Türk Tarım ve Doğa Bilimleri Dergisi 5(2): 175–179, 2018

https://doi.org/10.30910/turkjans.421361

TÜRK
TARIM ve DOĞA BİLİMLERİ
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TURKISH
JOURNAL of AGRICULTURAL
and NATURAL SCIENCES

Research Article

Effects of Different Salt Concentrations on the Germination Properties of Hungarian Vetch (*Vicia pannonica* Crantz.) Cultivars

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Received: 27.12.2017 Received in Revised: 23.03.2018 Accepted: 29.03.2018

Abstract

This research was carried out in the Mustafa Kemal University, Faculty of Agriculture, Department of Field Crops. It was used two Hungarian vetch cultivars (Altinova-2002 and Anadolu Pembesi-2002) and five salt concentrations (unsalted/0, 50 mM, 100 mM, 150 mM, 200 mM) as treatment. In this experiment, it was estimated germination rate (%), germination index and mean germination time (day) by using germination parameters and was also measured root and shoot length (mm) and seedling fresh weight (g). Salt concentrations negatively affected evaluated features for both cultivars in the final of this research. As the salt concentrations increased, all investigated properties except mean germination time were observed to decrease. In terms of germination rate, germination index, root and shoot length and seedling fresh weight between cultivars, Altionva-2002 cultivar gave higher value than Anadolu Pembesi-2002 cultivar. When we examined Cultivar x dose interactions, all properties were most affected adverse in the Anadolu Pembesi x 200 mM interaction This research clearly showed that the cultivation of Hungarian vetches of Anadolu Pembesi and Altınova-2002 will be affected in the soil that has been exposed to the problem of salinity.

Key words: Salinity, Hungarian vetch, germination, environment

Farklı Tuz Konsantrasyonlarının Macar Fiğ (*Vicia pannonica* Crantz.) Çeşitlerinin Çimlenme Özelliklerine Etkileri

Özet

Bu araştırma Mustafa Kemal Üniversitesi Ziraat Fakültesi Tarla Bitkileri Bölümünde yürütülmüştür. Çalışmada iki adet Macar fiği çeşidi (Altınova-2002 ve Anadolu Pembesi-2002) ve 5 adet tuz konsantrasyonu (kontrol, 50 mM, 100 mM, 150 mM ve 200 mM) uygulama olarak kullanılmıştır. Uygulamalar sonucunda; çimlenme oranı, çimlenme indeksi ve ortalama çimlenme süresi hesaplamıştır. Ayrıca radikula ve plumula uzunlukları ile fide yaş ağırlıkları ölçülmüştür. Araştırma sonucunda, tuz konsantrasyonları değerlendirilen tüm özellikleri olumsuz etkilemiştir. Tuz konsantrasyonu arttıkça ortalama çimlenme süresi dışında tüm özelliklerin ölçülen değerlerinin azaldığı gözlemlenmiştir. Çeşitler arasında çimlenme oranı, çimlenme indeksi, radikula ve plumula uzunluğu ve fide yaş ağırlığı özellikleri açısından, Altınova-2002 çeşidi Anadolu Pembesi-2002 çeşidinden daha toleranslı bulunmuştur. Çeşit x Doz interaksiyonları değerlendirildiğinde, tüm özellikler en fazla Anadolu Pembesi x 200 mM interaksiyonunda negatif yönde etkilenmiştir. Bu çalışma, tuzluluk problemi ile karşı karşıya kalmış topraklarda Macar fiğ tarımında Altınova-2002 ve Anadolu Pembesi çeşitlerinin olumsuz etkileneceğini açık bir şekilde göstermiştir.

Anahtar kelimeler: Tuzluluk, Macar fiği, çimlenme, çevre

Introduction

Salinity is one of the environmental problems that has a crucial influence on the germination of plants and succeeding plant growth. Soil salinity, a common problem in irrigated or arid areas of Turkey, may affect

germination of seeds either by creating an osmatic effect to the seed preventing water uptake, or through the toxic effect of ions found in salt on the germination. However, the way in which NaCl exerts its influence on these vital processes, whether it is through an osmotic effect or a specific ion toxicity, is still not found out. Salinity stresses are responsible for both inhibition or delayed seed germination and seedling growth (Almansouri, et al., 2001).

Leguminous forage crops improve the physical and chemical structure of soil in sustainable agricultural systems. Hungarian vetch is a cold-resistant crop among annual vetch species. Particularly, it is cultivated in the colder area. In these areas, this crop is very important as a forage crops in terms of ruminant feeding and rotation crops in terms of dry farming areas. Hungarian vetch was cultivated area is 10.411 ha for gain grain 71.834 ha for forage in Turkey (Anonymous, 2016).

The responses of each plant species to salt stress are different. Sometimes these differences can occur even in a varieties and/or cultivars of commercial crop species (Almansouri et al., 2001). The increase in salt content in the soil leads to an increase in the osmotic pressure, therefore reduces seed activity or prevents water uptake during germination and succeeding growth stages of the crops (Essa, 2002; Sadeghian and Yavari 2004). Reponses of newly registered Hungarian vetch cultivars to salinity stress during the germination and seedling growth is not well known. The effects of different salt concentrations on the seed germination and seedling growth of two Hungarian vetch cultivars were investigated in this work.

Materials and Methods

Material

Seeds of Altınova-2002 cv. registered by Field Crops Central Research Institute Directorate of Turkey and Anadolu Pembesi-2002 cv. registered by General Directorate of Agricultural Affairs of Turkey were used as plant materials.

Method

The seeds of two different Hungarian vetch cultivars used in this experiment were counted and taken in beakers separately. To make surface sterilizations of the counted seeds, 2% sodium hypochlorite solution was added to caver seeds and it was waited to deform microorganisms in the surface of seeds for 10 minutes and after 10 minutes seeds were rinsed 3 times with sterile water (Bilgili et al., 2011). The sterilized 35 seeds were placed on 11 cm diameter petri dishes containing double layer Whatman filter paper and 8 mL of sterilized water was applied for control treatment and 8 mL of respective salt concentrations (50, 100, 150, 200 mM) were applied as salinity treatments. These concentrations were determined according to previous research results of conducted similar crop or vetches. Pure sodium chloride (NaCl) was used to prepare salinity concentrations. The petri dishes were covered with parafilm to prevent moisture loss during germination. All the petri dishes were placed in the air conditioner cabinet and allowed to germinate at 70% relative humidity at 25 ºC for 4 days. At the end of 4 days, the lighting rhythm of the air conditioner cabinet was opened for 12/12 days/night for 4 days. Based on the number of germinated seeds every day, calculations were made according to the following formulas. After 8 days, radicle and plumula length was measured randomly selected 10 seedlings among the germinated and grown seedlings.

- Germination Rate; GR (%)=A/Bx100
- Germination Index; GI=Σ(Gt/Tt)
- Mean Germination Time; MGT (days)= Σ(fx)/ Σf
- A: Total germinated seeds
- B: Total not-germinated seeds
- Gt: Germinated seeds number on t day
- Tt: Number of days until t day
- f: Number of germinated seeds on the counting day
- x: Number of counted day

A randomized complete design was used with a factorial arrangement of treatments (Cultivar and NaCl level) with 4 replications and 35 seeds in each replicate. Data were analyzed by 2 way analysis of variance using the statistical package MINITAB 17 and the differences between the means were compared using Duncan's multiple range test (P≤0.05).

Results and Discussions

Before beginning this research, some characteristics of seeds in terms of germination were investigated and results were given in Table 1.

Germination parameters

Analysis of variance (ANOVA) showed that the effects of salt concentrations were statistically significant (P≤0.05) for all the evaluated parameters. In terms of germination parameters values that is obtained by treating different salt concentrations on two Hungarian vetch cultivars were given in Table 2.

As seen in Table 2, germination rates of cultivars were between 97.86-10.71 %. While the highest germination rate was obtained with the Altınova-2002 x Control treatment, the lowest value was obtained with the Anadolu Pembesi-2002 x 200 mM treatment. Germination index values were between 32.31-2.77. The highest value was on Altınova-2002xControl treatment while the lowest value was on Anadolu Pembesi -2002 x 200 mM treatment. Among the mean germination time values, Altınova-2002 x Control treatment was lowest value even as Anadolu Pembesi-2002 x 200 mM treatment was highest value. In terms of radicle and plumula length and seedling fresh weight, highest and lowest values were obtained Altınova-2002 x Control and Anadolu Pembesi-2002 x 200 mM treatments with the 23.65-2.38 mm, 36.03-2.30 mm and 0.0527-0.0133 g plant^{-1}, respectively. As the salt concentrations increased, germination rates of cultivars were decreased. Some researchers conducted an experiment to determine the effects of different salt concentrations on germination and early seedling stages of common vetch (*Vicia sativa* L.) and reported that as the salt concentrations increased, germination rate decreased in their study (Day and Uzun, 2016; Ertekin et al., 2017).

Table 1. Used seeds properties in this research

Varieties	Weight of 1000 seeds (g)	Moisture content of seeds (%)	Moisture intake rate (%)
Altınova-2002	39.34	6.67	103.40
Anadolu Pembesi-2002	42.14	5.96	95.71

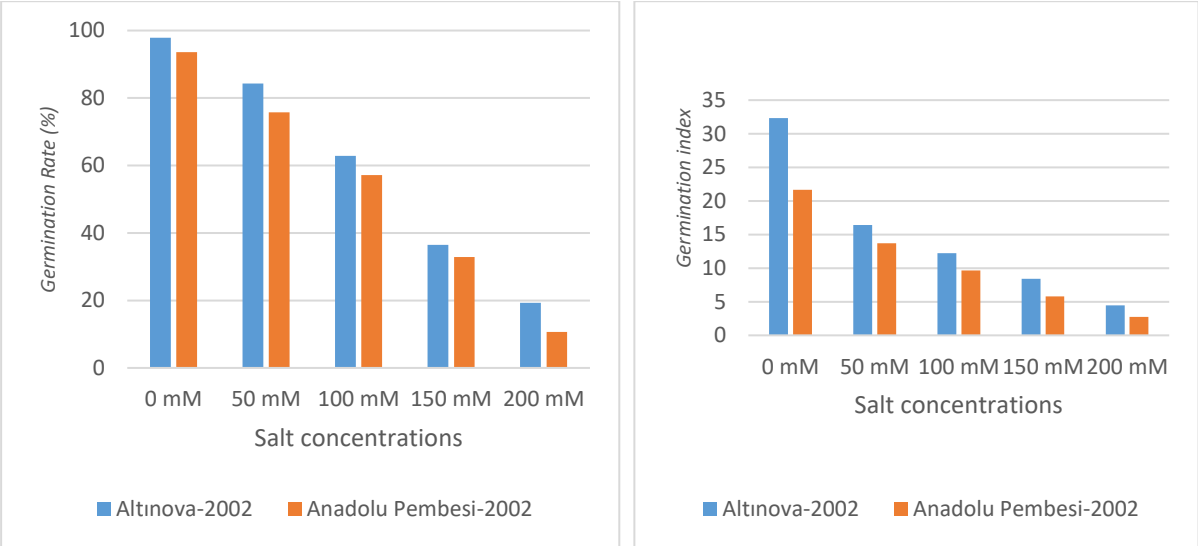

Figure 1. Germination rate (%) and germination index of cultivars under different salt concentrations.

As seen in Figure 1, Germination rate and Germination index values of seeds decreased as the salt concentrations increased. Onal-Asci and Uney (2016) who studied the effects of different salt concentrations on germination of Hungarian vetch and they stated that the germination rate decreased as the salt concentration increased from 0 to 30 mM.

Many other researchers have emphasized that studies on different plants germination rates in salt stress are reduced by the increase in salt concentration (Day et al., 2008; Carpici et al., 2009; Akhtar and Hussain, 2009; Dai et al., 2009; Çacan and Kokten, 2014). Some other researchers also reported that germination index, mean germination time, radicle length and plumula length were decreased as the salt concentrations increased (Duan et al., 2004; Carpici et al., 2009; Kusvuran, 2015; Onal-Aşçı and Uney, 2016). Our results confirmed similar results to those outlined in previous studies, but the response of the cultivars, the extent to salinity tolerance of cultivars the salt concentration was different.

Table 2. Evaluated properties of two Hungarian vetch cultivars under salinity stress

Cultivars	Salt Concentrations (mM)					Mean
	0	50	100	150	200	
	Germination Rate (%)					
Altınova-2002	97.86^{A}	84.29^{AB}	62.86^{C}	36.43^{D}	19.29^{DE}	60.10^{A}
Anadolu Pembesi-2002	93.57^{AB}	75.71^{BC}	57.14^{C}	32.86^{D}	10.71^{E}	54.00^{B}
Mean	95.71^{A}	80.00^{B}	60.00^{C}	34.64^{D}	15.00^{E}	
	Germination Index					
Altınova-2002	32.31^{A}	16.40^{BC}	12.21^{CDE}	8.40^{DEFG}	4.44^{FG}	15.80^{A}
Anadolu Pembesi-2002	21.67^{B}	13.71^{CD}	9.67^{DEF}	5.79^{EFG}	2.77^{G}	9.67^{B}
Mean	24.35^{A}	17.69^{B}	10.94^{C}	7.09^{CD}	3.60^{D}	
	Mean Germination Time (day)					
Altınova-2002	2.33^{C}	2.85^{BC}	3.28^{AB}	3.00^{AB}	3.16^{AB}	2.92^{B}
Anadolu Pembesi-2002	3.35^{AB}	3.32^{AB}	3.43^{A}	3.44^{A}	3.06^{AB}	3.32^{A}
Mean	2.84^{B}	3.08^{AB}	3.35^{A}	3.22^{A}	3.11^{AB}	
	Radicle Length (mm)					
Altınova-2002	23.65^{A}	18.58^{AB}	12.83^{BCD}	8.70^{CDE}	3.63^{E}	13.5^{A}
Anadolu Pembesi-2002	23.30^{A}	15.40^{B}	14.05^{BC}	6.70^{DE}	2.38^{E}	12.40^{A}
Mean	23.48^{A}	16.99^{B}	13.44^{B}	7.70^{C}	3.00^{D}	
	Plumula Length (mm)					
Altınova-2002	36.03^{A}	31.43^{AB}	26.10^{BC}	11.00^{D}	3.60^{DE}	21.60^{A}
Anadolu Pembesi-2002	31.38^{AB}	25.40^{BC}	18.68^{C}	8.98^{DE}	2.30^{E}	17.40^{B}
Mean	33.70	28.41	22.39	9.99	2.95	
	Seedling Fresh Weight (g plant^{-1})					
Altınova-2002	0.0527^{A}	0.0450^{AB}	0.0375^{BC}	0.0252^{DE}	0.0164^{EF}	0.0400^{A}
Anadolu Pembesi-2002	0.0450^{AB}	0.0370^{BC}	0.0295^{CD}	0.0203^{EF}	0.0133^{F}	0.0300^{B}
Mean	0.0489^{A}	0.0410^{B}	0.0335^{C}	0.0228^{D}	0.0149^{E}	

*P≤0.05

Conclusion

In this study, the germination and early seedling development stages of two commercial cultivars of Hungarian vetch were investigated under different salt concentrations. As the salt concentrations increased, all the properties of germination and early seedling traits values decreased when these values compared to control treatment. When the obtained results are evaluated as a whole; as the salt stress increased, germination and early seedling development of these cultivars significantly affected. This investigation indicated that commercial crop cultivars were differently reacted to salt stress and these two Hungarian vetch cultivars were substantially affected under increasing salt concentrations.

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