Original Research Article

Soil Nutrient Status of Coastal Region in WestBengal, India

ABSTRACT

The study conducted in the year 2022-23 at the Department of Soil Science and Agricultural Chemistry, The Neotia University, 24 Parganas (South), situated in coastal region of West Bengal, aimed to assess the nutrient status of the soils in the instructional farm. Soil samples (105 nos) were collected at 0-15 cm depth and analyzed for pH, electrical conductivity (EC), organic carbon (OC), and major nutrients such as available nitrogen, phosphorus, and potassium. The result showed that the soils were neutral in reaction and saline in nature, whereas organic carbon and available nitrogen content were at a medium level, but available phosphorus and potassium levels were high. Moreover organic carbon showed negative correlation with soil electrical conductivity (-0.384, $p<0.05$). The nutrient index values for available nitrogen and available phosphorus were between 1.66-2.33 range, categorizing it as medium fertility. Conversely, the nutrient index value for available potassium exceeded 2.33, classifying it as high fertility.

Keywords: Coastal region; saline soil; major nutrients; nutrient index; fertility.

1INTRODUCTION

Coastal soils play a vital role in the agricultural productivity of West Bengal, as they are heavily influenced by their proximity to the ocean and unique environmental conditions (1). These soils are generally deficient in organic matter and nutrients, poor physical properties and saline in nature [2] (Elayaraja et.al,2023), [3] (Mandal et.al, 2019), as well as high levels of soil salinity due to factors like sub-soil water, poor drainage, and intrusion of sea water. Moreover, it is found that the suitability of coastal soils for specific crops is varied, for example, while paddy crops were found to be well-suited for these soils, other crops like chilli, mustard, sunflower, and vegetables may face challenges in terms of nutrient availability and tolerance to the high salinity levels. However, there is a lack of detailed information regarding the soils of The Neotia University School of Agriculture and Allied Sciences in West Bengal. This study aims to assess the nutrient status of these coastal soils to provide valuable insights for effective soil management strategies.

2 MATERIALS AND METHODS

The research was conducted at Instructional Farm of The Neotia University (TNU), Sarisha, Diamond Harbour, West Bengal, India, located at $22^{0}48'$ N latitude and $88^{0}31'$ E longitudes with an average altitude of 8 m above the mean sea level (MSL) (Figure 1). The main crops grown within the study area are rice, maize, sunflower, groundnut, mustard, mungbean and black gram. The farm encompasses seven blocks viz. Uncultivated land (S1), Cultivated land (S2), Net house (S3), Poly house (S4), Upland (S5), Lowland (S6) and Orchard field (S7).

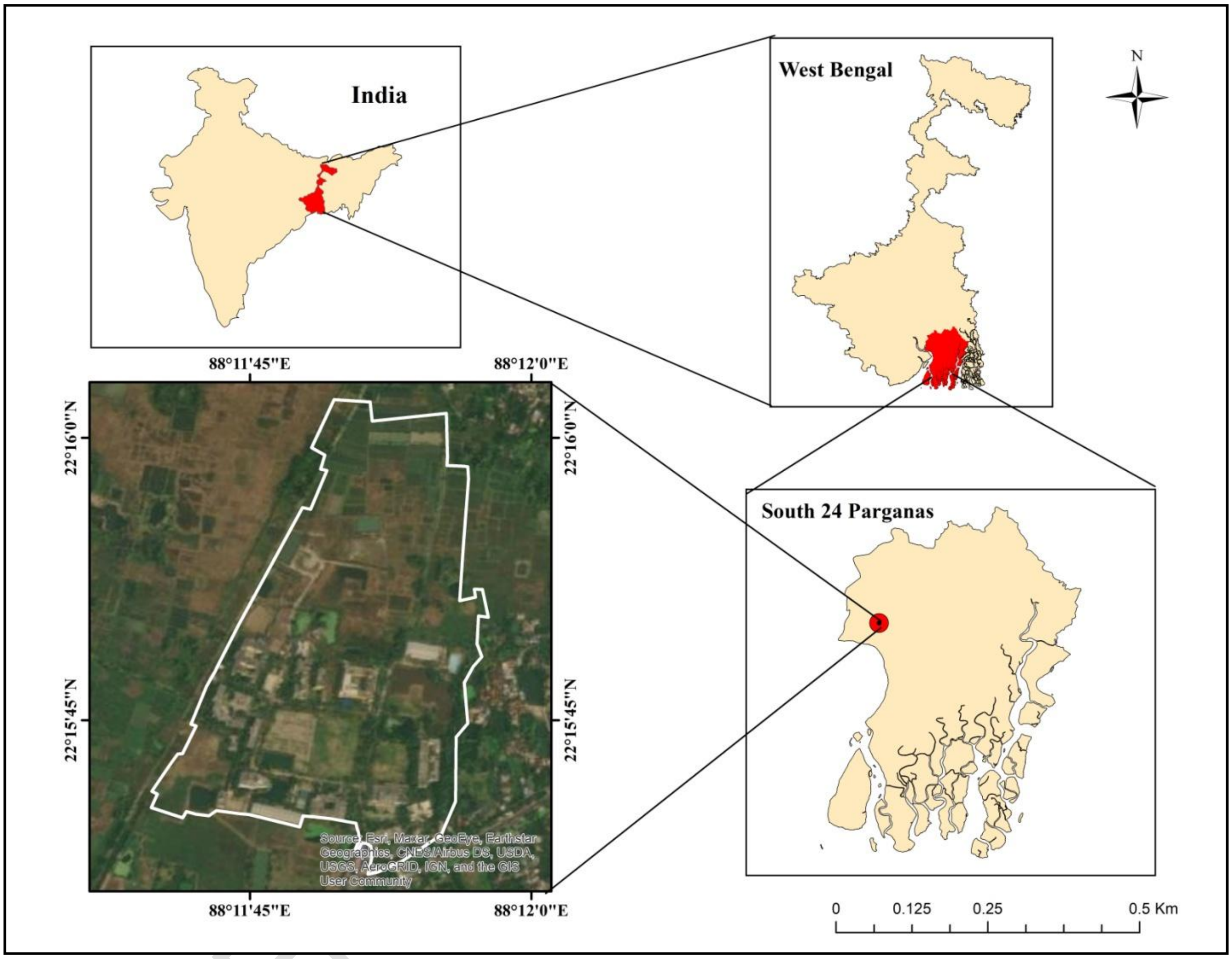

Figure 1: Soil Sampling area in TNU

For the study, 105 soil samples (15 representative soil samples from each seven blocks) from surface soil (0-15 cm depth) were collected from the instructional farm. These samples were air-dried, crushed using a wooden mallet, and sieved. After labeling, the samples were stored in plastic container for subsequent analysis. The analysis involved standard procedures to determine the available nutrient status. This included measuring of soil reaction (1:2.5; Soil: water), electrical conductivity, organic carbon via wet chromic acid digestion [4](Walkley and Black, 1934), available nitrogen through alkaline permanganate method [5] (Subbiah and Asija, 1956), available phosphorus via 0.5 M sodium bicarbonate [6] (Olsen et al., 1954), and available potassium using the neutral normal ammonium acetate method [7] (Stanford and English, 1949). Soil nutrient index was evaluated for the soil samples analyzed based on the formula suggested by [8] (Parker et al,1951) as given below:

$$Soil\ Nutrient\ Index\ (SNI) = \frac{N_1\ X\ 1 + N_2\ X\ 2 +\ N_3\ \ X\ 3}{N_T}$$

where,
N_1= Number of samples falling in low class of nutrient status;
N_2= Number of samples falling in medium class of nutrient status; and
N_3= Number of samples falling in high class of nutrient status.
N_T= Total number of samples.

Separate indices were calculated for different nutrients like N, P and K. The soils were rated as per the SNI values as low (<1.67), medium (1.67 to 2.33) and high (>2.33) (Parker et al. 1951).The database on analysis of soil available nutrient content was developed by using Microsoft Excel. Descriptive statistical parameters viz., mean, range, standard deviation and correlation of various soil parameters were computed using SPSS 22.0.

3RESULTS AND DISCUSSION

3.1 Soil pH

Soil pH, a critical property influencing nutrient availability and plant growth, was measured across seven blocks (S1 to S7) of a study area. The pH values varied within and between these blocks, ranging from 6.46 to 7.89 (Table1; Figure 2). Specifically, S1 recorded pH values between 7.25 and 7.71, S2 from 6.56 to 7.47, S3 from 6.46 to 7.27, S4 from 6.46 to 7.66, S5 from 6.53 to 7.89, S6 from 6.75 to 7.80 and S7 from 6.95 to 7.58. The mean pH values for these blocks were 7.55, 6.78, 6.94, 6.97, 7.01, 7.3 and 7.21 respectively. These results indicate that the soils fall under neutral to slightly alkaline category. These results are in agreement with [9] (Sarkar et al., 2001) who reported the pH of the coastal region ranged from 5.3 to 8.1.

3.2 Electrical Conductivity

In the study, the electrical conductivity (EC) of soil was analyzed across seven blocks (S1 to S7). The EC values varied as follows: S1 ranged from 0.218 to 0.481 dSm^{-1}, S2 from 2.30 to 2.99 dSm^{-1}, S3 from 0.58 to 0.77 dSm^{-1}, S4 from 2.22 to 2.55 dSm^{-1}, S5 from 1.30 to 1.85 dSm^{-1}, S6 from 1.028 to 1.63 dSm^{-1} and S7 from 2.081 to 2.367 dSm^{-1}. The mean EC values for these blocks were recorded as 0.388, 2.608, 0.676, 2.346, 1.555, 1.285 and 2.223 dSm^{-1}, respectively (Table1; Figure 2). These measurements indicate that the mean electrical conductivity of the surface soil across all blocks fell within the range of 0.388 to 2.608 dSm^{-1}categorizing the soils as saline. The study revealed that all soil samples had high electrical conductivity (EC) except for S1, S3 and S6 samples, indicating a saline nature with high salt concentration. These findings are consistent with those reported by [10, 11, 12] (Bandyopadhyay et al ,1988, and 2003, Muhr et al, 1965).

3.3 Organic Carbon

The recorded organic carbon content in the soil varied across different blocks. In S1, the range was 0.52 to 0.59 percent; in S2 it was 0.44 to 0.58 percent; in S3 0.45 to 0.58 percent; in S4 0.45 to 0.59 percent; in S5 and S6 0.41 to 0.59 percent respectively and in S7, 0.44 to

0.59 percent. The average organic carbon content across these seven blocks ranged from 0.41 to 0.59 percent (Table1; Figure 2). This indicates that the soil organic carbon levels in these blocks generally fell into the low to medium category. The correlation analysis revealed a negative association between electrical conductivity (EC) and organic carbon (r= -0.384; p <0.05) (Table 2). Tripathi et al. (2006) [13] found a decrease in soil organic carbon content with increasing salinity (r= -0.38; p <0.01), a trend also observed by [14] (Kaur et al.1998), who reported a significant negative relationship between organic carbon and EC. The organic carbon content in the studied area was found to be in medium range, consistent with findings by [15] (Joshi and Kadrekar, 1987), who observed variations in organic carbon in coastal soils ranging from < 0.5% to > 0.75%.

3.4 Available Nitrogen

In the study, the average available nitrogen content in the surface soil across different blocks showed varied result. The mean values recorded for each block were as follows: 235.18 kg/ha in S1, 339.04 kg/ha in S2, 318.05 kg/ha in S3, 324.36 kg/ha in S4, 329.35 kg/ha in S5, 327.48 kg/ha in S6 and 316.72 kg/ha in S7. The range of available nitrogen in these blocks also showed considerable variation, with S1 ranging from 210.48 to 259.24 kg/ha, S2 from 300.43 to 386.50 kg/ha, S3 from 286.2 to 374.01 kg/ha, S4 from 280.23 to 370.40 kg/ha, S5 from 258.62 to 381.62 kg/ha, S6 from 281.48 to 398.63 kg/ha and S7 from 278.74 to 3.76.50 kg/ha (Table1; Figure 3). Notably, S2 had the highest mean available nitrogen content at 339.04 kg/ha, while S1 had the lowest at 235.18 kg/ha. The soils in S1 were categorized as low in terms of available nitrogen status, whereas all other blocks were classified as medium in available nitrogen status.

3.5 Available Phosphorus (P_2O_5)

The study revealed considerable variation in the available phosphorus content in the soil across different blocks. The mean available phosphorus content in each block also varied, with S1 having a mean of 20.24 kg/ha, S2 54.98 kg/ha, S3 33.10 kg/ha, S4 35.03 kg/ha, S5 51.75 kg/ha, S6 50.99 kg/ha andS7 25.11 kg/ha (Table1; Figure 3). Interestingly, S2 recorded the highest mean available phosphorus content at 54.98 kg/ha, while S1 had the lowest at 20.24 kg/ha. In terms of classification, the available phosphorus content was low in S1 and S7 , while it was categorized as medium in the remaining five blocks. Shahandeh et al., 2003[16] stated that the reduced condition of soils increased the availability of soil phosphorus due to increased solubility of Fe-associated P and Mn-associated P.

3.6 AvailablePotassium (K_2O)

The study highlighted variations in the soil's available potassium content across different blocks. The mean available potassium content in each block was as follows: S1 had 267.72 kg/ha, S2 312.26 kg/ha, S3 290.63 kg/ha, S4 311.57 kg/ha, S5 364.28 kg/ha, S6 412.03 kg/ha, S7 310.43 kg/ha (Table1; Figure 3). S6 recorded the highest mean available potassium content at 412.03 kg/ha, while S1 had the lowest value at 267.72 kg/ha. Despite these variations, all the blocks were categorized as having a high level of available potassium status except S1 fell under low category.

Table: 1 Soil properties of different blocks of the Instructional farm, TNU (mean±sd)

Block No.	pH	EC (dS/m)	OC (%)	Available Nitrogen (kg/ha)	P_2O_5 (kg/ha)	K_2O(kg/ha)
1	7.55±0.14	0.39±0.10	0.553±0.02	235.18±15.68	20.24±0.18	267.72±2.33
2	6.78±0.24	2.61±0.25	0.516±0.05	339.04±30.73	54.98±0.35	312.26±4.56
3	6.94±0.28	0.68±0.07	0.533±0.04	318.05±28.25	33.10±0.32	290.63±4.19
4	6.97±0.37	2.35±0.08	0.524±0.05	324.36±32.15	35.03±0.36	311.57±4.77
5	7.01±0.44	1.56±0.21	0.485±0.06	329.35±36.46	51.75±0.41	364.28±5.41
6	7.30±0.38	1.28±0.14	0.519±0.06	327.48±37.76	50.99±0.42	412.03±5.60
7	7.21±0.21	2.22±0.09	0.535±0.06	316.72±36.47	25.11±0.41	310.43±5.41

Table 2: Pearson's Correlation of analysed soil properties of TNU

Parameter	pH	EC (dS/m)	OC (%)	Available Nitrogen (kg/ha)	P_2O_5 (kg/ha)	K_2O(kg/ha)
pH	1.00					
EC (dS/m)	-0.372*	1.00				
OC (%)	0.463*	-0.384*	1.00			
Available Nitrogen (kg/ha)	-0.738*	0.675*	-0.698*	1.00		
P_2O_5 (kg/ha)	-0.408*	0.397*	-0.820*	0.730*	1.00	
K_2O(kg/ha)	0.017*	0.161*	-0.653*	0.553*	0.710*	1.00

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

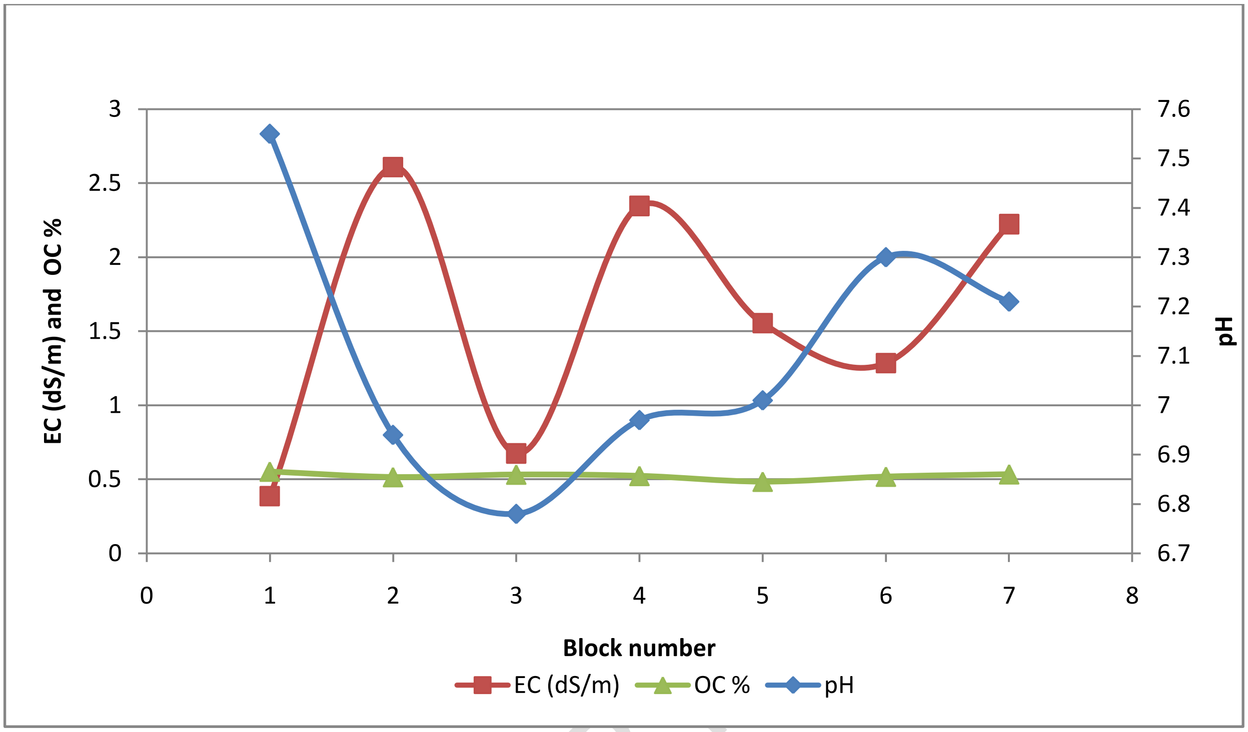

Figure 2. Physico-chemical parameters of different soil in TNU

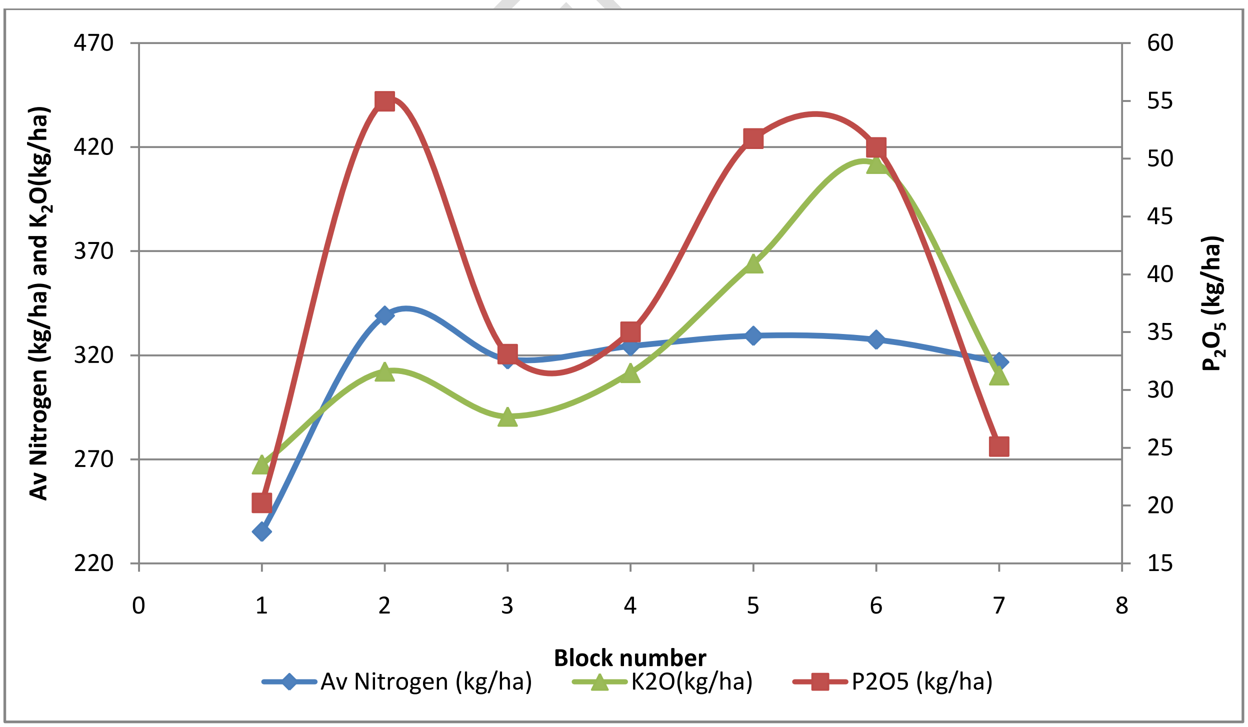

Figure 3. Macro nutrient of different soil in TNU

3.7 Soil Nutrient Index

A comprehensive understanding of soil nutrient levels is crucial for ensuring optimal crop production and soil health. By analyzing the nutrient index report, farmers and land managers can make informed decisions regarding fertilizer application, crop selection, and soil management practices. This report aims to provide an in-depth analysis of the soil's nutrient levels, helping to optimize agricultural productivity and sustainability. The values for available N, P, and K worked out from SNI were 1.83, 1.71 and 2.86 respectively, against the nutrient index values < 1.67 for low, 1.67 to 2.33 for medium and > 2.33 for high fertility status of the area[8] (Parker et al,1951). Table 3 presents the calculated Nutrient Index Values and Fertility Ratings for the soils of Instructional Farm of The Neotia University.

Table 3: Nutrient Index and Fertility Status of Soil

Parameter	Nutrient Index	Fertility Status
Available Nitrogen (kg/ha)	1.83	Medium
P_2O_5 (kg/ha)	1.71	Medium
K_2O(kg/ha)	2.86	High

4CONCLUSION

The coastal soil under the Instructional farm, The Neotia University were analysed and revealed that the soil exhibited neutral in soil reaction and saline characteristics. While organic carbon and available nitrogen content were medium, available phosphorus levels and potassium levels were high. The nutrient index for available nitrogen and available phosphorus was medium and for available potassium it was high.Hence to enhance soil fertility, it is imperative to replenish nutrients through the application of organic matter, green manures, and inorganic fertilizers. Adopting a comprehensive nutrient management approach, can ensure balanced nutrition for crops, thereby sustaining soil health and maximizing crop yields in this region.

REFERENCES

1. Mallik TK. Salient features of West Bengal coastal ecosystem and effective management of environment. *MedCrave Group,* 2020.
2. Elayaraja D, Senthilvalavan P and Kamalakannan P. Fortified Organic Manure and NPK Fertilizer Levels: Influence on Soil Properties, Yield and Micronutrients Biofortification of Brinjal in Coastal Soil International Journal of Plant & Soil Scienc. 2023; 35(19): 2027-2041.

3. Mandal UK, Burman D,Bhardwaj AK, Nayak DB, Samui A, Mullick S, Mahanta KK, Lama TD, Maji B, Mandal S, Raut S, Sarangi SK.. Waterlogging and coastal salinity management through landshaping and cropping intensification in climatically vulnerable Indian Sundarbans. Agricultural Water Management. 2019; 12–26.
4. Walkley A, Black CA. An examination of digestion method for determining soil organic matter and the proposed modification of the chromic acid titration method. Soil Science. 1934;37:29–38.
5. Subbiah V, Asija GL. A rapid procedure for estimation of available nitrogen in soil Current Science. 1956;5:259-260
6. Olsen SR, Watanabe FS, Cole CV, Dean LA. Estimation of Available P in Soils by Extraction with Sodium Bicarbonate.U.S.D.A. Circular No. 939;1954.
7. Stanford S, English L. Use of flame photometer in rapid soil tests of K. Canadian Journal of Agronomy. 1949;41:446-447.
8. Parker FW, Nelson WL, Winters E, Miles IE. The broad interpretation and application of soil test information. Agronomy Journal. 1951;43(3):105-112.
9. Sarkar D, Sahoo AK, Sah KD and Gajbhiye KS (2001). Coastal soils of eastern India-their characterisistics, potentials and limitations towards alternate land use. *Journal of Indian Society of Coastal Agricultural Research* **19(1&2)**: 80-83
10. Bandyopadhyay AK, Bhargava GP, Rao KGK, Sen HS, Sinha TS, Bandyopadhyay BK, Biswas CR, Bal AR, Dutt SK and Mandal RC (1988). *Coastal Saline Soils of India and Their Management*, Bull No. **13**. Central Soil Salinity Research Institute, RRS Canning, West Bengal, pp. 158.
11. Bandyopadhyay BK, Maji B, Sen HS and Tyagi NK (2003). *Coastal Soils of West Bengal- Their Nature, Distribution and Characteristics.* Bull. No. **1/2003**. Central Soil Salinity Research Institute, Regional Research Station, Canning Town, West Bengal, India, pp 1-62.
12. Muhr GR, Dutta NP, Sankara SH, Liley VK, and Donahue RR. (1965). Soil Testing in India. US Agency for International Development, New Delhi.
13. Tripathi S, Kumari S, Chakroborty A, Gupta A, Chakroborty K and Bandyopadhyay BK.(2006). Microbial biomass and its activity in salt affected coastal soils. *Biology and Fertility of Soils* **42**: 273-277.
14. Kaur B, Aggarwal AK and Gupta SR (1998). Soil microbial biomass and nitrogen mineralization in salt affected soils. *International Journal of Ecology and Environmental Sciences* **24**: 103-111.
15. Joshi RG and Kadrekar SB (1987). Fertility status of coastal salt affected soils of Maharashtra. *Journal of Indian Society of Coastal Agricultural Research* 5(1):111-116.
16. Shahandeh, H., Hossner, L. R and Turner, F. T. (2003). Phosphorus relationships to manganese and iron in rice soils. Soil Science. 168(7): 489-500.