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Original Research Article

MULTIVARIATE ANALYSIS FOR MORPHOLOGICAL TRAITS OF *AMARANTHUS VIRIDIS*

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Abstract *Amaranthus viridis, a weed found in upland rice farming poses a threat, to crop plants because it competes for vital resources like water, minerals, and nutrients. This competition leads to decreases in crop yield. To tackle this issue a designed study was conducted to examine the characteristics of Amaranthus viridis in three different locations with distinct environments. The results showed a meaningful connection between traits such as dry weight, fresh weight, plant height, leaf area, leaf width, leaf length and root length. Interestingly the width of the plant leaves was found impact on its height. Additionally, location two was identified as an environment for the vigorous growth and development of Amaranthus viridis plants. To effectively minimize losses, in crop yield caused by this weed it is strongly recommended to remove or control Amaranthus viridis populations. This study underscores the importance of population management strategies.*

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Keywords: *Amranthus viridis, morphological traits, ascending herb, correlation, regression*

Introduction

Amaranthus viridis L. is an annual herb belonging to family Amaranthaceae, popularly recognized as green amaranth. Many experts believe its origin can be traced back, to Asia (Ferdous et al., 2015a). Over time it has spread widely. Become a weed in various regions worldwide, including tropical, subtropical and even temperate areas (Gültekin & Korotyaev, 2012). People often come across it in places, like Europe, North America, Asia, Australia and equatorial Africa. This plant grows as an upright or ascending herb, occasionally persisting as a short-lived perennial, attaining heights of up to 1 meter. The stems are smooth and angular with branching patterns. May sometimes have hairs on the upper part (Khan et al., 2022). The leaves of *A. viridis* are arranged alternately along the stem and have petioles that can reach up to 10 cm in length. The leaf blades are deltoid-ovate to rhomboid-oblong in shape, measuring between 2 to 8 cm in length and 1.5 to 6 cm in width. The margins of the leaves may sometimes appear sinuate, and the apex is emarginate with a small mucro. The base of the leaves is shortly cuneate. The leaves can have textures depending on the plant; they may be smooth or covered in hairs (pubescent). In regions people occasionally cultivate this plant in countries, like Nigeria, Gabon and the Democratic Republic of the Congo (Babar et al., 2015). *Amaranthus viridis* exhibits slender clusters of axillary or mostly terminal spikes, which can reach up to 12 cm in length and are often paniculated. These spikes may form profilated axillary clusters in the lower part of the stem, approximately 7 mm in diameter. The flowers of this plant are green, subsessile, and unisexual (Das, 2012). Lanceolate-ovate bracts and bracteoles surround them. Male and female flowers are found together, but there are generally more female flowers. The bracteoles of flowers are oblong. Obovate, in shape and measure around 1 mm in length. Other hand, the bracteoles of flowers are slightly longer, ranging from 1 to 1.5 mm and they have a whitish membranous appearance. (Hodge & Doust, 2017).

Amaranthus viridis produces a sub-globose capsule, roughly 1.5 mm in diameter, which is either equal to or slightly larger than the perianth. The capsule has prominent wrinkles and remains closed when mature, not naturally splitting open (Ferdous et al., 2015b). Inside the capsule is a single seed, sub-globose and slightly flattened, with a shiny black appearance and approximately 1 mm in diameter. The seed has a sharp margin and may have a rough surface or inconspicuous features (Das, 2016). The leaves of A. viridis are used to treat various skin conditions, including rashes, psoriasis, and eczema. Apart from the earlier people have traditionally used *Amaranthus viridis* for medicinal purposes. These include using it as an anti-inflammatory for tract issues a diuretic, a treatment for diseases an intestinal worm expeller (vermifuge) a pain reliever (analgesic) a remedy for rheumatism (anti rheumatic agent) an ulcer treatment

(antiulcer remedy) a solution to control nausea and vomiting (antiemetic) and an appetite stimulant. It has also been employed as a laxative and in treating leprosy. Additionally, the plant has been employed in traditional medicine to address respiratory and eye problems and manage asthma (Rc & Dr, 2023). Apart, from its uses A. Viridis possesses other beneficial properties. It contains lectin properties that have antifungal effects and a protein that inactivates ribosomes. Additionally, the plant is a source of ß carotene, a precursor to vitamin A and plays a role in various physiological processes. Furthermore A. Viridis has shown activities indicating its potential in fighting infections (Hasan et al., 2021). However, it's crucial to acknowledge that while traditional uses have been extensively reported and culturally valued, there is evidence to support all the claimed analgesic and antipyretic activities. As a result, researchers recognize the need for further studies to verify the authenticity and effectiveness of these claims. Ongoing investigations aim to establish a foundation, for the diverse therapeutic applications of this plant and gain a better understanding of its potential health benefits (Rahman & Iffat Ara, 2014).

Material and Methods

Collection of plant material

Samples of *A. viridis* were gathered from three different locations at the back fields of the Faculty of Agricultural Sciences, University of the Punjab, Lahore. The entire plant material was then subjected to shade-drying.

Data collection

Various data points were collected, including the fresh weight of the plant, dry weight of plant which are measured using an analytical balance, moisture percentage of the whole plant (calculated as [(FW - DW) / FW * 100]), plant height, leaf length, leaf width, root length, and leaf area. To analyze the data, the researchers employed the variance analysis technique (Wang & Parsons, 1997).

Results and Discussions

The outcomes presented in table 1 demonstrate statistically notable results between the studied locations for *Amaranthus viridis*. The average plant height was recorded as (49.22±2.4795 cm), leaf width (3.4211±0.094 cm), leaf length (5.363±0.295 cm), leaf area (13.789±00.8505 cm^2), root length (17.111±0.1925 cm), fresh weight (17.5±0.3727 g), dry plant weight (4.4667±0.1764 g), and moisture content percentage (73.8±0.672%) for *Amaranthus viridis* plants gathered from the three distinct locations. The greater plant fresh weight indicates the robustness of *Amaranthus viridis*, allowing it to endure varying environmental conditions. The higher moisture content percentage further justifies its ability to tolerate harsh, hot, and dry climates. Notably, the species' capacity to survive under water deficit conditions suggests its potential to give challenging situation to crop plants for water, mineral, nutrients, and space, potentially impacting crop yield and production (Achigan-Dako et al., 2014), (Sami et al., 2023). These findings provide valuable insights into the adaptive and competitive characteristics of *Amaranthus viridis* in diverse ecological settings. *Amaranthus viridis* typically thrives in upland rice fields and is commonly found in well-drained soils, particularly in open waste areas and cultivated lands. It shows a preference for sandy soils or those rich in humus and prefers fairly moist conditions. However, its presence can significantly impact the yield of rice crops. Effective control measures should be implemented to migrate its negative effects on crop plants. These measures may include chemical treatments, manual methods and biological methods like phytoremediation to manage and minimize its potential risk to crop cultivation (The Nature Conservancy et al., 2001).

Table 1. Analysis of variance for different morphological traits of *Amaranthus viridis*

SOV	Plant Height	Leaf Weight	Leaf Length	Leaf Area	Root Length	Fresh Weight	Dry Weight	Moisture %
Locations	968.444*	1.33031*	2.51453*	47.0936*	40.1111*	210.083*	10.36*	20.533*
Error	18.444	0.02671	0.26102	2.1701	0.1111	0.417	0.0933	1.357
Grand Mean	49.222	3.4211	5.3633	13.789	17.111	17.5	4.4667	73.8
CV	8.73	4.78	9.53	10.68	1.95	3.69	6.84	1.58
Standard Error	2.4795	0.0944	0.295	0.8505	0.1925	0.3727	0.1764	0.6726

*=Significant at 5% probability level

A correlation analysis examined the relationship between various morphological traits of Table 2 presents the results for *Amaranthus viridis*, revealing significant and positive correlations among all the studied traits. These findings indicate the plant's remarkable capacity to thrive in harsh and hot environmental conditions. This ability can be attributed to the accumulation of organic compounds and its higher photosynthetic rate, which contribute to its robust growth and development (Bennett, 1987), (Sami et al., 2023).

Table 2. Correlation among morphological traits of *Amaranthus viridis*

Attributes	Dry Weight	Fresh Weight	Plant Height	Leaf Area	Leaf Length	Leaf Width
Fresh Weight	0.9779*					
Plant Height	0.857*	0.9352*				
Leaf Area	0.9144*	0.9238*	0.772*			
Leaf Length	0.8118*	0.8202*	0.7039*	0.8755*		
Leaf Width	0.7663*	0.7771*	0.6195*	0.8853*	0.5565*	
Moisture %	0.4382*	0.6115*	0.7843*	0.501*	0.3686*	0.5004*
Root Lenth	0.986*	0.9482*	0.7883*	0.9281*	0.8272*	0.7895*

*=Significant at 5% probability level

Regression analysis was conducted to assess the influential traits affecting Plant height. The results revealed that leaf width (76.61) was the most significant contributing factor, followed by leaf length (49.21), plant dry weight (10.68), and plant fresh weight (4.79). Conversely, leaf area (-24.20), root length (-7.65), and moisture percentage (-0.46) were identified as negatively contributing traits towards Plant height (Table 3). The regression equation predicting the relationship was formulated as follows: Y (PH) = -109.19 +49.220(LL)+76.615(LW)-7.651(RL)-24.209(LA)-0.468(MC)+10.687(DW)+4.791(FW).

Table 3. Stepwise multiple linear regression for Plant fresh weight of *Amaranthus viridis*

Traits	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-109.19	207.91	-0.5251	0.692	-2750.99	2532.60
LL	49.220	21.603	2.278	0.263	-225.275	323.714
LW	76.615	31.141	2.460	0.246	-319.069	472.299
LA	-24.209	8.823	-2.744	0.223	-136.320	87.903
RL	-7.651	4.055	-1.887	0.310	-59.170	43.867
FW	4.791	4.360	1.099	0.470	-50.607	60.188
DW	10.687	23.591	0.453	0.729	-289.063	310.437
MC	-0.468	2.112	-0.222	0.861	-27.298	26.362

LL=Leaf length, LW=Leaf Width, LA=Leaf Area, RL=Root length, FW=Fresh weight, DW=Dry weight, MC=Moisture, PH=Plant height

The Principal of Component Analysis (Figure 1) revealed that PC1 accounted for 94.4% of the observed variation in all studied morphological traits, indicating that the majority of the observed differences among the studied traits can be attributed to this single component common factor, which is captured by this component, while PC2 only predicted 4.5% of the variation. Additionally, the analysis indicated that location 2 is particularly favorable for the growth and development of *Amaranthus viridis* plants, as it showed the highest productivity. Based on these findings, it is recommended to implement plant population control measures specifically at location 2. Doing so makes it possible to mitigate potential yield losses in crop plants and ensure optimal growth conditions for *Amaranthus viridis*. This approach would lead to more efficient agricultural practices and improved crop productivity (Beiermann et al., 2022).

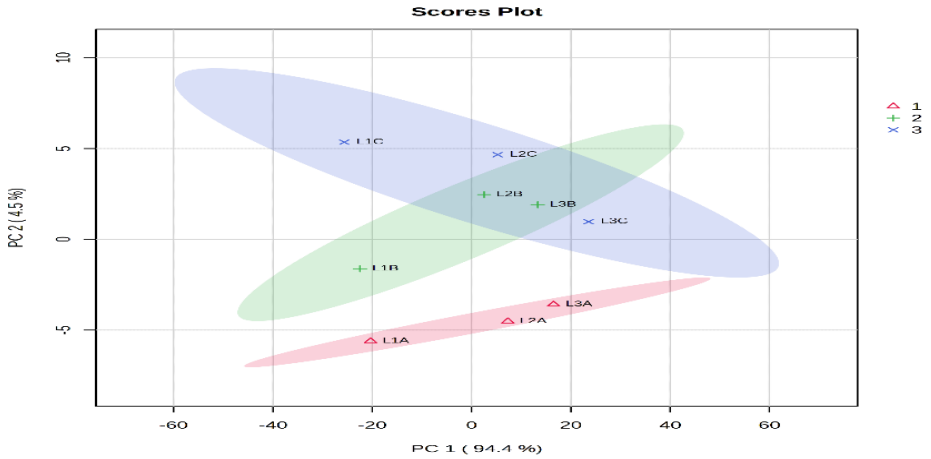

Figure 1. Total score plot for morphological traits of *Amaranthus viridis* under 3 different locations

Conclusions

Based on the study's findings, it has been determined that location 3 is the favorable, for the growth and development of *Amaranthus viridis*. Therefore, it is recommended to implement techniques to control the growth and development of *Amaranthus viridis* to minimize crop yield losses.

Data Availability statement

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

Ethics approval and consent to participate

These aspects are not applicable in this research.

Consent for publication

Not applicable

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Conflict of interest

The authors assure that there were no financial relationships involved that could be perceived as a conflict of interest.

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