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GENETIC VARIABILITY AMNOG MORPHOLOGICAL TRAITS OF *CHENOPODIUM ALBUM*

REHMAN A[1], TUFAIL MT[1]*, NAEEM N[2], NAQVI RF[3]

[1]*Department of Plant Breeding and Genetics, Faculty of Agricultural Sciences, University of the Punjab, P.O BOX. 54590, Lahore, Pakistan*
[2]*Department of Agronomy, Faculty of Agricultural Sciences, University of the Punjab, P.O BOX. 54590, Lahore, Pakistan*
[3]*Department of Horticulture, Faculty of Agricultural Sciences, University of the Punjab, P.O BOX. 54590, Lahore, Pakistan*
**Correspondence Author Email Address: tayyabtufail123@gmail.com*

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Abstract *Chenopodium album possess unique set of biological characteristics such as hyperbolic fecundity, metabolic endurance, sustained geosolic dormancy, and the ability to germinate in less favorable conditions. It can be grown in many different ways. Its ability to survive prolonged drought stress enables it to grow in a wide range of soils. In this study, the samples of Chenopodium album were collected from three distinct locations. Findings indicated that there is a statistically significant negative correlation between plant moisture contents with dry-weights: leaf width, leaf length, leaf area, plant height, root weight, and root length. Positive correlation was revealed between all other morphological traits. Higher heritability was recorded for all of the studied traits, while the genetic advance was found highest for leaf area. The positive correlation indicated that the growth and development of Chenopodium album was higher and may lead towards the loss of water, nutrients and minerals for crop plants where ever it will grow. So, it was suggested that the removal of Chenopodium album weed from crop fields is very important to avoid crop plant losses.*

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Keywords: *Chenopodium album; correlation; morphological traits; heritability; genetic advance*

Introduction

Weeds are one of the most serious biological risks to long-term agricultural productivity in the world. Integrated weed management (IWM) solutions are more dependable and successful in cropping systems, allowing farmers to reduce the harmful effects of herbicides while maintaining high crop output (Tang et al., 2022). The annual plant *Chenopodium album*, which is native to Eurasia and a member of the *C. album* aggregation, takes advantage of soil sources consisting of mild and vitamins, and it is one of the notorious weeds that decrease crop yields. However, *C. album* has additionally been grown as a crop in various nations; within the Himalaya region, it was considered to be a more nutritious crop species than rice, wheat, barley, and maize. Similarly, *C. album* changed into a green vegetable (Park et al., 2021). *Chenopodium album* is a ubiquitous weed that thrives in tropical, subtropical, and temperate climates. The species invaded China and has been identified as one of the most problematic weed species in agricultural systems, and it intensifies with factors such as conventional tillage combined with an extensive use of pesticides and nitrogen fertilizers. It appears frequently during spring and summer, with the germination peak in spring, and it quickly infests agricultural fields (Tang et al., 2022). Due to its allelopathic properties, it can inhibit the germination and growth of weeds and native flora. This herb represents a possible threat to global food security, as it can reduce agricultural production by more than 90% and infect a wide range of agricultural and horticultural crops (Kupdhoni et al., 2023). *C. alb*um has a remarkable ability to avoid high salinity environments, making it an alternative halophyte. *C. album* fruit extracts have a high amount of acids like vanillin, gallic acid, and protocatechuic acid, while the leaves are rich in m-coumaric acid. It has demonstrated a diverse set of biological activities. In particular, it shows antibacterial activity against many pathogenic bacteria, including Klebsiella pneumonia (Chamkhi et al., 2022). Common names of *C. album* include lamb's-quarters, fat hen, goosefoot, white goosefoot, and pigweed. *C.album* grows in conditions having sufficient daylight, high humidity and fertile

loam soil. *C. album* is an exotic weed found worldwide that quickly colonizes new places. It is one of the most dangerous weeds in 15 nations and is a common plant in another 34 nations in all types of cultivated land (Le et al., 2021). Most seeds fall on the soil around the mother plant due to a lack of a particular dispersion mechanism. The black seeds, but not the brown, are dormant. Seeds that mature into plants cultivated under long-day settings are more dormant than those produced under short-day conditions. Fluctuations between the temperatures usually affect the dormancy of the seed (Scheepens et al., 1997). Herbicides are widely used in controlling the *C. album*. Several studies show that post-emergence herbicides are effective for controlling *Chenopodium* in wheat (Bayat et al., 2019). Various cultural and mechanical strategies have been employed to manage this weed species, with varied degrees of effectiveness depending on cropping systems and levels of weed infestation. Similarly, alellopathy and biological control have demonstrated some potential, particularly in combating *C. album* (Bajwa et al., 2019).**Materials and methods**

The study sample was selected from the population of *Chenopodium album* with three replicates collected from each of the three sites at the Faculty of Agriculture Sciences, University of Punjab, Lahore, Pakistan. Thus, the experiment included a total of nine replicates, with three plants per replicate, resulting in 27 samples. Weed samples were collected whole, including the roots and surrounding soil. After collection, all samples were carefully transferred to the laboratory for processing and analysis. Morphological traits were measured, and the data were analyzed using ANOVA to assess statistical significance (Steele and Torrie, 1960).

Leaf Length (cm)

Leaf length was measured in centimeters using a scale. Three leaves per plant were measured, and their average length was calculated for analysis.

Leaf Width (cm)

For each leaf, width was measured at the base, center, and tip, and the mean width was determined.

Leaf Area (cm^2)

Leaf area for each leaf was computed by multiplying its length and width, followed by applying a correction factor of 0.74 cm.

Formula;

Leaf Area (A) = Length (L) × Width (W) × 0.74 (Jordan, 1969)

Plant height (cm)

The height of each plant was recorded from the stem base to the apex. Plant length was determined using the longest shoot from each plant.

Root length (cm)

Root length was measured by the cm scale of each plant separately. For this purpose, the measurements were taken from the end of the shoot to the end of the root.

Root weight (cm)

First, the roots of the plant were separated from the shoot end, and then the measurements were taken with the help of the weighing balance in cm.

Fresh weight (g)

The fresh weight of each weed sample was determined immediately after collection from the field to prevent any loss of moisture due to drying. The samples were carefully transported to the laboratory, and an electronic weighing balance was used to record their weight with precision.

Dry weight (g)

Initially, the collected weed samples were dried to eliminate moisture. For this purpose, a hot air oven or sunlight can be used. Oven drying was employed because it is a quick and efficient method for eliminating moisture from the samples. Sunlight drying is time-consuming, as it takes many hours to achieve complete moisture removal. To ensure proper drying, each sample was packed separately in envelopes before being placed in a hot air oven. Following 10–12 hours of drying, the samples were taken out and weighed on an electronic balance to determine their dry weight accurately.

Moisture (%)

To determine the total moisture content of the plants, the following formula was applied,

Moisture percentage = [(fresh plant weight –dry plant weight/fresh plant weight) × 100]

Results and discussions

Data in Table 1 showed statistically significant variation among the locations for each of the traits studied in *Chenopodium album.* Mean leaf length was recorded as (5.422±0.2411cm), leaf width (4.255±0.0609cm), leaf area (18.548±1.0038cm^2), plant height (47.456±0.206cm), root length (7.272±0.1456cm), root weight (7.633±0.1054g), fresh weight (41.533±1.1802g), dry weight (19.466±0.2062g) and moisture percentage (53.142±.2744%) for *Chenopodium album* samples were obtained from three separate sites. Increased plant weight and moisture content mean that it can withstand extreme climate conditions. Higher leaf area indicates the plant's potential for growth, development, and enhanced survival under diverse conditions. Removing *Chenopodium album* plants from agricultural fields is crucial because it competes with crops for nutrients, minerals, water, and space. The study found that all attributes showed reduced coefficients of variation, showing the increased dependability of the results (Al-Naggar et al., 2022).

Table1. Analysis of variance for morphological traits of *Chenopodium album*

SOV	leaf Length	Leaf Width	Leaf Area	Plant Height	Root Length	Root Weight	Fresh Weight	Dry Weight	Moisture Percentage
Location	14.774*	4.391*	411.60*	6.457*	4.896*	5.2300*	2.856*	13.5905*	61.8028*
Error	0.174	0.011	3.023	0.127	0.0631	0.033	4.178	0.1275	4.8725
Grand Mean	5.422	4.255	18.548	47.456	7.272	7.633	41.533	19.466	53.142
Standard Error	0.2411	0.0609	1.0038	0.206	0.1456	0.1054	1.1802	0.2062	1.2744
CV	7.7	2.48	9.37	0.75	3.47	2.39	4.92	1.83	4.15

*=Significant at 5% probability level, CV = Coefficient of variance

Correlation analysis was performed to examine the relationships among the measured morphological traits (Table 2). It was found from the results that a strong and statistically significant correlation was reported between most of the traits, while a statistically significant and negative correlation was reported between the leaf length, leaf width, leaf area, plant height, root length, root weight, and moisture content. A positive correlation indicates a strong association between traits. Plants with greater height and fresh weight have a greater capacity to facilitate the absorption of soil water and nutrients and their storage within plant tissues, leading to improved overall growth, biomass accumulation, and developmental progress of the plants in varying environments. Plants with larger leaf areas have a greater ability to produce and utilize compounds involved in photosynthesis. Elevated moisture content may help *C. album* survive under stressful conditions, yet it may also pose harmful effects on the growth and productivity of nearby crop plants. *C. album* seeds thrive in diverse climates and can remain viable for years. Allelopathy is the capacity of this weed to release substances that inhibit the growth of nearby plants (Hussain, Malik et al. 2022).

Table 2. Correlation among morphological traits of *Chenopodium album*

Traits	LL	LW	LA	PH	RL	RW	FW
LW	0.9713*						
LA	0.9940*	0.9756*					
PH	0.9653*	0.9760*	0.9568*				
RL	0.9575*	0.9834*	0.9578*	0.9944*			
RW	0.9637*	0.9862*	0.9541*	0.9807*	0.9784*		
FW	0.2564	0.3261	0.2004	0.3790	0.3487	0.3764	
DW	0.9585*	0.9933*	0.9614*	0.9797*	0.9831*	0.9902*	0.3473
MC	-0.9086*	-0.9175*	-0.9362*	-0.8821*	-0.8991*	-0.8924*	0.0575

*=Significant at 5% probability level, LW=Leaf width, LL=leaf length, LA=Leaf area, PH=Plant height, RL=Root length, RW=Root weight, FW=Fresh weight, DW=Dry weight, MC=Moisture content

Genetic analysis of morphological traits for *Chenopodium album* shows that Leaf area has the highest GCV (270%) along with high heritability, making it a suitable trait for selection. Leaf length and root length also showed high heritability and genetic variability, indicating strong additive genetic control. The maximum heritability was shown by leaf width of about 99.2% and moderate variability of about 58.7%, indicating the consistent, reliable improvement through selection. Parallel to that, plant height showed very low genetic variability of about 21% and high heritability, which shows limited progress due to environment and genetic effects. Root weight displayed moderate variability and heritability (98.13%), showcasing its potential for selection. Moisture content showed moderate heritability (70–80%) with lower variability, meaning it is influenced by both genes and environment (Bhargava et al., 2019).

Table 3. Estimates of Genetic Variability, Heritability, and Genetic Advance for Morphological Traits in *Chenopodium album*

Traits	M.S	G.M	GV	GCV %	PV	PCV %	EV	ECV %	h2bs%	GA%
Leaf length	14.774	5.422	4.866667	94.74058	5.040667	96.41936	0.174	17.91409	96.54808	125.5089
Leaf width	4.391	4.255	1.46	58.57694	1.471	58.79719	0.011	5.08448	99.25221	77.60062
Leaf area	411.6	18.548	136.1923	270.9741	139.2153	273.9649	3.023	40.3711	97.82854	358.9768
Plant height	6.457	47.456	2.11	21.08607	2.237	21.71138	0.127	5.173165	94.32275	27.93407
Root length	4.896	7.272	1.610967	47.06698	1.674067	47.97991	0.0631	9.315105	96.23074	62.35265
Root weight	5.23	7.633	1.732333	47.6396	1.765333	48.09121	0.033	6.575206	98.13066	63.11123
Fresh weight	2.856	41.533	8.034	19.34365	8.212	19.77223	0.178	0.428575	97.8332	14.09967
Dry weight	13.5905	19.466	4.487667	48.01445	4.615167	48.69174	0.1275	8.093134	97.23737	63.60782
Moisture	61.8028	53.142	18.97677	59.75746	23.84927	66.99132	4.8725	30.28008	79.5696	79.16455

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Declaration

Authors' Contributions

The author (AR) was involved in the conception, design, drafted the present manuscript and data analysis. All authors (RFN, NN) were involved in analysis and interpretation of data. AR, NN and MTT have been involved in critically revising the manuscript for important intellectual content.

Conflicts of Interest

The authors declare that they have no competing interests.

Ethics approval and consent to participate

Not applicable

Availability of data and materials

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