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Effects of Topography and Monsoon Rain on Vegetation Composition of Sandy Arid Areas of District Khairpur Mir's

K. A. ANSARI[++], A.R. MALIK, A.R.MAHAR, S. A. ABRO*

Department of Botany, Shah Abdul Latif University, Khairpur

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Abstract: Present study was conducted to evaluate the effects of monsoon rains and topography on plant communities of desert ecosystem of District Khairpur. The study was conducted at three desert sites differing in topography i.e. Kotdiji sand dunes, Ubhan Shah flat dunes and Sorah inter dunes, designated as site A, B and C respectively using quadrate method. The data of plant communities were recorded twice in a year during study period i.e. pre-monsoon and post-monsoon seasons and compared. The 35 plant species formed five plant communities at three sites. At site A *Aerva - Calligonum-Leptadenia,* formed pre-monsoon community and *Aerva - Leptadenia–Salvadora* formed post monsoon community. At site B, *Aerva-Calligonum-Leptadenia* and *Aerva-Leptadenia-Citrullus* formed pre and post monsoon communities respectively. While at site C, *Calotropis-Alhagi,* were dominant at pre and post monsoon. *L. pyrotechnica* showed significant correlation with *C. colosynthesis* and *S. oleoides.*

Keywords: Ecological studies, plant communities, IVI, Monsoon rains, Topography

1. INTRODUCTION

District Khairpur is situated on the left bank of the Indus River between 26°–12' to 27°-24' N and 68°–13' to 70°-10' E. The total area of District Khairpur is about 15910 Sq. Km, out of which one-fourth area is fertile while the rest is desert.

The district has arid climate with a maximum summer temperature ranges between 41.5°C to 44.3 °C, and a minimum winter temperature from 29.8°C to 6.4°C. The area receives very low annual precipitation however, the heaviest rains occur during July to September, a monsoon period. Aridity is the important characteristic feature of the area, with dry and wet years occurring in cluster (Qureshi and Bhatti, 2005).

The history and the vegetation of sand dunes of Thar region have been well described by (Chaudhri, 1965). (Chaudhri and Chutter, 1966; Qadir *et al*. 1966; Shaukat and Qadir, 1971; Shaukat *et al*. 1976). (Chaudhri, 1961; Khan and Frost, 2001).

In Pakistan, the southern part of Punjab and Sindh province possesses sandy area. Arshad and Rao (1995), Arshad and Akbar (2002), Akhtar and Arshad (2006), focused their studies on vegetation of Cholistan desert. Ansari *et al*. (1993) reported 80 plant species of 34 families in preliminary floristic information of District Khairpur on the basis of soil types and habitat of species. Bhatti *et al*. (1998 and 2002); Qureshi and Bhatti (2005; 2006; 2007; 2008a and 2008b) also studied the floristic nature of the area but they mostly focused on ethnobotany.

In harsh arid environment of desert area the monsoon rainfall is the major source of water for desert vegetation. The rainfall plays an important role in the formation of desert plant communities describing their phyto-sociological attributes but however, the topographic characteristics along with soil physico-chemical properties also play an important and significant role in the distribution of plant species. The topography is the key feature that controls both the soil moisture retention and distribution in desert areas. The few studies that have been carried out on the desert vegetation of Khairpur district mostly describe the distribution and structure of plant communities but they do not assess the environmental conditions pertaining to climate and topography of the area. This study therefore, is conducted with the basic objectives to evaluate 1) the impacts of topography of area on vegetation and community characteristics.

2. MATERIALS AND METHODS

Study area

Three different sites were selected for the study of vegetation and plant communities on the basis of topography, geographic position is located in map by GPS; Site A: KotDiji Sand dunes area (27°19'42. N – 68°42' 99. E). Site B: Ubhan Shah, Flat dunes area (27° 21'. 23 N – 68° 46'. 23 E). Site C: Sorah inter dune topography with hummacks (27° 17'.15 N– 68° 54'.54E) (**Fig.1**). The climate of area is arid with hot summer and dry cool winter. The detailed climatic conditions of area are presented in **(Table. 1).**

[++]Corresponding author Khalil Ahmed Ansari *khalilahmedansari@yahoo.com*
*Institute of Plant Sciences, University of Sindh, Jamshoro

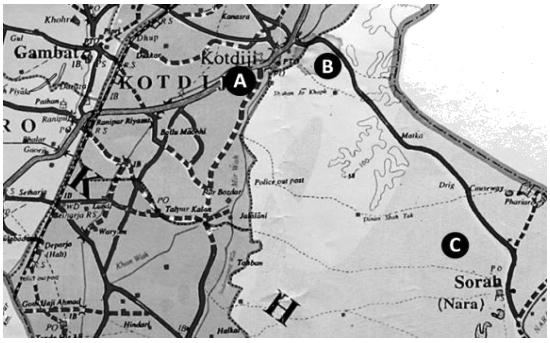

Fig 1. The map of study area showing three different sites/locations A, B and C with diverse topography.

The study plan

The vegetation was surveyed twice in the year in March, April (Pre-monsoon) and September, October (Post-monsoon). About 200 quadrates of 10 x 10 meters were laid down at three different habitats of study area viz. sand dunes, flat dunes, and Inter dunes topography. The collected plant specimens were identified with the help of Flora of Pakistan (Nasir and Ali, 1972 to 2000).

Ecological attributes such as density, frequency, cover and their relative values and important value index (IVI) were analyzed. Community structure farmed by different species was categorized on the basis of their highest IVI values. The dominant plants species of the plant communities of three different sites were correlated with each other. Similarly the data from permanent quadrates were also collected in different seasons and change in vegetation was studied.

Statistical Analysis

Analysis of data for plant communities and correlation of dominant plant species were arcsine transformed prior to analysis in order to ensure homogeneity of variance, all data were compared / analyzed with IBM SPSS 19.0 software.

3. RESULTS AND DISCUSSION

Importance value index (IVI)

Kotdiji Site A: The 14 constant plant species were observed in pre-monsoon and post-monsoon season. *Aerva javanica* with highest mean importance value index (IVI) 24.7, followed by *Leptadenia pyrotechnica* (Forsk) Dence 12.7 and *Calligonum polygonoides* L. 11.6, developed dominant plant communities at site A during pre-monsoon season, while during post-monsoon *Aerva javanica, Indigofera oblongifolia, Leptadenia pyrotechnica* and *Calligonum polygonoides* with 18.1, 14.7, 13.0 and 11.8 IVI were dominant communities respectively (Table.2). Similar results has been reported by Malik (1986), describing the *Aerva-Leptadina-Calligonum* as dominant plant communities with reference to soil types.

The IVI of *Aerva javanica* decreased annually from 33.5 in 2004 to 17.0 in 2007. While IVI of *Calligonum polygonoides* and *Leptadenia pyrotechnica* increased from 2004 to 2006 with a slight decrease in 2007. However the IVI values of *Indigofera oblongifolia* suggest no change in plant distribution throughout the study period.

Ubhan Shah Site B: The results of IVI are presented in Table-2. *Aerva javanica, Leptanedia pyrotechnica, Salvadora oleoides, Citrullus colosynthis Calligonum polygonoides,* formed the major taxa of area with mean IVI of 13.3, 13.4, 9.0, 7.5, 7.4, respectively during pre-monsoon. While, during post-monsoon *Aerva javanica* (IVI 15.2), *Leptanedia pyrotechnica* (11.3) *Citrullus colosynthis* (7.5), and *Calligonum polygonoides* (7.2) were dominant. Monsoon increased the vegetation of Aerva *javanica* while *Citrullus colosynthis* became dominant by replacing *Salvadora oleoides.*

Sorah Site C: The site comprised Inter dune area encircled with large sand dunes. On the basis of highest IVI, the dominant plant species were *Aerva javanica* (11.7), *Calligonum polygonoides* (11.0), and *Leptadenia pyrotechnica* (7.8), during pre-monsoon season. While, *Aerva javanica* (8.6), *Calligonum polygonoides* (7.9), *Leptadenia pyrotechnica* (6.4) were dominant during post-monsoon**.** Although *Aerva javanica* possessed high IVI values in pre-monsoon but its IVI decreased in post-monsoon season, whereas *Calligonum polygonoides* and *Leptadenia pyrotechnica* remained in stable position during pre-monsoon and post-monsoon seasons **(Table 2-3).**

Our findings are in line with Qureshi and Bhatti (2008b) who described the vegetation of Sawan Wari area, Nara desert, Khairpur. Qureshi and Ahmed (2010) studied four different microhabitats based on topography and determined four plant communities based on Summed Dominance Ration (SDR).

Table. 1. Climatic conditions of District Khairpur during the study period.

Parameter	Maximum	Minimum	Mean Annual
Temperature °C	41.5-44.3	6.4-29.8	42.4-18.1
Precipitation (mm)	44.7	0.00	29.7 – 99.4
Relative humidity (%)	56.0	16.0	34.8-39.2

Source: Computerized data processing center, Pakistan Metrological Department, University Road Karachi-75270. (Nearest metrological station at Sukkur Airport).

Table 2. Pre-monsoon and post-monsoon comparison of different species based on importance value index (IVI). Values in parenthesis show standard error of mean.

Code	Name of Species	Site A		Site B		Site C	
		Pre-Monsoon	Post Monsoon	Pre-Monsoon	Post Monsoon	Pre-Monsoon	Post Monsoon
1	*Aerva javanica* (Burm.F)Juss.	24.7 (8.1)	18.1 (0.7)	13.1 (0.3)	15.2 (0.4)	11.7 (0.8)	8.6 (0.3)
2	*Aerva tomentosa*Forssk.	.	.	.	.	2.9 (0.9)	3.0 (0.8)
3	*Alhagi maurorum*(L.) Bth.	.	.	.	.	6.4 (0.3)	5.9 (0.1)
4	*Aristida funiculata*Trin. &Rupr.	.	.	4.8 (0.4)	4.5 (0.2)	.	.
5	*Aristida mutabilis* T.& R.	.	.	.	.	5.0 (0.3)	5.7 (0.4)
6	*Boerhavia procumbens* Bank.	.	.	.	.	3.9 (0.6)	4.8 (0.7)
7	*Calligonum polygonoides* L.	11.6 (1.8)	11.8 (0.9)	7.4 (1.1)	7.2 (0.8)	11.0 (0.5)	7.9 (0.4)
8	*Calotropis gigantea* (Li.) Aiton f.	.	.	.	.	2.9 (0.8)	2.6 (0.3)
9	*Calotropis procera*(Ait.) Ait. f.	.	.	5.0 (0.4)	3.8 (0.9)	6.9 (0.8)	6.5 (0.6)
10	*Capparis decidua*(Forsk.) Edgew.	.	.	7.0 (0.7)	5.3 (0.6)	4.9 (0.2)	5.6 (0.4)
11	*Cassia italica* (Mill) F.W.Andr.	5.5 (0.4)	6.1 (0.2)	5.5 (0.2)	5.0 (0.2)	.	.
12	*Citrullus colosynthis* L.	8.0 (1.2)	8.7 (1.0)	7.5 (0.4)	7.5 (0.1)	3.8 (0.4)	5.5 (0.3)
13	*Cleome brachycarpa* Vahl.exDC.	.	.	3.3 (0.2)	3.3 (0.1)	.	.
14	*Convolvulus protrates* Fork.	.	.	.	.	5.5 (0.7)	5.4 (0.4)
15	*Cynodon dactylon*(L.) Pers.	.	.	.	.	2.8 (0.3)	3.7 (0.1)
16	*Cyperus arvenarius* Retiz.	.	.	3.7 (0.3)	3.7 (0.3)	.	.
17	*Digeraarvensis*Forsk.	3.9 (0.4)	3.8 (0.7)	.	.	.	.
18	*Dipterygium glaucum* Dence.	.	.	6.9 (0.7)	6.5 (0.3)	6.4 (0.8)	5.4 (0.5)
19	*Fagonia indica* Burm. f.	5.3 (2.9)	3.0 (0.6)	.	.	.	.
20	*Heliotropium europium* L.	.	.	.	.	2.0 (0.2)	3.7 (0.6)
21	*Indigofera argentea* Burm.f.	.	.	.	.	2.7 (0.3)	2.3 (0.2)
22	*Indigofera oblongifolia*	8.5 (2.9)	14.7 (0.9)	.	.	.	.
23	*Leptanedia pyrotechnica* (Forsk) Dence.	12.7 (1.5)	13.0 (0.4)	13.4 (0.8)	11.3 (0.4)	7.8 (0.4)	6.4 (0.4)
24	*Limeum indicum* Stocks ex T. And.	.	.	4.9 (0.3)	3.6 (0.3)	.	.
25	*Ochthochloa compressa* (Forsk.) Hil.	.	.	2.5 (0.3)	2.5 (0.4)	1.1	4.1
26	*Pluchea lanceolata* Olive &Hiern.	.	.	3 (0.0)	4 (0.0)	.	.
27	*Polygala erioptera* DC.	.	.	.	.	2.0 (0.2)	2.3 (0.1)
28	*Prosopis cineraria* (L.) Druce.	.	.	.	.	4.2 (0.4)	3.7 (0.2)
29	*Prosopis juliflora* (Swartz) DC.	2.2 (0.4)	2.0 (0.2)	.	.	.	.
30	*Saccharum spontaneum* L.	2.4 (0.4)	2.5 (0.4)	.	.	.	.
31	*Salvadora oleoides* Dencene.	5 (0.0)	6 (0.1)	9.0 (0.1)	12 (0.1)	4 (0.0)	4 (0.0)
32	*Stipagrostis plumosa* (L.) Munro.	.	.	4 (0.1)	5 (0.0)	.	.
33	*Tribulus longipetalus* Viv.	6.2 (0.7)	5.5 (0.5)	.	.	2.4 (0.2)	3.7 (0.1)
34	*Zizyphus nummularia* (Brum.F) Wt.	2 (0.0)	2 (0.0)	.	.	.	.
35	*Zygophyllum simplex* L.	2.6 (0.3)	2.9 (0.2)	.	.	.	.

Table: 3. Correlations of dominant plant species at the study sites of District Khairpur.

			1	22	23	7	12	31
1	*A.javanica* (Burm.F) Juss.	Pearson Correlation	1	-.587	.188	.032	.082	-.014
		Sig. (2-tailed)		.126	.380	.884	.704	.948
22	*I. oblongifolia*	Pearson Correlation	-.587	1	.646	.359	.167	.336
		Sig. (2-tailed)	.126		.083	.382	.693	.416
23	*L.pyrotechnica* (Forsk) Dence.	Pearson Correlation	.188	.646	1	.207	.748**	.453*
		Sig. (2-tailed)	.380	.083		.331	.000	.026
7	*C.polygonoides* L.	Pearson Correlation	.032	.359	.207	1	.249	-.465*
		Sig. (2-tailed)	.884	.382	.331		.241	.022
12	*C.colosynthis* L.	Pearson Correlation	.082	.167	.748**	.249	1	.433*
		Sig. (2-tailed)	.704	.693	.000	.241		.035
31	*S.oleoides* Dencene.	Pearson Correlation	-.014	.336	.453*	-.465*	.433*	1
		Sig. (2-tailed)	.948	.416	.026	.022	.035	

**. Significant at p< 0.01 level.
*. Significant at p< 0.05 level.

Plant Associations

Associations among major plant species, calculated as Pearson correlation, at three different sites of study area were significant at p< 0.01 and 0.05 **(Table. 3).**

The species *L. pyrotechnica* shows significanlty positive relationship with *C. colosynthesis* is (r=0.748 p<0.05) and *S. oleoides* (r = 0.453, *p* = 0.026). Another significantly positive relationship has been found between the species *C. colosythesis* and *S. oleoides* (r = 0.433, *p* = 0.035). While another dominant species *A. javanica* of the study areas does not show significant association with any other species suggesting solitary occurrence. The relationship among other species was non-significant although, there were observations of both negative and positive co-efficient.

4. CONCLUSIONS

The vegetation distribution is greatly influenced by both climatic and topographic factors. The results suggest great variation in the community structure affected both by monsoon rains and topography. Due to grazing and over-exploitation of the plants in area native species like *Aerva, Calligonum, Leptadenia* and *Indigofera* are decreasing their cover and density.

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