Proceedings of the Pakistan Academy of Sciences 48 (2): 79–82, 2011

ISSN: 0377 - 2969

Pakistan Academy of Sciences

Original Article

Plant-Soil Relationships in Korangi and Landhi Industrial Areas in Karachi, Pakistan

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Abstract: A relationship between soil characteristics and plant communities of the industrial areas of Korangi and Landhi in Karachi (Pakistan) was studied. Soil samples were analysed from twenty eight stands around the industrial areas of Korangi and Landhi. On the basis of leading dominant species, fifteen plant communities were recognized in which some of the communities were purely dominated by single species. The soil characteristics were also determined. All the communities were correlated with the edaphic conditions of the industrial areas. The range of coarse sand, water holding capacity, organic matter, total soluble salts and available sulfate were between 21-84%, 22-35%, 0.8-3.4%, 4.5-14.0% and 125-575 mg kg^{-1}, respectively, while, pH and $CaCO_3$ ranged between 8.0-8.3 and 9.5-35.8%, respectively. All the plant communities, mean values of soil characteristics were: coarse sand 41%, water holding capacity 29%, organic matter 1.5%, total soluble salts 9.9%, available sulfate 279 mg kg^{-1}, while the pH 8.2 and $CaCO_3$ 22% were high. In most of the dominant species, the soil characteristics were similar to those found in the respective plant communities.

Keywords: Industrial areas, plant communities, plant-soil relationships, soil characteristics

INTRODUCTION

Soil, air and water have been used as sites for the disposal of wastes. The soil of a natural community is a part of the ecosystem. Different soil support different types of plant communities that is effected by soil characteristics while the plant community also influences the physico-chemical characteristics of the soil [1]. Striking amount of soluble salts and insufficient leaching in soil causing halophytic types of vegetation around industrial sites. Iqbal et al. [2] described waterlogged and saline soils supported a halophytic type of vegetation at Valika Chemical Industry on the Sindh Industrial Trading Estate in Karachi. High organic matter provides nutrient availability for enhancement in plant growth. Shafiq and Iqbal [3] reported that soil has alkaline nature, appreciable calcium carbonate and little amount of organic matter around National and Javedan Cement Factories of Karachi which affected on plant communities growing around industries. Considerable available sulfate decrease the plant growth and excessive amount SO_2 is discharged by industrial emanation. Iqbal and Qamar-uz-Zaman [4] found high amount of available sulphur in soil near of Oil Refinery followed by Muhammadi Foundary and Ittefaq Foundary from Korangi industrial area of Karachi, while Karachi University Campus soil has lowest sulfur concentration was affected on vegetation pattern. High water holding capacity produce aggregation of vegetation in an area. Mehmood and Iqbal [5] reported sandy loam soil, slight variations in the water holding capacity, sufficient $CaCO_3$ concentration and high soil pH around wasteland of Valika Chemical Industries near Manghopir Road in Karachi influenced vegetation types.

Different industries are polluting the soils around the industries in Karachi. We investigated the effects of different industries on soil, their correlation with plant communities.

MATERIALS AND METHODS

The study was based on the analysis of soil samples collected from twenty eight stands

Received January 2010, Accepted June 2011
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around different factories where diverse plant communities was growing from Korangi and Landhi Industrial Areas of Karachi (Pakistan). Sampling of vegetation of these stands was conducted by Point Centered Quarter Method by employing twenty five sampling points in each stand. At each sampling point four plants were recorded. The circumference of each plant was also noted. Phytosociological attributes like cover, relative cover, density, relative density, frequency, relative frequency and importance value index of each species were calculated and analysed Curtis and McIntosh [6].

For soil analysis, two soil samples from each stand were obtained from upper layer at 0-30 cm depth and air-dried, lightly crushed and passed through a 2 mm sieve. For mechanical analysis of soil, coarse sand was determined by sieve method [7]. Water holding capacity was measured by the method of Keen [8]. Soil organic matter was determined according to Jackson [9]. Calcium carbonate ($CaCO_3$) was determined by acid neutralization, as described by Qadir et al. [10]. Bower and Wilcox [11] methodology was used to determine total soluble salts, whereas soil pH was recorded by pH-meter (MP 220 pH Meter) (Mettler, Toledo). Available sulfate in the soil was determined by the turbidity method [12] using colorimeter (Photoelectric Colorimeter AE-11M).

RESULTS AND DISCUSSION

Fifteen plant communities were recognized amongs the 28 stands on the basis of leading dominant species by high importance values index. Mean values of each soil characteristics of each stand were also combined and calculated average values of soil according to recognized fifteen plant communities and correlated edaphic characteristics of soil with plant communities in the vicinity of the industrial areas of Korangi and Landhi. In soil of most of the plant communities, coarse sand, water holding capacity, organic matter, total soluble salts and available sulfate were moderate while, $CaCO_3$ and pH were high. Soil characteristics of different plant communities are depicted in Table 1. Vegetation directly depends on the soil characteristics and conditions necessary for successful growth and distribution of plants. Nazarian et al. [13] have demonstrated that the soil moisture, soil pH, organic matter, slope, degree and altitude from sea level of the region are principal ecological factors. Coarse sand and calcium carbonate were considerably found in soil of *Cressa cretica* L. community as compared to the other communities. Mehmood and Iqbal [5] elaborated that in sandy soil, the surface was loose textured and the root system of plants could penetrate deep into soil and extract water from the lower soil horizons for their growth during dry season. A substantial amount of calcium carbonate (9.8-17.1%) is the characteristic feature of arid zone soils [14]. *Suaeda fruticosa* (L.) Forssk. community had notably adequate soil water retention capacity. In first dominant species *S. fruticosa* species also attained highest important value index in the stands on soils with high water holding capacity (Table 2). Soil texture and water holding capacity were correlated and influenced the distribution of species on soil in Korangi and Landhi industrial areas.

The organic matter content was sufficient in soils of *Abutilon indicum-Prosopis juliflora* community (Table 1) and as a dominant plant, soil of *Salsola baryosma* (R. & S.) Dandy species also has substantial soil organic matter (Table 2). In those communities which had a higher percentage of soil organic matter, the water holding capacity of soil was consequently increased due to the colloidal nature of the organic matter [15].

Soils of all communities and first dominant species had slightly high pH ranges in their stands (Table 1, 2). The pH of soils of the Korangi and Landhi industrial areas ranged between 8.0-8.3 in soils of all communities and ranged between 7.9-8.3 in soils of all first dominant plant species. Plants are sensitive to soil pH which effect concentrations of different nutrients in soil solution and make them less available to plants. However, many soil nutrients are soluble in neutral or near neutral solution (pH 6.5-7.2) [16] and become available to the plants.

Table 1. Correlation of soil characteristics with plant communities observed around the Korangi and Landhi Industrial Areas of Karachi.

Sr. No.	Community name	Coarse sand (%)	W.H.C.[a] (%)	Organic matter (%)	$CaCO_3$ (%)	Total soluble salts (%)	pH	Available sulfate (mg kg^{-1})	No. of soil stands of plant communities combined
1.	*Abutilon indicum-Prosopis juliflora*	21	23	3.4	28.5	12.0	8.1	308	1
2.	*Abutilon indicum*	33	30	1.6	18.8	9.6	8.0	210	6
3.	*Abutilon indicum-Cressa cretica*	38	23	1.6	22.8	11.0	8.3	424	2
4.	*Abutilon indicum-Tribulus terristris*	31	31	0.8	9.5	10.0	8.2	125	1
5.	*Cressa cretica*	84	22	1.5	35.8	10.3	8.2	351	2
6.	*Cressa cretica – Abutilon indicum*	31	33	1.3	10.5	7.5	8.0	431	1
7.	*Cressa cretica – Senna holosericea*	49	33	1.0	28.0	10.0	8.2	230	1
8.	*Digera alternifolia-Senna holosericea*	47	29	1.2	25.8	7.5	8.3	128	2
9.	*Suaeda fruticosa*	65	35	0.8	27.5	4.5	8.2	371	1
10.	*Salsola baryosma*	41	33	2.2	17.5	12.5	8.2	311	1
11.	*Corchorus trilocularis-Abutilon indicum*	28	30	1.3	18.0	8.2	8.0	219	3
12.	*Amaranthus viridus-=Prosopis juliflora*	25	26	0.9	10.2	11.7	8.2	213	3
13.	*Gynandropsis gynandra-Digera alternifolia*	42	28	1.4	29.3	12.8	8.1	168	2
14.	*Prosopis juliflora-Abutilon indicum*	24	29	2.1	29.5	14.0	8.0	575	1
15.	*Cenchrus biflorus-Senna holosericea*	49	30	1.6	14.0	6.5	8.3	128	1

[a]W.H.C. = Water Holding Capacity.

Table 2. Correlation of first dominant species with soil characteristics in Korangi and Landhi Industrial Areas of Karachi.

Dominant species	No. of stands in which sp. is showing 1st. position	Mean Importance value index	Coarse sand (%)	W.H.C[a]. (%)	Organic matter (%)	$CaCO_3$ (%)	Total soluble salts (%)	pH	Available sulfate (mg kg^{-1})
Suaeda fruticosa (L.) Forssk.	1	226.14	65	35	0.8	27.5	4.5	8.2	371
Salsola baryosma (R. & S.) Dandy	1	188.32	41	33	2.2	17.5	12.5	8.2	311
Corchorus trilocularis L.	2	174.71	32	32	1.7	22.0	8.8	7.9	274
Abutilon indicum (L.) Sweet	10	134.22	33	28	1.7	19.7	10.2	8.1	254
Cressa cretica L.	4	145.33	62	27	1.3	27.5	9.5	8.1	341
Amaranthus viridis L.	3	105.06	25	26	0.9	10.2	11.7	8.2	213
Digera alternifolia (L.) Aschers.	2	99.35	47	29	1.2	25.8	7.5	8.3	128
Corchorus depressus (L.) Stocks	1	94.59	19	25	0.6	10.0	7.0	8.1	108
Gynandropsis gynandra (L.) Briq.	2	91.90	42	28	1.4	29.3	12.8	8.1	168
*Prosopis juli*flora Swartz	1	87.69	24	29	2.1	29.5	14.0	8.0	575
Cenchrus biflorus Roxb.	1	76.57	49	30	1.6	14.0	6.5	8.3	128

[a]W.H.C. = Water Holding Capacity.

Abutilon indicum (L.) Sweet appeared as the most dominant species in ten stands as compared to other species (Table 2) and survival and resistant was conspicuous against industrial emission in the proximity of industrial locations in despite of considerable total soluble salts in soil. Same findings were also elucidated as first dominant plant in soil of *S. baryosma* species. The soil under *Prosopis juliflora-Abutilon indicum* community had higher total soluble salts and available sulfate. Soil dominated by *Prosopis juliflora* Swartz, had significantly notable concentration of $CaCO_3$, total soluble salts and available sulfate. Vegetation was adversely affected by anthropogenic activity and increased salts concentration in groundwater. Therefore, soluble salts produced a significant impact on the plant communities [16]. Low levels of SO_2 can be absorbed through plant leaves and utilized within plants, while high concentrations of this gaseous form of sulfur is toxic.

As first dominant species, in soils stands of *C. cretica* and *S. fruticosa* found high percentage of coarse sand and $CaCO_3$. All communities had adequate amount of $CaCO_3$ and total soluble salts in soils except soil of *Suaeda fruticosa* community which showed lowest level of total soluble salts. Soil of *Cressa cretica* and *Prosopis juliflora–Abutilon indicum* communities displayed distinct amount of coarse sand and available sulfate in soils, respectively.

In this investigation, *Prosopis juliflora, Abutilon indicum, Cressa cretica, Suaeda fruticosa* and *Salsola baryosma* were tolerant species against the polluted soil due to existence in different range of soils characters in different soil stands. The findings of this research would be helpful for monitoring the pollutant levels in soils according to correlation of plant communities as well as useful for landscaping and urban planning.

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