Turkish Journal of Agriculture - Food Science and Technology, 10(sp2): 3014-3021, 2022
DOI: https://doi.org/10.24925/turjaf.v10isp2.3014-3021.5756

Turkish Journal of Agriculture - Food Science and Technology

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

Cultivation of Purslane (*Portulaca oleracea)* under Soil Stress Conditions[#]

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A R T I C L E I N F O

[#]*This study was presented at the 6th International Anatolian Agriculture, Food, Environment and Biology Congress (Kütahya, TARGID 2022)*

Research Article

Received : 14/11/2022
Accepted : 26/11/2022

Keywords:
Organic matter
Irrigation
Field capacity
Drought
Salinity

A B S T R A C T

Purslane (*Portulaca oleracea L.*) is an edible wild plant that is widely grown in the world, including Türkiye. Purslane plant, which is an important component of Mediterranean cuisine, can grow spontaneously in nature. Stress conditions can directly or indirectly affect the growth and development of plant in the growing environment. In the current study, the effects of stress conditions of soil organic matter content, amount and salinity of irrigation water on plant growth were investigated in the pot experiments. The experiments were carried out in a 72 m^2 greenhouse established in Dokuz Eylül University Tınaztepe Campus. Soil organic matter doses were 1%, 1.8% (control), 3% and 5% on a dry weight basis. Fifteen purslane seeds were planted in each pot and left to germinate. The Irrigation treatments were 100%, 75%, 50%, 30% and 15% of the field capacity water content. Salinity levels of irrigation water were control (tap water- 0.5 mS/cm), 4 mS/cm, 8 mS/cm and 16 mS/cm. in the experiment had 4 replications and the study composed of 320 pots. The experiments were carried out for 90 days starting from the first day of planting. The increase in organic matter content increased plant germination. The effects of irrigation treatments and salinity levels were evaluated using principal component analysis (PCA). The decrease in water content caısed a significant decrease in plant growth, but the most severe decrease was recorded in 30% and 15% field capacity. The negative effects of salinity on plant growth were most significant at 8 mS/cm and 16 mS/cm salinity levels. The study proves the negative effects of field capacities below 50% and irrigation with saline water over 4 mS/cm on plant growth. Even in the lowest amount of irrigation with high salt content, the highest yield loss is seen to be 56%, drawing attention to the high tolerance of the study purslane plant.

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Introduction

Purslane is an annual, multi-leaved, creeping herbaceous plant belonging to the family of *Portulacaceae.* The purslane contains high levels of omega-3 fatty acids compared to other plants, and is a good source of vitamin C, rich in B-complex vitamins such as riboflavin, niacin, pyridoxine and carotenoids. The purslane is a vegetable with important nutritional value in terms of important minerals such as iron, phosphorus, copper, zinc, magnesium, calcium, potassium and manganese (Açak, 2017; Dweck 2001; Turan et al., 2003).. Wild forms germinates in the spring in the vegetable fields. The plant dries up and dies in winter. Although the wild forms were known for many years, its place and importance in human nutrition has only just begun to be understood. In Türkiye, the culture form of purslane is produced commercially in the Aegean, Marmara and Mediterranean regions, and its wild forms are mostly used in all regions (Eşiyok, 2012; Vural et al., 2000; Yurdagül, 2019). The plant quickly passes into the generative phase and blooms in hot season if there is a water problem. The amount of dry matter increases in plants grown from spring to summer (Convington, 2004; Günay, 2005; Uğur et al., 2014).

The growth of purslane plant under various soil stress factors has been the subject of various studies. Soil salinity is an important environmental factor with serious adverse effects on agricultural productivity and sustainability in semi-arid regions. Salt stress during the germination stage negatively affects the osmotic balance or the ionic balance, or both (Zivkovic, 2007). Yazıcı et al. (2007) conducted a research on the effect of salt stress on purslane. Purslane plants were grown in pots for two months under 65% humidity and 30/20 °C temperature conditions. At the end of two months, 0, 70 and 140 mM doses of salt were applied, and plant height decreased after salt applications. Kılıç et al., (2008) cultivated purslane plants at salt levels of 0.65 (control), 3.5, 5.0 and 6.5 dS/m. The fresh and dry weight decreased due to the increase in salinity. This decrease was 8.75% in 5.0 dS/m salt application and 8.21%

in 6.5 dS/m salt application. As the salt level increased, the ratio of Na and Cl increased, while the ratio of K decreased. Therefore, the purslane is considered to be an economical plant to use in removing Na and Cl from the soil in arid and semi-arid land conditions due to its salt tolerance, short vegetation period and ability to be produced several times a year. Jin et al. (2015) examined the changes in plant structure under drought stress and subsequent water application. Leaf samples were taken on the 5th, 10th, 15th and 22nd days and at harvest. At the end of 22 days, the leaves were wilted and rehydrated. However, drought stress caused decreases in leaf water content and chlorophyll content.

Another soil stress factor in plant growth is soil type and organic matter content. Kocamanoğlu (2018) investigated the effects of humic acid application doses on yield and quality characteristics of purslane grown in environments prepared using different ratios of peat and perlite in the early spring season. When the growing media were evaluated in terms of yield, all mixtures containing peat gave higher yield. Cros et al. (2007) studied the variation of yield and quality in purslane grown in different environments. Peat, perlite, vermiculite, coal, peat/perlite (1:1), peat/perlite (3:1) media were used in the study. Vermiculate peat/perlite (1:1) and peat/perlite (3:1) media were resulted with 14.7, 13.6 and 14.2 cm plant height values respectively, while perlite (6.2 cm) and coal dust (6.3 cm) media gave the lowest values. Montoya-Garcia et al. (2018) investigated the relationship between fertilization and changes in the fatty acid content and antioxidant capacity of purslane plant. Taking into account the effects of these ingredients with abiotic factors such as nitrogen, phosphorus and potassium, N, P, K fertilizations were applied in two different harvest turns (27 and 42 days) with different fertilizer doses. Nitrogen fertilization was investigated for the amount of total phenolic, flavonoid, β-carotene and chlorophyll at low doses, and the amount of linoleic and α-linoleic acid at high doses. P and K application increased the total phenolic and ascorbic acid content. It formed the idea that the content and antioxidant capacity of purslane plant could be controlled by fertilization adjustment.

The present study aims to investigate the purslane growth under different soil stress conditions. For this, different organic matter contents, different irrigation conditions and different salinity levels were tested in pot experiment. The plant germination under variable stress conditions and plant growth were monitored.

Materials and Methods

For pot experiments, natural purslane seeds were purchased from the market. Preliminary studies revealed that the seeds have a high germination rate. The soil used in the study was obtained through a local landscape company that is in contact with the soil sellers in the Aegean Region. In addition to these, goat manure and peat were obtained from the same seller to increase organic matter content in pot soils. Sand produced from crushed stone was supplied from a river mining facility and used to obtain lower organic matter in pot soils. The materials were mixed in different proportions to meet the desired organic matter conditions for the pot experiments.

Soil reaction (pH), electrical conductivity, water content and organic matter content of soil samples were determined. The soil pH and electrical conductivity were determined using the TS ISO 10390 and TS ISO 11265 standards, respectively. Measurements were carried out with Hanna HI 2030-02 pH/EC model measuring device. Water contents of soil samples were determined gravimetrically according to TS EN ISO 11461 standard. Organic matter content of soil samples was analyzed using ASTM D2974-13 standard. The field capacity of the soil mixtures were measured according to the standard gravimetric methods.

The experiments were carried out in a greenhouse on the Dokuz Eylül University Tınaztepe Campus (Figure 1a). The experimental set up was designed in plastic trial pots of 8 L volume, each containing 6 kg of soil mixture. Plant growth was monitored for 3 different parameters in the experiments. Sets were created by mixing sand, peat and goat manure with the first parameter, the organic matter content of the control, 1%, 3% and 5%. The second parameter, drought, was carried out by irrigation of plant growth with field capacities of 100%, 75%, 50%, 30% and 15% after germination. The third parameter, salinity, refers to the amount of salt in the irrigation water. For this, the plants were watered by preparing irrigation water containing control (tap water-0,4), 4 dS/m, 8 dS/m, and 16 dS/m salinity. While preparing brine, table salt was used and firstly a high salinity stock saline solution was prepared (200 dS/m), then the desired saline irrigation water was obtained by applying dilutions.

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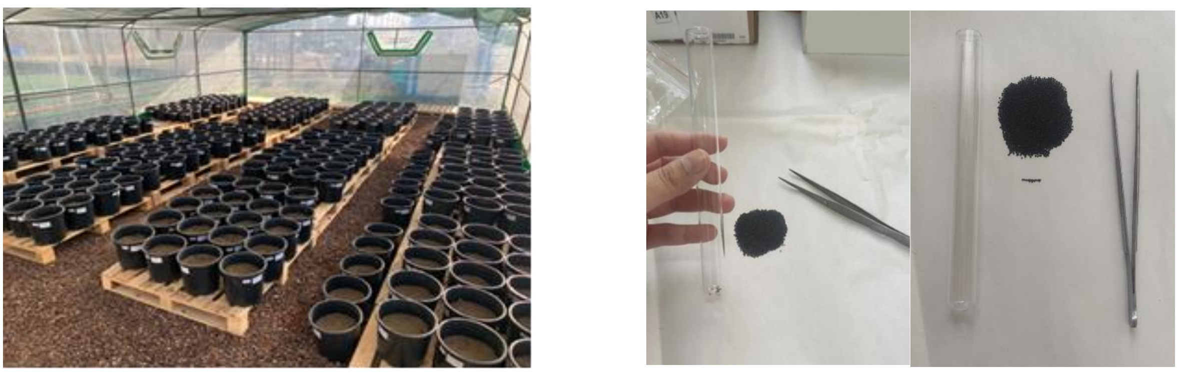


(a) (b)

Figure 1. a) Experimental pots in the greenhouse, b) Seed preparation

OM1.8 OM1 OM3 OM5

Figure 2. Young sprouts with different organic matter levels in soil

Seeds (15 seeds for each pot) were planted in March 2022 and the main irrigation was started at the end of the 4-week germination period. During germination, irrigation was carried out every other day, while the irrigation in growing period was applied twice a week.

During the experiments, plant growth monitoring was carried out by using calipers by taking the height and diameter measurements of the plants once a week. 60 days of growth was followed and then the plants were harvested. Pots containing all trial parameters were prepared with 4 replications and average values are presented.

Statistical evaluation of data was conducted using SPSS 24.0 (IBM Inc., Chicago, USA). The Pearson correlation coefficients between the number of average grown plant versus different soil OM (% dw), irrigation water applied (%FC), and irrigation water salinity (mS/cm) were determined (n=80). The principal component analysis was applied in order to determine the major factors influencing the plant growth.

In addition to that, the Pearson correlation coefficients among the data sets of soil OM (% dw), irrigation water applied (%FC), irrigation water salinity (mS/cm) and the average weights of plant roots (g), aerial parts(g) and the total plant weight (g) (n=80) were determined. The data sets are in normal distribution according to Tests of Normality (significances of Kolmogorov–Smirnov test were >0.05 for the data sets). Principal Component Analysis (PCA) was also applied to this data set, with exception of total plant weight, where Eigenvalues>1 and factor loadings >0.1 were considered and Varimax rotation was used. Kaiser-Meyer-Olkin Measure of Sampling Adequacy was calculated as 0.557 and the significance of Bartlett's Test of Sphericity were found as <0.0001; therefore the data set was available for PCA.

Results

General characteristics of soil, peat, goat manure and the sand are given with Table 1. There was no organic matter arrangements in the control pots and they were named as OM1.8. Considering the organic matter content, soil and sand were mixed at the rates of 43 and 57%, respectively, for the 1% OM (OM1) trial pots. For higher organic matter contents than the control pots, a goat manure/peat mixture was first prepared and a fertilizer with 50% organic matter was obtained. For 3% OM (OM3), 97.5% soil and 2.5% fertilizer were added. For the soil mixture containing 5% OM (OM5), the ratios of soil and fertilizer mixture were 93.4% and 6.6%, respectively.

The field capacities (100% FC) determined for 6 kg mixtures in soil mixtures are as follows; 980 ml for OM1, 1153 ml for OM1.8, 1250ml for OM3 and 1510 ml for OM5. In the irrigations carried out, 100 FC refers to irrigation with full field capacity, while other values express the percentage of full capacity of that value.

The study started by planting 15 seeds in the experimental pots, and the first germination was observed between 4-10 days. During the germination stage, irrigation was carried out with tap water, and it is shown in Table 2 that the germination efficiency increased due to the increase in organic content. The germination efficiency was only 23% in 1% organic content, and the average germination efficiency was 66% in 5% organic matter content.

The experiments conducted between April and June. High temperatures inside the greenhouse were controlled by constantly ventilating the greenhouse and covering the greenhouse ceiling with lime. The highest temperature measured was 46.8 °C, while the lowest temperature was 10 °C. The highest humidity was measured as 64% while the lowest was 3%. The average temperature was 29.4°C and the average humidity percentage was 25.4%.

Table 1. General characteristics of materials used in soil mixtures

	Water content, %	Organic matter in dw, %	pH	EC (dS/m)
Soil	2.61	1.80	7.72	0.167
Sand	0.09	0.32	8.03	0.067
Peat	9.98	30.95	6.17	0.404
Goat manure	9.58	73.58	7.81	3.240

Table 2. Purslane germination rates with different soil organic matter levels

OM content, %	OM1	OM1.8	OM3	OM5
Germination rate, %	23	31	52	66

Table 3. Number of plants grown in the pots under different conditions.

Pots	OM1***	OM1.8	OM3	OM5
100%FC* / tap water	3	8	8	7
75%FC / tap water	5	10	8	9
50%FC / tap water	3	9	8	12
30%FC / tap water	2	5	8	7
15%FC / tap water	4	7	6	7
100%FC / 4 salinity**	6	4	7	9
75%FC /4 salinity	6	3	8	10
50%FC / 4 salinity	4	3	6	12
30%FC / 4 salinity	4	4	9	12
15%FC / 4 salinity	6	2	8	11
100%FC / 8 salinity	2	3	6	11
75%FC / 8 salinity	5	4	10	9
50%FC / 8 salinity	3	5	10	11
30%FC / 8 salinity	6	3	8	11
15%FC / 8 salinity	1	3	5	12
100%FC / 16salinity	3	5	10	6
75%FC / 16 salinity	4	4	7	11
50%FC / 16 salinity	3	4	9	12
30%FC / 16 salinity	1	6	9	10
15%FC / 16 salinity	1	3	7	8

* %FC refers to irrigation amount with field capacity ratio (eg. 75%FC means irrigation with 75% of the field capacity of the soil mixture); ** X salinity refers to irrigation water having the salinity of X mS/cm (eg. 4 salinity means the irrigation water with 4 mS/cm electrical conductivity); *** OMX refers to the X% organic matter content of the soil mixture (eg. OM1 means soil mixture having 1% organic matter content)

Table 4. Number of thin and thick stem growths in the pots under different conditions

	# of thin stems					# of thick stems			
	OM1***	OM1.8	OM3	OM5		OM1	OM1.8	OM3	OM5
100%FC* / tap water	1	2	2	1	100%FC* / tap water	1	5	5	5
75%FC / tap water	4	4	4	2	75%FC / tap water	1	4	4	5
50%FC / tap water	2	5	3	4	50%FC / tap water	0	3	4	4
30%FC / tap water	1	3	4	2	30%FC / tap water	1	2	3	5
15%FC / tap water	3	6	4	5	15%FC / tap water	0	1	2	1
100%FC / 4 salinity**	6	2	2	3	100%FC / 4 salinity	0	3	4	4
75%FC /4 salinity	4	1	2	3	75%FC /4 salinity	2	2	5	5
50%FC / 4 salinity	4	1	2	6	50%FC / 4 salinity	1	2	3	2
30%FC / 4 salinity	4	2	4	5	30%FC / 4 salinity	0	1	3	3
15%FC / 4 salinity	6	1	6	6	15%FC/4 salinity	0	1	1	2
100%FC / 8 salinity	2	1	3	5	100%FC / 8 salinity	0	3	2	2
75%FC / 8 salinity	5	2	6	3	75%FC / 8 salinity	0	2	2	5
50%FC / 8 salinity	2	1	6	5	50%FC / 8 salinity	0	4	2	3
30%FC / 8 salinity	5	3	5	6	30%FC / 8 salinity	0	1	1	2
15%FC / 8 salinity	1	3	4	7	15%FC / 8 salinity	0	0	1	1
100%FC / 16salinity	2	3	5	3	100%FC / 16salinity	1	2	2	2
75%FC / 16 salinity	1	4	5	7	75%FC / 16 salinity	1	1	3	1
50%FC / 16 salinity	1	3	6	8	50%FC / 16 salinity	0	1	2	1
30%FC / 16 salinity	1	5	6	7	30%FC / 16 salinity	0	0	1	1
15%FC / 16 salinity	1	1	6	6	15%FC / 16 salinity	0	0	1	1

* %FC refers to irrigation amount with field capacity ratio (eg. 75%FC means irrigation with 75% of the field capacity of the soil mixture); ** X salinity refers to irrigation water having the salinity of X mS/cm (eg. 4 salinity means the irrigation water with 4 mS/cm electrical conductivity); *** OMX refers to the X% organic matter content of the soil mixture (eg. OM1 means soil mixture having 1% organic matter content)

During the irrigation process, plant growth was followed as the number of thin stems, the number of thick and thin stems, their diameters, and lengths. The number of plants under different conditions is given Table 3.

Thick stem diameters in pots varies between 4-9 mm. Pots with high thick stem diameters are OM3 and OM5 pots where more growth is observed. Thin diameters in pots vary between 1-3,8 mm. When the thick stem lengths in the pots are examined, it is seen that they vary between 11-30 cm. Plant height elongation was clearly observed in all pots except OM 1.

Thin stems generally develop towards thicker diameters over time. However, this improvement was not seen in pots with 30% and 15% field capacity, which is related to the negative impact of water deficit on purslane growth. Similarly, there was no thickening of thin stems under 8 and16 mS/cm salinity levels, indicating the negative effect of saline water on growth.

The numbers of thick stems increased over time under ≥50% FC and the > 8 mS/cm salinity. The plant growth decreased in 15% FC irrigation and the decrease was more evident in OM 1 and OM 1.8 pots. Although saline irrigation was somewhat tolerated in OM3 and OM5 pots, it was determined that 16 mS/cm irrigation was ceased the plant development. Pots with the highest number of thick stems were observed in OM3 and OM5, 75% and 100% FC and non saline environment.

When thin and thick stem diameters of plants are examined, it is seen that organic matter content does not have a serious effect on thin plant stems, but causes an increase in thick stem diameters. Decreased irrigation amount causes a decrease in plant diameters. Similarly, it was observed that there were significant decreases in thin and thick plant diameters as salinity increased. Thick stem values of less than 4 mm indicated in Table 5 can be explained by counting as zero for pots without thick stems, resulting from taking the average value of four pots. This was observed in pots with organic matter content of 1%, irrigation amount of 15% field capacity, and irrigation water salinity of 16 mS/cm.

In the study, the development of the plants irrigated with different field capacities and different doses of water salinity was evaluated by determining the total root and stem weights of the plants. Accordingly, the effect of irrigation amount on plant root and stem weight is illustrated in Figure 4.

In these trials, which were irrigated with tap water and constituted the control set of the study in terms of saline water irrigation, it was observed that irrigation with 75% field capacity (excluding pots containing 3% organic matter), gave the most efficient results from the study. Irrigation with 50% field capacity causes a decrease of 3-24%, except for OM1 pots, where plant growth is very weak. After this point, it was determined that plant growth also decreased with decreasing irrigation, and at the end of the experimental period, product weight (plants' roots and stems) loss between 48% and 70% was observed in irrigation with 15% field capacity compared to the most efficient irrigation of 75% field capacity irrigation.

Table 5. Average stem diameters under different conditions

Thin stem diameter,mm					Thick stem diameter,mm				
	OM1	OM1.8	OM3	OM5		OM1	OM1.8	OM3	OM5
100%FC* / tap water	2.2	2.4	2.6	0.7	100%FC* / tap water	2.3	4.7	5.4	5.5
75%FC / tap water	3.4	3.5	3.1	2.9	75%FC / tap water	2.1	4.6	5.6	6.1
50%FC / tap water	1.9	3.7	3.4	3.7	50%FC / tap water	1.2	4.4	4.8	5.1
30%FC / tap water	2.2	2.6	3.1	1.9	30%FC / tap water	0.0	4.3	4.6	5.4
15%FC / tap water	2.9	3.4	3.2	3.7	15%FC / tap water	1.0	2.3	3.9	3.1
100%FC/ 4 salinity**	3.5	3.4	2.7	3.6	100%FC / 4 salinity**	1.0	6.4	4.9	5.5
75%FC /4 salinity	3.1	0.9	2.7	3.2	75%FC /4 salinity	4.2	6.6	5.4	5.6
50%FC / 4 salinity	3.4	1.6	2.6	3.3	50%FC / 4 salinity	3.1	3.7	5.0	4.0
30%FC / 4 salinity	2.8	2.9	3.6	3.0	30%FC / 4 salinity	1.1	5.5	4.4	4.7
15%FC / 4 salinity	2.6	2.0	3.3	3.3	15%FC / 4 salinity	0.0	3.4	3.4	4.9
100%FC / 8 salinity	1.8	2.2	3.3	2.7	100%FC / 8 salinity	1.2	5.2	5.1	4.8
75%FC / 8 salinity	3.4	2.2	3.3	2.2	75%FC / 8 salinity	0.0	5.2	4.7	5.0
50%FC / 8 salinity	1.7	2.4	3.4	3.3	50%FC / 8 salinity	1.2	5.7	4.1	5.3
30%FC / 8 salinity	2.7	3.6	2.7	3.3	30%FC / 8 salinity	0.0	2.5	3.7	4.7
15%FC / 8 salinity	1.5	2.9	2.5	3.4	15%FC / 8 salinity	0.0	1.0	3.0	2.7
100%FC / 16salinity	0.9	3.7	3.5	2.5	100%FC / 16salinity	3.2	5.5	4.5	6.4
75%FC / 16 salinity	1.3	3.6	3.6	3.5	75%FC / 16 salinity	2.3	2.4	4.5	3.5
50%FC / 16 salinity	1.4	3.0	3.5	3.6	50%FC / 16 salinity	1.1	4.7	4.7	1.3
30%FC / 16 salinity	1.9	2.4	3.5	3.5	30%FC / 16 salinity	0.0	2.3	4.1	2.1
15%FC / 16 salinity	0.6	1.8	3.4	3.2	15%FC / 16 salinity	0.0	0.0	3.8	2.2

* %FC refers to irrigation amount with field capacity ratio (eg. 75%FC means irrigation with 75% of the field capacity of the soil mixture); ** X salinity refers to irrigation water having the salinity of X mS/cm (eg. 4 salinity means the irrigation water with 4 mS/cm electrical conductivity); *** OMX refers to the X% organic matter content of the soil mixture (eg. OM1 means soil mixture having 1% organic matter content)

Table 6. Pearson correlation coefficients (r) calculated between soil OM, amount of irrigation EC, and the weights of plant parts

		OM, % dw	FC, %	Salinity, mS/cm	Root, g	Aerial Parts, g	Total Plant Weight, g
OM, %	r	1	0.000	0.000	.703**	.775**	.775**
FC,%	r		1	0.000	.366**	.385**	.387**
Salinity, mS/cm	r			1	-.265*	-.269*	-.268*
Root, g	r				1	.909**	.921**
Aerial Parts, g	r					1	1.000**
Total Plant Weight, g	r						1

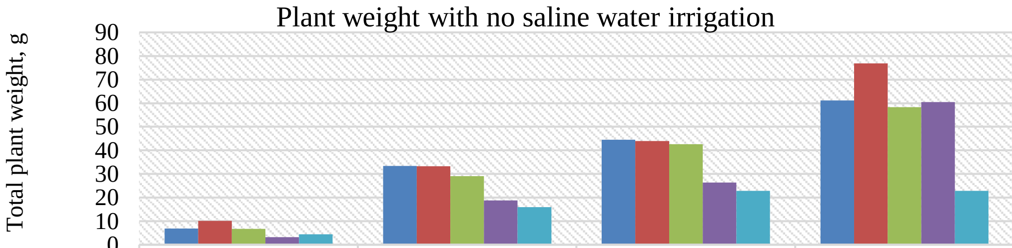
**. Correlation is significant at the 0.01 level (2-tailed).

Table 7. Rotated Component Matrix

	PC1 (49.06% of total variance)	PC2 (26.68% of total variance)
OM, %	0.950	-0.133
Aerial Parts, g	0.890	0.404
Root, g	0.857	0.415
%FC		0.896
Salinity, mS/cm	-0.151	-0.422

(a) (b) (c) (d)

Figure 3. Plant growth under saline water irrigation a) OM1, b) OM1.8, c) OM3, d) OM5



	OM1	OM1.8	OM3	OM5
100 % FC irrigation	6.9	33.45	44.5	61.15
75 % FC irrigation	10.125	33.3	44.025	76.925
50 % FC irrigation	6.775	29.05	42.625	58.325
30 % FC irrigation	3.2	18.8	26.35	60.475
15 % FC irrigation	4.475	15.925	22.875	22.8

Figure 4. Purslane plant growth (after harvesting) in different irrigation conditions

The effects of irrigation water salinity on plant growth are expressed in Figure 5. It is observed that plant growth weakens as the amount of irrigation water decreases. In comparisons where the amount of irrigation water is constant and the salinity changes, it is seen that plant growth is higher in pots irrigated with a water having 4 mS/cm conductivity than in control pots irrigated with tap water.

As can be seen in Figure 5, the yield tends to decrease as the salinity increases. The highest product loss rates due to salinity belong to sandy soil with 1% organic matter content and low yield under normal conditions (40.6%-92.6%). In the 16 mS/cm irrigations with the highest salinity, the greatest product yield loss (56%) was seen in the soil mix with 5% of organic matter.

When the irrigation water was 8 mS/cm, the decrease in product productivity was determined as 10.9-45% in the mixtures with 1% organic matter content, and it was calculated as 0.7%-33.3% in the mixtures containing 1.8% organic matter. In the mixtures containing 3% organic matter, the decrease in product productivity was observed in the range of 5.5%-27.4%, and in the soil mixtures containing 5% organic matter, it was determined at the rates of 0.7%-41%.

The Pearson correlation coefficients calculated for soil OM (% dw), irrigation water applied (%FC), irrigation water salinity (mS/cm) and the weights of plant roots (g) and aerial parts(g) are presented with Table 6.

Increasing soil OM had positive effect on the weights of Purslane roots and aerial parts and therefore increased the yield. The same approach is valid for increasing irrigation water amount. However, OM percentage is more effective on the weights of the aerial parts ($r=0.775$, $p<0.01$), where rate of FC is more important for the weight increase in aerial parts ($r=0.385$, $p<0.01$). The salinity of irrigation water has a statistically significant negative impact on the weights of both root and aerial parts of Purslane; where this negative impact is more strong on the aerial parts. It is also understood that, the total plant weight is directly correlated with the weights of the aerial parts.

PCA accounted with the 75.74% of the total variance of the data and two principal components were extracted with converged rotation (Table 7) to reveal the major factors influencing the Purslane yield.

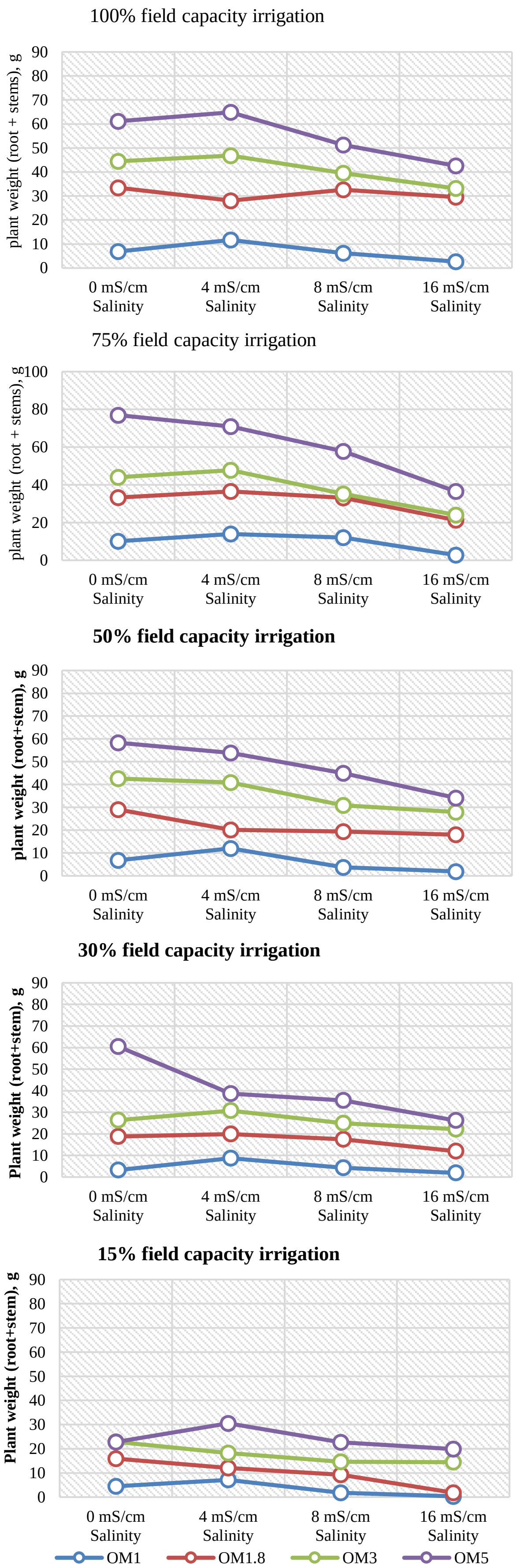


Figure 5. Purslane plant growth due to the saline irrigation conditions

Discussion

In the study, it has been proven that salinity and irrigation capacities have an effect on the development of purslane plant in terms of thin-thick diameter developments and plant weights, but their development can continue positively until irrigation with 8 mS/cm salt water and irrigation with 30% field capacity. This confirms the tolerance of the saddle purslane plant against high saline soil and irrigation water (Alam et al., 2014; Franco et al., 2015).

It is known that the organic matter content in the soil affects the germination and yield of the plants (Hosseinzadeh et al., 2021). In this study, the increase in germination due to the organic matter content is a proof of this. The PCA results also support this finding. The first principal component (PC1) accounted for 49.06% of the total variance and mainly loaded with the weight of plant parts and soil organic matter appeared with high factor loadings. This finding is in line with high correlation between OM content and number of plants grown in the pots. The results indicate the importance of soil organic matter on plant physical development and yield. PC1 also signifies the negative impact of irrigation water salinity on plant growth. It is known that the plant purslane has no yield reductions in moderate saline environments (Kilic et al., 2008, Teixeira and Carvalho, 2009). However, many studies show high levels of salinity cause yield reduction and a decrease in potential nutritional values (Teixeria et al., 2009; Giemenez et al., 2021). These are in agreement with our finding and explain the PC1 of the analysis. The second principal component (PC2) explained 26.68% of the total variance. The determinant parameter in PC2 is %FC with a factor loading rate of 0.896; which is understood from the experimental data that its higher rates resulted with higher yields. However, %FC and soil OM are oppositely signed in PC2; that can be explained that irrigations applied with very high field capacities may result poor availability of OM for the plants. This process can take place, which can be explained by the filling of soil pores with water and consequent lower oxygenation in the root zone, and inhibit the activities of soil biota, which breaks down OM, the plant nutrient source. The absence of water salinity (EC) in PC2 is a clue of our hypothesis; because the plant nutrient stress will be over it. The absence of water salinity (EC) in PC2 is a clue to support our hypothesis; because plant nutrient stress will take priority over salinity stress.

Conclusions

In the study, the effects of different soil stress conditions on purslane plant growth were investigated. The increase in organic matter had a significant positive effect on plant growth. The field capacities below 50% affect plant growth negatively. Similarly, irrigation with salt water above 4 dS/m has a negative effect on plant growth, especially on thick stem growth. However, when the plant growth conditions are assessed, it is seen that, even in irrigations with high salt content, the loss in the highest yield was 56%. This situation is in harmony with the literature and shows the resistance of the plant in drought and salinity conditions.

The purslane is a promising wild edible plant to be cultivated widely with its salt tolerance, especially in the areas with limited fresh water sources. In addition to that, Purslane yields are easily improving by adding manure and peat to the soil, which are not costly and easy to access in agricultural areas, instead of commercial fertilizers.

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