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Comparison of Torpedograss and Pickerelweed Susceptibility to Glyphosate

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ABSTRACT

Torpedograss (*Panicum repens* L.) is one of the most invasive exotic plants in aquatic systems. Repeat applications of (N-phosphonomethyl) glycine (glyphosate) herbicides provide limited control of torpedograss; unfortunately, glyphosate often negatively impacts most non-target native species that grow alongside the weed. This experiment studied the effect of glyphosate on pickerelweed (*Pontederia cordata* L.), a native plant that shares habitats with torpedograss. Actively growing plants of torpedograss and pickerelweed were cultured in 8-liter containers and sprayed to wet with one of four rates of glyphosate: 0%, 0.75%, 1.0%, or 1.5%. Each treatment included a surfactant to aid in herbicide uptake and a surface dye to verify uniform application of the treatments. All herbicide treatments were applied with a backpack sprayer to intact plants and to cut stubble of both species. Four replicates were treated for each species-rate-growth combination during each of two experiment periods. Plant dry weights 8 weeks after herbicide application suggest that torpedograss was effectively controlled by the highest rate of glyphosate applied to cut stubble. Pickerelweed was unaffected when the highest rate of glyphosate was applied as a cut-and-spray treatment. These data suggest that a cut-and-spray application of a 1.5% solution of glyphosate may be an effective strategy to control torpedograss without deleteriously affecting pickerelweed.

Key words: Panicum repens, Pontederia cordata, native plant, invasive plant, exotic species, non-target species.

INTRODUCTION

Wetlands play a critical role in the earth's ecological balance and act as a transitory region between aquatic and terrestrial ecosystems. These environmentally important areas provide habitat for wildlife and are an integral component of the global water cycle, as they facilitate storage of groundwater and often serve as biological filters (Mitsch and Gosselink 1986). A major dilemma in the stewardship of wetlands is the encroachment of exotic weeds. One of the most pervasive exotic species in wetland systems is torpedograss, a perennial grass found along the shorelines of lakes, ponds, ditches, and drainage canals in the southeastern United States (Godfrey and Wooten 1979). This rhizomatous species produces elongated surface runners that extend across water surfaces and quickly creates extensive monotypic colonies. Torpedograss was introduced to Florida as a forage crop but has little value as a livestock feed; in addition, the species has become one of the most invasive exotic plants in aquatic systems and its unchecked growth commonly crowds out native vegetation (APIRS 2003, Tarver 1979, Tobe et al. 1998).

Pickerelweed is a monocotyledonous perennial herb that frequently shares habitats with torpedograss and must compete with torpedograss for limited resources. This rhizomatous shoreline aquatic species is native to the United States and is found in marshes, swamps, ditches, streams, and shallow bodies of water throughout the southeastern United States and along the east coast from Florida north to Prince Edward Island and Ontario (Godfrey and Wooten 1979). Pickerelweed provides a refuge and habitat for many types of fauna. The flowers attract butterflies, skippers, and hummingbirds (Speichert and Speichert 2001). Florida apple snails (*Pomacea paludosa*) frequently use the sturdy emergent stems for ovipositioning (Turner 1996), while dragonflies and damselflies use the upright stems as perches to shed their final larval stage before reaching adulthood (Speichert and Speichert 2001). The fruit of pickerelweed is an important food source for ducks and small animals (Tobe et al. 1998). Lewis (2001) and Speichert and Speichert (2001) state that the fruits are edible; in addition, vegetative parts (e.g., leaves and stems) may be eaten by humans (Speichert and Speichert 2001, Taylor 1992).

Wetlands managers attempt to control the growth of exotic species like torpedograss with applications of herbicides, and one of the herbicides most commonly used for this purpose is glyphosate. Unfortunately, glyphosate is a broad-spectrum non-selective herbicide and often negatively impacts many of the non-target native species that grow alongside the weed; in addition, repeat applications of glyphosate-based herbicides are necessary to provide limited control of torpedograss (Shilling and Haller 1989, Smith et al. 1993). The goal of this study was to evaluate the effect of glyphosate on pickerelweed and to identify a glyphosate-based treatment that may control torpedograss without causing significant damage to pickerelweed.

MATERIALS AND METHODS

Plants were cultured in containers 21 cm in diameter and 26 cm in height (8 L) without drainage holes and irrigated with ca. 2.5 cm of pond water daily to maintain flooded conditions. Coarse builders' sand was used as a rooting substrate in all containers, and nutrition was supplied by the incorporation of 40 g of Osmocote Plus 15-9-12 (Scott's, Marysville, OH) per container. Each container was planted with either

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one rooted plant of pickerelweed obtained from the division of stock plants, or with four 2-node cuttings of torpedograss. Plants of both species were grown for ca. 6 weeks before herbicide application and were well-established and actively growing at the commencement of the study.

Rodeo® (Monsanto Co., St. Louis, MO) was selected for use as the source of glyphosate; this product is labeled for use in aquatic systems and contains the isopropylamine salt of glyphosate. Herbicide rates utilized in this study were chosen to reflect the manufacturer's low (0.75%), medium (1.0%), and high (1.5%) recommended label rates; in addition, a treatment with no glyphosate (0%) was used as a control. These treatment rates correspond to aerial broadcast rates of a low of 4.4 L per ha (60 oz per acre), a medium rate of 5.9 L per ha (80 oz per acre), and a high of 8.8 L per ha (120 oz per acre). Plants were sprayed to wet with one of the four rates of glyphosate. Each treatment included the surfactant Surf Aid (1.0%; Terra International, Inc., Sioux City, IA) and the surface dye Turf Trax (United Horticultural Supply, Greeley, CO) to provide visual confirmation of uniform treatment application.

In addition to the herbicide rate treatments outlined above, three plant growth treatments were examined in this study. The first plant growth treatment utilized intact plants of both species that were left undisturbed for 8 weeks after herbicide application. Regrowth potential was evaluated in the second plant growth treatment; intact plants of both species were treated with herbicide, then foliage was removed 4 weeks after application. Plants were allowed to resume growth in order to assess regrowth potential. The third plant growth treatment was designed to simulate a "cut-and-spray" technique and utilized cut stubble of both species; all vegetative growth above the soil line was removed manually using hand-held clippers ca. 1 hour before treatment and herbicide was applied to the exposed stubble.

All herbicide treatments were applied to intact plants and cut stubble of both species using a standard Solo® backpack sprayer (Solo, Inc., Newport News, VA). All plant material in each container was sprayed to wet. Two independent experiments were conducted following the same protocol; the first began on 2 June 2001, while the second commenced on 11 August 2001. Four replicates were performed for each species-rate-growth combination during each experimental period. The study was conducted as a randomized block design, with treatments randomized within rows (blocks). All living tissue was harvested 8 weeks after herbicide application; dry weights for root and live shoot biomass were obtained by drying plant material at 70 C until a uniform weight was achieved. Data were analyzed using the general linear model procedure and t-tests of SAS 8.1 (SAS Institute, Cary, NC). Sutton (1996) revealed that growth of torpedograss is affected by season, and we found this phenomenon to be true in this study as well. Seasonal differences were noted between Experiment 1 (started 2 June) and Experiment 2 (started 11 August) so data from each experiment were subjected to separate analyses; however, similar responses to treatments were noted during both experimental periods. All values presented are the mean dry weights per pot (pooled roots and live shoots biomass 8 weeks after herbicide application) of four containers of torpedograss or pickerelweed plants undergoing the same treatment during the same experimental period. Dry weights of plants subjected to the regrowth treatment include shoots removed 4 weeks after herbicide application, while dry weights of plants in the stubble treatments include shoots removed prior to herbicide application.

RESULTS AND DISCUSSION

Foliar Treatments

Intact plants of torpedograss used as controls produced an average of 666 g of dry biomass during Experiment 1, while plants treated with the low, medium, and high rates of glyphosate generated 144, 108, and 110 g of dry biomass respectively (Figure 1a, left sector). Similar trends were evident during Experiment 2. Torpedograss plants used as controls produced 578 g of dry biomass, while plants treated with the low, medium, and high rates of glyphosate generated 55, 18, and 17 g of dry biomass respectively (Figure 1b, left sector). In both experimental periods, control plants produced more dry biomass than plants treated with glyphosate, but no difference was evident among glyphosate rates in either experimental period.

Intact plants of pickerelweed used as controls produced an average of 340 g of dry biomass during Experiment 1, while plants treated with the low, medium, and high rates of glyphosate generated 193, 165, and 206 g of dry biomass respectively (Figure 2a, left sector). Similar trends were evident during Experiment 2. Pickerelweed plants used as controls produced 107 g of dry biomass, while plants treated with the low, medium, and high rates of glyphosate generated 18, 34, and 23 g of dry biomass respectively (Figure 2b, left sector). Control plants produced more dry biomass than plants treated with glyphosate during both experimental periods, but no difference was evident among glyphosate rates in either experimental period.

Regrowth Potential Following Foliar Treatments

Regrowth potential was evaluated by treating plants with herbicide at the beginning of the experimental period, then removing foliage 4 weeks after application. Plants were then allowed to resume growth in order to assess regrowth potential.

Plants of torpedograss used as controls produced an average of 472 g of dry biomass during Experiment 1, while plants treated with the low, medium, and high rates of glyphosate generated 153, 119, and 114 g of dry biomass respectively (Figure 1a, center). Similar trends were evident during Experiment 2. Torpedograss plants used as controls produced 341 g of dry biomass, while plants treated with the low, medium, and high rates of glyphosate generated 67, 37, and 29 g of dry biomass respectively (Figure 1b, center). In both experimental periods, control plants produced more dry biomass than plants treated with glyphosate, but no difference was evident among glyphosate rates in either experimental period.

Plants of pickerelweed used as controls produced an average of 254 g of dry biomass during Experiment 1, while plants treated with the low, medium, and high rates of glyphosate generated 222, 171, and 123 g of dry biomass respectively (Figure 2a, center). Pickerelweed plants used as controls during Experiment 2 produced 68 g of dry biomass,

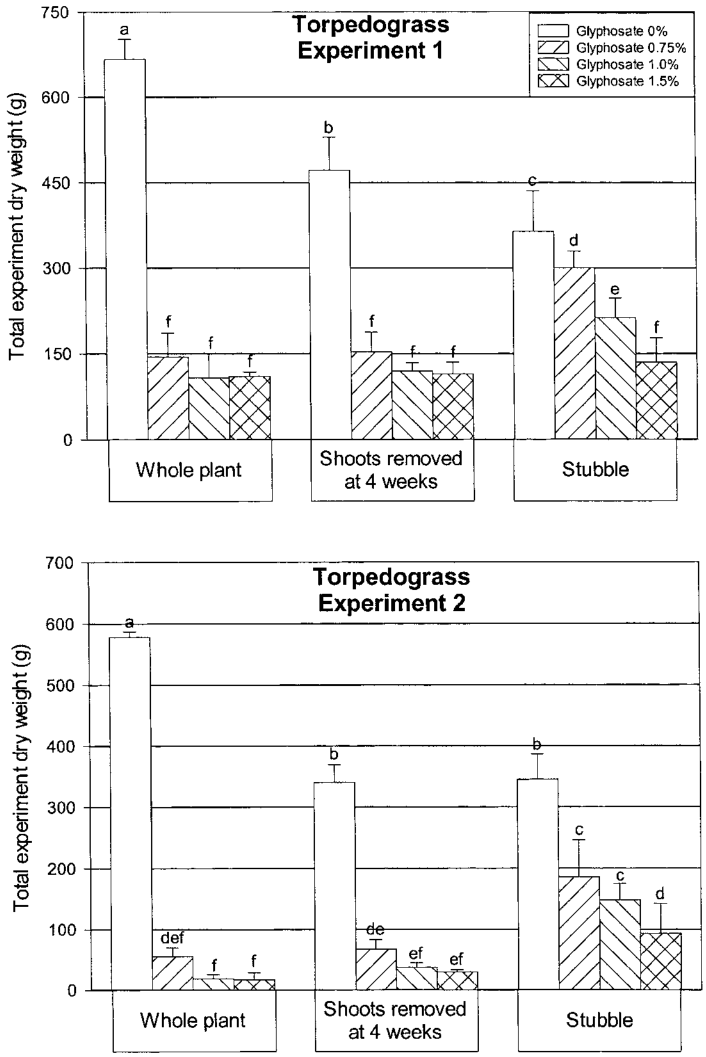

Figure 1. Total dry mass (g) of torpedograss 8 weeks after herbicide application. Bars represent the mean of four replicates of each treatment. Treatments coded with the same letter are not significantly different at $p < 0.05$. Fig. 1a: Experiment 1 (started 2 June 2001). Fig. 1b: Experiment 2 (started 11 August 2001).

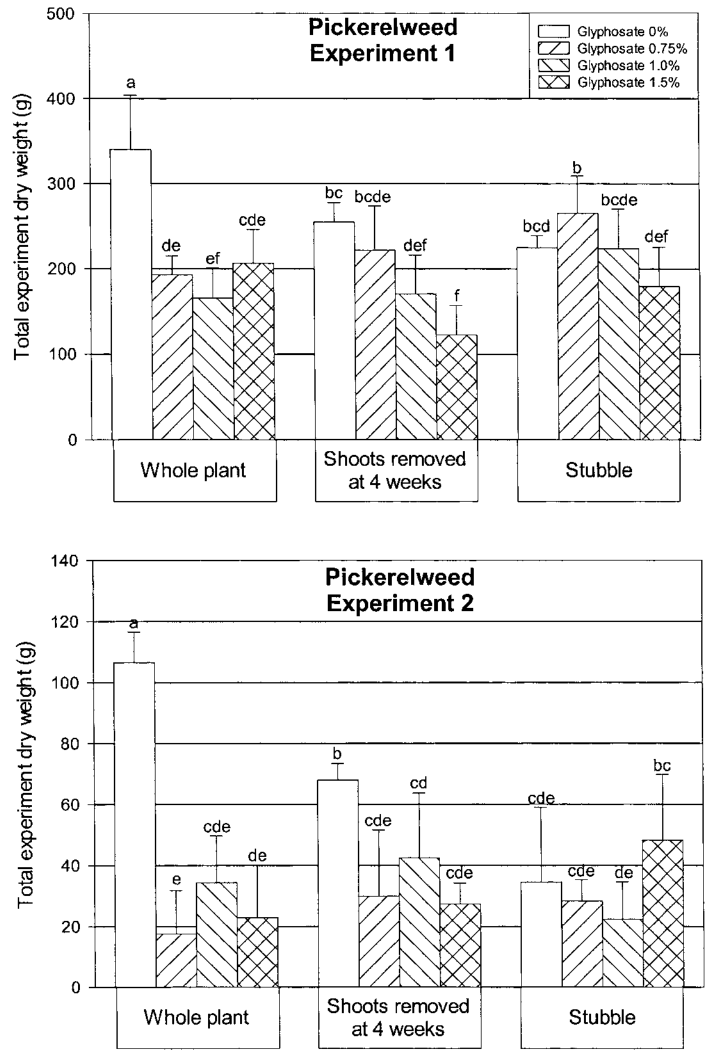

Figure 2. Total dry mass (g) of pickerelweed 8 weeks after herbicide application. Bars represent the mean of four replicates of each treatment. Treatments coded with the same letter are not significantly different at $p < 0.05$. Fig. 2a: Experiment 1 (started 2 June 2001). Fig. 2b: Experiment 2 (started 11 August 2001).

while plants treated with the low, medium, and high rates of glyphosate generated 30, 43, and 27 g of dry biomass respectively (Figure 2b, center). No difference was found between the control and low rate treatments during Experiment 1, but control plants produced more dry biomass than plants treated with the medium or high rates of glyphosate. There was no difference in Experiment 1 between plants treated with the low rate and those treated with the medium rate, and no difference was noted between plants treated with the medium rate and those treated with the high rate. Data from Experiment 2 showed that control plants produced more dry biomass than plants treated with glyphosate, but no difference was evident among glyphosate rates.

Cut-and-spray Treatments

The cut-and-spray procedure was accomplished by manually removing all vegetative growth above the soil line ca. 1 hour before treatment; herbicide was then applied to the exposed stubble. Stubble of torpedograss plants used as controls produced an average of 365 g of dry biomass during Experiment 1, while plants treated with the low, medium, and high rates of glyphosate generated 300, 212, and 135 g of dry biomass respectively (Figure 1a, right sector). Similar trends were evident during Experiment 2. Stubble of torpedograss plants used as controls produced 345 g of dry biomass, while plants treated with the low, medium, and high rates of glyphosate generated 186, 148, and 93 g of dry biomass respectively (Figure 1b, right sector). Control plants grown during both experimental periods produced more dry biomass than plants treated with glyphosate. In Experiment 1, stubble treated with the lowest rate of glyphosate produced more dry biomass than stubble treated with medium or high rates, and stubble treated with the medium rate generated more dry biomass than stubble treated with the high rate. During Experiment 2, no difference was found between stubble treated with the low and medium rates of glyphosate, but stubble treated with the high rate produced less dry biomass than plants subjected to the other rates of glyphosate.

Stubble of pickerelweed plants used as controls produced an average of 225 g of dry biomass during Experiment 1, while plants treated with the low, medium, and high rates of glyphosate generated 266, 224, and 180 g of dry biomass respectively (Figure 2a, right sector). Similar trends were evident during Experiment 2. Stubble of pickerelweed plants used as controls produced 35 g of dry biomass, while plants treated with the low, medium, and high rates of glyphosate generated 28, 22, and 48 g of dry biomass respectively (Figure 2b, right sector). No differences were noted among control plants and plants treated with any rate of glyphosate in either experimental period.

This study showed that growth of torpedograss was suppressed when glyphosate was applied at any label rate to intact plants; in addition, the herbicide prevented significant regrowth when treated foliage was removed 4 weeks after herbicide application. Unfortunately, negative responses to treatment were also noted in the desirable native species pickerelweed. This study revealed that application of the highest label rate of glyphosate to stubble of torpedograss also provided effective suppression of the weed, while growth of stubble of pickerelweed was unaffected by the same treatment. These results suggest that maximum control of torpedograss with minimum damage to pickerelweed is achieved when cut stubble of both species is sprayed with a 1.5% solution of glyphosate.

Smith et al. (1999) and Willard et al. (1998) found that application of high rates of glyphosate provided best control of torpedograss. These workers suggested the dense mats formed as a result of torpedograss colonization prevent adequate herbicide coverage and that high application rates are necessary to maximize the amount of glyphosate translocated to rhizomes of the species. The cut-and-spray treatment in our study removed foliage prior to herbicide application. This technique may have reduced the problems of incomplete and inadequate spray coverage associated with the dense vegetative growth of torpedograss, since the cut-and-spray treatment eliminated the leaf-rhizome translocation process and herbicide was applied directly to exposed rhizomes. Our study suggests that a cut-and-spray application of a 1.5% solution of glyphosate may be a useful management strategy in areas populated by both torpedograss and pickerelweed. The cut-and-spray treatment is labor-intensive and may not be practical on a large scale, but could have utility in high-value areas such as ornamental water gardens, golf course ponds, and created wetlands. Additional research is necessary to determine whether similar results may be obtained in other environments.

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