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Full Length Research Paper

Induced growth of phytoplankton using two fertilizers (NPK and agrolyser) under laboratory conditions

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An investigation was carried out on the ability of two types of fertilizer; agrolyser-micronutrient and NPK (nitrogen, phosphorus, potassium) -macronutrient in inducing phytoplankton growth for sixteen days under laboratory conditions. The parameters studied were abundance, species diversity and occurrence of the phytoplankton. Twelve 14 L plastics tanks labeled A, B, C and D was used. Each letter represented a fertilizer treatment (three replicates): A, 0.27 g agrolyser; B, 200 g NPK; C, 200 g agrolyser + 0.27 g NPK; and D which is the control. Before the application of these fertilizers, water samples were taken for phytoplankton analyses using 250 ml wide mouth plastic containers. All the tanks were allowed to be naturally inoculated for 3 days. Samples were collected for phytoplankton and physicochemical parameters at an interval of 3 days except temperature which was measured twice daily (morning and evening). A total of 1244 phytoplankton made up of 20 species, belonging to three families: Bacillariophyceae (diatoms), Cyanophyceae (blue-green algae) and Euglenophyceae (euglenophytes) were observed. Out of these algae, tanks C had 51.7%, B 33.2%, A 10.6% and D 4.5% phytoplankters. In the various groups of tanks, the orders of abundance, species diversity and percentage distribution of species of algae were C>B>A>D, C>B>A=D and C>B>D>A, respectively. This paper intends to provide preliminary information to fish farmers that agrolyser should be combined with a macronutrient fertilizer for better fertilization of pond.

Key words: Induced growth, phytoplankton, fertilizer, NPK, agrolyser.

INTRODUCTION

It is known that fishes depend directly or indirectly on plankton for their food (Boney, 1983) thus the study of plankton is necessary in the production of fish. The productivity of any water body is determined by the amount of plankton it contains; thus plankton is of great importance in aquaculture and fisheries. They also play important role in the food chains and webs. Plankton growth can be induced by the use of fertilizers. They help to maintain the nitrogen budget of any aquatic habitat. As a result of this useful function, they have received a lot of attention.

Fertilizer (inorganic and organic) application among other things has been used to achieve an increase in the productivity of pond. Biological productivity in any given aquatic body is a function of nutrients in it. Inorganic fertilizers are more effective than organic fertilizers; more quantity of organic fertilizer is required to fertilize a pond when compared to inorganic ones. Also inorganic fertilizers are more readily soluble and have immediate effect on plankton growth. Fertilizers are known to supply these nutrients required by phytoplankton for primary productivity and they have been reported to increase fish yield 3–4 times (Moses, 1983; Westly, 1984). The quantity of nutrients in a pond plays a major role in determining the amount and quality of plankton (Pearson et al., 1984). The relative availability of nutrients in aquatic environments is believed to play an important role in the structuring of phytoplanktonic communities (Harris, 1986). Nitrogen was found to be more of a limiting factor in pond productivity in the tropics (Henry et al., 1984) compared to temperate regions. Levine and Levine (1984) were of the opinion that increases in nitrogen produces phytoplankton communities dominated by cryptophytes, chlorophytes and non-heterocystous cyanobacteria and in some cases chrysophytes. Lowkman and Jones (1999) found that increase in phosphates leads to increase in chlorophyll a

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Table 1. Abundance, number of species, diversity and percentage distribution of species induced by agrolyser and NPK fertilizers.

Parameter	Phytoplankton family	Tanks (treatments)				Total	% Total phytoplankton
		A*	B	C	D		
Abundance	Bacillariophyceae (diatoms)	10	13	37	22	**82**	6.59
	Cyanophyceae (blue-green algae)	91	325	498	30	**944**	75.88
	Englenophyceae	31	75	108	4	**218**	17.52
	Total	**132**	**413**	**643**	**56**	**1244**	
Number of species	Bacillariophyceae *Achnathes ventricosa* *Cymbella amphioxys* *Cymbella ventricosa* *E. lunaris* *N. contenta*	3	4	5	5	**17**	
	Cyanophyceae Anabaenopsis sp *Dacfyl cocoopsis* *Microcystis aearogbinosa* *O. chahbae* *O. terebriformis* *O. amphibia* *Ph. uharinatom* *Ph. molie* *Lyngbya sp*	6	7	9	6	**28**	
	Englenophyceae *Trachalomonas ovenburgica* *T. hispida* *Strombomonas vernicosa* *E. acus* *Phacus sp* *Strombomonas vernicosa*	3	6	4	1	**14**	
Diversity	Diatoms	0.28	0.42	0.56	0.56		
	Blue-green algae	0.70	0.84	1.12	0.70		
	Englenophyceae	0.28	0.70	0.42	0.00		
Percentage distribution of species (%)	Diatoms	60	80	100	100		
	Blue-green algae	66.7	77.8	100	66.7		
	Englenophyceae	55.9	859	88.9	61.1		

A, 0.27 g agrolyser;
B, 200 g NPK;
C, 200 g agrolyser + 0.27 g NPK; and
D, control.

in streams by stimulating the growth column and thus stimulating the growth of periphyton.

Phytoplankton requires both macronutrients and micronutrients for their growth. Agrolyser (micronutrient fertilizer) is a balanced micronutrient formulation consisting of 10 micronutrients and secondary elements like copper, managanese, magnesium, iron, sodium, calcium, sulphur, boron, zinc, molybdenum. NPK is a chemical fertilizer having definite composition and major fertilizing nutrients are nitrogen, phosphorus and potassium. The use of fertilizers in fish ponds/tanks provides nutrients for planktonic productivity which in turn produce more food for fish and finally good fish yield under good water quality management. Phytoplankton requires light, moisture, nutrients, a favourable pH and temperature as well as absence of toxic substances for their growth (Boyd, 1979). Most species of phytoplankton disperse readily. The atmosphere contains spores and regulative bodies of many species of phytoplankton. Fish ponds are naturally inoculated with many species of phytoplankton.

Table 2. Some physico-chemical parameters recorded during the experiment

Physicochemical parameters	A*	B	C	D
Morning temperature (ºC)	26.23 ± 0.03 to 26.60 ± 0.00	26.25 ± 0.05 to 26.57 ± 0.04	26.20 ± 0.00 to 26.66 ± 0.03	26.20 ± 0.00 to 26.60 ± 0.00
Evening temperature (ºC)	27.33 ± 0.03 to 27.63 ± 0.03	27.14 ± 0.05 to 27.63 ± 0.03	27.10 ± 0.00 to 27.60 ± 0.00	27.10 ± 0.00 to 27.50 ± 0.00
pH	5.93 ± 0.12 to 7.11 ± 0.10	5.62 ± 0.14 to 6.85 ± 0.12	5.35 ± 0.23 to 6.42 ± 0.05	6.21 ± 0.04 to 7.33 ± 0.10
Turbidity (mg/l)	1.6 ± 0.33 to 20.2 ± 0.14	1.0 ± 0.00 to 51.7 ± 0.87	1.0 ± 0.00 to 57.8 ± 1.57	0.0 ± 0.00 to 1.0 ± 0.00
Transparency (cm)	50.0 ± 0.03 to 92.3 ± 0.20	25.6 ± 1.88 to 56.5 ± 3.41	17.4 ± 1.4 to 56.4 ± 3.16	57.1 ± 2.92 to 117.4 ± 0.95
Carbon-dioxide (mg/l)	2.4 ± 1.23 to 17.0 ± 0.01	51.3 ± 0.87 to 300.1 ± 2.31	103.8 ± 3.20 to 245.8 ± 4.88	1.0 ± 0.06 to 2.3 ± 0.20
Dissolved oxygen (mg/l)	5.7 ± 0.12 to 7.4 ± 0.10	3.5 ± 0.11 to 5.4 ± 0.24	3.0 ± 0.06 to 6.6 ± 0.08	5.9 ± 0.03 to 8.4 ± 0.03
Nitrate (mg/l)	0.0 ± 0.00 to 1.3 ± 0.02	1.0 ± 0.01 to 4.5 ± 0.04	1.0 ± 0.02 to 4.6 ± 0.11	0.1 ± 0.04 to 0.5 ± 0.03
Phosphate (mg/l)	0.00 ± 0.00 to 0.3 ± 0.01	25.9 ± 2.50 to 907.9 ± 39.5	52.1 ± 1.57 to 1307.5 ± 78.02	0.1 ± 0.05 to 0.6 ± 0.08
Sulphate (mg/l)	1.0 ± 0.00 to 14.5 ± 0.98	6.0 ± 0.57 to 47.6 ± 1.94	5.6 ± 0.33 to 50.6 ± 1.07	0.0 ± 0.00 to 1.0 ± 0.00

A, 0.27 g agrolyser;
B, 200 g NPK;
C, 200 g agrolyser + 0.27 g NPK; and
D, control.

Agrolyser has been used to fertilize fish ponds (National Institute for Freshwater Fisheries Research, 1998; Federal Ministry of Agriculture and Natural Resources, 1998) and the results have been tremendous. National Institute for freshwater Fisheries Research (1998) gave the reports of different fish farmers. They observed faster phytoplankton growth compared to animal manure. This study is intended to find out which of the two fertilizers (agrolyser and NPK) is more efficient to induce phytoplankton growth (in terms of abundance, diversity and occurrence). Also, to provide preliminary information to fish farmers that agrolyser should be combined with a macronutrient fertilizer for better pond fertilizer.

MATERIALS AND METHODS

Experimental site and culturing tanks

The experiment was conducted under laboratory conditions. Twelve 14 L plastic tanks labeled A, B, C and D was used. Each letter represented a fertilizer treatment (3 replicates): A, agrolyser; B, NPK, C, NPK and agrolyser; and D, control (no fertilizer). The tanks were filled to 2/3 with dechlorinated tap water (stored in an open plastic drum for 7 days in the laboratory).

Fertilizer application

Each group of tanks received the following quantities of fertilizer: A, 0.27 g agrolyser; B, 200 g NPK; C, 200 g NPK + 0.27 g agrolyser; and D, no fertilizer. Before the application of these fertilizers, water samples were taken from the tanks for phytoplankton analyses using 250 ml wide mouth plastic containers. All the tanks were allowed to be naturally inoculated for 3 days before applying fertilizer.

Phytoplankton analyses

Phytoplankton was analysed and enumerated using appropriate tools (Kemdirim 2001; Kadiri, 1988; Prescott, 1982; Durans and Leveque, 1980) . Samples were collected for phytoplankton analyses using 250 ml wide mouth plastic containers and physicochemical parameters measurement (250 ml bottles) at an interval of 3 days except temperature which was measured twice daily (morning and evening). The following physicochemical parameters were measured: temperature, colour, pH, turbidity, transparency carbondioxide, nitrate (nitrogen), dissolved oxygen, phosphates and sulphate using the appropriate scientific methods.

RESULTS

The main phytoplankton groups recorded were Bacillariophyceae (diatoms), Cyanophyceae (blue-green algae) and Englenophyceae (euglenophytes). (Table 1).Phytoplankton abundance followed the order of Cyanophyceae>Englenophyceae>Bacillariophyceae. A total of 1244 phytoplanktons made up of 20 species were recorded during the study period (Table 1). The percentage composition of each phytoplankton group was as follows: Cyanophyceae 9 species (75.88%), Englenophyceae 6 species (17.52%) and Bacillariophyceae 5 species (6.59%).

It is obvious that treatment C (agrolyser and NPK) had more phytoplankton 51.7% than B (33.2%), A (10.6%) and D (4.5%). The blue-green algae (diversity index 5.11) are more diversed followed by the diatoms (4.41), the least being euglenophytes (2.34) in all the tanks. The percentage distribution of species of algae was highest in treatment C (88.9%) and followed by B (85.9%). The percentage distribution of species of algae was as follows: diatoms (85%), blue-green algae (77.8%) and euglenophytes (58.34%). 75.9% of the identified phytoplankton were blue-green algae, 17.5% were euglenophytes and 6.6% were diatoms. In the various groups of tanks, the order of abundance and species diversity of the algae were C>B>A>D and C>B>A=D, respectively. The orders of number of species in the different treatments were:

A, blue-green>diatoms=euglenophytes;
B, blue-green>euglenophytes>diatoms;
C, blue-green>diatoms>euglenophytes; and
D, blue-green>diatoms>englenophytes.

The blue-green algae were the most diversified algae, the least being euglenophytes. In the various groups of tanks, the orders of abundance, species diversity and percentage distribution of species of algae were C>B>A>D, C>B>A=D and C>B>D>A, respectively (Table 1).

The mean physicochemical parameters are presented in Table 2. There was no significant difference in the temperature of the various treatments. The pH values increased with day in each treatment that is, becoming more alkaline. The highest turbidity was recorded in treatment C, followed by B, A and D. The Lowest transparency was observed in treatment C, followed by B, C and D as the experiment progressed. The highest carbondioxide was recorded in treatment B and least in treatment D. Treatment B and C had the maximum dissolved oxygen and A the least. For nitrate, phosphate and sulphate, treatment C had the highest value followed by B, A and D.

DISCUSSION

The observed highest number of phytoplankters in treatment C showed that micronutrients and macronutrients are very essential for the growth of phytoplankton as has previously been observed by Boyd (1979) and Boney (1983). It was evident from treatment D that fertilizers are important requirement for the induced growth of phytoplankton (Kolo et al., 1999; Wade and Stirling, 1999; Aminu and Ahmed, 1999). Micronutrients fertilizer can induce the growth of phytoplankton without the aid of macronutrients fertilizer.

It was obvious in treatment A and that the quantity applied was sufficient hence the growth of the phytoplankton was not limited in this study. This observation agreed with that of the Federal Ministry of Agriculture, Water Resources and Rural Development (1999). This Ministry reported that the pond fertilized with agrolyser turned green (indicating phytoplankton growth) within seven days while the pond treated with chicken manure did not turn green (no phytoplankton growth). The report from this present study is not contrary from the observations made by the National Institute for Freshwater Fisheries (NIFF, 1998).

The ranges of dissolved oxygen recorded in each treatment were desirable for the growth of phytoplankton and also for fish production (Boyd 1979; Wade and Stirling, 1999; Aminu and Raji, 1999; Adeniyi and Ovie, 1981, 1982). The observed pH in this study was suitable for the healthy growth of phytoplankton (Boney, 1983; Adeniyi and Ovie, 1981; Kemdirim, 2000) . The results of the transparency and turbidity revealed that agrolyser does not cause phytoplankton bloom. This was in agreement with the report of NIFF, 1998. The recorded values for the other physicochemical parameters agreed with the requirements for phytoplankton growth. The transparency of the tanks water reduced as the growths of the algae increased while the turbidity increased showing the effects of the agrolyser. The nitrate, phosphate and sulphate of treatment C were high due to the NPK fertilizer. More oxygen will be released during photosynthesis thus the oxygen concentration of tank C and B were higher compared to other treatments. The higher carbon dioxide recorded in treatments C and B was justified by the abundance of algae in these treatments.

In conclusion, the use of agrolyser (micronutrient fertilizer) with NPK (Macronutrient fertilizer) increased the phytoplankton population by providing more nutrients. Phytoplanktons are main food organisms for intermediate consumers. Both types of fertilizers are recommended for use in ponds especially those that are used for raising herbivorous fishes, and to achieve maximum plankton production in the ponds for maximum fish production and hence high profitability.

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