THE INFLUENCE OF CLIMATIC CONDITIONS ON *AMARANTHUS RETROFLEXUS L.* AND *CHENOPODIUM ALBUM L.* PLANTS

Mihaela Lăcătuș[1], Petruța-Elisabeta Andrei[1], Monica Dragomirescu[1], Mariana-Atena Poiană[1], Ioan Ladislav Caba[2]*, Laura Rădulescu[1], Georgeta-Sofia Popescu[1], Luminița Pîrvulescu[11], Despina-Maria Bordean[1]

[1] *University of Life Sciences "King Michael I" from Timisoara, Aradului Street no. 119, 300645 Timisoara, Romania*
[2] *National Institute of Research - Development for Machines and Installations designed to Agriculture and Food Industry - INMA, Bucharest 013813, Romania;*
e-mail:* cabaioan@yahoo.com

Abstract
The purpose of this research is to investigate how the climatic conditions influence the water content of the species *Amaranthus retroflexus* and *Chenopodium album*. The two species are noxious weeds spread all over the world and which grow rapidly especially in abandoned construction areas, people's gardens but also on agricultural lands among cultivated plants.
Plant materials were collected from a single location during three different months of 2025. Humidity was determined by gravimetric method and the values obtained were correlated with the meteorological factors specific to each month. The determinations obtained highlighted the fact that there are considerable differences in humidity between plant parts and between months, indicating a direct link between temperature, precipitation and humidity.
The results demonstrate the importance of climatic conditions in the adaptive capacity and the possibility of spreading of these invasive species.

Keywords: moisture content, adaptability, climatic stress, invasive species

Introduction
The ability of plants to adapt to the direct and indirect impacts of climate change will have implications for extinction risks, agricultural and environmental sustainability, and food security. One biological response, driven by shorter winters, earlier growth, and longer droughts is that many species emerge and reproduce considerably earlier in the year [1,2].
Amaranthus retroflexus L. (redroot pigweed) and *Chenopodium album L.* (lambsquartes) are fast-growing, weedy plants belonging to the *Amaranthaceae* family. Both are among the most common weeds in the world and are most commonly found in agricultural areas [3], where they lead to considerable issues They invade the crops they grow in and, due to their destructive development and allelopathic activity, make them highly competitive and result in reduced crop quality [4].
The two species are adapted to extremely poor and unpredictable environmental conditions, competing with other plants for nutrients, water, light and space [5]. The fact that plants have the ability to oscillate their morphological traits has been established as a favorable survival strategy, which has allowed plants to adapt to changing environmental conditions [6]. The way a plant develops is closely linked to the environment in which it grows [7]. For example, both the root [8] and the stem [9] can significantly modify their shape even in genetically identical plants, when exposed to different conditions. Thus, the same species can survive and thrive in varied habitats, due to its flexibility to adjust its morphology [10].
The aim of the work is to investigate how climatic conditions, air temperature, precipitation levels and humidity, influence the water content of the species Amaranthus retroflexus and

Chenopodium album. These two plants can provide important information about the adaptability and resistance of spontaneous vegetation to climatic stress. Analyzing the differences in humidity at the soil level and in the parts of the plant (soil, root, stem, leaves) allows a better understanding of how these species respond to environmental differences. The research contributes to a better understanding of the mechanisms by which plants from the spontaneous flora manage to maintain their competitiveness in agricultural crops, even under stress conditions.

Experimental

The plant samples were collected in 2025, from a single location in Timis County, Romania, Bazosul Nou (forest) for three months: June, August and September. Before analyzing them, the plants were washed very well with tap water and distilled water to remove dust and soil residues. After preparation, the plants were separated into different parts (soil, root, steam, leaves, flowers and seeds).

The water content of the plant parts of *Amaranthus retroflexus* and *Chenopodium album* was determined by thermogravimetric analysis. The samples (≈5 g) were weighed and placed in a Sartorius thermobalance. The dehydration process was carried out at increasing temperatures, up to 110°C. The progressive weight loss was monitored in real time, which allowed the precise calculation of moisture and the evaluation of its distribution in the different plant parts.

The weather records (temperature, precipitation, atmospheric humidity) of the studied months were extracted from official meteorological sources specific to the Timisoara region. The values were then processed and interpreted using statistical analysis, with the help of ChatGPT (version GPT-4o, part of OpenAI's GPT-4 family, developer OpenAI, San Francisco, CA, USA) under human supervision ensuring accuracy and consistency throughout the study.

Results and discussion

For a better understanding about the relationship between climate and moisture content in the analyzed plant parts, Table 1 was created and based on this data three graphical representations were constructed.

Table 1. The analyzed plant parts from *Amaranthus retroflexus* and *Chenopodium album* and meteorological conditions.

	ARU%	**CAU%**	**AvDT (°C)[11]**	**PP[mm] [12]**
Soil J	28,16	13,09	17,4	8
Root J	64,57	59,69	17,4	8
Steam J	87,53	77,64	17,4	8
Leaves J	84,78	81,67	17,4	8
Soil A	6,16	3,16	23,26	25,5
Root A	73,93	15,69	23,26	25,5
Steam A	82,02	83,02	23,26	25,5
Leaves A	7596	72,15	23,26	25,5
Soil S	3,21	6,9	17,3	50
Root S	64,27	50,27	17,3	50
Steam S	71,28	53,55	17,3	50
Leaves S	66,87	66,34	17,3	50

Legend: AR-*Amaranthus retroflexus*; CA-*Chenopodium album*; U%-moisture content; AvDT (**°C**)-Average daily temperature (Celsius degrees); J-june; A-august; S-september; PP[mm]-precipitation [milimeter].

Table 1 shows that in June (J), moisture content were high in both plants, particularly in stems and leaves. In August (A), a noticeable decrease was observed in *Chenopodium album* (CAU%), more noticeable in roots and soil, while *Amaranthus retroflexus* (ARU%) maintained higher values. By September (S), moisture continued to decrease, but the differences between species became smaller, suggesting a possible merging in their adaptation to the climatic conditions specific to late summer.

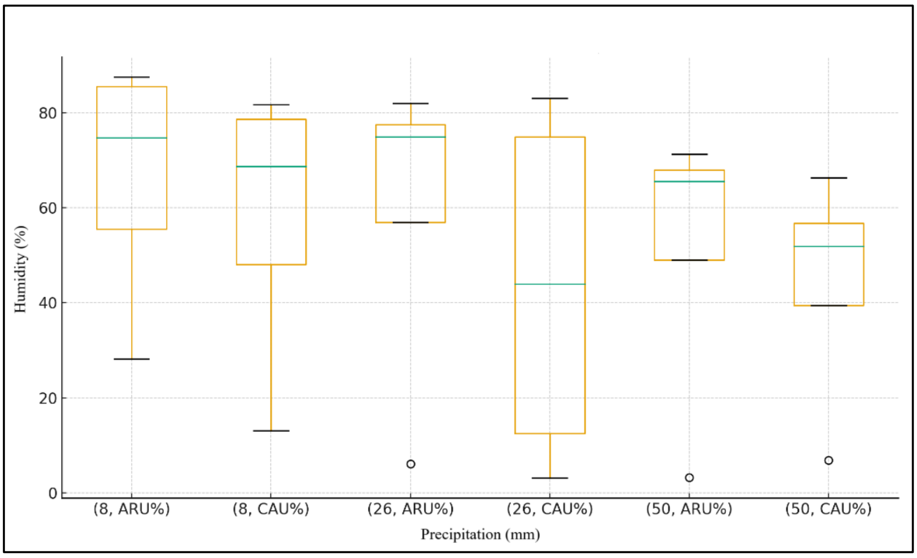

Figure 1. The influence of precipitation on humidity [13].

Legend: AR-*Amaranthus retroflexus*; CA-*Chenopodium album*; U%-moisture content; AvDT (**°C**)-Average daily temperature (Celsius degrees); J-june; A-august; S-september; PP[mm]-precipitation [milimeter].

In June (8 mm), plants had higher water content due to residual soil moisture. In August (26 mm), levels dropped as high temperatures offset rainfall. By September (50 mm), humidity rose slightly but stayed below June values. Figure 1 illustrates this relationship between rainfall, temperature, and plant water content.

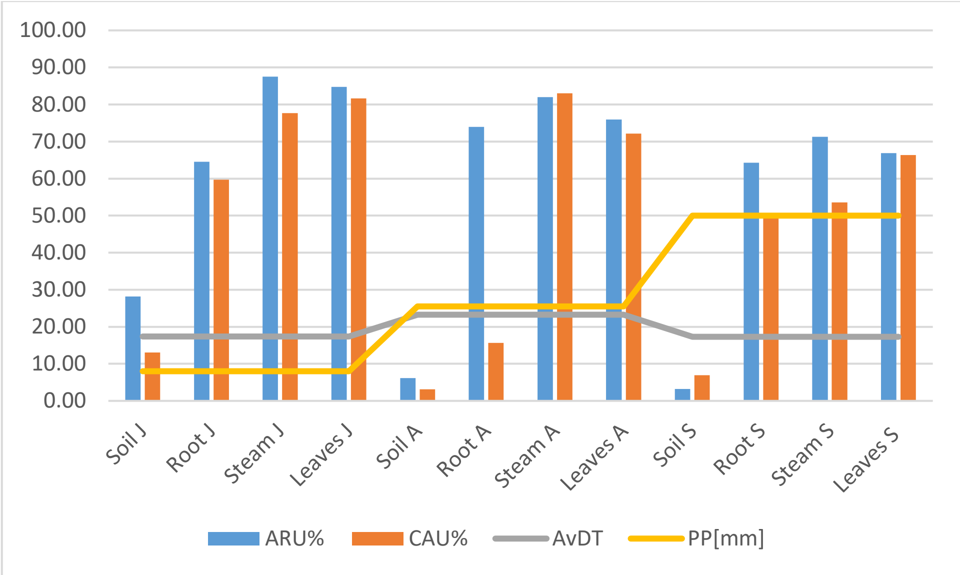

Figure 2. Comparison of water content in different parts of *Amaranthus retroflexus* and *Chenopodium* album.

Legend: AR-*Amaranthus retroflexus*; CA-*Chenopodium album*; U%-moisture content; AvDT (**°C**)-Average daily temperature (Celsius degrees); J-june; A-august; S-september; PP[mm]-precipitation [milimeter].

In June, both species showed high water content across all plant parts, especially in stems and leaves, with only minor differences between them. Despite the low rainfall, the soil still held enough residual moisture to sustain these levels. By August, the situation had changed: rising temperatures caused a clear drop in water content, more pronounced in *Chenopodium album*, while *Amaranthus retroflexus* managed to keep higher values, particularly in its roots and leaves. While the amount of precipitation was higher than in June, their effect was limited by the heat specific to the month. In September, with the decrease in temperatures and the increase in the rainfall regime, the water level in the plants increased again, but without reaching the values of June. At the same time, the differences between the two species decreased, which suggests a similar adaptation to the end-of-summer conditions.

Conclusion

Temperature, a major factor influencing water content and the increase in average temperature, resulted in a decrease in humidity, especially in August, regardless of the amount of precipitation. Precipitation had a secondary and temperature-dependent effect; in months with more rain but high temperatures (August), water content remained low, suggesting that the beneficial effect of precipitation is canceled by thermal stress. *Amaranthus retroflexus* has a greater capacity to maintain moisture in leaves and stems compared to *Chenopodium album*, which gives it an adaptive advantage in variable climatic conditions. The spread of water in plant parts differs depending on the species and month, indicating differences in physiological strategies in the use of water resources, a perspective that may influence the competitiveness and spread of these invasive species.

Acknowledgements

This study was funded by the University of Life Sciences "King Mihai I" from Timisoara” and the results will be included in the PhD Thesis of Mihaela Lăcătuş. The research was performed with the support of the Interdisciplinary Research Platform belonging to the University of Life Sciences “King Mihai I” from Timişoara.

References

[1]. Hamann, E., Weis, A. E., & Franks, S. J. (2018). Two decades of evolutionary changes in Brassica rapa in response to fluctuations in precipitation and severe drought. Evolution, 72(12), 2682-2696. https://doi.org/10.1111/evo.13631

[2]. Dickman, E. E., Pennington, L. K., Franks, S. J., & Sexton, J. P. (2019). Evidence for adaptive responses to historic drought across a native plant species range. Evolutionary Applications, 12(8), 1569-1582. https://doi.org/10.1111/eva.12803

[3]. Alebrahim, M. T., Majd, R., Mohassel, M. R., Wilcockson, S., Baghestani, M. A., Ghorbani, R., & Kudsk, P. (2012). Evaluating the efficacy of pre-and post-emergence herbicides for controlling Amaranthus retroflexus L. and Chenopodium album L. in potato. Crop Protection, 42, 345-350. https://doi.org/10.1016/j.cropro.2012.06.004

[4]. Bajwa, A. A., Zulfiqar, U., Sadia, S., Bhowmik, P., & Chauhan, B. S. (2019). A global perspective on the biology, impact and management of Chenopodium album and Chenopodium murale: two troublesome agricultural and environmental weeds. Environmental Science and Pollution Research, 26(6), 5357-5371. https://doi.org/10.1007/s11356-018-04104-y

[5]. Rodenburg, J., Riches, C. R., & Kayeke, J. M. (2010). Addressing current and future problems of parasitic weeds in rice. Crop Protection, 29(3), 210-221. https://doi.org/10.1016/j.cropro.2009.10.015

[6]. Gambino, P., & Vilela, A. (2011). Morphological traits and allocation patterns related to stress-tolerance and seed-yield in wild and domesticated evening primrose (Oenothera L. Onagraceae). Industrial Crops and Products, 34(2), 1269-1276. https://doi.org/10.1016/j.indcrop.2010.07.014Get rights and content

[7]. Mandák, B., Zákravský, P., Dostál, P., & Plačková, I. (2011). Population genetic structure of the noxious weed Amaranthus retroflexus in Central Europe. Flora-Morphology, Distribution, Functional Ecology of Plants, 206(8), 697-703. https://doi.org/10.1016/j.flora.2011.01.010

[8]. MacGregor, D. R., Deak, K. I., Ingram, P. A., & Malamy, J. E. (2008). Root system architecture in Arabidopsis grown in culture is regulated by sucrose uptake in the aerial tissues. The Plant Cell, 20(10), 2643-2660. https://doi.org/10.1105/tpc.107.055475

[9]. Teichmann, T., & Muhr, M. (2015). Shaping plant architecture. Frontiers in plant science, 6, 233. https://doi.org/10.3389/fpls.2015.00233

[10]. Urbas, P., & Zobel, K. (2000). Adaptive and inevitable morphological plasticity of three herbaceous species in a multi-species community: field experiment with manipulated nutrients and light. Acta Oecologica, 21(2), 139-147. https://doi.org/10.1016/S1146-609X(00)00115-6

[11].https://www.accuweather.com/ro/ro/timisoara/1-290867_18_al/june-weather/1-290867_18_al?year=2025

[12]. https://www.meteoromania.ro/clim/caracterizare-lunara/cc_2025_06.html

[13]. ChatGPT. OpenAI. Available online: https://chat.openai.com/ (accessed on 24 September 2025).