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Short Communication

Physicochemical characteristics of Dabus Kebele farmland soil, Bambasi District, Benshangul Gumuz regional state, western Ethiopia

Dessie Almaw Cherie* and Lejalem Abeble Dagnaw
Ethiopian Institute of Agricultural Research (EIAR), Assosa Agricultural Research Center, Assosa, Ethiopia
dalmaw121@gmail.com

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Abstract

Identification of soil properties at the particular location was decided to study the nutrient contents of the soil. This study aimed to evaluate the physicochemical parameters of Dabus villages agricultural land of pH, %OC, %TN, ppmP, exchangeable acidity, Cmol/100g soil of CEC, exchangeable acidity and potassium content, g/cm^3 of bulk density, %sand, %clay, %silt and textural class of the farming land. All soil samples collected from the villages showed unnoticeable amount result. However, all samples showed lower nutrient content than the standards, village nine (S9) was showed highest result in most parameters. The pH, N, P, K, organic carbon and CEC was evaluated. The pH was found to be strongly acidic. The result is concluded that, the study area contains insufficient organic carbon, and other essential nutrients for growth of plants.

Keywords: NPK, CEC, pH, Organic Carbon, Texture, Soil.

Introduction

Soil is composite mixtures of minerals, water, air, organic matter and countless organisms that are the decaying remains of once-living things. Soil is a vital component, medium of unconsolidated nutrients and materials used for formation of life layer of plants. Development of soil is as a result of pedogenic process through weathering of rocks, consists of inorganic and organic constituents, possessing definite chemical, physical and biological properties, having variability from depth to surface of the earth, and provides a medium for plant growth[1]. All of the processes that support human societies, economies and all other terrestrial life on the earth undeniably are soil dependent[2]. The world agricultural productivity and sustainability is highly dependent up on fertility and physicochemical characteristics of soil resources[3,4]. Most soil biological activities and organic matter formation takes place at the surface of the layer. In general, there is a higher nutrient availability in the surface soil than other soil[5,6].

Agriculture is the back bone of Ethiopian national economy. Approximately 50% of gross domestic product and 90% of its foreign exchange income is accounted by agriculture[7]. It is obvious that sustainable and high agricultural production needs fertile and productive soils, and physicochemical analysis of surface soil is important for sustainable agricultural productivity.

Soil nutrient analysis is a valuable tool for effective agricultural farm activities to determine the inputs required for efficient and economic production. An appropriate physicochemical soil test helps to meet the rate of fertilizer application and to ensure and manage fertility status of the soil for sustainable crop production[8,9]. Consequently, the objective of this study is to characterize the availability of soil nutrients or the need for its introduction and to predict the increase in yields and profitability of fertilization collected from Dabus villages, Bambasi district of Benshangul Gumuz regional state, Ethiopia.

Materials and methods

Study area: The study was conducted at Assosa agriculture research center (AsARC) soil, water and plant testing laboratories. The sample site is located in Benshangul Gumuz Regional State, Bambasi Woreda at Dabus kebele, which is 620 km in the west of Addis Ababa, Ethiopia. The research site is located between 09°49’94.9’’ and 09°49’98.3’’ North latitude and 34°42’35.8’’ and 34°42’55.3’’ East longitude, with 1443 to 1491 meter above sea level altitude. Crops grown on the area were Maize (*Zea mays*), and Sorghum (*Sorghum bicolor*). The selected agricultural farming lands have been intensively cultivated more than 40 successive years. In addition to extended period land utilization, improper natural and human activities trim down the fertility of farming soil.

Materials: Fifteen soil samples, pH meter (model No pH-016 Bench top pH meter), Spectrophotometer (model No DU 8800R), Flame photometer (model No PFP7), Digital burette (model No 16G10518), Texture homogenizer (model No PT3100), Bouyoucos hydrometer, Kjeldhal nitrogen distiller and digester, and electronic balance (model No 1A11003N) were materials used for experimental analysis.

Sample collection and preparation: Representative composite soil samples were collected at depth of 0-20cm from Dabus kebele 15 villages which are represented by sample-1 (S1) to sample-15 (S15) for this study. The collected soil samples were removed and freed from rubble, stones and air dried, ground and sieved in 1, and 2mm sieve size and then mixed thoroughly to obtain a homogeneous envoy sample mixture[10]. The sieved soil samples were packed and sealed in an airtight plastic cover and ready for nutrient analysis. All Chemicals/reagents and solvents used in laboratory analysis were analytical grade.

Methods of experimental analysis: The pH, organic carbon, total nitrogen, available phosphorus, cation exchangeable capacity, particle size distribution, potassium, exchangeable acidity and bulk density of soil samples were determined by 1:2.5 soil to water ratio, Walkley-Black method, micro kjeldhal method, Bray II method, ammonium acetate extraction with micro kjeldhal method, Bouyoucos hydrometeric with textural triangle method, 1N NH_4OAc extraction with flame photometer determination method, 1N KCl extraction with titration method and core sampler method respectively[11-17].

Soil Chemical Properties: Soil reaction (pH): Soil pH analysis is a key chemical parameter to evaluate fertility status and acidity classification of agricultural land. The value affects soil nutrient availability, class, microorganism activity as well as to choose method of some chemical analysis.

Organic matter: Soil organic matter is an aggregating mediator that binds minerals particles together to develop structure in the soil. Nitrogen present in the soil mainly comes from decomposition of organic matter. Nitrogen also required in large quantities for plant growth and production[12].

Available phosphorus: An appropriate amount of phosphorus of phosphorus is necessary for maintaining a balance between the other plant nutrients and ensuring the normal growth of crops. The availability of phosphorus in soil is very variable because it depends on the mineral soil composition, organic materials and its rate of decomposition, local climatic conditions and the morphological properties of soil[14].

Cation Exchange Capacity (CEC): Potassium (K^+), sodium (Na^+), calcium (Ca^{++}), magnesium (Mg^{++}), ammonium (NH_4^+), ions attract and retain with negatively charged ions in the soil. Cation exchange is a reversible process. Thus, elements or nutrients can be held in the soil and not lost through leaching, and can subsequently be released for crop uptake. Certain organic compounds contribute Cation exchange capacity (CEC) to the soil. The process is known as cation exchange capacity (CEC) of the soil[15].

Determination of Soil Physical Properties: Particle size distribution/soil texture describes the proportion of three sizes of soil particles and the fineness or coarseness of a soil. The structure is the arrangement of particles and pores in soils[16].

Methods of Data Analysis: All analyzed soil parameters were measured in triplicates to take mean ± SD (standard deviation) value. The standard calibration curves for potassium and phosphorus analysis were constructed using Microsoft excel 2007 for standard samples. Statistical analysis was also undertaken by analysis of variance (one way ANOVA) with Least Significant Difference (LSD) to compare result between villages soil sample at the same concentrations using SPSS statistics version 20. Result was considered statistically significant at P-value < 0.05.

Results and Discussion

Chemical parameters analysis result of collected soil samples from fifteen villages are presented in Table-1. The result verifies that the soil sample from respective locations have minute visual variations each other in chemical properties such as pH, %OC, %TN, ppmP, exchangeable acidity, CEC as well as in potassium content.

The ideal recommended optimum pH range for plants growth is 6.5 to 8.0, however pH of collected soil samples were found in range of 5.04±0.019 to 5.79±0.025 which indicate the strongly acidity of soils.

Exchangeable acidity of the soils were varied among the various samples collected for the study from 1.962±0.004 to 4.431±0.004 meq/100g soil. The area is exposed to wild fire, the effect of this activity might soil microorganisms disrupted and thus organic matter decrement consequence is raised of soil acidity.

Percent of soil organic carbon ranges from 0.554±0.005 to 1.306±0.006%. Study area soil organic carbon is remarkably low. This shows poor soil organic carbon reduces microbial biomass and nutrient mineralization the reason might be scarcity of energy sources by wild fire and soil erosion. Soil organic carbon results in less diversity in soil biota with a risk of the food chain equilibrium being disrupted which can cause disturbance in the soil environment[18-19].

As Table-1 result shows percent of total nitrogen for collected soil samples ranged between 0.034±0.007 and 0.120±0.005. The highest and lowest value percent of total nitrogen was recorded for sample 9 (village-9) and sample 8 (village-8) respectively.

The available phosphorus results of this study area was varied between 4.15±0.108 to 10.39±0.104 mg/kg of soil. In this study cation exchange capacity (CEC) ranges between 9.20±0.172 to 13.80±0.431Cmol/100g soil. Exchangeable potassium varies between 0.203±0.002 to 0.505±0.010Cmol/100g soil.

Nearly all analyzed soil samples have positive correlation between percent of organic carbon, total nitrogen, pH, and CEC and have less than the recommended amount of nutrient present in farming land soil. This study confirm the Ethiopian agricultural transformation agency (ATA) result[20]. The experimental result showed that village-9 (S9) and village-5 (S5) soil samples contain considerable amounts of pH, %OC, %TN, ppmP, K, and CEC. Village-9 and 5 results was showed better than the other. The findings of this study indicates that a soil test is important to optimize crop production, protect the environment from contamination by runoff and leaching of excess fertilizers, aid in the diagnosis of plant culture problems, improve the nutritional balance of the growing media and save money and energy by applying recommended amount of input needed.

As the result listed in Table-2; the value of sand content is higher than clay and silt content. Average experimental result of soil sand, silt and clay Content were 57.37%, 7.82% and 34.81% respectively. The studied soil samples bulk density showed variation between 1.089±0.0104 to 1.208±0.009g/cm^3.

Conclusion

Physicochemical soil parameters analysis is important to farming land for plants growth and soil management. Soil laboratory analysis is the measurement of nutrients present in the soil which is removed from the soil using an extracting solution. A physicochemical studies of composite fifteen soil samples from fifteen villages shows, all soil pH, %TN, ppmP, Cmol/100gK, Cmol/100g CEC and % organic carbon of selected area were categorized under the low status. As the previous researcher ranges of Ethiopian soil nutrient all analyzed nutrient concentration availabilities were inadequate amount for growth of plant and soil organisms[21]. Causes of farm land fertility reduction might be continuous cultivation, soil erosion, burning farm lands in the dry season, clearing of forests and grasslands for annual crop production and consistently loss of soil organic matter. This study gives base line information for particle size distribution of farming land, current status of land soil nutrients. Farmers arrange agricultural inputs in appropriate amount and type to increase yield of crop production as well as encourage appropriate reclamation measures for growing crops. Soil health is a key factor in the preservation of food security particularly for developing countries.

Table-1: The results of soil samples chemical analysis collected at Dabus kebele villages.

No	pH	% OC	% TN	ppm (P)	Cmol/kg soil (K)	Cmol/kg soil (CEC)	Ex. Acidity Cmol/kg soil
S1	5.27±0.017	0.625±0.007	0.084±0.002	4.71±0.087	0.216±0.002	9.70±0.140	3.904±0.012
S2	5.35±0.009	1.092±0.012	0.108±0.004	6.14±0.122	0.332±0.002	11.80±0.078	2.385±0.020
S3	5.61±0.021	1.201±0.008	0.104±0.002	7.29±0.201	0.487±0.012	14.00±0.210	1.966±0.006
S4	5.51±0.031	1.230±0.015	0.110±0.007	7.14±0.065	0.288±0.007	10.00±0.102	2.239±0.017
S5	5.690.002	1.306±0.006	0.106±0.003	9.87±0.085	0.314±0.002	12.60±0.081	2.023±0.012
S6	5.44±0.040	1.044±0.007	0.085±0.000	5.87±0.142	0.325±0.006	11.80±0.136	2.781± 0.013
S7	5.11±0.007	0.709±0.003	0.042±0.001	6.57±0.122	0.209±0.004	9.20±0.172	3.987±0.003
S8	5.04±0.019	0.554±0.005	0.034±0.007	5.57±0.058	0.203±0.002	9.28±0.055	4.431±0.004
S9	5.79±0.025	1.206±0.005	0.120±0.005	10.39±0.104	0.478±0.009	13.80±0.431	2.192±0.005
S10	5.48±0.007	1.004±0.012	0.113±0.003	9.14±0.082	0.289±0.005	11.80±0.091	2.519±0.008
S11	5.65±0.015	1.102±0.009	0.107±0.002	10.24±0.092	0.352±0.003	12.00±0.203	1.962±0.004
S12	5.57±0.009	1.042±0.021	0.069±0.007	5.45±0.201	0.423±0.004	11.00±0.105	2.075±0.005
S13	5.50±0.008	0.670±0.014	0.081±0.008	6.82±0.086	0.276±0.001	10.00±0.300	2.146±0.010
S14	5.56±0.014	0.706±0.004	0.101±0.002	7.165±0.090	0.505±0.010	14.00±0.091	2.058±0.009
S15	5.21±0.011	0.568±0.008	0.058±0.001	4.15±0.108	0.230±0.008	10.60±0.128	3.983±0.014

Table-2: Result of soil physical parameters analysis Collected at experimental sites.

No	BD in g/cm^3	Particle size distribution (Soil texture)			Textural Class
		% Sand	% Clay	% Silt	
S1	1.105±0.014	51.25±0.875	41.25±0.526	7.5±0.102	Sandy clay
S2	1.203±0.007	46.25±0.683	38.75±0.471	15±0.210	Sandy clay
S3	1.174±0.007	58.75±0.821	36.25±0.383	5±0.088	Sandy clay
S4	1.182±0.010	63.75±0.754	31.25±0.556	5±0.120	Sandy clay loam
S5	1.186±0.005	43.75±0.845	46.25±0.728	10±0.273	Sandy clay
S6	1.154±0.008	63.75±0.184	28.75±0.576	7.5±0.101	Sandy clay loam
S7	1.162±0.004	47.00±0.814	42.25±0.495	10.75±0.008	sandy clay
S8	1.175±0.006	61.25±0.693	31.25±0.881	7.5±0.072	sandy clay loam
S9	1.092±0.0102	58.75±0.866	38.75±0.387	2.5±0.065	Sandy clay
S10	1.210±0.007	53.75±0.920	38.75±0.628	7.5±0.048	Sandy clay
S11	1.205±0.0105	51.25±0.275	40.75±0.246	8±0.104	Sandy clay
S12	1.208±0.009	68.75±0.649	23.75±0.431	7.5±0.086	sandy clay loam
S13	1.183±0.0103	64.25±0.578	25.75±0.288	10±0.100	Sandy clay loam
S14	1.089±0.0104	53.25±0.485	40.25±0.510	6.5±0.005	sandy clay
S15	1.165± 0.020	54.75±0.774	40.25±0.492	5.0±0.007	sandy clay

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