Best Management Practices (BMP's) for *Rotala* and *Nymphoides* Control

Atul Puri and W.T. Haller
UF/IFAS Center for Aquatic and Invasive Plants

FWC Task 155

Annual Report
June 2010

Abstract:

Studies were conducted in mesocosms as well as in South Florida canals to develop best herbicidal management programs for *Nymphoides indica* and *Rotala rotundifolia*. Treatments included imazamox (50, 100, 200, 400 ppb), endothall (0.25, 0.5, 1.5 and 2.5 ppm), triclopyr (0.5, 1, 2, 2.5 ppm), flumioxazin (50, 100, 200, 400 ppb) and UF-20 (25, 50, 100, 200 ppb). For *N. cristata*, endothall was the most effective herbicide and gave 98-100% control at 1.5 and 2.5 ppm. UF-20 at 100 and 200 ppb gave 82 and 93% control, respectively. Flumioxazin was also effective at higher doses of 200 and 400 ppb and gave 82 and 87% control of *Nymphoides*, respectively. Tryclopyr and imazamox were the least effective treatments and even maximum labeled rate of tryclopyr (2.5 ppm) gave only 55% control. Results of field trial were similar. Submersed treatments of endothall at 2-3 ppm gave about 80-90% control 8 WAT. Other herbicide treatments were not effective in controlling this weed species. For *R. rotundifolia*, triclopyr was the most effective herbicide in the mesocosm experiments. Triclopyr was the most effective herbicide in the mesocosm experiments Triclopyr @ 1 or 2 ppm provided 100% control of *R. rotundifolia.* 2,4 D @ 1 ppm gave 93% and at 2 ppm provided 99% control and diquat @ 400 ppb provided 80% control. 2, 4 D was also effective at higher doses of 200 and 400 ppb and gave 82 and 87% control of *Nymphoides*, respectively. Other herbicide treatments were not effective in controlling this weed species.

Introduction:

In the past decade, *Nymphoides* and *Rotala* have escaped the ornamental plant trade and become established in South Florida canals. The native *Nymphoides* species are usually found in shallow wetlands and littoral areas of lakes and never considered a problem. Roundleaf toothcup (*Rotala rotundifolia*) is an emergent perennial aquatic plant from Southeast Asia, where it grows as a weed in rice paddies and wet soils. It was first introduced to the United States as an ornamental aquatic pond plant. With purple flowers and rounded emergent leaves, it is a favorite of the aquarium and water garden industries. However, in last 2 to 3 years, escaped populations of this aquatic plant have been found in Northwest Alabama and throughout south Florida (USGS Non-indigenous Aquatic Nuisance Species Database; USDA Plants Database). Based on the native distribution of the plant in Southeast Asia, roundleaf toothcup currently occupies a very small percentage of its potential ecological range in the United States. It is expected that the plant

would grow well in coastal communities throughout the southeastern U.S. from Virginia to Florida, and west to Texas.

Rotala is a fast growing plant which grows about 4 to 5 inches per week. Once the plant reaches the top of the water, it grows across the surface and quickly shades out the native aquatic vegetation. It requires high sunlight and CO_2 concentrations for optimum growth. Roundleaf toothcup belongs to the family Lythraceae that encompasses about 21 genera and 500 species. The family is mainly tropical but has a number of temperate members. Purple loosestrife (*Lythrum salicaria*) which is a troublesome invasive weed in the United States also belongs to the same family. Thus roundleaf toothcup has the potential to invade sites in the southeastern United States. In Florida, plants display both terrestrial and aquatic growth forms and produce many small seeds within capsules. Although little is known about the biology of roundleaf toothcup, the ability of the plant to reproduce from vegetative fragments, and its ability to produce seeds, further raises concerns about its potential invasiveness.

The snowflake or crested floating-heart (*N. cristata*), which arrived from Asia in the past 6 years, is also spreading through Florida. *N. cristata* has become a serious weed problem in the south Florida canals. Its heart-shaped leaves float on the water surface and five-petaled white flowers rise on little stalks above the leaves. A white ruffle lining the middle of each petal distinguishes the plant from the two natives in the same genus. The introduced species may look just as lovely, but it quickly covers the water surface with a canopy of its leaves and shades out the native plants underneath. The exotic *N. indica* and *cristata* are widely sold in the nursery and water garden trade. Of these, *N. cristata* is very aggressive and is rapidly spreading in southern Florida. It occurs in South Florida canals, storm water treatment areas, several central Florida canals and north into South Carolina, in the Santee-Cooper reservoir.

Rotala grows submersed and emergent similar to hygrophila. *N. cristata* roots into the hydrosoil and produces numerous small floating leaves on the water surface. Most of the plant biomass is below the water surface, so foliar applications have had only limited success.

Objectives:

To develop and disseminate Best Management Practices (BMP's) for control of *Nymphoides cristata* and *Rotala rotundifolia* in Florida.

Methodology:

Studies have been conducted at the Center for Aquatic and Invasive Plants (CAIP), University of Florida, Gainesville, FL. *N. cristata* plants were planted in 30 cm diameter plastic pots filled with 2/3 potting media covered with 1-2 inches of sand. After one month, these plants were transferred to 900 L concrete vaults (two pots per vault) each vault serving as a replication. Treatments included imazamox (50, 100, 200, 400 ppb), endothall (0.25, 0.5, 1.5 and 2.5 ppm), triclopyr (0.5, 1, 2, 2.5 ppm), flumioxazin (50, 100, 200, 400 ppb) and UF-20 (25, 50, 100, 200 ppb). Visual injury ratings were taken 2 weeks after treatment (WAT) and 6 WAT. Plants were

harvested 8 WAT and above ground biomass was determined as dry wt/plant. Plants were dried for 1 wk, weighed, and statistically analyzed for treatment differences.

Young roundleaf toothcup plants were planted in 30 cm diameter plastic pots filled with 2/3 potting media covered with 1-2 inches of sand. The plants were initially very slow in growth. After 4-5 months, these plants were transferred to 100 L tubs for treatment with different aquatic herbicides. Herbicides treatments included submersed application of triclopyr at 250, 500, 1000, 2500 ppb; UF-17 at 200, 400, 800, 1600 ppb; endothall at 250, 500, 1000, 2500 ppb; flumioxazin at 50, 100, 200, 400 ppb; diquat at 50, 100, 200, 400 ppb; and 2,4-D at 250, 500, 1000, 2000 ppb. Plants were harvested 10 WAT and above ground biomass was determined as dry wt/plant. Plants were dried for 1 wk, weighed, and statistically analyzed for treatment differences.

Results and Discussion:

The effect of herbicides in the mesocosm study was evaluated by visual estimates (% control) and dry weight analysis on *N. cristata* (Tables 1 and 2). Endothall was the most effective herbicide and gave 98-100% control at 1.5 and 2.5 ppm. UF-20 at 100 and 200 ppb gave 82 and 93% control, respectively. Flumioxazin was also effective at doses of 200 and 400 ppb and gave 82 and 87% control of *Nymphoides*, respectively. Tryclopyr and imazamox were the least effective treatments and even the maximum labeled dose of tryclopyr (2.5 ppm) gave only 55% control. Submersed treatments of endothall at 2 to 3 ppm gave about 80-90% control 8 WAT. Other herbicide treatments were not effective in controlling the *Nymphoides* species.

Table 1: Visual Injury symptoms at 2 and 6 WAT of *Nymphoides cristata* after application of herbicides; 0 %- No control, 100%: total death.

Herbicides	Rate	2WAT	6WAT
Imazamox	50ppb	12.5±2.5*	42.5±2.5
	100ppb	15±5	52.5±2.5
	200ppb	15±5	67.5±2.5
	400ppb	17.5±7.5	77.5±2
Endothall	0.25ppm	52.5±2.5	77.5±2.5
	0.5ppm	72.5±2.5	92.5±2
	1.5ppm	92.5±2.5	98.5±1.5
	2.5ppm	98.5±0.5	100±0
Flumioxazin	50ppb	25±0.5	52.5±2.5
	100ppb	52.5±2.5	62.5±2
	200ppb	72.5±2.5	82.5±1.5
	400ppb	80±0.5	87.5±2.5
Triclopyr	0.5ppm	0	22.5±2
	1ppm	12±2.5	35±5
	2ppm	20±0.5	42.5±7.5
	2.5ppm	32.5±2.5	55±5
UF-20	25ppb	20±0.5	65±5
	50ppb	27.5±2.5	77.5±2.5
	100ppb	31±1	82.5±2
	200ppb	42.5±2.5	92.5±1.5

* Mean values presented with standard error

Table 2: Effect of herbicides on dry weight of *N. cristata* 8 weeks after treatment in concrete tanks

	Rate (mg/L)	Dry wt 8-WAT[1]
Untreated		50 ± 4
Triclopyr	2.50[2]	28 ± 4
Imazamox	0.40[2]	12 ± 1
Flumioxazin	0.40[2]	12 ± 3
Topramazone	0.20[2]	2 ± 0.3
Endothall	0.25	27 ± 1
Endothall	0.50	9 ± 1
Endothall	1.50	0
Endothall	2.50	0

[1] Mean values with standard error
[2] Maximum rate if each herbicide tested

The effects of herbicdes on Rotala plants is presented in Table 3. Plants were harvested at 10 weeks after treatment to evaluate the effects of these herbicides on *R. rotundifolia.* ANOVA and regression analysis were utilized to determine rate effects of all the herbicides and make treatment comparisons. Conclusions from these studies are as follows:

- Triclopyr @ 1 or 2 ppm provided 100% control *R. rotundifolia*
- 2,4 D @ 1 ppm gave 93% and at 2 ppm provided 99% control
- Diquat @ 400 ppb – 80% control
- Endothall, flumioxazin, UF-17 are not effective in controlling *Rotala rotundifolia*

Future Studies:

Field trials in South Florida canals infested with *Nymphoides* and *Rotala* treatments are planned for the this summer. We will evaluate the herbicides which looked most promising in the greenhouse studies. All summarized data will be published in Aquatics Magazine and made available as a BMP manual on appropriate websites, such as UF/EDIS, and FWCC websites. Studies will be conducted on roundleaf toothcup for sensitivity to all registered aquatic herbicides, different tank mixture of contact and systemic herbicides. A *Rotala* plot (1/2 acre) was treated with 2 ppm triclopyr at East Connty Water Control District on May 18th, 2010. *R. rotundifolia* is spreading in this canal system and additional studies are planned.

Table 3: Dry weight of *Rotala rotundifolia* at 10 WAT (weeks after treatment) after application of herbicides; 0 %- No control, 100%: total death.

Herbicides	Rate	10 WAT
Untreated	0	6.5±1.2
UF-17	200ppb	6.5±0.7
	400ppb	6.2±0.8
	800ppb	4.5±0.9
	1600ppb	4.5 ± 0.8
Endothall	0.25ppm	5.9±0.5
	0.5ppm	5.6±0.5
	1.0ppm	5.2± 1.2
	2.5ppm	3.2± 0.8
Flumioxazin	50ppb	6.0±0.6
	100ppb	5.7±0.5
	200ppb	5.4 ± 0.5
	400ppb	4.2 ± 0.4
Triclopyr	0.25ppm	4.2 ± 0.2
	0.5ppm	1.4 ± 0.2
	1.0ppm	0.1 ± 0.2
	2.0ppm	0
Diquat	50ppb	5.8±0.3
	100ppb	4.4±0.7
	200ppb	1.7 ± 0.4
	400ppb	0.7± 0.4
2, 4- D	0.25ppm	3.2±0.5
	0.5ppm	2.1±0.3
	1.0ppm	0.6 ± 0.2
	2.0ppm	0.1 ± 0.2

* Mean values presented with 95% confidence interval.