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# Phytogeographical Distribution of Vegetation in Desert Area of Islamia University, Bahawalpur

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**Abstract**: To analyze the vegetation, phytogeographical study in desert area of Baghdad-ul-Jadeed Campus, Islamia University, Bahawalpur was conducted. Importance value index (IVI) pertaining to 19 plant species found in the study area. *Lasiurus scindicus, Cenchrus ciliaris, Aristida adscensionis, Capparis decidua, Calligonum polygonoides, Aerva persica and Tribulus longepetalus* were the commonest species in nearly highest values found in different quaderats of the desert followed by *Cenchrus biflorus, Salsola baryosma and Cymbopogan jwarancusa*. Rare and low IVI species were *Haloxylon salicornicum, Suaeda fruticosa, Alhagai maurorum* and *Launea* closely followed by *Euphorbia prostrata* and *Sesuvium sesuvioides*. Seasonal differences were significantly variable, the highest in February and October and the lowest in May, positively related with precipitation of the area. Ephemeral/annuals are the new comers in this study area being the rarest and the poorest for Importance Value Index (IVI) records.

**Key words:** Phytogeography, habitat, perennials, ephemerals, annuals

## Introduction

Baghdad-ul-Jadeed campus of Islamia University, Bahawalpur covering an area of 1257 acres lying on the fringe of Cholistan desert is almost a true replica of the adjoining lesser Cholistan desert. The Cholistan desert having an area about 2.6 million hectares (FAO, 1993, Akbar *et al*., 1996), with a length of about 480 km and width varying from 32 to 192 km (Khan, 1987 and Chaudhry, 1992), is the largest desert of the country. Geomorphologically lesser Cholistan desert comprises of saline alluvial flats (locally called dahars), sand dunes of low height (up to 10 m or so), and inter-dunal areas occasionally surfaced with moving sand; while, the greater Cholistan comprises river terraces, large and high sand dunes (measuring 100 m or so) and depressions (Baig *et al*., 1980, Khan, 1987, Akbar *et al*., 1996). Low and sporadic rainfall, high temperature, low relative humidity, strong summer winds and high salinity level characterize this desert. Ground water is mainly brackish containing Total Dissolved Solids (TDS) 9,000 to 24,000 ppm (Baig *et al*., 1980). High evaporation rate reduces the natural accumulation of surface water. The rainwater collected in the natural depressions locally dugout ponds called "Tobas". The rainfall data of the year 1998, recorded at Dingarh (Lesser Cholistan) is given in Fig. 1 for consultation.

Because of the inhospitable long summers and lack of proper infra structural facilities, in depth study of soils and plants remained ignored and inadequate. Potable water being the scarcest commodity has least been studied for its direct or indirect relationship on soil and its vegetation, however subsoil water table and its brackishness has been determined by WAPDA in details proving that central greater Cholistan has unfit whereas smaller one has marginally fit ground water.

Arshad and Rao (1995) identified four main phytogeographical divisions of Cholistan desert namely sand dunes, sandy plains, soils with gravels and high salinity areas. They indicated that specific plant communities characterize each division where sand dunes were found to be the richest in floral wealth. Rao *et al*. (1989) studied the Cholistan desert and identified eleven distinct phytosocialogical categories distinguished by the most prominent endemic plant species and its soil characteristics. They listed plant species and remarked that most plants were found to be site specific. Akbar and Arshad (1999) studied the vegetation restoration pattern of Cholistan desert as a natural habitat of Haubara Bustard and rangeland development. They recognized eleven phytosociological habitats where leading dominant, co-dominant, associated and rare plant species has been shown. Chughtai *et al*. (1987) reported unstable sites dominated by different sets of early colonizers from Attock Khurd. They named different plant communities but the stable one was *Cynodon – Imperata;* the highest number of plants among the dicots belonged Compositae family. Tareen & Qadir (1991) while working with phytosociology of Quetta recognized 23 plant communities on the basis of compositional similarities and grouped them into 7 steppe types showing co-relation with edaphic factors.

Arshad *et al*. (1999) while working on ecophysiological adaptability potential of *Sporobolous iocladus* in Cholistan desert reported inherent genetic variability in this perennial grass with four promising eco-types. The ecotypes encountered from Shaheedan Wala Toba and Lal Sohanra appeared to be the best one on the basis of some morpho-genetic characters contributing towards economic yield i.e. number of tillers per plant, fresh weight, number of leaves per tiller etc; utilizable to restore vegetation cover in the saline dahars. Arshad *et al*. (2000 a) calculated coefficient of relative abundance and dominance (CRAD) of 21 plant species. *Lasiurus scindicus* topped the list for CRAD values which ranged from 313 in protected areas to 26 in the unprotected areas during the period beginning from fall 1997 to post monsoon 1998, followed by *Haloxylon salicornicum* depicting the values of 279 in the protected and 200 in the unprotected areas. Arshad *et al*. (2000 b) elaborated the sustainability pattern of livestock in Cholistan desert and reported that out of 115 plant species belonging to 32 families nearly all off them are grazed by the livestock but in variable percentages.

The aim of the investigation was to study the phytogeography and degree of dominance among the plant species alongwith the determination of major plant communities in desert area of Baghdad - ul – Jadeed Campus of Islamia University.

## Materials and Methods

To achieve the laid out objectives of this study, quadrate methods as reported by Hussain (1989), Chughtai *et al*. (1978), Khan (1996), Kayani *et al*. (1988), Ahmad (1986), Hussain and Baz (1996) were applied. Three study sites $S_1$, $S_2$, and $S_3$ were

earmarked on the basis of structure/texture of the soil and its topography. $Q_1$ was the old bulldozed almost flat piece of soil deplete with representative flora, $Q_2$ was dominated by moving sand and partially stabilized dunes while $Q_3$ was dominated by stabilized dunes with a little area of moving sand and hard pans. These sites ($Q_1$, $Q_2$, and $Q_3$) were considered as $Q_4$, $Q_5$, $Q_6$ in May and $Q_7$, $Q_8$, and $Q_9$ in October respectively. Each quadrate ($Q_1$, $Q_2$, $Q_3$) was further divided into five sub-quadrates one each in the corner and fifth in the center, which were numbered from $Q_1$ to $Q_5$. Where the northern one was $Q_1$, eastern $Q_2$, southern $Q_3$, western $Q_4$ and the central one as $Q_5$. The pattern of this numbering was also followed in the other sites i.e. $Q_1$, $Q_2$, $Q_3$ of the experiment. The values of $Q_1$ to $Q_5$ from $Q_1$, $Q_6$ to $Q_{10}$ from $Q_2$ and $Q_{11}$ to $Q_{15}$ from $Q_3$ were averaged for the sake of brevity. Data on phytogeographical parameters such as frequency, density, relative cover of the plants occurring in each sub-quadrate was recorded during the three seasons i.e. spring (February), summer (May), and post monsoon (October) 1999. Relative frequency, relative density and relative cover were calculated following the methods of Hussain (1989), Chul and Moody (1983), Shukla and Srivastava (1992), Importance Value Index (IVI) for each species in each sample was calculated by the summation of relative density, relative frequency and relative cover. The soil samples were collected from each study site from a depth of 7 inches and their physio-chemical properties such as moisture content, pH and organic matter etc. were determined (Table 2).

## Results and Discussion

A glance of Table 1 (Fig. 2) revealed that in all, three perennial and two annual grasses, eight shrubs, and six ephemeral/annuals totaling 19 plant species were recorded during the three seasons of observation viz. February, May and October 1999. Site specific seasonal variation in the IVI showed a very wide variation among the quadrates $Q_1$ to $Q_9$ as well as among the species. This is incredible to note that *Lasiurus scindicus* showed a variation of 20.72 to 67.65 noted in $Q_9$ and $Q_4$ during the year. The next highest values of this species were found in $Q_1$ and $Q_2$ i.e. 61.6 and 50.9, respectively during spring. It may be mentioned here that this perennial grass survived throughout the year despite oddities of summer with variable values.

*Cymbopogon jwarancusa* was not recorded in $Q_2$, $Q_5$ and $Q_8$. Its values among other quadrates varied from 8.79 to 39.04 in $Q_9$ and $Q_4$, respectively. *Cenchrus ciliaris* was persistently recorded in all the quadrates where its IVI ranged from 67.05 to 28.8 in $Q_3$ and $Q_1$. Marwat *et al.* (1990) reported that some of the perennial grasses encountered in Zingilora Quetta were depicting one of the highest importance value. Zaman and Khan (1992) showed that *Sporobolus arabicus* (perennial) and *Aristida mutibulus* were encountered around coastal areas of Karachi but only after the rains. Hunderson *et al.* (1988) reported that in a deserted grassland community a correlation of 89% was existing between soil seed bank and the vegetation and further reported that this relationship may not hold good in all the circumstances. Harper (1977) earmarked that the dynamics of desert seed bank governs the distribution and depletion of the seeds from the seed bank.

*Lasiurus scindicus and Cenchrus ciliaris* diagonally depict contrasting values in the quadrates when both are present. Surprisingly, the quadrates with the highest values of *Lasiurus scindicus* show one of the lowest values of *Cenchrus ciliaris*. This pattern, although shows some departure, but more or less is antagonistic. The middle order values in both the grasses are nearly compatible viz. $Q_7$ and $Q_8$. It can be concluded that two species perhaps compete with each other. High values of one may hamper the second.

*Aristida adscensionis* and *Cenchrus biflorus* were two annual grasses found in the experimental site. Interestingly, *Aristida adscensionis* showed nearly the same values in all the quadrats excepting $Q_5$ and $Q_9$ where it was 89.25 and 35.95. The behaviour of *Cnechrus biflorus* was not different either. Except $Q_2$ having a value of 36.33 otherwise in all the quadrates the values did not change radically.

*Capparis decidua*, *Calligonum polygonoides* and *Aerva persica* were found in all the quadrates and *Salsola baryosma* was the next most common shrub when $Q_6$ was ignored. *Heliotropium crispum* was present in only four quadrates. *Haloxylon salicornicum*, *Suaeda fruticosa* and *Alhagi maurorum* were exclusively confined to only $Q_2$. In case of *Capparis decidua* the quadrates can be conveniently divided into two groups where $Q_3$, $Q_6$ and $Q_9$ exhibit nearly the same values, while the second groups $Q_1$, $Q_2$, $Q_4$, $Q_5$, $Q_7$ and $Q_8$ values are matching well except $Q_2$. *Calligonum polygonoides* has been showing nearly a uniform and consisting pattern of values in all the quadrates except $Q_2$ and $Q_5$. In case of *Aerva persica* the value of $Q_6$ was exceptionally high and $Q_3$ and $Q_6$ values are nearly half way through otherwise the remaining quadrates do not show much variation. In *Salsola baryosma* the pattern of variation is widely ranging from 3.56 to 27.32. *Heliotrpium crispum* as indicated above is only present in four quadrates with each one of them is in low value. *Haloxylon salicornicum*, *Suaeda fruticosa* and *Alhagi maurorum* are restricted only and only to $Q_2$ and remained absent in other quadrates.

The values from $Q_7$ to $Q_9$ pertain to post monsoon season and in general are on the increase as reported by Ungar (1987). Aziz (1994) while studying the seasonal dynamics of seed reserves in coastal marsh community dominated by *Cressa cretica* reported a transient seed bank as no seeds were found during the month of September – February; similarly no seeds were found in the month of August. Apparently all the seeds were germinated thus could not be found in the soil.

Considering the floristic composition during the year time span, 10 species were encountered apparently with no more change ($Q_4$, $Q_7$) whereas ($Q_5$ + $Q_8$) show big departure from rest of the quadrates. $Q_2$ was particularly rich inhibiting the maximum of eighteen species out of a total of nineteen. Similarly $Q_3$ had no significant variation during the year apparently due to the perennating species, however, the value under discussion ranged frequently due to the seasonal variations. Plant species when adjudged on the basis of frequency occurrence, *Lasiurus scindicus*, *Cenchrus ciliaris*, *Aristida adscensionis*, *Capparis decidua*, *Calligonum polygonoides*, *Aerva persica* and *Tribulus longepetalus* are the most endemic one's closely followed by *Cenchrus biflorus* and *Salsola baryosma*. The nearest are *Haloxylon salicornicum* *Suaeda fruticosa*, *Alhagi maurorum*, *Launea residefolia*, *Launea nudicaulis*, *Farsetia hamiltonii*, *Eupohorbia prostrata* and *Sesuvium sesuvioides*. None of the quadrates were able to show all the nineteen species of plants, listed in Table 1.

It was assumed that the texture and structure will not radically change among these three study sites, therefore for the sake of brevity soil samples one from stabilized dune, hard clayey pan and interdunal area (moving sand) were analyzed for physio-chemical properties given in Table 2. This may be interesting to note that availability of P, K, Na and Cl content varied among these habitats. Stabilized dunes showed significantly high amount of P as compared to the other two soil types, however K was on the reverse. Na and Cl were also markedly high in stabilized dunes as compared to the other two soil types.

$SO_4$ showed no significant change. The organic matter and

Table 1: Importance value index (IVI) of different plant species in different quadrats during three seasons of the year 1999.

| Plant Species | February | | | May | | | October | | | Habitat type |
|---|---|---|---|---|---|---|---|---|---|---|
| | $Q_1$ | $Q_2$ | $Q_3$ | $Q_4$ | $Q_5$ | $Q_6$ | $Q_7$ | $Q_8$ | $Q_9$ | |
| Perennial grasses | | | | | | | | | | |
| *Lasiurus scindicus* | 61.6 | 50.9 | 20.94 | 67.65 | 31.34 | 23.66 | 32.93 | 37.47 | 20.72 | SD + ID |
| *Cymbopoon jwarancusa* | 34.1 | - | 13.27 | 39.04 | - | 12.94 | 24.87 | - | 8.79 | HCP |
| *Cenchrus ciliaris* | 28.8 | 34.35 | 67.05 | 34.57 | 51.21 | 56.24 | 37.18 | 30.44 | 61.18 | D + ID |
| Annual grasses | | | | | | | | | | |
| *Aristida adscensionis* | 65.0 | 60.78 | 67.85 | 71.3 | 89.25 | 85.19 | 73.87 | 72.68 | 35.95 | SD |
| *Cenchrus biflorus* | 6.5 | 36.33 | 4.31 | 3.57 | - | 3.69 | 3.38 | 2.76 | 4.21 | SD + ID |
| Shrubs | | | | | | | | | | |
| *Capparis decidua* | 33.7 | 19.35 | 58.58 | 32.15 | 30.45 | 67.7 | 38.48 | 32.91 | 63.18 | SD + ID |
| *Calligonum polygonoides* | 25.7 | 15.35 | 22.86 | 26.1 | 11.63 | 25.54 | 29.66 | 22.97 | 26.27 | SD + ID |
| *Aerva persica* | 8.9 | 9.645 | 28.87 | 9.44 | 5.98 | 54.04 | 9.88 | 15.25 | 27.91 | SD + ID |
| *Salsola baryosma* | 17.2 | 16.53 | 3.56 | 6.8 | 27.32 | - | 19.96 | 25.81 | 4.2 | SD + ID |
| *Heliotropium crispum* | - | 3.766 | 6.93 | - | 2.94 | - | - | - | 8.05 | SD |
| *Haloxylon salicoricum* | - | 2.61 | - | - | - | - | - | - | - | ID |
| *Suaeda fruitcosa* | - | 4.38 | - | - | - | - | - | - | - | ID |
| *Alhagi maurorum* | - | 2.23 | - | - | - | - | - | - | - | SD + ID |
| Ephemerals/Annuals | | | | | | | | | | |
| *Tribulus longipetalus* | 12.6 | 34.63 | 7.17 | 8.7 | 22.56 | 8.7 | 33.47 | 74.28 | 39.4 | SD + ID |
| *Launea residefolia* | - | 12.24 | - | - | 11.83 | - | - | - | - | ID |
| *Launea nudicaulis* | - | 11.10 | - | - | - | - | - | - | - | SD + ID |
| *Farsetia hamiltonii* | - | 6.36 | - | - | - | - | - | - | - | ID |
| *Euphorbia prostrata* | - | 12.8 | - | - | 8.18 | - | - | - | - | SD + ID |
| *Sesvium sesuvioides* | - | 1.82 | - | - | - | - | - | 8.69 | - | SD |

SD = Stabilized Sand Dunes ID = Interdunal Areas (Moving Sand) HCP = Hard Clayey Pan

Table 2: Physico - chemical analysis of the soil of study areas

| Soil types | Moisture content% | EC ds/m | pH | Organic mater% | P meq/l | K meq/l | Ca meq/l | Mg meq/l | Na meq/l | $CO_3$ meq/l | $HCO_3$ meq/l | Cl meq/l | $SO_4$ meq/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dunal soil | 0.62 | 4.95 | 7.99 | 0.78 | 8.20 | 120 | 1.11 | 1.29 | 2.55 | 0.00 | 2.60 | 2.12 | 0.23 |
| Hard pn soil | 0.03 | 5.12 | 9.07 | 0.21 | 3.30 | 112 | 1.44 | 1.78 | 1.90 | 0.00 | 2.74 | 2.02 | 0.30 |
| Moving sand (interdunal area) | 0.35 | 3.82 | 8.35 | 0.00 | 4.30 | 180 | 1.08 | 0.80 | 1.44 | 0.00 | 3.28 | 0.85 | 0.29 |

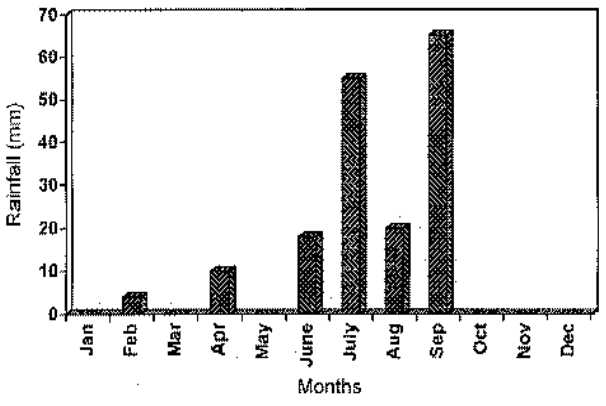


Fig. 1: Rainfall (mm) recorded during 1998 at Dingarh, Cholistan, Bahawalpur

moisture content was maximum in stabilized dunes as a result of natural mulching and minimum moisture content in hard pan due to its low permeability. A continuous movement of the interdunal soil caused the absence of organic matter while relatively high permeability resulted in moderate moisture content. When the endemic species are viewed related to the edaphic perspective *Cymbopogan jwarancusa* was seen confining itself to the hard pans of clayey soil only. This habitat is with the highest pH of 9.07 and minimal most moisture content. The Ca and Mg were the lowest and $HCO_3$ the highest. Stabilized dunes were colonized by *Aristida adscensionis, Heliotropium crispum* and *Sesuvium sesuvioides*. This is a habitat with one of the lowest pH, highest organic matter. P, Na and the moisture content. *Suaeda fruticosa, Launea residefolia, Farsetia hamiltonii* and *Haloxylon salicornicum* were exclusively inhibiting the interdunal areas. This habitat is with the highest K and $HCO_3$; whereas Na and Cl were the lowest. The remaining species were primarily seen thriving on dunal and interdunal habitats alike. Possibly they have wider adapatability pattern. Marwat *et al.* (1990) while discussing the Alhagi maurorum and Elymus community in mountainous range of Quetta assigned it to the higher quantity of the Ca and Mg contents. This is true in the present case. The results indicate that the dominance of *Aristida adscensionis* in all the three quadrates during February and May 1999, can be ascribed to the life cycle of plants and climatic conditions of the area. The dominance of this grass is an indication of the enhancing process of desertification since the undesirable plant species are replacing the desirable plants. A change in the pattern of leading dominant species was seen in the quadrate No. 2 and 3 ($Q_2$, $Q_3$) where *Tribulus longipetalus* and *Capparis decidua* respectively replaced the *Aristida adscensionis*. This change may be attributed to the

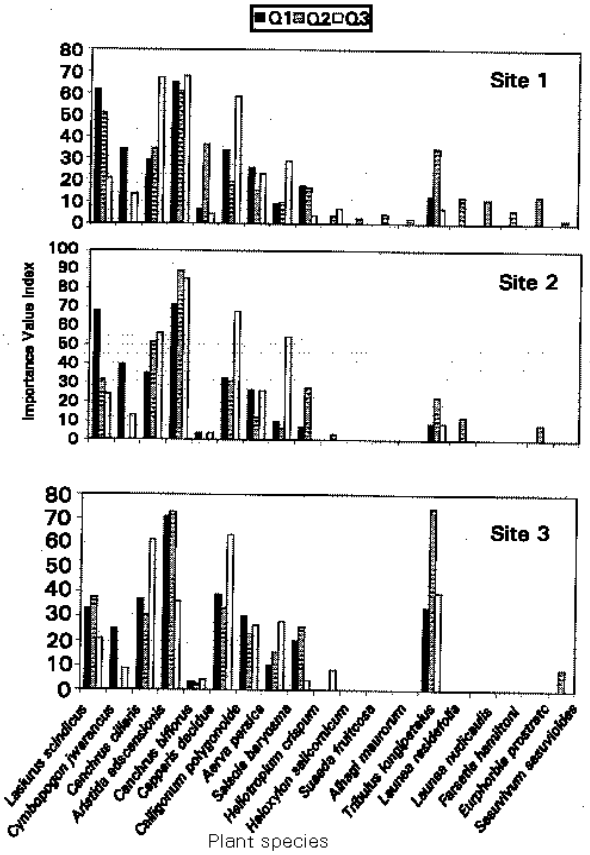


Fig. 2: Comparison of endemic species for importance value index during three seasons of 1999 and three sites

completion of life cycle of seasonal plants and partially to the non-significant monsoon rainfall which retarded the germination and growth of the perennial plant species.

The winter rainfall provided sufficient moisture content to the interdunal soils, dominant in quadrate No. 2 ($Q_2$), to support the maximum number of plant species during the spring season (Feb. 1999). The processes of evapotranspiration, in the next period of summer, reduced the moisture content worsened by non-availability of rain resulted in diffuse type of vegetation. Another factor was observed that clayey soil of hard pan only support the *Cymbopogan jwarancusa* and the interdunal area (sandy soil), with sufficient moisture, is capable to support more vegetation.

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