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Research Article

Effect of different salt concentrations on some forage pea cultivars during germination and early seedling stage

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ABSTRACT

In the present study, in order to reveal the differences in the germination of forage pea varieties at different salt concentrations and the differences in the physical properties of the roots and seedlings, the effect of different salt concentrations on nine different varieties of forage peas was carried out in Bilecik Şeyh Edebali University, Faculty of Agriculture and Natural Sciences, Agricultural Research and Biotechnology Center Laboratories in 2022. The effects of different salt concentrations (0, 25, 50, 75, 100, 125, 150, 175 and 200 mM) on nine forage pea cultivars (cv. Ürünlü, cv. Töre, cv. Ateş, cv. Guifredo, cv. Taşkent, cv. Özkaynak, cv. Kurtbey, cv. Uysal and cv. Nany) during the germination and early seedling stage were examined. The experiment was carried out according to Completely Randomized Factorial Designs with 3 replications. In the research; germination speed and power, root dry and fresh weight, root dry and fresh length, seedling dry and fresh weight, seedling dry and fresh length were investigated. According to the results obtained, a significant decrease was observed in germination speed and power, root dry and fresh weight, root dry and fresh length, seedling dry and fresh weight, seedling dry and fresh length of forage pea cultivars due to increasing salt concentration. It was determined that cv. Töre field pea has the highest germination rate and power. In addition, cv. Töre is followed by cv. Ateş in all parameters. The cultivars with the lowest germination rate and vigour were cv. Guifredo and cv. Uysal. As a result, the growth of forage pea varieties slowed down due to increasing salt concentration.

Keywords: Field Pea (*Pisum arvense L.*), salt stress, germination, seedling growth

Bazı yem bezelye çeşitlerinde farklı tuz konsantrasyonlarının çimlenme ve erken fide aşamasında etkisi

ÖZ

Bu çalışmada, farklı tuz konsantrasyonların da yem bezelyesi çeşitlerinin çimlenme ve oluşan kök ve fidelerin fiziksel özelliklerindeki farklılıklarını ortaya koymak amacıyla, farklı tuz konsantrasyonun yem bezelyesinin dokuz farklı çeşidi üzerine etkisi incelenmek üzere Bilecik Şeyh Edebali Üniversitesi Ziraat ve Doğa Bilimleri Fakültesi Tarımsal Araştırma ve Biyoteknoloji Merkezi Laboratuvarlarında 2022 yılında gerçekleştirilmiştir. Biri kontrol ve sekiz farklı tuz konsantrasyonunun (25, 50, 75, 100, 125, 150, 175 ve 200 mM) dokuz farklı yem bezelye çeşidinin (Ürünlü, Töre, Ateş, Guifredo, Taşkent, Özkaynak, Kurtbey, Uysal ve Nany) çimlenme ve fide gelişimi üzerine etkileri incelenmiştir. Deneme 3 tekerrürlü olarak tesadüfi parselleri faktöriyel deneme desenine göre yürütülmüştür. Araştırmada, çimlenme hızı ve gücü, kök kuru ve yaş ağırlığı, kök kuru ve yaş uzunluğu, fide kuru ve yaş ağırlığı, fide kuru ve yaş uzunluğu incelenmiştir. Elde edilen sonuçlara göre yem bezelyesi çeşitlerinde artan tuz konsantrasyonuna bağlı olarak, çimlenme hızı ve gücü, kök kuru ve yaş ağırlığı, kök kuru ve yaş uzunluğu, fide kuru ve yaş ağırlığı, fide kuru ve yaş uzunluğunda belirgin bir azalış gözlenmiştir. En yüksek çimlenme hızı ve gücüne sahip olan Töre yem bezelyesi çeşidi olarak tespit edilmiştir. Ayrıca Ateş çeşidi tüm parametrelerde Töre çeşidini takip etmiştir. En düşük çimlendirme hızı ve gücüne sahip çeşitler ise Guifredo ve Uysal tespit edilmiştir. Sonuç olarak artan tuz konsantrasyonuna bağlı olarak yem bezelyesi çeşitlerinin gelişimi yavaşlamıştır.

Anahtar Kelimeler: Yem bezelyesi (*Pisum arvense L.*), tuz stresi, çimlenme, fide gelişimi.

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1. INTRODUCTION

As a result of the rapid increase in the world population day by day, balanced and adequate nutrition problem has emerged and this situation has increased the importance of agricultural areas and animal production. Parallel to the population increase, the number of animals could not be increased to the desired level and this situation was also reflected in the red meat prices. In addition, adequate attention has not been given to the correct management of pastures and improvement studies and to increase the cultivation areas of forage crops for ensuring the adequate and balanced feeding of our current animals. However, animal husbandry is extremely important in terms of the development of countries, increasing export potential, supplying raw materials to industry, preventing unemployment in rural areas, and providing new employment.[1-3]

In countries with developed animal husbandry, the cultivation rate of forage crops constitutes 25% of the total agricultural land in England, 30% in Italy, 31% in the Netherlands and 36% in Germany.[4] It constitutes 13.65% in Türkiye and this ratio needs to be increased in order to close the roughage deficit in the country.[4,5] For this reason, field pea (*Pisum arvense L.*), which has a high nutritional value and is preferred by animals, is an important forage plant at the point of closing this deficit. In addition, field peas, whose grains, green and dry grass are used as a forage plant, are preferred both as a pasture plant and as a green manure crop.[5-7] In addition, field peas which are grown for animal feeding as silage are delicious as well as their high nutritional value.[8] However, salinity is an important problem for forage crops, especially for field peas.[9]

While plants continue their lives, diseases, damages or physiological changes occur that prevent their development. The negative changes that occur in the plant in these situations, are called stress. This stress is the condition that prevents growth, development and metabolism in the plant. Stress first negatively affects the metabolic and physiological mechanisms, and then causes damage to the plant and a decrease in product quality. Stress factors are divided into two as abiotic and biotic agents according to their source. Stress factors show their effects on the plant simultaneously and in combination. Abiotic stress agents are environmental factors such as temperature, frost, drought, salinity, excess water, radiation, oxidative stress, wind, various chemicals and nutrient deficiency in the soil, while biotic stress agents are pathogens, insects and herbivores including viruses, bacteria and fungi.[5,10]

Biotic and abiotic stress factors significantly limit plant growth and cause large yield losses in agriculture.[11,12] Especially abiotic stress factors prevent the survival of plants. The importance of these stress factors will increase in the future due to global climate change. According to 2003 report of the Intergovernmental Panel on Climate Change, crop production in Europe has decreased by about 30% due to the stress factors[9,13] salinity which is one of the abiotic stress factors, is the primary factor that will directly affect crop yield today and in the future.[13-16] According to the data of Food and Agriculture Organization of the United Nations (FAO, 2018), the area of salty soils in the world continues to increase regularly, data claims that 50% of them will face salinity problem by 2050.[5,14,17] Currently, over 6% of the world's land area and 20% of the world's irrigated land is affected by salinity salinity causes water deficit by reducing the osmotic potential of the solutes in the soil, even in well-irrigated soils, thus making it difficult for the roots to draw water from the surrounding environment (soil solution).[18,19]

Salinity is the accumulation of salt near the soil surface when the salts mixed with the groundwater due to washing in arid and semi-arid regions reach the soil surface by capillary way and the water evaporates and leaves the soil. This situation changes the soil structure and causes significant losses in plant yield and quality. In addition, salinity is not a concept limited to arid and semi-arid regions. The reason is that all soils and water resources on the earth contain a certain amount of salt, regardless of their quality.[5,20]

It is critical to study different genotypes of abiotic stress factor such as salt stress in order to grow field peas efficiently. Due to this critical situation, Avcı et al.[21] and Demirkol et al.[5] studied the effects of salt stress on the germination and early seedling growth of field pea in Türkiye. In another study, Okçu et al.[22], Petrovic et al.[23], and Pereira et al.[24] studied the responses of different pea genotypes to salt stress. In addition, they revealed that salinity reduces root and seedling formation and explained that this effect is dependent on salt concentration differences. The aim of this research is to evaluate the relationship between germination rate and germination rate and root and seedling growth of four types of field pea genotypes in sterile conditions and at different salt concentrations. The purpose of the study was to determine the germination rates and strengths, fresh and dry weights of some proprietary feed peas at different salt concentrations, and to improve this characteristic of feed pea varieties with low salinity tolerance by gene transfer in the continuation of the study.

2.MATERIALS AND METHODS

This study was carried out in 2022 at Bilecik Şeyh Edebali University Faculty of Agriculture and Natural Sciences Agricultural Research and Biotechnology Center Laboratories to examine the effects of different salt concentrations on germination and seedling

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development in nine different cultivars of field peas. Registered varieties such as cv. Ürünlü, cv. Töre, cv. Ateş, cv. Guifredo, cv. Taşkent, cv. Özkaynak, cv. Kurtbey, cv. Uysal and cv. Nany was used in the study. Nine different concentrations of NaCl (0, 25, 50, 75, 100, 125, 150, 175 and 200 mM) solutions were used in the study. Six ml of NaCl solution for each doses were added to each petri dishes containing five forage pea seeds. The seeds were firstly subjected to surface sterilization by mixing them with a 20% bleach solution for 7 minutes. Germination papers were first placed in sterile petri dishes, then 6 ml of NaCl solutions were added, and the seeds with surface sterilization were placed in each petri dishes with forceps as to be 5 seeds each. Afterwards, it was left to germinate for 8 days at 20±2°C in the climate chamber. The seeds were checked daily and the seeds with a rootlet length of 2 mm were considered as germinated. Seed germination speed at the end of the 5th day and the seed germination power at the end of the 8th day were calculated as described by Demirkol et al.[5] and Okçu et al.[22]. Mean germination speed/ power was calculated with the formula of Ellis and Roberts[25]:
Germination Seed/ Power (%) = (Number of germinated seeds/total number of seeds) ×100

2.1.Determining the root and seedling lengths

At the end of the 8th day, the roots and seedlings of the germinated seeds were cut with the help of a scalpel. The lengths of these roots and seedlings were measured with the help of a ruler.

2.2.Measuring the fresh and dry weights of the roots and seedlings

At the end of the 8th day, the roots and seedlings of the germinated seeds were cut with the help of a scalpel. Each of these roots and seedlings was weighed on sensitive scales and their wet weights were determined. Then, each root and seedling were dried in an oven at 65°C for 48 hours and dry weights were measured on a precision scale.

2.3.Statistical analysis

Data were subjected to Completely Randomized Factorial Designs analysis of variance, and the post hoc tests were performed using Duncan's Multiple. [26]

3.RESULTS AND DISCUSSION

In the study, it was revealed that different salt concentrations have significant effects on the germination and seedling growth of field pea varieties. It was revealed that cv. Töre, cv. Ateş, cv. Özkaynak and cv. Taşkent field pea cultivars had high germination rates.

Among these varieties, cv. Töre showed salt tolerance up to 175 mM salt concentration. It was determined that the germination rate of cv. Töre and cv. Taşkent at 200 mM salt level decreased by compared to the control condition. In cv. Guifredo and cv. Uysal, the germination rate at 25 mM salt concentration decreased according to the control condition. At 200 mM salt concentration, in addition to cv. Uysal, the germination rate decreased in cv. Urunlu, cv. Ozkaynak, cv. Kurtbey and cv. Nany according to the control condition. In general, it was determined that the increase in salt concentration adversely affected the germination rate at 150 mM and higher concentrations. (Figure 1).

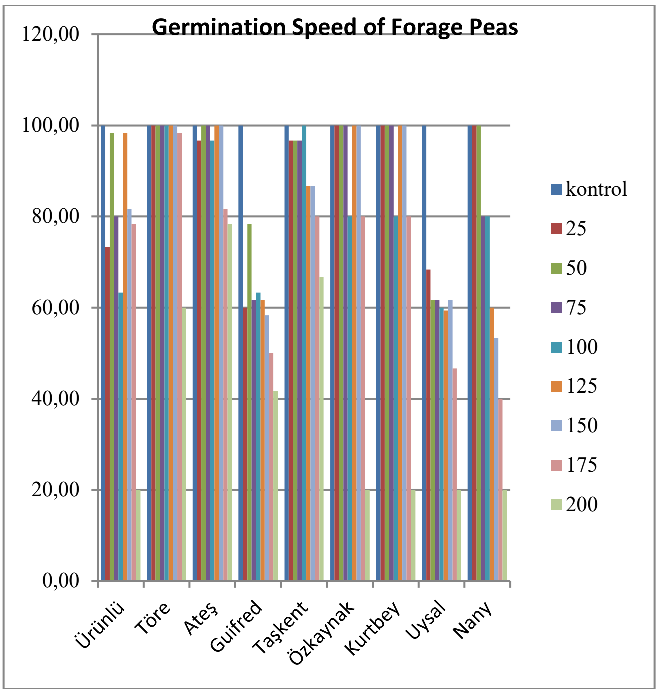

Figure 1. Germination speed of field peas at different salt concentrations (%)

Similarly, it was revealed that the germination power was parallel to the germination rate. At a salt concentration of 175 mM, the cv. Töre field pea has the highest germination power (Figure 2). Similar to these findings, Küçüközcü and Avcı[27] stated that the increase in salinity began to negatively affect germination at 10 ds/m and higher levels. Demirkol et al.[5] observed a significant decrease in germination rate in parallel with increasing salinity after 90 mM. Contrary to these findings, Okçu et al.[22] and Avcı et al.[21] reported that the germination percentage did not change according to the salinity level.In general, a decrease in root length was observed depending on the increase in salt concentration. In the mean salt concentration, decrease in root length was detected according to the control condition. It was revealed that the least decrease in root length at 200 mM salt concentration compared to the control condition was Töre and Ateş field pea varieties.

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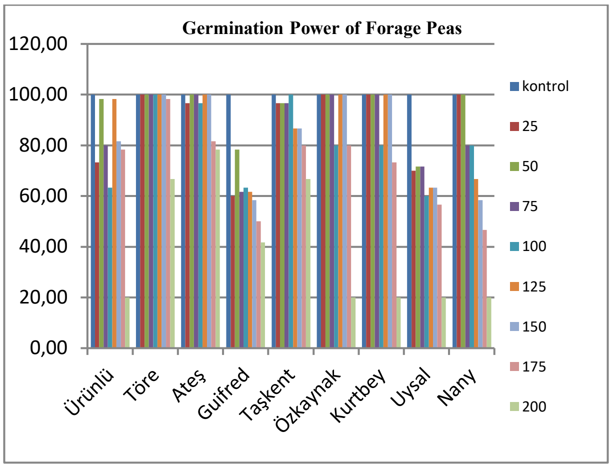

Figure 2. Germination power of field peas at different salt concentrations (%)

According to the control condition, the highest decrease was observed in the product with 25 mM salt concentration and in Taşkent field pea varieties. Töre has the longest root length at 150 mM, which is the critical salt concentration for germination speed and power. The highest root length was determined in Töre and Ateş varieties at 200 mM salt concentration (Figure 3).

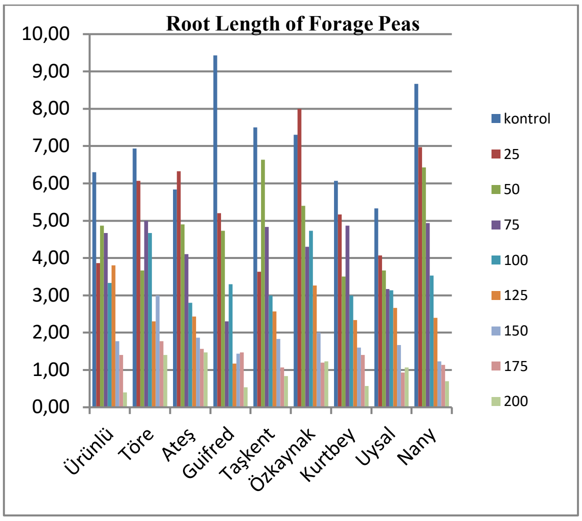

Figure 3. Root length of field peas at different salt concentrations (cm)

A decrease was observed in seedling length depending on the increase in salt concentration. The maximum decrease in seedling length was observed in Guifredo, Kurtbey and Özkaynak field pea varieties. On the other hand, the decrease in seedling length was observed in Urünlü, Töre, Ateş and Uysal field pea varieties. The longest seedling length was determined in Töre, Ateş, Özkaynak and Nany field pea varieties at 150 mM, which was determined as the critical salt concentration. All of the field pea varieties were significantly affected by the 200 mM salt concentration. In the study, root length was affected by lower salt concentrations than seedling length. Root length began to be affected at 25 mM salt concentration. Seedling length showed a significant decrease around 100 mM salt concentration (Figure 3 and Figure 4). Similar to these findings, Küçüközcü and Avcı[27] revealed that the salt rate of 20 ds/m negatively affects almost all varieties. Demirkol et al.[5] also found that salinity affected seedling growth negatively and the effect of pea genotypes on roots started at lower doses than shoots.

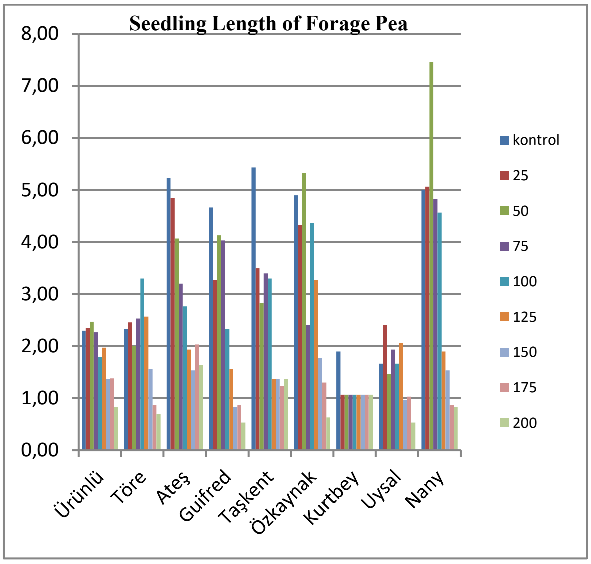

Figure 4. Seedling length of field pea varieties at different salt concentrations (cm)

In general, root fresh weight decreased with the increase of salt concentration The highest wet weights among all roots were obtained in the control condition. Excluding Ateş and Kurtbey field pea varieties, the root fresh weight was close to the control condition (Figure 5).

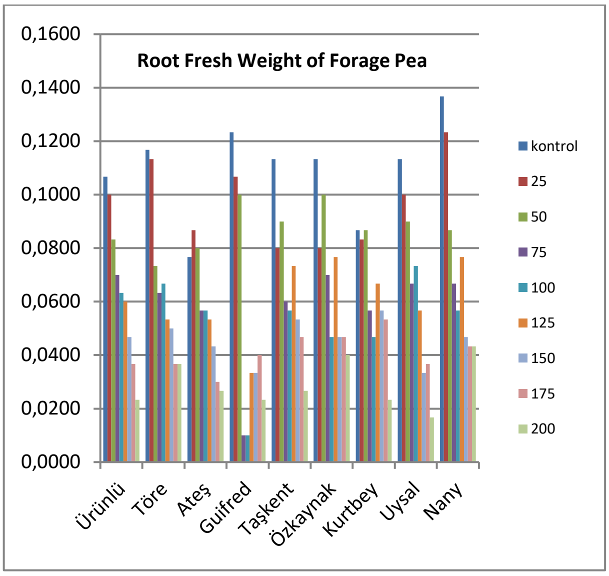

Figure 5. Root fresh weight of field pea varieties at different salt concentrations (g root^{-1})

Depending on the increase in salt concentrations, a decrease in root dry weight was also observed. In

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addition, no change was observed in root dry weight of Urunlu and Nany field pea varieties up to 175 mM salt concentration. In other field pea varieties, various fluctuations in root dry weight values were determined depending on the salt concentration (Figure 6).

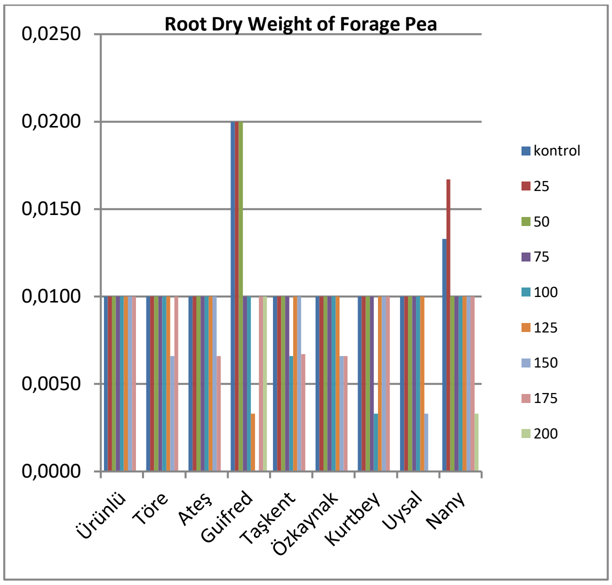

Figure 6. Root dry weight of field pea varieties in different salt concentrations (g root^{-1})

Depending on the increase in salt concentrations, a decrease in seedling fresh weight was also observed. Guifredo field pea variety with the highest seedling fresh weight among all varieties. However, the highest decrease was observed in Guifredo variety at 50 mM salt concentration with according to the control condition. When evaluated by root and seedling weight, root fresh weight was found to be higher in the control condition, while root and seedling fresh weights were found to be close at 200 mM salt concentration. While there were fluctuations in the dry weight of the seedlings at different salt concentrations, no significant change was observed when the 200 mM salt concentration was compared with the control conditions (Figure 7 and Figure 8).

In the studies, among all seedlings, the highest fresh and dry weights were obtained in Gölyazı variety under control condition, while the lowest value was obtained in 20 dS/m treatment in Taşkent variety. As the salinity increased, fresh and dry weights decreased in all varieties except Özkaynak, whose fresh and dry weights were positively affected by 5 dS/m salinity.

The lowest rate of decrease in fresh weight at 15 dS/m salinity was also recorded in this variety. Although all decrease rates in fresh weight of seedlings at 20 dS/m were similar, Taşkent variety was the most affected. Avcı et al.21, Tsegay and Andargie28, Demirkol et al.5 who supported these findings reported that fresh and dry weights of seedlings decreased in pea genotypes due to increased salinity.

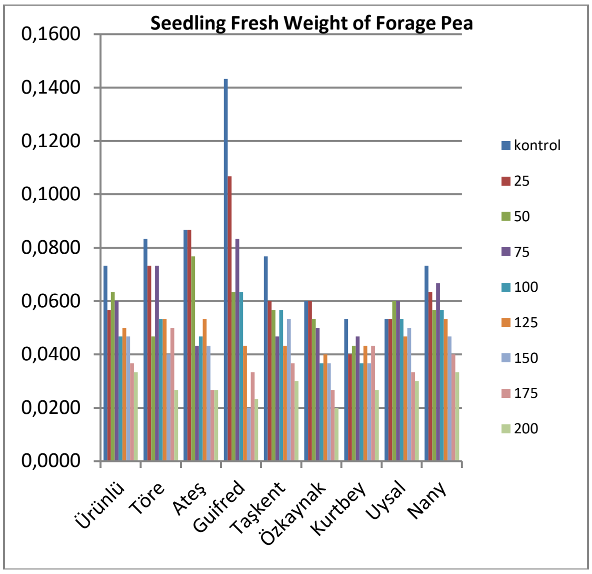

Figure 7. Seedling fresh weight of field pea varieties at different salt concentrations (g seedling^{-1})

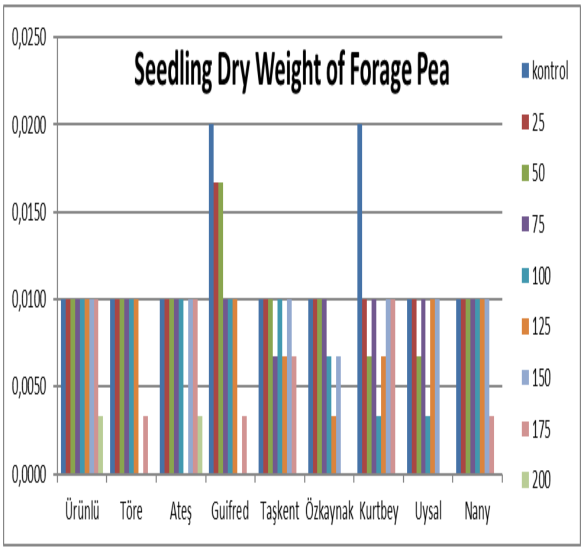

Figure 8. Seedling dry weight of field pea varieties at different salt concentrations (g seedling^{-1})

4.CONCLUSION

As a result, a significant decrease was observed in germination speed, germination power, root-seedling length and fresh-dry weights depending on the increasing salt concentration. It has been determined that Töre field pea variety has the highest germination rate and power. In addition, Ateş field pea followed Tore variety in all parameters. The varieties with the lowest germination speed and power are Guifredo and Uysal forage peas. The critical salt concentration was determined as 150 mM in the research. The first change for salt-tolerant varieties was observed at this concentration. As a result of the present study, salinity-sensitive and tolerant varieties were determined and the effects of different salt concentrations was investigated. Ateş and Töre varieties resistant to salt stress, Guifredo,

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and Uysal varieties that are sensitive will be used to improve salt tolerance by gene transfer as the continuation of this study. In this way, the effects of the Osmyb4 gene, which will be transferred to Ateş, Töre Guifredo, and Uysal varieties, on salinity will be evaluated. Also, more comprehensive field studies will be conducted to determine salinity stress.

Conflict of interests

I declares that there is no a conflict of interest with any institute, person, company, etc.

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