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Analysis of macro nutrients of soil in rice (*Oryza sativa* L.) fields in onattukara Wetlands Regions, Kerala

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Abstract

In the Onattukara wetland paddy fields special agricultural zone, this study aims to identify various topographic aspects and the properties of macronutrients in soil samples. The precise locations of multiple soil sampling spots located in various Onattukara blocks were identified using the Global Positioning System (GPS). In soil samples collected from several locations in the paddy fields region, the macro (N, P, K) nutrients were examined. 16 soil samples were collected, and their locations were determined using GPS technology in this field's Onattukara special agricultural wetland zone. Nearly all soil samples contained low levels of nitrogen and phosphorus, although potassium availability was found to be moderate. According to the data, soils are deficient in N, P, and K, making it necessary to add more fertiliser and manures in order to cultivate them and encourage healthy growth.

Keywords: nutrients, onattukara, soil analysis, topography survey, wetland

Introduction

The Onattukara region is a peculiar agro ecological zone with unique climate and soil characteristics. This area is distinguished by a double cropping system in wetlands. More over 9% (1,280 million hectares) of the Earth's land area is thought to be made up of wetlands. Wetlands contain a variety of physical properties and geographic distributions, and water determines wetland development, processes, and traits. They are vital resources for providing a variety of ecosystem goods and services, such as controlling, providing for, sustaining livelihoods, and providing cultural services that improve overall human well-being (Fiskel, 2006; Lopez-Hoffman *et al.*, 2010; Millennium Ecosystem Assessments, 2005) [3, 9, 10].

A rice paddy is a small, flat-bottomed pond that can hold 6 to 8 inches of water, allows for the control of water depth, and can drain entirely. A rice paddy system starts to behave as a man-made wetland after it is established, offering many of the same advantages as natural wetlands do. Six significant paddy - agroecosystems are identified in Kerala, including the Midland and Malayoram ecosystems, Palakkadu plains, Kuttanadu Agrosystems, Pokkali and Onattukara agro ecosystems, and High range ecosystems. These are identified by taking into account topography, soil and abiotic factors, variation in resource endowments, and accounting for the seasonal differences in when rice is grown in the state. "Latha *et al*" (2013) [8].

Key components of soil that affect fertility are macronutrients (N, P, and K). Humus, a vital plant food source, is trapped in top soil, boosting biological activity and soil fertility while regulating the soil's air and water content (Wilson and David, 2002) [16]. It is impossible to emphasise how vital soil fertility and plant nutrition are to the health and survival of all life. The need for essential components from soils will increase as the human population rises and human interference with the earth's ecosystem to produce food and fibre. It is crucial that we understand the connections between the chemical, biological, and physical factors that affect nutrient availability in the continuum of soil, plants, and atmosphere. Nutrient equilibrium is necessary for increased agricultural yields. Soil characterisation is essential for determining the fertility state of a region's or an area's soils in the context of sustainable agricultural output. In the state of Chhattisgarh, crops extract about 156 tonnes of nitrogen, 68 tonnes of phosphorus, and 137 tonnes of potassium annually (Tandon, 2004) [15]. Due to the imbalanced and inefficient use of fertilisers along with the low efficiency of other inputs, nutrients have substantially decreased in recent years under intensive agriculture. The ability of the earth to naturally supply plants with essential nutrients and the fertility of the soil are both essential for plant growth. While some contend that organic matter or soil texture play a significant role, soil fertility is linked to the amount of readily available nutrients, which is measured by crop production capacity. pH has an impact on all soil's physical, chemical, and biological characteristics (Brady and Weil, 2002) [2].

Due to the interaction of physical, chemical, or biological processes, fertility management based on soil tests is an effective strategy for increasing the productivity of agricultural soils with significant geographic variability

(Goovaerts, 1998) [5]. The ability of the soil to supply enough nutrients to meet the needs of agricultural plants is evaluated by soil sampling and testing. To ascertain whether additional nutrients are needed for the best crop output, the test results are contrasted with the typical response data. In order to determine the ideal single rate of supply, a representative assessment of a field's typical fertiliser demands was once created using soil sampling.
Examining macronutrients (N, P, and K) in the Onattukara special agricultural wetland zone is the main objective of the study. The study assists in estimating the potential for future vegetation growth in the area.

Materials and Methods

Study Area

The Onattukara region is an odd agroecological zone with unique climate and soil characteristics. This area included the Alappuzha district's Muthukulam, Harippad, Bharanickavu, Mavelikkara, and Ambalapuzha blocks as well as the Kollam district's Chavara, Ochira, and Sasthamcotta blocks (Fig 1). The region stretches from the south end of the Thottappally Spillway to the north end of the Neendakara bridge and is located on both sides of NH 66 (formerly NH 47). This area is located in the lowland tract between latitudes 8º55'44" and 9º21'09" north and 76º23'13" and 76º41'16" east. The typical annual rainfall is 2700mm. From 19.2 to 33.7 ^{O}C, the temperature changes. The area is rather level, with the garden lands having an average elevation of 1.0 to 3.5 metres above mean sea level (M.S.L).

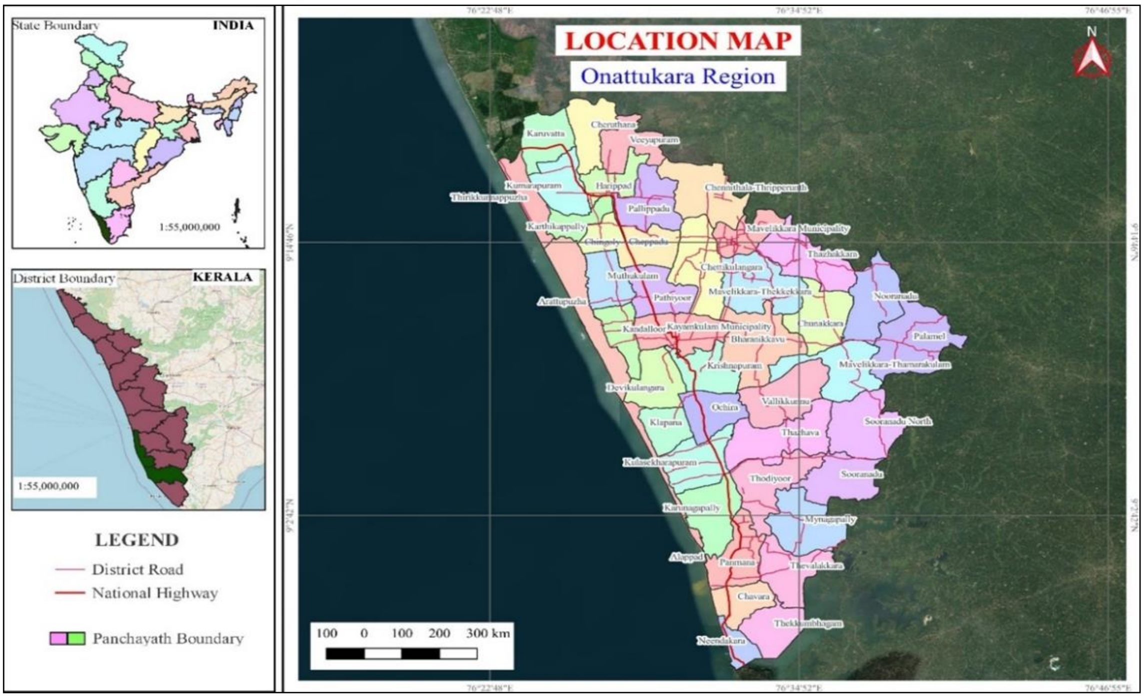

Fig 1: Map of the study area

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 analysed in the laboratory for the analysis of different chemical properties.

Table 1: Details of soil samples at different locations point

S.N.	Paddy field Name	Sample code	Depth(cm)	Location		
				N	E	Elevation(m)
1	Kottakogom paddy filed	CVA LF	21	8^0 58 57	76^0 32 41	18
2	Kumbazha paddy field	CVA SF	17	8^0 59 40	76^0 32 49	48
3	Vattakayal paddy field	OCR LF	16	9^0 05 28	76^0 35 36	11
4	Unduruthi paddy field	OCR SF	22	9^0 07 21	76^0 32 05	19
5	Kumaranjira paddy field	SCA LF	18	9^0 03 56	76^0 36 12	8.7
6	Chakkuvally paddy field	SCA SF	17	9^0 04 57	76^0 37 27	11

7	Ullitta puncha paddy field	MKM LF	19	9^0 13 21	76^0 29 26	28
8	Manjalam paddy field	MKM SF	21	9^0 08 40	76^0 29 35	15
9	Veeyapuram paddy field	HPD LF	18	9^0 19 34	76^0 29 16	23
10	Pandikizhakku paddy field	HPD SF	17	9^0 20 12	76^0 26 16	23
11	Chunakkara paddy field	BKV LF	19	9^0 12 18	76^0 36 50	5.4
12	Nooranad paddy field	BKV SF	18	9^0 12 17	76^0 37 04	9
13	Thazhakkara paddy field	MVK LF	19	9^0 12 56	76^0 36 31	9
14	Thekkekara paddy field	MVK SF	14	9^0 11 50	76^0 33 31	24
15	Ezhankery east paddy field	AMP LF	17	9^0 19 58	76^0 25 18	34
16	Karuvatta paddy field	AMP SF	15	9^0 18 51	76^0 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

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 macro properties of soil analysed by standard procedure as presented in (Table 2)

Table 2: Laboratory methods used for chemical analysis of soil

S.N.	Particulars	Method used
1	Available N (kg ha^{-1})	Alkaline permanganate method (Subbaiah and Asija, 1956) [14]
2	Available P (kg ha^{-1})	Olsen's method (Olsen et al., 1954) [12]
3	Available K (kg ha^{-1})	Flame photometric method (Jackson, 1967) [7]
4	pH	pH meter
5	Electrical Conductivity (mili mhos)	Solubridge conductivity meter method (Black, 1965) [1]

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) [13].

Electrical Conductivity
Electrical conductivity values affect the amount of soluble salts in soils. Depending on the salt content, solutions give some resistance to the flow of electric current through them. The resistance to the passage of salt concentration decreases as salt content increases. Since EC is the reciprocal of resistance, it rises as salt concentration does. The process outlined by determined it, and (Black and Evans 1965) [1]. Ohm's law states that conductivity and resistance are inversely related. Typically, lower measurements like milliohms/cm (mmhos/cm or microhms/cm at 25^0C) are used to measure the electrical conductivity of soil water extracts. Deci Siemen/m (dS/m) is the smaller SI unit and the international unit (SI) for the expression Siemens/m (S/m). One d /m equals a mmhos/cm.

Available Nitrogen
Alkaline potassium permanganate method was used to measure soil's available nitrogen, as explained by (Subbaiah and Asija 1956) [14]. The processes entail titrating the boric acid with standard sulphamic acid after distilling the soil with an alkaline potassium permanganate solution and absorbing the ammonia released.

Available Phosphorus
Available phosphorus was estimated by the ascorbic acid method as described by Olsen *et al.* (1954) [12].

Available Potassium
With the use of a suitable extractant neutral normal ammonium acetate, available potassium was extracted from the 5 gm soil by shaking, followed by filtration or centrifugation, and K was measured in the extract using a flame photometer. The technique described by was used to estimate the availability of potassium (Jackson, 1967) [7]. The intensity of the characteristic line emission provided by the element to be determined is measured as the basis for the photometer analysis.

Results and Discussion
pH and EC of Soil Nutrient
The pH value is used to determine the amount of H^+ ions to OH^- base ions in the soil. If the soil solution has a higher H^+ concentration, the soil is acidic. If the OH^- predominates, the soil is alkaline. The number of 7.0 represents the neutral balance between them. Brady found that the optimal pH range for plant nutrient availability is between 6.5 and 7.5. (Brady and Weil, 2002) [2]. As seen in (Fig-2), the pH ranges from 3.5 to 6.1

in several soil samples (average: 4.7). Foot & Ellis (Foth, and Ellis 1997) [4] found that 14.3 percent of soil samples were neutral, 28.6 percent were moderately alkaline, and 57.1 percent were somewhat alkaline.

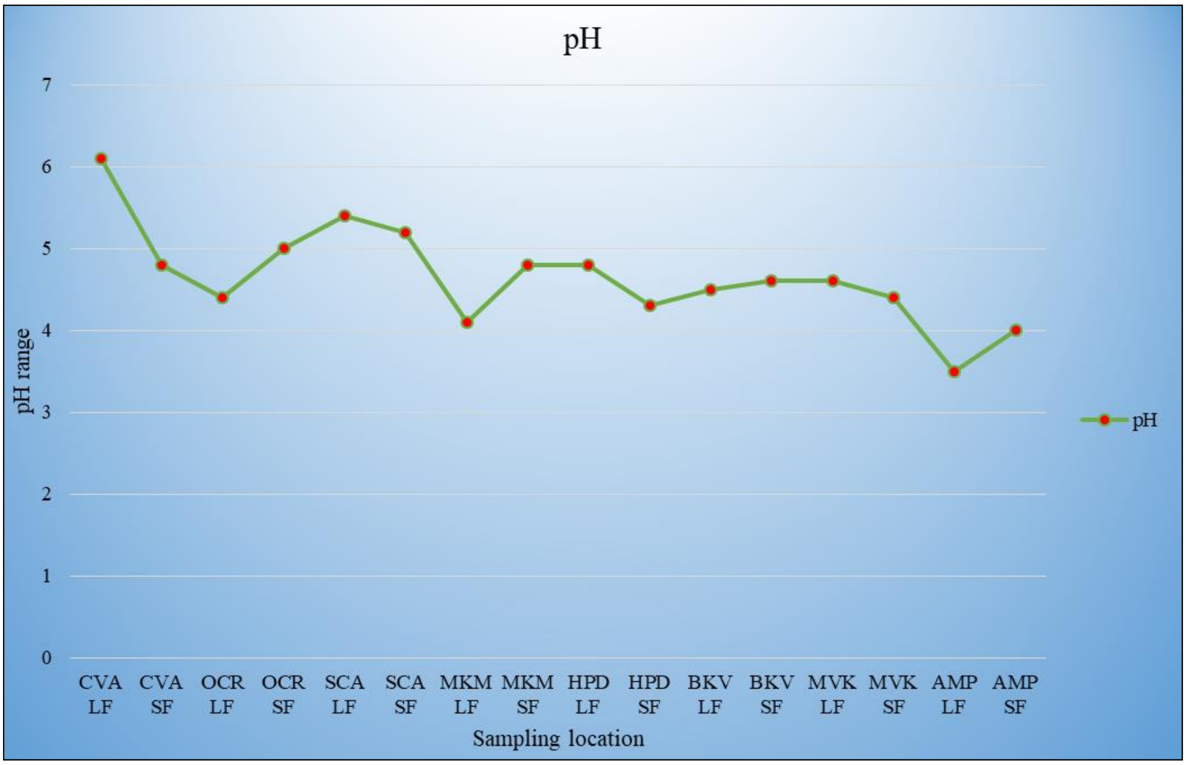

Fig 2: pH value of various soil samples

The average electrical conductivity (EC) of different soil samples is 0.2 milli mhos, but ranges from 0.06 to 1.08 milli mhos (Fig. 3). Sample HPD-SF contained the highest concentration of EC, 1.08 milli mhos, whereas Sample CVA-LF contained the lowest concentration, 0.06 milli mhos.

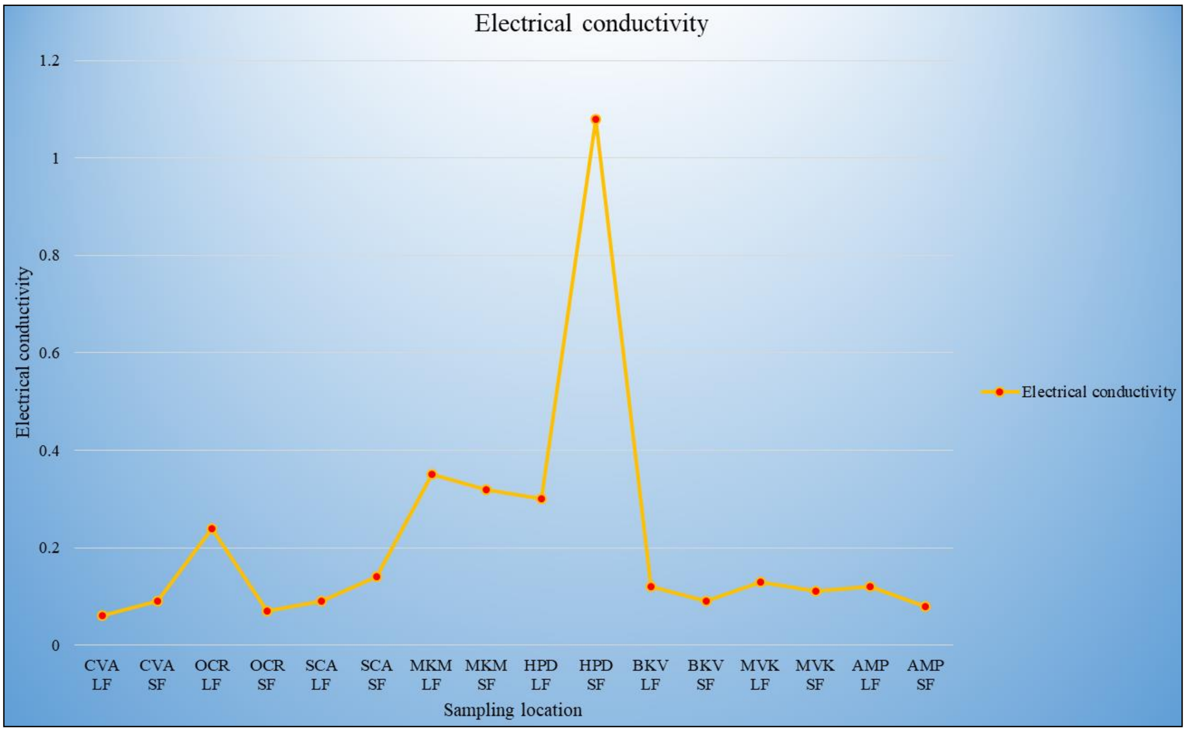

Fig 3: Electrical conductivity value of various soil samples

Macro Nutrient of Soil Samples

The range of nitrogen availability in various soil samples (11 to 51, average: 31.2 kg/ha) (Table-3), is displayed in 85.6 percent of the soil samples tested were low in nitrogen (250 kg ha^{-1}), and the remaining 14.3 percent were medium (250-500 kg ha^{-1}) according to Subbiah and Asija's nitrogen grading system (Subbaiah and Asija 1956)

[14]. A reduced nitrogen availability was seen in almost all of the samples. Nitrogen is not only a necessary component of carbohydrates, lipids, and oils, but it is also a necessary component of proteins. In order to improve soil fertility, it is important to increase the amount of nitrogen in the soil. In typical soil, there are 272 to 544 kg ha^{-1} of nitrogen available. Gupta *et al*. (2006) [6]. An absence of nitrogen leads older leaves to uniformly yellow, including the veins, before dying and turning brown. Due to the abundant nitrogen, plants will be dark green in colour and their new growth will be succulent.

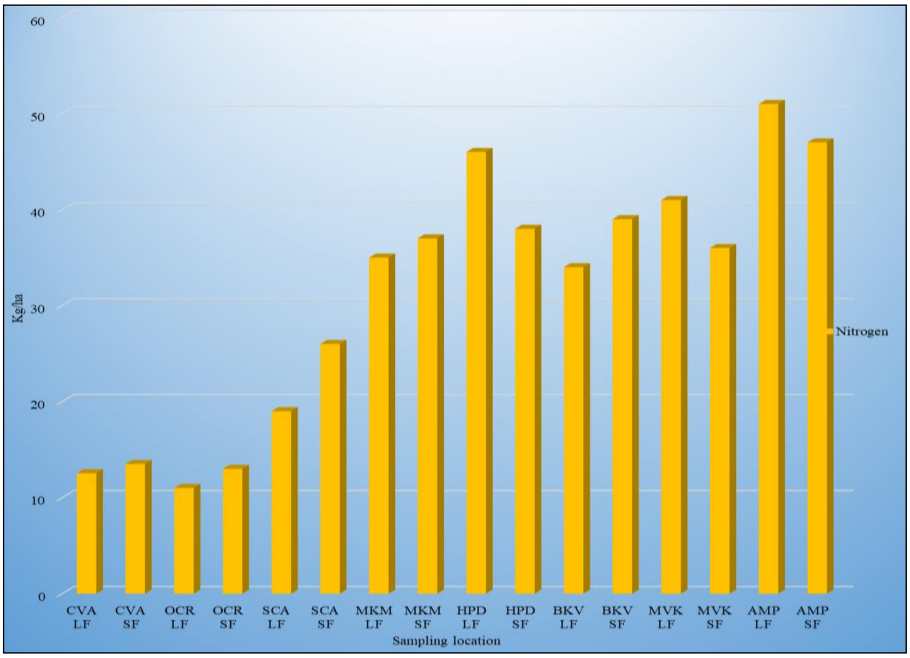

Fig. 4: Nitrogen value of soil samples

The average phosphorus concentration in numerous soil samples was 18.04 kg/ha, ranging from 0.79 to 81.19 kg/ha (Fig. 5). Phosphorus availability was lower in all of the soil samples (20 kg ha^{-1}) Muhr's suggested boundaries were used by Muhr *et al*. (1963) [11]. It is a cell nucleus component necessary for both cell division and the development of meristematic tissues at the growth sites. It makes up 0.1 to 0.5 percent of the dry weight of the plant. The recommended range for soil phosphorus content is 22.5 to 56 kg per hectare (kg ha^{-1}) Gupta *et al*. (2006) [6]. A phosphorus deficiency will produce poor, stunted plant growth, whereas an excess of phosphorus may not directly affect the plant but may result in obvious deficits of Zn, Fe, and Mn.

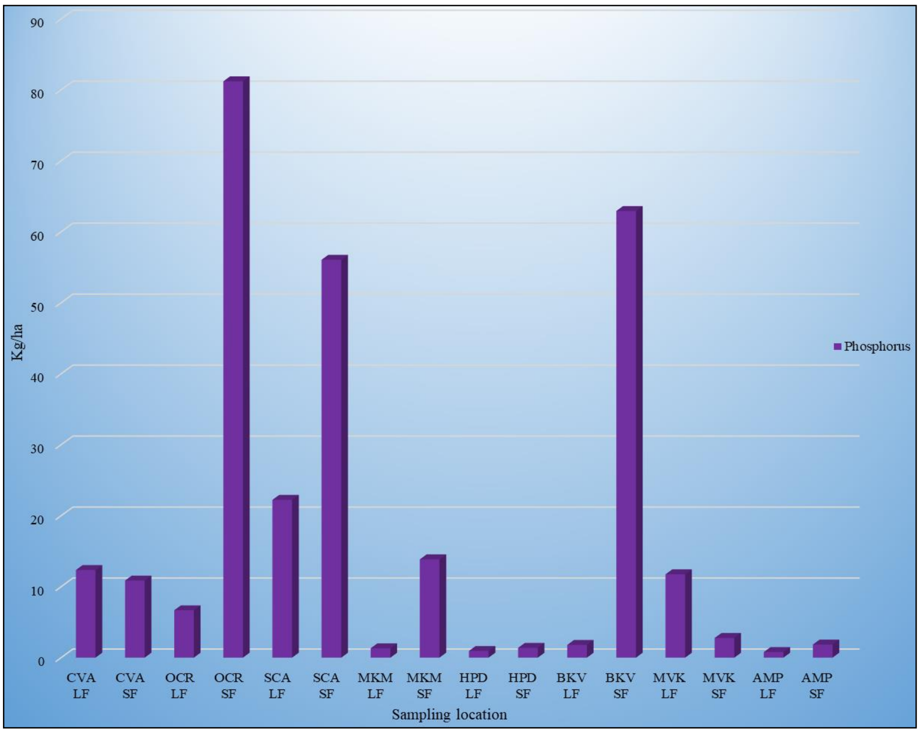

Fig 5: Phosphorus value of soil samples

Table 3: Macro nutrient properties of soil samples

S.N	Paddy field Name	Sample code	Chemical Properties				
			pH	Soluble salt (milli mhos)	Nitrogen available (kg/ha)	Phosphorus available (kg/ha)	Potash available (kg/ha)
1	Kottakogom paddy filed	CVA LF	6.1	0.06	12.54	12.35	22.288
2	Kumbazha paddy field	CVA SF	4.8	0.09	13.5	10.86	24.864
3	Vattakayal paddy field	OCR LF	4.4	0.24	11	6.67	87.696
4	Unduruthi paddy field	OCR SF	5	0.07	13	81.19	33.152
5	Kumaranjira paddy field	SCA LF	5.4	0.09	19	22.23	33.04
6	Chakkuvally paddy field	SCA SF	5.2	0.14	26	56.05	24.752
7	Ullitta puncha paddy field	MKM LF	4.1	0.35	35	1.32	419.216
8	Manjalam paddy field	MKM SF	4.8	0.32	37	13.85	48.608
9	Veeyapuram paddy field	HPD LF	4.8	0.3	46	0.95	366.24
10	Pandikizhakku paddy field	HPD SF	4.3	1.08	38	1.38	311.024
11	Chunakkara paddy field	BKV LF	4.5	0.12	34	1.8	51.968
12	Nooranad paddy field	BKV SF	4.6	0.09	39	62.93	61.6
13	Thazhakkara paddy field	MVK LF	4.6	0.13	41	11.75	395.472
14	Thekkekara paddy field	MVK SF	4.4	0.11	36	2.78	26.208
15	Ezhankery east paddy field	AMP LF	3.5	0.12	51	0.79	110.656
16	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

From 22.28 to 419.21 kg ha^{-1} (on average 130.2 kg ha^{-1}) of potassium was measured (Fig. 6). The majority of the soil samples (71.4%) were in the middle range (125-300 kg ha^{-1}), and the remainder (28.6%) were in the low ranges. According to Muhr's suggested limits, Muhr *et al.* (1963) [11]. A potassium deficiency is indicated by yellowing stars that appear from the tip/margin of lower leaves to the centre of the leaf base. Plants will display typical Mg and maybe Ca deficiency symptoms as a result of the excess potassium due to the cation imbalance.

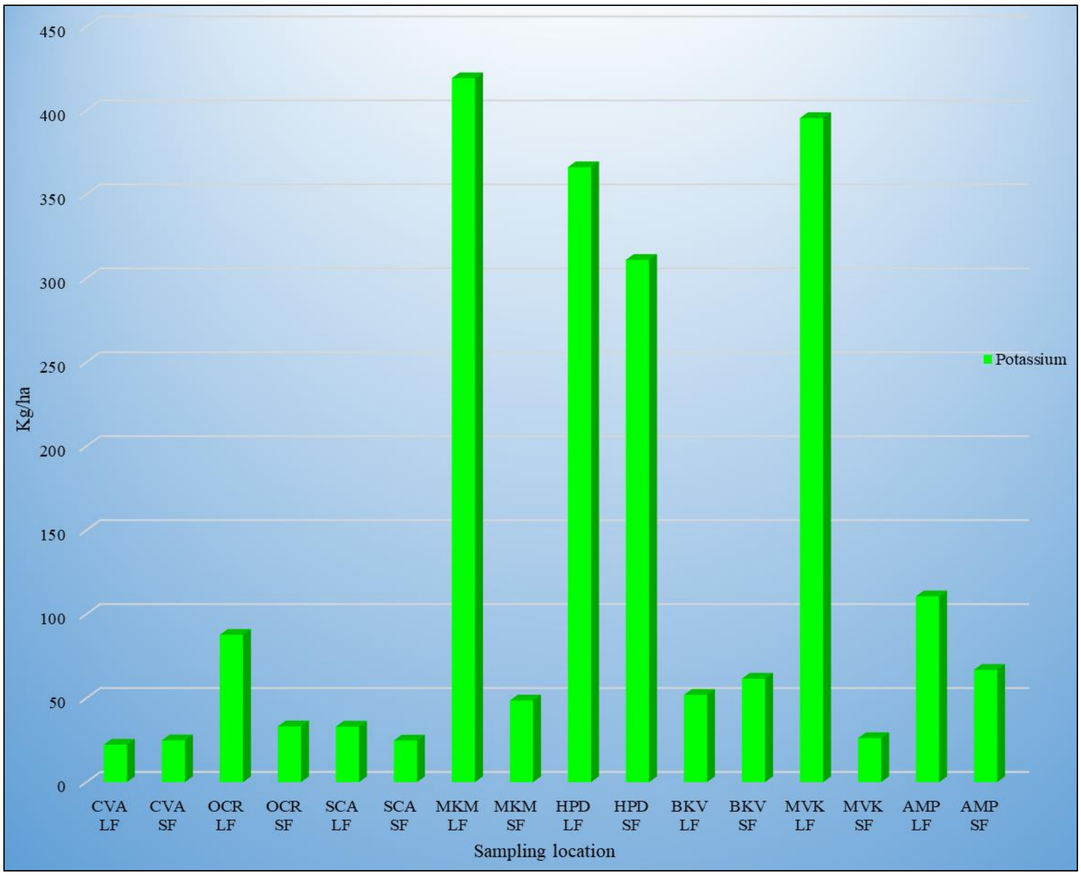

Fig 6: Potassium value of soil samples

Conclusions

The soil sample, for the most part, had a pH that was acidic and slightly low values for EC, N, and P. The potassium content was in the middle range in practically all soils. Only one sample had a high level of phosphorus compared to the other samples. The data indicates that additional fertiliser and manures are needed in areas where the soil is deficient in N, P, and K in order to make it suitable for cultivation and agricultural growth.

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