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The Quality and Germination Rate of Seeds Obtained From Garden Cress Grown Under Water Stress

Okan Erken[1]✉

[1] Çanakkale Onsekiz Mart University, Faculty of Agriculture, Department of Agricultural Structures and Irrigation, 17020, Çanakkale, Türkiye, oerken@comu.edu.tr

✉ Corresponding Author: oerken@comu.edu.tr

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ABSTRACT

The objective of this study is to determine the sustainability of seeds obtained from plants subjected to water stress. For this reason, seed quality and germination rates were determined in the seeds obtained from the garden cress plant (Lepidium sativum L.) grown under water stress in both laboratory and greenhouse conditions. In the study, apart from the seeds obtained from the 100% irrigated control plants, seeds from the garden cress irrigated with 50% and 25% water were used. The 1000-grain weight of the garden cress seeds, an indicator of seed quality, varied between 1.975-2.227 g in greenhouse conditions and between 2.121-2.248 g in laboratory conditions, where the changes in both conditions were statistically significant. The germination rates of the garden cress seeds grown under different water stress levels were found to be between 97-99% in greenhouse conditions. It was determined that in laboratory conditions all test subjects had a 100% germination rate. As a result, it was concluded that the seeds obtained from the garden cress plant, which was exposed to water stress during their growing period, continued their vitality despite water stress.

INTRODUCTION

Drought, which has been increasing with rising temperature levels as a result of global warming in recent years, is one of the most important factors affecting plant growth. Rising temperature levels and decreasing precipitation create more stress and risk in food security, especially in tropical and subtropical regions (Erken, 2022). In addition, groundwater pollution caused by nitrate leakage as a result of excessive irrigation is an issue that should be considered in terms of sustainable water management practices (Erken & Yıldırım, 2019).

According to Çırak & Esendal (2006), the optimum demands of the plants must be met for an efficient cultivation. The first stage of cultivation in plant production is the germination of seeds. Adverse ecological conditions, technical errors and problems arising from the structure of the seed at this stage,

however, may adversely affect the germination of seeds and seedling emergence (Karakurt et al., 2010).

The garden cress plant (*Lepidium sativum* L.) is one of the annual herbaceous plants grown in the winter season belonging to the Brassicaceae family. This herb has medicinal properties with its antiscorbutic, depurative and stimulating effects. It also is known that the garden cress plant is used against insect bites and as an insect-repellent when sprayed (Kumari & Patel, 2013). Another feature of the garden cress is that it can grow under any climate and soil characteristics (Wadhwa et al., 2012).

Plants, however, can be exposed to adverse conditions starting from the seed, which is the initial stage of development. In this case, both the germination and development of the seed are affected. For this purpose, in order to determine the reproducibility of the garden cress seeds, germination tests were carried out on seeds obtained from plants under water stress. This research was carried out on seeds obtained from the garden cress plants grown in greenhouse and laboratory conditions under water stress.

MATERIAL AND METHODS

This research was carried out in Çanakkale Onsekiz Mart University, Faculty of Agriculture, Department of Agricultural Structures and Irrigation, Plant Stress Monitoring and Thermography Laboratory in 2022. In obtaining the cress seeds, which are the subject of the research, two different water restrictions (50% irrigation, 25% irrigation) were applied besides the control (full irrigation) plants. The experiment was carried out in 8 replications using 10-liter pots. The water restrictions were applied in controlled conditions (at 25°C under 14 hours ~ 54 µE light and 10 hours of dark, and 55-60% relative humidity (Al-Sammarraie et al., 2020). After the flower stalk began to form in the water-stressed garden cress plant, water restriction continued in two different locations. Water restriction was continued until the seeds matured, both in a controlled laboratory condition and in a plastic-covered greenhouse, by dividing the 8 pots used in the research into two, in 4 replications.

After the garden cress seeds matured, the number of branches (pieces), branch length (cm), capsule length (cm) and 1000-grain weight (g) were determined. After some morphological features of the plants were determined, the seeds were collected from the middle of the capsules and preserved for germination tests. In addition, the collected seeds were counted with 100x4 replications. At the end of this counting, 1000-grain weights (g) of the seeds were calculated. In the obtained cress seeds, 50 seeds were taken into germination tests with 3 replications in each subject. All germination tests were performed in petri dishes with a diameter of 10 cm. Filter paper was placed in petri dishes and 50 seeds were placed in such a way that they did not come into contact with each other for each application. Seeds with a radicle length of 2 mm were counted as germinated at the same time every day. At the end of the experiment, the germination percentage and average germination times were measured.

The germination percentage was calculated as (%) according to Bewley & Black (1994).

Germination percentage was calculated using the following equation (1):

$$GP(\%) = \left(\frac{\sum n_i}{N}\right) \times 100 \quad (1)$$

where GP is the germination percentage (%), n_i is the time of germination (day), N is the total number of seeds put in the test.

Average germination time was calculated using the following equation (2):

$$MGT(days) = \frac{\sum(t_i \times n_i)}{\sum n_i} \quad (2)$$

where MGT is the mean germination time (days), t_i is the time elapsed since the beginning of the test (days), n_i is the number of germinated seeds each day $t(i)$.

Germination trials continued until the end of the 4th day. At the end of the experiment, the hypocotyl length (from root collar to cotyledon leaves) and radicle length (from root collar to root tip) were measured with a digital caliper by selecting plants whose seed coats were separated.

Table 1. Some morphological data from the harvested seeds

Treatment	Number of Branches (piece)	Branch Length (cm)	Capsule Size (cm)	1000 Seed Weight (g)
Green House 100% irrigation	9.75 ± 0.50 Ba	52.00 ± 2.94 Aa	22.00 ± 1.63 Ba	1.975 ± 0.12 Bb
Green House 50% irrigation	8.25 ± 0.50 Bb	42.75 ± 2.22 Ab	14.75 ± 0.96 Bb	2.086 ± 0.01 Bb
Green House 25% irrigation	4.50 ± 0.58 Bc	22.00 ± 1.63 Ac	8.75 ± 0.96 Bc	2.227 ± 0.07 Ba
Lab 100% irrigation	11.00 ± 1.16 Aa	49.50 ± 1.92 Aa	24.50 ± 2.52 Aa	2.198 ± 0.02 Ab
Lab 50% irrigation	9.25 ± 0.98 Ab	44.00 ± 2.83 Ab	16.00 ± 1.63 Ab	2.121 ± 0.06 Ab
Lab 25% irrigation	5.00 ± 0.82 Ac	20.00 ± 1.63 Ac	9.50 ± 1.00 Ac	2.248 ± 0.04 Aa
	*p=0.011	*p=0.255	*p=0.030	*p=0.003
	**p= 0.000	**p= 0.000	**p= 0.000	**p= 0.000

Note: *The large letters show the statistical differences ($p<0.05$) between greenhouse and laboratory conditions. **The small letters show the statistical differences ($p<0.05$) between different water treatments.

Table 2. Germination test results

Treatment	Germination Percentage (%)	Average Germination Time (day)	Hypocotyl Length (mm)	Radicle Length (mm)
Green House 100% irrigation	98.5±1.00Ba	3	39.52±1.67B	11.92±0.15ns
Green House 50% irrigation	87.5±6.61Bb	3	33.37±1.64B	11.26±0.47ns
Green House 25% irrigation	97.5±2.52Ba	3	37.61±5.02B	9.82±1.59ns
Lab 100% irrigation	100.0±0.00A	3	41.57±0.54A	12.08±0.15ns
Lab 50% irrigation	99.0±1.16A	3	42.62±4.62A	11.36±0.66ns
Lab 25% irrigation	99.0±1.16A	3	40.24±3.58A	10.91±0.39ns
	*p=0.001	ns	*p=0.009	*p=0.382
	**p=0.200	ns	**p=0.268	**p=0.270

Note: *The large letters show the statistical differences ($p<0.05$) between greenhouse and laboratory conditions. **The small letters show the statistical differences ($p<0.05$) between different water treatments.

Statistical differences of the measured parameters among different irrigation levels of the cultivated Garden Cress plant were estimated using One-Way ANOVA the Tukey Multiple Comparison test, where p-value of <0.05 was considered to be statistically significant. Minitab 19 was used as a software for the statistical analysis.

RESULTS AND DISCUSSION

The number of branches (pieces) and length (cm), capsule length (cm) and 1000-grain weight values obtained at the end of the research are given in Table 1. The highest number of branches in the garden cress grown in greenhouse and laboratory conditions were obtained from 100% control plants grown in the laboratory. When the plants measured for seed yield both in the greenhouse and in the laboratory are evaluated together, it is seen in Table 1 that the number of branches, the length of the branches and the length of the capsules statistically significantly decreased with reduced amount of irrigation water. According to the results of the experiments carried out under greenhouse conditions, the 1000-grain weights were determined as 1.975 in the control treatment, while the highest 1000-grain weight was obtained from the 25% irrigation treatment under heavy stress. Seeds grown under completely controlled conditions were determined at similar weights (2.198; 2.121; 2.248 g) in each trial (Table 1). It has been reported that 1000 grain weight of garden cress plant is between 1.6 – 2.0g (Anonymous, 2022). Compared with the results of the study, it was determined that the 1000-grain weight of the seeds obtained from the water-stressed cress plant was higher.

Germination tests were carried out on the garden cress seeds obtained at the end of the trials carried out in two different locations. The germination rates (%), average germination day and hypocotyl and radicle lengths after germination are given in Table 2. The germination power of cress seeds grown by applying water stress under controlled conditions was determined as 100%. The germination rate of cress seeds grown in greenhouse conditions under water stress varied between 97-99%. These differences were found to be statistically insignificant. Germination rate of garden cress exposed to water stress in both conditions were found to be over 95% and it was determined that water stress had no statistically significant effect on seed viability. Tang et al. (2010), applied different amounts of water stress to the seeds of *Lepidium perfoliatum* L. from the Brassicaceae family. According to the results of the study, it was stated that the germination rate of the seeds decreased significantly when they were exposed to water stress during the germination stage. However, when we look at the results of our study, it is seen that the viability and germination rates of cress seeds grown by applying water stress did not decrease significantly.

After germination started in petri dishes, garden cress seeds reached the maximum germination rate in 3 days (Table 2). Compared to other plants, the germination time of broccoli, which is in the same family as cress, is 10 days (Akyurt et al., 2011), and in another study it was stated that white cabbage (*Brassica oleracea* L. var. capitata cv. Bafra), black sea kale (*Brassica oleracea* L. var. acephala cv.), red cabbage (*Brassica oleracea* L. var. rubra cv. Möhrenkopf), Savoy cabbage (*Brassica oleracea* L. sabauda cv. Chieftain) seed germination times lasted 10 days (Ayhan & Ugur, 2011).

At the end of the germination tests, garden cress shoots separated from the seed coat were measured. When the hypocotyl lengths of garden cress seeds obtained by applying water stress in laboratory conditions were examined (Table 2), results were close to each other. The hypocotyl lengths of the seeds grown in greenhouse conditions after germination varied between 33.37-39.52 mm. Similar results were obtained with radicle lengths varying between 9.82 and 12.08 mm in cress seeds grown both in greenhouse and in vitro. Barış & Ünal (2021), in their study on broccoli, determined the hypocotyl and radicle lengths as approximately 75 and 45 mm, respectively. Post-germination measurements were carried out at the end of 9 days. In our study, the measurements were carried out on the 4th day after sowing, since full germination was completed in 3 days. The difference between the two studies is thought to be due to the measured day.

CONCLUSION

In this study, the viability and germination rates of seeds obtained from garden cress plant (*Lepidium sativum* L.) that were subjected to water stress at two different levels (50%, 25% irrigation) were determined. In previous studies, there are trials in which different levels of water stress are applied in both growing and seed stages. With these studies, it is stated by many researchers that yield and quality decrease with water stress in general. However, there are not many studies

examining the quality of seeds with the aim of maintaining plant production by applying water stress. Therefore, this study presented results on whether the viability of seeds obtained from plants exposed to water stress continued. According to these results, it was determined that the germination rate and strength of garden cress seeds exposed to adverse conditions in terms of water restriction were not affected by these conditions.

Compliance with Ethical Standards

Conflict of Interest

The author declares that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

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