ORIGINAL RESEARCH PAPER

Botany

MICRO NUTRIENT ANALYSIS OF SOIL IN SACRED GROVES - A CASE STUDY

KEY WORDS: Micro nutrients, Organic matter, Sacred grove, Vegetation stand.

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ABSTRACT

The texture and structure of soil system determine the quality of soil which make available water, nutrients and aeration for plants. Therefore, the properties of a soil have great influence on the natural distribution of diverse plant species including trees, lianas and climbers. Hence, the availability and stability of nutrients in the soil which are essential for plant growth and biomass production is decided by its chemical properties. However, the micro nutrients of a soil are decided by the level of organic matter content and their decomposition rate by microorganisms. But due to various anthropogenic activities in the forest ecosystem and when pressure is high and prolonged, the existing vegetational characteristics may change and become enough to alter the favourable soil and environmental characteristics existing in the ecosystem. The less diversity and decrease in the vegetation stand can cause reduction in the quantity and quality of organic matter content of the soil. This kind of a situation may lead to decrement in diversity and biomass of microbes in such soil which in turn may affect the decomposition rate of organic matter and may result in poor soil characteristics and quality. The present study tries to reveal the influence of difference in vegetational stand on soil property and quality by analyzing the micro nutrients of soil samples collected from selected sacred grove and nearly disturbed non-sacred grove land.

INTRODUCTION

Chemical properties are one of the important parameters of soil which are directly or indirectly correlated to its fertility and productivity. The texture and structure of soil system determine the quality of soil which make available water, nutrients and aeration for plants. Therefore, the properties of a soil have great influence on the natural distribution of diverse plant species including trees, lianas and climbers. However, the chemical properties of a soil are decided by the level of organic matter content and their decomposition rate by microorganisms. Hence, the availability and stability of nutrients in the soil which are essential for plant growth and biomass production is decided by its chemical properties (Osman, 2013). With respect to a natural forest ecosystem, the chemical properties are generally healthy and sustainable. However, due to various anthropogenic activities in the forest ecosystem and when pressure is high and prolonged, the existing vegetational characteristics may change and become enough to alter the favourable soil and environmental characteristics existing in the ecosystem. This may affect the survival of many endemic plants particularly of tree species in the ecosystem which are essential for providing favorable environment and habitat for many other plant species of natural existence. This change in vegetation and environmental characteristics may cause further reduction in diversity and richness of plant species in an area. The less diversity and decrease in the vegetation stand can cause reduction in the quantity and quality of organic matter content of the soil. This kind of a situation may lead to decrement in diversity and biomass of microbes in such soil which in turn may affect the decomposition rate of organic matter and may result in poor soil characteristics and quality.

OBJECTIVES

- To analyze the micro nutrients (available boron, extractable iron, manganese, zinc and copper) of soil samples collected from selected sacred grove and nearby disturbed non-sacred grove land.
- Compare the selected micro nutrients between the sacred grove and disturbed land with respect to two seasons in two consecutive years.

MATERIALS AND METHODS

1)Soil sample collection

Sankulangare sacred grove (S N puram, Thrissur, Kerala) and its nearby disturbed land are selected for detailed study. Soil samples are collected in triplicates from core region of sacred grove, transition region (the buffer region between the grove and disturbed land) and disturbed non-sacred grove region at a depth of 30 cm from the surface, using the core type soil auger to get comparatively less disturbed Pedon of soil. The soil samples are collected for analysis all the times from previously marked area from each regions of study. The soil samples are then carefully transferred to air tight polythene covers and subjected to analysis for chemical properties.

2) Analysis of micro nutrients in soil

Various micro nutrients of soil analyzed for the study include available boron, extractable iron, manganese, zinc and copper.

2.1) Estimation of extractable Iron (Fe^{2+}, Fe^{3}), Manganese (Mn^{2+}), Zinc (Zn^{2+}) and Copper (Cu^{2+}) (Lindsay & Norvell, 1978)

Principle: The major categories of micronutrient extract presently in use are dilute acids and solutions containing agents such as DTPA or EDTA.

Dilute acids (0.025-0.1 M) have been used as micronutrient extracts for many years, primarily on acidic soils. The most commonly used dilute acids are: Mehlich -1 (dilute double acid, 0.0125 M H_2SO_4 + 0.05 M HCl) (Sims & Johnson, 1991). Among the chelating agents, DTPA is the most commonly used one. The DTPA soil test, developed for near neutral and calcareous soil (Lindsay & Norvell, 1978) illustrates the evolution of the soil test extractant from theoretical principles. The extracting solution consists of 0.005 M DTPA and 0.01 M $CaCl_2.2H_2O$, buffered at pH 7.3 by 0.1 M triethanolamine (TEA). The DTPA extractant offered the most favourable combination of stability constants necessary to simultaneously extract four micronutrient cations (Fe, Mn, Cu and Zn). The buffered pH and presence of soluble Ca^{2+} prevent excessive dissolution of calcium carbonate avoiding the release of available micronutrients occluded by this solid phase. At pH 7.3, 70-80 % of the buffering capacity provided by TEA has been consumed.

Therefore, use of DTPA extractant on acidic soils will result in neutralization of remaining buffer capacity and unpredictable extraction pH. Reagents: Hydrochloric acid (HCl), 0.1 N: Add 8.1 mL of concentrated HCl (reagent grade) to approximately 900 mL of distilled water, mix cool to room temperature and make up to 1litre. DTPA: Prepare the extractant by dissolving 1.967 g of 14.92 g of TEA and 1.47 g of $CaCl_2.2H_2O$ in 200 mL of distilled water and dilute to approximately 900 ml. Adjust the pH to + or - 0.05 with 1:1 HCl and make up the volume to 1 litre.

Extraction and estimation:
Shake 2 g of soil with 20 mL of 0.1 M HCl for 5 minutes. Filter through Whatman No.42 filter paper. Collect the filtrate and estimate the contents of Fe, Mn, Zn and Cu using an Atomic Absorption Spectrophotometer.

CALCULATION:
Amount of micronutrient (mg kg^{-1} soil) =Concentration from the instrument × $\frac{20}{2}$

Amount of micronutrient (mg kg-1 soil) =Concentration from the instrument × 10

2.2) Estimation of available boron (H_3BO_3, BO_3)- Hot water-soluble boron (Gupta, 1967)
Principle: The hot water extraction procedure developed by Gupta (1967) is the easiest method.

Reagents: Buffer solution: Dissolve 250 gm of ammonium acetate and 15 g of EDTA (disodium salt) in 400 mL of distilled water, slowly add 125 mL of glacial acetic acid and mix thoroughly. Azomethine -H reagent: Dissolve 0.45 g of azomethine-H in 100 mL of 1 % L- ascorbic acid solution. Store in polypropylene bottle in refrigerator. Prepare fresh solution every week. Boron standard solution: Dissolve 0.114 g of AR grade boric acid (H_3BO_3) in distilled water and make the volume to 1000 ml. Each mL of this solution contains 20 µg of B. Dilute 0.5, 1, 2, 3, 4, 5, 10, 20, 30, 40 and 50 ml of this stock solution to 100 ml with distilled water to have solution concentrations of 0.1, 0.2, 0.4, 0.6, 0.8, 1.0, 2.0, 4.0, 6.0, 8.0 and 10 µg ml^{-1} respectively. Activated charcoal.

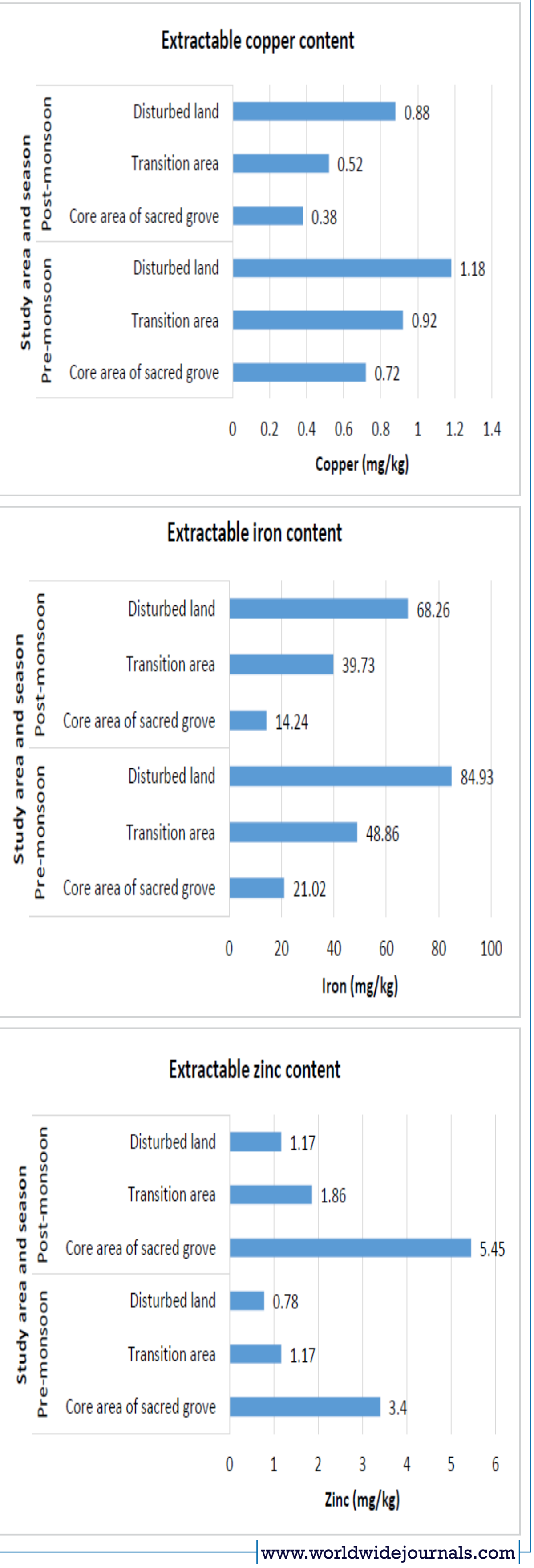
Procedure: Weigh 20 g of air-dried processed soil in a 250 ml quartz or other boron free conical flask and add 40 ml distilled water. Add 0.5 g of activated charcoal and boil for 5 minutes on a hot plate, filter immediately through Whatman no.42 filter paper. Cool the contents to room temperature and transfer 1 mL aliquot of blank, diluted boron standard or sample solution into a 10 ml polypropylene tubes. Add 2 mL of buffer and mix. Add 2 mL of azomethine-H reagent, mix and after 30 minutes read the absorbance at 420 nm on a spectrophotometer. Prepare a standard curve plotting boron (B) concentrations (0 to 10 µg B ml^{-1}) on X-axis and absorbance on Y-axis.

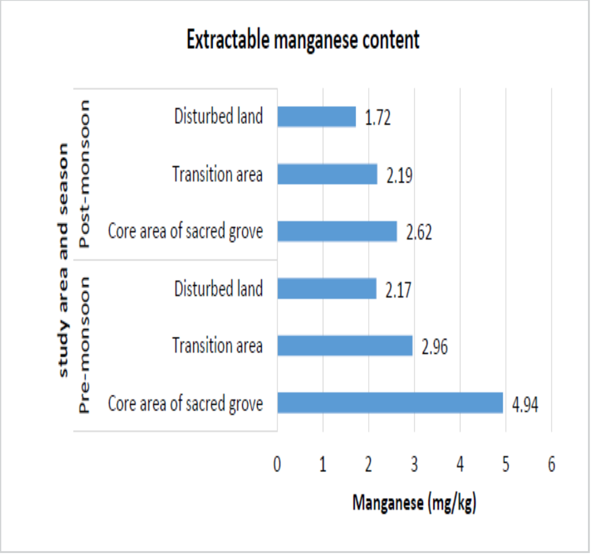
CALCULATION:
$$\text{Amount of B in soil (mg kg}^{-1}\text{ soil)} = \frac{\text{Absorbance reading}}{\text{Slope from curve}} \times \frac{40}{20}$$

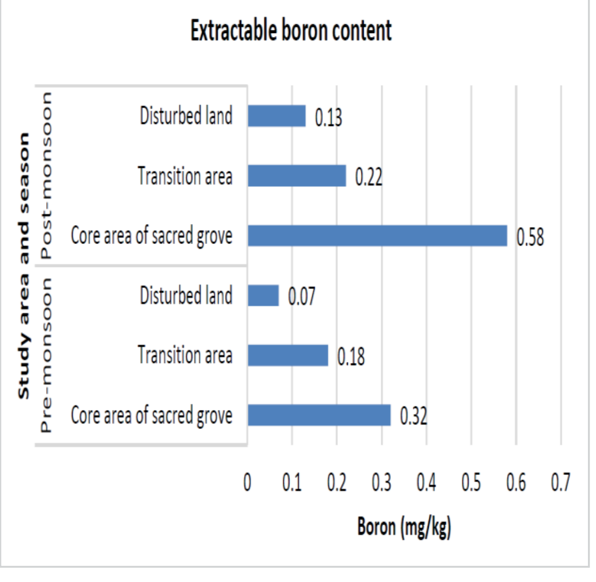
RESULTS AND DISCUSSION
The details of various physical properties of soil samples collected from the core region, the transition region and the disturbed non-sacred region at Sankulangara study site during the pre-monsoon as well as the post-monsoon season are shown in the figure 1.

The result indicate that the majority of the micronutrient parameters recorded comparatively higher values in the soil collected from the core region of sacred grove. This is immediately followed by the transition region and lower values are recorded in the disturbed non-sacred grove region. The results of the soil micronutrient parameters in the present study reveal that the concentration of Zn, Mn and B generally tend to exhibit a decreasing trend from soil of sacred grove region to transition region and then to disturbed non-sacred grove region. The comparison in the concentrations obtained in two different seasons with respect to Zn and B indicates, higher values for both being recorded during the post-monsoon period.

Figure 1: The micronutrient status of soil samples collected from different regions of Sankulangara study site during the pre-monsoon and post-monsoon periods







Higher concentration status of majority of micro elements observed in the soil of Sankulangara sacred grove over the disturbed non-sacred grove region may be due to better floristic composition and organic matter content of the groves. Rich vegetation particularly of trees existing in an area can maintain a constant supply of organic matter content through continuous addition of leaf litter and other plant components (Yang et al., 2005; Bhat & Jan, 2010). Better environmental conditions contributed by rich ground vegetation and higher rate of decomposition of organic matter by microorganisms in the grove area may be the reason for better soil chemical property. Lower concentration of many nutrients in the disturbed non-sacred grove and transitions regions observed in the study may be due to considerable reduction in the quantity and quality of vegetation and lower rate of release of mineral nutrients into the soil (Park et al., 2002). This could be the result of unfavorable microenvironment and poor microbial decomposition activity existing in these areas. Further, considerably lower quantity of litter fall deposition, particularly in the disturbed non-sacred grove regions, are not enough to replenish the depleted nutrient level by the uptake as well as the leaching process in the soil (Gosz et al., 1976; Morrison, 1991). However, higher concentration of Cu and Fe elements observed in the soil of disturbed region over the grove and transition regions in the study may be due to the influence of industrial pollution. The analysis of soil chemical properties in the transition region generally exhibits comparatively better nutrient status over the disturbed non-sacred grove region. These observations in the present investigation may be due to several factors which include comparatively higher vegetation stand and the leaching of humus and nutrients from grove area to immediate adjacent areas.

The significant improvements in the concentrations of many micro elements during the post-monsoon period in the grove region and to certain extend in the transition region compared to disturbed non-sacred grove region can be attributed to the higher decomposition rate of organic matter and increased rate in the release of nutrients into the pool of nutrients in the soil. The organic matter content and their decomposition and release of nutrients in the soil of a particular region are depending on several factors which include vegetation, season, climate and disturbances in the area (Schlesinger, 1977; Binkley, 1995). The litters are considered as natural fertilizers in the soil of natural ecosystem as these are the major raw material for the replenishment of nutrients in the soil. Favorable soil and microclimatic environment, particularly during the post-monsoon period could be able to trigger growth and diversity of microbial population and rate of decomposition activity. Accumulation of organic matter and nutrients from the grove regions through leaching during the monsoon towards the transition area may be the major reason for better soil chemical properties in the transition regions than the disturbed non-sacred grove regions. However, the decreasing trend and low concentration status of majority of the nutrients in the disturbed land with poor floristic composition and density during the post-monsoon period can be attributed to the erosion of organic matter and nutrients from the surface soil due to the heavy rain that occurred during the monsoon. Further, greater reduction in the canopy cover, particularly of trees and very low litter deposition can cause hot and dry climatic environment in the disturbed regions as a result of direct falling of sunlight on the ground. This may weaken microbial growth and decomposition activity, which in turn reduce the release of nutrients into the soil. In addition, the utilization of nutrients by the existing vegetation and reduction in the replenishment into the pool of nutrients in the soil of disturbed region can add to the lower-level concentration status of nutrients.

CONCLUSION

The studies on the micro nutrients of soil in the sacred grove region, transition region and disturbed non-sacred grove region in the study site clearly revealed significant role of sacred groves or undisturbed forest vegetation in the maintenance of quality and productivity of the soil. Higher floristic composition and diversity, higher microbial population and high rate of litter decomposition in the grove area compared to other areas of study could be the reason for better chemical properties. Higher or sufficient concentrations of majority of the micro nutrient elements in the soil of grove regions revealed better microbial population and their decomposition activity. However, the destruction of forest plants by human interference and activities like slash and burn practice for agricultural production, cutting of trees for timber and removal of forest for construction and developmental activities can cause degradation in the forest ecosystem, particularly the soil quality and its environment, which is a complex system bound by physical, chemical and microbiological parameters (Sahani & Behera, 2001; Olanrewaju, 2008). Low concentrations of many microelements in the soil of disturbed region reveal significant reduction in organic matter content and microbial decomposition activities. The comparatively better soil chemical properties observed in the transition region over the disturbed regions in the study sites may be due to the influence of leaching process and the better climatic environment prevailing in the grove region on the immediate transition areas of the grove. The present study finds that, the soil in the grove and immediate transition region are found with improved quality during the post-monsoon period over the pre-monsoon status while that of disturbed region exhibit a reverse trend.

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