A comparative study of soil fertility status under different crop cultivation in Gombe

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A comparative study was conducted among three different cropping areas. Samples were collected from each area and are taken to laboratory for analysis, and variables such as organic carbon, available phosphorous, total nitrogen, PH, electrical conductivity, particle size distribution, exchangeable bases and CEC were tested. The statistical analysis is used to obtain the mean values of the result obtained from each variable. A fertility rating score was design using the evaluation key to determine the fertility level under each cultivation area. The score shows that score one is extremely low, score two very low, and score three moderately low. The total scores obtained from each cropping area are summed up to obtain the total score from each land.

Key words: Fertility, soil, crop, cultivation.

INTRODUCTION

Soil has been defined in several ways by different people or users. To a local farmer, soil is the medium in which plants grow. Engineers view soil in terms of its suitability as a building material or as a support medium for roads, building and other structures. To a pedologist, soil is a collection of natural bodies occupying the portion of the earth surface that supports plant. It has properties derived from the combined effect of climate and living organisms as modified by topography, acting on parent materials over a period of time (Brady and Weil, 2002 in Abaye, 2007).

The soil on which plants grow contains certain nutrients which are classified as major (macro) and minor (micro) nutrients. These nutrients are absorbed by the roots of plants and used for their growth and yield. When these nutrients are not obtained or when they are not available in sufficient quantity, crops perform poorly and show deficiency symptoms.

Plants require relatively large quantity of major elements to build up their tissue but they need relatively small amount of minor element. Plants cannot survive without these micro elements since a deficiency in any of them may lead to poor growth and eventually death of plant. These elements are therefore of vital importance to plants.

Since agricultural revolution, man's primary interest in soil has been centered on its potential to support plants which provide food, fiber, and forest products. In the tropics, many plants are grown on the soil in traditional farming practices and many of them present different
fertility problems in different soil type (Mansurat, 2000).

How good a soil is, as a medium for plant growth, depends on its ability to support plant food, to support and hold adequate proportion of air and water for the plant. This is referred to as soil fertility and it is determined by the chemical and physical condition of the soil.

A soil is regarded as being fertile when crops can be successfully grown on it. The fertile soil should be neither too sandy nor contain too much clay and should be properly aerated. Also, a fertile soil must not be short of water, and should not be waterlogged; good soil structure and texture are also important. Therefore when soil fertility falls, method of improving it must be found.

The aim of this paper is to determine and compare the fertility level of soil under different crop cultivation and the specific objectives are as follows:

To determine the fertility level of soil under different crop cultivation.
To compare the fertility status of soil under different crop cultivation, and
To provide the way of maintaining and improving the fertility of the soil in the study area.

RESEARCH METHODOLOGY

The source of data used in this study includes both the primary and secondary sources of data and these include geographical maps, text book, unpublished dissertations, laboratory analysis and other information obtained from local people through participatory rural appraisal.

The study area

Gombe Metropolis is located between latitude 10° 0'N to 10° 20'N and longitude 11° 01'E and 11° 19'E. It shares common boundary with Akko LGA in the South and West; Yamaltu-Deba to the East and Kwami to the North. It occupied a total land area of about 40 Km². It is the capital of Gombe State (Aliyu, 2012).

Gombe lies in the stretch of the Benue, which, from the structural point of view is known as Zambuk Ridge area.

The study area consists of two types of soil which correspond to the two geological formations from which they are derived, (Mbaya 2012). Sandy soil is found in the Northwest of the metropolis and is underlain by keri-keri formation from which it was derived. Soil depth varies between 2.0cm as in the area where gullies originated and as deep as 15-20cm in some other places (Orazulike, 1992).

The soils are ferruginous which are red in color and contain nodules of ironstone; this soil is marked by deposits of iron oxide pebbles and is loose, very permeable and deficient in plant nutrients (Mbaya, 2012). Clayey soil occurs in the south and southeast of the metropolis and around the Kware River, round railway station. The soil is either derived from the Pindiga formation or clay of Gombe sandstone. The soil is grey and rich in organic matter, and possesses an appreciable shrink-swell capacity as the soils go through periods of drying and wetting (Orazulike, 1987).

Pre-field activities: - a reconnaissance survey of the area was carried out from which boundaries of the farmlands were demarcated, and the base map prepared. On the base map sampling, points were marked using stratified random sampling technique where each farmland was divided into a strata. The croplands to be studied are maize, groundnut and beans.

Field activities:- individual samples were marked on the base map. A composite sampling was made from each stratum where three samples are collected from each stratum and mixed vigorously to form a composite sample for soil fertility.

RESULT AND DISCUSSION

This work involves the determination of the fertility level under different crop cultivation in the study area.

Soil fertility consists of both physical and chemical properties. It depends not only on parent material but also on land use practice and continuous cultivation without proper management causes nutrient imbalance. Fertility is also a function of capacity to produce healthy plants (Mansurat, 2000).

The fertility rating levels were designed and used in this study. The scoring scheme was prepared in order to ensure its proper level of fertility in each cultivated area. It was indicated that whenever you see extremely low, it will score one mark, very low score two marks and moderately low score three marks. This will be sum up at the end of the random rating in order to know which of the cultivated area has the highest score. Therefore, the fertility rating and the score of the cultivated area are presented in Table 1.

The table indicates the fertility level obtained from each cultivated area, based on the scores obtained from each area. It was observed that the fertility level is higher under maize; this may be attributed to the frequent application of organic waste and inorganic fertilizer at different location in the area.

The cultivated ground nut and beans farms have the same level of fertility, based on the scores obtained from each land (Table 1). The similarities in the scores obtained may be due to the lack of application of any kind of fertilizer to the land. Even though, there are some variations in the means values of different variables obtained from this two cropping lands; groundnut is higher because of the presence of natural vegetation which constantly supplies organic residue through forest litter.

Comparative analysis of fertility ratings

The objective of this study also involves comparative analysis among three different cropping farms in the study area. Table 1 provides the fertility rating for the three areas of crop cultivation and this can be used to compare the fertility level of the areas.

Under groundnut farm, available phosphorous rated as moderately low, has the mean value of 29 ppm which scores three marks, while organic carbon, exchangeable Na, Ca, and CEC are rated as very low. This variable has
Table 1. Fertility table and rating of some variables.

<table>
<thead>
<tr>
<th>Crop under cultivation</th>
<th>Variables</th>
<th>Mean</th>
<th>Fertility rating</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organic carbon</td>
<td>0.85</td>
<td>Very low</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Total Nitrogen</td>
<td>0.03</td>
<td>Extremely low</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Avail. Phosphorous</td>
<td>29</td>
<td>Moderately low</td>
<td>3</td>
</tr>
<tr>
<td>Groundnut</td>
<td>Exchange Na</td>
<td>0.88</td>
<td>Very low</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&quot; K</td>
<td>0.38</td>
<td>Extremely low</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&quot; Ca</td>
<td>4.39</td>
<td>Very low</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&quot; Mg</td>
<td>2.88</td>
<td>Extremely low</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>CEC</td>
<td>6.25</td>
<td>Very low</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Organic carbon</td>
<td>0.78</td>
<td>Very low</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Total Nitrogen</td>
<td>0.03</td>
<td>Extremely low</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Avail. Phosphorous</td>
<td>28</td>
<td>Moderately low</td>
<td>3</td>
</tr>
<tr>
<td>Maize</td>
<td>Exchange Na</td>
<td>0.70</td>
<td>Very low</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&quot; K</td>
<td>0.36</td>
<td>Extremely low</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&quot; Ca</td>
<td>4.60</td>
<td>Very low</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&quot; Mg</td>
<td>3.13</td>
<td>Extremely low</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>CEC</td>
<td>7.0</td>
<td>Moderately low</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Organic carbon</td>
<td>0.67</td>
<td>Very low</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Total Nitrogen</td>
<td>0.02</td>
<td>Extremely low</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Avail. Phosphorous</td>
<td>26</td>
<td>Moderately low</td>
<td>3</td>
</tr>
<tr>
<td>Beans</td>
<td>Exchange Na</td>
<td>0.60</td>
<td>Very low</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&quot; K</td>
<td>0.35</td>
<td>Extremely low</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&quot; Ca</td>
<td>4.60</td>
<td>Very low</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&quot; Mg</td>
<td>2.73</td>
<td>Extremely low</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>CEC</td>
<td>6.0</td>
<td>Very low</td>
<td>2</td>
</tr>
</tbody>
</table>

The mean values of 0.85, 0.88, 4.93 and 6.25 respectively which scored two marks (Table 1).

Exchangeable K, Mg and total nitrogen are rated as extremely low. These have the values of 0.38, 2.88 and 0.03 ppm respectively, which score one mark under the same land. The extremely low level of the exchangeable K is due to the fact that leafy crops such as groundnut generally contain about 2% K in their dry matter and large amounts are removed when they are harvested (Russells, 1988).

The mean value for nitrogen is 0.03 which is rated as extremely low; the low level of nitrogen under groundnut is attributed to the accelerated erosion and leaching since these invariably result in the loss of nitrogen. They also take away the leafy part of the crops without returning it to the land; thereby leading to low level since it contains certain percentage of nitrogen.

Land under maize in the study area shows that the organic carbon, exchangeable Na, Ca are rated as very low, which score two marks with mean values of 0.78, 0.70 and 4.60 respectively.

The mean value for total nitrogen, potassium and magnesium are 0.03, 0.36 and 3.13 ppm respectively, rated as extremely low with the score of one mark; while available phosphorus and CEC are rated as moderately low with the mean value of 28 ppm and 7.0 respectively with the scores of three marks. This resulted in total marks of fifteen (15) for maize.

The mean values of 0.67, 0.60, 4.60 and 6.0 are obtained from organic carbon, exchangeable Na, Ca and CEC respectively, under beans in the study area. These values are rated as very low with the scores of two marks. Total nitrogen, exchangeable K and Mg are rated as extremely low with mean values of 0.02, 0.35 and 2.73 ppm respectively; their score is one. While, available phosphorus was rated as moderately low with three score and mean value of 26 ppm. This has a total of 14 marks for land under beans.

Groundnut and beans score the same marks with the same fertility rating. This indicates that they have the same fertility in the study area; this may be due to the fact that they do not enjoy the application of both organic and inorganic fertilizer and also have the same type of management.

Land under maize proves to have higher fertility rating than the land under groundnut and beans. The higher fertility may be due to the frequent application of both organic and inorganic fertilizer to the land, irrespective of
the problems of erosion and leaching.

Beans and groundnut areas have the same fertility problems; firstly the release of nutrients in the area is low. Secondly, the ability of soils in the area to retain nutrients is low as a result of leaching and this problem can be overcome by building up of the organic matter reserves of the soil in the area.

Conclusion

An evaluation of fertility status of soil in the study area shows that the soil is generally low in fertility. The low fertility level is due to general sandy nature of the soil which allows leaching and the organic matter level of the soil, both of which give rise to low nutrient accumulation. Low level of clay was observed in the area. This may be due to lack of proper management of pedological properties of the soil that ensures water holding capacity. Problems such as accelerated erosion and bareness of the soil to the wind without being covered by vegetation also contribute to the depletion of the soil.

RECOMMENDATION

In order to improve the fertility level of the soil in the study area, the following recommendations are outlined:

Soil conservation measures should embark upon for adequate maintenance and improvement of pedological properties that enable effective water holding capacity and adsorption of nutrient. Measures such as crop rotation, inter cropping, fallowing of the land should be embarked upon for at least three years to allow the balance of the nutrient. It has been observed that the total nitrogen level in the area is extremely low based on the fertility rating; therefore, much fertilizer application for nitrogen should be provided where necessary. Both organic and inorganic fertilizer should be properly and frequently applied in small quantity to the soil due to the sandy nature of the soil. This may reduce the leaching away of most of the fertilizer applied. Special consideration should also be made to the efficiency of management; this may also involve the amount of time and resources spent on the land.

Conflict of Interests

The authors have not declared any conflict of interests.

REFERENCES


