Utilization of organic (rice straw extract) and inorganic compounds as a fertilizer for phytoplankton and zooplankton under laboratory conditions

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Abstract: An experiment was carried out to evaluate the effect of rice straw extract as organic fertilizer on the water quality parameters and plankton density, using four treatments compared to two inorganic treatments. No significant effect on the temperature, pH, dissolved oxygen and electrical conductivity properties of the aquaria water. Nitrate and phosphate were significantly varied among treatment. Fertilizer increased chlorophyll-a concentration in organic treatments C and D, after 7 days. Phytoplankton, with 750×10^4 cell L^{-1}, had the highest density in treatment F (Inorganic fertilizer) after 35 days; On the other hand, the lowest standing crop (165×10^4 cell L^{-1}) was recorded at treatment D (Organic fertilizer) after the same period. The present experiment shows that zooplankton population increased remarkably after fertilization. These values varied between 230 and 280 Ind. L^{-1} to 87 and 81 Ind. L^{-1} in organic treatment (B) and control aquaria after 7 and 14 days, respectively. There was a significant variation in the total zooplankton count in inorganic treatment, where the density reached maximum (about 2000 Ind. L^{-1}) after 28 days. The application of Rice straw extract as an organic manure to produce sufficient quantity of phytoplankton and zooplankton for nursery fish pond management is not only better but also safe than the raw animal dung.

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1. Introduction

The aquaculture systems have been vigorously developed in recent years mainly to serve food security and income generation for the people in developing countries. To satisfy these demands, aquaculture has been undergoing diversification of cultured species and intensification of culture systems (Shahabuddin*et al.,* 2012). Development of low-cost technologies and their application to current farming practices would help in enhancing aquaculture production. For centuries fish farmers have increased fish yields by fertilizing their fishponds using inorganic fertilizers. However, due to rising cost of inorganic fertilizers, most especially in developing countries as reported by Swift (1993), greater attention is being focused on the use of organic fertilizers; such as animal and plant waste as documented by Das *et al.* (2005). Pond fertilization provides deficient nutrients and enhances the pond productivity, through efficient manipulation of autotrophic and heterotrophic pathways in extensive and semi-intensive culture system. Fertilization is an essential step in efficient farm management to increase pond productivity. Organic fertilizers decompose and release nitrogen, phosphorous and potassium which are used by phytoplankton for growth and reproduction (Knud-Hansen, 1998). In this way more natural food organisms are produced for fish. By providing organic matter, heterotrophic food production can be increased several fold and if the substrate assist to grown natural food and more fish should be able to harvest microorganisms directly in significant quantity (Schroeder, 1978) and if the substrate would mitigate the clay turbidity at the same time, that would support fish production. Provision of plant substrate is therefore being useful for the growth of natural food in the pond.

In the face of the increasing cost of fertilizers, the deterioration of soil health, environmental pollution and unsustainable crop yields, integrated nutrient management has emerged as a key issue (Mirhaj*et al.,* 2014). Thus, there is a renewed. Different plant Different plant substrates like sugarcane bagasse, rice straw and dried *Eichhornea* can be utilized for enhancing fish growth by inducing biofilms development. These are supplemented with organic manure and fertilizers (Ramesh *et al.,* 1999). Fertilizer type (Anetekhai*et al.,* 2005) and dosage (Bhakta *et al.,* 2004) strongly influences the quality and quantity of planktons, which ultimately contribute to well being and better growth performance of fish species.

Rice is the world's second largest cereal crop after wheat; however, it produces large amounts of crop residues. Only about 20% of rice straw was used for purposes such as ethanol, paper, fertilizers and fodders and the remaining amount is either removed from the field, in situ burned, piled or spread in the field, incorporated in the soil, or used as mulch for the following crop. Burning cause's air pollution called the "Black Cloud" and loss of nutrients depending on the method used to burn the straw. Park *et al.* (2006) mentioned that rice straw extract showed allelopathic activity to Microcystis. But very few researches have been done to explore the potential of using rice straw to improve water quality, algal control and enhance fish production. It was found that covering pond dikes with rice straw reduced the clay turbidity and enhanced growth of tilapia (Lin *et al.,* 2000 and Yi *et al.,* 2003) Therefore, use of rice straw should be one of the best alternatives option for water quality management and microbial production. It has large potential to be used for controlling water quality, phytoplankton production. However, little research has been conducted to investigate the physical, chemical and biological changes caused by rice straw in fishponds.

The present study was undertaken to assess the effect of rice straw extract on water quality profile, phytoplankton, zooplankton abundance and community structure and to optimize the loading of rice straw extract to fertilized fish ponds.

2.Material and Methods

Rice straw extract:

Rice straw (45g fresh) was cut into uniform lengths (5cm). These fragments were boiled in distilled water (1000 ml) for 2 h. Following cooling, the solution filtered through glass fiber paper (Whatman GF/C) and the filtrate volume adjusted to 1000 ml. This extract stored at -20°C until required.

Fertilization program:

During this experiment a fertilization program was carried out during September to October (2013) in the wet Lab. condition. Fertilizers were added into glass aquaria containing 40 liters of filtered fresh water (plankton net 100µm mesh diameter). Equal aliquots of freshly collected zooplankton (plankton net 55µm-mesh diameter) were introduced into the aquaria. An additional aquarium containing the same water and plankton, without fertilizers were used as a control to estimate plankton mortality. Fertilizers were added at a rate of 2.5, 5, 10, 15 ml/L for Rice straw extractas organic and 6-12and 4-8mg/L for super phosphate and urea as inorganic fertilizers respectively based on designed treatments. The aquaria stayed in laboratory condition for up to 35 days with continuous aeration and illumination of mean photon flux density of 80 µmol m^{-2} s^{-1}. Plankton samples were collected in duplicates at zero time and after 7, 14, 21, 28 and 35 days. The amounts added to each of the aquarium are indicated in table (1).

Table 1: Amounts of different components (fertilizers) used in the experiment (2).

	Groups						
		Organic fertilizer(Rice straw extract)				Inorganic fertilizer	
	Control	A (2.5 ml/l)	B (5 ml/l)	C (10 ml/l)	D (15 ml/l)	E	F
N (µg/l)	---	39	78	155	233	638	1292
P (µg/l)	---	18	35	71	106	157	542

Sampling program:

A weekly water, zooplankton, phytoplankton and chlorophyll-a samples were collected from each aquaria for 35 days. The following variables were determined using the following methods:

A biotic variable:

Water temperature (^{0}C), pH and conductivity (µScm^{-1}) were in-situ measured using Hydrolab model (YSI. SCT-33). The methods discussed in the American Public Health Association (APHA, 1992) were used for the determination of the chemical parameters; dissolved oxygen (mg L^{-1}) was carried out using modified Winkler method. Nitrate (µg L^{-1}) was measured by cadmium reduction method. Ammonia (µg L^{-1}) was determined by using phenate method. Orthophosphate (µg L^{-1}) was estimated by using ascorbic acid molybdate method.

Biotic variables:

For phytoplankton analysis, 500 ml of water was collected from each glass aquaria, immediately preserved with Lugols iodine. The samples were transferred into a glass cylinder and left 5 days for settling. About 90% of the supernatant siphoned off using plastic tubes covered with plankton net (5µ), and adjusted to a fixed volume. Lugol-preserved sub-samples were prepared for species identification and enumeration using inverted microscope. Each sample was examined and counted using a Drop method technique (APHA, 1992). The main references used in phytoplankton identification were Starmach (1974), Prescott (1978), Tikkanen (1986), Popovsky and Pfiester (1990) andKrammer and long Bertalot (1991).

Chlorophyll-a had been measured by filtrate a known volume of water samples, through glass micro filter paper GF/F. chlorophyll-a was extracted by 90% acetone and determined according to the equations of Jeffrey and Humphrey (1975). Chlorophyll a was estimated using Kontron 930 UV visible spectrophotometer.

Zooplankton organisms were collected weekly, 1liter of water were filtered through plankton net of mesh diameter 55µm. Zooplankton samples was immediately preserved in 4% neutral formalin. A sample of (3 ml) were drawn with a wide mouthed pipette and poured into a counting cell. All organisms completely counted and grouped. Zooplankton species were identified according to Ruttner- Kolisko (1974), Koste (1978), Shiel and Koste (1992), Einsle (1996) and Smirnov (1996).

Statistical analysis:

The data was first checked for analysis of variance. The data was then subjected to analysis of variance (ANOVA) Microsoft Office Excel 2003. Similarities between treatments, groups and duration of the experiments were calculated using XL Stat (2001) program.

3. Results

Physical and chemical parameters:

The results of physical and chemical variables of glass aquaria water are present in (Fig.1). Generally, there were no marked variations in temperature between the various treatments and control groups observed at any given point of time. Water temperature fluctuated between 28.3°C in treatment F after 7 days and 23.6°C in treatment F after 7 days, with an overall average value of 26.4°C. The present results show a narrow variation in conductivity distribution patterns at the surveyed aquaria. The conductivity reading was ranged between 527µS/cm in treatment D after 35 days and 345µS/cm in treatment E during the beginning of experiment (Fig. 1). pH values of the studied aquaria were always on the alkaline side. Throughout the period of experiment pH values ranged between 8.46 in treatment F after 28 days and 7.99 in control aquarium after 35 days, with an average value of 8.16. The water of the studied aquaria was well oxygenated throughout the study period, with an average of 7.4 mg L^{-1}. The values for nitrate were obviously high at the aquaria with inorganic fertilizer. It ranged between 2752 µg L^{-1} at treatment F after 35 days to 98 µg L^{-1} at control during the beginning of the experiment. The concentration of ammonia was fluctuated between 182.5 µg L^{-1} at treatment D after 7 days to 31.8 µg L^{-1} at treatment A after 35 days. The orthophosphorus content of the aquaria water was lowest (22.4 µg L^{-1}) at control during the beginning of the experiment.On the other hand, the highest value of 968.6 µg L^{-1}had been recorded during treatment D after 28 days µg L^{-1}.

Chlorophyll- a

Organic fertilizer (Rice straw extract) increased chlorophyll-a concentration in treatments C and D, after 7 days, obviously decrease reaching minima after 21 days, followed by a slight increase until the experiment end. When compared to those at inorganic treatment, chlorophyll- a concentrations were highly propagated after 35 days at treatments F and E with a yield of 574 and 278 µg L^{-1} , respectively. (Fig. 2).

Phytoplankton

In total, 101 phytoplankton taxa were recorded in the aquaria samples (Table 2). Bacillariophycea was abundant, forming 78.2% of total phytoplankton standing crop, with 26 taxa, followed by Cyanophyceae, with 26 taxa, contributing 9.1%. Although, Chlorophyceae was highly diverse group (38 species), it was only contributing about 7.7%. Other phytoplankton groups were Dinophyceae (2 taxa), Chrysophyceae (4 taxa), Euglenophyta (3 taxa), and Cryptophyta (2 taxon) (Table 2). It seems that there is a clear obvious variation of phytoplankton population among the different treatment. In fact, phytoplankton, with 750 × 10^4cell L^{-1}, had the highest density in treatment F (Inorganic fertilizer) after 35 days; On the other hand, the lowest standing crop (165 × 10^4 cell L^{-1}) was recorded at treatment D (Organic fertilizer) after the same period. Bacillariophycea was the abundant group, forming 78% of total phytoplankton density. It exhibit the same general trends as total phytoplankton i.e. an augmented in its standing crop was noticed at treatment A, comparing with the other organic once. On the other side the abundance of this group was obviously high at inorganic treatments in compared with the organic once, particularly after 35 days (Fig. 3). *Syndra ulna* and *Fragilariaconstruens* were abundant within the group, forming 59 and 23% of Bacillariophycea crop, respectively. Cyanophyceae came next, contributing about 9% of total phytoplankton density. Cyanophyceae was sharply propagated in density with treatment C and D (Rice straw extract) and treatment F (Inorganic fertilizer) after 7 and 25 days, respectively. *Eucapsisminuta*, *Lyngbyalimnetica*, *Oscillatorialimosa* and *Spirolinaplatenensis* were dominated the other Cyanophyceae taxa. Chlorophyceae represented by 38 species was constituted about 8% of total phytoplankton density. *Ankistrodesmusfusiformis*, *Actinastrumhanzchii*, *Monoraphidiumcontortum* and *Scenedesmusquadricuda* were augmented with inorganic treatment. Few numbers of taxa in low density belonging to Chrysophyceae, Dinophyceae, Cryptophyceae, and Euglenophyceae were infrequently recorded during the present experiment.

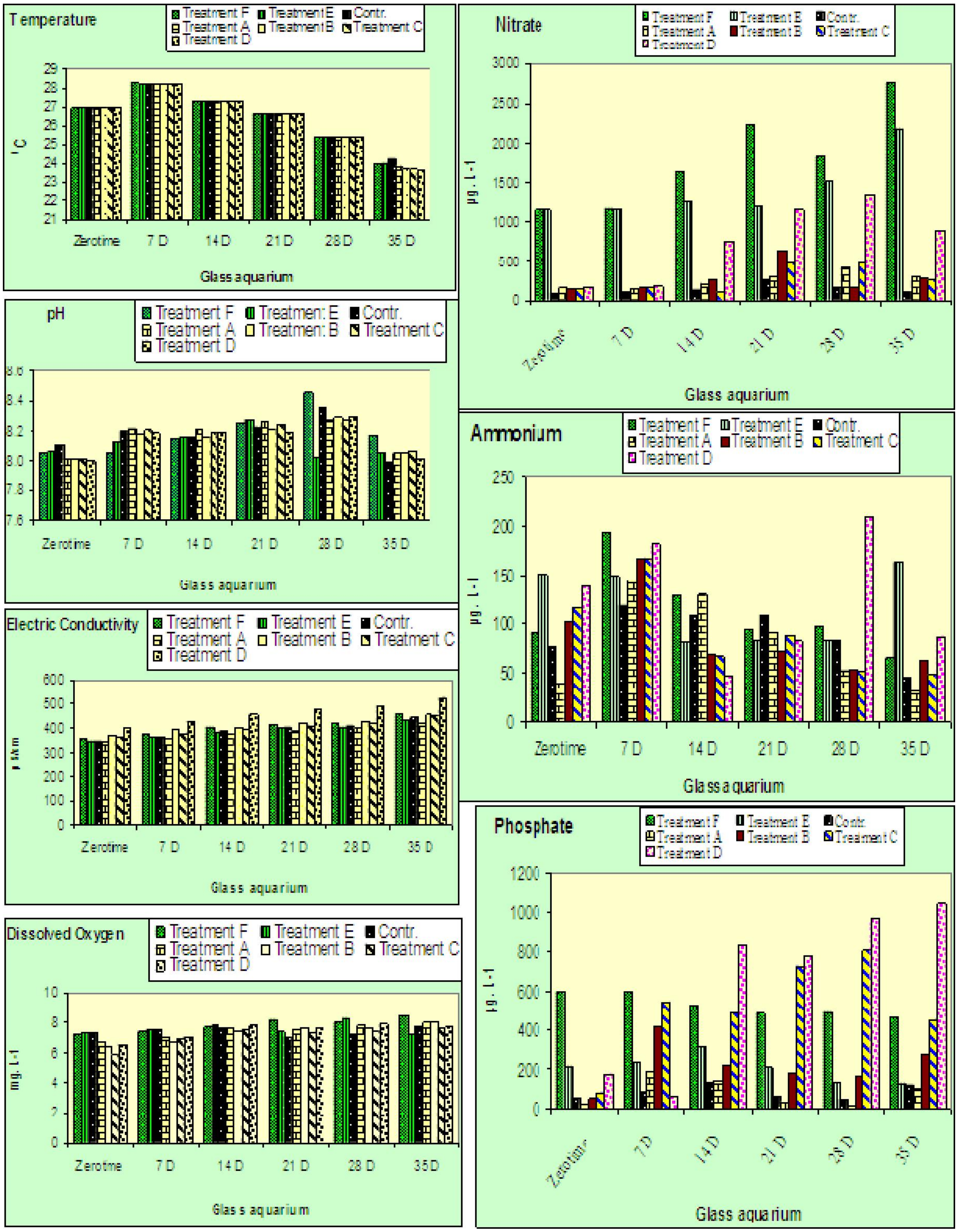


Fig. (1). Changes in physico-chemical profile of the aquaria water along the experiment period.

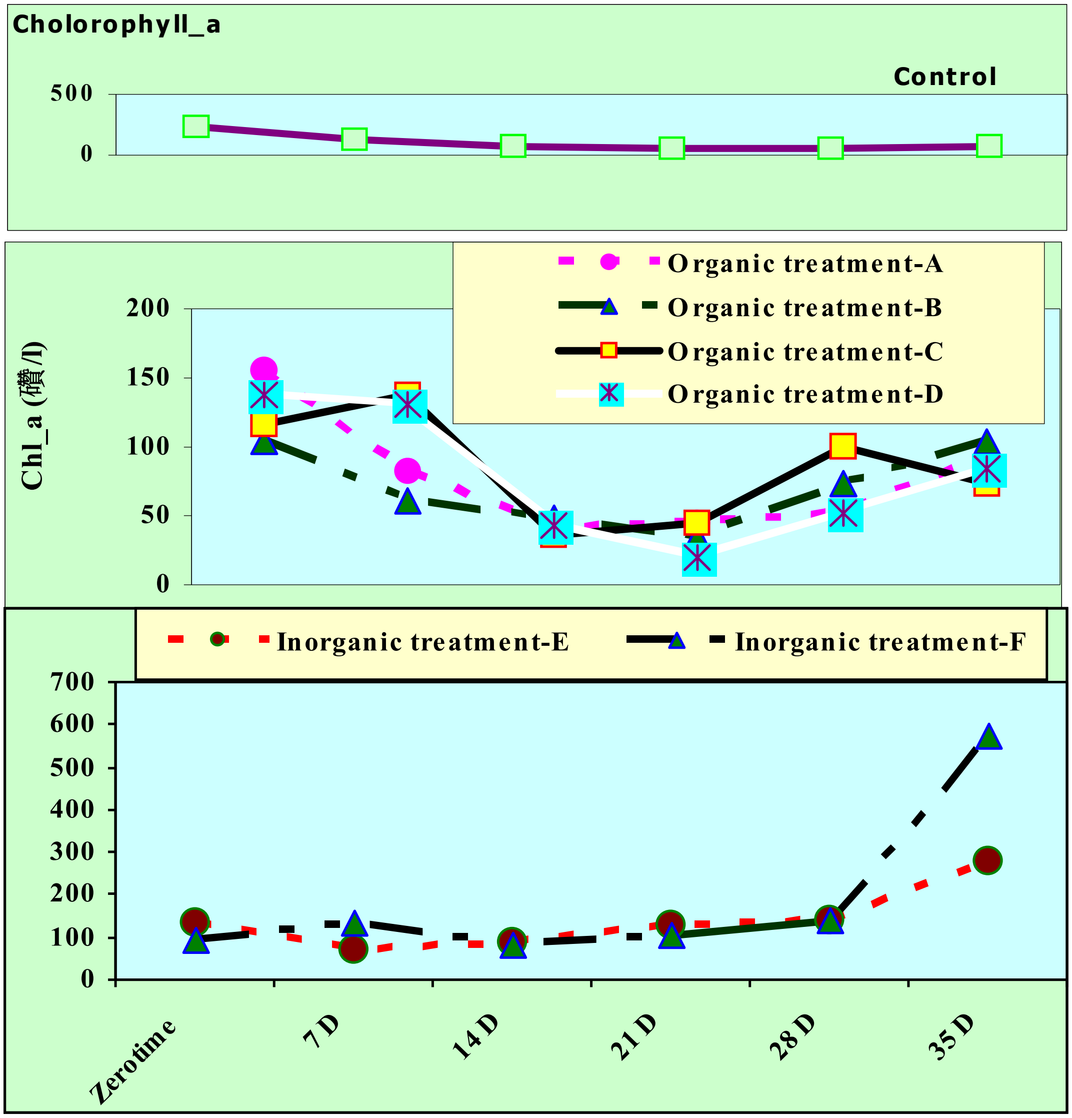


Fig. (2): Changes in chlorophyll-a concentration among the studied aquaria

Zooplankton

A total of 67 zooplankton *taxa* belonging to 5 main groups (Protozoa, Copepoda, Rotifera, Cladocera and meroplankton) were recorded (Table 3). Zooplankton was respond quickly to organic treatment, propagated its density after 7 days and reached maximum after14 days, then gradually decreased to minima at the experiment end. Copepoda represented the abundant zooplankton group, forming 46.5% of total zooplankton crop. It follows the same general trends as total zooplankton (Fig. 4). Copepodanauplii and copepodid dominated over adult stages, contributing more than 90 % of total copepod density. They show the highest peak of 250 and 170 Ind.L-1 at treatment E after 28 days. *Thermocyclopsneglectus* and *Acanthocyclopstrajani* were abundant within copepods. In the present experiment rotifera was the second abundant group, forming 27 % of total zooplankton abundance. Rotifera was rapidly respond to organic treatment, in particular treatments B, C after 7 and 14 day and shapely decreased to minima at the end of experiment. In Inorganic treatment, rotifera shows a steady slight increase until 21days, followed by a rapid propagation in density reaching pinnacle after 28 days in treatment E, then shapely decline after 35 days. *Lecane bulla*, *Lecanearcula*, *Lepadella patella* and*Lecaneclosterocerca*were positively responding with inorganic and organic fertilization, respectively. Cladocera respond slowly to organic treatments reached maximum after 14 and 21 days and follows the same trends as copepoda in inorganic treatment (Fig. 3). *Ceriodaphniadubia*, *Chydorussphaericus* was augmented with organic treatment B and C. *Bosminalongirostris*, *Diaphanosomamonoglainum* and

Ceriodaphniadubia were propagated with inorganic treatment F. Few numbers of Meroplankton and protista were infrequently recorded during the present experiment.

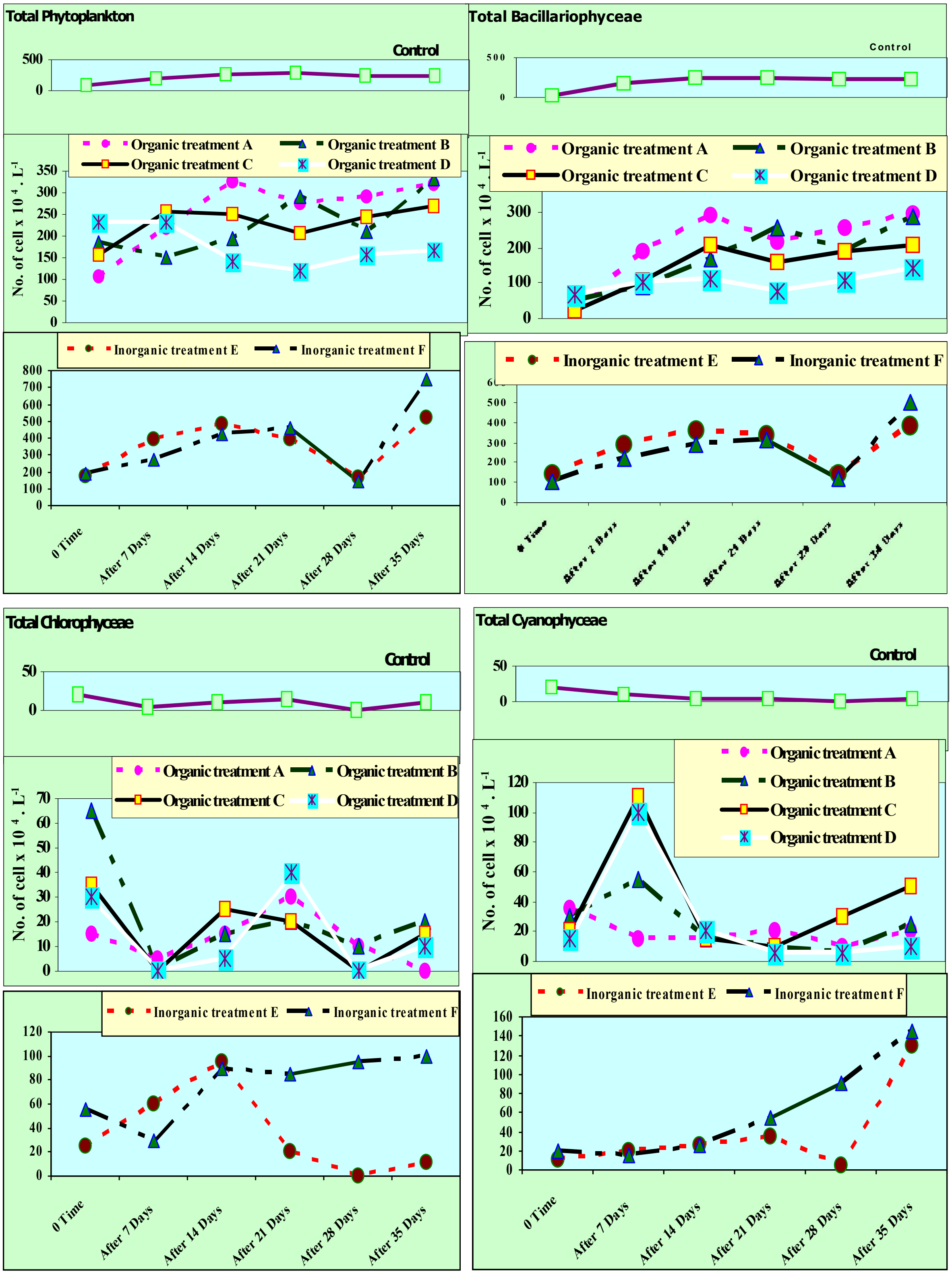


Fig. (3) Changes in abundance of phytoplankton and its main groups among the different treatment

Table (2): A list of the recordrd phytoplankton species during present experiment.

Bacillariophyceae	*Scenedesmusbicaudatus*
Achnanthisminutissma	*Scenedesmusdimorphus*
Amphora ovalis	*Scenedesmusquadricuda*
Cocconeisplacentula	*Scenedesmusecornis*
Cyclotellaglomerata	*Scenedesmusacuminatus*
Cyclotellameneghiniana	*Scenedesmusportuberance*
Cyclotellaocellata	*Selenastrumgracile*
Cyclotellaoperculata	*Sterococcussuperbus*
Cyclotellastelligera	*Tetraedrontumidulum*
Diatomahiemale	*Tetraedron minimum*
Fragilariaconstruensver.venete	
Fragilariacrotonensis	***Cyanophyceae***
Melosiragranulata	*Anabaena fertilissma*
Melosiragranulata var. angustissima	*Aphanocapsaelachistaver.conferta*
Melosiradistans	*Beggiatoa minima*
Naviculadicephala	*Chroococcusdispersus*
Naviculacreptocephala	*Chroococcuscohren*
Naviculapusilla	*Coelosphaeriumkuetzingianum*
Nitizschialongissima	*Cylindrospermopsisraciboroskii*
Nitizschiaacicularis	*Eucapsisminuta*
Nitzschiapalea	*Eudrinaunicocca*
Nitzschiafonticola	*Gloeocapsacompacta*
Nitzschiafrustulum	*Gloeocapsa minima*
Raphoneisamphiceros	*Gomphosphariumlacustris var. compacta*
Syndra ulna	*Gomphosphariumlacustris*
Syndra ulna var. subtaequalis	*Gomphosphariumcompacta*
Syndrapulchella	*Lyngbyalimnetica*
	Lyngbyaversicolor
Chlorophyceae	*Lyngbyaporphyrosiphonis*
Ankistrodesmusfusiformis	*Merismopedia minima*
Ankistrodesmusconvulatus	*Merismopediapunctata*
Ankistrodesmusfalcutus	*Myxosarcinaspectabilis*
Ankistrodesmusnitizschiod	*Oscillatorialimosa*
Actinastrumhanzchii	*Oscillatorialimnetica*
Chlymedemonas sp.	*Phormidiuminterruptum*
Coelastrummicroborum	*Phormidiumlaminosa*
Coelastrumsphericum	*Phormidiumpurpurascens*
Coelastrumretculatum	*Spirolinaplatenensis*
Cosmariumgrantum	
Cosmariumgalenitum	***Dinophyceae***
Cosmarium sp.	*Peridiniumumbonatum*
Chodatellaciliate	*Prorocentrummicans*
Dictyosphaeriumpulchellum	
Elakatothrixgelatinosa	***Chrysophyceae***
Golenkiniaradiata	*Chrysococcusrufescens*
MicractiumPusillum	*Mallomonasacaroides*
Monoraphidiumcontortum	*Mallomonashelvetica*
Oocystisgigas	*Ochromonasmutabilis*
Oocystissolitaria	
Oocystiscrassa	***Cryptophyceae***
Oocystislacustris	*Creptomonaserosa*
Pediastrum duplex	*Pyramimonas sp.*
Pediastrum duplex var. gracillimum	
Pediastrum simplex	***Euglenophyceae***
Pediastrum simplex var.duodenarium	*Trechlomonasvolvocina var. deyephora*
Rhabdodermalineare	*Trechlomonasarmata*
Staurastrumparadoxium	*Euglena gracilis*

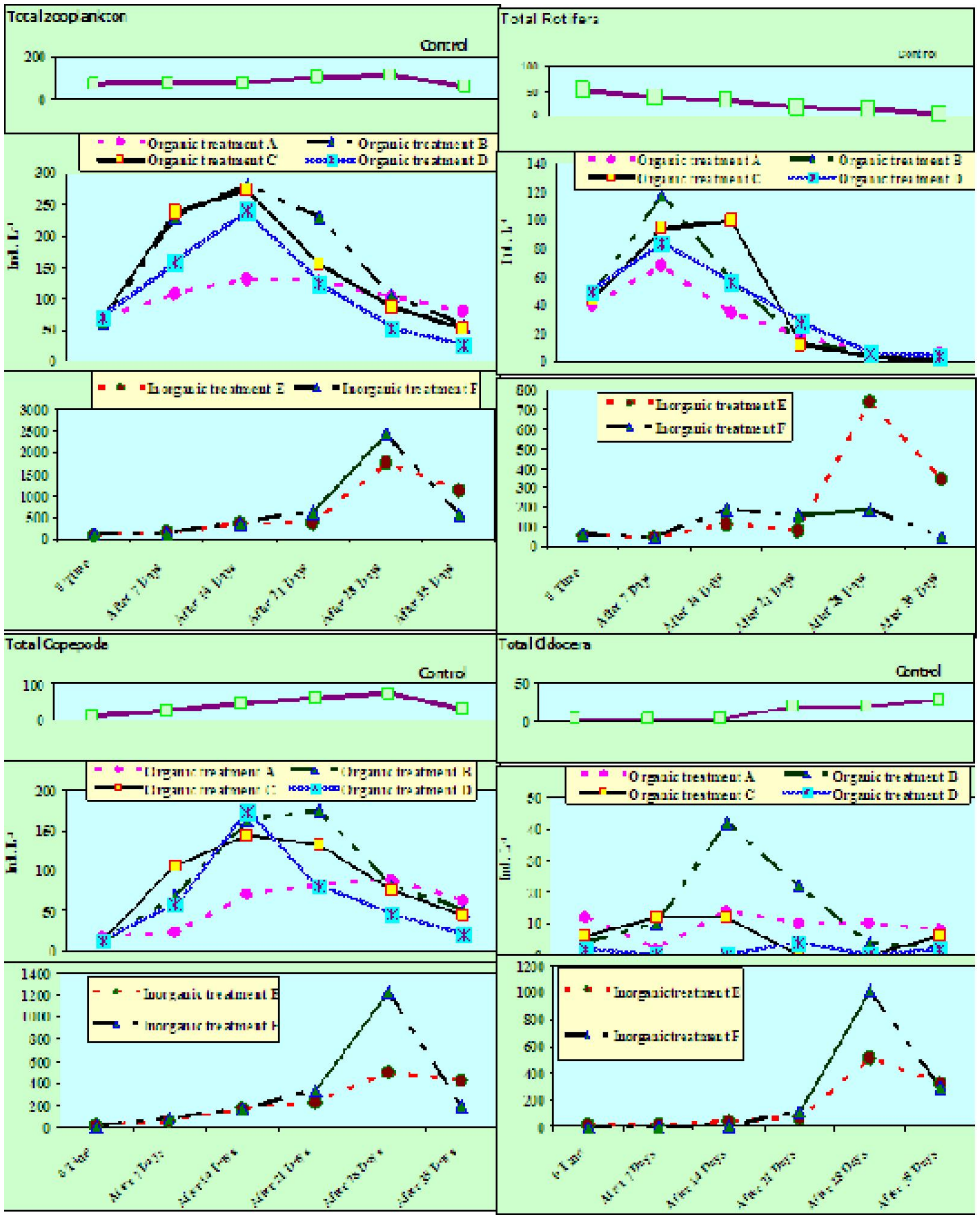
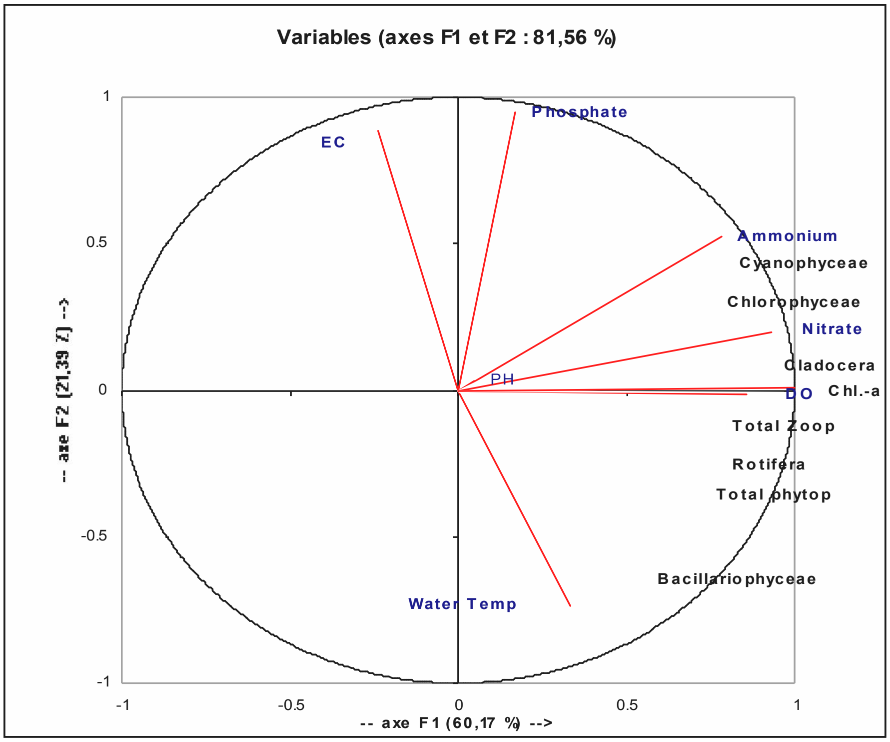


Fig. (4) Changes in abundance of zooplankton and its main groups among the studied aquaria

Principal component analysis(PCA) characterised patterns of variation in plankton assemblages relative to fertilizer treatment. It allowed discrimination of a group surrounding the F1 and F2 component axes (Fig. 5), thus explaining 81.56% of the variance. Axis I, explaining 60.17% of the variance in species scores was well correlated with dissolved oxygen, nitrate and Ammonium. The eigenvalue of axis I was 9.03 Chl-a, Total phytoplankton, Cyanophyceae, Chlorophyceae, Total Zooplankton Cladocera had the highest score on axis I, while Phosphate and electric conductivityrevealed the lowest. Axis II explained 21.39% of the variation. Nitrate showed a positive correlation with Chl.-a, total phytoplankton, Cyanophyceae, Chlorophyceae, Bacillariophyceae, total zooplankton, cladocera (r= 0.95, 0.85, 0.83, 0.94, 0.66, 0.96, 0.98, respectively), while electrical conductivity was negatively correlated with Bacillariophyceae (r=-0.73). Dissolved oxygen showed a positive correlation with Chl.-a, total phytoplankton, Cyanophyceae, total zooplankton, Cladocera (r=0.85, 0.74, 0.81, 0.79, 0.86) and phosphate was positively correlated with Cyanophyceae (r=0.61) (Fig. 5). Cluster analysis confirm that both treatment E and F (inorganic fertilizer) are closed to each other and have the same effect on plankton communities. Treatment A (organic fertilizer) is closed to control and the others organic treatment (Fig. 5).

Table (3): A list of the recodrd zooplankton species during present experiment.

Rotifera	*Proralidessp*
Anuraepsisfissa	*Rotatoriasp*
Asplanchnellagirodi	*Synchaetaoblonga*
Brachionusangularis	*Squatinellamutica*
Brachionusbudapstinensis	*Testudinella patina*
Brachionuscalyciflorus	*Trichocercacylindrica*
Brachionuscaudatus	*Trichocercaelongata*
Brachionuspatulus	*Trichocercalongiseta*
Brachionusplicatilis	*Trichocercapusilla*
Brachionusquadridentatus	*Trichotriatetractis*
Brachionusurceolaris	**Copepoda**
Brachionusfalcutus	Nauplius larva
Cephalodelladelicata	Cyclopoidcopepodid
Colurellaadriatica	*Thermocyclopsneglectus*
Colurellaobtusa	*Acanthocyclopsamericanus*
Euchalanusdilitata	*Apocycylops*
Epiphanesbrachionus	*Schizoprsnilotica*
Filinialongiseta	**Cladocera**
Hexarthramira	*Alonarectangula*
Keratellacochlearis	*Bosminalongirostris*
Keratellatropica	*Ceriodaphniaquadrangula*
Lepadella patella	*Chydorussphaericus*
Lecane bulla	*Diaphanosomamonoglainum*
Lecaneclosterocerca	*Ilyocryptusagilis*
Lecane ungulate	*Macrothrixlaticornis*
Lecaneluna	*Moinamicrara*
Lecaneleontina	**Meroplankton**
Lecanearcula	Free living nematoda
Lecanequadridentata	Chironomus larvae
Monommataaequalis	*Oscracoda spp.*
Notommatacopeus	**Prortozoa**
Philodinaroseola	*Arcella spp.*
Pompholyxcomplanata	*Centropayxacoelata*
Polyarthra vulgaris	*Dileptusanser*
Platyiasquadricornis	*Pseudodileptus spp.*
Poralesdicipiens	*Stylonychiamytilus*



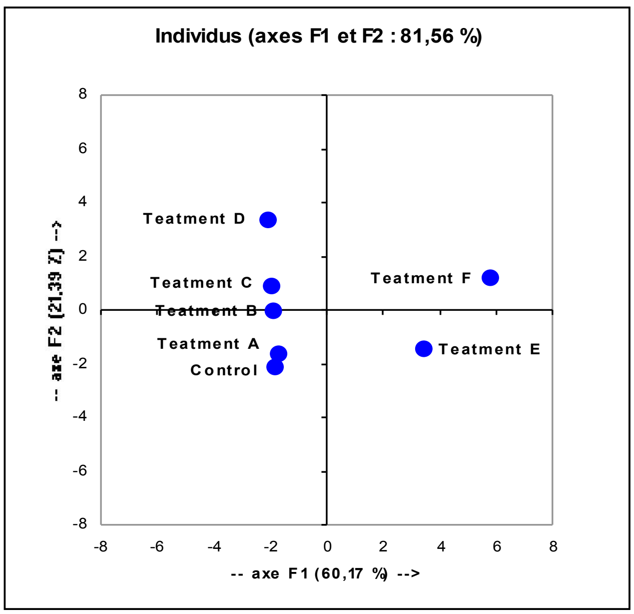


Fig. (5): Principal component analysis (PCA) (Axis I and II) performed on plankton community structure and some physico-chemical profile after fertilizer treatments.

4. Discussion

Pond fertilization is a management protocol to enhance biological productivity by means of organic and inorganic fertilizers. The role of fertilizers in increasing fish production has been emphasized in many studies covering tropical conditions (Bhakta *et al.,* 2004). The biological justification for fertilizing rearing ponds is to stimulate the development of aquatic bacteria, algae, and protozoa, and thus a variety of phytoplankton and zooplankton species which can be eaten by fish. The abundance and composition of these forage organisms can also be manipulated by selective application of organic and inorganic fertilizers. The major elements of importance in this dynamic cycle are nitrogen, phosphorus, and carbon. Effective water management in fishponds is one of the important factors contributing to the success of fish culture, reducing the occurrence of fish disease and enhancing fish growth and survival. Factors such as light, temperature and nutrients play an important role in phytoplankton productivity in aquatic systems (Wetzel, 1983). In the present study, the physico-chemical parameters remained within favorable ranges for plankton growth and survival. Hydrogen ion concentration or pH as one of the vital environmental characteristics decides the survival, metabolism, physiology and growth of aquatic organisms. Ramanathan*et al.* (2005) recommended optimum range of pH 6.8-8.7 for maximum growth and production of aquatic organisms. pH did not differ significantly among different treatment during the present experiment period. Dissolved oxygen can be said to be the most important among the water quality parameters without which plankton production is impossible. Desirable concentration of dissolved oxygen for most aquatic organisms is 5 mg/l. Qin *et al.* (1995) verified that ponds with organic fertilizers showed lower oxygen contents when compared to those fertilized with inorganic material. Organic fertilizers function as an energy source for bacterial growth, which leads to aerobic decomposition, an important factor in decreasing oxygen supply in fishponds. The concentrations recorded in all the aquaria used in this study have been within this range. Phosphorus is a key element involved in virtually all aspects of cellular metabolism, including phosphorylation reactions and synthesis of nucleotides, phosphorylated intermediate compounds, and various vitamins and enzymes. It is usually the limiting factor in plankton production in freshwater systems (Schindler, 1978; Welch *et al.,* 1978). Fred *et al.* (1980) determined experimentally that phytoplankton absorbs phosphorus and nitrogen at a 1:4 ratio. Santhosh and Singh (2007) described the favorable range of nitrate of 0.1 mg L^{-1} to 4.0 mg L^{-1} in fish culture water. Seymour (1980) found that dense blooms of nitrogen-fixing algae (mainly blue-greens) could be controlled by manipulating the nitrogen-phosphorus balance in ponds; some of his data indicated that the 1:4 ratiowas advantageous to phytoplankton production in ponds. Schroeder (1978) indicated that the addition of organic manure to chemically fertilized ponds did not increase primary productivity, possibly due to the inorganic fertilizer supplying the nutrient needs of photosynthesis; also, photosynthetic productivity could not exceed the levels set by the amount of solar energy penetrating the pond surface.

Organic fertilizers are decomposed to inorganic carbon (usually CO_2) and inorganic nitrogen by a wide variety of aquatic fungi, bacteria, and protozoa. The initial decomposition rates are usually high as simple organic compounds break down; the more resistant organic compounds (cellulose, chitin, etc.) are the last to decompose (Boyd, 1979: Wetzel, 1983). Because of this differential decomposition, the carbon: nitrogen ratio can be used as an indicator of organic decomposition (Boyd, 1979). Organic fertilizers with high carbon: nitrogen ratios, such as wheat and rice straw, decompose more slowly than green crop-residues, such as cottonseed meal and alfalfa meal, or some of the animal manures (Snow *et al.,* 1964; Boyd, 1979). Almazan (1974) found that the decomposition of organic material was increased by the addition of ammonium nitrate, which apparently stimulated increased bacterial production. Sherr*et al.* (1982) discovered that the decomposition of organic detritus could also be enhanced by microflagellate protozoa. Klimczyk (1964) found that fertilizing fish ponds with inorganic appeared to be advantageous to copepod development, whereas cladocerans appeared to benefit from the organic manure. According to Okojin and Obi (1999), organic fertilizer increases the growth of smaller sized zooplankton (Rotifera) while inorganic fertilizer favors growth of bigger sized zooplankton (Copepoda), the later resulting in more favorable conditions for fish culture. Predominance of juvenile organisms (nauplii) among crustaceans may be associated with the management adopted (fertilization) (Begum *et al.,*2007). High concentrations of total phosphorus, ammonium and high temperature promote species with a fast reproduction rate and short life span, such as Rotifera (Walz*et al*., 1995). Chakrabarti and Sharma (1998) mentioned that inorganic fertilizer favored an abundance of Copepoda, followed by Cladocera, and Rotifera. Dhawan and Laur (2002) and Mischke and Zimba (2004) also reported that organic and inorganic fertilizers also favored dominance of Rotifera, followed by Copepoda and Cladocera. The present experiment shows that zooplankton population increased remarkably after fertilization. These values varied between 230 and 280 Ind. L^{-1} to 87 and 81 Ind. L^{-1} in organic treatment (B) and control aquaria after 7 and 14 days, respectively. There was a significant variation in the total zooplankton count in inorganic treatment, where the density reached maximum (about 2000 Ind. L^{-1}) after 28 days. Kaur and Ansal (2010) reported a similar findings. Zooplankton responses to fertilization were also studied in Texas ponds without fish. Small cladocerans reached maximum densities on day 15, copepod nauplii and adults on day 26, and Daphnia spp. on day 30 (Parmley and Geiger, 1985). However, Mischke and Zimba (2004) mentioned that zooplankton populations reached peak concentrations earlier and began increasing at an accelerating rate 7–10 days after filling so filling fry at 2–3 weeks before stocking were recommended at ponds (Mischke*et al.,*2003). Morris and Mischke (1988) reported that phytoplankton populations alone do not necessarily increase zooplankton populations as zooplankters will eat more fungi and bacteria associated with decaying organic substances than phytoplankton directly.

It would be quite feasible to mention here that use of rice straw extract has no deleterious effect on the hydrological characteristics and productivity profile of freshwater used for cultivable fish ponds. It is therefore could be concluded that the application of this extract as an organic manure to produce sufficient quantity of phytoplankton and zooplankton for nursery fish pond management is not only better but also safe than the raw animal dung.

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