

RESISTANCE OF *LUNARIA REDIVIVA* TO ABIOTIC ENVIRONMENTAL FACTORS

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Abstract

The genus *Lunaria* L. belongs to the Brassicaceae family and is of interest to humans due to its numerous properties. This study aimed to investigate *Lunaria rediviva*'s tolerance to high temperatures, low positive temperatures, and soil salinity by germination of the seeds. To achieve this goal, the following objectives were established: assess the high-temperature tolerance, low-temperature tolerance, and salt tolerance of *Lunaria rediviva* by measuring the percentage of germinated seeds under these conditions. Seeds were germinated in the Petri dishes. Six different concentrations of the salt were used. A seed was considered germinated if it produced a root. This species is not tolerant of high temperatures for germination. The tolerance to the low positive temperatures is at a medium level. A salt concentration of 2% totally blocked germination. A low salt concentration (up to 0.5% of salt) does not significantly influence the germination of the seeds. At a 1% salt concentration, seed germination was very low. Overall, the salt tolerance of *Lunaria rediviva* is moderate.

Keywords: germination, high temperature tolerance, low temperature tolerance, *Lunaria rediviva*, salt tolerance

1. INTRODUCTION

Nowadays, the issues surrounding climate change are critical and urgent. The rise in global temperatures has a profound impact on the growth and health of plants and animals, particularly on valuable crops that are essential to humans. Many agricultural regions worldwide, including those in Europe, are experiencing the effects of temperature changes. Conditions have shifted significantly in many areas. Spring temperatures are rising rapidly, and rainfall and snowfall are decreasing. As a result, plants may experience unsuitable conditions at the beginning of their life cycle, particularly during seed germination. Therefore, we require additional information about germination under various abiotic conditions.

The second significant aspect of modern agriculture, which is also linked to rising temperatures, is the increase in soil salinity. As water availability decreases and evaporation rates increase, the concentration of salts in the soil rises faster than before.

Plant development begins with seed germination. Therefore, if seeds cannot germinate, we will never have plants in our fields. Investigating the germination process under various conditions helps us better understand which crops will be more effective and fruitful in specific regions.

Besides high temperatures, the seeds in the spring can also be influenced by low temperatures. That is why investigating the tolerance to low temperature during germination is also vital for understanding crops and their requirements for environmental factors.

The genus *Lunaria* L. belongs to the *Brassicaceae* family and is of interest to humans due to its numerous properties. Recently, interest in this genus has increased (Petrović Jovana et al., 2025; De Nicola, 2024; Stanković Jelena S. Katanić et al., 2022). However, scientists mainly investigate the annual species of this genus, *Lunaria annua* L.

Plants from the *Lunaria* genus (both annual and perennial species) are ornamental and suitable for semi-shaded to shaded areas. Due to their early spring blooming, these flowers are among the first ornamental plants to appear.

The genus *Lunaria* consists of two species: annual (*Lunaria annua*) and perennial (*Lunaria rediviva*). At Zaporizhzhia National University, we work with both species (Boika, 2016; Boika, 2018) and have obtained interspecific hybrids between them (Boika & Lyakh, 2017a).



Figure 1. Overall look and flowers of Lunaria rediviva (author's photo)

Lunaria rediviva is a perennial plant that can grow up to 100 cm tall (Fig. 1).

The stems are straight and branched at the top, covered with small hairs. The upper leaves are slightly elongated, narrow, and arranged alternately, almost sessile. The lower leaves have long petioles and are oppositely arranged, heart-shaped, and serrated. The flowers are purple, white, or violet, fragrant, and measure up to 4 cm in diameter, gathered in a panicle inflorescence. The fruits are large, reaching up to 5 cm in length, oval-lanceolate pods that are pointed at both ends, and they ripen in August. It has been cultivated since 1597.

The seeds of the *Lunaria* genus contain a high amount of oil (30–35%) that consists mainly of long-chain fatty acids, of which erucic acid (up to 44%) and nervonic acid (nearly 23%) are dominant. They both are used as industrial lubricants, but nervonic acid also has pharmaceutical value since it is used to produce a drug against multiple sclerosis, Alzheimer's disease, and many other diseases of the nervous system. So, this is a valuable medicinal plant.

According to our investigations (Boika, 2016), the content of fatty acids in the seeds of *L. rediviva* is higher than in *L. annuella*; therefore, growing the perennial species is more effective in extracting more valuable acids. However, the harvest can only be yielded in the second year of planting. This study aimed to investigate *Lunaria rediviva*'s tolerance to high temperatures, low positive temperatures, and soil salinity. To achieve this goal, we established the following objectives: assess the high-temperature tolerance, low-temperature tolerance, and salt tolerance of *Lunaria rediviva* by measuring the percentage of germinated seeds under these conditions.

2. MATERIALS AND METHODS

For the investigation, the seeds of *Lunaria rediviva* L. were chosen (Fig. 2). The seeds were collected at the research plots of the Department of Genetics and Plant Resources of Zaporizhzhia National University (Zaporizhzhia, Ukraine).



Figure 2. Pods and seeds of *Lunaria rediviva* (author's photo)

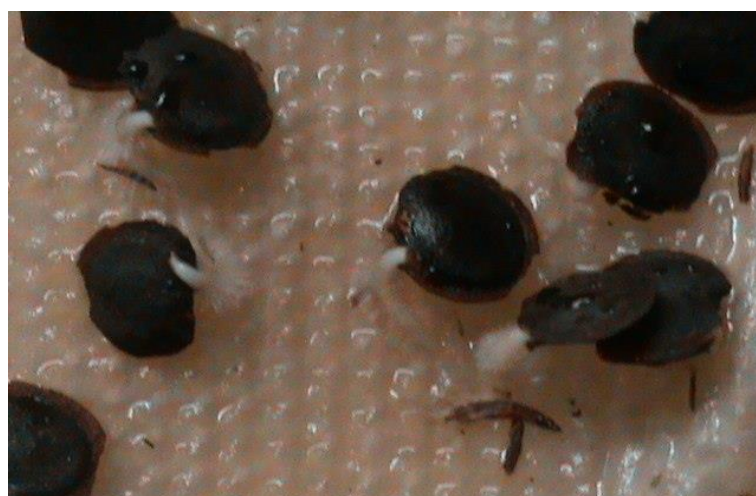


Figure 3. Germinated seeds (author's photo)

Seeds were germinated in the Petri dishes at +40 °C to investigate their tolerance to high temperatures. Seeds were also germinated in the Petri dishes at +4 °C to assess their tolerance to low positive temperatures. To investigate salt tolerance, seeds were germinated in the Petri dishes at various concentrations of NaCl: 0.06%, 0.125%, 0.25%, 0.5%, 1%, and 2%. For the control, the seeds were germinated under standard room conditions (+24- 25 °C). The experiments were conducted in triplicate. A seed was considered germinated if it produced a root (Fig. 3). The data were statistically processed.

3. RESULTS AND DISCUSSIONS

The results of the investigation of the germination of the seeds under different temperature conditions are presented in Table 1. As shown in the table, these plants exhibit excellent germination under standard room conditions (100%). These results are similar to our previous investigations (Boika & Lyakh, 2017b).

Most studies of high temperature tolerance are about vegetation (different stages) (Yu *et al.*, 2024). However, the development of any plant begins with germination, and without germination, no plant can grow. Therefore, the investigation of high temperature tolerance should begin from the start, with the germination of the seeds.

In natural conditions, *Lunaria rediviva* grows in the temperate climate zone, so it is not significantly affected by high temperatures, especially during the early stages of development. That's why the tolerance to high temperatures during germination is very low (only 6% of seeds germinated). On the other hand, in spring, it is possible to have a low positive temperature in the temperate climate zone. This species showed a moderate level of tolerance to the low positive temperatures during its germination. Less than 50% of the seeds germinated. However, this level is sufficient for this species to survive in the exact area, characterised by low positive temperatures in the spring.

Table 1. Results of the germination of the seeds of *Lunaria rediviva* under different temperature conditions

Plant material	Percentage of germinated seeds under control conditions	Percentage of germinated seeds under high-temperature (+40) conditions	Percentage of germinated seeds under low-temperature (+4) conditions
<i>Lunaria rediviva</i>	100	6	40

Regarding salt tolerance, we have obtained interesting results. For the investigation, six different concentrations of the salt were chosen. It was essential not only to assess the level of salt tolerance but also to compare the dynamics of seed germination in *Lunaria rediviva* over time.

Under the conditions of different salt concentrations, the germination of the seeds of the *Lunaria rediviva* was not equal. Results are shown in Table 2.

Table 2. Results of the germination of the seeds of *Lunaria rediviva* under different salt conditions

Variant	Day 5, %	Day 10, %	Day 14, %
Control	60	93	97
0.06 % NaCl	12	92	92
0.125 % NaCl	12	89	89
0.25 % NaCl	0	47	85
0.5 % NaCl	0	24	84
1 % NaCl	0	12	25
2 % NaCl	0	0	0

It is clearly shown that a 2% concentration of the salt blocks germination, and by the end of the experiment (14 days), no seeds have germinated.

By day 5, only the lowest concentrations of the salt (0.06% and 0.125%) had germinated seeds. But the level of germination (12%) was lower than in the control (60%). Therefore, we can conclude that even the most minor concentrations of the salt affected the germination process. However, by day 10, the number of germinated seeds reaches the highest level of germination in this experiment (92% and 89%, respectively), and this level remains constant until the end of the investigation.

In the control variant, seed germination continued after day 10, and by the end of the experiment, the germination level reached 97%.

The seeds under the influence of the highest concentration of the salt (0.25%, 0.5% and 1%) start germinating only by day 10. On day 5, germinated seeds were absent. On day 10, all these concentrations have germinated seeds. However, the level of germination was different. Under the influence of 0.25%, it was the highest, 47%. 24% of germinated seeds were detected in the case of 0.5% salt concentration, and only 12% of seeds germinated when they were germinated at 1% salt concentration.

The salt concentrations of 0.25% and 0.5% resulted in 85% and 84% germination of seeds, respectively, by the end of the experiment. The differences between these results and the control are statistically significant. Under the influence of the salt, the level of germinated seeds decreases.

The lowest level of germinated seeds detected by the end of the experiment, which was only 25%, occurred under the 1% salt concentration. This result is also statistically significant; moreover, the differences are observed between all other variants of the experiment, including all other salt concentrations. That's why the effect of the 1% salt is the greatest.

4. CONCLUSIONS

Based on our results, we can draw some conclusions about the tolerance of *Lunaria rediviva* plants. This species does not tolerate high temperatures during germination. The tolerance to low positive temperatures is at a medium level. A salt concentration of 2% completely inhibited germination. A low salt concentration (up to 0.5% salt) does not significantly affect the germination of the seeds. At a 1% salt concentration, seed germination was the lowest. Overall, the salt tolerance of *Lunaria rediviva* is moderate.

6. REFERENCES

- Boika, O. (2016). Inheritance and variability of qualitative and quantitative traits of plants of the genus *Lunaria* L. PhD thesis. Odessa: Plant Breeding and Genetics Institute – National Center of Seed and Cultivar Investigation.
- Boika, O. (2018) *Lunaria* a new and perspective horticulture species. *International Scientific Symposium «Current Trends in Natural Sciences» : Book of Abstracts (Pitesti, April 19-21, 2018)*. Pitesti: Pitesti. C. 48.
- Boika, O., Lyakh, V. (2017a) Interspecific hybrids of honesty and inheritance of some qualitative and quantitative traits. *2nd International Balkan agriculture congress (16-18 may 2017, Tekirdag, Turkey)*. Tekirdag. C. 255.
- Boika, O., Lyakh, V. (2017b). Seed germination of *Lunaria* genus depending on the year of collection and level of pod maturity. *Cruciferae Newsletter*. № 36. C. 5-7.
- De Nicola, G.R., Montaut, S., Leclair, K., Garrioux, J., Guillot, X., Rollin, P. (2024) Cultivated Winter-Type *Lunaria annua* L. Seed: Deciphering the Glucosinolate Profile Integrating HPLC, LC-MS and GC-MS Analyses, and Determination of Fatty Acid Composition. *Molecules*, 29, 3803. <https://doi.org/10.3390/molecules29163803>
- Petrović Jovana et al. (2025) Exploring the potential of underrated yet versatile crop *Lunaria annua* L.: New insights into honesty plant. *Heliyon* 11 e42248 <https://doi.org/10.1016/j.heliyon.2025.e42248>
- Stanković, Jelena S. Katanić et. al (2022) The qualitative composition and comparative biological potential of *Lunaria annua*. (*Brassicaceae*) extracts. *Kragujevac J. Sci.* 44 75–89. doi: 10.5937/KgJSci2244075K
- Yu, J., Du, T., Zhang, P., Ma, Z., Chen, X., Cao, J., Li, H., Li, T., Zhu, Y., Xu, F., et al. (2024) Impacts of High Temperatures on the Growth and Development of Rice and Measures for Heat Tolerance Regulation: A Review. *Agronomy*, 14, 2811. <https://doi.org/10.3390/agronomy14122811>
- Zhang et al. (2025) Unveiling tolerance mechanisms in pepper to combined low-temperature and low-light stress: a physiological and transcriptomic approach *BMC Plant Biology*, 25:171 <https://doi.org/10.1186/s12870-025-06169-7>