



MULTIVARIATE ANALYSIS OF STELLARIA MEDIA MORPHOLOGICAL TRAITS

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Abstract *Stellaria media*, habitually recognized as chickweed, is an annual therapeutic herb associated with the family Caryophyllaceae. The present study provides valuable insights into the genetic diversity, population demographics, and phenotypic traits of *S. media*. The investigated populations manifested prominent variation in both morphological traits and genetic composition. Owing to its vast ecological versatility, this species often synchronized with three associated species. It is broadly scattered all around southern and central Europe and is presently distributed into the northern regions of central Europe. In this study, ANOVA illustrates a detailed phenotypic and genotypic variation among different populations of *Stellaria media* from different field locations. It also provides multivariate Regression, Correlation, GGE biplot descriptions of different samples of the *Stellaria media* population from different field locations. The strong positive association among dry weight (DW), leaf traits (LL and LW), and shoot height (SH) suggests a coordinated pattern of vegetative growth, where taller plants with larger leaves enhance light interception and consequently promote greater biomass accumulation. It was found from results that the location 3 was found better for the growth and development of *Stellaria media*.

Keywords: Caryophyllaceae, genetic diversity, ecological versatility, morphological traits, multivariate, field locations

Introduction

Species identification plays a critical role in several aspects of Biology, Biochemistry, Ecology, and conservation biology. The genus *Stellaria* (Caryophyllaceae) comprises more than 120 species distributed throughout the temperate regions of Europe and Asia (Bittrich, 1993; Bozchaloyi & Keshavarz, 2014; Mehri, Ajirlou, & Kolbadi, 2020; Mehri, Shirafkanajirlou, & Kolbadi, 2020; Ullah et al., 2019) (Morton & Committee, 2005; Saqib & Gul, 2018). Species of *Stellaria* are extensively scattered and typically thrive on moist mountainous slopes, although some species have also been found in desert habitats. Genus is characterized with existence of bifid petals and five sepals; nevertheless, in specific species, petals are incredibly minimized or totally absent (Fior, Karis, Casazza, Minuto, & Sala, 2006; Harbaugh et al., 2010). In *Stellaria*, only a confined number of studies have been conducted on genome topology and cytogenetics analysis. The leaves of *Stellaria media* are polished and plumped. *S. media* customarily grows in a variety such as barren lands, unobstructed terrain, turf, and pastures, and is broadly distributed across Iran. The plant is both edible and wholesome and has been significantly used in time honored therapeutics. It is persuasiveness recognized for its cogency in assuaging efflorescence (Andreev et

al., 2012; Andreeva et al., 2012; Slavokhotova et al., 2011; Slavokhotova et al., 2014; Романенкова, Зими́на, Сермягин, & Кольцов, 2021). *Stellaria media* demonstrates significant phenotypic and genotypic deviation, even within a unique spot. The necessary duration for flowering was 30–40 days in most arctic, alpine, and some Mediterranean plants, whereas it ranged from 40–60 days in most cosmopolitan and inevitable Mediterranean species, and 50–70 days in plants commencing from maritime climates. However, the judgments of Van Der Vegte (1978) recommend that such genetically discrete demographics may cohabit in the same location. It is, as a rule, non-existent only in the exorbitant Arctic regions and exceptionally arid areas; nevertheless, in tropical regions, it is habitually found predominantly in alpine environments (Turkington, Kenkel, & Franko, 1980). It is a deliberately harmful weed farm produce as well as a colonizer, widely recognized by rapid development and broad biospheric studies, multifaceted. Its profound phenotypic plasticity has encouraged some authors to illustrate numerous taxa; conversely, these categorizations are chiefly premised upon attribute conviction persuaded by climatic conditions, not contended under fostering growth, and manifesting fluctuations gradually (Scholte, 1978a, 1978b; Turkington et al., 1980). Two cytoforms of

Stellaria media s. str. have been disclosed in Europe. The 2n = 40 karyotype is globally dispersed, whereas the 2n = 44 cytotype is confined to the southern territories of the continent (Scholte, 1978b). *Stellaria media* is an autogamous and intermittently cross-pollinated summer or winter annual (Morton & Committee, 2005; Peterson, 1936; Slavík, 1990). Confined chromosomal records are obtainable for *Stellaria* worldwide. Basic chromosome numbers of x = 10, 11, 12, and 13 have been recorded within the genus (MOORE, 1977; Rice et al., 2015; Roitman, Flaks, Fradkina, & Federov, 1974). *Stellaria media*, generally referred to as chickweed, is an annual plant with a thin stalk bearing hairs unilaterally. The current research intended to evaluate the multivariate morphological characteristics of *Stellaria media* obtained from different locations in the field.

Materials and Method

Three replicates of each sample were drawn from the *Stellaria media* population at Pakistan's University of the Punjab's Faculty of Agriculture Sciences, Lahore. Thus, there were a total of 9, in addition to three plants from each repeat (total samples were 27). After collection, the samples were taken to a seed

biotechnology facility for additional analysis. Various morphological characteristics were documented and surveyed for the data, and the ANOVA(Analysis of Variance) was done in order to determine the importance of the consequences (Attar, Esfandani-Bozchaloyi, Mirtadzadini, Ullah, & Zaman, 2019; Podani, 2000). The data were recorded for leaf area (Leaf area = leaf width × leaf length × 0.74), leaf length, leaf width, fresh weight, dry weight, plant height, and moisture percentage (Moisture% = [(FW - DW/FW) × 100]).

Results and Discussions

The results from Table 1 considering the morphological traits of *Stellaria media* collected from various field locations. It is commonly used in Plant Breeding and Genetics studies to evaluate the extent of variability, heritability, and genetic advance among traits. Most traits exhibit very high heritability, which indicates that these traits are governed by genetic factors and can be improved by selection. High genetic advance percentage with high heritability indicates additive gene action and effective selection possibilities.

Table 1. Estimates of genetic parameters for quantitative traits in *Stellaria media* population

Traits	MS	GM	GV	GCV %	PV	PCV %	EV	ECV %	h ² bs%	GA%
SH	103.213	32.489	34.401	102.90	34.411	102.915	0.01	1.754	99.970	31.678
RL	30.1062	6.2844	10.02	126.314	10.050	126.463	0.023	6.023	99.773	88.332
FW	1.46008	2.0378	0.482	48.671	0.495	49.265	0.011	7.628	97.602	59.115
DW	0.13523	0.13523	0.044	57.621	0.045	57.960	0.0005	6.260	98.833	273.388
MC%	626.283	83.173	208.567	158.355	209.147	158.575	0.58	8.350	99.722	30.431
LL	2.17444	3.2889	0.717	46.716	0.738	47.398	0.021	8.012	97.143	44.558
LW	240.461	13.838	80.127	240.622	80.219	240.771	0.009	8.458	99.876	113.450
LA	18.3931	5.2889	6.123	107.600	6.146	107.80	0.023	6.565	99.6299	81.960

SH=shoot height, RL=root length, FW=fresh weight, DW=dry weight, MC%=moisture content percentage, LL=leaf length, LW=leaf width, LA=leaf area, MS=mean sum of square, GM=grand mean, GV=genotypic variance, GCV%=Genotypic coefficient of variance, EV=environmental variance, ECV%=environmental coefficient of variance, h²bs=broad sensed heritability, h²bs%=heritability percentage, GA%=genetic advance percentage.

Table 2 represents the ANOVA for different morphological traits of *Stellaria media*. ANOVA illustrates whether significant variation exists among the studied population. Mean square values for locations were highly significant for plant height, root length, leaf length, leaf width, leaf area, fresh weight, dry weight, and moisture content percentage, demonstrating significant fluctuation among populations collected from different field locations. The significant differences observed among locations for all studied traits recommend the indication of

notable morphological variability in *Stellaria media* populations. Such variation may result from genetic diversity as well as environmental influences predominant in different habitats. The low error variance and moderate coefficient of variation values demonstrate that the experimental data were precise and dependable. Similar findings have been recorded in previous studies where geographical variation significantly affected morphological traits in plant populations.

Table 2. ANOVA for morphological traits of *Stellaria media*

SOV	PH	RL	LL	LW	LA	FW	DW	MC%
Locations	103.213*	30.1062*	2.17444*	240.461*	18.3931*	1.46008*	0.13523*	626.283*

Error	0.01	0.0228	0.02111	0.099	0.0228	0.01186	0.00053	0.58
Grand Mean	32.489	6.2844	3.2889	13.838	5.2889	2.0378	0.3067	83.173
Standard Error	0.0576	0.0873	0.0839	0.1814	0.0872	0.0629	0.0133	0.4398
CV	0.31	2.41	4.42	2.27	2.85	5.34	7.53	0.92

*=Statistically significant at 5% level of probability, PH=plant height, RL=root length, LL=leaf length, LA=leaf area, FW=fresh weight, DW=dry weight, MC%=moisture content percentage, SOV=source of variation, CV=coefficient of variation.

From Table 3, Regression analysis is used to determine the relationship and contribution of predictor variables towards a dependent variable. The regression coefficient revealed both positive and

negative associations among the studied variables. All predictor values show the non-significant P-values ($P > 0.05$), indicating that none of the studied traits had a statistically significant effect on the dependent variables.

Table 3. Stepwise multiple linear regression for the fresh weight of *Stellaria media*

Predictor Variables	Coefficient	Std error	T	P
Constant	41.3186	28.3114	1.46	0.3824
DW	14.7245	20.9213	0.7	0.6096
FW	-0.23909	4.53656	-0.05	0.9665
LA	3.70172	2.98569	1.24	0.4321
LL	7.87889	4.73049	1.67	0.3442
LW	-2.48957	1.21245	-2.05	0.2885
MC	-0.1835	0.37364	-0.49	0.7094
RL	-1.37425	0.70002	-1.96	0.2999

Std error= standard error of the coefficient, T= t- test value, P= probability value, DW= dry weight, FW= fresh weight, LA= leaf area, LL= leaf length, LW=leaf width, MC= moisture content, RL= root length.

From Table 4, the correlation analysis explained numerous significant relationships among the evaluated morphological traits. Dry weight (DW) indicates strong and statistically significant positive correlations with leaf length (LL, $r = 0.7597$, $p < 0.05$), leaf width (LW, $r = 0.7019$, $p < 0.05$), and shoot height (SH, $r = 0.7754$, $p < 0.05$). Conversely, fresh weight (FW) was strongly negatively correlated with leaf dimensions, showing significant negative correlations with LL ($r = -0.8205$, $p < 0.05$) and LW ($r = -0.8862$, $p < 0.05$). Furthermore, moisture content (MC) exhibited pronounced negative correlations with leaf area (LA, $r = -0.7181$, $p < 0.05$), LL ($r = -0.8793$, $p < 0.05$), and LW ($r = -0.8446$, $p < 0.05$). Root length (RL) also displayed a significant inverse relationship with LL ($r = -0.6905$, $p < 0.05$). The strong positive association among dry weight (DW), leaf traits (LL and LW), and shoot height (SH) suggests a coordinated pattern of vegetative growth, where taller plants with larger leaves enhance light interception and consequently promote greater

biomass accumulation ([Abbas, Arshad, Rehman, Bukhari, & Zaman, 2024](#)).

In contrast, the pronounced negative correlation between moisture content (MC) and these growth-related traits indicates a physiological trade-off, whereby an increase in structural development and dry matter accumulation is accompanied by a reduction in relative water content within plant tissues. Furthermore, the negative relationship between root length (RL) and above-ground characteristics such as leaf length and dry weight reflects a resource allocation strategy within the plant system. The significant negative correlation ($r = -0.690$) suggests that greater investment in root elongation may occur at the expense of shoot and leaf development, particularly under conditions where plants allocate more energy toward water and nutrient acquisition ([ALI, 2022](#); [Arshad, Iqbal, Farooq, & Abbas, 2024](#)). According to figure 1 the location 3 was found good location for the growth and development of weed plants.

Table 4. *Stellaria media* morphological traits Correlation

Traits	DW	FW	LA	LL	LW
FW	-0.3008				
LA	0.5406	-0.9589			
LL	0.7597*	-0.8205*	0.9228*		
LW	0.7019*	-0.8862*	0.9746	0.9825	
MC	-0.9704	0.516	-0.7181*	-0.8793*	-0.8446*
RL	-0.9848	0.1973	-0.4359	-0.6905*	-0.6148

SH	0.7754*	0.3442	-0.1014	0.2128	0.106
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*=Statistically significant at 5% level of probability, DW= dry weight, FW= fresh weight, LA= leaf area, LL= leaf length, LW= leaf width, MC= moisture content, RL= root length, SH= shoot height

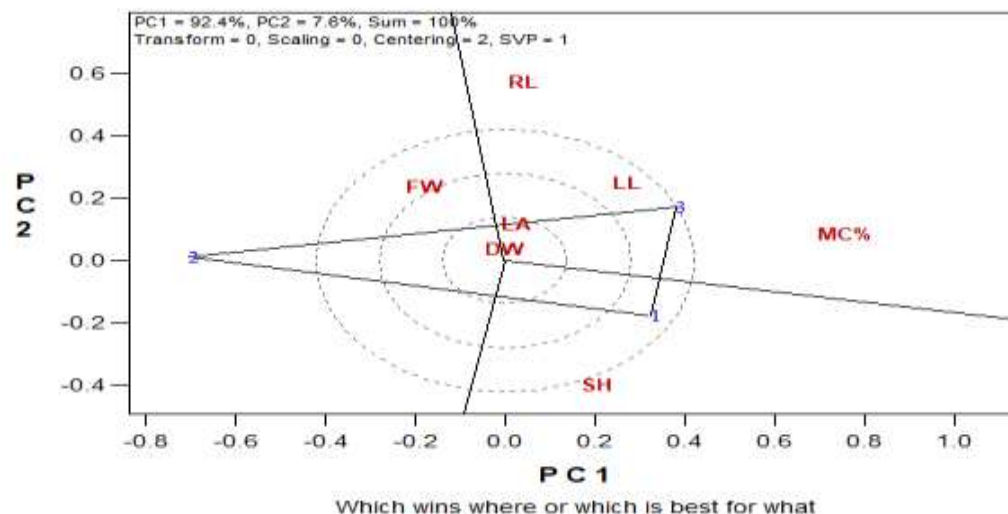


Figure 1. *Stellaria media* morphological traits in a GGE biplot at three different locations

Conclusion

The findings provide valuable insights into the multivariate traits and variability of *Stellaria media* contributing to a better understanding of its ecological adaptation and genetic variability.

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Declaration**Data Availability statement**

All authenticated data have been included in the manuscript.

Consent for publication

Not applicable

Declaration of Competing Interests

The authors declare that they have no conflict of interest.

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AS collected data and conducted research and wrote article. Final editing was carried out and approved for final publication.

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