TWINSPAN classification of vegetation from South West aspect of Lower Tanawal, Abbottabad Pakistan

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Abstract

The aim of this research study was to explore the vegetation of Lower Tanawal, Pakistan from South west aspect. The ordination techniques Two-Way Indicator Species Analysis (TWINSPAN), Extended Correspondence Analysis and Canonical Correspondence Analysis were used to classify the data. TWINSPAN classified the 165 species and 24 stands into four plant communities namely *Grewia-Dodonaea-Carissa, Melia–Duchesnea–Oxalis*, *Pinus–Rubus–Cynodon*, and *Olea–Punica–Rumex* community. This study provided information on the Southwest aspect of the Lower Tanawal vegetation, Pakistan.

Keywords: TWINSPAN, Vegetation, ECA, CCA, Lower Tanawal

Resumo

O objetivo deste estudo de pesquisa, foi explorar a vegetação do Baixo Tanawal, Paquistão, sobre o aspecto Sudoeste. As técnicas de ordenação *Two-Way Indicator Species Analysis* (TWINSPAN), Análise de Correspondência Distendida e Análise de Correspondência Canônica foram utilizadas para classificar os dados. O TWINSPAN classificou 165 espécies e 24 povoamentos em quatro comunidades de plantas: *Grewia-Dodonaea-Carissa*, *Melia-Duchesnea-Oxalis*, *Pinus-Rubus-Cynodon* e *Olea-Punica-Rumex*. Este estudo forneceu informações sobre o aspecto do Sudoeste da vegetação do Baixo Tanawal, Paquistão.

Palavras-chave: TWINSPAN, Vegetação, ACD, ACC, Baixo Tanawal

Resumen

El objetivo de este estudio de investigación fue explorar la vegetación del Bajo Tanawal, Pakistán desde el aspecto suroeste. Para la clasificación de los datos se utilizaron las técnicas de ordenación *Two-Way Indicator Species Analysis* (TWINSPAN), Análisis de Correspondencia Distendido y Análisis de Correspondencia Canónica. TWINSPAN clasificó las 165 especies y 24 rodales en cuatro comunidades de plantas, a saber, la comunidad *Grewia-Dodonaea-Carissa*, *Melia-Duchesnea-Oxalis*, *Pinus-Rubus-Cynodon* y *Olea-Punica-Rumex*. Este estudio proporcionó información sobre el aspecto suroeste de la vegetación del Bajo Tanawal, Pakistán.

Palabras clave: TWINSPAN, Vegetación, ACD, ACC, Bajo Tanawal

1. Introduction

The understanding and survey of plant species in forests or different natural environments, if correctly understood, must investigate regional and local floristic patterns, including in forest fragments more subject to potential sources of mainly anthropogenic impact (Hirata et al., 2010). Nowadays, there is a certain forest fragmentation that started to have larger contact zones with the surrounding environment, favoring the exposure of part of the vegetation to sunlight and stronger winds or even the cold in certain regions of the planet. According to Bierregaard et al. (1992) and Rodrigues and Nascimento (2006) the patterns of special distribution, mortality and diversity of plant species are often modified with the edge effect, water reduction, among other factors.

Two-Way Indicator Species Analysis (TWINSPAN) is a classification technique on stands and plant species (Hill, 1979). The canonical correspondence analysis (CCA) is used to determine the relationship between species and

the environment, and extended correspondence analysis (DCA) determines the relationship between vegetation (Antoine & Niklaus, 2000).

This study aimed to evaluate the vegetation of the southwest region of Lower Tanawal, Pakistan, through the TWINSPAN, CCA and DCA technique, thus raising the floristic connection with mathematics allied to botanical models.

2. Materials and Methods

The Lower Tanawal is part of the Lesser Himalayas. The Lesser Himalayas comprise on whole area of Hazara division (Hussain & Ilahi, 1991). The Lower Tanawal located in District Abbottabad, Pakistan. It lies between the 34°12'32" and 34°15'76" North latitude to 73°09'39" and 73°03'31" East longitudes (Bibi et al., 2019).

The vegetation analysis of Lower Tanawal from south west aspect was done in various season from 2016-2018. In this research study LINE transects method was used for quantitative sampling. To measure the distribution of plants species measuring tape of 50 m was used (Dasti et al., 1998). During this research study 24 stands and 165 species were documented. The IV values of 165 plants were calculated. By using MS Excel 2007, the data of 165 species from 24 stands along with environmental factors was analyzed (McCune, 2006). The plant community was given name on the basis of three dominant plant species. TWINSPAN was used to classify the plant species and samples (Hill, 1979). For ordination of samples and species DCA was used (Hill 1973; Gauch, 1980). The CCA was used for the ordination of species, sample and their relationships to environmental factors (Ter Braak, 1986 and 1994).

3. Results

By using TWINSPAN classification 24 stands and 165 species were noted. The data were classified into two groups. Twenty two stands were placed in negative groups (*0) where as 2 stands were placed in positive group (*1). In division 1 the eigenvalue was 0.53. In division 2 (22) 5 stands were positioned in negative group (*00) while 17 stands were placed in positive group (*01). In division 3 (17) 8 stands were placed in negative group (*00) while 9 stands were positioned in positive group (*01). Then on the basis of indicator species four plant communities like *Grewia-Dodonaea-Carissa, Olea–Punica–Rumex, Pinus–Rubus–Cynodon* and *Melia–Duchesnea–Oxalis* community were formed (Figure 1).
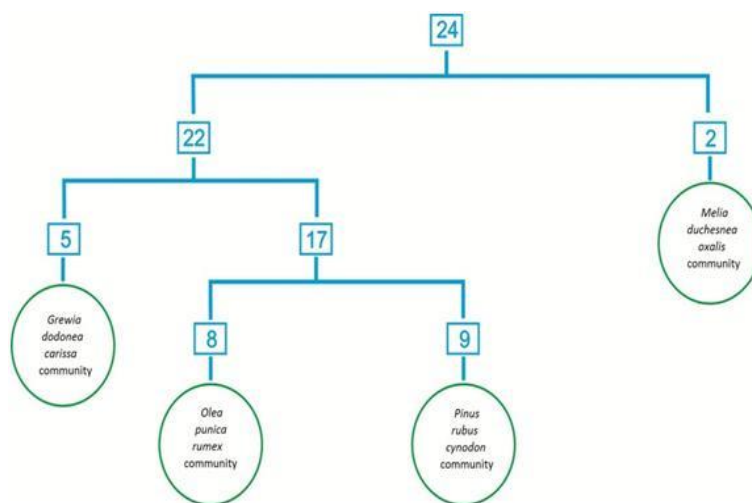

Figure 1. TWINSPAN classification of vegetation from South West aspect. Source: Author, 2022.

Grewia-Dodonaea-Carissa Community

At the elevations of 2396 to 4952 ft this community was formed. In this community 5 stands (21, 27, 28, 63, 67) and 54 species were documented. The diversity index of this community was 0.76 while the species richness was

10.48 (Figure 2). The soil of this community was loam and pH range of the soil was 6.90 to 7.22. In this community the dominant life form was Therophytes (Figure 8). Dominant leaf spectrums were Mesophyll in this community (Figure 9).

Olea–Punica–Rumex Community

In this community 8 stand (9, 10, 15 17, 25, 33, 39, 40) and 120 species were recorded between an elevation of 3613 to 4591 ft. The diversity index of this community was 0.13 while the species richness was 18.13 (Figure 2). The soil of this community was loam to clay loam and pH range of the soil was 6.90 to 7.86. The dominant life form was Therophytes (Figure 8). A dominant leaf spectrum was Mesophyll (Figure 9).

Pinus–Rubus–Cynodon Community

In this community 8 stands (53, 34, 42, 43, 45,48, 61, 69) and 73 species were documented between elevations of 3014-4876 ft. The diversity index was 0.85 whereas the species richness was 5.29 (Figure 2). The soil of the community was loam to clay loam and pH range of the soil was 6.92 to 7.40. In this community the dominant life form was Therophytes (Figure 8). A dominant leaf spectrum was Mesophyll (Figure 9).

Melia–Duchesnea–Oxalis Community

At the elevation of 3418-4385 this community was noted. In this community 2 stands and 49 species were noted. The diversity index was 0.26 while the species richness was 6.49 (Figure 2). The soil of the community was loam and pH range of the soil was 7.10 to 7.18. Therophytes was dominant life form (Figure 8). A dominant leaf spectrum was Mesophyll (Figure 9).

DCA Ordination of Vegetation of Lower Tanawal from South West Aspect

In DCA ordination maximum gradient length (3.04) at axis 1 with Eigenvalue 0.48 At axis 2 the gradient length was 2.30 with Eigenvalue 0.26. The gradient length at axis 3 was 2.29 with Eigenvalue 0.18. The gradient length for axis 4 was 1.88 having Eigenvalue 0.12. At axis 1 the dominant gradient length shown that mostly species have resemblances on axis 1.

It was observed that *Parthenium hysterophorus, Diospyros lotus, Artemisia absinthium, Randia tetrasperma,* and *Adiantum capillus–veneris* have positive correlation with each other at axis I. Similarly, *Celtis australis, Daphne mucronata, Cotinus coggygria, Morus nigra, Berberis lycium, Veronica stewartii* have positive correlation at axis 2. *Carissaa opaca*, *Ficus benghalensis, Acacia modesta, Albizia lebbeck* were on negative side of axis 1 and 2. *Adiantum capillus–veneris, Dryopteris marginalis,* indicated positive correlation with each other and negative correlation with *Dodonaea viscosa* and *Bauhinia variegata* (Figure 3)**.** DCA ordination of stands revealed that stands 21, 27 and 63 were present at axis 1. Similarly stand 28, 33, 67, 15, 69 and 39 were present at axis 2, whereas stand 70 was present on the top of ordination space shown diverse species (Figure 4).
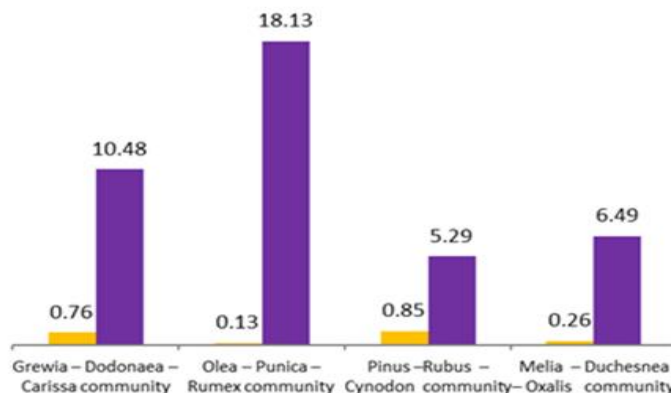

Figure 2. Diversity index and species richness of South West aspect. Source: Author, 2022.
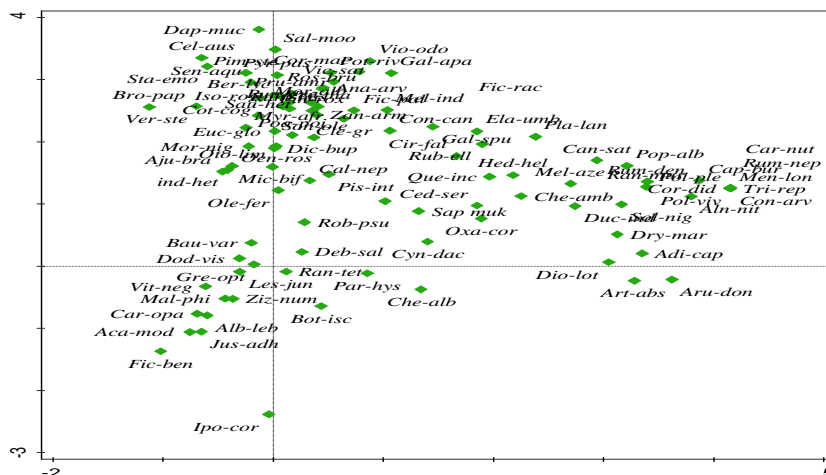
Figure 3. South West DCA ordination of species of Lower Tanawal. Source: Author, 2022.
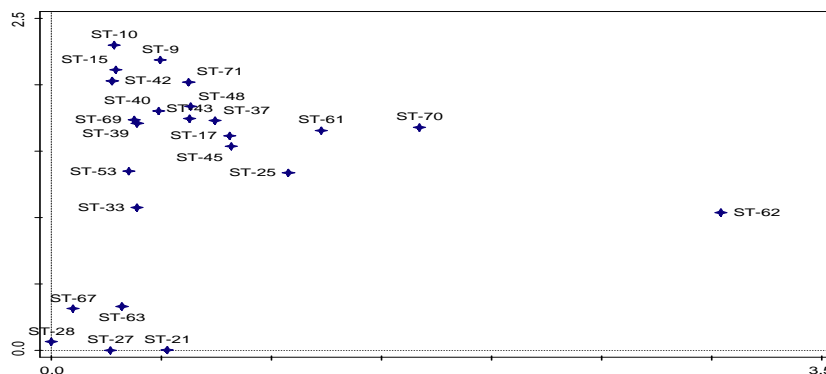

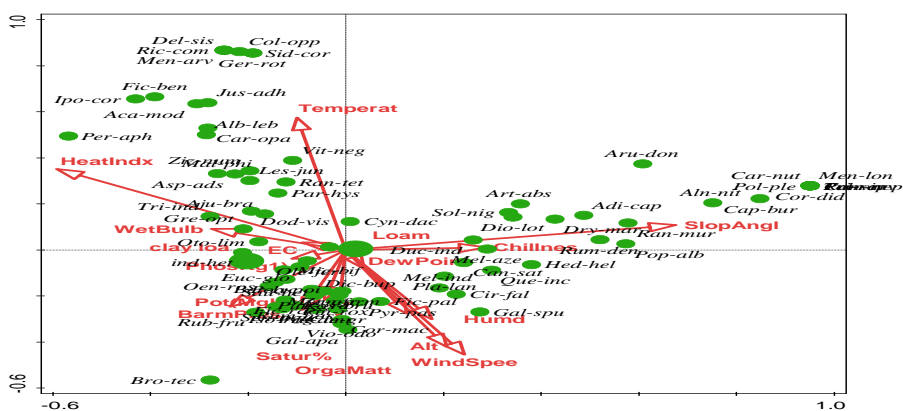**Figure 4.** South West DCA ordination of stands of Lower Tanawal. Source: Author, 2022.

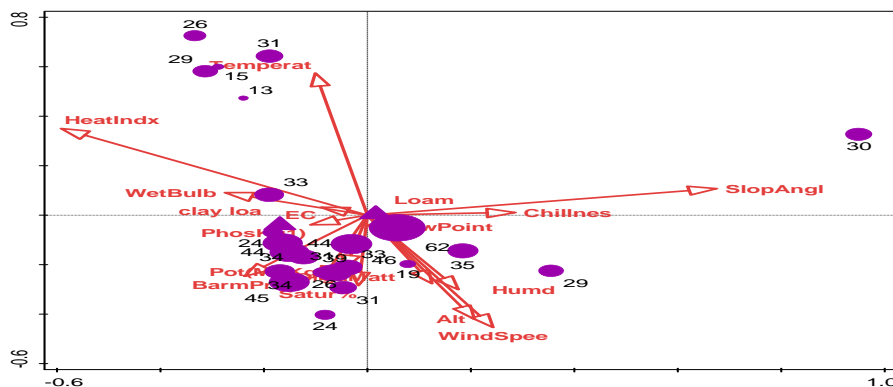**Figure 5.** South West CCA ordination of species and environmental variable. Source: Author, 2022.

Figure 6. South West CCA ordination of stands and environmental variable. Source: Author, 2022.
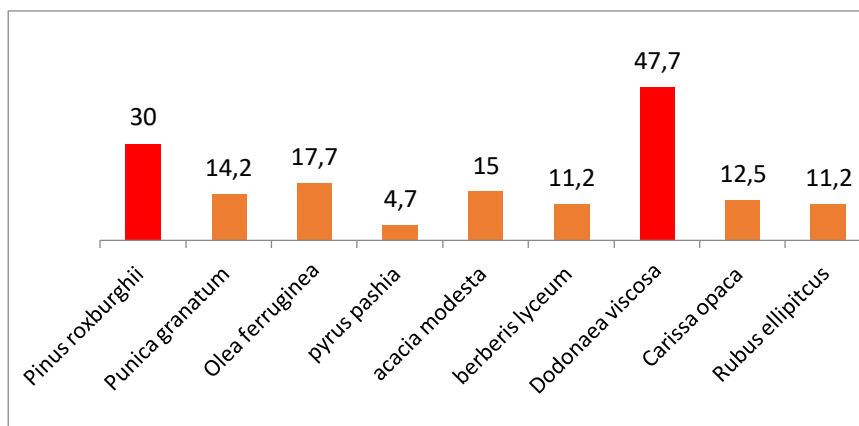

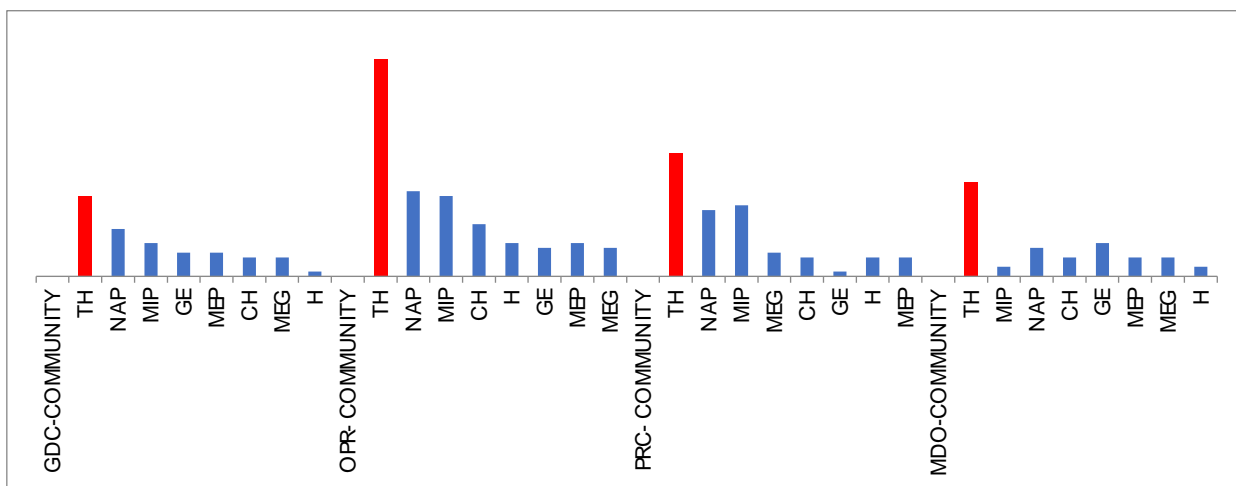**Figure 7.** Density of major tree and shrubs from South West aspect. Source: Author, 2022.

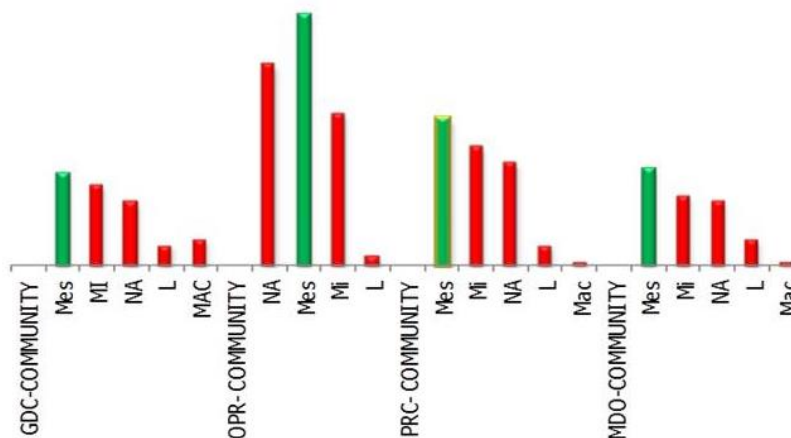**Figure 8.** Life form of South West community. Source: Author, 2022.

Figure 9. Leaf spectra of South West community. Source: Author, 2022.

CCA Ordination of Vegetation of Lower Tanawal from South West Aspect

CCA ordination indicated that the maximum Eigenvalue for axis I (0.41) followed by axis 2 (0.34) and for axis 3 (0.20) and 4 (0.17). The CCA ordination shown that *Grewia optiva, Dodonaea viscosa, Carissa opaca, Albizia lebbeck, Ajuga bracteosa* indicated positive correlation with wet bulb, temperature and heat index and negatively correlated with dew point and humidity. *Rumex dentatus, Ziziphus nummularia, Ranunculus muricatus, Asparagus adscendns, , Dryopteris marginalis,* and *Diospyros lotus* showed positive correlation with slope angle and chillness. *Melia azedarach, Cornus macrophylla, Ficus palmata,* and *Pyrus pashia* shown positive correlation with wind speed, dew point, humidity, altitude and negatively correlated with temperature.

Oenothera rosea, Eucalyptus globulus, Rubus ellipticus, Indigofera heterantha showed positive correlation with organic matter, phosphorus, saturation, potassium, barometer pressure and negatively correlated with slope angle (Figure 5). The environmental variables heat index, temperature and wet bulb showed positive correlation with each other and negative correlation with humidity, altitude, wind speed, and dew point. Slope angle and chillness showed positive correlation with each other and negative correlation with potassium, barometer pressure, phosphorus, organic matter and saturation.

CCA ordination shown that temperature, heat index and slope angle have maximum vector strength. The intermediate vectors strength was documented wind speed, altitude and humidity. Phosphorus, potassium, chillness and wet bulb have less strength of vectors (Figure 6). It was revealed that community which was present on South west aspect have maximum density of *Dodonaea viscosa* (47.7), followed by *Pinus roxburghii* (30) (Figure 7).

4. Discussion

It was the first study which was conducted on the Lower Tanawal. It was noted that *Olea–Punica–Rumex* community has maximum species richness. While *Pinus–Rubus–Cynodon* Community has maximum diversity index. Therophytes was dominant life form in South West aspect which revealed that there is severe environmental condition and biotic pressures on the vegetation of the area. Our results are agreed with Ali et al. (2016) who specified that dominant life form was Therophytes from Chail valley, Swat, Pakistan. Ali et al. (2015) also reported from Buner Hills, Pakistan that therophytes were the dominant life form in the study area.

Malik et al. (2007) identified from Ganga Choti and Bedori Hills that therophytes were the dominant life form. Khan et al. (2012 a) also reported similar findings. Mesophylls were dominant leaf spectra in southwest aspect of the study area. Our results are agreed with Baudoin et al. (2020). It was revealed that Southwest aspect has maximum density of *Dodonaea viscosa* followed by *Pinus roxburghii* which indicated Southern aspect was drier and due to that density of, *Dodonaea viscosa* and *Pinus roxburghii* was maximum in this aspect. Our results are agreed with Kassas and Zahran (1971). The DCA showed the highest gradient length (3.04) at axis 1. It indicated that maximum species have similarities at axis 1.The results of CCA ordination shown that maximum vectors strength was noted for temperature, heat index and slope angle. It means that these are more influential

environmental variable in this aspect.

5. Conclusions

  It is concluded that in DCA ordination maximum gradient length (3.04) at axis 1 with Eigenvalue 0.48 At axis 2 the gradient length was 2.30 with Eigenvalue 0.26. The gradient length at axis 3 was 2.29 with Eigenvalue 0.18. The gradient length for axis 4 was 1.88 having Eigenvalue 0.12. At axis 1 the dominant gradient length shown that mostly species have resemblances on axis 1. DCA ordination of stands shown that stands 21, 27 and 63 were present at axis 1.   Similarly stand 28, 33, 67,15,69 and 39 were present at axis 2, whereas stand 70 was present on the top of ordination space shown diverse species.CCA ordination indicated that the maximum Eigenvalue for axis I (0.41) followed by axis 2 (0.34) and for axis 3 (0.20) and 4 (0.17).

The CCA ordination shown that *Grewia optiva, Dodonaea viscosa, Carissa opaca, Albizia lebbeck, Ajuga bracteosa* indicated positive correlation with wet bulb, temperature and heat index and negatively correlated with dew point and humidity. *Rumex dentatus, Ziziphus nummularia, Ranunculus muricatus, Asparagus adscendns, Dryopteris marginalis,* and *Diospyros lotus* showed positive correlation with slope angle and chillness. *Oenothera rosea, Eucalyptus globulus, Rubus ellipticus, Indigofera heterantha* showed positive correlation with organic matter, phosphorus, saturation, potassium, barometer pressure and negatively correlated with slope angle. The environmental variables heat index, temperature and wet bulb showed positive correlation with each other and negative correlation with humidity, altitude, wind speed, and dew point.

CCA ordination shown that temperature, heat index and slope angle have maximum vector strength. It was noted that *Olea–Punica–Rumex* community has maximum species richness. While *Pinus–Rubus–Cynodon* Community has maximum diversity index. Therophytes was dominant life form in South West aspect which revealed that there is severe environmental condition and biotic pressures on the vegetation of the area. Mesophylls were dominant leaf spectra in southwest aspect of the study area. It was revealed that Southwest aspect has maximum density of *Dodonaea viscosa* followed by *Pinus roxburghii* which indicated Southern aspect was drier and due to that density of, *Dodonaea viscosa* and *Pinus roxburghii* was maximum in this aspect.

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