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RELATIONSHIPS BETWEEN PLANT COMMUNITIES AND SOIL CONDITIONS IN NASIRABAD AND SIBI DISTRICTS, BALUCHISTAN, PAKISTAN.

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Abstract

Twenty stands of vegetation were sampled in Nasirabad and Sibi districts. Importance value of each species of three strata i.e. trees, shubs and herbs/grass layers was calculated. On the basis of similarity indices 9 plant communities associated with fine to coarse textured and moderate to strongly calcarious soils were recognized. These soils were generally very low in CO_3 and HCO_3, salt free to strongly saline and sodium free to strongly sodic. Importance values of dominant plants and soil characteristics indicated that *Suaeda fruticosa, Tamarix indica, Cynodon dactylon* and *Desmostachya bipinnata* were positively correlated with ESP, Cl^- and Ca^+ Mg^{++} contents. *C. dactylon* was positively correlated with sand, *D. bipinnata* with electrical conductivity and *Panicum repens* with amount of silt and negatively correlated with electrical conductivity.

Introduction

Sibi (20.6° N, 67.8° E) and Nasirabad (28.5° N, 68.3° E) districts form south-eastern part of Baluchistan. Vegetation of the area has been described as tropical thorn forest group (Champion *et. al.*, 1965; Beg, 1975), however, no phytosociological report for the region was available. The objectives of the present study were to recognize the plant communities and to ascertain the relationships of vegetation with the soil physical and chemical conditions.

Materials and Methods

Location: Twenty stands (approx. 1000 sq. m. each) in the surroundings of Bellpat (29.0° N, 68.0° E, stands No. 14, 15 & 16), Chattar (28.8° N, 68.3° E, stand No. 13), Dera Murad Jamali (28.5° N, 68.2° E, stands No. 9 & 12), Jhatpatt (28.3° N, 68.3° E, stands No. 6, 7 & 8), Mushkaf (29.9° N, 67.7° E, stand No. 3), Sibi (28.2° N, 67.8° E, stands No. 17-20) were established for studies in October 1983 to March 1984. The study area is a part of Arid Sub-tropical Continental Lowlands (Ahmed, 1951; Ali, 1971), characterized by high summer temperature and low rainfall. The mean maximum temperature in June is around 43°C and mean minimum in January is 5.5°C. Rainfall is about 100 mm per year, about 50% of which falls between July and September. There are only a few frosty days and humidity is generally low.

Vegetation Study: The vegetation was sampled by quadrat method. In each stand 30 quadrats of 40 x 4.0 m size for tree layer, 10 x 4.0 m size for shrub layer and 4.0 x 0.25 m for herb/grass layer were laid systematically. Similarity indices between plant communities having common dominants were calculated following Sorensen (1948). The vegetation samples having more than 50% similarity were grouped into one community. The details of method of vegetation study and floristic composition of each stand of these communities have been described by Kayani (1984).

Soil Analysis: From each stand soil samples were obtained from 0-15, 15-30 and 30-45 cm depths. From each depth 3 composite soil samples (total 3 x 3 = 9) were obtained. Soils were analysed for texture by hydrometer method (Bouyoucos, 1951), electrical conductivity by Beckman conductivity meter, alkaline earth carbonates ($CaCO_3$) were determined by acid neutralization method (Anon., 1954), soluble ion, Ca^{++}, Mg^{++}, CO^{-}_3, HCO_3 and Cl were determined by titration methods (Anon., 1954). Na^+ was determined by flame photometry.

Results

On the basis of importance value (Curtis & Mc-Intosh, 1951) initially 17 plant communities were found but taking into consideration the index of similarity (Sorensen, 1948) 9 plant communities were recognized.

1. *Distribution of Plant Communities*

Seven plant communities, viz. *Crotolaria burhia-Capparis decidua, Cyperus rotundus-Tamarix indica, Panicum repens, Prosopis cineraria-C. decidua, P. cineraria-Cynodon dactylon, Suaeda fruticosa-C. decidua* and *T. indica-Desmostachya bipinnata* were recognized in moderate to strongly calcarious fine textured soils. These soils were low in CO_3 and HCO_3 and low to high in soluble Ca + Mg and C1 contents (Table 1).

Soils of *C. rotundus-T. indica, T. indica-D. bipinnata, P. cineraria-C. dactylon, P. cineraria-C. dactylon, P. cineraria-C. decidua* and *S. fruticosa-C. decidua* communities were salt free to strongly saline. Soils of former three communities were sodium free to slightly sodic while those of latter two were sodium free to strongly sodic (Table 1). *C. burhia-C. decidua* and *P. repens* communities were present in salt free soils. Soils of the former were sodium free, while those of latter were slightly sodic.

P. cineraria-Corchorus depressus-Aerua pseudotomentosa, Rhazya stricta-Haloxylon recurvum-Aerua pseudotomentosa communities were found in coarse textured soils having high amounts of $CaCO_3$ but low amounts of CO_3 and HCO_3. In *P. cineraria-C. depressus-A. pseudotomentosa* and *R. stricta-H. recurvum-A. pseudotomentosa* communities

Table 1. Soil characteristics of various plant communities of Nasirabad and Sibi Districts.

Means of three replicates per-stand; ± Standard error.

Plant Communities	Stand No.	Sampling Depth, Cm.	Soil Characteristics: Textural class	CaCO3 Equivalent in percent	Electrical Conductivity dsm^{-1}	ESP	Soluble cations Ca + Mg m. eq/l.	Soluble anions CO3 and HCO3 m. eq/l.	Cl m. eq/1.
1*	8**	0-15	Clay Loam	41.45 ± 6.56	3.03 ± 0.03	73.16 ± 3.23	26.66 ± 2.02	0.5 ± 0.0	14.00 ± 0.76
		15-30	Loam	50.25 ± 0.91	0.8 ± 0.05	79.96 ± 3.02	8.66 ± 0.33	0.5 ± 0.0	4.83 ± 1.36
		30-45	Silt Loam	39.37 ± 4.91	0.5 ± 0.0	78.50 ± 3.92	8.00 ± 0.75	0.5 ± 0.0	2.16 ± 0.72
2		0-15	Silt Loam	37.08 ± 11.22	8.31 ± 5.70	17.88 ± 1.89	74.16 ± 46.63	2.75 ± 2.25	168.58 ± 163.56
	9	15-30	Silt clay Loam	40.49 ± 10.85	7.7 ± 6.23	16.18 ± 2.57	55.66 ± 36.77	2.75 ± 2.25	136.33 ± 134.40
	10	30-45	Loam	39.45 ± 11.44	6.89 ± 4.26	15.42 ± 3.32	41.33 ± 31.09	2.75 ± 2.25	117.5 ± 115.84
	11, 12	0-15	Silt Loam	40.87 ± 0.82	2.41 ± 0.21	11.65 ± 3.74	38.83 ± 20.56	2.75 ± 2.25	5.25 ± 2.25
3	15	15-30	Silt Loam	43.1 ± 0.90	2.76 ± 0.23	13.56 ± 0.48	43.33 ± 20.73	3.00 ± 2.00	3.08 ± 0.08
		30-45	Silt Loam	42.16 ± 14.16	2.85 ± 0.15	12.24 ± 1.97	48.83 ± 28.58	2.75 ± 2.25	3.66 ± 1.66
		0-15	Silt clay Loam	32.68 ± 4.35	28.8 ± 14.08	29.59 ± 14.99	409.59 ± 292.69	3.25 ± 1.01	148.53 ± 81.66
4	7, 5	15-30	Silt Loam	32.96 ± 6.17	23.29 ± 10.67	28.12 ± 17.06	243.74 ± 172.52	3.12 ± 1.08	717.87 ± 639.46
	13, 14	30-45	Silt Loam	42.85 ± 4.41	13.13 ± 6.08	19.96 ± 7.97	159.99 ± 62.96	2.87 ± 1.23	93.49 ± 56.05
		0-15	Sandy Loam	46.33 ± 9.23	0.76 ± 0.03	38.69 ± 4.0	7.33 ± 0.88	0.05 ± 0.0	2.16 ± 0.16
5	16	15-30	Sandy Loam	38.97 ± 13.71	2.56 ± 0.03	26.09 ± 2.6	16.35 ± 0.35	1.0 ± 0.0	5.16 ± 0.33
		30-45	Sandy clay Loam	30.90 ± 8.40	0.86 ± 0.03	38.46 ± 4.0	8.66 ± 0.88	1.0 ± 0.0	2.26 ± 0.99
		0-15	Loam	22.74 ± 0.0	117.33 ± 2.66	9.56 ± 0.96	755.53 ± 40.80	5.0 ± 0.0	482.66 ± 4.33
6	17	15-30	Loam	27.31 ± 6.73	60.00 ± 0.0	11.58 ± 1.1	375.66 ± 41.38	5.0 ± 0.0	249.33 ± 4.68
		30-15	Silt Loam	25.01 ± 0.0	5.6 ± 0.0	16.82 ± 1.6	229.0 ± 4.0	5.0 ± 0.0	217.0 ± 2.0
		0.15	Sandy Loam	55.14 ± 4.94	0.96 ± 0.08	3.15 ± 0.5	21.33 ± 4.67	0.5 ± 0.0	12.00 ± 1.52
7	3	15-30	Loamy Sand	57.87 ± 0.74	0.95 ± 0.05	13.98 ± 1.2	8.66 ± 1.20	1.0 ± 0.0	2.33 ± 0.44
		30-45	Loamy Sand	60-69 ± 9.34	1.36 ± 0.03	11.24 ± 1.2	18.66 ± 1.33	2.0 ± 0.0	3.66 ± 0.66
		0-15	Silt Loam	41.72 ± 2.71	32.71 ± 15.03	71.78 ± 8.96	507.77 ± 212.21	0.5 ± 0.0	162.13 ± 82.43
8	1, 2, 4	15-30	Silt Loam	40.73 ± 3.86	30.59 ± 23.40	73.68 ± 9.31	435.10 ± 246.28	0.5 ± 0.0	279.92 ± 126.16

(Table 1. Contd.)

				Soil Characteristics					
Plant Communities	Stand No.	Sampling Depth, Cm.	Textural class	CaCO3 Equi-valent in percent	Electircal Conductivity dsm^{-1}	ESP	Soluble cations Ca + Mg m. eq/l.	Soluble anions CO3 and HCO3 m. eq/l.	Cl m. eq/1.
		30-45	Silt Loam	48.56 ± 5.01	27.05 ± 15.22	43.13 ± 19.86	352.22 ± 176.44	0.5 ± 0.0	208.66 ± 158.30
		00-15	Silt Loam	30.62 ± 8.92	24.45 ± 7.17	9.97 ± 2.40	304.66 ± 229.20	2.33 ± 1.36	642.16 ± 571.41
9	6, 18, 19, 20	15-30	Silt Loam	55.19 ± 7.23	8.62 ± 3.83	34.51 ± 21.08	198.88 ± 130.12	2.25 ± 1.24	629.77 ± 595.90
		30-15	Silt Loam	46.43 ± 7.97	28.75 ± 23.28	34.56 ± 19.16	188.44 ± 136.39	2.16 ± 1.24	121.88 ± 99.74

**Crotolaria burhia, Capparis decidua*, 2. *Cyperus rotundus, Tamarix indica*, 3. *Panicum repens*, 4. *Prosopis cineraria, Capparis decidua*, 5. *Prosopis cineraria, Corchorus depressus, Aerua pseudo tomentosa*, 6. *Prosopis cineraria, Cynodon dactylon*, 7. *Rhazya stricta, Haloxylon recurvum, Aerua pseudo tomentosa*, 8. *Suaeda fruticosa, Capparis* decidua, 9. *Tamarix indica, Desmostachya bipinnata*.

**Only one stand was sampled.

soils were salt free and slightly sodic (except *R. stricta-C. depressus-A. pseudotomentosa* surface soil) with high amount of Ca + Mg and Cl^- (Table 1).

2. *Coefficient of Correlation between Importance Value and Soil Characteristics*

Of 8 dominant plants, 3 species, viz. *C. decidua, C. rotundus* and *P. cineraria* did not show any significant correlation with any of the soil characteristics. *S. fruticosa* and *T. indica* were positively correlated with ESP and amount of silt, *C. dactylon* and *D. bipinnata* with Cl^- and $Ca^+ + Mg^{++}$, *C. dactylon* with sand and *D. bipinnata* with electrical conductivity. *P. repens* was positively correlated with silt and negatively with electrical conductivity and ESP.

Discussion

In three out of nine communities, *P. cineraria* occurred as a leading dominant. This species was also reported to be a strong associate in other communities of the study area (Kayani, 1984). *P. cineraria* is an important component of climax vegetation of the arid regions of Pakistan (Chaudhri, 1957; 1965). Its xerophytic characteristics, i.e., small leaves, deeper and rapid growing root system, high root to shoot ratio plus its indifference towards variations in soil characteristics (Table 2) have made this species adaptable to grow in diverse types of habitats. Coventry (1915) remarked that before extension of canal irrigation in Indus plains, *P. cineraria* forest extended over an area of 2000 sq. miles. Its dominance in salt affected soils (Table 2) indicates its reasonably high ability to withstand saline and sodic conditions.

C. decidua occurred as a second dominant in 3 plant communities (Table 1). It grows with wide variety of asssociates and represents high ecological amplitude (Joshi, 1957; Qaiser & Qadir, 1972; Chughtai *et. al.*, 1978). Importance value of *C. decidua* did not show any correlation with either soil physical or chemical characteristics (Table 2). This confirmed the observations made by the above workers. *T. indica* occurred as a first as well as second dominant in the study area. Its presence in silt loam plus its significant positive correlation with amount of silt (Table 1 & 2) indicated its preference for fine soil. It is a common plant of river beds and banks of Baluchistan and Northern regions of Pakistan (Qaiser, 1981). These areas are generally rich in silt.

C. dactylon and *D. bipinnata* occurred as second dominants each in one community with fine textured saline and sodic soils (Table 1). Chughtai *et al.*, (1978) also found these species in fine textured saline soils. Sultana (1972) found *D. bipinnata* in fine textured saline soils. Muftee (1966) reported fairly high degree of salt resistance in *C. dactylon*. Presence of *P. repens* community in salt and sodium free soil plus its significant negative correlation with electrical conductivity and ESP (Table 2) confirmed its sensitivity toward salts.

Table 2. Coefficient of correlations (r) between I.V. of dominant plants and soil characteristics.

Plant Species	Soil Characteristics							
	Sand	Silt	Clay	$CaCO_3$	Cl^-	Ca^{++} Mg^{++}	Electrical Conductivity	ESP
Capparis decidua	—0.464	0.516	—0.305	0.025	0.128	0.530	0.468	0.480
Cynodon dactylon	0.898*	—0.541	—0.518	0.670	0.728*	0.899*	0.710*	0.312
Cyperus rotundus	—0.193	0.307	—0.360	—0.110	0.423	0.249	0.014	0.456
Desmostachya bipinnata	0.447	—0.400	0.359	0.068	0.891*	0.874	0.888*	0.153
Panicum repens	—0.036	0.400*	—0.333	—0.212	—0.366	—0.22	—0.429*	0.500*
Prosoips cineraria	0.100	0.05	—0.325	—0.398	0.207	0.255	0.183	0.180
Suaeda fruticosa	—0.210	0.314	—0.169	—0.080	—0.159	0.384	0.142	0.923**
Tamarix indica	—0.289	0.697*	—0.323	0.106	0.045	—0.273	0.273	—0.400

*P 0.05, **P 0.01

S. fruticosa-C. decidua community is present in salt free to strongly saline and sodium free to strongly sodic soils (Table 1). This indicated their wide ecological amplitude in terms of their adjustment to saline environment. Significant positive correlation of *S. fruticosa* with ESP (Table 2) suggests its high tolerance for sodic conditions. Kayani *et al.*, (1984) also found its maximum vegetative cover in strongly sodic and chloride rich soils.

R. stricta-H. recurvum-A. pseudotomentosa community was found in coarse textured, nonsaline and nonsodic soils. *H. recurvum* and *A. pseudotomentosa*, however, have also been reported from saline-sodic soils (Qadir *et al.* 1966; Chaudhri & Qadir, 1958).

Soils of almost all communities had very low amounts of CO_3 and HCO_3, low to high amounts of Ca^{++} + Mg^{++} and Cl^- and high contents of $CaCO_3$ (Table 1). Formation of CaCO3 and accumulation of soluble salts are characteristic features of arid environment (Aubert, 1960). Low concentrations of CO_3 and HCO_3 in the soils of the study area is due to their low solubility. Both the anions have very low (30 meg/1) solubility.

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