Evaluation of *Calotropis procera* as a biomonitor of soil pollution in Mysore and Periyapatna.

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Abstract

The increase in population in the few last decades has caused uncontrolled and unplanned industrialization and urbanization. The main source of pollutants in the environment is from traffic and industrial establishments. In the present study soil pollution has been assessed using the plant *Calotropis procera*. The concentration of nutrients (Ca, Mg, Na, K, P, S, Tot N and Org C) and heavy metals (B, Ni, Fe, Mn, Zn, Cu, Pb and Cd) were analyzed in the leaves of *C. procera* and soil collected from Mysore and Periyapatna roadsides of traffic area as per following the APHA 2012 standards. In *C. procera* of both the areas Iron is most dominant followed by Manganese and Zinc. Higher concentration of some physico chemical parameters were observed in Pre-monsoon followed by Post-monsoon and in Monsoon seasons. The results showed that *C. procera* can be used as a bio-monitor of soil pollution.

**Keywords:** Heavy metals, *Calotropis procera*, biomonitoring, biomonitor and soil pollution

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INTRODUCTION
The increase in population in the last few decades has caused uncontrolled and unplanned industrialization and urbanization. The pollutants in the urban areas are mainly from traffic and industrial establishments. The pollution can be assessed using plants as biomonitors. Biomonitors are the organisms which provide quantitative information on environmental quality (Bargagli, 1998; Markert et al., 2003). Biomonitors provide site-specific information on the soil quality as they incorporate local environment (Wright and Welborn, 2002). Analysis of soil does not give the information about the availability status of elements for the living organisms. Therefore the availability of metals can be assessed simultaneously by analyzing soil and plant samples (Bargagli, 1998). Both leaf and soil analysis are required for assessing the extent of pollution or otherwise the quality of environment and hence it should be treated as complementary to each other. (Ross 1994, Pilgrim and Hughes, 1994; Kabata-Pendias and Pendias, 1992). The extent of accumulation of heavy metal depends on the growing plant species and even heavy metal which will be observed (Sesli, 2004; Ozturk et al., 2008). In the last few decades the use of plant leaves as Biomonitors of pollution in the environment has been increasing. Determination of environmental pollution using Bioindicators and Biomonitors is a cheap, simple and reliable method. It is observed that the presence of heavy metals in the soil will be reflected by vegetation growing in it. (Butcher 1992, Kabat-Pendias and Pendias 1992, Badri and Springuel, 1994). Therefore plants can be used as Biomonitors of heavy metals and it is also documented in literature (Ernst, 1993). The aim of the present study is to determine the concentration of heavy metals and other elements in soil and in plant leaves of *C. procera*.

MATERIALS AND METHODS
*Calotropis procera* is a large shrub belongs to the family Apocynaceae and grows to a height of 3-6 ft. The stems are waxy and leaves are greyish green colored and contain milky sap. They are native to Western and Southern Asia, Africa and Indochina. *C. procera* is considered as an indicator of disturbed and overgrazed lands in arid and semiarid regions (Tezara et al. 2011). It helps in soil binding and can act as a nursing crop for other species in afforestation programs (Orwa et al. 2009). And it is also used as green manure in paddy fields (Orwa et al. 2009, Banta et al. 1984).

Samples of soil and *C. procera* were collected from roadsides of Mysore and Periyapatna in three different seasons; pre-monsoon, monsoon and post monsoon. Mysore is the second largest city in Karnataka, India. It is spread across an area of 128.42 sq Km and is located at 12° 18' N 76° 39' E 12.30° N 76.65° E. Periyapatna is a taluk in Mysore district. It is located at 12° 20' N 76° 06' E/ 12.34°N 76.1°E/12.34;76.1. The study areas are situated on National Highway 275. In each
area, leaves were collected from 5 trees of *C. procera* randomly at a distance of 0 to 3 mts away from roads having high traffic density of Mysore and P. Patna. Samples were mixed together to get a composite sample and packed in muslin bags. They were brought to the laboratory and washed with distilled water to remove adhering dust and soil particles. The leaves were shade dried followed by oven drying at 65-70°C for 48 h. They were grounded using homogenizer with stainless steel blades (mixers), after grinding, the samples were mixed thoroughly and dried again at 70°C to remove moisture and passed through 1.5 mm sieve. Plant samples were stored in screw type plastic bottles for further use. The soil samples were collected from the top 10 cm using stainless steel trowel around the *C. procera* which has been sampled. It was air dried and passed through 2 mm sieve and stored in self-sealing plastic bags for analysis. Samples were analyzed for some physico chemical parameters using standard analytical procedures (APHA 2012). The heavy metal concentrations were detected using ICP (Perkin Elmer Optima 8000).

**RESULTS AND DISCUSSION**

**Table 1**: Physico-chemical parameters and heavy metals concentration (mg/kg) in soil collected from roadsides of Mysore traffic area.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Parameters</th>
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BDL: Below detectable level
PRM: Pre-monsoon
MON: Monsoon
POM: Post-monsoon
Table 2: physico-chemical parameters and heavy metals concentration (mg/kg) in soil collected from roadsides of Periyapatna traffic area.

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Table 3: physico-chemical parameters and heavy metals concentration (mg/kg) in the leaves of *C. procera* collected from roadsides of Mysore traffic area.

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Soil samples pH ranged from 7.41-7.51 in Mysore and 7.52-7.68 in P. patna. In the three seasons tested pH of soil remained alkaline in both places. EC was maximum in PRM and low in Monsoon season in both Mysore and P. patna. The average organic carbon concentration was 0.32% and 0.49% in Mysore and P. patna respectively. The average concentration of nutrients (mg/kg) and heavy metals (mg/kg) in Mysore soil were 10.07(Ca), 7.08(Mg), 0.80(Na), 5.07(K), 0.54(P), 13.79(S), 5.05(Tot.N), 51.47(Cr), 48.67(Ni), 4656(Fe), 333.33(Mn), 83.37(Zn), 41.90(Cu), 13.72(Pb) and
2.45(Cd). The concentration of nutrients (mg/kg) and heavy metals (mg/kg) in P. patna soil were 9.86(Ca), 6.51(Mg), 0.74(Na), 5.52(K), 0.55(P), 13.38(S), 5.65(Tot.N), 33.10(Cr), 40.35(Ni), 3992.67(Fe), 188.73(Mn), 26.73(Cu) and 10.20(Pb). Cadmium was absent in P.patna soil and Boron was below detectable limit in both places in all the seasons.

The source of contamination of soil by heavy metals may be as a result of industrial activity and traffic density and also their natural presence in the soil as they are non-degradable (Nriagu 1990\textsuperscript{16}, Adeyeye 2005\textsuperscript{17}). The heavy metals concentration in soil was in the order Fe>Mn>Zn>Cr>Ni>Cu>Pb>Cd, and it was higher in soil as compared to plant. The accumulation level of elements depends on the type of plant and kind of heavy metal being studied (Alloway 1996\textsuperscript{18}).

**Calotropis procera**

pH variation was from 6.41 to 6.91 and from 6.63 to 6.92 in Mysore and Periyapatna plants respectively. EC ranged from 89.8 to 91.3 dS/m and from 73.42 to 81.3 dS/m. Average values for calcium, magnesium and Sulphate were 5.54 mg/kg, 0.98 mg/kg and 0.71mg/kg respectively in Mysore and 3.87 mg/kg, 0.79 mg/kg and 0.59 mg/kg respectively in Periyapatna. In both places Ca and Mg contents in *C. procera* were above the prescribed values (GKVK Manual 2010\textsuperscript{19}). Average Sodium and Organic carbon were 0.6 mg/kg and 0.46 mg/kg in Mysore and 0.6 mg/kg and 0.37 mg/kg in Periyapatna. Potassium and Total N were within the recommended values (GKVK Manual 2010\textsuperscript{19}) in all the seasons in both areas. Phosphate ranged from 0.48 to 0.72 mg/kg in Mysore and 0.5 to 0.64 mg/kg in Periyapatna, and it was above the prescribed limit (GKVK Manual 2010\textsuperscript{19}) in PRM and POM seasons in both areas. Chromium is known as a toxic element. In the present study total Cr ranged from 8.6 to 11.68 mg/kg and 3.43 to 5.23 mg/kg in Mysore road side and Periyapatna road side respectively. High contents of Cr were observed in Mysore city area compared to Periyapatna. In both the places Cr concentrations were high compared to prescribed limits (Burke et al 2000\textsuperscript{20}). Boron was below detectable limit in both places. Nickel is essential in minute quantity for organisms as it plays an important role in insulin production, and it varied from 3.61 to 5.81 mg/kg and 0.92 to 3.23mg/kg in Mysore and Periyapatna respectively. Both areas had Ni content within permissible limits (Allen 1989\textsuperscript{21}, Kabata Pendias & Pendias 2001\textsuperscript{22}) except in POM season in Mysore. The average values of Iron, Manganese, Zinc and Copper in *C.procera* were 372.8 mg/kg, 181.83 mg/kg, 49.97 mg/kg, and 20 mg/kg respectively in Mysore road side. In Periyapatna the average values of Iron, Manganese, Zinc, and Copper were 284.62 mg/kg, 177.24 mg/kg, 29.68 mg/kg and 8.88 mg/kg respectively. All these parameters were within the recommended values (Kabata Pendias & Pendias 1994\textsuperscript{23}). Lead is the most toxic element for the living organisms; main source for lead pollution is
vehicular smoke. Both areas had Pb content within prescribed limits (Kabata Pendias & Pendias 1992) except in PRM season (10.6 mg/kg) in Mysore. Cadmium enters into the environment mainly due to vehicular exhaust and industrial activities. It showed its presence only in Mysore in POM season and its content was above the recommended level (Kabata Pendias & Pendias 1994).

**Graphical Representation of Variations in Physico Chemical Parameters and Heavy Metals:**

![pH variations in soil](image)

![pH Variations in C. procera](image)

![EC variations in soil](image)
EC Variations in *C. procera*

Ca variations in soil

Ca Variations in *C. procera*

Mg variations in soil
Evaluation of Calotropis procera as a Biomonitor of Soil Pollution.

**Mg Variations in C. procera**

- **Mysore**
- **P. patna**

**Na Variations in soil**

- **Mysore**
- **P. patna**

**Na Variations in C. procera**

- **(Mysore)**
- **P. patna**

**K variations in soil**

- **Mysore**
- **P. patna**
**Variations in C. procera**

- **K Variations in C. procera**
  - Mysore vs. P. patna
  - Seasons: PRM, MON, POM

- **Total PO₄ variations in soil**
  - Mysore vs. P. patna
  - Seasons: PRM, MON, POM

- **Total PO₄ variations in C. procera**
  - Mysore vs. P. patna
  - Seasons: PRM, MON, POM

- **SO₄ variations in soil**
  - Mysore vs. P. patna
  - Seasons: PRM, MON, POM
Evaluation of Calotropis procera as a Biomonitor of Soil Pollution...

- **SO₄ variations in *C. procera***
  - **Mysore**
  - **P. patna**
  - *Seasons*:
    - PRM
    - MON
    - POM

- **Total N variations in soil**
  - **Mysore**
  - **P. patna**
  - *Seasons*:
    - PRM
    - MON
    - POM

- **Total N Variations in *C. procera***
  - **Mysore**
  - **P. patna**
  - *Seasons*:
    - PRM
    - MON
    - POM

- **Org C variations in soil**
  - **Mysore**
  - **P. patna**
  - *Seasons*:
    - PRM
    - MON
    - POM
Org C variations in *C. procera*

- **Org C %**
- **Seasons**: PRM, MON, POM
- **Variations**: Mysore, P. patna

Tot Cr variations in soil

- **Tot Cr mg/kg**
- **Seasons**: PRM, MON, POM
- **Variations**: Mysore, P. patna

Tot Cr variations in *C. procera*

- **Tot Cr mg/kg**
- **Seasons**: PRM, MON, POM
- **Variations**: Mysore, P. patna

Ni variations in soil

- **Ni mg/kg**
- **Seasons**: PRM, MON, POM
- **Variations**: Mysore, P. patna
Evaluation of Calotropis procera as a Biomonitor of Soil Pollution.

Ni variations in C. procera

Fe variations in soil

Fe variations in C. procera

Mn variations in soil
Mn variations in *C. procera*

Zn variations in soil

Zn variations in *C. procera*

Cu variations in soil
Evaluation of Calotropis procera as a Biomonitor of Soil Pollution...

**Cu variations in C. procera**

- **PRM**
- **MON**
- **POM**

**Pb variations in soil**

- **PRM**
- **MON**
- **POM**

**Pb variations in C. procera**

- **PRM**
- **MON**
- **POM**

**Cd variations in soil**

- **PRM**
- **MON**
- **POM**
CONCLUSION

In the present study nineteen parameters have been considered from *C. procera* and soil samples in Mysore and P. Patna study area. Their levels varied from element wise and from location wise. Variations may be due to differences in anthropogenic activities of that region especially traffic density. In both areas Iron is most dominant followed by Manganese and Zinc. Higher contents of elements were evident in PRM season followed by POM and Monsoon seasons. This is mainly due to leaching of nutrients and heavy metals during precipitation. The results provide baseline information for biomonitoring of soil pollution. The study also recommends the use of *C. procera* as an effective biomonitor. And also further studies can be done to know the variations in uptake between different plant species.

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REFERENCES


[5] Pilgrim, W. Hughes, R.N., 1994, Lead, cadmium, arsenic and Zinc in the


[19] GKVK manual 2010


[34] Madyon p, Murillo JM, Maranon T, Cabrera F, Lopez R., 2002, Bioaccumulation of As, Cd, Cu, Fe and Pb in wild grasses affected by the Aznalcollar mine spill (Sw Spain). The Science of the Total Environment 290, 105-120.

