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IMPACT OF CLIMATE CHANGE ON SECONDARY AND MICRO NUTRIENTS STATUS IN KOLE LANDS, KERALA, INDIA

Latha A.[1], Chijina K.*[2], Asha V. Pillai[1], Anasooya Sebastian[1] and Bhavyasree R.K.[3]
[1]Department of Agronomy, Agricultural Research Station, Mannuthy, Kerala, India
[2]Department of Agronomy, College of Horticulture, Vellanikkara, Thrissur, Kerala, India
[3]Research scholar, Department of Plant Breeding and Genetics, Agricultural Research Station, Mannuthy, Kerala, India
*Corresponding Author Email: chijinakbharathan@gmail.com

Abstract

Kole wetlands, Ramsar site since 2002, are lying 0.5-1.0 m below mean sea level and is one of the rice granary of the state. It provides forty per cent of the rice requirement of Kerala. Occurrence of seasonal natural flood due to climate change has reflected the fertility and productivity of land. An investigation was conducted by Agricultural Research Station, Kerala Agricultural University, Mannuthy to study the impact of flood on the physico-chemical properties of soil in kole lands. Soil samples were collected from five different locations (Anthikkad, Puzhakkal, Mullassery, Cherpu and Irinjalakuda) during the period 2011- 2019 and periodic changes in the physico-chemical properties of the soil was determined through the soil analysis. The data of soil analyzed revealed hundred per cent deficiency of magnesium in soils of kole lands. The micro nutrients zinc and boron were also found to be deficient in these samples before flood. After the devastating flood in 2018, the data of soil analysis showed that the soil was highly fertile with high organic carbon content of 3.45 per cent. The available phosphorus and potassium content were in the sufficient range. The data on content of micro nutrients revealed sufficiency of these nutrients in the soils of kole land after flood. A high productivity of 12 tonnes/ha was recorded in kole lands due to cropping in 2018. This indicated that silt deposition through flood was highly fertile with higher content of secondary and micronutrients and maintained a balanced nutrition to the crop which resulted in enhanced yield. Correlation study on soil nutrient status and rainfall revealed that no positive correlation exists between these parameters except for manganese.

***Keywords*:** climate change, flood, micro and secondary nutrients, physico -chemical properties.

Introduction

Kole lands, the rice granary of Thrissur and Malappuram districts comprises of 13500 ha, and provides forty per cent of Kerala's rice requirement. The kole wetlands are low lying tracts lying 0.5 to 1 m below mean sea level is located between $10^{o}20'$ and $10^{o}40'$N latitude and between $75^{0}58'$ to $76^{0}11'$E longitude. Karuvannur and Kechery are the two major rivers of kole lands which discharge the flood water into kole area leads to raise in water level to more than three meters(Johnkutty and Venugopal, 1993). Typical warm humid climate prevails in kole area. Soils of kole lands is formed typically as alluvium and colluvium; texture varying from clay, sandy clay, sandy loam and loam depending upon flood basin location and nearness to land and sea. Soil nutrient status of kole lands depends on the alluvial deposition during monsoon. These areas are submerged in water from June to September. The normal seasons of cultivation are late mundakan and punja. The yield of rice ranges from 7 to 9 tonnes/ha. On 16th August 2018, a severe flood affected the Kerala state due to unusual high rainfall during the monsoon. The occurrence of seasonal natural flood due to climate change had significant impact on the soil fertility and productivity of land. An assessment was done to study the impact of flood and climate change on soil properties and consequently yield of rice in kole lands.

Materials and Methods

An investigation was conducted by Agricultural Research Station, Kerala Agricultural University, Mannuthy, to study the impact of climate change on the physico-chemical properties of soil in kole lands during 2011- 2019. The rainfall received during the period of study in Thrissur District is depicted in the Fig. 1 and 2. Soil samples were collected from five different locations of kole land (Anthikkad, Puzhakkal, Mullassery, Cherpu and Irinjalakuda) during these period and the periodic changes in physico-chemical properties of the soil was determined through soil analysis. The content of macro and micro nutrients of soil were analyzed using standard procedures (Jackson, 1973; Walkley and Black, 1934; Hesse, 1971).

Results and Discussion

During 2011-13, Soil samples were collected from 55 locations of different kole padavus of Thrissur district (Table 1) and analyzed for major and micronutrients for deficiency/sufficiency level of nutrients in soil. From the data of soil samples it was revealed that there is widespread deficiency of Calcium (50.9%), Magnesium (100%) and Copper (65.4%). Zn and boron deficiencies were noticed in 7.2% and 25.2% of the locations in kole lands respectively. This might be due to the acidity of the soil. In highly acidic soil iron become more available and more toxic to plants which lead to deficiency of above nutrients in soil. After the devastating flood in 2018, the cultivation started in kole lands during November. The soil was analyzed before the start of cultivation from different locations of kole lands. The data on analysis of soil revealed that the soil was highly fertile with increase in organic carbon content of 3.45 per cent due to the silt deposition in kole lands due to flood. The pH of soil was also decreased to 4.84 resulting in increased soil acidity (Table 2). This occurs when base cations such as calcium, magnesium, potassium and sodium were leached out from the soil due to high rainfall. Available phosphorous content of soil was in high range and potassium content in medium range. The secondary nutrients calcium, magnesium and sulfur were in sufficiency range. The data of soil analyzed during the last five years revealed hundred per cent

deficiency of magnesium in the soils of kole lands. But after flood due to deposition of silt, the magnesium content increased to 234.4 mg/kg of soil which was higher than the sufficiency level of 120 mg/kg. The micronutrients zinc and boron which was deficient in soils before flood was found to be in sufficient range after flood. This might be due to highly fertile sediment deposition. The results are in conformity with the findings of Tsheboeng *et al*., 2014.

After first crop of paddy during January 2019, the soil was analyzed and the results of soil analysis showed increase in nutrient content which may be due to application of fertilizers. Secondary nutrients especially magnesium was in the sufficient range. There was a decline in iron content of soil due to application of lime. Boron content though showed a decline from 1.34 to 0.64 mg/ kg due to cropping found to be in the sufficient range.

The result of soil analysis after second cropping during May 2019 revealed decline in organic carbon from 2.69 per cent after first cropping to 1.6 per cent after second cropping due to absorption by plant. Phosphorus and potassium showed a drastic decline from 40.79 kg/ha and 592 kg/ha after first crop to 17 and 95 kg/ha after second crop respectively. Magnesium was found to be deficient after second cropping of paddy. The micronutrients had also revealed a declining trend though in the sufficiency range. This might be due to the uptake of these nutrients by crop and non-application of recommended dose of fertilizers during second cropping by the farmers.

A high productivity of 12 tonnes/ha was recorded in kole lands during first cropping in 2018 after flood. This indicated that silt deposition through flood was highly fertile with higher content of secondary and micronutrients and maintained a balanced nutrition to the crop which resulted in enhanced yield. Data on physico-chemical properties of soil, before and after flood were subjected to the correlation analysis. Correlation coefficient between physico-chemical properties of soil and rainfall received over the years revealed that no positive correlation exists between these parameters except for manganese (Table 3).

Conclusion

The results of soil analysis and high productivity during 2018 indicated the necessity of maintaining the available nutrient status of soil in the sufficiency levels. The favorable and adequate soil environments pave way for increased absorption of nutrients and their efficient utilization in the plant resulting in enhanced yield. This implies the importance of soil test based nutrient management and application of nutrients for balanced nutrient availability and absorption.

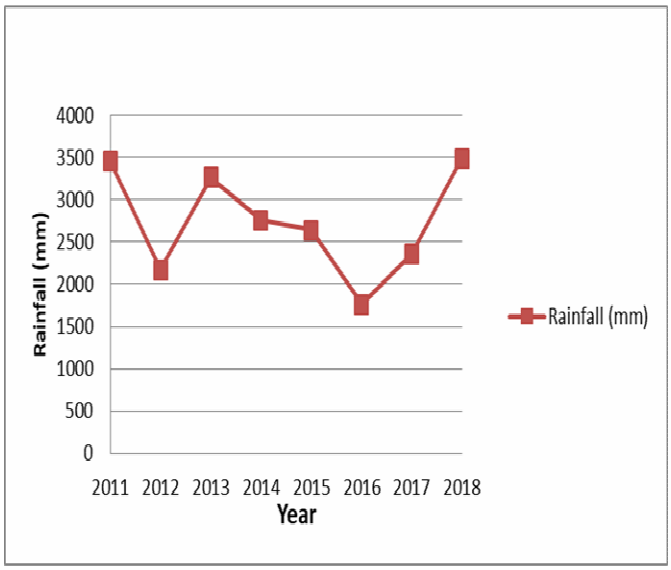

Fig. 1 : Rainfall received in Trissur District of Kerala state during 2011-2018

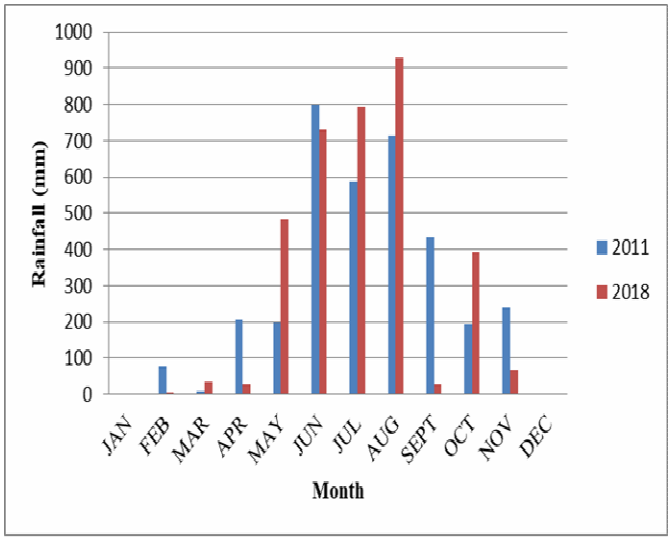

Fig. 2 : Rainfall received in Trissur District of Kerala state during 2011 and 2018 (monthly data)

Table 1 : Details of analysis of soil samples during 2011 -13

Blocks of kole lands selected & Area	No of soil samples analysed	Ca deficiency	Mg deficiency	Cu deficiency	Zn deficiency	Boron deficiency
Anthikkad 14 ha	7	1	7	5	0	0
Puzhakkal 26 ha	13	5	13	1	0	12
Mullassery 10 ha	5	1	5	0	0	2
Cherpu 30 ha	15	15	15	15	2	0
Irinjalakuda 30 ha	15	6	15	15	2	0
Total 110 ha	**55**	**28 (50.9%)**	**55 (100%)**	**36 (65.4%)**	**4 (7.2%)**	**14 (25.4%)**

Note: soil sampling is done at the rate of one sample for every two hectare area.

Table 2 : Variation in Physico-chemical properties and nutrient content of soil due to climate change (Mean of five locations)

	pH	EC (dS/m)	OC (%)	P (kg/ha)	K (kg/ha)	Ca (mg/kg)	Mg (mg/kg)	S (mg/kg)	Fe (mg/kg)	Mn (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	B (mg/kg)
2011-12	6.04	0.10	1.92	37.27	81.99	609.16	8.56	26.47	3073.51	20.28	2.92	0.66	1.59
2012-13	4.87	0.10	1.96	42.92	202.74	411.51	14.96	31.36	1198.02	100.23	2.86	1.20	0.23
2013-14	6.04	0.08	2.56	91.86	280.43	958.22	18.05	22.54	1203.01	95.40	1.45	1.95	2.62
2017 -18 September	4.84	0.22	3.45	27.61	293.49	835.39	234.73	32.73	1907.58	65.36	13.06	5.73	1.34
2018-19 January (after first crop)	4.48	0.47	2.69	30.88	509.47	1389.30	225.50	151.35	484.19	40.00	12.80	5.15	0.64
2018-19 May (after second crop)	5.2	0.20	1.60	17.00	95.00	650.00	95.00	25.00	250.00	20.00	3.50	4.20	0.80

Table 3 : Correlation on physico-chemical properties of soil and rainfall received over the years (Mean of five locations)

	PH	EC	OC	P	K	Ca	Mg	S	Fe	Zn	Mn	Cu	B	Rain
PH	1	-0.6	-0.426	0.406	-0.651	-0.417	-0.593	-0.559	0.749	-0.503	-0.594	-0.459	0.741	0.619
EC		1	0.472	0.116	.940**	.965**	0.807	.933**	-0.384	0.79	-0.177	0.745	-0.271	-0.154
OC			1	0.312	0.699	0.558	.836*	0.345	0.216	.901*	0.364	0.673	0.289	-0.803
P				1	0.275	0.326	0.031	0.293	0.781	0.26	-0.201	-0.142	0.624	-0.045
K					1	.936**	.861*	.906*	-0.222	.895*	0.07	0.708	-0.172	-0.442
Ca						1	.820*	.897*	-0.134	.848*	-0.284	0.753	-0.017	-0.137
Mg							1	0.601	-0.181	.972**	0.061	.945**	0.016	-0.518
S								1	-0.328	0.638	-0.104	0.465	-0.343	-0.127
Fe									1	0.005	-0.215	-0.234	.932**	0.016
Zn										1	0.068	.865*	0.147	-0.56
Mn											1	-0.158	-0.388	-.837*
Cu												1	0.054	-0.288
B													1	0.082
Rain														1

**. Correlation is significant at the 0.01 level (2-tailed)

*. Correlation is significant at the 0.05 level (2-tailed)

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