Experimental Evaluation of Lime Requirement Estimators for Global Sites-Isolation Column Experiment

Interim Work Plan, Africa Study 3

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Introduction

Aquaculture ponds with acid bottom muds and soft waters are commonly treated with lime to raise soil pH and base saturation levels and to increase the alkalinity of the pond water to an acceptable level. Pond mud pH readings of less than about 6.0 or pond water alkalinities of 20 mg $CaCO_3$/L or less are usually taken as indications that a given pond needs to be limed (Boyd 1979). Aquaculturists have used a number of methods (both agricultural and aquacultural) to estimate the amount of lime that should be added to ponds. Agricultural methods generally estimate the lime requirement (LR) for raising soil pH to a particular level, whereas aquacultural methods go a step further by estimating the LR for raising pond water alkalinity to a desired level.

Study B of Revised Work Plan 7 was designed to evaluate the suitability of several different LR estimators for different types of soils by testing them in laboratory microcosms. This extension of that study was designed to investigate the use of artificial enclosures ("isolation columns") as in-pond test units, and to compare the results obtained in such enclosures with results obtained in laboratory microcosms.

Materials and Methods

Soil samples from a pond with acid soil and low alkalinity water at Soap Creek (Department of Fisheries and Wildlife, Oregon State University, Corvallis, Oregon, USA) were collected, air-dried, and crushed to pass a 2mm sieve, and the lime requirement of a composite sample was determined according to the method of Pillai and Boyd (1985).

Isolation columns were constructed using 5-gallon plastic buckets with the bottoms cut out, 29-cm diameter "layflat" polyethylene tubing, rigid 30-cm steel rings, plastic clothespins, and 6-ft fiberglass plant stakes. Six of these columns were pressed firmly into the pond bottom (minimum depth of 10cm into the soil) in a single pond at Soap Creek. The columns were placed at a water depth of approximately 1m. Two treatments were applied to the columns in triplicate: three columns were limed according to the Pillai and Boyd (1985) estimate, and three columns were left unlimed. Water column samples (from the surface to approximately 10cm above the pond bottom) were collected after 1, 3, 7, 14, 21, and 28 days and returned to the laboratory for immediate determination of total alkalinity. Samples were taken at approximately 1100 hours on each sampling day. The starting, ending, and sampling dates for the isolation column portion of the experiment were the same as for the laboratory part.

The laboratory microcosm part of the experiment was conducted in a constant temperature room at the Oak Creek Laboratory of Biology, Oregon State University, Corvallis, Oregon. Glass beakers with a capacity of 800 ml were filled with 750 ml of soft dilution water (alkalinity of approximately 18 mg $CaCO_3$/L, to nearly match the alkalinity in the pond at Soap Creek). Subsamples of the composite soil sample from the pond at Soap Creek were used in laboratory microcosms. The appropriate amount of agricultural limestone was thoroughly mixed with 25 g of the soil and then added to the dilution water. The soil-lime-water mixture was stirred vigorously with a glass rod for 10 seconds to begin the experiment. An unlimed treatment was also prepared. Each treatment was applied in triplicate. Water temperatures in the beakers were maintained at between 23 and 26°C. Samples of approximately

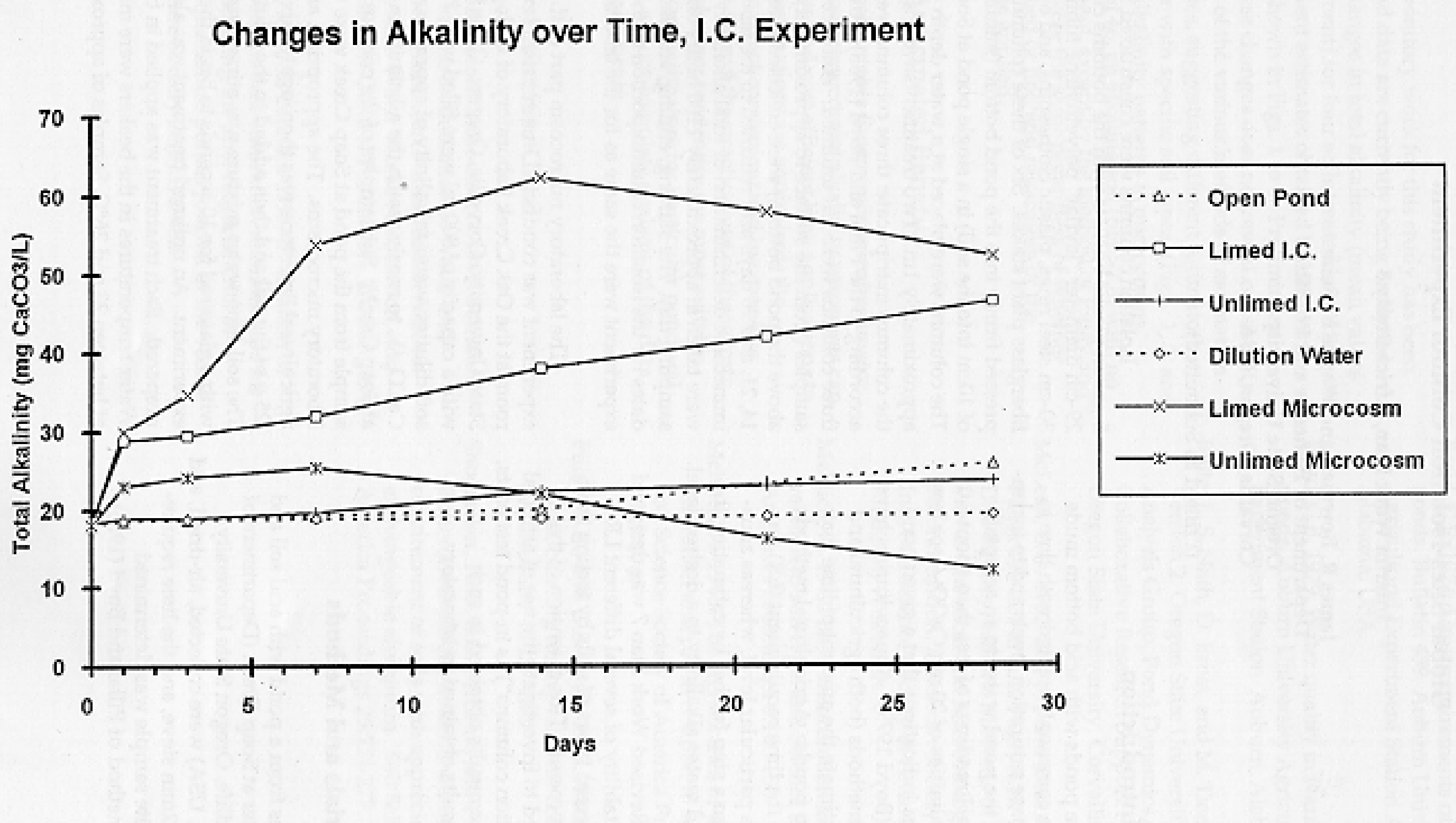

Figure 1. Trends in total alkalinity for in-pond enclosures (isolation columns), open pond water, and limed and unlimed laboratory microcosms. containing soil from the same pond. Isolation columns and microcosm treated identically did not respond in the same way, whether limed or unlimed. The alkalinity trend in unlimed isolation columns was similar to that in the open pond.

12.5 ml were removed after 1, 3, 7, 14, 21, and 28 days for determination of total alkalinity. Alkalinity was determined according to the methods described in Standard Methods (APHA, 1989).

Results and Discussion

The field and laboratory portions of this study have been completed and data analysis is in progress. A plot of the total mean alkalinity trends for each treatment for samples taken from the Soap Creek open pond, limed isolation columns, and unlimed isolation columns and the laboratory microcosms (limed and unlimed) is shown in Fig. 1. Preliminary analysis of these trends shows that the responses of laboratory microcosms and in-pond enclosures were similar after 28 days although the time course of alkalinity was not the same for either unlimed treatments or treatments limed at the same rate (Fig. 1). Total alkalinities in the unlimed isolation columns remained close to those in the open pond, suggesting that under the conditions of this experiment the effect of the isolation columns on pond water alkalinity may have been minor. This suggests the small laboratory microcosms do not represent pond responses as well as isolation columns for unlimed soils.

Anticipated Benefits

The suitability of in-pond enclosures of the type tested for conducting liming and possibly other chemical experiments will be determined. Comparison of the results from the enclosures with results from laboratory microcosms will allow additional evaluation of the results of microcosm experiments conducted in the laboratory.

Literature Cited

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