ANALYSIS OF BOTTOM SOIL QUALITY PARAMETERS OF SHRIMP POND CULTURE IN MODIFIED EXTENSIVE METHOD

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Abstract

Soil analysis is commonly needed in aquacultural research or in making decisions on water quality management in aquaculture ponds of modified extensive system. Concentrations of organic carbon, organic matter, total nitrogen, available nitrogen, electrical conductivity, soil texture, soil pH, phosphorous and potassium were analyzed at various periods of culture like, pre culture and post harvest period. The soil pH varied between 7.8 and 8.6, almost neutral in reaction. The electrical conductivity (EC) value of the pond soil was in the range from 1.7 to 3.2 with an average value of 2.6. Organic carbon content ranged from 0.41 to 0.74% with an average value of 0.56%. The minimum nitrogen content in the soil of the pond ranged 0.0353% and minimum range was observed from 0.0637%. Salinity plays an important role in transformation of soil nitrogen – available nitrogen increased at salinities 10-20 ppt. Therefore purpose of the present study was to compare the soil properties on aquaculture pond ecosystem.

Keywords: Organic matter, Pond soils, Shrimp ponds, Salinity, Soil quality, Extensive method.

Introduction

Shrimp farming is a major aquaculture industry in many tropical countries, but in spite of its overall success, it has been plagued with epidemics of various shrimp diseases and impaired water and soil quality in ponds (Wyban, 1992; Phillips *et al*., 1993; Boyd *et al*., 1994a; Browdy and Hopkins, 1995). Soils are a major factor in pond aquaculture, because ponds are made of soil material, and the condition of pond bottoms influences water quality and production. Banerjea (1967) revealed that the potential for fish production in ponds was influenced by pH and concentrations of organic matter, nitrogen, and phosphorus in soils. Concentrations of nutrients and phytoplankton productivity in pond waters are related to pH and nutrient concentrations in soils (Boyd 1995; Boyd and Munsiri 1996, 1997). The composition of shrimp pond soils is altered by residues from feeds and fertilizers, settling of dead plankton, and accumulation of sediment and salts (Hopkins *et al.*, 1994; Boyd 1995). The soil act as “Store House of Nutrients” supplying nutrients to overlying water and helping in the mineralization of organic bottom deposits. The soil also provides food and shelter for bottom dwellers. The nature of bottom soil is considered to be of great importance in aquaculture ponds. Benthic algae which form the main fish food organisms in fresh/brackish water ponds derive their nutrients either directly from the soil or water interface. Studies on culture of white shrimp and physico-chemical and sediments analysis are more in the Vellar belt related to brackish water farming in the semi-intensive method but very less study in the modified extensive method especially for *L. vannamei*. The productivity of ponds depends largely on the nature and properties of the bottom soil. Hillary *et al*. (1962) observed that the algal production was associated with nutrients status of the pond soil in some aquaculture ponds. Boyd (1973) found a close relationship between the base saturation of bottom mud and total hardness of the water. Bottom soil plays vital role in the shortage and release of nutrients into the water (ii) the mineralization of bottom deposits, providing shelter and for bottom dwelling organisms and act as a bed for the growth of algal Pasteur. It has considered worthwhile to make a detailed study of physico-chemical properties of the soils. Negative correlations between shrimp growth and survival and sulfide concentrations in aquatic soils have been observed (Ritvo *et al*. 1998). Therefore comparative study of the nature and properties of soil in brackish water shrimp pond was made. The bottom soil characteristics of different ponds and their biomass production under fluctuating soil properties were analyzed in this study.

Materials and Methods

Samplings were made from the pond and sediment sample was collected randomly by using a corer (4 cm diameter) at 10 cm depth at various periods of culture like, pre culture, during culture and post harvest. The soil sample was shade dried. The dried sample was analyzed for organic carbon, organic matter, total nitrogen, available nitrogen, electrical conductivity, soil texture, soil pH, phosphorous and potassium at the instrumentation laboratory at, CAS in Marine Biology, Annamalai University, Tamilnadu, India.

Results and Discussion

Soil characteristics and nutrients present in grow out pond are presented in the Table 1 and Fig.1. Soil pH is one of the important parameters for successful shrimp culture. In the culture pond, the pH was ranged from 6.5 to 7.5 favouring the growth of benthic algae. The range of soil pH is said to be highly responsive to the release of the nutrients. The soil pH varied between 7.8 and 8.6, almost neutral in reaction. A low oxygen supply results in slow decomposition of organic matter. This produces mainly reduced or partially oxidised compounds like H_2S, CH_4, and short chained fatty acids.

Table 1. Analysis of Physico-chemical parameters in shrimp pond culture
E.C = Electrical Conductivity, OC = Organic Carbon, OM = Organic Matter, AN = Available Nitrogen, TN = Total Nitrogen, P = Phosphorous, K = Potassium

The pH value of soil ranged from 7.8 to 8.3 with an average value of 8.0. The importance of alkaline pH in pond soil and water on shrimp production has been emphasized by several earlier works (Nees, 1946). According to these workers, slightly alkaline pH values of the soil of an aquaculture pond in West Bengal were considered to be conducive for higher production of shrimp. Soil pH is influenced by the degree of base unsaturation of cation exchange sites, the presence or absence of carbonates, and acidity resulting from oxidation of sulfide minerals in some soils (Boyd 1995).

Stages of culture	Soil pH	EC	OC	OM	AN	TN	P	K	Soil texture
Before culture	7.8	1.7	0.74	1.2757	0.0637	0.6378	11	327	Sandy clay
During culture	8.0	3.2	0.55	0.9482	0.0474	0.4741	30	516	Silty clay
After harvest	8.3	2.9	0.41	0.7068	0.0353	0.3534	17	546	Clay loam

The electrical conductivity (EC) value of the pond soil was in the range from 1.7 to 3.2 with an average value of 2.6. The EC value of semi-intensive and intensive farms is as high as 8.0-8.6 due to the presence of several water soluble cations and anions in such soils (Subramaniyan *et. al*., 1976). The organic carbon and nutrient content of the soils have relationship with the productivity of ponds and different size fractions of the soil particles. EC is a measure of soil cation adsorption capacity (Foth and Ellis 1988). Organic carbon content ranged from 0.41 to 0.74% with an average value of 0.56%. Banerjee (1967) rated the productivity of freshwater fish ponds on the basis of organic carbon content of the bottom soils and considered the values below 0.5% as too poor for fish production. Organic matter in the soil is another important character of productivity. It controls the character of water body, reduces seepage loss and increases the availability of bed soil. Further, it is an essential in pond soil-water interface to regulate the food chain. Nitrogen is the vital limiting factor for the production of aquatic biomass and its presence always in optimum level is highly desirable. The nitrogen content in the soil of the pond ranged from 0.0353-0.0637%. Salinity plays an important role in transformation of soil nitrogen – available nitrogen increased at salinities 10-20 ppt.

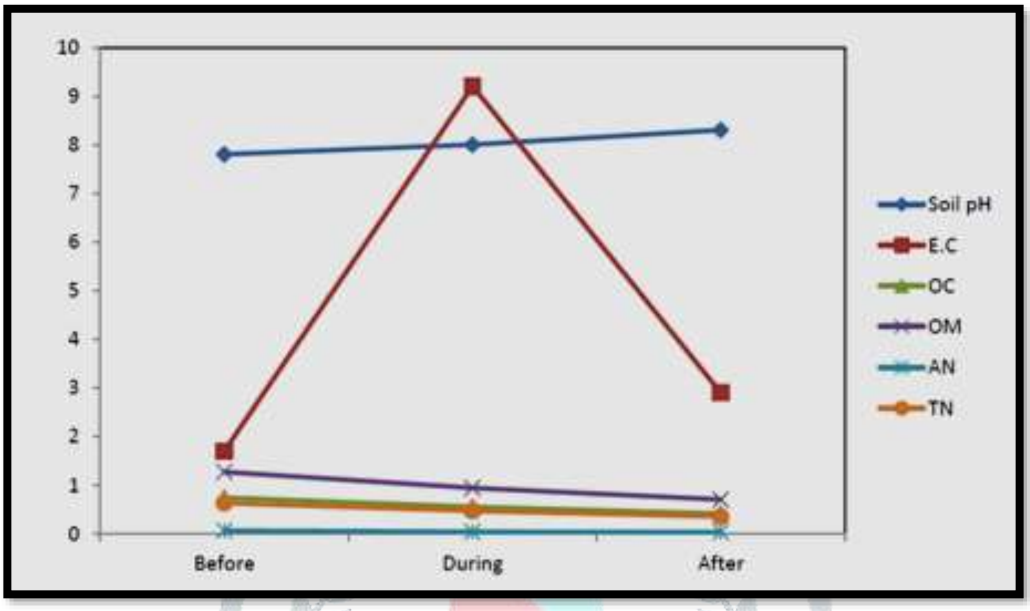

Fig. 1: Graphical representation of the soil quality parameters

Atmospheric nitrogen in its different forms is the main source of soil nitrogen which is present in organic forms. Nitrogen availability is a problem with high level of pH in both soil and water of aquaculture ponds.

High clay content in soil is associated with a high phosphorus fixation capacity (Boyd and Munsiri 1996), and it often is difficult to initiate plankton blooms in semi-intensive shrimp ponds with heavy clay soils even when heavy phosphate fertilization is used. Better growth and survival of penaeid shrimp has been reported on sandy substrates (Chien *et al*. 1989; Pruder *et al*. 1992; Bray and Lawrence 1993). Soils with 5 to 10% clay and a well-graded particle size distribution are preferable to clays for earthwork construction (McCarthy 1998) and more agreeable to drying and tilling between crops (Boyd 1995). Thus, selection of high clay content soils for pond culture of shrimp and other species may be less important than once consideration.

The texture and composition of the bottom soil plays an important role in maintaining the productivity of the soil and hence is the third most important factor in the site selection criteria of an aquaculture pond. Soil characteristics such as texture, composition and fertility are the major factors which govern the productivity of the pond.

Tang and Chen (1967) surveyed some milk fish ponds in Taiwan and described that majority of high productivity ponds were distributed into the regions having silty loam soils, therefore indicate that the aquaculture fish ponds in West Bengal are likely to have fairly good productive potential.

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