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Soil variables affecting growth of Vetiver (*Chrysopogon zizanioides*) in the hyperarid region of Sistan plain

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ABSTRACT: In Sistan plain, 120 days of wind, drought and lack of vegetation cause erosion and soil degradation. Vetiver (*Chrysopogon zizanioides* L. Robert) is widely used worldwide for soil stabilization. The aim of this study was to evaluate the soil variables affecting germination of vetiver in the hyperarid regions of Sistan, Iran. The treatments in this study were degraded soil along a riverbank, soil around drainage areas, agricultural land, saline land and waterlogged soil in the vicinity of a wastewater treatment plant. A total of 30 bases of *C. zizanioides* with three repetitions per treatment were planted in March 2015. With care and watering, germination and establishment of the plants were studied in the treatment soil types for six months. The electrical conductivity, pH, moisture content, nominal specific weight and porosity of the soil in the study areas were measured and recorded. The data was analyzed in SPSS Statistics using Duncan's test and ANOVA. The results showed the compatibility of vetiver with riverbank, wastewater treatment and agricultural land soil. The nominal specific weight, electrical conductivity and average pH in the soil showed significant differences. The average moisture content and porosity of the soil in the wastewater margins and saline land showed no significant differences, but the variables were significant in the others areas. The correlation between soil variables indicated that the acidity, moisture content, nominal specific weight and nominal specific weight of the soil were significantly correlated at a confidence level of 99%.

Keywords: Sistan, Hyperarid, Vetiver, Soil Degradation, Germination, Growth

INTRODUCTION

The Sistan plain is depositional sediment without structure that has been exposed by erosion due to lack of suitable vegetation as protection against the wind and monsoons in areas subjected to drought (Comprehensive Consulting Engineers of Iran, 2004). The characteristics of the desert in the Sistan region causes moisture from the lower layers of the soil to rise to the underlying surface, depositing harmful salts from the subsoil at the surface and leading to high salinity and alkalinity in a large portion of the plain (Soil and Water Consulting Engineers, 2009).

Vetiver (previous name: *Vetiver zizanioides* L. Nash) has recently been reclassified as *Chrysopogon zizanioides* L. Robert (Truong et al., 2010). This plant is known in warm and dry regions at the macro level (Sanei Dehkordi *et al.,* 2011). Vetiver can control desertification with the production of biomass and prevention of dust transport (Nilforooshan Dardasht *et al.,* 2011). Vetiver is an important salt-resistant and alkalinity-resistant plant. C. zizanioides was imported by the Forest, Range and Watershed Management Organization from Australia to Iran and was planted with favorable results at Ketchikan Research Station in Golestan province (Mirinia *et al.,* 2010). This plant is consistent with the climate of Iran, but is still not well-known (Nilforooshan Dardasht *et al.,* 2013).

Vetiver initially reduces erosion and stabilizes eroded land. As a source of food and moisture, it can decrease soil erosion up in 67% in areas with slopes of 5%-80% (Truong, 2006). Vetiver is widely used in arid and hyperarid regions where salinity is an important factor in plant growth (Edelstein, 2009). Desertification is a major problem and one of the positive management actions is the restoration of vegetation by planting plant species that are determined to be compatible after testing. It is possible to cultivate such plants under specific regional conditions (Khalkhali, 2006). The aim of the current study was to evaluate soil variables affecting growth of vetiver in the hyperarid region of Sistan.

MATERIALS AND METHODS

The Sistan plain is located in southeastern Iran in the northern part of the province of Sistan and Baluchestan around the city of Zabol.

This area is bordered on the north and east by Afghanistan and from its southwestern corner at the city of Nosratabad to its northwestern corner at the city of Nehbandan in southern Khorasan province by the Lut Desert (Green Thinkers Consulting Engineers, 2011). Sistan is a hyperarid zone in terms of climatic classification. It features intense heat (up to 50°C), low rainfall (average of 59 mm), high evaporation, high elevation (4600 mm) and blowing seasonal winds (over 100 km/h) that cause wind erosion.

The study was conducted in a completely randomized design in Sistan plain for vetiver cultivation locations and treatments. Because vetiver is known to possess phytoremediation properties, the drainage area around a wastewater treatment plant in Zabol was selected as the first treatment area. The second location was the drainage margins of agricultural land and pumping stations. The third location was on the banks of the Sistan River as a site requiring removal of sediment and anchoring of dust. The fourth location was on saline land. The fifth location was in agricultural land. The statistical population included all plant bases cultivated in the five treatments in these five locations. The total population was 450 plant bases.

A. Laboratory operations
Soil samples were transported to the laboratory to determine the electrical conductivity (EC), pH, nominal specific weight and moisture content of the soil. The percentage of porosity was calculated after defining the nominal specific weight of the soil.

B. Measuring soil EC
A ratio of 1:5 was used to determine the EC of the samples. Five grams of soil sample were placed in a beaker and 25 ml of distilled water was added. It was then mixed to determine EC.

C. Measuring soil acidity
A ratio of 1:5 was used to determine the pH of the soil. Five grams of dried soil were mixed with 25 ml of distilled water and the pH was determined after passing the mixture through a filter paper.

D. Measuring moisture content
To determine the moisture content, the samples were taken with a core sampler so that the soil volume was constant at all harvested areas. The soil samples were then weighed and placed in a oven at 110°C for 24 h. The dried soil samples were weighed in the oven after cooling.

E. Determination of nominal specific weight of soil
To determine the nominal specific weight of the samples, they were taken with a core sampler so that the soil volume was constant at all harvested areas. The soil samples were weighed and placed inside an oven at 105°C for 24 h. The soil was again weighed and the weight of the dry soil was calculated. The volume of the cylinder was then calculated as the weight ratio of the dry soil to the volume of the cylinder.

F. Calculation of soil porosity
After calculating the nominal specific weight of the soil samples, the actual specific weight of 65.2 g/cm^3 was used to determine the percentage of porosity (Alizadeh, 2011) as:

$$n = \left(1 - \frac{f_b}{f_s}\right) \times 100 \quad (1)$$

where f_b is the nominal specific weight of the soil and f_s is the actual specific weight of the soil.
The data from the variables were entered into SPSS and analyzed for a normal distribution (Kolmogorov-Smirnov test), homogeneity of variance (Levine test) and Perth and final values (box plots). After determining the pre-test assumptions, one-way ANOVA and the Duncan test were used to determine averages that were significantly different at a 95% confidence level.

RESULTS

The descriptive statistics of the soil variables in wastewater drainage margins, agricultural land, river banks, saline land and agricultural drainage margins are shown in Table 1.

Table 1: Average soil variables by region.

Region	pH	EC (ds/m)	Moisture content (%)	Nominal specific weight (g/cm^3)	Porosity (%)
Wastewater margins	8/3300	8/2000	0/3600	1/7100	36/0000
Saline land	8/7000	33/8000	0/3600	1/7000	36/0000
Drainage margins	8/3000	7/3000	0/2800	1/9100	28/0000
Agricultural land	8/9800	0/3000	0/3800	1/6600	38/0000
Riverbanks	8/6000	8/1800	0/2600	1/9700	36/0000
Total	8/5820	11/5560	0/3280	1/7900	32/8000

Table 2 shows the results of ANOVA for which the significance level of all the variables was <0.5 and the null hypothesis was rejected. There were significant differences between the average of each variable at a 5% error level; thus, the Danken test was used to compared the soil variables between regions.

Table 3 shows that the average pH, EC and nominal specific weights of the soil have significant differences. The average moisture content and soil porosity in wastewater margins and saline land were not significantly different, but were significantly different in the other areas.

Table 2: Results of ANOVA for soil variables showing regional impact.

Soil variable	Fisher statistic	Significant level
pH	1/07E+30	<0/001
EC	3/90E+32	<0/001
Moisture content (%)	3/33E+31	<0/001
Nominal specific weight	9/23E+30	<0/001
Porosity (%)	1/378E+52	<0/001

Table 3: Results of Duncan post hoc test for comparison of soil variables in different regions.

Soil variable	Number	Agricultural land	Riverbank	Wastewater margins	Saline land	Drainage margins
pH	90	8/980	8/600	8/330	8/700	8/300
EC	90	0/300	8/180	8/200	33/800	7/300
Moisture content (%)	90	0/380	0/260	0/360	0/360	0/280
Nominal specific weight	90	1/660	1/970	1/710	1/700	1/910
Porosity (%)	90	38	26	36	36	28

Pearson's correlation coefficient between variables was calculated and presented in Table 4. The significant test results have been reported along with their level of significance (p-value). The results in the first row show that there was a significant relationship between the pH, moisture content, nominal specific weight and porosity of the soil at the 1% error level.

Table 4: Pearson correlation coefficient and significance for soil variables.

Soil variable		pH	EC(ds/m)	Moisture content (%)	Nominal specific weight (g/cm^3)	Porosity (%)
pH	correlation	1	0/009	0/473**	-0/463**	0/473**
	p-value		0/951	0/001	0/001	0/001
EC (ds/m)	correlation	0/009	1	0/163	-193/0	0/163
	p-value	0/951		0/258	0/179	0/258
Moisture content (%)	correlation	0/473**	0/163	1	-0/999**	1/000**
	p-value	0/001	0/258		0/001	0/001
Nominal specific weight	correlation	-0/463**	-193/0	-0/999**	1	-0/999**
	p-value	0/001	0/179	<0/001		<0/001
Porosity (%)	correlation	0/473**	163/0	000/1**	-/999**	1
	p-value	001/0	0/258	<0/001	<0/001	

** Significant at the level of 1% error

There was a significant correlation between changes in EC in the growth regions and no germination was observed in the saline land (33.8 ds/m). EC was a deterrent to germination and growth. No germination was observed on the margins of the drainage areas (EC 7.3); thus, in addition to EC, another deterrent was also effective in this region. In this study, the EC threshold was 8.2 ds/m. Vetiver well tolerated the high alkalinity and salinity in the arid regions and grew to reach its proper height.

Trong (2004) studied tolerance of salinity in vetiver and other plants. He found that the salinity threshold for vetiver was 8 ds/ m. In the current study, a salinity threshold 8.2 ds/m was recorded for EC.

In the current study, there was a significant correlation between soil pH in the areas in which vetiver was cultivated ($p < 0.05$). Previous research on tolerance of vetiver to acidity (Truong and Baker, 1998) determined a pH threshold of 3 at the place of cultivation. In the current study, an alkaline threshold pH of 8.98 was recorded.

The mean moisture content of the soil on the wastewater margins and saline land were not significantly different ($p > 0.05$). There was a significant difference in other areas ($p < 0.05$). The moisture content of the soil in the saline land and on the wastewater margins was 36%. Plant growth has been recorded at higher and lower percentages; thus, in this region, the moisture content of the soil was not a deterrent for plant growth.

There was a significant correlation between the nominal specific weight of soil in the areas cultivated with vetiver ($p < 0.05$). There was no significant relationship between average porosity on the wastewater margins and saline land ($p > 0.05$), but there was a significant relationship in other areas ($p < 0.05$).

The results showed that vetiver can grow well in the hyperarid region of Sistan in soil having electrical conductivity and a high pH. Generalizing these results to other hyperarid regions can provide a broader range for growth of vetiver under similar circumstances.

REFERENCES

Alizadeh, A. (1999). Water, soil and plant relationship. Ferdowsi University Publication, Mashhad, Iran, 351 P.

Atriplex canescens cultivated area, range management master's thesis, Department of Natural Resources, Tehran University, 150 p.

Consulting Engineers Iran Comprehensive Survey. (2004). 16 crisis centers Department of Natural Resources and Watershed Jzynk wind erosion region of Sistan and Baluchestan 400 pages.

Edelstein, M., plaut, Z., Dudai, N and Hur, M. (2009). Vetiver (*Vetiveria zizanioides*) responses to fertilization and salinity under irrigation conditions. *Journal of Environmental Management,* **91**(1): 215-21.

Green thinkers Consulting Engineers in. (2011). Identify and control wind erosion crisis centers Kftargy city Zehak, 335 page

Khalkhali, S. (1998). Brrsy interactions between soil properties and plant characteristics in two Atriplex canescens cultivated area, range management master's thesis, Department of Natural Resources, Tehran University, 150 p.

Mirnia, Kh., Qazalsflou, A and Maramaei, M. (2010). Assess the situation of technology as a means of controlling erosion and sedimentation assess the situation in East loess lands in Golestan Province, the fourth national conference on erosion and sedimentation, light.

Nilforooshan Dardashti, B., Habibi, D., Khosravi, H and Rezaie, Kh. (2013). Vetiver solution to prevent the spread of deserts and a bulwark against desertification, National Conference of passive defense in the agricultural sector, Qeshm Island, Iran's leading cooperative promoting science, Soil and Water Consulting Engineers 2009. Soil studies Sistan plain, 350 pages.

Nilforooshan Dardashti, B., Habibi, D., Khosravi, H and Rezaie, Kh. (2011). Vetiver solution to prevent the spread of deserts and a bulwark against desertification, National Conference of passive defense in the agricultural sector, Qeshm Island, Iran's leading cooperative promoting science.

Sanei Dehkordi, K., Akhtarian, F and Farid, N, (2011). To investigate the possibility of optimal utilization of vetiver grass for feeding animals and resuscitation areas subcatchments two points of the province, the fifth conference of watershed management and soil and water resource management, Kerman, Iran Irrigation & Water Engineering.

Truong, P. N and Baker, D. (1998). Vetiver Grass System for environmental protection. Technical Bulletin No. Pacific Rim Vetiver Network. Royal Development Progects Board, Bangkok, Thailand.

Truong, P. (2010). Vetiver system For Prevention and treatment of contaminated water and Land. First Latin American Conference of Vetiver, Santiago, Chile.

Truong, P.N.T. (2004). Vetiver Grass Technology for mine tailings rehabilitation. Ground and Water Bioengineering for Erison Control and Stope Stabilization. Editors: D. Barker, A. Watson, S. Sompatpanit, B. Northcut and A. Maglinao. Science Publishers Inc. NH, USA.