3. PHYSICO-CHEMICAL PARAMETERS OF WATER

3.1 Introduction

The freshwater ecosystem is one of the most important productive ecosystems which play a vital role in the survival of many species of flora and fauna, including human beings. Despite their great values, the wetlands are getting deteriorated throughout the world. In Tamilnadu, 39,000 irrigation tanks are formed, which constitute 17% of their size, have immense economic and ecological values (Kumari et al., 2007).

Water, the dynamic abiotic component is directly related to human beings for different purposes (Narayan et al., 2007). Visitors and pilgrims use the water of Dhar (a natural freshwater flow in lake) and “Sitana hani” for bathing and washing. Besides drinking, discharge of sewage from hotels, hospitals and industries, released directly into the pond or lake, which makes the quality of water unpleasant (Pawar, 2010). The quality of water is described by the physical, chemical and biological characteristics (Adarshkumar et al., 2006). Seasonal variation in physico-chemical characters of water prevailing in the pond ecosystems was reported by many researchers (Singh, 2000; Ramachandra et al., 2005; Papastergiadou et al., 2007 and Whelan et al., 2008). Water quality has a direct impact on species specificity, composition, distribution pattern, stability and productivity of an aquatic ecosystem (Pendse et al., 2000 and Radhika et al., 2004).

Various activities of man on aquatic ecosystem create water pollution. According to WHO (1995), 30 – 80% of human diseases occur due to the use of impure water. The chemistry of water is influenced by the different types of inputs
containing minerals, rainfall pattern, depth of water, soil properties, human impact and contamination from several sources, which are the major ecological crisis today. Begum and Harikrishnan (2008) has reported the untreated sewage affects the primary productivity and pollution status of the aquatic ecosystems in India.

Several biotypes with acute contamination of pollutants are the outcome of dumping off domestic, agricultural, municipal and industrial wastes into these aquatic system of life (Srivastava et al., 2003; Khan and Shah, 2004; Usha and Ramalingam, 2006; Zuber and Sharma, 2007 and Parray et al., 2009). As water is the basic necessity of life, such resources need to be managed for human survival. Physico-chemical characteristics not only reflect the quality of an aquatic ecosystem but also its biological diversity (Ghavzan et al., 2006).

Seasonal variation in ecological parameters exerts a profound effect on the population density of both animals and plant species (Odum, 1971). Various physico-chemical parameters like temperature, transparency, pH, total hardness, biological demand, nitrates, phosphates etc. are regulating the planktonic biomass and productivity of the freshwater bodies (Adeyemo et al., 2008). Nutrients from different sources were drawn into the ponds, which in turn have a direct influence on the aquatic vegetation (Harikrishnan and Azis, 2000 and Mandol et al., 2003). For the maintenance of ecological balance, physico-chemical parameters are required and different ecological conditions highlight the limnological studies. Raushankumar and Ramachandra (2010) has reported the global values of wetlands ($3.2 trillion per year) rivers and lakes ($1.7 million per year) which indicate the key importance of freshwater to human beings.
Contamination of water bodies leads to a change in their trophic nature and several factors could act as stressors. Agarkar and Thombre (2005) highlighted the biological assessment is a useful alternative tool for assessing the ecological quality of an aquatic ecosystem since biological communities integrate the environmental effects of water chemistry.

In recent years, intensive agricultural and other developmental activities meet the needs of the escalating population affecting the surface and ground water sources at an alarming rate throughout the country (Karunakaran and Ramalingam, 2008). Remarkable changes were made on nutritional levels by the increase in urbanization, industrialization and over exploitation of natural resources (Eswari and Ramani, 2002 and Sawant and Telave, 2009). Recent studies were made throughout India regarding the physico-chemical parameters of ponds (Devi and Sharma, 2003; Jeyakumar and Karpagam, 2005). Shanthi et al. (2003) have reported the nutrient analysis of Singanallur lake in Coimbatore. Seasonal variation of hydrological parameters and distribution of nutrients in the Veli – Akkulam lake was highlighted by Jacob et al., (2008). Murugesan et al. (2004) has pointed out the importance of water bacteria in maintaining the water quality. The ecological variation of a freshwater pond was studied by Sasmal et al., (2005). Thirumala et al., (2006) presented the diurnal variation in water quality of Ayyanakere lake, Western Ghat region of Chikmagalore, Karnataka. The freshwater habitats have their own characteristic features which was moulded by local conditions and physiographic features (Gunkel, 2000). Variation in dissolved oxygen and biological oxygen demand in two freshwater bodies of Bodhan, Andhra Pradesh was studied by Solanki et al. (2007). They reported the different pollutants
in the water system determine the quality of water. As suggested by Raina and Vobra (1996) the freshwater ecosystems required conservation to maintain the physico-chemical and biological quality of water. Hence, the present study is selected to know the annual and seasonal variations of physico-chemical parameters of water and its influence on the distribution and seasonal abundance of Chlorophyta.
3.2 Materials and Methods

Surface water samples were collected from the eight selected ponds at monthly intervals for a period of two years from February 2007 to January 2009. The collections were made between 6 am to 8 am by using clean sample bottles.

Parameters like nitrite, nitrate and phosphate were estimated by photometric method. Sodium, potassium, calcium, magnesium, chloride, total alkalinity and TDS were analysed by standard method of APHA (1998).

3.2.1. Temperature

Temperature is measured in the field by immersing thermometer in proper depth.

3.2.2. pH

Known quantity of water was scooped from the surface of the pond in a clean glass bottle, transported to the laboratory without much agitation. The pH was measured immediately by using the pH meter.

3.2.3. Dissolved oxygen (Wrinkler’s Iodometric method)

For the estimation of dissolved oxygen, water samples were collected in 250 ml reagent bottles and fixed with alkaline iodide and manganous sulphate. For further estimation they were brought to the laboratory.

3.2.4. Biological Oxygen Demand (Wrinkler’s Iodometric method)

Water is collected from the pond by BOD bottles and after five days of incubation at 20°C. The water was titrated by using Wrinkler’s Iodometric method.
3.2.5. Estimation of Nitrate (Phenoldisulphonic acid method)

A known volume of the water sample was treated with phenol disulphonic acid (1 phenol, 2:4 disulphonic acid) and the amount of nitrate reacted with it to form 6 nitro 1, 2, 4 phenoldisulphonic acid. The sodium or potassium salt contained in it produces a yellow colour whose intensity can be measured by calorimeter.

3.2.6. Estimation of Nitrite

The nitrite nitrogen is determined colorimetrically after the formation of a reddish purple colour at pH which is kept from 2.0 to 2.5 by the coupling of diazotized sulphanilic acid with naphthylamine hydrochloride.

3.2.7. Estimation of phosphate (Vanadomolybdophosphoric acid calorimetric method)

In a dilute orthophosphate solution, ammonium molybdate reacts under acid conditions to form a heteropoly acid, molybdophosphoric acid. In the presence of vanadium, yellow nandomolybdophosphoric acid is formed. The intensity of the yellow colour is proportional to phosphate concentration.

3.2.8. Estimation of potassium

Potassium can be determined in either a direct-reading or internal standard type of flame photometer at a wavelength of 766.5 nm.

3.2.9. Determination of calcium and magnesium

Making use of ethylene diamine tetraacetic acid (EDTA) the concentration of calcium and magnesium is estimated.
3.2.10. **Estimation of sodium** (Flame photometry)

Sodium emits a bright yellow colour when exited in the flame. The intensity of emission is proportional to the concentration of sodium in the sample which is measured by flame photometer.

3.2.11. **Estimation of chloride** (Argentometric method)

The chloride present in the water is precipitated as silver chloride by titration with standard silver nitrate solution using potassium chromate as the indicator. After all the chloride is precipitated, the excess of silver nitrate combines with potassium chromate indicator to form flesh red precipitate of silver chromate.

3.2.12. **Estimation of alkalinity**

Hydroxyl ions present in a sample as a result of dissociation of hydrolysis of solutes react with additions of standard acid. Alkalinity thus depends on the end point pH used.

3.2.13. **Total Dissolved Solids**

A well mixed sample is filtered through a standard glass fiber filter, and the filtrate is evaporated to dryness in a weighed dish and dried to constant weight at 180°C. The increase in dish weight represents the total dissolved solids.

Descriptive statistics for evaluating physico-chemical properties of water were used for each sample taken from different study ponds. Replicates were averaged to determine the mean value and utilized for data analysis with ANOVA and correlation (Zar, 1996). The significance level was observed at P < 0.05.
3.3 Results

3.3.1 Rainfall

Monthly variations of rainfall data in the four taluks of Kanyakumari district are shown in Figure 3 and 4. In the first year (February 2007 to January 2008), maximum rainfall of 455.6 mm was reported from Vilavancode taluk against the absence of rain in Agasteeswaram taluk (0 in January), Thovalai taluk (January and December), and Kalkulam taluk (January, November and December). In the following year (February 2008 to January 2009), Kalkulam taluk recorded maximum of 633.0 mm rainfall in September against the absence of rain in Agasteeswaram taluk (December), Thovalai taluk (January, May and December) and Vilavancode taluk (December).

3.3.2 Water temperature

The monthly variation of surface water temperature recorded at different perennial ponds during the period of investigation is given in Figure 5. During the first year of study, temperature remains low (23.0°C) in P7 in December and remain high (27.5°C) in P1 and P2 in May. The annual mean value of surface water temperatures in the ponds are arranged in the following decreasing order as P4>P3>P2>P1>P5>P6>P7>P8> (Table 2). Seasonal fluctuation in temperature showed the highest value of around 27.4°C ± 0.11 during summer (P1) against the lowest temperature of 23.5°C ± 0.50 during northeast monsoon (P7) (Table 3). Two way ANOVA reported a significant variation between seasons and between ponds (F = 105.78; P < 0.05 and F=4.91;  P < 0.05). Temperature showed (Table 6) a significant positive correlation with pH, BOD (P1 and P2), CO₂ (P2, P5), alkalinity (P1, P4, and P5) and TDS (P1 and P6).
In the following year, the minimum temperature reported was 23.1°C in P_7 and P_8 in the month of December against the high temperature of 27.6°C in the month of April and May in most of the ponds (Fig. 6). The annual mean temperature is given in Table 4. The lowest mean value of 24.50°C ± 1.45 was observed in P_7 against the highest of 26.3°C ± 0.86 in P_3. Seasonal observations showed the minimum of 23.20°C ± 0.26 in P_7 (northeast monsoon) against the maximum of 27.5°C ± 0.1 in P_2 (summer). Two-way ANOVA revealed a significant variation between seasons (F = 78.46; P < 0.05) and between ponds (F = 6.50; P < 0.05). Temperature showed a significant positive correlation (Table 7) with chloride (P_2, P_5, P_8), magnesium (P_1, P_5, P_7), BOD (P_5, P_6) and with pH (P_6).

3.3.3 Water pH

The monthly variation of pH recorded at different ponds in the first year is shown in Figure 7, in which a minimum of 6.2 was reported in P_7 (January) and P_4 (May) against the maximum of 8.8 (May) in P_8. The annual mean pH of different ponds indicated the highest pH (7.6 ± 0.57) in P_8 and the lowest (6.9 ± 0.45) in P_6 (Table 2). Seasonal variation in the water pH showed the lowest of 6.47 ± 0.30 in P_4 during summer, and the highest of 8.3 ± 0.35 in P_8 in the same season (Table 3). Two way ANOVA revealed that there was a significant variation exists between seasons. In the first year of study, a significant positive correlation (Table 6) was reported between TDS, alkalinity (P_1, P_8) and BOD (P_8). It also showed negative correlation (Table 23) with Chlorophycean population (P_5) and dissolved oxygen (P_4).
In the following year, the reported values are shown in Figure 8. Among the eight ponds, P₁ showed the lowest value (6.2) in August and the highest value of 8.1 in May (P₄). The annual mean of 7.26 was the maximum pH obtained from P₄ against the minimum of 6.8 (P₁) (Table 4). The seasonal mean pH values are given in Table 3. During south west monsoon, the maximum pH of 7.55 ± 0.10 was observed in P₄ and the minimum mean pH was 6.6 ± 0.11 in P₁ during northeast monsoon. Two way ANOVA revealed that the variation between seasons alone was statistically significant (F = 6.89; P < 0.05). There was a significant positive correlation observed between dissolved oxygen in all the ponds except P₇. It also showed a significant positive correlation with CO₂ (P₃, P₄, P₆, and P₈) TDS (P₃, P₆, and P₈), calcium and chloride (P₃, P₄ and P₂, P₃). pH showed significant negative correlation with Chlorophycean population in P₃ (Table 6 and 7).

3.3.4 Dissolved oxygen (mg/l)

The monthly variation of dissolved oxygen content observed is shown in Figure 9 and 10. In the first year, dissolved oxygen expressed its peak value in the month of September as 8.8 mg/l in P₂ and P₃ and low value of 4.1 mg/l in P₇ in October. The annual mean values are shown in Table 2. High mean value was recorded in P₆ (6.90 ± 0.98) against the low value of 5.63 ± 1.01 mg/l in P₇. The seasonal mean values are presented in Table 3. The maximum dissolved oxygen content was 7.87 ± 0.55 mg/l during southwest monsoon in P₂ and minimum was 4.66 ± 0.39 mg/l during northeast monsoon in P₁ and P₇ (Table 3). Two way ANOVA revealed that the variations between the seasons and ponds are significant (F = 27.41; F = 3.24; P < 0.05). In 2007, dissolved oxygen (Table 23) had a significant positive correlation with Chlorophycean population (P₁, P₂, P₄, P₅ and
P6) and with nitrate in P1 and P2. A significant negative correlation (Table 6) was reported between CO2 (P4, P5, and P6), TDS (P4, P5, P6) and BOD (P4).

During the second year, the dissolved oxygen content reached its peak value in November as 7.3 mg/l in P3 and low value (4.8 mg/l) in March in P8 (Fig. 10). The annual mean value was low as 5.8 ± 0.83 mg/l in P8 and high as 6.63 ± 0.37 mg/l in P6 (Table 2). The seasonal variation of dissolved oxygen showed high value (6.92 ± 0.09 mg/l) during southwest monsoon in P6 and low value of oxygen content (4.97 ± 0.17 mg/l) in P8 during summer season (Table 3). A significant positive correlation (Table 24) was reported between DO and Chlorophyean population (P2, P6 and P7) and nitrate (P2, P6 and P8). DO (Table 7) showed a significant negative correlation with BOD in all ponds except P5, CO2 (P3, P7, P8); TDS (P3, P7, P8) and calcium (P3, P5 and P7).

3.3.5 Biological Oxygen Demand (BOD) (mg/l)

Biological Oxygen Demand (BOD) recorded in the ponds during the first year is illustrated in Figure 11. The maximum amount of BOD was (2.4 mg/l) observed in P4, P5 and P8 in May, whereas the minimum of 1 mg/l of BOD was observed (P1) in October. The annual mean values are shown in Table 2. P4 showed highest of 1.87 ± 0.34 mean value and P1 showed lowest mean value of 1.48 ± 0.39. Seasonal observation reported was 2.20 ± 0.22 as the highest value in P8 during summer season against the lowest value of 1.15 ± 0.12 mg/l in P1 during north-east monsoon. Two way ANOVA indicated a significant variation by the seasons (F = 34.16, F = 3.03; P < 0.05) and ponds. In 2007, BOD showed (Table 6) a significant positive correlation with CO2 in all the ponds except P8, with total alkalinity in most of the ponds except P1, P6, P2 with TDS (P1, P4, P5), temperature
(P₁, P₂) and with pH (P₂ and P₈) A significant negative correlation was observed between dissolved oxygen (P₄) and phosphate (P₆ and P₈).

In the following year, the biological oxygen demand observed in the experimental ponds are shown in Figure 12. The highest (2.1 mg/l) values were reported from P₁ and P₈ in the months February, April and May. The lowest values were observed (1.0 mg/l) in P₄, P₅, P₇ and P₈ in September, October and November. The annual mean values recorded from the experimental ponds are shown in Table 2 and it was minimum of 1.34 ± 0.42 mg/l in P₇ against the maximum of 1.68 ± 0.26 mg/l in P₃. Seasonal observation showed 2.05 ± 0.15 mg/l as the highest value of BOD in P₈ during summer against the lowest of 1.00 ± 0.08 mg/l in P₇ during monsoon (Table 5). Two way ANOVA indicated a significant variation (F = 20.20; P < 0.05) between seasons and non-significant variation between ponds. In 2008, BOD showed a significant positive correlation (Table 7) with CO₂ and TDS in almost all the ponds except P₄. With pH, sodium, alkalinity, chloride and potassium, it showed a positive correlation in most of the ponds. There was a negative correlation observed with dissolved oxygen (P₁, P₂, P₃, P₆, and P₇), nitrate and nitrite in most of the ponds.

3.3.6 Phosphate: PO₄ (mg/l)

The monthly variation of phosphate content in the experimental ponds are displayed in Figure 13 and 14. It shows maximum concentration of 0.34 mg/l (P₂) in July and minimum value of 0.06 mg/l in March (P₁). The annual mean values of phosphate content in the ponds are shown in Table 2. P₃ reported a high mean value of 0.22 ± 0.07 mg/l, whereas P₁ reported a low annual mean value (0.17 ± 0.08) mg/l. Seasonal variation of phosphate content reached maximum of 0.30 ±
0.03 mg/l during southwest monsoon in P3 against minimum of 0.08 ± 0.01 mg/l in
P1 during summer in the year 2007. Two way ANOVA revealed a significant
variation existed between seasons and between ponds (F = 154.91, F = 3.31;
P < 0.05). Phosphate showed a significant positive correlation (Table 23) with
Chlorophycean population (P2, P4, P5, P6 and P7) nitrate and nitrite (P5, P6, P7, and
P8). A significant negative correlation (Table 6) was reported between total
alkalinity and phosphate (P6, P7 and P8).

In the following year, the monthly variation of phosphate content reported
from the ponds are illustrated in Figure 14. Among the eight ponds P2 showed a
high value of 0.16 mg/l in August and a very low value of phosphate (0.01 mg/l) in
P3, P7 and P8 in February and May. The annual mean value registered was high as
0.09 ± 0.04 mg/l in P2 against the low concentration of 0.04 ± 0.01 mg/l in P8
(Table 4). During southwest monsoon maximum value of 0.14 ± 0.01 mg/l (P2)
and the minimum value of 0.02 ± 0.01 mg/l (P5) during non-monsoon season were
noticed (Table 5). Two way ANOVA indicated that there was a significant
variation between seasons (F = 64.79; P < 0.05) and non-significant variation
between ponds. Like 2007, phosphate showed a significant positive correlation
(Table 24) with Chlorophycean population (P2, P3 and P7) and nitrate (P1, P2, P6 and
P7). It showed a significant negative correlation (Table 7) with BOD (P1, P2, P7),
sodium and chloride (P1, P6 and P7).

3.3.7 Nitrate (mg/l)

The monthly nitrate content reported from the study ponds are shown in
Figure 15. It reached maximum of 1.5 mg/l (P3) in the month of June against the
minimum of 0.1 mg/l (P7) in May and January (P5). The annual mean value of
nitrate content was high as 0.68 ± 0.39 mg/l (P2) and the low as 0.56 ± 0.38 mg/l (P6) were observed (Table 2). The seasonal mean value of 0.87 ± 0.41 mg/l during monsoon seasons in P2 against 0.25 ± 0.09 in P6 as the low value during summer (Table 3). Statistical analysis by two way ANOVA reported a significant variation between seasons (F = 7.29; P < 0.05) and a non-significant variation between ponds. In 2007, nitrate (Table 23) showed a significant positive correlation with Chlorophycean population (P6 and P8) nitrite (P1, P2, P6 and P8) oxygen (P1 and P2) and phosphate (P5 and P7).

During the second year of study, the recorded monthly variations of nitrate content are shown in Figure 16. It reached a peak level of 1.94 mg/l (P8) during September and a low level of 0.12 mg/l (P3) in January. The annual mean value (Table 4) registered was high in P4 as 0.8 ± 0.52 mg/l against low value of 0.69 ± 0.51 mg/l (P5). During southwest monsoon in P8 the value was high (1.53 ± 0.39 mg/l); and during summer the value was low (0.26 ± 0.11 mg/l) in P1 and P2 (Table 5). Data on two way ANOVA shows a significant variation between seasons (F = 189.52; P < 0.05) and non-significant between ponds. In the year 2008, nitrate showed a significant positive correlation (Table 24) with Chlorophycean population (P1 and P2), phosphate (P1, P2, P3, P7) and (Table 7) sodium (P1, P2, P7 and P8). There was a negative correlation observed between BOD (P1, P2, P3, P7 and P8) alkalinity (P6, P7, and P8) and TDS (P1, P2, P4 and P7).

3.3.8 Nitrite (mg/l)

Data on monthly variation of nitrite concentration in the eight ponds under study is given in Figure 17. The values ranged from a minimum of 0.1 mg/l in P8 in May to the maximum of 1.3 mg/l (P1, P3, P4, P5 and P8) in October and
November. The highest and lowest annual mean value were 0.64 ± 0.38 mg/l and 0.51 ± 0.45 mg/l in P1, P3 and P6 (Table 2). Data on seasonal variation in nitrite concentration observed during the study period is displayed in Table 3. When compared with the other ponds, P1 showed highest mean value (1.15 ± 0.12 mg/l) during north east monsoon season, whereas P6 showed lowest value (0.13 ± 0.13 mg/l) during south west monsoon season of the year 2007 (Table 3). Two way ANOVA revealed that the variations between seasons were significant (F = 108.52; P < 0.05) and non-significant between ponds. Nitrite showed a significant positive correlation (Table 6) with dissolved oxygen and nitrate (P1, and P2), phosphate in (P5, P7, and P8) and magnesium (Ponds 5, 6 and 7). There was a significant negative correlation observed between nitrite and pH (P3 and P5).

In the second year, the monthly variation in nitrite concentration recorded in the experimental ponds are given in Figure 18. The peak value of 1.94 mg/l was reported during October in P7 and low value of 0.08 mg/l (P1, P2 and P3) during summer months. The maximum and minimum annual mean values were 0.70 ± 0.52 mg/l and 0.39 ± 0.46 mg/l in P3 and P8 respectively (Table 4). Seasonal variation of nitrite concentration under study showed that the mean values were high (1.28 ± 0.79 mg/l) in P7 during northeast monsoon, whereas P1 and P6 showed low nitrite content of 0.13 ± 0 mg/l during south-west monsoon and summer (Table 5). Analysis by two way ANOVA indicated a significant deviation between seasons and non-significant variation between ponds (F = 84.22; P < 0.05). During 2008 there was a significant positive correlation (Table 7) observed between dissolved oxygen (P1, P3 and P7). It showed a negative correlation with BOD in almost all the ponds (P1, P2, P4, P5 and P7).
3.3.9 Potassium (mg/l)

Results on potassium content of water samples from the eight experimental ponds under investigation during the year 2007 is given in Figure 19. The values ranged from 1 mg/l in September (P8) to 12 mg/l in May (P2). The maximum and minimum annual mean values were observed from P2 as 9.2 mg/l and 3.6 mg/l in P8 (Table 2). Seasonal observation reported from the ponds showed minimum of 3.5 ± 0.57 mg/l in P8 during northeast monsoon and maximum of 11.5 ± 0.57 mg/l in P2 and P7 during northeast monsoon and southeast monsoon respectively (Table 2). Two way ANOVA revealed that the variation in potassium content was significantly influenced between ponds (F = 3.08; P < 0.05) and non-significant between seasons. There was a significant negative correlation with temperature (P1, P2), magnesium (P3, P4) and chloride (P4 and P7) (Table 6).

In the second year, the monthly variation of potassium content observed from the experimental ponds are shown in Figure 20. The values were high (11.0 mg/l) in P1 and P2 against the low value (1.0 mg/l) in P3, P5, P6, P7 and P8 during monsoon months. The annual mean values observed were shown in Table 4. Among the eight ponds P2 (5.9 ± 2.84 mg/l) was observed with maximum value and P8 (2.5 ± 4.02 mg/l), was with minimum value. Seasonal observation highlighted a peak value of 8.5 ± 2.38 mg/l during non-monsoon season in P2 and low value of 1.5 ± 0.57 mg/l (P8) during southwest monsoon season (Table 5). Statistical analysis by two way ANOVA revealed that there was positive significant variation (F = 2.58; P < 0.05) between seasons and non-significant variation between ponds. Most of the ponds, except Pond 5, showed a significant positive
correlation (Table 24) with potassium and BOD. There was a significant negative correlation recorded with Chlorophycean population (P4 and P7).

3.3.10 Calcium (mg/l)

Data on the monthly variation of calcium concentration recorded in the experimental ponds during the year 2007 is illustrated in Figure 21. The peak value of 40.08 mg/l in P5 was observed in May and low value of 6.0 mg/l was noticed in the month of February (P3) and March (P3). The high annual mean value of 23.53 mg/l (P7) and low of 16.6 ± 6.10 mg/l (P3) were observed (Table 2). During northeast monsoon, the seasonal mean value was maximum of 28.02 ± 2.28 mg/l (P1) and minimum (14.01 ± 6.74 mg/l) in P3 during summer season. Calcium showed a significant positive correlation (Table 6) with sodium (P1, P2 and P6) and chloride (P5 and P6).

During the second year, the results obtained on the variation of calcium content are illustrated in Figure 22. It showed higher value of 46 mg/l (P6) in May against the lower value of 7.00 mg/l (P3) in November. The annual mean value of 26.0 ± 6.44 mg/l was recorded in P7 as maximum and 13.1 ± 6.88 mg/l as minimum in P5. Data on two way ANOVA revealed that a significant variation exist between seasons and between ponds (F = 8.15; P < 0.05) and F = 4.42; P < 0.05) respectively. There was a significant positive correlation (Table 7) with calcium and potassium (P4, P5); magnesium (P2, P4, P6, P7); sodium (P2, P4, P6, P8) and alkalinity (P1, P2, P4, P6 and P7). It showed a significant negative correlation with nitrate (P3, P5 and P6).
3.3.11 Magnesium (mg/l)

The monthly variations of magnesium content at different experimental ponds during the study period are shown in figures 23 and 24. The highest value of 27.95 mg/l was recorded in the month of May (P7) and the lowest value of 1.2 mg/l (P6) in January. The annual mean (Table 2) was high as 15.16 mg/l (P1) and low as 12.31 mg/l (P3). Seasonal variation showed the lowest of 7.89 mg/l (P6) during north east monsoon and highest of 17.62 mg/l (P1) during south west monsoon (Table 3). Two way ANOVA showed a significant variation between seasons (F = 7.02; P < 0.05) and a non-significant variation between ponds. Magnesium (Table 6) showed a significant positive correlation with nitrite (P5 and P6).

During the second year of study, in the month of May there a maximum value of 19.5 mg/l (P1) and a minimum value of 2 mg/l (P3, P5 and P6) in the month of December and January were observed. The annual mean value recorded was 12.0 mg/l (P1) as maximum and 1.64 mg/l (P2) as minimum (Table 4). Observations on the seasonal fluctuation of magnesium (Table 5) showed a lowest of 3.73 mg/l in P4 during northeast monsoon and highest of 15.62 mg/l in P2 during summer. Date on the two way ANOVA revealed that there was a significant variation between seasons and between ponds (F = 45.75; P < 0.05 and F = 0.79; P < 0.05). It showed a significant positive correlation (Table 7) with potassium (P3, P4 and P6); calcium (P2, P4, P6 and P7); sodium (P2, P3, P4, P6 and P8) and chloride (P1, P2, P3, P4, P6 and P8). Magnesium showed a negative correlation with dissolved oxygen (P1, P5 and P7).
3.3.12 Sodium mg/l

The quantity of sodium recorded from the experimental ponds during the study period is shown in Figure 25 and 26. During the first year of study the maximum value of 86.0 mg/l was recorded (P₃) in June and minimum of 7.0 mg/l (P₁) in March. The annual mean value recorded was ranged from 21.2 mg/l to 40.2 mg/l (P₆ and P₂) (Table 2). The seasonal fluctuation of the study period is shown in Table 3. There exists a maximum value of 48.5 mg/l in P₂ during southwest monsoon and minimum of 16.5 mg/l in P₁ during summer. Statistical analysis of two way ANOVA revealed a significant variation between seasons (F = 8.58; P < 0.05) and between ponds (F = 2.77; P < 0.05). Sodium (Table 6) showed a significant positive correlation with potassium (P₁, P₄, P₅, and P₆); chloride (P₃, P₅, P₆, and P₈); and calcium (P₁, P₂ and P₆). A negative correlation with sodium and total alkalinity (P₁ and P₂) were also noticed.

In the second year, a maximum value of 62.0 mg/l (P₂) in May and minimum value of 5 mg/l (P₇ and P₈) in August were recorded. The annual mean value (Table 4) was high as 34.2 mg/l (P₂) and low as 14.3 mg/l (P₈). Seasonal fluctuation in the sodium content of the experimental ponds are shown in the Table 5. During summer 48.00 mg/l was recorded in P₂ as high and 6.0 mg/l in P₇ as low during southwest monsoon. Two way ANOVA revealed that there was a significant variation between seasons (F = 8.58; P < 0.05) and between ponds (F = 2.77; P < 0.05). Sodium showed a significant positive correlation with pH, BOD, potassium, magnesium, chloride, total alkalinity and TDS in most of the ponds (Table 7).
3.3.13 Chloride mg/l

The chloride content recorded from the experimental ponds are shown in Figure 27 and 28. During the first year, in the month of May a maximum value of 150.0 mg/l was registered in P₁, against a minimum value of 3.0 mg/l (P₂) in February. The annual mean values recorded are shown in Table 2. A high annual mean value of 72.2 mg/l in P₁ and minimum annual value of 33.0 mg/l in P₅ were noticed. Seasonal variation showed highest value of 108.75 mg/l in P₁ during summer and lowest value of 17.5 mg/l in P₆ during north east monsoon. Data on two way ANOVA revealed that there was a significant variation between seasons and between ponds (F = 1.27; P < 0.05), (F = 0.93, P < 0.05). A significant positive correlation (Table 6) was observed with potassium (P₂, P₄, P₆ and P₇) and sodium (P₅, P₆ and P₈).

During the second year, maximum amount of chloride content of 112.00 mg/l (P₂) in May and minimum of 10.00 mg/l (P₇) in June and July were observed (Fig. 28). P₂ showed a high annual mean value of 52.3 mg/l and P₇ showed a low value of 20.8 mg/l during the study period (Table 3). Seasonal variation of chloride content is shown in Table 5. P₂ showed a higher concentration of 74.2 mg/l during summer and P₇ showed low concentration of 11.5 mg/l during southwest monsoon. A significant variation was shown by two way ANOVA between seasons and between ponds (F = 10.92; P < 0.05; F = 3.70; P < 0.05). Chloride showed a significant positive correlation with temperature (P₂, P₅, P₈) and BOD (P₁, P₂, P₃ and P₆). In this year most of the ponds chloride showed a significant positive correlation with potassium, magnesium, sodium and total alkalinity (Table 7).
### 3.3.14 Total Alkalinity mg/l

The monthly variations of total alkalinity observed during study period are shown in Figure 29 and 30. The peak value of 120.0 mg/l was registered in the month of March and May (P₄). In P₈ during September the values remained very low (20.0 mg/l). In the year 2007 the annual mean (Table 2) value was high in P₁ (76.25 mg/l) and low in P₈ (50.25 mg/l). The seasonal variations in total alkalinity recorded are shown in Table 3. Seasonal mean value were high (107.5 mg/l) during summer in P₄. Low seasonal mean value was registered during southwest monsoon in P₈ and the value was 22.75 mg/l. Data on two way ANOVA revealed that there was a significant variation exist between ponds and between seasons (F = 18.88; P < 0.05), (F = 2.14; P < 0.05). A significant positive correlation (Table 6) with temperature was noticed (P₁, P₄, and P₅). BOD and TDS in most of the ponds. Total alkalinity showed a negative correlation with dissolved oxygen (P₄, and P₆) and phosphate (P₆, P₇ and P₈).

In the second year of the study, P₄ showed maximum value of 120.0 mg/l in the months of February, March and May. The high minimum value of 20.0 mg/l (P₇) during June and July was registered. The annual mean value of 80.9 mg/l (P₄) and low value of 48.75 mg/l (P₈) were observed (Table 4). A low seasonal value of 23 ± 1.15 mg/l (P₈) during southwest monsoon and high seasonal value of 109.0 mg/l in P₄ during summer were observed. Statistical analysis on two way ANOVA revealed that there was a significant variation between ponds and between seasons (F = 18.44; P < 0.05; F = 2.45; P < 0.05). During 2008, total alkalinity showed a significant positive correlation (Table 7) with sodium, calcium, potassium, chloride
and TDS in most of the ponds. There was a significant negative correlation with total alkalinity and dissolved oxygen in P8.

3.3.15 TDS (mg/l)

The variations in the total dissolved solids collected from the experimental ponds are shown in Figure 31 and 32. During 2007 the higher content of 386.0 mg/l (P2) in May and lower content of 100.0 mg/l (P3) during November and December were observed. The data on annual mean values showed the highest value of 249 mg/l in P2 and lowest value of 164.5 mg/l in P8 (Table 2). The seasonal variation in both years of study is presented in Table 3 and 5. Among the ponds, P2 showed a maximum seasonal mean value of 310.25 mg/l during summer and P6 showed a minimum of 115.75 mg/l during northeast monsoon. Two way ANOVA revealed a significant variation between seasons (F = 11.98; P < 0.05) and between ponds (F = 2.94; P < 0.05). TDS showed a significant positive correlation with BOD (P1, P4 and P5) and total alkalinity (P2, P4, P5 and P8). There was a negative significant correlation (Table 6) with dissolved oxygen and TDS (P4 and P5).

In the second year, in May a maximum value of 388 mg/l and minimum value of 78.0 mg/l (P6) in the months of August and September were registered. The high annual mean of 254.6 mg/l (P2) and low mean value of 137.9 mg/l in P6 were noticed (Table 4). A low seasonal value of 96.75 mg/l (P6) during northeast monsoon and high seasonal value of 319.0 mg/l in P2 during summer season were recorded (Table 5). Data on two way ANOVA revealed a significant variation between seasons (F = 17.55; P < 0.01) and between ponds (F = 7.24; P < 0.05). All the ponds except P4 showed a significant positive correlation with BOD and
sodium (Table 7). It also showed a positive correlation with pH (P₁, P₆ and P₈) and total alkalinity (P₁, P₃, P₄ and P₈).
3.4 Discussion

One of the factors that determine the functioning of an aquatic ecosystem is temperature. It is a catalyst, a depressant, an activator, a restrictor, a controller, a killer and also it is one of the most important influential factors on water quality (Govindaswamy et al., 2007). It controls the distribution of biota (Dwivedi and Pandey, 2002 and Sedamkar and Angadi, 2003). In the present study the ponds, temperature ranged from 23.1°C to 27.5°C in the northeast monsoon and summer. Such higher temperature of the present study coincides with the earlier reports of Ali et al. (2005), Koliyar and Vokade (2008) and Karne (2010). Moreover, the temperature during summer increased which may be due to the bright sunshine, high rate of evaporation and low levels of water in the ponds. The present observation is supported by the findings of Kumar (1998) in the pond of South Bihar, Mohanraj (2001) in Tamilnadu, Kavitha (2006) in a few ponds of Kanyakumari district. The low temperature of the present observation during monsoon period in P7, and P8 may be due to the prevailing low atmospheric temperature and onset of winter (Ida, 2005). It is interesting to note that Vilavancode taluk (P7 and P8) of the district received heavy rainfall, which may be due to the dense plantation of rubber and banana. In an aquatic ecosystem, water temperature influences the growth, distribution and abundance of algae (Singh and Mathur, 2005; Iwona and Lauri, 2003; Asmon, 2006 and Ali et al., 2010). Verma and Mohanty (1995) pointed the influence of high temperature and nutrients enhanced the growth of phytoplankton. Water temperature is inversely proportional to the dissolved oxygen concentrations. Among the eight ponds, the depth of P2 is 6 to 7 metres and the temperature reached maximum of 27.5°C in May. Cole
(1983) has observed that the temperature increases with depth and is true in the present study. Moreover, high temperature had a direct effect on algal growth and aquatic life (Garg et al., 2006 b). Temperature showed a significant variation between seasons in all the experimental ponds.

The hydrogen ion concentration or pH of water is another essential factor that gives a precious indication of its quality and determines the metabolic activities of aquatic organisms (Wang et al., 2002). The optimum pH required for sustainable aquatic life is 6.5 to 8.5 (Murdoch et al., 2001). Khan and Khan (1985) highlighted the pH changes in the aquatic ecosystem which indicate the overall productivity and habitat diversity. In the present study, pH values ranged from a minimum of 6.2 (January and May) to the maximum of 8.8 (May) in P8 in the first year and also from 6.2 (August) in P1 to 8.1 (May) in P2 during the second year (Fig. 7 and 8). It showed a gradual but significant increase during summer and low during monsoon. Khan (1985) has observed higher value of pH during pre-monsoon season was due to the uptake of CO2 by photosynthesizing organisms. Gowd and Kotaiah (2000), Radika et al. (2004), Hujare (2008), Ganal et al. (2010) and Patra et al. (2010) also reported similar trends in their studies. A sharp decline of pH during monsoon season may be due to the entry of fresh water influx, low temperature and decomposition of organic matter and it was related to the findings of Mistra et al. (2005). In most of the aquatic ecosystems, pH values are mostly related with the reduction of algal population (Sharma and Sarang, 2004). The suitable range of pH for the growth of phytoplankton reported was 5 to 8.5. Santhosh (2002) noted that the pH values below 5.0 considerably reduce the
productivity of the aquatic ecosystem and had adverse affect on the fishery resources.

Dissolved oxygen is one of the important parameter in water quality assessment and reflects the biological and physiological processes prevailing in the water. Oxygen enters the water body directly from the atmosphere and by aquatic plants and algal photosynthesis. Oxygen is removed from the water by respiration and decomposition of organic matter (Solanki et al., 2007). In the present study, dissolved oxygen concentration ranged from a minimum of 4.1 mg/l (P7) in October to 8.8 mg/l (P2 and P3) in September during the first year and from 4.8 mg/l (P8) in March to 7.3 mg/l (P3) in November during the second year (Fig. 9 and 10). Similar trends were observed by De (1999), Rawat and Sharma (2005) and Rajagopal et al. (2010). A decreased trend of dissolved oxygen during summer was pointed out by Kaur et al. (2000). Seasonal observation of the present study revealed peak values of dissolved oxygen during monsoon and low values during summer (Table 3 and 5). Previous reports of Shastri et al. (2004) showed the same which trend from the fresh water bodies. As reported by Sachidanandamurthy and Yajurvedi (2005) the higher levels of dissolved oxygen was due to photosynthetic activity facilitated by increased temperature and pH. In general, the dissolved oxygen content of freshwater depends upon the factors like water movement, pollution, temperature, addition of fresh water into the ponds from different sources, production of oxygen and consumption by aquatic organism and microbes (Hutchinson, 1957). In the second year of study, dissolved oxygen in P7 showed a negative correlation with temperature (r = 0.626) which proved that at high temperature, the dissolved oxygen decreases in water. Das (2000a) reported that
concentration of dissolved oxygen is more than 5 mg/l which favours the better growth of flora and fauna. However, high dissolved oxygen was encountered in unpolluted waters while decreased amount of dissolved oxygen was an indication of organic pollution (Pawar, 2010). However, DO is essential to maintain proper balance of life to make water healthy.

Biological Oxygen Demand (BOD) gives an idea about degradable organic substances present in water which is subjected to aerobic decomposition of microorganism and provides a valuable information of pollution status (Mathur and Maheswari, 2005; Kulshrestha and Sharma, 2006). BOD values of the present investigation varied from 1.00 mg/l (P₁) to 2.40 mg/l (P₄, P₅ and P₈) during the study period. Late summer and early monsoon seasons showed high levels of BOD. The high BOD content during summer may be due to the high rate of organic decomposition, influenced by high temperature (Bhatt et al., 1999). Heavy load of sewage mixing and organic matter in the ponds may also raise the levels of BOD (Raveen et al., 2008). In the present study, P₁, P₅ and P₈ showed maximum amount of BOD. The dense growth of aquatic weeds, and aquatic plants may cause the reduction of oxygen and addition of BOD level. Upadhyaya and Rane (1991) and Mini et al. (2003) reported that lower levels of BOD during rainy season are attributed mainly by the dilution effects of rain water and surface entry of water into the ponds.

Phosphate is an essential nutrient for living organisms and exists in water bodies in both dissolved and particulate form. In general, it limits the nutrient for algal growth and controls primary productivity (Harsha et al., 2006). Present observation of phosphate reported a minimum of 0.06 mg/l (March) in P₁ of
phosphate concentration to the maximum of 0.34 mg/l (P₂) in July during the first year of study and 0.01 mg/l (P₃, P₇ and P₈) in February and May to 0.16 mg/l (P₂) in August during the second year of study (Fig. 13 and 14). Seasonal observation also pointed out high mean values during monsoon in both the years of observation and low mean values during summer. The present results are in agreement with the findings of Nair and Rajendran (2000) and Thakkar and Ranade (2002). The main reason for high phosphate content may be due to the mixing of agriculture based fertilizers from the nearby paddy and banana field as evidenced by Drusilla et al. (2005) and Karibasappa et al. (2009). The present observation also indicated the presence of higher concentration of phosphate during monsoon periods which may be due to the entry of surface water and mixing of rain water into the aquatic ecosystems. Moreover, migratory birds visited P₂ during late monsoon season and their excreta along with the decayed organic matter may influence the phosphate concentration. In several studies, rich source of phosphate causes eutrophication and bloom formation (Mohar and Beena, 2010). The concentration of phosphate varied between seasons in both the years and between ponds in the first year by two way ANOVA. The phosphate and nitrate concentration in the aquatic ecosystem favour the growth of bloom forming algae like *Chlorella*, *Scenedesmus* and *Oocystis* etc. (Tiwari and Shukla, 2007). The low concentration of phosphate during summer season was mainly due to the high utilization of phosphates by phytoplankton and aquatic plants and it coincides with the study of George and Mathew (2008).

In most of the aquatic systems, nitrogen sources are from chemical fertilizers, mixing of animal wastes with the water. Different sources of nitrogen
compounds influence the nutritional level and diversity of aquatic organisms. The oxidized form of nitrogen is nitrite and it occurs as an intermediate compound during the inter-conversion process of nitrate to ammonia. In the present observation, the concentration of nitrate content detected was ranged from 0.1 mg/l ($P_5$ and $P_7$) during summer to the maximum of 1.5 mg/l ($P_8$) during monsoon months in the first year and from 0.12 mg/l to 1.94 mg/l ($P_8$) during the second year (Fig. 15 and 16). Similar values were observed by Ida et al. (2004) and Kavitha (2006) in their studies on freshwater environments. The high values of the present study during monsoon month also coincide with the study of Chaulya et al. (2002). Decomposing bacteria during summer months and eutrophication nature of ponds may be the reason for the reduced nature of nitrites in the present study. Presence of appreciable amount of nitrates in water bodies indicate pollution by sewage, municipal wastes, industrial effluents, launches from refused dumps, presence of decaying organic matter and atmospheric washouts (Solanki et al., 2007).

Nitrite ion is the common form of combined nitrogen found in natural waters. High concentration of nitrite in water helps better growth of phytoplankton and the permissible limit is 50 mg/l (Patra et al., 2010). Nitrites when present in high concentration in drinking water are considered as harmful to infants because of the production of blue bad diseases (Bindiya et al., 2008). Nitrite concentration in the aquatic ecosystem depends upon the activity of nitrifying bacteria (Johnson et al., 2005). During the study period the values ranged from 0.1 mg/l ($P_8$) in May to 1.3 mg/l in October and November ($P_1$, $P_3$, $P_4$ and $P_5$) in the first year (Fig. 17 and 18). In the second year also the values ranged from 0.08 mg/l during summer months ($P_1$, $P_2$ and $P_3$) to 1.94 mg/l in October ($P_7$). In most of the ponds, nitrite
concentration reached maximum during monsoon and minimum during summer. The present observation coincides with the previous reports of Ayyappan and Gupta (1981) and Harikrishnan et al. (1999), which may be due to the biological uptake by algae and also due to the planktonic biomass (Nazneen, 1980). Higher levels of nitrite concentration during summer months (May) in both the years of study were due to the reduced water levels of the ponds as reported by Sanap et al. (2008). The present observation is the same with the findings of Munawar (1970), Kodarkar et al. (1998), Verma et al. (1984) and Johnson et al. (2005). The results of two way ANOVA revealed that the nitrite concentration varied seasonally in both the years of observation and are similar to the results of Loganayagi et al. (2008).

Potassium is a naturally occurring essential macronutrient in an aquatic ecosystem (Chapman, 1996). Under low concentration the growth rate and photosynthesis of blue green algae become poor and the respiration rate is increased (Wetzel, 1983). It is closely related to sodium and the fourth ranking caution in pond water (Cole, 1979). Present observation highlighted the higher annual mean values 9.2 mg/l and 5.9 mg/l (P2) both the years of the study period. The higher levels may be due to the bird’s wastes that dissolve in water as evidenced by Esakki (2006) in Koonthankulam pond. Several observations pointed out a higher level of potassium during monsoon in the first year and summer in the second year. This may be due to the reduced water levels. The less amount of potassium and sodium during summer was due to lattice fixation (Ahmed et al., 1996). The permissible limit is 10 mg/l (ICMR) and the present study reported minimum quantities of potassium in all the experimental ponds.
Like potassium, sodium is also a naturally occurring element but the concentration in freshwater bodies remains quite lower than potassium and calcium (Garg et al., 2010). In both the years the annual mean values of sodium content (Table 2 and 4) was observed high in P2. Seasonal variation reported higher values during southwest monsoon 48.5 mg/l (P2) in the first year and in the second year 48.0 mg/l in summer (P2). Irregular fluctuation is also reported from the present study. Similar observations were pointed out by Prakash and Somasekar (2006). Higher concentration of sodium and potassium gives a salty taste that may cause foaming in boilers and limits the use of water for irrigation (Damodarkumar et al., 2008). TDS mainly influenced the concentration of magnesium, sodium and chloride ions.

Calcium is one of the most abundant elements in natural water in the form of calcium carbonate which is the prime factor for hardness. The principal cation that imparts hardness is Ca++ and Mg++ (Kumar et al., 2005). Calcium and magnesium are directly proportional to total hardness of water. The main source of these ions is sedimentary rocks, seepage and runoff from soil (Paul and Misra, 2004). The salts of calcium, sodium and potassium contribute chlorides in water. Large content of chloride in freshwater is an indication of organic pollution (Khamabrade and Mule, 2005). Ca and Mg are major scale forming substances in raw water. In the present study, calcium value showed a fluctuation from 6 mg/l (P3 and P5) to 40 mg/l (P3) in the first year and 7 mg/l (P6) to 46 mg/l in the second year (Fig. 21 and 22). Moreover, it showed maximum values during monsoon and minimum during summer season. Jain et al. (1996) reported high concentration of hardness (150 – 300 mg/l) and above which may cause kidney problems.
Magnesium is also an important cation of water which is associated with calcium in all kinds of water but its concentration remains generally lower than calcium and a major element for hardness (Rajkumar et al., 2006). Magnesium is essential for chlorophyll and acts as a limiting factor for the growth of phytoplankton (Dagaonkar and Saxena, 1992). According to WHO (1995), the permissible limit of magnesium is 150 mg/l. Present study reported higher values during monsoon and lower values during summer. Similar findings were observed by Dhanalakshmi et al. (2008).

Chloride in the form of chloride ion, is one of the major inorganic anions in water and waste water (Harsha et al., 2006). In general, it occurs in the discharges of effluent from industries, sewages, irrigation waste, etc. (Manivasakam, 2003). Freshwater contains 8.3 mg of chloride per litre (Swarnalatha and Rao, 1998). In the present observation, the values were high during summer and low in northeast monsoon. The higher chloride contents were mainly by the decreased water levels and mixing of sewages and detergents in the ponds (Mruthunjaya and Hosmani, 2004). The reported annual values were ranged from 20.8 mg/l (P7) to 72.2 mg/l (P1) during the study period (Fig. 27 and 28). Similar results were reported by Dhanapakiam et al. (1999) and Mathivanan et al. (2005). Domestic waste and rainfall in association with high temperature also contribute chloride concentration (Negi and Kumar, 2001). Cole (1979) reported that higher level of chloride is an index of pollution and is harmful to aquatic life. Moreover, the concentration of chloride recorded from the present study is within the permissible limit, according to WHO (1995) is less than 500 mg/l.
Alkalinity is a total measure of the substance in water that has acid neutralizing ability. It is the measure of weak acid present in it and of the cations balanced against it. Several bases like carbonates, bicarbonates, nitrates, phosphates, etc. were added to alkalinity which helps in evaluating the buffering capacity of water (Singbarh et al., 1986). According to Kaur et al. (2000) high alkalinity values are the indicators of eutrophic nature. In both years of study the values ranged from 20 mg/l (P7 and P8) to 120 mg/l (P4). Similar results were reported by several authors (Vyas and Sawant, 2007 and Kamaraj et al., 2008). Seasonal observation reported high mean values during summer and low during southeast monsoon. Higher values made the aquatic environment with high productivity (Munawar, 1970). Increased alkalinity was resulted due to the increase in free CO2. Higher levels of alkalinity resulted in the present observation was mainly due to agricultural runoff and surface in P4. Such observations coincide with the results of Ajagekar et al. (2011). Lower alkalinity values, except P1, in the present observation showed dilution effects (Koliyar and Vokade, 2008). The higher alkalinity in summer months (Table 29 and 30) which may be attributed with high rate of decomposition where CO2 was released and reacted with water to form HCO3 and thereby increasing the total alkalinity. Similar findings were given by Gupta and Anuj (2007) and Prajapathi and Raol (2008).

In natural water, dissolved solids are composed of carbonates, bicarbonates, chlorides, sodium, potassium, nitrates, phosphates, etc. (Esmaeili and Johal, 2005). Excess amount of TDS (P2) in water disturbed the ecological balance and caused suffocation to aquatic fauna (Klein, 1972). The total dissolved solids registered from the ponds showed much fluctuation. In the present study, TDS concentration
remains high during summer (P₂) and low (P₅ and P₆) during monsoon in most of the ponds (Table 31 and 32). Among the eight experimental ponds, P₂ (April) showed maximum TDS (310.25 mg/l) which may be due to the failure of monsoon and higher withdrawal of ground water. According to Hutchinson (1957) excess amount of TDS might be attributed by excessive evaporation during summer. The present observation of high TDS during summer is similar to the findings of Nagaraju et al. (2011), Karunakaran and Ramalingam (2008). It was also reported by Pawar (2010) that the increase in surface run off causes an increased level of TDS in freshwater environment. The present observation also pointed out the amount of TDS remains within the prescribed limit of WHO (1995) is less than 500 mg/l.