CHEMICAL AND BIOLOGICAL CHARACTERISTICS OF ACIDIC FISHPOND SOIL TREATED AND UNTREATED WITH CARBIDE SLUDGE

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Abstract

This study aimed to evaluate the effect of carbide sludge as a neutralizing agent in fishpond soils under laboratory conditions. The changes in physico-chemical characteristics of a carbide sludge-treated and untreated fishpond soils were compared and the population densities of plankton and meiofauna present in treated and untreated fishpond soils were also determined.

The carbide sludge were taken from COACO and MCCI, in Iligan City. MCCI sludge had the highest pH value. In terms of their ability to neutralize acidity, agricultural lime obtained the highest score followed by MCCI and COACO sludge. In terms of their solubility and readiness to mix with pond soil, MCCI sludge had substantially the highest efficiency rating, followed by COACO sludge, and agricultural lime.

There was a remarkable increase in pH immediately for water and three weeks for soil after the soil were treated with liming materials. COACO sludge showed the highest pH increase of 1.35 and MCCI

sludge the lowest pH increase of 1.12. The temperature during the application of liming materials was hot at 27.6°C to 35.1°C. Warm temperature speeds up the chemical processes and activities of microorganisms which convert plant nutrients into available forms.

Treated soil showed an increase of organic matter among treated soils but their waters contained less planktonic organisms. The growth of lablab, a biological complex of small plants and animals, was observed in treated soils. As lablab grew, layers developed and formed a flabby mat at the surface of the water level. Meiofaunal population is absent in treated and untreated soils.

Rationale

Carbide sludge, an effluent of Maria Cristina Chemical Industries and Iligan Oxygen and Acetylene Company, has shown potential basic property. Its usefulness has not been utilized, although a study conducted at MSU Naawan indicated that, like lime, it can act as a neutralizing agent in acidic soils for a period of 14 days. While it is believed that it can improve conditions favorable to fish culture, there is no evidence to support this because the changes in biological and chemical parameters have not been determined. An investigation of these factors in a carbide sludge-treated acidic fishpond can provide more information on the utilization of this cheap alternative source of lime to improve capabilities of fishpond areas that have been associated with low production, thus contributing to a large extent in food production.

Objectives

The general objectives to test the usefulness of carbide sludge as a neutralizing agent in fishponds involved the following specific: to determine the changes in chemical characteristics and meiofauna and plankton population of a sludge-treated fishponds.

Review of Related Literature

One of the problems usually encountered in fish farming is the low production due to acid sulfate soils. The low productivity of acid sulfate soils is due to low pH, the poisonous effects of iron and aluminum, low availability of plant nutrients, particularly phosphorous, and poor physical conditions of the soil. Furthermore, acidic soils could result to fish mortalities and deprive fishes of natural food, like algae and plankton or microscopic plants and animals that survive in water (PCARR Farm News, 1980).

To increase fish production in ponds, lime has been widely used and the most available and commonly used in ponds is agricultural lime or calcium carbonate, $CaCO_3$. Few studies have been conducted on the different sources of neutralizing agents and those include the reports of De Los Santos (1978), experts from the University of the Philippines at Los Baños (1980), and Yosores (1990).

Carbide sludge, a by-product of Maria Christina Chemical Industries (MCCI) and Cebu Oxygen and Acetylene Company (COACO) - Iligan Branch, contains approximately 60% to 65% total calcium oxide (CaO). Initially, Daitia (1985) conducted a study on the neutralizing capacity of carbide sludge in MSU at Naawan. While it is believed that it can improve soil conditions favorable to fish culture, there is no supporting evidence because the changes in chemical and biological parameters have not been determined. An investigation of these factors in a carbide sludge-treated acidic fishpond soils can provide more information on the utilization potential of this alternative source of lime.

Methodology

The carbide sludge samples were taken from COACO and MCCI, in Iligan City, on June 20, 1990. The samples were air-dried for lime analysis, specifically for its neutralizing value, efficiency rating and pH.

Fishpond soils with low pH were taken from Pond 9 of MSU-Naawan. Twelve (12) plastic basins, each having a surface area of 2017.06

sq cm were utilized for the study. Each is filled with fishpond soil at 15 cm depth. They were placed outside the MSU-Naawan Wet Laboratory for air-drying. To simulate the conditions of the fishpond during pond preparation, the soils in the plastic basins were dried until the soil surface had hardened and cracked. These were flooded with brackishwater, 6 cm deep, and the water level was maintained during the entire study period. The experimental setup was covered with a cellophane sheet during rainy days only.

There were four treatments with three replicates. The first treatment, Treatment1, was fishpond soil with low pH as a control; the second, Treatment2, was fishpond soil with low pH treated with agricultural lime; and the third, Treatment3, was fishpond soil with low pH treated with COACO sludge and the fourth, Treatment4, was fishpond soil with low pH treated with MCCI sludge to attain a soil pH of 6.5.

Soil samples from each basin were taken at 0-10 cm with the '6S'6 use of a corer (diameter, 2.5 cm) and placed in the plastic bags for soil analysis. For meiofauna samples, a short (10 cm) suction corer was vertically pushed to a depth of 5 cm. When withdrawn, the cored sample was extruded from the corer and placed in pre-labeled plastic bottles (Hulings and Gray, 1971 and Vicente, 1978). Water and plankton samples were collected by grab method using plastic bottles.

Initial analysis of soil, water, plankton and meiofauna samples were taken before and immediately after the application of lime. Then, monitoring of plankton and meiofauna were done daily and once in every four days, respectively. Water and soil analysis for selected physico-chemical characteristics were determined once a week for a period of nine weeks. Soil and water pH were measured with a Polymetron pH meter, soil and water temperatures with a mercury-filled thermometer and salinity with a refractometer. Lime requirement of soil, soil texture, organic matter, total nitrogen, aluminum content, iron content and available phosphorus were measured based on Standard Methods of Analysis of Soils, Water, Plants and Fertilizers. Nitrate, ammonia and phosphate concentrations were determined based on the procedures of Swingle (1969). Plankton and meiofauna were analyzed both qualitatively and quantitatively using the procedures by SEAFDEC (1989) and Vicente, (1978) respectively.

Results and Discussion

A. Lime Analysis

The mean values of the characteristics of different lime sources are presented in Table 1. Although only slight differences were noted from other lime sources, MCCI sludge had the highest pH value. The relative ability of different liming materials to neutralize acidity is shown by their neutralizing values. Agricultural lime obtained the highest neutralizing value, followed by MCCI sludge, and COACO sludge. All other factors being equal, the finer a liming material is ground, the more rapidly it will dissolve and the more thoroughly it can be mixed with the soil (Foth and Turk, 1972). As depicted in Table 1, MCCI sludge had substantially the highest efficiency rating of followed by COACO sludge, and agricultural lime.

B. Soil Analysis

The textural class name for the soil sample taken from MSU Pond 9 was sandy clay loam (Daitia, 1980). This implies that the soil contained high percentage of sandy (Foth and Turk, 1972).

The amount of lime needed to apply to the acidic soils to obtain pH 6.5 was determined (Table 2).

Although fluctuations of pH readings had been initially noted in treated soils, there was a remarkable increase in soil pH during the third week sampling (Fig. 1A). The pH level in Treatment1 as control was 6.64, slightly acidic and all the experimental treatments, Treatment2, Treatment3, and Treatment4 had reached the alkaline level of pH 8.44, 9.09 and 8.49, respectively. The mean values of pH before and after the.application of different lime sources during the extent of the study period were calculated (Table 4). Among the lime sources used, application of COACO sludge showed the highest pH increase of 1.35 and MCCI sludge, the lowest pH increase of 1.12.

Despite the variability of soil temperature readings, the ranges of all treatments were considerably hot at 27.6°C to 35.1°C (Fig. 1B and Table

4). Warm temperature speeds up the chemical processes and activities of microorganisms which convert plant nutrients into available forms (Foth and Turk, 1972 and Boyd, 1979).

The readings of organic matter, total nitrogen, available phosphorus, iron and aluminum during the entire study period are plotted (Figs. 1C, 1D. 1E. 1F and 1G). Varied results of the analyses for organic matter, total nitrogen, available phosphorus, iron and aluminum were observed. As depicted in Table 4, Treatment1 showed a decline in organic matter content whereas the three experimental treatments showed increase of organic matter content. Phosphates associated with iron (III) and aluminum predominate in acid soils and sediments while calcium phosphates predominate in neutral and alkaline soils (Jackson, 1964; Stumn and Morgan, 1970; Ponnamperuma, 1972). Precisely, ferric and aluminum phosphates release phosphate as pH increases, while calcium phosphates liberate phosphate as pH decreases (Stumn and Morgan, 1970; Ponnamperuma, 1972). However, the significance of liming materials to the available phosphorus, total nitrogen, iron and aluminum during the entire study period remained obscure. Probably, the high concentration of iron and aluminum limits the availability of phosphorus and total nitrogen to the plants.

C. Water Analysis

The pronounced increase of water pH to alkaline level was observed after the application of liming material to Treatment2, Treatment3, and Treatment4 as compared to Treatment1 which exhibited a slight increase. only (Table 3A and 4). Varied results of temperature, salinity, and alkalinity of water samples were noted (Tables 3B, C, D, and 5). The effect of weather changes and the heat of the sun on the water in the basin is evident in the salinity readings. The values of NO - NH3, and PO43 - are presented in Tables 3E, F, and G). During the six-week period, NO2- and NH3 readings exhibited marked increases (Tables 3E and 3F). Despite the increases in NO2 content of the experimental treatments after the application of lime, liming had not significantly increased the essential nutrients like NH_3 and PO43. This is due to the unavailability of fertilizers in the water.

Table 3A. Water pH

WEEK	TREATMENT			
	T1	T2	T3	T4
B	6.35	6.46	6.01	6.57
A	7.03	9.91	8.97	8.41
1	7.90	8.25	8.60	8.82
2	8.35	9.88	9.72	9.45
3	8.00	8.89	8.74	8.85
4	6.43	8.60	8.67	8.47
5	6.88	8.95	8.76	8.80
6	6.92	7.79	7.55	7.52
7	7.07	8.57	8.20	8.20
8	7.15	8.58	8.38	8.75
9	7.07	7.97	7.86	7.65

Table 3B. Water Temperature, oC

WEEK	TREATMENT			
	T1	T2	T3	T4
B	38.30	38.70	38.20	38.50
A	38.40	38.30	39.50	38.90
1	38.00	38.20	38.00	38.30
2	38.40	38.20	38.80	38.60
3	36.70	36.30	36.10	35.70
4	32.00	30.60	31.30	30.40
5	29.10	29.40	30.30	29.70
6	38.00	38.30	38.50	39.70
7	32.90	32.80	33.80	33.70
8	30.70	30.30	30.70	30.70
9	28.50	29.30	29.10	29.10

Table 3C. Salinity, ppt

WEEK	TREATMENT			
	T1	T2	T3	T4
B	27.80	27.30	25.30	19.70
A	25.70	25.30	26.70	25.70
1	30.00	35.00	30.70	30.30
2	30.20	37.00	36.80	32.50
3	25.30	25.30	26.70	19.30
4	12.30	13.30	12.30	10.30
5	15.00	16.30	16.00	13.70
6	15.30	15.30	19.00	15.00
7	20.70	22.00	22.00	19.00
8	35.00	37.00	43.00	34.30
9	39.30	44.30	47.00	40.30

Table 3D. Alkalinity, ppm CaCO3

WEEK	TREATMENT			
	T1	T2	T3	T4
B	13.30	22.00	11.30	15.30
A	18.00	12.00	16.00	18.70
1	04.50	12.70	16.00	18.30
2	01.50	05.20	12.30	16.80
3	05.30	10.70	11.70	09.00
4	04.00	05.70	06.70	06.30
5	03.70	12.50	19.30	14.00
6	03.70	13.00	32.70	24.70
7	08.30	20.00	25.30	24.70
8	26.70	24.30	09.70	19.70
9	08.30	20.70	27.00	23.70

Table 3E. Nitrate, NO_{2-}, ug N/liter

WEEK	TREATMENT			
	T1	T2	T3	T4
B	08.00	03.33	06.00	06.00
Q	02.00	03.33	83.67	02.00
1	00.03	00.33	00.03	00.00
2	00.00	00.00	00.00	00.00
3	00.00	00.00	00.00	00.00
4	00.08	00.04	00.02	00.04
5	00.00	00.00	00.00	00.00
6	60.67	111.33	137.00	60.67
7	2x10-4	3x10-5	00.00	00.00
8	00.50	00.10	00.20	00.30
9	4x10-5	1x10-6	1x10-6	1x10-6

Table 3F. Ammonia, NH_3, ug N/liter

WEEK	TREATMENT			
	T1	T2	T3	T4
B	30.00	31.67	46.67	31.67
A	20.00	16.67	23.33	35.00
1	00.10	20.00	03.40	00.10
2	00.10	00.10	00.10	00.10
3	00.27	00.23	00.33	00.23
4	02.00	01.00	01.00	01.00
5	26.67	00.33	00.33	00.67
6	439.00	329.30	315.67	727.33
7	137.67	165.00	206.00	260.70
8	74.00	60.67	76.67	00.93
9	70.00	64.67	67.00	75.33

Table 3G. Phosphates, PO_43- ug P/liter

WEEK	TREATMENT			
	T1	T2	T3	T4
B	02.67	02.00	35.67	19.67
A	46.67	07.67	23.67	48.33
1	00.00	01.00	01.00	10.00
2	00.00	00.00	00.00	00.00
3	00.33	03.37	00.10	00.03
4	04.10	00.15	13.37	04.07
5	00.00	00.00	00.00	00.00
6	08.00	02.33	05.43	05.67
7	17.33	01.67	00.30	00.17
8	09.33	04.00	09.20	06.00
9	04.33	00.01	00.03	00.05

D. Plankton Analysis

Table 6 presents the phytoplankton count, cells per ml per ‘6‘6 day and its percentage dominance. The highest total phytoplankton count occurred in Treatment1, the control, followed by Treatment3, COACO sludge; Treatment4, MCCI sludge; and agricultural lime. The most dominant species in all treatments was *Chaetocer os* sp. The largest number of species identified was 12 species in Treatment2, followed by 8 species each both in Treatment3 and Treatment4 and 7 species in Treatment1.

Few species of zooplankton (animal-like organisms) were found in all treatments as shown in Table 7. The most dominant species present in Treatment1, Treatment2, and Treatment3 was *Stylonichia* sp. while in Treatment4 those were *Notholca* sp. and nematode. The largest number of species identified was 5 species in Treatment3 and 4 species each of the other treatments: Treatment1, Treatment2 and Treatment4.

E. Meiofauna Analysis

It was found out that no meiofauna was present in all the treatments. Presumably, there was no available meiofauna present during the transport of pond soils to the wet laboratory.

F. Growth of Lablab

The growth of lablab, a biological complex of small plants and animals, was observed in Treatment2, Treatment3 and Treatment4. As lablab grew, layers were developed forming a flabby mat at the surface of the water level.

Implications and Recommendations

1. The increase of soil pH to alkaline level in soils treated with carbide sludge indicates that the carbide sludge from COACO and MCCI could be used as alternatives for agricultural lime.

2. Due to the high concentration of iron and aluminum that limits the availability of phosphorus and nitrogen for the acid soils, there is a need to apply the fertilizers two to three weeks after the introduction of lime.

3. Further study of different liming materials on bigger pond areas is recommended.

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