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Assessment of Macro and Micro Nutrients of Soil in Rice (*Oryza sativa* L.) Fields in Onattukara Wetlands Regions, Kerala

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ABSTRACT

Background: The purpose of this study is to determine various topographic features as well as the characteristics of micro and macro nutrients in soil samples in the Onattukara wetland paddy fields' special agricultural zone. Using the Global Positioning System, the particular locations of several soils sampling areas located in different Onattukara blocks were found (GPS). The macro (N, P, K) and micro (zinc, iron, copper, manganese) nutrients in soil samples taken from various places in the paddy fields region were studied.

Methods: The Onattukara special agricultural wetland zone in this field investigation during 2017-2018, GPS technique method was used to locating 16 soil samples were collected. Laboratory methods used for chemical analysis of soil.

Result: Nitrogen and phosphorus availability were found to be poor in almost all soil samples, whereas potassium availability was found to be medium. In almost all soil samples, the presence of micronutrients (zinc, copper and iron) was found to be critical. The data shows that soils are lacking in N, P and K, necessitating the addition of additional fertilizer and manures to make them acceptable for cultivation and promote healthy growth.

Key words: Nutrients, Onattukara, Soil Analysis, Topography Survey, Wetland.

INTRODUCTION

Onattukara region is a peculiar agro ecological zone with specific soil and climatic conditions. This region is characterized by cropping pattern of double crop system in wetland. Wetland ecosystems are estimated to cover more than 9% (1,280 million hectares) of the Earth's land surface. Water determines wetland formation, processes and characteristics and wetlands have diverse physical characteristics and geographical distributions. They are critical resources important for delivering a wide range of ecosystem goods and services including regulating, provisioning, livelihood services and cultural services that contribute to general human well-being (Fiskel, 2006; Lopez-Hoffman *et al.,* 2010; Millennium Ecosystem Assessments, 2005).

A rice paddy is a shallow pond with a flat bottom that can hold 6-8 inches of water, provides for control of water depth and is able to drain completely. Once a rice paddy system is established, it begins to function as a man made wetland supplying many of the same benefits that natural wetlands provide. Taking into consideration topography, soil and abiotic factors and variation in resource endowments and reckoning the seasonal differences in which rice is grown in the state, six significant paddies-agroecosystems are identified in Kerala namely, Midland and Malayoram ecosystems, Palakkadu plains, Kuttanadu Agrosystems, Pokkali and Onattukara agro ecosystems and high range ecosystems Latha *et al.* (2013).

Macronutrients (N, P and K) as well as Micronutrients (Fe, Mn, Zn and Cu) are key soil constituents that influence fertility. Top soil traps humus, a key plant food source, increasing biological activity, soil fertility and controlling soil air and water content (Wilson and David, 2002). The importance of soil fertility and plant nutrition to all life's health and survival cannot be overstated. As the human population grows, human disturbance of the earth's ecosystem to generate food and fibre will raise the need for vital elements from soils. As a result, it's vital that we learn more about the chemical, biological and physical aspects that influence nutrient availability in the soil-plant-atmosphere continuum, as well as their interactions. Increased crop yields are dependent on nutrient balance. In the context of sustainable agriculture production, soil characterization is critical for assessing the fertility status of an area's or region's soils. Crops remove roughly 156 tonnes of nitrogen, 68 tonnes of phosphorus and 137 tonnes of potassium every year in the state of Chhattisgarh (Tandon, 2004). Nutrients have

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declined dramatically in recent years under intensive agriculture due to unbalanced and ineffective fertiliser use combined with low efficiency of other inputs. Plant growth is reliant on soil fertility and the earth's intrinsic capacity to provide critical nutrients to plants. Soil fertility is linked to the amount of accessible nutrients, which is evaluated by crop yield capacity, whereas some believe it is largely determined by organic matter or soil texture. All chemical, physical and biological soil qualities are affected by pH (Brady and Weil, 2002).

Fertility management based on soil tests is an efficient method for boosting the production of agricultural soils with considerable geographical variability due to the combination of physical, chemical, or biological processes (Goovaerts, 1998). Soil sampling and testing provide an assessment of the soil's ability to provide sufficient nutrients to meet the needs of agricultural plants. The test findings are compared to the standard response data to determine whether additional nutrients are required for optimal crop yield. Soil sampling used to be used to create a representative assessment of a field's average fertiliser needs so that the optimal single rate of delivery could be calculated.

The study's major goal is to examine macronutrients (N, P and K) as well as micronutrients (Fe, Mn, Zn and Cu) in the Onattukara special agricultural wetland zone. The research aids in determining the region's future vegetation growth potential.

MATERIALS AND METHODS

Study area

Onattukara region is a peculiar agro ecological zone with specific soil and climatic conditions. This region comprised of Muthukulam, Harippad, Bharanickavu, Mavelikkara and Ambalapuzha blocks of Alappuzha district and Chavara, Ochira, Sasthamcotta blocks in Kollam District (Fig 1). The area lies on both sides of NH 66 (previously NH 47) and spread from south end of Thottappally Spillway to the north end of Neendakara bridge. This region lies in the lowland tract between 8°55′44″ to 9°21′09″ N latitude and 76°23′13″ to 76°41′16″ E longitude (Table 1). Average rainfall is about 2700 mm. The temperature varies from 19.2 to 33.7°C. The terrain is more or less even and the garden lands a mean elevation of 1.0-3.5 meter above Mean Sea Level (M.S.L).

Topography

The GPS surveying techniques was used to identify the specific locations of various soil samples situated at eight blocks under the villages (Fig 1) since the Global Positioning System (GPS) is an integral part of topograhic surveys. The topographic datasets were originally stored as point measurement. Each point had northing, easting and elevation values.

Analytical details of soil samples

Total 16 soil samples were collected from different depth at various locations (Table 1). These samples were dried at room temperature and grind in powder form and this experiment was conducted the year 2017-2018, analysed in the Department of Botany, University College, Thiruvananthapuram, Kerala for the analysis of different chemical properties.

A V-shaped hole was duged with the required depth and slice of approximately 2.5-3.0 cm thick was cut out. Both sides of the slice were trimmed leaving a 3.0 cm strip, which is then put in a clean container. After that, the soil was mixed thoroughly in the container and all soil clods had broken up. From the bulked sample, about 500 gm sample was taken as air-dried at room temperature within 12 hours of extraction. The micro and macro properties of soil analysed by standard procedure as presented in (Table 2).

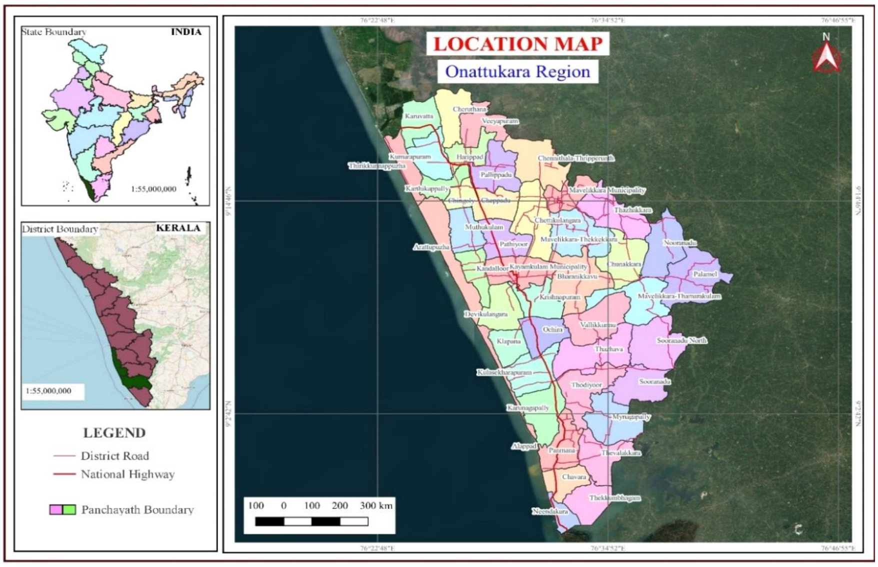

Fig 1: Map of the study area.

pH

It was measured by glass electrode pH meter in 1:2.5 soil water suspension after stirring for 30 minutes as described by (Piper 1967).

Electrical conductivity

The soluble salts in soils are determined by values of electrical conductivity. Solution offers some resistance to passage of electric current through them, depending upon the salt content. Higher the salt content, lower is the resistance to flow of salt concentration. EC which is reciprocal of resistance, thus, increases with increase in salt concentration. It was determined by the procedure as described by (Black and Evans 1965). According to ohm's law-Conductivity is inversely proportional to resistance. The EC of soil water extract is generally measured in smaller units such as milliohms/cm (mmhos/cm or microhms/cm at 25°C). The international unit (SI) of expression Siemens/ m(S/m) and smaller SI unit is deci Siemen/m (dS/m). One dS/m = one mmhos/cm.

Available nitrogen

Available nitrogen in soil was determined by alkaline potassium permanganate method as described by (Subbaiah and Asija 1956). The procedures involve distilling the soil with alkaline potassium permanganate solution and absorb the ammonia liberated in boric acid which is then titrated with standard sulphamic acid.

Available phosphorus

Available phosphorus was estimated by the ascorbic acid method as described by Olsen *et al.* (1954).

Available potassium

Available potassium was extracted from the 5 gm soil with the help of suitable extractant neutral normal ammonium acetate by shaking, followed by filtration or centrifugation and K is determined in the extract using flame photometer. The availability of potassium was estimated by the method described by (Jackson, 1967). The photometer analysis is based on the measurement of the intensity of characteristic line emission given by the element to be determined, All the macronutrients data was presented in (Table 3).

Micro nutrient

The available Zn, Cu, Mn and Fe in soils was estimated by the method developed by (Lindsay and Norvell 1978) using DTPA (Diethyl Triamine Penta Acetic Acid) which was found useful for separating soils into deficient and non-deficient categories for Zn, Cu, Mn and Fe by using atomic absorption spectrophotometer, the data was presented in (Table 4).

RESULTS AND DISCUSSION

pH and EC of soil nutrient

The ratio of H^+ ions to OH^- base ions in the soil is measured by the pH value. The soil is acidic if the soil solution contains higher H^+. The soil is alkaline if the OH^- dominates. The neutral equilibrium between them has a value of 7.0. Brady discovered that a pH range of 6.5 to 7.5 is ideal for nutrient availability in plants (Brady and Weil, 2002). As shown in Table 3, pH values in several soil samples range from 3.5 to 6.1 (average: 4.7) (Table 3). According to Foot and Ellis (Foth and Ellis 1997), 57.1 per cent of soil samples had a somewhat alkaline nature, 28.6 per cent had a moderately

Table 1: Details of soil samples at different locations point.

Paddy field name	Sample code	Depth (cm)	Location		
			N	E	Elevation(m)
Kottakogom paddy filed	CVA LF	21	8°58 57	76°32 41	18
Kumbazha paddy field	CVA SF	17	8°59 40	76°32 49	48
Vattakayal paddy field	OCR LF	16	9°05 28	76°35 36	11
Unduruthi paddy field	OCR SF	22	9°07 21	76°32 05	19
Kumaranjira paddy field	SCA LF	18	9°03 56	76°36 12	8.7
Chakkuvally paddy field	SCA SF	17	9°04 57	76°37 27	11
Ullitta puncha paddy field	MKM LF	19	9°13 21	76°29 26	28
Manjalam paddy field	MKM SF	21	9°08 40	76°9 35	15
Veeyapuram paddy field	HPD LF	18	9°19 34	76°29 16	23
Pandikizhakku paddy field	HPD SF	17	9°20 12	76°26 16	23
Chunakkara paddy field	BKV LF	19	9°12 18	76°36 50	5.4
Nooranad paddy field	BKV SF	18	9°12 17	76°37 04	9
Thazhakkara paddy field	MVK LF	19	9°12 56	76°36 31	9
Thekkekara paddy field	MVK SF	14	9°11 50	76°33 31	24
Ezhankery east paddy field	AMP LF	17	9°19 58	76°25 18	34
Karuvatta paddy field	AMP SF	15	9°18 51	76°26 10	5

CVA-Chavara, OCR-Ochira, SCA-Sasthamcotta, MKM-Muthukulam, HPD-Harippad, BKV-Bharanickavu, MVK-Mavelikkara, AMP-Ambalappuzha, LF-Large field, SF-Small field.

alkaline character and 14.3 per cent had a neutral nature. The pH value of sample AMP-LF was found to be 3.5, while sample CVR-LF had a value of 6.1. The reaction of applied fertilizers material with soil colloids resulted in the reaction of basic cations on the exchangeable complex of the soil, resulting in a neutral to alkaline pH.

Electrical Conductivity (EC) in diverse soil samples ranges from 0.06 to 1.08 milli mhos (average: 0.2 milli mhos) (Table 3). The largest quantity of EC was identified in Sample HPD-SF at 1.08 milli mhos, while the lowest amount of EC was found in Sample CVA-LF at 0.06 milli mhos.

Macro nutrient of soil samples

The availability of nitrogen in different soil samples varied (11 to 51, average: 31.2 kg/ha) (Table 3). According to Subbiah and Asija's nitrogen grading system, 85.6 percent of the soil samples were found to be low (250 kg ha^{-1}) and the remaining (14.3 per cent) to be medium (250-500 kg ha^{-1}) (Subbaiah and Asija 1956). Almost all of the samples revealed a reduced nitrogen availability. Nitrogen is not only a necessary component of carbohydrates, lipids and oils, but it is also a necessary component of proteins. The amount of nitrogen available in the soil is a key component in increasing soil fertility. The amount of nitrogen available in normal soil ranges from 272 to 544 kg ha^{-1} Gupta *et al.* (2006). Similar results were reported by Farni *et al.* (2022). Polthanee *et al.* (2021) also reported the high yield in rice and groundnut cultivation in nitrogen available in field. A nitrogen deficit causes older leaves to yellow uniformly, including veins, finally becoming brown and dying. Plants will be dark green in colour and new growth will be succulent due to the excess nitrogen.

Phosphorus levels in several soil samples ranged from 0.79 to 81.19 kg/ha (average: 18.04 kg/ha) (Table 3). All of the soil samples exhibited a decreased availability of phosphorus (20 kg ha^{-1}) Muhr *et al.* (1963) based on Muhr's proposed limits. The macro nutrient content in crop growth yield stimulated in the rice variety is results reported in Singh *et al.* (2021). It's a component of the cell nucleus that's required for cell division and the formation of meristematic tissues at the growing points. It accounts for 0.1 to 0.5

Table 2: Laboratory methods used for chemical analysis of soil.

Particulars	Method used
Available N (kg ha^{-1})	Alkaline permanganate method (Subbaiah and Asija, 1956)
Available P (kg ha^{-1})	Olsen's method (Olsen *et al.*, 1954)
Available K (kg ha^{-1})	Flame photometric method (Jackson, 1967)
pH	pH meter
Electrical conductivity (mili mhos)	Solubridge conductivity meter method (Black, 1965)
Micro component (Zinc, Iron, copper, Manganese) ppm	Atomic absorption Spectrophotometeric method

Table 3: Macro nutrient properties of soil samples.

Paddy field name	Sample code	pH	Chemical properties			
			Soluble salt (milli mhos)	Nitrogen available (kg/ha)	Phosphorus available (kg/ha)	Potash available (kg/ha)
Kottakogom paddy filed	CVA LF	6.1	0.06	12.54	12.35	22.288
Kumbazha paddy field	CVA SF	4.8	0.09	13.5	10.86	24.864
Vattakayal paddy field	OCR LF	4.4	0.24	11	6.67	87.696
Unduruthi paddy field	OCR SF	5	0.07	13	81.19	33.152
Kumaranjira paddy field	SCA LF	5.4	0.09	19	22.23	33.04
Chakkuvally paddy field	SCA SF	5.2	0.14	26	56.05	24.752
Ullitta puncha paddy field	MKM LF	4.1	0.35	35	1.32	419.216
Manjalam paddy field	MKM SF	4.8	0.32	37	13.85	48.608
Veeyapuram paddy field	HPD LF	4.8	0.3	46	0.95	366.24
Pandikizhakku paddy field	HPD SF	4.3	1.08	38	1.38	311.024
Chunakkara paddy field	BKV LF	4.5	0.12	34	1.8	51.968
Nooranad paddy field	BKV SF	4.6	0.09	39	62.93	61.6
Thazhakkara paddy field	MVK LF	4.6	0.13	41	11.75	395.472
Thekkekara paddy field	MVK SF	4.4	0.11	36	2.78	26.208
Ezhankery east paddy field	AMP LF	3.5	0.12	51	0.79	110.656
Karuvatta paddy field	AMP SF	4	0.08	47	1.85	66.864
Average		4.7	0.21	31.2	18.04	130.2

CVA-Chavara, OCR-Ochira, SCA-Sasthamcotta, MKM-Muthukulam, HPD-Harippad, BKV-Bharanickavu, MVK-Mavelikkara, AMP-Ambalappuzha, LF-Large field, SF-Small field.

Table 4: Micro nutrient properties of soil samples.

Paddy field name	Sample code	Chemical properties			
		Zinc (ppm)	Iron (ppm)	Copper (ppm)	Manganese (ppm)
Kottakogom paddy filed	CVA LF	2.42	103.29	2.04	6.17
Kumbazha paddy field	CVA SF	2.46	33.78	2.06	6.7
Vattakayal paddy field	OCR LF	3.14	347.52	2.65	15.38
Unduruthi paddy field	OCR SF	3.92	328.14	2.85	9.75
Kumaranjira paddy field	SCA LF	4.31	275.72	3.37	12.61
Chakkuvally paddy field	SCA SF	2.8	293.63	3.06	9.05
Ullitta puncha paddy field	MKM LF	7.27	539.58	7.52	43.73
Manjalam paddy field	MKM SF	2.87	295.12	2.94	14.51
Veeyapuram paddy field	HPD LF	14.16	732.48	15.02	68.78
Pandikizhakku paddy field	HPD SF	18.1	681.89	14.17	74.19
Chunakkara paddy field	BKV LF	9.28	539.65	6.67	20.47
Nooranad paddy field	BKV SF	6.03	319.12	4.16	15.14
Thazhakkara paddy field	MVK LF	7.33	392.49	6.54	19.78
Thekkekara paddy field	MVK SF	2.39	238.12	2.27	9.09
Ezhankery east paddy field	AMP LF	4.4	256	3.9	48.11
Karuvatta paddy field	AMP SF	2.63	247.4	2.34	9.92
Average		5.8	351.5	5.0	23.10

CVA-Chavara, OCR-Ochira, SCA-Sasthamcotta, MKM-Muthukulam, HPD-Harippad, BKV-Bharanickavu, MVK-Mavelikkara, AMP-Ambalappuzha, LF-Large Field, SF-Small field.

per cent of the plant's dry weight. Phosphorus levels in soil should be between 22.5 and 56 kilogrammes per hectare (kg ha^{-1}) Gupta *et al.* (2006). Similar finding was reported Rani *et al.* (2022) Plant growth will be slow and stunted if there is a phosphorus shortfall, but an overabundance of phosphorus will have no direct effect on the plant but may cause visible deficiencies of Zn, Fe and Mn.

Potassium values ranged from 22.28 to 419.21 kg ha^{-1} (average: 130.2 kg ha^{-1}) (Table 3). Most of the soil samples (71.4%) were found to be in the medium range (125-300 kg ha^{-1}) and the rest (28.6%) were found to be in the low ranges Muhr *et al.* (1963), according to Muhr's advised limits. Similar finding reported in Vasileva *et al.* (2022). Yellowing stars appear from the tip/margin of lower leaves to the middle of the leaf base, indicating a potassium shortage. Because of the extra potassium, plants will show typical Mg and potentially Ca shortage symptoms as a result of the cation imbalance. Similar findings were reported in Bhimanpallewar *et al.* (2022) The formulation of organic fertilisers can result in fertilisers of a standard quality, with relatively balanced levels of NPK elements, increasing the ability of biofresh biological agents to effectively increase the disease suppression index by 30.12 per cent, with an increase in productivity of 14.31 per cent of non-standard organic fertiliser treatments. Additionally, 70.6 per cent of Biofresh biological agents were used effectively the results reported in Wijayanto *et al.* (2022). Similar results were reported by Yamika *et al.* (2021) in cut leaf ground cherry.

Micro nutrient analysis of soil samples

Zinc level in diverse soil samples ranged from 2.39 to 18.1 ppm, with an average of 5.8 ppm (Table 4). Upper leaves with a zinc shortage will have chlorosis on the midrib. The extra zinc indicates that a Fe deficiency is on the way.

In separate soil samples, the value of iron content ranged from 33.78 to 732.48 ppm (average: 351.5 ppm) (Table 4). A lack of iron causes veins to remain noticeably green and other leaf portions to turn yellow and white, whereas an excess of iron causes bronzing of the leaves with minute brown patches.

In several soil samples, the copper nutrient value ranged from (2.04 to 15.02, average: 5.0 ppm) (Table. 4). A lack of copper causes leaves to turn yellow and white, resulting in marginal leaf burning, whereas an excess of copper causes leaves to turn yellow and white, resulting in marginal leaf burning. With very sluggish growth, Fe insufficiency can be produced. It's possible that the roots will be stunted.

Manganese concentration in soil samples ranged from 6.17 to 74.19 parts per million (ppm), with an average of 23.10 ppm (Table 4). Manganese shortage causes interveinal yellowing of young leaves that does not progress to whiteness, whereas excess manganese causes brown patches surrounded by a chlorotic zone and circle on older leaves.

CONCLUSION

The majority of the soil sample had an acidic pH and slightly low EC, N and P values. In almost all soils, the potassium level was in the medium range. Excess phosphorus has no direct effect on the plant but may cause visual deficits in Zn, Fe and Mn, whereas excess potassium causes characteristic Mg and perhaps Ca deficient symptoms due to cation imbalance. The excess micronutrient causes bronzing of the leaves, as well as little brawn spots on the leaves. The data shows that in locations where the soil is weak in N, P and K, additional fertiliser and manures are required to make the soil acceptable for cultivation and agricultural growth.

Conflict of interest: None.

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