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Application of Inorganic Fertilizers and Organic Manures on the Production of Autotrophic Plankton in Madhupur Tract Soil Contained Miniature Tank

M. E. Huda[1*] and M. R. Nabi[2]

[1]Department of Environmental Sciences, Jahangirnagar University, Savar-Dhaka,
[2]Department of Zoology, Jahangirnagar University, Savar-Dhaka.
*Corresponding author: mdemadul@yahoo.com

Abstract

Appropriate fertilizer and their impact on physico-chemical parameters of water and productivity is very important for aquaculture and ecology. Optimum fertilizer dose can help in fish farmer as well as aquaculture sector. From the study it was found that the total physicochemical parameters of water were suitable for aquaculture, drinking water, irrigation and domestic use. The average water temperature was 26.45±2.75ºC; 26.50±3.24ºC; 25.83±4.08ºC; 26.57±3.02ºC and 26.53±2.93ºC for MCRT-1 to 5 gradually. Water p^H in an average was 7.37±0.61; 7.44±0.55; 7.25±0.58; 7.33±0.54 and 7.47±0.49 for Minature Circular Research Tank (MCRT)-1 to 5 respectively. Average water DO were 6.98±1.05 mgl^{-1}; 6.75±1.53 mgl^{-1}; 6.90±1.64 mgl^{-1}; 6.59±1.19mgl^{-1} and 6.77±1.60mgl^{-1} for MCRT-1 to 5 respectively. Average water hardness were 71.88 ± 20.47 mgl^{-1}; 60.5 ±2 1.25 mgl^{-1}; 83.38 ± 23.39 mgl^{-1}; 59.13 ± 25.57 mgl^{-1} and 52.63 ± 7.92 mgl^{-1} for MCRT-1 to 5 gradually. Average water total phosphorus were 0.77 ± 0.18 mgl^{-1}; 0.83 ± 0.19 mgl^{-1}; 0.78 ± 0.21 mgl^{-1}; 0.84 ± 0.17 mgl^{-1} and 0.84 ± 0.16 mgl^{-1} for MCRT-1 to 5 gradually. From planktonic study it was found that the highest phytoplankton and Zooplankton were in MCRT-3. Phytoplanktons were under 27 no. of genera. Their groups were Cyanophyceae, Chlorophyceae, Bacillariophyceae, Euglenophyceae and Hepatecae.Zooplankton were five major taxa and they were Protozoa, Rotifera, Cladocera, Copepod and Ostracoda respectively.

Key words: Ecology, Fertilizer, Miniature tank and Productivity

Introduction

Fertilization of pond with inorganic and organic sources is now an indispensable part (Bhakta, 2006) for all kinds of aquaculture particularly fish through stimulating the autotrophic pathway (De Silva and Hasan, 2007; Jha, 2008).In this practice, the inorganic fertilizer has been more accepted because of its lower loading rates, higher nutrient content and lower oxygen demand (Colman and Edwards, 1987) as such, increasingly used in carp culture ponds throughout the Asian countries from the seventies of last century. Here, the bottom soil acts like a reservoir to supplement the upper laying water column with the required nutrient is necessity. The soluble inorganic fertilizers make their elements available to the water immediately these are applied, while, the organic manures comparatively slower rate of release of nutrients to the water over a long period of time as the decomposition proceeds. Besides, the organic manures enrich the organic matter content of soil and water and, within the limits of manurial dose, release carbon dioxide and nutrients on decomposition, sustaining the fertility of water, unless hasten the depletion of dissolved oxygen and enhance production of toxic gases (Huet, 1975; Jhingran, 1985; Pillay, 1993). Application of different types and proportions of organic manures may also differ according to soil types. Several pioneer workers, such as, Zehmen (1917), Schaperclaus (1933), Le Mare (1948), Alikunhi (1955), Hora and Pillay (1962), Huet (1975), Jhingran (1985); Pillay, (1993); Lickacz and Penny, (2001) have reviewed the application of farmyard manures in different water bodies in their respective areas. Bangladesh, because of its geographical location supports huge number of lentic and lotic water bodies. It is encouraging that these water bodies are now getting more and more importance to the owners either by themselves or leasing management practices in fish production to mitigate animal protein deficiency for the burgeoning population of the country (Mazid, 2002). Whereas, in total production of fish from a water body, fertilization and artificial feeding are considered as a major cost enhancing sector due to either under or over supply and thus needs standardization through time to time scientific studies. Physico-chemical parameter of water is very important factor for aquaculture. This parameters determine the planktonic condition of a water body. The present study is an initiative to settle the possible fertilizer dose in case of the Madhupur tract soil type of Bangladesh through trials in a miniature earthen tank. This study will help the fish farmer in their fertilizer use in pond fish culture.

Materials and Methods

Research tanks

Five miniature circular research tanks (MCRTs), each of $0.88m^2$ in diameter were used for this research work. For the obtaining scientific data in every step of research, these were established in usually sunny and well aerated place adjacent to the Environment Sciences Department, JU. Initially, one-third of each MCRT was covered with the Madhupur tract soil collected from the respective area and mixed with the following doses of organic manures but, always with 263 $Kgha^{-1}$ lime (excluding MCRT-5) two days before filled up with natural pond water up to its neck.

Preparation of MCRTs

For recording, all the MCRTs were numbered 1-5 respectively and accordingly MCRT-5 was used as a controlled tank with neither of the treatments. After two days of watering, following doses of inorganic fertilizers were applied against the production of autotrophic plankton in different MCRTs.

To follow the standard unit, applied treatments were expressed in Kgha^{-1}.

Organic manures and Inorganic fertilizers

Tanks	Poultry drops (dry)	Urea	TSP
MCRT-1	4375 kgha^{-1}	137 kgha^{-1}	117 Kgha^{-1}
MCRT-2	2923 kgha $^{-1}$	29.2 kgha^{-1}	525 Kgha^{-1}
MCRT-3	1736 kgha^{-1}	188 kgha^{-1}	425 Kgha^{-1}
MCRT-4	2500 kgha^{-1}	106 kgha^{-1}	224 Kgha^{-1}

MCRT-5 Controlled.

Sampling

For water quality analysis, samples of water were collected 15 days after the preparation of MCRTs and the process continued accordingly March to February, 2012. For this reason, water samples were collected from each MCRT separately with a 250 ml beaker within 4:00 – 5:00 pm and instantly water temperature was determined using a Celsius thermometer (scale ranging from 0 – 100°C; Model: SH-135 CE, China). Then, water pH, Dissolved oxygen, Total hardness and Total phosphorus were analyzed using standard methods as suggested by AOAC (1989) and APHA (1998). For the qualitative and quantitative study of autotrophic plankton, 100 ml water samples were collected before the water parameters analyses from each MCRT and immediately preserved in a conical flask containing Lugol's solution and counted in the laboratory under a Nikon compound microscope (Japan) at a magnification of 400x and the procedure repeated three times with each sample.

Calculation:

Density as individualL^{-1} = (V_1 x V_2) x T x 1000

where, V_1 = volume (ml) of plankton concentrate in three times.

V_2 = volume (ml) of counted cells.

T = Total number of individual plankter in three replicated counting.

1000 = Numerical value of the unit liter (L)

Statistical analysis

All statistical analyses were performed with the help of a computer software SPSS program.

Results and Discussion

The results indicated a remarkable seasonal variation of water quality parameters in all the MCRTs. Although the pattern of variation was almost similar, but wide difference obtained in the level of hardness and phosphate determining components and consequent water quality parameters (Table 1). Hence, temperature exerts an immense influence on the maintenance of a healthy aquatic environment and production of food organisms (Brett, 1979) therefore, the mean range of temperature (25.83-26.57°C) reflected the usual semi-tropical water including the seasonal variations (Lewis, 2000; Ayoade, 2006) for normal growth of aquatic organisms (Wetzel, 2001; Mazid, 2002). Similar result also reported by Dhawan and Kaur (2002), while, Boyd (1982) suggested that the range of water temperature from 26.06-31.97°C is suitable for fish culture. Thus the result showed that the water temperature were within the permissible limit for aquaculture (Table-1). The level of pH varied from 6.82-8.72, 6.02-8.27, 6.36-8.39, 6.26-8.61 and 6.90-8.89 in MCRT 1-5 respectively. p^{H} values varied from 6.26 to 8.89 which coincide with permissible limit for different uses like fish culture, irrigation, domestic and recreational, according to standard value of DoE (pH 6 to 9). According to Boyd (1982), water pH values range between 7.0 to 9.0 is the indicative suitable for fish culture. Thus, the obtained pH values under different treatments were almost healthy for fish culture. Similar results obtained by Dhawan and Kaur (2002); Okbah and Gohary (2002). Kohinoor *et al*. (2012) reported that the similar range of pH value even suitable for catfish culture (Table-1). The dissolved oxygen (DO) contents in the experiment ranged between 5.25-9.51, 2.30-8.34, 2.75-9.60, 4.00-8.73 and 3.34-9.15 mgL^{-1} respectively with the mean values 6.98±1.05, 6.75±1.53, 6.90±1.64, 6.59±1.19 and 6.77±1.60 mgL^{-1}. The average DO permit the DO level 6 mgL^{-1} for drinking, 4 to 5 mgL^{-1} for recreation, 4 to 6 mgL^{-1} for fish and livestock and 5 mgL^{-1} for industrial application (EQS, 1997). The studied values were lower DO in the MCRT-2 and 3 in the later summer to early part of monsoon may be the result of decomposition of plankton and autochthonous organic maters. A similar report was recorded by Okayi (2003). However, the level of DO was within the acceptable ranges (Boyd, 1982) in all the MCRTs throughout the experiments (Table-1).The obtained hardness range in all the MCRTs under different treatments were 41.50-125.00, 32.50-106.00, 43.00-124.50, 31.50-119.00 and 41.00-64.50 mgL^{-1} respectively. Boyd (1982) revealed that total hardness values for natural water may vary from greater than 30 up to 150 mgL^{-1}.are considered good for fish culture. According to the DoE (Department of Environment), (EQS: Environmental Quality Standard for Bangladesh, 1997) standard, the permissible limit of Hardness of drinking water is 200 to 500 ppm. According to Huq and Alam (2005), the hardness standard is 123 ppm. Thus the obtained hardness range permit the the treatment were suitable for aquaculture, drinking water, irrigation and domestic purpose (Table-1). The recorded range of phosphorus were always within the productive condition (Table-1). Natural waters having phosphorus contents of more than 0.2mgL^{-1} are likely to be quite productive (Idowu and Ugwumba, 2005). Similar result obtained by Okbah and Gohary (2002).

Table 1. Water quality parameter (mean ± SE) of MCRTs under different inorganic fertilizers treatments

MCRTs	Parameters	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	M±SD
MCRT-1	Temp.(ºC)	29.1	27.7	28.2	28.15	28.65	28.15	27.6	25.6	23.55	20.8	22.3	27.6	26.45±2.75
	p^H	6.96	7.36	7.21	7.03	7.14	8.72	7.34	6.86	6.82	7.36	8.61	6.98	7.37±0.61
	DO(mgl^{-1})	7.38	6.69	7.96	5.25	6.07	6.59	6.69	6.32	6.37	7.78	9.51	7.13	6.98±1.05
	Hard(mgl^{-1})	65.5	81	81.5	41.5	55	62.5	58	62.5	88.5	79	62.5	125	71.88±20.47
	Phos(mgl^{-1})	0.99	0.96	0.98	0.69	0.68	0.73	0.44	0.84	0.96	0.69	0.82	0.45	0.77±0.18
MCRT-2	Temp(ºC)	29.4	26.35	29.15	27.35	29.35	28.35	28.4	27.35	24.45	23.2	18.25	26.35	26.50±3.24
	p^H	7.21	7.28	7.66	7.26	7.23	8.27	7.97	7.76	6.02	7.2	7.96	7.44	7.44±0.55
	DO(mgl^{-1})	8.34	6.66	7.65	2.30	5.79	6.43	7.35	6.96	6.36	8.33	7.13	7.66	6.75±1.53
	Hard(mgl^{-1})	32.5	82.5	43	61	43.5	43	45	79.5	82.5	106	52.5	55	60.5±21.25
	Phos(mgl^{-1})	1	0.98	0.99	0.73	0.85	0.78	0.53	0.69	0.96	0.99	1	0.45	0.83±0.19
MCRT-3	Temp(ºC)	29.55	26.25	29.5	27.25	29.25	28.45	28.45	27.25	24.35	23.3	18.2	18.15	25.83±4.08
	p^H	7.16	6.86	7.61	7.12	7.64	8.39	7.45	7.64	6.67	7.7	6.36	6.36	7.25±0.58
	DO(mgl^{-1})	7.20	7.00	8.75	2.75	5.61	5.79	6.84	7.40	6.67	9.60	7.57	7.57	6.90±1.64
	Hard(mgl^{-1})	43	82.5	82	102.5	87.5	74.5	45.5	85	119	124.5	77.5	77	83.38±23.39
	Phos(mgl^{-1})	1	0.96	0.99	0.73	0.78	0.74	0.44	0.84	0.99	1	0.46	0.46	0.78±0.21
MCRT-4	Temp(ºC)	29.25	26.45	29.55	27.05	29.55	28.35	28.15	27.45	24.35	23.1	19.4	26.15	26.57±3.02
	p^H	7.36	6.83	7.35	7.06	7.25	8.61	7.63	7.59	6.26	7.04	7.7	7.27	7.33±0.54
	DO(mgl^{-1})	7.05	4.00	6.15	8.73	5.45	5.95	6.55	8.07	7.25	6.38	7.37	6.16	6.59±1.19
	Hard(mgl^{-1})	50.5	82.55	64	44	41	42.5	31.5	32.5	119	90.5	43.5	68	59.13±25.57
	Phos(mgl^{-1})	0.99	1	0.99	0.78	0.86	0.67	0.46	0.68	1	0.69	0.96	1	0.84±0.17
MCRT-5	Temp(ºC)	29.25	26.4	29.15	27.25	29.5	28.15	28.15	27.25	24.45	23.15	19.5	26.15	26.53±2.93
	p^H	7.70	7.10	6.90	7.08	7.32	8.89	7.51	7.14	7.39	7.43	7.71	7.48	7.47±0.49
	DO(mgl^{-1})	6.56	4.32	6.39	8.79	3.34	6.16	7.35	6.49	7.28	9.15	8.12	7.23	6.77±1.60
	Hard(mgl^{-1})	43.5	61	62	41	46.5	48.5	42.5	53.5	58.5	59	51	64.5	52.63±7.92
	Phos(mgl^{-1})	1	1	0.95	0.73	0.73	0.79	0.53	0.7	1	0.69	1	0.95	0.84±0.16

Plankton population study

Phytoplankton were five major groups, such as, Cyanophyceae, Chlorophyceae, Bacillariophyceae, Euglenophyceae and Hepateacae were recorded with variation in different MCRTs throughout the studied periods. Among these groups, 27 genera were identified which presented (Table 2). The result showed that the the highest phytoplankton number were in MCRT-3.The phytoplankton, while counted in each MCRT throughout the study period showed that the environment as developed due to defined treatment in MCRT-1 produced maximum quantity 57.08 % of Euglenophyceae followed by 21.99 % and 8.03 % of Chlorophyceae and Bacillariophyceae among the all genera of major texa (Table 3). Similarly, in MCRT-2 the percentage composition was dominated by 47.70 % of Euglenophyceae and the next 37.36 %, 6.32 % and 4.45 % occupied by Chlorophyceae, Cyanophyceae and Hepatecae in the total phytoplankton genera observed (Table 3). The MCRT-3 showed highest percentage composition as 38.96 % of Euglenophyceae, then, 32.78%, 23.96% and 2.41% of Chlorophyceae, Hepatecae and Cyanophyceae respectively in the total obtained of phytoplankton (Table 3). Within the studied, it was found that the MCRT-4 produced maximum 42.38% population of Euglenophyceae, 33.84 % Hepatecae, 18.61 % Chlorophyceae (Table 3). At the same time, the controlled MCRT-5, dominated by Euglenophyceae with 42.38%, which followed by Hepatecae and Chlorophyceae by the percentage of 25.0% to 24.83% respectively in the total recorded phytoplankton in this study (Table 3).

Table 2. Mean density (indiv.L^{-1}) of Phytoplankton and Zooplankton under different major genera as obtained during the study in different MCRTs of Madhupur Tract Soil

Phytoplankton				Zooplankton			
Major Taxa	Genera	Total no.	Mean Density±SD	Major Taxa	Genera	Total no	Mean Density±SD
Cyano.	*Aphanocapsa sp*	20	4.0±5.65	Protozoa	*Collosphaera sp.*	275	55.0±17.56
	Coelosphaerium sp	21	4.2±5.76				
	Chroococcus sp.	18	3.6±5.37				
	Holopedium sp	03	0.6±1.34				
	Oscillatoria sp.	97	19.4±6.69				
	Skujella sp.	08	1.6±3.58				
Chloro.	*Chlorella sp.*	890	178.0±59.66	Rotifera	*Asplanchna sp.*	584	116.80±88.37
	Cosmerium sp.	58	11.6±14.17				
	Kirchneriella sp.	03	0.6±1.34				
	Microspora sp	07	1.4±3.13				
	Pithophora sp	22	4.4±9.84				
	Spirogyra sp	05	1.0±2.24				
	Tetraspora sp	05	1.0±2.24				
	Ulothrix sp	02	0.4±0.89				
	Voivox sp	393	78.6±133.71				
Eug.	*Euglena sp.*	2159	431.8±197.5	Cladocera	*Daphnia sp.*	61	12.20±16.89
					Diaphanosoma sp.	44	8.80±12.13
	Phaecus sp.	83	16.6±3.91				
					Bosmina sp.	87	17.40±16.85
Hep.	*Riccia sp.*	1165	233.0±215.9	Copepoda	*Cyclops sp.*	129	25.80±17.05
					Eucalanus sp.	51	10.20±22.81
				Ostracoda	*Cypris sp.*	436	87.20±54.90

These were Protozoa, Rotifera, Cladocera, Copepoda and Ostracoda. Again, among them only Cladocera and Copepoda were represented by the three and two genera respectively, while, the rest with one genus of each. However, the maximum mean density 116.80±88.37 indivL^{-1} shown by the Rotifera, of all Zooplankton observed. The second and third dominant group was Ostracoda and Protozoa with 87.20±54.90 and 55.0±17.56 indivL^{-1} of the total Zooplankton studied (Table 2). From this study it was found that the number of Zooplankton was highest in MCRT-3 (Table 3). The study recorded 8 genera in Madhupur tract soils, under 5 major taxa throughout studied period. Hutchinson (1967) concluded that the main groups composing zooplankton communities are the protozoans, rotifers and crustaceans, particularly copepods and cladocerans, although freshwater zooplankton especially in tropical regions may contain a diverse set of taxonomical categories (Dummont *et al*., 1994; Wetzel, 2001). Jhingran (1985) and several other scientists reported about the diurnal vertical migration of certain Zooplankters, but considering the depth of MCRTs, such a probability can be omitted here. MBO (2007); Davies and Otene (2009) concluded that the abundance and distribution of planktonic organisms might be adduced to many factors such as, DO, transparency, depth, salinity, pH, temperature and nutrients. FAO (2006) opined that the distribution and composition vary from place to place and year to year due to the dynamic nature of the aquatic systems.

Table 3. Density (indiv.L^{-1}) of Phytoplankton and Zooplankton with percentages under different major group as obtained during the study in different MCRTs of Madhupur Tract Soil

MCRT-1	Phytoplankton	Cyanophyceae	Chlorophyceae	Bacillariophyceae	Euglenophyceae	Hepaticae	Total
	Indiv./L	29	126	46	327	45	573
	%	5.06	21.99	8.03	57.08	7.85	11.14
	Zooplankton	Protozoa	Rotifera	Cladocera	Copepoda	Ostracoda	Total
	Indiv./L	42	117	58	45	158	420
	%	10	27.85	13.81	10.71	37	25.19
MCRT-2	Phytoplankton	Cyanophyceae	Chlorophyceae	Bacillariophyceae	Euglenophyceae	Hepaticae	Total
	Indiv./L	44	260	29	332	31	696
	%	6.32	37.36	4.17	47.7	4.45	13.53
	Zooplankton	Protozoa	Rotifera	Cladocera	Copepoda	Ostracoda	Total
	Indiv./L	52	55	58	35	58	258
	%	20.15	21.31	22.48	13.57	22.48	15.48
MCRT-3	Phytoplankton	Cyanophyceae	Chlorophyceae	Bacillariophyceae	Euglenophyceae	Hepaticae	Total
	Indiv./L	41	557	32	662	407	1699
	%	2.41	32.78	1.88	38.96	23.96	33.04
	Zooplankton	Protozoa	Rotifera	Cladocera	Copepoda	Ostracoda	Total
	Indiv./L	71	250	23	29	132	505
	%	14.05	49.5	4.55	5.74	26.13	30.29
MCRT-4	Phytoplankton	Cyanophyceae	Chlorophyceae	Bacillariophyceae	Euglenophyceae	Hepaticae	Total
	Indiv./L	29	292	52	665	531	1569
	%	1.85	18.61	3.31	42.38	33.84	30.51
	Zooplankton	Protozoa	Rotifera	Cladocera	Copepoda	Ostracoda	Total
	Indiv./L	75	131	27	52	59	344
	%	21.8	38.08	7.85	15.11	17.15	20.63
MCRT-5	Phytoplankton	Cyanophyceae	Chlorophyceae	Bacillariophyceae	Euglenophyceae	Hepaticae	Total
	Indiv./L	24	150	23	256	151	604
	%	3.97	24.83	3.81	42.38	25	11.74
	Zooplankton	Protozoa	Rotifera	Cladocera	Copepoda	Ostracoda	Total
	Indiv./L	35	31	26	19	29	140
	%	25	22.14	18.57	13.57	20.71	8.39

Conclusions

From this study it can be concluded that successive improvement on the productive conditions within all the MCRTs were found. Among doses, the dose which treated in the MCRT-3 given best result. The characteristics of different species of plankton can sometimes help scientists to distinguish one water mass from another.

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