Jahangirnagar University Environmental Bulletin, Vol.2, 26-34, 2013

Jahangirnagar University Environmental Bulletin

ISSN:2304-3326

Contents lists available at Bangladesh Journals Online

Journal homepage: http://banglajol.info/index.php/JUEB

Comparative study on physico chemical parameters of soil and water among three aquatic successional stages at Jahangirnagar University campus

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Abstract

This study was conducted on the physico-chemical parameters of soil and water of the aquatic succession stages (submerged floating, and emerged) of the wetlands of Jahangirnagar University campus. Three sites were selected along the study area and studied during January 2010 to October 2010. On an average, water P^H, dissolved oxygen, acidity, alkalinity, total hardness, nitrate and free CO_2 on submerged stage water contained 6.2 ± 0.19; 6.85 ± 0.21mg/l; 36 ± 2.31ppm; 19.7 ± 2.31 mg/l; 96.4 ± 4.40 mg/l; 62.8 ± 7.8 mg/l and 1.6 ± 0.52 mg/l respectively & soil P^H, moisture, nitrate, organic carbon and organic matter, were 6.57 ± 0.18; 6.17 ± 0.89%, 0.27 ± 0.02mg/gm; 0.98 ± 0.05% and 1.69 ± 0.08% consequently. The average values of water P^H, dissolved oxygen, acidity, alkalinity, total hardness, nitrate and free CO_2 on floating stage water were 6.86 ± 0.88; 6.82 ± 0.42 mg/l; 34.8 ± 3.43 mg/l; 19.7 ± 1.81 mg/l; 93.2 ± 4.64 mg/l; 62 ± 11.2 mg/l and 1.5 ± 0.52 mg/l respectively. And soil P^H, moisture, nitrate organic carbon and organic matter, were 6.38 ± 0.08; 6.13 ± 0.94%; 0.35 ± 0.02 mg/gm; 0.99 ± 0.07%; and 1.7 ± 0.12% respectively. For emerged stages water P^H, dissolved oxygen, acidity, alkalinity, total hardness, nitrate and free CO_2, of floating stage were 6.8 ± 0.26; 6.83 ± 0.37 mg/l; 34.8 ± 3.43 mg/l; 19.8 ± 1.81 mg/l; 93.2 ± 4.64 mg/l; 68 ± 8.69 mg/l ; 1.7 ± 0.48 mg/l respectively. And soil P^H, moisture, nitrate, organic carbon and organic matter, were 6.43 ± 0.11; 6.11 ± 0.95%; 0.40 ± 0.02 mg/gm; 0.96 ± 0.03% and 1.66 ± 0.05% respectively. Positive and negative correlations among these parameters were also studied. Strong positive correlations were found in between organic carbon-organic matter (r=0.99) in submerged stage, P^H-dissolved oxygen (r = 0.79), acidity-free CO_2 (r=0.73), organic carbon-organic matter(r=0.99) in floating stages. And in emerged stage, P^H -dissolved oxygen (r=0.81), organic carbon-organic matter (r=0.99) showed strong positive correlation. Strong negative correlations were found in between alkalinity-total hardness (r=-0.69) in emerged stage. Organic carbon and organic matter showed significantly strong correlation (r=0.99) in all studied stages. From this study, it was found that, the water P^H values were higher in floating and emerged stages than submerged stage. Dissolved oxygen was higher in submerged stages than floating and emerged stages. These may be because of submerged stage was early stage of aquatic succession stages. For the decomposition process, variation of acidity, alkalinity and total hardness were found in three succession stages. High concentrations of water nitrate were obtained; this may due to the decomposition process on the lakes.

Keywords: *Physicochemical parameters, Lake, ecology*

Introduction

Observation of the natural changes in vegetation long ago resulted in the concept of succession. Under natural conditions the vegetation occupying a given habitat is called plant community. Since the community is not stable, it passes through many developmental stages in definite sequence and in the definite direction generally from simple to complex and rarely from complex to simple. The gradual replacement of one

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type of plant community by the other is referred to as plant succession.(Shukla and Chandel, 1989).The main causes of succession are Climatic, Topographic and Biotic. Plants can not adjust with the long range variations in the climate. The fluctuating climate sometimes lead the vegetation towards total or partial destruction, as a result, the bare area develops which becomes occupied by such plants as the better adapted or changed climatic conditions. Drought, heavy snowfall and lightning are some of the important factors for the destruction of vegetation. Sometimes new bare ground is formed by emersion of land from the bodies of water (ponds, rivers, etc).These are concerned with changes in the soil. Depending upon the nature of bare area on which it develops, the succession may be of two types: primary and secondary (Shukla and Chandel, 1989). Secondary succession has fewer stages than the primary succession and the climax is reached very quickly in the secondary succession. The primary successions may be different types such as Hydrosere, Halosere, Xerosere etc. Hydrosere is a plant succession which occurs in a freshwater lake. During this change, a range of different land types such as swamp and marsh will succeed each other. The succession from open water to climax woodland is likely to take at least two hundred years some intermediate stages will last a shorter time than others. Hydrosere is a primary successional sequence which develops in aquatic environments such as lakes and ponds. It results in conversion of water body and its community into a land community. If water body is large and very deep, a strong wave action is at work, therefore in these bodies a noticeable change cannot be observed. However, in smaller water body such as a pond the succession is easily recognizable. Different plant communities occupy different zones in a water body and exhibit concentric zonation. The edges of the water body are occupied by rooted species, submerged species are found in the littoral zone and the plankton and floating species occupy open water zone. Different stages are found in aquatic succession(Shukla and Chandel, 1989). This study will be focus on the physico-chemical parameters of Floating, Submerged and Emerged stages in aquatic environment (Verma and Agarwal, 1985).The quality of any water body is governed by its physicochemical factors. The monitoring of physicochemical characteristics of a water body is vital for both long term and short term analysis (Wood, 1995). Distribution and productivity levels of organisms are largely determined by physicochemical factors (Ashton and Schoeman, 1983).Variations in physicochemical parameters of a water body could significantly influence the water treatment processes, portability of water supply as well as have long term effects on aquatic environment (Adakole et al., 1998).

Materials and Methods

Site selection is important in research work to relate the results with the spatial context in fulfillment of the aims and objectives of the research work. For convenient, three wetlands of Jahangirnagar University campus were selected those have fulfilled the aims and objectives of the research work. Locations and codes of samples are described in the following:

Different samples identification: Sample ID-Lake-1; Lake-2 and Lake-3 & their succession stages were submerged, floating and emerged stages.

Analysis of water samples:

Water PH: The pH of water sample was determined by using a glass electrode pH meter (Griffin pH meter, model No.40).

Dissolved Oxygen (DO): Dissolved oxygen content of sample water was determined by using DO meter (HANNA INSTRUMENTS: H19143).

Total Hardness: A compleximetric titration using EDTA is a classical method for determining Ca and Mg simultaneously or individually (APHA-1998).

Acidity of water: A compleximetric titration using EDTA is a classical method for determining acidity (APHA-1998).

Alkalinity of Water: A compleximetric titration using EDTA is a classical method for determining acidity (APHA-1998).

Free Carbon Dioxide: A compleximetric titration using EDTA is a classical method for determining acidity (APHA-1998).

Water nitrate-nitrogen: Water nitrate-nitrogen was measured by Phenol disulphonic acid method as described by APHA-1998.

Soil parameters:

Soil pH : The pH of freshly collected moist soil was determined by using soil PH meter.

Soil Moisture: Both soil PH and moisture content was measured by using soil PH meter.

Soil Nitrate-nitrogen: Soil nitrate-nitrogen was measured by Phenol disulphonic acid method as described by APHA-1998.

Soil Organic Carbon: Soil organic carbon content was estimated by titration method.

Soil Organic Matter: The organic matter content of the soil was determined by multiplying the percentage of organic carbon with conventional van Bemmelen's factor of 1.724.

Statistical analysis: Statistical analysis was followed by 'An introduction to statistics and probability (Islam, 2001)'

Results and Discussion

Water parameters:

Water P^H: Water P^H values were 6.7, 6.9, 6.7, 6.9, 7.2, 6.5, 6.7, 6.9, 7, and 6.7 for the lake-1. Similarly these values were 6.8, 6.8, 6.9, 6.7, 7.6, 6.7, 6.9, 6.8, 6.9, and 6.5 for Lake-2 & 6.8, 6.7, 6.8, 6.8, 7.5, 6.8, 6.5, 6.6, 6.8, and 6.8 for Lake-3 respectively(Table-1, 2 and 3).

Water Dissolve Oxygen: Water dissolved oxygen values were 6.93, 6.32, 6.95, 6.65, 7.29, 6.63, 6.86, 6.57, 6.28, 6.75 mg/l for the lake-1. Similarly these values were 6.91, 6.30, 6.82, 6.75, 7.88, 6.66, 6.80, 6.66, 6.66, and 6.85 mg/l for Lake-2 & 6.95, 6.28, 6.86, 6.62, 7.73, 6.65, 6.75, 6.85, 6.85, 6.75 mg/l for Lake-3respectively(Table-1, 2 and 3).

Acidity: Water acidity values were 32, 36, 36, 38, 32, 36, 38, 38, 36, 38 mg/l for the lake-1. Similarly these values were 38, 32, 30, 32, 30, 36, 38, 38, 38, and 36 mg/l for Lake-2 & 34, 34, 34, 30, 34, 38, 34, 36, 36, 34 mg/l for Lake-3 respectively (Table-1, 2 and 3).

Alkalinity: Water alkalinity values were 15, 18, 19, 21, 22, 19, 18, 21, 22, 22 mg/l for Lake-1. Similarly these values were 18, 19, 21, 20, 23, 20, 17, 18, 21, and 21 for Lake-2 & 17, 17, 20, 22, 22, 22, 19, 21, 19, 23 ppm for Lake-3 respectively (Table-1, 2 and 3).

Total hardness: Water total hardness values were 92, 100, 100, 88, 100, 96, 96, 92, 100, and 100 mg/l for the Lake-1. Similarly these values were 100, 88, 92, 92, 96, 88, 92, 100, 88, and 96 mg/l for Lake-2 & 100, 96, 96, 88, 96, 92, 100, 88, 92, 88 mg/l for Lake-3 respectively(Table-1, 2 and 3).

Water nitrate-nitrogen: Water nitrate values were 56, 56, 66, 68, 77, 71, 66, 56, 56, 56 mg/l for Lake-1. Similarly these values were 72, 71, 56, 68, 56, 45, 43, 73, 68, and 68 for Lake-2 & for 56, 79, 68, 65, 52, 68, 70, 75, 75, 75 mg/l Lake-3 respectively (Table-1, 2 and 3).

Free CO_2: Water free CO_2 values were 2.0, 2.0, 1.0, 1.0, 2.0, 1.0, 1.0, 2.0, 2.0, 2.0 mg/l for Lake-1. Similarly these values were 2.0, 1.0, 1.0, 1.0, 1.0, 2.0, 1.0, 2.0, 2.0, and 2.0 for Lake-2 & 2.0, 2.0, 1.0, 1.0, 2.0, 1.0, 2.0, 2.0, 2.0, 2.0 mg/l for Lake-3 respectively (Table-1, 2 and 3).

Table 1: Monthly variation on physic-chemical parameters of Lake-1

Parameters	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.
P^H	6.7	6.9	6.7	6.9	7.2	6.5	6.7	6.9	7	6.7
DO (mg/l)	6.93	6.32	6.95	6.65	7.29	6.63	6.86	6.57	6.28	6.75
Acidity (mg/l)	32	36	36	38	32	36	38	38	36	38
Alkalinity (mg/l)	15	18	19	21	22	19	18	21	22	22
Hardness (mg/l)	92	100	100	88	100	96	96	92	100	100
Nitrate-nitrogen (mg/l)	56	56	66	68	77	71	66	56	56	56
Free CO_2 (mg/l)	2.0	2.0	1.0	1.0	2.0	1.0	1.0	2.0	2.0	2.0

Table 2: Monthly variation on physic-chemical parameters of Lake-2

Parameters	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.
P^H	6.8	6.8	6.9	6.7	7.6	6.7	6.9	6.8	6.9	6.5
DO (mg/l)	6.91	6.30	6.82	6.75	7.88	6.66	6.80	6.66	6.66	6.85
Acidity (mg/l)	38	32	30	32	30	36	38	38	38	36
Alkalinity (mg/l)	18	19	21	20	23	20	17	18	21	21
Hardness (mg/l)	100	88	92	92	96	88	92	100	88	96
Nitrate-nitrogen (mg/l)	72	71	56	68	56	45	43	73	68	68
Free CO_2 (mg/l)	2.0	1.0	1.0	1.0	1.0	2.0	1.0	2.0	2.0	2.0

Table 3: Monthly variation on physic-chemical parameters of Lake-3

Parameters	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.
P^H	6.8	6.7	6.8	6.8	7.5	6.8	6.5	6.6	6.8	6.8
DO (mg/l)	6.95	6.28	6.86	6.62	7.73	6.65	6.75	6.85	6.85	6.75
Acidity (mg/l)	34	34	34	30	34	38	34	36	36	34
Alkalinity (mg/l)	17	17	20	22	22	22	19	21	19	23
Hardness (mg/l)	100	96	96	88	96	92	100	88	92	88
Nitrate-nitrogen (mg/l)	2.0	2.0	1.0	1.0	2.0	1.0	2.0	2.0	2.0	2.0
Free CO_2(mg/l)	2.0	2.0	1.0	1.0	2.0	1.0	2.0	2.0	2.0	2.0

Soil parameters:

Soil P^H: Soil P^H values were 6.4, 6.8, 6.8, 6.3, 6.4, 6.8, 6.6, 6.6, 6.5, and 6.5 for Lake-1. Similarly these values were 6.4, 6.4, 6.3, 6.4, 6.3, 6.4, 6.3, 6.5, 6.5, and 6.3 for Lake-2 & 6.3, 6.4, 6.4, 6.4, 6.3, 6.6, 6.4, 6.6, 6.6, 6.5, and 6.4 for Lake-3 respectively (Table 4, 5 and 6).

Soil moisture: Soil moisture values were 7.0, 6.4, 5.2, 5.3, 8.0, 5.2, 5.2, 6.5, 7.2, and 6.2 for Lake-1. Similarly these values were 7.0, 6.4, 5.4, 5.4, 8.0, 5.4, 5.2, 5.2, 7.5, and 6.3 for Lake-2 & 7.0, 6.4, 4.0, 5.2, 8.0, 5.2, 5.4, 5.3, 7.3, and 6.4 for Lake-3 respectively (Table 4, 5 and 6).

Soil nitrate-nitrogen: Soil nitrate values were 0.26, 0.28, 0.27, 0.27, 0.27, 0.28, 0.26, 0.27, 0.27, 0.27 mg/gm for Lake-1. Similarly these values were 0.38, 0.38, 0.34, 0.38, 0.35, 0.34, 0.34, 0.35, 0.34, 0.34 mg/gm for Lake-2 & for 0.43, 0.39, 0.39, 0.39, 0.43, 0.40, 0.40, 0.39, 0.39, 0.43 mg/gm Lake-3 (Table 4, 5 and 6).

Soil organic carbon: Soil organic carbon values were 1.02, 0.96, 0.94, 1.02, 0.92, 1.02, 0.96, 0.92, 1.02, and 1.02 for Lake-1. Similarly these values were 0.96, 0.94, 0.96, 0.92, 0.96, 0.92, 1.08, 0.98, 1.08, and 1.08 for Lake-2 & 0.94, 0.98, 0.94, 0.96, 0.92, 0.96, 0.99, 0.99, 0.98, 0.96 for Lake-3(Table 4, 5 and 6).

Soil organic matter: Soil organic matter values were 1.76, 1.68, 1.61, 1.76, 1.58, 1.76, 1.65, 1.76, 1.76, and 1.76 for Lake-1. Similarly these values were 1.65, 1.61, 1.65, 1.58, 1.65, 1.58, 1.86, 1.68, 1.86, and 1.86 mg/l for Lake-2 & 1.61, 1.68, 1.61, 1.65, 1.58, 1.65, 1.71, 1.71, 1.68, and 1.71 for Lake-3 (Table 4, 5 and 6).

Table 4: Monthly variation on physico-chemical parameters of Lake-1

Parameters	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.
Soil P^H	6.4	6.8	6.8	6.3	6.4	6.8	6.6	6.6	6.5	6.5
Soil Moisture (%)	70	64	52	53	80	52	52	65	72	62
Soil nitrate-nitrogen (mg/g)	0.26	0.28	0.27	0.27	0.27	0.28	0.26	0.27	0.27	0.27
Soil Organic Carbon (%)	1.02	0.96	0.94	1.02	0.92	1.02	0.96	0.92	1.02	1.02
Soil Organic Matter (%)	1.76	1.68	1.61	1.76	1.58	1.76	1.65	1.76	1.76	1.76

Table 5: Monthly variation on physico-chemical parameters of Lake-2

Parameters	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.
Soil P^H	6.4	6.4	6.3	6.4	6.3	6.4	6.3	6.5	6.5	6.3
Soil Moisture (%)	70	64	54	54	80	54	52	52	75	63
Soil nitrate-nitrogen (mg/g)	0.38	0.38	0.34	0.38	0.35	0.34	0.34	0.35	0.34	0.34
Soil Organic Carbon (%)	0.96	0.94	0.96	0.92	0.96	0.92	1.08	0.98	1.08	1.08
Soil Organic Matter (%)	1.65	1.61	1.65	1.58	1.65	1.58	1.86	1.68	1.86	1.86

Table 6: Monthly variation on physico-chemical parameters of Lake-3

Parameters	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.
Soil P^H	6.3	6.4	6.4	6.4	6.3	6.6	6.4	6.6	6.5	6.4
Soil Moisture (%)	7.0	6.4	4.0	5.2	8.0	5.2	5.4	5.3	7.3	6.4
Soil nitrate-nitrogen	0.43	0.39	0.39	0.39	0.43	0.40	0.40	0.39	0.39	0.43
Soil Organic Carbon (%)	0.94	0.98	0.94	0.96	0.92	0.96	0.99	0.99	0.98	0.96
Soil Organic Matter (%)	1.61	1.68	1.61	1.65	1.58	1.65	1.71	1.71	1.68	1.71

Discussion

Water P^H: The average P^H values for the Lake-1 (submerged stage), Lake-2 (floating stage), and Lake-3 (emerged stage) were 6.2±0.19, 6.9±0.88, and 6.8±0.26 respectively.The investigated P^H of the wetlands varies from 6.5 to 7.6 with no noticeable variation with months. The highest value of P^H was found in floating stage at the month of May. It was noticed that water P^H of Lake-2 and Lake-3 was more than Lake-1 (Table- 1, Table- 2, and Table- 3). This may be due to Lake-1 was in early stage (submerged stage) of succession. P^H was within the range of inland waters (P^H 6.5-8.5), as reported by Antoine and Saadi (1982). Boyed and Lichtkoppler (1979), reported P^H range of 6.09-8.45 as being ideal for supporting aquatic life including fish. Thus, the pH range obtained in this study is within the acceptable level of 6.0 to 8.5 for culturing tropical fish species (Huett,1977).Correlations among the physico-chemical parameters were also evaluated. In submerged stage pH showed positive correlation with alkalinity (r=0.52) and free CO_2 (r=0.52).In floating stage P^H showed strong positive correlation with dissolve oxygen (r=0.79). In emerged stage P^H showed strong positive correlation with dissolve oxygen (r=0.81).

Dissolved oxygen: The average value of DO for Lake-1 (submerged stage), Lake-2 (floating stage), and Lake-3 (emerged stage) were 6.85±0.21 mg/l, 6.82±0.41 mg/l, and 6.83±0.37 mg/l respectively. In submerged stage the maximum dissolve oxygen was 7.29 mg/l measured, 7.88 mg/l in floating stage and 7.73 mg/l for emerged stage found in the month of May. Lake-1 contained more dissolve oxygen than Lake-2 and Lake-3.this may be because in floating and emerged stage the water level becomes very much decreased due to progressive build up of Lake Substratum (Verma and Agarwal, 1985). It was found that in submerged stage dissolve oxygen showed weak negative correlation with all other physicochemical parameters. In floating stage dissolve oxygen showed strong positive correlation with pH (r=0.79) and moderate positive correlation with total hardness (r=0.41), alkalinity (r=0.57).

Acidity: The average acidity values were 36±2.31 mg/l, 34.8±3.43 mg/l, and 34.4±2.01 mg/l respectively for Lake-1 (submerged stage), Lake-2 (floating stage), and Lake-3 (emerged stage) respectively. In submerged stage the minimum value for water acidity was 32 mg/l , 30 mg/l found in floating stage and 30 mg/l was for emerged stage. Water acidity was found in high concentration. These may be due to high decomposition process. Acidity in submerged stage showed weak negative correlation with pH, dissolve oxygen, total hardness, free CO_2, nitrate and weak positive correlation with alkalinity. In case of floating stage acidity showed strong negative correlation with alkalinity (r=-0.61) & strong positive correlation with free CO_2 (r=0.73). Acidity in emerged stage showed weak positive correlation with nitrate, free CO_2 total hardness and weak negative correlation with pH , alkalinity.

Alkalinity: The average values of alkalinity for Lake-1 (submerged stage), Lake-2 (floating stage), and Lake-3 (emerged stage) were 19.7±2.31 mg/l, 19.8±1.81 mg/l, and 20.2±2.14 mg/l respectively. The investigated alkalinity of the wetlands varies from 15 to 23 mg/l with no noticeable variation with months. The highest value for Lake-1, Lake-2 and Lake-3 were 22, 23, 23 mg/l. The negative correlation values obtained indicated that alkalinity of water increase with decreasing water level (Holden and Green, 1960). The evaluated correlation of Alkalinity in submerged stage showed positive correlation with pH (r=0.52).In floating stage alkalinity showed moderate negative correlation with acidity (r=-0.61) & moderate positive correlation with dissolve oxygen (r=0.57). Alkalinity in emerged stage showed strong negative correlation with total hardness (r=-0.69).

Total Hardness: The average values of total hardness for the Lake-1 (submerged stage), Lake-2 (floating stage), and Lake-3 (emerged stage) were 96.4±4.40 mg/l, 93.2±4.64 mg/l, and 93.6±4.69 mg/l respectively. The highest values were 100 mg/l for Lake-1, Lake-2 and Lake-3. From the study it was found that water hardness was higher. This is the result of low water levels and the concentration of ions. Similar result shown by Oladimeji, 2004.

Nitrate-nitrogen: The average nitrate values for Lake-1 (submerged stage), Lake-2 (floating stage), and Lake-3 (emerged stage) were 62.8±7.8 mg/l, 62±11.2 mg/l, and 68.3±8.69 mg/l consequently. The highest value was observed in the Lake-1 and the lowest value was observed in lake-2. From the study it was found that Nitrate-nitrogen value of three lakes is in alarming condition. These may be results of decomposition. Similar works have been done Khandakar,2008 and their results were 373 mg/l, 93 mg/l, 88 mg/l, 110 mg/l Nitrogen-nitrate concentration in Gulsan Lake, Banani Lake, Shahidullah Hall Lake and Dhanmondi Lake respectively (Khandakar,2008). In this study, nitrate in submerged stage showed strong positive correlation free CO_2(r = 0.89).

Free CO_2: The average Free CO_2 values for Lake-1 (submerged stage), Lake-2 (floating stage), and Lake-3 (emerged stage) were 1.6±0.52 mg/l, 1.5±0.53 mg/l, and 1.7±0.48 mg/l respectively. The investigated free CO_2 of the wetlands varies from 10 to 20 mg/l with no noticeable variation with months. The amount of free CO_2 found may be due to the huge amount of vegetation in the study area. From statistical analysis, it was found that CO_2 was positively correlated with acidity (r=0.74).

Soil P^H: The average soil P^H values for the Lake-1 (submerged stage), Lake-2 (floating stage), and Lake-3 (emerged stage) were 6.57±0.18, 6.38±0.08, and 6.43±0.11 consequently. The investigated soil P^H of the wetlands varies from 6.3 to 6.8 with no noticeable variation with months. These values indicate that the studied soil consist slightly acidic conditions. Soil P^H in submerged stage showed moderate positive correlation with nitrate (r=0.54). Emerged stage soil P^H showed moderate positive correlation with organic carbon (r=0.52), organic matter (r=0.59) and moderate negative correlation with soil moisture (r=-0.51), soil nitrate (r=-0.58).

Soil Moisture: The average soil moisture for the Lake-1 (submerged stage), Lake-2 (floating stage), and Lake-3 (emerged stage) were 6.17±0.89%, 6.13±0.94%, and 6.11±0.95% gradually.

The investigated moisture of the wetlands varies from 5.2 to 7.5% with no noticeable variation with months. These values indicate that the Lake water consist slightly acidic conditions. Soil moisture in submerged stage showed moderate positive correlation with soil nitrate (r=0.54). Soil moisture in emerged stage showed positive correlation with soil nitrate (r=0.57) and negative correlation with soil pH (r=-0.51).

Nitrate-nitrogen: The average soil nitrate values in Lake-1 (submerged stage), Lake-2 (floating stage), and Lake-3 (emerged stage) were 0.27±0.01 mg/gm, 0.35±0.02 mg/gm and 0.40±0.02 mg/gm. The highest value for Lake-1, Lake-2, and Lake-3 were 0.28, 0.38 and 0.43 mg/gm. The amount of soil nitrate found indicate higher uptake by submerged, floating and emerged vegetation. Soil nitrate in submerged stage showed positive correlation with pH (r=0.54). In case in floating stage nitrate showed d negative correlation with organic matter (r=-0.56), organic carbon (r=-0.55). Nitrate in emerged stage showed positive correlation with moisture(r=0.58) and negative correlation with P^H(r=-0.58) and organic matter (r= -0.57).

Soil Organic carbon: The average organic carbon values for the Lake-1 (submerged stage), Lake-2 (floating stage), and Lake-3 (emerged stage) were 0.98 ± 0.05%, 0.99±0.07%, and 0.96 ± 0.03% respectively. Lower amount of organic carbon may be due to decomposition process. Soil organic carbon submerged stage showed strong positive correlation with soil organic matter (r = 0.99). In floating stage organic carbon showed positive correlation with organic matter (r = 0.99). Organic carbon in emerged stage positive correlation with P^H (r = 0.59), organic matter (r = 0.99) and negative correlation with nitrate (r = -0.53).

Soil Organic matter: The average organic matter in Lake-1 (submerged stage), Lake-2 (floating stage), and Lake-3 (emerged stage) were 1.69±0.08 %, 1.7±0.12 %, 1.66±0.05%. The values vary from 1.58 to 1.86% gradually. Lower amount of organic matter may be due to decomposition process. Soil organic matter of submerged stage showed positive correlation with organic carbon (r = 0.99). In floating stage soil organic matter showed positive correlation with organic carbon (r = 0.99). Soil organic matter in emerged stage was positive correlation with soil P^H (r = 0.59) and organic carbon (r = 0.92).

Conclusion

In the study area water P^H value was higher in floating and emerged stages than submerged stage. Dissolve oxygen was higher in submerged stages than floating and emerged stages. Due to the decomposition process, variation of acidity, alkalinity and total hardness were found in three succession stages. Concentration of nitrate in studied lakes water was higher than the standard value. High concentrations of water nitrate were the result of decomposition process and also for contained huge amount of submerged vegetation. Organic carbon and organic matter showed strong correlation (r=0.99) in submerged, floating and emerged stage. From this study it can be said that nitrate level was high in the studied lakes and should be controlled by taking proper steps to prevent nitrate pollution.

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