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Physico-Chemical Factors Influencing Paddy Fields at Thiruvaiyaru Block Thanjavur District, Tamil Nadu, South India

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ABSTRACT
This study focused on the influencing physico-chemical parameters of the soil at different paddy sampling sites. The study period was from January to June 2020. Soil samples were collected using the systematic-random sampling method and hand sorting method (25 x 25 x 30 cm). The study area of this research work is Thiruvaiyaru Block (Maharajapuram, Vilangudi, Kandiyur, Nadukauvery and Karupur) at Thanjavur District. The Nitrogen values ranged from 1.06±0.43 to 5.00±2.04 mg/kg; Phosphorus values ranged from 0.44±0.18 to 4.80±1.96 mg/kg and Potassium values ranged from 1.40±0.57 to 3.26±1.33 mg/kg. Heavy metals like zinc, chromium, arsenic, lead, mercury and cadmium were analyzed by atomic spectrophotometer. Following are the average values of heavy metals: Zn =1.31 ppm, Cr =0.18 ppm, As =0.78 ppm, Pb =0.32 ppm, Hg =0.09 ppm, and Cd =0.10 ppm. The low level of heavy metals appears at all study sites. The origin of the nutrients and their availability certainly affect the soil quality, while the presence of low levels of heavy metals in the soil samples contaminates the paddy soil, which is a global problem.

Key words: Paddy, Physico-chemical, properties, Soil, Heavy metals.

INTRODUCTION

The 'Granary' of the integrated Thanjavur district of South India was adopted by the ancestors as a serious agricultural activity. Paddy is the major crop of the District, covering about 60% of the cultivated land (Vaithilingam 2015). Sugarcane (*Saccharum officinarum*), groundnut (*Arachis hypogaea*), pulses (*Phaseolus mungo),* ginger (*Zingiber officinale)* and coconut (*Cocos nucifera*) are the other crops grown in the District. Our human society solely depends on soil, for food production. All the soil properties ensure the soil productivity and the optimal environment for micro and macro fauna. To achieve increased production of crop yield, man-made chemical fertilizers are being used in addition to agricultural soil. (Moorthi et al. 2018). The major usage of fertilizers and pesticides contaminate the soil leading to the accumulation of heavy metals in agricultural soils. Heavy metals are toxic to crops, animals and humans because heavy metals can easily accumulate in vital elements and threaten crop growth and human health (Moorthi et al. 2016). Various paddy fields in Thanjavur District have very limited data on current soil fertility. Therefore, the purpose of the study is to evaluate the soil fertility determined by certain soil physico-chemical parameters in the selected paddy cultivated area of Thiruvaiyaru block in Thanjavur District of Tamil Nadu. It is important to study the current soil fertility of the paddy field in Thanjavur District. since there are somehow very few numbers of sets of information available for that research area in the Thanjavur District.

MATERIAL AND METHODS

Study area

The present study was conducted between January to June 2020 on an area of 68.79 km^2 paddy field. The area under investigation lies in between the 78^o 45' 50'' E to 79^o 35' 55'' E and 10^o 10' 0'' N to 11^o 10' 6'' N. The average annual ambient temperature is 35.5^{o}C and the rainfall 474 mm. Thanjavur is noted Rice bowl of Tamil Nadu for its rapid growth of agricultural, industrialization and urbanization. Thanjavur District lies on the East coast of Tamil Nadu. It extends to an area of 3396.57 km^2. The District is bounded on the north by the Cuddalore and Peramabalur districts and on the east; it is bounded by the Thiruvarur and Nagapattinam and on the south by the Palk Strait and west by

Pudukkottai and Tiruchirappalli Districts. This District can be divided into 3 main divisions and 12 deltaic regions. The upland area is mainly consisted for deltaic region. The study mainly focuses on Thiruvaiyaru Taluk under villages like Maharajapuram (MRP), Vilangudi (VG), Kandiyur (KD), Nadukavery (NK) and Karupur (KP) (Fig. 1). The main purpose of the study is mainly for current soil fertility status of paddy field in the rice bowl of Tamil Nadu.

Figure 1. Study area map

METHODS

Soil samples were taken using the systematic-random sampling method and hand sorting method (25 x 25 x 30 cm) (Marañón et al. 1999). The following parameters were analyzed in this study. They are soil structure, pH, Electrical conductivity, N, P, K, Ca and Mg. pH and EC were determined by the method described by (ISI Bulletin 1982). The total nitrogen content of the sample was estimated by the Kjeldahl method as described by (Tandon 1993). Total phosphorus content of the substrate was estimated by the colorimetric method as described by (Tandon 1993). Total potassium content of the sample was determined by flame photometric method as described by (Tandon 1993). Total Calcium and Total Magnesium content of the collected sample was determined by Cation exchange capacity Method as described by (Steve Culman et al 2019). The digested soil sample was analyzed for heavy metals are Zn, Cr, As, Pb, Hg and Cd concentrations using the Atomic Absorption Spectrometer (Buckley and Cronston, 1993). The Statistical analysis of physico-chemical characteristics and heavy metal content of soil samples was done with using SPSS.

RESULTS AND DISCUSSION

Analytical data for samples are given in Tables 1, 2 and 3. The soils of study area consist mainly of slit and clay soils. The pH of the soil in the region varies from neutral to slightly alkaline (pH 6-7), the pH values ranged from 6.8±0.04 to 7.5±0.07 (Table 2). The EC average of the study was 0.14 (dS/m), values ranged from 1.1±0.04 to 1.5±0.05dS/m (Table 2). The electrical conductivity of the soil is very strongly related to the particle size and soil structure. Soil prone to drought or excess water shows variations in soil structure that can be defined using soil electrical conductivity (Moorthi and Nagaragan 2013). Nitrogen ranges from 1.06±0.43 to 5.00±2.04 mg/kg (Table 2). Nitrogen is a highly mobile plant nutrient, with many factors affecting metamorphosis processes and the distribution of nitrogen in the soil (Shepherd et al. 2001). Availability of nitrogen in soil depends upon soil texture, soil pH and organic matter (Tucker et al. 1984). Phosphorus ranges from 0.44±0.18 to 4.80±1.96 mg/kg (Table 2). Phosphorus is an essential element for plant growth. It is an important component of DNA and RNA, and is the genetic memory unit of all living things (Smith et al. 1993). Potassium ranges from 1.40±0.57 to 3.26±1 mg/kg (Table 2). Potassium is essential for photosynthesis and chlorophyll growth. It improves the vigor of plants to withstand adverse climatic conditions, reduces lodging in cereals, regulates stomata opening and closing, and regulates the movement of ions within plants, hence it is called the 'Traffic policeman of the plant' (Sudduth et al. 2005). Calcium ranges from 0.20±0.08 to 0.38±0.15 mg/kg (Table 2). Calcium is a secondary nutrient that is important for crop growth. It is needed in large quantities by all plants to form cell walls and cell membranes, and it plays an important role in soil structure. Due to calcium immobilization in soil and plant tissues, there must be a continuous supply of access to paddy plants (Moorthi et al. 2016a). Magnesium values ranged from 2.40±0.98 to 3.80±1.55 mg/kg (Table 2). Mg from the soil solution and slowly fill up with soil reserve. Magnesium is involved in many physiological and biochemical processes. It is an essential element for paddy plant growth and development and plays an important role in plant protection mechanisms under abiotic stress

Table 1. List of villages under Thiruvaiyaru Block with their river, GPS coordinates and paddy variety

Sl.No	Name of Village	Nearby Rivers	GPS coordinates	Varieties of Paddy
1	Kandiyur (KD)	Kudamurutti	10.8515'N 79.1069'E	Adt38
2	Karupur (KP)	Cauvery	10.9347'N 79.4169'E	ASD16
3	Maharajapuram (MRP)	Cauvery	10.8827'N 79.1036'E	ASD20
4	Nadukauvery (NK)	Kudamurutti	10.8614'N 79.0468'E	Adt36
5	Vilangudi (VG)	Kollidam	10.9192'N 79.1020'E	Karuppukavuni

Table 2. Physico-chemical characters of soils from Thiruvaiyaru Block (Mean ± S.E)

Village	pH	EC (dS/m)	N (mg/kg)	P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)
KD	7.2±0.05	1.2±0.00	2.90±1.18	0.98±0.40	2.52±1.02	0.20±0.08	2.76±1.12
KP	7.4±0.04	1.1±0.00	4.46±1.82	0.44±0.18	2.62±1.07	0.38±0.15	3.20±1.31
MRP	7.5±0.07	1.4±0.00	5.00±2.04	4.80±1.96	3.2±1.33	0.11±0.04	3.80±1.55
NK	6.8±0.04	1.5±0.00	1.06±0.43	0.44±0.18	1.40±0.57	0.18±0.07	3.53±1.44
VG	6.9±0.04	1.2±0.00	4.75±1.94	1.60±0.65	3.2±1.30	0.38±0.15	2.40±0.98

Table 3. Heavy metal content of soils in Thiruvaiyaru Block (Mean ± S.E)

Village	Zn (ppm)	Cr (ppm)	As (ppm)	Pb (ppm)	Hg (ppm)	Cd (ppm)
KD	0.75±0.30	0.21±0.08	0.68±0.28	0.25±0.10	0.08±0.03	0.13±0.05
KP	1.36±0.55	0.14±0.06	0.85±0.35	0.28±0.11	0.41±0.16	0.07±0.02
MRP	1.16±0.47	0.16±0.06	0.57±0.23	0.30±0.12	0.00±0.00	0.12±0.05
NK	2.25±0.91	0.27±0.11	0.87±0.35	0.27±0.11	0.00±0.00	0.06±0.02
VG	1.04±0.42	0.13±0.05	0.95±0.39	0.50±0.20	0.00±0.00	0.13±0.05

conditions (Moorthi et al. 2019, Abbiramy 2018).

The maximum value 2.25±0.91 ppm of heavy metal zinc was found in NK and the lowest value was found to be 0.75±0.30 ppm in KD. The maximum value of chromium (0.27±0.11 ppm) was found in NK and the lowest value was 0.13±0.05 ppm in VG. The maximum value of arsenic was found in VG (0.95±0.39 ppm) and the lowest in MRP was 0.57±0.23 ppm. The maximum value of lead (0.50±0.20 ppm) was found in VG; the lowest value in KD was 0.25±0.10 ppm. Mercury's maximum value (0.41±0.16 ppm) was found in KP; the lowest value was 0.007±0.003 ppm in MRP. The maximum value of cadmium (0.13±0.05 ppm) was found in VG; the lowest value was 0.06±0.02 ppm in NK (Table 3). Some studies have blamed the adverse chemical effects on soil properties (Barrion and Litsinger 1997); (Stevens and Warren 2000) while others have shown that altering soil structure and chemical properties can improve rice growth (Brown et al. 1999).

CONCLUSIONS

Paddy fields in the study area is experiencing an increase in the usage of chemical pesticides due to the practice intensive agricultural activities. Organophosphate, chlorinated compounds and pyrethroids are sprayed against pests in fields and crops. However, the nutrients' origin and availability affect the microorganism's distribution and soil quality. In contrast, heavy metals in the soil samples contaminate the paddy soil.

Authors' contributions: RS conducted the field data collection and lab analyses. MM supervised the work. Both the authors equally contributed to the preparation of the manuscript.

Conflict of interest: The authors declare that they have no **conflict of interest** in this paper.

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