Turkish Journal of Agriculture - Food Science and Technology, 10(6): 1186-1190, 2022
DOI: https://doi.org/10.24925/turjaf.v10i6.1186-1190.5323

Turkish Journal of Agriculture - Food Science and Technology

Available online, ISSN: 2148-127X | www.agrifoodscience.com | Turkish Science and Technology Publishing (TURSTEP)

The Effect of Irrigation Water Quality and Leaching Ratio on Some Yield Parameters in Alfalfa (*Medicago Sativa* L.)

Sertan Avcı[1,a,*], Engin Yurtseven[1,b]

[1]*Department Farm Structures and Irrigation, Agriculture faculty, Ankara University, 06110 Dışkapı, Ankara, Türkiye*
[*]*Corresponding author*

A R T I C L E I N F O

Research Article

Received : 13/06/2022
Accepted : 27/06/2022

Keywords:
Alfalfa
Water quality
Leaching ratio
Yield
Salinity

A B S T R A C T

This study was carried out over the experimental fields of Ankara University, Faculty of Agriculture Gümüşdere Campus. Experiments were conducted with 3 different irrigation water salinity levels (S1=0.25 dS/m – control/tap water, S2=1.5 dS/m, S3=3.0 dS/m) and 4 different leaching ratios (LF1=10%, LF2 =20%, LF3 = 35%, LF4=50%) in randomized plots factorial experimental design with 3 replications. Totally, 36 (3×4×3) lysimeters were used in present experiments. Plant height, fresh and dry herbage yield and total ash content of alfalfa plants were analyzed. With increasing salinity levels, plant height, fresh and dry herbage yields decreased and total ash contents increased. Positive effects of leaching applications were observed, but this effect was not found to be significant. The main reason for this situation may be the necessity of a good drainage system for a good leaching application.

[a] *sertanavci@gmail.com* *https://orcid.org/0000-0003-2872-0563* | [b] *yurtsev@ankara.edu.tr* *https://orcid.org/0000-0001-6789-8810*

Introduction

Today, with increasing population, the need for agricultural production is also increasing. On the other hand, as a result of unconscious use of water and soil resources, which are the basic inputs of agricultural production, it becomes difficult to meet such needs. Irrigation water needed for agricultural production cannot be met in terms of quantity and quality as a result of the decrease in water resources and the pollution of existing resources by various pollutants. Irrigation applications with low irrigation water quality also add more salt to the soil. Increasing soil salinity is one of the main factors affecting yield.

In addition, changing ecological conditions due to global warming and the threat of drought cause the plant species on meadows and pastures, which are the source of plant gene stores, to disappear day by day (Genç Lermi and Palta, 2014). Alfalfa is one of the most important forage crops all over the world, due to its high adaptation rate to different climates, high forage yield and good forage quality in wide environmental conditions (Zhang et al. 2008). Also called the queen of forage crops, alfalfa has a higher forage value than almost all cultivated forage crops, and is a plant with high protein yield per unit area. In addition, dry and green herbage is the main component of feed rations for dairy cattle, beef cattle, horses, sheep, goats and other domestic animals (Abdel-Rahman and Abu-Suwar 2012).

Salinity is divided into two groups as primary (natural) and secondary salinity according to the reasons for its formation. Causes of primary salinity formation is weathering of the main rocks, salt reservoir oceans and climate factors (Munns and Tester 2008). The reasons for the occurrence of secondary salinity can be listed as intense irrigation in agricultural areas, elevation of groundwater that contain various salts to reach in the soil surface, overgrazing, opening of agricultural lands by destroying the natural vegetation of a region, and contamination of soils with chemicals that cause salinity (Pessarakli and Szabolcs 1999).

All water used for irrigation contains more or less salt depending on the nature of the source. Salts added to the soil with irrigation water and fertilizers and ultimately deposited in the root zone of the plant. After a certain period of time, these salts affect the physical and chemical properties of the soil and the yield of the plant (Bhumbla 1977; Somani 1991).

Leaching is an absolute necessity for sustainable irrigated agriculture to prevent the accumulation of soluble salts in the root zone. Leaching of salts from the root zone means increasing the salinity of the drainage water. For this reason, reducing the leaching rate, that is, increasing the irrigation efficiency, means reducing the salt load of the drainage water, although it means an increase in the salt concentration in the lower parts of the root zone. After all, irrigation management also means controlling the salinity of drainage water under certain conditions (Oster and Rhoades 1978).

In this study, it was aimed to reveal the changes in some yield parameters of alfalfa (Medicago Sativa L.) despite the decrease in irrigation water quality. In addition, the effect of leaching applications on soil salinity and yield were tried to be revealed.

Material and Methods

The research was carried out in the form of open cultivation in the experimental area surrounded by wire mesh in Gümüşdere Campus of the Faculty of Agriculture of Ankara University. As a result of the laboratory analysis of the soil that used in the research, 21% clay, 21% silt and 58% sand were obtained and the soil texture was determined as sandy-loamy-clay (SLC) according to these values. As a result of the analyzes made, the moisture content of the experimental soil, which is expressed as the starting soil, was found as 2.12%, pH value as 8.18, organic matter content as 1.33% and electrical conductivity value of saturation extract as 188.4 µS/cm. The field capacity value was found to be 23.06% in the trial soil, and the permanent wilting point was found to be 17.38%. Accordingly, the trial soil has low salinity and moderate alkaline reaction.

Three different irrigation water salinity levels were used. These are S1= 0.25 dS/m S2= 1.5 dS/m and S3= 3.0 dS/m. Ankara municipal tap water was used in the preparation of irrigation waters. The saltier irrigation waters (S2 and S3) were created by adding NaCl and $CaCl_2$ to the tap water. Tap water was determined as the first quality water (C1S1) according to USA Salinity Laboratory classification system. S2 treatments were C3S1 and S3 treatments were C4S1 class.

The study was carried out with 3 replications in randomized plots factorial experimental design. Four different leaching ratios (LR1=10%, LR 2=20%, LR 3=35%, LR 4=50%) were used in present experiments. In this way, the experiment consisted of 36 (3x4x3) lysimeters in total. PVC lysimeters with a diameter of 40 cm and a depth of 115 cm were used in the study.

Lysimeters were filled with the soil that were taken from the experimental fields of the Faculty of Agriculture, sieved and for which the analysis was given. During the filling phase, care was taken to add the same amount of soil to all lysimeters and to preserve the natural volume weight as much as possible. In addition, approximately 5 cm thick sand / gravel was placed at the bottom of the lysimeters to facilitate drainage water flow. Lysimeters were filled until there was a gap of about 5-6 cm from the top.

Irrigation was carried out with a drip irrigation system. Irrigation waters were prepared in a 300 liter tank according to salinity levels and conveyed to the system with the help of a pump. Irrigation was done using self-regulating spider type drippers placed in each lysimeter. The cross-section of the experimental setup is given in Figure 1.

Irrigation times were determined by associating the vegetative development of the plant with the harvest dates. In order to determine the leaching volume values during irrigation applications and to put them into practice, the following procedures were carried out, respectively: At the time of irrigation, the soil moisture values were determined by the gravimetric method from the spare lysimeters with the TDR readings, and the irrigation water requirement value (LR1), which was calculated as the completion of the existing moisture to the field capacity, was applied by adding 10% leaching volume. After the irrigation water was applied, it was waited for a while and the leakage of the drainage water was observed. When the drainage water comes out, this amount of water is taken into account as LR1, and the leaching volumes that need to be applied to other subjects (LR 2, LR 3 and LR 4) were calculated and the depleted irrigation waters were completed.

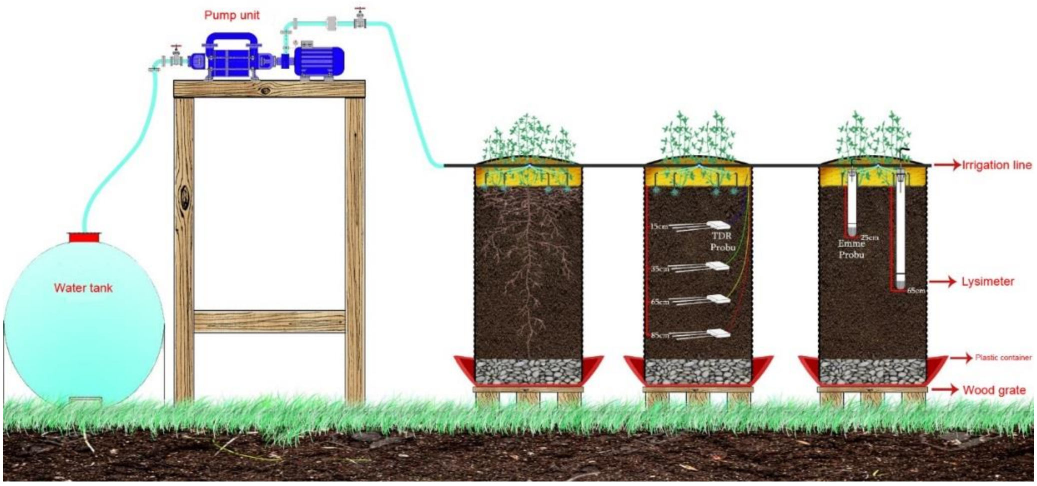

Figure 1. Experimentation layout

In order to determine the yield of alfalfa, grass form was cut. The grass shape was made so that approximately 10% of the alfalfa leaves after flowering, and cut 5-7 cm from the surface. During the breeding period, alfalfa plants were cut 5 times. Green herbage yield was calculated for each lysimeter and samples were dried in ovens at 70°C to a constant weight for dry matter content (Martin et al., 1990).

Total ash; The total mineral content of the harvested product was determined by burning it in a muffle furnace at 550°C until it reaches a constant weight (Kacar 1972).

Results and Discussion

Plant Height

Plant heights were measured in weekly periods starting from May. The tallest 3 plant heights were measured in each lysimeter, including the replications for each treatment. Graph obtained as the average of the salinity treatments, regardless of the harvest periods of the data obtained during the growing period is given Figure 2. The graph obtained by using the averages of the leaching treatments is given in Figure 3.

It was seen that there was a decrease in plant height with increasing salinity levels. This decrease was 4.3% for T2 and 7.5% for S3 as compared to S1. The highest plant height reduction was seen in the highest salinity level (S3). This decrease was 7.5% according to the lowest salinity level (S1) and 3% according to the medium salinity level (S2). The main reason for this is the increase in the salinity components transferred to the soil profile with the increase in the salinity level of the irrigation water and the inability of the plant to get the nutrients it needs due to the effect of increasing osmotic pressure. This effect is more pronounced at S3 salinity level because the salinity level used was higher than the threshold salinity value (2 dS/m) of alfalfa.

It was seen that the plant height increases with leaching applications. This increase was 1.8% between LR1 and LR2 treatments and 1.2% between LR2 and LR3 treatments. No significant increase was seen between LR3 and LR4 treatments.

Green and Dry Herbage Yield

In the study, 5 cuts were made during the growing period. The obtained green and dry herbage yield graphs are shown in Figure 4 and Figure 5, respectively, according to salinity treatments.

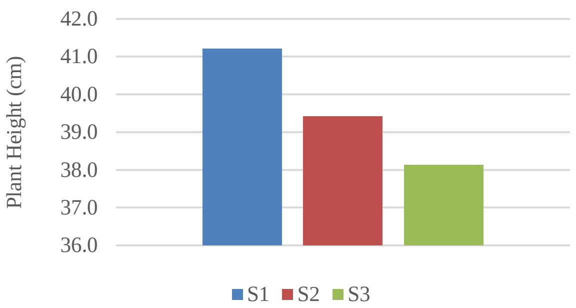

Figure 2. Variation of plant height with salinity

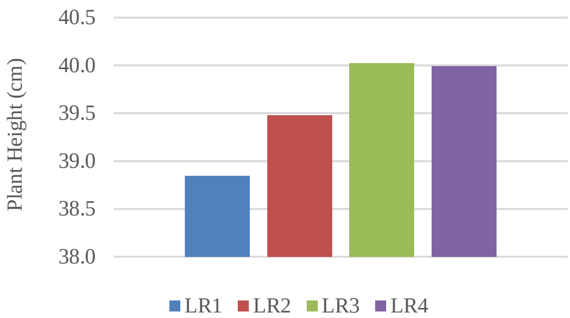

Figure 3. Variation of plant height with leaching ratio

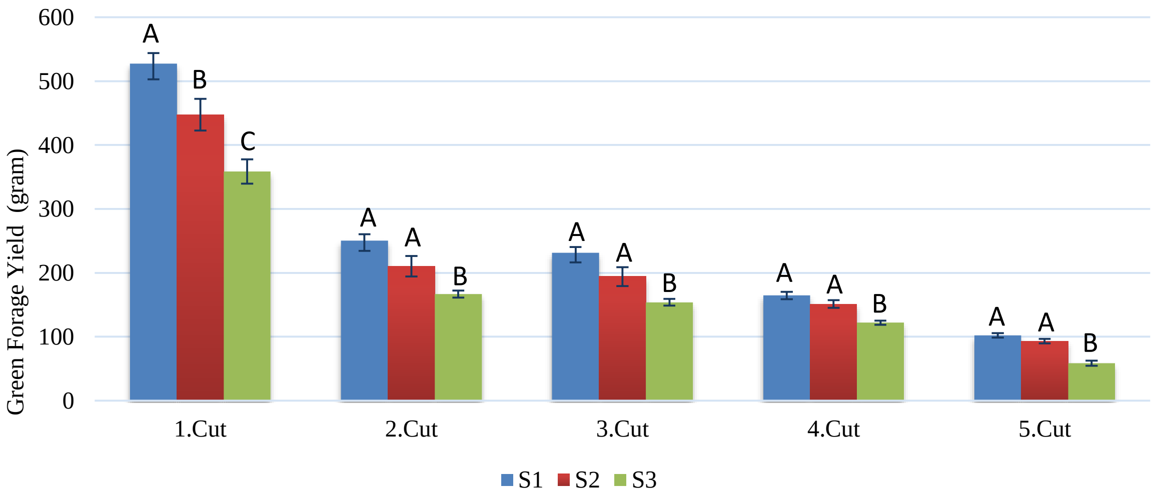

Figure 4 Variation of green harbage yield with salinity

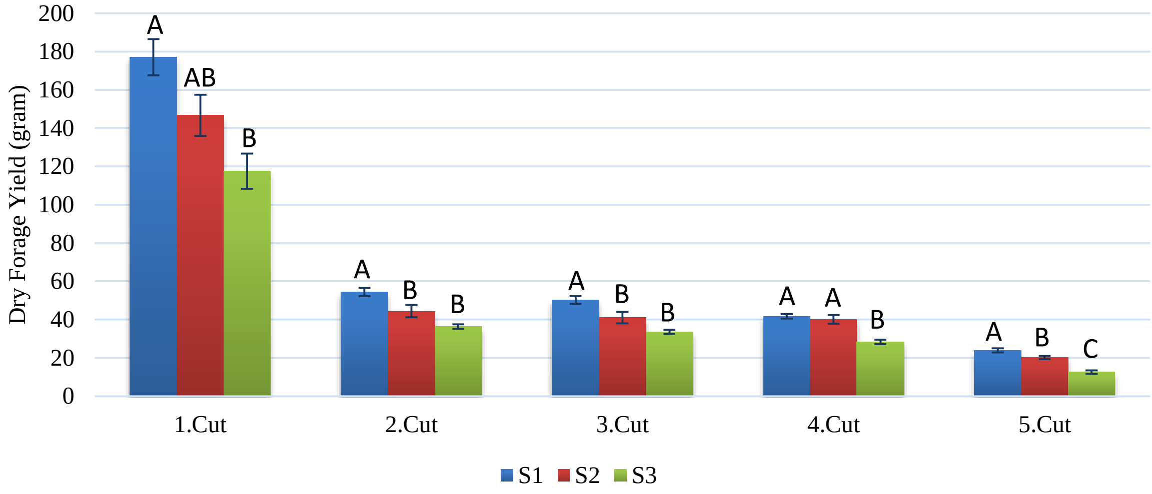

Figure 5. Variation of dry harbage yield with salinity

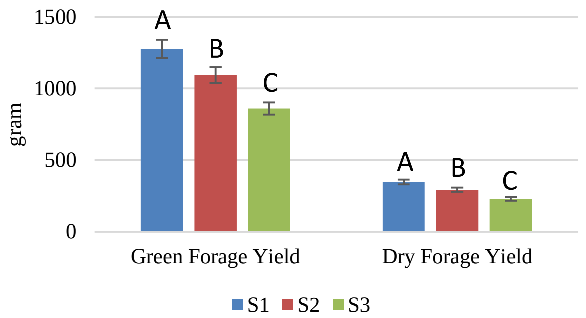

Figure 6. Variation of total green and dry harbage yield with salinity

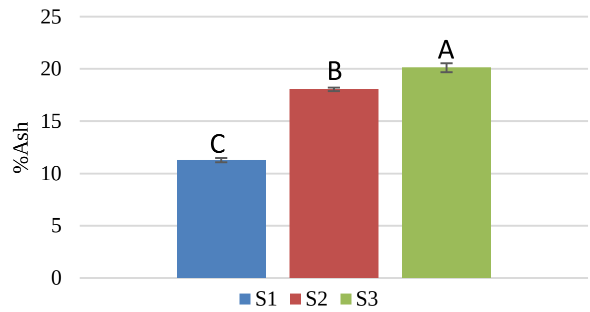

Figure 7. Variation of average ash contents with salinity

When the graphs are examined, it was seen that the green herbage yields decreased in every cut. In the analysis of variance, the effect of salinity was related to the green herbage yield. Considering the effects of salinity treatments, green herbage yields decreased as irrigation water salinity increased. This effect is clearly seen especially in the first cut and total green yield (Figure 6). As Yurtseven and Sönmez (1996) stated, depending on the salinity of the water with irrigation, the salinity increased in the soil and decreased the yield and quality over time. Although it was seen that the green yield decreased with the increasing salinity levels in the crops after the first cutting, the difference between S1 and S2 treatments was not significant. However, being constantly exposed to the same effect throughout the season caused a decrease in the total green yield (Figure 6). Excessive amount of NaCl slows down the dry matter production in the plant and reduces the green yield (Altherton and Rudich 1986).

When the dry herbage yields are examined, it was seen that the dry herbage yield decreased in all cuts. Especially with the start of intensive irrigation, there was a significant decrease after the first cut. In general, while the highest yield was obtained in S1, dry herbage yield decreased with the increase in salinity levels. While there was no differentiation between S2 and S3 treatments until the 3rd cutting, dry herbage yield reached the lowest value in S3 treatment in the following cuttings. Considering the total dry herbage yields, it was seen that there was a decrease in yield with the increase in salinity levels, as in the green yields (Figure 6).

Leaching treatments do not appear to have a significant effect on yield. This situation is due to the characteristics of the trial soil. Gungor et al. (1993) in their study in which they examined the effect of irrigation water salinity on the chemical composition of soybean plants, found that the effect of leaching ratio on yield was insignificant.

Total Ash

In order to reveal the effects of irrigation water quality and leaching ratios, which are the subjects covered in the study, on mineral substance accumulation in alfalfa, total ash analysis was performed. The total ash content in the plant material is also an indicator of the total amount of mineral matter accumulated in the plant material (Kacar 1972). The variation of average ash contents with salinity levels is given in Figure 7.

As a result of the plant quality analysis, it was found that the total ash content increased with the increase in salinity levels. In other words, due to the increase in salinity, the mineral substance content of the soil solution increased and the plant took more mineral substance into its structure for this reason. A decrease in the ash content was observed with the increase of leaching ratios. However, this amount of decrease was found to be insignificant.

Conclusions

For alfalfa cultivation, especially if the yield parameters are taken into account, the use of low quality irrigation water during a growing period has a certain effect on the yield. However, if the application is continued in the same way in the following years, there will be a significant decrease in the yield parameters. Especially, the use of irrigation water with electrical conductivity higher than the salinity threshold value will have a more pronounced negative effect on yield.

There was no significant effect of leaching applications on alfalfa yield. For efficient leaching applications, the salinity parameters should be moved below the effective root depth, especially in plants with a high root depth such as alfalfa. The washed water must be removed from the land with an effective drainage system. If there is no effective drainage system in lands with high ground water and low effective soil depth, leaching applications are not recommended in alfalfa cultivation.

References

Abdel-Rahman EM, Abu-Suwar AO. 2012. Effect of seeding rate on growth and yield of two alfalfa (Medicago sativa L.) cultivars. International Journal of Sudan Research Vol. 2, No. 2

Anonymous. 1954. Diagnosis and improvement of saline and alkali soils. (Ed: L.A. Richards) US Salinity Lab. Agric. Handbook No:60.

Atherton JG, Rudich J. 1986. The Tomato Crop: A Scientific Basis for Improvement. Chapman and Hall,London and New York, 1986 Pp.

Bhumbla DR. 1977. Chemical composition of irrigation water and its effects on crop growth and soil properties. In: Arid Land Irrigation in Developing Countries Environmental Problems and Effects. Pergaman Press. Oxford, pp: 279-287.

Genç Lermi A, Palta Ş. 2014. Bartın ekolojisindeki Medicago polymorpha L.'nin bazı bitkisel özellikleri üzerine araştırma. Çanakkale Onsekiz Mart Üniversitesi Ziraat Fakültesi Dergisi, 2(2): 141-149.

Güngör Y, Yurtseven E, Artık N. 1993. Sulama Suyu Tuzluluğunun Soya Kimyasal Bileşimi Üzerine Etkisi. Tübitak, Doğa Tr. J. Of Agricultural And Forestry, 17, 443-449.

Kacar B. 1972. Bitki ve Toprağın Kimyasal Analizleri: II. Bitki Analizleri. A.Ü.Ziraat Fak. Yayınları No.453, Uyg. Kılavuzu No.155, 646s., Ankara.

Martin RC, Voldeng HD, Smith DL. 1990. Intercropping corn and soybean for silage in a cool-temperate region: yield, protein, and economic efects. Field Crops Res. 23:295-310.

Munns R, Tester M. 2008. Mechanisms of Salinity Tolerance, Annual Review of Plant Biology, 59, 651¬681.

Oster JD, Rhoades JD. 1978. Calculated drainage water compositions and salit burdens resulting from irrigation with river waters in the Western United States. J. of Environmental Quality, 4:73-79, 1978.

Pessarakli M, Szabolcs I. 1999. Soil Salinity and Sodicity as Particular Plant/Crop Stress Factors, Handbook of Plant Crop Stress, ISBN 0-8247-1948-4, New York, 1198 p.

Somani L. 1991. Crop Production with saline water. Agrobotanical Puplishers (India), IVE-176 J.N. Vyas Kagar, Bikaner 334 001.

Yurtseven E, Sönmez B. 1996. Sulama suyu tuzluluğunun domates verimine ve toprak tuzluluğuna etkisi. Tr.J. of Agriculture and Forestry, 20 (1) 27-33.

Zhang T, Wang X, Han J, Wang Y, Mao P, Majerus M. 2008. Effects of between-row and within-row spacing on alfalfa seed yields. Crop Sci., 48:794-803