RESEARCH ARTICLE

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Study of Some Physiochemical Properties of Soil in Selected Sites of Shatiya Wetland for Enhancement of Fish Productivity

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ABSTRACT

A study was conducted to detect some physiochemical properties and metals concentration in soil sample of selected sites of Shatiya wetland near Manjhagarh in Gopalganj district of north Bihar. The soil samples were collected from the different sites based on water depth of wetland. The soil parameters like soil texture, pH, total dissolve solids (TDS), conductivity and metals concentration were determined. The pH of wetland soil ranged from 5.6 to 7.2 with an average value 6.4, total dissolved solids (TDS) ranged from 15.2 to 23.6 mg/L with an average value 19.4mg/L, while electrical conductivity ranged from 45.2 to 74 s with average value 62.6 s, respectively. The concentrations of some metals i.e., sodium, potassium, calcium, manganese, iron and chromium in soil were found to be 16-18% at site 1, 18-20% at site 2 and 21-23% at site 3 of soil, respectively. As bottom soil of reservoir provides all the important nutrients with water, therefore, our present study would be helpful to understand the quality of soil in a eutrophicated and seasonal wetland and its impact on all aquatic biota found in this circumstances.
Key words: *Shatiya wetland, Soil Physiochemical Properties of selected sites*

INTRODUCTION

The productivity is determined to a great extent by the nature and properties of the bottom soils in the wetlands as shallow and ponds. Importance of bottom soils in determining the fish productivity is well documented (Jhingaran, 1975). The significant role of bottom soils in influencing availability of different nutrient elements to primary fish food organisms has been discussed in details by Boyd, *et al.* (1997). However, the basic properties of a particular soil group being largely different than the other ones, the fish harbor under a particular soil zone are likely to exhibit some specific characters of the soil and water environment which may be reflected in their biological productivity levels also. Considering this fact, Boyd, *et al.* (1997), while discussing different aspects of aquaculture river bottom soil management, suggested that the soil deficiencies should be identified and treated while undertaking new fish culture programs in any river. In this study, an attempt has been made to identify the major soil factors associated with primary production in the Shatiya wetland giving special emphasis to nitrogen in influencing productivity of reservoir at three selected sites. It is hoped that the study will help to find out the major productivity limiting soil factors for wetland under these three sites and, thereby, to develop adequate soil system based productivity management programs for such seasonal wetlands known locally as chaur.

MATERIALS AND METHODS

Bottom soil samples were collected from upper 15 cm layers of three selected sites in wetland situated under three different topographic soil with different texture as hard, soft and mixed alluvial type to three replicates from each zone. The samples were air dried, ground and sieved to 80 mesh size and used for analyzing pH, organic carbon, easily mineralizable nitrogen, mineralized nitrogen, available phosphorus (Bray's extractant no.1), available potassium, texture, and DTPA extractable micronutrients. The soil samples required for estimation of parameters other than texture and organic carbon were incubated under submerged condition for 10 days using 1:10 soil: water ratio for developing a semi-aerobic condition in the soil simulating to wetland situation and were then used for the estimations.

Water samples of respective selected sites were analyzed for pH, total alkalinity, total dissolved solid (TDS), electrical conductivity and water soluble N, P and K. Gross (GPP) and net (NPP) primary productivity values were also estimated using light and dark bottle method (Odum, 1973) and estimating the dissolved oxygen by following the method described by (Winkler, 1988). Statistical analyses of the results were carried out through correlation coefficient studies of different soil and water properties with the dependent variable GPP.

RESULT AND OBSERVATION

Ranges of different soil properties of the river under three selected sites of Shatiya wetland and their average values have been presented in table 1.

Table 1: Soil Parameters in three selected sites

Parameters	Site 1	Site 2	Site 3
pH	5.6-6.2	5.8-6.4	6.3-7.2
Mineralizable N(mg kg-1)	56.24-63.32	62.46-73.12	124.3-156.22
Available P (mg kg-1)	25.13-31.24	36.42-47.23	48.21--53.62
Available K (mg kg-1)	48.23-52.54	56.23-61.21	71.23-74.92
EC (dSm-1)	11.2-11.4	13.4-13.6	14.2-14.4
Organic Carbon (%)	1.12-1.15	1.21-1.24	1.36-1.39
Micronutrients (%)	16-18	18-20	21-23

Table 2: Water Parameters and Gross Primary Productivity of wetland

Parameters	Site 1	Site 2	Site 3
pH	5.9-6.5	6.1-6.7	6.6-7.5
Available N(mg l^{-1})	10.32-12.23	12.46-14.12	24.31-27.22
Available P (mg l^{-1})	1.32-1.41	1.33-1.54	1.42-1.63
Available K (mg l^{-1})	18.23-20.54	26.23-28.21	31.23-34.32
EC (dSm^{-1})	0.452-0.456	0.563-0.565	0.737-0.740
Total Alkalinity (ppm)	21.12-21.23	32.36-32.43	46.22-47.12
TDS (gl^{-1})	1.52-1.54	2.14-2.16	2.34-2.36
GPP (mg cm^{-3} h^{-1})	32.13-33.22	46.56-47.63	56.62-57.71
NPP (mg cm^{-3} h^{-1})	16.23-16.42	24.21-24.42	28.48-28.64

As observed from the table, pH values of the wetland soils of site 1 appeared to be predominantly acidic ranging between 5.6-6.2 and an average value of 5.9 followed by the soil samples of site 2 ranging between 5.8-7.5 and 6.4 as an average value. On the other hand, the soil samples of site 3 were found to be between neutral to alkaline in nature ranging from 6.3-7.2 with an average value of 6.8. Similar trend of pH was observed for wetland water of these three zones also. The wetland site 1 showed lowest range of pH in water ranging between 5.9-6.5 with an average value of 6.3 while the site 2 were 6.1-6.7 and 6.6-7.5 respectively with corresponding average values of 7.6 and 7.68.

The organic carbon content of the wetland soils varied as 11.2 to 11.5 in site 1, 12.1 to 12.4 at site 2 and 13.2 to 13.8 at site 3. This low occurrence of organic carbon may affect other soil properties like availability of different Available N values of the soils of the three different sites showed ranges of 56.24-63.32, 62.46-73.12 and 124.3-156.22 mg N kg-1 soil (Table 1). Similarly, the water soluble N content of these three zones showed a range of 10.32-12.23, 12.46-14.12 and 24.31-27.22 mg l-1 respectively (Table-2).

In the present study, available P in wetland soil values in the selected sites ranged between 25.13-31.24, 36.42-47.23 and 48.21-53.12 mg kg-1 respectively. On the other hand, the range and average values of water soluble phosphorus content of the three different sites were 13.1-14.1, 13.3-15.4 and 14.2-16.3, respectively. In the present study, the wetland soil at site 1 and 2 exhibited, in general, comparatively lower values of available K ranging from 48.23-52.54 and 56.23-61.21 mg kg-1 with average values of 50.2 and 58.72 mg kg-1 respectively, than what were observed at the site 3. Availability of Micronutrients of the selected sites as 16-18, 18-20 and 21-23 percent showed variable requirements for proper aquaculture in this wetland. Range and average values of electrical conductivity of both soil and water were presented in table 1 and table 2 respectively which were observed to be considerably low.

The amount of acid required to titrate the bases in water is a measure of alkalinity. Numbers of bases like hydroxides, carbonates, bicarbonates, ammonia, silicate, phosphate etc may contribute to alkalinity of water. In the present study, the total alkalinities of the water samples of three different zones of wetland were presented in terms of mg kg-1 of CaCO3 -. The range and average values are presented in table 2. The maximum value of average alkalinity was observed at site 3 and the minimum value was observed at site 1. For the present study, total dissolved solids (TDS) of water samples of three different sites were measured and the range and average values have been presented in table 2. As observed from the table, the site 3 exhibited considerably higher TDS values in water than the other two sites.

Table 3: Correlation of Soil parameters with Gross Primary Productivity (GPP)

Parameters	Correlation with GPP	Level of Significance
pH	0.3241	.05
Mineralizable N (mg kg^{-1})	0.3180	.05
Available P ((mg kg^{-1})	0.4164	.05
Available K ((mg kg^{-1})	0.2842	.05

Table 4: Correlation of Water parameters with Gross Primary Productivity (GPP)

Parameters	Correlation with GPP	Level of Significance
pH	0.2256	.05
Mineralizable N (mg l^{-1})	0.5264	.01
Available P ((mg l^{-1})	0.2873	.05
Available K ((mg l^{-1})	0.5161	.01

To assess the significance of the studied soil properties to wetland productivity, therefore, attempts were made to correlate these values with respective gross primary productivity levels of the other wetlands. The studies revealed that out of the different properties studied, only pH and available N, P and K values of the wetland soils and waters were positively correlated with primary productivity of the wetland (Table 3 and 4).

DISCUSSION

The study showed that although there were considerable variations in pH values of the bottom sediments of the wetland sites under three different soil zones, yet the water pH values were comparatively higher for all the sites and the mean values assumed almost similar values. This behavior may be probably attributed to photosynthetic activities of the primary producers in these sites which helped to maintain higher pH values in water (Delince, 1992) tended to reduce their variations. Importance of neutral to slightly alkaline pH of bottom soils for good productivity of fish productivity has been emphasized by Boyd (1995) and Mandal and Chattopadhyay (1992).

In the present study, low ranges of primary productivity levels of the studied wetland sites (table-2) probably tended to restrict accumulation of organic matter in the soils. In addition, long summer spells of the tropical countries also encouraged the oxidation of soil organic matter. This probably restricted formation of organic materials in the chaur boundary places. While discussing the nature and properties of reservoirs, (Boyd, *et al,* 2002) suggested occurrence of less than 1.0% of organic carbon to be indicative of low organic matter content in reservoir soils. Considering his views, a large section of the studied sites could be considered as low in organic carbon content. Production of fish food organisms contributes largely to accumulation of organic matter in bottom soils of water body (Hepher, 1965).

Banerjee (1967) stated that the bottom soils with less than 250 mg kg-1of available N content might be considered to be low for fish catches in India. Considering his views, the observed values of available N in all the sites could be taken to be rather poor. Mean values of easily mineralizable N in the bottom soils of the wetland under all these three sites indicated large deficiency of Nitrogen. Since occurrence of N in any soil environment remains closely related with organic carbon content of that soil, such low availability of N in different sites was quite expected.

Phosphorus is recognized to be the most critical single factor in the maintenance of reservoir productivity (Jhingaran, 1975). Below 13.0 mg kg-1 of available P in bottom soil and less than 0.05 mg l-1in water phase have been suggested as the index of poor productivity of wetlands in India as reported by Banerjee (1967). In the present study, however the mean availability of this nutrient element was marginally above this threshold value.

In spite of being the third major nutrient element in reservoir nutrition, little work has so far been done on K dynamics of reservoirs (Mandal and Chattopadhyay, 1992). Wetland soils are considered to have good supplies of K because of their alluvial origin, clayey texture and large scale occurrence of K bearing minerals (Dutta, 1985). Submerged soils generally tend to reduce the availability of Zn (Mandal and Chattopadhyay, 1992). Values of available Cu also showed low availability in all the three sites.

Electrical conductivity (EC) indicates the total concentration of ionized constituents of a system. It is closely related to the sum of cations or anions, as determined chemically, and usually correlates with the amount of total soluble solids. Considering that changes in EC are associated with release or depletion of soluble ions in soil-water systems, EC might have an indirect role to play in wetland productivity (Mandal and Chattopadhyay, 1992).

Total solids of water sample represent different constituents. Different forms of solids e.g. total solids (TS), total dissolved solids (TDS), total suspended solids (TSS) and total volatile solids (TVS) are present in water. Higher rates of alluviation of fine soil particles in wetlands probably resulted in such increased TDS values.

Gross primary production (GPP) in fish reservoir is well known to be closely related with the yield levels of fishes in various fish culture systems (Lavrentyeva, 1996; Downing and Leibold, 2002). Since gross primary production is a major indicator of productivity levels of water body, this study indicates that adequate management of the primary productivity limiting soil parameters viz. pH, easily mineralizable N, Available P and K would be helpful to increase productivity of a wetland significantly.

CONCLUSION

The results of this study indicate that there is wide spread deficiency in availability of nitrogen in the selected sites of Shatiya wetland near Manjhagarh of Gopalganj district in north Bihar. This emphasizes the need of application of nitrogenous fertilizers in such water body for increasing their fish productivity. The studies revealed that out of the different properties studied, only pH and available N, P and K values of the wetland soils and waters were positively correlated with primary productivity of such small and seasonal reservoirs.

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