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Hydrilla Response to Mariner[1] Applied to Lakes[2]

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ABSTRACT

Mariner, which contains the active ingredient bensulfuron methyl, was applied at different times and concentrations to four lakes in Florida to determine its effect on hydrilla growth and reproduction. In one lake, four sequential applications every 44 days of sufficient Mariner to result in 25 ppb bensulfuron methyl resulted in no observable above-sediment hydrilla biomass 1 yr after application of the product. Hydrilla was also eliminated 1 yr after application from another lake treated once with 100 ppb bensulfuron methyl, and lake volume occupied by hydrilla remained less than 5% of pretreatment levels in this lake 2 yr after application. In a third lake, 40-ppb bensulfulron methyl eliminated hydrilla biomass for the period of a growing season. In the fourth lake application of 25 ppb bensulfuron methyl resulted in a small reduction in biomass, and vigorous growth was evident 11 months after application. Mariner was applied to this lake again to target 50 ppb bensulfuron methyl, and hydrilla biomass approached zero 1 yr following the second application. Hydrilla tuber density was reduced in all lakes where Mariner was applied and tuber density was measured. However, even after large reductions in tuber numbers, high tuber density (up to 300/sq m) remained in the hydrosoil of two lakes and tubers were not eliminated from any of the lakes.

Key words: bensulfuron methyl, biomass, Florida, tubers, growth, aquatic weed control.

INTRODUCTION

Mariner, which contains the active ingredient bensulfuron methyl (methyl2-[[[[[(4,6-dimethoxy-2-pyrimidinyl]amino] carbonyl]amino]solfonyl]methyl]benzoate), was registered for experimental use in aquatic sites by E. I. du Pont de Nemours & Co., Inc. from 1989 through 1991. Several laboratory studies have demonstrated that hydrilla (*Hydrilla verticillata* (L.f.) Royle) growth is sensitive to this compound. Growth was reduced by exposure to 1 ppb, and 50 ppb resulted in 60% reduction in growth (Anderson and Dechoretz 1988). Van and Vandiver (1992) exposed hydrilla to 50, 100, and 200 ppb bensulfuron methyl for 4 weeks and reduced dry weight accrual by 90% after 2 months with all concentrations. Langeland and Laroche (1992) observed cessation of growth when hydrilla was exposed to 200 ppb for 192 hr. Inability of hydrilla to produce tubers has also been observed under laboratory conditions (Anderson 1988, Van and Vandiver 1992, Haller *et al.* 1992, Langeland and Laroche 1992) when the plants were exposed to bensulfuron methyl.

In a field study, where bensulfuron methyl was applied to the bottoms of dewatered irrigation channels, Bowmer *et al.* (1992) observed fair control of elodea (*Elodea canadensis* Rich.) and moderate control of ribbonweed (*Vallisneria gigantea* Graebner), which are closely related to hydrilla.

The purpose of this study was to determine the response of hydrilla growth and tuber production to application of Mariner in operational settings in lakes. This information is necessary to develop use patterns for the product if it is registered for aquatic use.

MATERIALS AND METHODS

Sufficient Mariner was applied to Johnny's Lake (Brevard Co., FL) to result in 25 ppb bensulfuron methyl (all concentrations are nominal) on May 17, June 28, August 8, and October 10, 1990. The lake was 2.2 ha in surface area and 5 m in average depth at all application times except October when the average depth was 4 m. Total alkalinity was 104 ppm as $CaCO_3$ and pH was 8.0. Hydrilla presence in the water column was recorded routinely with a recording fathometer (Raytheon DE-719). Five biomass samples were collected with the "Waterways Experiment Station's Hydraulically Operated Submersed Aquatic Plant Sampler" (Sabol 1984), along each of five transects, prior to the first Mariner application and 1, 2, 5, 7, 12, 14, and 16 months after application. Biomass samples were returned, on ice, to Gainesville, FL, where they were dried to constant weight in a forced air drying oven and weighed. Tuber density was not measured in this lake because of the hard rocky bottom and depth.

[1]Mariner is a registered trade name of E. I. du Pont de Nemours & Co., Inc.

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Sufficient Mariner was applied to Catfish Lake (Pasco Co., FL) on July 10, 1990, to result in 100 ppb bensulfuron methyl. The lake was 10.4 ha in surface area and 2.3 m in average depth at the time of application. Total alkalinity was 31 ppm as $CaCO_3$ and pH was 7.4. Hydrilla presence in the water column was measured routinely with a recording fathometer (Raytheon DE-719). Tuber density was measured routinely by collecting 15 samples in each of three locations within the lake with an 81-cm^2-diameter core sampler similar to that described by Sutton (1982) and compositing the samples within each sample site.

Sufficient Mariner was applied to Palmer Ranch Lake (Sarasota Co., FL) to result in 25 ppb bensulfuron methyl on August 30, 1990 and 50 ppb on August 13, 1991. The lake was 3.4 ha in surface area and 2.8 m in average depth at the time of the first herbicide application and 3.5 m in depth at the time of the second application. Total alkalinity and pH were 108 ppm as $CaCO_3$ and 8.2, respectively. Hydrilla presence in the water column was measured with a recording fathometer (Raytheon DE-719). Hydrilla biomass was measured by hand collecting all hydrilla from within four 0.24-sq-m quadrants at each of three locations in the lake, and determining dry weight. Tuber density was determined as previously described.

Sufficient Mariner was applied to Lake Wastena (Pasco Co., FL) on August 29, 1991, to result in a bensulfuron methyl concentration of 40 ppb. At the time of application, the lake was 10 ha in surface area and average water depth was 3.7 m. Rains occurred during the week following application that increased water depth by approximately 0.7 m. Total alkalinity and pH were 2 ppm as $CaCO_3$ and 6.2, respectively. Hydrilla presence in the water column was measured with a recording fathometer (Raytheon DE-719). Twenty-six biomass samples were collected with the "Waterways Experiment Station's Hydraulically Operated Submersed Aquatic Plant Sampler" (Sabol 1984) along two transects and dry weights and tuber density were determined.

All Mariner was applied in 187-L water/ha (20 gal/acre) with 3.7-m long hoses trailed from the bow of an airboat.

Biomass and tuber density were averaged over all samples collected in each lake, at each collection time. Hydrilla response to Mariner applications is presented as the regression of biomass or tuber density as the dependent variable and time after application as the independent variable. Lake volume occupied by hydrilla was determined in Catfish Lake as the proportion of dots that contacted hydrilla images on fathometer tracings (Maceina and Shireman 1980) compared to the number of dots occupied by the entire cross section of the tracing, using an Eros Data Center (March 1977) Area Dot Grid (100 dots/sq in.). Hydrilla response in Catfish Lake is presented as the regression of percent lake volume occupied by hydrilla as the dependent variable and time after herbicide application as the independent variable.

RESULTS

Presence of hydrilla in the water column of Johnny's Lake declined 3 months after the initial Mariner application (two 25-ppb applications had been made by this time), and occupied less than the bottom 3 ft of the water column 6 months after application (four 25-ppb applications had been made by this time), as determined by recording fathometer tracings (data not presented). Hydrilla biomass had increased slightly 2 months following the initial 25-ppb Mariner application and then began to decline approximately 1 month later (Figure 1). Biomass then declined rapidly and no observable biomass was present after 1 yr. Sprouting hydrilla tubers were observed 16 months after application, which suggests that the herbicide was no longer impacting hydrilla growth in the lake.

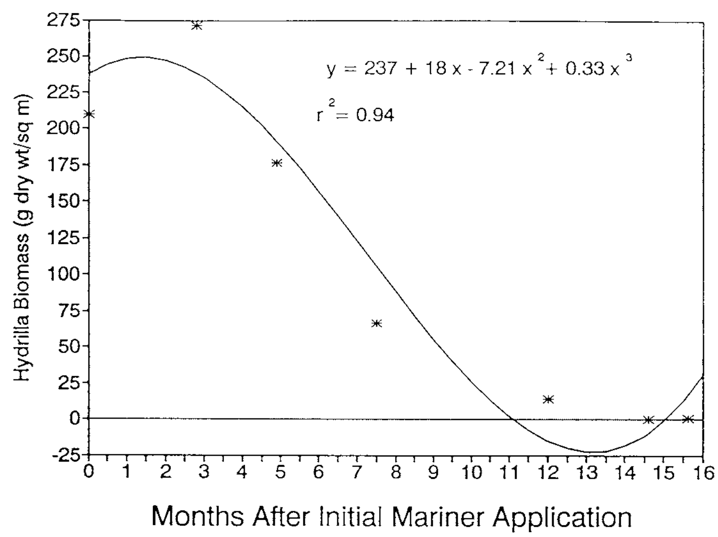

Figure 1. Hydrilla biomass in Johnny's Lake after four sequential applications, every 44 days (May , June, August, October 1990), of sufficient Mariner to result in 25 ppb bensulfuron methyl each (each asterisk represents an average of 25 observed values).

Lake volume occupied by hydrilla in Catfish Lake declined rapidly after Mariner application and was unmeasurable less than 1 yr after application (Figure 2). Almost 2 yr after application, presence remained very low, although sprouting hydrilla tubers could be observed along the lake margin. Tuber density in Catfish Lake decreased from over 200/sq m at the time of Mariner application to approximately 25/sq m 28 months after application (Figure 2).

Hydrilla was reduced to less than 1 ft in height, as determined by fathometer tracings, 8 months after application of 25 ppb bensulfuron methyl (August 1990) to Palmer Ranch

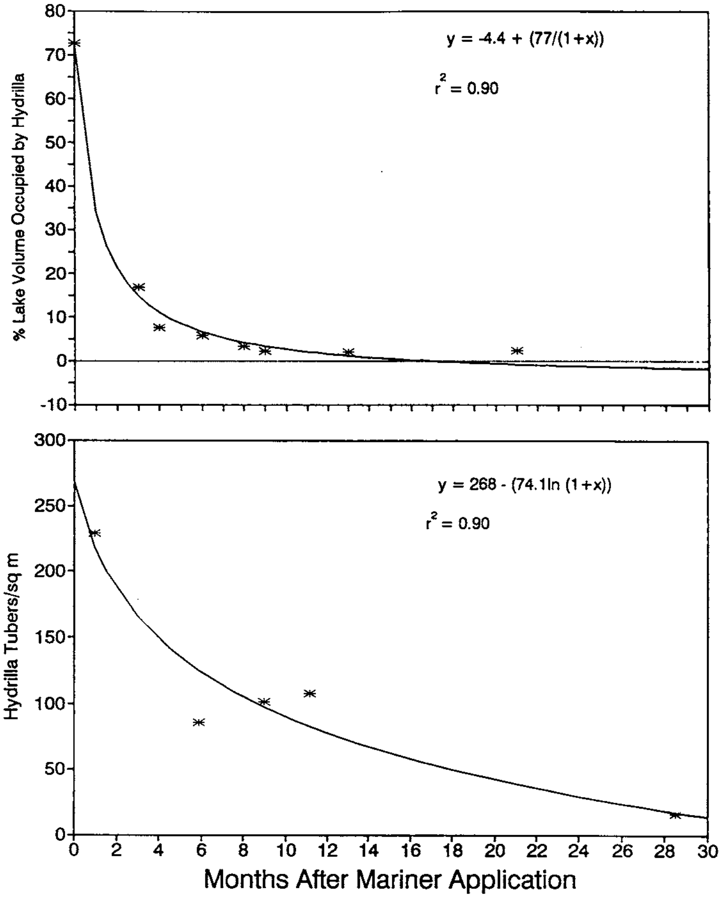

Figure 2. Lake volume occupied by hydrilla and tuber density in Catfish Lake after application of sufficient Mariner to result in 100 ppb bensulfuron methyl, in July 1990 (each asterisk represents an average of five observed biomass values or 3 tubers/sq m values).

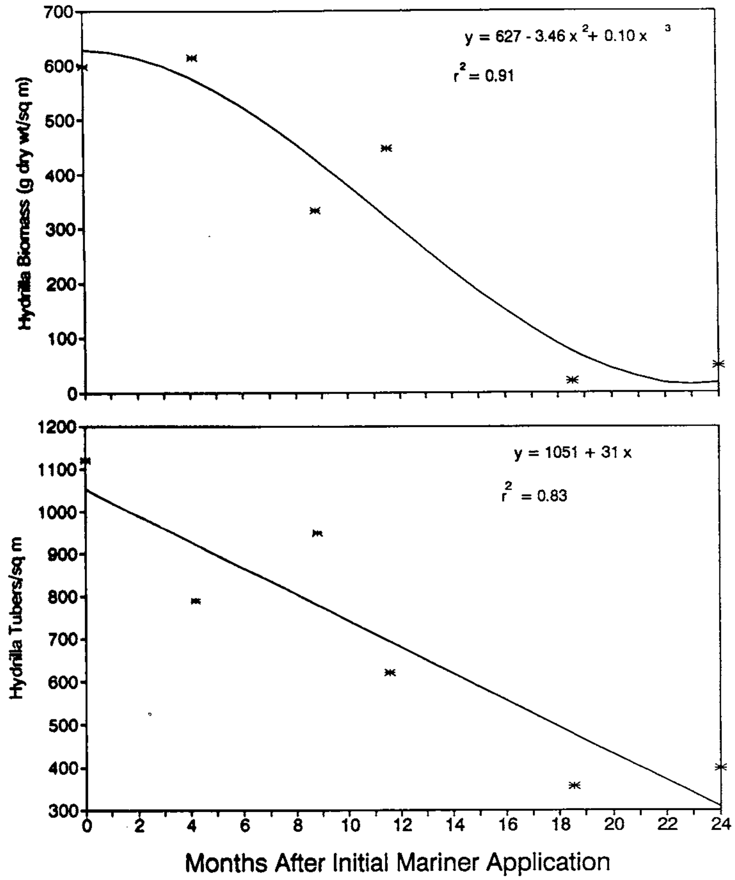

Figure 3. Hydrilla biomass and tuber density in Palmer Ranch Lake after application of sufficient Mariner to result in 25 ppb bensulfuron methyl, in August 1990, followed by 50 ppb 1 yr later (each asterisk represents an average of 12 observed biomass values or 3 tubers/sq m values).

Lake (data not presented). However, 11 months after application, hydrilla was actively regrowing. By 1-1/2 months after 50 ppb bensulfuron methyl was applied (11 months after the initial application) hydrilla had again fallen to the bottom. Biomass declined slowly during the 8 months following the initial application (Figure 3). Biomass then appeared to increase 1 yr following application, as indicated by the observed average biomass shown in Figure 3. However, application of 50 ppb in August 1991 resulted in continued decline, with biomass approaching zero by 2 yr after the initial Mariner application (Figure 3). Tuber density decreased linearly from 1,000 to 400 per sq m following Mariner applications in Palmer Ranch Lake.

Hydrilla in Lake Wastena was falling to the bottom, as it had in the other lakes of this study, by 53 days after application of 40 ppb bensulfuron methyl. Hydrilla biomass and tuber density decreased linearly during the year following Mariner application (Figure 4). Hydrilla was only recently introduced into this lake; therefore, biomass and tuber density were initially low compared to the other lakes in the study. One year following application, hydrilla biomass had declined to an unobservable level and tuber density to less than 10/sq m.

DISCUSSION

In Palmer Ranch Lake, 25 ppb bensulfuron methyl was not sufficient to control hydrilla but appeared to act as a growth regulator. Hydrilla was not killed but biomass was reduced and the decrease in tuber density suggests that tubers were not formed during that growing season. Therefore, Mariner may have potential use for hydrilla growth regulation. All applications of 40 ppb or greater (sequential applications in Johnny's Lake) resulted in at least season-long control and up to 2 yr of control. All hydrilla tissue exposed to the treated lake water appeared to die. Therefore, Mariner also has potential as a herbicide for hydrilla control.

The herbicidal affect of Mariner, when applied at bensulfuron methyl concentrations of 40 to 100 ppb, is somewhat unexpected based upon previous laboratory studies because hydrilla did not die when Langeland and Laroche

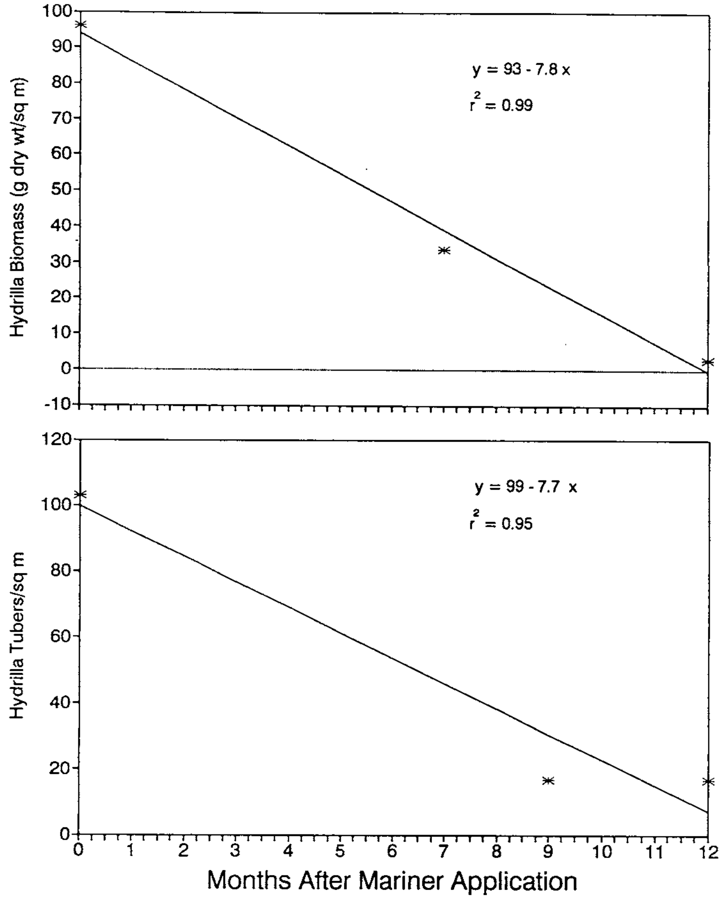

Figure 4. Hydrilla biomass and tuber density in Lake Wastena after application of sufficient Mariner to result in 40 ppb bensulfuron methyl in August 1991 (each asterisk represents an average of 26 observed biomass values or 3 tubers/sq m values).

(1992) exposed plants to concentrations up to 100 ppb for up to 192 hr or when Van and Vandiver (1992) exposed plants to concentrations up to 200 ppb for 4 weeks. In these studies, plants renewed growth after initial growth reduction. A possible explanation for the difference is that whole lake application to these enclosed lakes (little water exchange) resulted in longer exposure to low bensulfuron methyl concentrations, relative to the laboratory studies. The importance of exposure time suggests that special techniques may be necessary for the compound to be effective in flowing water or for partial application in large lakes.

Inhibition of hydrilla tuber production and subsequent decrease in tuber density in these lakes following Mariner application suggest the potential for use of the product to reduce the year-to-year regrowth potential of hydrilla. Sequential applications of Mariner could be used for this purpose, or Mariner could be applied sequentially with other herbicides. However, the large numbers of tubers that were present, even after large reductions, suggests that elimination of hydrilla tubers from lakes will be a long-term process. Van and Steward (1990) demonstrated that 4 years were necessary to deplete monoecious hydrilla tuber populations under experimental conditions due to "environmentally-imposed forced dormancy." Therefore (assuming similar longevity of dioecious hydrilla tubers), several annual sequential applications to inhibit tuber production would be necessary to eliminate potential hydrilla regrowth from tubers in lakes.

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