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Floral and edaphic data recorded from Sahiwal District, Pakistan analyzed by multivariate techniques

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ABSTRACT

The current exploration was focused to study vegetation and environmental parameters associated with Sahiwal district. For the phytosociological survey Braun-Blanquet's methodology was employed. In order to classify the vegetation data, ordination research tactics i.e., Two Way indicator species analysis (TWINSPAN) and Canonical Correspondence Analysis (CCA) were used. Vegetation data obtained from forty quadrats was compiled. Thirty eight plant species belonging to twenty one families were recorded. TWINSPAN bifurcated the flora of entire study zone into two main communities that had been again separated into smaller i.e., sub communities. Canonical correspondence analysis recognized the relation of vegetation assembly to underlying environmental factors. This correlation was studied by CANOCO analysis. In the Canonical correspondence analysis of species for Sahiwal, it was found that environmental variables, i.e. water content, soil EC and water EC had clear influence on species distribution.

Key Words: *Ordination, Sahiwal District, Plant Classification, Soil, Water.*

INTRODUCTION

The Sahiwal district is located between 30°37′760″N and 72°52′059″E. It is the land formed by the rivers Sutlej and Ravi. Its height above sea level is about 50 meters. The soil of the city is made of alluvium brought by the rivers Bias, Ravi, and Sutluj. Close to the river sides, the soil texture is mostly loamy to silty loam. However the soils have good drainage and deep water table.

The objective of present exploration had been to enumerate the flora of Sahiwal district by employing ordination techniques in order to evaluate a variety of edaphic and also hydrological variables within the study area which may impact the relationship of soil, water and vegetation. There is extreme need for biological assessment in order to classify the vegetation of the area to be able to conserve the particular environment for long term positive aspects like stabilization of plant communities and ecosystems, maintenance of water table, control of extreme weather events etc (Agosti *et al*., 2000; Shahbaz *et al*., 2007). For this specific purpose Two-way Indicator Species Analysis (TWINSPAN), a multivariate technique for vegetation data analysis was applied (Graveson, 2009). Ahmad *et al*., (2013) completed the multivariate investigation with the roadside plants along Motorway (M-1), Pakistan by using TWINSPAN. Ahmad *et al*., (2014) assessed the vegetation data of Changa Manga Park Lahore, Pakistan by TWINSPAN investigation and recognized 45 species belonging to 24 families.

Newest development in ordination methods is CCA developed by Ter Braak (1988). Its associated computer program is CANOCO. Ordination is an exercise that examines role of environmental factors in species distribution (Kent & Coker, 1995; Kashian *et al*., 2003). Khan *et al*., (2013) used CCA to find out the response of plant species to moisture stress in several zones of Changa Manga Forest. Ahmad *et al*., (2014) accomplished a work on Korang river, Islamabad and studied vegetation and soil relationships and associations. The data was analyzed through CCA.

MATERIALS AND METHODS

Extensive floristic surveys of the area were performed in spring and on end summer of 2014. The study involved inventorying connected with natural flora by way of comprehensive survey of every site with specimen collection, phytosociological analysis and employing quadrat approach. The Flora of Pakistan was consulted to identify the collected plant specimens (Nasir & Ali, 1970-1989; Ali & Nasir, 1990-1992 and Ali & Qaisar, 1992-2010).

Field vegetation parameters i.e., percentage cover and frequency were documented (Kent &

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Coker, 1992) and sampling was accomplished by utilizing quadrat of $1m^2$ intended for grasses, 5 m^2 intended for shrubs along with 10 m^2 intended for trees following Braun-Blanquet approach. The phytosociological information was examined by TWINSPAN software along with environmental information by CCA Analysis. Soil samples were obtained from 0-6 inches depth. These samples were analyzed to determine physical (soil texture, colour, soil moisture content) along with chemical parameters details like EC and pH following standard procedures. Similarly besides recording water table depth its pH and EC was determined.

RESULTS AND DISCUSSION

Vegetation assessment was carried out in spring and summer seasons.

The outcomes of the study described into two parts are outlined beneath:

TWINSPAN findings constitute the first part of the results while second part embodies outcome associated with CCA investigation of plants. Table1 represents the abbreviations for Plant Species in Fig.,1 and 2.

Table I: Abbreviations for Plant Species Presented in Fig.,1 and 2.

Sr. No.	Species	Families	Abbreviations
1.	*Achyranthes aspera* Linn.	Amranthaceae	*Ach-asp*
2.	*Ageratum houstonianum* Mill.	Asteraceae	*Age-hou*
3.	*Albizia lebbeck* (Linn.) Benth.	Mimosaceae	*Alb-leb*
4.	*Alhagi maurorum* Medic.	Papilionaceae	*Alh-mau*
5.	*Amaranthus viridis* Linn.	Amaranthaceae	*Ama-vir*
6.	*Cannabis sativa* Linn.	Cannabaceae	*Can-sat*
7.	*Capparis spinosa* Linn.	Capparidaceae	*Cap-spi*
8.	*Chenopodium album* Linn.	Chenopodiaceae	*Che-alb*
9.	*Chenopodium murale* Linn.	Chenopodiaceae	*Che-mur*
10.	*Convolvulus arvensis* Linn.	Convolvulaceae	*Con-arv*
11.	*Conyza bonariensis* Linn.	Asteraceae	*Con-bon*
12.	*Cynodon dactylon* (Linn.) Pers.	Poaceae	*Cyn-dac*
13.	*Cyperus rotundus* Linn.	Cyperaceae	*Cyp-rot*
14.	*Dalbergia sissoo* Roxb.	Papilionaceae	*Dal-sis*
15.	*Desmostachya bipinnata* (Linn.) Stapf	Poaceae	*Des-bip*
16.	*Digitaria arvensis* Linn.	Poaceae	*Dig-arv*
17.	*Digera muricata* (Linn.) Mart.	Amaranthaceae	*Dig-mur*
18.	*Eclipta prostrata* Linn.	Asteraceae	*Ecl-pro*
19.	*Euphorbia prostrata* Ait.	Euphorbiaceae	*Eup-pro*
20.	*Malvastrum coromandelianum* (Linn.) *Caske*	Malvaceae	*Mal-cor*
21.	*Melilotus indica*(Linn.) All.	Papilionaceae	*Mel-ind*
22.	*Morus alba* Linn.	Moraceae	*Mor-alb*
23.	*Nicotiana plumbaginifolia* Viv.	Solanaceae	*Nic-plu*
24.	*Panicum antidotale* Retz.	Poaceae	*Par-ant*
25.	*Parthenium hysterophorus* Linn.	Asteraceae	*Par-hys*
26.	*Prosopis cineraria* (Linn.) Druce	Mimosaceae	*Pro-cin*
27.	*Polygonum plebejum* R. Br.	Apocyanaceae	*Pol-pleb*
28.	*Salvadora oleoides* Decne.	Salvadoraceae	*Sal-ole*
29.	*Sesbania sesban* (Linn.) Merrill.	Papilionaceae	*Ses-ses*
30.	*Solanum nigrum* Linn.	Solanaceae	*Sol-nig*
31.	*Suaeda fruticosa* Forssk.	Chenopodiaceae	*Sua-fru*
32.	*Tamarix aphylla* (Linn.) Karst.	Tamaricaeae	*Tam-aph*
33.	*Terminalia arjuna* (Roxb. ex DC.) Wt. & Arn.	Combretaceae	*Ter-arj*
34.	*Trianthema portulacastrum* Linn.	Aizoaceae	*Tri-por*
35.	*Tribulus terrestris* Linn.	Zygophyllaceae	*Tri-ter*
36.	*Withania somnifera* (Linn.) Dunal.	Solanaceae	*Wit-som*
37.	*Xanthium strumarium* Linn.	Asteraceae	*Xan-str*
38.	*Ziziphus nummularia* (Burm.f.) W. & Arn.	Rhamnaceae	*Ziz-num*

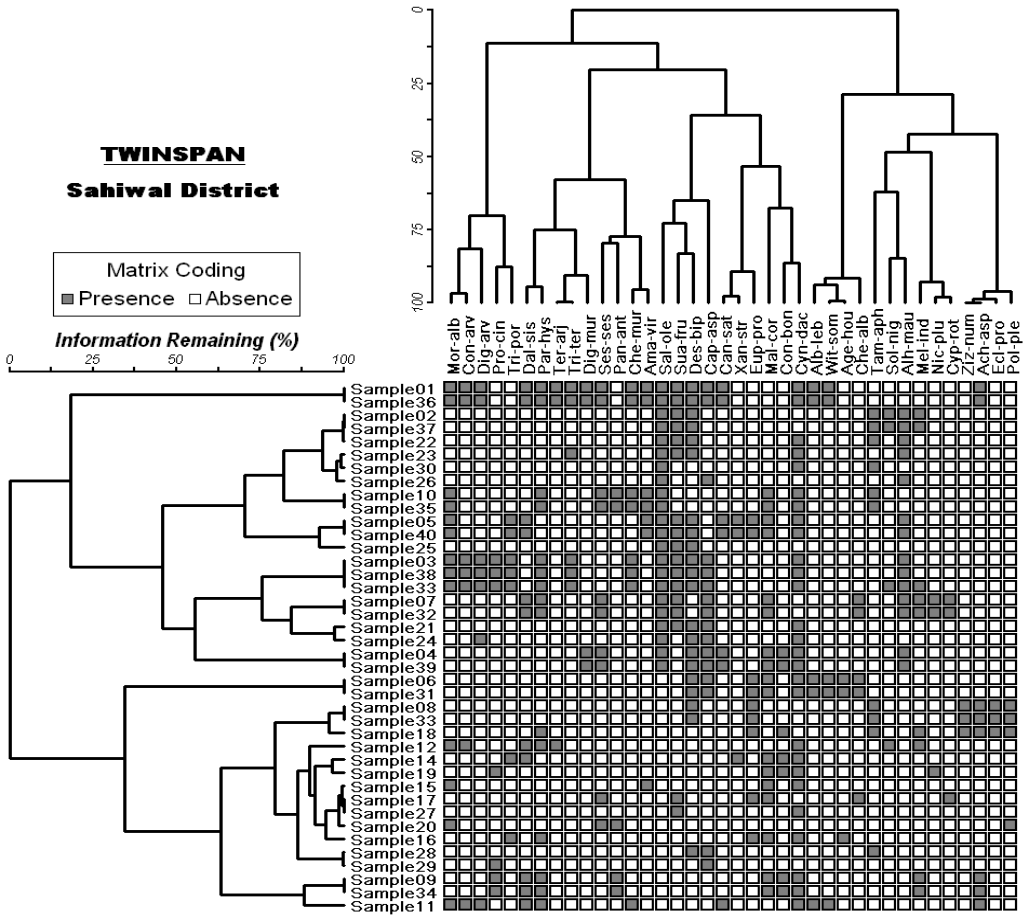

Fig., 1: TWINSPAN Analysis of species at Sahiwal District

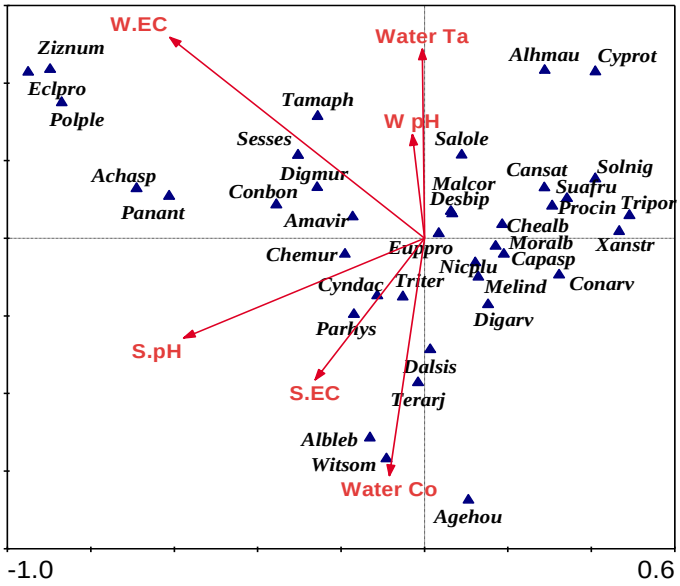

Fig., 2: Biplot diagram of species and environmental variables for Sahiwal

TWINSPAN Classification of Species at Sahiwal

A total of 38 plant species of 21 families were listed out of 40 quadrats. At the first level, TWINSPAN analysis bifurcated vegetation of whole study area into two major communities that were again divided into smaller communities. All the communities were named after the most dominant species (Fig.,1).

Major Community 1: *Cynodon dactylon* and *Salvadora oleoides*
Sub- communities:

1.1 *Morus alba* and *Convolvulus arvensis*

This community was in few quadrats at Government Forest of Chicha Watni. *Morus alba* commonly occurs in agricultural fields, road side, along railway tracks and barren lands. (http://www.issg.org/database/species/ecology.asp?si=1559andfr=1andsts=andlang=EN). Whereas *Convolvulus arvensis*, a noxious weed, inhabits road margins, forests and crop fields. This group appeared in twenty quadrats and their co- existence revealed that environmental conditions in these quadrats were favorable enough for its healthy growth.

1.2 *Parthenium hysterophorus* and *Dalbergia sissoo*

This community was in areas adjacent to Lower Bari Doab Canal and along road leading to Chicha Watni from Faisalabad. The dominant species of this sub- community showed quite good percentage cover values e.g., *Parthenium hysterophorus* 23 % and *Dalbergia sissoo* 20 %. *P. hysterophorus* widely grows on road edges and unused lands (Javaid & Anjum, 2005). In Punjab, farmers plant *D. sissoo* as shelter belt around the fields. Other species with percentage cover values of more than 5 % that were part of this community were *Solanum nigrum, Ageratum houstonianum, Xanthium strumarium* and *Trianthema portulacastrum.*

1.3 *Cynodon dactylon* and *Salvadora oleoides*

The dominant communities of this group are same as that of major community 1. These were growing on waste places located along Harappa to Sahiwal Railway line. The group was recorded from only 16 quadrats and the comprising species displayed a good percentage cover e.g., *Salvadora oleoides* 26 % while *Cynodon dactylon* 13 %. *Cynodon dactylon* showed its existence everywhere due to its ability to grow in infertile soils under water stress. While *Salvadora oleiodes* is usually found in semi- arid areas of Punjab and is utilized as fodder for domestic animals. As this sub- community comprised of ten species so no further division of this group was made.

Major Community 2: *Alhagi maurorum* and *Tamarix aphylla*
Sub- communities:

2.1 *Albizia lebbeck* and *Withania somnifera*

This small community happened in a few quadrats at Faisalabad road. All the quadrats were laid down and studied in greatly disturbed areas. *Albizia lebbeck* is a common tree of the arid regions. Due to constant browsing pressure its population is decreasing. It can survive on every type of soil ranging from alkaline to saline soils (Prinsen, 1986). *Withania somnifera* was found growing together with *Albizia lebbeck* on banks of river, agricultural fields and road margins in the area under study. The co-existence of this sub- community in about 18 quadrats showed that prevalent conditions in these quadrats were promising enough for their growth.

2.2 *Alhagi maurorum* and *Tamarix aphylla*

The species of this group are common with major community 2. This sub- community consisting of 10 species, marked its presence in the surroundings of Harappa Museum i.e., along boundaries of ditches, waste and often saline lands etc. They co-existed due to same environmental and microhabitat needs. This group was recorded from twenty four quadrats but the percentage cover values of two dominant species were very low. *Alhagi maurorum* a spiny bush is not consumed as fodder by animals (Ditomaso, 2007). *Tamarix aphylla*, an evergreen tree is considered as the most dominant species of this area (www.FAO.orgh/WAICENET/FAOINFO/AGRICUL.doc). Other key species of this sub- community were *Achyranthes aspera, Solanum nigrum, Polygonum plebejum, Melilotus indica* etc.

Biplot Figure of Plant Species and Edaphic parameters

The biplot diagram obtained after CCA analysis of data obtained from Sahiwal District showed that all the 38 species recorded were scattered along two axes, with slightly more concentration of species towards right side of the diagram. Environmental parameters, such as water content, soil EC and water EC showed positive impact. This diagram emphasized the importance of water EC, soil EC, water content and water pH in the

grouping of species. This pattern of species distribution of species specifies the dynamic nature of the area selected for study. The biplot figure showed that most of the parameters were strongly associated, but were not responsible for grouping together of species. Soil water content played some role in association of *Albizia lebbeck, Withania somnifera and Ageratum houstonianum* as these species were grouped together in the Fig., 2. While *Ziziphus nummularia* and *Eclipta prostrata* exhibited relationship with water EC. Likewise, *Salvadora oleoides* distribution represents its sensitivity to water pH levels.

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