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J. Aquat. Plant Manage. 30: 20-23

Organic Sedimentation Associated with Hydrilla Management[1]

J. C. JOYCE,[2] K. A. LANGELAND,[2] T. K. VAN[3] AND V. V. VANDIVER, JR.[4]

ABSTRACT

The production of organic sediment by hydrilla was determined for five different management schemes under experimental conditions in outdoor, concrete tanks. Levels of hydrilla management evaluated represented percent of water volume occupied prior to herbicide treatment of 0%, 33%, 66%, 100%, and 100% (untreated). Hydrilla management at levels which prevented the plant from forming canopies (0, 33%, and 66%) produced significantly (as much as 2.1 times) less organic sediment than untreated hydrilla and also reduced tuber number and total weight. These results indicate an ecological advantage to maintenance control of hydrilla.

Key Words: Hydrilla verticillata, maintenance control, sediment production, organic matter, herbicides, endothall.

INTRODUCTION

Aquatic weed problems are most often associated with an exotic plant's ability to occupy aquatic habitats not normally colonized by native plant species and results in interference with man's use of the waterbody. Large scale management of these problems typically relies on mechanical removal or the use of approved aquatic herbicides. A public concern over the management of nuisance aquatic vegetation with herbicides is the deposition of organic material onto the lake or river bottom by the decaying plants. The public generally does not understand that the plants' productivity and growth habit naturally contribute large amounts of organic material to lake sediments whether treated or not.

Due to difficulties of "in situ" measurement, there is a paucity of published data which quantifies sedimentation contributions from the natural senescence or man-induced necrosis of submersed macrophytes. It is known however, that the chemical decomposition of organic matter produced by algae and aquatic macrophytes and thus their relative contribution to the sediments is variable (Godshalk and Wetzel 1976). This variability is a function of the plant species, its environment, seasonal factors, growth form,

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[2] Director and Associate Professor, respectively, University of Florida, IFAS, Center for Aquatic Plants, 7922 NW 71st Street, Gainesville, FL 32606.

[3] USDA Aquatic Weed Laboratory, 3205 College Ave., Ft. Lauderdale, FL 33314.

[4] Associate Professor, University of Florida, IFAS, Ft. Lauderdale Research and Education Center, Ft. Lauderdale, FL 33314.

lake morphology and circulation, grazing by detritivores, and other factors. (Westlake 1960, Godshalk and Wetzel 1978a). Kleerehoper (1953) found that decay of detritus derived from plankton is rapid and underwent maximum decay while sinking through the epilimnion. The decomposition of aquatic macrophytes is largely dependent upon the fiber content and C:N ratio of the plants with the general increasing resistance to decomposition being floating leaved, submersed, and emergent species (Godshalk and Wetzel 1978a, 1978b). Biomass losses due to natural death of aquatic plants also varies from site to site. In temperate waters, losses occur predominately in autumn and winter and are generally small until the maximum biomass is obtained. In tropical and subtropical regions, however, biomass losses occur throughout the year usually at much the same rate as new material is produced (Sculthorpe 1967). Table 1 provides a comparison of the standing crops and productivity measurements for some common aquatic plants which provides an indication of the relative potential for these plants to contribute organic sediments. The cycling of minerals, nutrients, dissolved gases and organic compounds by nuisance aquatic plant species can have profound effects on the aquatic ecosystem's ability to compensate for the increased organic loading created by these plants (Godshalk and Wetzel 1976, Sculthorpe 1967). If conditions become anoxic, relatively little dissolved organic matter derived from the plants is degraded, but in aerated systems conversion is nearly complete. Furthermore, as lakes become more productive there is a tendency towards massive development of emergent macrophytes which are more resistent to decomposition than submersed or floating leaved plants. The normal decomposition of this detrital material may be overwhelmed by excessive quantities of resistant carbon compounds and the generation of anaerobic conditions in the decomposing littoral sediments as well as in the hypolimnion. Accumulation rates of sediments then accelerate rapidly (Godshalk and Wetzel 1976). Studies have shown that unmanaged waterhyacinths (*Eichhornia crassipes,* (Mart.) Solms) can contribute up to 11.66 MT $ha^{-1}yr^{-1}$ of organic material, however, management at levels less than 5% surface area coverage, reduced organic sedimentation by a factor of 4.0 over uncontrolled plants (Joyce 1985, Brower 1980, Reddy and DeBusk 1990, Reddy and D'Angelo 1990).

The contribution of hydrilla (*Hydrilla verticillata* (L.f.) Royle) to the cycling of organic matter and nutrients within aquatic ecosystems is becoming an important water resource management consideration because it has become a major aquatic weed within the Southeastern U.S. and has shown the ability to occupy nearly 100% of the surface area of large recreational lakes. The intent of this study was to determine the relationship between sedimentation created by herbicide management of hydrilla and the natural senescence of hydrilla.

TABLE 1. STANDING CROP YIELDS AND PRODUCTION MEASUREMENTS (DRY WEIGHT) OF SELECTED AQUATIC MACROPHYTES (REDDY 1985, 1990, WESTLAKE 1963, SCULTHORPE, C. D. 1967, AND BOWES, ET AL. 1979).

Aquatic plant	Biomass yield (mt ha^{-1})	Productivity (mt ha^{-1} yr^{-1})
Waterhyacinth	9–20	44
Cattails	8–23	25
Bulrush	5	25
Hydrilla	3	7
Elodea	3	13
Phytoplankton	1.5	2.6

METHODS AND MATERIALS

In each of 12 – 950 l concrete tanks, 12 hydrilla plants (5 cm long), sprouted from tubers were established in 7 plastic pans (13 by 30 by 15 cm deep). The rooting medium per pan consisted of 12.5 cm of builder's sand with a layer of fertilizer mix (35g Osmocote, 0.9g Esmigran, 5.6g dolomite) covered with another 2.5 cm of builder's sand (Sutton 1986). An additional three tanks contained the same number of pans and potting mix but no hydrilla. These latter tanks were established in order to determine sedimentation from non-macrophyte generated sources. The plants were planted on September 3, 1987 at the IFAS Ft. Lauderdale Research and Education Center. A continuous flow of pond water was passed through the tanks in order to reduce algal growth, maximize hydrilla growth, and to reduce temperature extremes. The rate of water flow was sufficient to exchange tank volume every 24 hours. Periodic inspection of the outflow indicated that no significant amount of hydrilla fragments were leaving the tanks. In a further attempt to limit the growth of filamentous algae in the tanks, all tanks were periodically treated with chelated copper (alkanolamine) at concentrations up to 0.25 mg Cu/l. This treatment did not cause any visible damage to the hydrilla.

The plants in all tanks were initially allowed to grow until they reached the surface in an attempt to simulate a system with 100% hydrilla coverage prior to initiation of management activities and to ensure uniform establishment of hydrilla prior to the initial treatment (November 4, 1987). After the initial treatment, the plant growth (i.e. depth below the water surface prior to treatment) was monitored and three of the tanks were treated with dipo tassium salt of endothall (7-oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid) when the hydrilla had reached 1/3 of the tank height, three were treated when the plants reached 2/3 of the tank height, and three were treated when the plants reached the water surface and had formed a surface mat. Water flow through the tanks was stopped for 3 days after each treatment in order to allow sufficient herbicide contact time with the plants. Each time the plants reached their specified treatment height, they were again treated to reduce the biomass back to the hydrosoil. Each herbicide treatment utilized between 0.75 to 1.00 mg/l endothall salt. Hydrilla in three other tanks was allowed to grow to the surface and was never treated with endothall during the year long study. The control tanks with no hydrilla received no treatment other than the chelated copper treatments which occurred at the same time as the other tanks.

On December 6, 1988, the experiment was terminated and the plants harvested. The experiment was terminated at a point in time when the 1/3 tanks were in need of treatment. The hydrilla plants in each pan were harvested by cutting the plants just above the hydrosoil. Hydrilla biomass was determined by drying the plants at 60°C for 96 hours and weighing to the nearest 0.1g. After allowing the disturbed sediments to settle, the water was slowly siphoned from the tanks in order to minimize loss of the bottom sediments. The plastic pans containing the growth medium and remaining hydrilla biomass (stubble, rhizomes, roots and tubers) were carefully removed to prevent loss of organic sediments from the pans to the tanks. The pans were removed from the tanks, potting mixture was screened, tubers present were separated into sprouted and unsprouted categories, counted, and dry weights were determined. The remaining water in the tanks was allowed to evaporate until it reached the surface of the organic sediments in the bottom of the tanks. The organic material was scraped from the tanks, oven dried, and sand-free dry weights determined (Humphries 1956). The amount of organic material generated per tank was determined by subtracting the area of the six pans which were removed from the tanks (to determine tuber density and weight) and dividing the weight of material remaining by the resulting area. The data from each tank was pooled as a replication of each treatment. Data were analyzed for statistical differences using SAS (SAS Institute, Inc.) Duncan's multiple range test ($\alpha = .05$).

RESULTS AND DISCUSSION

Management of hydrilla before it reached the water surface (surface-matted) in tanks reduced the number and weight of tubers produced (Table 2). Hydrilla that was not treated until it surface-matted produced an average of 3.9 times more tubers than hydrilla treated when it reached 2/3 the distance to the water surface and total tuber weight was 7 times greater. Percent of tubers sprouting was also greater in herbicide treated tanks (Table 2). This apparent stimulation of tuber sprouting was probably caused by chemical and physical changes in the rooting medium, such as diffusion of dissolved gasses and increased light penetration, when the plant canopy was removed. Haller et al. (1976) and Van and Steward (1990) demonstrated that the proportions of oxygen and carbon dioxide in the hydrosoil affect tuber sprouting.

TABLE 2. EFFECTS OF VARIOUS HERBICIDE TREATMENT SCHEDULES ON HYDRILLA TUBER AND PLANT BIOMASS PRODUCTION. NUMBERS WITH THE SAME LETTERS WITHIN A COLUMN ARE NOT SIGNIFICANTLY DIFFERENT ($p < 0.05$).

	Tubers	Tubers sprouted	Weight of tubers	Plant biomass
Treatment[1]	(no.)	(% of total)	(g)	(g)
100% – Surface matted non-treated	1712 a	11 a	213.7 a	1133.3 a
100% – Surface matted treated	2192 a	23 a,b	189.9 a	930.7 a
66% – 2/3 to water surface	562 b	40 b	26.9 b	367.8 b
33% – 1/3 to water surface	710 b	39 b	49.4 b	416.4 b
0% – No hydrilla	–	–	–	–

[1]percent of vault occupied prior to treatment.

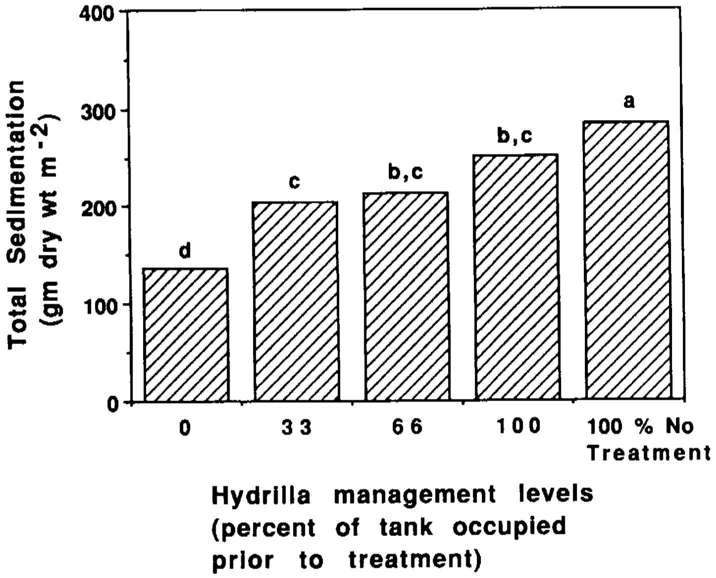

Fig. 1. Effects of various herbicide treatment schedules on hydrilla sediment production. Levels with the same letters are not significantly different ($p < 0.05$).

Tanks that were treated with herbicide before hydrilla surface-matted contained less biomass at the end of the experiment than either hydrilla that was not treated until it surface-matted or untreated hydrilla (Table 2). However, biomass of hydrilla that was not treated until it surface-matted was not different from the untreated hydrilla tanks. Treating hydrilla when it reached 2/3 of the way to the water surface decreased biomass to 33% of the biomass of untreated hydrilla tanks at the end of the experiment.

The quantities of organic sediments produced followed a relationship similar to that of previous research on the chemical control of waterhyacinths (Brower 1980, Joyce 1985). Nontreated hydrilla produced the greatest quantity of organic sediments (284.6 g/m^2) which was 2.1 times greater than the tanks with no hydrilla (136.5 g/m^2) (Figure 1.) This is a net increase of 148.1 g/m^2 (1.48 MT/ha) of organic sedimentation for hydrilla. The nontreated hydrilla tanks also produced more total organic sediment than the intensely managed plants (1/3 and 2/3 treatments).

These results indicate that the aggressive maintenance of hydrilla over an extended period of time should decrease the rate of organic sedimentation and decrease hydrilla tuber production as well as residual tuber density in the hydrosoil. The results are similar to previous experiments with waterhyacinths and further substantiate the ability of uncontrolled exotic vegetation to increase the organic sedimentation of natural systems.

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Factors Influencing Gas Evolution Beneath a Benthic Barrier[1]

DOUGLAS GUNNISON AND J. W. BARKO[2]

ABSTRACT

Laboratory studies were conducted to determine the influences of temperature, sediment type, and sediment organic matter on rates of gas evolution beneath a benthic barrier. Gas evolution was measured at two temperatures (15 and 30 C) from two compositionally distinct (sand and clay) sediments with and without additions of organic matter. Sediments amended by addition of coontail (*Ceratophyllum demersum*) produced gas at both 15 and 30 C. However, incubation temperature determined both the onset of gas formation and the maximum gas production rate achieved. Results demonstrate that gas evolution begins earlier and gas production rates are greater at warmer temperatures. Examination of the effect of organic matter level on gas evolution rates revealed pronounced increases in gas evolution rates from clay sediments amended by additions of 13 to 130 g of coontail at 30 C. Composition of the gases released proved similar for all of the treatment combinations (nitrogen – 47 to 55 percent; oxygen – 13 to 15 percent; methane – 3 to 4 percent; carbon dioxide – 28 to 36 percent). Based on findings of these studies, benthic barriers scheduled for deployment in areas sustaining high seasonal plant production rates should be emplaced during cooler periods of the year when the standing crop and decomposition rates are low.

Key words: Gas evolution, permeability, organic matter, sediment type, coontail.

INTRODUCTION

Benthic application of barrier fabrics provides a means to physically limit nuisance growth of aquatic plants (Mayer 1978, Perkins et al. 1979, Lewis 1983, Cooke 1986). Benthic barriers provide an attractive alternative to other types of control because they can be deployed and left in place for several growing seasons, thus eliminating the need for repetitive treatment efforts. Barriers can be easily installed with very limited training of personnel (Pullman 1990); however, benthic barriers cannot be recommended for widespread field use until their effectiveness has been firmly established.

A specific concern related to barrier use is the limitations on barrier performance resulting from sediment gas evolution following placement. Available barrier fabrics are reported to differ extensively in both their immediate and long-term permeabilities to gases (Pullman 1990). Permeability may be essential to prevent pockets of gas from buoying the barrier fabric up to the water surface, where wind and wave action can cause displacement.

An earlier study conducted at Eau Gallie Reservoir, Spring Valley, WI, was conducted to initially characterize

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[2] Research Microbiologist and Research Biologist, respectively, Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199.