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DETERMINATION OF CORRELATION BETWEEN PLANT DISTRIBUTION AND ECOLOGICAL FACTORS IN NAROWAL DISTRICT PUNJAB, PAKISTAN

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Abstract

In order to study correlation between ecological factors and vegetation distribution, multivariate analysis was undertaken. Thirty four plant families represented by 59 species were recorded. For classifying the plant communities TWINSPAN (Two Way Indicator Species Analysis) software program was used. After analysis plants were categorized into two large (major) and six small (sub) communities. Water and soil samples were analyzed for pH, EC, soil colour and soil water content. Canonical correspondence analysis (CCA) was employed to correlate species distribution pattern to environmental factors. Results showed that despite many variables being strongly correlated, they were of little value in grouping together of species. However, soil pH and electrical conductivity (EC) had effects on distribution of vegetation.

Introduction

Narowal is a district of province Punjab, Pakistan and its total area is about 2337 km^2. It lies at 32°13′44″N and74°57′1″E and is surrounded by Sialkot district, Jammu and Kashmir, Gurdaspur district and Sheikhupura district. Its fertile loamy soil has a good proportion of silt which makes it suitable for growing various crops. Narowal is located in the sub humid climatic zone of Pakistan.

In order to conserve a habitat for longer period of time and classify the flora of that area biological assessment is employed (Shahbaz *et al*. 2007). TWINSPAN technique was applied for analysis of floral data (Graveson 2009). Ayub *et al*. (2017) classified the herbaceous vegetation in a valley of district Zhob, by employing TWINSPAN. In another study at waste landfills of Seoul Metropolitan area TWINSPAN analysis identified 275 species belonging to 63 families of vascular plants and grouped them into 6 communities (Kim 2013).

CCA technique is a combination of Correspondence Analysis and Regression Method (Braak 1986). Distribution of plant communities is influenced by multiple of environmental factors, hence CANOCO program possesses the capacity to consider and manipulate these influences (Kent and Coker 1995, Kashian *et al*. 2003). Ayub *et al*. (2017) used CCA to study the distribution of plant species under the influence of edaphic factors at Shinghar Valley, district Zhob. They found zinc and organic matter of the soil were playing most important role in the distribution pattern of vegetation. Zereen *et al*. (2017) worked in district Sahiwal, Punjab and used CCA to develop vegetation, water and soil relationships and associations. Main purpose of present survey was to document the flora of Narowal district that was not studied before. The effect of edaphic and hydrological factors operating in the study area on the distribution of plant communities was estimated by using multivariate techniques i.e., TWINSPAN and CCA.

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Materials and Methods

Narowal is one of the districts of Province Punjab, Pakistan. Its land comprised of piedmont plains and adjoining plains of River Ravi, Deg, Bias and Basantar. Its soils are silty and loamy, suitable for cultivation of a variety of crops. This district is divided into three tehsils namely, Narowal that lies at 32°21′N and 74°54′ E, Shakargarh that lies at 32°15′46″ N and 75°9′30″ E and Zafarwal that lies at 32°21′0 N and 74°54′0 E. From each tehsil at least three study sites were selected.

Sampling and data collection of vegetation were carried out at flowering stage, during spring season i.e., February to April. Forty quadrats of different sizes after Braun-Blanquet method were used. Sampled plant species were identified by consulting literature and flora of Pakistan (Nasir and Ali 1970-1989; Ali and Nasir 1990-1992 and Ali and Qaisar 1992-2010). Plant cover and frequency values were recorded (Kent and Coker 1992).

Sampling of soil was carried out from each quadrat and its texture, colour, moisture content, pH and EC were analyzed in laboratories of Soil Survey of Punjab. Similarly water table depth, pH and EC were recorded for water samples (Allen *et al*. 1974).

The phytosociological statistics were analyzed by TWINSPAN software that identified the major and sub plant communities at the study site. CCA was used to establish floristic-environment relationship. Matrix sheets prepared in Microsoft Excel were run in CANOCO and species scatter biplot graph was obtained. Fig. 1 is depicting the sequence of steps followed in the study.

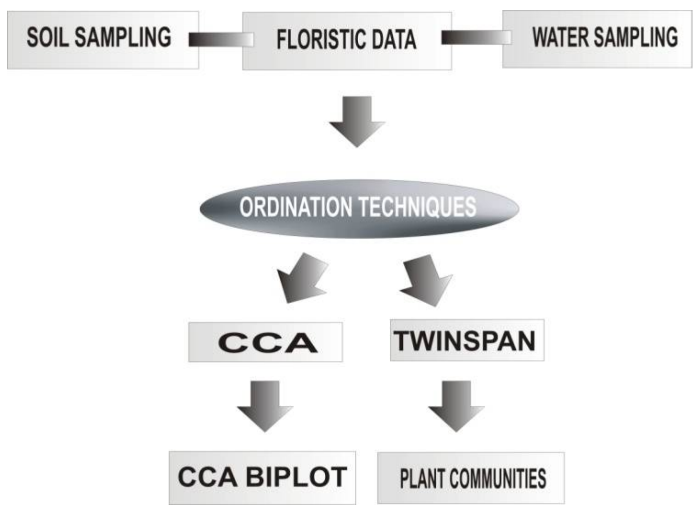

Fig. 1. Flow chart of methodology.

Results and Discussion

Percentage cover values of 59 species recorded out of 40 quadrats at Narowal district were used for analysis in TWINSPAN program and two major and six sub-communities were identified. All the communities were named on most dominant species with respect to their cover values (Fig. 2). Table 1 embodies the abbreviations for plant species used in Figs 2 and 3.

Major community 1: Oxalis corniculata and *Solanum nigrum* community had highest cover values in the area. It had two sub-communities.

Sub-community *Dalbergia sissoo* and *Ricinus communis*: It was a minor community comprised of seven species. Plants part of this community appeared on margins of crop fields, abandoned plots and edges of road leading from Narowal to Pasrur. Data for this plant community were recorded from 24 quadrats. This study site was mostly surrounded by wheat fields.

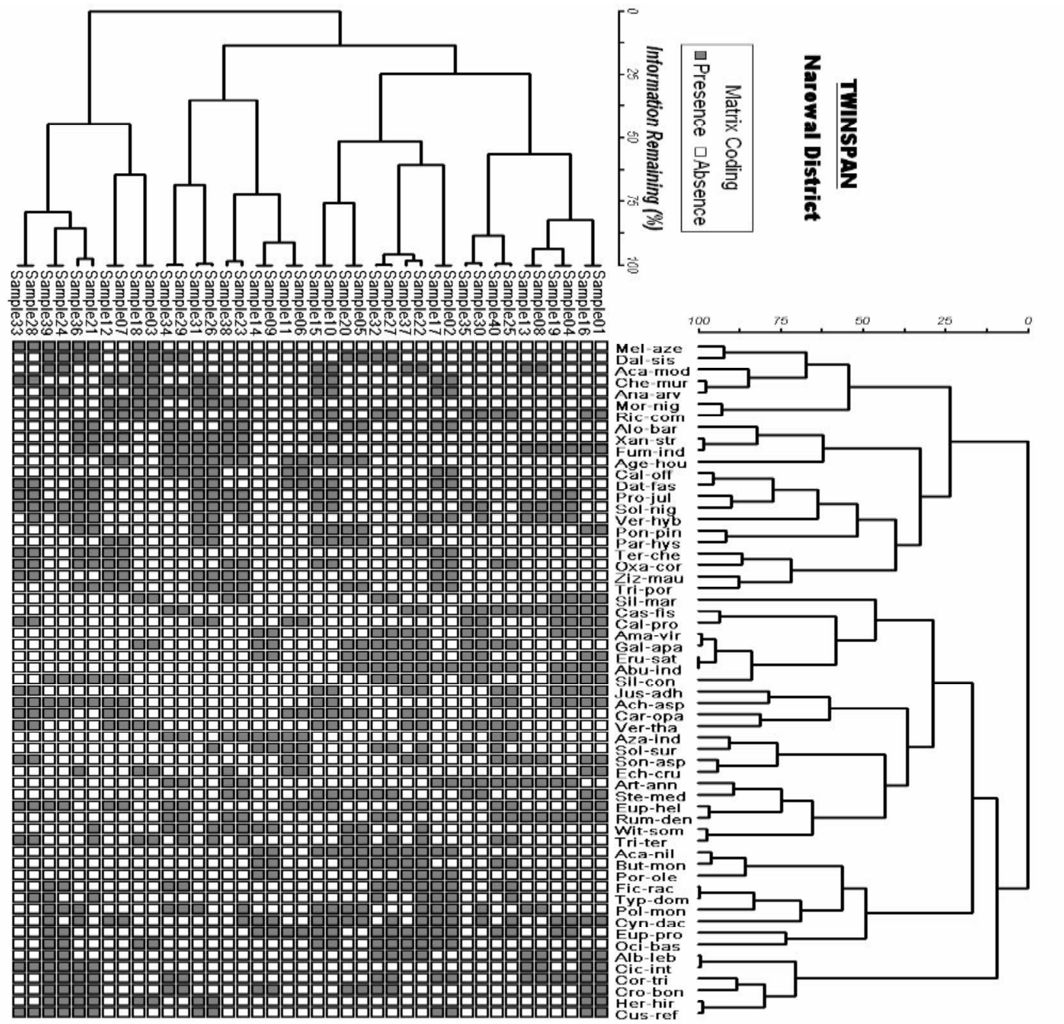

Fig. 2. TWINSPAN analysis of floristic data.

Sub-community Solanum nigrum and Oxalis corniculata: Dominant species of this community were same as of major community 1. It was large group compared to previous one and existed on margins of cultivated fields in Zafarwal village of Tehsil Shakargarh. Coexistence of *Solanum nigrum* and *Oxalis corniculata* indicates their similar ecological requirements and characteristics. This group showed presence in 31 quadrats and high cover values for two major species.

Table 1. Abbreviations for plant species presented in Figs 2 and 3.

Sr. No.	Species	Families	Abbreviations
1.	*Abutilon indium* L.	Malvaceae	*Abu-ind*
2.	*Acacia modesta* Wall.	Fabaceae	*Aca-mod*
3.	*Acacia nilotica* (L.) Delile	Fabaceae	*Aca-nil*
4.	*Achyranthes aspera* L.	Amranthaceae	*Ach-asp*
5.	*Ageratum houstonianum* Mill.	Asteraceae	*Age-hou*
6.	*Albizia lebbeck* (L.) Benth.	Mimosaceae	*Alb-leb*
7.	*Aloe barbadensis* (L.) Burm.f.	Asphodelaceae	*Alo-bar*
8.	*Amaranthus viridis* L.	Amaranthaceae	*Ama-vir*
9.	*Anagallis arvensis* L.	Primulaceae	*Ana-arv*
10.	*Artemisia annua* L.	Asteraceae	*Art-ann*
11.	*Azadirachta indica* Adr.Juss	Meliaceae	*Aza-ind*
12.	*Butea monosperma* (Lain.) Taubert	Papilonaceae	*But-mon*
13.	*Calotropis procera* (Ait.) Ait.f.	Asciepiadaceae	*Cal-pro*
14.	*Cassia fistula* L.	Fabaceae	*Cas-fis*
15.	*Calendula officinalis* L.	Asteraceae	*Cal-off*
16.	*Chenopodium murale* L.	Chenopodiaceae	*Che-mur*
17.	*Cynodon dactylon* (L.) Pers.	Poaceae	*Cyn-dac*
18.	*Dalbergia sissoo* Roxb.	Papilonaceae	*Dal-sis*
19.	*Datura fastuosa* L.	Solanaceae	*Dat-fas*
20.	*Carissa opaca* Stapf ex Haines	Apocynaceae	*Car-apa*
21.	*Cichorium intybus* L.	Asteraceae	*Cis-int*
22.	*Corchorus trilocularis* L.	Tiliaceae	*Cor-tri*
23.	*Croton bonplandianum* Baill	Convolvulaceae	*Cro-bon*
24.	*Cuscuta reflexa* Roxb.	Cuscutaceae	*Cus-ref*
25.	*Echinochloa crusgalli* (L.) P.Beauv.	Poaceae	*Ech-cru*
26.	*Euphorbia prostrata* Linn.	Asteraceae	*Ecl-pro*
27.	*Eruca sativa* Mill.	Brassicaceae	*Eru-sat*
28.	*Euphorbia helioscopia* L.	Euphorbiaceae	*Eup-hel*
29.	*Ficus racemosa* L.	Moraceae	*Fic-rac*
30.	*Fumaria indica* (Hausskn.) Pugsley	Fumaraceae	*Fum-ind*
31.	*Galium aparine* L.	Rubiaceae	*Gal-apa*
32.	*Herniaria hirsute* L.	Illecebraceae	*Her-hir*
33.	*Justicia adhatoda* L.	Acanthaceae	*Jus-adh*
34.	*Melia azedarach* L.	Meliaceae	*Mel-aze*
35.	*Morus nigra* L.	Moraceae	*Mor-nig*
36.	*Ocimum basilicum* L.	Labiatae	*Oci-bas*
37.	*Oxalis corniculata* L.	Oxalidaceae	*Oxa-cor*
38.	*Parthenium hysterophorus* Linn.	Asteraceae	*Par-hys*

(Contd.)

39.	*Polypogon monspeliensis* (L.) Desfontaines.	Poaceae	*Pol-mon*
40.	*Pongamia pinnata* (L.) Pierre.	Fabaceae	*Pon-pin*
41.	*Portulaca oleracea* L.	Aizoaceae	*Por-ole*
42.	*Prosopis juliflora* (Swartz) DC	Fabaceae	*Pro-jul*
43.	*Ricinus communis* L.	Euphorbiaceae	*Ric-com*
44.	*Rumex dentatus* L.	Polygonaceae	*Rum-den*
45.	*Silene conoidea* L.	Caryophyllaceae	*Sil-con*
46.	*Silybum marianum* (L.) Gaertn.	Asteraceae	*Sil-mar*
47.	*Solanum nigrum* L.	Solanaceae	*Sol-nig*
48.	*Solanum surattense* Burm.f	Solanaceae	*Sol-sur*
49.	*Sonchus asper* L.	Asteraceae	*Son-asp*
50.	*Stellaria media* (L.) Will	Caryophyllaceae	*Ste-med*
51.	*Terminalia chebula* Retzius	Combretaceae	*Ter-che*
52.	*Trianthema portulacastrum* L.	Aizoaceae	*Tri-por*
53.	*Tribulus terrestris* L.	Zygophyllaceae	*Tri-ter*
54.	*Typha domingensis* Pers	Typhaceae	*Typ-dom*
55.	*Verbascum Thapsus* L.	Scrophulariaceae	*Ver-tha*
56.	*Veronica hybrida* L.	Plantaginaceae	*Ver-hyb*
57.	*Withania somnifera* (L.) Dunal.	Solanaceae	*Wit-som*
58.	*Xanthium strumarium* L.	Asteraceae	*Xan-str*
59.	*Ziziphus mauritiana* Lam.	Rhamnaceae	*Ziz-mau*

Table 2. Chemical and Physical Properties of Soils from Narowal Districts.

Sl. No.	District	Physical properties			Soil textural class	Soil color (Dry soil)	*pH	*EC dS/m	*Water content (%)
		Sand (%)	Silt (%)	Clay (%)					
1	Narowal	49	37	14	Loam	Brown (10YR.5/3)	7.6	2.5	12

*Mean value.

Table 3. Chemical characteristics of water from Narowal District.

Sl. No.	District	Source	*pH	*EC dS/m	Water Table (ft)
1	Narowal	Hand pump	7.40	0.69	60 - 65

*Mean value.

Major community 2: Cynodon dactylon and *Euphorbia helioscopia* are prominent species of this community because of its greater frequency and cover values. It had four sub communities.

Sub-community Silene conoidea and Abutilon indicum: This community was growing at abandoned pieces of land besides the canal in Ahmadabad Town. *Silene conoidea* and *Abutilon indicum* were dominant species here. The group appeared in 33 quadrats with high cover values e.g., *Silene conoidea* 41% and *Abutilon indicum* 39%.

Sub-community Achyranthes aspera and Euphorbia helioscopia: This community existed on unused lands, field edges and road margins throughout Shakargarh. Microclimate requirements by dominant species appeared similar. So the sub-community occurred in quadrats fulfilling their microclimatic requirements.

Sub-community Cynodon dactylon and Euphorbia prostrata: The plant species of this community existed together because of similar microhabitat and ecological requirements. Plants of this community existed throughout the study area i.e., along roads, crop fields and abandoned lands where Muridkey road links with Pasrur road. The percentage cover values of dominant species were relatively higher i.e., *Cynodon dactylon* 51.4 % and *Euphorbia prostrata* 46%. Further important plants of this community were *Ficus racemosa, Acacia nilotica, Ocimum basilicum* and *Polypogon monspeliensis*.

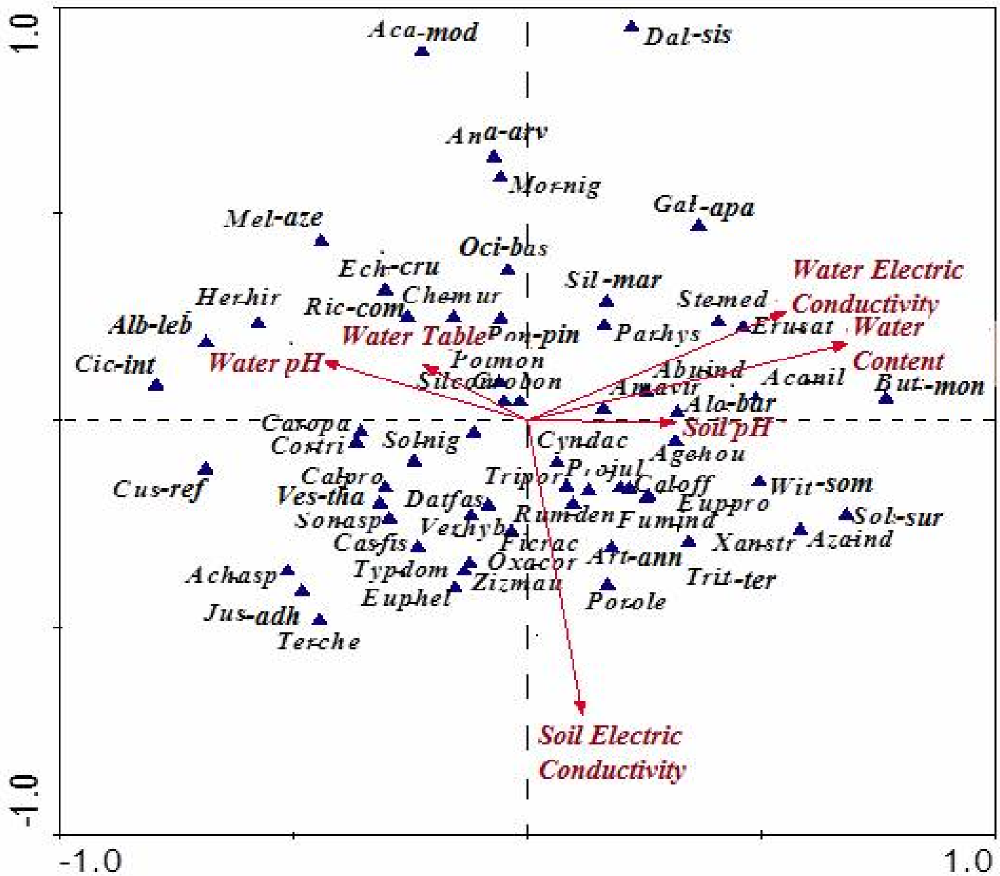

Fig. 3. CCA biplot graph of species and ecological parameters.

Sub-community Croton bonplandianus and Corchorus trilocularis: This small community was recorded from quadrats studied at Aliabad village, Shakargarh. This area is highly disturbed. The sub- community comprised of six, mostly herbaceous species i.e., *Cuscuta reflexa, Herniaria hirsuta, Croton bonplandianum* and *Cichorium intybus.*

CCA biplot for species and ecological parameters: In CCA biplot graph, for plant distribution with reference to ecological parameters, majority of factors exhibited strong correlation with each other but did not perform any significant part in plant grouping. In Fig. 3 soil EC has longest arrow while water EC and water content were having equal length arrows. Arrows for soil pH, water EC, and water content showed positive correlation as their arrows pointing in same direction, while arrows for water pH and water table were directed oppositely exhibiting negative correlation with respect to other ecological parameters. Same reaction of soil pH to water EC has been observed in the studies carried out by Gulshad *et al.* (2016) and Ahmad *et al.* (2013). *Parthenium hysterophorus, Setaria intermedia* and *Eruca sativa* were being more affected by electrical conductivity (EC) of water. Biplot graph for plants and ecological parameters presented existence of strong relationship between species distribution and environmental factors along axis 1. Water content appears to play role in assemblage of *Acacia nilotica* and *Butea monosperma* as they exist near water content arrow. *Silene conoidea* and *Polypogon monspeliensis* showed association with water table. While reporting results of their studies Gulshad *et al.* (2016) reported that pH, organic matter content and soil moisture content play key role in determining plant abundance and distribution. Various other studies also proved that plant frequency and cover in an area depends on soil quality (Urooj *et al.* 2016, Yuce and Göunlűl 2016). Results of water and soil samples collected from study area are presented in Tables 2 and 3.

Vegetation cover is very important as it performs many important functions like preventing soil erosion, providing habitat and food for wild life, pollutant absorption, having esthetic value etc. In order to maintain resources on sustainable basis strong management is required for preservation and protection of vegetation of the area. Over exploitation of natural resources should be avoided.

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