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RESEARCH ARTICLE

"ECOLOGICAL STUDY AT MORBI DISTRICT NEAR LITTLE RANN OF KACHCHH IN WESTERN INDIA"

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Abstract

Vegetation and soil in the vicinity of Little Rann of Kachchh in Morbi district of Gujarat State in India at diverse expanse from edge was investigated. Total nineteen species were found of which fourteen species of herbs and five of trees. Three species each belongs to Poaceae and Mimosaceae and two species belong to Chenopodiaceae. Contagious distribution pattern of plants was obtained. Number of species found at site 1 (near Little Rann of Kachchh) was less then at site 2 (away from Little Rann of Kachchh). Total plant density; concentration of dominance and diversity indexes were almost similar at site 1 and 2. Anatomical characters of *Echinochloa colona* (Linn.) Link and *Eragrostis ciliaris* (Linn.) R.Br. affect the density, density of E. colona was found to be greater at both sites due to the presence of continuous layer of sclerenchyma at periphery around vascular bundles then E. ciliaris where continuous layer of sclerenchyma was absent. Water holding and bulk density was found to be more at site 1 while field capacity, particle density and porosity and sand particles was greater at site 2. The outcome of the study illustrate that as study shifts away from saline desert the physical properties of the soil confirm positive consequence on vegetation and diverse species

INTRODUCTION

Land degradation may be defined as long-term loss of ecosystem function and productivity caused by disturbances from which land cannot recover unaided. It has also been used to estimate vegetation change, either as an index[1&2] or as one input to dynamic vegetation models[3,4&5].

Twenty-four per cent of the land area has been degrading over the last 25 years[6], directly affecting the livelihoods of 1.5 billion people; this is on top of the legacy of thousands of years of mismanagement in some long-settled areas. GLASOD estimated that 15% of the land was degraded, much of which does not overlap with the areas highlighted by the new analysis; land degradation is cumulative – this is the global issue. Unsustainable land use is driving land degradation – a long-term loss in ecosystem function and productivity which requires progressively greater inputs to recoup the situation. Its symptoms include soil erosion, nutrient depletion, salinity, water scarcity, pollution, disruption of biological cycles, and loss of biodiversity. This is a global development and environment issue recognised by the UN Convention to Combat Desertification, the Conventions on Biodiversity and Climatic Change, and the Millennium Goals[7&8].

Quantitative, up-to-date information is needed to support policy development for food and water security, environmental integrity, and economic development. But land degradation is a contentious field.

Changes in land cover (biophysical attributes of the earth's surface) and land use (human purpose or intent applied to these attributes) are among the most important[9&10]. Land-use and land-cover changes directly impact biotic diversity worldwide[11]. Drought stress, desertification, low germination and high seedling mortality, and low water

and nutrient use efficiencies are among principal constraints to high biomass production in soils. Absence of protective vegetation cover on the surface and moisture in the soil, the exposed fine grained top soil is easily blown away by the wind. The only practical solution is to provide an effective vegetation cover to the soil. Grasses are more adapted to soil and climatic conditions of study area. Grasses provide permanent cover to the land surface and result in a substantial reduction in the wind erosion hazard. Equally important is their role in providing a permanent source of forage which is always in short supply.

India, with its growing population, increasing demands for cultivable land, fuel, fodder need for its growing industries, and its large area within the degraded land, is very much threatened by problems of land degradation. Some others[12&13] reported that recovery of damaged forest ecosystems suggest restoration of nutrient status of soil. With this alarm, we require to focus on present status of vegetation and soil at Maliya tehsil of Morbi district in Gujarat state of India. The objective of the study was to analysis of different parameters of vegetation and soil. As these are the chief indicators of land desertification/ degradation.

METHODOLOGY

Study area

The study was conducted near at Maliya tehsil of Morbi district in Gujarat state of India which is the border of the Little Rann of Kachchh. It is located at 23°05'N; 70°45'E near the Tropic of Cancer. Two sites of 1.8 km^2 were selected for the research near the border of Little Rann of Kachchh which is a saline desert. Site 1 was very near to border and another site was about 20 km away. Total 32 quadrates of 10*10 and 1*1 m^2 were organised for vegetation analysis and soil was also collected from the similar quadrates.

Vegetation analysis

The vegetation data were quantitatively analyzed for density, abundance and frequency following Curtis & McIntosh[14]. The relative values of frequency, density and dominance were determined following Phillips[15]. These values were summed to estimate IVI of individual species[16&17]. The ratio of abundance to frequency for different species was determined for eliciting the distribution patterns. This ratio indicates regular (<0.025), random (0.025 to 0.05) and contagious (>0.05) distributions[18].

Data analysis

The species diversity index (DI) for different sites was determined by using Shannon-Wiener[19] information function ($\overline{H}$).

$$\overline{H} = -\sum_{i=1}^{s} (Ni/N) \log_e (Ni/N)$$

Where, Ni is the importance value of each species, and N is the total importance value of all the species in a stand. Concentration of dominance (CD) was computed by Simpson's index[20].

$$CD = \sum_{i=1}^{S} (Ni/N)^2$$

Where, Ni and N are the same as for Shannon-Wiener information function. The calculations for the species diversity and concentration of dominance were made on tree individuals.

Soil Analysis

Collection of Soil samples

Soil samples were randomly collected from eight places at each site for three depths, namely, 0-15 cm, 15-30 cm and 30-45 cm. Soil samples were thoroughly mixed depth wise, and from the composite soil, one sample was drawn for each depth and brought to the laboratory. All these soil samples were air dried and stored in polyethylene bags to determine their physical and chemical properties. For soil aggregate analysis, soil samples were collected separately from each site. Due care was taken, specially, in sampling and in transportation to the laboratory, so that the soil aggregate should not be disturbed.

Analysis of soil

In the present investigation following physical properties were studied at research sites with different methodologies.

Water holding, Field capacity and Porosity were determined following Misra (1968)[17]. Bulk density: A pit of 10 cubic cm was dug and soil was taken out and oven dried to a constant weight. Soil weight in unit volume was computed to determine bulk density.

Particle density: It was measured by method given by USDA[21].

Soil aggregates: Soil structure was determined by "wet sieving method[22]" with the help of a Yoder sieve shaker (3/4 inch stroke at 29 strokes per minute).

RESULT

The ecological study at Morbi district near Little Rann of Kachchh was alienated into two diverse sites and analysis was done for soil and vegetation. Soil was also occupied from the similar spot where vegetation scrutiny was executed. Massive deviation was noticed between the results of each site. Anatomical study was carried out for some plants.

Vegetation analysis:

During analysis total nineteen species were found of which fourteen species of herbs and five of trees. Out of nineteen species three species each belongs to Poaceae family and Mimosaceae and two species belongs to Chenopodiaceae.

Herbs:

Density wise *Suaeda nudiflora* was dominating followed by *Echinochloa colona*, while *Commelina diffusa* and *Cyperus bulbosus* was found to be recessive at both study area. 100% frequency of any species was not obtained. Maximum 50% was found for *S. nudiflora* at site 2 and followed by *D. muricata* at site 1. Abundance of *D. muricata* at site 2 and *Eragrostis ciliaris* at site 1 were more while minimum abundant species was *C*. diffusa. This A/F value (0.071 to 0.480) shows a contagious distribution (Table 1). Average maximum cover was obtained from *Phyllanthus fraternus* (23.800 cm^2) at site 2 and *Boerhavia diffusa* (20.333 cm^2) at site 1 while minimum cover obtained from *C. Bulbosus* (5.400 cm^2) at site 2 and *Cynodon dactylon* (4.375 cm^2) at site 1. On the base of IVI the dominating species was *S. nudiflora* (64.544) and recessive species was *E. colona* (12.009). CD Concentration of Dominance) on the base of density (Table 2) was similar at both sites (0.016) while maximum CD on the base of basal cover(0.015) and IVI (0.014) was obtained at site 1. DI (Diversity Index) on the base of density, basal cover and IVI was maximum obtained at site 1 (0.329, 0.336 and 0.344). *Argemone mexicana* (12.853 gmm^2) had maximum biomass and *D. muricata* (0.031 gmm^2) had minimum at site 1. At site 2 *Rhynchosia minima* (2.155 gmm^2) had maximum biomass and *Phyllanthus fraternus* (0.081 gmm^2) had minimum (Table 3).

Trees:

Prosopis juliflora was dominating followed by *Salvadora oleoides*, while *Acacia nilotica* was found to be recessive at both study area (Table 4). 100% frequency of any species was not obtained. Maximum 50% was found for *P. juliflora*. Abundance of *P. juliflora* at each site was maximum while minimum abundant species was *A. nilotica*. A/F value was 0.065 to 0.240. This A/F value shows a contagious distribution. On the basis of IVI the dominating species was *P. juliflora* (213.250) and recessive species was *A. nilotica* (21.923). Maximum CD (Table 5) on the basis of density, abundance and IVI was at site 2 (0.348, 0.250 and 0.294). DI on the basis of density, abundance and IVI was maximum found at site 2 (0.348, 0.499 and 0.434).

Anatomy with relation to Density:

Anatomical characters of two species *E. colona* and *E. ciliaris* was studied. *E. colona* consists of two circles of vascular bundles. The outer circle is near to the periphery and surrounded by a continuous ring of sclerenchyma. While *E. ciliaris* consists of scattered vascular bundles (Fig. 1), but continuous ring of sclerenchyma was absent. Sclerenchyma cells are the strengthening elements for a plant. Vascular bundles were less in *E. colona* then *E. ciliaris.* Due to a reduced amount of vascular bundle the harmful solutes doesn't uptake by the plants in large quantity while more vascular bundles uptake large quantity of solutes which depress the plant growth and affects the density of *E. ciliaris*. Of these two species more density was found for *E. colona* and less was found for *E. ciliaris*. In *E. colona* the continuous ring of sclerenchyma provides it strength to tolerate harsh condition of the nature.

Soil analysis:

Both sites confirm distinct results at different depths. WHC of site 1 (14.217%) and site 2 (11.020%) was maximum at a depth of 0-15 cm while least was obtained at a depth of 30-45 cm which is 11.163 and 9.720% for site 1 and 2. FC was maximum at site 1 (58.770%) at a depth of 15-30 cm while minimum at site 2 (46.790%) at same depth. Same result was also found for BD but at different depth i.e. 0-15 cm, at site 1 highest value was obtained ($1.610gcc^{-1}$) and at site 2 lowest values was obtained ($1.163gcc^{-1}$). Result found for PD was almost similar at each site. Highest value of PD at site 1 and 2 was found at a depth of 0-15 cm (3.003 and $3.210gcc^{-1}$) and lowest at 15-30 cm (2.530 and $3.097gcc^{-1}$). When porosity was considered then maximum value was found at different depth but minimum value was found at similar depth (Table 6). At site 1and 2 highest values was found at a depth of 30-45 and 0-15 cm (57.871 and 63.751%) on the other side lowest value was obtained at 15-30 cm (42.110 and 52.436%). Result of soil aggregate (Table 7) shows that at sieve size of 0.212 to 1mm maximum value was obtained while least value was obtained at < 0.025, >2 and 1to2mm sieve size. Soil texture (Table 8) was analysed and in maximum amount of sand (84.503%) was obtained at site 2 at a depth of 30-45 cm and minimum was found at same site (60.611%) at 0-15 cm. Percent of silt and clay was maximum(26.351%) at site 2 at 0-15 cm while percent of gravel was maximum at site 1 (10.616%) at 30-45 cm. At each site high percent of sand was obtained during study.

Table 1: Analysis of Herbs at different sites near Little Rann of Kachchh

Sr.No.	Species	Density (plants m-2)	Frequency (%)	Abundance (plants m-2)	A/F	Cover (cm2)	IVI
		SITE 1					
1	*Argemone mexicana* Linn.	0.625 ± 2.000	12.500	5.000	0.400	4.700	18.885
2	*Cynodon dactylon* (Linn.) Pers.	0.500 ± 0.408	25.000	2.000	0.080	4.375	23.668
3	*Boerhavia diffusa* Linn.	0.563 ± 1.155	18.750	3.000	0.160	20.333	35.666
4	*Eragrostis ciliaris* (Linn.) R.Br.	1.313 ± 0.577	18.750	7.000	0.373	16.400	41.606
5	*Digera muricata* (Linn.) Mart.	1.188 ± 1.579	37.500	3.167	0.084	11.000	45.100
6	*Corchorus fasicularis* Lam.	0.750 ± 2.000	12.500	6.000	0.480	12.900	27.942
7	*Echinochloa colona* (Linn.) Link	2.000 ± 1.691	31.250	6.400	0.205	10.900	51.993
8	*Commelina diffusa* Burm. f.	0.625 ± 1.202	18.750	3.333	0.178	18.667	34.941
9	*Cyperus bulbosus* Vahl	0.313 ± 0.500	12.500	2.500	0.200	10.500	20.200
		SITE 2					
1	*Abutilon indicum* (Linn.) Sw.	0.375 ± 1.000	12.500	3.000	0.240	12.050	19.223
2	*Commelina diffusa* Burm. f.	0.063 ± 0.000	6.250	1.000	0.160	17.200	15.617
3	*Corchorus fasicularis* Lam.	1.250 ± 1.225	25.000	5.000	0.200	17.467	40.464
4	*Cyperus bulbosus* Vahl	0.250 ± 0.000	12.500	2.000	0.160	5.400	13.034
5	*Digera muricata* (Linn.) Mart.	1.750 ± 2.273	25.000	7.000	0.280	13.750	44.479
6	*Echinochloa colona* (Linn.) Link	0.188 ± 0.500	12.500	1.500	0.120	5.100	12.009

7	*Eragrostis ciliaris* (Linn.) R.Br.	0.125 ± 0.000	6.250	2.000	0.320	13.200	13.700
8	*Phyllanthus fraternus* Webster	0.563 ± 1.500	12.500	4.500	0.360	23.800	29.720
9	*Rhynchosia minima* (Linn.) DC.	0.625 ± 0.289	25.000	2.500	0.100	15.225	30.734
10	*Suaeda fruticosa* (Linn.) Forsk.	0.250 ± 0.333	18.750	1.333	0.071	6.000	16.475
11	*Suaeda nudiflora* (Willd.) Moq.	2.188 ± 1.426	50.000	4.375	0.088	16.975	64.544

Table 2: Concentration of Dominance and Diversity Index of Herbs at different sites

Sites	CD			DI		
	Density	Cover	IVI	Density	Cover	IVI
1	0.016 ± 0.007	0.015 ± 0.004	0.014 ± 0.003	0.329 ± 0.032	0.336 ± 0.032	0.344 ± 0.022
2	0.016 ± 0.008	0.010 ± 0.002	0.011 ± 0.004	0.257 ± 0.044	0.302 ± 0.024	0.294 ± 0.028

Table 3: Variation between Above Ground Biomass and Below Ground Biomass of different Herbs species

Species	Site 1			Site 2		
	Below Ground Biomass (gm)	Above Ground Biomass (gm)	Total Biomass (gm)	Below Ground Biomass (gm)	Above Ground Biomass (gm)	Total Biomass (gm)
Abutilon indicum (Linn.) Sw.				0.010	0.200	0.210
Argemone mexicana Linn.	0.613	12.240	12.853			
Boerhavia diffusa Linn.	0.080	1.440	1.520			
Commelina diffusa Burm. f.	0.030	0.300	0.330	0.048	0.243	0.292
Corchorus fasicularis Lam.	0.028	0.128	0.156	0.025	0.905	0.930
Cynodon dactylon (Linn.) Pers.	0.024	0.124	0.149			
Cyperus bulbosus Vahl	0.008	0.230	0.238	0.055	0.245	0.300
Digera muricata (Linn.) Mart.	0.001	0.030	0.031			
Echinochloa colona (Linn.) Link	0.018	0.162	0.180	0.029	0.154	0.183
Phyllanthus fraternus Webster				0.006	0.075	0.081
Rhynchosia minima (Linn.) DC.				0.195	1.960	2.155
Suaeda fruticosa (Linn.) Forsk.				0.030	0.125	0.155
Suaeda nudiflora (Willd.) Moq.				0.091	0.676	0.767

Table 4: Analysis of Trees at different sites near Saline Desert of Little Rann of Kachchh

Sr.No.	Species	Density (plants 10m^{-2})	Frequency (%)	Abundance (plants 10m^{-2})	A/F	IVI
SITE 1						

1	*Acacia nilotica* (L) Dell	0.063 ± 0.000	6.250	1.000	0.160	21.923
2	*Capparis decidua* (Forsk.) Edgew.	0.313 ± 1.500	12.500	2.500	0.200	58.536
3	*Prosopis cineraria* (L) Druce	0.125 ± 0.000	12.500	1.000	0.080	32.645
4	*Prosopis juliflora* (Sw) DC	1.500 ± 0.812	43.750	3.429	0.078	164.973
5	*Salvadora oleoides* Deene.	0.063 ± 0.000	6.250	1.000	0.160	21.923
SITE 2						
1	*Prosopis juliflora* (Sw) DC	1.625 ± 0.861	50.000	3.250	0.065	213.250
2	*Salvadora oleoides* Deene.	0.375 ± 1.000	12.500	3.000	0.240	86.750

Table 5: Concentration of Dominance and Diversity Index of Trees at different Sites

Sites	CD			DI		
	Density	Abundance	IVI	Density	Abundance	IVI
1	0.111 ± 0.104	0.053 ± 0.027	0.073 ± 0.058	0.259 ± 0.051	0.421 ± 0.041	0.367 ± 0.043
2	0.348 ± 0.313	0.250 ± 0.020	0.294 ± 0.211	0.348 ± 0.105	0.499 ± 0.009	0.434 ± 0.084

Table 6: Physical properties of Soil at three different depths near Little Rann of Kachchh

Sr.No.	Parameters	Soil Depth (Cm)	SITE 1	SITE 2
1	**WHC (%)**	**0-15**	14.217 ± 0.159	11.020 ± 0.724
		15-30	12.813 ± 0.221	9.787 ± 0.472
		30-45	11.163 ± 0.276	9.720 ± 0.124
2	**FC (%)**	**0-15**	49.657 ± 5.320	62.120 ± 3.170
		15-30	58.770 ± 6.691	46.790 ± 0.581
		30-45	36.527 ± 3.808	59.487 ± 5.708
3	**PD (gcc-1)**	**0-15**	3.003 ± 0.124	3.210 ± 0.036
		15-30	2.530 ± 0.200	3.097 ± 0.066
		30-45	2.657 ± 0.260	3.157 ± 0.026
4	**BD (gcc-1)**	**0-15**	1.610 ± 0.180	1.163 ± 0.035
		15-30	1.473 ± 0.193	1.463 ± 0.201
		30-45	1.103 ± 0.038	1.220 ± 0.051
5	**Porosity (%)**	**0-15**	46.153 ± 6.538	63.751 ± 1.155
		15-30	42.110 ± 4.823	52.436 ± 7.559
		30-45	57.871 ± 3.092	61.367 ± 1.405

Table 7: Soil aggregates at three different depths near Little Rann of Kachchh

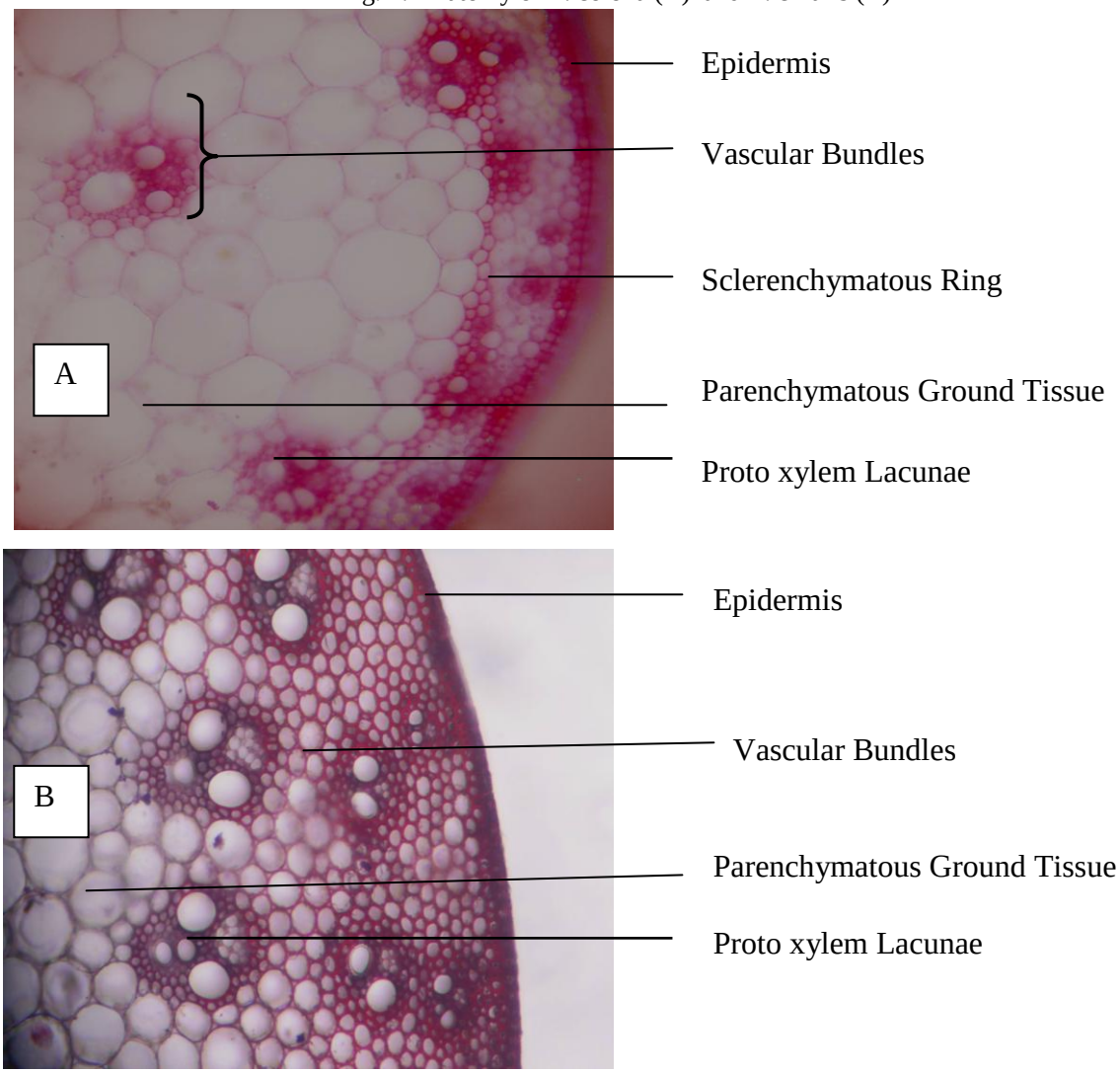
Soil Depth →	0-15 (Cm)		15-30 (Cm)		30-45 (Cm)	
Size (mm)	**Site 1**	**Site 2**	**Site 1**	**Site 2**	**Site 1**	**Site 2**
>2	10.029	13.038	7.200	6.321	10.616	4.044
1 to 2	9.050	9.863	12.683	5.342	16.121	8.190
0.212 to 1	27.424	9.099	40.247	53.725	25.885	59.544

.125 to .212	12.498	18.565	8.074	9.842	11.206	3.982
.063 to .125	20.196	23.084	11.975	14.477	11.173	12.787
.025 to .063	9.442	12.489	10.694	6.742	16.186	5.952
< .025	11.361	13.863	9.128	3.552	8.814	5.501

Table 8: Soil texture at three different depths near Little Rann of Kachchh

Soil Depth →	**0-15 (Cm)**		**15-30 (Cm)**		**30-45 (Cm)**	
Type	**Site 1**	**Site 2**	**Site 1**	**Site 2**	**Site 1**	**Site 2**
Gravel	10.029	13.038	7.200	6.321	10.616	4.044
Sand	69.167	60.611	72.978	83.386	64.384	84.503
Silt & Clay	20.803	26.351	19.822	10.293	25.000	11.453

Fig. 1: Anatomy of E. colona (A) and E. ciliaris (B)



DISCUSSION

The study was conducted near Little Rann of Kachchh at Morbi district of Gujarat state in India which is located at the border of the Gulf of Kutch. It is a saline area which is generally affected by sea water, very less rainfall and high temperature. During study total nineteen species of plants were found. Density and number of species varies at each site. Due to high temperature, evaporation and transpiration remove pure water (as vapours) from the soil solution and this water loss concentrates salts. Water from ocean dispersed over land and evaporates, adding to increased soil salinity. When land contains high concentration of solutes and there is no opportunity to flush out accumulated salts to drainage system, salts can quickly reach levels that are injurious to salt sensitive species. High concentrations of salts have detrimental effects on plant growth[23&24] and excessive concentrations kill growing plants[25]. During earlier study many investigators have reported retardation of germination and growth of seedlings at high salinity[23, 26&27]. However, plant species differ in their sensitivity or tolerance to salts[28].

Nine species of herbs were found at site 1 while thirteen species at site 2. Main point behind less number of species and less density of plants is excess salinity in soil water which can decrease plant available water and cause plant stress. Salinity can impair plant function, growth and developmental processes. In the extreme it can reduce survival. Reduced water availability is the initial stress perceived by shoots during a salt incursion into the environment of roots. Plants minimize salt injury by reducing salt exposure of meristems, particularly in the shoots. Maximum salinity during dry periods which lowers the osmotic potential of soil water[29] may also cause loss of vegetation in the saline area. Due to high concentration of salinity there are different factors which do not allow vegetation to grow at the full strength such as salinity reduces nitrogen accumulation in plants and imbalance of the uptake of the essential nutrients[30&31]. Highly saline and sodium induced soil reduces amount of water to pass through the root zone regardless of the amount of water actually in the root zone. The high Na^+ concentration of a sodic soil not only injures plants directly but also degrades the soil. As salinity causes fine particles to bind into aggregates. Maximum salinity during dry periods which lowers the osmotic potential of soil water[29] may also cause loss of vegetation in the saline area. Due to high concentration of sodium in soil, soil dispersion, clay platelet and aggregate swelling takes place. This soil dispersion causes clay particles to plug soil pores, resulting in reduce soil permeability. Soil dispersion hardens soil and blocks water infiltration, making it difficult for plants to establish and grow. WHC and FC was high which might be due to the high concentration of salt. Due to salinity and sodium the clay particles swells and decrease the pore space of the soil. During rainfall water leaches salt down, the soil profile which is beneficial for the germination of new seedlings and growth of the plants. Rainfall leaches salts down the soil profile, as far down as the ground water, with a compensating upward movement as a result of capillary action.

CONCLUSION

It is concluded that the high intensity of temperature and salinity of sodic soil injures plants directly and degrades the soil structure and water availability to plants instead of having greater values of soil moisture to plants. Less number of vascular bundle and sclerenchyma ring increase the growth and density of the plants.

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