THE POTENTIAL OF JUTEORC (*CORCHORUS OLITORIUS* L.), A GEOTEXTILE MATERIAL, UNDER SALINE SOILLESS CULTURE CONDITIONS IN TURKEY

AKAT SARACOGLU, O.

Greenhouse Program, Bayindir Vocational School, Ege University, 35840 Bayindir-Izmir, Turkey
(e-mail: ozlem.akat@ege.edu.tr; phone: +90-232-581-6317; fax: +90-232-581-7330)

(Received 5th Aug 2021; accepted 28th Oct 2021)

Abstract. The present study was conducted to determine the possibility of the employed of jute (*Corchorus olitorius* L.), a natural fiber used as geotextile cover material, under saline soilless culture conditions, which constitute of the biggest problems in agriculture. The effect of the jute material employed in Mexican marigold (*Tagetes erecta*) cultivation under saline soilless conditions was determined. For this purpose, the Mexican marigold cultivation was tested in a pot experiment under greenhouse conditions for two growth periods in İzmir, Turkey. The salinity levels in the experiment were compared based on whether the treatment included the jute material (G1) or did not include jute material (G0). The measured salinity level of Hoagland nutrient solution employed the irrigation and fertilization of plants was one of the studied factors and was considered as control (S1). The measured EC (electrical conductivity) level of Hoagland nutrient solution was increased by 1 dS m^{-1} (S2) and 2 dS m^{-1} (S3) with stock NaCl solution, and 3 salinity factors were tested. According to the results of the present study the highest salinity was observed in the G0 group without jute cover. It was demonstrated that the jute cover on the pot media reduced the mean salinity concentration in growth medium by 22.56%. This finding was associated with the ability of the jute material to hold the salt in the nutrient solution, preventing spread of the salinity around the root zone.
Keywords: *agrotextiles, root zone, salt removal, growth medium, electrical conductivity (EC)*

Introduction

Technical textile materials improve the yield, quality and safety of agricultural products due to their excellent environmental resistance, mechanical properties, easy processing and durability properties (Agrawal, 2013). Geotextile is a combination of the terms geo, meaning earth-soil, and textile. Geotextiles are permeable geosynthetic textile materials employed as foundation material in buildings and in geotechnical engineering as an integral part of projects, structures and systems along with soil and rock. Geotextile products are expected to possess at least one of five functions: separation, reinforcement, filtration, drainage and barrier. Geotextile products should have tensile, bearing and tear strength, a certain stiffness, resistance to elongation under load, air and water permeability, chemical and ultraviolet (UV) resistance (Horrocks and Anands, 2003). Geotextile products are generally employed in road construction, parks, railways, building foundations, concrete grounds, pavement applications, underground pipes and channels, storage areas, airports, ports and sports fields, drainage and filtration systems, drainage pipes, drainage channels, surface drainage, building drainage, hydraulic structures, coastal protection structures, dams, river beds and canal protection, artificial ponds, water dams and garbage and waste landfills (Mecit et al., 2007).

Jute is a geotextile material employed in various textile and industrial applications. Jute is not employed only in the traditional sense such as pulp and paper, but also in the manufacturing of other value-added products such as geo-textiles, composites and home textiles. Jute is an annually renewable energy source with high biomass production per

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2001_397411

land unit. It is biodegradable and its byproducts could be easily disposed of without leading to environmental hazards (Islam and Ahmed, 2012). In addition to packaging material, jute is employed in the wood industry as flooring substitute, home furniture, and fiber composite, and in paper and automotive industries, soft suitcase production, and increasingly in garment industry (Chavan, 2001). In addition to environmental friendly and biodegradability properties, the employed of natural fibers such as flax, hemp, kenaf, jute and kapok as cost-effective synthetic fiber alternatives has increased (Çavuş et al., 2020).

All employed jute materials are biodegradable and recyclable. Jute, a vegetable material, decomposes in the soil when root and leaf residues are mixed with the soil and serves as organic macro and micronutrients for other plants; thus, reducing use of fertilizers, which are among important agricultural inputs (Islam and Ahmed, 2012). Jute is preferred in agricultural cultivation since it is environmentally friendly, does not produce toxic substances and all stages of production, employed and disposal are inexpensive (Sarkar, 2008). Geotextile materials have a significant potential in minimizing pre-harvest and post-harvest crop losses, increasing productivity and reducing costs in agricultural industry. Furthermore, the employed of these high value-added agricultural products significantly increases agricultural yield (İlhan, 2015). In recent years, geotextile material used for landscape design weed control does not restrict plant growth. By using geotextile cover, weed control is carried out, and water consumption by weeds is prevented by protecting the design. The water loss that will occur as a result of evaporation on the soil surface can also be minimized (Çakar et al., 2019; Çakar, 2021).

Salinity is a problem that limits vegetative production worldwide in agriculture and has the potential to reduce the visual quality of ornamental plants (Veatch-Blohm et al., 2014). As the most ornamental plants are produced in greenhouses in Turkey., the problem of salinity-limiting cultivation is an important matter (Akat et al., 2019). At least one third of the global agricultural land is saline (Carter et al., 2005; Cassaniti et al., 2009) and it is possible that the surface area affected by salinity increases every day (Munns and Tester, 2008; Shibli et al., 2007). Salty water is employed in irrigation where quality water is not sufficient for irrigation. Thus, the increase in soil salinity over time reduces plant growth, yield and product quality (Villora et al., 2000; Wahome et al., 2000). However, despite the fact that salinity inhibits plant growth, plants have a certain level of tolerance to salinity (Grattan, 1993). This is called salt tolerance and described as the ability of plants to withstand high salinity at the root zone. Salt tolerance of plants is affected by the nature of salinity, the plant, soil, climatic factors and the correlations between these variables, and was described as the proportional decrease in yield due to various salinity levels (Kotuby-Amacher et al., 2000). Salinity at concentrations that exceed the plant salt tolerance inhibits development, reduces flower quality (Sonneveld, 2000), leads to deformation and drying in leaves (Villarino and Mattson, 2011), and death in plant organs in later stages (Cassaniti et al., 2012). Similar to traditional cultivation, salinity problems arise in soilless growth systems, due to the accumulation of salt in the nutrient solution around plant roots over time (Sonneveld and Voogt, 2001). It is known that water used for solution preparation, other than nutrient solutions, often has high salinity (Sonneveld, 2000). Thus, due to the very small root volume in soilless culture, salt accumulation is faster in the root zone when compared to traditional agriculture and a serious salinity problem could be observed (Sonneveld et al., 1999). However, due to the employed of high-quality water in human

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2001_397411

consumption in irrigated agriculture fields, it may be necessary to use bitter, saline or recycled water of insufficient quality and high electrical conductivity (EC) in agriculture (Villarino et al., 2011; Cassaniti et al., 2013). The availability of low-saline irrigation sources, the employed of alternatives such as recycled wastewater increased interest in the employed of innovative facilities and water management strategies to reduce the negative effects of salt and specific ions. It was emphasized that these types of low-quality water would not harm plant growth, yield and quality (Grive et al., 2013). Thus, the employed of techniques that reduce the effects of low-quality water and high salinity on plant growth became necessary. There are several methods and techniques that reduce the negative effects of salinity in agriculture (Kanber et al., 2005; Machado and Serralheiro, 2017; Karaoğlu and Yalçın; 2018). Soil reclamation is a technique that reduced salinity. This is perhaps the most effective and long-lasting way to minimize or even eliminate detrimental effects of salinity. However, besides being slow and expensive, the process requires large quantities of quality water and effective soil drainage. The other technique is maintenance leaching application. Leaching is absolutely necessary to achieve long-term successful irrigation. A leaching fraction (LF) of 15% to 20% is commonly recommended (Hoffman and Genuchten, 1983). The required leaching frequency depends on the degree of salinization and evaporation demand and the salt sensitivity of the crops. Another technique is irrigation method, management (irrigation and soil fraction) and soil cultivation, water use (WUE) and utilization, by influencing its salt and salt and water salinity, and to design and target water salinity from the front. Besides, the use of biofertilizers can also reduce salinity effects on vegetables and reduce soil salinity (Machado and Serralheiro, 2017). The present study aimed to present an alternative to the existing techniques that employed an innovative facility and water management strategy. Although jute is frequently employed in agriculture, there are no previous studies on the employed of this material in saline agricultural conditions. The present study aimed to develop an alternative method to reduce the salinity problem in the growth media or irrigation water, which is one of the most significant problems in agriculture, with an environment-friendly approach.

Materials and methods

The present study was conducted between 2018 and 2020, in a polyethylene (PE) greenhouse located at the Ege University Bayindir Vocational Training School in Izmir, Turkey (38 ° 12’ 09.9” N, 27 ° 40’ 20.8” E), during two consecutive production seasons to determine the possibility of the employed of jute, a geotextile material, in salinity growing conditions. To investigate the impact of salinity, jute, a natural geotextile material, was used since it does not lead to the accumulation of harmful chemical compounds in plant nutrients (Daira et al., 2020) and is an environment-friendly product (Annapoorani, 2018; Anonoymus, 2021). Certain properties of the jute fabric employed in the trials are presented in *Table 1*. Results given in *Table 1* were obtain from tests. Tests were done according to ISO 3801 and ISO 2060.

Table 1. *Jute material of properties*

Material	Weight	Warp count cm^{-1}	Weft count cm^{-1}
Jute	310 g m^{-2}	11	11

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2001_397411

The plant material included Mexican marigold (Tagetes erecta ‘Proud Mari Yellow’) seedlings with moderate salt resistance (Sayyed et al., 2014) and 3-4 true leaves and procured from a seedling firm (*Fig. 1*).

Figure 1. *Mexican marigold seedlings*

Mexican marigold (*Tagetes erecta* ‘Proud Mari Yellow’) which has a high importance in trade because of its flowers, in landscape designs, medicine, cosmetics and textile industry, fowl breeding, keeps its flower during summer, annual, summer-growing plant (Patel et al., 2019). Plastic pots (measuring 75 cm × 25 cm × 16 cm, with a volume of 24 L) were used for the cultivation. The number of the pots is six in each treatment. A total of 108 plants were planted in balcony pots at a distance of 25 cm × 25 cm (3 plants per pot). Plants were cultivated under soilless culture conditions. A 1: 1 peat and perlite mixture, which is common in Turkey, was preferred as the plant growth media (*Fig. 2*).

Figure 2. *Growth media (perlite + peat)*

The study, where the effects of the certain parameters on jute material were investigated, was conducted in 3 replicates with a randomized blocks trial design in two cultivation seasons in two consecutive years. Plant nutrients required by plants were added to irrigation water as a nutrient solution (Maloupa, 2002; Sevgican, 2002). An irrigation controller (Rainbird, models ESP-RZX Indoor Controller) and electro moto-pomp was set up to operate drip irrigation system. Pressure regulator, manometer, meter, filter, electric (selenoid) valve were used at the pump output and an automation

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2001_397411

control unit was created to provide automation of irrigation. This automated irrigation system was used in the distribution and application of the Hoagland nutrient solution (Hoagland and Arnon, 1950). For this purpose, a drip irrigation system with a pressure regulator dripper that provided 2.3 liters h^{-1} flow per plant on a 16 mm diameter polyethylene (PE) pipe was employed. Three nutrient solution tanks were used to provide 3 salinity levels in irrigation applications.

Three salinity levels were created to determine the effects of jute on plant growth in salinity conditions. In soilless cultivation, the measured electrical conductivity (EC) of the Hoagland nutrient solution prepared for the irrigation and fertilization of the plants was accepted as the control-K (S1) application as one of the salinity levels in the study. The content of the modified standard Hoagland nutrient solution (mM) included a combination of 12 N-NO3, 3.8 N-NH4, 2.8 P, 8.4 K 3.5 Ca, 1.4 Mg, 9.5 Na, 8.0 Cl, 2.7 S, 0.04 Fe chemicals (Alberici et al., 2008). The control salinity (C:S1) was increased by 1 and 2 dS m^{-1} for each application, respectively to obtain 2 salinity levels [C + 1 dS m^{-1} (S2), C + 2 dS m^{-1} (S3)]. Thus, a total of 3 salinity levels were tested in the study. To determine the reaction of jute to salinity, salinity levels in groups other than the control were obtained with a stock NaCl solution. The growth medium in the pots in the study area was covered with 25 cm x 75 cm jute clothes based on the pot size (*Fig. 3*).

Figure 3. *Jute cover material*

Small crevices were created on the jute cover at 25 cm intervals that equaled to the planting distance. Three plants were planted in each pot (*Fig. 4*).

Figure 4. *Covering the pots with jute*

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2001_397411

The test area was organized by allowing the plants to pass through these crevices in the pots. Pot cultivation applications with (G1) and without jute cover were compared. In the study, to determine the effect of salinity on jute material, electrical conductivity (EC) and pH levels of the jute material were measured at the end of both cultivation periods. pH measurements were conducted based on ISO 3071:2005 and AATCC 81-2006 (Oktav Bulut and Akçalı, 2013). Salinity in the jute material was also measured based on ISO 3071:2005 and AATCC 81-2006 methods. At the end of both production periods, two whole cover samples were taken from each repetition of jute materials covering a total of 36 pots (the remaining 36 of the 72 pots are not covered with jute material). Geotextile material samples were collected from salinity groups at the end of the trial period and first divided into 1 g using a precision scale (Ohaus Adventurer Analytical Balance, models AR-1530). Acetic acid was added to samples to obtain pH 5.5 and they were transferred into 50 ml purified water. The samples were stirred for 30 min with a magnetic stirrer (WISD magnetic stirrer, models WiseStir MSH-20A) and filtered. pH was measured with a pH meter [WTW, Ph 3210 (330i) pH meter set (portable)] and EC (electrical conductivity) was measured with a conductivity meter (WTW, Cond 330i conductivity meter set).

To determine the salt accumulation in the growth medium, EC and pH levels were measured at the end of both cultivation periods. The cultivation medium samples were collected and purified water was added to the samples and they were stirred in a magnetic stirrer (WISD magnetic stirrer, models WiseStir MSH-20A) for 30 min and filtered. PH measurements were conducted with a calibrated pH measurement device [WTW, Ph 3210 (330i) pH meter set (portable)] and EC measurements were conducted with an electrical measurement device (WTW, Cond 330i conductivity meter set) (Riley, 1986; Çeltek, 1992).

In order to determine the effect of geotextile application on salinity levels, two-way anova analysis was used. In this analysis, the effect of two independent variables on one dependent variable was investigated. The dependent variable in this analysis is the EC value, which indicates the salt concentration. The independent variables are salinity levels (S1:Control, S2: Control + 1 dS m^{-1}, S3: Control + 2 dS m^{-1}) and geotextile usage conditions (1: without geotextile cover, 2: with geotextile cover). It was aimed to investigate the effect of both salinity levels and geotextile employed on EC value together with two-way anova analysis. The effect of independent variables on the dependent variable was determined by the interaction test. For this purpose, Partial Eta Squared values were examined. These values indicate the effect superiority of the independent variables. These values take the maximum value of 1. The fact that these values are close to the value of 1 indicates that this independent variable is so effective (Kalaycı, 2006).

The study datas were analyzed with the IBM SPSS Statistics (v21) software package program.

Results

The mean EC and pH levels were measured in the nutrient solutions that were administered to obtain various salinity levels in the trial groups in different cultivation periods (*Table 2*).

It was determined that the measured EC of the Hoagland nutrient solution added to the irrigation water, and the salinity concentrations in S1 (control), and S2 and S3 groups, the salinity applications for which were obtained by increasing the salt

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2001_397411

concentration of the control group by 1 dS m^{-1} and 2 dS m^{-1}, respectively, in both cultivation periods were at recommended levels. According to *Table 2,* the mean EC levels in the nutrient solution remained between 1.70 dS m^{-1} and 3.70 dS m^{-1}, and pH levels remained between 6.20 and 6.66. The salt application was 59% more in S2 and 118% more in S3 when compared to the control group (S1).

Table 2. *The mean EC and pH levels in nutrient solutions administered to obtain various salinity levels in the trial groups in different cultivation*

Salinity application	**Salinity (EC: dS m^{-1})**	**pH**
S1 (Control)	1.70	6.40
S2 (Control + 1 dS m^{-1})	2.70	6.60
S3 (Control + 2 dS m^{-1})	3.70	6.20

The jute material EC (*Fig. 5*) and the jute material pH (*Fig. 6*) were measured after the jute cover material was removed from the pot media after each cultivation period for different salinity concentrations. According to one-way ANOVA analysis, there is a significant difference at the 5% significance level in terms of EC values compared to different salt concentration media (F = 9.987, p = 0.000).

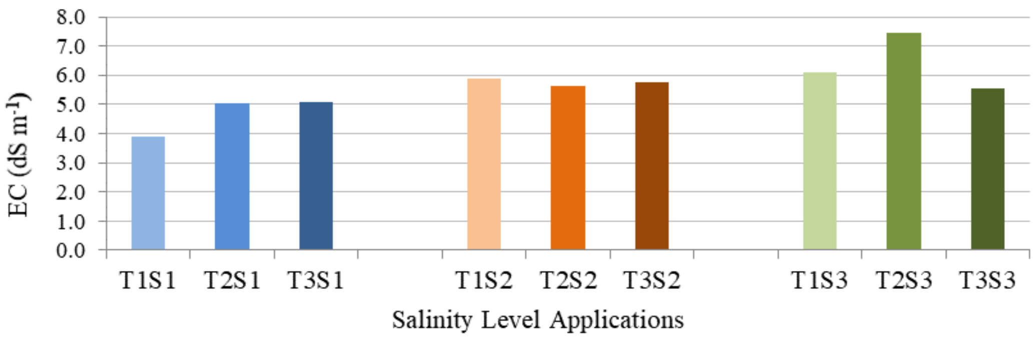

Figure 5. *The jute material EC measurements in salinity applications*

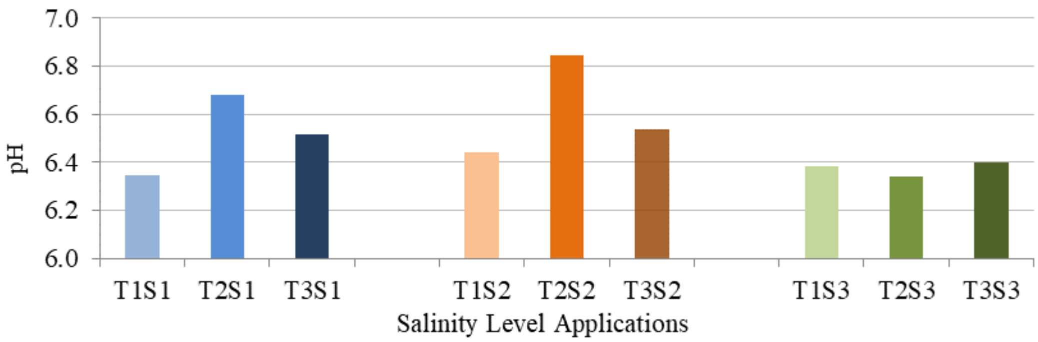

Figure 6. *The jute material pH measurements in salinity applications*

The review of the *Figure 5* would reveal that the lowest EC measurements were observed in S1 (control) group jute material samples, and the highest measurements were observed in the S3 group with the highest salinity. The mean jute cover material

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2001_397411

EC measurements were 4.68 dS m^{-1}, 5.76 dS m^{-1}, 6.36 dS m^{-1} in S1, S2 and S3 groups, respectively. The EC measurements conducted on the jute cover material on the salt administered growth media in the were 28% higher in the S2 and 36% higher in the S3 groups when compared to the control.

The review of the *Figure 6* would demonstrate that the mean jute material pH scores for different trial groups varied between 6.38 and 6.61. These pH measurements conducted on the jute material were similar to the mean pH score for the saline nutrient solution administered to the trial groups (6.20-6.66). According to one-way ANOVA analysis, there is a significant difference at the 5% significance level in terms of pH values compared to different salt concentration medias ($F = 6.524$, $p = 0.004$).

To determine whether the geotextile cover material had an impact on the reduction of the salinity in the medium, the salinity concentrations (EC: dS m^{-1}) were measured in the growth media. The two-way analysis of variance (ANOVA) was conducted to determine whether there were statistically significant differences between the salinity (EC: dS m^{-1}) of different growth media based on salinity applications and the employed of the geotextile cover material.

Descriptive statistics were made that demonstrate the mean salinity levels for both cultivation periods in plant growth media on salinity applications (*Table 3*).

Table 3. *Salinity levels of plant growth media based on cultivation periods*

Dependent variable: EC2 (dS m^{-1})				
Salinity-II (S2)	**Geotextile cover**	**Mean**	**Std. deviation**	**N**
S1 (Control)	Without cover **(G0)**	4.1117	.89076	6
	With cover **(G1)**	3.1183	.59314	6
	Total	3.6150	.88864	12
S2 (Control + 1 dS m^{-1})	Without cover **(G0)**	5.9433	1.19928	6
	With cover **(G1)**	4.6233	1.16011	6
	Total	5.2833	1.31936	12
S3 (Control + 2 dS m^{-1})	Without cover **(G0)**	6.8417	1.78599	6
	With cover **(G1)**	5.3333	1.57853	6
	Total	6.0875	1.78969	12
Total	Without cover **(G0)**	5.6322	1.72076	18
	With cover **(G1)**	4.3583	1.46122	18
	Total	4.9953	1.70076	36

According to *Table 3,* the lowest mean salinity levels in growth media with geotextile cover material were 4.11 dS m^{-1}, 4.62 dS m^{-1}, and 5.33 dS m^{-1} for S1, S2 and S3 groups, respectively. Based on the mean cultivation period figures, the highest salinity was 5.63 dS m^{-1} in G0 group without geotextile cover and the lowest salinity was 4.36 dS m^{-1} in G1 group with geotextile cover. Thus, the mean salinity in the growth media decreased by 22.56% with the application of jute cover material. It was determined that in all growth medium salinity applications (S1, S2 and S3 groups), the employed of geotextile cover material over the pots led to lower salinity concentrations when compared to groups without geotextile material covers. However, two-way ANOVA revealed that the differences were not statistically significant. Before the analysis, the assumption of equality of variances was investigated (*Table 4*). Since p was greater than 0.05 as seen in *Table 3,* the assumption of equality of variances was confirmed.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2001_397411

Table 4. *Levane's test of equality of error variances*[a]

Dependent variable: EC2 (dS m^{-1})			
F	**df1**	**df2**	**P (Sig.)**
.837	5	30	.534*

*Statistically significant at 5% significance level (p > 0.05)

According to the statistical analysis results that revealed the correlation between the salt applications and the employed of jute cover material on salinity of the growth media; based on the sig. values presented in the table, both salt application (group 2) and the employed of geotextile cover material had statistically significant effects on salinity (*Table 5*). On the other hand, the interaction between the salinity applications and jute cover employed (group2-Jtex) did not have a statistically significant effect on salinity in the growth media. In other words, the variables alone had a significant impact on salinity. Based on the Partial Eta Squared analysis, it was determined that different salinity levels had greater effects on salinity in the growth media.

Table 5. *Intra-group effect tests*

Dependent variable: EC2 (dS m^{-1})						
Source	**Type III sum of squares**	**df**	**Mean square**	**F**	**Sig.**	**Partial eta squared**
Corrected model	53.186[a]	5	10.637	6.641	.000	.525
Intercept	898.301	1	898.301	560.800	.000*	.949
group2	38.173	2	19.087	11.916	.000*	.443
JTex	14.605	1	14.605	9.118	.005*	.233
group2 * JTex	.407	2	.204	.127	.881	.008
Error	48.055	30	1.602			
Total	999.541	36				
Corrected total	101.240	35				

*Statistically significant at 5% significance level (p > 0.05)

The mean, standard deviation and confidence intervals for salinity determined based on salt administrations to the growth media are presented in *Table 6*.

Both the averages and confidence intervals revealed that the lowest salinity was determined in S1 (control) group, followed by S2 (control + 1 dS m^{-1}) and S3 (control + 2 dS m^{-1}) groups.

Table 6. *The mean values based on salt applications*

Salinity media-II				
Dependent variable: EC2 (dS m^{-1})				
Salinity media-II	**Mean**	**Std. error**	**95% Confidence interval**	
			Lower bound	**Upper bound**
S1 (Control)	3.615	.365	2.869	4.361
S2 (Control + 1 dS m^{-1})	5.283	.365	4.537	6.029
S3 (Control + 2 dS m^{-1})	6.088	.365	5.341	6.834

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2001_397411

The mean salinity, the standard deviation and confidence intervals for the growth media based on geotextile cover employed are presented in *Table 7*.

Table 7. *The mean values based on geotextile cover employed*

Dependent variable: EC2 (dS m^{-1})				
Salinity media-II	**Mean**	**Std. error**	**95% Confidence interval**	
			Lower bound	**Upper bound**
Without geotextile (G0)	5.632	.298	5.023	6.241
With geotextile (G1)	4.358	.298	3.749	4.968

Based on both averages and confidence intervals, the mean salinity was lower in growth media covered with geotextile material when compared to growth media without geotextile cover material. In other words, the employed of geotextile cover material in cultivation reduced salinity in the growth media around the roots.

The mean salinity, standard deviation and confidence intervals based on the interaction between the growth media with different salinity levels and the employed of geotextile cover material are presented *Table 8*.

Table 8. *The mean values based on the interaction between salinity applications and geotextile employed*

Salinity media-II * Geotextile employed					
Dependent variable: EC2 (dS m^{-1})					
Salinity media-II	**Geotextile employed**	**Mean**	**Std. error**	**95% Confidence interval**	
				Lower bound	**Upper bound**
S1 (Control)	Without geotextile **(G0)**	4.112	.517	3.056	5.167
	With geotextile **(G1)**	3.118	.517	2.063	4.174
S2 (Control + 1 dS m^{-1})	Without geotextile **(G0)**	5.943	.517	4.888	6.999
	With geotextile **(G1)**	4.623	.517	3.568	5.679
S3 (Control + 2 dS m^{-1})	Without geotextile **(G0)**	6.842	.517	5.786	7.897
	With geotextile **(G1)**	5.333	.517	4.278	6.389

As seen in *Table 8*, The effect of the interaction between the salinity media and geotextile cover material (group2-Jtex) on salinity levels (EC: dS m^{-1}) was not statistically significant. Although the salinity was lower in the groups with geotextile cover in each salinity media, it was determined that the confidence intervals intersected. Thus, the impact of the jute cover material was statistically more significant.

Discussion

The present study findings demonstrated that the highest salinity was observed in the G0 group without jute cover and the lowest salinity was observed in the G1 group with jute cover. It was demonstrated that the jute cover on the pot media reduced the mean salinity concentration in growth medium by 22.56%. The salinity in growth media was reduced by 24.17% in the S1 group, 22.21% in the S2 group, and 22.05%

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2001_397411

in the S3 group when the pot growth media was covered with jute material when groups with and without cover material were compared. This finding was associated with the ability of the jute material to hold the salt in the nutrient solution, preventing the salinity around the root zone. Although there are no previous on the control of salinity with geotextile material under soilless growth conditions, few studies reported the retention of salinity by geotextile material in conventional agriculture. The results of these existing few studies seem to support the results obtained from this study. In a study conducted in saline soil conditions, the ability of various fabric types (nylon, cotton, geotextile and gauze) to remove soil salinity was investigated based on the correlations between desalination, evaporation loss and structural fabric properties, which are the main factors that affect desalination efficiency. The findings demonstrated that the fabric cover on the soil surface was significantly affected by desalination efficiency, fabric structure, and hydrophilicity/hydrophobicity. Furthermore, it was reported that among the four investigated fabric types, geotextile material had the highest desalination effect. The authors emphasized that further studies were required to determine the desalination properties of geotextile materials based on the spatial heterogeneity of soil texture, soil salinity and climatic conditions (Xu et al., 2021). In another study conducted on orange tree cultivation with geotextile cover material in saline conditions, the water and salinity distribution in sandy soil irrigated with a sprinkler system was investigated with mulch mats developed with geotextile cover. The findings demonstrated that the employed of geotextile material in reclaimed agricultural fields led to higher water distribution and lower soil salinity in the root zones (Derbala and Elmetwalli, 2015). As observed in the findings reported in both studies, geotextile material reduced salinity, consistent with the present study findings. According to the results of several other similar studies, plastic and organic mulching has favorable effects on reduction of soil evaporation and improvement of saline soils (Heydarzadeh et al., 2014; Wang et al., 2019).

Several methods are employed to desalinate the growth medium in agriculture (Ayers and Westcot, 1989; Burn et al., 2015). The most common methods to improve the soil affected by salinity in Turkey include the employed of various drainage systems, washing processes, chemicals, physical and cultural treatments with organic and inorganic substances, and bio-treatment plants (plant-based improvement). In addition to the fact that several of these methods are expensive, they have disadvantages such as excessive water use in washing applications and the inability to discharge the drainage water, and the exploitation of nutrients in the growth medium (Hanay et al., 2013; Temel et al., 2013). To provide an alternative to known salinity removal techniques, the present study aimed to provide an alternative method where jute cover material is used for agricultural purposes, different from its original intended use. The study provided certain findings that would improve the comprehension of the effectiveness of jute cover material under various salinity conditions in greenhouse conditions, which are commonly used in agriculture in certain locations based on climatic conditions. The findings on the desalination potential of the material suggested that jute was a promising material to prevent salt accumulation in growth media. The present study findings would contribute to the literature for the development of innovative facilities and water management strategies to reduce the negative effects of salinity and specific ion concentrations that lead to salinity.

Conclusion

It was concluded that the plant root zone salinity could be reduced when jute geotextile material is employed as cover in soilless culture. According to the results of the present study the highest salinity was observed in the G0 group without jute cover. It was demonstrated that the jute cover on the pot media reduced the mean salinity concentration in growth medium by 22.56%. It was determined that in all growth medium salinity applications (S1, S2 and S3 groups), the employed of geotextile cover material over the pots led to lower salinity concentrations when compared to groups without geotextile material covers. However, as an alternative to known desalination methods, the method presented in the study should be analyzed economically and compared to other existing methods to precisely determine the of the jute material. Furthermore, the proposed alternative technique should be supported with economic analysis findings based on yield losses due to salinity, which is significant problem in soilless culture systems. Further similar studies should develop different soilless farming systems in different salinity levels for different salt-sensitive plant species to demonstrate the applicability of the technique by the farmers in large fields.

REFERENCES

[1] Agrawal, S. K. (2013): Application of textile in agriculture. – International Journal of Advance Research in Science and Engineering 2(7): 9-18.
[2] Akat, H., Akat Saracoglu, O., Cakar, H. (2019): Yield response of *Limonium sinuatum* cultivars under salinity stress. – Journal of Environmental Biology (JEB) Special Issue 41(2): 302-309.
[3] Alberici, A., Quattrini, E., Penati, L., Martinetti, M. L., Gallina, P. M., Ferrante, A., Schiavi, M. (2008): Effect of the reduction of nutrient solution concentration on leafy vegetables quality grown in floating system. – ISHS Acta Horticulture 801: 1167-1176.
[4] Annapoorani, S. G. (2018): Agro Textiles and Its Applications. – Woodhead Publishing India Pvt. Ltd., New Delhi.
[5] Anonoymus, 2021. Report of The Working Group on Textiles & Jute Industry for Eleventh Five Year Plan. – https://niti.gov.in/planningcommission.gov.in/docs/aboutus/committee/wrkgrp11/wg11_textiles.pdf (accessed on 05 October 2021).
[6] Ayers, R. S., Westcot, D. W. (1989): Water Quality for Agriculture. – FAO Irrigation and Drainage Paper 29. FAO, Rome.
[7] Burn, S., Hoang, M., Zarzo, D., Olewniak, F., Campos, E., Bolto, B., Barron, O. (2015): Desalination techniques—a review of the opportunities for desalination in agriculture. – Desalination 364: 2-16.
[8] Carter, C. T., Grieve, C. M., Poss, J. A., Suarez, D. L. (2005): Production and ion uptake of *Celosia argentea* irrigated with saline wastewaters. – Scienta Horticulturae 106: 381-394.
[9] Cassaniti, C., Leonardi, C., Flowers, T. J. (2009): The effects of sodium chloride on ornamental shrubs. – Scienta Horticulturae 122: 586-593.
[10] Cassaniti, C., Romano, D., Flowers, T. J. (2012): The Response of Ornamental Plants to Saline Irrigation Water. – In: Garcia-Garizabal, I. (ed.) Water Management Pollution and Alternative Strategies. InTech, Rijeka, pp. 131-158.
[11] Cassaniti, C., Romano, D. I., Hop, M. E. C. M., Flowers, T. J. (2013): Growing floricultural crops with brackish water. – Environmental and Experimental Botany 92: 165-175.

[12] Chavan, R. B. (2001): Indian Textile industry - Environmental issues. – Indian Journal of Fibre and Textile Research 26(1): 11-21. http://nopr.niscair.res.in/bitstream/123456789/24908/1/IJFTR%2026(1-2)%2011-21.pdf. (accessed on 19 April 2021).
[13] Çakar, H. (2021): The Influence of geoextile materials used for landscape design on the growth of plants. – Pakistan Journal Agriculture and Sciences 58(3): 771-777.
[14] Çakar, H., Akat Saraçoğlu, Ö., Kılıç, C. C., Akat, H., Yücel, Ö. (2019): The performance analysis of geotextile materials used for irrigation water and weed control in stone garden landscape design. – Textile and Apparel 29(3): 237-245.
[15] Çavuş, Z., Özen, M. S., Gençtürk, A., Evirgen, S., Akalın, M. (2020): Otomotiv iç mekânlarında kullanılan doğal elyaf takviyeli iğnelenmiş dokunmamış kumaşların ses yutum özellikleri. – Nonwoven Technical Textiles Technology 28 Aralık 2020, İstanbul. http://nonwoventechnology.com/tag/dogal-elyaf/ (accessed on 19 April 2021).
[16] Çeltek, M. (1992): Topraksız Kültür Ortamında Kullanılabilecek Harç Materyallerinin Özelliklerinin Belirlenmesi. – Master Thesis, Ege University, Institute of Graduate School of Natural and Applied Science, Izmir, Tukey.
[17] Daria, M., Krzysztof, L., Jakup, M. (2020): Characteristics of biodegradable textiles used in environmental engineering: a comprehensive review. – Journal of Cleaner Production 268(2020): 122129. https://doi.org/10.1016/J.JCLEPRO.2020.122129.
[18] Derbala, A., Elmetwalli, A. (2015): Using geotextile mats to enhance the distribution of water and salinity under sprinkling irrigation. – International Journal of Agronomy and Agricultural Research (IJAAR) 6(6): 68-74.
[19] Grattan, S. R. (1993): How Plants Respond to Salts. – In: Hanson, B., Grattan, S. R., Fulton, A. (eds.) Agricultural Salinity and Drainage. University of California Irrigation Program, University of California, Davis, pp. 3-5.
[20] Grive, C. M., Grattan, S. R., Mass, E. V. (2013): Plant Salt Tolerance. – In: Wallender, W., Tanji, K. (eds.) Agricultural Salinity Assessment and Management. Chapter 13. ASCE, Reston, pp. 405-459. https://ascelibrary.org/doi/10.1061/9780784411698.ch13.
[21] Hanay, A., Büyüksönmez, F., Kiziloglu, F. M., Canpolat, M. Y. (2013): Reclamation of saline sodic soils with gypsum and MSW Compost. – Compost Science & Utilization 12(2): 175-179.
[22] Heydarzadeh, M., Khorsandi, F., Mousavi, A. A. 2014. The effects of three types of lithic mulches on salinity and moisture conservation in a heavy textured soil. – Advances in Environmental Biology 8(811): 1168-1172.
[23] Hoagland, D. R., Arnon, D. I. (1950): The Water Culture Method Growing Plants Without Soil. – California Agriculture Experiment Station Circular, The College Of Agriculture University of California, Berkeley, pp. 34-39.
[24] Hoffman, G. J., Genuchten, M. T. V. (1983): Soil Properties and Efficient Water Use: Water Management for Salinity Control. – In: Taylor, H. M., Jordan, W. R., Sinclair, T. R. (eds.) Limitations to Efficient Water Use in Crop Production. Chapter 2C. ASA-CSSA-SSSA, Madison, WI, 73-85 pp.
[25] Horrocks, A. R., Anand, S. C. (2003): Technical Textiles Handbook. 2nd Ed. – Woodhead Publishing, Cambridge.
[26] Islam, M. S., Ahmed, S. K. (2012): The Impacts of jute on environment: an analytical review of Bangladesh. – Journal of Environment and Earth Science 2(5): 24-31.
[27] İlhan, İ. 2015. Textile products used in agricultural applications. – Journal of The Faculty of Engineering and Architecture 30(1): 183-196.
[28] Kalaycı, Ş. (2006): SPSS Uygulamalı Çok Değişkenli İstatistik Teknikleri. – Asil Yayın Dağıtım, Ankara, Türkiye.
[29] Kanber, R., Çullu, M. A., Kendirli, B., Antepli, S., Yılmaz, N. (2005): Sulama, Drenaj ve Tuzluluk. – www.zmo.org.tr/etkinlikler/6tk05/013ri zakanber.pdf (accessed on 29 September 2021).

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2001_397411

[30] Karaoğlu, M., Yalçın, A. M. (2018): Soil salinity and sample of Iğdır plain. – Journal of Agriculture 1(1): 27-41.
[31] Kotuby-Amacher, J., Koenig, R., Kitchen, B. (2000): Salinity and Plant Tolerance, AG-SO-03. – Electronic Publishing, Utah State University.
[32] Machado, R. M. A., Serralheiro, R. P. (2017): Soil salinity: effect of vegetable crop growth. Management practices to prevent and mitigate soil salinization. – Horticulturae 3(2): 30. https://doi.org/10.3390/horticulturae3020030.
[33] Maloupa, E. (2002): Hydroponic Systems. – In: Savvas, D., Passam, H. (eds.) Hydroponic Production of Vegetables and Ornamentals. Embryo Publications, Athens, pp. 143-178.
[34] Mecit, D., Ilgaz, S., Duran, D., Başal, G., Gülümser, T., Tarakçıoğlu, I. (2007): Technical textiles and applications (Part: 2). – Textile and Apparel 17(3): 154-161.
[35] Munns, R., Tester, M. (2008): Mechanisms of salinity tolerance. – Annual Review of Plant Biology 59: 651-681.
[36] Oktav Bulut, M., Akçalı, K. (2013): The effects of storage conditions on performance properties of textile materials dyed with reactive dyestuffs and top white. – Erciyes University Journal of Institute of Science and Technology 30(1): 39-47.
[37] Patel, M. A., Chawla, S. L., Chavan, S. K., Shah, H. P., Patil, S. D. (2019): Genetic variability, heritability and genetic advance studies in marigold (*Tagetes Spp*.) Under the South Gujarat region. – Electronic Journal of Plant Breeding 10(1): 272-276.
[38] Riley, J. L. (1986): Laboratory Methods for Testing Peat. – Ontario Peatland Inventory Project. Open File Report 5572. Ontario Geological Survey, Ontario.
[39] Sarkar, S. (2008): Good practices for jute and allied fibre crops in Souvenir. – International Symposium on Jute and Allied Fibre Production, Utilization and Marketing, Organized by Indian Fibre Society (Eastern Region), pp. 1-3.
[40] Sayyed, A., Gul, H., Hamayun, M., Nangyal, H., Fazal, I. (2014): Influence of sodium chloride on growth and chemical composition of *Tagetes erecta*. – South Asian Journal of Life Sciences 2(2): 29-32.
[41] Sevgican, A. (2002): Örtüaltı Sebzeciliği (Topraksız Tarım) Cilt – II. Ege University Faculty of Agriculture Publishing, Izmir-Turkey.
[42] Shibli, R. A., Kushad, M., Yousef, G. G., Lila, M. A. (2007): Physiological and biochemical responses of tomato microshoots to induced salinity stress with associated ethylene accumulation. – Plant Growth Regulation 51: 159-169.
[43] Sonneveld, C. (2000): Effects of salinity on substrate grown vegetables and ornamentals in greenhouse horticulture. – Doctoral Thesis (Ph.D. Dissertation), Wageningen University, The Netherlands.
[44] Sonneveld, C., Voogt, W. (2001): Chemical analysis in substrate systems and hydroponics - use and interpretation. – Acta Horticulturae 548: 247-260.
[45] Sonneveld, C., Baas, R., Nijssen, H. H. M., De Hoog. J. (1999): Salt tolerance of flower crops grown in soilless culture. – Journal Plant Nutrition 22: 1033-1048.
[46] Temel, S., Şimşek, U., Keskin, B., Yılmaz, İ. H. (2013): Tuzlu Toprakların Düzeltilmesinde Biyo-İyileştirici Olarak Tuza Tolerans Dereceleri Farklı Buğdaygil Yem Bitkilerinin Etkisi. – X. Tarla Bitkileri Kongresi, 10-13 Eylül 2013, Konya-Türkiye, pp. 651-658.
[47] Veatch-Blohm, M. E., Sawch, D., Elia, N., Pinciotti, D. (2014): Salinity tolerance of three commonly planted *Narcissus* Cultivars. – HortScience 49(9): 1158-1164.
[48] Villarino, G. H., Mattson, N. S. (2011): Assessing tolerance to sodium chloride salinity in fourteen floriculture species. – HortTechnology 21: 539-545.
[49] Villora, G., Moreno, A., Pulgar, G., Romero, L. (2000): Yield Improvement in zucchini under salt stress: determining micronutrient balance. – Scientia Horticulturae 86: 175-183.
[50] Wahome, P. K., Jesch, H. H., Grittner, I. (2000): Effect of NaCl on the vegetative growth and flower quality of roses. – Journal of Applied Botany 74: 38-41.

[51] Wang, J., Liu, H., Wang, S., Liu, Y., Cheng, Z., Fu, G., Mo, F., Xiong, Y. (2019): Surface mulching and a sandy soil interlayer suppress upward enrichment of salt ions in salt-contaminated field. – Journal of Soils and Sediments 19: 116-127.
[52] Xu, Z., Mao, X., Adeloye, A. J., Hu, K., Zhu, Y., Ma, X. (2021): Geotextile covering: potential technique for farmland salinization control. – Land Degradation and Development 32(3): 2493-2508.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2001_397411