USING GRASS STRIPS TO FILTER CATFISH POND EFFLUENT

Suhas R. Ghate[1], Gary J. Burtle[2], George Vellidis[3], and G. Larry Newton[2]

AUTHORS: [1]Professor, Biological & Agricultural Engineering Department; [2]Associate Professor, Animal & Dairy Science Department; [3]Assistant Professor, Biological & Agricultural Engineering Department; The University of Georgia, Coastal Plain Experiment Station, Tifton, Georgia 31793-0748.
REFERENCE: Proceedings of the 1995 Georgia Water Resources Conference, held April 11 and 12, 1995, at The University of Georgia, Kathryn J. Hatcher, Editor, Carl Vinson Institute of Government, The University of Georgia, Athens, Georgia.

Abstract. Twelve 4.5 m x 24 m grass strips comprising of two slopes (3% and 1.5%), two grasses (Bermuda and Bahia) and three replications were used to filter pond effluent from an intensive catfish production system. The effluent was applied as overland runoff at the upper ends of the plots and collected at the bottom as it flowed downslope through the grasses. From two years' data, it was found that the grass strips removed nonfilterable (suspended) solids in the ranges of 36%-61% and 19%-82% from the effluent depending upon the initial amounts of solids. This filtering technique may have practical application in reducing nutrient discharge to natural waters and in reducing groundwater consumption by recirculating the filtered effluent.

BACKGROUND

The farm value of channel catfish *(Ictalurus punctatus)* in Georgia was around $15 million in 1992. The Georgia aquaculture industry is expanding because of plentiful groundwater supply, suitable climate, and relatively inexpensive land. Continued expansion of the aquaculture industry will have two serious impacts on the state's natural resources. Large volumes of ground water will be needed to fill and flush catfish culture ponds; and direct discharge of the pond effluent into surface waters could impair quality of the receiving waters.

Farmers must stock fish at high densities and feed the fish heavily to have a profitable business. Catfish ponds may be lowered and refilled with freshly withdrawn groundwater several times during the growing season to manage water quality (Ghate and Burtle, 1993). Even where catfish ponds are not lowered for management of water quality, they are almost always completely drained at the end of the growing season during harvesting. Also, a partial draining of the ponds may help seining operations during multiple, selective harvest of desired size fish, such as food fish weighing about 0.25 kg for which there is a market demand in Georgia, Florida, and some other states.

The combination of high stocking density and high feeding rates deteriorates fish pond water quality as high levels of nutrients; solids comprising of phytoplankton, unused feed and fecal matter; and chemical oxygen demand (COD) quickly accumulate. Continued and increased untreated catfish effluent discharge to receiving waters may cause serious pollution problems; primarily eutrophication and increased turbidity. In 1989, an estimated 2400 ha of catfish ponds (approximately half commercial and half sports fishing) were actively used for production in Georgia. During this year, an estimated 1.5×10^{10} L of water were withdrawn from ground water supplies, 1.5×10^{10} L captured from freshwater streams, and 1.5×10^{10} L of pond effluent were discharged to the state's receiving waters.

Purification of pond effluent for reuse in production ponds would not only drastically reduce effluent discharge but would also reduce groundwater withdrawal and provide substantial savings in costs associated with groundwater withdrawal. According to Wax and Pote (1990), water conservation potential for catfish production ranges from 65 to 82%.

Considerable research has been done in water quality and conservation aspects of aquacultural production systems. Mires et al. (1990) reused pond effluent after passing it through a large reservoir biofilter in intensive tilapia production. Ghate and Burtle (1993) tried intermittent flushing followed by refilling operations for managing water quality. Brune and Drapcho (1991) suggested that a sedimentation pond in conjunction with some type of flocculation method might be useful in removing settleable material before effluent is discharged to natural waters. The effluent thus "filtered" will have reduced amounts of solids and lower levels of COD and Biochemical oxygen demand (BOD).

In some agricultural systems, grass buffer strips have been used for filtering solids from animal waste (Bingham et al. 1980; Maggette et al. 1989; Dillaha et al. 1989; Schellinger and Clausen, 1992). Using vegetative strips or other filtering methods might be viable for filtering catfish pond effluent so that filtered water can be reused in fish production, thereby conserving groundwater resources and minimizing effluent discharge to natural waters. The conventional filters used in closed culture systems (Wheaton, 1977) do not appear to be suitable for pond culture because of large quantities of water used in pond culture.

MATERIALS AND METHODS

Objective

The objective of this research was to determine the effectiveness of grass strips to filter catfish pond effluent.

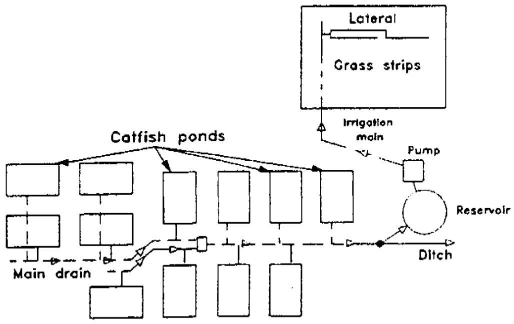

Figure 1. Schematic of catfish ponds and grass strip plots.

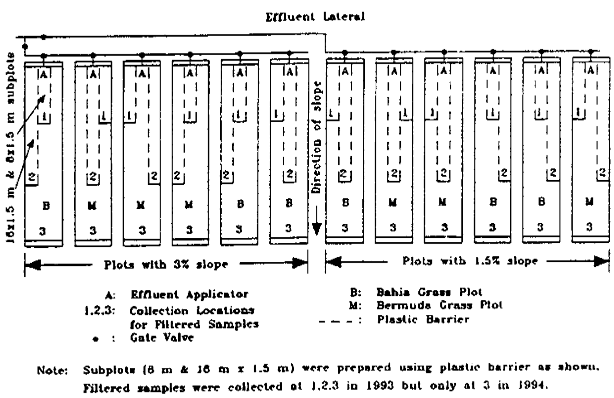

Figure 2. Grass strip plots to filter catfish pond effluent.

Grass Strip Plot Design

Grass strips were established in a field adjoining the catfish pond research facility at the Coastal Plain Experiment Station, Tifton, GA. The facility consisted of twelve 0.1 ha catfish ponds, a reservoir to collect pond effluent, a pumping station and an irrigation pipe network to deliver pond effluent to the field (Figure 1). Twelve grass strip plots were established for the filtration experiment.

Each grass strip was 24 m long × 4.5 m wide. Six strips had a uniform land slope of 1.5% and six had a slope of 3%. Three strips on each slope were planted with Bermuda grass sod (*Cynodon dactylon* (L.) Pers. *var. Dactylon*) and three were planted with Bahia grass (*Paspalum notatum* Fluegge) seed. Each grass filter plot was separated from the adjoining plot by a 1 m wide x 0.3 m tall berm. Plastic flow barriers (25 cm wide x 1.5 mm thick) were installed in the berms separating the filter strips. The six 1.5% slope strips were separated from the six 3% slope strips by a 3 m wide buffer plot. Each grass filter strip was longitudinally subdivided into three 1.5 × 24 m regions. Figure 2 shows the details of the grass plots and randomization used in conducting the experiment.

Stocking, Feeding, and Aeration

Nine ponds were filled to a depth of 1.2 m with well water and stocked with channel catfish fingerlings at the rate 44,000 fish/ha. The daily feeding rate was kept at 3% of fish body mass. All ponds were continuously aerated using air-lift aerators to keep the oxygen level above 4 mg/L at all times. In addition, surface aerators were used as an emergency aeration method.

Experimental Procedure

Water levels were lowered from the pond bottoms, and effluent was applied to the grass filter strips at the high end through an effluent applicator manifold consisting of 13 uniformly spaced 10 mm holes drilled in a 5 cm (2 in) diameter 4.5 m long PVC pipe. The effluent was applied to the grass uniformly over a narrow strip of gravel to minimize any soil erosion due to application intensity. The effluent application rates were 18 and 26 L/min. Input samples (500 mL) were collected in three replicates. After 30 minutes, output samples were collected at the center of the collection locations. A device similar to a dust pan was constructed from sheet metal and it was manually held so that water travelling through the grass would be collected for analysis. A sample of 500 mL was thus collected at three locations (denoted by 1,2, & in Figure 2) from each of the 12 grass plots in 1993. In 1994, three samples were collected only at the bottom of the strip (denoted by 3 in Figure 2). Nonfilterable or suspended solids (NFS) were determined from the input and grass filtered water samples. Seven complete tests were conducted in 1993 and 24 in 1994. NFS were determined by following the procedures outlined by Boyd (1979).

RESULTS AND CONCLUSIONS

The 1993 results indicated that the filtration technique was partially successful in removing nonfilterable solids (in the range of 31%-61%) from the effluent. The filter strip slope had no effect on filtration efficiency. Bermuda grass was somewhat better than the Bahia grass in removing solids. Samples collected at the bottom of the plots (24 m travel distance) contained relatively less solids than the samples collected at intermediate travel distances of 8 m or 16 m. From 1994 data (Table 1), it was found that the types of grass and the land slope did not significantly alter the amounts of nonfilterable solids removed by the grass strips. When the nonfilterable solids concentration was low (less than 30 mg/L), the filter strips were not useful in filtering the solids. The strips were highly effective in solids removal when the solidsconcentration in the pond effluent was high (greater than 200 mg/L). When the concentration of solids in the effluent was moderate (30 to 200 mg/L), the strips removed the solids by as much as 50%. This rate of removal is significant. The filtering process is simple, relatively inexpensive, and has potential as a method of removing solids from catfish pond effluent before discharging it to natural waters or recycling back to production ponds.

ACKNOWLEDGMENTS

The authors want to thank Mr. Ray Jensen, Tifton Sod, Tifton, for the gift of Bermuda sod for conducting this research and Mr. Charles Welsh and Mr. Richard Mayne for technical assistance.

LITERATURE CITED

Bingham, S.C., P.W. Westerman, and M.R. Overcash, 1980. Effect of grass buffer zone length in reducing the pollution from land application areas. *Transactions of the ASAE* 23(2):330-335 and 342.

Boyd, C.E., 1979. *Water quality in warmwater fish ponds.* Auburn University, Agricultural Experiment Station, Auburn, AL 359 pp.

Brune, D.E. and C.M. Drapcho, 1991. Fed pond aquaculture. *Proceedings of the WAS and ASAE Jointly Sponsored Session at World Aquaculture Society 22nd Annual Meeting*, ASAE, St. Joseph, MI, 15-33.

Dillaha, T.A., R.B. Reneau, S. Mostaghimi, and D. Lee, 1989. Vegetative filter strips for agricultural nonpoint source pollution control; *Transactions of the ASAE* 32(2):513-519.

Ghate, S. R. and G.J. Burtle, 1993. Characterization of water in catfish ponds periodically lowered for crop irrigation and refilled with well water. *In* Techniques for Modern Aquaculture, *Ed. by* Wang, J.K., *Proceedings of an Aquacultural Engineering Conference*, ASAE, St. Joseph, MI 177-186.

Maggette, W.L., R.B. Brinsfield, R.E. Palmer, and J.D. Wood, 1989. Nutrient and sediment removal by vegetated filter strips. *Transactions of the ASAE* 32(2):663-667.

Mires, D., Y. Amit, Y. Avnimelech, S. Diab, and M. Cochaba, 1990. Water quality in a recycled intensive fish culture system under field conditions. *The Israeli Journal Aquaculture-Bamidgeh*, 42(4):110-121.

Schellinger, G.R. and J.C. Clausen, 1992. Vegetative filter treatment of dairy barnyard runoff in cold regions. *Journal of Environmental Quality* 21:40-45.

Wax, C. L. and J. W. Pote, 1990. A climatological basis for conservation of groundwater in aquaculture in the southern region. Technical Bulletin 169. Mississippi Agricultural and Forestry Experiment Station, Mississippi State University, Mississippi State, MS 17 pp.

Wheaton, F.W. ,1977. *Aquacultural Engineering.* R.E. Krieger Publishing Company, Malabar, FL, 708 pp.

Table1. Average Amount of Nonfilterable (NFS) Solids Removed by Grass Strips in 1994, as Percent of NFS in Pond Effluent.

Range of NFS in Effluent, mg/L	No. of Samples	Avg NFS removed, % NFS in Effluent	SD, %
200 and above	78	82.2	18.1
100 to 200	324	50.4	19.8
30 to 100	432	44.3	23.4
Less than 30	102	18.6	19.3

SD=Standard deviation of the mean.