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MULTIVARIATE ANALYSIS FOR THE ASSESSMENT OF HERBACEOUS ROADSIDES VEGETATION OF WAH CANTONMENT

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ABSTRACT

The present research was conducted along the roadside of Wah Cantonment to determine the associations and relationships between the plant communities and soil, grouping and quantification of plant communities using multivariate ordination techniques. Braun-Blanquet technique was applied for herbaceous data collection and quadrats of 1×1 square meter were laid. The whole floristic data were collected from 50 different sites through random sampling and cover values for plants were predicted through visual estimation.A whole of 36 species belonging to 18 different families were indentified. The ordination techniques of TWINSPAN (Two Way Indicator Species Analysis) and DCA (Detrended Correspondence Analysis) were carried out to classify the data. TWINSPANdivided the whole data into four groups with two major groups having communities of *Vicia-Verbena, Convolvulus-Parthenium, Cynodon-Rumex and Euphorbia-Lepidium* while minor groups had communities of *Cannabis-Dicliptera* and *Coronopus-Sisymbrium*. DCAwas used to classify the data and it identified the cluster of species in ordinate space, divided the data in four groups, and verified the results obtained from TWINSPAN. *Cynodondactylon* and *Cannabis sativa* were emerged as the most dominant and second dominant species after DCA.The present study will provide the baseline information about the roadside vegetation of Wah Cantonment and will be helpful for preserving and better management of the native flora.

Key words: *Cannabissativa*, *Cynodondactylon*, DCA, TWINSPAN, Wah Cantonment.

INTRODUCTION

In the 21st century, world is transformed into global village. Communication is becoming more and more important for people's survival. Roads are considered as simplest means of communication among the people living in different strata's of world. Roads play an important role for the economy and trade of any country by providing the major ways of communication among the different cities for competing with International positions (Harper, 2001).Therefore, for development of the any country (economically, politically and socially, construction and maintenance of roads are considered to be very important (Ahmad, 2013). Roads may act as corridors, barriers or habitats for the distribution of species of plants and animals (Angold, 1997).Roadside plants had a capability to trap more large sized particulate matter as compared to the plants away from roadside thus reducing air pollution (Shabbir *et al*., 2014). Roadside vegetation not only controls pollution but also act as a bridge between road network and natural landscape (Sera, 2010). This roadside vegetation whether exotic or native helps in preserving landscape characteristics (Khalid *et al.*, 2008)

Roadside verges comprises of variedbiological and environmental conditions. Roadside verges help in supporting the habitat and for conservation of specie for maintaining nature's value (Wilson *et al*. 1992). Roadside vegetation is delegated as troubled environment, where the plant'sfunctioning and development is often differed as compared to non-roadside plants. Particularly in arid and semi-arid regions,wateravailability from road surface run-off has positive effects on plants growing along roadsides (Frenkel, 1977). Ecological species groups are often built-up in connection with ecosystem classification to deduce species distributions among environmental gradients treated as continuums or compared among ecosystem types (Abella *et al.*, 2003).

Researches along roadside verges vegetation have gained colossal significance for urban planning. Way (1977) demonstrated the conservational function of roadside vegetation in UK while in other countries; the ecological and preservation value of roadside vegetation has already been documented(UllmannandHeindl, 1989). In Australia and Netherland many roadside vegetation have been affirmed as Sites of Special Scientific Interest (SSSI) and RNR (Roadside Nature Reserves). In some parts of world, mainly in Europe, North America and New Zealand, roadsides are given due importance for assessment of vegetation growing along with them (Sara, 2006). These roadsides provide habitat to plant species and sometimes to animals as well (Jesse *et al*., 2008). However, sometimes the developments of roads also results in habitat loss, pollution, native animal mortality and habitat fragmentation which results in loss of biodiversity (Spellerberg, 1993; Tromans,1991). But proper planning can overcome all these problems and help in providing habitat to animals, plants and can

prevent from loss of biodiversity (Bennett,1991; Brocks, 1993). Road sides verges, owing to immense importance for urban planning, economic growth and conservational purpose have provided a new corridor for habitat preservation of endangered plant species as well as helped in better management of abundant and less abundant species.

Ahmad (2013) studied the roadside vegetation along M-1, motorway (Rwp- Attock) using TWINSPAN and DCA for illuminating the distribution of herbaceous vegetation and their major communities formulated due to ordination classification.M-1 connects Punjab and Khyber Pakhton Khawa, Pakistan with a total length of 175 km out of which 67 km lies in Punjab and the remaining 108 km in Khyber Pakhton Khawa. Herbaceous samples were collected from 40 different sites from both sides of motorway road and as a result of it total 45 plant species belonging to 23 different families were recorded. The whole vegetation is divided into two main groups and fourteen sub communities by TWINSPAN with the further application of a Detrended Correspondence Analysis (DCA). The major communities dominating the roadside include *Carthamusoxycantha, Cynodondactylon, Calotropisprocera, Chrysopoganaucherii, Heteropogoncontortus, Lepidiumapetalum* and *Conyzacanadensis*. DCA verified the communities identified by TWINSPAN and also helped in identification of cluster of species in ordinate space.

Ahmad (2007) conducted a research for providing the initial source data for studying the succession changes with reference to different environmental conditions in future. The study highlighted the importance of wild medicinal plants along road side verges (M-2) Pakistan using DCA and total four communities were identified mainly differing on the basis of their ecological amplitudes.

Acar*et al.,* (2004) utilized TWINSPAN and DCA to study the ground cover species of roadsides along with rocky and forest habitats in Trabzon. The ground cover species assemblages were quantatively studied in order to describe the floristic composition and diversity patterns and as a result of it total 10 groups for 100 road sides were classified. The effect of different environmental factors such as pH, moisture content, sand as well as altitudinal factors such as cover skeleton were studied and results indicated that these factors had immense effect on diversity and vegetation composition along roadside, rocky and forest habitats.

The main objective of the study was to classify and quantify herbaceous vegetation along the roadside verges of Wah Cantonment and to find out the relationship between soil and vegetation by using ordination techniques.

MATERIALS AND METHODS

Study Area: The survey of soil and vegetation relationship was carried out along the roadsides of Wah Cantonment which is abbreviated as Wah Cantt, Rawalpindi. Wah Cantonment lies between 33.7714° North latitudes and 72.7518°East longitudes. Wah Cantonment is a military city located in the Punjab province of Pakistan, 30 km (19 mi) to the north west of Rawalpindi/Islamabad. The area of the city is 90.65 km^2 (35.00 sq. miles) and elevation is 471 m (1545 ft.). The area with moderate climate is suitable for cultivation of every type of crop especially fruits and is surrounded by hills in all direction. The modern city of Wah Cantonment was established in 1951.

Selection of sites: Quadrats were laid down systematically at regular interval of 1 km^2 on both sides of roads. The disturbed area was left during sampling. Total 150 species (36 species individually) were collected from 50 quadrats. Quadrats of $1\times1m^2$ were laid down on both sides of roads. Total 50 quadrats were laid down and their cover value was estimated through Cover estimation (Kent and Coker, 1992). Sampling was done in the month of April 2014 when the flora of area was on full on bloom.

Multivariate Analysis: Multivariate analysis was carried out for classification and for application of ordination techniques. Two-Way Indicator Species Analysis (TWINSPAN) was carried out for identification of vegetation types and helped in classification of vegetative species. Detrended Correspondence Analysis (DCA) was applied for finding the relationship existing between the vegetation types.

RESULTS

Total 50 quadrats were laid from both sides of road by using the approach of Braun-Blanquet and cover estimation was noted for each species in each quadrat. Total 36 different species belonging to 18 different families were recorded.

TWINSPAN: Multivariate analysis was carried out for applying the ordination techniques and for classifying the plant communities. For this purpose, TWINSPAN analysis was done which resulted in formation of two way clustered dendogram that helped in deep interpretation of data for two cut levels. Adendogram is hierarchical depiction of species and is characterized in graphical form. TWINSPAN alienated the study area into four groups. The first two groups are further subdivided into sub groups (Figure 2). The results of TWINSPAN indicated the frequency of different species and compared their abundance. Shaded squares represented presence of species in particular quadrat and empty squares

represented the absence and grouping was demonstrated by dendrogram (Figure 1). The intensity of species is proportional to its abundance (Vermeersch *et al.*, 2003).

The Two Way Cluster Dendogram was divided into two major groups and two minor groups. The major groups were symbolized as Q1 and Q2. Q1 was further subdivided into Q1a and Q1b while Q2 was further divided into Q2a and Q2b. The minor groups were represented by Q3 and Q4.

Table 1. List of plant species identified

Sr.No	Species	Family	Common Name
1.	*DiclipteraroxburghianNees.*	Acanthaceae	Not known
2.	*AmaranthusspinosusL.*	Amaranthaceae	Spiny amaranth
3.	*AchyranthesasperL.*	Amaranthaceae	Prickly chaff
4.	*Digeramuricata(L.) Mart.*	Amaranthaceae	False amaranth
5.	*PartheniumhysterophorusL.*	Asteraceae	White top weed
6.	*TaraxacumofficinaleL.*	Asteraceae	Common dandelion
7.	*CarthamusoxyacanthaM.Bieb.*	Asteraceae	Jeweled distaff thistle
8.	*Conyzacanadensis(L.)Cronquist.*	Asteraceae	Horse weed
9.	*SonchusasperL.*	Asteraceae	Spiny sow thistle
10.	*Silybummarianum (L.) Gaertn.*	Asteraceae	Milk thistle
11.	*LepidiumsativumL.*	Brassicaceae	Garden cress
12.	*Capsellabursapatoris (L.) Medic*	Brassicaceae	Pick purse
13.	*CoronopusdidymusL.*	Brassicaceae	London rocket
14.	*SisymbriumirioL.*	Brassicaceae	Swine wart cress
15.	*OpuntiamonacanthaHaw.*	Cactaceae	Prickly pear
16.	*Cannabis Sativa L.*	Cannabaceae	Hemp, Marijuana
17.	*Chenopodium album L.*	Chenopodiaceae	Pig weed
18.	*Convolvulus arvensisL.*	Convolvulaceae	Field bind weed
19.	*Cucumismeloagrestis L.*	Cucurbitaceae	Wild melon
20.	*Euphorbia heliscopia L.*	Euphorbiaceae	Madwoman's milk
21.	*Euphorbia prostrateAiton.*	Euphorbiaceae	Prostrate sandmat
22.	*Euphorbia hirta L.*	Euphorbiaceae	Garden spruge
23.	*Medicagopolymorpha L.*	Fabaceae	Toothed medick
24.	*TephrosiapurpureaL.*	Fabaceae	Wild indigo. Fish poison
25.	*ViciasativaL.*	Fabaceae	Garden vetch, common vetch
26.	*Malvaparviflora L.*	Malvaceae	Cheese weed, Little mallow
27.	*Malvastrumcoromandelianum (L.) Garcke*	Malvaceae	Broom weed
28.	*Oxalis corniculata L.*	Oxalidaceae	Creeping wood sorrel
29.	*CenchrusbiflorusRoxb*	Poaceae	Indian sandbur
30.	*Cynodondactylon L.*	Poaceae	Bermuda grass
31.	*Dichanthiumannulatum(Forssk) stapf.*	Poaceae	Sheda grass
32.	*Rumexdentatus L.*	Polygonaceae	Toothed dock
33.	*Ranunculus muricatusL.*	Ranunculaceae	Spiny fruit butter cup
34.	*LycopericonesculentumMill.*	Solanaceae	Tomato
35.	*Verbena tenuisectavar. alba*	Verbenaceae	Moss verbena
36.	*Tribulusterrestris L.*	Zygophyllaceae	Goat head, Bindii

Sub group Q1a included *Achyranthesasper* , *Euphorbia hirta* , *Cucumismeloagrestis, Opuntiamonacantha, Tribulusterrestris* ,*Oxalis corniculata* , *Vicia sativa* and *Verbena tenuisecta* but were dominated by *Vicia sativa* and *Verbena tenuisecta* so the name assigned to this group was ***Vicia-Verbena.***

Subgroup Q1b was comprised of *Convolvulus arvensis, Tephrosiapurpurea, Euphorbia prostrate, Malvaparviflora, Sonchusasper, Dichanthiumannulatum, Malvastrumcoromandelianum* and *Partheniumhysterophorus*. The dominating species were *Convolvulus arvensis* and *Partheniumhysterophorus* so the title endorsed to this group was *Convolvulus-Parthenium*. *Taraxacumofficinale* and *Capsellabursapsatoris*was not forming any community.

Q2 was divided into Q2a and Q2b. Q2a included *Carthamusoxyacantha, Lycopericonesculentum, Digeramuricata, Cynodondactylon, Rumexdentatus*, and *Medicagopolymorpha* and the dominating species were

Cynodondactylon and *Rumexdentatus*, so the name accredited to this group was ***Cynodon-Rumex.***

Q2b included *Euphorbia heliscopia, Lepidiumsativum, Cenchrusbiflorus Roxb* and *Conyzacanadensis*. The ruling species in this group were *Euphorbia heliscopia* and *Lepidiumsativum*, so the title ascribed to this group was ***Euphorbia-****Lepidium*. *Ranunculus muricatus* was forming no community.

Authoritative species in group Q3 was *Cannabis sativa* and *Diclipteraroxburghiana*, so the title allotted to this group was *Cannabis-Dicliptera.*

Dominating species in group Q4 included *Coronopusdidymus* and *Sisymbriumirio*, so the title assigned to this group was ***Coronopus-Sisymbrium*.** Some species present in dendogram were showing no affinity to form a community hence they were placed independently.

DCA: DCA or Detrended Correspondence Analysis was carried out to find trends in clustering species of major groups in ordination space (Ahmad *et al.*, 2013). The species were further classified to find out the distribution pattern and major plant communities. The herbaceous species were represented by a triangular point on each group and green color was assigned for representation of specie name. Different herbaceous species present with closely same abundances in the same quadrat had occupied the same point on graph. The species distribution on the graph was represented by the distances between points present on the graph. DCA resulted in giving two major groups and two minor groups along with an outlier. The eigenvalues for first two quadrats were 0.778 and 0.681 which were good enough for easier interpretation of results (Figure 3).

Major Groups:

- **Group A:** Major group A consists of *Cynodondactylon , Diclipteraroxburghiana, Euphorbia heliscopia , Verbena tenuisecta, Rumexdentatus , Cenchrusbiflorusroxb, Vicia sativa, Capsellabursapastoris, Conyzacanadensis, Cannabis sativa, Amaranthusspinosus, Ranunculus muricatus, Silybummarianum, Lepidiumsativum*and*Chenopodium album* .

- **Group B:** Major Group B consists of *Sisymbriumirio, Oxalis corniculata, Tephrosiapurpurea, Dichanthiumannulatum, Taraxacumofficinale, Partheniumhysterophorus, Euphorbia hirta, Achyranthesasper, Malvastrumcoromandelianum, Convolvulus arvensis, Cucumismeloagrestis* and *Coronopusdidymus.*

Minor Groups:

- **Minor Group A:** Minor group A consists of three species i.e. *Euphorbia prostrate, Carthamusoxyacantha* and *Lycopericonesculentum.*

- **Minor Group B:** Minor Group B consists of *Medicagopolymorpha, Malvaparviflora* and *Sonchusasper*.

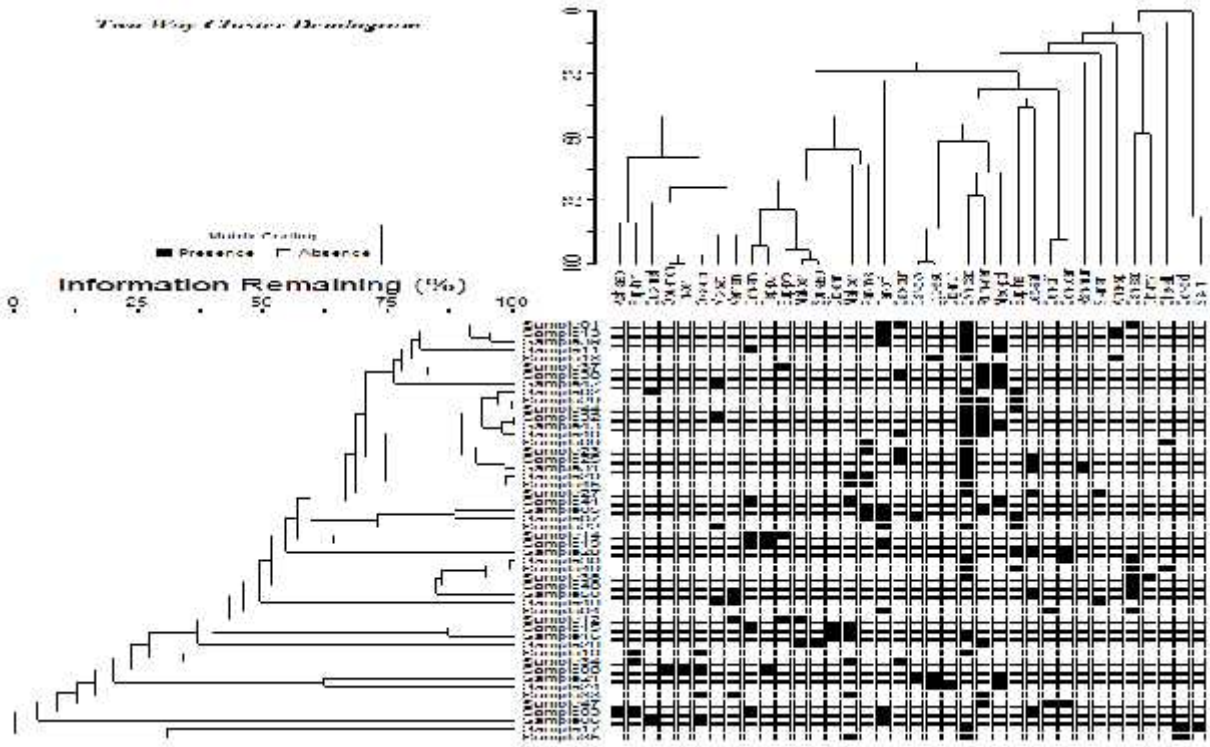

Fig. 1. Two Way Cluster Dendogram

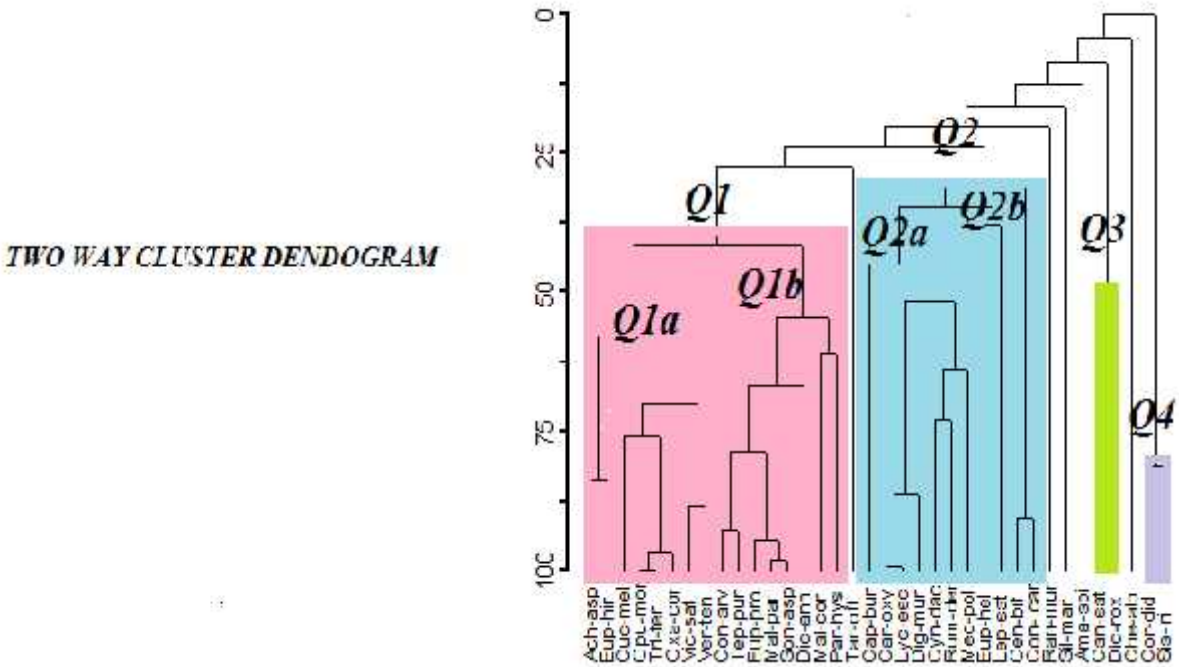

Fig.2.Group of species along Roads of Wah Cantonment

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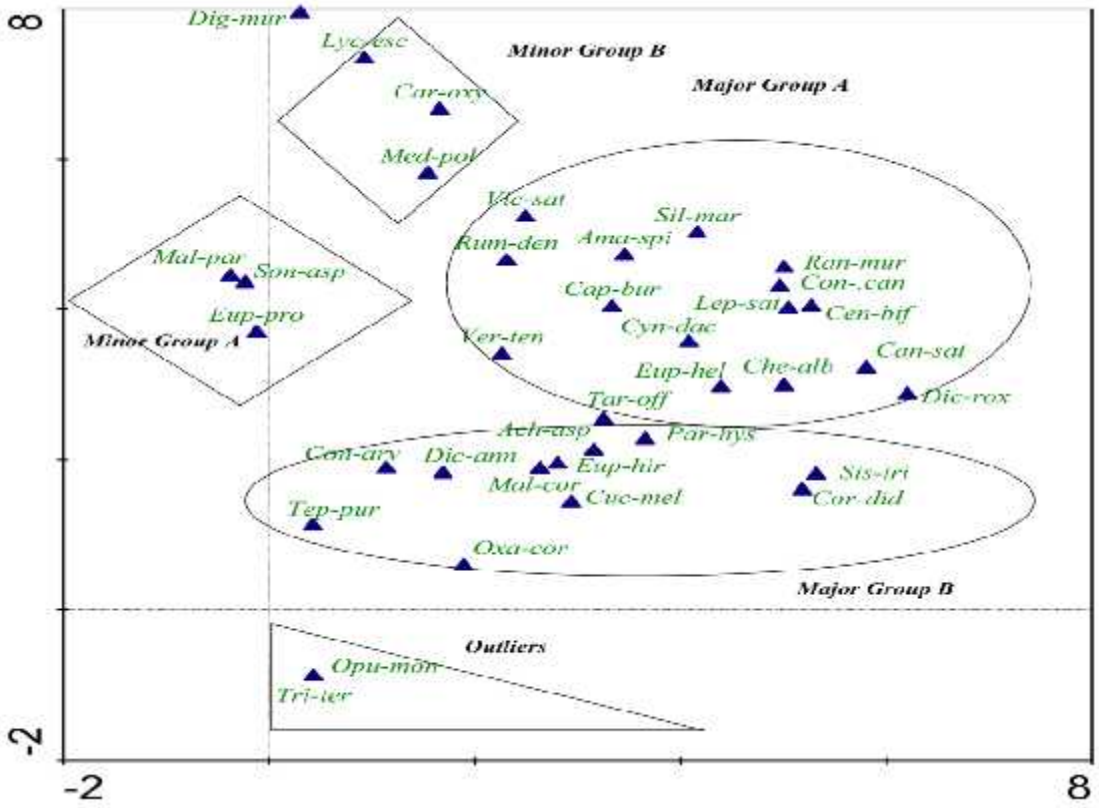

Fig. 3. DCA scatter plot for species data

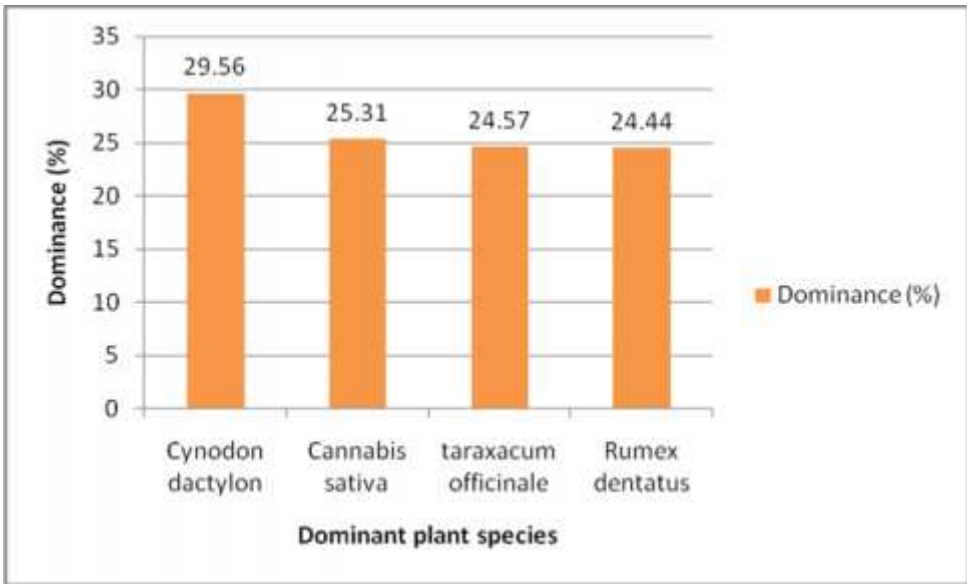

Fig. 4. Species- frequency graph

DISCUSSION

Roads are considered as important and prime means of communication among the different cities, town and villages for trade and economy. Trade routes are developed between countries to increase their trade which helps them to boast up their international positions and also helps them to exchange their cultural values and local handicrafts along with industrial goods. Silk route for trade between Pakistan is one of such examples. The roadside verges and wild vegetation present on their sides play an important role in overcoming the tribulations dealing with soil stabilization, pollution release and microclimate. Roadside vegetation diminishes the detrimental effects of gaseous and particulates along roadsides and absorb these pollutants, thus inhibiting their access to crops and agricultural terrain. Roadside verges help in protecting the food chain from accumulation of injurious particulates (Ramsay, 1993). The present study was conducted at roadsides of Wah Cantonment, Rawalpindi. The most abundant plants species were *Cynodondactylon, Cannabis sativa, Taraxacum officinale,* and *Rumexdentatus* presented in species- frequency graph.

TWINSPAN (Two Way Indicator Species Analysis) was applied for general classification of flora of Wah Cantonment which had produced Two Way Clustered Dendogram. A sum of four vegetation communities containing 52 herbaceous species was identified by TWINSPAN. The study was carried out on MargallaHills (Ahmad and Jabeen,2009). Ahmad (2013) applied TWINSPAN and learned the vegetation communities present along the Motorway (M-1) from Rawalpindi to Attock. 45 species belonging to 23 different families emerged the vegetative flora of the area. The whole data of 45 species were divided into two major groups and 14 subgroups via TWINSPAN. The first major group had population of *Lepidiumapetalum and Carthamusoxycantha* but was overruled by *Carthamusoxycantha* species while second major community had *Euphorbia helioscopia* and *Partheniumhysterophorus.* The dominating community in second major community was *Euphorbia spp.* TWINSPAN delivered the information that how the rows and columns were associated with each other and highlighted the correlation between individual data set and cluster analysis thus helped in providing basis for management and conservation of indigenous flora.

In the recent study, the two way cluster dendogram was divided into two major groups and two minor groups. The major groups were further subdivided into sub communities. The subgroups of major communities were assigned the name of *Vicia-Verbena, Convolvulus-Parthenium, Cynodon-Rumex and Euphorbia-Lepidium*. The authoritative communities in minor communities were *Cannabis-Dicliptera* and *Coronopus-Sisymbrium.Vicia sativa, Partheniumhysterophorus* were the dominating species in group 1 while*C.dactylon*and*E.heliscopia*were the ruling species of group 2. The species of*C. sativa* and *C.didymus* were forming dense population of minor groups. *C. dactylon* was the most dominant species of major group and it belonged to the family Poaceae. It had capability of growing at optimum temperature of 15°C in sunny locations but affected by shady areas such as close to tree trunks (Shukla *et al.,* 2011). There were several benefits of *C.dactylon*, its paste helped in healing wound while its fresh juice helped in alleviating fever; diarrhea and nose bleed (Quershi *et al.,* 2010). *C. sativa* had a capability of tolerating wide range of climatic condition

and was appeared as the most dominating weed in Wah Cantonment (Riaz and Javaid, 2009) that's why *C. sativa* appeared as the dominating species in minor group 1. *C. sativa* provided wide range of benefits to mankind by helping in pollen dispersal to large distance, medicinal drugs, fibers for spinning and weaving clothes and seeds to be used for animal and human nourishment. It was annual crop with the requirement of sunny location, sufficient nutrients and water, light and well-drained soil for seed germination. Disturbed lands and neglected farmlands, roadsides and railways provided active sites for growth of *C. sativa* (Musty, 2004). *C.didymus* favored moist soil, semi shade area and the growth occurred in month of April and October. It had pinnate leaves with biglobose fruit (Liu *et al.*, 2002). The plant belonging to Brassicaceae family helped the mankind by providing fumigants for insect control (Quershi *et al.* 2009). *P.hysterophorus* was an invasive species of Asteraceae family, commonly present in North America, South America, the Caribbean, and many parts of Africa, Asia, and Australia (Navie *et al.*1996). The plant found its way to India through food grains import in 1950 (Chandras and Vartak, 1970). From India, the plant spread in Pakistan. The plant had several negative impacts like skin rashes, hay fever, and asthma (Cheney, 1998; McFadyen, 1995) loss of biodiversity, reduced crop yield and fodder for animals (Kohli and Rani, 1994). *E.helioscopia* germinated through a seed in month of June to July and the whole part of plant provided valuable services for mankind (Khan *et al.*, 2013).

DCA was a computer technique used for the classification of data in ordinate space. It helped in identification of cluster of species and verification of these groups. Ahmad (2010) analyzed the vegetation data along motorway with the help of DCA. The analysis of data divided it into four groups on the basis of clustering, coexistence and allopathic activity. *Carthamusoxycantha* appeared as a most dominant species in group-I while *Conyzabanariensis* and *Cymbopoganjawarancusa* took dominant specie's place in second and third group. The fourth and last group was subjugated or dominated by *Cynodondactylon*. Hansen and Jansen (1972) reported high frequency of dominant species after the research on roadside vegetation of Denmark. In the present study, DCA divided the data into four groups along with outlier species. Two groups appeared as major groups in which *Cynodondactylon* and *Cannabis sativa* appeared as most dominating species in major group A and B. The minor group A had more population of *Euphorbia prostrate* and minor group B had dominating population of *Medicagopolymorpha*.

C .dactylon was the most dominant species of major group A. Ali *et al.*, (2004) found *C.dactylon*as a dominating species in various areas of Punjab. It adapted to wide range of climatic conditions i.e. arid to rainy climate and had capability of sustaining harsh hot and dry climate (Guertin, 2003).

C. sativa was found as a second most dominating species. Riaz and Javaid (2009) found *C.sativa* as the dominating weed in Wah Cantonment with absolute frequency of 86%.The problems of Asthma as well as pollen allergy is very common in Wah which might by due to the presence of *C.sativa* and *P. histerophorus* in areas. The area management must control its extensive growth.The area management must allocate separate department under the supervision of environmentalist, who can wisely decide which plants should be grown and which should be avoided.

Conclusion: TWINSPAN and DCA demarcated the whole plant species into four major groups and *Cynodondactylon* was emerged as the dense population of study area.The study will help the area management department in conserving the indigenous flora of area and controlling the alien weeds (invasive plants) affecting the health of citizens.

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