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Response of Monoecious and Dioecious Hydrilla to Bensulfuron Methyl

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ABSTRACT

Responses of monoecious and dioecious hydrilla [*Hydrilla verticillata* (L.f.) Royle] to bensulfuron methyl (methyl 2-[[[[[(4,6 dimethoxy pyrimidin-2-yl)amino]carbonyl]-amino]sulfonyl]methyl]benzoate) at 0.05, 0.10, and 0.20 mg/L were determined under outdoor culture conditions in South Florida from December 1989 to June 1990. Bensulfuron methyl suppressed subterranean turion (tuber) formation at virtually all concentrations tested, and the tuber suppression level was often much greater than the corresponding reduction of plant biomass exhibited by the same herbicide treatment. The duration of tuber suppression increased with increasing treatment rates. At 0.20 mg/L, bensulfuron methyl prevented tuber formation in both monoecious and dioecious hydrilla during the 6-month culture period. Tuber formation in monoecious hydrilla was delayed for 3 months by the 0.05 mg/L treatment, but tubers were formed rapidly from April to June so that the treatment became ineffective after 6 months. In dioecious hydrilla, a similar treatment at 0.05 mg/L also delayed tuber formation for 2 to 3 months; however, there was no evidence of tuber production from April to June, likely due to the seasonal pattern of tuberization in the dioecious biotype. As a result, tuber formation by dioecious hydrilla was still reduced by more than 84% after 6 months in all bensulfuron treatments. These results suggest that proper timing of bensulfuron methyl treatments could increase the herbicide performance in dioecious hydrilla.

Key words: Chemical control, herbicides, growth regulators, propagules, tubers, reproduction.

INTRODUCTION

Hydrilla is a serious aquatic weed in the southeastern United States and many other areas. Until recently, only dioecious female plants had been observed in the United States; however, a monoecious hydrilla was identified in 1982 in the Potomac River, Virginia (Steward et al., 1984). Since that time, the monoecious biotype has been reported in several other locations in the northeast. Verkleij et al. (1983) indicated that dioecious and monoecious hydrilla in the United States are genetically distinct, suggesting that possible differences exist between the two hydrilla biotypes in terms of survival abilities and responses to management techniques.

One major problem encountered in hydrilla management is the rapid regrowth of the plant from vegetative propagules. The subterranean turions, commonly called tubers, are particularly troublesome since they serve as a source of regrowth in areas where the hydrilla shoots have been controlled by chemical or mechanical methods. Dioecious hydrilla produces tubers in response to short photoperiods, with a critical day length of 13 h or less (Van et al., 1978). Haller et al. (1976) reported that dioecious hydrilla in North Florida produces tubers from October through April and the tubers germinate in the following May. This seasonality of tuber production and germination suggests that timing of control procedures is important for effective hydrilla management. More recent studies, however, indicated that monoecious hydrilla produces tubers under both 10-h and 16-h photoperiods (Van, 1989), and in both summer and winter growth conditions in South Florida (Sutton et al., 1992). These data indicate the potential for year-round production of tubers if the monoecious biotype were to become naturalized in water bodies in the southeastern U.S. Also, the lack of a strict photoperiod requirement for tuberization in monoecious hydrilla suggests that different management approaches might be required to prevent tuber formation in this hydrilla biotype.

Bensulfuron methyl, currently registered for use in rice, is a member of the sulfonylurea class of herbicides. The sulfonylureas inhibit isocitrate lyase (Beyer et al., 1988), leading to a loss in the formation of essential amino acids such as leucine, isoleucine, and valine. Consequently, proteins used for growth and reproductive development are not synthesized. Recent research has shown that bensulfuron methyl is a potent growth regulator with great potential to reduce or regulate hydrilla growth and reproduction at relatively low application rates. Anderson and Dechoretz[3] reported that vegetative growth of monoecious hydrilla was reduced by early post-emergent applications of bensulfuron methyl at 0.01 mg/L or less. Tuber production also was decreased when established hydrilla was exposed to 0.05 mg/L bensulfuron methyl. Duration of exposure required to produce these effects ranged from 7 to 21 days (Anderson, 1988). Langeland and LaRoche (1990) observed that bensulfuron methyl reduced growth of hydrilla at very low rates; however, concentrations of 0.10 mg/

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[3]Anderson, L.W.J. and N. Dechoretz. 1988. Bensulfuron methyl: A new aquatic herbicide. Proc. Aquatic Plant control. Misc. Paper A-88-5. U.S. Army Engineers Waterways Experiment Station, Vicksburg, MS., pp. 224-235.

L or higher, and longer exposure periods of 7 days or more were needed to control dioecious hydrilla in Florida. In the present investigation, we compared responses of monoecious and dioecious hydrilla to various bensulfuron methyl treatments over a period of 6 months. Our main objectives were to determine the duration of the growth regulating activity of bensulfuron methyl, and possible differential responses between monoecious and dioecious hydrilla to this herbicide in terms of tuber formation.

MATERIALS AND METHODS

Monoecious and dioecious hydrilla plants used in this study were obtained from stock cultures grown over a period of several months in outdoor aquaria. The monoecious hydrilla was established initially from tubers collected from the Potomac River in Virginia. Dioecious hydrilla was established initially from stem apexes from Rodeo Lake in Davie, FL.

The investigation was conducted in 24 outdoor tanks located on the grounds of the Fort Lauderdale Research and Education Center, University of Florida in Fort Lauderdale. The tanks were 0.8 m wide by 2.2 m long (surface area of 1.7 × 10^{-4} ha) and filled with pond water to a depth of 0.6 m. Pond water was from the same source as described previously (Van and Steward, 1986). Uniform low water pressure was maintained by constant overflow in a standpipe, and flow to individual tanks was regulated by small petcock valves to provide one water volume change every 24 h. The herbicide treatments (concentrations × biotypes) were arranged as a 4 × 2 factorial with three replicates, and were assigned to the tanks in a complete randomized design.

Hydrilla tubers of both biotypes were allowed to germinate in pond water at 25 C under continuous light for 3 weeks before planting. Ten sprouted tubers, 10 cm long, were planted in plastic pans 26 cm wide by 30 cm long and 15 cm deep. The pans were filled with a rooting medium consisting of approximately 12 kg of sandy loam (60% sand, 26% silt, 14% clay) enriched with 10 g of a slow release fertilizer.[4] Four pans of a given hydrilla biotype were placed in each tank and the plants were allowed to grow for 2 weeks prior to herbicide treatment. On 19 December 1989, water flow to individual tanks was stopped, and bensulfuron methyl was applied to the tanks at concentrations of 0, 0.05, 0.10, and 0.20 mg/L. The plants were exposed to the bensulfuron methyl for 4 weeks, after which water exchange was resumed. At the end of 1, 2, 4, and 6 months after herbicide application, one pan of each biotype from each tank was harvested. The harvested biomass was partitioned into shoots, roots, and tubers, and oven dried at 70 C to a constant weight. Data for dry weights and tuber numbers were subjected to analysis of variance using a split plot model with herbicide treatments as main plots and harvest dates as subplots. Because of significant herbicide concentration by plant biotype interactions ($P<0.05$), the model was reduced and data for the two biotypes were analyzed separately. Regression analyses of various plant responses over time were then performed for each biotype.

[4]Sierrra (17-6-10) with an 8- to 9-month release time is manufactured by Sierra Chemical Company, Milpitas, CA 95035. Mention of a trademark or a proprietary product does not constitute a guarantee or warranty of the product by the USDA or the University of Florida and does not imply its approval to the exclusion of other products that also may be suitable.

RESULTS AND DISCUSSION

Plant dry weight of untreated hydrilla increased according to a third order polynomial, and reached a maximum weight of 91 and 104 g per pan after 4 months of growth for monoecious (Figure 1a) and dioecious (Figure 1d) hydrilla, respectively. Severe plant damage, including shoot tip reddening and whole plant necrosis, was observed 2 weeks after exposure of hydrilla to all bensulfuron methyl treatments. Growth of both hydrilla biotypes exposed to this herbicide was suppressed for approximately 2 months, resulting in more than 90% reduction in plant dry weight in all application rates as compared to untreated plants at the second harvest in February. These results are consistent with an earlier report by Anderson (1988) of excellent initial herbicidal effect after 1 and 2 months. Subsequent harvests from the same herbicide treatments, however, revealed various levels of regrowth depending on different treatment rates. For monoecious hydrilla, regrowth was most heavy in the 0.05 mg/L treatment rate, and plants recovered completely after 6 months based on dry weight measurements (Figure 1a). The 0.10 mg/L treatment reduced plant dry weight of approximately 20% after 6 months, while sustained low levels of biomass were observed only in the 0.20 mg/L treatment rate over the entire study period.

Bensulfuron methyl also suppressed tuber formation in both monoecious (Figure 1b) and dioecious (Figure 1e) hydrilla at virtually all concentrations tested. The suppression level of tuber formation was often much greater than the corresponding reduction of plant biomass exhibited by the same bensulfuron treatment, suggesting that the inhibition of tuber formation was independent from a general retardation of plant growth. For example, tuber production in monoecious hydrilla treated at 0.10 mg/L bensulfuron methyl was reduced by as much as 79% after 6 months (Figure 1b) when no more than a 20% loss in plant weight was observed (Figure 1a). The growth regulating effect of tuber inhibition also appeared to persist long after the plants had recovered from the initial herbicidal effects. The duration of effect of tuber suppression increased with increasing treatment rates. In monoecious hydrilla, tuber formation was suppressed for a period of approximately 3, 4, and 6 months in the 0.05, 0.10, and 0.20 mg/L treatments, respectively (Figure 1b). As a result, tuber formation in monoecious hydrilla was reduced by 79% in the 0.10 mg/L treatment, and 97% in the 0.20 mg/L treatment after 6 months. Tuber formation in the 0.05 mg/L treatment also was reduced by 80% after 4 months, but tubers were formed rapidly from April to June, so that total tuber weight produced after 6 months reached similar values as the tuber weight in untreated plants (Figure 1b). The ability of monoecious hydrilla to form tubers during the summer months in South Florida was consistent with an earlier report by Sutton et al. (1992). An interesting result was the

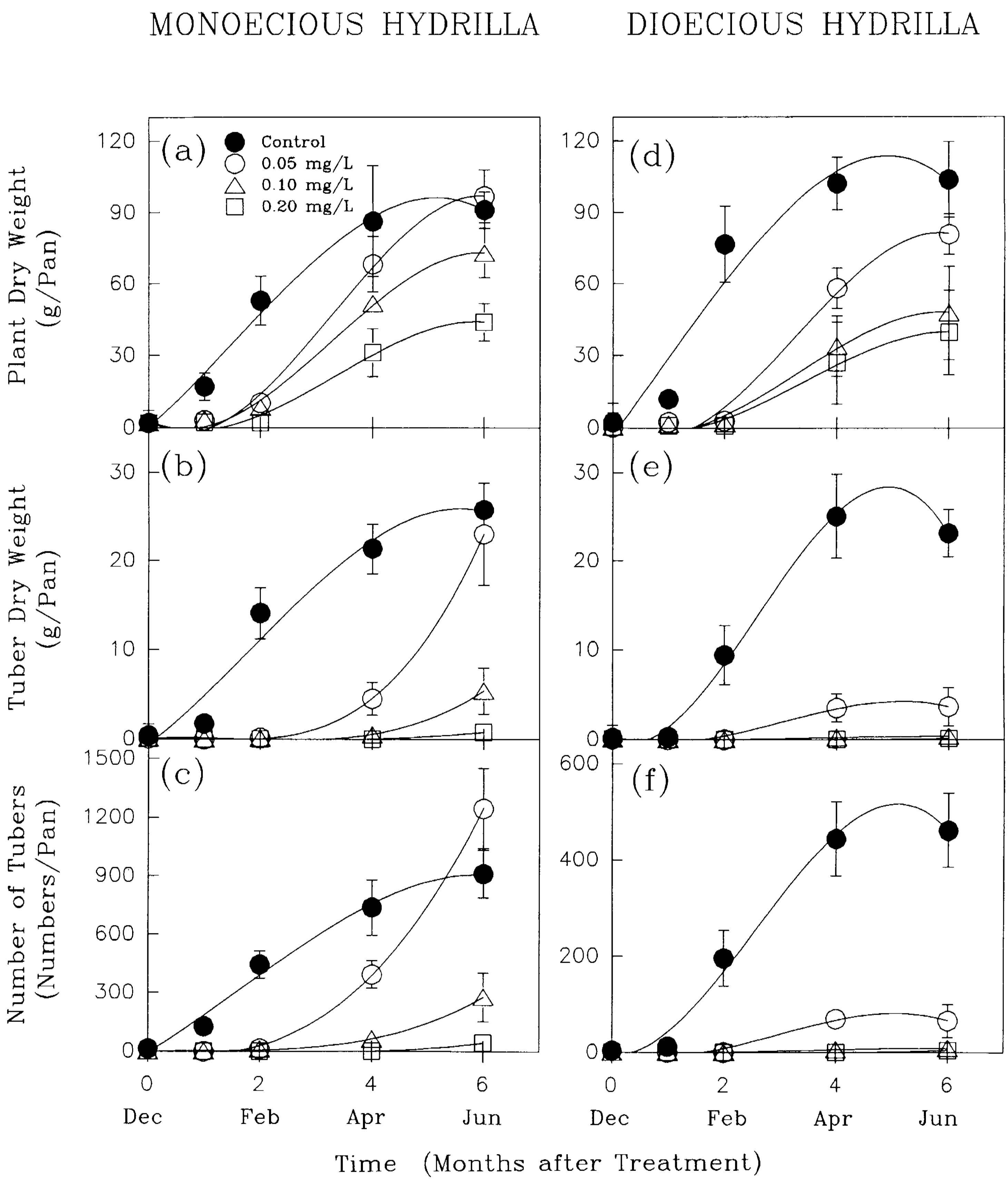

Figure 1. Effects of various bensulfuron treatment rates on vegetative growth and tuber production in monoecious and dioecious hydrilla grown in outdoor tanks over a period of 6 months from December 89 to June 90 in South Florida. The curves represent best fitted polynomial regression equations. Vertical lines indicate means ± 1 standard deviation.

apparent stimulation of tuber formation in monoecious hydrilla treated at 0.05 mg/L after 6 months based on measurements of number of tubers (Figure 1c). The tubers produced in the 0.05 mg/L treatment were much smaller, however significantly more tubers were formed, thus the total tuber weight in this treatment was similar to tuber weight in untreated plants (Figure 1b). Furthermore, laboratory tests indicated no differences in germinability between these smaller tubers collected from the bensulfuron methyl treatments and those from untreated plants (data not shown).

Untreated dioecious hydrilla began to form tubers 1 month after planting, reaching a maximum number of 444 tubers per pan in April (Figure 1f). Tuber production in dioecious hydrilla apparently ceased from April to June however, as the tuber curves remained flat during these summer months. This seasonal pattern of tuber production in dioecious hydrilla in Florida was consistent with earlier findings by Haller et al. (1976) and Sutton et al. (1992). In the 0.05 mg/L bensulfuron methyl treatment, tubers were formed from February to April, but again there was no evidence of tuber production from April to June (Figures 1e and 1f). As a result, tuber formation in dioecious hydrilla was still reduced by 84% or more after 6 months in all bensulfuron methyl treatment rates tested. These results suggest that proper timing of bensulfuron methyl applications according to the seasonal tuber production in dioecious hydrilla could increase the herbicide performance in this biotype.

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Potential Use of Bensulfuron Methyl for Sediment Application in Irrigation Systems in Australia[1]

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ABSTRACT

The use of bensulfuron methyl as a soil-residual herbicide in irrigation channels was investigated by treatment of empty channels about a week before the start of irrigation water flows in spring. Assessments in the late summer, some 4 to 5 months after treatment, showed poor control of common watermilfoil (*Myriophyllum papillosum*) Orchard, sp. nov.), fair control of elodea (*Elodea canadensis* Rich.), moderate control of ribbonweed (*Vallisneria gigantea* Graebner) and excellent control of floating pondweed (*Potamogeton tricarinatus* F. Muell. & A. Benn. ex A. Benn (1892)). Floating pondweed exhibited a 96% reduction in freshweight biomass 4 months after treatment with only 100 g/ha of bensulfuron methyl, and substantial control continued for at least 15 months. Even though plot length was limited (13 to 50 m) there was no evidence of plot-to-plot movement, suggesting that bensulfuron methyl is rapidly immobilized in sediment or weeds.

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