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- *RESEARCH ARTICLE*-

Some abiotic stress on growth and lipid peroxidation on wheat seedlings

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Abstract

The structure of the soil deteriorates with the changing world structure and increases the stress factors for plants. Water stress causes many morphological, physiological and biochemical changes in plants; however, it causes a decrease in photosynthesis and chlorophyll content. Drought stress affects the development of the organs of the plant such as stem, shoot and leaf area, and reduces the fresh and dry biomass of the leaves. It is important to determine malondialdehyde (MDA) value, which is an indicator of oxidative stress in plants exposed to abiotic stress, and the relationship of proteins with stress tolerance. In our study, 2 different varieties (Dağdaş and Doğankent) belonging to the *Triticum aestivum* L. species were used. By forming 4 different groups of this wheat (1st group; control – 2nd group; flooding – 3rd group; drought – 4th group; salinity). At the end of the 12th day, the plants were harvested. Compared to the control group of both wheat varieties, it was observed that the development of stress factors adversely affected shoot length, shoot dry weight in groups under stress. With the effect of abiotic stresses, a decrease occurred in chlorophyll a, chlorophyll b and total chlorophyll levels; however, it was observed that chlorophyll values of Dağdaş varieties decreased more than Doğankent and this decrease was mostly at salinity stress. Additionally, MDA accumulation was mostly in drought group of Doğankent seedlings and salinity group of Dağdaş seedlings. As a result; It can be stated that Dağdaş variety is resistant to drought and salinity stress and Doğankent seedlings are more resistant to drought stress.

Keywords:
Drought, salinity, flooding, chlorophyll, MDA
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Introduction

Turkey is a country rich in plant diversity due to location, allowing many plant species to grow in different seasons of the year. It is also one of the most important gene centres where wheat was

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first grown. For this reason, it has the local wheat richness, durability and diversity that can be used in wheat breeding studies. (Akçura, 2006).

Plants are frequently exposed to abiotic stresses such as salinity, drought, waterlogging, low and high temperatures, UV radiation, nutrient deficiency and metal toxicity (Hasanuzzaman et al., 2019).

Abiotic stress is the primary cause of product loss in the world. Water is the main abiotic factors that shape vegetative evolution. Environmental stresses such as drought, salinity, high and low temperatures cause negative effects on plant growth and economic conditions. Drought stress leads to an osmotic flow of water from plant cells. This situation increases the high solute concentration in the plant cells, causing low water potential entry through the membranes and cell structure is disrupted, causing the most important events such as photosynthesis to be negatively affected (Sayyaril et al., 2013).

Plants that are under stress can survive by reacting in different ways in some cases. Some of them use the mechanism of avoidance by removing the inside of the cell from this environment despite the stress conditions in the external environment. Tolerance is getting rid of the plant's stress environment by plants' creating biochemical, hormonal responses and genetic conditions against stress. Abiotic stress types such as high temperature, drought, salinity, and oxidative stress seriously threaten agricultural areas (Yıldız and Terzi, 2007).

Water is the source of life for all living things. Its deficiency and excess can seriously damage metabolism. If the plants are exposed to excessive flooding, an anaerobic environment is formed at the roots (Hossain et al., 2011). Oxygen deficiency significantly affects the uptake of atmospheric gases necessary for respiration and photosynthesis in plants, and Interruption of the TCA cycle causes oxidative phosphorylation (Sairam et al., 2008). Water stress can result in photoinhibition, which causes irreversible inactivation of the photosynthesis mechanism. Water stress causes a kind of oxidative stress at the cellular level, which increases the production of reactive oxygen species (ROS) such as superoxide radicals, hydrogen peroxide and hydroxyl radicals (Lotfi et al., 2015).

Drought and salinity stress that significantly restrict plant growth and sustainable agricultural development (Zhang et al., 2020). Drought significantly affects the increase in reactive oxygen species (ROS), including superoxide (O^{2-}), hydroxyl radical (OH^-) and hydrogen peroxide (H_2O_2), which can attack lipids. Drought stress causes damage to plants' chlorophyll structure and photosynthetic components, causing photosynthesis damage. It inhibits photochemical activities and reduces the activity of enzymes in the Calvin cycle in photosynthesis (Hosseini et al., 2015).

Salinity is one of the major problems of the world's soils. Salinity is rising of soluble salts mixed with groundwater to the surface of the soil and accumulation of water on the surface of the soil as a result of evaporation in arid and semi-arid climate regions (Ergene, 1982; Kwiatkowski and King, 1998). As salt stress can directly kill the plant, it affects metabolic activities, limiting many biological activities such as germination, cell division, growth, and development, depending on the salt concentration of the environment, exposure time to salinity, and salt tolerance of the plant. As the amount of salt increases, cleavage in chlorophylls, shrinkage in thylakoids and accretion in adjacent grana membranes are observed, and the operability of the electron transport system in thylakoids decreases significantly under salty conditions for this reason salinity causes a decrease in pigment quantities (chlorophyll a, chlorophyll b, chlorophyll a+b, and carotenoid) of plants (Şen and Aliakmanoğlu, 2011).

The average rainfall in our country has decreased significantly in recent years and our country has faced the danger of thirst. One of the most important threats to agriculture in the future is drought stress due to global warming. Today, the effects of drought stress are already being felt (Palta, 2009).

Therefore, in this study, salt, flood and drought stresses were applied to wheat seedlings and it was investigated how different varieties respond. It was observed that these answers differed according to various growth parameters, chlorophyll a, b and total chlorophyll values and changes in the amount of MDA. Considering these differences, it is aimed to cultivate which varieties in which areas and to increase the amount of product. Our study aims to know the structure of agricultural areas and to help to plant by choosing suitable wheat varieties to obtain more productive crops.

Material and methods

As plant material in our research (*Triticum aestivum* L. cv. Doğankent and Dağdaş) wheat seeds were used. Wheat seeds were provided from the Eastern Mediterranean Agricultural Research Institute.

Plant Growing Conditions

Plastic pots with a diameter of 20 cm were used in plant growing. These pots were filled with air-dry soil consisting of a mixture of raw soil, organic fertilizer N-P-K (18; 18; 18) and sand (2v / 2v / 1v). 150 seeds were planted in each pot without any pre-processing and covered with a layer of soil about 1 cm thick. Immediately after planting the seeds, all the pots were watered with 200 ml of distilled water and taken to the climate cabin. Plants were grown in the climate cabin at an average temperature of 24 ± 2 Co, the relative humidity of 66% and light conditions of an average of 1198 lux. Until the end of the sixth day, they were given 100 ml of water every two days under the same conditions. On the third day, the wheat began to germinate. Each of these trials has been applied jointly in different stress groups. After the sixth day, 4 different groups were formed as follows;

1. Normal Water Application (Control): The application of 100 ml of water every two days from the planting of seeds was continued until the twelfth day.

2. Flood: Planting was done in pots supported with waterproof nylon bags. At the end of the 6th day, it was irrigated with a continuous layer of water 1 cm above ground level. Until 12th day, the water layer was kept above the soil level.

3. Drought: Normal irrigation application was made until the 6^{th} day. After the sixth day, there was no irrigation until the 12^{th} day.

4. Salinity (0.7% NaCl): Plant soil in this group was mixed by adding 0.7% NaCl w / w. In order not to prevent seed germination due to the salt effect, a 1 cm thick salt-free soil layer was created on the surface and the seeds were planted on this soil. Irrigation was irrigated until the end of the 12th day as in normal water application.

Plant Growth Measurements

Each trial unit was conducted with 3 repetitions. Plants were harvested by removing it from pots at the end of the twelfth day. After harvesting, plant growth and chlorophyll measurements were carried out from fresh material. After harvest, shoot lengths were measured by selecting 3 samples each from control, salt, flood and drought groups.

Chlorophyll Analysis

The chlorophyll amounts were measured according to Porra et al. (1989).

MDA analysis

Determination of lipid peroxidation in plant tissues made according to Hodges et al. (1999).

Evaluation of Data

For statistical regression analysis, the related SPSS package program was used and the variance analysis was performed using the MacAnova program. Fisher's Least Significant test was used to compare the mean of threshold cycles (Ct) ($p<0.05$). The differences between the results were determined by the Duncan test according to the homogeneity between the variances.

Results and Discussion

In this study, wheat seedlings (*Triticum aestivum* L.cv. Dağdaş, Doğankent) were exposed to flood, drought and salt applications and differences between them were determined. Shoot length, dry weight, chlorophyll (a, b, total) amount and MDA content were examined in the wheat seedlings used in the experiments.

Effects of Abiotic Stresses on Plant Growth

In the study, both varieties, all three abiotic stress applications caused a decrease in shoot length ($p\geq0.01$) while the decrease in seedlings of Dağdaş cultivars was observed in the most salinity stress, the decrease in shoot length of seedlings of Doğankent cultivars was determined to be caused by the most drought stress (Figure 1).

The decrease in Doğankent and Dağdaş seedlings exposed to stress was statistically determined to decrease only due to stress varieties ($p\geq0.01$), while wheat varieties were statistically not significant in stress factors ($p \geq0.05$).

Kara and Kara (2009) stated that there were significant reductions in the shoot length and dry weight of seedlings exposed to salt application in wheat varieties.

Çulha and Çakırlar (2011) determined that salt stress is a decline in plant growth, especially in arid regions.

In our study, flood, drought and dry weight of Doğankent and Dağdaş seedlings shoots exposed to salt applications were determined to lead to reductions in dry weight. ($p\leq0.01$). The reduction in dry weight of flood-exposed seedlings was not significant compared to the control group, ($p\geq0.05$) in seedlings that were exposed to salinity, it has been seen that decrease in shoots dry weight was more than the flood exposed seedlings. It was observed that both seedlings exposed to drought stress caused a significant reduction in the dry weight of the stem according to the control (p≤0.01) (Figure 2).

Konak et al. (1998) observed reductions in shoot dry weight and shoot lengths in proportion to salt concentration in wheat variations. The results obtained in our study were in line with the findings of the researchers.

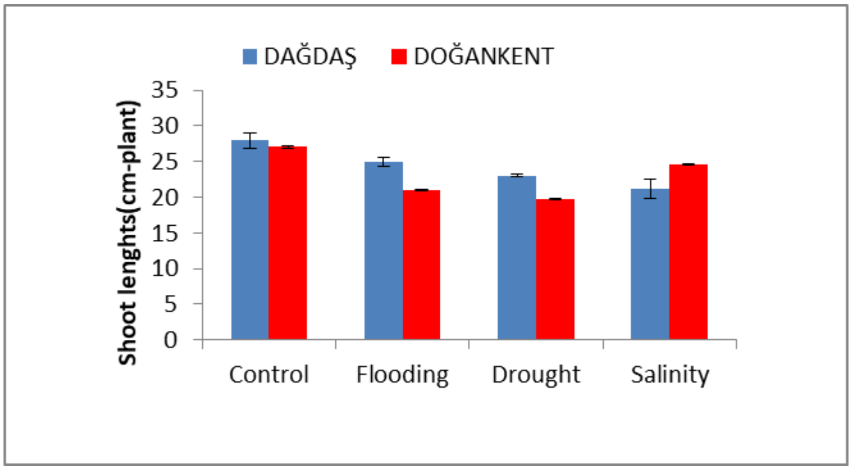

Figure 1. Changes in the heights of the average stem of wheat seedlings (*Triticum aestivum* cv. Dağdaş and Doğankent) (cm/plant) (n = 3)

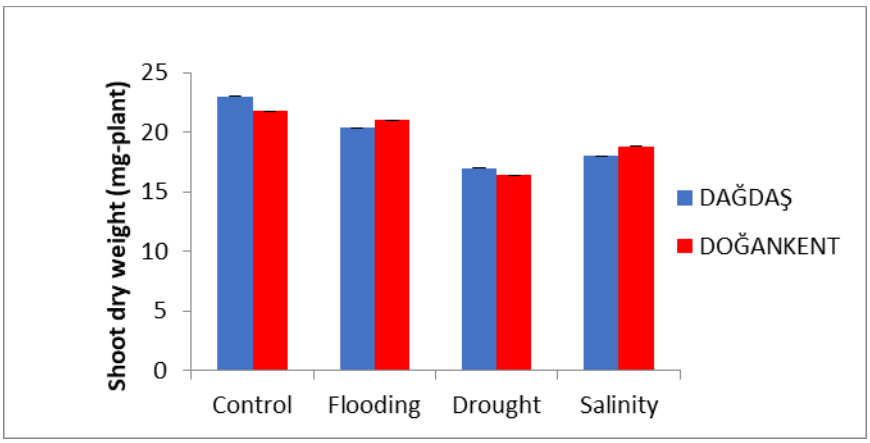

Figure 2. Changes in the average dry weight of stem in wheat seedlings (*Triticum aestivum* cv. Dağdaş and Doğankent) that grown under flood, drought, salt applications(mg/plant) (n=3)

Effects on Pigment Quantity

The amount of chlorophyll a in the Dağdaş seedlings exposed to flooding caused a 50% decrease according to the control. Drought stress caused a 25% decrease in seedlings (p≤0.01). The greatest reduction in the amount of chlorophyll a was observed in seedlings exposed to the salt application.

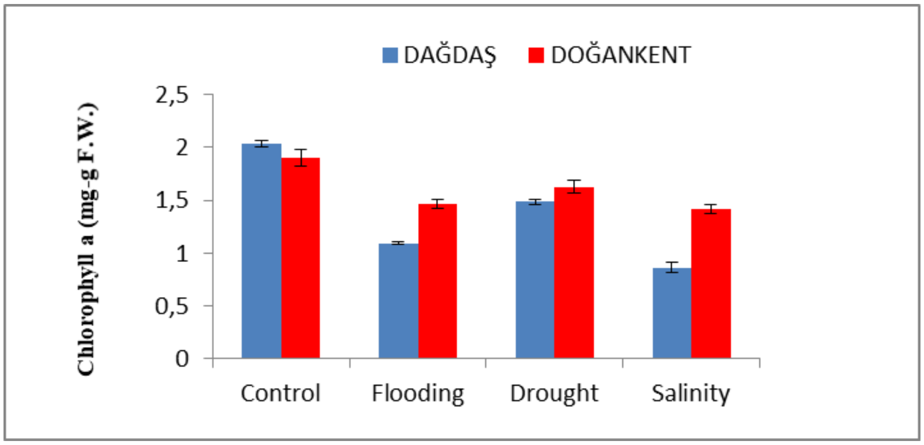

Figure 3. Changes in the total amounts of chlorophyll-a in wheat seedlings (*Triticum aestivum* cv. Dağdaş and Doğankent) that grown under flood, drought, salt applications (mg/plant) (n=3)

A decrease in chlorophyll a was observed in Doğankent seedlings according to control. Seedlings exposed to flooding and salinity were found to produce approximately (25%) reduction in chlorophyll a ($p \geq 0.01$), while the greatest decrease was observed in flood and salinity conditions ($p \geq 0.01$). It was statistically determined that abiotic stress caused changes in the amount of chlorophyll-a in wheat varieties (Figure 3).

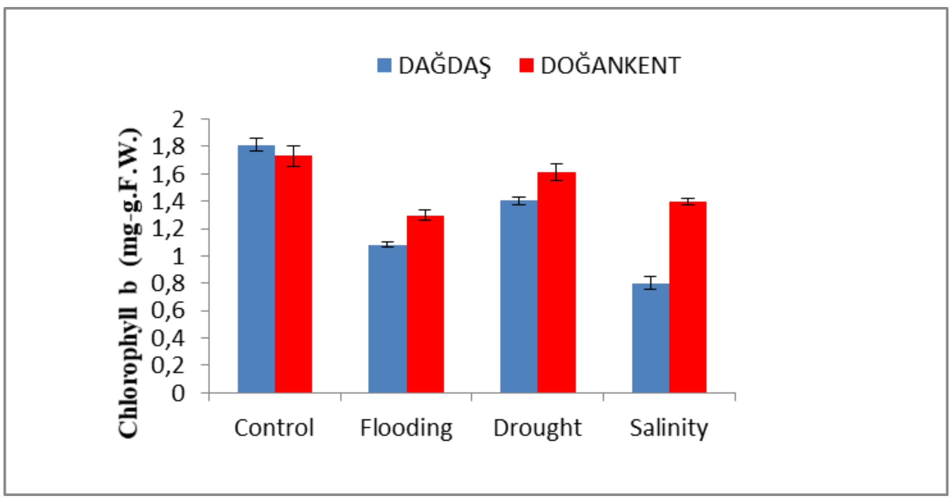

Figure 4. Changes in the total amounts of chlorophyll b in wheat seedlings (*Triticum aestivum* cv. Dağdaş and Doğankent) that grown under flood, drought, salt applications. (mg/plant) (n=3)

In our study, it was observed that the amount of chlorophyll b in Dağdaş seedlings decreased by 50% in flood stress. Drought stress caused a 25% decrease in wheat seedlings ($p \leq 0.01$). The greatest reduction in the amount of chlorophyll b has been observed in seedlings exposed to the salt application (Figure 4).

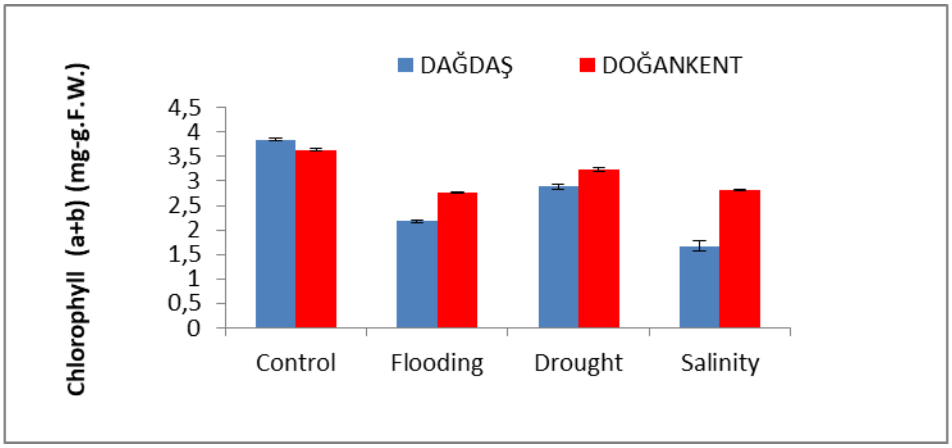

Figure 5. Changes in the total amounts of chlorophyll in wheat seedlings (*Triticum aestivum* cv. Dağdaş and Doğankent) that grown under flood, drought, salt applications. (mg/plant) (n=3)

According to the control, the total amount of chlorophyll has decreased by 50% in flood stress in Dağdaş seedlings and by 25% in seedlings exposed to drought stress ($p \leq 0.01$). It was determined that the greatest decrease in total chlorophyll amount was in seedlings in salt stress (Figure 5).

In Doğankent seedlings, a certain decrease was observed according to the control. It has been observed that seedlings exposed to flooding and salinity decreased by approximately 25% ($p \leq 0.01$) and the greatest decrease again occurs under these stress conditions.

Effects on MDA

In our study, it was found that drought and salt application significantly increased the amount of MDA in Doğankent and Dağdaş wheat seedlings according to control ($p \leq 0.01$). It was observed that the amount of MDA was at least in drought stress application and at most in salinity stress ($p \leq 0.01$) according to the control of the Dağdaş wheat seedlings.

The amount of MDA has increased in all three stress conditions in the wheat seedlings of the Doğankent variety, but the most increase has occurred in drought stress ($p \geq 0.05$). So it has been observed that the stress conditions that both wheat varieties are resistant to are different when considering the two wheat varieties ($p \leq 0.01$) (Figure 6).

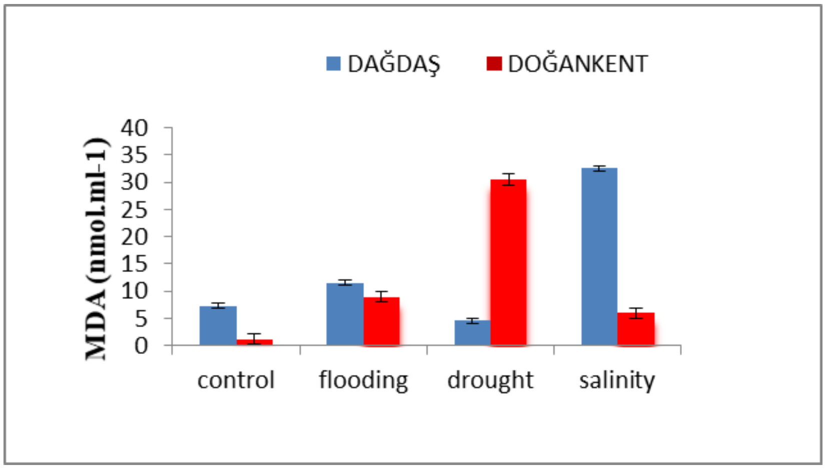

Figure 6. Changes in the average MDA average in wheat seedlings (*Triticum aestivum* cv. Dağdaş and Doğankent) that grown under flood, drought, salt applications. (mg/plant) (n=3)

Çelik and Atak (2012), stated that MDA is a parameter that formed against the environmental stress tolerance of plants. They found out that the level of MDA increased significantly according to control in both tobacco varieties which they applied salt. They determined that the MDA level in Izmir, Ozbaş tobacco variety plants was lower than the salt-sensitive Akhisar 97 variety. Accordingly, we know that the amount of MDA of Dağdaş seedlings that are tolerant to drought stress is lower than Doğankent seedlings, which confirms our results.

Bayat et al. (2014), reported an increase in the amount of MDA when exposed to salt stress in *Cucurbita pepo L.*

Plants respond in various ways under various environmental stress conditions (Slesak et al., 2007). Environmental stresses such as salinity, drought, flooding, high temperature inhibit the growth of plants (Öncel and Keleş, 2002; Özçubukçu et al., 2014). In our study, it was determined that there was a significant decrease in shoot growth and dry weight in wheat seedlings under stress conditions compared to control. It was determined that the length of the shoot caused the most reductions in Doğankent seedlings and that the reduction in Dağdaş seedlings was at the most salinity stress, which we know to be resistant to drought stress. The reduction in both wheat varieties in the dry weight of shoots has been observed to affect the most drought stress.

Under stress conditions, lipid peroxidation of plant cells increases (Yaşar et al., 2008) and this increase differs according to the sensitivity or tolerance status of the plants. It is expected that the amount of MDA will be less in plants with high tolerance and the amount of MDA will increase in sensitive varieties. It was observed that the amount of MDA in Doğankent seedlings increased under all stress conditions compared to control, and decreased in drought stress in Dağdaş seedlings.

The type of plant in stress conditions such as flooding, drought, salinity, development, duration of stress, etc. it is stated that the response of the plant varies considerably depending on situations (Kuşvuran et al., 2008). Salinity is known to cause significant losses in crop production. It has been determined that plants subjected to abiotic stress, especially flooding, drought and salinity stress, may differ depending on the type of plant, the age of the plant, duration, etc. Because plants can develop tolerance to stress factors, it is very important to know the physiological and molecular mechanisms that enable this situation.

Conclusion

As a result of our work; It was determined that Doğankent variety seedlings were affected more by drought and salinity stress than Dağdaş variety. Both wheat varieties were mostly affected by drought stress and shoot dry weight decreased. Salinity stress in Dağdaş seedlings, flooding and salinity stress of Doğankent seedlings significantly decreased in total chlorophyll amount. It was observed that it was decreased mostly by being affected by salinity stress. It is observed that the MDA value, which is known as the indicator of oxidative stress, increased in drought stress in Doğankent seeds and salinity stress in Dağdaş seeds.

In our age, the world population is salinity, drought and so on. Increasing with. In order to avoid problems such as food shortage in the future, detailed studies are needed to determine and improve the molecular and physiological responses related to stress in wheat cultivation.

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Conflicts of Interest

The authors declare that they have no conflicts of interest to report regarding the present study.

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