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Herbicide Evaluation for Control of Wild Taro

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INTRODUCTION

Wild taro (*Colocasia esculenta* (L.) Schott), is an exotic, emergent perennial that has established in many shallow-water wetlands throughout the southern United States. Although wild taro is a cultivated crop in many tropical and subtropical areas of the world, its invasion in riverine and lacustrine wetlands in the U.S. has resulted in the loss of habitat for native plant species. Once established, wild taro forms dense, monotypic stands that reduce the diversity of native vegetation, as has occurred in Louisiana, Florida, and Texas (Akridge and Fonteyn 1981, Simberloff et al. 1997). Akridge and Fonteyn (1981) reported that although wild taro is considered naturalized in south-central Texas, its present dominance along the San Marcos River has altered the native vegetational structure and dynamics of this river system. One of the concerns for using herbicides to remove wild taro, and thereby restore the native emergent plant community at this site, is the potential impact of chemical treatment to neighboring stands of Texas wild rice (*Zizania texana* Hitchc.), a federally listed endangered plant that grows exclusively in the San Marcos River.

Restoration and preservation of native plant communities in conjunction with chemical management practices are achievable goals. Recent research on the use of herbicides to selectively control nuisance, exotic species has demonstrated that aquatic herbicides can be safely used to remove a target species with minimal harm to non-target communities (Getsinger et al. 1997, Netherland et al. 1997, Petty et al. 1998). Little information is available on the use of currently labeled aquatic herbicides for control of nuisance populations of wild taro. Moreover, the non-target effects of herbicide application on Texas wild rice are also unknown. The objective of this study was to evaluate the efficacy of four aquatic herbicides for control of wild taro.

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MATERIALS AND METHODS

The study was conducted in large, outdoor tanks located at the U.S. Army Engineering Research and Development Center, Waterways Experiment Station, Vicksburg, MS. Wild taro plants were collected from Florida and transplanted into 7.6-L plastic pots (one plant per pot) filled with a potting soil-sand mixture amended with Osmocote® plant fertilizer. Potted plants were placed into large outdoor tanks (75 cm tall by 122 cm diameter) and water was added to the tanks to a depth sufficient to cover the soil surface with 3 to 5 cm of water. Plants were allowed to grow for 1 month prior to chemical treatment. Water was added to the tanks as needed to maintain saturated soil conditions.

The aquatic herbicides evaluated in this study included: diquat (Reward®), 2,4-D (2,4-D 4 Amine IVM®), triclopyr (Renovate®), and glyphosate (Rodeo®). Each herbicide was applied as a 1- and a 2% solution based on a total spray volume of 935 L ha^{-1} (100 gal $acre^{-1}$), using a CO_2-pressurized backpack sprayer equipped with a hand-held, single-nozzle spray boom. All herbicide rates were within the maximum label rate of application for use on emergent vegetation in aquatic sites using hand-held equipment. A non-ionic surfactant approved for aquatic use (X-77®), was added to all spray mixtures at a rate of 0.25% volume:volume. At the time of treatment, potted plants of equal size (50 to 60 cm height with 3 to 4 mature leaves per plant) were selected and removed from tank cultures for herbicide treatment. After herbicide application and when plant surfaces were dry, the treated plants were replaced in the large tanks for post-treatment monitoring. Treatments were arranged in a randomized block design (a tank consisted of a block) with 4 replicates.

Visual ratings of herbicide injury were recorded at 1, 2, 3, and 4 weeks after treatment (WAT) and were assessed on a 1 to 9 scale where 1 = death or necrosis of all plant tissues; 2 = severe damage, 75% stand kill; 3 = severe injury on 50% of plant tissues; 4 = distinct symptoms, more severe than 5; 5 = visible symptoms with possible reduction in biomass; 6 = clear symptoms, may not affect overall biomass; 7 = mild symptoms, acceptable appearance; 8 = very mild symptoms, suggestion of effect; 9 = no visible injury. Plant stunting, discoloration, wilting, plant deformity, and necrosis were considered when making the visual injury rating. Changes in injury ratings over time may also reflect plant regrowth. Remaining live shoot (leaves, stems, and stolons) and root (roots and corms) biomass were harvested 6 WAT, dried to a constant weight at 70C, and dry weights recorded. Data were subjected to analysis of variance and treatment means were separated using the Waller-Duncan K-ratio T test procedure.

RESULTS AND DISCUSSION

Results showed that both application rates of triclopyr, 2,4-D, and glyphosate provided complete control of wild taro above- and below-ground biomass 6 WAT (Table 1). Although diquat significantly reduced shoot and root biomass by as much as 87 and 79%, respectively when compared with untreated plants, it did not provide complete control of the plants. There were no differences between the two diquat rates of application.

Symptoms of herbicide injury were noted one week after application with all chemical treatments (Table 1). Petiole bending and twisting (epinasty) and leaf necrosis were noted on plants treated with 2,4-D and triclopyr and are characteristic symptoms for growth regulator-type herbicides. Herbicide injury was least severe with glyphosate 1 WAT but by the next evaluation period, injury ratings decreased indicating increased chemical activity. Treatment with diquat provided immediate necrosis of aboveground plant tissues by 1 WAT which is a typical response from a contact herbicide however, new, healthy aboveground plant tissues regrew from surviving corms by 3 WAT. In terms of visual symptoms of herbicide injury, plants treated with the higher rate of diquat (2% solution) recovered more slowly than those treated with the low rate.

In conclusion, the results of this evaluation showed that a 1% solution of either 2,4-D, triclopyr, or glyphosate was sufficient to eliminate shoot and root biomass of wild taro under these experimental conditions. Treatments with diquat were unsuccessful for long-term control due to regrowth from surviving underground plant tissues. Since a federal permit for conducting experimentation with an endangered species using herbicides has not been granted at this time, the direct effect of these herbicide treatments on Texas wild rice has yet to be investigated. It should be noted, that two of the active ingredients evaluated in this study, 2,4-D and triclopyr, are registered for post emergence broadleaf weed control in agricultural rice (*Oryza sativa*) production (Meister Publishing 1998). Moreover, 2,4-D has little to no activity against established grasses (Weed Science Society of America 1994), but can be effective on some aquatic, broad-leaved monocot species such as waterhyacinth (*Eichhornia crassipes* (Mart.) Solms) (Gopal 1987). Triclopyr is also used to selectively control weeds in many grass crops. Although Texas wild rice and cultivated rice varieties are classified within different genera, both are members of the grass family (Gramineae). It is likely that 2,4-D and triclopyr could be utilized for wild taro management with minimal impact to adjacent stands of Texas wild rice. Glyphosate, on the other hand, is a broad-spectrum herbicide that may pose a greater hazard to non-target vegetation. It should be noted however, that herbicide applications for controlling emergent vegetation (e.g., wild taro) are usually sprayed onto the foliage above the water line with little chemical lost to the water itself (Joyce and Ramey 1986). Therefore proper herbicide application should pose little hazard to submersed vegetation. Leaves, stems and stolons of Texas wild rice grow completely submerged in 0.3 to 2.0 m of flowing water, with only the inflorescences emerging above the water surface (Terrell et al. 1978). Timing herbicide application for control of wild taro prior to flowering of Texas wild rice, would minimize the risk of non-target chemical injury to emergent plant tissues. Further evaluation is required to confirm the tolerance of Texas wild rice to herbicide applications. The use of selective herbicides for preserving threatened plant species through elimination of aggressive, exotic competitors that share the same habitat should be a management priority.

TABLE 1. HERBICIDE INJURY AND SHOOT AND ROOT BIOMASS OF WILD TARO FOLLOWING TREATMENT WITH FOUR AQUATIC HERBICIDES.[1]

		Dry weight biomass, g (+ S.E.)					
		Shoot	Root	Herbicide injury			
Treatment[2]	Rate[3] kg ae ha^{-1}	6 WAT	6 WAT	1 WAT	2 WAT	3 WAT	4 WAT
Untreated Control	0	38.2 (5.1) a	70.4 (9.2) a	9.0 a	8.5 a	9.0 a	9.0 a
1% Diquat	4.2 (ai)	5.1 (2.7) b	14.8 (6.7) b	2.0 c	1.5 c	8.3 a	9.0 a
2% Diquat	8.4 (ai)	9.8 (2.2) b	23.5 (5.5) b	1.3 d	1.5 c	6.6 b	8.8 b
1% 2,4-D	4.3	0.0 c	0.0 c	2.3 c	1.5 c	1.0 c	1.0 c
2% 2,4-D	8.5	0.0 c	0.0 c	2.0 c	1.0 d	1.0 c	1.0 c
1% Triclopyr	3.4	0.0 c	0.0 c	2.0 c	1.0 d	1.0 c	1.0 c
2% Triclopyr	6.7	0.0 c	0.0 c	2.0 c	1.0 d	1.0 c	1.0 c
1% Glyphosate	4.5	0.0 c	0.0 c	5.5 b	2.0 b	2.0 c	1.0 c
2% Glyphosate	9.0	0.0 c	0.0 c	5.0 b	2.0 b	1.5 c	1.0 c

[1]Data shown are means of four replicates. Comparable means in a column followed by the same letter are not significantly different at $\alpha = 0.05$ according to the Waller-Duncan K-ratio T test. Herbicide injury based on a 1 to 9 scale: 1 = death of all plant tissues and 9 = no visible injury. WAT = Weeks after treatment.
[2]Rate of application as percent solution based on a total spray volume of 935 L ha^{-1}.
[3]Rate in terms of kg ha^{-1} as the acid equivalent (ae) or active ingredient (ai). For diquat, the active ingredient is reported as diquat dibromide salt.

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