EFFECT OF NUTRIENT MANAGEMENT ON THE PHYSICO-CHEMICAL PROPERTIES AND MICROBIAL POPULATION OF PADDY FIELD SOIL

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Abstract : Soil samples were collected from direct seeded, double crop lands of Kuttanadu paddy fields [Ramankary Block, Alappuzha District, Kerala] maintained under a particular nutrient status for the last five years. Soil samples were obtained during the Kharif crop season at the tillering stage of the crop. Four treatments were used in the experiment and were numbered as T1, T2, T3 and T4.Various physical,chemical and biological parameters of the soil samples were studied. Among the different treatments analysed T4 recorded the highest values for most of the parameters such as amount of available phosphorous, organic carbon and micronutrients. The microbial diversity as indicated by bacterial and fungal CFU count also exhibited highest value in T4. In T4 the field was fertilized with N, P and K on soil analysis basis at the rate of 90:45:45 kg/ha along with lime at the rate of 250kg/ha and farmyard manure at the rate 5 ton/ha.

***IndexTerms* - soil ,physical properties,biological parameters, nutrient management**

I. INTRODUCTION

Soil is a complex, living, changing and dynamic component of the agro ecosystem. Hilgard defined soil as "the more or less loose and friable material in which, by means of their roots, plants may or do find a foothold and nourishment, as well as other conditions of growth." (Hilgard., 1914) Recognizing the importance of soil quality in paddy fields, the present investigation was conducted with the objective of selecting appropriate nutrient management treatments for paddy field soil of Ramankary Block, Alappuzha District, Kerala. To do so, several biological, chemical and physical indicators of soil quality were evaluated using data collected form paddy fields of Ramankary Block, Alappuzha District, Kerala, maintained under a particular nutrient status for the last five years.

RESEARCH METHODOLOGY

3.1. Location

Soil samples were collected from direct seeded, double crop lands of Kuttanadu paddy fields [Ramankary Block, Alappuzha District, Kerala] maintained under a particular nutrient status for the last five years. Soil samples were obtained during the Kharif crop season at the tillering stage of the crop.

3.2. Treatments

Four treatments were used in the experiment and were numbered as T1, T2, T3 and T4.The details of the treatments are given in table 3.1. One plot each was identified for each treatment.

Table 3.1 treatment details

Name	Particulars
T1	The field was fertilized with N, P and K at the rate of 90:45:45 kg/ha as urea, FACTAMPHOS and potash.
T2	The field was not supplied with fertilizers or organic manure
T3	Field was fertilized with N, P and K at the rate of 90:45:45 Kg/ha along with lime at the rate of 250kg/ha
T4	Field was fertilized with N, P and K on soil analysis basis at the rate of 90:45:45 kg/ha along with lime at the rate of 250kg/ha and farmyard manure at the rate 5 ton/ha

3.3 Determination of bacterial and fungal colony forming units

Microbial community analysis in soils were done using viable plate count method. 25 grams of soil was dispersed in 50 ml sterile water and shaken for 30 minutes on a rotary shaker. Allowed the soil particles to settle down. After settling, soil suspension was serially diluted (up to 10^{-6} dilution) using sterile distilled water. 250 µl each of the diluted samples were inoculated into 3 petri plates for bacteria and 3 for fungi. Nutrient agar was used for bacterial culture and potato dextrose agar was used for fungal culture. Petri plates were incubated for 24 hrs at 37^0 C for bacteria and 1 day at room temperature for fungi. Bacterial and fungal colony forming units (CFU) per gram soil were estimated.

3.3 Determination of soil pH

10 gram freshly collected soil is dispersed in 50 ml sterile distilled water and shaken for 30 minutes on a rotary shaker. Allowed the soil particles to settle down and the pH was noted using a Eutech pH meter.

3.4 Determination of electrical conductivity

10 gram freshly collected soil is dispersed in 50 ml sterile distilled water and shaken for 30 minutes on a rotary shaker. Allowed the soil particles to settle down and the electrical conductivity is measured by conductivity bridge and it is expressed in millimohms per centimetre.

3.5 Determination of soil colour

Colour of the freshly collected soil is visually observed and recorded.

3.6 Estimation of soluble phosphorous

The soluble phosphorous content in the soil was determined by Subba and Fiske method (Subba and Fiske .,1925). Weighed out 1 gram of soil sample and 10ml water was added to it. Shaken well and the samples were then centrifuged at 10,000 rpm for 10 minutes. 1ml of the supernatant was taken and volume was made up to 2 ml using sterile water. 0.5 ml of acid moybdate reagent and 0.2 ml of ANSA reagent were added to each tube. A control was prepared using double distilled water. The intensity of blue colour is read spectrophotometrically at 660nm . A standard graph was prepared using standard phosphate solution.

3.7 Estimation of organic carbon

One gram of soil was taken in a dry 100 ml conical flask.10 ml of 1N Potassium dichromate solution was added and swirled a little followed by the addition of 10 ml of sulphuric acid and swirled again. After keeping 30 minutes on an asbestos sheet, the content in the flask was carefully centrifuged for 10 minutes. The green chromium sulphate colour of the supernatant layer was read in the colorimeter at 660 nm .Standard curve prepared using sucrose and potassium dichromate solution was used to determine the concentration of organic carbon.

3.8 Estimation of available phosphorous

The following reagents were prepared for the estimation of available phosphorous.

Bray extractant: Dissolved 22.g of ammonium fluoride in 200 ml distilled water, filtered and added to the filtrate 18 litres of distilled water containing 40 ml of con.HCl .Made up the volume to 20 litres with distilled water. **Boric acid:** Dissolved 50 grams of boric acid in 1 litre of distilled water.

Reagent A: Dissolved 12 grams of ammonium molybdate reagent in 250 ml of distilled water. In 100 ml of distilled water dissolved 0.2908 grams of antimony potassium tartarate. Added both of the dissolved reagents to 1000 ml of 5N H_2SOP_4, mixed thoroughly and make up to 2 litre with distilled water. Stored in a pyrex glass bottle in dark and cool . Reagent B**:** Dissolved 1.056 grams of ascorbic acid in 200 ml of Reagent A and mixed.

Added 25 ml of Brays extract to 2.5 grams of soil sample in a 100 ml conical flask .Shaken for 5 minutes. Taken 5 ml aliquot and added 3.5 ml boric acid and 4 ml of reagent B. The p^H of the solution was adjusted to 5, added 3.5 ml boric acid solution ,diluted to 20 ml with distilled water and added 4ml of reagent B .Made up the volume to 25 ml. Waited for 10 minutes and read the intensity of blue colour in colorimeter. Standard curve was prepared using standard phosphate solution.

3.9 Estimation of available potassium

The following reagent was prepared for the estimation of available phosphorous.

One normal neutral ammonium acetate solution : Dissolved 1540 grams of ammonium acetate in 20 litres of water. p^H of the solution is checked and adjusted to 7 by adding ammonium hydroxide or acetic acid .

25 ml ammonium acetate solution was added to 5 grams of soil sample. Stirred for 5 minutes and filtered. 2 drops of butyl alcohol was added to the filtrate and determined the amount of potassium with flame Photometer.

3.10 Estimation of micronutrients

3.10.1 Reagent preparation

The following reagents were prepared for the estimation of micronutrients using atomic absorption spectroscopy.

DPTA (diethylene triamine penta acetic acid) reagent : Weighed out 1.97 grams of diethylene triamine penta acetic acid and 1.47 grams of calcium chloride and dissolved in water. Added 13.1 ml of triethanolamine and brought the volume to 1 litre. The p^H of the solution was adjusted to 7.3.

Stock Solutions:

(1) Zinc 1000 ppm: accurately weighed out one gram of zinc metal and dissolved it in 30 ml 5M hydrochloric acid. Diluted to one litre using distilled water, and stored the solution in polythene bottle.

(2)Copper 1000ppm: accurately weighed out one gram of copper metal and dissolved it in 50 ml of 5M nitric acid. Diluted to one litre using distilled water, stored in polythene bottle .Dissolved 3.7980 grams of cupric nitrate in 250 ml distilled water , diluted to one litre and stored in polythene bottle.

(3) Manganese 1000ppm: accurately weighed out one gram of manganese metal and dissolved in 50 ml hydrochloric acid and diluted to one litre using distilled water, stored it in a polythene bottle. Dissolved 3.6077 grams of manganese dichloride in 50 ml hydrochloric acid. Diluted to one litre using distilled water and stored in a polythene bottle.

(4) Iron 1000ppm: accurately weighed out one gram of iron granules and dissolved in mixture of 20 ml of 5 M hydrochloric acid and 5 ml of nitric acid. Diluted it to one litre using distilled water and stored it in a polythene bottle.

3.10.2 Procedure - Atomic absorption spectroscopy

Weighed out 10 grams of soil and added 20 ml of DPTA reagent, shaken the contents continuously for 2 hrs on a rotary shakesr, filtered and determined the concentration of DPTA extractable zinc, copper, manganese and iron in atomic adsorption spectrophotometer using the respective hollow cathode lamps and at wavelength 213.9, 324.8, 279.5 ,248.3 respectively. The measurement was carried out at Kerala Agricultural University, Regional Agriculture Station. Pattamby.

IV. RESULTS AND DISCUSSION

4.1 Bacterial and fungal colony forming units (CFUs) in soil samples

Microbial community analysis in soils were done using viable plate count method. 25 grams of soil was dispersed in 50 ml sterile water and shaken for 30 minutes on a rotary shaker. Allowed the soil particles to settle down. After settling, soil suspension was serially diluted (up to 10^{-6} dilution) using sterile distilled water. 250 µl each of the diluted samples were inoculated into 3 petri plates for bacteria and 3 for fungi. Nutrient agar was used for bacterial culture and potato dextrose agar was used for fungal culture. Petri plates were incubated for 24 hrs at 37^0 C for bacteria and 1 day at room temperature for fungi. Bacterial and fungal colony forming units (CFU) per gram soil were estimated. The counts were given in table 4.1a-b and fig. 4.1a-b.

Table 4.1a. bacterial CFU in different treatments

Treatment	Bacterial CFU/g Soil
T1	55
T2	140
T3	562
T4	742

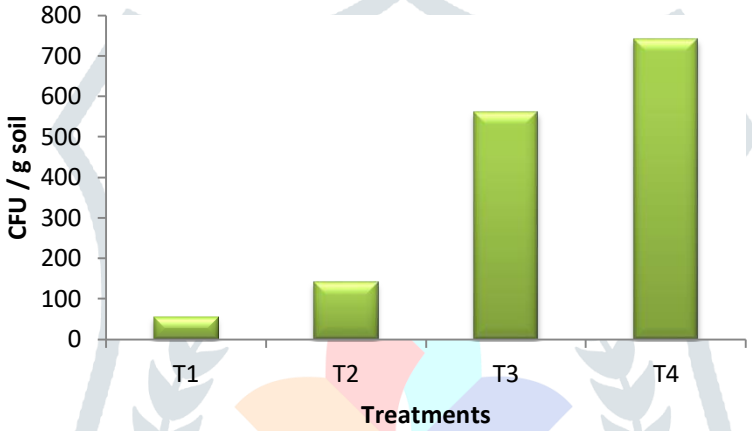

Fig. 4.1a. bacterial CFU in different treatments

Bacterial CFU count varied significantly with different treatments. The values ranged from 55 to 742 CFUs / g soil. Highest value was recorded in T4. Lowest value of 55 CFU/g soil was recorded in T1.

Table 4.1b. fungal CFU in different treatments

Treatment	Fungal CFU/g Soil
T1	153
T2	169
T3	322
T4	476

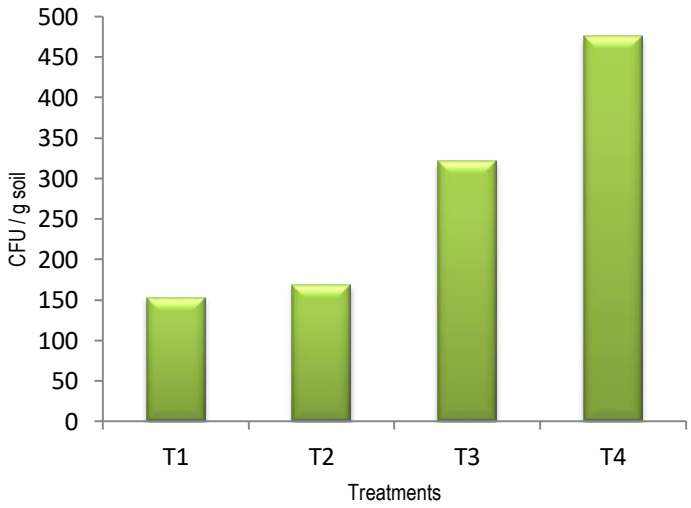

Fig. 4.1b. fungal CFU in different treatments

As evident from table 4.1.b and fig. 4.1 b various treatments influenced the fungal population in the soil. CFU counts ranged from 153 to 476 CFUs / g soil. T1 showed the least value of 153 CFU/g soil which was on par with T2 (169 CFU/g soil).

Soil microbial population are involved in a framework of interactions known to affect plant fitness and soil quality. They are involved in fundamental activities that ensure the stability and productivity of both agricultural systems and natural ecosystems.

In the samples under study the various treatments significantly affected the soil microbial flora. It is interesting to note that T4 recorded the highest count of bacterial and fungal CFUs/ g soil. This may be attributed to the high amount of organic matter added in the treatment in the form of farmyard manure (5 ton/ha). Increased organic content in the farmyard manure and an optimum pH produced by the addition of lime might have provided suitable conditions for the multiplication of the soil microbes in T4.

4.2 Soil p^H :

p^H of the soil samples from the four different treatments was measured using a p^H meter and ie given in table 4.2.

Treatment	pH
T1	6
T2	5.8
T3	5.9
T4	6

Table 4.2. Soil pH in different treatments

As evident from the data given in table 4.2 the soil pH of the different treatments were on par with each other. Soil pH is one of the important attributes which affects the availability of soil nutrients and controls the composition and diversity of soil microbial communities. In the present study wide fluctuations were not observed in pH among the treatments and this may be due to the buffering action of manure application and straw incorporation (Chaudhaury, 1977).

4.3 Electric conductivity

Electric conductivity of different soil types was determined using conductivity bridge. Total salt accumulation in the soil as measured by electric conductivity showed no variation in the different treatments. It was found to be 0.7 millimhos/cm for all the soil types. The relatively high electric conductivity indicates the high salt concentration in the soil which is true to the paddy field soils of Alappuzha District as the fields are flooded by sea water annually.

4.4 Soil colour

Soil samples from the different treatments were uniformly black in colour.

4.4 Available Phosphorous

It can be inferred from table 4.3 and fig. 4.3 that the amount of available phosphorous ranged from 175 to 254 kg/ha. T4 recorded the highest quantity of 254 kg/ha and T2 recorded the lowest value of 175 kg/ha. Treatments 1 and 3 were found to be on par with T4.

Table 4.3. available phosphorous in different treatments

Treatment	Available P(kg/ha)
T1	250
T2	175
T3	232
T4	254

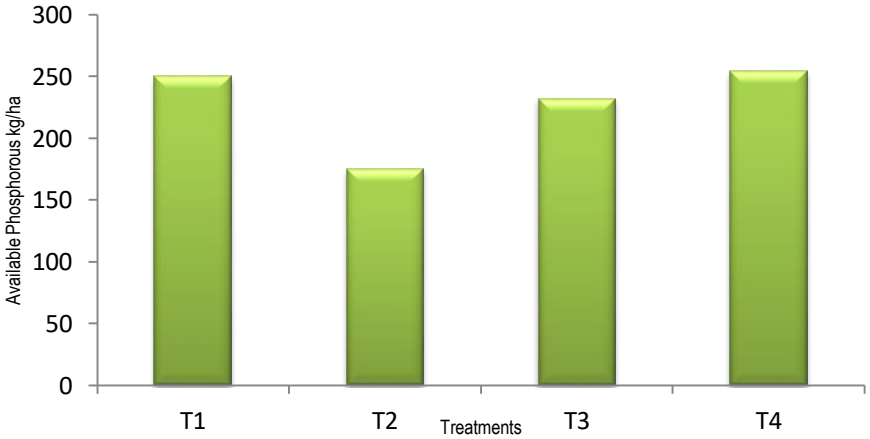

Fig. 4.3. available phosphorous in different treatments

Phosphorous is one of the major essential macronutrients limiting plant growth owing to its low availability in soils (Feng *et a*l., 2004). Fertilizer P tends to be fixed soon after the application and mostly unavailable, resulting in low recovery by crops and a considerable P accumulation in soils. From the data presented in table 4.3 it is inferred that treatment involving the application of farmyard manure was significantly influencing the available P status and registered higher value for available P. Increase in available P content of soil with the addition of fertilizer along with manure was reported by Sharma *et al*., 2005.

4.5 Organic Carbon

Table 4.4. organic carbon in different treatments

Treatment	Organic Carbon (%)
T1	1.5
T2	0.83
T3	1.62
T4	1.9

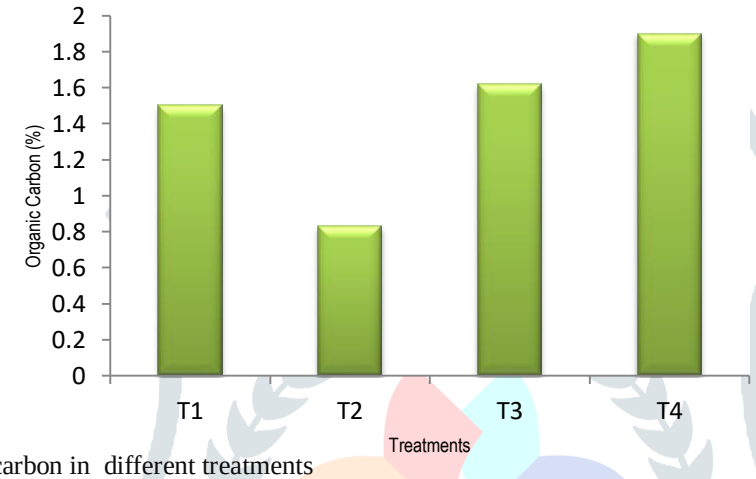

Fig. 4.4. organic carbon in different treatments

The results revealed that the applied treatments had significant effect on the organic carbon content of the soil (table 4.4). The values ranged from 0.83% to 1.9%. The highest value was recorded by T4, followed by T1 and T3. The lowest value was recorded by T2. As evident from table 4.4 the application of farmyard manure in combination with lime and chemical fertilizers caused a slight increase in the organic carbon content. This might have been due to the direct incorporation of organic matter, better root growth and more plant residues addition on realizing higher crop yields (Kumar and Yadav, 2003).

4.6 Potassium

Table 4.5. potassium in different treatments

Treatment	Potassium (kg/ha)
T1	130
T2	104
T3	99
T4	88

As evident from table 4.5 various treatments significantly influenced the available potassium content of soil. The values ranged from 88 – 130 kg/ha. T1 registered the highest amount and T4 registered the least amount. The highest amount recorded in T1 may be due to direct application of potassium without proper soil testing.

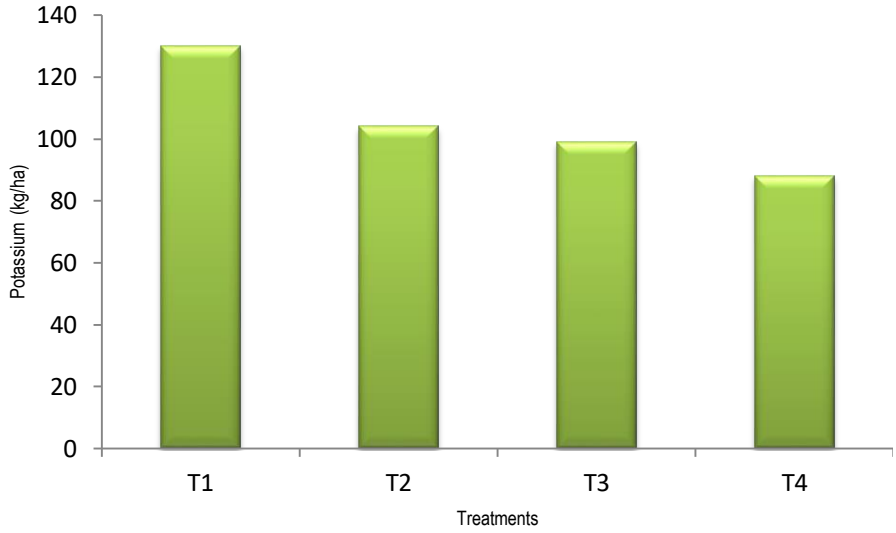

Fig. 4.5. potassium in different treatments

4.7. Micronutrients

Table 4.6. micronutrients in different treatments:

Treatment	Zn (ppm)	Fe (ppm)	Cu (ppm)	Mn (ppm)
T1	3.02	393.9	5.31	8.61
T2	2.54	250.8	4.81	15.37
T3	3.59	350.5	5.72	18.16
T4	4.78	425.98	5.83	18.41

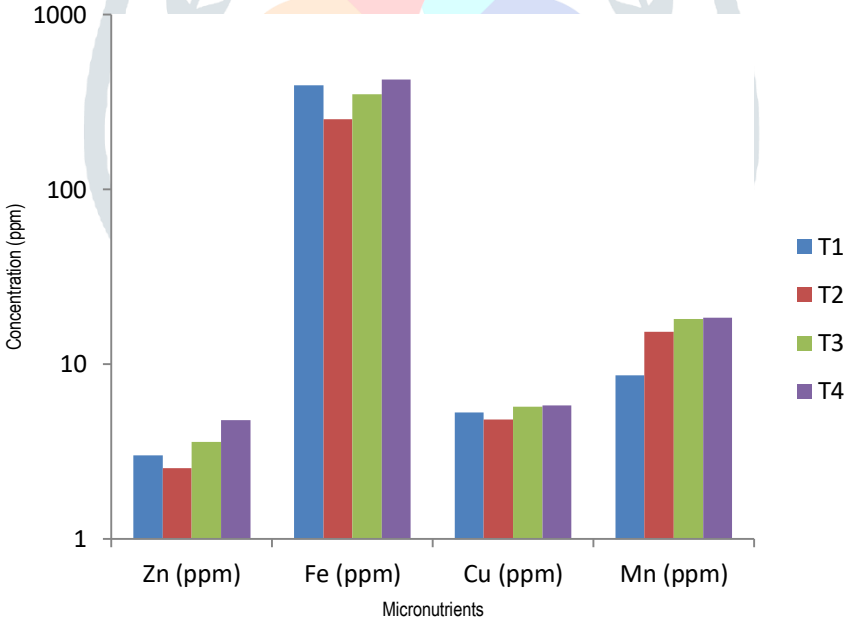

Fig. 4.6. micronutrients in different treatments

Role of micronutrients in balance plant nutrition is well established. However exploitative nature of modern agriculture involving the use of high amount of NPK fertilizers coupled with limited use of organic manures and reduced recycling of crop residues have contributed the accelerated exhaustion of micronutrients. As evident from table 4.6, T4 recorded the highest amounts of all the micronutrients studied. T4 received the application of farmyard manure @ 5 tons/ha. This observation is in agreement with that of Swarup (1984) who reported the increased availability of micronutrients by the application of farmyard manure.

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