Journal Homepage: - www.journalijar.com
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)
Article DOI: 10.21474/IJAR01/7802
DOI URL: http://dx.doi.org/10.21474/IJAR01/7802

RESEARCH ARTICLE

SOIL-PLANT DEGRADATION AND THEIR INTER-RELATION AT SALINE DESERT ECOSYSTEM.

Pilania P.K[1], N. Parejiya[2] and N.S. Panchal[2].
1. P.G. Memorial College, J.C.D. Vidyapeeth, Sirsa-125055.
2. Department of Biosciences, Saurashtra University, Rajkot-360005.

Manuscript Info

Manuscript History
Received: 3 August 2018
Final Accepted: 5 September 2018
Published: October 2018

Keywords:
Desert, Calcium, Soil, Salinity, Sodium, Vegetation.

Abstract

High salinity is contributing significantly to environmental degradation. Saline desert (Little Rann of Kutch of 4860 ha) was selected to study soil and vegetation. Soil was analyzed at different depth 0-15, 15-30 and 30-45cm. Maximum salinity was 24.033dSm^{-1}. Mean values for FC, WHC, OC, N, P, Ca, K and Na were 20.456%, 28.250%, 0.344%, 0.030%, 22.727kg ha^{-1}, 103.293mg kg^{-1}, 841.276mg kg^{-1} and 144.395mg kg^{-1}. Calcium and herbaceous density (153.601mg kg^{-1} and 0.646plants m^{-2}) was maximum and sodium (65.490mg kg^{-1}) was minimum (site two). Results suggest that calcium have beneficial effect to overcome salinity and minimise the effect of sodium in the soil.

Introduction:-

Salinity is one of the harshest environmental factors restraining the productivity of the land. Most vegetation is responsive to salinity caused by high concentrations of salts in the soil. Worldwide, it is estimated that nearly two billion hectares of biologically productive land have been rendered unproductive due to irreversible degradation (Vilanculos, 1994).The present rate of land degradation is estimated at 5 to 7 million hectares per year, suggesting that 0.3 to 0.5% of the world's arable land is lost annually due to soil degradation (FAO, 1983; Vilanculos, 1994). So it is must to spotlight on the soil properties on a desert area so that the productivity can be improved.

The chief effect of salts on vegetation is, during increased osmotic pressure plants find it gradually more difficult to haul out water from the soil. This is the main cause of vegetative demur on saline areas, leading to many of the adverse environmental consequences of salinization of desert. Change in vegetation, either to dominance of additional salt tolerant species or through reduced growth of existing species, is frequently the first understandable signs of desert salinization trouble. These effects depend, mainly on seasonal conditions, plant growth and root zone salt levels varying according to rainfall pattern and the occurrence of periods of drying weather (Charman and Junor, 1989).

Soil characteristics manipulate the availability of water for plant use by controlling the infiltration and percolation of water (McAuliffe 2003). Such as, sandy soils allow for quick and deep movement of water (Walter 1979, Noy-Meir 1973, Sala *et al.*, 1996, McAuliffe 1994, 2003). However, clay-rich soils have higher water holding capacity in shallow layers but tend to confine deep percolation (McAuliffe 1994, 2003). The deep percolation and storage of moisture in coarse-textured soils will supply a source of soil moisture for plants that is more importunate through time than the source of soil moisture that is found on fine-textured soil. The spatial and temporal distributions of soil moisture strongly influence vegetation composition, structure and productivity in arid and semiarid regions (McAuliffe 2003). The characteristics of divergent soil types are significant for plant carbon and water exchange (Smith *et al.*,1995; Hamerlynck *et al.*, 2000, 2002, 2004; Huxman *et al.*,2004b,c) and at last ecosystem processes

Corresponding Author:-Pilania P.K.
Address:- P.G. Memorial College, J.C.D. Vidyapeeth, Sirsa-125055

(Huxman *et al.*, 2004b, c; Potts *et al.*,2006). Soil and vegetation are mutually supporting each other. Diverse aspects of soil influence vegetation of any vicinity (Pilania and Panchal, 2014). Little Rann of Kutch is a salt marshland with soaring salinity (Gupta and Ansari 2012). The key objectives of this research were to analyse the soils with different physical and chemical properties and their influence on vegetation.

Material and Methods:-

Study Area

The study was conducted in India at Little Rann of Kutch known as "The Wild Ass Sanctuary", named after endangered Ghudkhur (*Equs hemionus khur*). It is situated between 22° 55" to 24° 35" North latitudes and 70° 30" to 71° 45" East longitudes.

Soil Analysis

Field analysis and collection of samples were done in the months of summer *i.e.* March, April May and half of June. Soil samples were randomly collected from 108 places from four different sites for three depths, namely, 0-15 cm, 15-30 cm and 30-45 cm.

Analysis of Physical Properties of Soil

Soil Texture was determined by "Bouyoucos Hydrometer Method" (Bouyoucos, 1951). Soil Aggregates was determined by "Wet sieving method" (Yoder, 1936) with the help of a Yoder sieve shaker. For the analysis of bulk density (BD) 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 (PD) was measured by method given by USDA, 1968. Value of bulk density was used to determine porosity (PO) of soil (Misra, 1968) and expressed in percentage.

Soil Moisture Constants

Field Capacity (FC) and water holding capacity (WHC) was determined following Misra (1968) and the results are expressed in percentage of oven-dry weight (Oven-drying was done at 105^0C temperature).

Analysis of Chemical Properties of Soil

Soil pH was measured by a pH meter preparing soil paste with distilled water (1:5 ratio). Electrical Conductivity (**EC**) was measured by an E. C. meter. Organic carbon (**OC**), Organic matter (**OM**) and Nitrogen (**N**) were measured by following the method of Jackson,. M.L.(1973). Available Phosphorus (**P**) was measured by following the method of Olsen *et al.* (1954). Potassium (**K**), Sodium (**Na**), Calcium (**Ca**), Zinc (**Zn**), Copper (**Cu**), Iron (**Fe**), Lead (**Pb**) and Manganese (**Mn**) were measured (Lindsay and Norvell, 1978) by AAS (Atomic Absorbance Spectrophotometer).

Vegetation analysis

For each site the vegetation data were quantitatively analyzed for density following Curtis and McIntosh (1950) to identify the correlation between different parameters of soil.

Results:-

Characterization of soil properties at different depths

The results of soil test designated that the property varies from depth to depth (Table 1). The result is comprised from 0-15, 15-30, 30-45 cm as well as 0-45 cm depth to estimate a value for this region. The regional mean values for BD, PD, PO, FC and WHC were 2.097 gcc^{-1}, 2.994gcc^{-1}, 28.654%, 20.456% and 28.250% respectively. BD, PD and FC (2.181gcc^{-1}, 3.085gcc^{-1} and 21.375%) were found maximum at 30-45 cm soil depth while PO (31.862%) was found to be maximum at upper layer of soil (0-15cm). The inherent soil texture change very slowly with depth. The average clay content (35.926%) was higher than silt and sand content (29.205 and 34.869%). However major difference was not obtained between these variables at different soil depths. Variables of soil aggregate show a major difference at various depths. Maximum values obtained for aggregate size greater than 2mm and 0.212 to 1mm.

Fourteen different variables for chemical characters of soil at different soil depths were studied. More than 55% shows maximum values at upper layer of soil (0-15cm) while only 28% have maximum values at lower depth of soil (30-45cm). The regional mean value for EC, OC, N, P, Ca, K and Na were 12.322 dSm^{-1}, 0.344%, 0.030%, 22.727

kg ha^{-1}, 103.293 mg kg^{-1}, 841.276 mg kg^{-1} and 144.395 mg kg^{-1} respectively. EC and Na were found to be high (24.033 $dSm^{-1}$and 310.820 mg kg^{-1}) due to the saline characteristics of the land. EC, OC, N, K and Na (14.291dSm^{-1}, 0.361%, 0.031%, 854.578 mg $kg^{-1}$and 147.744 mg kg^{-1}) were found to be maximum at upper layer of soil (0-15 cm) depth. Saline characters of soil is represented by high median and mode values of EC (11.000 and 21.000 dSm^{-1}) which is the combine effect of different salts of Na, Mn, K *etc*. Mn and Ca, Na and Ca, Ca and K show negative correlation of 0.448, 0.562 and 0.578 (Figure 1). K and Zn, Na and K show positive correlation of 0.961 and 0.923.

Characterization of soil and vegetation properties at different sites
The average herbaceous density was maximum (0.646 plants m^{-2}) at site two while minimum (0.221 plants m^{-2}) at site four but species richness was maximum (23) at site three and minimum (3) at site two. The average tree/shrub density was maximum (1.839 plants $10m^{-2}$) at site 4 while minimum (0.600 plants $10m^{-2}$) at site two but in case of trees species richness was maximum (6) at site four and minimum (3) at site three. The density of *Prosopis juliflora* (Sw.) was found to be 0.250, 0.688, 2.063 and 3.458 plants $10m^{-2}$ at site one to four respectively.

A physical and chemical variable varies at different sites. High BD (2.191 gcc^{-1}) and low porosity (25.169%) highly affects the herbaceous vegetation at site four. High PD (3.118 gcc^{-1}), low FC and WHC (15.619 and 24.372%) negatively affects the tree's density at site two. Sand (48.157%) and clay (44.057%) was found maximum at site two and four respectively while minimum values at vice versa. This suggests that soil texture affects the density of herbs and trees, as herbaceous or fibrous roots cannot penetrate deep inside the soil due to clustering of clay particles while tuberous or tap roots of trees may penetrate inside the soil.

Ca (153.601 mg kg^{-1}) and herbaceous density (0.646 plants m^{-2}) was maximum at site two and Na (65.490 mg kg^{-1}) was minimum, which suggests that Ca have beneficial effect to overcome salinity as well as on sodium content of the soil.

64% of the chemical variables at site three obtained greater values then others sites (site one, two and four). OC, OM, N, P, Zn, K, Cu, Fe, Na (0.368%, 0.635%, 0.032 % and 25.541 kg ha^{-1}, 142.863, 939.921, 25.197, 111.884 and 227.407 mg kg^{-1}) were found to be maximum at site three. Maximum species richness (23) at site three for herbs was found. This observation shows that positive effect of OC, OM, N and P was minimised by salts of Na, K *etc* and it was also found that Ca was also lowest at this site (91.839 mg kg^{-1}).

EC (14.685 dSm^{-1}) was maximum at site four with lowest herbaceous density and highest tree density which indicates that total salinity effects more negatively to herbs than to trees. Positive correlation between Fe with density (0.993) was found at the study area.

Discussion:-
Saline soil (physical and chemical properties) and their influence on vegetation at saline desert of western India (Little Rann of Kutch) were studied. Physical and chemical value of soil varies depth as well as site wise (horizontally) and the soil factors affect the vegetation. Salinization of soil is more common in arid and semi-arid regions than in humid ones. The high salt content lowers osmotic potential of soil water and consequently the availability of soil water to plants. The salt-induced water deficit is one of the major constraints for plant growth in saline soils (Ramoliya *et al.* 2004). EC and Na were found to be as high as 24.033dSm^{-1} and 310.820 mg kg^{-1}. In addition, high concentrations of Na^+ the availability and uptake of nutrients by plants in saline soils are affected by many factors in the soil–plant environment. The solid segment of the soil and the concentration and composition of solutes in the soil solution manage the activity of the nutrient ion. Soil solution pH influences the speciation and thus availability of firm nutrients (Patel *et al.* 2011).

Maximum Ca (153.601 mg kg^{-1}) and herbaceous density was obtained at site two, which suggests that Ca have detrimental effects on salinity. Application of gypsum has long been considered a common practice in reclamation of saline-sodic and sodic soils (Marschner 1995). Addition of calcium to the soil (as gypsum or lime) displaces Na^+ from clay particles. This prevents the clay from swelling and dispersing (Sumner 1993) and also makes it possible for Na^+ to be leached deeper into the soil. Thus, exogenously supplied calcium not only improves soil structure, but also alters soil properties in various ways (Shabala *et al.* 2003) that benefit the plant growth. Moreover, an improved Ca/Na ratio in the soil solution enhances the capacity of roots to restrict Na^+ influx (Marschner 1995). Importance of interaction between Na and Ca was recognized after LaHaye and Epstein (1969) reported that exogenously supplied calcium may significantly alleviate detrimental effects of Na^+ on the physiological performance of hydroponically grown plants.

In this study WHC, FC, OC and N were 28.250, 20.456, 0.344 and 0.030% while Panchal and Pandey (2002) found that in Gujarat near Little Rann of Kutch (Saurashtra Region) WHC, FC, OC and N were 26.4, 20.2, 0.43 and 0.008%. Some slight variations are found in these values due to environment, climatic conditions and topography of the soil. They mentioned that soil salinity increases with degradation of soil or desertification. Spatial variability of soil physical and chemical properties at a large scale is mainly due to geological, geomorophological and pedological soil forming factors that could be altered and induced by other factors such as land use managements. Therefore, it is essential to study the extent of spatial variability at soil surface. The study conducted at arid desert of Iran, shows that BD, Clay and Silt (1.18 gcc^{-1} 37.02% and 44.02%) by Motaghian *et al.* 2008. Another study at arid region (Azimzadeh *et al.* 2008) of Iran shows that pH, EC, sand, silt, clay and OM (7.7, 2.5 dSm^{-1}, 70%, 18%, 12%, and 0.3%) varies with the results of earlier scientists. This suggests that from site to site the results of soil variables at regional level.

In present study at different depth the soil variables vary and out of fourteen chemical variables more than 55% shows maximum values at upper layer of soil (0-15cm) while only 28% have maximum values at lower depth of soil (30-45cm).

OC, OM (0.368%, 0.635%) were found to be maximum at site three with high species richness (23) for herbs and less density. This observation shows that positive effect of OC and OM was minimised by salts of Na, K *etc* and it was also found that Ca was also lowest at this site (91.839 mg kg^{-1}). According to Singh *et al.* (1989) organic substances stimulate immobilization of nutrients in the soil biomass. Consequently, with depletion of organic substances, the conservation of nutrients is also reduced which results in the decline of nutrient status of soil. Nitrogen is added in the soil by decomposition of organic matter and nitrogen fixation by microbes. The reduction of organic substances may adversely influence the microbial activity with degradation of land. It is considered that the soil organic matter is the major pool of carbon and nutrients, and regulates to a large extent the physical, chemical and biological properties of soil (Miller, 1990; Gupta and Malik, 1996).

The concentration of salts of Na, K and Mg increases in soil with degradation. High concentration of salts in soil, in general, causes detrimental effects on plant growth (Bernstein, 1967; Kramer, 1983; Pandey and Thakarar, 1997; Mer *et al.* 2000). As per Donahue *et al.* (1983), excessive concentrations of salts may kill growing plants. Salinity appears to affect two plant processes *i.e.* water and ionic relations (Cramer and Nowak, 1992). During the revelation to salinity, the plants experience water stress and during long-term revelation to salinity, the plants experience osmotic effects related to ionic effects. However, plant species differ in their sensitivity or tolerance to salts (Troech and Thompson, 1993). At earlier study small plots were studied at Little Rann of Kutch and it was found that high EC, pH and high percentage of clay affects vegetation negatively and are harmful for the growth of the vegetation (Pilania and Panchal 2014) and the same result was found during this recent study.

Temperature and rainfall affects the soil as well as vegetation (Pilania and Panchal, 2013b) of an area. Due to less rainfall and high temperature the salinity of the soil increases. The main reason behind less number of species and density of plants is that excess salinity in soil water can decrease plant available water and cause plant stress. Maximum salinity during dry periods which lowers the osmotic potential of soil water (Hirpara *et al.* 2005) may also cause loss of vegetation in the saline area. Due to high concentration salinity reduces nitrogen accumulation in plants and imbalance of the uptake of the essential nutrients (Feigin 1985, Garg *et al.* 1993). According to Zare *et al.* (2011) increase in soil depth leads to increase in amount of sand, lime, gypsum, BD and soil hydraulic conductivity while EC, clay, silt, OM, FC, K and N decreased. Soil texture doesn't show conformation with the findings of Zare *et al.* (2011) but in case of EC, OM, K and N was found to be highest at the upper layer and shows conformations.

Conclusion:-

Species richness and density of herbs was found inversely proportionate. High density of *Prosopis juliflora* (Sw.) and concentration of Na may allow to germinating plant but are not able to sustain therefore species richness was high and low density. On other hand low species richness and high density found due to less density of *P. juliflora* and low concentration of Na and high concentration of Ca which allow germination of few species with sustainable growth as per niche pre-emption hypothesis and severe competition among species.

Table 1:-Descriptive of Soil (Physical and Chemical variables) at different soil depths. (BD=Bulk density, PD= Particle density, PO= Porosity, FC= Field capacity, WHC= Water holding capacity, EC= Electrical conductivity, OC= Organic carbon, OM= Organic matter, N= Total nitrogen, P= Available phosphorous, Ca= Total calcium, Zn= Zinc, K= Potassium, Cu= Copper, Fe= Iron, Na= Sodium, Pb= Lead, Mn =Manganese, Size of soil aggregate is given in mm)

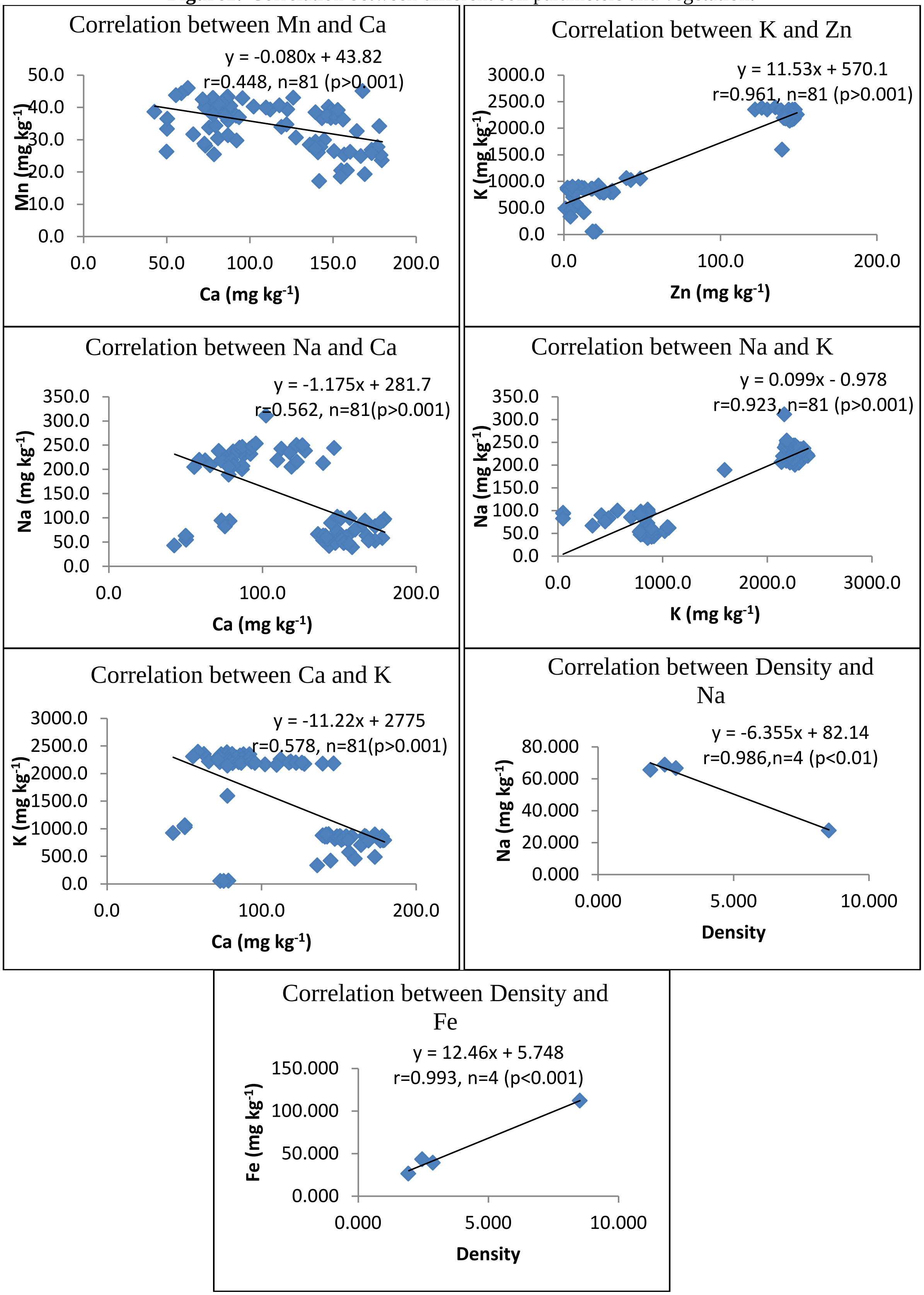
Parameters	Soil Depth (cm)			Combined data from 0-45 cm soil depth				
	0-15	15-30	30-45	Minimum	Maximum	Mean	Median	Mode
PHYSICAL PROPERTIES								
BD (gcc^{-1})	2.045 ± 0.026	2.065 ± 0.032	2.181 ± 0.023	1.380	2.843	2.097 ± 0.016	2.085	2.061
PD (gcc^{-1})	3.039 ± 0.072	2.856 ± 0.079	3.085 ± 0.070	1.642	4.926	2.994 ± 0.043	2.907	2.899
PO (%)	31.862 ± 1.398	26.341 ± 1.062	27.758 ± 1.137	10.190	58.625	28.654 ± 0.711	27.047	25.491
FC (%)	20.067 ± 0.810	19.927 ± 0.764	21.375 ± 0.880	10.020	42.925	20.456 ± 0.473	18.010	38.161
WHC (%)	27.928 ± 0.468	28.503 ± 0.695	28.321 ± 0.814	13.190	56.488	28.250 ± 0.388	27.107	25.888
SOIL TEXTURE (%)								
Sand (%)	35.223 ± 1.423	34.756 ± 1.449	34.627 ± 1.537	25.132	50.002	34.869 ± 0.839	34.976	28.058
Clay (%)	35.892 ± 1.351	35.916 ± 1.361	35.971 ± 1.379	22.008	45.823	35.926 ± 0.777	35.995	34.004
Silt (%)	28.885 ± 0.459	29.328 ± 0.434	29.402 ± 0.408	23.017	34.023	29.205 ± 0.249	28.994	27.984
SOIL AGGREGATE (%)								
>2	39.199 ± 6.358	36.877 ± 6.233	31.353 ± 7.244	1.436	97.436	35.810 ± 3.796	15.445	10.182
1to2	12.856 ± 2.018	11.389 ± 1.765	13.457 ± 1.943	0.290	36.651	12.567 ± 1.094	9.797	1.228
0.212to1	30.412 ± 3.261	30.035 ± 3.172	34.493 ± 4.582	1.366	76.413	31.647 ± 2.137	29.570	40.729
0.125to0.212	8.407 ± 1.426	8.222 ± 1.014	9.410 ± 1.276	0.243	27.953	8.680 ± 0.715	7.820	14.144
0.063to0.125	5.679 ± 1.017	9.357 ± 1.627	7.703 ± 1.284	0.290	23.234	7.580 ± 0.778	4.556	18.938
0.025to0.063	1.752 ± 0.409	2.448 ± 0.569	2.323 ± 0.321	0.083	9.616	2.174 ± 0.256	1.217	7.567
<0.025	1.695 ± 0.417	1.671 ± 0.370	1.261 ± 0.225	0.057	7.211	1.542 ± 0.199	0.725	7.211
CHEMICAL PROPERTIES								
pH	8.244 ± 0.019	8.397 ± 0.028	8.424 ± 0.014	7.200	10.973	8.355 ± 0.020	8.383	7.290
EC (dSm^{-1})	14.291 ± 0.034	11.111 ± 0.056	11.565 ± 0.043	0.443	24.033	12.322 ± 0.044	11.000	21.000
OC (%)	0.361 ± 0.016	0.320 ± 0.010	0.350 ± 0.011	0.011	0.923	0.344 ± 0.007	0.345	0.337
OM (%)	0.622 ± 0.027	0.551 ± 0.017	0.604 ± 0.019	0.019	1.592	0.593 ± 0.013	0.595	0.581
N (%)	0.031 ± 0.001	0.028 ± 0.001	0.030 ± 0.001	0.001	0.080	0.030 ± 0.001	0.030	0.029
P (kg ha^{-1})	19.123 ± 0.522	23.681 ± 0.542	25.377 ± 0.611	6.754	36.022	22.727 ± 0.364	22.514	24.015
Ca (mg	102. ± 2.0	104. ± 2.5	103. ± 2.7	42.773	178.09	103. ± 2.4	87.1	51.9

kg^{-1})	154		75	259		42	466		64		1	293		60	51	10
Zn (mg kg^{-1})	77.144	±	0.596	77.619	±	0.725	77.509	±	0.741	1.158	148.936	77.424	±	0.687	42.866	30.006
K (mg kg^{-1})	854.578	±	2.533	841.192	±	2.508	828.059	±	2.365	50.159	1194.342	841.276	±	2.469	867.288	792.811
Cu (mg kg^{-1})	21.007	±	1.360	21.977	±	1.311	22.443	±	1.270	2.519	45.966	21.809	±	1.314	20.714	15.205
Fe (mg kg^{-1})	82.890	±	1.011	67.402	±	1.846	69.407	±	1.007	18.211	519.359	73.233	±	1.288	63.043	47.530
Na (mg kg^{-1})	147.744	±	1.190	143.767	±	1.055	141.674	±	1.590	39.046	310.820	144.395	±	1.278	99.480	55.378
Pb (mg kg^{-1})	61.311	±	2.125	60.385	±	1.772	61.459	±	1.290	26.723	134.073	61.051	±	1.729	57.888	51.768
Mn(mg kg^{-1})	35.373	±	1.391	34.316	±	1.243	33.585	±	0.960	17.114	45.926	34.425	±	1.198	36.620	36.916

Table 2:-Descriptive of Soil (Physical and Chemical variables) and Vegetation analysis at different sites.

Parameters	Site 1			Site 2			Site 3			Site 4		
Herbs												
Average Density (plants m^{-2})	0.309	±	0.298	0.646	±	1.130	0.371	±	0.637	0.221	±	0.219
Total species	8			3			23			13		
Trees												
Average Density (plants $10m^{-2}$)	1.453	±	0.616	0.600	±	0.222	0.840	±	0.798	1.839	±	0.676
Total species	4.000			5.000			3.000			6.000		
Physical Properties												
Bulk Density (gcc^{-1})	2.025	±	0.020	2.152	±	0.030	2.097	±	0.029	2.191	±	0.030
Particle Density (gcc^{-1})	2.747	±	0.042	3.118	±	0.107	3.102	±	0.077	2.933	±	0.030
Porosity (%)	25.477	±	1.084	30.132	±	1.982	30.714	±	1.146	25.169	±	1.077
FC (%)	20.588	±	1.105	15.619	±	0.848	20.993	±	0.473	24.272	±	2.124
WHC (%)	28.664	±	0.925	24.372	±	0.462	28.806	±	0.388	30.050	±	1.896
Soil Texture												
Sand (%)	31.823	±	1.622	48.157	±	0.424	34.166	±	0.623	27.302	±	0.283
Clay (%)	39.520	±	1.637	24.252	±	0.463	35.707	±	0.417	44.057	±	0.120
Silt (%)	28.657	±	0.383	27.591	±	0.583	30.127	±	0.383	28.642	±	0.235
Soil Aggregate												
>2	16.620	±	1.325	39.212	±	2.672	52.031	±	1.499	5.758	±	1.496
1to2	20.122	±	1.402	14.130	±	3.541	5.722	±	0.103	22.520	±	2.044
0.212to1	35.033	±	1.327	32.567	±	1.806	26.972	±	4.644	42.773	±	1.064
0.125to0.212	12.121	±	0.739	8.992	±	3.400	6.138	±	1.920	11.249	±	0.710
0.063to0.125	10.470	±	0.667	3.374	±	0.776	6.728	±	2.215	10.132	±	0.888
0.025to0.063	3.264	±	0.291	0.829	±	0.297	1.484	±	0.390	4.420	±	0.396
<0.025	2.371	±	0.116	0.896	±	0.463	0.924	±	0.211	3.148	±	0.420
Chemical Properties												
pH	7.711	±	0.089	9.902	±	0.178	8.437	±	0.018	7.438	±	0.049
EC (dSm^{-1})	12.940	±	1.511	9.103	±	0.250	12.435	±	0.644	14.685	±	1.222
OC (%)	0.362	±	0.037	0.248	±	0.012	0.368	±	0.008	0.323	±	0.020
OM (%)	0.624	±	0.064	0.427	±	0.021	0.635	±	0.014	0.556	±	0.034
N (%)	0.031	±	0.003	0.021	±	0.001	0.032	±	0.001	0.028	±	0.002
P (kg ha^{-1})	17.868	±	0.812	21.201	±	1.028	25.541	±	0.635	23.904	±	1.116
Ca (mg kg^{-1})	98.127	±	11.091	153.601	±	3.960	91.839	±	3.563	97.907	±	16.567
Zn (mg kg^{-1})	22.237	±	2.521	3.695	±	0.451	142.863	±	0.904	20.930	±	3.554
K (mg kg^{-1})	722.626	±	68.843	748.119	±	57.502	939.921	±	13.884	814.876	±	15.210
Cu (mg kg^{-1})	18.266	±	2.093	15.709	±	1.275	25.197	±	1.515	23.530	±	3.983
Fe (mg kg^{-1})	43.009	±	4.936	26.201	±	1.074	111.884	±	11.395	38.978	±	2.881
Na (mg kg^{-1})	68.690	±	4.984	65.490	±	2.274	227.407	±	3.442	66.524	±	7.089
Pb (mg kg^{-1})	66.610	±	5.112	56.130	±	2.670	57.358	±	1.247	70.650	±	14.540
Mn (mg kg^{-1})	31.782	±	1.345	30.351	±	2.132	38.611	±	0.721	27.878	±	2.628

Figure1:-Correlation between different soil parameters and vegetation**.**



References:-

1. Azimzadeh, H.R., Ekhtesasi, M.R., Refahi, H.Gh., Rohipour, H. and Gorji, M., Wind erosion measurement on fallow lands of Yazd-Ardakan plain, Iran. *Desert. 2008,* **13**, 167-174.
2. Balling, R.C., Klopatek, J.M., Hildebrandt, M.L., Moritz, C. and Watts, C.J., Impacts of land degradation on historical temperature records from the Sonoran desert. *Climatic Change.* 1998, **40,** 669–681.
3. Bernstein, L., Osmotic adjustment of plants to saline media I Steady state. *Am. J. Bot*. 1967, **48,** 909-918.
4. Bouyoucos, G.J., A recalibration of the Hydrometer Method for Making Mechanical Analysis of soils. *Agron. J., 1951,* **43,** 434-438.
5. Charman, P.E.V. and Junor, R.S., Saline seepage and land degradation - a New South Wales perspective. *BMR Journal of Australian Geology & Geophysics, 1989,* **2,** 195·203
6. Cramer, G.R. and Nowak, R.S., Supplemental manganese improves the relative growth, net assimilation and photosynthetic rates of salt-stressed barley. *Physiologia plantarum, 1992,* **84,** 600-605.
7. Curtis, J.T. and McIntosh, R.P., The interrelations of certain analytic and synthetic phytosociological characters. *Ecology, 1950,* **31,** 434-455.
8. Donahue, R.L., Miller, R.W. and Shickluna, J.C., Soils: *An Introduction to soils and Plant Growth.* PrenticeHall, London, 1983.
9. Dukes, J.S. and Mooney, H.A., Does global change increase the success of biological invaders? *Trends in Ecology and Evolution, 1999,* **14(4),** 135-139.
10. FAO Guidelines: Land evaluation for rainfed agriculture. Soils Bull. 52. FAO, Rome, Italy, 1983.
11. Feigin, A., Fertilization management of crops irrigated with saline water. *Plant Soil, 1985,* **89,** 285-299.
12. Garg, B.K., Vyas, S.P., Kathju, S., Lahiri, A.N., Mali and Sharma P.C., Salinity-fertility interaction on growth, mineral composition and nitrogen metabolism of Indian mustard. *Journal of Plant Nutrition, 1993,* **16,** 1637-1650.
13. Goswami, D., Dhandhukia, P., Patel, P. and Thakkera, J.N., Screening of PGPR from saline desert of Kutch: Growth promotion in *Arachis hypogea* by *Bacillus licheniformis* A2. *Microbiological Research, 2014,* ***169,*** 66–75.
14. Gupta, V. and Ansari, A.A., Geomorphic portrait of the Little Rann of Kutch. *Arab J Geosci., 2012,* **2,** 1–10.
15. Gupta, S.R. and Malik, V., Soil ecology and sustainability. *Tropical Ecology, 1996,* **37,** 43-55.
16. Hamerlynck, E.P., Huxman, T.E., McAuliffe, J.R. and Smith, S.D., Carbon isotope discrimination and foliar nutrient status of *Larrea tridentata* (creosote bush) in contrasting Mojave Desert soils. *Oecologia, 2004,* **138,** 210-215.
17. Hamerlynck, E.P., McAuliffe, J.R., McDonald, E.V. and Smith, S.D., Ecological responses of two Mojave Desert shrubs to soil horizon development and soil water dynamics. *Ecology, 2002,* 83, 768-779.
18. Hamerlynck, E.P., McAuliffe, J.R. and Smith, S.D., Effects of surface and sub-surface soil horizon on seasonal performance of *Larrea tridentate* (creosotebush). *Functional Ecology, 2000,* **14,** 596-606.
19. Hirpara, K.D., Ramoliya, P.J., Patel, A.D. and Pandey, A.N., Effect of salinisation of soil on growth and macro- and micro-nutrient accumulation in seedlings of *Butea monosperma* (Fabaceae). *Anales de Biología, 2005,* **27,** 3-14.
20. Huxman, T.E., Cable, J.M., Ignace, D.D., Eilts, J.A., English, N.B., Weltzin, J. and Williams, D.G., Response of net ecosystem gas exchange to a simulated precipitation pulse in a semi-arid grassland: the role of native versus non-native grasses and soil texture. *Oecologia, 2004c,* **141,** 295-305.
21. Huxman, T.E., Snyder, K.A., Tissue, D., Leffler, A.J., Ogle, K., Pockman, W.T., Sandquist, D.R., Potts, D.L. and Schwinning, S., Precipitation pulses and carbon fluxes in semiarid and arid ecosystems. *Oecologia, 2004b,* **141,** 254-268.
22. Jackson, M.L., Soil chemical Analysis, prentice – Hall of India Private Limited, New Delhi, 1973, 38-56.
23. Kramer, P.J., *Water Relation of Plants*. Academic Press, New York, 1983.
24. LaHaye, P.A. and Epstein, E., Salt toleration by plants: enhancement with calcium. *Science, 1969,* **166,** 395-396.
25. Lindsay, W.L. and Norvell, A.W., Development of DTPA soil test for zinc, iron, manganese and copper. *Soil Sci. Am. J., 1978,* **12,** 421-428.
26. Marschner, H., Mineral Nutrition of Higher Plants. London: Academic Press, 1995, pp 889.
27. McAuliffe, J.R., Landscape evolution, soil formation and ecological patterns and processes in Sonoran Desert bajadas. *Ecological Monographs, 1994,* **64,** 111-148.
28. McAuliffe, J.R., The interface between precipitation and vegetation: The importance of soils in arid and semi-arid environments. In: Weltzin JF, McPherson GR, (eds) Changing Precipitation Regimes and Terrestrial Ecosystems: A North American Perspective. University of Arizona Press, Tucson, Arizona, USA, 2003, 9-27.

29. Mer, R.K., Prajith, P.K., Pandya, D.H. and Pandey, A.N., Effect of Salts on Germination of Seeds and Growth of Young Plants of *HordeumVulgare*, *Triticum astivum*, *Cicer arietinum* and *Brassica Juncea*. *J. Agronomy & Crop Science*, *2000.*
30. Miller, R.H., Soil microbial input for sustainable agricultural system. In : C. A. Edwards R, Lal P, Madden RH, Miller & G. House (eds.), *Sustainable Agricultural System*. Soil and Water Conservation Society, Ankney, Iowa, 1990.
31. Misra, R., *Ecology Workbook.* Oxford and IBH Publishing Co., New Delhi, 1968.
32. Motaghian, H., Mohammadi, J. and Karimi, A., Catchment-scale spatial variability analysis of soil hydro-physical properties in a semi- arid region of Iran. *Desert, 2008,* **13,** 155-165.
33. Noy-Meir, I., Desert ecosystems: environment and producers. *Annual Review of Ecology and Systematics, 1973,* **4,** 51-58.
34. Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A., Estimation of available phosphorus in soils by extraction with sodium bicarbonate. *US Dept. Agric. Circ.*939, 1954.
35. Panchal, N.S. and Pandey, A.N., Study on Soil Properties and Their Influence on Vegetation in Western Region of Gujarat State in India. 12th ISCO Conference, Beijing 2002, 610-615.
36. Pandey, A.N. and Thakarar, N.K., Effect of chloride salinity on survival and growth of *Prosopis chilensis* seedlings. *Trop. Ecology, 1997,* **38,** 145-148.
37. Patel, N.T., Panchal, N.S., Pandey, I.B. and Pandey, A.N., Implications of calcium nutrition on the response of *Acacia senegal* (Mimosaceae) to soil salinity. *Anales de Biologia*, *2011,* **33,** 23-34.
38. Pilania, P.K. and Panchal, N.S., Soil and plant relation at Little Rann of Kutch of Gujarat in western India. *International Journal of Advanced Research 2014,* **2, 7**, 1-10.
39. Pilania, P.K. and Panchal, N.S., Vegetation analysis at Little Rann of Kachchh in Mallya Tehsil of Gujarat state in India. *Journal of Basic and Applied Biology*, 2013b, **7,** 6-10.
40. Potts, D.L., Huxman, T.E., Cable, J.M., English, N.B., Ignace, D.D., Eilts, J.A., Mason, M.J., Weltzin, J.F. and Williams, D.G., Antecedent moisture and seasonal precipitation influence the response of canopy-scale carbon and water exchange to rainfall pulses in a semi-arid grassland. *New Phytologist, 2006,* **170,** 849-860.
41. Ramoliya, P.J., Patel, H.M. and Pandey, A.N., Effect of salinization of soil on growth and macro- and micronutrient accumulation in seedlings of *Salvadora persica* (Salvadoraceae). *Forest Ecology and Management, 2004,* **202,** 181-193.
42. Sala, A., Smith, S.D. and Devitt, D.A., Water use by *Tamarizramosissima* and associated phreatophytes in a Mojave Desert floodplain. *Ecological Applications, 1996,* **6,** 888-898.
43. Shabala, S., Shabala, L. and Volkenburgh, E.V., Effect of calcium on root development and root ion fluxes in salinised barley seedlings. *Functional Plant Biology, 2003,* **30,** 507-514.
44. Singh, J.S., Raghubanshi, A.S., Singh, R.S. and Srivastava, S.C., Microbial biomass acts as a source of plant nutrients in dry tropical forest and savanna. *Nature, 1989,* **338,** 499-500.
45. Smith, S.D., Herr, C.A., Leary, K.L. and Piorkowski, J.M., Soil-plant water relations in a Mojave Desert mixed shrub community : a comparison of three geomorphic surfaces. *Journal of Arid Environments, 1995,* **29,** 339-351.
46. Sumner, M.E., Sodic soils: new perspectives. *Australian Journal of Plant Physiology, 1993,* **31,** 683-750.
47. Troeh, F.R. and Thompson, L.M., *Soils and Soil Fertility*. Oxford university press, New York, 1993.
48. USDA, Diagnosis and Improvement of Saline and Alkaline Soils. Agril. Handbook no. 60, USDA, Oxford and IBH Publ. Co. Calcutta, 1968.
49. Vilanculos, M.F., Interlinkages of soil and land use using remote sensing and GIS, a case study of the Ping Valley, Chiang Mai, Thailand. M.Sc. thesis. ITC, Enschede, the Netherlands, 1994.
50. Walter, H., Vegetation of the earth and ecological systems of the geo-biosphere, 2nd edn. Springer-Verlag, New York, USA, 1979.
51. Yoder, R.E., A direct method of aggregate analysis of soils and a study of the physical nature of erosion losses. *J. Am. Soc. Agron., 1936,* **28,** 337-351.
52. Zare, S., Jafari, M., Tavili, A., Abbasi, H. and Rostampour, M., Relationship between Environmental Factors and Plant Distribution in Arid and Semiarid Area (Case Study: Shahriyar Rangelands, Iran). *American-Eurasian J. Agric. & Environ. Sci*., 2011, **10 (1),** 97-105.