Duckweed control in Mississippi waters

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Duckweed (*Lemna minor* L.) is a free floating plant that is native to the southeastern United States. However, duckweed has an invasive growth habit and can overtake stagnant waters in both lakes and rivers. Two studies, a field demonstration and a replicated tank study, were done in Mississippi during 2007. The field demonstration was conducted in a 4.4 hectare lake near Holcomb, MS that was completely covered with duckweed. Fluridone was used in a sequential treatment of 50 parts per billion (ppb) on May 28th followed by 40 ppb treatment one month later. Duckweed biomass was reduced by greater than 90% following the second treatment ($p < 0.01$). The second study was conducted in outdoor 40 L tanks at the R.R. Foil Plant Science Research Station, Mississippi State University. Duckweed was treated with diquat at 0.37 parts per million (ppm) injected into the water, diquat at 0.37 ppm with a methylated seed oil (MSO) at 1% v/v injected into the water, diquat at 2 gallons per surface acre with 1% MSO applied to the surface, and 1% MSO alone. Biomass was significantly reduced 3 days after treatment ($p < 0.01$) with all treatments. We have demonstrated several different tools that may be used to control nuisance growths of duckweed in Mississippi waters.

Keywords: Invasive Species, Ecology, Wetlands

Introduction

Common duckweed (Lemna minor L.) (here after referred to as duckweed) is a floating aquatic plant that can cause severe nuisance problems in water bodies throughout the United States. Despite duckweed being a native plant, its invasive growth can cause severe environmental problems as well as aesthetic problems, such as impeding navigation, reduce plant diversity, and deplete dissolved oxygen which can lead to a reduction in fish productivity (Parr et al. 2002). Duckweed infestations are typically using one of two aquatic herbicides, diquat or fluridone.

Diquat [(6,7-dihydrodipyrido (1,2-a:2',1'-c) pyrazinedium dibromide)] is often the prescribed herbicide for control of duckweed; however, it has at times been inconsistent in effectiveness. Previous studies have shown diquat to be an effective herbicide against duckweed infestations at both small laboratory scales as well as pond and lake scales (Berry and Schreck 1975, Blackburn and Weldon 1965, Langeland et al. 2002, Peterson et al. 1999). Fluridone [(1-methyl-3-phenyl-5-[3-trifluoromethyl)phenyl]-4(1H)-pyridinone)] is another commonly prescribed herbicide for duckweed control. Fluridone has been demonstrated to provide excellent control of duckweed in early screening trials with rates as low as 0.03 part per million (ppm) achieving 100 percent control eight weeks after treatment (McCowen et al. 1979).

While there are lab and controlled outdoor experiments of fluridone use for control of duckweed (McCowen et al. 1979), no publications are available to describe the efficacy of fluridone on duckweed under operational conditions. The objective of this study is to demonstrate the effectiveness of using fluridone to control duckweed at the pond scale.

Materials and Methods

The study was conducted on a 10.8 acre lake in Holcomb, Mississippi with an average depth of 5.7 ft. The study began in May 2007 and continued through September 2007. The lake was 67% covered two weeks prior to treatment with duckweed; however, at the time of treatment there was a 100% cover of duckweed throughout the 10.8 acre lake. Fluridone (as Avast® Aquatic Herbicide, SePRO Corporation 11550 North Meridian Street, Suite 600, Carmel, IN 46032) was applied at a total rate of 90 parts per billion (ppb) to the entire lake, split over two treatments; a 50 ppb initial treatment followed by a 40 ppb treatment one month later. The application was delivered using a 10 foot john boat outfitted with a sub-surface injection system calibrated to 20 gal/acre. A lower delivery volume for the treatment was used because of debris in the water column and the need to avoid exceeding the labeled rate for a particular area. Biomass was collected using a 2 in. (0.002 m2) PVC harvesting tool developed specifically for

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duckweed and similar species. Biomass was collected before, 30 and 120 days after treatment (DAT). Biomass samples were dried at 158°F to obtain a constant mass and weighed to determine post treatment biomass. Data was analyzed using a mixed model ANOVA with repeated measures. The analysis was conducted at the p= 0.05 level of significance using SAS (SAS Institute 2002).

Results and Discussion

Duckweed was highly susceptible to fluridone throughout the entire study. One month (30 DAT) following the 50 ppb initial treatment, duckweed biomass was reduced from 47.0 to 0.4 g DW m-2 ($p < 0.001$) (Figure 1). Duckweed biomass was reduced even further at 120 DAT from 0.4 to 0 g DW m-2; however this reduction was not significantly different from the 30 DAT biomass ($p=0.9577$) (Table 1). Biomass was significantly reduced from the pre-treatment assessment to the 120 DAT, from 47.0 to 0 g DW m-2 ($p < 0.001$) (Figure 1). Fluridone resulted in a 100% control of duckweed from the pond (Figure 1). Our results coincide with results found in laboratory screenings of duckweed control using fluridone (McCowen et al. 1979). The efficacy of fluridone may be due to the unique characteristics of this herbicide in combination with the nutrient uptake of duckweed. Fluridone is a slow acting herbicide and commonly requires 60 to 90 days of contact time to achieve acceptable control in submersed plants (Netherland et al. 1993, Netherland and Getsinger 1995). This longer contact time, combined with the ability of duckweed to take up nutrients not only from the water column (Ice and Couch 1987) and from the upper surface of the frond (Meijer and Sutton 1987), allows for thorough uptake of fluridone from the pond.

Results from this study indicate that duckweed can be controlled by fluridone applied using a subsurface application. Sequential applications of fluridone did not significantly differ in reduction of biomass. However, the second treatment of 40 ppb may have contributed to maintaining a lethal amount of fluridone in the system to continue controlling any new duckweed fronds that may have been formed during the study. Continued management of duckweed may be done with either fluridone or diquat. Selection of diquat versus fluridone for duckweed control may depend on the price of the available products and the relative amount of infestation. Diquat has been proven to adequately control duckweed as a foliar or subsurface application and is the better choice for partial infestations of the plant. Fluridone is preferred when the entire pond is infested with duckweed.

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Literature Cited

Berry, C.R. Jr. and C.B. Schreck. 1975. Toxicity of diquat and endothall separately and combined on several species of aquatic plants. 53rd Annual Meeting of the Virginia Academy of Science. May 6-9, 1975. Harrisonburg, VA.

Blackburn, R. D. and L. W. Weldon. 1965. The sensitivity of duckweeds (Lemnaceae) and azolla to diquat and paraquat. Weeds 13:147-149.

Ice, J. and R. Couch. 1987. Nutrient absorption by duckweed. J. Aquat. Plant Manage. 25:30-31.

Langeland, K. A., O. N. Hill, T. J. Koschnick and W. T. Haller. 2002. Evaluation of a new formulation of Reward Landscape and Aquatic Herbicide for control of duckweed, waterhyacinth, waterlettuce, and hydrilla. J. Aquat. Plant Manage. 40:51-53.

McCowen, M.C., C.L. Young, S.D. West, S.J. Parka, and W.R. Arnold. 1979. Fluridone, a new herbicide for aquatic plant management. J. Aquat. Plant Manage. 17:27-30.

Meijer, L. E. and D. L. Sutton. 1987. Influence of plant position on growth of duckweed. J. Aquat. Plant Manage. 25:28-30.

Netherland, M. D. and K. D. Getsinger. 1995. Potential control of hydrilla and Eurasian watermilfoil under various fluridone half-life scenarios. J. Aquat. Plant Manage. 33: 36-42.

Netherland, M. D., K. D. Getsinger, and E. G. Turner. 1993. Fluridone concentration and exposure time requirements for control of Eurasian watermilfoil and hydrilla. J. Aquat. Plant Manage. 31: 189-194.

Parr, L. B., R. G. Perkins and C. F. Mason. 2002. Reduction in photosynthetic efficiency of Cladophora glomerata, induced by overlying canopies of Lemna spp. Water Res. 36:1735-1742.

Peterson, H.G., C. B. Boutin, K. E. Freemark, and P.A. Martin. 1999. Toxicity of hexazinone and diquat to green algae, diatoms, cyanobacteria, and duckweed. Aquatic Toxicology 39:111- 134.

SAS Institute. 2002. SAS v. 9.1. SAS Institute Inc. Cary, NC, USA.

Table 1. The results of the mixed procedures ANOVA model with repeated measures.

Effect	Survey	T Value	P Value
Survey	Pre x 30 DAT	7.06	<0.0001
Survey	Pre x 120 DAT	7.12	<0.0001
Survey	30 DAT x 120 DAT	0.05	0.9577

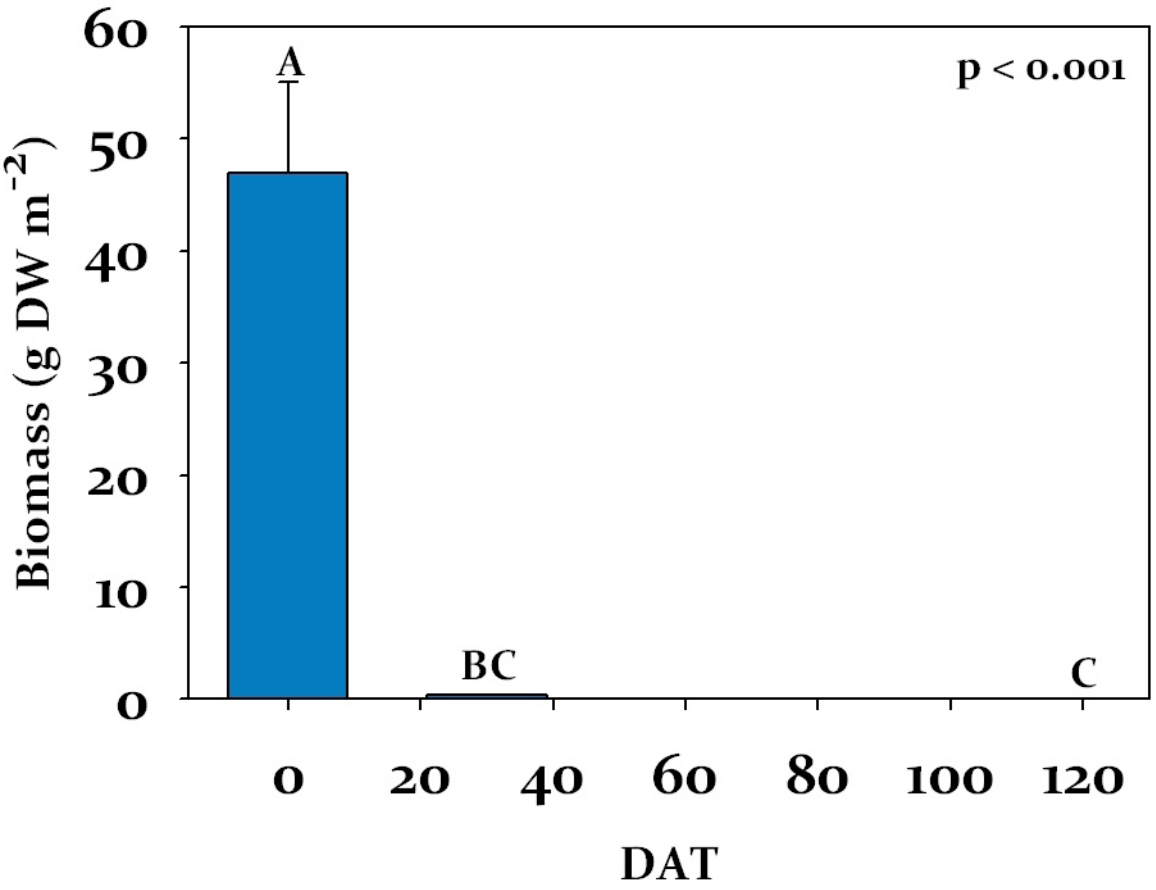

Figure 1. Mean biomass (± 1 SE) of duckweed (Lemna minor) harvested Pre-treatment, 30 DAT, and 120 DAT with sub-surface applications of fluridone.