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ORIGINAL ARTICLE

Assessment Of Macro And Micronutrients In Soils From Mannargudi Area, Thiruvarur District, Tamil Nadu, India

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ABSTRACT

Soil is a medium through which crops grow to perform the need of human for food and cloths. Agriculture refers to an art of hoist plants from the soils and is one of the most economical factors for human beings. In achieving better crop yield the farmers should be made aware about the status of soil constituents, chemistry of water available, nutrient supply to the crop, climatic conditions etc. Periyakoattai and Thirumangalkkattai is rice bowl of Thiruvarur region of Tamil Nadu which is a staple food of majority of the people. Most of the rice producers are small farmers who lack resources and because of this the productivity of rice in this area is declining. This study has focused on the investigation of macro- and micronutrients in soils from Periyakoattai (S1) and Thirumangalkkattai (S2) area of Tamil Nadu. The soil samples collected from Periyakoattai and Thirumangalkkattai in January 2015. The different physical parameters and macro elements were analyzed in laboratory are pH, EC, C_{org}, P and K. The micro elements such as Cu, Zn, Fe, Mn were estimated by Atomic Absorption Spectroscopy while calcium and magnesium, carbonate, bicarbonate, chloride were estimated volumetrically. The observed values of microelements and macronutrients found to be high in S2 compared to S1 sample. In this study soils show high pH values (< 8) indicating their alkaline nature which can be counteracted by adding basic fertilizers. The high value of EC could be due to accumulation of soluble salts. The study indicates that in all the soil samples natural manure and organic fertilizers are the best alternatives to augment C_{org} and micro-organism which will help increasing the rice productivity.

Keywords: *Macronutrients, Micronutrients, Physico-chemical analysis, Rice field soils Periyakoattai and Thirumangalkkattai.*

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INTRODUCTION

Soil can also be defined as “A dynamic natural body on the surface of earth, in which plants grow, composed of materials and organic materials and living forms.” Or “The collection of natural bodies, occupying parts of the earth’s surface that support plants, and that have properties due to the integrated effect of climate and living matter acting upon parent material, as conditioned by relief over periods of time”[1]. Soils like a film envelop the surface of our planet. These are the Youngest” or rather the most recent formations. The origin of soils, their position as the boundary between the lithosphere and the biosphere, and their peculiar structure and composition, which make them so different from other natural bodies, means that they must be treated as complicated biogeochemical system [2, 3].

Agriculture refers to an art of raising plants from the soils and is one of the most economical factors for human beings. Agriculture is largely influenced by controlling factors like climate, soil topography while soil erosion is a serious problem for agricultural productivity. Currently, there is widespread interest in developing sustainable agricultural systems that are less dependent on external inputs, especially chemical fertilizers and herbicides, to reduce impacts on the environment and to conserve and improve soils [4]. Reuse of Industrial and domestic and bioenergy by-products is one of the new ways of recovering and re-using nutrient resources in agriculture [5], however, these byproducts can potentially harm the soil and related environments. Chemical fertilizers may gradually increase the acidity of the soils. Healthy soils indicate the integrity ofterrestrial ecosystems which remain intact and having ability to recover from disturbances such as drought, climatechange, pest infestation, pollution and human exploitation, including agriculture [6]. In general soil chemical fertility and in particular lack of nutrient inputs is a major factor in soil degradation [7] and hence tropical soils often have negative soil nutrient balances [8] because of inherent low fertility status, inappropriate land use, poor management, erosion and salinization [9]. To boost and sustain rice yield. Tabi *et al* [10] suggested soil management practices defined for identified units instead of a common management for all units.

Soil is made of several components, including the solid mineral component of the soil, the organic component and the porous component. The amount and type of organic matter can have an effect on how the soil is constructed between the different components. In turn, how the solid mineral component of the soil is constructed can affect how the soil organic matter will influence the soil. Generally the more clay, the less will be the influence of the soil organic matter. The main objectives were also taken into consideration for the present work is to study the types of the soil, Physical and chemical examination of the soil and also correlate the available soil macro- and micronutrients with properties of the soil from Periyakoattai (S1) and Thirumangalkkattai (S2) area of Thiruvarur district, Tamil Nadu.

MATERIALS AND METHODS

Collection of the soil samples

In the present work chemical analysis of rice field soil samples collected from Mannargudi region, Thiruvarur district of Mannargudi, Tamil Nadu, South India has been carried out. The location of the samples listed below

Sample 1 : Periyakoattai (S1)
Sample 2 : Thirumangalkkattai (S2)

Sample Preparation

After the collection of the gross samples, precaution was taken to avoid further chemical reactions. The soil samples were dried for 24 to 48 h in shade and were changed into powder. After this samples were preserved in plastic bags. Each soil sample prepared as above was analysed in the laboratory as early as possible to avoid adsorption of NH_3, SO_2, SO_3 gases in the laboratory.

SOIL ANALYSIS

Analysis of the soil was carried out under the following two major categories:

Physical Examination

Physical examination of the soil sample was done for the following:

(i) Soil Colour

Soil has colour perhaps is the most obvious characteristic of soil at the first sight. It was used in is differentiating soils of a site from another site. Soil colour was noted for each sample as it was observed by naked eye at the site.

(ii) Soil temperature

Solar radiation is the principle source of heat and losses are due to radiation and convection. The main source of the soil temperature is solar radiation. The soil temperature is also affects by decomposition of dead organic matter and forest cover. Soil temperature also depends upon the atmospheric air, temperature and moisture content of the soil. Soil temperature was determined for a given sample immediately after it was collected, with the help of a simple thermometer.

(iii) Soil Texture

S.No	Experience	Type	Texture Class
1.	Very gritty, does not form balls, does not strain finger	Very light	Sand
2.	Very gritty, forms ball but very easily broken stain finger slightly.	Light	Loamy Sand
3.	Moderately gritty, forms fairly firm ball which is easily broken, definitely stains finger	---	Sandy Loam
4.	Moderately sticky, slightly gritty feel forms moderately hard ball when dry, stains, ribbons out on squeezing but the ribbon breaks easily	Heavy	Clay Loam
5.	Same as above but very smooth, shows flucking on ribbon surface, similar to still loam	Heavy	Silt Clay Loam
6.	Very sticky feel, forms ball which when dry can not be crushed by fingers, stains heavily, squeezes out at right moisture in to long (2-5 cm) ribbon	Very heavy	Clay
7.	Neither very gritty nor very smooth, forms firm ball but does not ribbon, stains finger appreciably	Medium	Loam
8.	Smooth or sticky, butterly feel, forms firm ball, stains and has a slight tendency to ribbon with flasky surface	----	Silt Loam

(iv) Bulk Density (BD)

Soil Bulk density (BD) is defined as the oven dry weight of soil per unit of its Bulk volume. The bulk volume comprises volume of soil solids and of pore spaces. The density is expressed in the unit of gm/cm3or mg/m3. Soil was filled in a pre-weighed 100 mL graduated cylinder and the soil as made compact by tapping the bottom of the cylinder about 10 times with the help of palm. Soil was added further by following the tapping process till a tapped soil-volume of 100 mL was obtained the cylinder containing the soil was kept in an oven for 24h and was weighed after cooling in a dissector.

Calculation:

$$\text{Bulk density} = \frac{\text{Oven dry mass of soil}}{100}\ \text{mg/ m3}$$

Chemical Examination

The chemical examination of the soil samples of all the sites was done for the following:

(i) pH of the Soil

The acidity, neutrality or alkalinity of a soil is measured in terms of hydrogen ion concentration of the Soil-Water system. Hydrogen ions are important for plant growth. 20g air-dry soil and 40 mL distilled water were shaken on a rotary shaker for 10 to 15 minutes. This gave the 1:2 soil water suspensions. The Microprocessor based pH meter (Systronics, m pH 362) was calibrated using buffer solutions pH = 4 and pH = 7.9. The pH of the soil samples was then determined the above digital pH-meter.

Electrical Conductivity

Electrical Conductivity is important in order to determine the concentration of soluble salts present in the soil suspension. 20 g of air-dry soil and 40 mL of distilled water were shaken on a rotary for 10 to 15 minutes. After this solution was filtered through Whatman filter paper No. 1 and a clear solution was obtained. The Electrical Conductivity of the clear solution thus obtained was then determined using a Microprocessor based digital Conductivity Meter (Systronics – 306).

Cation Exchange Capaciy (CEC)

The capacity of negatively charged clay and organic matter to adsorb cations by simple physical, attractive force is called the Cation Exchange Capacity (CEC) of a soil. Which is quantitative measure of all Cation adsorbed on the surface of the soil colloids. Cation exchange capacity of the soil sample determined in N-ammonium acetate (CH_3COONH_4) extract. The soil sample was washed 4-5 times by ethanol (C_2H_5OH, 95%). Finally the sample was treated with 1.0 N ammonium acetate solution (4 times; 25 mL each time). Every time it was centrifuged and supernatant liquid was decanted in a 100 mL volumetric flask. This way the sodium ions came in volumetric flask, replaced by ammonium ions. This liquid thus obtained was thus diluted up to 100 mL and sodium concentration was determined by flame photometer after necessary setting.

Calculation:

CEC in milli equivalents per kg

$$= \frac{\text{Sodium concentration in milli equivalents per L x 10}}{\text{Mass of soil sample in g}}$$

Organic Carbon

The organic matter content of soil is estimated from the organic carbon, determined by using Titrimetric method [11].

Micronutrients Available Metallic Ions (Zn, Cu, Fe, Mn)

Lindsay and Norvell [12] gave the method commonly used for determining the available micronutrients in soil sample which consists of use of DTPA (Diethylene triamine penta acetic acid) as an extractant which has been widely accepted for the simultaneous extraction of micronutrient cations viz. Zinc (Zn), Copper (Cu), Iron (Fe), Manganese (Mn) in neutral and alkaline soils. The extract is determined on an Atomic Absorption spectrophotometer (AAS).

Total Nitrogen (by Kjeldahl Method)

Nitrogen (N) is one of the major nutrients required for the nutritents of soil. The total amount of N present in soil nearly 95 – 99% is in the organic from and 1 – 5% in the inorganic forms a ammonion and nitrates. The "Kjeldahl Method" of conversion of N into [$(NH_4)_2SO_4$]. 500 mg (80 mesh) oven dry soil samples were taken in the digestion tube, 5 ml conc. H_2SO_4 and 1 – 2 g catalyst were added into the tube. The digestion tube was than placed in digestion unit or block and heated to boiling until green Heating time was very long and temperature at that time was very high. After complete digestion, the digestion tubes were allowed to cool for 5 – 10 minutes outside the block and then 20 mL of distilled water was used to dilute the contents. Finally the volume was made up 50 mL.

Flame Photometry

The estimation for sodium, calcium, Magnesium and potassium ions was carried out using Systronics mediflame 127 – flame photometer.

RESULTS AND DISSCUSSION

Soil is defined as an independent body with a unique morphology from the surface down to the parent material as expressed by the sample profiles [13]. Soil Can also be defined as the collection of natural bodies occupying parts of the earth's surface that support plant and that have properties due to the integrated effect of climate and living matter acting upon parent material as conditioned by relief over period of time [14].

The study of soil is also known as the soil science or pedology (pedos means earth or edaphology edaphos means soil). Soil may also be defined as the part of the earth crust in which humus is present [15]. In the present study, all the study area samples have clay texture. The colour of the all the samples were Blackish Brown in nature. The temperature rang were found to be 16 to 21 ºC. The bulk density was 1.35 to 1.78 found to be in study area.

pH value is a measure of the hydrogen ion activity of the soil water system. Soil pH is an important consideration for farmers and gardeners for several reasons, including the fact that many plants and soil life forms prefer either alkaline or acidic conditions or the pH can affect the availability of nutrients in the soil [16]. It also determines the availability of nutrients, microbial activity and physical condition of soil. The values of soil pH (Table 1) in this area range from 8.26 to 8.56 indicating an alkaline nature of soil

Total ion contents in the soil solution is expressed by electrical conductivity (EC) which also determine the current carrying capacity of the soil giving a clear idea of the soluble salts present in the soil. EC values range from 0.72 to 0.89 mS/cm (normal EC ranges from 0.02 to 2.0 mS/cm) [17] and such soil is said to be non-saline. The low ES values could be due to high rainfall in this area which washes out soluble cations from the soils.

One of the most widely used test for assessment of available nitrogen in soil is based upon estimation of readily oxidizable organic carbon which roughly represents 58 % of the total soil organic matter. The values for C_{org} range from 0.56 to 0.61% (Table 1) which are below 2% and hence the soils are deficient in organic matter and alternatively in nitrogen also.

The ultimate source of organic matter for most soils is through the fixation of carbon dioxide from the atmosphere through photosynthetic reactions by plants. There is also a very small input from autotrophic bacteria [18]. However, in some instances there may also be some input from industrial and mining products derived from petroleum or coal. At the broad scale these sources of soil carbon are insignificant. Soil organic matter is derived from organic materials that are added to the soil and the majority of soil organic matter derives from the breakdown of residues remaining after plants have died. These residues can take the form of root residues located in the soil matrix or leaves, stems and stubble existing as litter on the soil surface. Animals also provide a proportion of the soil organic matter to varying degrees depending on management and the ecosystem. Soil organic matter includes plant debris, root exudates and animal materials; their degradation products; and products synthesised by soil microorganisms and other soil biota. Included in soil organic matter is the finer root material of living plants, fungal hyphae and bacteria, as well as small soil fauna.

Loveland [19] undertook a review of critical values of organic matter for agricultural soils. They concluded that although it is widely believed a major threshold is 2% soil organic carbon (3.4% soil organic matter), the quantitative evidence for this threshold is slight. The data suggested that more research is required on the nature of soil organic matter and its influence on the properties of a range of soil types under different land uses [20] in a field classification of surface soils identified the importance of sodicity levels for more clayey soils and organic matter for soils of lower clay content.

Table 1 Physiochemical examination of soil in different location

Sl. No.	Name of the Parameter	S1	S2
1	pH	8.26	8.56
2	EC (dsm^{-1})	0.89	0.72
3	Colour	Blackish Brown	Blackish Brown
4	Texture	Clay	Clay
5	Temperature (ºC)	16	18
6	Bulk density	1.56	1.78
7	Organic Carbon (%)	0.56	0.61

Phosphorous is necessary for seed germination and essential for flowering and fruits formation deficiency symptoms are purple stems and leaves, yields of fruit and are poor. Observed values of phosporous range between 0.125 to 0.198% with only two samples (S2 and S1)showing higher vvalues. Potassium values range between 0.715 to 0.825% (Table 2). Among the various macronutrients, the Nitrogen, phosphorous and potassium were high in S2 when compared to other samples.
The concentrations of Cu range between 0.62 to 0.58 ppm indicating enrichment of Cu in the soils (optimum range for Cu is 0.2 to 2.5 ppm). Iron content in analyzed samples has been found to be between 4.59 ppm and 4.68 ppm which are also very high as the normal range for Fe is 2.5 to 4.5 ppm (Table 2). Manganese content in the normal soils range from 1.58 to 1.96ppm and since the soils samples from the study area show manganese content from 1.27 to 1.96ppm the soils are normal in Mn. Similarly soils are also contain normal in Zinc (ranging between 0.89and 0.92 ppm, (Table 2) as in normal soil it ranges from 0.51 to 1.21ppm [17]. Among the various micronutrients, the Zn and Fe was high in and Cu and Mn was high in S1.
Iron is an most essential mineral that is required for human and plants life for their growth. The iron content in the body is found in red blood cells and carries oxygen to every cell in the body. Iron also is involved in producing ATP (adenosine triphosphate, the body's energy source). Extra iron is stored in the liver, bone marrow, spleen & muscles. In the industrial fields, iron is major elemental component for all the purposes made by industries. Copper is usually used in all the industries as a electrical purposes and it would be change over from time to time and finally it would be discarded as one of the waste material.

Table 2 Micro and Macronutrients analysis of soil in different location

Sl. No.	Name of the Parameter	S1	S2
Available Macronutrients			
1	Available Nitrogen (%)	0.967	1.026
2	Available Phosphorus (%)	0.125	0.198
3	Available Potassium (%)	0.712	0.825
Available Micronutrients			
4	Available Zinc (ppm)	0.89	0.92
5	Available Copper (ppm)	0.62	0.58
6	Available Iron (ppm)	4.59	4.68
7	Available Manganese (ppm)	1.96	1.58

Soil fractions fine sand, ciarse sand, silt and clay were found tobe normal limit represent in the table 3 . Cation exchange capacity and excchangeble bases such as calcium, magnesium, sodium and potassium were found to be normal limit represented in table 3 . Among the two samples, the calcium, magnesium, sodium and potassium is high in S2.

Table 3 Analysis of Soil fractions and Exchangeable ions in soil of different location

Sl. No.	Name of the Parameter	S1	S2
1.	Fine Sand (%)	33.25	35.49
2.	Coarse Sand (%)	12.69	14.35
3.	Silt (%)	18.36	17.26
4.	Clay (%)	35.70	32.90
5.	**Cat ion Exchange Capacity** (C. Mole Proton$^+$/kg)	32.19	33.25
6.	Calcium	15.69	16.25
7.	Magnesium	12.68	13.65
8.	Sodium	3.96	4.25
9.	Potassium	0.09	0.16

It is concluded that the soils from the study area are enriched in micronutrients like Zn, Mn, Cu, Fe although they show varying range but present in the normal range. Among the various micronutrients, the Calcium, Magnesium, Sodium, Potassium Nitrogen Phosphorus Potassium Zinc and Iron high in Thirumangalkkattai (S2) than Periyakoattai. For all the soils in the area the natural manures and organic fertilizers would be best alternative to chemicals fertilizers because it would increase the C_{org} and microorganisms in the soils which help crop growth and yield.

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