Enhancement of Fish Production with Periphyton-based aquaculture by using aquatic weed, Ipomoea sp. in irrigation tanks and dissemination of the technology of fisher folk

Project Report

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Submitted to

University Grants Commission
MRP-F. No. 42-548/2013 (SR)
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Contents

1. Introduction

Water is a necessity for all living beings, without it; there would be no life. Water is known to contain a large number of chemical elements. Life originated in water and the ultimate basis of it, the protoplasm, is a colloidal solution of complex organic molecules in a watery medium (70 to 90% water). Most of the biological phenomena take place in water medium. Moreover, wherever water exists in nature it always holds life. So the study of a water body is the study of life as well. Water is essential at all levels of life, cellular to ecosystem. The healthy aquatic ecosystem is depended on the physico-chemical and biological characteristics (Venkatesharaju et al 2010). It is essential to circulation of body fluids in plants and animals, and it stands as the key substance for the existence and continuity of life through reproduction and different cyclic process in nature; it plays the central role in mediating global scale ecosystem processes, linking atmosphere, lithosphere, and biosphere, by moving substances among them, and enabling chemical reactions to occur. Humans depend on this resource for all their needs of existence and survival. Nature has an innate mechanism to maintain its purity after every natural use. But it is unable to do this at the rate at which modern humans add dirt to it. Nature does not know how to deal with several toxins and pollutants that are flowing from industrial and other wastes. Therefore, humans are bound to monitor the impact of this activity on natural freshwaters continuously.

Water is the base of life and development. Water is the physical support in which they carry out their life functions such as feeding, swimming, breeding, digestion and excretion (Bronmark and Hansson, 2005). The wetland forms unique biological fresh water ecosystem on the planet earth. These water bodies store the freshwater from adjoining are during rainy season. It plays an important role in any ecosystem, hydrology of area and economy. They provide the habitats for migratory birds, aquaculture, plants, animals and microbes. Freshwater is a natural home of innumerable living things, many of them harmless or even beneficial, some of them directly or indirectly injurious to man. The environmental pollution affects the general quality of our health. Several studies have been made on the limnology of fresh water bodies in India. Water resources in

India have reached a point of crisis due to unplanned urbanization and industrialization. Urbanization has directly negative impacts on water bodies. Therefore now a days freshwater has become a scare commodity due to over exploitation and pollution. Reservoir water is one of the most important and widely distributed natural resources which are considered as supplemental resource to meet the domestic, agriculture and industrial requirements.

Last half of the 20th century is witness to the three phenomena of great ecological consequences first, an unwanted population growth, the second, fertilizers intensive agriculture and the third industrialization. All had adverse impacts on environment in general and water resources in particular. The latter manifesting in terms of gross pollution of ground and surface water, destruction of catchments and progressive reduction of water holding capacity of water bodies. With reference to lakes and impoundments mainly created for irrigation purpose, the derivative untreated domestic sewage, solid waste disposal and in many cases industrial effluents. Fresh water has become the most precious resources due to its ever increasing demand in domestic, agricultural and industrial sectors and there is an urgent need for its judicious utilization and conservation. In the 21st century, the urban water problem in terms of adequate supply to satisfy demand of ever-exploding population and industry and increasing quantum of freshwater in the form of sewage and industrial effluents, is going to be a big challenge to urban policy makers and planners. As pointed out by world commission on environment development 21st century will be largely urban world.

In limnological study the consideration of physico-chemical factors contributes in making up of the specific ecosystems, which determines the trophic dynamics of the water body. Shweta Tagy and et al (2013). It is necessary to know the physico-chemical properties of water to study the culture practices of the fish in water bodies. The productivity of water sheets depend primarily on the physico-chemical and biological characteristics of water. These properties again depend on the nature of bottom soil and climatic conditions. Beuro of Indian Standards for Drinking water 2012 (BIS 2012). The physico-chemical parameters of water like temperature, pH, Electric Conductivity dissolved oxygen, biological oxygen demand, chemical oxygen demand, total alkalinity, carbonates, bicarbonates, calcium, magnesium, hardness, chlorides, sulphates, nutrients like nitrates and phosphates, turbidity and total dissolved solids are important to know the trophic nature of the water body. Water bodies are generally of three types-oligotrophic mesotrophic and eutrophic. Usually mesotrophic water bodies are highly productive in nature. Standard APHA methods for the examination of water, 22^{nd} Edition, (2012). To asses that monitoring of these parameters is essential to identify magnitude and source of any pollution load. These characteristics can identify certain condition for the ecology of living organisms and suggest appropriate conservation and management strategies. Many researches are being carried out till present (Rajesh *et al* 2002, Jayaraman *et al* 2003, Sharma & Gupta 2004; Rajasekar *et al*., 2005; Sridhar *et al.*, 2006; Anilakurmary *et al*., 2007; Prabu *et al*., 2008; Raja *et al*., 2008; Pradhan *et al*., 2009; Srivastava et., 2009; Damotharan *et al*., 2010; Prasanna and Ranjan, 2010). Niranjan K. *et.al*. (2011).

The assemblage of the organisms vary from one ecosystems to another because the habitat condition unique to each type of ecosystem tend to affect the species distributions. An aquatic ecosystems dependent on one another and their water environment for nutrients.(eg, Nitrogen and Phosphorus) and shelter. Healthy aquatic ecosystems are those where human disturbances have not impaired the natural functioning nor appreciably altered the structure of the system. An unhealthy aquatic ecosystem is one when natural state is out of balance. Ecosystems are also composed of four basic components eg, water, land, air and living things (plants and animals). Everything in an ecosystem is related to everything else. Consequently, anything that occurs in one of these basic components will have an effect on the other three. Phyto plankton is small organisms that play a crucial role in the food chain. While increased amounts of phytoplankton provide more food for organisms at higher tropic levels. Phytoplankton is the chief primary producer of the aquatic environment which fixes solar energy by process of photosynthesis, assimilating carbon dioxide and water to produce carbohydrates. The term plankton refers to those microscopic aquatic forms having little or, no resistance to the water current and are free floating and suspended in open or pelagic waters. The planktonic plants are referred to as "Phytoplankton (microscopic algae and Bacteria) occurs as unicellular, colonial or filamentous forms. Many carryon photosynthesis and are grazed upon by zooplankton and other aquatic organisms. The phytoplankton is an assemblage of heterogeneous microscopic algal forms of aquatic systems whose movement is more or less dependent upon water currents. The phytoplankton population in reservoir are influenced by the development of communities in upstream reservoirs with species typical from sites with higher retention time.

Planktons, particularly, phytoplankton was used as indicators of water quality (APHA, 2005). Phytoplankton the most important biological phenomenon in nature on which the entire array of life depends, is the integral part of riverine ecosystem which determines the primary productivity of the eco system and also bio-indicators of water pollution. Its appearance, disappearance, density and pattern of distribution depend on biotic and a biotic factors (Escaravage and Prins, 2002; Gupta *et al*., 2005; Kauppila *et al*., 2004; Komala *et al*., 2013; LeQuere *et al*., 2005 and Lewitus *et al*., 1998; Escaravage *et al*., 1999). Phytoplankton's are the primary producers forming the first tropic level in the food chain. Diversity of planktonic organisms in quite high in fertile standing water bodies. Phytoplankton diversity responds rapidly to changes in the aquatic environment particularly in relation to silica and other nutrients (Chellappan, 2008).

Planktons are very sensitive to the environment they live in any alteration in the environment leads to the change in the plankton communities in term of tolerance, abundance, diversity and dominance in the habitat. Therefore, plankton population observation may be used as a reliable tool for biomonitoring studies to assess the pollution status of aquatic bodies (Davis, 1995; Mathivanan *et al.*, 2008). Zooplanktons are microscopic animals that eat other plankton. Zooplanktons occupy a central position between the autotrophs and other heterotrophs and form an important link in food web of the freshwater ecosystem. Zooplanktons constitute the food source of organisms at higher trophic levels

Phytoplankton forms the vital source of energy in the fresh water environment. They initiate the fresh water food chain, by serving as food to primary consumers, which include zooplankton, finfish, shell fish and others (Tas *et al.*, 2007). The qualitative and quantitative studies of phytoplankton have been utilized to assess the quality of water (Shekhar *et al.*, 2008). Phytoplanktons are the major primary producers in many aquatic ecosystems and are important food source for other organisms as reported by Sukumaran *et al.* (2008) in his studies on species composition and diversity of phytoplankton of Pechiparai dam. Phytoplanktons not only serve as food for aquatic animals, but also play a crucial role by maintaining the biological balance and quality of water as revealed by Pandey *et al.* (1998) while studying the algal flora of Fatehsagar Lake. Various physicochemical factors like pH, DO, alkalinity and the dissolved nutrients affect the phytoplanktonic production. Plankton diversity quickly responds to change in the environment of aquatic system, particularly in relation to nutrients.

The zooplankton (microscopic drifting or wandering animals) occupies a vital role in the tropic structure of an aquatic ecosystem and plays a key role in the energy transfer. Unlike algae or phytoplankton, zooplankton are microscopic animals that do not produce their own food. Freshwater zooplankton play an important role in ponds, lakes and reservoirs ecosystem and food chain. They are responsible for the eating millions of little algae that may otherwise grow to an out-of-control state. However, not all algae are edible and oftentimes it's the blue green algae that we would like to see disappear that cannot be eaten. In fact, as mostly filter feeders, a community of zooplankton can filter through the volume of an entire lake in a matter of days. The zooplankton community is composed of both primary consumers (which eat phytoplankton) and secondary consumers (which feed on the other zooplankton). The zooplankton forms a major link in the energy transfer at secondary level in aquatic food webs between autotrophs and heterotrophs. Nearly all fish depend on zooplankton for food during their larval phases and some fish continue to eat zooplankton in their entire lives. The aquatic ecosystems are affected by several health stressors that significantly deplete biodiversity.

Zooplankton species have different types of life histories influenced by seasonal variations of biotic factors, feeding ecology and predation pressure. In the future, a loss of biodiversity and its effects are predicted to be greater for aquatic ecosystems than for terrestrial ecosystems. The zooplankton is also a valuable food source for planktivorous fish and other organisms. The presence or absence of healthy zooplankton populations can determine some commercial fisheries success in both fresh and salt water bodies. By insuring that the lower parts of the food chain are healthy, we can protect the higher ordered organisms, like fish, whales and even humans.

The major zooplankton groups vary in their relative abundance and they belong to these groups Rotifera, Cladocera, Copepoda, and Ostracoda. In ecologically, zooplankton are one of the most important biotic components influencing all the functional aspects of an aquatic ecosystem, such as food chains, food webs, energy flow and cycling of matter (Dadhick and Sexena 1999; Sinha and Islam 2002). The distribution of zooplankton community depends on a complex of factors such as, change of climatic conditions, physical and chemical parameters and vegetation cover.

Periphyton is of growing interest worldwide. It is immensely important for various reasons: (i) it is a significant, and often the dominant, contributor to carbon fixation and nutrient cycling in aquatic ecosystems; (ii) it is an excellent indicator for changes occurring in the aquatic environment; (iii) it is used to improve water quality in lakes and reservoirs; (iv) it increases food availability in aquatic production systems; (v) it can provide specialty foods for fish and shellfish larvae culture; and (vi) it can be used for wastewater treatment. The variety of organisms found in periphyton is enormous; it harbours algae, bacteria, fungi, protozoa, zooplankton and other invertebrates. These organisms function as a community, making them highly efficient in capturing and processing nutrients. Periphyton is immensely important in aquatic systems as it provides community structure and primary productivity that support a wide range of aquatic organisms. Periphyton is easily grazed upon by small invertebrates, fishes and shrimps and hence contributes considerably to the productivity of aquatic ecosystems, natural or human-made.

Periphyton is a complex mixture of autotrophic and heterotrophic organisms and cannot simply be regarded as attached equivalent of phytoplankton, although it certainly performs similar functions in ponds, such as oxygen production and the uptake of inorganic nutrients. There is an intense exchange of inorganic and organic nutrients between autotrophic and heterotrophic components of the periphyton assemblage, which probably results in less accumulation of detritus of periphyton origin on the bottom of the ponds in comparison to a phytoplankton-dominated system. In addition, suspended organic material is trapped and processed by the periphyton layer.

Thus, in a periphyton-based system the bio-mass produced remains in the aerobic layers of the pond where decomposition is faster and where it is more accessible to grazing by fish. In this way, periphyton probably contributes to making pond system more nutrients efficient. Adding substrates to experimental ponds in Bangladesh held to an 54-64% increase in nitrogen use efficiency (N in fish / N in inputs) but overall nitrogen efficiency remained quite low (8.7% with bamboo substrates). Several studies show a positive effect of periphyton on nitrification, leading to lower ammonia concentrations. Maximum periphyton production can be achieved at lower nutrient levels than those needed for phytoplankton. Nutrient concentrations in the water column may be poor indicators of conditions for periphyton close to the substrate, where step nutrient gradients exist.

Ichthyofaunal diversity indicates the potential of any aquatic system and also depicts its trophic status. It is important to have an adequate knowledge of the constituent biota especially for the purpose of conservation and management of the inland water resources such as rivers, reservoirs and ponds. Fish constitute half of the total number of vertebrates in the world and live in almost all conceivable aquatic habitats. Around the world approximately 22,000 species of fishes have been recorded out of which 11% are found in India, i.e., about 2,500 species of fishes of which, 930 live in freshwater and 1,570 are marine (Kar, 2003; Ubharane *et al*., 2011).

India is one of the mega biodiversity countries in the world and occupies the ninth position in terms of freshwater mega biodiversity (Shinde *et al.*, 2009). However, there are still a large number of habitats/ regions for which the ichthyofaunal diversity is still to be reported. Moreover, such habitats are being exploited for various resources and also they experience the natural climate change that is bound to impact its faunal diversity and abundance. Fisheries is directly associated with the economy of the country and provide alternate resource of food for the growing population. Fishery sector is one of the Engines of growth. Fishes are valuable source of high grade protein and they occupy a significant position in the socio-economic fabric by providing the population not only the nutritious food but also income and employment opportunities.

Water quality is the first most important limiting factor in pond. It is also the most difficult production factor to understand, predict and manage. Water is not just where the fish live. Its quality directly affects feed efficiency, growth rates, the fish's health and survival. Most fish kills, disease outbreaks, poor growth, poor feed conversion efficiency and similar management problems are directly related to poor water quality. Water quality refers to anything in the water, be it physical, chemical or biological that affects the production of fish. Maintenance of a healthy aquatic environment and production of sufficient fish food organisms in ponds are two factors which are primarily importance for successful pond cultural operations. To keep the aquatic habitat favorable for existence, Physical and Chemical factors like pH, Turbidity, Dissolved Oxygen, and Carbonates, Bicarbonates, Total hardness, Calcium, Magnesium, Chlorides, Phosphates, Nitrates, are essential. Similarly the productivity of pond depends upon a large number of animal and plant communities living in various zones of the pond. According to Sarkar (2002) quality of water is essential to understand whether a particular water body is suitable for fish and water pollution may occurs when these substances, which degrade the water quality of pond, enter the water way and alter their natural function and water bodies have been profoundly altered and have lost much of their value.

Hence it is very essential and important to test the water before it is used for drinking, domestic or agricultural. Water must be tested with different physic-chemical parameters. Selection of parameters for testing of water bodies is solely depends upon for what purpose we going to use that water and what extent we need its quality and purity. So the objective of the present study is to review and present a concise opinion regarding the optimum levels of water quality and relatively provide stress free environment that meets the physical, chemical and biological standards for the fishes normal health and production performance

The term periphyton refers to the entire complex of aquatic biota attached to an associated with submerged substrates. The principle of periphyton-based aquaculture, derived from traditional brush-park fisheries, is to provide substrates on which bacteria, protozoa, fungi, phytoplankton, zooplankton, benthic organisms, and arrange of other invertebrates colonize. These organisms supplement artificial feed. The hard substrates also act as shelter and minimize the territorial effects of cultured animals. Nitrifying bacteria can colonize the substrates in a well-oxygenated water column and improve water quality through higher rates of nitrification. Periphyton that grows on a substrate in freshwater ponds can serve as one of these additional food sources (Azim and Wahab, 2005). Conversion of nutrients into harvestable products, through the adoption of periphyton-based production in existing pond systems, is one solution worth exploring (Azim *et al*., 2003)

In aquaculture, they have been used to improve water quality and the production of the culture species (Khatoon *et al*., 2007). Adding substrates to enhance periphyton growth in fertilized ponds has been shown to increase fish production. A number of studies have shown higher fish production in ponds with substrates for periphyton development than in ponds without substrates (Hem and Avit, 1994; Wahab *et al*., 1999; Ramesh *et al*., 1999; Keshavanath *et al*., 2001; Azim *et al*., 2001a; Azim *et al*.,2002a). Growth and the final mean weight of rohu (*Labeo rohita*), catla (*Catla catla*) and common carp (*Cyprinuscarpio*) were higher in the substrate treatments than those in the control (Rai *etal*., 2008). This is due to the fact that filter feeding of planktonic algae is unlikely to fully cover the energy demands of most herbivorous carp and tilapia specie (Dempster *et al*., 1995). In order to fully utilize the nutrients available in the fertilized fish ponds, applying periphyton based aquaculture should be an efficient alternative, particularly for Indian major carps.

In recent years, the concept of periphyton-based aquaculture has been tested and applied with varied degrees of dependence on periphyton as food or substrates as shelter for cultured animals. For finfish, the reported increases in production due to substrates have ranged 30-115% in Indian major carp monoculture and 30-210% in carp polyculture, depending on the amounts and types of substrates used, cultured species, nature of ponds, feeding and fertilization practices, and other management aspects. Periphyton-based systems have shown higher nutrient utilization efficiency when compared to traditional substrate-free systems (Verdegem *et al*., 2005; Uddin, 2007), so an optimum fertilization rate forth traditional substrate-free ponds is expected to be sufficient for maximizing fish production in periphyton-based systems.

The overall objective of this study was to determine the technical and economic performance of periphyton-based aquaculture systems. It thus addressed one of the key constraints for the poor to benefit from fish culture limited access to resources such as fertilizers and feeds while trying to maximize the conversion of these resources into fish. Environmental friendly production system like periphyton based aquaculture is of interest. In the present study the species were selected on the basis of their feeding behavior, Ease of culture and high market demand. Nutritional quality of periphyton was adequate to support the dietary needs of the experimental fish.

2. Objectives of the study

- Survey and selection of water tanks for the implantation of research project study
- Water quality and biodiversity assessment of the water tanks
- Collection and bundling and introduction of Ipomea sp in water tanks
- Stoking of fish seed in control and experimental water tanks
- Plankton analysis and abundance of year 2014-2016
- Biochemical analysis of Ipomea sp
- Fish Growth observations of both control and experimental tank
- Ichthyofaunal diversity of both control and experimental tank

3. Review of Literature

An aquatic ecosystems dependent on one another and their water environment for nutrients (eg, Nitrogen and Phosphorus) and shelter. Healthy aquatic ecosystems are those where human disturbances have not impaired the natural functioning nor appreciably altered the structure of the system. An unhealthy aquatic ecosystem is one when natural state is out of balance. Ecosystems are also composed of four basic components eg, water, land, air and living things (plants and animals). Tank irrigation is one of the oldest and significant sources of irrigation in India and is particularly in south India (Palanisamy, 1998). The tanks occupy vital role in the irrigation as well as local ecosystem in the semi-arid and regions of south India. This perennial tank provides multiple uses like source of drinking water for uncountable rural and urban communities and livestock, fish culture, recharge of ground water, control of floods etc**.,** (Gurunathan, 2006).

The healthy aquatic ecosystem is depended on the physico-chemical and biological characteristics (Venkatesharaju *et al* 2010). The quality of water in any ecosystem provides significant information about the available resources for supporting life in that ecosystem. Good quality of water resources depends on a large number of physico-chemical parameters and biological characteristics. To asses that monitoring of these parameters is essential to identify magnitude and source of any pollution load. These characteristics can identify certain condition for the ecology of living organisms and suggest appropriate conservation and adopt management strategies. Many researches are being carried out till present (Rajesh *et al* 2002, Jayaraman *et al* 2003, Sharma & Gupta 2004; Rajasekar et al., 2005; Sridhar et al., 2006; Anilakurmary et al., 2007; Prabu *et al*., 2008; Raja *et al*., 2008; Pradhan *et al*., 2009; Srivastava *et al.*, 2009; Damotharan *et al*., 2010; Prasanna and Ranjan, 2010).

As water is one of the most important compounds of the ecosystem, but due to increased human population, industrialization, use of fertilizers in the agriculture and man-made activity. The natural aquatic resources are causing heavy and varied pollution in aquatic environment leads to change water quality and depletion of aquatic biota. It is therefore necessary that the quality of drinking water should be checked at regular time of interval, because due to use of contaminated drinking water, human population suffers from varied of water borne diseases. It is difficult to understand the biological phenomena fully because the chemistry of water revels much about the metabolism of the ecosystem and explain the general hydro-biological relationship.

Surface water quality depends not only on natural processes like precipitation inputs, erosion, and weathering of crustal material, etc., but also on anthropogenic influences like urban, industrial, and agricultural activities (Ravikumar et al., 2013). Therefore, scientific study needs to review strategies for conservation and better utilization of lakes and aquatic ecosystems (Nikitaraj, 2012). Surface water quality encompasses a wide range of conditions that are part of the aquatic environment in a water stream. In turn, the aquatic environment provides diverse habitat and a clean water supply for aquatic life, wildlife and humans. There is no single or simple measure for water quality. Water may be tested for a few characteristics or numerous natural substances and contaminants, depending on the need. This can be done using traditional methods, such as collecting representative water samples from a water body and analyzing them to an analysis laboratory or on-site by hand-held electronic meters. Many factors influence water quality including climate and precipitation, soil type, geology, vegetation, groundwater, flow conditions and human activities. The greatest impacts are usually from point sources associated with the discharge of treated wastewater from municipalities and industries. This long-range transport can also include soil minerals, nutrients and numerous man-made chemicals. The imposed quality standards for surface waters/rivers have to be related with the river usage type. For example, the drinking water implies higher standards than the water used for industrial or agricultural purposes. Water quality monitoring data are compared over time, from place to place, and to expected conditions.

Water quality affects the quality of drinking water and the capacity of the water body to support wildlife and healthy ecosystems. Water quality can be degraded by many different stressors in the watershed, including poor development practices and sprawl, poor storm water management, destruction of wetlands, runoff from agricultural areas, and point source pollution. Wastewater discharge from sewage and industries are major component of water pollution, contributing to oxygen demand and nutrient loading of the water bodies, promoting toxic algal blooms and leading to a destabilized aquatic ecosystem (Morrison et al, 2001). The crucial role of water as the trigger and sustainer of civilizations has been witnessed throughout the human history. The initial effect of waste is to degrade the physical quality of the water. Later biological degradation becomes evident in terms of number, variety and organization of the living organisms in the water (Gray, 1989). Often the water bodies readily assimilate waste materials they receive without significant deterioration of some quality criteria; the extent of this is referred to as its assimilative capacity (Adekunle and Eniola, 2008). Except in manifestly undesirable situations, the available water was automatically deemed utilizable water. Environmentalists and scholars in other disciplines have attempted to examine the impact of industrial activities on the physico-chemical parameters and heavy metal concentration of rivers/streams (Adekunle and Eniola, 2008; Ogedengbe and Akinbile, 2004; Ogbonnaya, 2008; Fakayode, 2005; Fisher *et al*. 1998; Olajire and Imeokparia, 2001; Akoto *et al*. 2008), while others carried out a bacteriological assessment (Olayemi, 1994; Adekunle, 2008; Ikurekong et al. 2008; Adekunle and Eniola, 2008;). However, little or no information is available only during the last three decades of the twentieth century the concern for water quality has been exceedingly felt so that, by now, water quality has acquired as much importance as water quantity.

In limnological study, the consideration of physico-chemical factors contributes in making up of the specific ecosystems, which determines the trophic dynamics of the water body. It is necessary to know the physico-chemical properties of water to study the culture practices of the fish in water bodies. The productivity of a water bodies depend primarily on the physico-chemical and biological characteristics of water. These properties again depend on the nature of bottom soil and climatic conditions. In India the first ecological study on a reservoir was carried by Ganapath*i*, (1929) on Redhill Lake, Madras.

Prediction of water quality parameters based on few known parameters like pH, Turbidity, total Dissolved Solids, Dissolved Oxygen, Biological oxygen Demand, Chemical Oxygen Demand, Total Alkalinity, Total Hardness, Calcium, Magnesium, Chlorides, Nitrates and Phosphates, turbidity and total dissolved solids are important to know the trophic nature of the water body. Water bodies are generally of three types- oligotrophic mesotrophic and eutrophic. Usually mesotrophic water bodies are highly productive in nature. Irrigation tanks are one of the important inland fisheries resources in Telangana state as well as in India besides providing agricultural water.

The zooplankton constitute an important component of secondary production in aquatic ecosystems that play a key role in energy transfer from primary to higher level in the ecosystem. The most significant feature of zooplankton is its immense diversity over space and time. Thus, similar aquatic systems may have dissimilar assemblage of organisms varying in species composition and biomass. Further, in spite of convergent similarities, zooplankton species have different types of life histories influenced by seasonal variations of abiotic factors, feeding ecology and predation pressure. Zooplankton diversity is one of the most important ecological parameters in water quality assessment. Various indices like richness, diversity and evenness index can be calculated with the data on taxonomy of different zooplankton is available (Sakhare, 2007). Zooplankton comprising of rotifers, cladocerans, copepods and ostracods are considered to be most important in terms of population density, biomass production, grazing and nutrient regeneration in any aquatic ecosystem. Their diversity and density is mainly controlled by availability of food as favorable water quality (Chandrasekhar and Kodarkar, 1997). According to Reid (1961), the plankton population on which the whole aquatic life depends directly or indirectly is governed by the interaction of a number of physical, chemical and biological conditions and the tolerance of the organisms to variations in one or more of these conditions. The water quality parameters and nutrient status of water play the most important role in governing the production of planktonic biomass.

Zooplanktons are tiny animals found in all aquatic ecosystems, particularly the pelagic and littoral zones. They are one of the primary consumers of the aquatic ecosystem.

They themselves are an important food source for large animals and are important in the re mineralization and transport of nutrients which is very important in the conservation of modern aquatic food webs. Marine ecosystem of the estuaries and lagoon are among the most productive and zooplankton rich in the world. High zooplankton biomass and productivity are related to the input of energy and matter from mangrove forests, which are the most common coastal vegetations in the tropics. The species diversity and abundance of the community structure of the zooplankton is necessary to assess the potential fishery resource of a place. Zooplankton provides an important food source for larval vertebrates and invertebrates in natural waters and in aquaculture ponds. It has been reported that in many countries the failure of fishing is attributed to the reduced zooplankton. Zooplankton species distribution shows wide spatio temporal variations due to the different hydrographical factors on individual species.

The aquatic ecosystems are affected by several health stressors that significantly deplete biodiversity. Zooplankton species have different types of life histories influenced by seasonal variations of biotic factors, feeding ecology and predation pressure. In the future, a loss of biodiversity and its effects are predicted to be greater for aquatic ecosystems than for terrestrial ecosystems. The zooplankton is also a valuable food source for planktivorous fish and other organisms. The presence or absence of healthy zooplankton populations can determine some commercial fisheries success in both fresh and salt water bodies. By insuring that the lower parts of the food chain are healthy, we can protect the higher ordered organisms, like fish, whales and even humans. Zooplankton has been used as an indicator for monitoring the water quality, trophic status and pollution level. Various ecological aspects of zooplankton have been a subject of study in India by several workers.

Several authors have worked out a number of faunal expeditions of aquatic bodies. The notable Indian contribution to the information of zooplankton i.e Sewell (1934), (Thakar & Sonawane 2013), who studied on plankton rotifers. Ganpati (1943), studied on the distribution of zooplankton in water bodies near Madras. George (1961), reported the seasonal distribution of rotifers in ponds and lakes. Gouder and Joseph (1961), reported the seasonal distribution of copepods. Govind (1963) investigated on the relationship between copepods and physico-chemical parameters in Tungabdhra reservoir, Karnataka. Biswas (1964), observed the species of cladocerans from lentic water bodies of North part of India. Michael (1968), worked on several aspects such as distribution and abundance of zooplanktons in different water bodies near Chennai. Rajendra (1973), observed the occurrence and abundance of copepods in lentic water bodies in Tamil Nadu. David et al. (1974) recorded the abundance of copepods in the tank situated in Malnadu and coastal tanks in Karnataka. Rao and Mohan (1982) carried out a detailed investigation on rotifers of Andhra pradesh. Ayyappan and Gupta (1980) carried out an ecological studies on zooplankton of Ramasamudra tank Dakshina Kannada, Karnataka. Yousuf and Quadri (1985) observed the seasonal fluctuations of the major zooplankton communities of lake Manasabal, Kashmir. Saha and Pandit (1985) compared the density of zooplankton between lotic and lentic environment.

Datta *et al.* (1987) worked on abundance of zooplankton in limnetic water of Kolkata. From ecological point of view rotifers, cladocerans, copepods and ostracods are considered to be most important components, which play a vital role in energy allocation in different tropic levels. Biodiversity is essential for stabilization of ecosystem, protection of overall environmental quality for understanding intrinsic worth of all species on the earth (Nelson 2006). The zooplanktons from major link in the energy transfer at secondary level in aquatic biotopes. The occupy an intermediate position in aquatic food webs between autotrophs and heterotrophs. The distribution and diversity of zooplankton in aquatic ecosystems terms depends mainly on the physico-chemical proportion of water. Pollution of water bodies by different sources will result in drastic changes in zooplankton potential of the ecosystem. In India, considerable work has been done on ecology and seasonal distribution of zooplankton than other tropical and sub-tropical countries (Battish, 1992; Ranga Reddy, 2001; Slathia and Dutta, 2013).

In rural India, lakes and tanks are the most important water sources for drinking and agriculture activities. With the onset of green revolution, these water bodies get exposed to the inflow of residues of chemical fertilizers from agricultural fields. Extended anthropogenic activities has led to shrinkage and disappearance of these water sources. Study of freshwater zooplankton of a specified area is much complicated due to its diversity, influence of physical, chemical, biological and various geographical factors. Understanding how these extrinsic drivers influence diversity remains one of the most significant intellectual challenges to ecologist and biogeographers.

The Indian major carps *Catla catla, Labeo rohita and Cirrhinus mrigala* are the most important commercial fishes in India with a maximum market demand and acceptability as food by the consumers due to their taste and flesh. They contribute about 67% of total freshwater fish production (ICLARM, 2001). Nature offers a great diversity of food to fish including plants and animals. Artificial feed plays an important role in semi intensive fish culture where it is required to maintain a high density of fish than the natural fertility of the water can support (Jhingran, 1991). The role of artificial feed in intensive fish farming cannot be ignored as nutritional requirements of fish depend upon the feed supplied. The quantity and quality of feed consumed have a pronounced effect on growth rate, efficiency of feed conversion and chemical composition of fish (Hassan *et al*., 1996; Jena *et al*., 1998; Erfanullah and Jafri, 1998).

The analysis of life history traits has been widely used by ichthyologists to differentiate among different species and different populations within a species; fortunately, this method continue to be used successfully (Ihssen et al., 1981). Studies of morphologic variation among populations still have an important role to play in stock identification, despite the advent of biochemical and molecular genetic techniques, which accumulate neutral genetic differences between groups (Mir, Sarkar, Dwivedi, Gusain & Jena, 2013). Studies on age and growth, maturity of commercially important fishes, provide baseline information that typically assists with the initial recognition and delineation of geographic regions that are representative of individual stocks (Pawson & Jennings, 1996) and is an almost essential prerequisite for successful stock identification (Griffiths, 1997). The use of such parameters is an efficient and cost-effective tool for stock identification, as these data are routinely collected for assessment and management purposes (Ihssen et al., 1981). Aspects of the two major carps of India, *Cirrhinus* *mrigala* and *Catla catla* have been investigated previously (Khan & Siddiqui, 1973; Sarkar, Negi & Deepak, 2006; Mir *et al*., 2012.

The natural resources of this fish extends from the network of the Ganga, the Sindh and the Brahmaputra river systems in the North, and the East and West coast river systems flowing through in the South and Central India. This species of fish grows up to 200cm size (Frimodt, 1995); however, a considerable decline in the overall size and species in natural waters (Mir et al., 2013) has been observed, and the species is now categorized as LC (Least Concern) as per IUCN (2012). Recently, the National Bureau of Fish Genetic Resources (NBFGR), Lucknow, India, has started a flagship network programme on the stock identification of *L. rohita* (Lakra & Sarkar, 2010). Besides, to successfully develop and manage the population of *L. rohita* in natural waters of the Ganga basin, it is important to understand the current pattern of biological traits in natural habitats.

4. Material and Methods

4.1. Study area

To evaluate the water quality, two districts Karimnagar and Nizamabad were selected and total four ponds were taken to the experiment two from each district. One pond is treated as Control (Kurella Pedda cheruvu, Kurella) and another treated as Experimental Tank (Taalla cheruvu). Koheda mandal, Karimnagar District, of Telangana State, India.The climatic condition of the study area was hot summer and cool winter. In the present study period temperature range a minimum 28ºC and a maximum of 39ºC. The region gets much rainfall from south west monsoon. The place gets most of its rainfall from June to September during the monsoon. The average rainfall of this study area is 100.9 mm.

The water of this water body is used for agriculture and supports fish culture. Due to lack of sufficient rain in the selected water bodies the last two years (2014-15 & 2015-16) of the experiment is conducted in only Karimnagar district. The experiment was conducted during for two years (2014-15 & 2015-16) in Karimnagar district to study the impact of periphyton on cultivable fishes by using *Ipomoea carnea* as substratum. To conduct the experiment two irrigation tanks were used, one as control in which *Ipomoea carnea* was not removed and second tank as experimental tank, in which *Ipomoea carnea* was removed and introduced the bundles for periphyton growth after the process of drying and bundling.

4.2. Sampling procedure

In each water tank three points were identified to collect the water samples for physicochemical analysis. The water samples collected bi-monthly from control and experimental tanks in a polythene bottle are tightly stopped and used for physicochemical analysis from July 2014 to March 2015 and July 2015 to March 2016. The samples were collected in the morning hours between 7.00 a.m. to 8.30 a.m. Another two bottles filled with surface water for biological analysis. Dissolved oxygen and pH values are estimated at the site. Plankton net used to filter 50 litres of surface water to obtain the net plankton concentration. All the samples packed in a cane basket protecting them from intense sunlight, contamination and transported to the laboratory without any delay.

4.3. To Determine the Physico-Chemical parameters

1. **pH:** pH Digital Meter method (APHA,2012)
2. **Turbidity:** Nephelo meter (APHA, 2012)
3. **Dissolved Oxygen:** Winklers method (APHA, 2012)
4. **Carbonates:** Acid Titrimetric method (APHA, 2012)
5. **Bi carbonates:** Acid Titrimetric method (APHA, 2012)
6. **Total Hardness:** EDTA Titrimetric method (APHA, 2012)
7. **Calcium:** Muroxide–EDTA Titrimetric method (APHA, 2012)
8. **Magnesium:** Brilliant Yellow method (APHA, 2012)
9. **Chlorides:** Argentometric method (Tritrimetric method) (APHA, 2012)
10. **Nitrates:** Brucine method (APHA, 2012)
11. **Phosphates:** Stannous chloride method (APHA, 2012)

4.4. Enumeration of plankton

A plankton net (Mesh size 65 um) was used to filter 50 litres of surface water to obtain 100 ml of the net plankton concentration. All the samples were packed in a cane basket protecting them from intense sunlight and contamination was transported to the laboratory without any delay. Zooplankton samples were collected from four stations. Every month from July 2014 to April 2015 and July 2015 to Apr 2016. The samples were collected between 7.00 to 8.30 AM. For collecting zooplankton the plankton net of 65µ mesh size was towed at the surface to a depth of two feet for about 25 times (Battish, 1992). The collected plankton samples were fixed and preserved in 4% Formalin. For quantitative analysis 100 litres of water sample was passed through the plankton net and the concentrated zooplankton were fixed and preserved in 4% Formalin. In laboratory 1ml of this concentrated and preserved sample was examined in a Sedgwick-Rafter cell chamber and different groups of zooplankton were enumerated by using standard keys (Battish, 1992; Needham and Needham, 1962) and counted under compound microscope. The data was statistically analysed to study the abundance and significance of seasonal variation in number of zooplankton population.

4.5. Qualitative analysis

Sedgwick-Rafter cell of 1.0 ml. capacity used for counting micro algal forms, Rotifers and micro-crustaceans from net-plankton samples. Depending on the population density the number of organisms in three S-R cells counted. Appropriate multiplication factor used to finally estimate the total number of organisms per litre (Welch, 1952).

4.6. Quantitative analysis

50 litres of water collected and poured it through plankton net then collected plankton, measured with measuring jar. The density of Zooplankton is expressed as organisms per liter using formula:

$$\mathbf{N = n \times v/V}$$

Where N= Total number of organisms/ liter of water filtered

n = Number of organisms counted in 1 liter sample

v = Volume of concentrated sample (ml)

V= Volume of total water filtered/Liter (ml)

Zooplankton species were identified by following the works of Koste (1978), Michael & Sharma (1988), Sharma (1998) and Sharma &Sharma (1999a, 1990b, 2000, 2008). Community similarities (Sorensen's index), species diversity (Shannon's index), dominance (Berger-Parker's index) and evenness (Pileou's index) were calculated by the following Ludwig & Reynolds (1988) and Magurran (1988).

4.7. Preparation of *Ipomoea* bundles

Ipomoea plants were collected from the tanks and allowed to dry for 10-12 days. The leaves and small branches were removed and bundles were prepared with remaining stems. Such bundles were introduced into experimental tank. The periphyton communities identified as per APHA (2005), Edmondson (1992) and Smith (1940). The chemical composition of periphyton - dry matter(DM), ash-free dry matter (AFDM) total pigments, ash, carbohydrates, proteins and lipids were analyzed as per APHA (2005) The growth rates of fishes were monitored and calculated for month-wise. The biochemical constituents - carbohydrates, proteins, lipid sand free amino acids (FAA) in the muscles of fish were analyzed to know any variation due to the consumption of periphyton developed on *Ipomoea* bundles as per Carroll *et al* (1956), Lowry *et al* (1951), Barnes and Black stock (1973) and Moore and Stein(1954).

4.8. Experimental fishes

The following Indian major carps were used for the experiments.

Catla catla
Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cypriniformes
Family: Cyprinidae
Genus: Catla
Species: catla

Labeo rohita
Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cypriniformes
Family: Cyprinidae
Genus: Labeo
Species: rohita

Cirrhinus mrigala
Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cypriniformes
Family: Cyprinidae
Genus:Cirrhinus
Species: mrigla

Marginal weed, *Ipomoea carnea* was used as substratum for production of periphyton and found abundantly in irrigation tanks. It is creating many problems like obstructing the fish growth by occupying the space in water and restricting the movement of fish further due to infestation of *Ipomoea carnea* in the tanks the stocked fish was suffering with Arugulas infection. It can be used to produce periphyton, which is used as fish food.

Kingdom: Plantae
Phylum: Angiosperms
Class: Eudicots
Order: Solanales
Family: Convolvulaceae
Genus: *Ipomoea*
Species: *cornea*

4.9. Seed stocking

Finger lings of *Catla catla* species were collected and kept in aquarium and the water used was clear and unchlorinated (APHA, 1980). Fishes were fed daily with fish pellets and acclimatized for 30 days. The tissue was homogenized with 1ml. of Tris- HCl buffer. The protein and carbohydrate were estimated by standard methods (Carroll *et al*., 1956). The water tanks were selected for control and experiment and stocked with fish fingerlings (26-30 mm total length) of three species of Indian major carp, namely *Catla catla , Labeo rohita, Cirrhinus mrigala*. These fish seed were obtained from nearby fish seed production farms by packing in plastic bags with water and oxygen. Bags containing fish seed were placed in water of tank for 10 minutes for acclimatization. Bags were opened and fish fingerlings were gradually released into water tank with the help local fishermen.

4.10. Fishing crafts and gear

Most of the fishing is done by cast nets and drag nets. The nets used by the Fishermen Co-operative Society members are made up of nylon/high density polythene. Normally cast net was used for single operation at shallow depth about 3-5 feet. Another net was a drag net which was used for dragging the fish from entire water body during the month of January. During the month of January harvested fish was brought to the shore and segregated species- wise. The total catch of each species weighed and calculated the total production species-wise.

4.11. Fish growth and yield

The fish growth studied monthly for six months. The weight of fish fingerlings was taken during the stocking, later on randomly every month for six months. After 356 months of culture of *catla* these fishes were harvested from both the control and experimental tanks. The fish production was compared in both the control and experimental tanks. The growth of fishes stocked in both control and experimental tanks were measured by recording the weight of fish at the end of every month of culture period. This was continued up to the end to experiment (six months).

Survey of tanks in and around Koheda, Karimnagar district

S.No.	Name of the Tank	Village	Mandal	Total Area (acres)	Remarks
1	Baadugula cheruvu (Pedda cheruvu)	Koheda	Koheda	10	Ipomoea is Lesley distributed.Half kilometer from Koheda village
2	Baadugula cheruvu (Pedda cheruvu)	Koheda	Koheda	05	Ipomoea is not foundUnfit for experiment
3	Taalla Cheruvu	Koorella	Koheda	22.28	Ipomoea is moderately distributed Near to Koorella village
4	Koorella Pedda cheruvu	Koorella	Koheda	2.37	Ipomoea is Lesley distributed Half kilometer from Koorella village
5	Naagula kunta	Vinjapally	Koheda	6	Ipomoea is Largely distributed Half kilometer from Vinjapally village
6	Kotha Cheruvu	Vinjapally	Koheda	11.5	Ipomoea is Lesley distributed Half kilometer from Vinjapally village
7	Kummari kunta	Koheda	Koheda	4.2	Ipomoea is Lesley distributed One kilometer from Koheda village
8	Teegala kunta	Teegalakunta pally	Koheda	8.6	Ipomoea not not found 200 meters from Teeglakunta village
9	Errakunta	Vinjapally	koheda	3.2	Ipomoea is Lesley distributed 3 kilometers from Vinjapally village

Survey of tanks in and around Kamareddy, Nizamabad, (district)

S.No.	Name of the Tank	Village	Mandal	Total Area(acres)	Remarks
1	Gundi Cheruvu	Domakonda	Kamareddy	20	Ipomoea is fully distributed 100 meters near to domakonda fort Polluted by Ganesh Idols& seavage
2	Gundla Cheruvu	Domakonda	Kamareddy	50	Ipomoea not found2-3 kilometers from domakonda Without pollution
3	Jangampally Cheruvu	Jangampally	Biknoor	65	Ipomoea not foundLocatednear to NH7 towards kamareddy
4	Chinnamallareddy Cheruvu	Chinnamalla reddy	kamarddy	70	Ipomoea is not found Washerman activity is present
5	Adluru Ellareddy Cheruvu	Adluru Ellareddy	Sadhashiva nagar	50	Ipomoea not found
6	Sadhashiva nagar cheruvu	Sadhashiva nagar	Sadhashiva nagar	45-50	Ipomoea not found
7	Chandrayan pally Cheruvu	Chandrayan pally		30	Ipomoea not found
8	Indalvai cheruvu	Indalvai	Indalvai	30	Ipomoea not found
9	Dichpally Nagpur gate cheruvu	Dichpally	Dichpally	03	Ipomoea not found
10	Boddemmala cheruvu	Quilla	Nizamabad	60-70	Ipomoea not found Cultivation of fishes is prohibitedDrinking water supplied to Nizamabad town
11	Mallaram cheruvu	Mallaram	Nizamabad	20-30	Ipomoea not found
12	Jankampet Vheruvu	Jankampet	Vedpally	25	Ipomoea not found
13	Hedi cheruvu	Mittapally	Dichpally	15-20	Ipomoea found
14	Kandal kunta	Mittapally	Dichpally	8	Ipomoea found

Location Map of Experimental and Control Water Tanks (Satellite Images)

Control water tank kurella, Karimnagar District

Experimental water tank kurella, Karimnagar District

Control water tank Mittapally, Nizamabad District

Experimental water tank Mittapally, Nizamabad District

5. Results and Discussion

5.1. Physico-Chemical Parameters of Water

Water quality management forms an integral part of aquaculture, at times a challenging one. Most of the problems that arise in aquaculture are the result of the degradation of water quality. Thus knowledge of chemistry of water quality is vital for successful aquaculture. The aquaculture environment is a dynamic one in which various physico-chemical factors vary with seasons and time, and the variations are caused invariably as the result of interactions between them. Various physico-chemical parameters like pH, Turbidity, TDS, D.O, Hco3, T.H, Ca2+, Mg2+, Cl-, No3 during 2014-15 and 2015 to 2016.

The Physico-chemical parameters values of the Control and Experimental water tanks are calculated and it is describe as bellow

5.1.1. pH

The pH is a term used universally to express the intensity of the acid or alkaline condition of a solution. Most of the water samples are slightly alkaline due to presence of carbonates and bicarbonates. The pH mean values found in control 7.2 and 8.0 experimental tank during first experiment 2014-2015. The mean values were found in both control and experimental tanks 7.4 and 8.53 respectively during second experiment 2015-2016. Fluctuations in pH were similar to the fluctuations of the alkalinity. Similar reports were also given by Sharma and Sharma (2008), Singh and Bala singh (2011). Similar reports were also given by Malu (2001) and Das *et al* (2001). Pradhan and Chekraborty (2006), Sharma and Sharma (2008), Singh and Bala singh (2011). The alkaline pH provides the growth of natural food organisms and increases the productivity and fish yield. Similar reports were made by Piska *et al* 2001. Malu (2001) reported that the higher pH can be attributing to higher primary productivity and it can be attribute to high rate of photosynthetic activity which will raise the pH. The growth of fish will be good in the range of 7-8. It is a tolerable range for most fish Devi Priyamvada *et al.*, 2012.

5.1.2. Turbidity (NTU)

In most water turbidity is due to colloidal and extremely fine dispersions. The Turbidity mean values found in control 5.8 and 5.3 experimental tank during first experiment 2014-2015. The mean values were found in both control and experimental tanks 6.3 and 5.7 respectively during second experiment 2015-2016. Water turbidity is mainly due to suspended inorganic substances like mud, clay, silt, phyto- and zooplankton and sand grains (Piska, 1999). Lakes with clay bottom are likely to have high turbidity. The light penetrates only to shallow depths. The lower layer of water, being divided of photosynthetic plants and also being in close contact with the decaying organic matter, suffers from oxygen depletion, causing the death of fish (Piska, 2000).Turbidity is caused when the light is blocked by large amounts of slit, microorganisms, plant fibers and sawdust, woo dashes, chemicals and coal dust (Devi Priyamvada *et al.,* 2012).

5.1.3. Total dissolved solids (TDS) in mg/l

Total dissolved solids indicate the salinity behavior of groundwater. Water containing more than500 mg/L of TDS is not considered desirable for drinking water supplies. TDS mean values found in control 76.3 and 85.2 experimental tank during first experiment 2014-2015. The mean values were found in both control and experimental tanks 79.4 and 85.9 respectively during second experiment 2015-2016. Large amounts due to run off water from attachment area. Shunmugavelu and G.Radha (2010) reported that the maximum productivity obtained when the physical and chemical parameters are at optimum level. A high content of dissolved solids elevates the density of water, influences the osmoregulation of fresh water organisms, reduces the suitability of gases and utility of water. The common salts present in natural waters are carbonates, bicarbonates, chlorides, sulphates, phosphates and nitrates of calcium, magnesium, sodium, potassium, iron, manganese, etc. Total suspended solids denote the impurities present in the water and most of them are organic in nature and pose severe problems of water pollution (Piska, 2000). Large amounts due to run off water from attachment area. Shunmugavelu and G.Radha (2010) reported that the maximum productivity obtained when the physical and chemical parameters are at optimum level. Similarly Khan et al (2012) studied and reported that, there was a significant seasonal variation in some physico chemical parameters of Triveni lake of Amaravati in Maharastra and the water is best for drinking purpose in winter and summer season.

5.1.4. Dissolved oxygen (DO) in mg/l

Dissolved oxygen is important parameter in water quality assessment and reflects the physical and biological processes prevailing in the water. The D.O values indicate the degree of pollution in water bodies. D.O mean values found in control 6.8 and 6.8 experimental tank during first experiment 2014-2015. The mean values were found in both control and experimental tanks 6.9 and 6.9 respectively during second experiment 2015-2016. Das (2005) studied the limno-chemistry of important lakes of Andhra Pradesh and stated that dissolved oxygen along with turbidity could provide information about the nature of an ecosystem better than any other chemical parameters. Dissolved Oxygen Concentration a Remarkable Indicator of Ground Water Pollution, Basavaraddi (2012). Oxygen is also naturally incorporated into water from the atmosphere through surface diffusion and turbulence caused by wind (Tushar Kumar Gandhi, 2012). Lower values of Dissolved oxygen in summer season due to higher rate of decomposition of organic matter and limited flow of water in low holding environment due to high temperature. (Ch.Sammaiah *et., al* 2012).

5.1.5. Bicarbonates (HCO_3^-) mg/l

Bicarbonate is an intermediate form of carbonic acid. It is a polyatomic anion with the chemical formula HCO_3 Bicarbonate serves a crucial biochemical role in the physiological pH buffering system. Bicarbonates mean values found in control 53.5 and 64.7 experimental tank during first experiment 2014-2015. The mean values were found in both control and experimental tanks 52.9 and 67.8 respectively during second experiment 2015-2016.Alkalinity can be increased by adding agricultural limestone [CaCO3 and CaMg (CO3)2] to ponds or lakes or lakes (Tushar Kumar *et al.*2012).

5.1.6. Total hardness (TH) in mg/l

Hardness is the property of water which prevents the lather formation with soap and increases the boiling points of water. Hardness of water mainly depends upon the amount of calcium or magnesium salts or both. The total hardness mean values found in control 97.4 and 80.7 experimental tank during first experiment 2014-2015. The mean values were found in both control and experimental tanks 97.4 and 81.6respectively during second experiment 2015-2016. Hardness could be temporary due to carbonates and bicarbonates or permanent due to sulphate and chlorides. Biologically temporary hardness plays a key role in buffering capacity, thus neutralizing the pH due to addition of acidic products. This has a great effect on biotic diversity of an ecosystem. These high values may be due to the addition of calcium and magnesium salts. The increase in hardness can be attributed to the decrease in water volume and increase in the rate of evaporation at high temperature (M.Thirupathaiah *et al*., 2012).

5.1.7. Calcium (Ca^{2+}) in mg/l

Calcium is the major cation present in the natural waters, its main source being leaching of rocks in the catchment. Its concentration restricts water use, while it is an important component in the exoskeleton of arthropods and shell in molluscans. Calcium is directly related to hardness mean values found in control 37.0 and 36.7 experimental tank during first experiment 2014-2015. The mean values were found in both control and experimental tanks 37.9 and 37.4 respectively during second experiment 2015-2016. According to **Srivastava *et al*., (2011)** drains are the main source of water pollution especially for rivers flowing within the city carry industrial effluent, domestic waste, sewage and medicinal waste results in pooring the water quality.

5.1.8. Magnesium (Mg^{2+}) in mg/l

Magnesium is another dominant cation in natural eaters and lakes to calcium, magnesium is added to the lakes, by leaching of rocks in the catchment. It is vital component of chlorophyll, very high concentration of magnesium imports an unpleasant taste to the potable water. Magnesium mean values found in control 64.5 and 45.7 experimental tank during first experiment 2014-2015. The mean values were found in both control and experimental tanks 65.5 and 46.7 respectively during second experiment 2015-2016. The relative composition and concentration of the cations in the aquatic ecosystem determines the water quality for different uses. Calcium and magnesium cycle through biotic and abiotic components of the ecosystems. As a results ambient concentration is under the influence of the photosynthetic precipitation, biotic utilization and tropolyte release. Higher hardness values during summer and lower values of calcium found during winter and magnesium in monsoon months (Boyd, 1973), similar observations made by Chary(2003) and Rao (2004).

5.1.9. Chloride (Cl -) in mg/l

The chloride concentration serves as an indicator of pollution by sewage. People accustomed to higher chloride in water are subjected to laxative effects. In the present analysis, chloride mean values found in control 55.1 and 52.9 experimental tank during first experiment 2014-2015. The mean values were found in both control and experimental tanks 55.8 and 53.7 respectively during second experiment 2015-2016. Pulle and Khan (2001) reported that chloride content was found to be 32.2 to 48.7 mg/1 in Isapur dam water of Maharasthra and the presence of chloride indicates the availability of organic matter, presumably of animal origin and increase the amount of ammonical nitrogen and organic matter. The concentration of chloride increases with the degree of eutrophication. Yelavarthy (2002) has reported the low chloride levels of Red Hills Lake, Tamilnadu. Chary (2003) and Rao (2004) reported high values of chlorides in Jamulamma lake. Similar results were reported by Swarnalatha and Narsing rao, S. A. Manjare *et al*.(2010). Natural water normally has a low chloride content compared to bicarbonates and sulphate. High chlorides indicate pollution from domestic sewage and industrial effluents. Chloride content above 250 ppm makes water salty in taste. (Pulle and Khan, 2001).

5.1.10. Nitrate (NO^{3-}) in mg/l

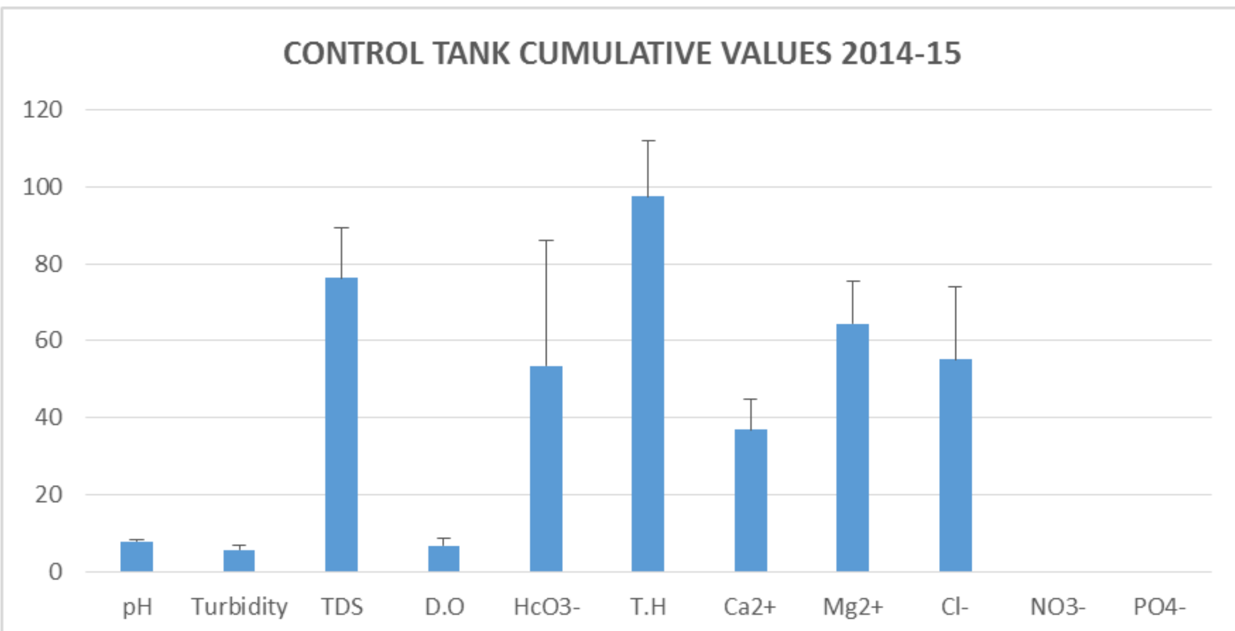
The nitrogen pool of limnetic environment comprises of two components namely the organic component consisting of organic materials liberated by the biota or generated in the heterotrophic bacterial activity upon pertinacious substrates. The second component is made up of inorganic compounds of nitrogen such as ammonia, nitrate and nitrite. A great deal of work on the distribution pattern of different forms of nitrogen and their inter relationship in fresh waters has been made by Mohanthy, (2000) and Das (2001). Surface water contains nitrate due to leaching of nitrate with the percolating water. Surface water can also be contaminated by sewage and other wastes rich in nitrates. R. M. Khan, M. J. Jadhav, I. R. Ustad (2012). The nitrate mean values found in control 0.1 and 0.1 experimental tank during first experiment 2014-2015. The mean values were found in both control and experimental tanks 0.1 and 0.1respectively during second experiment 2015-2016.

5.1.11. Phosphate ($PO4-^{3-)}$ in mg/l

Phosphate content was higher during summer due to its transport from the soil into water by the macrophytes. Decomposition of macrophytes during summer also increases the phosphate content in the water. The droppings of large number of residential and migratory birds add to the phosphate content in water. Phosphate may occur in surface water as are result of domestic sewage, detergents, and agricultural effluents with fertilizers. The phosphate mean values found in control 0.1 and 0.9 experimental tank during first experiment 2014-2015. The mean values were found in both control and experimental tanks 0.1 and 0.1 respectively during second experiment 2015-2016. Phosphate is the key nutrient in the productivity of water in reservoirs. Das (2001) and Yelavarthi (2002) studied the levels of phosphates in major reservoirs of Andhra Pradesh and Red Hills of Tamilnadu reservoir respectively, S. Chandra, A. Singh and P. K. Tomar (2012).

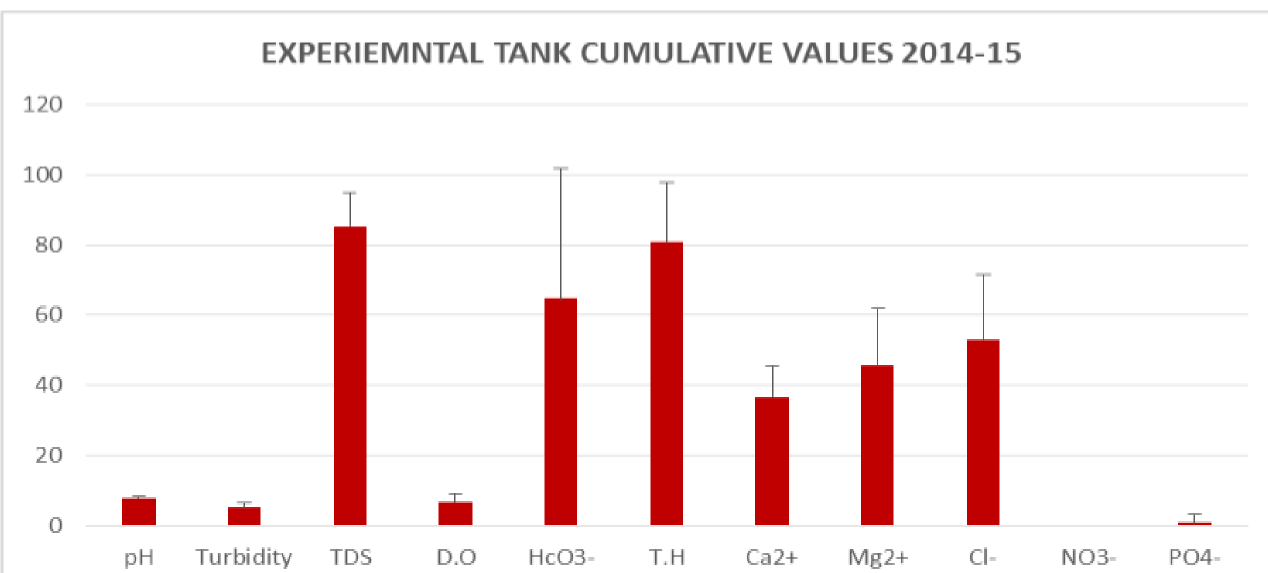
CONTROL TANK CUMULATIVE VALUES 2014-2015										
Parameter	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**Mean+SD**
pH	7.20	7.50	7.27	7.83	7.83	8.83	8.67	8.07	8.40	8.0±0.6
Turbidity	4.83	4.77	6.00	8.00	6.60	6.00	5.17	5.40	5.17	5.8±1.0
TDS	84.00	70.43	71.33	86.00	92.00	76.67	47.25	77.33	82.00	76.3±12.9
D.O	4.43	5.27	5.27	5.30	5.90	7.20	8.37	8.77	8.27	6.3±2.0
HCO3-	32.00	35.33	31.00	109.00	49.00	111.00	34.33	39.00	40.67	53.5±32.5
T.H	77.00	81.33	79.67	99.67	98.33	108.67	106.00	115.00	110.67	97.4±14.5
Ca2+	28.67	27.43	25.25	46.67	41.42	41.47	38.91	41.37	42.03	37.0±7.7
Mg2+	52.67	56.00	51.39	55.00	69.33	69.20	68.67	76.29	81.92	64.5±11.1
Cl-	33.33	34.33	36.73	62.33	74.67	38.35	68.66	71.20	76.12	55.1±18.9
NO3-	0.03	0.02	0.02	0.03	0.03	0.04	0.03	0.03	0.03	0.1±0.1
PO4-	0.09	0.02	0.01	0.06	0.03	0.05	0.05	0.06	0.05	0.1±0.1

All values are mg/L except pH, Turbidity



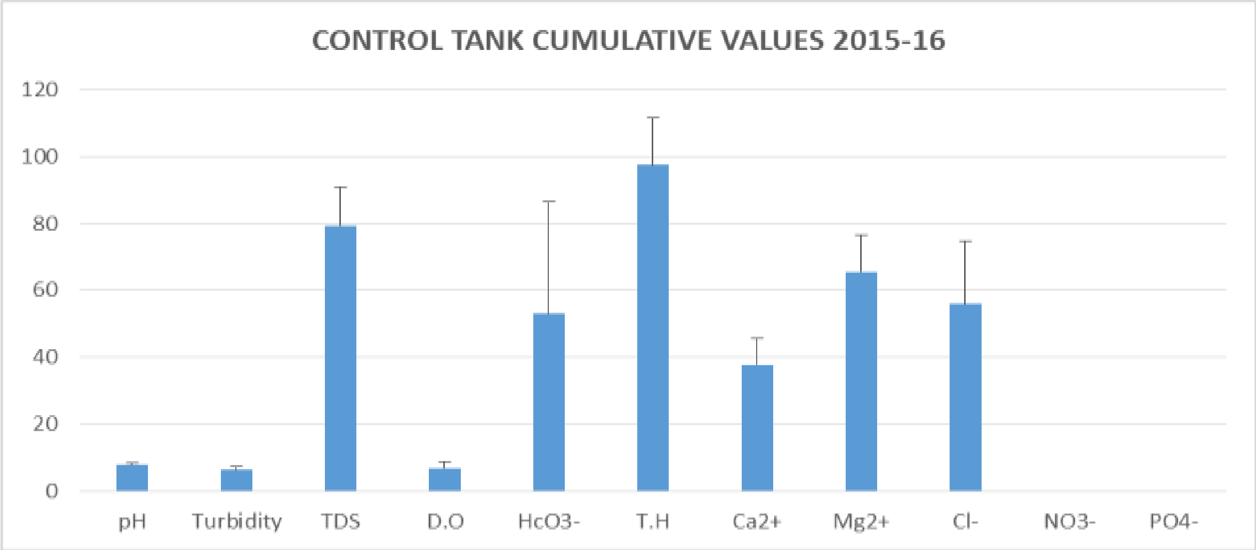
EXPERIMENTAL TANK CUMULATIVE VALUES 2014-2015										
Parameter	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**Mean+SD**
pH	7.90	7.60	7.40	7.73	8.47	7.70	8.53	8.57	8.30	8.0±0.4
Turbidity	4.10	5.23	4.47	7.97	3.73	4.53	5.63	4.97	7.07	5.3±1.4
TDS	78.67	86.67	75.33	97.33	69.00	88.67	83.00	96.00	92.00	85.2±9.6
D.O	4.47	4.67	7.13	4.50	4.73	8.07	8.03	8.10	8.10	6.4±2.3
HCO3-	93.33	39.33	31.22	48.40	97.00	141.00	41.67	44.00	46.33	64.7±37.1
T.H	67.00	81.33	54.33	82.43	67.33	72.00	100.00	101.00	101.00	80.7±17.1
Ca2+	44.60	27.07	18.22	33.00	44.89	38.88	42.22	39.95	41.08	36.7±9.0
Mg2+	23.67	57.61	32.90	55.00	25.67	33.78	58.67	61.08	63.00	45.7±16.3
Cl-	41.00	40.33	36.33	40.00	36.83	50.34	74.65	77.97	79.00	52.9±18.7
NO3-	0.03	0.02	0.02	0.03	0.04	0.03	0.04	0.03	0.03	0.1±0.1
PO4-	0.05	0.02	0.03	7.73	0.07	0.04	0.05	0.05	0.06	0.9±2.6

All values are mg/L except pH, Turbidity



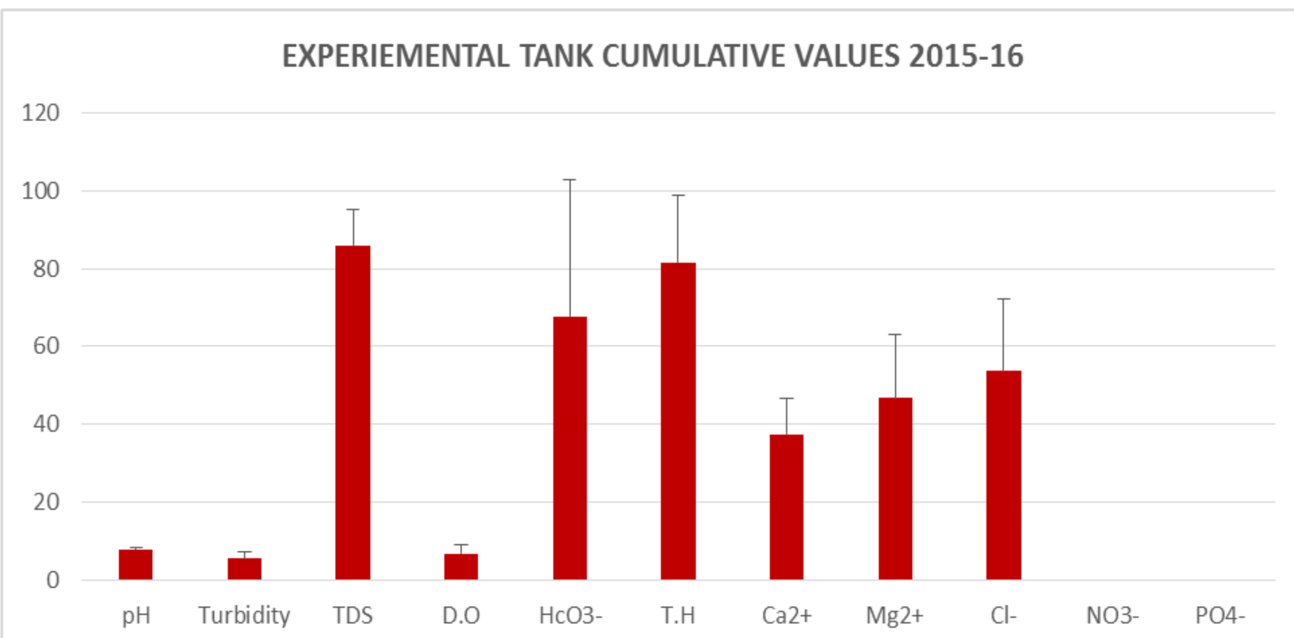
CONTROL TANK CUMULATIVE VALUES 2015-2016										
Parameter	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	Mean+SD
pH	7.10	7.60	7.37	7.97	8.00	8.60	8.33	8.20	8.50	8.0±0.5
Turbidity	5.23	5.17	6.40	8.67	7.30	6.40	5.57	5.63	6.03	6.3±1.
TDS	84.33	71.07	72.33	87.67	92.33	77.00	90.33	56.77	83.00	79.4±11.3
D.O	4.40	5.37	5.40	5.43	6.60	7.30	8.45	8.57	8.63	6.6±2.0
HCO3-	33.00	36.33	32.00	110.00	50.00	110.67	22.50	40.00	41.67	52.9±33.4
T.H	76.67	82.33	80.67	99.67	99.33	108.00	107.00	114.33	109.00	97.4±14.0
Ca2+	29.67	28.43	25.92	47.67	42.37	41.82	39.59	42.71	43.03	37.9±7.8
Mg2+	53.67	57.00	52.07	56.00	70.33	69.28	70.67	77.64	83.24	65.5±11.2
Cl-	34.33	35.33	37.67	63.33	75.00	38.37	69.03	71.88	76.87	55.8±18.8
NO3-	0.03	0.03	0.03	0.04	0.04	0.03	0.04	0.04	0.03	0.1±0.1
PO4-	0.04	0.03	0.02	0.05	0.03	0.04	0.05	0.05	0.03	0.1±0.1

All values are mg/L except pH, Turbidity



EXPERIMENTAL TANK CUMULATIVE VALUES 2015-16										
Parameter	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	Mean+SD
pH	8.00	7.70	7.50	7.83	8.53	7.80	8.37	8.30	8.40	8.0±0.4
Turbidity	4.50	5.63	4.57	8.37	4.10	4.93	6.40	5.40	7.53	5.7±1.5
TDS	79.67	87.00	76.33	98.33	70.00	89.67	83.67	96.33	92.33	85.9±9.4
D.O	4.57	4.77	7.23	4.60	5.13	8.47	8.91	8.00	7.87	6.7±2.2
HCO3-	92.33	41.00	54.00	49.13	97.67	141.00	42.67	45.00	47.33	67.8±34.8
T.H	68.00	82.33	55.33	83.20	68.33	73.00	101.00	101.33	102.00	81.6±17.0
Ca2+	45.30	28.06	18.25	34.00	45.56	39.55	42.23	40.95	42.42	37.4±9.1
Mg2+	24.67	58.55	33.91	56.00	26.67	35.44	59.67	61.10	64.33	46.7±16.2
Cl-	42.00	41.33	37.33	41.00	37.63	50.50	75.64	78.31	80.00	53.7±18.6
NO3-	0.04	0.03	0.03	0.04	0.03	0.03	0.03	0.04	0.04	0.1±0.1
PO4-	0.05	0.03	0.04	0.02	0.07	0.04	0.04	0.05	0.05	0.1±0.1

All values are mg/L except pH, Turbidity



5.2. PLANKTON ANALYSIS

Plankton is the most sensitive floating community which is being the first target of water pollution, thus any undesirable change in aquatic ecosystem affects diversity as well as biomass of this community. Conservation ratio at various trophic level and resources as an essential input for proper management of reservoir. Some notable studies on phytoplankton and zooplankton diversity have been made by Rao and Choubey, 1990; Deorari1993; Ariyadej *et al*., 2004; Mishra *et al*., 2010; and Joseph and Yamakanamardi, 2011). According to Pawar *et.al.*(2006) the plankton study is very useful tool for the assessment of biotic potential and contributes to overall estimation of basic nature and general economic potential of water body. Use of variety of agrochemicals in the catchment and human pressure are causing depletion of aquatic biota due to water pollution in the case of lakes and reservoirs. During monsoon turbidity caused by agricultural and surface runoff and soil erosion severely affect the production of plankton (Akhtar, *et al.*, 2007).

Planktons are used as a food by large number of animal species including fishes. Phytoplanktons and zooplanktons constitutes natural food of fish fry, fingerlings and adults and an adequate supply of these items are essential for proper growth of fishes. Phytoplankton can be related to differences in their morphologies, which thus represent a fundamental adaptive value **(Naselli-Flores and Barone 2011),** the environmental differences among waterbodies, acting as a sieve, select the best-fitting morphologies. Among unicellular organisms, phytoplankton has a prominent role. Although it accounts for <1% of the photosynthetic biomass on Earth, phytoplankton production is nearly 50% of the global net primary production **(Salmaso et al. 2012)**. Phytoplankton is an ecological group of photosynthetic, unicellular, or colonial organisms adapted to live in suspension in open waters.

5.3. Phytoplankton

Phytoplankton are the important component of an ecosystem, which responds to ecosystem alterations rather rapidly. It is due to the fact that plankonic organisms play an important role in the turnover of organic matter and energy conversion through the ecosystem. Phytoplankton plays an essential role of primary producers in an aquatic environment, hence it is the first component in the trophic tier. Various aquatic plants and animals bring about changes in the chemical composition of water. Phytoplankton which includes blue green algae, gren algae, diatoms, desmids, euglenoids etc are an important among aquatic flora. They are ecologically significant as they form the basic link in the food chain of all aquatic animals. Phytoplankton are pioneer in an aquatic food chain. The productivity of an aquatic ecosystem is directly correlated with the density of phytoplankton. These three elements are essential for the bloom of phytoplankton. The phytoplankton ecosystem as zooplankton feeds on phytoplankton. It is the main source of food for many organisms like fishes, prawns, molluscs. Chlorophyceae (Blue Algae), Cyanophyceae (Blue-green Algae), Bacillariophyceae (Diatoms) and Euglenophyceae constitute the phytoplankton bulk in the control and experimental tanks.

Among phytoplankton community, the Cyanophyceae communities were found to be rich and dominated in the control and experimental tanks (Table4.2). Six genera of Cyanophyceae were found in both experimental tanks and four genera found in control and experimental tanks of both the experiment. The percentage of Cyanophyceae communities were 73.50 % in control and 71.47% in experimental tank of the first experiment and 71.80% in control and 69.51% in experimental tanks respectively (Table 4.2). The common Cyanophyceae communities observed in the tanks were *Microcystis, Anabena, Oscillatoria, and Merismopodia. Spirulina and Nostac* were absent in both control tanks of both the experiments. The second dominating phytoplankton was found to be the Bacillariophyceae, which contributes 19.24% in control and 19.99% in experimental tank in the first experiment and 17.76% in control and 20.51% in second experiment (Tale 4.2). Nine Bacillariophyceae genera were found in the tanks. The common Bacillariophyceae communities observed in the tanks were *Navicula, , Amphipleura, , Pinnularia, , Synedra, Nitzchia, , Gamphonena , Diatoma and Diaptoma.* The third dominating phytoplankton was the Euglenophyceae, which contributes 5.21% in control and 5.38% in experiment in the first experiment and 7.77% in control and 6.31% in experiments in second experiment (Table 4.2). Two Euglenophyceae genera were found in the tanks *Euglena* and *Peranema* which are found most abundantly in all tanks.

The least dominating phytoplankton was the Chlorophyceae, which contributes 2.02% in control and 3.15% in experiment in the first experiment and 2.65% in control and 3.65% in second experiment (Table 4.2). Eight Chlorophyceae genera were found in the tanks. The common Chlorophyceae communities observed in the tanks were *Spirogyra, Ulothrix, Volvax, Oedogonium*. *Closteridium, Scenodesmus, Pediastrum* and *Microspora*. Pendse *et al*., (2000) observed the Euglenophyceae species, in percolation tank of Dasane village, Maharashtra. Perumalsamy *et al*., (2003) reported 43 species of phytoplankton in perennial ponds in Tamilnadu. Among these 11 species belong to Bacillarionphyceae, 18 species to Chloro[hyceae, 11 species belong to Cyanophyceae and 3 species belongs to Charophyceae.

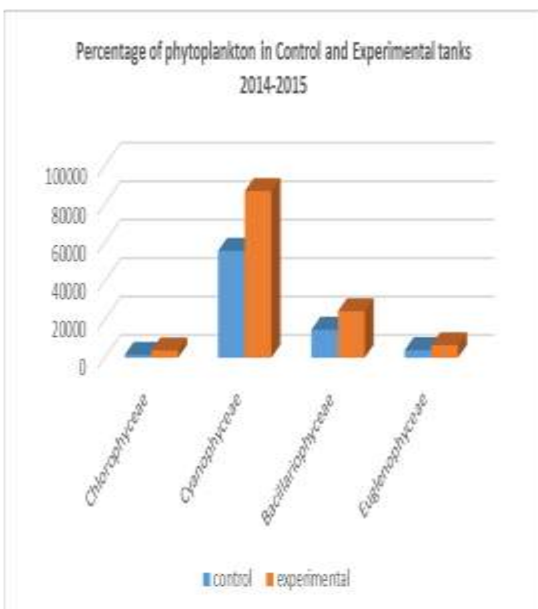
Rao and Raju (2003) observed the Bacillariophyceae species such represented by seven genera in fish culture pond at Nambur near Guntur, Andhrapradesh. Occurrence of Mycrocystis, the toxin producing blue green in bloms, is a significant feature of tropical water Harris and James (1974), Wetzel(1975). Sirsat et.al. (2004) reported 24 genera of phytoplankton belonging to four groups Chlorophyceae, Bacillariophyceae, Cyanophyceae, and Euglenophyceae during the study period at Dhamap uri in Beed district. Kumavaath and Jawale (2003) recoeded 59 genera of phytoplankton from a fish pond at Anjale. Somani and Jawale (2003) reported 14 genera of Chlorophyceae, in the lake Masunda, Thane, Nafeessa Begum and Narayana (2006) recorded 85 species of phytoplankton from four lentic water bodies in and around Devanagare city, Karnataka. Among functional traits of phytoplankton (e.g., presence of flagella, ability to form colonies, ability to fix nitrogen, presence of vacuoles or gas vesicles, typology of cell wall, and typology of storage substances), morphological features of shape and size represent the starting point to fully understand the relationships between this group of organisms and its environment (Naselli-Flores and Barone 2011). Predicting phytoplankton dynamics based on observed initial conditions can be a difficult task (Bauer et al. 2013), however, seasonal and annual changes in the physical environment trigger seasonally predictable autogenic dynamics of phytoplankton (Hoyer et al. 2009, Padisák et al. 2010, Rigosi and Rueda 2012).

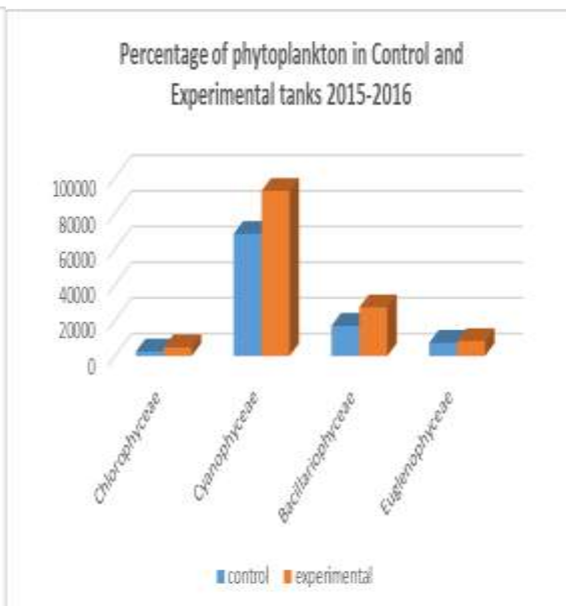
Table. Phytoplankton populations and their abundance in Control and Experimental tanks

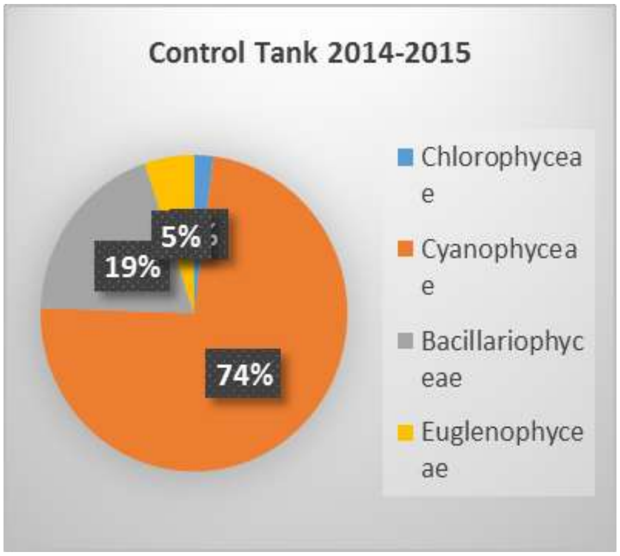
Group	Name of the Plankton	First experiment 2014-2015		Second experiment 2015-2016	
		Control	Experimental	Control	Experimental
Chlorophyceae	*Spirogyra*	++	+++	++	+++
(8 genera)	*Ulothrix*	+	++	+	+
	Volvax	++	+++	++	+++
	Oedogonium	++	++	++	+++
	Closteridium	+	+	+	+
	Scenodesmus	+	++	+	+
	Pediastrum	++	++	-	+++
	Microspora				
Cyanophyceae	*Microcystis*	++	++	++	++
(6 genera)	*Spirulina*	-	+	-	+
	Anabena	+	++	++	++
	Oscillatoria	++	++	++	++
	Merismopodia	+	+	-	+
	Nostoc	-	+	+	+
Bacillariophyceae	*Navicala*	++	+++	+	++
(9 genera)	*Amphipleura*	+	+	+	+
	Cymbella	+	+++	++	++
	Diaptoma	++	+++	-	++
	Pinnularia	-	+	+	+
	Syneda	+	+	+	+
	Nitzschia	++	++	+	+++
	Gomphonema	+	+	++	++
	Diatoma				
Euglenophyceae	*Euglena*	+	++	+	++
(2 genera)	*Paranema*	+	+	-	+

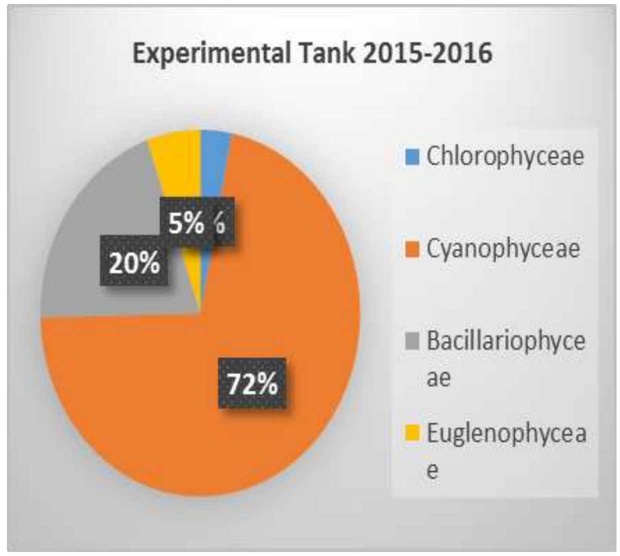
Table. Percentage of phytoplankton in Control and Experimental tanks

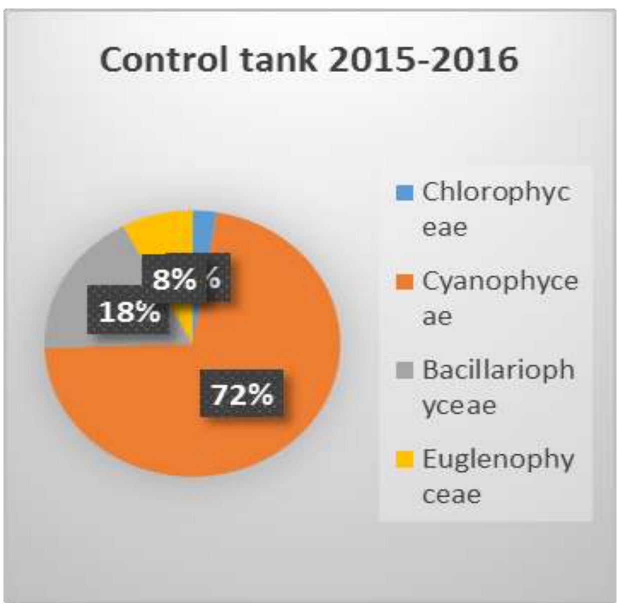
Plankton	**First experiment 2014-2015**				**Second experiment 2015-2016**			
	Control		**Experimental**		**Control**		**Experimental**	
	Total	%	Total	%	Total	%	Total	%
Chlorophyceae	1538	2.02	3826	3.15	2531	2.65	4872	3.65
Cyanophyceae	55698	73.50	86754	71.47	68512	71.80	92584	69.51
Bacillariophyceae	14587	19.24	24265	19.99	16954	17.76	27319	20.51
Euglenophyceae	3954	5.21	6535	5.38	7423	7.77	8415	6.31
Total	75777	100	121380	100	95420	100	133190	100






Control Tank 2014-2015
Chlorophyceae
Cyanophyceae
Bacillariophyceae
Euglenophyceae
5%
19%
74%

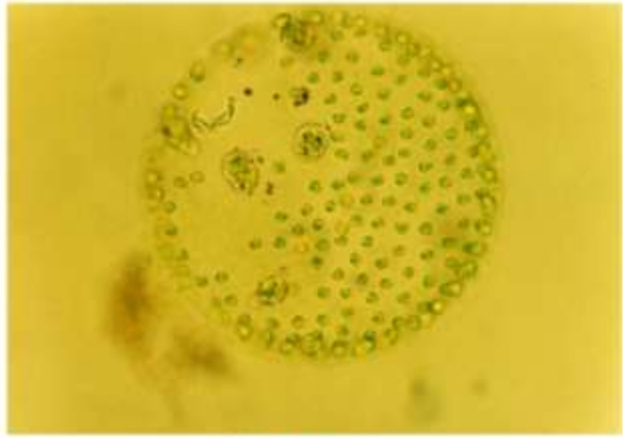

Experimental Tank 2015-2016
Chlorophyceae
Cyanophyceae
Bacillariophyceae
Euglenophyceae
5%
20%
72%


Control tank 2015-2016
Chlorophyceae
Cyanophyceae
Bacillariophyceae
Euglenophyceae
8%
18%
72%

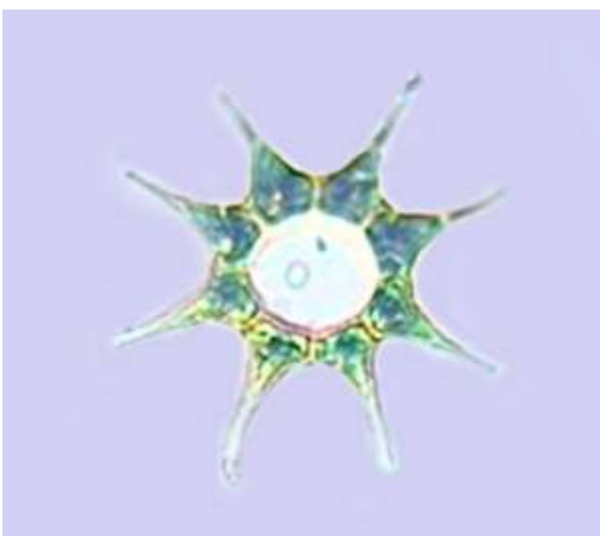

Experimental tank 2015-2016
Chlorophyceae
Cyanophyceae
Bacillariophyceae
Euglenophyceae
6%
20%
70%

Group: Chlorophyceae

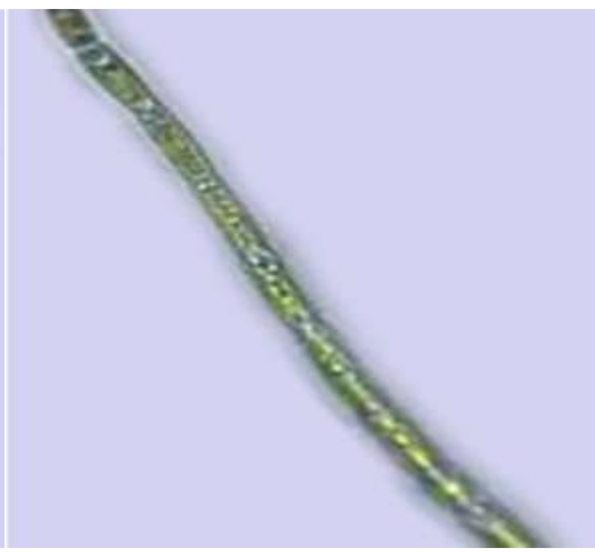
Spirogyra punctiformes



Volvax aureus

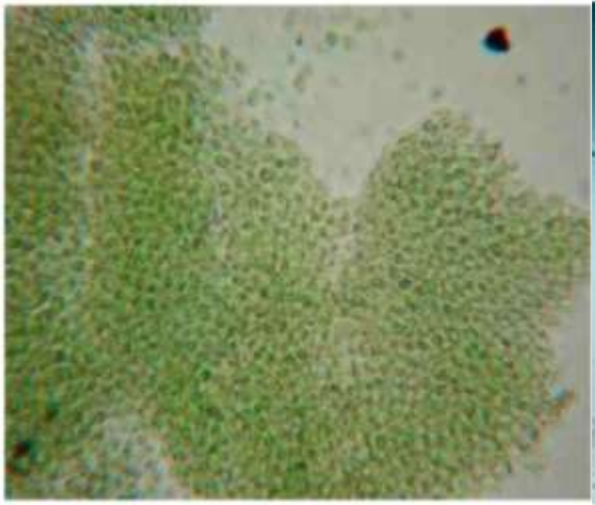


Pediastrum

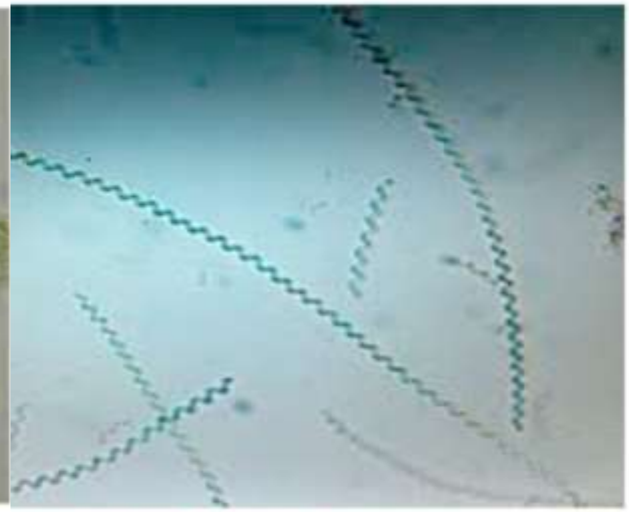


Oedogonium

Group:*Cyanophyceae*

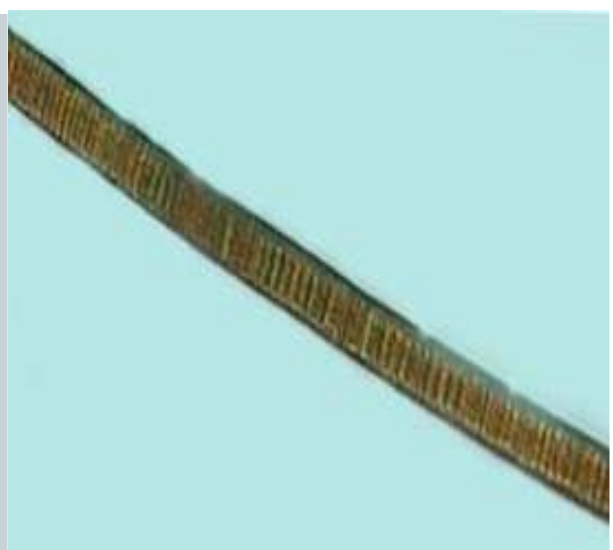


Microcystis aeruginosa



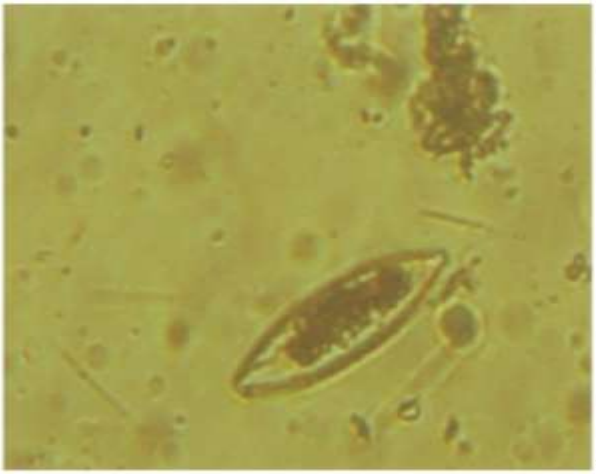
Spirulina major

Microcystis sps.



Oscillotoria

Group:Bacilloriophyceae



Navicula caspidata

Diaptoma vulgaris

Synedra

Navicula sps.

Gomphonema ***Pinnularia sps.***

Pinnularia nobilis ***Cvmbella***

5.4. ZOOPLANKTONS

Zooplanktons considered an important compartment of aquatic ecosystems for its role in the trophic equilibrium. It represents the channel of transmission of the energy flux from the primary producers to the top consumers. Through vertical migrations, as well as sedimentation of pellets and dead individuals, it accelerates the nutrient transfer from epilimnion to ipolimnion waters and by grazing and nutrient release it regulates phytoplankton production and community structure. Zooplankton organisms are one of the components of fauna of freshwater bodies. There are different varieties of zooplankton which thrive in varied types of freshwater bodies. The occurrence and abundance of zooplankton depends on its productivity which in turn is influenced by abiotic factors and the level of nutrients present in it. The freshwater zooplankton form an important group as most of them feed upon and incorporate the primary producers into their bodies and make themselves available to higher organisms in food chain. With the global loss of many species everyday as a result of pollution and habitat disturbance assessment of species diversity is needed today.

Zooplankton as indicators are extensively used due to their important role, in fast emerging concepts in environmental management. The zooplanktonic organisms in reservoirs show distinct seasonal dynamics that have been attributed mainly to changes in ambient physico-chemical parameters like light, temperature and nutrients which in turn govern primary production and autotrophy-herbivore interactions (Hessen et al., 2005). Zooplankton was represented by Rotifera, Copepoda, Cladocera and Ostracoda (Table 4.4). Among zooplankton, Rotifera was dominated followed by Copepoda, Cladocera and Ostracoda. The most dominating zooplankton was the Rotifera, which contributes 53.11% in control and 52.75% in experimental tank in the first experiment and 53.00% in control and 58.03% in experimental tank in second experiment (Table 4.4). Seven Rotifera genera were found in the tanks (Table4.4). The common Rotifera communities observed in the tanks were *Keratella, Brachionus, Hexarthra. Epiphanus, Rotaria, Filina and Ceprolodella.*

The second dominating zooplankton was the Copepoda, which contributes 30.77% in control and 29.60% in experiment in the first experiment and 29.96% in control and

26.04% in experiments in second experiment (Table 4.4). Five Copepoda genera were found in the tanks (Table--). The common Copepoda communities observed in the tanks were *Cyclops, Mesocyclops, Canthocamptus*,*Diaptomus and Heliodiaptomus* was found. The third dominating zooplankton was the Cladocera, which contributes 09.05% in control and 08.99% in experiment in the first experiment and 09.25% in control and 09.01% in experiments in second experiment. Seven Cladocera genera were found in the tanks (Table 4.4). The common Cladocera communities observed in the tanks were *Daphnia, Moina, Daphnisoma, Leydiga, Cereodaphnia, Alona, and Sida,*. The least dominating zooplankton was the *Ostracoda*, which contributes 07.05% in control and 08.64% in experiment in the first experiment and 07.78% in control and 08.08% in experiments in second experiment. One *Ostracoda* genus, Cypris was found in the tanks.

Similar results were observed in Pillowa reservoir in Shivbari temple tank of Bikaner Twenty eight species of zooplankton with six species of Cladocera, fourteen species of Rotifera, five species of Copepoda and three species of Ostracoda were reported in Sirur dam, Nanded (Pawar *et al.,* 2003). Patil *et al.* (2008), have identified 70 species of zooplankton in Rishi lake among them were 34 species of rotifers, 10 species of Protozoa, 10 species of Copepoda, 9 species of Cladocera and 7 species of Ostracoda in this lake. In holy lake of Pushkar of Ajmer, sixteen species of zooplankton were identified. Out of which two species of Protozoa, five species of Rotifera, five species of Cladocera and four species of Copepoda were identified (Khanna and Yadav, 2009). In Harsi reservoir, a total of 67 species of zooplankton has been identified (Shrotriy, 2010).

Similar findings were recorded by Rajan *et. al*., (2008) in polluted water bodies in Tamil Nadu. Pradhan et al (2006), also reported minimum rotifers in monsoon and post monsoon period. Rotifer richness and diversity were found to be maximum in summer indicating the influence of temperature. This observation is in concurrence with work of Kaushik and Sharma (1994) and Singh (2000), who studied zooplankton population in Matsya Sarovar Gwalior and in a tropical lake. The distribution of zooplankton community depends on a complex of factors such as, change of climatic conditions, physical and chemical parameters and vegetation cover. Most of the species of planktonic organisms are cosmopolitan in distribution (B.K. Sharma *et.al*.2011).

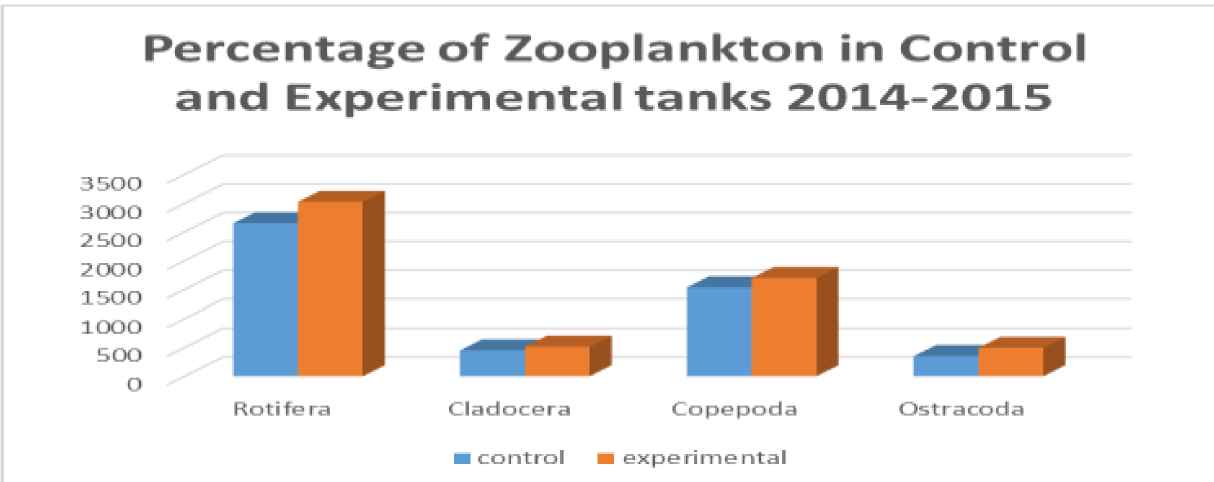
Zooplanktons are integral components of aquatic food webs and contribute significantly to aquatic productivity in freshwater ecosystems**.** They have been studied from various inland aquatic environs of India (Karuthapandi *et.al*.2013) but a review of the limnological literature indicates limited information on their composition, ecology and role in aquatic productivity in the floodplain lakes in particular. Thirupathaiah. M et al (2012) reported that diversity of zooplankton in Lower Manair reservoir, Karimnagar, AP, India. High rotifer species in the water body indicates enrichment due to direct inflow of untreated domestic sewage from adjacent areas. Rotifers dominance was also reported by Solanki VR et al., (2015) Pandu Lake of Bodhan, Telangana State. The zooplanktons community fluctuates according to Physico-chemical parameters of the environment, especially rotifer species change with biotic factors (Karuthapandi et al 2013).

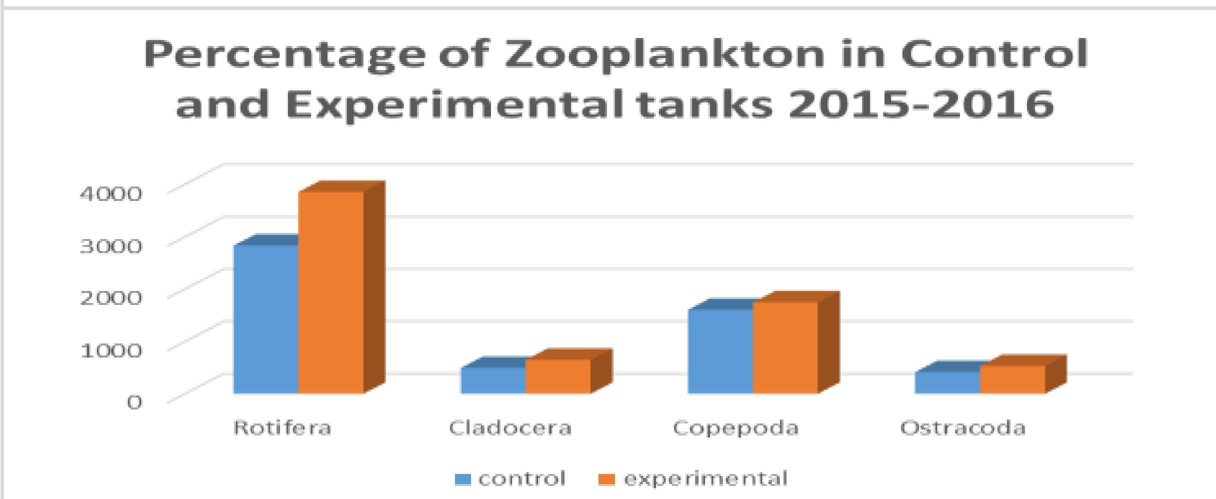
Table. Zooplankton populations and their abundance in Control and Experimental tanks

Group	**Name of the Plankton**	**First experiment 2014-2015**		**Second experiment 2015-2016**	
		Control	**Experimental**	**Control**	**Experimental**
Rotifera 7genera	*Keratella*	+	+++	++	+ ++
	Brachionus	+	+	-	+
	Hexarthra	-	+++	+	+++
	Epiphanus	+	++	+	++
	Rotaria	-	+	-	++
	Filina	-	+	+	+
	Cephalodella	+	++	-	++
Cladocera 7 genera	*Daphnia*	+	++	+	++
	Moina	+	+	+	+++
	Daphniosoma	++	+++	++	++
	Leydiga	++	+++	++	++
	Cereodaphnia	-	+	+	+
	Alona	+	+	+	++
	Sida	+	++	++	++
Copepoda 5 genera	*Cyclops*	+	+++	++	+++
	Mesocyclops	+	+	+	++
	Canthocamptus	-	++	+	++
	Diaptomus	++	+++	++	+++
	Heliodiaptomus	+	+	-	+
Ostracoda 1 genera	*Cypris*	+	++	++	+++

Table. Percentage of Zooplankton in Control and Experimental tanks

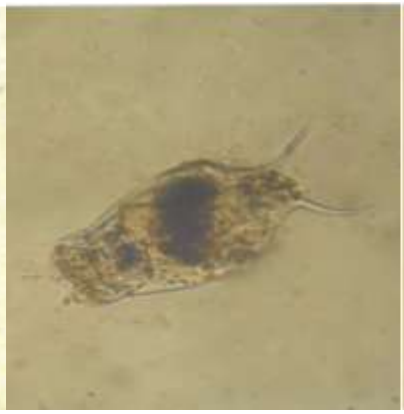
Plankton	First experiment2014-2015				Second experiment 2015-2016			
	Control		Experimental		Control		Experimental	
	Total	%	Total	%	Total	%	Total	%
Rotifera	2651	53.11	3026	52.75	2834	53.00	3854	58.03
Cladocera	452	09.05	516	08.99	495	09.25	652	09.01
Copepoda	1536	30.77	1698	29.60	1602	29.96	1745	26.04
Ostracoda	352	07.05	496	08.64	416	07.78	534	08.08
Total	4991	100	5736	100	5347	100	6605	100



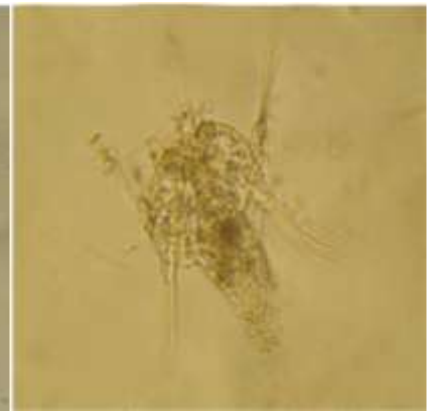


Group: Rotifers

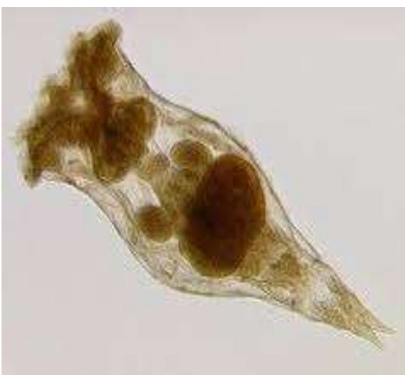
Keratella



Brachionus

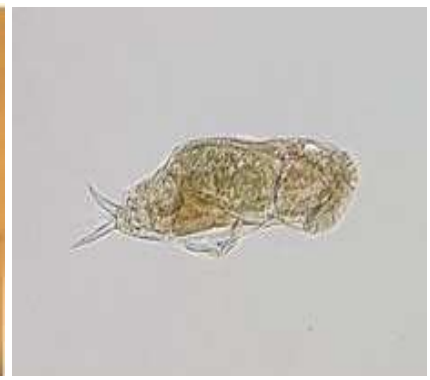


Hexartha



Epiphanus

Filinia



Cephalodella

Group: Cladocera

Dophnea

Moina

Dioaphonosama

Leidigi

Ceriodaphinia

Sida

Group: Copepod

Cyclops

Mesocyclops

Cccanthocanptus

Diatamus

Deliodiatamus

Cypris (**Ostracods)**

5.5. Chemical composition of periphyton

The chemical composition of periphyton developed on branches of *Ipomoea* bundles in experimental tanks are depicted in (Table 4.5 & 4.6). The chemical composition of periphyton like dry matter (DM) ash free dry matter (AFDM), chlorophyll, ash, proteins, lipids and carbohydrates were analysed. **DM** content was found in experimental tanks 1.16 mg/cm2 in first experiment and 1.36 mg/cm2 in second experiment in July, 2.11 mg/cm2 in first experiment and 2.30 mg/cm2 in second experiment in August, 1.64 mg/cm2 in first experiment and 1.41 mg/cm2 in second experiment in September, 1.52 and 1.62 mg/cm2 in first and second experiments respectively in October, 1.54 and 1.71 mg/cm2 in first and second experiments respectively in November, 1.62 mg/cm2 and 1.61 mg/cm2 in second experiment in December and 1.78 mg/cm2 and 1.54 mg/cm2 in first and second experiments respectively in January and 1.76 mg/cm2 and 1.61 mg/cm2 in first and second experiments respectively in February and 1.64 mg/cm2 and 1.34 mg/cm2 in first and second experiments respectively in March (Tables 4.5 & 4.6).

AFDM content was found in experimental tanks 1.38 mg/cm2 in first experiment and 1.48 mg/cm2 in second experiment in July, 1.62 mg/cm2 in first experiment and 1.94 mg/cm2 in second experiment in August, 1.51 mg/cm2 in first experiment and 1.78 mg/cm2 in second experiment in September, 1.78 and 1.61 mg/cm2 in first and second experiments respectively in October, 1.72 and 1.52 mg/cm2 in first and second experiments respectively in November, 1.65 mg/cm2 and 1.53 mg/cm2 in second experiment in December and 1.72 mg/cm2 and 1.68 mg/cm2 in first and second experiments respectively in January and 1.68 mg/cm2 and 1.46 mg/cm2 in first and second experiments respectively in February and 1.28 mg/cm2 and 1.28 mg/cm2 in first and second experiments respectively in March (Tables 4.5 & 4.6).

Chlorophyll content was found in experimental tanks 6.22 mg/cm2 in first experiment and 4.12 mg/cm2 in second experiment in July, 8.08mg/cm2 in first experiment and 13.16 mg/cm2 in second experiment in August, 10.26 mg/cm2 in first experiment and 11.78 mg/cm2 in second experiment in September, 8.57 and 9.42 mg/cm2 in first and second experiments respectively in October, 9.98 and 10.18 mg/cm2 in first and second experiments respectively in November, 7.92 mg/cm2 and 7.64 mg/cm2 in second experiment in December and 10.00 mg/cm2 and 8.22 mg/cm2 in first and second experiments respectively in January and 11.92 mg/cm2 and 12.0mg/cm2 in first and second experiments respectively in February and 8.72 mg/cm2 and 7.92 mg/cm2 in first and second experiments respectively in March (Tables 4.5 & 4.6).

Ash content was found in experimental tanks 23.17 mg/cm2 in first experiment and 22.17 mg/cm2 in second experiment in July, 26.16 mg/cm2 in first experiment and 26.18 mg/cm2 in second experiment in August, 28.10 mg/cm2 in first experiment and 28.11 mg/cm2 in second experiment in September, 21.33 and 27.32 mg/cm2 in first and second experiments respectively in October, 24.35 and 26.48 mg/cm2 in first and second experiments respectively in November, 26.18 mg/cm2 and 29.31 mg/cm2 in second experiment in December and 28.30 mg/cm2 and 30.31 mg/cm2 in first and second experiments respectively in January and 30.17 mg/cm2 and 28.00 mg/cm2 in first and second experiments respectively in February and 29.10 mg/cm2 and 29.17 mg/cm2 in first and second experiments respectively in March (Tables 4.5 & 4.6).

Carbohydrates content was found in experimental tanks 31.64 mg/cm2 in first experiment and 28.34 mg/cm2 in second experiment in July, 37.20 mg/cm2 in first experiment and 37.21 mg/cm2 in second experiment in August, 38.20 mg/cm2 in first experiment and 39.22 mg/cm2 in second experiment in September, 33.80 and 37.56 mg/cm2 in first and second experiments respectively in October, 35.60 and 34.24 mg/cm2 in first and second experiments respectively in November, 37.40 mg/cm2 and 36.24 mg/cm2 in second experiment in December and 39.00 mg/cm2 and 38.04 mg/cm2 in first and second experiments respectively in January and 38.24 mg/cm2 and 39.04 mg/cm2 in first and second experiments respectively in February and 32.14 mg/cm2 and36.24 mg/cm2 in first and second experiments respectively in March (Tables 4.5 &4.6).

Protein content was found in experimental tanks 12.86 mg/cm2 in first experiment and 14.26mg/cm2 in second experiment in July, 14.12mg/cm2 in first experiment and 15.15 mg/cm2 in second experiment in August, 13.96 mg/cm2 in first experiment and 13.28 mg/cm2 in second experiment in September, 12.98 and 12.38 mg/cm2 in first and second experiments respectively in October, 13.42 and 12.49 mg/cm2 in first and second experiments respectively in November, 12.89 mg/cm2 and 13.23 mg/cm2 in second experiment in December and 15.21mg/cm2 and 14.56 mg/cm2 in first and second experiments respectively in January and 15.76 mg/cm2 and 13.10 mg/cm2 in first and second experiments respectively in February and 14.26 mg/cm2 and 14.46 mg/cm2 in first and second experiments respectively in March (Tables 4.5 & 4.6).

Lipid content was found in experimental tanks 2.24 mg/cm2 in first experiment and 2.44 mg/cm2 in second experiment in July, 3.12 mg/cm2 in first experiment and 2.98 mg/cm2 in second experiment in August, 2.86 mg/cm2 in first experiment and 2.41 mg/cm2 in second experiment in September, 2.17 and 2.58 mg/cm2 in first and second experiments respectively in October, 2.72 and 2.46 mg/cm2 in first and second experiments respectively in November, 2.81 mg/cm2 and 2.21 mg/cm2 in second experiment in December and 2.92 mg/cm2 and 2.34 mg/cm2 in first and second experiments respectively in January and 2.16 mg/cm2 and 2.49 mg/cm2 in first and second experiments respectively in February and 2.12 mg/cm2 and 2.13 mg/cm2 in first and second experiments respectively in March (Tables 4.5 & 4.6).

Azim *et al*. (2002a) analyzed elemental C:H:N ratios of periphyton colonized on different artificial substrates in freshwater ponds and reported 4-7% N, 46-49% C and 6-7% H (all based on AFDM), depending on the type of substrate. **Burford *et al.* (2004)** determined more or less similar periphyton C: N ratios (range 6.2-8.7) in shrimp ponds. In the absence of fish, pond periphyton comprised 15-40% ash, depending on substrate types **(Azim *et al.*, 2002a).** Under optimum grazing pressure by fish, the proportion of ash was even lower **(Azim *et al.*, 2002b).** The stable nitrogen isotope ratio in periphyton samples from the Florida Everglades ranged from 1.1 to 2.7%0 **(Inglett *et al.* 2004). Jones *et al.* (2004)** determined the natural abundance of stable nitrogen isotopes in periphyton grown on stones from 30 upland lakes with different nutrient status and reported that the ratios ranged from -2.5 to 4.1 %0 and were positively correlated with the ratios of total dissolved nitrogen. As described in periphyton colonisation models **(Hoagland et al., 1982; Steinman, 1996)**, AFDW and Chl *a* levels increased until a maximum biomass was reached.

In contrast to previous studies **(Richard et al., 2009, Richard et al., submitted)**, long immersion of meshed substrates (10.5 months) enabled the development of green algae and large-sized amphipods. In the same way, DW and specifically Chl *a* means were significantly higher in this experiment. In subsequent studies, meshed substrates could be attached on rigid structures to render them inflexible and to improve the efficiency of mullet grazing, as was done with poles in carp **(Azim et al., 2001a)** and tilapia periphyton-based ponds **(Keshavanath et al., 2004)**.

Table.No.4.5. Chemical composition of periphyton in 2014-2015

Month	Tank	DM (mg/cm^2)	AFDM (mg/cm2)	Chl (ug/cm)	Ash (%)	Protein (%)	Lipid (%)	sugars (%)
Jul	Con	0	0	0	0	0	0	0
	Exp	1.16±0.02	1.38±0.03	6.22±1.12	23.17±2.51	12.86±1.04	2.24±0.03	31.64±3.02
Aug	Con	0	0	0	0	0	0	0
	Exp	2.11±0.04	1.62±0.05	8.08±1.02	26.16±3.52	14.12±2.0	3.12±0.21	37.2±3.21
Sep	Con	0	0	0	0	0	0	0
	Exp	1.64±0.02	1.51±0.06	10.26±1.2	28.10±3.46	13.96±2.51	2.86±0.46	38.2±3.42
Oct	Con	0	0	0	0	0	0	0
	Exp	1.52±0.03	1.78±0.02	8.57±0.86	21.33±3.10	12.98±2.10	2.17±0.05	33.8±2.96
Nov	Con	0	0	0	0	0	0	0
	Exp	1.54±0.04	1.72±0.03	9.98±1.26	24.35±4.51	13.42±2.24	2.72±0.08	35.6±4.40
Dec	Con	0	0	0	0	0	0	0
	Exp	1.62±0.03	1.65±0.04	7.92±1.15	26.18±5.10	12.89±2.32	2.81±0.03	37.4±4.06
Jan	Con	0	0	0	0	0	0	0
	Exp	1.78±0.02	1.72±0.02	10.00±1.3	28.30±3.32	15.21±2.15	2.92±0.08	39.0±4.86
	Con	0	0	0	0	0	0	0
Feb	Exp	1.76±0.04	1.68±0.05	11.92±1.2	30.17±3.38	15.76±1.04	2.16±0.04	38.24±4.26
Mar	Con	0	0	0	0	0	0	0
	Exp	1.64±0.03	1.28±0.05	8.72±1.43	29.10±3.52	14.26±1.04	2.12±0.03	32.14±3.02

Table.No.4.6. Chemical composition of periphyton in 2015-2016

Month	Tank	DM (mg/cm^2)	AFDM (mg/cm2)	Chl (ug/cm)	Ash (%)	Protein (%)	Lipid (%)	sugars (%)
Jul	**Con**	0	0	0	0	0	0	0
	Exp	1.36±0.03	1.48±0.03	4.12±1.12	22.17±2.61	14.26±1.05	2.44±0.04	28.34±3.04
Aug	**Con**	0	0	0	0	0	0	0
	Exp	2.30±0.05	1.94±0.03	13.16±1.5	26.28±3.61	15.15±2.10	2.98±0.10	37.21±3.46
Sep	**Con**	0	0	0	0	0	0	0
	Exp	1.41±0.04	1.78±0.05	11.78±1.6	28.11±3.02	13.28±2.31	2.41±0.12	39.22±4.32
Oct	**Con**	0	0	0	0	0	0	0
	Exp	1.62±0.05	1.61±0.04	9.42±1.56	27.32±3.13	12.38±2.05	2.58±0.06	37.56±4.04
Nov	**Con**	0	0	0	0	0	0	0
	Exp	1.71±0.07	1.52±0.03	10.18±1.4	26.48±3.62	12.49±1.66	2.46±0.80	34.24±4.22
Dec	**Con**	0	0	0	0	0	0	0
	Exp	1.61±0.05	1.53±0.06	7.64±1.68	29.31±3.72	13.23±1.62	2.21±0.04	36.21±3.46
Jan	**Con**	0	0	0	0	0	0	0
	Exp	1.54±0.03	1.68±0.07	8.22±1.42	30.31±3.41	14.56±1.10	2.34±0.06	38.04±4.06
	Con	0	0	0	0	0	0	0
Feb	**Exp**	1.61±5.0	1.46±0.20	12.0±3.27	28.0±5.05	13.10±1.07	2.49±6.07	39.04±6.07
Mar	**Con**	0	0	0	0	0	0	0
	Exp	1.34±0.03	1.28±0.04	7.92±1.22	29.17±3.48	14.46±1.05	2.13±0.05	36.24±4.04

5.6. FISH GROWTH AND PRODUCTION

In the present study the periphyton was grazed by Catla, Rohu and Mrigala and the growth of these three fishes were enhanced due to high protein, energy and organic matter in periphyton. In a periphyton-based fish pond, fish yields depend on periphyton substrate density, quantity and the nutritional quality of the periphyton, the grazing efficiency of the cultured fish species, fish species combination and density etc. In polyculture ponds, using bamboo as substrates at submerged surface area densities equivalent to 50, 75 and 100% of the pond water surface area, fish production was found to increase linearly with increasing substrate surface area (Azim *et al.,* 2004). No maximum production was reached within the range of densities used.

The nutritional quality of periphyton is highly variable, depending particularly on habitats and substrate types and grazing pressure. The overall nutritional quality of periphyton is much better in closed waters, especially in aquaculture ponds, than in open waters (Azim and Asaeda, 2005; Van Dam *et al.,* 2002). This is mainly because periphyton is purposely grown in managed ponds by positioning substrates in euphotic zones. However, it is very important that the nutritional quality of periphyton is sufficient to support the dietary needs of cultured animals; otherwise, supplemental feed should be applied to the ponds. Not all fish are able to graze on periphyton; morphological and physiological adaptations to periphyton grazing are required. However, more insight is still needed into the mechanisms for periphyton exploitation through selective feeding by different fish communities.

Shrestha and Knud-Hansen (1994) conducted two experiments in Thailand where plastic sheets and bamboo poles (7.7 m^2 extra surface areas per tank) were used vertically as substrates in concrete tanks (2.5 x 2 x 1.1 m^3). Sex-reversed all-male Nile tilapia *(Oreochromis niloticus)* were stocked at a density of three fish per m^2 and grown over a 56-day period. Although there was evidence that the fish utilized periphyton from the substrates, there was no difference in net fish growth and yield between tanks with and without plastic sheets as substrate. In another experiment bamboo substrates resulted in greater net fish growth and yield (3.43 $g/m^2/day$) than plastic sheets (2.51 $g/m^2/day$), but the contribution of bamboo substrate was not quantified due to absence of a treatment without bamboo substrate.

Shankar *et al.*, (1998) reported that the growth of Tilapia, *Oreochromis mossambicus* and common carp, *Cyprinus carpio* has increased 48% and 50%, respectively, in fertilized 1 m^2 cement tanks provided with sugarcane bagasse (waste sugarcane fibre) as substrate compared to ponds without substrate during a 91-day culture period. Based on this result, a further investigation was carried out in three 25 m^2 cement cisterns (Ramesh *et al.*, 1999). Sugarcane bagasse was suspended in cisterns fertilized with cow dung and urea and only fertilized cisterns were used as control. Phadate and Srikar (1998) reported that growth of catla, common carp and silver carp increased significantly with formulated feeds. Piska *et al* (2008) used bamboo poles and sugar cane bagasse for the production of periphyton as substrata and also worked out the growth rates and production of mrigal in cisterna with mud bottom.

5.6.1. Growth of *Catla*

The growth of fish stocked in control and experimental tanks were measured by recording the length and weight of fish at the end of every month of culture period. This was continued up to the end of experiment for nine months. Growth of *catla* in the control and experimental tanks in this experiment were depicted in. Table 5.1. Fingerling stage of catla in control and experimental tank with size of 3.5 mm total length and 20 gm body weight was stocked during last week of July in each year. The mean growth was 11.27 cm in length and 228.11 g in body weight in control tank and 14.35 cm length and 370.22 g body weight in experimental tank during first experiment in 2014-2015 as the same way the mean growth of Catla was 13.05 cm in length and 260.55 g body weight in control tank and 16.35 cm in length and 428.77 g body weight in experimental Tank during second experiment 2015-2016.

5.6.2. Growth of *Rohu*

The growth of Rohu fish stocked in control and experimental tanks were measured by recording the length and weight of fish at the end of every month during culture period.

This was continued up to the end of experiment for nine months. Growth of *Rohu* in the control and experimental tanks in this experiment were depicted in. table 5.2. Fingerling stage of catla in control and experimental tank with size of 3.5 mm total length and 20 gm body weight was stocked during last week of July in each year. The mean growth was 11.57 cm in length and 213.77 g in body weight in control tank and 13.83 cm length and 310.11 g body weight in experimental tank during first experiment in 2014-2015 as the same way the mean growth of Rohu was 11.76 cm in length and 218.77 body weight in control tank and 14.1 cm in length and 327.66 g body weight in experimental Tank during second experiment 2015-2016.

5.6.3. Growth of *Cirrhinus mrigala*

The growth of Mrigala fish stocked in control and experimental tanks were measured by recording the length and weight of fish at the end of every month during culture period. This was continued up to the end of experiment for nine months. Growth values of *Mrigala* in the control and experimental tanks in this experiment were depicted in. Table 5.3. Fingerling stage of catla in control and experimental tank with size of 3.5 mm total length and 20 gm body weight was stocked during last week of July in each year. The mean growth was 10.0 cm in length and 207.33 g in body weight in control tank and 12.56 cm length and 311.0 g body weight in experimental tank during first experiment in 2014-2015 as the same way the mean growth of Catla was 10.22 cm in length and 237.44 body weight in control tank and 12.16 cm in length and 305.77 g body weight in experimental Tank during second experiment 2015-2016.

Table.5.1. Growth of Catla catla in control and experimental tanks

Month	First Year experiment 2014-2015				Second Year experiment 2015-2016			
	Average Length (cm)		Average Weight (gr)		Average Length (cm)		Average Weight (gr)	
	Con	Exp	Con	Exp	Con	Exp	Con	Exp
Jul	3.9	4.6	26	46	3.9	5.8	36	60
Aug	4.2	5.8	28	56	4.3	6.2	40	72
Sep	5.8	7.9	52	118	7.2	8.4	89	163
Oct	8.3	11.3	140	215	9.1	12.4	165	250
Nov	10.4	15.5	206	325	11.9	17.4	268	425
Dec	14.6	18.2	290	482	15.8	21.5	382	561
Jan	17.8	21.1	425	655	20.2	24.3	448	768
FEB	18.0	22.0	436	710	22.0	25.0	455	775
MAR	18.5	22.8	450	725	23.1	26.2	462	785
Mean	11.27	14.35	228.11	370.22	13.05	16.35	260.55	428.77

Table.5.2. Growth of Labeo rohita in control and experimental tank

Month	First Year experiment 2014-2015				Second Year experiment 2015-2016			
	Average Length (cm)		Average Weight (gr)		Average Length (cm)		Average Weight (gr)	
	Con	Exp	Con	Exp	Con	Exp	Con	Exp
Jul	3.8	4.6	21	28	4.0	5.1	28	38
Aug	4.1	5.3	25	32	4.3	5.6	30	42
Sep	5.9	7.1	51	78	6.5	8.1	66	96
Oct	8.0	11.5	126	182	8.3	11.9	112	192
Nov	11.0	16.2	193	265	11.4	14.5	193	286
Dec	16.5	18.8	293	420	15.3	16.8	275	396
Jan	17.8	19.8	395	580	18.2	21.0	415	622
FEB	18.1	20.2	400	596	18.8	21.8	420	635
MAR	19.0	21.0	420	610	19.1	22.1	430	642
Mean	**11.57**	**13.83**	**213.77**	**310.11**	**11.76**	**14.1**	**218.77**	**327.66**

Table.5.3. Growth of *Cirrhinus mrigala* in control and experimental tank

Month	First Year experiment 2014-2015				Second Year experiment 2015-2016			
	Average Length (cm)		Average Weight (gr)		Average Length (cm)		Average Weight (gr)	
	Con	Exp	Con	Exp	Con	Exp	Con	Exp
Jul	3.4	4.0	22	30	3.6	4.4	32	50
Aug	3.9	4.3	24	42	4.3	53	36	56
Sep	5.5	6.1	45	66	5.3	6.2	56	76
Oct	7.2	9.6	110	140	7.4	8.2	120	165
Nov	9.0	13.2	185	196	8.9	10.2	185	230
Dec	11.2	15.6	240	380	12.1	14.6	265	345
Jan	14.8	18.4	380	620	15.3	18.3	460	535
FEB	16.2	20.3	425	645	16.8	19.2	485	630
MAR	18.8	21.6	435	680	18.3	23.1	498	665
Mean	**10.0**	**12.56**	**207.33**	**311.0**	**10.22**	**12.16**	**237.44**	**305.77**

Images of Comparative growth observations of Indian Major Carps

Images of Comparative growth observations of Indian Major Carps

5.7. MAJOR CARP PRODUCTION TRENDS

Today, fish seed production is a widespread commercial activity, recent development of aquaculture is increasingly taking advantage of the continual production of fish seed. Firstly, the excellence of carp seeds greatly depends on quality and source of brood fishes. The value of hatchery products such as spawns and fingerlings is also variable depending on several factors, viz. species, supply, demand, season, transportation and quality of spawns. It is reported that the price of spawns of Indian Major Carp and Chinese carp varies both in private and public farms from 1,000 to 3,000 BDT per kg (Sarder, 2007).

5.7.1. Fish yield

In the first experiment 2014-2015, major carp yield were found 1100.70 Kg/ha and 1107.84 Kg/ha in control and experimental tanks respectively. Catla production was found to be 450.20 Kg/ha in control tank and 485.18 Kg/ha in experimental tank and Rohu production was found 300.50 Kg/ha in control and 326.36 Kg/ha in experimental tank. Mrigala production was found 300.50 Kg/ha in control and 296.30 Kg/ha in experimental tank. Major carp production was enhanced to 07.14%. Catla production enhanced to 34.98 % and Rohu production enhanced to 25.86 % and Mrigala production 95.80 % in experimental tanks when compared to that of control tank (Tables5.6, 5.7, 5.8, and 5.9).

In the second experiment, major carp yield was found to be 1161.65 Kg/ha and 1643.23 Kg/ha in control and experimental tanks respectively. Catla production was found to be 400.20 Kg/ha in control tank and 570.20 Kg/ha in experimental tank and Rohu production was found to be 396.24 Kg/ha in control and 622.45 Kg/ha in experimental tank and Mrigala production was found to be 365.21 Kg/ha in control and 450.58 Kg/ha in experimental tank. Major carp production was enhanced to 481.58%. Catla production enhanced to 170 % and Rohu production enhanced to 226.21 % and Mrigala 85.37 %in experimental tanks when compared to that of control tank (Tables5.6, 5.7, 5.8, 5.9). According to Sreenivasan (1999) catch composition of catla, rohu, mrigal, common carp and silver carp in Kovilar and Periyar reservoirs of Tamilnadu was 8.73% - 5.79%, total catch in 1990-91 and 51.65% - 51.43% in 1994-95. Devi (1997) reported that the contribution of major carps was 91.42% in Ibrahimbagh and 96.40% in Shathamraj reservoirs of Andhra Pradesh during 1993-1995. Mahapatra (2003) recorded only 15.6 kg/ha/yr in Hirakud reservoirs and 5-10 kg/ha/yr in other major reservoirs in Orissa and concluded that there was scope for increase the yield rate to 100 kg/ha/yr by proper management. The 'stocking efficiency' for each species must be determined while planning correct stocking (Sreevasan, 1999). It is also concluded that the stocking of a reservoir with fingerlings in the place of fry is beneficial and provides higher production. (Sakhare, 1999 – Yeldari reservoir, Maharasthra. Das *et al*, (2002) reservoirs of Karnataka). According to Mahapatra *et al* (2002) scientific stocking using the right species of proper size and number would definitely help in enhancing the fish yield in Umiam reservoir, Meghalaya, as the growth performance of the Indian major carps was found to be promising. Ansar (2010) reported that, productivity and number of fry for production of 1 kg fish were more in the Jammulamma reservoir, Gadwal in Mahaboob Nagar District. More number of fry (67.68) to produce one kilogram of fish indicated that the growth rate was less or it may be due to mortality of fry or fingerlings in the reservoir.

Image.4.1. Harvesting of fish from the tank.

Table.5.4. Seed stocking rate and percentage of three Indian Major carps for the control and experimental tanks during first experiment.

Year	2014-2015 control Tank		2014-2015 experimental Tank	
Type of major Carp	**Number of seed Stocking**	**Percentage of Stocking**	**Number of Stocking**	**Percentage of Stocking**
Catla	8000	44%	12000	38%
Rohu	5000	27%	10000	32%
Mrigala	5000	27%	9000	29%

Table.5.5. Seed stocking rate and percentage of three Indian Major carps for the control and experimental tanks during second experiment.

Year	2015-2016 control Tank		2015-2016 experimental Tank	
Type of major Carp	**Number of seed Stocking**	**Percentage of Stocking**	**Number of Stocking**	**Percentage of Stocking**
Catla	10000	40%	15000	40%
Rohu	8000	32%	12000	32%
Mrigala	7000	28%	10000	27%

Table No: 5.6. The stocking and productivity of Indian major carps from control tank during 2014 – 2015

TYPE OF CARP	Present stocking rate(Nos)	Present productivity (Kg/ha/Yr)	No of Fish for present production of 1 Kg Fish
CATLA	8000	450.20	45
ROHU	5000	300.50	39
MRIGALA	5000	300.50	36
TOTAL	18000	1100.70	120

Table.5.7.The stocking and productivity of indian major carps from experimental tank 2014 -2015

TYPE OF CARP	Present stocking rate(Nos)	Present productivity (Kg/ha/Yr)	No of Fish for present production of 1 Kg Fish
CATLA	12000	485.18	40
ROHU	10000	326.36	33
MRIGALA	9000	296.30	34
TOTAL	31000	1107.84	107

Table.5.8.The stocking and productivity of Indian major carps from control tank

2015 -2016

TYPE OF CARP	Present stocking rate(Nos)	Present productivity (Kg/ha/Yr)	No of Fish for present production of 1 Kg Fish
CATLA	10000	400.20	36
ROHU	8000	396.24	34
MRIGALA	7000	365.21	32
TOTAL	**25000**	**1161.65**	**102**

Table.5.9. The stocking and productivity of major carps from experimental tank

2015 -2016

TYPE OF CARP	Present stocking rate(Nos)	Present productivity (Kg/ha/Yr)	No of Fish for present production of 1 Kg Fish
CATLA	15000	570.20	28
ROHU	12000	622.45	32
MRIGALA	10000	450.58	31
TOTAL	37000	1643.23	91

5.8. Ichthyofaunal diversity

Fishes excel as a source of commerce and recreation. They from a rich source of food, and are cultured both, intensively and extensively to give the best values of their raising. In addition, they yield a number of by-products of high economic value. They inhabit a variety of different kinds of environments ranging from deep water of the ocean to the boundless surface of the open sea and from high tropics to the receding Polar Regions. They live in fast running torrential streams, the muddy water of the bays, brackish waters, estuaries, stagnant pools and in the waters several feet under the ground in caves. The surviving fish species are most numerous of all the vertebrates, of these 14. 2% inhabit the water and 58. 2% the marine water of the world, Nearly 800 native fish species in 36 families inhabit the freshwater rivers, streams, and lakes of the United states and Canada. America has the most diverse temperate freshwater fish fauna in the world. Only about 5 percent of these are the familiar sport or game fishes like trout and bass. The remaining 95 percent are little known, but colourful, nongame (not sport fish) fishes such as darters, minnows, shiners, and dace.

Fisheries is directly associated with the economy of the country and provide alternate resource of food for the growing population. Fishery sector is one of the Engines of growt. Fishes are valuable source of high grade protein and they occupy a significant position in the socio economic fabric by providing the population not only thenutritious food but also income and employment opportunities.

In the present study the Ichthyofauna of both control and experimental tanks for two years were depicted in table no 6.1. Ichthyofauna consisting of 14 species, *Labeo rohita (Rohu), Catla catla (catla), Cirrhina mrigala (Mrigal), Salmostoma bacaila, Amblypharyngodon mola (Mole), Channa stiatus (Stripped murrel), C. punctatus (Spotted murrel), C. marulius (Gaint murrel), C. gachus (Gaint murrel), Clarius batrachus (Marurf), Heteropneustes fossilis (Singhi), Mastacembelus armatus, Notopterus notopterus (Razor fish),* which belongs to 5 Orders 6 groups.Table 6.1.

Ichthyodiversity refers to variety of fish species; depending on context and scale, it could refer to alleles or genotypes within fish population to species of life forms within a fish community and to species or life forms within a fish community and to species of life forms across aqua regimes (Burton *et al*., 1992).

Sharma, et. al., (2007) reported 70 commercially important fish species from the lower reaches of Brahmaputra River. Saha and Bordoloi (2009) also reported 59 fish species belonging to 40 genera, 19 families and 8 orders from two *beels* of Goalpara district, Assam. However, seasonal variations of fishes were also noticed. Ali, et. al. (2004) reported variation of fishes in two seasons *i.e.* winter and summer in the fish landing centres. Sirat *et al* (2010) reported that 21 species of fishes were in Bendsura reservoir, Maharashtra. Around the world approximately 22,000 species of fishes have been recorded out of which 11% are found in India, i.e., about 2,500 species of fishes of which, 930 live in freshwater and 1,570 are marine (Kar, 2003; Ubharane *et al*., 2011). 18 species from Ekrukh lake Solapur district where Cyprinidae family was dominant with 8 species Sakhare V.B(2001). 37 species from Issapur dam in district Yavatmal where Cyprinidae family was dominant with 20 species.

And also observed 27 species belonging to 11 families where Cyprinidae family was dominant with 13 species from Ambadi dam in the district of Aurangabad, Maharashtra Ubarhande S.B (2011), 27 species from the Koilsagar reservoir in Mahabubnagar district of Telangana where Cyprinidae family was dominant with 13 species Laxmappa B, Jithender Kumar Naik S, Vamshi S (2014). These studies also support the present study. The abundance of the tilapia, and the African catfish, *Clarias gariepinus* is more in the canal water fed tanks in the district Laxmappa B, Ravinder Rao Bakshi, Mohd. Vazeer(2015). Results of this study delineated increased abundance of these fishes in the fishery and have now established feral population in the canal fed water irrigational tanks.

Table.6.1.Ichthyofuna of Control and Experimental tank during 2014 - 2015 to 2015 – 2016

Order	Group	Fish species
Cypriniformes	Major Carps (3)	*Labeo rohita (Rohu)*
		Catla catla (catla)
		Cirrhina mrigala (Mrigal)
Cypriniformes	Carps minnors (2)	*Salmostoma bacaila*
		Amblypharyngodon mola (Mole)
Channiformes	Murrels (4)	*Channa stiatus (Stripped murrel)*
		C. punctatus (Spotted murrel)
		C. marulius (Gaint murrel)
		C. gachus (Gaint murrel)
Siluriformis	Cat fishes (2)	*Clarius batrachus (Marurf)*
		Heteropneustes fossilis (Singhi)
Mastacembeliformis	Snake fishes (1)	*Mastacembelus armatus*
Clupeiforms	Other fishes (2)	*Notopterus notopterus (Razor fish)*

Catla catla

Labeo rohita

Cirrhinus mrigal

Salmostoma bacaila

Amblypharyngodon

Channa gachua

Channa marulius

Channa striatus

Notopterus notopterus

Clarius batrachus

Channa functatus

6. CONCLUSIONS

- The overall findings of the research suggest that the Periphyton based aquaculture technology is an economically viable technology.
- Periphyton based aquaculture technology has got a lot of comparative and positive advantages over the simple pond fish culture.
- At the same time it can intensify the fish culture cope with environment and contribute for sustainable economic development of the country.
- *Ipomoea carnea* was used as substratum for the production of periphyton, which was developed abundantly on the bundles.
- The physico - chemical parameters indicated the mesotrophic conditions of TWO water bodies.
- The phytoplankton was represented by Green algae, Blue green algae, Diatoms and Euglenoides, which were found abundantly in water bodies.
- The zooplankton was represented by Rotifers, Copepods, Cladocerans and Ostracodas.
- The periphyton communities like Green algae, Blue green algae and macro invertebrates were developed on *Ipomoea* bundles.
- The growth of Catla, Rohu and Mrigala were satisfactory and these two fishes growth rate was more in experimental tanks when compared to that off control tanks.
- The concerned government agencies should take positive steps to train up the fish farmers who are interested to adopt this technology.

- To improve the fish growth and economics, during project study (2014-16) were conducted four demonstration and training programmes to disseminate the ipomia based fish culture technology to Fisherman co-operative society, Kurella village about 52-60 society members are participated.
- The results were very much significant in terms of fish growth, weight and health.
- The new technology increased fish size, weight and market values which helped to improve the socio-economic status of fisherman's.
- The ipomoea based technology increased about 1 ½ times of market of fisherman co-operative society, Kurella village, Karimnagar district.
- Finally the study provides the most valuable information for farmers, researchers, form management specialists and policy makers regarding the profitability of Periphyton based aquaculture.

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9. Demonstration photos:

కూరెల్లలో ప్రసంగిస్తున్న రాజశేఖర్

చేపల పెంపకంతో అధిక లాభాలు

కూరెల్ల, (కోహెడ), న్యూస్‌టుడే: మత్స్య కార్మికులు ఆధునిక పద్ధతులు పాటించి చేపల పెంపకంతో అధిక దిగుబడులు సాధించవచ్చునని ఉస్మానియా విశ్వవిద్యాలయం ప్రొఫెసర్ ఏవీ రాజం పేర్కొన్నారు ఆదివారం కూరెల్ల మత్స్య కార్మిక సంఘం సభ్యులకు అవగాహన కల్పించారు రోజూ వారి ఆహారంలో చేపల వినియోగం ద్వారా చాలా మట్టుకు ఆరోగ్య సమస్యలను దూరం చేయవచ్చునన్నారు గ్రామాల్లోని చెరువుల్లో లభించే పిచ్చి మొక్కలను ఎండ బెట్టి మళ్లీ చెరువుల్లో వేస్తే వాటిపై పెరిగే నాచుతో చేపల పెరుగుదల అనూహ్యంగా ఉంటుందన్నారు కార్యక్రమంలో ఓయూ పరిశోధకుడు టి జగదీశ్వరాచారి, ఎ సునీల్ కుమార్, మహేందర్ యాదవ్, సంఘం నాయకులు ఈగ బాలయ్య, శ్రీరామ కళాశాల అధ్యాపకులు ఎల్ రాజు, మత్స్య కార్మిక సంఘం సభ్యులు పాల్గొన్నారు

రానున్న రోజుల్లో మత్స్యకారుల జీవితాల్లో, వెలుగులు

మాట్లాడుతున్న ప్రొఫెసర్ ఏవీ రాజశేఖర్ బృందం

కోహెడ: మిషన్‌కాకతీయ పథకం వల్ల రాబోయే కాలంలో నీటి వనరుల అభివృద్ధి జరిగి, తెలంగాణ రాష్ట్రం మత్స్యాసంపద రావడమే కాకుండా, మత్స్యకారుల జీవితాల్లో వెలుగులు నింపే దిశ రానుందని ప్రొఫెసర్ ఏవి రాజశేఖర్ అన్నారు. ఆదివారం చేపల ఉత్పత్తికోసం రాష్ట్రంలో పరిశోధనలో భాగంగా కూరెళ్ల గ్రామంలోని చెరువులను పరిశీలించారు. ఈ సందర్భంగా ఆయన మాట్లాడుతూ చాలా చెరువులు, కుంటలు ఎండిపోయి చేపల పెంపకానికి అనుకూలంగా లేవన్నారు. తెలంగాణ ప్రాంతంలోని జలవనరులు, చేపల పెంపకానికి అనుకూలతలపై అన్ని ప్రాంతాల్లో సందర్శిస్తున్నామన్నారు. ప్రభుత్వ సహాయంతో మత్స్యకారులందరికి నూతన సాంకేతిక పద్ధతుల ద్వారా చేపల పెంపకంపై శిక్షణ ఇస్తామన్నారు. అధునిక చేపల ఉత్పత్తి కోసం పరిశోధనలు నిర్వహిస్తున్నామన్నారు. ఈ పరిశోధన ఫలితాలను ప్రభుత్వానికి అందజేస్తామని వివరించారు. ఈ కార్యక్రమంలో డాక్టర్ తూమోజు జగదీశ్వరచారి, పరిశోధన విద్యార్థులు ఏ సునీల్‌కుమార్, ఎం మహేందర్‌యాదవ్, మత్స్యకార్మిక సంఘం అధ్యక్షులు బాలయ్య, లక్ష్మయ్య తదితరులున్నారు.

చేపల పెంపకంలో ఆధునిక పద్ధతులు పాటించాలి

కోహెడ, ఫిబ్రవరి 23(టీ మీడియా): చేపల పెంపకందారులు ఆధునిక పద్ధతులు పాటించి అధిక ఉత్పత్తి సాధించాలని ఉస్మానియా యూనివర్సిటీ ప్రొఫెసర్ ఏ రాజశేఖర్ అన్నారు. మండలంలోని కూరెల్ల గ్రామంలో ఆదివారం స్థానిక మత్స్యకారులకు అవగాహన కల్పించారు. పిచ్చిమొక్కలను ఏరివేసి ఎండబెట్టి తిరిగి నీటిలో వేస్తే అది నాచుగా మారుతాయన్నారు. కార్యక్రమంలో రీసెర్చ్ స్కాలర్స్ తూమోజు జగదీశ్వరాచారి, ఏ సునిల్‌కుమార్, మత్స్యకారుల సంఘం అధ్యక్షులు తీగ బాలయ్య, ఉపన్యాసకులు మహేష్‌యాదవ్, లింగంపల్లి రాజు తదితరులు పాల్గొన్నారు.

సమావేశంలో మాట్లాడుతున్న ప్రొఫెసర్ రాజశేఖర్

'చేపల పెంపకంలో ఆధునిక పద్ధతులు పాటించాలి'

కోహెడ: గ్రామీణ ప్రాంతంలోని చెరువుల్లో ఆధునిక పద్ధతులు పాటించి చేపల పెంపకంలో అత్యధిక ఉత్పత్తిని చేయాలని ఉస్మానియా యూనివర్సిటీ ప్రొఫెసర్ ఏవీ రాజశేఖర్ అన్నారు. ఆదివారం మండలంలోని కూరెల్ల గ్రామ మత్స్య కార్మిక సంఘం సభ్యుల సమావేశానికి ఆయన హాజరై మాట్లాడారు. గ్రామాల్లోని చెరువుల్లో ఉండే పిచ్చిమొక్కులను తీసి వేసి వాటిని ఎండబెట్టి వాటిని నీటిలో వేసినట్లయితే వాటిపై పెరిగే నాచు చేపల పెరుగుదలకు దోహదపడుతుందన్నారు. ఇది చాల తక్కువ ఖర్చుతో కూడిన పద్ధతి అని పరిశోధనల నిరూపణ జరిగిందన్నారు. రిసార్చ్ స్కాలర్స్ తూమోజు జగదీశ్వరాచారి, సునిల్‌కుమార్, మహేందర్‌యాదవ్, సంఘం అధ్యక్షులు తీగ బాలయ్య, లింగంపల్లి రాజులున్నారు.

ఆంధ్రజ్యోతి

హుస్నాబాద్ జోన్

9★★★★★★ 24-2-2014 సోమవారం

హుస్నాబాద్, చిగురుమామిడి, కోహెడ, భీమదేవరపల్లి, సైదాపూర్

చేపల పెంపకంలో ఆధునిక పద్ధతులు పాటించాలి

కోహెడ, న్యూస్‌లైన్ : మత్స్యకార్మికులు చేపల పెంపకంలో ఆధునిక పద్ధతులు పాటించి అధిక ఉత్పత్తి పొందాలని ఓయూ ప్రొఫెసర్ ఎ.వి.రాజశేఖర్ సూచించారు. కూరెల్లా మత్స్య కార్మికుల సంఘం సభ్యులతో ఆదివారం నిర్వహించిన సమావేశంలో మాట్లాడారు. గ్రామాల్లోని చెరువుల్లో పెరిగిన పిచ్చిమొక్కలను తొలగించి, ఎండబెట్టి అనంతరం చెరువుల్లో వేస్తే నాచు పెరిగి చేపల ఉత్పత్తికి దోహదపడుతుందన్నారు. చేపల ఆహారంలో అనేక పోషక పదార్థాలు ఉంటాయన్నారు. అంతకుముందు గ్రామంలోని చేపలు పెంచుతున్న చెరువును పరిశీలించారు. కార్యక్రమంలో సంఘం అధ్యక్షుడు ఈగ బాలయ్య, ఓయూ రీసర్చ్ స్కాలర్స్ తూమోజు జగదీశ్వరాచారి, సునీల్‌కుమార్, మహేందర్‌యాదవ్, సుమారు 50 మంది సంఘం సభ్యులు పాల్గొన్నారు.

మాట్లాడుతున్న ప్రొఫెసర్ ఎ.వి.రాజశేఖర్