

# Floral diversity and Identification of adaptive plants in relation to their soil properties at municipal waste dumpsites, Guwahati, Assam, India

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## ABSTRACT

This study investigates the influence of soil properties on plant diversity in the Boragaon Disposal Site, a major dumpsite in Guwahati, compared to an adjacent undisturbed area. Soil analysis revealed significant differences, with the affected area exhibiting higher alkalinity (pH 8.06), moisture content (21.6%), water-holding capacity (72.87%), and electrical conductivity (1.579 dS/m), along with lower bulk density (0.833 g/cm<sup>3</sup>) than the unaffected site (pH 7.7, moisture 7.8%, WHC 51.74%, EC 0.581 dS/m, bulk density 1.058 g/cm<sup>3</sup>). Floristic surveys recorded 32 plant species from 19 families in the affected area, dominated by *Ricinus communis* (IVI = 63.31), while the unaffected site hosted 31 species from 16 families, with *Eleusine indica* (IVI = 69.57) as the dominant species. Species diversity was marginally higher in the affected area (Shannon index = 3.128) compared to the control site (2.979), indicating that waste deposition modifies soil conditions, favoring specific plant communities. Distribution patterns also varied, with contagious distribution (16 species) prevalent in the affected area and regular distribution (15 species) dominating the unaffected site. The findings suggest that long-term waste accumulation alters soil properties, facilitating ecological succession and promoting distinct floristic assemblages shaped by anthropogenic disturbances. This study highlights the role of modified soil conditions in shaping plant diversity in degraded ecosystems and selecting suitable plant species for further phytoremediation studies under control circumstances, which will be supportive in understanding the role of soil properties in vegetation formation and growth on such sites.

**Keywords:** Floral diversity, Soil properties, Dumpsite ecology, IVI, Distribution patterns, Guwahati, Assam.

## Introduction

In India, many cities have open dumping sites and

unscientific landfills where municipal waste is discarded, creating substrates that support the growth of various plant communities. While these landfills

often exhibit poor vegetation, plants that naturally grow on both natural and manmade grounds demonstrate their ability to adapt to challenging growth conditions (Leone *et al.*, 1977; Moffat and Houston, 1991; Nagendra and Gopal, 2010). These dumping sites may anchor a range of toxins due to the varied composition of waste and the plants growing in these areas may help in removing these contaminants (Nagendran *et al.*, 2003; Nyiramigisha, 2021). To achieve this, it is crucial to select suitable plant species from the native flora to understand their potential for phytoextraction. For effective species selection, it is essential to examine the ecological factors present in such habitats. These include the density, abundance, distribution pattern, frequency, and species diversity of plants. Despite the limited surface area of these sites, they often provide a unique environmental niche where a large diversity of flora and fauna can thrive. Waste from various sources accumulates at these sites, creating an environment where some plant species thrive due to competitive advantages, while others remain rare (Sukopp *et al.*, 1972). These waste deposits, which include both organic and inorganic materials, represent habitats with varied geographical characteristics, genesis and substrate toxicity (Pysek *et al.*, 1996). Vegetation in these distinctive habitats offers valuable opportunities to study plant responses to extreme environmental conditions (Antonovics *et al.*, 1971). Furthermore, the age of the dumpsite also influences plant colonization and growth (Borpujari, 2008). Among the various factors influencing plant establishment, soil physiochemical properties play a critical role in vegetation development (Gairola and Soni, 2010). For example, soil structure and acidity affect the absorption and accumulation of mineral elements by plants, thereby influencing vegetation growth (Tresow, 1970). Guwahati, the most populous district in Assam, faces a high municipal waste generation rate, approximately 530 metric tons per day. Prior to 2021, the Guwahati Municipal Corporation (GMC) operated a single dumping site at Boragaon, but a new site at Chandrapur was added to the list. The Boragaon Disposal Site is of particular interest due to its long history of waste disposal, spanning approximately 12 years, and its large size and diverse plant communities. While several reports have focused on waste management practices in Guwahati, most have emphasized the characterization and management of municipal solid waste, with little attention given to the plant communities

that thrive in these areas. Studies on the native plants and their adaptations to waste dumping grounds are notably absent. Therefore, the Boragaon Disposal Site was selected for a study on plant occurrence and distribution patterns, which will help inform future research on appropriate plant species for Phyto management efforts.

The primary objectives of the present study are to identify the plant communities growing on municipal waste dumpsites, utilize ecological parameters to examine the occurrence and distribution of plant species, assess the impact of soil properties and waste accumulation age on plant patterns, and identify the most adaptive and dominant species at these sites. This research is crucial for understanding the tolerance and phytoremediation potential of plants growing in such challenging environments (Tripathi and Misra, 2012).

## Materials and Methods

### Study site

This study focuses on Guwahati, a major city along the Brahmaputra River, Assam. The research specifically examines the Boragaon Disposal Site, located at 26°11'N latitude and 91°68'E longitude, covering approximately 46 acres. Guwahati experiences a subtropical climate with semi-dry summers and cold winters. The city generates substantial amounts of solid waste, with more than 70% being dumped at the Boragaon site, while only a small portion is recycled. Every 30 minutes, a Guwahati Municipal Corporation truck disposes of tons of waste at this site, which includes a mix of organic and inorganic materials such as food waste, paper, metals, plastics, textiles, and sewage slag. To provide a comparative perspective, the study also includes unpolluted sites within a 1 kilometer radius of the Boragaon Disposal Site. These unaffected sites serve as controls to assess the impact of waste accumulation on the surrounding environment.

### Soil sampling and analysis

Soil was collected from different directions and at the center of the waste accumulations from 20cm depth rooting zone at each site. 10 sites were selected from both dumpsite and adjoining unaffected areas (five from waste dumpsite area and five from adjoining unaffected area) of Boragaon Disposal site, Guwahati. The collected samples were sieved,

grounded, air dried and subjected to further physical analysis such as pH, conductivity, moisture content, soil texture, water holding capacity and bulk density (Hamdeh, 2004; Blake and Hartge, 1986; Saxena, 1989).

### Collection and identification of Angiosperm plant species

A floral survey and investigation were conducted at the study site and nearby areas within a 1 kilometer radius. During the study, both sites were visited to collect plant specimens for identification and herbarium preparation, following the methods outlined by Jain and Rao (1977).

### Diversity and distribution of angiosperms

Two locations, namely affected area, Boragaon and unaffected area was selected sites for study of the plants. The density was measured by placing quadrat (10m×10m) randomly on the survey sites. Five quadrates were placed at each site of the survey spot. All species under the quadrat like trees, shrubs, herbs, climbers were counted. The data were quantitatively analyzed for frequency, density and abundance following Curtis and McIntosh (1950) and the relative values of frequency, density and abundance were determined as per Phillips (1959) and summed these values to get Important Value Index (IVI).

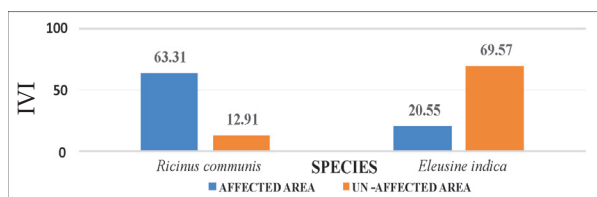
## Results and Discussion

The physical characteristic of soil samples, which are selected from Boragaon dumpsites and adjoining unaffected areas have been studied or analyzed and the results are summarized (Table 1 and Fig. 1)

**Table 1.** Physical Properties of Soil

Soil Parameters	Affected Area	Un-affected Area
Moisture Content	21.60%	7.80%
Water Holding Capacity	72.866%	51.736%
Bulk Density	0.833g/cm <sup>3</sup>	1.058g/cm <sup>3</sup>
pH	8.06	7.7
Conductivity	1.579dSm <sup>-1</sup>	0.581dSm <sup>-1</sup>

The soil composition in the affected area comprises 90% sand, 28.57% silt, and 7.14% clay, classifying it as sandy soil. In contrast, the unaffected area contains 80% sand, 10% silt, and 10% clay, classifying it as sandy loam soil. Soil moisture content var-



**Fig. 1.** IVI of *Ricinus communis* and *Eleusine indica*

ies significantly across sites, with the affected area showing the highest soil moisture retention at 21.60% and the unaffected area the lowest at 7.80%. High moisture content probably due to the topography of the dumpsite which is low lying ground along the roadside which helps in retaining more rainwater for longer duration than the un-affected sites (Tripathi and Misra, 2011). The high moisture content serves to protect the roots in the soil as well as uptake of water and nutrient from the soil (Eden *et al.*, 2011). These findings indicate that the affected area has a greater water-holding capacity (72.866%) compared to the unaffected area (51.736%). In terms of bulk density, the highest value (1.058 g/cm<sup>3</sup>) was observed in the unaffected area, while the lowest value (0.833 g/cm<sup>3</sup>) was found in the affected area. Soil pH in both areas indicates alkaline conditions, with the affected area showing a higher pH of 8.06 compared to 7.7 in the unaffected area. Electrical conductivity in the affected area was recorded at 1.579 dS/m, whereas it was significantly lower in the unaffected area at 0.581 dS/m. High pH and high bulk density can decrease the mobility of some elements in the soil (Rosselli *et al.*, 2003).

Species diversity, relative frequency, relative density, relative abundance, importance value index (IVI), and distribution patterns of plant species were analyzed using Whitford's Index (W) at the Boragaon disposal site (affected area) and its adjoining unaffected area. In the affected area, 32 plant species were recorded. Among these, *Ricinus communis* (Euphorbiaceae) was the most abundant, with the highest IVI of 63.31 (Table 2, 3 and 4).

In this investigation, 32 species are recorded from the Boragaon disposal site (affected area). Among the whole species, the *Ricinus communis* (Euphorbiaceae family) is present abundantly and it is the first dominant plant in the study area which has highest IVI (63.31) (Fig. 1). From the view of the family, the most species are from Fabaceae family. The species like *Anadenanthera colubrina*, *Mimosa pudica*, *Samanea saman*, *Senna hirsuta*, *Senna occidentalis* are from Fabaceae family. 31 species are

**Table 2.** Floral Distribution of affected and un-affected area

Sl. No	Species	Affected Area	Un-affected Area	Family	Common Name	Habit
1	<i>Abutilon indicum</i> Linn.	(+)	(-)	Malvaceae	Indian Mallow	Shrub
2	<i>Achyranthes aspera</i> Linn.	(-)	(+)	Amaranthaceae	Chaff-Flower	Herb
3	<i>Alternanthera sessilis</i> Linn.	(+)	(+)	Amaranthaceae	Brazilian Spinach	Herb
4	<i>Amaranthus albus</i> Linn.	(+)	(-)	Amaranthaceae	Tumble Pigweed	Herb
5	<i>Anadenanthera colubrina</i> Vell.	(+)	(-)	Fabaceae	Vilca	Tree
6	<i>Asclepias eriocarpa</i> Benth.	(+)	(-)	Apocynaceae	Woollypod Milkweed	Herb
7	<i>Azadirachta indica</i> A. Juss.	(+)	(-)	Meliaceae	Neem	Tree
8	<i>Benincasahispida</i> Thunb.	(+)	(-)	Cucurbitaceae	Ash Gourd	Annular climber
9	<i>Calotropis gigantea</i> Linn.	(+)	(+)	Apocynaceae	Crown Flower	Shrub
10	<i>Calotropis procera</i> Aiton.	(-)	(+)	Apocynaceae	Giant Milkweed	Shrub
11	<i>Camonea umbellate</i> Linn.	(-)	(+)	Convolvulaceae	Yellow Wood Rose	Climber
12	<i>Camonea vitifolia</i> Burm.f.	(-)	(+)	Convolvulaceae	Grape-leaf Wood Rose	Climber
13	<i>Citrullus colocynthis</i> Linn.	(+)	(-)	Cucurbitaceae	Bitter Cucumber	Annual vine
14	<i>Cleome hassleriana</i> Linn.	(-)	(+)	Capparaceae	Spider Flower	Herb
15	<i>Cleome viscosa</i> Linn.	(+)	(-)	Cleomaceae	Asian Spiderflower	Herb
16	<i>Coccinia grandis</i> Linn.	(+)	(-)	Cucurbitaceae	Ivy Gourd	Climber
17	<i>Commelina diffusa</i> Burm.f.	(+)	(-)	Commelinaceae	Spreading Dayflower	Herb
18	<i>Crotalaria pallid</i> Aiton.	(-)	(+)	Fabaceae	Rattle Box	Shrub
19	<i>Datura stramonium</i> Linn.	(+)	(-)	Solanaceae	Jimsonweed	Shrub
20	<i>Descurainia pinnata</i> Walter.	(-)	(+)	Brassicaceae	Western Tansy	Shrub
21	<i>Eleusine indica</i> Linn.	(+)	(+)	Poaceae	Indian Goosegrass	Herb
22	<i>Euphorbia heterophylla</i> Linn.	(-)	(+)	Euphorbiaceae	Mexican Fire Plant	Herb
23	<i>Ficus religiosa</i> Linn.	(+)	(-)	Moraceae	Peepal Tree	Tree
24	<i>Grevillea robusta</i> Alan.	(+)	(-)	Proteaceae	Silver Oak	Tree
25	<i>Heliotropium indicum</i> Linn.	(+)	(-)	Boraginaceae	Indian Turnsole	Herb
26	<i>Ipomoea cairica</i> Linn.	(-)	(+)	Convolvulaceae	Railway Creeper	Climber
27	<i>Ipomoea carnea</i> Jacq.	(-)	(+)	Convolvulaceae	Bush Morning Glory	Climber
28	<i>Lantana camara</i> Linn.	(+)	(+)	Verbenaceae	Common Lantana	Shrub
29	<i>Lippia alba</i> Mill.	(-)	(+)	Verbenaceae	Bushy Matgrass	Herb
30	<i>Melia azedarach</i> Linn.	(+)	(-)	Meliaceae	Bead-Tree	Tree
31	<i>Microstegium vimineum</i> Trin.	(-)	(+)	Poaceae	Packing Grass	Herb
32	<i>Milletia pinnata</i> Linn.	(-)	(+)	Fabaceae	Malapari	Tree
33	<i>Mimosa pudica</i> Linn.	(+)	(+)	Fabaceae	Touch-me-not Plant	Herb
34	<i>Neolamarckiacadamba</i> Roxb.	(+)	(-)	Rubiaceae	Burflower Tree	Tree
35	<i>Oldenlandiacorymbosa</i> Linn.	(+)	(+)	Rubiaceae	Old World Diamond Flower	Herb
36	<i>Oxalis corniculata</i> Linn.	(-)	(+)	Oxalidaceae	Sleeping Beauty	Herb
37	<i>Parthenium hysterophorus</i> Linn.	(+)	(+)	Asteraceae	Santa Maria Feverfew	Shrub
38	<i>Persicaria maculosa</i> Linn.	(-)	(+)	Polygonaceae	Red Shank	Shrub
39	<i>Physalis peruviana</i> Linn.	(+)	(-)	Solanaceae	Goldenberry	Herb
40	<i>Portulaca oleracea</i> Linn.	(+)	(-)	Portulacaceae	Common Purslane	Herb
41	<i>Ricinus communis</i> Linn.	(+)	(+)	Euphorbiaceae	Castor Oil Plant	Shrub
42	<i>Rumex crispus</i> Linn.	(-)	(+)	Polygonaceae	Curley Dock	Herb
43	<i>Samanea saman</i> Jacq.	(+)	(-)	Fabaceae	Rain Tree	Tree
44	<i>Scoparia dulcis</i> Linn.	(+)	(+)	Plantaginaceae	Goatweed	Herb
45	<i>Senna hirsute</i> Linn.	(+)	(-)	Fabaceae	Wolly Cassia	Shrub
46	<i>Senna occidentalis</i> Linn.	(+)	(+)	Fabaceae	Antbush	Shrub
47	<i>Solanum nigrum</i> Linn.	(-)	(+)	Solanaceae	Black Nightshade	Shrub
48	<i>Solanum toroum</i> Sw.	(-)	(+)	Solanaceae	Turkey Berry	Tree
49	<i>Solanum xanthocarpum</i> Linn.	(+)	(+)	Solanaceae	Kantakari	Herb
50	<i>Urena lobata</i> Linn.	(+)	(-)	Malvaceae	Caesarweed	Shrub
51	<i>Xanthium strumarium</i> Linn.	(-)	(+)	Asteraceae	Rough Cocklenbur	Herb
52	<i>Ziziphus mauritiana</i> Lam.	(-)	(+)	Rhamnaceae	Jujube	Tree

(+) indicate present; (-) indicate absent

**Table 3.** Diversity and IVI value of the species found in affected and unaffected areas

Sl. No.	Species	Affected (A)/ Unaffected (U) area	DIVERSITY	R.F.	R.D.	R.Do.	IVI
1	<i>Abutilon indicum</i>	(A)	0.082788381	1.96	2.32	0.8	5.08
		(U)	-	-	-	-	-
2	<i>Achyranthes aspera</i>	(A)	-	-	-	-	-
		(U)	0.178334465	4.25532	6.53846	6.2446	17.0384
3	<i>Alternanthera sessilis</i>	(A)	0.150503212	3.92	5.42	4.35556	13.6956
		(U)	0.133810192	4.25532	4.23077	2.61452	11.1006
4	<i>Amaranthus albus</i>	(A)	0.177231973	3.92	6.97	7.2	18.09
		(U)	-	-	-	-	-
5	<i>Anadenanthera colubrina</i>	(A)	0.035499812	1.96	0.77	0.08889	2.81889
		(U)	-	-	-	-	-
6	<i>Asclepias eriocarpa</i>	(A)	0.082788381	3.92	2.32	0.8	7.04
		(U)	-	-	-	-	-
7	<i>Azadirachta indica</i>	(A)	0.061026284	3.92	1.55	0.35556	5.82556
		(U)	-	-	-	-	-
8	<i>Benincasahispida</i>	(A)	0.035499812	1.96	0.77	0.08889	2.81889
		(U)	-	-	-	-	-
9	<i>Camonea umbellata</i>	(A)	-	-	-	-	-
		(U)	0.021387237	2.12766	0.38462	0.02161	2.53388
10	<i>Camonea vitifolia</i>	(A)	-	-	-	-	-
		(U)	0.021387237	2.12766	0.38462	0.02161	2.53388
11	<i>Calotropis gigantea</i>	(A)	0.119605612	5.88	3.87	2.22222	11.9722
		(U)	0.197303797	6.38298	7.69231	8.64304	22.7183
12	<i>Calotropis procera</i>	(A)	-	-	-	-	-
		(U)	0.097320771	2.12766	2.69231	1.05877	5.87874
13	<i>Citrullus colocynthis</i>	(A)	0.164318411	3.92	3.1	1.42222	8.44222
		(U)	-	-	-	-	-
14	<i>Cleome hassleriana</i>	(A)	-	-	-	-	-
		(U)	0.021387237	2.12766	0.38462	0.02161	2.53388
15	<i>Cleome viscosa</i>	(A)	0.102105887	1.96	2.32	0.8	5.08
		(U)	-	-	-	-	-
16	<i>Coccinia grandis</i>	(A)	0.082788381	1.96	1.55	0.35556	3.86556
		(U)	-	-	-	-	-
17	<i>Commelinadiffusa</i>	(A)	0.061026284	3.92	6.2	5.68889	15.8089
		(U)	-	-	-	-	-
18	<i>Crotalaria pallida</i>	(A)	-	-	-	-	-
		(U)	0.051485415	2.12766	1.15385	0.19447	3.47597
19	<i>Datura stramonium</i>	(A)	0.082788381	3.92	2.32	0.8	7.04
		(U)	-	-	-	-	-
20	<i>Descurainia pinnata</i>	(A)	-	-	-	-	-
		(U)	0.037442573	2.12766	0.76923	0.08643	2.98332
21	<i>Eleusine indica</i>	(A)	0.189344521	3.92	7.75	8.88889	20.5589
		(U)	0.303580236	8.51064	17.3077	43.7554	69.5737
22	<i>Euphorbia heterophylla</i>	(A)	-	-	-	-	-
		(U)	0.051485415	2.12766	1.15385	0.19447	3.47597
23	<i>Ficus religiosa</i>	(A)	0.035499812	1.96	0.77	0.08889	2.81889
		(U)	-	-	-	-	-
24	<i>Grevillea robusta</i>	(A)	0.035499812	1.96	0.77	0.08889	2.81889
		(U)	-	-	-	-	-
25	<i>Heliotropium indicum</i>	(A)	0.135656739	3.92	4.65	3.2	11.77
		(U)	-	-	-	-	-

Table 3. Contiued ...

Sl. No.	Species	Affected (A)/ Unaffected (U) area	DIVERSITY	R.F.	R.D.	R.Do.	IVI
26	<i>Ipomoea cairica</i>	(A)	-	-	-	-	-
		(U)	0.141958845	2.12766	4.61539	3.1115	9.85454
27	<i>Ipomoea carnea</i>	(A)	-	-	-	-	-
		(U)	0.157318232	2.12766	5.38462	4.23509	11.7474
28	<i>Lantana camara</i>	(A)	0.189344521	3.92	7.75	8.88889	20.5589
		(U)	0.141958845	4.25532	4.61539	3.1115	11.9822
29	<i>Lippia alba</i>	(A)	-	-	-	-	-
		(U)	0.086975127	2.12766	2.30769	0.77787	5.21323
30	<i>Melia azedarach</i>	(A)	0.035499812	1.96	0.77	0.08889	2.81889
		(U)	-	-	-	-	-
31	<i>Microstegium vimineum</i>	(A)	-	-	-	-	-
		(U)	0.133810192	2.12766	4.23077	2.61452	8.97295
32	<i>Mimosa pudica</i>	(A)	0.150503212	3.92	5.42	4.35556	13.6956
		(U)	0.10711508	4.25532	3.07692	1.38289	8.71513
33	<i>Millettia pinnata</i>	(A)	-	-	-	-	-
		(U)	0.021387237	2.12766	0.38462	0.02161	2.53388
34	<i>Neolamarckiacadamba</i>	(A)	0.035499812	1.96	0.77	0.08889	2.81889
		(U)	-	-	-	-	-
35	<i>Oldenlandiacorymbosa</i>	(A)	0.119605612	3.92	3.87	2.22222	10.0122
		(U)	0.051485415	4.25532	1.15385	0.19447	5.60363
36	<i>Oxalis corniculata</i>	(A)	-	-	-	-	-
		(U)	0.16457489	6.38298	5.76923	4.86171	17.0139
37	<i>Parthenium hysterophorus</i>	(A)	0.102105887	5.88	3.1	1.42222	10.4022
		(U)	0.16457489	4.25532	5.76923	4.86171	14.8863
38	<i>Persicaria maculosa</i>	(A)	-	-	-	-	-
		(U)	0.10711508	2.12766	3.07692	1.38289	6.58747
39	<i>Peruvian groundcherry</i>	(A)	0.035499812	1.96	0.77	0.08889	2.81889
		(U)	-	-	-	-	-
40	<i>Portulaca oleracea</i>	(A)	0.061026284	1.96	1.55	0.35556	3.86556
		(U)	-	-	-	-	-
41	<i>Ricinus communis</i>	(A)	0.28553224	7.84	16.27	39.2	63.31
		(U)	0.149786614	4.25532	5	3.65169	12.907
42	<i>Rumex crispus</i>	(A)	-	-	-	-	-
		(U)	0.037442573	2.12766	0.76923	0.08643	2.98332
43	<i>Samanea saman</i>	(A)	0.035499812	1.96	0.77	0.08889	2.81889
		(U)	-	-	-	-	-
44	<i>Scoparia dulcis</i>	(A)	0.119605612	1.96	3.87	2.22222	8.05222
		(U)	0.051485415	2.12766	1.15385	0.19447	3.47597
45	<i>Senna hirsuta</i>	(A)	0.082788381	3.92	2.32	0.8	7.04
		(U)	-	-	-	-	-
46	<i>Senna occidentalis</i>	(A)	0.119605612	3.92	3.87	2.22222	10.0122
		(U)	0.037442573	2.12766	0.76923	0.08643	2.98332
47	<i>Solanum nigrum</i>	(A)	-	-	-	-	-
		(U)	0.021387237	2.12766	0.38462	0.02161	2.53388
48	<i>Solanum torvum</i>	(A)	-	-	-	-	-
		(U)	0.051485415	2.12766	1.15385	0.19447	3.47597
49	<i>Solanum xanthocarpum</i>	(A)	0.061026284	1.96	1.55	0.35556	3.86556
		(U)	0.037442573	4.25532	0.76923	0.08643	5.11098
50	<i>Urena lobata</i>	(A)	0.061026284	1.96	1.55	0.35556	3.86556
		(U)	-	-	-	-	-

Table 3. Continued ...

Sl. No.	Species	Affected (A)/ Unaffected (U) area	DIVERSITY	R.F.	R.D.	R.Do.	IVI
51	<i>Xanthium strumarium</i>	(A)	-	-	-	-	-
		(U)	0.178334465	4.25532	6.53846	6.2446	17.0384
52	<i>Ziziphus jujube</i>	(A)	-	-	-	-	-
		(U)	0.021387237	2.12766	0.38462	0.02161	2.53388

(A) indicate Affected area; (U) indicate Unaffected area

recorded from the adjoining un-affected areas. In where, *Eleusine indica* from Poaceae family has highest IVI (69.57) (Fig. 1) and secondly *Calotropis gigantea* from Apocynaceae family has second highest IVI (22.71). But here, the *Ricinus communis* has

only 12.91% IVI which are very low in comparison to affected area and more area are covered by plant species which were under Convolvulaceae and Fabaceae family.

From the observations, the most dominant family



Plate 1. Boragaon Disposal Study Area

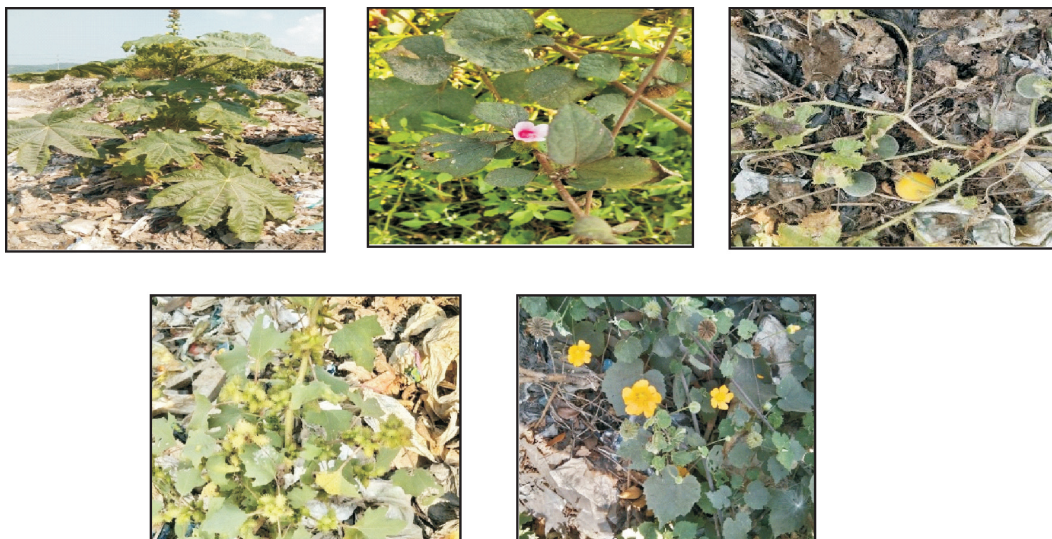


Plate 2. Collected Plants from study site

**Table 4.** Whitfold's index (W) and distribution pattern of the species found in affected and unaffected area

Sl No.	SPECIES	Affected (A)/ Unaffected (U) area	W	Distribution Pattern
1	<i>Abutilon indicum</i>	(A) (U)	0.15 -	Contagious -
2	<i>Achyranthes aspera</i>	(A) (U)	- 0.10047	- Contagious
3	<i>Alternanthera sessilis</i>	(A) (U)	0.0875 0.04206	Contagious Random
4	<i>Amaranthus albus</i>	(A) (U)	0.1125 -	Contagious -
5	<i>Anadenanthera colubrina</i>	(A) (U)	0.05 -	Random -
6	<i>Asclepias eriocarpa</i>	(A) (U)	0.0375 -	Random -
7	<i>Azadirachta indica</i>	(A) (U)	0.025 -	Random -
8	<i>Benincasahispida</i>	(A) (U)	0.05 -	Random -
9	<i>Camonea umbellata</i>	(A) (U)	- 0.0007	- Regular
10	<i>Camonea vitifolia</i>	(A) (U)	- 0.0007	- Regular
11	<i>Calotropis gigantea</i>	(A) (U)	0.02778 0.0927	Random Contagious
12	<i>Calotropis procera</i>	(A) (U)	- 0.03407	- Random
13	<i>Citrullus colocynthis</i>	(A) (U)	0.05 -	Random -
14	<i>Cleome hassleriana</i>	(A) (U)	- 0.0007	- Regular
15	<i>Cleome viscosa</i>	(A) (U)	0.15 -	Contagious -
16	<i>Coccinia grandis</i>	(A) (U)	0.1 -	Contagious -
17	<i>Commelinadiffusa</i>	(A) (U)	0.1 -	Contagious -
18	<i>Crotalaria pallida</i>	(A) (U)	- 0.00626	- Regular
19	<i>Datura stramonium</i>	(A) (U)	0.0375 -	Random -
20	<i>Descurainia pinnata</i>	(A) (U)	- 0.00278	- Regular
21	<i>Eleusine indica</i>	(A) (U)	0.125 0.35198	Contagious Contagious
22	<i>Euphorbia heterophylla</i>	(A) (U)	- 0.00626	- Regular
23	<i>Ficus religiosa</i>	(A) (U)	0.05 -	Random -
24	<i>Grevillea robusta</i>	(A) (U)	0.05 -	Random -
25	<i>Heliotropium indicum</i>	(A) (U)	0.075 -	Contagious -
26	<i>Ipomoea cairica</i>	(A) (U)	- 0.10012	- Contagious

27	<i>Ipomoea carnea</i>	(A)	-	-
		(U)	0.13627	Contagious
28	<i>Lantana camara</i>	(A)	0.125	Contagious
		(U)	0.05006	Random
29	<i>Lippia alba</i>	(A)	-	-
		(U)	0.02503	Random
30	<i>Melia azedarach</i>	(A)	0.05	Random
		(U)	-	-
31	<i>Microstegium vimineum</i>	(A)	-	-
		(U)	0.08413	Contagious
32	<i>Mimosa pudica</i>	(A)	0.0875	Contagious
		(U)	0.02225	Regular
33	<i>Millettia pinnata</i>	(A)	-	-
		(U)	0.0007	Regular
34	<i>Neolamarckiacadamba</i>	(A)	0.05	Random
		(U)	-	-
35	<i>Oldenlandiacorymbosa</i>	(A)	0.0625	Contagious
		(U)	0.00313	Regular
36	<i>Oxalis corniculata</i>	(A)	-	-
		(U)	0.05215	Random
37	<i>Parthenium hysterophorus</i>	(A)	0.02222	Regular
		(U)	0.07822	Contagious
38	<i>Persicaria maculosa</i>	(A)	-	-
		(U)	0.0445	Random
39	<i>Peruvian groundcherry</i>	(A)	0.05	Random
		(U)	-	-
40	<i>Portulaca oleracea</i>	(A)	0.1	Contagious
		(U)	-	-
41	<i>Ricinus communis</i>	(A)	0.06563	Contagious
		(U)	0.05875	Random
42	<i>Rumex crispus</i>	(A)	-	-
		(U)	0.00278	Regular
43	<i>Samanea saman</i>	(A)	0.05	Random
		(U)	-	-
44	<i>Scoparia dulcis</i>	(A)	0.25	Random
		(U)	0.00626	Regular
45	<i>Senna hirsuta</i>	(A)	0.0375	Random
		(U)	-	-
46	<i>Senna occidentalis</i>	(A)	0.0625	Contagious
		(U)	0.00278	Regular
47	<i>Solanum nigrum</i>	(A)	-	-
		(U)	0.0007	Regular
48	<i>Solanum torvum</i>	(A)	-	-
		(U)	0.00626	Regular
49	<i>Solanum xanthocarpum</i>	(A)	0.1	Contagious
		(U)	0.00139	Regular
50	<i>Urena lobata</i>	(A)	0.1	Contagious
		(U)	-	-
51	<i>Xanthium strumarium</i>	(A)	-	-
		(U)	0.10047	Contagious
52	<i>Ziziphus jujube</i>	(A)	-	-
		(U)	0.0007	Regular

(A) Indicate Affected area; (U) indicate Unaffected area

in this area was found to be Fabaceae, represented by species such as *Anadenanthera colubrina*, *Mimosa pudica*, *Samanea saman*, *Senna hirsuta*, and *Senna occidentalis* (Demie, 2015). In the unaffected area, 31 species were recorded. *Eleusine indica* (family Poaceae) had the highest IVI of 69.57, followed by *Calotropis gigantea* (family Apocynaceae) with an IVI of 22.71. Notably, *Ricinus communis* had a much lower IVI (12.91%) in the unaffected area compared to the affected area. The present of *Ricinus communis* in wasteland area was also reported by Tripathi and Misra (2011). Additionally, plant species in the unaffected area were predominantly from the Convolvulaceae and Fabaceae families. Chen *et al.* (1996) and Odjegba and Sadiq (2002) also reported the tolerance of soil pollution by some species of Amaranthaceae. Gupta and Shukla (1991) observed an increasing trend in species diversity with the age of dumpsites, indicating a more stochastic development of ecosystems over time. The high diversity at dumpsites suggests that these environments can provide suitable habitats for certain plant species. In the affected study area, some plant species exhibited greater growth compared to the unaffected area. This is attributed to the accumulation of waste over the years, which enriches the soil with organic matter through degradation, thereby improving soil conditions and making them more conducive to plant growth. Plant species at dumpsites contribute to changes in the physicochemical properties of the soil, facilitating the growth and development of vegetation in these challenging habitats. Similarly, Pandey and Singh (1985) reported an increase in species diversity during ecological succession in other degraded ecosystems.

## Conclusion

The investigation indicates that among the 32 plant species of affected area, *Ricinus communis* is highly adaptive and from the un-affected areas *Eleusine indica* is adaptive. And the dominant plant of affected area (*Ricinus communis*) is lesser in the un-affected area. Similarly, the dominant plant of un-affected area (*Eleusine indica*) is present in limited quantities on waste dumpsite. It is observed that annual and perennial shrubs are more adaptive than the others group of plants on the municipal dumpsites, which consist mixed urban wastes. These plant species can tolerate alkaline soils. Plant species such as *Ricinus communis*, *Lantana camara*,

*Mimosa pudica*, *Alternanthera sessilis*, *Cammelina diffusa* are of highly important due to high biomass production activity on wasteland site. These species also add more organic matter to the soil through litter fall and decaying of plant tissue, thereby they also promote soil regeneration of such sites (Tripathi and Misra, 2011). The plant species from the affected study sites are helpful for dealing with the removal of a range of contaminants polluting the soil-environment. This investigation makes such platform to explore the phytoremediation potentials of these adaptive plant species by further experimental examinations. A selective plantation programme should be developed by using the adaptive plants which can tolerate the polluted soils and environment of these dumpsites, will be helpful against the open landfills and the toxic environment of the dumpsites. The present study on plant diversity in dump site concludes a good number of species (52) growing in relatively small area. Amongst the species commercially valuable species like *Ricinus communis*, *Calotropis procera* and *Achyranthes aspera* offer a chance for revenue initiation with phytoremediation. The absence of invasive species like *Parthenium hysterophorus* and *Eupatorium odoratum* from the dump site further offer a hope for developing this site to grow economically sustainable species.

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## References

- Antonovics, J., Bradshaw, A.D. and Turner, R.G. 1971. Heavy metal tolerance in plants. *Advances in Ecological Research*. 7: 1-85.
- Blake, G.R. and Hartge, K.H. 1986. Bulk density. In: *Methods of Soil Analysis, Part I: Physical and mineralogical methods*. ASA Monograph, Madison. 363-376.
- Borpujari, D. 2008. Studies on the occurrence and distribution of some tolerant plant species in different spoil dumps of Tikak opencast mine. *The Ecoscan*. 2(2): 255-260.
- Chen, J., Chen, W. and Hsu, R. 1996. Biosorption of copper from aqueous solutions by plant root tissues. *Journal of Fermentation Bioengineering*. 81: 458-463.
- Curtis, J.T. and Cottam, G. 1956. *Plant Ecology Work Book*.

- Laboratory Field Reference Manual. Burgers Publishing Co., Minnesota.
- Demie, G. 2015. Floristic composition and diversity of sacred site and challenges towards sustainable forest management: The case of remnant forest patch of Debrelibanos Monastery, Ethiopia. *Journal of Natural Science Research*. 5(15).
- Eden, M., Schjonning, P., Moldrup, P. and Jonge, LWDe, 2011. Compaction and rotoavation effects on soil pore characteristics of a loamy sand soil with contrasting organic matter content. *Soil Use and Management*. 27(3): 340-349.
- Gairola, S.U. and Soni, P. 2010. Role of soil physical properties in ecological succession of restored mine land - A case study. *International Journal of Environmental Sciences*. 1(4): 475-480.
- Gupta, O.P. and Shukla, R.P. 1991. The composition and dynamics of associated plant communities of sal plantation. *Tropical Ecology*. 32: 296-309.
- Hamdeh-Abu, N.H. 2004. The effect of tillage treatments on soil water holding capacity and on soil physical properties. ISCO 2004 - 13th International Soil Conservation Organisation Conference- Brisbane, July 2004 Conserving Soil and Water for Society: Sharing Solutions Paper No. 669: 1-6.
- Jain, S.K. and Rao, R.R. 1977. *Field and Herbarium Methods*. Today and Tomorrow Publishers, New Delhi.
- Leone, I.A., Flower, F.B., Arthur, J.A. and Gilman, E.F. 1977. Damage to woody species by anaerobic landfill gases. *Journal of Arboriculture*. 3: 221-225.
- Margalef, R. 1968. *Perspective in Ecological Theory*. University of Chicago press, 112.
- Moffat, A.J. and Houston, T.J. 1991. Tree establishment and growth at pit sea landfill site. *Waste Management and Research*. 9: 35-46.
- Nagendra, H. and Gopal, D. 2010. Street trees in Bangalore: Density, diversity, composition and distribution. *Urban Forestry & Urban Greening*. 9(2): 129-137.
- Nagendran, R., Selvamand, A. and Joseph, K. 2003. Effect of MSW floral diversity and plant growth. A case Study at Perungudi and Kodungaiyur dumping grounds, Chennai, India. Presented in *ARRPET organized workshop at Kasetsart University, Thailand, October*.
- Nyiramigisha, P. 2021. Harmful impacts of heavy metal contamination in the soil and crops grown around dumpsites. *Reviews in Agricultural Science*. 9: 271-282.
- Odjegba, V.J. and Sadiq, A.O. 2002. Effect of spent Engine Oil on the growth parameters, chlorophyll and protein levels of *Amarathus hybridus* L. *The Environment*. 22: 23-28.
- Pandey, A.N. and Singh, J.S. 1985. Mechanism of ecosystem recovery: a case study from Kumaun Himalaya. *Reclamation and Revegetation Research*. 3: 271-292.
- Phillips, E.A. 1959. *Methods of Vegetation Study*. Holt, Rinehart and Winston, New York, 107p.
- Pysek, A. and Hajek, M. 1996. Vegetation of municipal waste deposits and its use for the indication of habitat conditions. Proceedings of anthropization and environment of ruderal settlements: Flora and vegetation. *Satoraljaújhyly, Hungary*. 144-148.
- Roselli, W., Keller, C. and Boschi, K. 2003. Phytoextraction capacities of trees growing on metal contaminated soils. *Plant and soil*. 256: 265-72.
- Saxena, M.M. 1987. *Environmental Analysis- Water, Soil and Air*. Agro Botanical Publishers (India). 123-148.
- Sukop, H., Blume, H.P., Kunick, W. 1979. The soil, flora and vegetation of Berlin's waste land. Nature in cities- The natural environment in the design and development of urban green space. *Chichester*. 115-132.
- Treshow, M. 1970. Environment and plant response. *The Agricultural Science*. 222-223.
- Tripathi, A. and Misra, D.R. 2011. Floral distribution at municipal waste dumpsites in relation to their soil properties: Identification of adaptive plants". *Bulletin of Environmental and Scientific Research*. 1(2):1-10.
- Tripathi, K.P. and Singh, B. 2009. Species diversity and vegetation structure across various strata in natural and plantation forests in Katerniaghat Wildlife Sanctuary, North India. *Tropical Ecology*. 50(10): 91-200.
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