A Vegetational survey of some mineral exploration areas in Lalitpur, Uttar Pradesh, India

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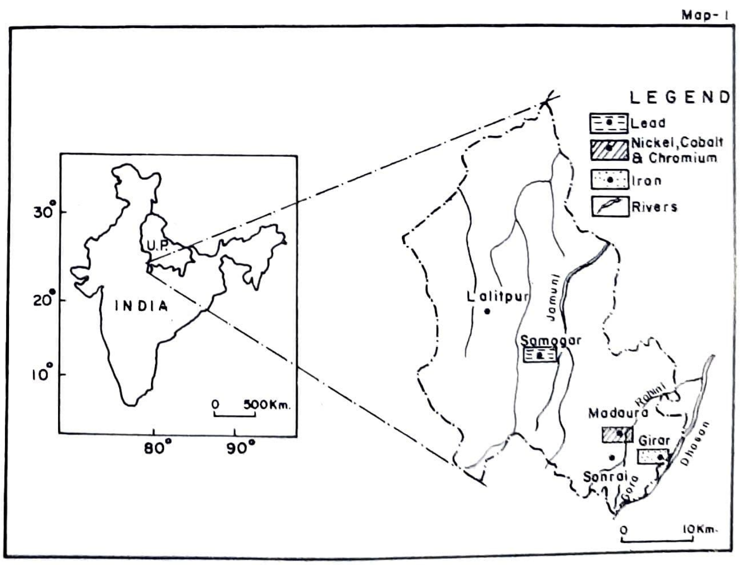
The use of biological materials as indicators and monitors of natural ore body contaminants in soil has gained wide acceptance all over the world in recent years. A vegetational survey of some mineral exploration areas in Lalitpur District (U.P.) was carried out in February - March 1992. In this paper, results of the survey of the region of mineral exploration inter alia existing vegetation with reference to abundance occasional appearance or absence of various plant species in the mineralized and non-mineralized regions are presented. A total number of 45 plant species were observed in the region. Out of these, *Gymnosporia* and *Carissa* species were abundant and flourishing in the entire region followed by members of Mimosaceae. However, both the species were absent in mineralized area of Girar region. Apparently, the number of plant species, its abundance and growth show a marked difference between the mineralized and non-mineralized areas.

Key-words - Vegetation, mineralized and non mineralized area, Lalitpur, U.P.

INTRODUCTION

Heavy metal pollution in the terrestrial environment is but one facet of the impact of toxic substance on the natural environment. The primary source of heavy metals in the environment is from naturally occurring geochemical materials. Input of trace metals to terrestrial ecosystems has acted as stimulus to the scientific investigation of the cycling of trace metals in ecosystems. Plants growing on contaminated soils from ore body form definite and distinct associations which can be easily identified (Ernst, 1966, 1974; Simon, 1978). In recent years, there has been growing interest among research workers on the role of plants as indicators of heavy metal contaminants in the soil as well as in the atmosphere. This is specially significant in mineral exploration areas and ore sites. The present communication reports the findings of a vegetational survey of mineralized and non-mineralized area in Girar, Madaura and Samogar, Lalitpur District, southwest Uttar Pradesh.



Map 1. Index Map of Lalitpur District, inset showing the mineral exploration area.

PHYSIOGRAPHY OF THE AREA

The area of investigation is bounded to the west by longitude 78° 39'E, to the north by latitude 24° 36'30"N, to the east by the boundary of Madhya Pradesh State. Access to and in the area is by good metalled road traversing the northern, central and western parts (Map 1).

The topography of the area is characterised by rolling plains with occasional craggy hillocks. The ridges are formed by the ultrabasic intrusives and banded iron formation. The ground slopes vary from 2° to 5° in the north and 20° to 35° in the south. The drainage in the area is generally of dendritic sub parallel type usually unrelated to the geological structures. The main rivers flowing in the region are Dhasan, Bandai, Rohini, Goranala, Onri and the Jamuni.

The climate is typical of Bundelkhand region having dry and cold winters followed by hot and dry summers with average 80° F temperature. The average relative humidity is 58 per cent with annual rainfall of 93 to 100 cm.

The area is confined between Bundelkhand basement coupled in the north with the Berwar-Bijawar cover in the southwest. The major rock types are marked by granite gneisses in the north, the ultrabasics and banded haematite quartzite in the southwest of the area. Dark Mar soils are typical of the northern region and thin, sandy reddish soils overlie parts of the genisses and granites towards the northeast.

The areas of mineralization and non-mineralization were taken into account as demarcated by U.P. Directorate of Geology and Mining. The term 'Abundant', 'Common' and 'Rare' used in the observations are based on the following criteria:

Abundant - 100 to 200 plants per sq. km
Common - 10 to 40 plants per sq. km
Rare - 1 to 5 plants per sq. km

The ore-deposit at Girar is confined to a hillock about 100 m high above general ground level traversing an area of 4 sq. km. The ore-deposit at Madaura and Samogar are still under investigation with slope gradient from 5° 30° . The nonmineralized area was adjacent to the mineralized area covering an area of 2 km. in all directions (Map 1)

RESULTS AND DISCUSSION

The plants occurring in the region are listed in tables 1, 2 and 3 and are differentiated into 'Universal' and 'Local' indicators after Malyuga (1964). The term 'Universal' is restricted to those species which are found exclusively on substrates containing high concentrations of the metal for which the species is proposed as an indicator species. Similarly, the term 'Local' is restricted to those species which are associated with metal-bearing substrates in certain geographical areas but which also grow in non-mineralized areas provided that the competition from other species is not too intense.

An average of 30 per cent iron deposits in the form of haematite and magnetite have been explored in the Girar area by U.P. Directorate of Geology and Mining. The plant species enlisted in table 1 constitute the vegetation of the region. There is no apprent variability in the vegetation with the increasing height of the hillock.

All the plant species mentioned, show dense population at the foot of the hillock too. However, the plain area adjoining the hillock shows relatively sparse vegetation, probably due to cattle grazing and human interference like raising land for agriculture. This area also shows comparative variation in vegetation such as *Buchanania* sp was abundant in plains but made only occasional appearance on the hillock. Similarly, *Madhuca indica, Ficus pakaria, F. glomerata* and *F. religiosa* were absent in the hillock but present in abudance in the plain. *Gymnosporia* sp. and *Carissa* sp. were profusely flourishing in plain but absent on hillock. In *Butea monosperma* the flowering was delayed in the mineralized area with leaves showing necrotic symptoms (Pl. 1, fig. 4).

It is observed that *Diospyros* sp. shows gigantism in mineralized region but dwarfism in non-mineralized region with necrotic black spots on leaves (Pl. 1, fig. 1) along with reduced leaf size. Since iron is essential as components of enzymes or co-enzymes which characterizes the chlorophyll-synthesizing reactions, it could be possible that the reasonable quantity of ionic iron from ore deposits available in soil solution might have entered the plants through root system favouring the growth of *Diospyros*. Thus the region shows luxuriant growth in most of the plant species which are well adapted to mineralized soil and

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PLATE 1

1. Leaves of *Diospyros melanoxylon* Roxb. showing unusual black spots.
2. *Lagerstroemia parviflora* Roxb. showing unsual black spots surrounded by a chlorotic margin on leaves.
3. *Casearia tomentosa* Roxb. leaves showing bronzing and necrotic symptoms.
4. *Butea monosperma* Lam. leaf showing necrotic spots.
5. Leaves of *Anona squamosa* showing bronzing and chlorotic symptoms.
6. Chlorotic symptoms on leaves of *Bauhinia* sp.

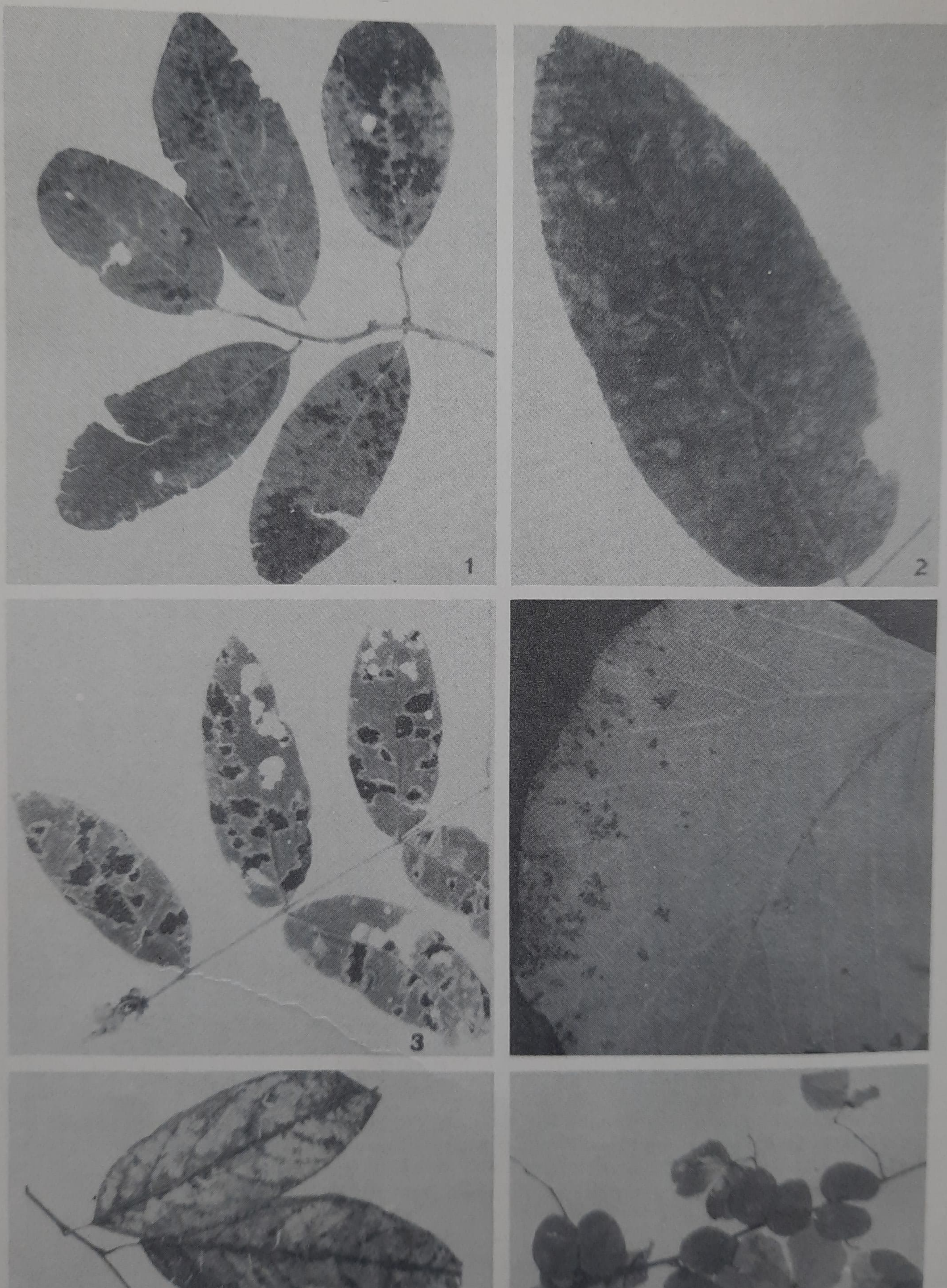

PLATE 1

Table 1. List of plants in Girar area .

Sl. No.	Botanical name	Common name	Family	Occurrence in		Indicator type Universal/Local
				Mineralized area	Non-mineral-ized area	
1	2	3	4	5	6	7
1.	*Acacia arabica* Willd.	Babool	Leguminosae	+	-	U
2.	*A. leucophloea* Willd.	Renja	Leguminosae	++	++	L
3.	*Aegle marmelos* Corr.	Bel	Rutaceae	++	+	L
4.	*Alangium salvifolium* (Linn.f.) W ang.	Akola	Alangiaceae	+	-	U
5.	*Anogeissus latifolia* Wall.	Dhao	Lythraceae	+	-	U
6.	*Anona squamosa* Linn.	Sharcefa	Anonaceae	++	0	L
7.	*Areca catechu* Willd.	Kattha	Leguminosae	++	++	L
8.	*Barleria cristata* Linn.	Reer	Acanthaceae	+	+	L
9.	*Bauhinia racemosa* Lam.	Kachnar	Leguminosae	++	-	L
10.	*Bridelia retusa* Spreng.	Kasai	Euphorbiaceae	++	-	U
11.	*Buchanania lanzan* Spreng.	Chiraunji	Anacardiaceae	+	++	L
12.	*Butea monosperma* (Lam.) Kuntz.	Palas	Leguminosae	+	++	L
13.	*Carissa spinarum* Linn.	Karaundi	Apocynaceae	-	++	S
14.	*Casearia tomentosa* Roxb.	Chila	Samydaceae	++	+	L
15.	*Cassia fistula* Linn.	Amaltas	Leguminosae	+	+	L
16.	*Diospyros melanoxylon* Roxb.	Tendu	Ebenaceae	++	+	L
17.	*Elaeodendron glaucum* Pers.	Jamras	Celastraceae	+	+	L
18.	*Eranthemum nervosum* Dalz. & Gibs.		Acanthaceae	+	-	U
19.	*Flacourtia indica* Merr.	Kankar	Flacourtiaceae	++	++	L
20.	*Ficus glomerata* Roxb.	Gular	Moraceae	-	+	S
21.	*F. infectoria* Roxb.	Pakar	Moraceae	-	+	S
22.	*F. religiosa* Linn.	Peepal	Moraceae	-	+	S
23.	*Gymnosporia montana* (Roth.) Benth.	Bekal	Celastraceae	-	++	S
24.	*Holoptelea integrifolia* Planch.	Papri	Ulmaceae	+	-	U
25.	*Ipomoea carnea* Jacq.	Behaya	Convolvulaceae	-	++	S
26.	*Lagerstroemia parvifolia* Roxb.	Seja	Lythraceae	++	+	L
27.	*Lantana camara* Linn.	Ghaneri	Verbenaceae	-	++	S
28.	*Madhuca indica* J.F. Gmel.	Mahua	Sapotaceae	-	+	S
29.	*Mimosa himalayana* Gamble.	Aar	Leguminosae	++	++	L
30.	*Nyctanthes arbortristis* Linn.	Siyonri	Oleaceae	+	-	U
31.	*Tamarindus indica* Linn.	Tamarind	Leguminosae	+	0	L
32.	*Woodfordia fruticosa* Kurz.	Dhawai	Lythraceae	-	++	S
33.	*Xeromorphis* sp.	Mainar	Rubiaceae	+	-	U
34.	*Ziziphus oenoplia* Lam.	Ber	Rhamnaceae	++	-	U

\+ Common
++ Abundant
0 Occasional

L = Local
U = Universal
S = Sensitive species of mineralized area

could be referred to as iron-efficient plants (Brown, 1976). The exceptions are, however, *Lagerstroemia* sp. and *Casearia* sp. which show comparatively stunted growth (Pl. 1, figs 2, 3). Chlorotic spots were observed occasionally in some plant species, like *Anona squamosa* and *Bauhinia* sp. (Pl. 1, figs 5, 6). This could be due to high surface gradient of the hillock, restricting water percolation in soil and thus creating water stress for plants. Such a condition where iron is available and is essential for chlorophyll it could be possible that water stress might have induced chlorosis as 'H' is the most active component of chlorophyll. An unusual black necrotic spot observed in *Lagerstroemia parviflora* (Pl. 1, fig. 2) apparently indicating the toxicity of either absorption or displacement of essential micro or macro-nutrient under the contamination stress in the mineralized area.

Variance in the vegetation was also observed in the mineralized and non-mineralized areas at Madaura. The soil and rock are mainly enriched in Mn, Cu, Co and Cr. The plant species associated are listed in Table 2. Here, *Gymnosporia montana* and *Carissa spinarum* were abundant showing bronzing of leaf along with necrotic spots all over the surface. Large trees associated with this rock type are absent except *Madhuca indica* which was abundant in the region. Comparatively, plants show dwarfism in the mineral rich area with chlorotic and necrotic lesions on leaves.

Chlorosis and bronzing were more in *Carissa* sp. showing stunted growth. However, members of Mimosaceae seem to be quite resistant to the mineral soil as no symptomatic differences observed when compared to those plant species growing in the non-mineralized area. Chlorosis or yellowing of the leaves followed by necrosis due to Ni toxicity has been described by Mishra and Kar

Table 2. List of plants in Madaura area .

Sl. No.	Botanical name	Common name	Family	Occurrence in		Indicator type Universal/Local
				Mineralized area	Non-mineral-ized area	
1	2	3	4	5	6	7
1.	*Acacia arabica* Willd.	Babool	Leguminosae	++	++	L
2.	*Acacia leucophloea* Willd.	Renja	Leguminosae	++	++	L
3.	*Areca catechu* Willd.	Kattha	Leguminosae	+	+	L
4.	*Argemone mexicana* L.	Sialkanta	Papaveraceae	++	+	L
5.	*Bauhinia* sp.	Kachnar	Leguminosae	+	+	L
6.	*Butea monosperma* (Lam.) Kuntz.	Palas	Fabaceae	-	+	S
7.	*Caesulia axillaris* Roxb.	Weed	Compositae	+	+	L
8.	*Canscora diffusa* Br.	Kyonkpan	Gentianaceae	+	+	L
9.	*Carissa spinarum* Linn.	Karaundi	Apocynaceae	++	+	S
10.	*Cassia fistula* Linn.	Amaltas	Leguminosae	-	+	S
11.	*Cocculus hirsutus* Linn.	Saleta	Menispermaceae	++	++	L
12.	*Dalbergia sissoo* Roxb.	Sheesham	Leguminosae	-	+	S
13.	*Diospyros melanoxylon* Roxb.	Tendu	Ebenaceae	++	-	U
14.	*Emblica officinalis* Gaertn.	Aonla	Euphorbiaceae	+	-	U
15.	*Emilia sonchifolia* DC.	Hirankhuri	Asteraceae	++	+	L
16.	*Flacourtia indica* Merr.	Kankar	Flacourtiaceae	+	-	U
17.	*Grewia helicterifolia* Wall.	Ghatiyaar	Tiliaceae	+	-	U
18.	*Gymnosporia montana* (Roth.) Benth.	Bekal	Celastraceae	++	+	L
19.	*Ipomoea carnea* Sacq.	Behaya	Convolvulaceae	+	+	L
20.	*Lantana camara* Linn.l	Ghaneri	Verbenaceae	+	++	L
21.	*Launaea nudicaulis* Hook.	Dudhlak	Compositae	+	+	L
22.	*Leucas procumbens* Desf.	Weed	Compositae	+	+	L
23.	*Madhuca indica* J.F. Gmel.	Mahua	Sapotaceae	++	+	L
24.	*Mangifera indica* Linn.	Mango	Anacardiaceae	-	+	S
25.	*Mimosa himalayana* Willd.	Aar	Leguminosae	++	++	L
26.	*Polycarpon loeflingiae* Benth.	Weed	Caryophyllaceae	+	+	L
27.	*Sida rhombifolia* L.	Sweet karela	Malvaceae	++	+	L
28.	*Sygygium heyneanum*	*Kath Jamun*	*Myrtaceae*	-	++	S
29.	*Tamarindus indica* Linn.	Tamarind	Leguminosae	-	+	S
30.	*Vetiveria zizanioides* Linn.	Khas	Gramineae	-	+	S
31.	*Woodfordia fruticosa* Kurz.	Dhawai	Lythraceae	+	++	L
32.	*Xeromorphis* sp.	Mainar	Rubiaceae	+	+	L
33.	*Ziziphus mauritiana* Lam.	Ber	Rhamnaceae	-	+	S
34.	*Z. nummularia* W. & A.	Jharberi	Rhamnaceae	+	+	L

+ Common, ++ Abundant, - Absent, 0 Occasional

(1974). Other toxic symptoms include stunted growth of the roots and shoots, and an unusal spottings on leaves and stems. Present observations converge to the inference that Ni along with Cu, Co and Cr present in the mineral soil could have been absorbed by the plants in the region showing toxic symptoms as documented in the literature (Wild, 1974; Lounamaa, 1956; Malyuga, 1964; Bowen *et al.*, 1962; Tiffin, 1967)

High traces of 'lead' deposits are under investigation in the Samogar region. At Girar and Madaura areas *Carissa carandus* has taken place of *C. spinarum*. Among the large trees only *Madhuca indica* was abundant with occasinal appearance of *Dalbergia* sp. However, the vegetation was sparse in the region of lead deposit and profuse in the non-mineralized region. Absence of a large number of species from the mineralized area points out the toxicity of lead as documented in the literature (Zimdahal & Koeppe, 1977).

Soils enriched with heavy metals and the phenomenon of adapatation of plants to such soils have been well documented (Ernts, 1974; Antonovics *et al.*, 1971; Baker, 1981). Concludingly, present observations reveal that heavy metal resistance and toxicity shown by plants could be correlated to the metal concentration in soil available for plants. However, toxicity symptoms observed in plants might be either due to uptake of heavy metal at the site or due to displacement and imbalance created for other micro or macro-plant nutrients along with water stress conditions.

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Table 3. List of plants in Samogar area.

Sl. No.	Botanical Name	Common name	Family	Occurrence in Mineralized area	Occurrence in Non-mineral-ized area	Indicator type Universal/Local
1	2	3	4	5	6	7
1.	*Acacia arabica* Willd.	Babool	Leguminosae	+	+	L
2.	*A. leucophloea* Willd.	Renja	Leguminosae	+	+	L
3.	*Aegle marmelos* Corr.	Bel	Rutaceae	-	+	S
4.	*Anona squamosa* Linn.	Shareefa	Anonaceae	-	++	S
5.	*Areca catechu* Willd.	Kattha	Leguminosae	0	+	L
6.	*Butea monosperma* Lam.) Kuntz.	Palas	Fabaceae	-	+	S
7.	*Carissa carandus* Linn.	Karaundi	Apocynaceae	++	+	L
8.	*Dalbergia sissoo* Roxb.	Sheesham	Leguminosac	0	+	L
9.	*Ipomoea carnea* Sacq.	Behaya	Convolvulaceae	-	++	S
10.	*Lantana camara* Linn.	Ghaneri	Verbenaceae	++	++	L
11.	*Madhuca indica* G.F. Gmel.	Mahua	Sapotaceae	+	+	L
12.	*Mimosa himalayana* Gamble.	Aar	Mimosaceae	+	+	L
13.	*Syzygium cumini* Linn.	Jamun	Myrtaceae	-	++	S
14.	*Tectona grandis* Linn.	Teak	Verbenaceae	-	+	S

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REFERENCES

Antonovics, J., Bradshaw, A.D. & Turner, R.G. 1971. Heavy metal tolerance in plants. *Adv. Ecol. Res.* 7: 1-85.

Baker, A.J.M. 1981. Accumulators and excluders-strategies in the response of plants to heavy metals. *J.Plant Nutr.* 3:643-654.

Bowen, H.J.M., Cawse, P.A. & Thick, J. 1962. The distribution of some inorganic elements in plant toxic extracts. *J. Exp. Bot.* 13: 257-67.

Brown, J.C. 1976. Screening plants for iron efficiency. In: M.J. Wright (Ed.) -*Plants Adaptation to Mineral Stress in Problem Soils*.:35-58 Cornell University Agricultural Experimetal Station, Ithaca. :35-58

Ernst, W.H.O. 1966. Okologish - Soziologische unter Sernchungen an Schwer metallpflanzed gestelt schaften sudfrankreichs und des ostlicher harzvor handes. *Flora* 156: 301-18.

Ernts, W.H.O. 1974. *Schwermetallvegetation der Erde*. Stullgart, Fisher.

Lounamaa, J. 1956. Trace elements in plants growing wild on different rocks in Finland *Ann. Bot. Soc. Zool. Bot. Fenn. Vanamo* 29: 1427-32.

Malyuga, D.P. 1964. *Biogeochemical Methods of Prospecting* (Translated from the Russian) Consultant Bureau, New York.

Mishra, D. & Kar M. 1974. Nickel in Plant growth and Metabolism. *Bot. Rev.* 40: 395-452.

Simon, E. 1978. Heavy metals in soils, vegetation development and heavy metal tolerance in plant populations from metalliferous areas. *New Phytol.* 81: 175-88.

Tiffin, L.O. 1967. Translation of manganese, iron, cobalt and zinc in tomato. *Plant Physiol.* 42: 1427-32.

Wild, H. 1974. Indigenou plants and chromium in Rhodesia. *Kirkia* 9: 233-41.

Zimdahl, R.L. & Koeppe, D.E. 1977. Uptake by plants. *In* : Bogges, W.R. (Ed.)--*Lead in the Environment* :99-104. National Science Foundation, Washington D.C.