Assessment of chemical properties of soils from different ecosystems located in Hyderabad

Praveen Kumar Y, Rajakumar R, Sunil Kumar M and Kalyan Kumar K

Abstract

Nutrients present in the soil are most important elements required for the soil fertility and plant growth. These nutrients require plants in adequate proportions. This study was conducted to evaluate the chemical properties of selected soil ecosystems in outer side of Hyderabad – agricultural, organic farming, forest and industrial area. The variables tested included P, EC, OC, N, P, K to understand status of soil fertility. The study revealed the PH of the soil samples ranges from 7.01 to 7.41 and was on slightly alkaline side but within the limits 6.5 – 8.5 which is optimum for crops except forest soil shows lower value. The EC values ranged from 0.2 dS m\(^{-1}\) to 0.503 dS m\(^{-1}\) and were within in the limits of 0.8 dSm\(^{-1}\) indicates lower the salinity of soil samples. Organic carbon content showed similar values for all soil samples. Available Nitrogen and Phosphorous content negatively affected all soil samples except organic farming. Potassium levels optimum for organic and forest but lower the values for chemically fertilized and industrial soil samples.

Keywords: Chemical characteristics, soil nutrients, soil health, forest, organic carbon

Introduction

Soil is a natural body developed as a result of pedogenic processes through weathering of rocks, consisting of mineral and organic content, having precise mineralogical, chemical, physical and biological properties as a medium for plant growth (Velayutham and Bhattacharya, 2000). Soil is a critical component in ecosystem and important contributor to human wealth by providing food, water and energy (Gaur, 1997) \(^{[9]}\) and supports the life through various processes which include purification of water, increasing biomass production, remediation of pollutants, restoration of ecosystem, and cycling of C, N, S, P and H\(_2\)O. It is the most important and natural resource for human beings and animals as these living entities primarily depends upon agriculture and allied areas which are dependent on soil sources. Soil is an organic thin layer of earth crust and contain organic matter, nutrients, water and air which constitute a system that supports the growth of plants is one of the important factor for crop production. In order to achieve higher productivity and profitability, farmer should realize that the fertility levels must be measured as these can be used for determining soil fertility. Currently various techniques are available for measuring the fertility includes indigenous knowledge, Plant/Tissue analysis, Visual observation, remote sensing, soil analysis, green house experiments and biological tests. Of these all techniques soil analysis was mostly employed for measuring soil fertility as this is simple, cost-effective, accurate, universal, and works with all types of soils.

In the present world soil resources were in limit, and easily degrading by various anthropogenic activities in natural systems that leads to conversion of agricultural to non-agricultural uses (Lal, 1998) \(^{[13]}\). Soil degradation is a severe issue and process of degradation can be speedup with soil erosion, decreasing the content in organic matter, changes in soil structure, depletion in plant nutrients and salinization. Intensive agricultural and excessive chemical unbalanced fertilizer farming practises for food production showing adverse effects on soil health. Extensive application of agrochemicals and contaminated irrigation water from industrial waste water led to deterioration soil health (Rayment et al., 2002; Kaur et al., 2014) \(^{[17, 11]}\). According to the Indian Council of Agricultural Research (2010), out of total geographical area in India 37% affected by various kinds of land degradation that include soil acidity, water erosion, soil salinity, soil alkalinity, mining and industrial waste, which directly effects on crop production across the country. In order to meet the current and future food requirement, the degraded soils and ecosystem must be improve and depleted organic matter should be restored. The healthy soils are essential for food, fuel, water, fibre, herbal and medicinal products. Soil fertility comprises three main components: physical fertility, chemical fertility and biological fertility (Christopher johns et al. 2017) \(^{[5]}\).
The physical and chemical properties of the soil play an important role in the plants ability to take nutrients water (B.S. Griffith, 2010) [3]. The physical fertility refers to the size, shape, pore spaces, texture, organic material, nutrient composition in the soil. The chemical properties include pH of the soil, electrical conductivity, organic composition and various mineral composition. Different soil ecosystems have different levels of physical and chemical properties and working with them requires understanding of these properties. The knowledge of physical and chemical properties of the soil helps in soil management procedures while working with that particular soil (N. Brady, 2002) [13].

In other way the forest provide soil ecosystem functions that are fundamental to sustain terrestrial systems (Abson et al., 2014; Chazdon et al., 2009) [1, 4]. The functions include goods services needed to maintain human populations (Matson, 1997) [14]. Fuel and fibre (Rojstaczer et al., 2001; Vitousek et al., 1986) [16, 20]. They can also regulating pest control (Bale et al., 2008) and also supporting pollinating services (Kremen et al., 2002) [12]. To improve the productivity from any soil ecosystem the knowledge on different properties of soil is important to update (B.S. Griffith, 2010) [2]. To get better yields, reduce pollution, and achieve sustainable agricultural practices, soil fertility needs to be maintained at optimum level (Diaccono and Montemurro, 2010) [7]. Hence, soil analysis is the way to know the available major nutrient levels in different land use systems to develop sustainable management strategy to conserve soils. To the best of our knowledge, such study has not been undertaken from this region. Therefore, the aim of present study was to find the differences in the Chemical properties of the soil under different land use systems.

Materials and methods

The study sites are located in city outer part of Hyderabad, in Telangana state, southern part of India. The composite soil samples were collected from four regions - local forest region, paddy soil with chemically fertilized, paddy with organic fertilized soil and industrial area (cherlapally). The principle crop is paddy in this region. The composite soil samples in triplicates were collected (0-15cm) in small sterilized low density polythene bags and were brought to the laboratory. The soil samples were air-dried and passed through 2 mm sieve for further chemical properties. The processed soil samples were used for determining pH and Electrical conductivity were determined in 1:2 soil: water suspension by potentiometric method (Jackson, M.L., 1977) [10] and conductivity bridge method (Jackson, M.L., 1977) [10] respectively. The Organic carbon was estimated by wet digestion method (Walkley and Black, 1934) [22]. The nutrients level of Total Nitrogen is estimated by alkaline permanganate method (Subbaiah and Asija, 1956) [18]. Available phosphorus estimated in the Olsen’s extract by ascorbic acid (Watanabe and Olsen’s 1965) [21] and available potassium by Ammonium acetate extract method (Mervin and Peach, 1951). The soil electrical conductivity (EC) is a major soil indicator of salinity or salt content level. The values of EC observed in the range from 0.2 to 0.5 dS m⁻¹ and the highest average value was in agriculture. Soil organic carbon plays important role soil biological function and is a measurable component of organic matter. Most of the Organic matter is from dead or decaying materials. The results showed moderate in all soil samples in considerable concentrations. The low OC can be attributed to continuous cultivation, removal crop residue without return, effects of water and wind erosion which preferentially remove the soil colloids including the organic fractions. The Nitrogen, Phosphorous and Potassium are the major primary macronutrients of the soil and are important plant growth. Nitrogen is important element present in chlorophyll which increases vegetative growth of protein content. The deficiency of nitrogen results in stunted growth of plants and excess present soil is also a problem to the plant which will be reflected by the delayed maturity and most susceptibility to insects and diseases. The fertility is generally reflected by the levels of Nitrogen in the soil and available nitrogen varied from 139.2 kg/acre (organic soil) to 927 kg/acre (Industrial). The use extensive chemical fertilized agriculture practices may leads to the nitrogen content high in agriculture soil which was beyond the limits for this region and similar pattern was observed in forest may due to unavailability of nitrogen source. Phosphorus (P) in the soil is an important factor which influences the chemical, biochemical characteristics of soil.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Parameters</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>1:2.0 soil water suspension by Using pH meter.</td>
</tr>
<tr>
<td>2</td>
<td>Electrical conductivity</td>
<td>1:2 soil water suspension by using Conductivity bridge.</td>
</tr>
<tr>
<td>3</td>
<td>Organic Carbon</td>
<td>Walkley and Black’s oxidation method (Walkley, a and Black, I.A, 1934)</td>
</tr>
<tr>
<td>4</td>
<td>Total Nitrogen</td>
<td>Alkaline permanganate method (Subbaiah and Asija, 1956)</td>
</tr>
<tr>
<td>5</td>
<td>Available Phosphorus</td>
<td>Olsen’s extraction method (Olsen, S.R, 1954)</td>
</tr>
<tr>
<td>6</td>
<td>Available Potassium</td>
<td>Ammonium acetate extract method (Mervin and Peach, 1951)</td>
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The soil electrical conductivity (EC) is a major soil indicator of salinity or salt content level. The values of EC observed in the range from 0.2 to 0.5 dS m⁻¹ and the highest average value was in agriculture. Soil organic carbon plays important role soil biological function and is a measurable component of organic matter. Most of the Organic matter is from dead or decaying materials. The results showed moderate in all soil samples in considerable concentrations. The low OC can be attributed to continuous cultivation, removal crop residue without return, effects of water and wind erosion which preferentially remove the soil colloids including the organic fractions. The Nitrogen, Phosphorous and Potassium are the major primary macronutrients of the soil and are important plant growth. Nitrogen is important element present in chlorophyll which increases vegetative growth of protein content. The deficiency of nitrogen results in stunted growth of plants and excess present soil is also a problem to the plant which will be reflected by the delayed maturity and most susceptibility to insects and diseases. The fertility is generally reflected by the levels of Nitrogen in the soil and available nitrogen varied from 139.2 kg/acre (organic soil) to 927 kg/acre (Industrial). The use extensive chemical fertilized agriculture practices may leads to the nitrogen content high in agriculture soil which was beyond the limits for this region and similar pattern was observed in forest may due to unavailability of nitrogen source. Phosphorus (P) in the soil is an important factor which influences the chemical, biochemical characteristics of soil.
and is important for fertility. Phosphorus is an important factor that helps in cell division, stimulates root growth and formation and also provides the biological energy as ATP which makes the plants more tolerant to drought, cold and diseases. The availability of phosphorus depends on pH and Organic carbon. The forest soil shows maximum value whereas organic soil given lesser. However, overall all soil samples contains high concentrations in the region. Potassium (K) in the soil is an important macro element which influences various biochemical functions. Potassium deficiency in plants show harmful effects exhibited by leaves turning brown especially in marginal, drying and stunted growth. The agriculture soil and industrial soil contain less content of this element due to chemical and industrial pollution. Medium level concentration this element shown as in case of organic and forest soil ecosystems 72 kg/acre and 56 kg/acre respectively. We can observe various levels of N, P, K present in all soil systems presented in figure.1.

Table 1: Chemical properties of different Soil (Mean ± SE)

<table>
<thead>
<tr>
<th>SL. No</th>
<th>Parameters</th>
<th>Agriculture</th>
<th>Organic</th>
<th>Forest</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PᵢH</td>
<td>7.0 ± 0.049</td>
<td>7.1 ± 0.011</td>
<td>6.12 ± 0.011</td>
<td>7.41 ± 0.125</td>
</tr>
<tr>
<td>2</td>
<td>EC (dS m⁻¹)</td>
<td>0.503 ± 0.017</td>
<td>0.236 ± 0.017</td>
<td>0.206 ± 0.006</td>
<td>0.306 ± 0.063</td>
</tr>
<tr>
<td>3</td>
<td>Organic carbon</td>
<td>0.79 ±0.008</td>
<td>0.74 ±0.014</td>
<td>0.76 ±0.008</td>
<td>0.78 ± 0.023</td>
</tr>
<tr>
<td>4</td>
<td>Nitrogen kg/acre</td>
<td>875.3 ± 1.45</td>
<td>139.2 ± 0.68</td>
<td>850.6± 1.169</td>
<td>927 ± 3.214</td>
</tr>
<tr>
<td>5</td>
<td>Phosphorus kg/acre</td>
<td>68.5 ± 0.435</td>
<td>49.38 ± 0.33</td>
<td>74.16 ± 0.33</td>
<td>57.86 ± 0.20</td>
</tr>
<tr>
<td>6</td>
<td>Potassium kg/acre</td>
<td>29.03 ± 0.688</td>
<td>72 ± 0.577</td>
<td>55.86 ± 0.35</td>
<td>43.5 ± 0.692</td>
</tr>
</tbody>
</table>

Fig 1: NPK Levels in four soil systems

Conclusion
The study indicates the soil chemical properties such as available Nitrogen content and available Phosphorus content are negatively affects the agriculture, industrial and forest systems except the organic farming soil system where the soil effected only by phosphorus. The high quantities of nitrogen, available phosphorus and organic carbon (forest) content in the soil system indicates that it has considerable impact on nutrient build-up and accumulation by reducing the loss through soil erosion and leaching due to high litter production. The is the first study from outer side region of hyderabad which can be helpful for farmers and measures must be taken to ensure adoption more environment friendly agricultural practices for sustainable production and also maintain soil health by good soil management procedures. Further study is required to know the microbial profiling across all the four soil ecosystems which would give microbial interaction with respect to the soil management practices.

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