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The effect of *Chromolaena odorata* on the soil quality in Dimoria Tribal Belt of Assam

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Abstract

Chromolaena odorata is a highly invasive exotic species and has dominated the fallow lands along with other exotics in Dimoria Tribal Belt of Assam. The present study was conducted to observe the effect on the soil quality due to invasion of the species. The important soil quality indicators namely texture, temperature, bulk density, moisture content, pH, organic matter, nitrate, phosphorus and potassium were investigated in 3 stations under the species and compared with a nearby natural forest vegetation. The study revealed that most of the soil quality parameters were low under the exotic species.

Keywords*: Physico-chemical properties, Soil organic carbon, Soil quality, Chromolaena odorata, Dimoria*

1. Introduction

Chromolaena odorata or Siam weed is recognised as one of the 100 world's worst invasive alien species. It is a native to South America and Central America and introduced in the tropical regions of Asia, Africa and the Pacific where it has become invasive (Lowe *et al.*, 2000). It has an extremely fast growth rate (up to 20 mm per day) and prolific seed production. According to Schmidt and Schilling, 2000, it was earlier taxonomically classified under the genus *Eupatorium*, but is now considered more closely related to other genera in the tribe *Eupatorieae*. It is a perennial weed of plantations, agricultural fields, pasturelands, wastelands and roadsides.

C. Odarata leaves and root extracts has allelopathic effect on the native and non-native invasive herbs which may have contributed to its ability of becoming dominant (Hu and Zhang, 2013). It has inhibitory effect on seed germination and seed performance (Adetayo *et al.*,1999). Similarly, the leachates and the extracts of the weed inhibited crop growth (Ambika and Jayachandra, 1980). The leaves are not eaten by the cattle (Meyers *et al.*, 1984). It has the ability to build up organic matter in tropical soil in fallow system (Agbim, 1987; Obatolu and Agboola,1993). By addition of large quantities of organic matter to the soil, the populations of nematodes may reduce (M. Boob, 1991). The soil quality may improve with large quantity of standing biomass produced by it (Tondoh *et al.*, 2013).

Assam is one of the biodiversity richest zone of North-East India and accounts for nearly 50% of the total number of the plant species in India as a whole. Invasive plant species like *Lantana camara, Chromolaena odorata, Mikenia micrantha, Mimosa pudica, Ageratum conyzoides, Parthenium hysterophorus* have dominated the fallow lands of Assam. Das and Duarah (2013) recorded 18 invasive alien plants along road side areas of Jorhat, Assam belonging to 18 families. However, limited studies have been undertaken to assess the impacts of invasive species on the soil quality in Assam. The present study is an attempt to study the effect of *C. odorata* on the soil quality in Dimoria Tribal Belt of Assam.

2. Materials and Methods

2.1 Study area

The Dimoria Tribal Belt is situated in South-Eastern part of the Kamrup Metro District of Assam and on the south bank of river Brahmaputra. It is bounded by Meghalaya on the south, by Morigaon District on North-East and by greater

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Guwahati City on the west up to Jorabat Amrigog. The present boundary of Dimoria lies between $26^{0}0'$ N and $26^{0}14'0''$ N latitudes, and $91^{0}51'0''$ E and $92^{0}10'0''$ E longitudes (figure-1).

The area falls under subtropical monsoon climate. The average annual temperature is 27^{0}C and the rainfall is about 200 cm. Semi evergreen and mixed deciduous with the presence of occasional sub-tropical broad-leafed forest type are found in the area. The vegetation types bear a similarity to the vegetation of foothills of Meghalaya. *Dipterocarpus macrocarpus, Shorea robusta, Cassia fistula, Gmelina arborea, Acacia catechu, Areca catechu, Tectona grandis, Dalbergia sisso* are the important tree species of the area. Tall grass species belonging to the genera *Saccharum sp., Phragmitis sp., Arundo sp. and Erinthus sp*. and large number of herbaceous plants found in cultivated fields, roadsides and wasteland forms the ground layer of vegetation.

2.2 Selection of sampling station

Three plots consisting primarily of *C. odorata* were selected randomly near National Highway No. 37 from Khetri Tiniali, Dimoria Block, Assam during Febraury, 2015 (fig.2). A nearby forest known as Matapahar Forest with no invasive plant species was chosen as control to see its effect on soil quality.

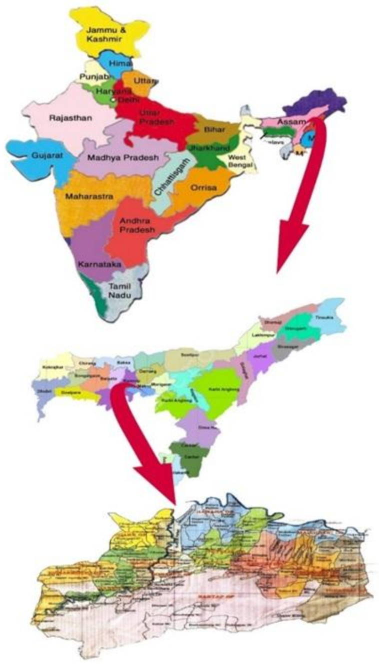

Figure 1: Location of Dimoria Tribal Development Block

Figure 2: Google map of soil sample sites under C. odorata

2.3 Sampling procedure

In order to collect soil samples (0-15 cm depth) grasses, mosses, litter and other plant residues were removed from soil surface. Collection of soil samples was done by using an auger. In each case, a triangular block was cut with the help of the auger. Soils were collected in plastic bags, which were sealed, and labeled properly. One sample each was also taken from 0 to 15 cm layer for bulk density determination.

Soil samples were brought to the laboratory for analysis. Before analysis, the samples were spread out thinly on a piece of hard paper for drying in air in a shade. The big lumps were broken down, and plant roots, pebbles and other undesirable matter were removed. After the soil become completely dry, it was sieved through a 2 mm sieve. The samples were preserved in clean sealed polythene bags for analysis.
Soil properties and their methods of measurement are given in the table 1 below:

Table 1: Soil properties under study with their methods of measurement

Soil properties	**Methods**
Texture	Feel method
Temperature	Soil thermometer
Bulk density	Core sampling method (Blake and Hartge, 1986)
Moisture content	Gravimetric method
p^{H}	Potentiometrically in 1:2.5 (v/v) soil suspension in water by Digital p^{H} meter (Systronics)
Organic matter	Titrimetric method (Walkley and Black, 1934)
	% Soil organic matter =% organic carbon x 1.724 (Allison, L.E., 1965)

Nitrate nitrogen	Spectrophotometric method (ELICO, SL-159)
Available phosphorus	Spectrophotometric method (ELICO, SL-159)
Available potassium	Flame photometer method (ELICO, CL 22 D)

3. Results and Discussion

The results of the soil quality have been discussed with respect to some representative physio-chemical parameters (table 2).

Table 2: Mean Physico-chemical properties of the soil under C. odarata and Matapahar Forest (control)

Parameters	***C. odarata***	**Matapahar Forest (control)**
Texture	Loamy sand	Silt loam
Soil temperature (^{0}C)	25.5	21.6
Bulk density (g/cm^3)	1.6	1.5
Moisture Content (%)	17.3	28.3
pH	4.1	5.1
Organic Matter (%)	2.3	3.1
NO_3^- N (mg/Kg)	1.6	1.9
AP (kg/ha)	11.8	15.8
AK (kg/ha)	26.1	43.2

The same is presented in the figure 3 below:

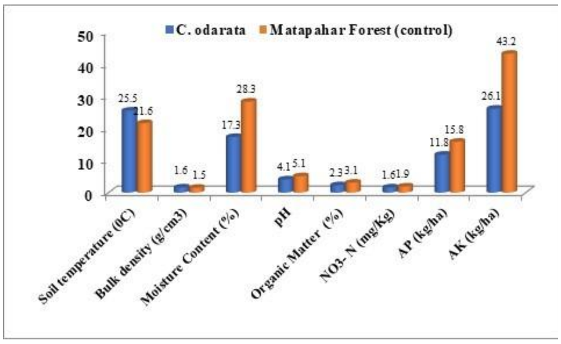

Figure 3: Comparative study of physico-chemical parameters of soil under C. odarata and Matapahar forest (control)

Soil texture is one of the most important factors and effects many properties like structure, chemistry, and most notably, soil porosity, and permeability. The soil texture under the exotic sp. (*C. odorata*) was loamy sand whereas it was silt loam under the natural forest. Soil moisture is the most vital controlling factor in soil temperature. The soil temperature was found 25.5 under the exotic whereas the soil temperature of natural forest was 21.6^{0}C. It may be due to presence of thick plant cover on the natural forest during the sampling time. Bulk density under the exotic was found 1.6 gm/cm^3, in contrast the bulk density under natural forest was 1.5 gm/cm^3. The moisture content of soil was found 17.3 % under the exotic, while it was 28.3 % under natural forest. The value of pH was 4.1 under the exotic, whereas it was 5.1 under natural forest. Soils in the range 5.6 to 6.0 are moderately acidic and below 5.5 are strongly acidic in nature (ICAR, 2005). The high acidity may be the factor for soil quality deterioration under the exotic. Low amount of OM (2.3%) was found under the exotic, whereas 3.1% was noted under natural vegetation which was moderate according to ICAR rating, 1997.

The amount of nitrate nitrogen was found to be 1.6 mg/kg under the exotic and 1.9 mg/kg under natural forest. The amount of available phosphorus under the exotic was 11.8 kg/ha, while it was 15.8 (kg/ha) under natural forest. The amount of available potassium under the exotic was 26.1 kg/ha, while higher amount of available potassium 43.2 kg/ha was found under natural forest. Low nitrogen and phosphorus content under the exotic may be attributed to low amount of organic matter than the natural forest.

4. Conclusion

The study revealed that most of the soil quality parameters were low under *C. odorata* than the natural vegetation. The species were observed to be found in open areas with exposed soils. The exotics cause threat when the native plants are replaced. So, management of the land under exotics is necessary and its invasion should be controlled by physical, chemical and biological methods.

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