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Study on post-flood soil fertility of Vaikom block of Kottayam district in Kerala

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Abstract
The devastating flood of 2018 affected major parts of the state of Kerala. A study was conducted in 2019 to analyse various chemical attributes of soil viz., pH, EC, OC, available primary and secondary nutrients and boron in the post flood condition. The main crops generally cultivated in the Vaikom block are rice, coconut, banana and vegetables. Results of the study showed that most of the areas were having low pH which is a major constraint for crop production. Soil analysis for the nutrients revealed that all the nutrients except nitrogen and boron was in the sufficiency range. Nutrient index values were also calculated which was high for organic carbon and available phosphorous, medium for available potassium and low for nitrogen.

Keywords: 2018 floods, post-flood soils of Vaikom block, soil fertility, nutrient index

Introduction
In 2018, the state Kerala received 42% more rainfall than normal which lead to a flooded condition in all districts except Kasaragod. Kuttanad agro ecological unit (AEU) covers some region of Alappuzha, Kottayam and Pathanamthitta district and is known as the rice bowl of Kerala. The study area comes under Kuttanad and this region suffers from frequent floods.
Flooding may erode the top soil (0-15cm) which holds the plants, retains soil moisture, abundant in organic matter, microbial activity and earthworms. Despite of the consequences flooding may deposit a significant amount of organic matter and minerals which can improve the quality of soils. This research article will show a light upon the effects of flooding in the soils of Vaikom block of Kuttanad.

Materials and Methods
The present study was conducted in Vaikom block of Kottayam district. Twenty- six (6 each from T.V Puram and Udayanapuram, 5 from Chempu and 4 each from Thalayazham and Vechoor) surface soil samples (0-15 cm) were collected from 5 different panchayats (T.V, Puram, Udayanapuram, Thalayazham, Vechoor, Chempu) based on the severity of flood and was collected in the month of April, 2019 for analysing various chemical parameters like pH, electrical conductivity, organic carbon, available macronutrients and available boron (micronutrient).
pH and electrical conductivity were analysed in the 1:2.5 soil water suspension using pH meter and EC meter respectively (Jackson, 1958) [6]. Wet oxidation method for organic carbon (Walkley and Black, 1934) [14], Alkaline permanganometry for mineralizable nitrogen (Subbiah and Asija, 1956) [13], Bray extraction followed by spectrometry for available phosphorus (Bray and Kurtz, 1945) [2], neutral normal ammonium acetate extraction followed by flame photometry for available potassium (Jackson, 1958) [6], versanate titration for calcium and magnesium (Hesse, 1971) [4], $CaCl_2$ extraction followed by turbidimetry for available sulphur (Mossoumi and Cornfield, 1936) and hot water extraction followed by spectrometry for available boron (Gupta, 1972) [3] were followed for the analysis. After analysing the chemical parameters, nutrient indices were calculated for organic carbon and available primary nutrients for the area (Parker *et al.*, 1951) [11].

Results and Discussion

Soil fertility analysis revealed that pH was low. The lowest value was recorded at Vechoor panchayat (3.59) and highest value was recorded at T.V. Puram (5.73) with a mean value of 5.12. The EC values reported to be maximum as 0.71 dSm^{-1} at Vechoor and minimum as 0.16 dSm^{-1} at T.V. Puram with a mean value of 0.35 dS m^{-1}

The higher acidity generated can be due to the oxidation of sulphur compounds such as pyrites in kari soils and organic acid released from the decomposition of organic compounds. Iyer (1989) [5] reported the presence of pyrites in low lying areas of Kerala. The saline water intrusion at summer in these areas can increase the conductivity. The values for conductivity recorded was safe for the crop growth.

The organic matter was high in Vechoor panchayat which recorded a mean value of 6.07 per cent. Similar findings were reported by Kannan *et al.* (2014) [8] where the OC content varied from 2.79 to 7.7 per cent. Organic carbon in the area is generally high. Iyer, (1989) [5] opined it to be due to the abundance of partially decomposed fossil woods and roots were observed at different stage of decomposition.

Table 1: Soil pH, electrical conductivity and organic carbon in the post flood soils of Vaikom block

Panchayat	Soil pH		Electrical conductivity (dSm^{-1})		Organic carbon (%)	
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
TV Puram	5.73 ± 1.06	4.30 - 6.96	0.32 ± 0.34	0.10 - 0.98	1.14 ± 0.43	0.81 - 1.98
Udayanapuram	5.43 ± 0.81	4.58 - 6.80	0.19 ± 0.04	0.16 - 0.26	1.56 ± 0.73	0.84 - 2.51
Vechoor	3.59 ± 0.17	3.38 - 3.74	0.71 ± 0.34	0.36 - 1.00	6.07 ± 4.08	3.17 - 12.1
Thalayazham	4.59 ± 1.06	3.23 - 5.65	0.46 ± 0.35	0.14 - 1.00	3.99 ± 5.12	0.47 - 13.0
Chempu	5.18 ± 1.03	4.72 - 7.30	0.16 ± 0.07	0.11 - 0.26	1.50 ± 0.66	0.92 - 2.61
Vaikom block	5.12 ± 1.18	3.23 – 7.30	0.35 ± 0.31	0.10 – 1.00	2.62 ± 3.12	0.47 - 13.0

The nitrogen contents of the soils were generally low in almost all locations. The available nitrogen recorded the lowest mean value at T.V. Puram (130 kg ha^{-1}) and highest mean value at Vechoor (279 kg ha^{-1}). The low availability of nitrogen in spite of the higher organic carbon content was noticed. This may be due to the slow decomposition of organic matter on submergence. The other reason can be attributed to the presence of organic carbon in various forms. Irene (2014) pointed out that hot water extractible carbon can be used for determining available or mineralizable nitrogen since they found a significant correlation between HESC with total nitrogen and available nitrogen.

Phosphorus availability was high in the study area and recorded a mean value of 47.5 kg ha^{-1}. The high availability of phosphorus was reported to be high due to the high input of P fertilizers and organic matter addition (Rajasekharan, 2013).

Potassium was also found to be high in the area which can be attributed to the straw incorporation in the rice fields. The K fertilizer application in the rice fields are recommended only if the availability was found to be low after straw incorporation (KAU, 2016) [9]

Mean values for the availability of secondary nutrients for all the panchayats were recorded to be sufficient but localized deficiencies were reported in some areas. Kabeerthumma and Patnaik (1978) [7] reported a rise in exchangeable Ca in flooded soil which was attributed to the increased solubility due to combined effect of CO_2 and increased pH. Beena (2005) [1] reported similar observation were calcium content ranged from 514 to 1456 mg kg^{-1} in various parts of Kuttanad. Increased use of dolomite as a liming material could be a reason for the availability of magnesium. The high availability in sulphur may be due to immense presence of sulphur compounds like pyrites in the soils of Kuttanad.

Table 2: Availability of primary nutrients in the post flood soils of Vaikom blocks

Panchyat	Available N (kg ha^{-1})		Available P (kg ha^{-1})		Available K (kg ha^{-1})	
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
TV Puram	130 ±42.5	75.3-201	71.7±56.5	15.5-157	153±85.2	67.2-280
Udayanapuram	201±47.0	151-289	40.0±29.7	11.9-73.5	291±190	101-582
Vechoor	279±18.8	263-301	15.8±18.9	2.28-43.2	487±146	269-571
Thalayazham	221±107	138-376	59.0±60.1	2.74-158	296±417	44.8-1030
Chempu	176±32.0	151-226	41.6±19.1	13.0-65.0	166±95.2	78.4-280
Vaikom block	195±72.2	75.3-376	47.5±43.0	2.28-158	266±232	44.8-1030

Table 3: Availability of secondary nutrients in the post flood soils of Vaikom block

Panchyat	Available Ca (mg kg^{-1})		Available Mg (mg kg^{-1})		Available S (mg kg^{-1})	
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
TV Puram	773±413	180-1380	160±81.6	48.0-252	72.5±154	2.50-387
Udayanapuram	620±377	260-1280	170±78.7	72.0-252	34.8±35.8	3.00-101
Vechoor	585±326	180-920	510±508	24.0 -1080	459±503	18.5-965
Thalayazham	456±153	240-660	185±294	36.0-708	24.0±467	3.50-1079
Chempu	904±871	340-2420	125±52.0	36.0 -168	11.6±7.71	6.00-24.5
Vaikom block	673±475	180-2420	214±254	24.0-1080	145±310	2.50-1079

Boron is one of the micronutrients which is found to be deficient in Kerala. The samples of Vaikom block also recorded low values for availability of boron and were deficient. It varied from 0.11 to 0.35 mg kg^{-1}.

The nutrient index values obtained represents the nutrient status of the area. The high value greater than 2.33 represent high fertility status. Nutrient index values were high for organic carbon and available phosphorous, Medium for available potassium and low for nitrogen.

Table 4: Availability of boron in the post-flood soil of Vaikom block

Panchyat	Available B (mg kg^{-1})	
	Mean±SD	Range
TV Puram	0.23 ± 0.19	0.06 - 0.55
Udayanapuram	0.11 ± 0.07	0.01 - 0.20
Vechoor	0.35 ± 0.06	0.27 - 0.42
Thalayazham	0.20 ± 0.11	0.06 - 0.35
Chempu	0.16 ± 0.15	0.01 - 0.37
Vaikom block	0.20 ± 0.14	0.01 - 0.55

Table 5: Nutrient indices for organic carbon and primary nutrients in the post flood soils of Vaikom block

Panchayat	Nutrient index (OC)		Nutrient index (N)		Nutrient index (P)		Nutrient index (K)	
	NI	Status	NI	Status	NI	Status	NI	Status
TV Puram	2.17	Medium	1.00	Low	2.67	High	1.67	Medium
Udayanapuram	2.50	High	1.17	Low	2.50	High	2.17	Medium
Vechoor	3.00	High	1.50	Low	1.75	Medium	2.75	High
Thalayazham	2.4	High	1.40	Low	2.60	High	1.80	Medium
Chempu	2.4	High	1.00	Low	2.80	High	1.60	Low

Conclusion

Acidity was found to be a major constraint of the study area. All the macronutrients were reported to be sufficient for crop production except nitrogen. Application rate of phosphorus and potassic fertilizers can be reduced. Effective flooding, liming, washing, surface and subsurface drainage can be employed to reduce the problem of acidity.

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