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Determination of the Relationships between Plant Distribution and Salinity in Water Source of Kırşehir Province, Turkey

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Abstract

Knowing the quality and content of the irrigation water used in agriculture irrigation management is very important in terms of the impact on soil-plant and the environment. All surface and underground water used in irrigation also contain salts dissolved in their plant bodies. Salts transmitted to the soil by irrigation water, affect the physical and chemical properties of the soil and as a result, they decrease in yield and quality. This study was carried out to investigate the salt contents of irrigation water in irrigated agricultural areas in Kırşehir province in the Middle Kızılırmak region and to determine the relationship between the amount of salinity in irrigation water and the distribution of plant. In the study, 120 irrigation water samples were taken from 40 different irrigation points, and the analysis of the mentioned samples was carried out at Chemistry Laboratory of Ahi Evran University Mucur Vocational High School. As a result, it has been observed that related to the contents of the water and the plants grown. The amount of salinity varied from 201 µS/cm to 1878 µS/cm. Grain plants such as barley, wheat and triticale are at the foreground in areas where salinity is high, while plants such as walnut, grape, bean and lentil are grown in places where salinity is low. In the studied areas, very high salinity was observed in 23 areas, while low salt concentration in 38 areas was observed. The remaining 59 regions were found to have moderate salinity.

Key words: Salinity, production pattern, irrigation water, Kırşehir, Middle Kızılırmak

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INTRODUCTION

Salinity is an important environmental factor that can severely inhibit plant growth and agricultural productivity (Lidia Vysotskaya et al., 2010). Salinity in irrigation water and in soils is one of the major abiotic constraints on agriculture worldwide, and the situation has worsened over the last 20 years due to the increase in irrigation requirements in arid and semi-arid regions such as those found in the Mediterranean area (Colla et al., 2010, Cirillo et al., 2016).

As a result of the drought and improper watering that is experienced throughout the world, soils have been exposed to serious wasteland and salinity. The increased salt density in the soil limits their activities by affecting the root regions of the plants (Karadavut, 1997). Above the limit value, it can make toxic effects on the plants and cause death of the plants which are very sensitive especially during the germination and early development periods (Lauter et al., 1981). Plants vary greatly in their tolerance to saline water. The extent of yield loss when plants are irrigated with saline water depends on several factors including soil type, drainage and the frequency, method and time of irrigation.

As plants grow, salt tolerance increases. However, it should be noted that the increase is a limit and that the amount of salt remains at the limit values (Levitt, 1980). When the limit values are exceeded, salt first disrupts the energy balance in the plant and slows down plant growth (Çulha and Çakırlar, 2011). While vegetative growth is reduced in plants, gas exchange decreases and yield decreases (Parida and Das, 2005).

All the physiological events such as diffusion, osmosis, plasmolysis and substance transport, which are necessary for the survival of the plants, can be done with the help of water and the properties of the water (Lauter and Munns, 1986). Therefore, water usage should be considered especially in irrigation studies and applications. In particular, the content of water is becoming more important. Unconscious and excessive irrigation practices in water use can lead to salinity problems (Karadavut, 1995). Sairam and Tyagi (2004), in their study, increased the salinity of the water in the plant with Ca 2^{+} is released and in order to create tolerance to the plant to limit the growth or inhibition of plant growth. Munns and Tester, (2008), the increase in salt amount of stomata and water transmission in the stomata are closed. It is suggested that in such environments salt-resistant or tolerant plants should be cultivated. It is stated that grain tolerance is better, but edible legumes and garden plants are weaker (Bernstren, 1974; Bewley and Black, 1981; Maaş, 1985). It is stated that the amount of salt has an effect on the cultivated plant pattern and it can change the botanical composition (Bernstein et. al., 1974; Karadavut, 1997; Yurtseven ve ark., 2001; Kanber et al., 2005)

Water used for irrigation always contains measurable quantities of dissolved substances which as a general collective term are called salts. These include relatively small but important amounts of dissolved solids originating from dissolution or weathering of the rocks and soil and dissolving of lime, gypsum and other salt sources as water passes over or percolates through them.

Knowing the quality and content of irrigation water used in agricultural areas in irrigation management is very important in terms of its impact on soil-plant and environment. All surface and underground water used in irrigation also contain salts dissolved in their plant bodies. Salts transmitted to the soil by irrigation water, affect the physical and chemical properties of the soil and as a result, they decrease in yield and quality. This study was carried out to investigate the salt contents of irrigation water in irrigated agricultural areas in Kırşehir province in the Middle Kızılırmak region and to determine the relationship between the amount of salinity in irrigation water and the distribution of plant.

MATERIALS AND METHOD

This study was carried out in areas where irrigation was carried out throughout the central district of Kırşehir.

In the study, water samples were taken from 40 wells, which were determined by simple random sampling, and water samples were sampled in three replicates with 120 samples. The study area is shown in Figure 1. Water samples were taken from the well as the point where the water out. Salinity values of water samples taken during the irrigation period between May and September were investigated. The analyzes of water were carried out in the chemical laboratories of the Mucur Vocational High School at Kırşehir Ahi Evran University. According to the salinity values of the irrigation water, plant species and varieties distribution in settlements were determined and the differences among salinity, plant species and varieties were determined.

The suitability of a water for irrigation will be determined by the amount and kind of salts present. With poor water quality, various soil and cropping problems can be expected to develop. Special management practices may be required to maintain full crop productivity. With good quality water there should be very infrequent or no problems affecting productivity. 0-250 µS / cm, water is the best quality waters. 251 to 750 µS / cm moderately saline water, from 751 to 2250 µS / cm highly saline waters and waters above 2250 µS / cm are evaluated in waters having very high water salinity problem (Baştuğ, 2018; Temizel, 2018). In addition, the correlation coefficient was used for the relationship between the variables. Correlation coefficient is said to be significant correlation between the significant variables. The data were analysed by using SPSS 21 V statistical package programme.

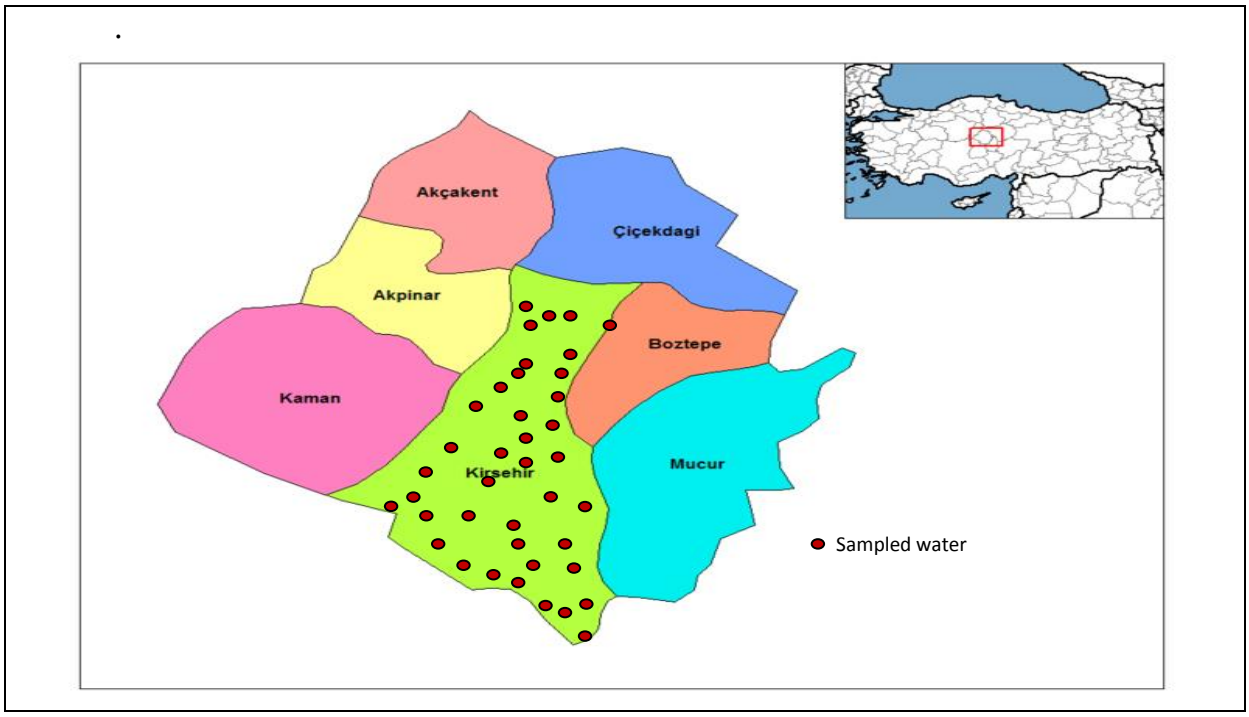

Figure 1. Location of water samples

RESULTS AND DISCUSSION

The data obtained in the study is given in Table 1. When the Table 1 is examined, it is seen that there is generally medium and high salinity in the study area. A high degree of salinity was detected in 14 irrigation centers, while the remaining 26 irrigation centers had moderate salinity. It is observed that wheat and barley plants are the main plant where high salinity is detected, and oat and rye plants are observed.

However, although rye plants have a high tolerance to salinity, the lower amount of cultivation in comparison with other plants is due to the fact that this plant has very high competition with other plants and suppresses the growth of other plants. It is observed that

these plants are also grown in places that are moderately salty. It should be noted here that these four plants are ecologically grown as a necessity. Because of the arid and semi-arid climate of Kırşehir province, there is not much change in plant species and diversity (Karadavut, 1997).

Table 1. Salinity in terms of settlements and growing plants

Vilages/ Grown products / ***Water salinity***			*walnut*	Wheat	Barley	Sugar beet	Grape	Maize	Oat	Rye	Trifolium	Lentil	Chickpea	Vetches	Apple	Sunflower	Potato	Cumin	Almond	Triticale	Tomato	Bean	Kiona	Safflower	Kavaklık
Karaboğaz Vilage	787.0 µs/cm	High		X	X	X	X										X								
Rahmalar Vilage	588.7 µs/cm	Moderate	X	X	X		X					X	X									X			
Saraycık Vilage	500.3 µs/cm	Moderate	X	X	X	X	X																		
Ecikağıl Vilage	753.7 µs/cm	High		X	X		X						X					X							
Değirmenkaşı Vilage	1343.0 µs/cm	High		X	X	X	X	X	X		X		X	X								X			
Kocabey Vilage	1548.0 µs/cm	High		X	X	X		X			X			X											
Akçaağıl Vilage	691.7 µs/cm	Moderate	X	X	X		X	X	X																
Güzler Vilage	618.7 µs/cm	Moderate	X	X	X				X		X				X						X				
Tepesidelik Vilage	1253.3 µs/cm	High		X	X		X	X		X			X												
Yukarı Homurlu Vilage	587.0 µs/cm	Moderate	X	X	X		X		X					X		X									
Dulkadirlikaraisa Vilage	566.3 µs/cm	Moderate	X	X	X		X					X	X							X					
Dulkadirliyarımkale Vilage	747.0 µs/cm	Moderate		X	X			X	X		X		X	X		X				X					
Tosunburnu Vilage	312.3 µs/cm	Moderate		X	X				X				X	X		X		X	X						
Taburoğlu Vilage	517.3 µs/cm	Moderat		X	X			X	X		X	X		X		X									

		e																							
Homurlu Üçler Vilage	521.0 µs/cm	Moderate		X	X				X		X		X			X									
Çuğun Vilage	692.3 µs/cm	Moderate		X	X		X	X	X		X		X	X		X									X
Körpınar Vilage	417.3 µs/cm	Moderate	X	X	X				X					X						X					
Homurlu Beşler Vilage	814.7 µs/cm	High		X	X		X		X																
Hashöyük Vilage	866.3 µs/cm	High		X	X				X		X		X	X		X									
Kartalkaya Vilage	683.7 µs/cm	Moderate		X	X				X	X															
Kırkpınar Vilage	487.3 µs/cm	Moderate		X	X				X	X															
Yeşiloba Vilage	434.3 µs/cm	Moderate		X	X				X				X							X					
Tatarilyas Yayla Vilage	325.0 µs/cm	Moderate	X	X	X		X		X				X												
Tatarilyas Kışla Vilage	375.0 µs/cm	Moderate		X	X		X		X				X												
Karıncalı Vilage	423.7 µs/cm	Moderate	X	X	X		X		X			X	X	X											
Sıdıklı Ortaoba Vilage	980.7 µs/cm	High		X	X	X	X						X												
Sıdıklı Büyükoba Vilage	1858.0 µs/cm	High	X	X	X	X	X		X		X										X	X	X		
Sıdıklı Darboğaz Vilage	1519.3 µs/cm	High		X	X	X																			
Kortullu Vilage	1096.0 µs/cm	High		X	X	X	X				X	X			X										
Yağmurlu Kale Vilage	273.3 µs/cm	Moderate		X	X																				

Kesikköprü Vilage	1578.7 µs/cm	High		X	X		X			X			X												
Kalankaldı Vilage	393.0 µs/cm	Moderate	X	X	X		X		X				X												
Sıdıklı Küçükoba Vilage	665.0 µs/cm	Moderate	X	X	X		X		X		X														
Karalar Vilage	784.3 µs/cm	Moderate	X	X	X		X		X																
Sevdiğin Vilage	463.7 µs/cm	Moderate		X	X			X				X	X												
Yağmurlu Armutlu Vilage	687.7 µs/cm	Moderate			X																				
Dedeli Vilage	426.0 µs/cm	Moderate		X	X		X				X			X	X	X								X	
Kuruağıl Vilage	1768.3 µs/cm	High		X	X	X	X			X	X	X	X												
Yeşilli Vilage	504.0 µs/cm	Moderate	X	X	X		X					X	X									X			
Yağmurlu Büyükoba Vilage	485.0 µs/cm	Moderate	X	X	X		X		X				X		X	X									

Apart from basic plants, it is possible to grow some other plants in small areas. Salinity is washed out in arid and semi-arid areas, and the soluble salts that go down to the ground go to the soil surface together with the ground water and increase the salinity by evaporation (Ergene, 1982; Kara, 2002). Due to this, there are differences in plant species and diversity (Kwiatowsky, 1998). The high tolerance of salt to the plants seen as the basic plant may be the result of this selectivity. Because, graminea are resistant more than legumes to soil salinity (Ashraf, 1994; Maas,1985)

It is seen that walnut plant is grown in medium salty areas in general and it is not cultivated in high salty areas. In the villages of Karalar and Sıdıklı Büyükoba, the situation is slightly different. However, it was seen that water are taken from wells for walnuts grown was not taken from irrigation wells. Sugar beet plants, which have a very important place among the cultivated plants, are generally grown in high salt areas. It is thought that the beet growing in these areas eliminates as metabolically and allows for great difficulties in terms of growth and development. However, the lower sugar content than the beet grown in neighboring provinces suggests that the source of irrigation may be irrigation water. Because of the salinity effects of plants as well as the reduction in the amount of fresh weight can be seen. (Yurtsever et al., 2001). High salt concentrations in the irrigation water effect on reducing of plant growth , limiting leaf expansion and changing the relationship between the aerial and root parts (Tattini et al., 1995; Cramer, 2002, Munns and Tester 2008).

In addition, biomass production is significantly reduced (Güngör et al., 1993). The effect of salinity may become more pronounced in growth and development stages. It has been observed that edible seed legume crops such as chickpeas and lentils, which are one of the important plants of the region, have the opportunity to cultivate in medium and high salinity values. In particular, the chickpea plant is highly resistant to salt in parallel with the belief that there is a high salt in places where chickpea farming is seen. In studies conducted, it is stated that salinity has positive contribution to the physiological structures of legume plants (Geren et al., 2011).

Plants increase their performance with physiological self-preservation instinct and show positive improvements beyond expectations (Mahdavi and Sanav, 2007). When the results are taken into consideration, the tolerance of salinity indicated for chickpea plant may be caused by the well-developed development of the plant as a result of the efforts of the plant. Lentil plants are less tolerant than chickpeas and can be affected faster and negatively more than salt stress. It is stated that the saltiness and salt water effect is higher in the arid and semi-arid areas where monocultures are made (Sivritepe ve Eriş, 1998; Sonneveld, 2001). On the other hand, when the irrigation culture is not sufficiently established and the wrong fertilization is added, the negative effect increases. (Sevgican, 2002; Hale and Orcutt, 1987).

Most of the salty soils are suitable for cultivation of crops, provided that they do not exceed a certain percentage (Ünlükara et al., 2006). In the case of very high salinity, the plants have low yields and the higher salinity starts with death. The harmful effect of salinity can vary depending on climatic conditions, light intensity, irrigation methods, plant species, plant cultivar or soil conditions (Tang et al., 2015).

It is stated that even if the growth and development is completed smoothly or with very few problems, the plants are very weak in terms of vitamins and minerals and may lose their nutritional value (Elçi, 2005). Since no specific study was carried out for the nutritional values of the grown products, it was not determined whether or not there was a change. However, it is understood that needs to be done. These deficiencies in the soils of such plants grown will create deficiencies in humans and animals which benefit from such plants, it is clear that the nutritional supplement should be taken. This problem is clearly stated in the studies on the subject. It is stated that barley plant produces very high energy value in saline soils and nutritional value decreases (El Shaer, 2010).

The results of the correlation analysis to determine whether there is a relationship between the salinity values in the waters and the plant species grown are given in Table 2. It was determined that the cultivation of barley, rye and triticale plants under high salt water was highly correlated. Sugar beet and chickpea plants can be grown in medium and high salt waters. Barley, rye and triticale plants are known as plants that like saline soils and can be grown successfully. However, the fact that sugar beet has such a relationship could not be explained. Walnut is a very important plant for the province of Kırşehir. In the study, it was understood that it can grow with success under moderate salty waters. Similarly, oats, vetch and safflower plants could be successfully grown in medium salt waters. In the other plants it has not been detected in any relationship. Accordingly, we can say that other plants can grow in suitable conditions for themselves.

Table 2. Plant species-salinity relationship

Plant Varieties	**Water-Salinity Plant Species "r" value**	**Significance**
Walnut	r=0,514**	Moderate salinity
Wheat	r=0,307	not significant
Barley	r=0,635**	High salinity
Sugar beet	r=0,494** r=0,466*	Moderate and High salinity
Grape	r=0,155	not significant
Maize	r=0,263	not significant
Oat	r=0,571*	Moderate salinity
Rye	r=0,648*	High salinity
Trifolium	r=0,096	not significant
Lentil	r=0,309	not significant
Chickpea	r=0,551* r=0,493**	Moderate and High salinity
Vetches	r=0,459*	Moderate salinity
Apple	r=0,168	not significant
Sunflower	r=0,197	not significant
Potato	r=0,226	not significant
Cumin	r=0,198	not significant
Almond	r=0,207	not significant
Triticale	r=0,530**	High salinity
Tomato	r=0,119	not significant
Bean	r=0,263	not significant
Kinoa	r=0,248	not significant
Safflower	r=0,528*	Moderate salinity
Podlar	r=0,384	not significant

CONCLUSIONS

In the study area, surface irrigation method is applied as irrigation systems (free, pans etc.). Excessive irrigation is carried out by farmers, due to the lack of adequate irrigation culture during surface irrigation. As a result, soil salinity due to salinity in the water increases. Fort this reason, changing of irrigation methods will give better salt control as change cultural practices. The harmful effect of the salt in the soil varies depending on the irrigation method, plant species and varieties, soil characteristics and ecological characteristics. Considering the ecological characteristics of the region, it was thought that it would be more appropriate to

make drip irrigation water because of the fact that both the amount of water consumed in free irrigation methods and the effect of increasing the salinity in the soil. Because, drip irrigation permits the use of water with a higher salt content than other delivery methods, since evaporation losses are minimal. The drip irrigation method also allows to continuously maintaining moist soil around the plant roots. It can also reduce the effects of salinity by continuously draining the salt to the edge of the wetted region.

As can be seen in the study, important relationships were determined between plant species and species and salinity. Therefore, it is advisable to select salt-resistant or tolerant plant species and varieties in high salinity areas. From this point of view, it can be recommended to grow cereals such as wheat, barley and rye, and edible legume plants such as chickpeas. It is also thought that the vetch plant, which is a legume fodder plant, can be successfully cultivated. As a result, this study is important because it is the first in the region. After that, it can be a guide for the studies related to the subject.

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