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Baseline Study of Roadside Vegetation of Lahore-Islamabad Motorway (M-2) and its Fertility Status

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Abstract: The present vegetation survey of road verges along Lahore-Islamabad motorway (M-2) was conducted to elucidate the percentage frequency and cover of each of the most frequent species in the study area and to assess the fertility status of the soil. The results of the study revealed that species diversity at a large scale (i.e. 227 species), but less number of frequent and dominant species throughout the study area. Similarly, the nutrient status of the roadside soil was found to be sub-optimum to optimum. Therefore comprehensive studies of pattern of different plant communities and various ecological and edaphic factors are necessary for the presentation of natural assets, habitat, species diversity and their conservation.

Key words: Species diversity, roadside vegetation, soil fertility, Motorway (M-2)

INTRODUCTION

Vegetation in man-made habitats has received increasing attention of researchers. The attention is partially because of the growing importance of the man made habitats, which are linked to ever increasing synanthropisation of vegetation. Synanthropisation refers here to totality of changes in the plant cover caused directly or indirectly by human activities and which consists of a number of processes as discussed by Korans[1].

Roadsides provide an excellent system for photo-geographic surveys because of the similarity in road construction and roadside management across geographic and climatic borders and because of presence of the roadside habitat in most parts of the world[2,3]. The advantage of roadsides for study of species and vegetation performance is now widely acknowledged. Most studies, to date, have focused on the vegetation of outer road verges, i.e. the part of roadside most remote from the road surface itself[4-6]. This may be because of the pronounced anthropogenic gradient in the site conditions between the outer and inner edges of the roadside[7] that causes a zonation of roadside vegetation perpendicular to the road[8]. However, zonation from the outer verge to the inner edge of the roadside offers an excellent opportunity to examine the effects of greater disturbance and edaphic modification near the road. In most parts of the world, especially in Europe, Australia, New Zealand and North America, roadsides are regarded as excellent habitats to examine vegetation and species responses to changes in the environment[4-6].

The present study was aimed at compilation of floristic and soil data from all the sites. The objectives of the study were to find:

- The range and frequency of occurrence of different vascular plants found in the study area.
- The average cover of each of the most frequent species in the study area.
- The difference in the frequency and cover of different species in relation to different zones of the road.
- The ranges of various edaphic characteristics of roadside soils in the study area.

These analyses were oriented at discovering the trends and patterns in the plants and soil data.

MATERIALS AND METHODS

Vegetation Data Collection. For the collection of vegetation data Braun-Blanquet approach[9] was used, which is recognized worldwide. In this approach, sampling is carried out by the use of quadrats, which are vegetation samples that are not randomly located and carefully selected as representative area of a vegetation type[10].

Based on the usual observation of vegetation structure the quadrat size of 1x2 m^2 was selected, which comprised mostly of herbs and grasses. Within each quadrat, vascular plants and their estimated cover was recorded by visual estimation using the Domin cover scale[10]. Roadside habitats include the shoulder of the road and adjacent road reserve that is demarcated from the adjacent private or state owned land by a fence. The

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Table 1: Percentage cover values calculated according to Currall[11] Formula for different Domin covers scores

Domin score	Cover range	Domin 2.6 percentage
10	95-100	99.5
9	75-95	75.7
8	50-75	55.7
7	33-50	39.4
6	25-33	26.4
5	10-25	16.4
4	5-10	9.2
3	1-5	4.3
2	<1 scattered	1.5
1	<1 seldom	0.3
+	<1 solitary	-

study site normally comprises of two zones: Zone (1) the road shoulder adjacent to the edge of road sealing. It is usually 1-3 m wide; soil is comparatively stable and affected to lesser extent by traffic and Zone (2) the fence zone that is demarcated from the adjacent private or state owned land by fence.

Conversion of domin values into percentage values: The use of Domin cover scale in vegetation surveys saves a lot of effort and time but its use in simple mathematical calculations, such as working out means of various scores is not directly possible because it is a nonlinear scale. To overcome this difficulty, a transformation formula, referred to as "Domin score "proposed by Curral[11] was used (Table 1) Percentage cover = (Domin Score) 2.6/4

This transformation enables cover percentages to be calculated from Domin values with greater accuracy than direct averaging[11]. Table shows the percentage cover values calculated for different Domin cover scores by using Currall's formula.

Soil analysis: From each quadrat, a soil sample was taken with a stainless steel trowel. The soil was generally taken from 10-15 cm of the topsoil because much of the nutrient uptake by plant lies within this depth[12]. The total nitrogen was determined using Kjeldahl's procedure as described by Meston[13]. For phosphate determinations, soil extractions were made with Olsen's reagent. Olsen's reagent is recommended for the extraction of phosphate in neutral and calcareous soils. Potassium was estimated using an extract from 5 gm of air-dried soil, using 125 ml of 1 M ammonium acetate (pH 7) using atomic absorption spectrophotometer[12].

RESULTS

The most frequent species: On the basis of the survey of the roadside verges in the study area which comprised of floristic data collected from 400 quadrates; 227 vascular plants species were recorded. Due to large number of species recorded during the survey. Of 227 species only

Table 2: Species frequently occurring on the roadside verges in the study area (in order of decreasing frequency in 400 quadrats)

Species name	No of quadrats	% frequency	% cover
Cynodon dactylon	236	59.0	11.9
Calatropis procera	210	52.5	13.7
Cenchrus ciliaris	111	27.7	5.5
Heteropogon contortus	76	19.0	4.8
Bothriochloa pertusa	65	16.2	2.3
Rhynchosia minima	65	16.2	2.1
Cleome viscosa	54	13.5	1.6
Sonchus asper	44	11.0	2.3
Polygala chinensis	43	10.7	1.1
Saccharum munja	41	10.2	1.6
Launaea procumbens	41	10.2	1.4
Convolvulus arvensis	40	10.0	1.3
Artemisia scoparia	39	9.7	1.5
Digitaria bicornis	39	9.7	1.4
Croton sparsiflorus	36	9.0	1.4
Euphorbia hirta	35	8.7	2.2
Aeruva javanica	33	8.2	1.8
Tribulus terrestris	33	8.2	1.2
Xanthium strumarium	33	8.2	0.9
Conyza bonariensis	30	7.5	1.1
Cymbopogon martini	29	7.2	0.9
Dodonea viscosa	28	7.0	1.4
Withania somnifera	27	6.7	1.8
Dactyloctenium aegyptium	27	6.7	1.3
Achyranthes aspera	26	6.5	1.7
Cyperus rotundus	25	6.2	1.0
Aristida hirtigluma	25	6.2	0.9
Parthenium hysterophorus	24	6.0	2.4
Fagonia cretica	24	6.0	1.0
Chenopodium album	23	5.7	1.2
Indigofera linifolia	23	5.7	1.2
Poa araratica	22	5.5	0.9
Sorghum halepense	22	5.5	0.9
Callistemon lanceolatus	22	5.5	0.6
Setaria glauca	21	5.2	1.1
Fumaria indica	21	5.2	0.8
Carthamus oxyacantha	20	5.0	1.3
Capparis aphylla	20	5.0	1.2
Medicago sativa	19	4.7	0.5
Euphorbia prostrata	18	4.5	1.0

12 species occurred with a frequency of more than 10% and are presented (Table 2). Table 2 also enumerates the percentage cover of each of these species calculated on the basis of the whole study area.

From Table 2, it appears that the roadside vegetation in the study area is dominated by (*Cynodon dactylon, Calatropis procera, Cenchrus ciliaris, Heteropogon controtus, Bothricola petrusa* and *Rhynocosia minima*). Out of these *Cynodon dactylon, Calatropis procera, Cenchrus ciliaris and Heteropogon controtus* cover 35.90% of the area. Therefore these species are described as dominant and leading species of road verges in the study area in both qualitative and quantitative terms. Besides the above-mentioned species, other species such as *Cleome viscosa, Sonchus asper, Polygala Chinesis, Saccharum munja, Launea procumbens* and *Convolvulus arvensis* were also found to occur quite frequently.

Table 3: Species frequently occurring on the roadside verges in the study area (in order of decreasing cover in 400 quadrats)

Species name	No of quadrats	% frequency	% cover
Calatropis procera	210	52.5	13.7
Cynodon dactlon	236	59.0	11.9
Cenchrus ciliaris	111	27.7	5.5
Medicago sativa	19	4.7	5.0
Heteropogon contortus	76	19.0	4.8
Parthenium hysterophorus	24	6.0	2.4
Bothriochloa pertusa	65	16.2	2.3
Sonchus asper	44	11.0	2.3
Euphorbia hirta	35	8.7	2.2
Rhynchosia minima	65	16.2	2.1
Aeruva javanica	33	8.2	1.8
Withania somnifera	27	6.7	1.8
Achyranthes aspera	26	6.5	1.7
Cleome viscosa	54	13.5	1.6
Saccharum munja	41	10.2	1.6
Artemisia scoparia	39	9.7	1.5
Launaea procumbens	41	10.2	1.4
Digitaria bicornis	39	9.7	1.4
Croton sparsiflorus	36	9.0	1.4
Dodonea viscosa	28	7.0	1.4
Convolvulus arvensis	40	10.0	1.3
Dactyloctenium aegyptium	27	6.7	1.3
Carthamus oxyacantha	20	5.0	1.3
Tribulus terrestris	33	8.2	1.2
Chenopodium album	23	5.7	1.2
Indigofera linifolia	23	5.7	1.2
Capparis aphylla	20	5.0	1.2
Polygala chinensis	43	10.7	1.1
Conyza bonariensis	30	7.5	1.1
Setaria glauca	21	5.2	1.1
Cyperus rotundus	25	6.2	1.0
Fagonia cretica	24	6.0	1.0
Euphorbia prostrata	18	4.5	1.0
Xanthium strumarium	33	8.2	0.9
Cymbopogon martini	29	7.2	0.9
Aristida hirtigluma	25	6.2	0.9
Poa araratica	22	5.5	0.9
Sorghum halepense	22	5.5	0.9
Fumaria indica	21	5.2	0.8
Callistemon lanceolatus	22	5.5	0.6

Table 4: Range of concentrations of three major nutrients in soil

Element	Low	High	Source
Nitrogen (%) (Total)	0.1	0.5	Allen[12]
Phosphorus $\mu g\ g^{-1}$ (Extractable)	3	80	Allen[12]
Potassium $\mu g\ g^{-1}$ (Extractable)	50	500	Allen[12]

Similarly Table 3 presents the data of species on the basis of maximum cover value. Only species having cover greater than 0.6% are presented here. From this table it appears that *Cynodon dactylon, Calatropis procera, Cenchrus ciliaris, Medicago sativa, Heteropogon controtus, Parthenium hysterophorus* are the most dominating species as regard to the percentage cover values of the species based on whole study area. Out of these dominating species *Calatropis* and *Cynodon* present a maximum cover value of 13.7 and 11.9%, respectively. The occurrence of *Parthenium hysterophorus* among these species, share a maximum cover value also supports the fact that disturbance frequently implicated in the spread of invasive exotic plants[14]. Apart from these species, other species, which were enlisted on the basis of cover, are *Bothricola pertusa, Sonchus asper, Euphorbia hirta, Rhynocosia minima, Auerva javanica* and *Withania somnifera.*

Table 5: NPK* Variables Calculated for the whole data set n**=400.Values are represented as minimum, maximum and mean of standard error

Factor	Minimum	Maximum	Mean±S.E.
Total Nitrogen (%)	0.01	0.17	0.07±0.002
Phosphorus $\mu g\ g^{-1}$	5.00	80.00	26.92±0.24
Potassium $\mu g\ g^{-1}$	17.00	400.00	132.56±4.89

*NPK = Nitrogen, Phosphorus, Potassium.
** n= number of samples

Table 6: Frequencies of ten most frequent roadside species in different zones of the road verges

Species	Zone I and III (Verge)	Zone II and IV (Fence)	Total Frequency %
Cynodon dactylon	28.00	31.00	59.0
Calatropis procera	25.50	27.50	52.5
Cenchrus ciliaris	12.50	15.25	27.7
Heteropogon contortus	11.00	8.00	19.0
Bothriochloa pertusa	9.75	6.50	16.2
Rhynchosia minima	9.00	7.25	16.2
Cleome viscosa	8.00	5.50	13.5
Sonchus asper	6.50	4.50	11.0
Polygala chinensis	6.75	4.00	10.7
Saccharum munja	8.25	5.00	10.2

Table 7: Mean percentage cover values of the ten most frequent roadside species in different zones of the road verges

Species	Zone I and III (Verge)	Zone II and IV (Fence)	Total Cover %
Calatropis procera	6.60	7.10	13.7
Cynodon dactylon	6.20	5.68	11.9
Cenchrus ciliaris	2.13	3.40	5.5
Medicago sativa	1.75	3.25	5.0
Heteropogon contortus	2.97	1.83	4.8
Parthenium hysterophorus	1.80	0.60	2.4
Bothriochloa pertusa	1.75	0.61	2.3
Sonchus asper	1.48	0.81	2.3
Euphorbia hirta	0.60	1.60	2.2
Rhynchosia minima	1.10	1.07	2.1

Fertility of roadside soil: Soil fertility is an important factor and affects the distribution of individual species and plant communities[15]. Soil fertility is generally considered to be related to three major nutrients, nitrogen, phosphorus and potassium[16,17]. Although needs of different plant species for these elements vary but all are needed by pants in substantial quantities. Table 4 presents low and high values of these elements. In soils, however, the concentrations of these elements show a lot of variation and these values should be considered as a rough guide to their concentrations in roadside soils[12].

In the present study, the exchangeable potassium concentration of soil showed a low mean level of 17 $\mu g\ g^{-1}$ compared to Allen's figures. A mean total Nitrogen percentage in the soils is 0.07 (Table 5) shows a fairly low nitrogen contents in the roadside soils. Extractable phosphorus levels in the roadside soils

(5 µg g^{-1}) were also towards the bottom end of Allen's range. It shows that roadsides have sub-optimum to optimum concentrations of potassium and phosphorus, while nitrogen is in general present in low amount. The pH of overall study area is around 7.43.

DISCUSSION

Habitat alteration (including habitat loss, degradation and fragmentation) is now among the major risks of ecosystem degradation by the human activities[18]. The evidence that human activity, as early as Iron Age in France had an important influence on plant biodiversity[19]. Similarly in the present study the analysis of the vegetation data and roadside soils reveals a number of points that may be concluded in relation to the objectives of the study. On the whole, the roadside flora is quite rich in species with the recording of 227 species corroborating the fact. This exploration also supports the previous studies calling for the recognition of the botanical importance of the roadside verges[20]. This argument is further supported by the fact that landscapes are never static; their elements are in permanent temporal and spatial flux[21].

Despite the large number of species recorded on the road verges in the study area, the number of frequent species is not very large. There is a limited number of species that show dominance throughout the study area. It indicates wide ecological amplitude of the dominant species of road verges.

The pattern of plant distribution on the road verges shows that in general, roadside plant species can be divided into two large groups: are mainly present on the verge zone (I and III) and another one on the Fence zone (II and IV). As compared to the verge zone, the fence zone exhibits a relatively similar species composition with one another. Thus the list of most frequent species for verge and fence share the same seven species (*Cynodon dactylon, Calatropis procera, Cenchrus ciliaris, Heteropogon controtus, Bothricola petrusa* and *Rhynocosia minima and Sonchus asper)***.** However there are differences in the rank of frequency and cover of these species in different zones (Table 5 and 6). There is a definite change in frequency and cover of roadside species in the different zones of road verges[22].

As far as the roadside soils are considered, it was found that most roadside soils in the study area are of neutral pH. The other micronutrients essential for the plant growth such as potassium and phosphorus were present in accordance with the normal range described by Allen[12], whereas nitrogen found to be little bit insufficient. The roadside soils suffer from moderate deficiencies of nitrogen[23]. The availability of nitrogen ions in soil might be affected by the pH of the soil. At very low pH (4-5) or very high pH (7-8) phosphorus ions may be tied up in such a manner that they are less available to plants[24]. Since the roadside soils have a mean pH of 7.43, it might be assumed that phosphorus availability might have been adversely affected. By considering these facts, it can be concluded that the nutrient status of the roadside soils is sub-optimum to optimum.

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