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RESEARCH ARTICLE

Current Status of *Olea Spp.* by Using Multivariate Approaches Along Subtropical Western Himalaya, Azad Jammu And Kashmir

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Manuscript Info *Abstract*

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The present study was aimed to conduct a Quantitative assessment of wild and cultivated olive in Azad Jammu and Kashmir and providing potential sites of olive species in this area. No complete study was carried so far on *Olea cuspidata* and *Olea europaea* to take account of single tree species or forest dominated by a single tree species. Twenty five stands were sampled in forests dominated by *Olea* during summer in 2010. Phytosociological attributes like relative frequency, relative density and importance value are presented. Based on importance values following association were recognized.

Four plant associations, *Olea-Berberis-Punica*, *Olea-Olea-Dodonaea*, *Olea-Olea-Zanthoxylum* and *Olea-Ficus-Ricinus* were recorded by cluster analysis and Detrendent correspondence analysis (DCA) technique. The dense *Olea* forests were found within the range of 390-1500 m, considered as potential sites, whereas the sparse populations were found beyond the range of 1500 m. This area has suitable climatic conditions to support cultivation of olive in Azad Jammu and Kashmir. The present study strongly recommended that olive cultivation practices, its effective management and sustainable utilization should be promoted among local communities.

Introduction

Olive is known as Zatoon in Arabic, Urdu, Hindi, Jatoon in Sanskrit, Kahu in Kashmiri and Panjabi. This has been cultivated for over 4,000 years (Neal, 1965).In Mediterranean and Himalayan region the olive is the most important crop tree, producing oil, has been used in pharmaceutical industries, baking (cooking) purposes, as lubricant, for perfumes and lighting (Crossman, 2002).

O. cuspidata is distributed in Pakistan, India, China, Iran, Nepal, Soadi Arabia and Southeast Africa (Bartolini *et al.,* 2002; Ganino *et al.,* 2006). *Olea* thrive in regions with xeric conditions; shallow, stony soil with diminutive fertilizer, hot summer, adopted well in coastal regions can tolerate these harsh weather conditions (Brenzel, 1995).

This tree was regarded as holy plant, believed to be originated from Pamir and Turkestan and occupied from east to west entering into Mediterranean region. Olive has extended to the other parts of world such as Australia, South Africa, America, China and the geographic areas with monsoon characteristics. In Pre-Himalayan region of Northern Pakistan, Jammu and Kashmir and Himachal Pradesh olive cultivation have been reported by Rahim *et al.* (2011).

In its native range olive is a small-medium evergreen tree grow in open wood lands and rocky slopes attains height of 5 to10 m and trees can achieve height of 15 to18 m in their ideal growth conditions such as stream banks. It could be established in bush land (Crossman, 2002). *Olea cuspidata* synonym*ferruginea* is a native evergreen tree species of south Asia having broad leaves usually growing from 400 to 2000 m altitude in different ecological and microclimatic conditions

(sub-tropical, dry temperate and moist temperate regions) of Pakistan (Baquar, 1969; Sheikh, 1993).

Olea is sensitive to cold weather (-7°C) but it was evident that it can survive and tolerate at 15 °F temperatures(Brenzel, 1995). Warm temperate climate is considered best for olive and geographical areas as mediterranean region, 30°-45° latitude and at higher altitude of lower latitudinal zones are suited for *Olea* cultivation (Paudel, 2009). This species has a wide range of rainfall adaptation, though it is a xerophytic species. Intense growth of olive can be observed in monsoon climate during June to August (Paudel, 2009).

In Pakistan, olive has been grown traditionally for the production of oil for several years. However, few olive groves existed in hilly and plain areas of Pakistan and its cultivation was recognized in the 1970s. Pakistan is a developing country, faced with acute shortage in the production of edible oil for inhabitants, therefore, large amount of valuable foreign exchange are spent on the import of edible oil though numerous non-traditional oil seed yields have been promoted, but proved insufficient to replace the conventional crops. Thus it is important to familiarize a crop that can be grown on the peripheral lands to address this socio-economic issue so that it may prove helpful in breading the spiteful cycle of scarcity and degradation of natural resources. In Pakistan millions of *O. cuspidata* trees grow wildly in the areas of Azad Jammu and Kashmir, Federally Administrated Tribal Area (FATA), Peshawar, most of the Punjab province and northern region of Baluchistan (Ahmed *et al.,* 2009). The existence of such huge quantity of trees indicates that the agro-climatic conditions of these areas are conducive for cultivation of olive. Different varieties of *Olea europaea* were familiarized into the several parts of the country, which are successfully bearing fruits. In Pakistan and Azad Jammu and Kashmir, 668278 hectares area are suitable for olive cultivation of which, only 480 hectares area are covered by olive plantation up till now (Awan *et al.,* 2011). This frost and drought resistant species has adapted 250 mm to 1000 mm per year precipitation and – 10°C to 40°C temperature, therefore can be planted easily on wide areas of Pakistan with minimum input. This way, watershed, microclimatic, environmental and edaphic conditions of the area can also be improved through plantation of this tree (Ahmed *et al.,* 2009). In addition most parts of this tree are useful, may be utilized as oil, fodder, fuel and construction material. Lot of phytosociological study has been carried out and published from numerous parts of Pakistan; however, little attention is paid to take account of single tree species or forest dominated by a single tree species. Beside some work of Cheema and Qadir (1973) on *Acacia senegal*, Beg and Khan (1984) on dry oak forests of Swat, Ahmed *et al*., (2008) on Juniper forest of Ziarat, *Pinus gerardiana* forest of Zhob, *Cedrus deodara* forest respectively and Siddiqui *et al*., (2009) on *Pinus roxburghii* of subtropical region of Pakistan have been reported. In Azad Jammu and Kashmir no complete studies were carried so far on *Olea cuspidata* and *Olea europaea*. Considering the environmental, economical and ecological importance of *Olea*, detailed study was carried out at 25 different locations of Azad Kashmir. It is hoped that the present study would add to our existing knowledge in terms of its community and association. Due to the very recent establishment and promotion of olive cultivation (Awan *et al.,* 2011), little information is available about the appropriate cultural practices to obtain economic yields under the diverse agro-climatic conditions. The great variation in the climatic requirements of each variety and the climatic conditions of the olive growing areas in Azad Jammu and Kashmir, make it imperative to conduct a Quantitative assessment of wild and cultivated olive in Azad Jammu and Kashmir and providing potential sites of olive species.

Materials and Methods

Sites Selection

Ecological characteristics of sampling sites were recorded from 390 m to 2158 m on gentle slopes of Azad Jammu and Kashmir. Sampling was restricted to dense population of olive (Fig. 1). Global Positioning System (GPS 2000) device was used to navigate the selected sample locations. The olive cultivation sites at different locations of study area were studied during 2009-10 to understand recent status of olive distribution (Table 1).

Community Structure

A community is an association of interacting species inhabiting some defined area. Community ecologists seek to understand how abiotic and biotic components of the environment influence the structure of communities (Malik, 2005).

Determination of Suitable Size

Quadrat method was used to study community structure after suitable size of quadrat was determined by minimal area species curve (Malik, 2005). Quadrats of different sizes were taken to study different strata of vegetation. For the measurement of trees the quadrat size was 10×10 meter for shrubs, 5×5 meters and for herbaceous species 0.5×0.5 (Malik, 2005).

Number of Quadrats

The number of quadrats also varies for trees shrubs and herbs in each community. For sampling trees total five quadrats were laid whereas for shrubs

ten (10) and for herbs 20 quadrats were laid, (Malik, 2005).

Distribution of Quadrats

The quadrats were laid randomly depending on the slopes and steepness and aspect of the site. The number of individuals of each species was counted (Malik, 2005) to work out the phytosociological attributes which were as.

1. Species density
2. Species frequency

Density

Density is defined as the number of individuals of a species per unit area sampled (Sing and Singh, 2010). It was calculated by using the following formula

$$\text{Density} = \frac{\text{No. of individual of ith species}}{\text{Total no. of quadrate}}$$

Frequency

It is the degree of uniformity of the occurrence of the individuals with in an area (Hanson and Churchill, 1961).

$$\text{Frequency} = \frac{\text{No, of Occurrence of a species}}{\text{Total No. of Quadrat}} \times 100$$

Relative Values

From above information the following attributes were worked out and the status of available plant species was determined.

1. Relative density
2. Relative frequency
3. Importance value

Relative Density (R.D)

Relative density was determined by expressing the density of a single species as a percentage of the proportion of total density of all the species.

$$\text{R.D} = \frac{\text{Density of a particular species}}{\text{Total density of all species in a stand}} \times 100$$

Relative Frequency (R.F)

It was determined the percentage proportion of frequency of a given species present to total frequency of all species.

$$\text{R.F} = \frac{\text{Frequency of a species}}{\text{Toal frequency values for all species in a stand}} \times 100$$

Importance Value (I.V)

It is the sum of all the relative values of density and frequency. It was calculated by using the formula as described by Curtis and MacIntosh, (1950). The species with in a stand were arranged on the basis of importance values to enlist dominant, codominant, associated and rare components of the stand.

The stand was named after two or three leading species having the highest importance value, the closely approaching species were considered as co-dominants. The species having I.V below than 10 were considered rare components, while remaining species were taken as associated components, (Malik, 2005).

Data Analysis

The data collected from 25 sampling sites were analyzed through multivariate analysis in PC-ORD version 5 (McCune and Mefford, 1999). Cluster analysis using Sorensen measures, based on presence/absence data (Smith, 2010) was carried out to identify pattern of distribution and association among the species. Detrendent correspondence analysis (DCA) (Hill and Gauch, 1980) was carried by using PC-ORD version 5 (McCune and Mefford, 1999), to seek main species gradient in olive growing area.

Results and Discussion

A plant community is defined as collection of plant species growing together in a particular location that's how a definite association with each other (Muller-Dombois and Ellenberg, 1974). The species in a community grow together in a particular environment because they have similar requirements of edaphic and environmental factors, (Billings, 1974). It is believed that most of the subtropical forests in the world are cleared because of human settlement pressure, (Wilcove *et al*., 1986). In Himalayas, the rapid population growth has generated many environmental problems (Ives and Messerli, 1989). The system of classification and description of communities is a significant feature of ecology (Sing and Singh, 2010). The species living together at the same time in the same place having common ecological tolerance form a community (Magurran, 1988).

Ecological characteristics of sampling sites were recorded from 390m to 2158m on gentle slopes of Azad Jammu and Kashmir. Sampling was restricted to dense population of olive. *Olea* spp. was recorded most abundant and widely distributed in all 23 stands. It was absent only in Sudan Gali and Rawalakot areas. *Olea cuspidata* communities were determined by their associated dominant species on the basis of importance value. Cluster analysis technique was used to describe plant associations. Four plant groups were recognized on the basis of cluster analysis and Detrendent correspondence analysis (DCA) from the study area (Fig. 3). The

importance value index of plant species recorded in each association is presented in Table 2. The DCA results clustered the vegetation of the study area into four associations. The vegetation groups on the basis of DCA ordination were as,

Group-A

***Olea-Berberis-Punica* Group**

This association was recorded from 390m to 650m altitude and 33°08.47 to 34°23.03N latitude. *Olea europaea*, *Berberis lycium* and *Punica granatum* were the leading components of this association with importance value of 19.35 percent, 19.17 percent and 21.39 percent respectively while *Olea cuspidata*, *Fragaria nubicola*, *Maytenus royleanus* and *Fumaria parviflora* were codominant components of this association. A total 34 plant species were recorded from this association which comprises of 4 trees, 5 shrubs, 4 grasses and 2 fern species. Remaining 19 species were herbs in this association. The *Olea europaea*, *O. cuspidata*, *Pinus roxburghii* and *Morus alba* were trees present in this association while *Berberis lyceum*, *Mytenus roylianus*, *Mallotus philipensis* and *Indigofera heterantha* were the shrubs recorded from this association (Table 2).

Group-B

***Olea-Olea-Dodonaea* Group**

This group was distributed between 696m to 896m altitude and 33°44.027 to 34°16.953N latitude. *Olea europaea*, *Olea cuspidata* and *Dodonaea viscosa* attained the dominant position in this association with importance value of 21.87 percent, 20.69 percent and 15.76 percent respectively (Table 2). *Geranium nepalensis*, *Plectranthus rosis* and *Fragaria nubicola* were codominant components of this association. This group consisted of 8 stands with 53 species. *Dryopteris stewertii* was the only fern species recorded in this group. Eight species viz; *Cynodon dactylon*, *Dicanthium annulatum*, *Phalaris theorosa*, *Digitalis sategra*, *Agrostis caninaCyperus rotundus* and *Cyprus mariscus* were grasses.

Group-C

***Olea-Olea- Zanthoxylum* Group**

This group recorded from 911m to 1109m altitude and 33°34.125 to 34°16.118N latitude was characterized by the dominance of *Olea europaea*, *Olea cuspidata* and *Zanthoxylum alatum* which contributed the importance value of 16.56 percent, 13.69 percent and 13.61 percent respectively. The associated components of this association were *Oxalis corniculata* and *Artemesia scoparia* with 10.32 percent and 8.83 percent importance value (Table 2). This association had 6 contributing stands comprised of 45 species.

Group-D

***Olea-Ficus-Ricinus*Group**

This group was characterized by *Olea europaea*, *Ficus palmata* and *Ricinus communis* species with I.V. of 15.49 percent, 14.48 percent and 16.85 percent respectively. *Olea cuspidata* and *Zanthoxylum alatum* were codominant components of this group with 12.89 percent and 11.14 percent importance value. This group was recorded from 810m to1585m altitude and 33°45.959 to 33°50.812N latitude, which had three contributing stands. A total of 48 species were recorded from this stand with 29 herbs, 6 grasses, 8 shrubs, 4 trees and only one fern (Table 2).

Table 1: Sampling sites of Azad Jammu and Kashmir

S.No.	Localities	Altitude (m)	Latitude	Longitude
1	Kutla	1000	34°16.118N	73°51.769E
2	Kathae	1089	34°09.329N	73°51.769E
3	Nadhool Hattian	896	34°10.815N	73°43.198E
4	Khun Bandway	750	34°16.953N	73°33.945E
5	Chala Muzaffarabad	650	34°23.034N	73°28.195E
6	Bahaawan	696	34°16.255N	73°30.401E
7	Chattar Kalas	623	34°12.072N	73°30.425E
8	Barhan Barsala	838	34°08.315N	73°30.261E
9	Khapdar	570	33°59.097N	73°31.963E
10	Goi	911	33°34.125N	74°01.198E
11	Bismeela	830	33°49.145N	73°16.577E
12	Satra Meel	800	33°49.003N	73°16.605E
13	Orchid Bharakahu	603	33°45.668N	73°13.104E
14	Salgran Chattar	810	33°49.024N	73°16.626E
15	Bhimber	390	33°08.470N	73°44.576E
16	Tetrinot	854	33°45.027N	73°59.613E
17	Khaegala	1587	33°50.812N	73°49.619E
18	Rawalakot	1713	33°51.467N	73°45.446E

19	Ghaziabad	976	33°57.813N	73°36.499E
20	Islamgar	410	33°10.094N	73°52.673E
21	Phagwati Hajira	933	33°45.959N	73°53.760E
22	Bagh City	1058	34°00.006N	73°46.577E
23	Mera Chaprian	1109	33°57.455N	73°44.693E
24	Arja	760	33°58.045N	73°39.695E
25	Sudan Gali	2158	34°04.402N	73°44.402E

Figure 1: Distribution map of wild and cultivated olive in Azad Jammu and Kashmir

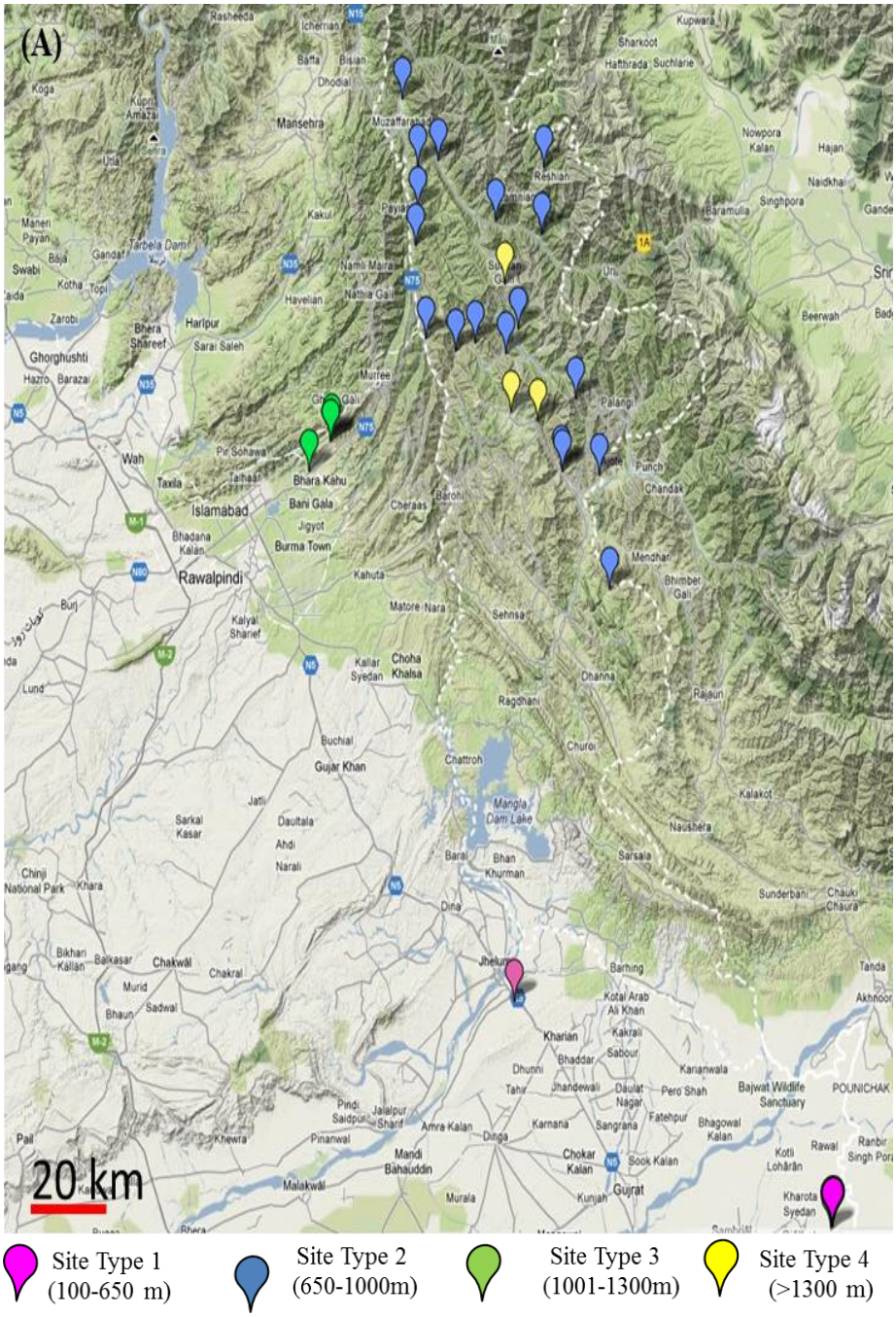

Figure 2: Dendrogram of 87 plant species collected from 25 different sites of Azad Jammu and Kashmir showing plant groups after principle component ordination

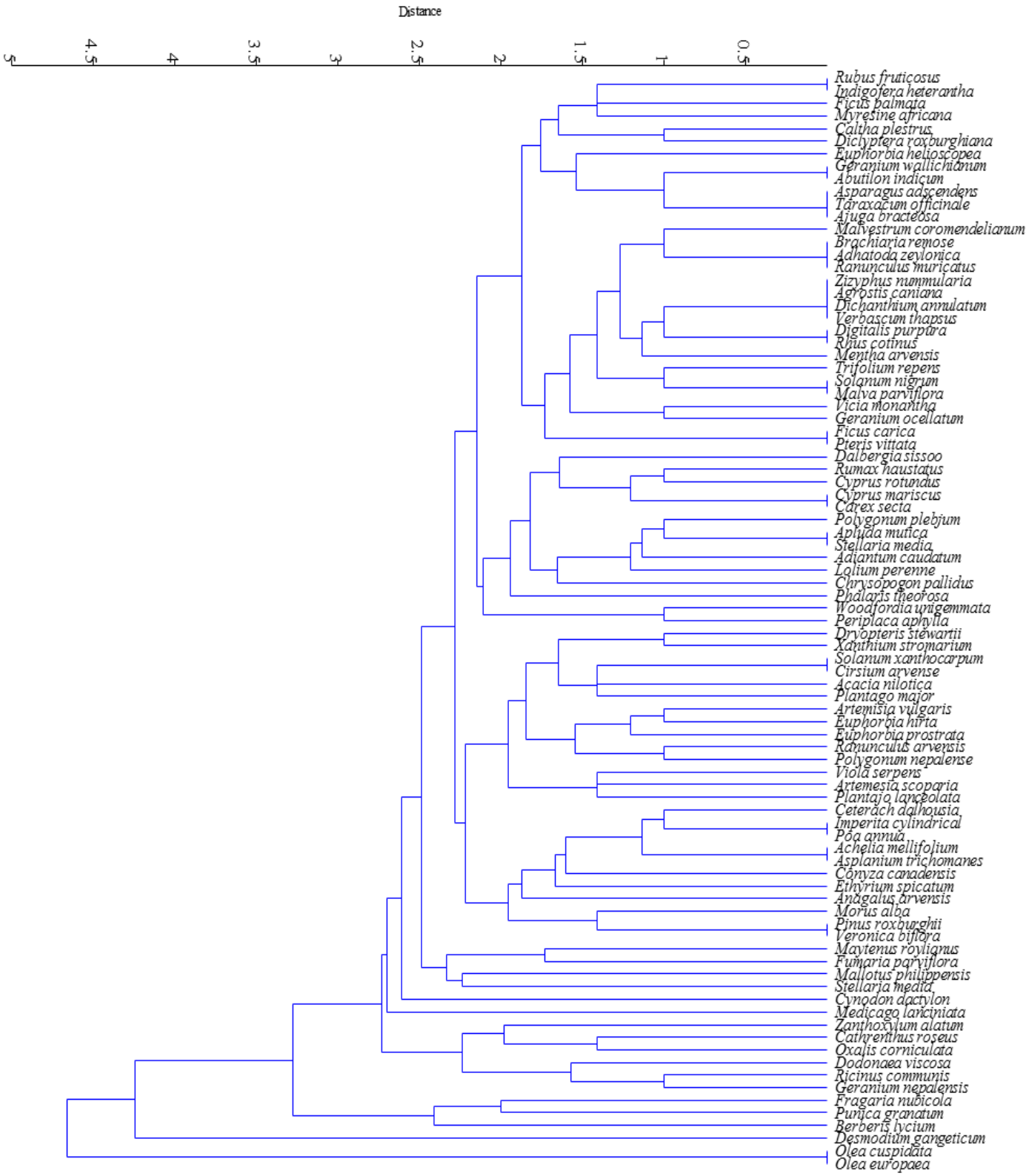

Figure 3:Detrendent Correspondence Analysis (DCA) ordination of plant species of Azad Jammu and Kashmir on two axes extracted by DECORANA computer program

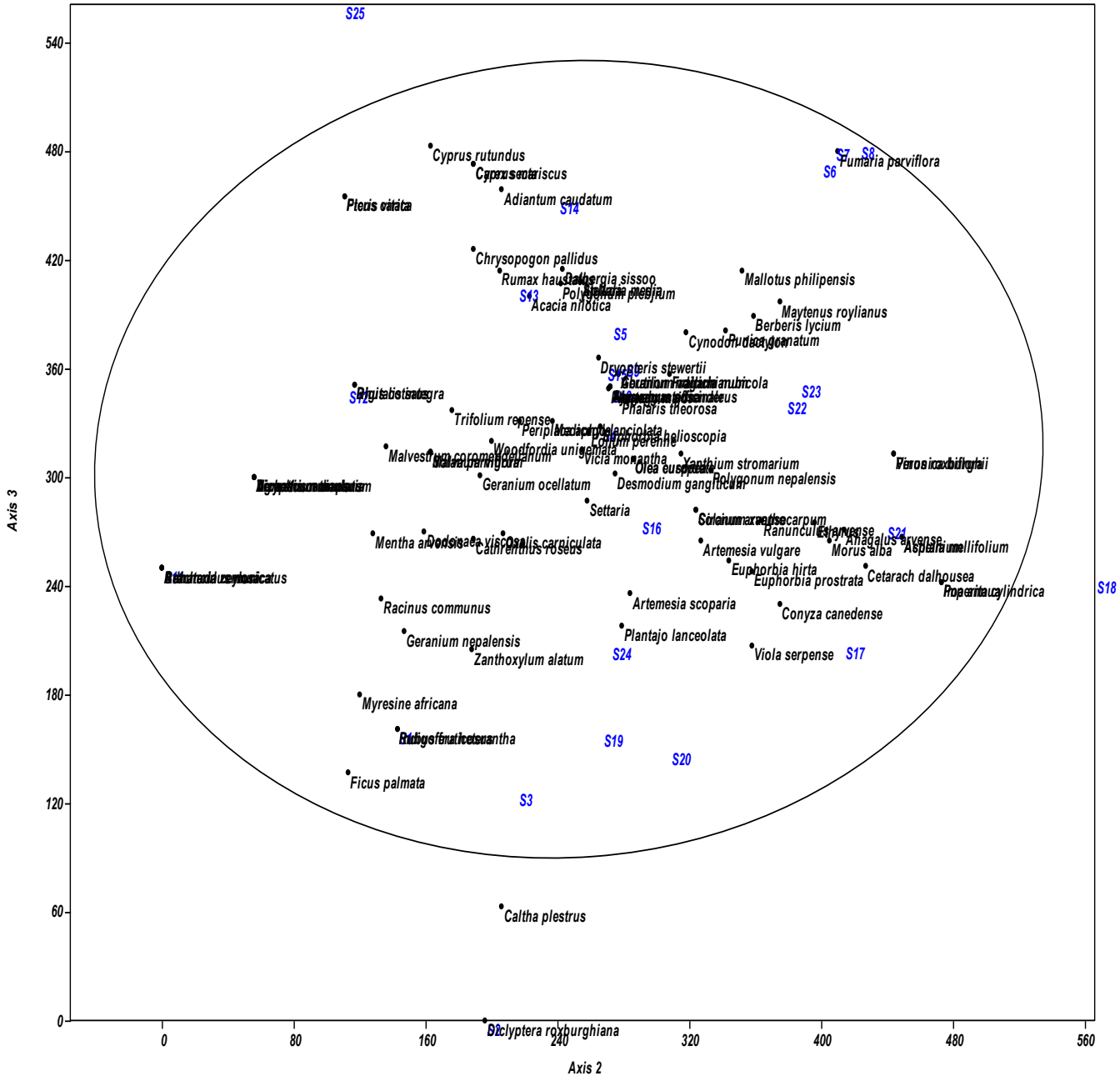

Table 2: Importance value index of plant species recorded in different plant associations in Azad Jammu and Kashmir

S. No.	Species Name	Family	G-A	G-B	G-C	G-D
1	*Olea europaea* L.	Oleaceae	19.35	21.87	16.56	15.49
2	*Olea cuspidata* Wall.	Oleaceae	13.59	20.69	13.69	12.89
3	*Rubus fruticosus* L.	Rosaceae	-	3.11	-	-
4	*Ficus palmata* Forssk.	Moraceae	-	3.71	-	14.48
5	*Zanthoxylum alatum* DC.	Rutaceae	-	1.76	13.61	11.14
6	*Caltha plestrus* L.	Ranunculaceae	-	-	1.22	2.48
7	*Plectranthus rosus* Wall.	Lamiaceae	-	7.05	1.61	3.28
8	*Oxalis corniculata* L.	Oxalidaceae	-	5.84	10.32	2.64
9	*Fragaria nubicola* (Hook.f.) Lindl.	Rosaceae	15.28	7.37	4.42	2.99
10	*Cynodon dactylon* Linn.	Poaceae	3.98	5.70	-	0.96
11	*Euphorbia helioscopia* L.	Euphorbiacea	-	2.31	-	-
12	*Malvastrum coromandelianum* L.	Malvaceae	-	2.99	-	1.64
13	*Maytenus royleanus* Wall. Cat.	Celastraceae	16.44	-	1.77	-
14	*Mallotus philippensis* Lam.	Euphorbiacea	5.71	3.96	-	-
15	*Berberis lycium* Royle	Berberidaceae	19.17	3.89	2.07	0.87
16	*Punica granatum* Linn.	Punicaceae	21.39	1.43	4.7	1.53
17	*Fumaria parviflora* Lam.	Fumariaceae	11.10	-	-	-
18	*Geranium wallichianum* D.Don	Geraniaceae	-	8.54	7.65	-
19	*Ricinus communis* L.	Euphorbiaceae	-	4.33	-	16.85
20	*Geranium nepalensis* L.	Geraniaceae	-	2.94	4.29	7.80
21	*Dodonaea viscosa* Linn.	Sapindaceae	-	15.76	5.46	3.01
22	*Indigofera heterantha* Wall.	Papilionaceae	3.89	-	-	-
23	*Myrsine Africana* Linn.	Myrsinaceae	-	3.04	2.74	0.81
24	*Stellaria spp.*	Caryophyllaceae	1.44	3.00	1.76	-
25	*Dicliptera roxburghiana* Nees.	Acanthaceae	-	-	-	9.52
26	*Abutilon indicum* Lamk.	Malvaceae	-	5.30	6.90	-
27	*Asparagus adscendens* Roxb.	Asparagaceae	-	-	2.74	-
28	*Taraxacum officinale* F.H. Wigg.	Asteraceae	-	-	2.28	-
29	*Ajuga bracteosa* Wall.	Lamiaceae	-	-	3.28	-
30	*Zizyphus nummularia* Burn.	Rhamnaceae	-	1.17	-	1.53
31	*Agrostis canina* Linn.	Poaceae	-	0.1	-	1.30
32	*Dichanthium annulatum* Forsk.	Poaceae	-	1.07	-	1.59
33	*Brachiaria ramose* Linn.	Poaceae	-	-	-	2.22
34	*Digitalis purpura* L.	Planataginaceae	-	2.36	-	1.3
35	*Rhus cotinus* L.	Anacardiaceae	-	1.5	-	3.25
36	*Verbascum thapsus* L.	Scrophulariaceae	-	1.22	-	0.91
37	*Adhatoda zeylanica* Medic.	Acanthaceae	-	-	-	0.93
38	*Dalbergia sissoo* Roxb.	Papilionaceae	-	2.81	-	1.22
39	*Ficus carica* L.	Moraceae	-	0.33	-	-
40	*Pteris vittata* L.	Pteridaceae	-	0.22	-	-
41	*Desmodium gangeticum* (Linn.) DC.	Papilionaceae	-	1.23	1.62	-
42	*Rumax haustatus* D.Don	Polygonaceae	-	0.60	1.25	-
43	*Polygonum plebejum* R. Br.	Polygonaceae	-	3.59	-	-
44	*Adiantum caudatum* L.	Adiantaceae	-	0.73	-	1.32
45	*Apluda mutica* Linn.	Poaceae	-	0.36	-	0.92
46	*Stellaria media* L.	Caryophyllaceae	-	0.56	-	2.49
47	*Dryopteris stewartii* Fran. Jen.	Dryopteridaceae	-	2.51	0.85	-
48	*Acacia nilotica* Linn.	Mimosaceae	-	-	1.61	4.3
49	*Xanthium stromarium* L.	Asteraceae	-	1.36	3.81	-
50	*Solanum xanthocarpum* Schrad and	Solanaceae	-	-	3.09	1.93

	Wendl.					
51	*Cirsium arvense* L.	Asteraceae	-	-	2.78	1.14
52	*Artemisia scoparia* Waldst. and Kit.	Asteraceae	-	-	8.83	7.32
53	*Artemisia vulgaris* Linn.	Asteraceae	1.70	-	3.0	7.76
54	*Euphorbia hirta* L.	Euphorbiaceae	3.61	-	4.68	2.48
55	*Euphorbia prostrata* Ait., Hort	Euphorbiaceae	3.38	-	5.86	6.43
56	*Polygonum nepalense* Meisn.	Polygonaceae	2.39	-	1.99	2.16
57	*Ceterach dalhousia* Hook.	Aspleniaceae	1.64	-	3.69	-
58	*Viola serpens* Wall.	Violaceae	-	-	6.14	-
59	*Anagallis arvensis* L.	Primulaceae	3.66	-	2.34	-
60	*Plantago major* Linn.	Plantaginaceae	-	-	8.0	-
61	*Plantajo lanceolata* Linn.	Plantaginaceae	-	-	3.96	-
62	*Ranunculus arvensis* L.	Ranunculaceae	3.11	-	2.66	-
63	*Achillea millefolium* Linn.	Asteraceae	7.70	-	5.38	-
64	*Imperita cylindrical* L.	Poaceae	4.0	-	1.01	-
65	*Asplanium trichomanes* L.	Aspleniaceae	6.51	-	3.39	-
66	*Poa annua* Linn.	Poaceae	1.01	-	1.61	-
67	*Conyza Canadensis* L.	Asteraceae	1.32	3.66	0.65	-
68	*Ethyrium spicatum*	Dryopteridaceae	1.07	-	1.09	-
69	*Morus alba* L.	Moraceae	1.37	2.8	-	-
70	*Pinus roxburghii* Sargent	Pinaceae	4.71	-	-	-
71	*Veronica biflora* L.	Scrophulariaceae	2.5	-	-	-
72	*Solanum nigrum* L.	Solanaceae	0.81	1.22	-	7.06
73	*Trifolium repens* L.	Papilionaceae	3.15	2.01	-	5.59
74	*Medicago laciniata* Var.	Papilionaceae	5.98	5.19	-	4.38
75	*Vicia monantha* Retz.	Papilionaceae	4.22	-	-	2.63
76	*Malva parviflora* L.	Malvaceae	0.82	1.44	-	2.28
77	*Geranium ocellatum* Camb	Geraniaceae	2.32	-	-	0.62
78	*Ranunculus muricatus* L.	Ranunculaceae	-	-	-	0.81
79	*Mentha arvensis* L.	Lamiaceae	-	4.08	-	1.32
80	*Woodfordia unigemmata* Maki.	Lythraceae	-	5.29	-	-
81	*Periplaca aphylla* Dcne.	Asclepiadaceae	-	5.30	-	1.31
82	*Chrysopogon* pallidus (R.Br.) Steud.	Poaceae	-	3.10	-	9.4
83	*Cyprus rotundus* L.	Cyperaceae	-	0.30	-	-
84	*Cyprus spp*	Cyperaceae	-	3.12	-	-
85	*Carex secta* L.	Cyperaceae	-	1.99	-	-
86	*Phalaris spp*	Poaceae	2.66	2.03	2.64	-
87	*Lolium perenne* L.	Poaceae	-	1.29	2.14	3.20

Plant sociology is a simple and rapidly applied technique of field survey and assessment of vegetation, used to investigate features of a plant community. This technique is commonly applied to reveal variation patterns in qualitative and quantitative characteristics which are used to classify community (Becking, 1957). Relative values of quantitative characters collectively give rise to importance value index of plant species in a stand (Malik, 2005). All such species are not equally important in structuring the community but there are few overtopping species, having highest importance value which modify the habitat and control the growth of other species of the community called as dominants of the community. This communal relationship of plants is called phytosociology (Gaston, 2000). Dominant species represent the major trends in local vegetation thus allowing researchers to identify, distinguish and discuss dynamics of the communities, (Leveque, 2001).

These groups of DCA showed the distribution and dispersal of plant species with respect to human activities and major environmental factors. Present study was in line with Naqinezhad *et al.*, (2008) and Jabeen and Ahmad, (2009). The results suggested that it is difficult to generalize the trends in vegetation composition along the altitude in sub-tropics. The DCA axis 2 and 3 showed negative

correlation with altitude i.e. -0.18027 and -0.11466 respectively because of similar environmental constraints and human influence in the investigated area. The results of ordination showed the gradual variation among the communities in sub-tropical zone (Lieberman *et al.,* 1996; Lovett, 1996; Tallents *et al.,* 2005). There might be certain unmeasured variables which influence species dispersal and association along the hillocks of investigated area which may give rise to discrete zonation. The results of DCA and cluster analysis in present study revealed that group-A with leading components of *Olea europaea, Berberis lycium and Punica granatum* was recorded at an altitude of 390-650m. *Olea europaea, Olea cuspidata, Dodonaea viscosa* (group-B) were recorded from 696-896m elevation. *Olea europaea, Olea cuspidata, Zanthoxylumalatum* of group-C were recorded from 911-1109m. *Olea europaea, Ficus palmata* and *Ricinuscommunis* were dominant components of group-C at the height of 810-1587m in the investigated area. *Olea europaea* was recorded dominant component in all the associations from the study sites with *Olea cuspidata* as an associated component of those communities. Present findings were in harmony with Malik and Hussain, (1987); Hussain and Illahi, (1991).

Olive grows in mild climate with warm summer whereas winter chill was reported essential for flowering and fruiting of olive trees. It can flourish very well in temperature up to 40°C with adequate soil moisture (Panhwar, 2005). This frost and drought resistant species has adapted 250mm to 1000mm per year precipitation and -10°C to 40°C tolerable range of temperature which was highly appropriate for its growth and cultivation, (Awan *et al.,* 2011). Lower elevations of Azad Jammu and Kashmir experienced 37.3°C to -3.0°C temperature variation in summer and winter months of the year, which showed that this area is good for the growth of olive. However increased precipitation may inhibit pollination in olive plants as described by Panhwar, (2005). In present findings olive was absent in the stands (18 and 25), recorded above 1600m, as higher altitudes were recorded negatively correlated with olive distribution in Pakistan (Ahmed *et al.,* 2009).

Conclusion

In Pakistan and Azad Jammu and Kashmir, 668278 hectares area was recorded suitable for olive cultivation but up till now only 480 ha area is covered by olive plantation. Different varieties of *Olea europaea* were introduced in different part of this country, which are successfully bearing fruits. It is suggested that some combined effects as temperature, precipitation and elevation might be the important factors in the distribution pattern of olive in lower altitudinal ranges of Azad Jammu and Kashmir. Most wild olives were found in subtropical areas of Azad Jammu and Kashmir.

The dominance of *Olea cuspidata* in different associations (A, B, C, D), recorded in Azad Jammu and Kashmir indicated that the agro-climatic condition of this area is favourable for olive cultivation. The dense *Olea* forests were found within the range of 390-1500m that were considered as potential sites, whereas the sparse populations were found beyond the range of 1500m. This area has suitable climatic conditions to support cultivation of olive in Azad Jammu and Kashmir. The present study strongly recommends that olive cultivation practices, its effective management and sustainable utilization should be promoted among local communities.

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