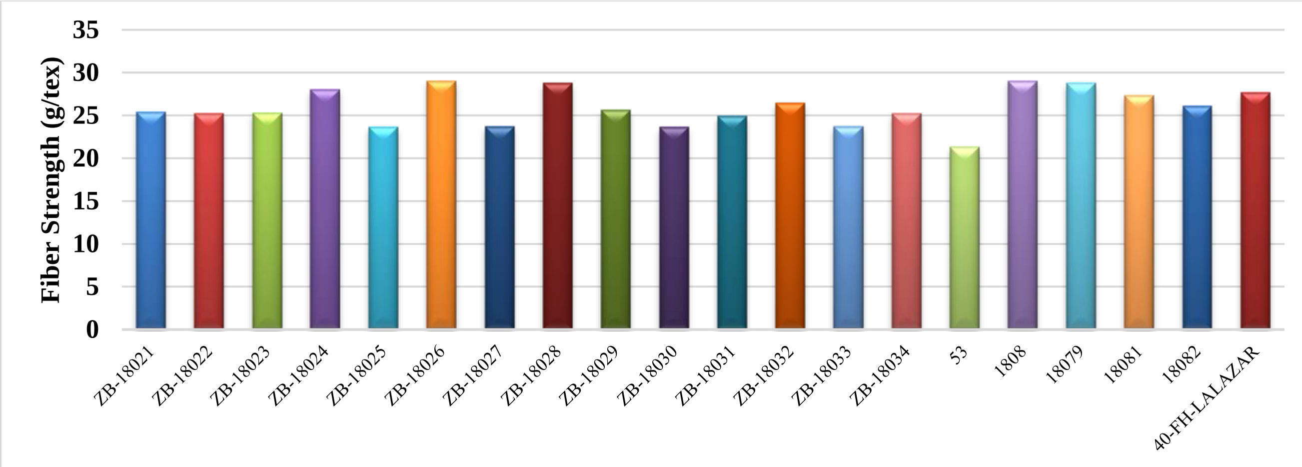


Fig 11: Mean performance of 20 *Gossypium hirsutum* L. genotypes for fiber fineness

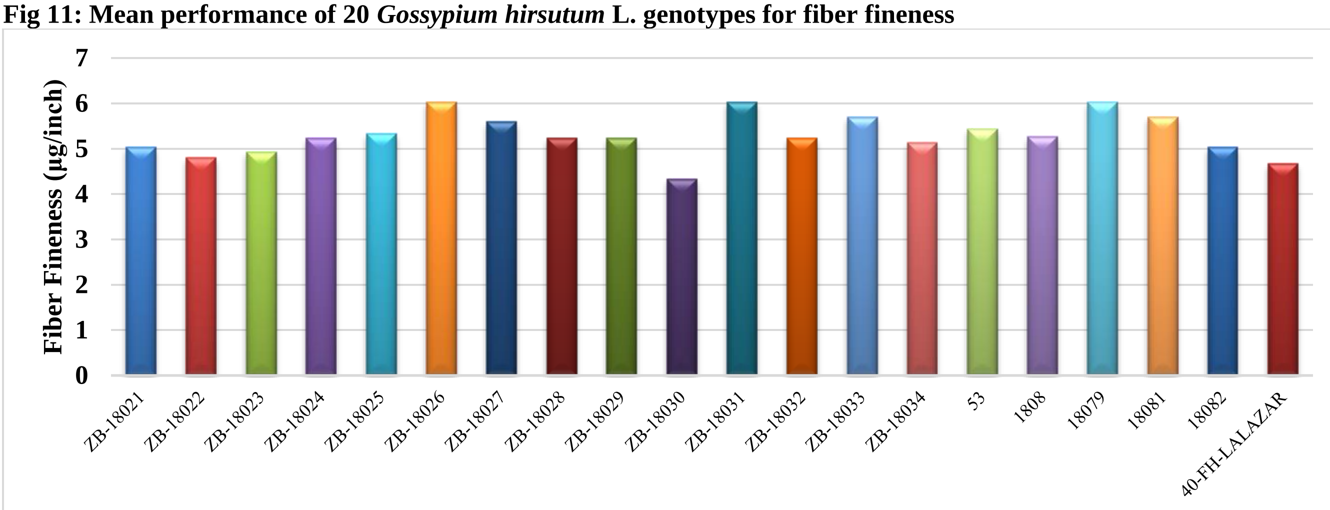


Fig 12: Mean performance of 20 *Gossypium hirsutum* L. genotypes for seed surface area

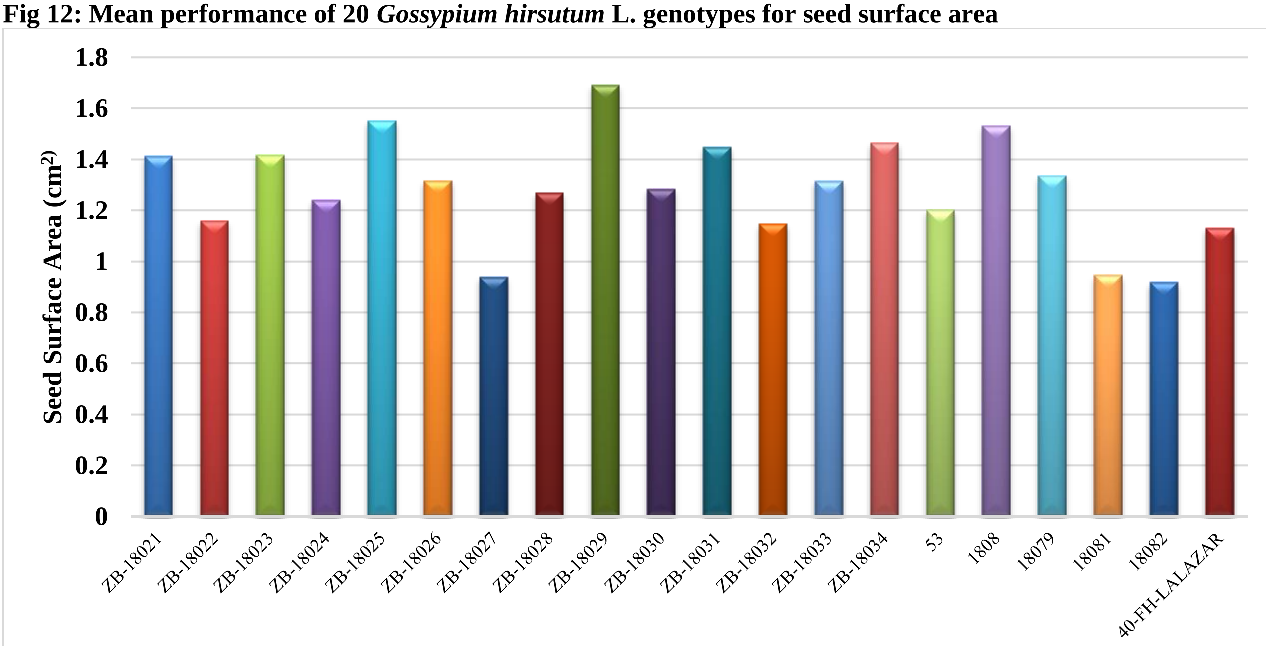


Fig 13: Mean performance of 20 *Gossypium hirsutum* L. genotypes for lint mass per boll

[Citation: Iqbal, Z., Ullah, M.I., Chohan, S.M., Iqbal, J., Farooq, M.S., Sarwar, M.K.S., Khan, R.A.R., Latif, A., Nazar, M.Z.K., Saleem, M., Majeed, T., Ahmad, M.I., Bano, T. (2023). Evaluation of genetic variability for different fiber and yield related components in cotton (*Gossypium hirsutum* L.). *Biol. Clin. Sci. Res. J.*, **2023***: 177*. doi: https://doi.org/10.54112/bcsrj.v2023i1.177]

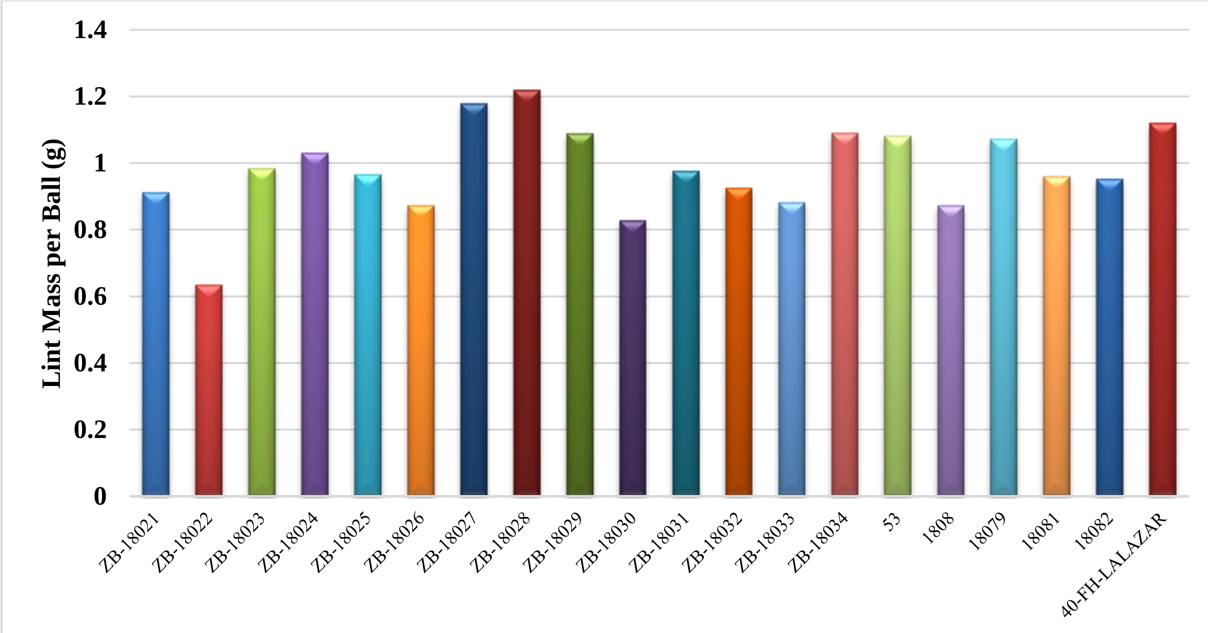


Fig 14: Mean performance of 20 *Gossypium hirsutum* L. genotypes for seed mass per boll

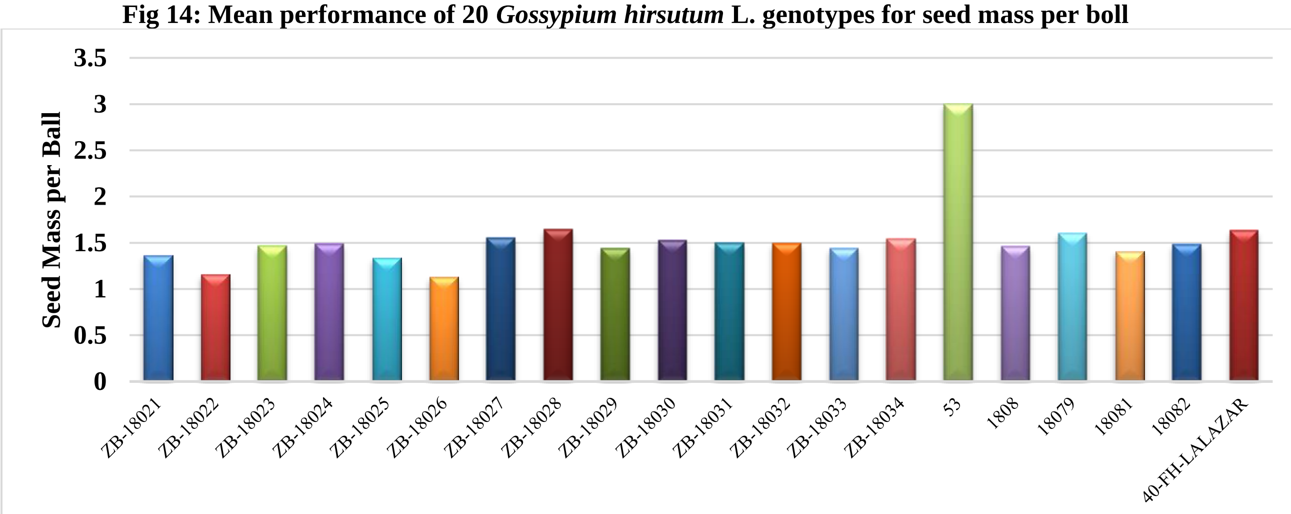


Fig 15: Mean performance of 20 *Gossypium hirsutum* L. genotypes for lint mass per seed

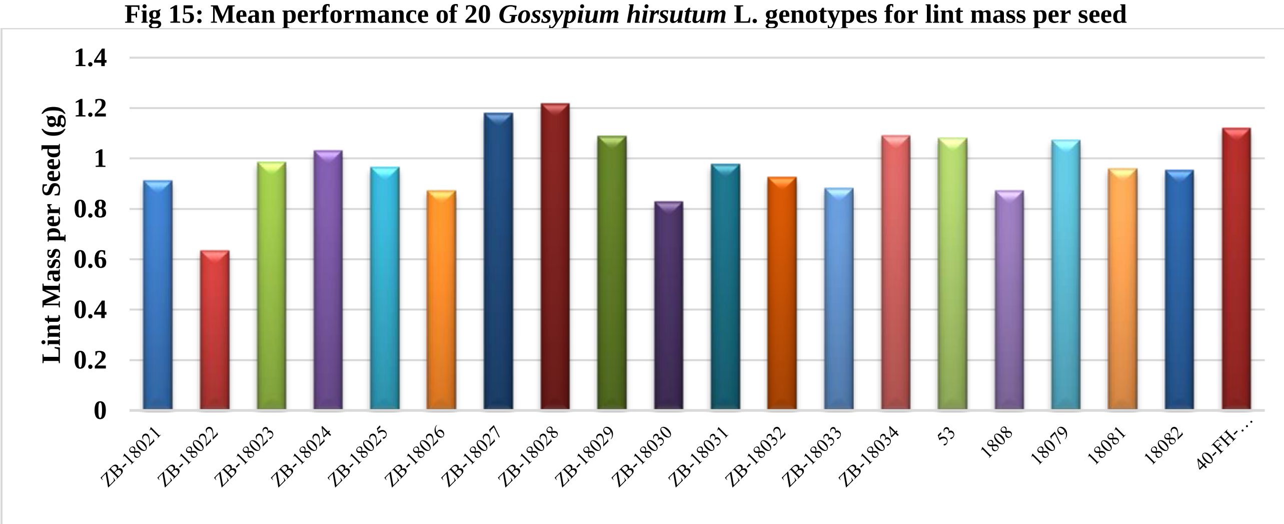


Fig 16: Mean performance of 20 *Gossypium hirsutum* L. genotypes for lint percentage

[Citation: Iqbal, Z., Ullah, M.I., Chohan, S.M., Iqbal, J., Farooq, M.S., Sarwar, M.K.S., Khan, R.A.R., Latif, A., Nazar, M.Z.K., Saleem, M., Majeed, T., Ahmad, M.I., Bano, T. (2023). Evaluation of genetic variability for different fiber and yield related components in cotton (*Gossypium hirsutum* L.). *Biol. Clin. Sci. Res. J.*, **2023***: 177*. doi: https://doi.org/10.54112/bcsrj.v2023i1.177]

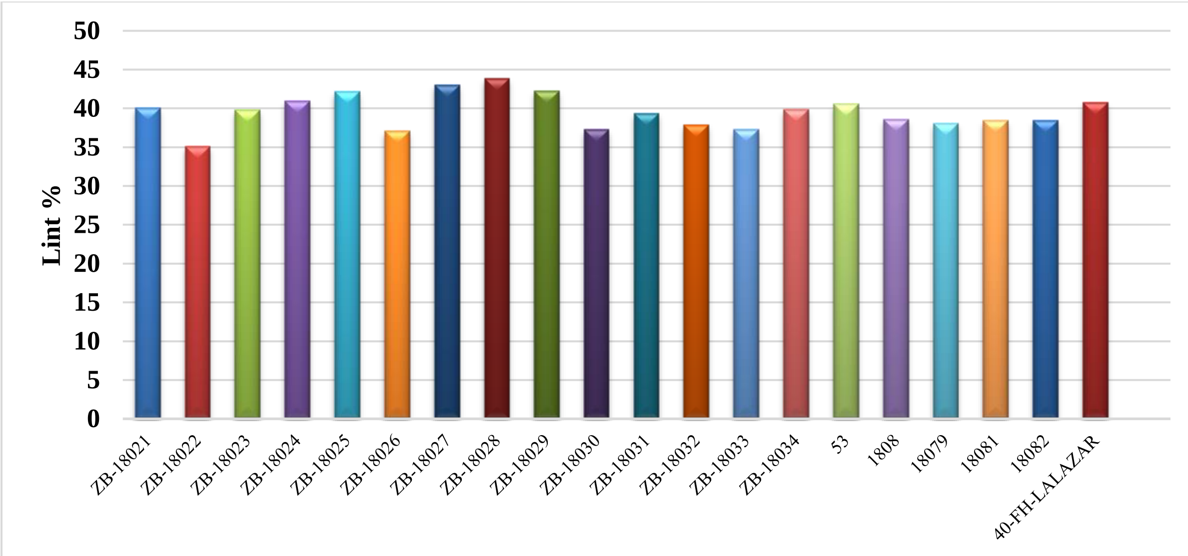


Fig 17: Mean performance of 20 *Gossypium hirsutum* L. genotypes for seed volume

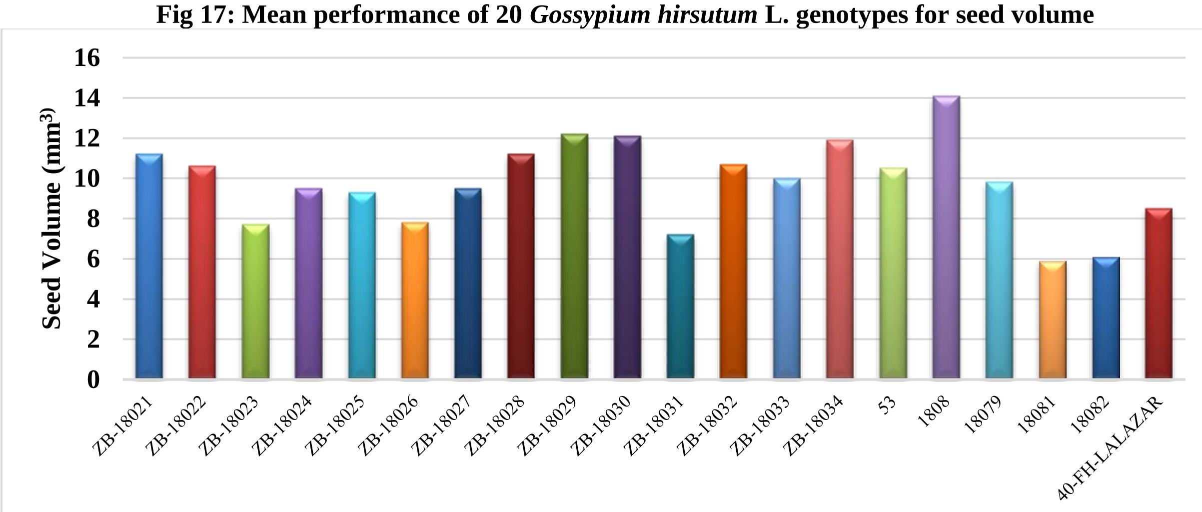


Fig 18: Mean performance of 20 *Gossypium hirsutum* L. genotypes for seed density

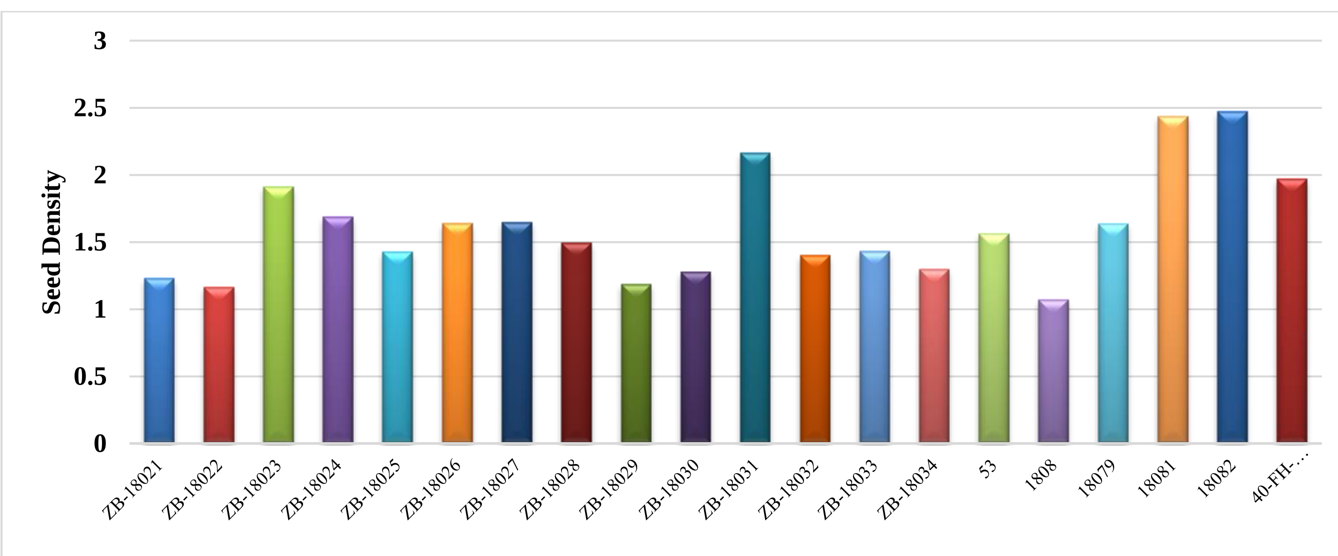
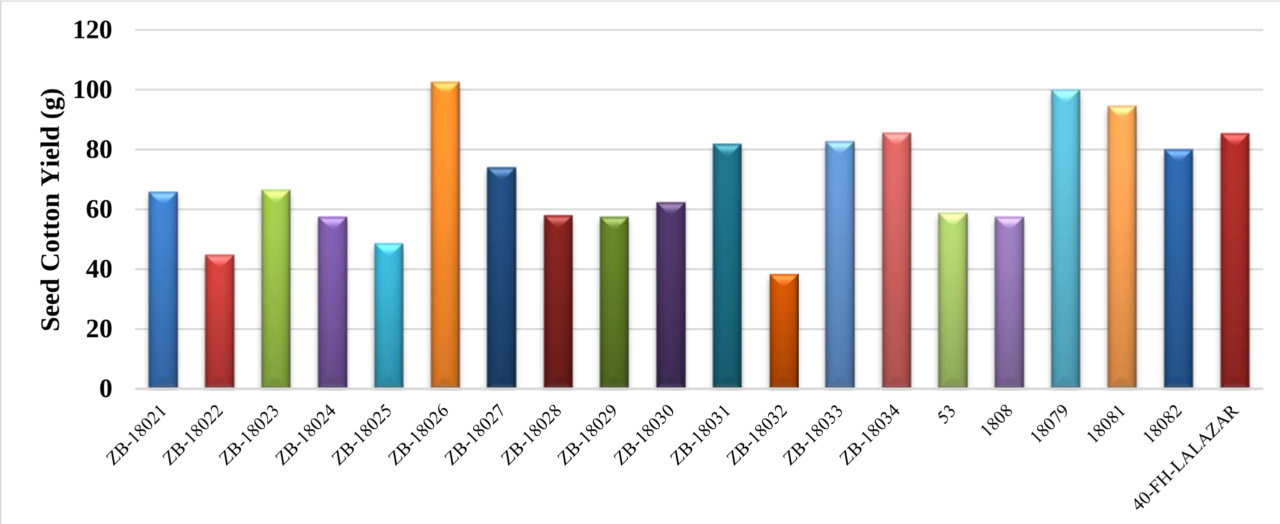


Fig 19: Mean performance of 20 *Gossypium hirsutum* L. genotypes for seed cotton yield

[Citation: Iqbal, Z., Ullah, M.I., Chohan, S.M., Iqbal, J., Farooq, M.S., Sarwar, M.K.S., Khan, R.A.R., Latif, A., Nazar, M.Z.K., Saleem, M., Majeed, T., Ahmad, M.I., Bano, T. (2023). Evaluation of genetic variability for different fiber and yield related components in cotton (*Gossypium hirsutum* L.). *Biol. Clin. Sci. Res. J.*, **2023***: 177*. doi: https://doi.org/10.54112/bcsrj.v2023i1.177]



Conflict of interest

The authors declared absence of conflict of interest.

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