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Determination of the effect of drought stress on fresh and dried seedling weight of buckwheat (*Fagopyrum esculentum*)

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ABSTRACT

Fagopyrum esculentum (Buckwheat) plant, which belongs to the Polygonaceae family, is one of the important medicinal plants. Buckwheat plant, like many plants, is affected by drought, which is one of the ecological factors that occurs as a result of climate change. In this research, the effects of drought stress on fresh and dry seedling weight of buckwheat plant were discussed. The experiment was established in 2023 at Düzce University Faculty of Agriculture Department of Field Crops Laboratories, according to the completely randomized design, with three replications. Four different concentrations of polyethylene glycol were applied to buckwheat seeds to measure their response to drought stress, and the data obtained were compared according to the control factor. In the experiment, a statistically significant difference was observed between the average seedling fresh and dry weight. According to the results, it was observed that the fresh and dry seedling weights of buckwheat plant were affected by drought. Seedling fresh and dry weight decreased as stress increased; It was observed that the highest fresh and dry seedling weight occurred in the control factor and the lowest fresh and dry seedling weight occurred in the germination medium containing 60 mg/l PEG.

Kuraklık stresinin karabuğday (*Fagopyrum esculentum*) yaş ve kuru fide ağırlığı üzerine etkisinin belirlenmesi

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ÖZET

Polygonaceae familyasına ait olan *Fagopyrum esculentum* (Karabuğday) bitkisi önemli tıbbi bitkilerden birisidir. Karabuğday bitkisi de birçok bitki gibi iklim değişikliği sonucu meydana gelen ve ekolojik faktörlerden biri olan kuraklıktan etkilenmektedir. Bu araştırmada kuraklık stresinin karabuğday bitkisinin yaş ve kuru fide ağırlığı üzerine etkileri ele alınmıştır. Deneme 2023 yılında Düzce Üniversitesi Ziraat Fakültesi Tarla Bitkileri Bölümü Laboratuvarlarında, tesadüf parselleri deneme desenine göre üç tekerrürlü olarak kurulmuştur. Karabuğday tohumlarına kuraklık stresine tepkisini ölçmek için polyethylene glycol'un dört farklı konsantrasyonu uygulanmış olup elde edilen veriler kontrol faktörüne göre kıyaslanmıştır. Denemede fide yaş ağırlığı ve fide kuru ağırlığı ortalamaları arasında istatistiksel olarak önemli derecede farklılık görülmüştür. Sonuçlara göre karabuğday bitkisinin yaş ve kuru fide ağırlıklarının kuraklıktan etkilendiği gözlemlenmiştir. Fide yaş ve kuru ağırlığının stres arttıkça düştüğü; en fazla yaş ve kuru fide ağırlığının kontrol faktöründe ve en düşük yaş ve kuru fide ağırlığının 60 mg/l PEG içeren çimlendirme ortamında meydana geldiği görülmüştür.

1. Introduction

Medicinal and aromatic plants have been used by humans for various health and cosmetic purposes for thousands of years. These plants generally have an important place due to their natural properties, pleasant scents and various health benefits. In addition, medicinal and aromatic plants are plants that contain various biochemical components

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and can provide positive effects on human health (Bakkalı et al., 2008; Meşe, 2019). Some medicinal plants are used as food supplements to contribute to daily nutrition. Additionally, many herbs used as spices add flavor to dishes and support digestion. Medicinal and aromatic plants play an important role in ecosystems. It increases plant diversity and maintains ecosystem balance through pollination by insects such as bees (Acıbuca & Bostan Budak, 2018). Buckwheat is one of the medicinal plants used both in medicine, food and beekeeping. Buckwheat (*Fagopyrum esculentum*) is an annual herbaceous plant species belonging to the Fagopyrum genus from the Polygonaceae family. Buckwheat belongs to the pseudo-cereal group, which has both similarities and differences with grains. The main structural difference is that buckwheat is a dicotyledonous plant. Additionally, this plant has the ability to develop rapidly at high altitudes. Common buckwheat (*Fagopyrum esculentum* Moench) and Tatar buckwheat (*Fagopyrum tartaricum* Gaerth) are the buckwheat species most commonly grown as a food source (Dizlek et al., 2009).

Buckwheat cultivation is affected by environmental factors, like the cultivation of other plants. Meteorological factors such as precipitation, temperature, wind, humidity, sunshine duration, and intensity have significant effects on agriculture (Öztürk et al., 2014). Among these factors, the one that has the largest impact is the drought factor. Drought causes serious social, environmental and economic damage. This phenomenon is defined as a natural phenomenon that causes land and water resources to be negatively affected and the hydrological balance to deteriorate as a result of precipitation falling significantly below normal levels. Large temporal and spatial changes in meteorological factors cause serious fluctuations in agricultural production. It is predicted that significant crop losses will occur due to climate change, global warming and drought disasters expected in the 21st century (Kapluhan, 2013; Yurgiden, 2019). Germination of the seed begins with the intake of water under suitable conditions. However, there are many factors in the soil that prevent the uptake of water by the seed, such as drought, salinity and low temperature. In drought stress, seeds cannot germinate because they cannot get enough water, or their germination period is prolonged (Şehirali, 1997; Ashraf et al., 2021). Plants exposed to drought stress experience less dry matter production, higher susceptibility to diseases and pests, lower product quality and reduced quantity (Monti,1987).

In this study, the effect of drought applied to the growing environments of buckwheat seeds on the fresh and dry weight of seedlings was examined.

2. Materials and Methods

The ''Güneş'' buckwheat variety registered by the Bahri Dağdaş International Agricultural Research Institute Directorate was used as plant material in the experiment. The research was conducted in 2023 in Düzce University Faculty of Agriculture, Department of Field Crops Laboratories, in three repetitions according to the randomized complete block design. To test the effect of drought stress on fresh and dry weights of buckwheat seedlings, control and four different polyethylene glycol (PEG 6000) concentrations (0, 15, 30, 45 and 60 g/L) were used. Distilled water was used as a control in the experiment. Seeds were randomly selected and sterilized before planting. In the sterilization process, the sterilization process was completed by keeping the seeds in 10% bleach for 10 minutes and then washing them with distilled water 3 times (Jabeen & Ahmad, 2012). Germination experiments were conducted in a completely dark incubator at 20±1°C between petri dishes and blotting paper, with 3 replications and 20 seeds in each replication. Every two days, the papers were changed and 10 ml of solution was

added again and the germination of the seeds was monitored. In addition, the development of the seeds was monitored every day, and seeds with a radicle length of 2 mm were considered germinated. Germination trials were continued for 14 days, which is the last counting day for buckwheat according to ISTA (2018). Then, to obtain data on seedling fresh weight, the weight of ten randomly selected seedlings on the 14th day from each repetition was weighed on a 0.001 g precision scale and calculated as mg/plant by proportioning. Also, after determining the fresh weight of 10 randomly selected seedlings from each replicate, the dry weight of the seedlings dried in the oven at 70 °C for 48 hours was weighed on a precision scale and determined as mg/plant. At the end of the experiment, variance analysis of the data obtained for the examined features was carried out according to the random parcel design and in 3 repetitions, with the SPSS package program, and the LSD test was used to determine the significance levels of the differences between the applications.

3. Results and Discussion

3.1. Seedling fresh weight (mg/plant)

In the experiment, the fresh weight of ten randomly selected seedlings from each repetition on the 14th day was weighed on a 0.001 g precision scale and the variance analysis results of the data calculated as mg/plant are given in table 1. According to Table 1, there was a statistically significant difference in seedling fresh weights between PEG doses. According to Table 2, it was observed that the control factor was the heaviest and the other factors were in the lightest group in terms of seedling fresh weight. In the experiment, the highest seedling fresh weights were observed in the control factor seedlings, with an average of 1118.00 mg/plant. Additionally, the lowest seedling dry weight was observed as 415.66 mg/plant in media containing 60 mg/l PEG.

Table 1. Variance analysis of data obtained from different PEG doses used to determine *Fagopyrum esculentum* plant seedling fresh weight

S.O.V	df	Seedling Fresh Weight (mg/plant)	
		MS	F
General	14	-	-
PEG	4	253817.567	60.105**
Error	10	4222.933	-
			C.V%=10.81

**: It is important at the level p<0.01.

Table 2. Effects of different PEG doses used to determine *Fagopyrum esculentum* plant fresh weight

PEG (g/L)	Seedling Fresh Weight (mg/plant)**
Control	1118.00 a
15	506.00 b
30	473.00 b
45	494.33 b
60	415.66 b

** Letters in the same column indicate different groups according to the LSD test at the 0.01 level.

In the study conducted by Bilgili (2016) using different doses of PEG 6000 on some bread wheat varieties; It was determined that the seedling fresh weight decreased significantly. Kahraman (2018), explained that examined amaranth seeds in terms of dry weight and allowed them to germinate under drought stress conditions, and as a result, the highest fresh weight was observed in the lowest PEG (0% PEG 6000) application,

while the lowest fresh weight was observed in the highest PEG (10% 6000 PEG) application. (Akyürek, 2020; Nazirzadeh, 2018) reported that drought testing on exotic vegetable species resulted in a decrease in seedling fresh weights.
It was observed that the data obtained in the experiment were in line with the literature discussed above.

3.2 Seedling dry weight (mg/plant)

After determining the fresh weight of 10 seedlings randomly selected from each replicate in the experiment, the samples were dried in the oven at 70 ^{o}C for 48 hours and weighed on a precision scale, and the variance analysis results of the obtained data are given in table 3. According to Table 3, there was a statistically significant difference in seedling dry weights between PEG doses. According to Table 4, it was seen that the control factor was the heaviest and the other factors were in the lightest group in terms of seedling dry weight. In the experiment, the highest seedling dry weights were observed in the control factor seedlings, with an average of 878.00 mg/plant. Additionally, the lowest seedling dry weight was observed as 322.00 mg/plant in media containing 60 mg/l PEG.

Table 3. Variance analysis of data obtained from different PEG doses used to determine *Fagopyrum esculentum* plant dry weights

S.O.V	df	Seedling Dry Weight (mg/plant)	
		MS	F
General	14	-	-
PEG	4	159343.600	79.744**
Error	10	1998.200	-
			C.V%= 9.54

**: It is important at the level p<0.01.

Table 4. Effects of different PEG doses used to determine *Fagopyrum esculentum* plant dry weights

PEG (g/L)	Seedling Dry Weight (mg/plant)**
Control	878.00 a
15	397.33 b
30	365.33 b
45	381.33 b
60	322.00 b

** Letters in the same column indicate different groups according to the LSD test at the 0.01 level.

In the study conducted by (Bilgili, 2016; Harmancı, 2020) using different doses of PEG 6000 on some bread wheat varieties; It was determined that the seedling dry weight decreased significantly. Akyürek (2020) observed that the seedling dry weight in some plant species he examined decreased against increasing drought.

4. Conclusion

Medicinal and aromatic plants have been used by humans for thousands of years and are produced for various health and cosmetic purposes. Medicinal and aromatic plants, like other plants, can be affected by environmental factors and vary in yield and active ingredient amounts. Among the environmental factors, drought is the factor that affects plant development the most. Drought causes serious social, environmental and economic damage. In order to prevent these damages, the effect of drought on plant growth, especially the effect of drought on the seed germination stage, should be thoroughly examined. In this study, it was observed that the control factor was the heaviest and the

other factors were the lightest in terms of seedling wet weight. It was observed that the control factor was the heaviest and the other factors were the lightest in terms of seedling dry weight. As can be seen, drought has an effect on fresh and dry seedling weights, which are buckwheat seed germination characteristics. It has been observed that the germination characteristics of this plant may show different reactions if grown in arid ecological conditions. As a result, it has been observed that the buckwheat plant, which is sensitive to drought, will be sensitive to different levels of drought during the seedling development period. It is recommended that the results obtained be used in buckwheat cultivation and breeding studies.

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Author Contribution

The authors' contributions to the study are equal.

Conflict of Interest Declaration

There is no conflict of interest.

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