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Adaptability of Mangroves in Shrimp Farm Discharge Water

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In brackishwater aquaculture, discharge water is generated either from water exchange to maintain water quality in ponds or during the harvest of a crop. The treatment of the aquaculture effluent is expensive because of the large volume of dilute effluent. In fact the wastewater enriched with nutrients is a resource, and exploitation of nutrient sources from wastewater is an appropriate strategy. In case of low saline aquaculture effluent, it can be used for the irrigation of salt tolerant field crops, whereas the brackishwater aquaculture effluents require most salt tolerant field crops. In this context mangrove proves may be an appropriate solution. However the adaptability of the mangroves in shrimp farm discharge water needs to be ascertained. Hence a preliminary pot culture experiment was conducted to assess the adaptability of mangrove species (rhizophora) under different types of soils prevailing in coastal areas, viz. sandy loam, loamy sand and clay loam. The seedlings were irrigated with wastewater collected from the shrimp pond. The biometric parameters, viz. height (cm), number of lateral branches and leaves and surface area of the leaves of the seedlings were monitored weekly for three months. The changes in the soil quality were assessed. The study revealed that there was not much variation in biometric parameters among the three soils. Review on mangroves as biofilters has also been enumerated.

(**Key words:** *Shrimp pond, Effluent discharge water, Mangroves*)

In brackishwater aquaculture discharge water is generated either from water exchange to maintain water quality in ponds or during the harvest of a crop. Intensive shrimp aquaculture systems rely on high protein feed pellets to produce high rates of growth, but a large proportion of the pellets are not assimilated by the shrimps. Approximately 10% of the feed is dissolved and 15% remains unused. The remaining 75% is ingested, but 50% is excreted as metabolic waste, producing large amounts of gaseous, dissolved and particulate waste. The dissolved nutrients and organic material in shrimp ponds stimulate rapid growth of bacteria, phytoplankton and zooplankton. Though all these nutrients and organic wastes are biodegradable, the discharge water if enriched with nutrients, may cause the eutrophication of the receiving water body. Moreover, it may also lead to the self pollution of aquaculture ponds, i.e. the pond effluent is fed back through the farm intake and associated with disease and low quality-aquaculture products (Sakthivel, 2001). Although aqua-culturists are moving towards systems where the discharge of wastewater is minimized and treatment methodologies developed, the problem of the disposal of the discharge water continues to challenge the brackishwater aquaculture. In case of low saline aquaculture effluent, it can be used for the irrigation for salt tolerant field crops (Macintosh and Fitzsimmons, 2003), whereas the brackish water aquaculture effluents require a most salt tolerant field crop. In this context mangrove proves to be an appropriate solution.

Mangroves have multipurpose uses. They provide important economic benefits to coastal communities including the production of charcoal, firewood and construction materials for local fisheries and as well as for coastline protection. Mangroves can tolerate upto varyin gdegrees of salinity and it plays a vital role in breeding and nursery phases of many riverine and marine organisms of commercial value. Hence the environmentalist highlights the importance of mangroves in coastal areas. Deforestation of mangroves is caused by conversion to agriculture, salt ponds, industrial uses, urbanization or mining activity and also due to shrimp farms in many countries and it is associated with decline in shrimp seed densities, saltwater intrusion and accelerated coastal erosion (Rao and Ravichandran, 2001). In fact, most of the mangrove rehabilitation programme is for the cyclone protection, erosion control rather than wastewater treatment.

MATERIALS AND METHODS

Mangroves seedlings were collected and planted in pots of different soils, viz. sandy loam, loamy sand and clay loom. The seedlings were irrigated with wastewater collected from the shrimp pond. The initial water characteristics were monitored for various water quality parameters, viz. pH, salinity, turbidity TAN, nitrite nitrogen and total phosphorous. The biometric parameters, viz. height (cm), number of lateral branches and, leaves and surface area of the leaves of the seedlings were monitored weekly for three months. The height of each individual was measured from the stem base to the nodes of the last leaves. The changes in the soil quality were assessed. The collected data were analyzed statistically.

RESULTS AND DISCUSSION

The discharge water from aquaculture pond has been collected and the characteristics were studied as given in Table 1. On comparison with the guidelines issued by the Ministry of Agriculture, it could be observed that all the parameters were within the permissible limits. The total suspended soil ranged from 35-42 mg l^{-1}. The ammonical nitrogen ranges from 1.1 to 1.8 mg l^{-1}. The nitrite nitrogen ranged between 0.045 to 0.013 mg l^{-1}. Similarly the phosphate ranged between 0.224 to 0.344 mg l^{-1}.

The biometric parameters observed, viz. the height and the no. of leaves of the mangrove seedlings are given in Fig. 1 and Fig. 2. It could be observed from the Fig.1 that the height of the seedlings was more in clay loam. The statistical analysis revealed that there was no significant variation with respect to height among the three soils, whereas the growth of the number of leaves was significantly different in sandy loam when compared with loamy sand and clay loam. The changes in the soil characteristics were given in Table 2. The soil analysis revealed that the soil pH and EC increased. The increase in soil pH and EC was due to continuous application of the discharge water which was saline. The organic carbon also increased slightly. The presence of higher concentration of suspended and dissolved solids contributed to the build-up of organic matter.

Mangroves grow well on silty clay soils which are prevalent along the coastline. Research in Ranaong on the Andaman sea coast of Southern Thailand has shown that mangroves could be planted successfully in shrimp waste sludge, dumped into holding areas in the intertidal zone around the shrimp farm (Macintosh, 1996).

It has been suggested earlier that mangroves, grasses and other hydrophonic system can filter the nutrients in wastewater. Besides their nutrient sripping capabilities, mangrove also trap suspended sediments (SS) to a great extent. Earlier research

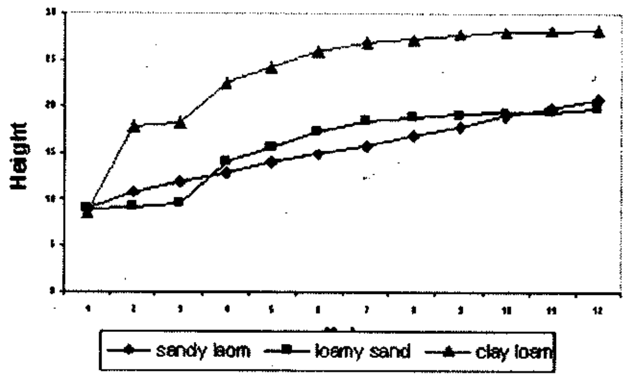

Fig. 1. Height of the seedlings in different soils

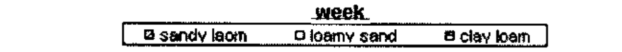

Fig. 2. No. of leaves of the mangrove seedlings in different soils

Table 1. *Characteristics of the shrimp pond discharge water*

Parameter	Shrimp pond waste water	Standards for the aquaculture pond wastewater discharged into		General standards
		Coastal marine waters	Creek	Marine coastal areas
pH	8.3-8.7	6.0-8.5	6.0-8.5	5.5-9.0
Salinity (ppt)	36-39	-	-	-
Suspended solids (mg/l)	35 - 42	100	100	100
T. Ammonia N (mg/l)	1.1- 1.8	1.0	0.5	5
Nitrite N (mg/l)	0.045 to 0.13	-	-	-
Phosphorus (mg/l)	0.224 to 0.344	2.0	2.0	-

Table 2. Soil characteristics

Parameter	Initial soil characteristics			Soil characteristics after three months		
Texture	**Sandy loam**	**Loamy sand**	**Clay loam**	**Sandy loam**	**Loamy sand**	**Clay loam**
Soil pH	8.3	7.9	8.4	9.41	9.06	9.47
EC (dS/m)	40.15	150.24	225.3	44.02	183.5	285.6
OC (%)	0.23	0.25	0.34	0.23	0.28	0.42

shows that heavy metals can also be absorbed by mangroves (Tam and Wong, 1995). Though many researchers have advocated the role of mangroves as biofilters (Kutty, 2001) only very few works on the effectiveness of mangroves as biofilters have been done in India.

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