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Variation in leaf litter decomposition rate according to salinity and water regime in *Juglans regia* L.

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Abstract

Decomposition is one of the basic process in ecosystems which provide nutrient cycles by transforming organic matters to stabile forms. Several factors are effective on decomposition such as litter quality, climate and soil features. This study aimed to determine the decomposition rates according to salinity and water regime. Senescent leaves of *Juglans regia* L. were collected as freshly fallen senescent leaves under the trees. Litter bag technique was used to examine the decomposition rate. In order to determine the impacts of water regime and salinity two sets of experiments were established. In one set litter bags were irrigated weekly by three different substances, water, 10 % salty water and 20 % salty water, and in the other set litter bags were irrigated with three different frequencies, one in a week, in two weeks and in four weeks. Decomposed litter bags were collected about 3 month later and dry weights were calculated. Both water and salt addition are increased the litter decomposition rate up to certain level. But high levels of water supply and salt content decreased the litter mass loss. It is thought that these were caused by direct and indirect inhibition effects of these substances on microbial activity.

Keywords: Decomposition, *Juglans regia* L., water regime and salinity.

Introduction

Organic matters which are the basic nutrient resource in ecosystems come from the remains and waste products of organisms. Abscission of leaves is important organic matter resources especially in forest ecosystems. Abscised leaves and other remains of organisms form litter layer on the ground. Litter layer has important roles in ecosystems such as sustainability of elements in the soil protection of soil, regulation of temperature, and evaporation from the soil, inhibition of soil freeze, creating a food, and home or habitat for organisms. Decomposition is a process consists of physical, chemical and biological mechanisms that provide disintegration and transformation of organic matters to stabile forms (Berg and McClaugherty, 2008). Because of its importance for sustainability of ecosystems, plant ecologist focused on understanding decomposition process and factors which have impacts on this process (Berendse, 1994; Cárdenas and Campo, 2007; Huang et al., 2007; Zhang et al., 2008). Previous studies reported that, rate of decomposition is strongly affected by litter quality and environmental conditions such as climatic factors, soil structure, microbial composition, and community structure (Moretto ve Distel, 2003; Zhang et al., 2008; Karavin, 2010). Litter quality and environmental conditions such as climate modulate the microbial and other decomposers activity. Climatic factors that control litter decomposition rates such as mean annual precipitation and annual actual evapotranspiration were poorly examined by scientist (Moore, 1986; Dyer et al., 1990; Berg et al., 1993; O'Neill et al., 2003; Zhang et al.,

2008). Climatic factors such as moisture regulate microbial activity by affecting enzyme kinetics and nutrient diffusion (Gaxiola and Armesto, 2015). Decomposition process comprises of several chemical mechanisms which need water. For lots of chemical reaction water is an essential substance. So, determining the impacts of water supply on litter decomposition is important.

This study aimed to determine the rates of decomposition in senescent leaves of *Juglans regia* L. according to salinity and water regime. It is hypothesized that decomposition rate may decreases with increasing water and decrease with increasing salinity. It is known from the previous studies that soil factors such as water, oxygen, temperature and salinity are effective on microbial flora and fauna. These factors may be altered the rates of microbial activity. Impact of water and salinity supplies on litter decomposition rate are little known in terrestrial ecosystems. Changing environmental factors caused by climate change and global warming threat soil features and hence plant communities. The need to identify the effects of water and salinity on decomposition becomes important in the context of the ecosystem maintenance.

In light of this information, the goal of the study is to examine the effect of water regime and salinity on litter decomposition rate. The study carried out by using senescent *Juglans regia* leaves which is an economically important crop in the World. In addition, *Juglans regia* is intercropped tree on various crops. So, litter decomposition of these types of trees has additional importance for both other plant species and ecosystems. It is thought that the results of the study provide useful information to plant ecology and agriculture.

Materials and Methods

The study are is in Amasya in the Middle Black Sea Region of Turkey between 34° 57'06"- 36° 31'53" east longitudes and 41° 04'54"- 40° 16'16" North latitudes. It is about 411.69 m a.s.l. The mean annual temperature is 13.6 °C and total annual precipitation is 461.3 mm. Senescent *Juglans regia* leaves were collected as freshly fallen senescent leaves under the trees. Undamaged leaf samples were selected and healthy leaf samples were put into drying oven at 75 °C and dried until constant weight was reached. Litter bag technique was applied in order to examine leaf litter decomposition rate. Litter bags were made from fibreglass net with 2 mm mesh size. Size of the litter bags is 20×20 cm. Oven-dried leaf samples were weighted as 5 g and putted into litter bags. Two sets of experiments were established for examining the effects of salinity and the water regime on litter decomposition. Three repetitions were done for each testing set. Litter bags were carefully carried to study area in plastic bags and fastened with iron nails to the soil surface. In order to determine the impact of salinity litter bags were irrigated weekly by three different substances, water, 10 % salty water and 20 % salty water. Additionally, in order to examine the effect of water regime on litter decomposition, litter bags were irrigated with three different frequencies, one in a week, one in two weeks and one in four weeks. Then, decomposed litter bags were collected from the study area about 3 month later. The litter bags air-dried at laboratory and then cleaned and washed with distilled water. Decomposed leaf samples were dried at 75 °C into drying oven until constant weight was reached and weighed.

SPSS (20) was used for all statistical analyses. Mean dry masses were analysed by one-way ANOVA. Tukey post-hoc test performed to determine the differences between means.

Results and Discussion

The mean dry weights of leaf litters according to salinity and water regimes were given in Figure 1. The results showed that irrigation of litter bags significantly altered the litter decomposition (Table 1). The maximum decomposition rate was obtained in litter bags which were irrigated one time in four weeks. More frequent irrigation caused to a bit decrease in decomposition rate but this decrease is not important. The minimum decomposition rate was obtained in control litter bags released to nature. In the light of these results, water addition is effective to a certain extent. Water addition expedites the litter decay and chemical processes. However, high levels of water supply fill gaps which is important for gas exchange and aerobic activities. Because of aneorobic conditions litter decomposition rate may decelerate. In the anaerobic conditions water addition doesn't affect metabolic activity (Coûteaux et al., 1995). Excessive water supply may carry away the necessary elements from the decomposing material such as N and C which are used by decomposers. N, P and C are limiting elements for decomposition process because of their impacts on microbial activity. Various inferences were obtained in the previous studies. In the results of Conner and Day (1991), initial mass loss didn't varied among three sites with different water levels within 26 weeks. After that, decomposition rate significantly

increased according to water status. Ellis et al. (1999) reported that decomposition rate increased with flooding. In contrast, O'Neill et al. (2003) reported initially reduction in litter mass loss by precipitation, except spring treatment. However, Zhang et al. (2008) demonstrated that decomposition rate tended to increase with precipitation. Coûteaux et al. (1995) explained that the rising soil moisture cause increase in metabolic activity until an optimum plateau is reached and low soil moisture limits metabolic activity. Results of the current study correspond to most of these studies. As a summary, the presence of certain amount of water leads to increase in decomposition rate. But, high levels of water cause reduction in decomposition rate due to by both filling the gaps and carrying away the elements such as N which is necessary as a food resource for decomposers.

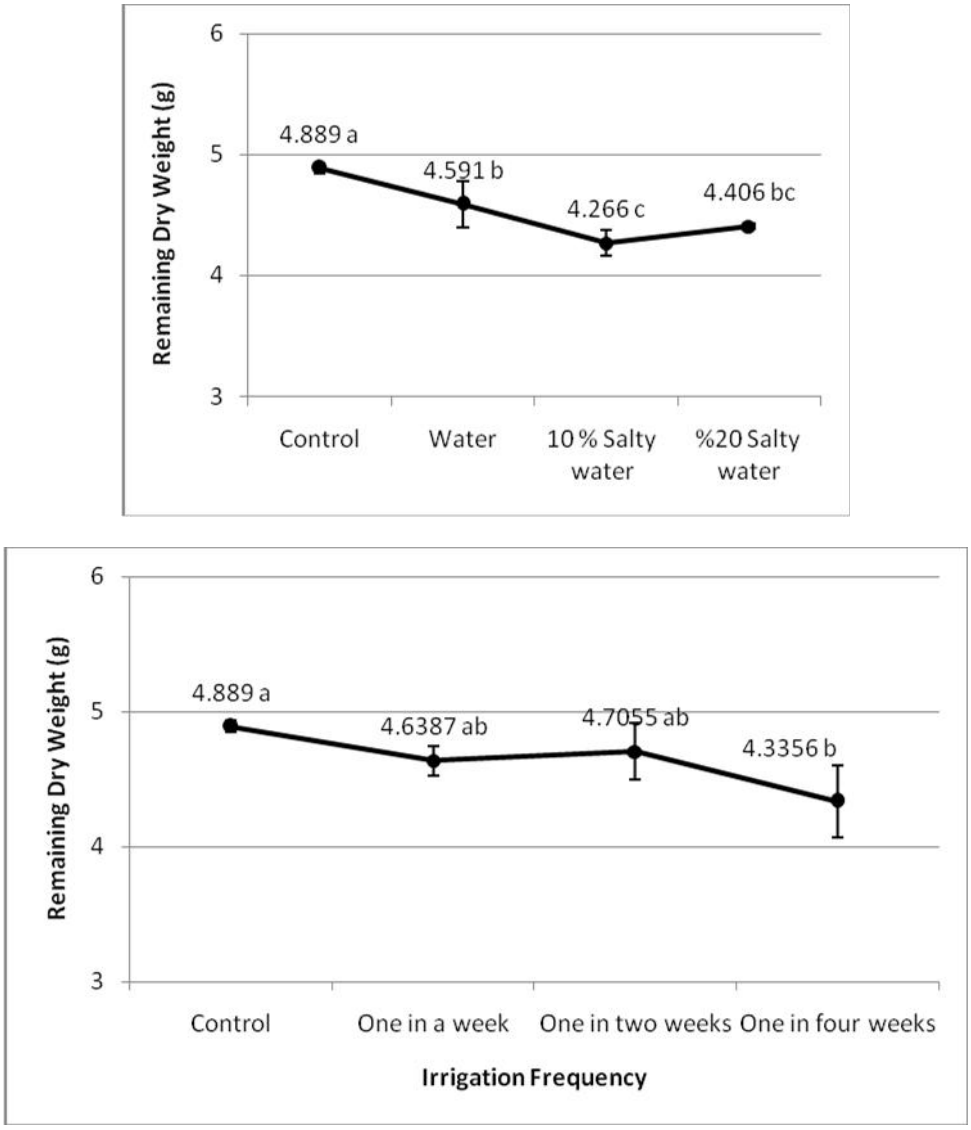

Figure 1: Means and differences in litter dry weight according to salinity and water regime

Table 1: ANOVA table indicates effect of salinity and water regime on litter decomposition.

	Sum of Squares	df	Mean Square	F	Sig.
Salinity	0.652	3	0.217	17.054	0.001
Water Regime	0.477	3	0.159	4.954	0.031

Addition of salty water to the litter bags increased the litter decomposition rate. The maximum decomposition rate was obtained in the litter bags irrigated with 10 % salty water. When the amount of salt was increased, decomposition rate a bit decreased. Connolly et al. (2013) didn't found a clear relationship between salinity and percent mass loss. However, Hemminga et al. (1991) determined that higher salinity of the soil water suggests decrease in decomposition rate. A laboratory experiment of Roache et al. (2006) were showed that leaf mass loss due to decomposition decreased with increasing salinity (Connolly et al., 2013) and Reice and Herbst (1982) determined that litter decomposition was negatively affected by salinity (Mendelsshon et al., 1999). It was reported that the growth of bacteria and fungi on litter may be inhibited by high salinity. Previous studies reported negative correlation between water or soil salinity and microbial activity (Connolly et al., 2013). Van Bruggen and Semenov (2000), Rietz and Haynes (2003) and Sardinha et al. (2003) suggest decrease in microbial activity due to increasing salinity in terrestrial ecosystems. In contrast in the current study decomposition rate increased with addition of 10 %. But, the increase in salt content decreased the decomposition rate. It was thought that high concentrations of salt inhibit microbial activity but, up to a certain level of salt content may be expedite the litter decay by affecting the chemical processes. In salty and drought conditions microorganisms were exposed to osmotic stress, which cause drying and lysis of cells (Wichern et al., 2006). In addition, according to Wichern et al. (2006) long-term salt stress cause decrease in fungal diversity in the study of Van Bruggen and Semenov (2000) because of its sensitivity of salt.

As a consequence, both water and salt addition are increased the litter decomposition rate up to certain level. But high levels of water supply and salt content decreased the litter mass loss. It is thought that these were caused by direct and indirect inhibition effects of these substances on microbial activity. Because water and salinity conditions of fields are important for sustainability of plants and ecosystems, these factors should be examined detailed by field and laboratory experiments in order to determine limit values.

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