Journal of Life and Social Sciences
eISSN: 3006-2675
www.bbasrjlifess.com
*J. Life Soc. Sci, Volume, **2**: 17*

Original Research Article ***Open Access***

GENETIC VARIATION AND ASSOCIATION OF VARIOUS CHICKPEA (CICER ARIETINUM L.) TRAITS AT SEEDLING STAGE

REHMAN AU*, UZAIR M

Department of Plant Breeding and Genetics, Faculty of Agricultural Sciences, University of the Punjab P.O.Box.54590, Lahore, Pakistan
**Correspondence author email address: atiq9119@gmail.com*

(Received, 4th January 2023, Revised 28th December 2024, Published 30th December 2024)

Abstract *Chickpea (Cicer arietinum L.) is the world's second most important legume crop. Because of its high nutritional content, capacity to adapt to many climates, and ability to fix nitrogen, it is significant for global food security and sustainable practices. At the University of the Punjab's Experimental Area, a pot experiment was conducted in October 2023 to evaluate the genetic variability and correlation of diverse morphological characteristics among distinct chickpea genotypes throughout the seedling phase. Three replications with a randomized complete block design (RCBD) were used. The following characteristics were assessed: leaf length (LL), leaf width (LW), leaf area (LA), shoot length (SL), root length (RL), seedling biomass (SB), and R-S ratio. Standard statistical analysis also calculated genetic variability, heritability (h^2bs), and genetic advance (GA). Seedling biomass, leaf area, and leaf width showed high genotypic coefficients of variation (GCV), heritability and genetic advance. These genotypes can be selected to develop desirable varieties based on these parameters.*

[*Citation: Rehman, A.U, Uzair, M. (2023). Genetic variation and association of various chickpea (Cicer arietinum L.) traits at seedling stage. J. Life Soc. Sci, **2023**: 17*]
Keywords: *Cicer arietinum; genetic variability; heritability; genetic advance; morphological*

Introduction

Grain legumes, also known as the poor man's meat, are a vital source of nourishment for the diets of millions of people in developing countries. As critical sources of protein, calcium, iron, phosphorus, and other minerals, legumes play a crucial part in the diets of vegetarians, as other foods they eat are poor in protein (Merga and Haji, 2019). Legumes are a crop with great versatility that may be used as feed in various agricultural systems or eaten raw in various processed forms. The chickpea was the first pulse cultivated in antiquity (Khamassi et al., 2012). Its common names are bengal gram, channa, and garbanzo beans (Parwada et al., 2022). Legume crops are commonly grown in rotation with cereals because they fix nitrogen. However, throughout the past few decades, the output and yields of legume crops have stagnated in emerging economies. Several nations have concentrated on agricultural research and development to lower crop losses and increase grain yields and output to attain food security. (Merga and Haji, 2019). According to (Huisman and Van Der Poel, 1994), chickpeas are the most readily available and cost-effective source of lipids (11.4%), ash (4.8%), sugars (57–60%), protein (19.5%), and moisture (4.9–15.59%). Chickpeas are favored over edible beans in many places since they may be utilized for many things (Siddique et al., 2000). The regions in southeast Turkey today and the adjacent Syrian territories are thought to be the birthplaces of the chickpea (Ali et al., 2011b; Ali et al., 2010b; Keneni et al., 2013). The two most popular varieties of chickpeas are Desi and Kapuri. The Desi cultivar is known for its exceptional nutrition, geometric seed morphologies, and vividly colored seed coats. Large seeds, a beige or white color, and "rams-head" shaped seed coverings are characteristics of the Kambri cultivar (Keneni et al., 2013). Chickpea seeds are a suitable addition to diets centered on grains, as they include 21% (range: 17–26%) protein. In impoverished nations, where individuals may not have access to animal protein or may prefer a vegetarian diet, this is especially important (Aaliya et al., 2016; FLOWERS et al., 2010).

Methodology

The University of the Punjab Lahore's Department of Plant Breeding and Genetics is where the current work was conducted in an experimental environment. The primary experimental material consisted of five genotypes of chickpeas: line 161, line 1118, line 220, line 2009, and line 108. Every one of these samples was taken at the Faisalabad University of Agriculture. For this experiment, three replications of each genotype in RCBD were employed. Several characteristics are evaluated, such as the biomass of seedlings (SB), root-to-seedling length ratio (RSLR), leaf area (LA), leaf width (LW), and seedling length (SL) as well as root length (RL).

Results and Discussion

The morphological traits, including Seedling Length (SL), Root Length (RL), Root-to-Seedling Length Ratio (RSLR), Seedling Biomass (SB), Leaf Length (LL), Leaf Width (LW), and Leaf Area (LA), were assessed in the chickpea seedling experiment (TOKER and ILHAN CAGIRGAN, 2004) The statistical analysis found significant differences between these characteristics. Shoot Length (SL) across chickpeas' genotypes under study showed a significantly significant variation. The phenotypic coefficient of variation (PCV) was 4.1497%, from the genotypic and environmental coefficients of variation, which were 4.0499% and 1.1079%, respectively (Table 1). SL had a high broad-sense heritability of 95.24%, indicating a dominant type of genet effects. The lower genetic advance (GA) of 7.01% indicates that there is potential for genetic improvement in Seedling Length (Ali et al., 2017; Ali et al., 2015; Ali et al., 2013; Ali et al., 2016; Arshad et al., 2003). Root Length (RL) showed a higher PCV of 7.3841% and a higher GCV of 7.30% compared to SL, suggesting a significant genotypic influence. The 97.77% heritability estimate for RL indicated a significant genetic impact. The fact that the genetic progress for RL was noticeably higher, at 12.81%, suggests that selection for longer roots may be effective. With a much lower PCV of 5.26%, the Root-to-Seedling Length Ratio (RSLR) showed a significant analysis of variance. The genetic progress of 8.63% and the heritability of 92.38% for RSLR suggest that the root-to-shoot length ratio might benefit from genetic enhancement. Seedling Biomass (SB) exhibited significant genotypic variation with PCV, GCV, and ECV values of 20.66%, 20.54%, and 2.77%, respectively. SB had a higher 36.23% genetic advance and the highest heritability of 98.80%. Significant genotypic differences were observed for leaf characteristics, namely leaf length (LL), leaf width (LW), and leaf area (LA). In LL, LW, and LA, moderate to high PCV (9.64%, 13.04%, and 15.90%) and GCV (7.60%, 12.09%, and 15.48%) and ECV (7.25%, 5.97%, 4.41%) were observed, indicating a substantial degree of genetic heterogeneity. The genetic improvements, which were 10.64%, 19.90%, and 26.77% for LL, LW, and LA, respectively, show the potential for genetic improvement in leaf morphology. The higher heritability values for RL, SB, LW and LA indicate the presence of dominance gene action; selection can be done based on these parameters. The higher heritability genetic advance for SL and RSR indicates the presence of additive gene action, and the selection in this scenario may be effective (Ahmad et al., 2012; Ali et al., 2014; Ali and Malik, 2021).

Table 1: Genetic Components of Several Chickpea Seedling Characteristics

Traits	Phenotypic Co-efficient of Variation (PCV)%	Genotypic Co-efficient of Variation (GCV)%	Environmental Co-efficient of Variation (ECV)%	Broad Sense Heritability %	Genetic Advance (GA)%
Shoot Length	4.14	4.04	1.10	95.24	7.01
Root Length	7.38	7.30	1.35	97.77	12.81
Shoot Root Ratio	5.26	5.06	1.78	92.38	8.63
Seedling Biomass	20.66	20.54	2.77	98.80	36.23
Leaf Length	9.63	7.60	7.25	62.24	10.64
Leaf Width	13.04	12.09	5.97	86.00	19.90
Leaf Area	15.90	15.48	4.41	94.86	26.77

Table 2: Pearson correlation between traits under study

Traits	SL	RL	RSR	SB	LL	LW
RL	0.8340**					
RSR	-0.3762	-0.7617**				
SB	-0.1814	0.2189	-0.5393*			
LL	0.3292	0.4785	-0.3708	0.2143		
LW	0.4013	0.3429	0.0879	-0.0699	0.5676*	
LA	0.7324	0.8559	-0.5872	-0.0085	0.6800	0.5965**

Correlation

The correlation matrix shows the pairwise correlations for the seven qualities. Two traits have a positive association when they both rise or fall. A negative correlation suggests a propensity for the two attributes to diverge. The intensity of the association is shown by the value of the correlation coefficient, which goes from -1 to 1 (Balqees et al., 2020). The correlations between several plant parameters, namely Shoot Length (SL), Root Length (RL), Root-Shoot Ratio (RSR), Seedling Biomass (SB), Leaf Length (LL), and Leaf Width (LW), are depicted in Table 2. There is a significant positive correlation of 0.8340 between SL and RL. Additionally, a notable positive association of 0.5965 between LW and LA exists. A significant negative correlation of -0.7617 exists between RSR and RL. There is a moderately negative association of -0.5393 between RSR and SB. There is a -0.0699 slight negative connection between LW and SB. Root Length tends to rise greatly when Shoot Length increases, according to the strong positive connection between SL and RL. The negative correlation between RSR and RL implies an inverse link between Root-Shoot Ratio and Root Length. When LW and LA have positive relationships, leaf area and width usually grow together (Ali et al., 2010a; Ali et al., 2011a; Ghafoor et al., 2020). These parameters should be kept in mind while selecting based on them.

Regression Analysis

The regression analysis for the traits various traits with Shoot Length as reference indicates a very positive value for Root Length (RL) (1.4345), Root Shoot Length ratio (RSR) (14.7090), and Leaf Length (LL) (0.7130), while negative value for Seedling Biomass (SB) (-2.8247), Leaf Width (LW)-0.0374), and Leaf Area (LA) (-1.3120) as shown in Table 3. The positive value for RL, RSR, and LL indicates that these three traits positively impact Shoot Length's growth. While, the negative values for SB, LW, and LA indicate that these traits negatively impact Shoot Length. The multiple R-value (0.9473), R Square value (0.8974), and adjusted R-value (0.8204) were observed, which further validates our results. If we are to select plants based on these traits, we anticipate that selection based on RL, RSR, and LL will be beneficial (Ali et al., 2015; Ali et al., 2013; Ali et al., 2010c; Iqra et al., 2020).

Table 3: Regression analysis of different Chickpea traits

Traits	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
RL	1.4345	0.2985	4.8042	0.0013	0.7459	2.1230
RSR	14.7090	13.1908	1.1150	0.2971	-15.7091	45.1272
SB	-2.8247	2.1581	-1.3089	0.2269	-7.8014	2.1518
LL	0.7130	2.1307	0.3346	0.7465	-4.2005	5.6266
LW	-0.0374	3.4254	-0.0109	0.9915	-7.9364	7.8616
LA	-1.3120	2.0169	-0.6505	0.5335	-5.9631	3.3390

Conclusion

A high association between root and shoot growth is shown by the fact that Root Length (RL) emerged as a significant positive predictor of Shoot Length (SL). This aligns with the known principles of plant growth dynamics, which state that the development of roots promotes the absorption of nutrients and water, hence elongating shoots. Root shoot length ratio and leaf length also positively influenced shoot length, indicating that the root length can be a good targeting factor for developing tall varieties for chickpea.

References

Aaliya, K., Qamar, Z., Ahmad, N., Cd, A., Farooq, A., and Husnain, T. (2016). Transformation, evaluation of GTGene and multivariate genetic analysis for morpho-physiological and yield attributing traits in Zea mays. *Genetika* **48**, 423-433.

Ahmad, H. M., Ahsan, M., Ali, Q., and Javed, I. (2012). Genetic variability, heritability and correlation studies of various quantitative traits of mungbean (Vigna radiate L.) at different radiation levels. *International Research Journal of Microbiology* **3**, 352-362.

Ali, F., Kanwal, N., Ahsan, M., Ali, Q., Bibi, I., and Niazi, N. K. (2015). Multivariate analysis of grain yield and its attributing traits in different maize hybrids grown under heat and drought stress. *Scientifica* **2015**.

Ali, Q., Ahsan, M., Ali, F., Aslam, M., Khan, N. H., Munzoor, M., Mustafa, H. S. B., and Muhammad, S. (2013). Heritability, heterosis and heterobeltiosis studies for morphological traits of maize (Zea mays L.) seedlings. *Advancements in Life sciences* **1**.

Ali, Q., Ahsan, M., and Saleem, M. (2010a). Genetic variability and trait association in chickpea (Cicer arietinum L.). *Electronic Journal of Plant Breeding* **1**, 328-333.

Ali, Q., Ahsan, M., Tahir, M. H. N., Elahi, M., Farooq, J., Waseem, M., and Sadique, M. (2011a). Genetic variability for grain yield and quality traits in chickpea. *International Journal of Agro-Veterinary and Medical Sciences* **5**, 201-208.

Ali, Q., Ahsan, M., Tahir, M. H. N., Waseem, M., Farooq, J., Elahi, M., and Sadique, M. A. (2011b). Genetic variability for grain yield and quality traits in chickpea (Cicer arietinum L.). *International Journal for Agro Veterinary and Medical Sciences* **5**, 201-208.

Ali, Q., Ali, A., Ahsan, M., Nasir, I. A., Abbas, H. G., and Ashraf, M. A. (2014). Line× Tester analysis for morpho-physiological traits of Zea mays L seedlings. *Advancements in Life sciences* **1**, 242-253.

Ali, Q., and Malik, A. (2021). Genetic response of growth phases for abiotic environmental stress tolerance in cereal crop plants. *Genetika* **53**, 419-456.

Ali, Q., Muhammad, A., and Farooq, J. (2010b). Genetic variability and trait association in chickpea (Cicer arietinum L.) genotypes at seedling stage. *Electronic Journal of Plant Breeding* **1**, 334-341.

Ali, Q., Muhammad, A., and Farooq, J. (2010c). Genetic variability and trait association in chickpea (Cicer arietinum L.) genotypes at seedling stage. *Electronic Journal of Plant Breeding* **1**, 334-341.

Balqees, N., Ali, Q., and Malik, A. (2020). Genetic evaluation for seedling traits of maize and wheat under biogas wastewater, sewage water and drought stress conditions. *Biological and Clinical Sciences Research Journal* **2020**.

Flowers, T. J., Gaur, P. M., Gowda, C. L. L., Krishnamurthy, L., Samineni, S., SIDDIQUE, K. H. M., Turner, N. C., Vadez, V., VARSHNEY, R. K., and COLMER, T. D. (2010). Salt sensitivity in chickpea. *Plant, Cell & Environment* **33**, 490-509.

Ghafoor, M. F., Ali, Q., and Malik, A. (2020). Effects of salicylic acid priming for salt stress tolerance in wheat. *Biological and Clinical Sciences Research Journal* **2020**.

Huisman, J., and Van Der Poel, A. F. B. (1994). Aspects of the nutritional quality and use of cool season food legumes in animal feed. *In* "Expanding the Production and Use of Cool Season Food Legumes: A global perspective of peristent constraints and of opportunities and strategies for further increasing the productivity and use of pea, lentil, faba bean, chickpea and grasspea in different farming systems" (F. J. Muehlbauer and W. J. Kaiser, eds.), pp. 53-76. Springer Netherlands, Dordrecht.

Iqra, L., Rashid, M. S., Ali, Q., Latif, I., and Mailk, A. (2020). Evaluation for Na+/K+ ratio under salt stress condition in wheat. *Life Sci J* **17**, 43-47.

Keneni, G., Bekele, E., Assefa, F., Imtiaz, M., Debele, T., Dagne, K., and Getu, E. (2013). Evaluation of Ethiopian chickpea (Cicer arietinum L.) germplasm accessions for symbio-agronomic performance. *Renewable Agriculture and Food Systems* **28**, 338-349.

Khamassi, K., Bettaiëb, L., Bettaieb Ben Kaâb, L., Khoufi, S., Chaabane, R., Teixeira da Silva, J., Mackay, I., and Ben Naceur, M. b. (2012). Morphological and Molecular Diversity of Tunisian Chickpea. *European Journal of Horticultural Science* **77**, 31-40.

Merga, B., and Haji, J. (2019). Economic importance of chickpea: Production, value, and world trade. *Cogent Food & Agriculture* **5**, 1615718.

Parwada, C., Parwada, T., Chipomho, J., Mapope, N., Chikwari, E., Mvumi, C., Ashokkumar, K., and Dania, S. (2022). Evaluation of Cicer arietinum (Chickpea) growth performance and yield in different soil types in Zimbabwe. 16-27.

Toker, C., and Ilhan Cagirgan, M. (2004). The use of phenotypic correlations and factor analysis in determining characters for grain yield selection in chickpea (Cicer arietinum L.). *Hereditas* **140**, 226-228.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Funding

Not applicable

Conflict of Interest

Regarding conflicts of interest, the authors state that their research was carried out independently without any affiliations or financial ties that could raise concerns about biases.