Research Journal of Agricultural Science, 54 (4), 2022; ISSN: 2668-926X

COMPARISON STUDY ABOUT THE RESISTANCE OF WHEAT GERMS EXPOSED AT CONTROLLED HYDRIC STRESS

R. JURCUT[1], F. IMBREA[1], L. BOTOS[1], S. BĂTRÎNA[1]

[1] University of Life Sciences "King Michael I" from Timisoara, Faculty of Agriculture, Timişoara, Calea Aradului, nr.119,
Corresponding author: raul.cristian19@gmail.com

Abstract. *Knowing the importance of wheat culture both nationally and internationally, we decided to start a study which demonstrate the resistance of wheat germs to water stress. Water is one of the most essential elements for the development of plants, it has the role of helping the plants to assimilate more easily the nutrients from the soil, necessary for the vegetation period. The premise of this experiment is based on meteorological data recorded in recent years, from which resulted that, from year to year, wheat crops are faced with a permanent water stress due to the lack of precipitation, snow, and improperly executed soil works. Thus, the amount of water in the soil at the time of sowing and also during development is very small, which leads to a delay or poor development of wheat germs, something that will make it difficult for the plants to withstand winter hardening. In the spring of 2022, we had collected the data resulted from the experience and started to analyse the results. The objectives were, determining of the stage of resistance of the seedling, the development of the root system and the number of viable plants, concluding by selecting which variety adapted the best to the conditions being exposed.*

Keywords*: Wheat, Water, Water stress, Germination.*

INTRODUCTION

Wheat is one of the most cultivated plants worldwide, ensuring the world's food security through its nutritional properties (12). Moreover, wheat is grown on an area of approximately 2.1 million km^2 with an average production of 700 million tons, providing more than 20% of the total amount of calories consumed by the world's population (10). Water is one of the primary elements of cellular functioning, something that is also reflected in the good development of plants (13; 7; 9). One of the main causes that can affect wheat production is represented by the drought we face year after year, in conjunction with temperature fluctuations between night and day (8; 6).

Lack of precipitation or severe drought is one of the main causes when it comes to plant production, which is why several studies have been carried out to monitor the duration and influence that lack of water can have on wheat production (16; 15).

MATERIAL AND METHODS

The area where the experience was carried out is around of the town of Timișoara, more precisely between the city of Timișoara and the town of Sânandrei in Timiș county.

The experimental part was carried out in the fall of 2021, more precisely in October and lasted until March of 2022, consisting of the choice of 4 varieties of wheat grown as a rule in the Western Plain. These varieties are constituted by: Triticum durum (Wintergold) – durum autumn wheat; *Triticum aestivum* (Antonius) – Antonius, autumn wheat; *Triticum aestivum* (Glosa) – Glosa, autumn wheat; *Triticum aestivum* (Apache) – Apache, autumn wheat.

The wheat seeds were sown in 12 individual plastic containers, each variety being allocated 3 plastic containers. 40 wheat seeds were sown in each container, thus having the possibility to determine the rate of development and resistance of the germs depending on the amount of water applied.

To create an environment as similar as possible to the seeds sown in the field, the plastic containers were positioned in a place protected from precipitation, but at the same time exposed to light and temperatures from the external environment.

Following the research carried out, we deduced the degree of resistance to water stress of each wheat variety analysed, and also their germination power, such as the number of viable germs (5; 2).

The working process for this experiment consisted in the selection of a number of 40 wheat seeds of each variety chosen for the experiment. In order to obtain the most conclusive results, the largest and healthiest seeds were chosen, so that each variety benefited from the same number of seeds and the same selection criteria.

After the selection was made, the germinal bed was prepared for sowing the seeds, which were distributed in equal quantities in each plastic container.

The wheat seed sowing process consisted of making 40 holes distributed equally over four rows. In each row, ten holes were made so that for each seed corresponded a hole. Three containers corresponded to each variety of wheat, each container from each variety representing the number of water distribution carried out during the experiment.

After placing the seeds in each hole, the next step was to distribute an amount of water equivalent to 200 ml for each plastic container, then covering the grains with a layer of dry soil in order to facilitate the coleoptile to get through the soil more easily, this work being carried out on October 4, 2021.

The first watering was programmed on October 18, 2021 and water was distributed only to one container of each variety; it should be noted that the temperature felt in the air was on average 10 degrees Celsius. The first watering was done by distributing an amount of 200 ml of water only for one container of each variety, thus creating the impression of precipitation.

The second watering was programmed at an interval of 14 days, more precisely on November 1, 2021, and water was applied only to containers that ended with one and two. On that date, the sum of temperatures dropped considerably compared to the sowing date, which caused certain difficulties regarding the germination process. When the second watering was carried out, it was observed that the wheat seeds had a uniform germination, the germination percentage of the seeds being between 70-80% per plastic container.

The third watering took place on November 15, 2021, at the same interval as the second watering, when the same amount of water was applied as in the previous waterings, but with the mention that this time, all three plastic containers were watered, so container number 3 of each variety was watered for the first time after a time interval of 28 days from sowing.

In the days between watering number 2 and watering number 3, the temperatures recorded were very low, and the exposure of the wheat germs to the alternation of temperatures between day and night made it difficult for the plants that were deprived of water to develop.

After the third watering was carried out, the results of the experience began to take shape, being visible the level of development of each plastic container depending on the variety and the number of waterings applied. When the temperatures started to drop below zero degree Celsius, the decision was made to keep the containers in their growth medium from that moment, with the aim of being able to accurately determine the resistance of the germs after completing the vernalization period. Finally, the results of the experience being collected in March 2022.

RESULTS AND DISCUSSIONS

In March 2022, data extraction and analysis were carried out, followed by getting the results of how wheat germs got through the germination and vernalization process, thus obtaining the following results:

1. *Triticum durum* – durum autumn wheat Wintergold

In the case of the Wintergold durum wheat variety, it can be observed that the seedlings in container 1.1, respectively the container that benefited from all the waterings applied, have poorly developed roots compared to containers 1.2 and 1.3, which shows that the amount of water applied is not in direct correlation with the degree of development of the roots, but it makes a difference in terms of the number of viable germs, which is highlighted in figure 1.

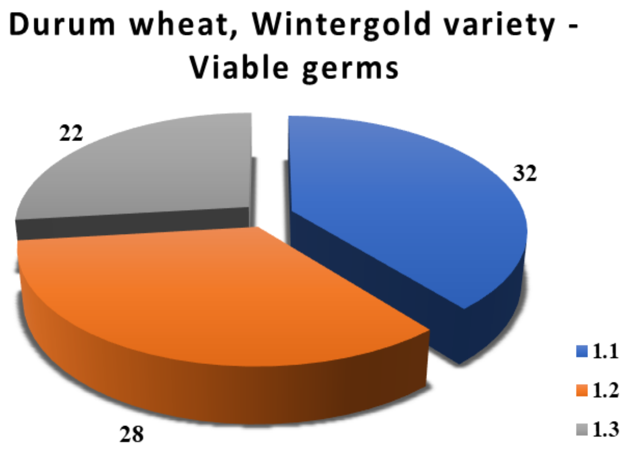
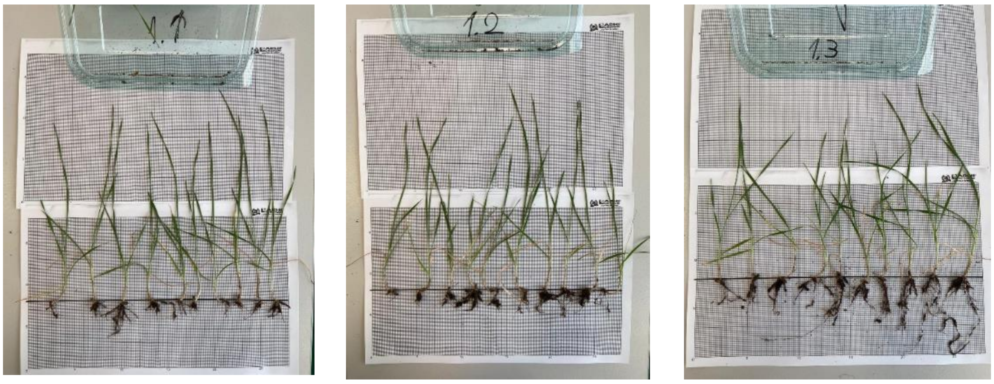


Figure 1. – The number of viable seedlings of the Wintergold variety

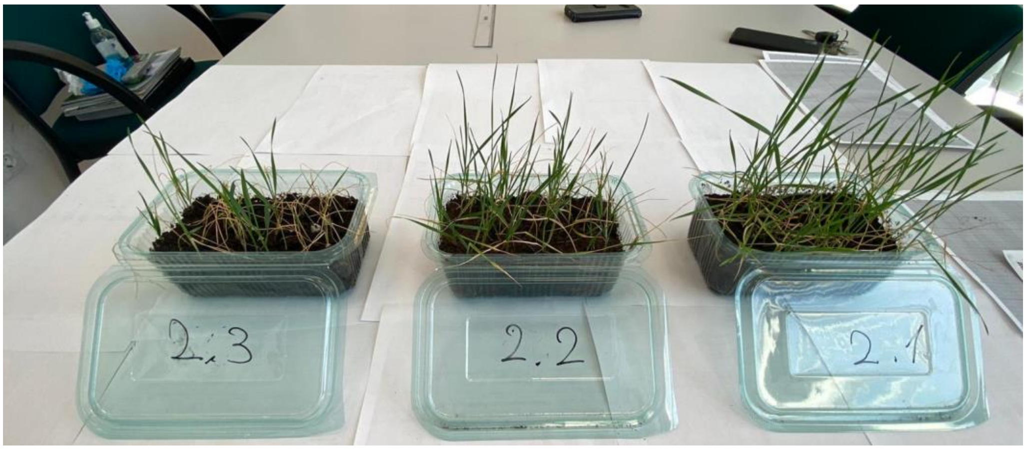
Regarding container 1.3, it is visible that the leaves do not have the same vigour and colour as those in containers 1.1 and 1.2, but the root system of the plants in container 1.3 is much better developed, and in the case of a pedological drought in the field, this variety would go well over the period of hydric-stress and the frost in winter.



Picture 1. – Development stages of plants of the Wintergold variety depending on the amount of water administered.

2. *Triticum aestivum* – autumn wheat Antonius

The plastic containers represented for the Antonius variety showed some differences in development and germination, an important aspect is the fact that the number of germs from container 2.3 was lower compared to containers 2.1 and 2.2. This leads us to the conclusion that, although at the time of sowing the amount of water distribution was equal, the lack of water at the time of germination induces a dormant state in the wheat germs, which makes them start in vegetation only when a quantity of water is applied (3; 4). Something visible in the case of container 2.2 watered every 14 days and in container 2.3 watered at an interval of 28.



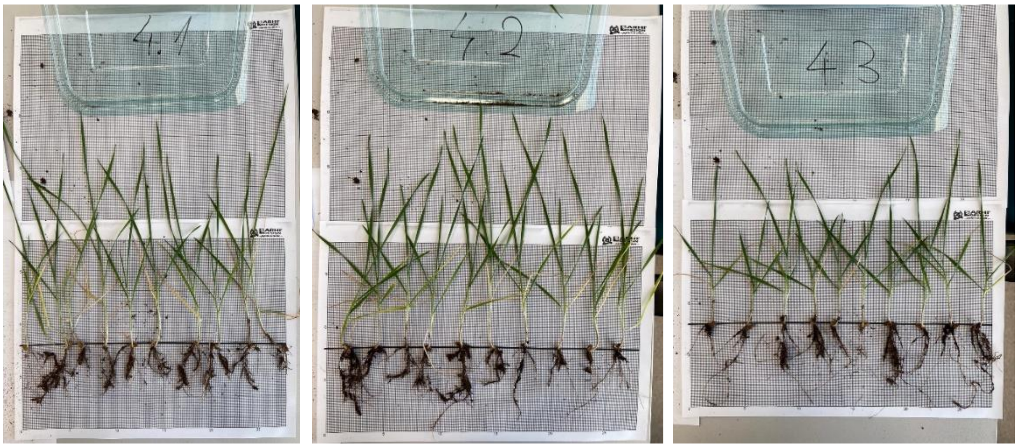
Picture 2. - The level of development of germs depending on the amount of water applied.

Another aspect that was taken into account was the size of the seedling, their length was smaller in the case of container 2.3, compared to container 2.1, visible in picture 2 and 3.

Picture 3. – Developmental stages of plants depending on the amount of water applied.

3. *Triticum aestivum* – autumn wheat Anapurna.

Compared to the varieties analysed above, Anapurna winter wheat showed the most positive signs of drought resistance. The plants of this variety showed good resistance throughout the experiment, the roots had a relatively equal development throughout the duration of the experiment.



Picture 4. – The degree of development of wheat plants represented for the Anapurna variety.

It should be noted that the container with number 4.3 shows the most uniform development of the root system, a fact also found in the case of container 4.2 where the development of the root system as well as the leaf system is consistent.

We can say about this wheat variety that, although it was exposed to water stress, the degree of germ development was not affected by the lack of water in the soil, which means that it presents a higher degree of adaptability compared to the other analysed varieties (1).

Regarding the seed germination percentage, it was noted that container 4.1 recorded a percentage of 85% (34 germs), container 4.2 recorded 77.5% (31 germs) and container 4.3 recorded 70% (28 germs).

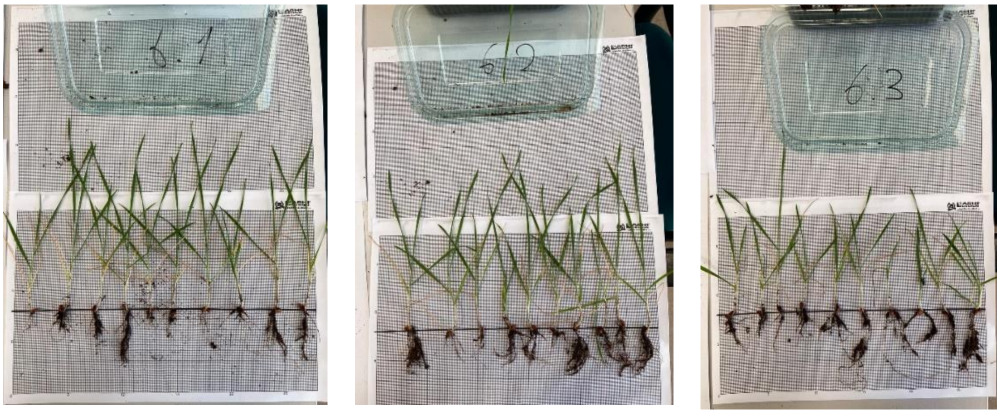
Picture 5. - Exposing the developmental differences of plants represented for the Anapurna variety.

4. *Triticum aestivum* – autumn wheat, variety Apache

The Apache wheat variety was characterized by good root development, at the end of the experimental phase, the seedlings presented a well-consolidated and fasciculate root system, this leading to uniform leaf development. By comparison, the plants in container 6.1 were watered at every watering interval and their development was similar to that of container 6.2 which benefited from a lower amount of water.

Among other things, although the resistance to water stress was favourable, the number of germinated seeds was not a considerable one, as can be seen below:

- Container 6.1 – 22 germs.
- Container 6.2 – 21 germs.
- Container 6.3 – 21 germs.



Picture 6. - Root and leaf development for representative plants of the Apache variety.

As a result of the research carried out, several sets of data were obtained on the basis of which the variety most adaptable and resistant to the climate of the area around the city of Timișoara was established. Thus, the variety with the most developed root system and also the most developed leaves was chosen.

According to the data, the common winter wheat variety, Anapurna, and the durum wheat variety, Wintergold showed the best characteristics for cultivation in the chosen area, both of which showed a very well consolidated leaf system, taking into account the conditions in which they developed. The leaves had a very well-defined green colour, with no wilted leaves, indicating that, although they were water-deficient, the roots were active enough to utilize all the water they had.

As for the variety Antonius and Apache, although they developed a well-established root system, they did not have the ability to utilize water long enough to develop the leaf system as well, an example would be represented in container 2.3 of the variety Antonius whose germs did not have a very good resistance to water stress, resulting in small-sized plants, of which a quarter died.

Therefore, the study carried out can represent a landmark for choosing the right variety, given that the drought is more and more accentuated from year to year, and the lack of precipitation and the soil works performed incorrectly, lead to the waste of water from the soil . (14), (11).

CONCLUSIONS

1. The wheat varieties Anapurna and Wintergold are recommended for cultivation in the climatic conditions of the Western Plains of Romania.

2. Wheat germs of the Anapurna and Wintergold cultivars showed remarkable resistance when they were not watered for 28 days.

3. Even though the root system of representative plants of the Wintergold variety were not as developed as those of the Anapurna variety, the developed leaf mass had the same growth parameters.

4. It was discovered that the wheat germs of the Anapurna and Wintergold varieties showed the same viability even at a watering interval of 14 days, the germs watered at the interval of 28 days being less developed.

5. Almost all the varieties went well through the frost period during the winter, except for the Antonius variety which, at the time of harvesting, showed dry plants for one third of the total harvested.

BIBLIOGRAPHY

AFRIDI F., MAHAJAN K. AND SANGWAN N., 2022 - The gendered effects of droughts: Production shocks and labor response in agriculture, Labour Economics 78, Elsevier, India.

AHMAD N., AHMED J., ABDULLAH M., ASGHAR S., GOHAR S., IQBAL J., JAVED A., JAVED K., SHER A., QAYYUM A., 2022 - Estimation of drought effects on different bread wheat genotypes using morpho-physiological traits, Biochemical Systematics and Ecology, Volume 104, Science Direct, Pakistan.

AMERY F., BEIRINCKX S., DE KEYSER A., DECKERS T., EMILIE FROUSSART SI J., HAMONTS K., VIAENE T., RAES J., SOFIE GOORMACHTIG, TANG L.,VÁZQUEZ-CASTELLANOS J. F., VANDENABEELE S., 2021 - Interactions between soil compositions and the wheat root microbiome under drought stress: From an in silico to in planta perspective, Computational and Structural Biotechnology Journal, Elsevier, Saudi Arabia.

AVALBAEV A., ALLAGULOVA C., BEZRUKOVA M., FEDOROVA K., KUDOYAROVA G., LUBYANOVA A., MASLENNIKOVA D., SHAKIROVA F., YULDASHEV R., 2020 - Wheat germ agglutinin is involved in the protective action of 24-epibrassinolide on the roots of wheat seedlings under drought conditions, Plant Physiology and Biochemistry,Volume 146, Elsevier, Rusia.

AYOUBI S. A., AHMAD S., BIBI Y., JENKS M.,QAYYUM A., SHER A., SHEN Z.,. 2021 - Improvement in drought tolerance in bread wheat is related to an improvement in osmolyte production, antioxidant enzyme activities, and gaseous exchange, Saudi Journal of Biological Sciences, Volume 28, Issue 9, Pages 5238-5249, Scince direct, Saudi Arabia.

AZARBAD H., BAINARD L.D., CONSTANT P., GIARD-LALIBERTÉ C., YERGEAU E., 2018 - Water stress history and wheat genotype modulate rhizosphere microbial response to drought, oil Biology and Biochemistry, Volume 126, Scince direct, Canada.

BILJON A., GUZMAN´ C., OLCKERS S.L., OSTHOFF G., LABUSCHAGNE M., WENTZEL B., 2022 - Drought and heat stress effects on gluten protein composition and its relation to bread-making quality in wheat, Journal of Cereal Science,Volume 108, Elsevier, South Arica.

CASTELLI G., ELENA B., PIEMONTESE L., PENNA D., VILLANI L., 2022 - Drought risk assessment in Mediterranean agricultural watersheds: A case study in Central Italy, Agricultural Water Management, Elsevier, Italy.

CHENG W., DANG Y., FAN T., LI S., WANG S., WANG L., ZHANG J., ZHAO G., 2022 - Response of dryland crops to climate change and drought-resistant and water-suitable planting technology for spring maize, Journal of Integrative Agriculture, Elsevier, China.

CHU Q., CHEN F., JIANG Y., LEI Y., ZHANG L., 2021- Impacts of climate change on drought risk of winter wheat in the North China Plain, Journal of Integrative Agriculture, Volume 20, Issue 10, Pages 2601-2612, Elsevier, China.

DUBOVYK O., GHAZARYAN G., GERDENER H., HERBERT C., HAGENLOCHER M., ISABEL M., JORDAAN A., KUSCHE J., POPAT E., RHYNER J., REZAEI E., SIEBERT STNOURI H.,WALZ Y., 2021 - Drought risk for agricultural systems in South Africa: Drivers, spatial patterns, and implications for drought risk management,Science of The Total Environment, Volume 799, 149505, Elsevier, South Africa.

FAROOQ M., HAFEEZ M. B., ULLAH A., SIDDIQUE K. H.M., WAHID A., ZAHRA N., 2021 - Grain development in wheat under combined heat and drought stress: Plant responses and management, Environmental and Experimental Botany, Volume 188,Elsevier, Pakistan.

HONGBIN L., YUPING L., YUANYUAN L., ZHANG S., 2017 - Improving water-use efficiency by decreasing stomatal conductance and transpiration rate to maintain higher ear photosynthetic rate in drought-resistant wheat, The Crop Journal,Volume 5, Issue 3, Elsevier, China.

IMBREA F.,2014 Integrated Technologies. Vol. I. Cereals and legumes for grains., Ed. Eurobit,Timișoara.

LIFENG Z., QIANG S.,SHENGPENG C., SHENG Y., WANG Y., YI H., YALI Z., YI C., 2022 - Effects and contributions of meteorological drought on agricultural drought under different climatic zones and vegetation types in Northwest China, Science of The Total Environment, Elsevier, China.

ZHANG X., GUO P., WANG Y., GUO S. 2022 - Impacts of droughts on agricultural and ecological systems based on integrated model in shallow groundwater area, Science of The Total Environment, Volume 851, Part 2, Elsevier, China.