



Effect of Rotational Pokkali cultivation and Shrimp farming on the Soil Characteristics of two different Pokkali field at Chellanam and Kadamakudi, Kochi, Kerala, INDIA

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Abstract

Pokkali field is prevalent in the coastal saline tracts of Kerala. Pokkali fields are able to produce paddy and shrimp rotationally in an organic way. The sediment characteristics were studied in two Pokkali fields, Chellanam and Kadamakudi, Ernakulam District, Kerala, India during April to June 2013. The soil pH varied highly acidic to 7.15 slightly alkaline in Chellanam and alkaline in Kadamakudi. The least value of conductivity and salinity were occurred on the first half of the June. The highest value of total organic carbon was 1.05% in Chellanam and 6.225% in Kadamakudi observed on the second half of April. The highest value of phosphate was 0.1578 mg/g in Chellanam and 0.2125 mg/g in Kadamakudi with a mean and standard deviation of 6.87 ± 7.67 and 0.14 ± 0.05 respectively on the first half of the May. The nitrogen content of the soil also showed the same trend as phosphate. The carbon content of the soil showed a slight increasing trend. The sulphur content of the soil is negligible except last half of may showed 0.18%. In Chellanam and Kadamakudi, the sulphur content of the soil showed a decreasing trend from April to June. C – N ratio was in the range of 6.3: 1 to 8.1: 1. C- N ratio in Chellanam and in Kadamakudi was in the range of 9: 1 to 10.2: 1. The sediment characteristics in this area were completely depends on the south west monsoon and the tides of the Vembanad estuary.

Keywords: Pokkali, soil conductivity, pH nitrogen, phosphate, sulphur, carbon nitrogen ratio.

Introduction

The Vembanad wetland complex provides a means of livelihoods for local who are dependent on fishing and related industries, an important tourist destination and also supports an agricultural system including the 'rice bowl of Kerala'¹. A variety of rice which are salt resistant locally called Pokkali are cultivated in the coastal regions of Ernakulam, Alappuzha and Thrissur districts of Kerala state, India has been upgraded into the the status of registered Geographical Indication (GI) by the Geographical Indications Registry Office, Chennai, Tamil Nadu². The pokkali fields adjacent to the Vembanad Lake below sea level and having acid saline soils³. Traditionally natural available prawns and fish seeds collected by trapping of natural saline waters from the Vembanad estuary, which enters to the field during the high tides is collected for the farming on a seasonal basis are traditionally known as pokkali fields. It is a unique ecosystem situated adjacent to Vembanad Lake having with rich biodiversity and capacity to produce rotational paddy and shrimp organically². It is a classic example of sustainable agri – aqua integration providing a means of rural livelihood. The rice seedling grows in the natural way without addition of any fertilizers. These fields are waterlogged throughout the year. The crop that can grow upto 2m can survive in this area⁴. The rice produced from this area is purely organic⁵. In Kerala, traditional and extensive shrimp culture is in practice and the total area under traditional farming system is 12,986.6 ha, of

which 84% is under pokkali fields⁶. There are about 4000 hectares of paddy fields under pokkali cultivation in Ernakulam district, while in Alappuzha and Thrissur the extent of paddy cultivation is in about 3000 hectares and 2000 hectare respectively². The Pokkali fields of Kerala have been declining from 25,000 hectares to 9000 hectares³. The Pokkali fields which are marshy situated close to the sea and the mouth of the rivers. Therefore, they are prone to flooding and salinity. The successful growth, propagation, survival, reproduction and harvest of shrimps are heavily dependent upon the quality of the field soil and water, degradation of which often limits the production in aquaculture systems^{7,8}. Keeping in view, the benefits of farm organic agriculture and shrimp farming and also the declining of pokkali farms, a study was taken to estimate the soil quality parameters after shrimp farming and before pokkali farming.

Material and Methods

Study area: The coastal saline soils along the Ernakulam district are referred to as pokkali fields. The traditional paddy cultivation involving a salt-resistant and tall pokkali variety of paddy, which used to cultivate from May-June to September-October is followed by shrimp filtration⁹. According to Pillai¹⁰ during high tides, the water entered into the pokkali fields through the sluice in twice daily. During night, the mouth of the sluice was fitted with bulbs / hurricanes / petromaxes etc for

attracting shrimp seeds into the fields. Water was let out from the field for a period of about one hour based on the tide, water flow and depth of the field. During the time, net was fixed on the sluice for preventing escape of shrimps from the fields. The harvesting was done twice based on the lunar phase with net fixed on the sluice. The fields are situated below the mean sea level and having the problems of water-logging and have no addition of chemical pesticides or fertilizers in the Pokkali rice fields which make them different from the other farming practices in Kerala¹¹.

In this study, sediment samples were collected from two pokkali fields, Chellanam and Kadamakudi in Ernakulam District of Kerala (figure-1). Chellanam pokkali field is of 175 ha and Kadamakudi is of about 900 ha. The soil samples are collected during the period in which any cultivation was not carrying out from second half of April 2013 to first half of June 2013 from

both the Pokkali fields. The rotational pokkali and shrimp filtration were carried out in both Pokkali fields for many years.

Collection and analysis of sediment samples: Sediment samples were collected from Pokkali field in every once in two weeks from April to June. Sediment samples were collected from the bottom surface by Van veen grab. Sampling of sediment was done at four points from each station. The collected samples are mixed and then were air dried, ground to fine powder by using mortar, and stored in air tight polythene bags for analysis. pH and electrical conductivity was measured immediately after the collection following standard methods¹². The Nitrogen, Carbon and Sulphur of the soil was analysed by CHNS analyser of the model, Elementar Vario EL II. The iron content of the soil samples was analysed by Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES) of the model Thermo Electron IRIS INTREPID II XSP DUO.

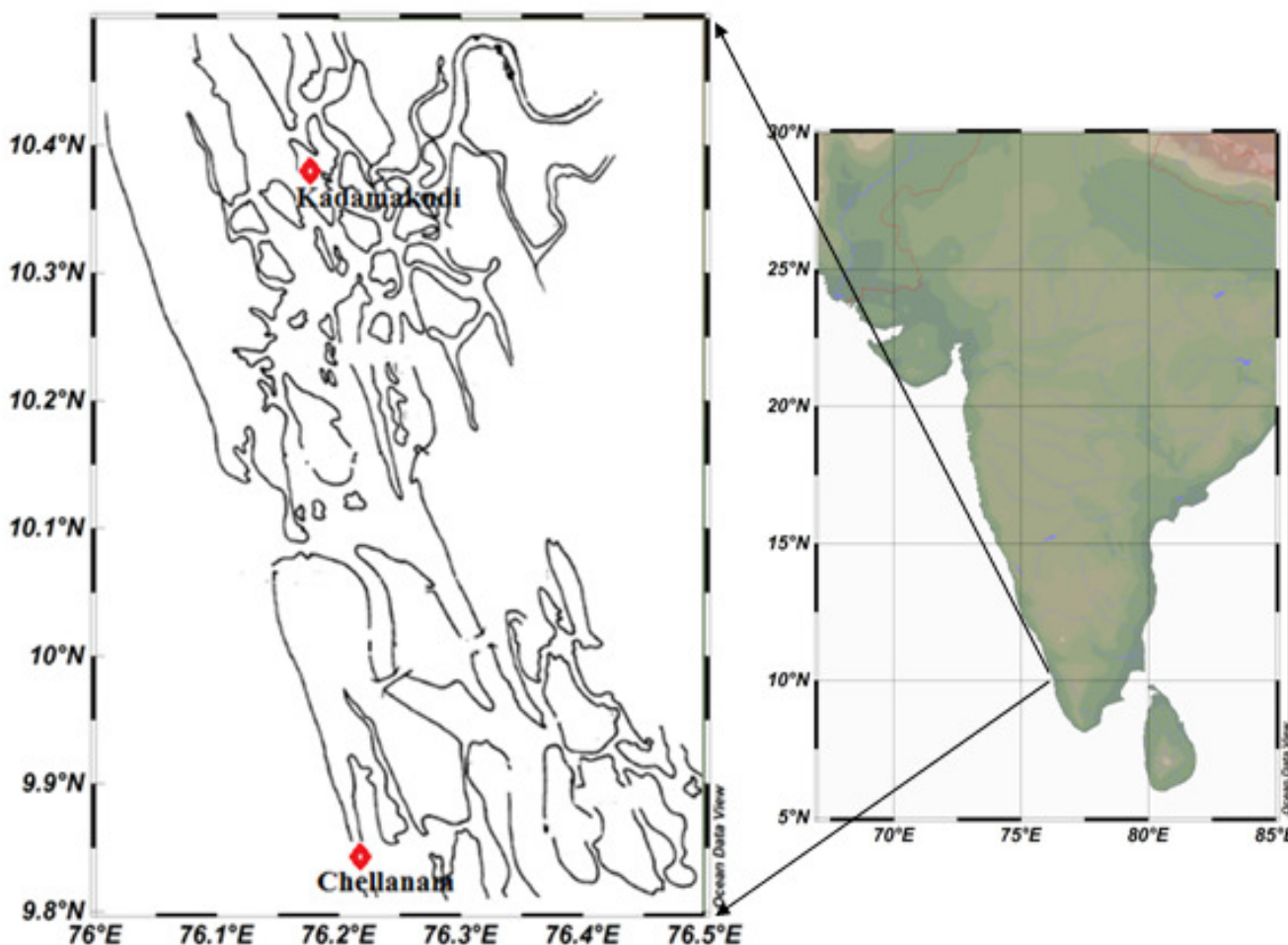


Figure-1
Map showing the Pokkali fields, Chellanam and Kadamakudi in Kerala, INDIA

Results and Discussion

The study has been carried out by considering the peculiarity Pokkali field, which has been modified for agricultural and aquaculture purposes with an aim of enhancing the productivity. The sediment characteristics of these areas were analysed. The mean values and the standard deviations of the chemical characteristics of the soil on the pokkali field during the dry period is shown in table-1.

Table-1
Mean and standard deviations of the chemical characteristics of the soil

Parameters	Chellanam (Mean± Stdv)	Kadamakudi (Mean ± Stdv)
pH	6.66 ± 0.52	7.65 ± 0.23
Conductivity (mS)	11.79 ± 6.20	8.81 ± 3.42
Salinity (ppt)	0.73 ± 0.77	0.02 ± 0.001
Total Organic carbon (%)	1.46 ± 0.45	3.96 ± 2.18
Phosphate (mg/g)	6.87 ± 7.67	0.14 ± 0.05
Nitrogen (%)	0.88 ± 0.72	0.21 ± 0.07
Sulphur (%)	0.68 ± 0.57	1.03 ± 0.52
Iron (%)	0.92 ± 0.55	1.99 ± 0.52
C-N Ratio	7.1 ± 3.69	4.33 ± 2.46

Soil properties of Chellanam after rotational farming: The maximum value of pH in Chellanam was 7.17 and minimum was 5.95. The soil pH varied considerably during the period. The maximum value of soil conductivity was 19.72 mS and minimum was 2.909 mS. The observed maximum value of salinity of the soil was 0.01833 ppt and the minimum value was 0.01335 ppt. The observed range of total organic carbon was from 1.05 % to 0.0325 %. The maximum value was on the first half of May. The range of phosphate in the soil was ranged from 0.0325 mg/g to 0.1578 mg/g. The recorded value of nitrogen in maximum was 0.16 % and minimum was 0.14 %. The only recorded value of sulphur in the soil was 0.18 % on the first half of the May. The iron content of the soil ranged from 0.88% to 2.77%. The C – N ratio varied from 7 to 8.067.

Soil properties of Kadamakudi after the rotational farming: The maximum value of pH in Kadamakudi was 7.97 and minimum was 7.41. The maximum value of soil conductivity was 12.19 mS and minimum was 4.237 mS. The conductivity during the first half of June was more less compared to other due to the low saline content of the soil. The observed maximum value of salinity of the soil was 0.01595 ppt and the minimum value was 0.01359 ppt. The low salinity during first half of June was of the washing of Pokkali field with monsoon. The observed range of total organic carbon was from 6.225% to 1.495%. The range of phosphate in the soil was ranged from 0.2125 mg/g to 0.096 mg/g. The maximum value was on the first half of May. The recorded value of nitrogen in maximum was 0.28% and minimum was 0.12 %. The recorded value of sulphur in the soil was 1.5 % and minimum was 0.39%. The

iron content of the soil ranged from 2.73% to 1.46%. The C – N ratio varied from 9.083 to 10.

Chellanam and Kadamakudi: In Chellanam, the least value of conductivity occurred on the first half of the June. The conductivity of the soil in Kadamakudi also showed a decreasing trend. This is due to the dilution effect of the south west monsoon. During monsoon months, the inflow of freshwater is considerably high and this large scale of fresh water run off extends far beyond the mouth of harbour¹³. In both, the low value of salinity occurred on the first half of the June due to the dilution effect of fresh water. The highest value of total organic carbon observed on the second half of April and showed a decreasing trend in both Chellanam and Kadamakudi. This was due to the presence of dead remains of the Pokkali and shrimp farming. According to Nandan, and Abdul Aziz¹⁴, Premonsoon season is most favourable for organic matter accumulation. The value of phosphate was higher on the first half of the May than the second half of the April in both the Pokkali fields. This much time needed for the micro organisms for degrading the dead remains which leads to the release of phosphate. This agreed with Nambiar and Raveendran⁴ in which the trapped dead remains are degraded thoroughly by the innumerable array of micro organisms present in the coastal paddy fields of kerala. The nitrogen content of soil also showed the same trend as phosphate in both Pokkali fields. The carbon content of the soil showed a slight increasing trend in both the stations. This was due to decrease in temperature of south west monsoon. The onset of monsoon brought a drastic change in the salinity distribution and after the monsoon there was an increase in salinity both at the surface and at the bottom of the Vembanad lake¹⁵. According to Post W.M. et al¹⁶ the storage of carbon in the soil increases with precipitation, and having an increase in soil C with decreasing temperature upto a particular level of precipitation. Brady and Weil¹⁷ reported that the C:N ratio for cultivated surface horizons ranges between 8:1 to 15:1. Accordingly, the present work in Chellanam has also C – N ratio was in the range of 6.3: 1 to 8.1: 1. C- N ratio indicates the biological productivity of that area in which Varapuzha has in the range of 9: 1 to 10.2: 1.

The soil pH varied highly acidic to slightly alkaline in Chellanam and alkaline in Varapuzha. This variation was due to the freshwater influx by rainfall and through estuaries. The inflow of freshwater, particularly during monsoon months is considerably high and the influx of this large scale freshwater runoff extends far beyond the harbour mouth during this period¹³. The sulphur content of the soil is almost negligible except last half of May showed 0.18% in Chellanam. This may be due to the presence of acid sulphate soil due to the improper washing of soil. The lowest value of pH was also obtained during this time. But in Kadamakudi, the sulphur content of the soil showed a decreasing trend which indicates the washing of soil by tides. The problems associated with sulfur caused in the environment include acid precipitation, forest decline, acid mine drainage, acid sulfate soils, and even some toxic effects in

drinking water used by humans and livestock¹⁷. For about the iron content of the soil in Chellanam, highest value was on the first half of the May. Iron is highly soluble in the lowest ranges of pH which are suitable for plant growth¹⁸. The lowest value of pH was on that time. But in Kadamakudi, the iron content of the soil showed a decreasing trend and also has high pH.

Conclusion

Sediment characteristics revealed that both the stations are productive in nature even without addition of any type of fertilizers. Kadamakudi is comparatively more productive than Chellanam as Kadamakudi is closer to the Vembanad Lake. The farming in this area will completely depend on the south west monsoon and the tides of the Vembanad Lake. We can protect the valuable wetland resources and can maintain the ecological balance through the organic pokkali – shrimp rotational farming practice.

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