Aquatics

Fall 2001

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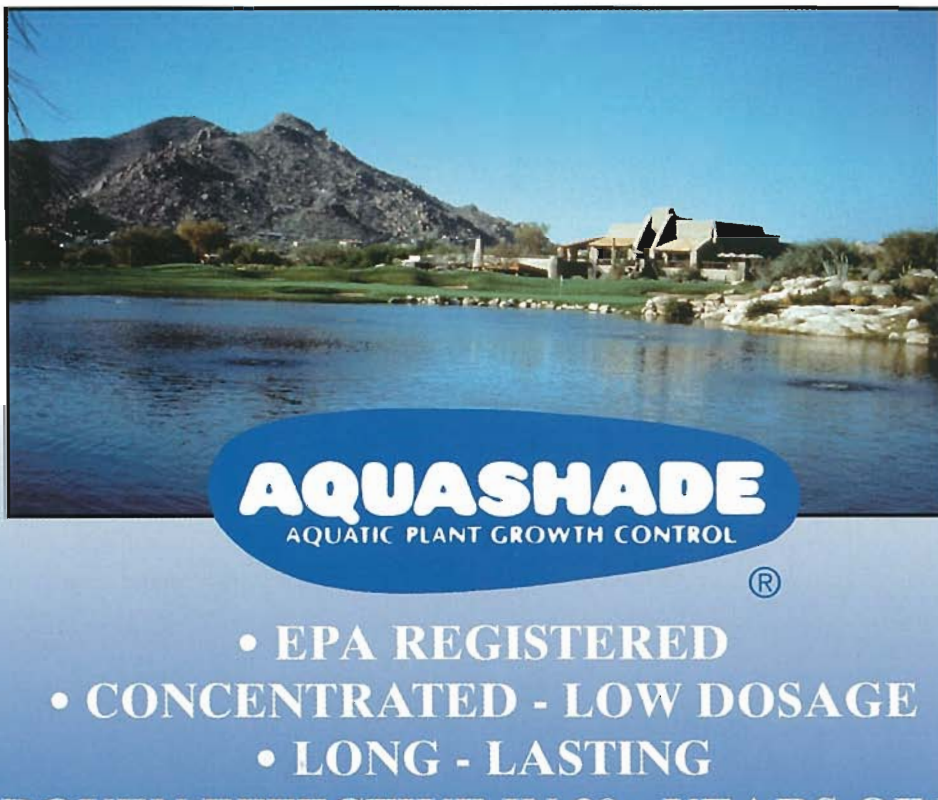

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Aquatics

Fall 2001 / Vol. 23, No. 3

Editorial

Recent events such as our extraordinary drought, detection of tolerant hydrilla, greater state and national awareness of invasive species, record low floating plant levels, and record high funding levels, add up to remarkable times for Florida's natural resources and those who manage them. It is under these circumstances that the Florida Department of Environmental Protection's (DEP) Invasive Plant Management funding programs enter new management opportunities. On July 1, 2001, nearly $30 million became available for DEP's invasive (upland and aquatic) plant management program through the Florida Forever Act.

The Upland Invasive Exotic Plant Management Program has a FY 2001-2002 budget of approximately $7 million for control of plants like Brazilian pepper, melaleuca, climbing fern, and more than 140 other recognized weeds on Florida's public conservation lands. One million dollars is mandated for melaleuca control, and because of work started in 1991 by DEP and the South Florida Water Management District, melaleuca is now an "endangered" species in Lake Okeechobee and the water conservation areas where it once infested many thousands of acres!

The Aquatic Plant Management Program has a FY 2001-2002 budget of approximately $23 million. With this funding, aquatic plant managers will continue to keep floating plants at maintenance levels, intensify hydrilla control, expand the management of EPPC Category I aquatic species such as torpedograss, and participate with the Florida Fish and Wildlife Conservation Commission on habitat improvement projects. Also, managers from the upland and aquatic programs can now coordinate control of plants infesting both wet and dry habitats, such as climbing fern in Fisheating Creek.

FAPMS members should be proud of their integral role in the management of Florida's invasive plants, especially since many now wear two hats, one "in the water" and one "on land." FAPMS' 25-year hallmark is its educated, skilled, enthusiastic, and dedicated members. Because of our collective efforts during the past 25 years, we are now better equipped, financially and logistically, to confront Florida's invasive plant challenges.

P.S. Look for a future article in *Aquatics* about the Upland Invasive Plant Management Program.

Judy Ludlow

FAPMS Website:
www.homestead.com/fapms/main.html

Lake Tsala Apopka in early fall. Photo by Jim Kelley

Contents

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Discussion of Fluridone "Tolerant" Hydrilla

Gregory E. MacDonald, Michael D. Netherland and William T. Haller


Photo by David Tarver

Since the beginning of aquatic weed control with herbicides, aquatic plant managers have never had to confront herbicide tolerance or resistance. However, this is an all-too-common phenomenon for weed scientists in traditional row crop agriculture. It is also a major problem for entomologists in the case of insecticides, and plant pathologists in the case of fungicides. In fact, the development of resistance or tolerance is routinely considered when developing pest management strategies. Since this is a recent phenomenon in aquatic situations, it is our intent to discuss the development of weed/herbicide tolerance in general and to introduce you to the occurrence of increased fluridone tolerance by hydrilla.

Plants in the aquatic environment respond in three ways to a herbicide application: 1) those that are susceptible are controlled or killed by an application of the herbicide; 2) those plants not controlled by a normal application of a herbicide, but killed at higher rates (considered tolerant) and; 3) those plants that are not controlled by very high application rates (considered resistant). These three responses are the basis of selectivity where selectivity is based upon herbicide application rates. For example, while hydrilla is typically controlled with 6-10 ppb fluridone, Illinois pondweed or vallisneria are not.

Sometimes, an individual plant or group of plants within a species tolerates a lethal rate of a herbicide. These plants are referred to as a different "biotype" and often look identical to susceptible plants. Tolerance of these biotypes could be due to several factors including: 1) the tolerant biotype might not absorb as much herbicide; 2) it may not translocate the herbicide to a site of action; 3) it may detoxify (metabolize) the herbicide before it reaches the target site; or 4) a change in the target site may have occurred, preventing the herbicide from binding to the active site. No matter how this tolerance has occurred, the continued use of the same herbicide in the same areas will often result in selection and proliferation of the tolerant "biotype." In terrestrial weed management, crop managers can manage tolerant or even resistant weeds by using a herbicide with a different mode of action or use combinations of herbicides that the biotype cannot tolerate. However, in aquatic weed management we are limited in our choices of herbicide due to the few compounds registered for aquatic use. Furthermore, the unique properties of fluridone (use rates, water use restrictions, non-target impacts) allow for use patterns that are not possible with other currently registered compounds.

Examples of weed tolerance and resistance in terrestrial plants has been found to occur in about half of the 20-25 families of herbicides, including the triazines (simazine, atrazine), bipyridilluums (diquat), imidazolinones (imazapyr), sulfonylureas (chlorsulfuron), 2,4-D and glyphosate. Tolerant or resistant weeds in aquatic systems have not been reported or documented at this time, possibly because many of the weedy aquatic plants (including hydrilla) reproduce largely by asexual or vegetative means and lack the genetic variability often associated with herbicide resistance.

In summary, the development of herbicide tolerant or resistant weeds from those species that are controlled by "normal" application rates of herbicides has not been reported in aquatic situations. However, weed tolerance/resistance has

been extensively documented and studied for many terrestrial weed/herbicide combinations. Herbicides do not always create "new" plants, the herbicides often have simply selected for plants that were already in the weed populations.

Therefore, it was highly unexpected for hydrilla to develop tolerance to fluridone. Hydrilla has spread throughout Florida by vegetative means resulting in all plants being essentially identical in genetic terms. In addition, there has never been tolerance reported for any plants to bleaching type herbicides, including fluridone.

Fluridone was discovered in 1976 and received full EPA aquatic registration in 1985. Since the early 1980's its use has increased steadily because it provides very cost effective hydrilla and milfoil control at relatively low application rates (< 10 ppb). We have reported that hydrilla control can be achieved by long-term exposure of hydrilla to low doses of fluridone in Lake Harris, upper St. Johns River and the Withlacoochee River, among others.

However, in 1999 and 2000 it became evident that standard application rates and exposure periods (6-10 ppb for 10-15 weeks) were not providing typical two years or even season-long control of hydrilla. Could this lack of expected results in 1999 and 2000 occur from wind, rain, dilution, organic sediments, changes in herbicide formulation or some other physical phenomenon? As these factors were eliminated we started to examine the physiology and biochemistry of tolerant hydrilla plants exposed to various concentrations of fluridone.

Fluridone prevents the formation of plant pigments called carotenoids. These molecules protect chlorophyll from excess sunlight by absorbing energy from the chlorophyll molecule. The specific enzyme that is inhibited by fluridone is phytoene desaturase. This enzyme converts the precursor pigment phytoene to carotene - a carotenoid pigment. These pigments; phytoene, carotene and chlorophyll are not difficult to assay in plants, so experiments were set up exposing susceptible and tolerant hydrilla to various concentrations of fluridone. These laboratory studies confirmed the fact that certain hydrilla plants were responding differently to identical concentrations of fluridone.

In susceptible plants phytoene levels become very high because fluridone prevents conversion of phytoene into carotenoids. Subsequently, carotenoids are greatly reduced, chlorophyll is unprotected and the plant becomes bleached and dies. Fluridone tolerant plants required relatively higher levels of herbicide to attain the same results. This differential response can also be shown by monitoring growth of fluridone susceptible and tolerant hydrilla over a range of fluridone concentrations (Figure 1). Hydrilla collected from various Florida Lakes (identified as Lakes 4, 6, and 11) were planted in test aquaria and allowed to grow under identical conditions until the plants reached approximately 10 grams dry weight. At this time, the aquaria were treated with fluridone at 0, 6, 12, 18 and 24 ppb. Eight weeks later, all plants were harvested and dry weights determined. There was no statistical difference in growth between the 3 populations at 0.0 ppb - the control.

The differential response to fluridone in Figure 1 is evident at the 6 ppb rate where growth of hydrilla from Lake 6 was completely halted, while hydrilla from both Lakes 4 and 11 continued to grow above pre-treatment levels at 6 ppb. At 12 ppb hydrilla from Lake 11 stopped growing, but Lake 4 continued to grow - although at a much slower rate. In fact, hydrilla from Lake

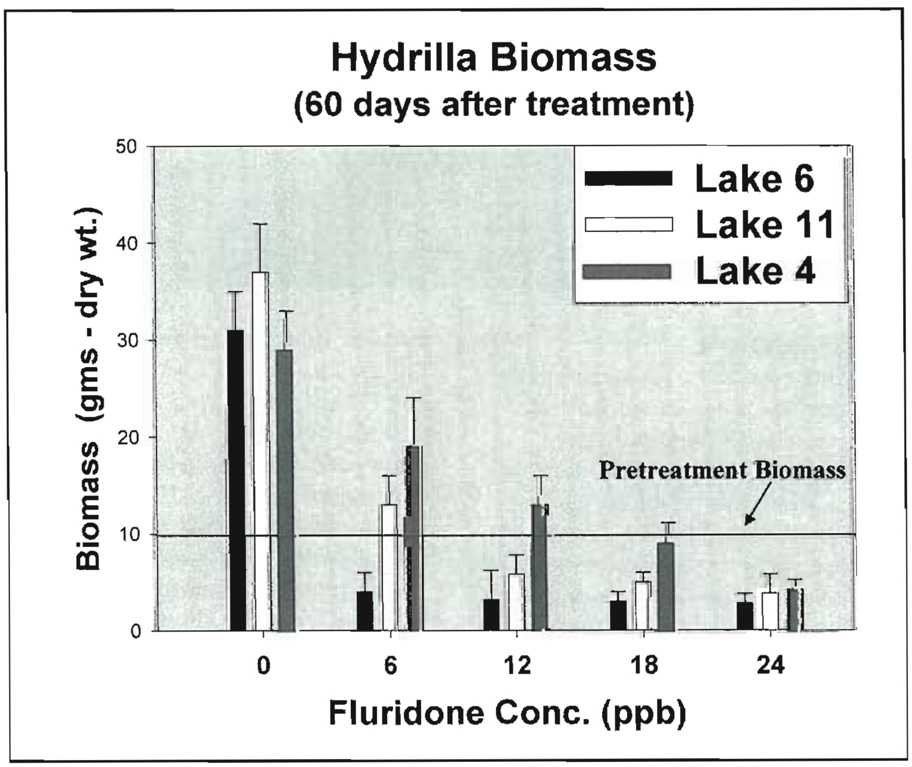


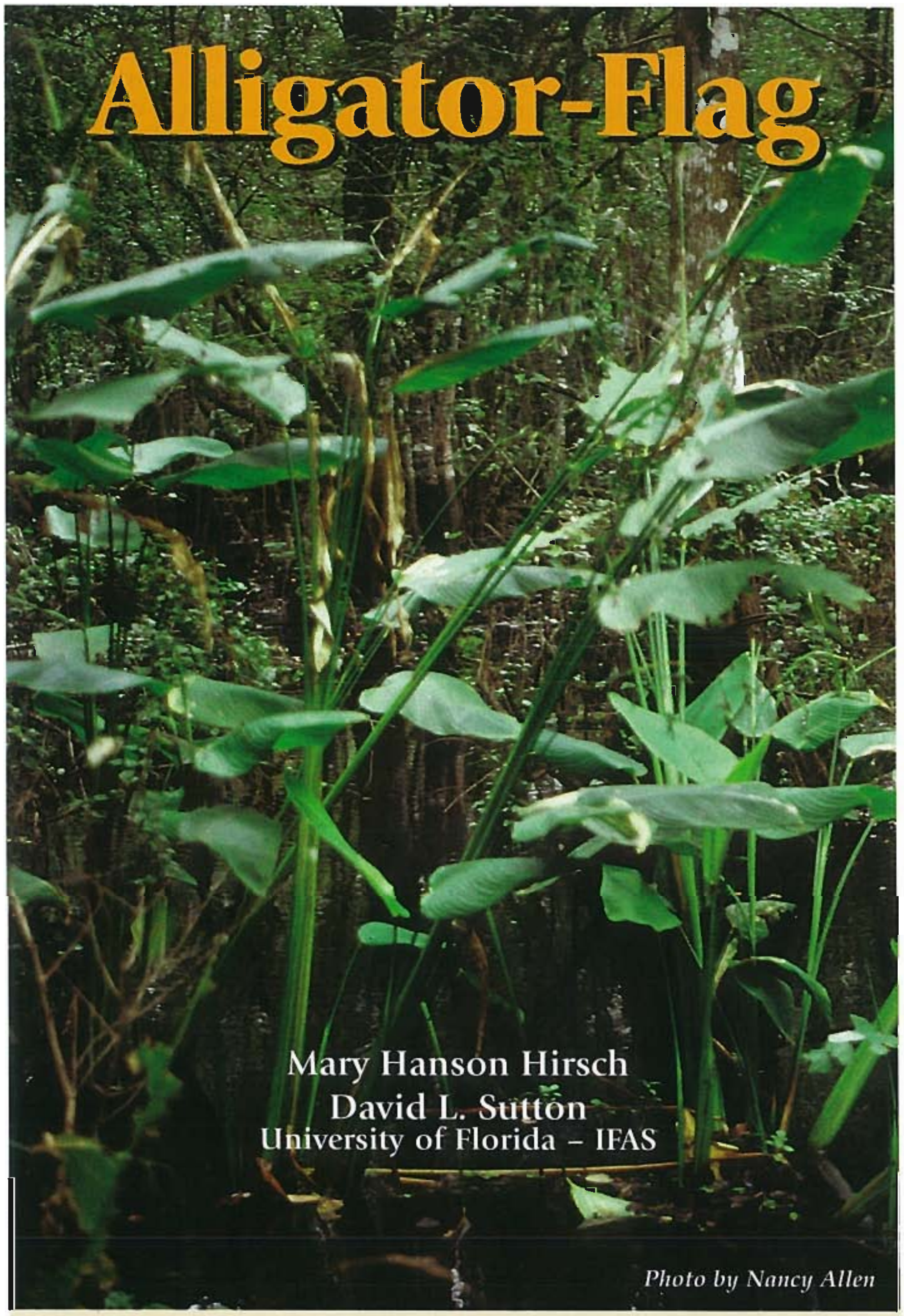
Figure 1. Hydrilla collected from 3 separate waterbodies in Florida was grown under identical laboratory conditions (light, water quality, sediment) and exposed to 4 rates of fluridone. Significant biomass differences were noted between lakes within a given fluridone concentration. In addition, differences were also noted between fluridone rates for lakes 4 and 11. Plants that increased biomass above pretreatment levels were generally lacking in strong visible injury symptoms.

4 is quite tolerant to fluridone, requiring 24 ppb herbicide to shut growth down similar to the susceptible hydrilla from Lake 6 whose growth was essentially halted by 6 ppb fluridone.

The significance of these and similar studies indicates that significant levels of carotenoids are being formed in tolerant hydrilla at fluridone concentrations which in the past had controlled these plants. The fact that high (> 24 ppb in Figure 1) fluridone concentrations still provides control indicates that these hydrilla biotypes have attained a level of tolerance, not resistance, in the strict definition of the term. While environmental conditions (e.g. dilution, hydrilla maturity, sediment type, and timing of treatment) are known to impact fluridone efficacy, the discovery of increased hydrilla tolerance will become a key factor in future management decisions.

At this time fluridone tolerant hydrilla has been confirmed in several Florida lakes. In the meantime, the Florida Department of Environmental Protection (DEP) and the SePRO Corporation have provided research funds to answer some very important questions such as: How does the tolerance come about? How does hydrilla tolerate previously lethal rates? Will the tolerance levels increase? Are any other non-target plants showing this tolerance?

The reader's most common question will be "do I have these tolerant plants?" Florida DEP biologists and SePRO research staff have good records and knowledge of where problems have occurred. More than likely, you are **not** affected at this time; however, potential spread of these plants to other water bodies remains a concern. At this point we all have many questions and in the search for answers we will keep *Aquatics* readers abreast of our results as they become available.



Alligator-Flag

Mary Hanson Hirsch
David L. Sutton
University of Florida - IFAS

Photo by Nancy Allen

Introduction

There are three remaining true wilderness areas in the United States: Danali National Park, Alaska; Bob Marshall Wilderness Area, Montana; and Everglades National Park, Florida. The Everglades wilderness in southern Florida is one of the Earth's unique biological areas. Its wetlands provide many habitats including some that allow periods of inundation.

The Everglades is home to a number of aquatic plants, including the large and lovely alligator-flag (*Thalia geniculata* L.), so named because both the plant and the alligator prefer the same habitat of depression marshes. This plant is also commonly called fire-flag, or it is simply referred to as thalia.

Alligator-flag is native to the West Indies and is thought to have migrated to the Florida peninsula when that land mass appeared approximately 10,000 years ago.

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Alligator-flag occurs primarily in southern Florida but not in the Keys nor in any other areas in North America. Alligator-flag thrives in the annual wet-dry cycle of the Everglades ecosystem. It is conspicuously stately and glossy in the depressions, marshes, and edges of canals and ponds from spring to fall. In the fall it dies back, and the dormant plants look like dull haystacks during the dry winter months.

Family Characteristics

Alligator-flag is a member of the Marantaceae or Arrowroot family, which includes about 30 genera and about 450 species, all of which are found in the tropics and subtropics. The family was named for Bartolommeo Maranta, an Italian herbalist who lived during the 16th century.

Members of the Arrowroot family are erect, perennial, monocotyledonous herbs that grow from thick rhizomes. Plants are characterized by the presence of distinctly three-sectioned leaves. The leaves have an open basal sheath, round petiole with a swelling at its juncture with the blade, and pinnately veined asymmetrical blades. The leaves are notably two-ranked on opposite sides of the stem (distichous), and often overlapping like shingles on a roof (imbricated).

Flowers of the Arrowroot family are arranged in mirror image pairs enclosed by conspicuous bracts. They are perfect, meaning that each flower contains both functional female (pistil) and male (stamen) parts. The family is considered the most advanced of the Zingiberales order because of the complexity of the flower. The flower is a single stamen and a single ovule in each of three locules (the cavities within the ovary). Usually only one ovule is fertile. The seeds have an additional covering and a curved embryo.

Economic values of the Arrowroot family include production of maranta starch and use as ornamentals. Approximately 16 genera are commonly grown for ornamental use, including *Calathea, Maranta,* and *Thalia.* Members of *Thalia* are popular aquatic garden plants and also are used in wetland restoration and mitigation plantings. West Indian arrowroot (*Maranta arundinacea* L.) is cultivated as a crop plant for the highly digestible starch produced by the rhizome. The starch is used in special diets. West Indian arrowroot is not to be confused with the Cycad taproot that the Seminole Tribe of Indians in Florida processed for export and sale in Cuba in the early 1800s in exchange for guns to fight the Seminole Wars.

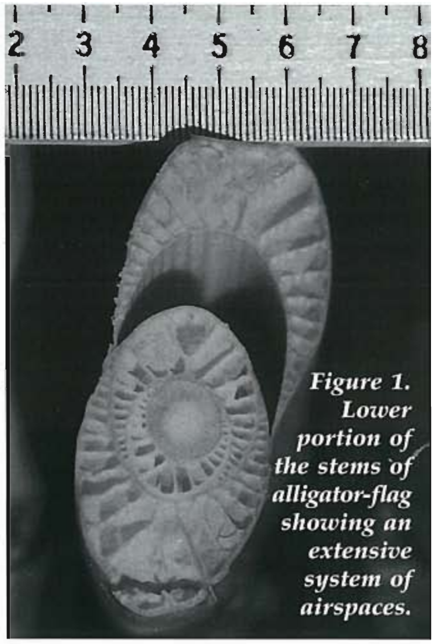

Figure 1. Lower portion of the stems of alligator-flag showing an extensive system of airspaces.

Photo by Dave Sutton

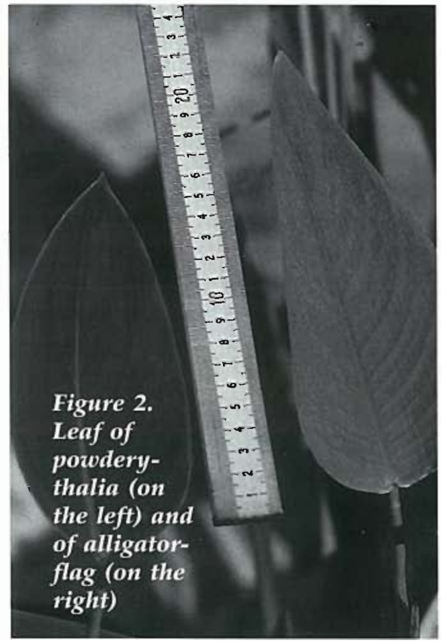

Figure 2. Leaf of powdery-thalia (on the left) and of alligator-flag (on the right)

Photo by Dave Sutton

Genus Characteristics

Thalia is the only genus of the Marantaceae family native to the United States. *Thalia* was named for Johann Thal, a 16th century German physician and naturalist. Interestingly, the name also belongs to one of the Three Graces, three sister goddesses in Greek mythology, who were known to dispense charm and beauty.

The number of species thought to occur within the genus ranges from 5 to 11, but only two occur in North America: 1) alligator-flag, and 2) powdery-thalia (*Thalia dealbata* Roscoe). These monocots are usually found in relatively deep water with their roots and thick rhizomes well below the surface of the substrate. The stems have an extensive system of air spaces that allow for movement of oxygen to the lower portions of plants growing in anaerobic conditions (Figure 1). These plants also grow along the shoreline above the surface of the water.

The leaves and flower stalks of *Thalia* may grow underwater, but their leaf blades and inflorescences are held high above water. Their overall appearance is frequently glaucous, like the bluish-green color of the sea.

The long petioles of the alternate leaves extend from the rhizome. The point of union with the blade has a ligulate articulation, which is a sheathlike extension similar to those seen frequently on grasses. The bases of leaves vary from cordate (heart-shaped) to truncate (terminated in a straight line, like a plane).

The anatomical characteristics of interval length between the flowers and the shape of the fruit help to distinguish the two species. Alligator-flag flowers have zigzag intervals of 0.2 to 0.5 inch (0.6 to 1.3 cm) long and an oval fruit, while the related powdery-thalia has its flowers crowded with zigzag intervals of about 0.1 inch (0.3 cm) long and a globose fruit. Also, leaf differences were noted for plants of both species grown under similar culture conditions at the Fort Lauderdale Research and Education Center (Figure 2).

Powdery-thalia occurs in the coastal plains from South Carolina to Texas and into Missouri and Oklahoma. The range of alligator-flag is limited to southern Florida and the West Indies.

The commercial success of these two species varies because of the wider range and thus relative hardiness of powdery-thalia. It is favored as a landscaping plant, while alligator-flag is ideal for authentic wetlands restoration or mitigation. Both produce an equally dramatic effect in either an aquatic garden or a wetlands setting.

Red-stemmed thalia (*Thalia geniculata forma rheumoides* Shuey) is a variety of alligator-flag that has unusual red petioles. The variety is easily propagated from the rhizome. Apparently only a small percent of plants produced from seed of red-stemmed thalia will show the red coloring.

Alligator-flag Characteristics

Alligator-flag plants may grow to over 9 feet (2.7 m), taller than the more well-known and common Everglades sawgrass (*Cladium jamaicense* Crantz). Alligator-flag dies back in December but begins growing in the spring from rhizomes and seed.

Alligator-flag has leaves that are broadly lanceolate to ovate-lanceolate and somewhat symmetrical. They may be up to 2 feet (0.6 m) long and 8 inches (20 cm) in width and are supported by long, stout petioles. At the junction of the petioles, the leaf blades appear to relax outward, away from the central group of petioles.

The inflorescence of alligator-flag is terminal and tall-scapose, meaning that the flower grows from the rootcrown on a stem without leaves. From a distance, these plants may be recognized by their distinctive tracery effect of spikes with zigzagging axes. The panicles (irregularly-branched flower clusters) are widely and loosely branched. They have long, zigzag internodes (areas between the nodes, or knots where buds appear) that angle away from each other at over 30 degrees.

The flowers occur in pairs, subtended by two persistent bracts that remain on the winter's dry stalks. The three sepals are minute and easy to overlook. The three petals are distinct, purple, and translucent (Figure 3). One petal is lanceolate and the other two are obovate, meaning that one is narrow toward the top and the others are narrow toward the stalk attachment. The staminodia

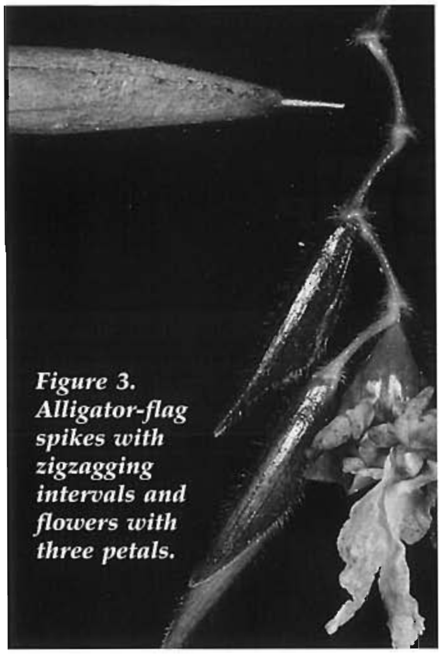

Figure 3. Alligator-flag spikes with zigzagging intervals and flowers with three petals.

Photo by Dave Sutton

are purplish and petal-like, with the middle one largest, broad, and lip-like, bearing a fertile stamen. The ovary is inferior (below the petals, sepals, and stamens) and contains three cell-like locules. Only one of the locules bears an ovule. The ovule produces a bluish purple utricle or oval unicellular fruit (Figure 4).

Insect Damage

The only significant insect damage found on alligator-flag plants at the Fort Lauderdale Research Center (FLREC) has been from a brown skipper butterfly (*Calpodes ethlius* Stoll). Plants in the Marantaceae family have many similarities with the Cannaceae, or Canna family, and both are in the Zingeberales order. Plants of the Canna family are the common host for larvae of the brown skipper butterflies. Canna plants are cultured at the FLREC, thus allowing this insect the chance to feed on either plant. The brown skipper butterflies usually deposit their eggs on the undersurface of a leaf. The larvae begin feeding by cutting and folding the leaf margins. Because they are generally found on the cannas, the brown skipper butterflies are often referred to as "canna leafrollers."

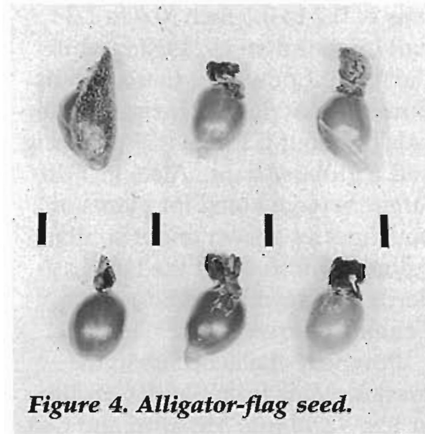

Figure 4. Alligator-flag seed.

Photo by Dave Sutton

Take in the View

To see alligator-flag, take a drive out Alligator Alley or Tamiami Trail, the two highways that cross the Everglades, anytime from spring through late fall. Or better yet, get out of your car and take advantage of the parking areas along either route for a close-up view of this attractive plant. Clyde Butcher, who is renowned for his photographs of the Everglades, has his Big Cypress Gallery on the south side of Tamiami Trail, midway between Naples and Miami. Alligator-flag is growing on the edge of his parking and picnicking area.

Acknowledgments

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Barley Straw for Algae Control

By Carole A. Lembi, Purdue University

The use of barley straw for algae control has received a lot of publicity in recent years. It is now common to find small barley bales being sold in nurseries and garden shops for use in watergardens and small pools for algae control. The word-of-mouth reports of success with this method have led many people to suspect that barley might also control algae in ponds and lakes. The demand from the public over the past several years for information on the potential of barley straw to control algae in these larger bodies of water has definitely increased. Unfortunately, research efforts in the U.S. have not kept pace with this demand for information. However, since Stratford Kay reported on his research results with straw in the Spring 1997 issue of *Aquatics*, several other studies have been initiated. The results of these studies were presented at a symposium on the use of barley straw as an algaecide at the November 2000 meeting of the North American Lake Management Society (NALMS). This article will review those studies and will also describe the regulatory position taken by the Environmental Protection Agency (EPA) on the use of barley straw for algae control.

Where It All Started

The technique of using barley as an algaecide was developed in the early 1990s in England, where it is widely used in many bodies of water, including reservoirs and canals. The largest body of water currently being treated is a 550 acre lake in Ireland (1). In general, it is thought that fungi decompose the barley in water, which causes a chemical to be released that prevents the growth of the algae. It is known

Figure 1. For treatments of small ponds, barley straw can be repacked into 50-lb onion mesh bags. Each bag holds about 7 pounds of barley straw. Photo courtesy of Steve McComas, Blue Water Science, St. Paul, MN.

Figure 2. For treatments of larger ponds, barley straw can be repacked using a Christmas tree baler to feed the straw into a mesh bag. A manageable sized tube of barley is 7 to 9 feet long and weighs 60 to 70 pounds. Photo courtesy of Steve McComas, Blue Water Science, St. Paul, MN.

that approximately 750 compounds are released from decomposing barley (1). About 49 of these have been characterized, but the specific toxic chemical(s) has not been identified (oxidized polyphenolics and hydrogen peroxide are two types of decomposition products that have been suggested). Also, it is not clear whether the chemical is exuded from the barley itself or if it is a metabolic product produced by the fungi. The activity of barley straw has been described as algae-static (prevents new growth of algae) rather than algaecidal (kills already existing algae).

Laboratory studies conducted by English researchers suggest that barley will not control the growth of all species of algae. In fact, some of the studies are contradictory, claiming that certain types of algae are susceptible while other studies claim that those algae are not susceptible. But, the field evidence does suggest that, in most cases, water clarity will improve over time and that this is due to reduction in algal populations.

A review of some of the early English research was published by Eldridge Wynn and Ken Langeland in the Fall 1996 issue of *Aquatics*.

Research in the U.S.

Results of research at Purdue University have been inconsistent. Our first studies were conducted in the laboratory, and we found that some algal species were indeed susceptible to barley but others were not. The approximate susceptibility of microscopic algal groups from greatest to least was blue-green algae (cyanobacteria) > diatoms = green algae > euglenoids. Barley provided at best only 50% control of the mat-forming algae *Pithophora* and *Spirogyra*. A similar laboratory study at the University of Maryland (2) also showed that algal species vary in their susceptibility. Decreased growth was reported for 3 species, no effect was measured on 5 species, and increased growth was noted in 4 species. There was no pattern in susceptibility among the algal groups.

We then tried larger studies which were conducted in stock tanks (outdoors) and in plastic cylinders (in the greenhouse). Although at times we were able to monitor a decrease in microscopic algal growth (mostly planktonic green algae), we often noticed an increase in *Rhizoclonium* and *Oedogonium*, two of our most common summer mat-formers in the Midwest.

Researchers at the University of Nebraska initiated a field study in April 2000 (3). They applied barley to a 4 acre lake that had a history of noxious phytoplankton blooms (blue-green algae). The barley did not control the blooms, and in fact, it might have enhanced algal growth. Although the barley was left in the lake over the winter, the study was discontinued in the spring 2001.

On the other hand, the application of barley by the city of Lakeville (4) to a 7.5-acre lake in Minnesota in the spring of 2000 seemed to provide some algal control. Water clarity, as measured by Secchi disk, increased from 2.7 ft in 1999 to 4.8 ft. in 2000, and observations suggested control of mat-forming algae as well. The treatment of 15-acre Northwood Lake by the city of New Hope appeared to result in an increase in Secchi disk transparency from 1.3 ft. in 1999 to 4.6 ft. in 2000.

Stratford Kay's research (5) at North Carolina State University, reported in the Spring 1997 issue of *Aquatics*, showed no effect of barley on ponds containing *Pithophora* and *Spirogyra*. At the University of Florida (6), a small scale study conducted several years ago found that predigestion of the straw (incubation in water) for at least a month was necessary for activity. As shown in the English studies the effect was algaestatic rather than algaecidal. The conclusion from this study was that the amount of straw needed, if extended to a pond scale, was too large to be practical in Florida, particularly since its ponds and lakes are warm, shallow, and have such a long growing season. Furthermore, barley is not commonly grown in Florida (or other parts of the southeast; it is not even commonly grown in eastern states as far north as Indiana). Several pond trials conducted in the Naples, FL area were unsuccessful.

At this time, research is continuing at the University of Maryland, although most of this is focused toward harmful algal bloom species in estuaries. A new study was initiated in late April 2001 by researchers at Iowa State University (7) in which barley straw treatments were placed in plastic enclosures installed in a lake. Also, the Minnesota DNR is allowing the treatment of several ponds in the Twin Cities area in 2001 for water clarification (see EPA, below). We will have to wait and see what occurs with these studies.

In summary, results from barley research in this country have not been overwhelmingly positive. Whether we are dealing with algal species, water conditions, climatic conditions, or other factors that differ from those of the typical English water body is simply not known at this time. Allowing ample flow of oxygen through the barley is considered to be critical to the aerobic decomposition of the straw, and it is quite possible that either the way in which the barley is packaged or the static nature of test sites prevents sufficient exposure to oxygen. Furthermore, dosages have not been tested in replicated field studies under different water quality conditions and algal populations. Finally, the use of barley straw is not a process that is going to produce rapid results like an algaecide application. Algal control using barley, according to the English researchers, can take several months, and the effects may be more subtle than what we are used to. Perhaps we Americans are just too impatient!

EPA's Views on Barley

After the apparently successful Lakeville, Minnesota test, a number of lake associations in that state were anxious to begin using barley as an alternative to traditional pesticides. Members of the Minnesota Department of Natural Resources were concerned that not enough was known about the potential effects of barley. They questioned whether it provides consistent control, and whether they could approve its use in "public" waters. The agency (8) asked EPA for guidance on this matter.

EPA's response is summarized as follows: The EPA defines a pesticide as "any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest." If a claim is made that barley "controls" algae (a pest), it is legally considered to be a pesticide. However, no company has ever registered barley for use as a pesticide. It has not gone through the testing that is required for registration. Therefore, barley cannot be sold as a pesticide to control algae. This ruling has serious implications for certified commercial applicators and lake management specialists. These individuals cannot recommend or apply barley for algae control; this application would be the same as distributing an unregistered pesticide. Likewise, garden shops and nurseries cannot legally sell barley straw for the stated or implied purpose of algae control.

A homeowner with a "private" pond or lake is in a different situation. For the homeowner who does work on their own pond, barley qualifies as a "home remedy" and does not come under EPA authority. Pond owners who wish to purchase barley and apply it to ponds on their own property themselves are perfectly free to do so. However, a person who lives on a public lake cannot apply barley because public waters are "owned" by the public and managed by state government and therefore would fall under EPA restrictions. EPA does not provide guidance on which ponds/lakes are "private" vs. "public", and how this distinction is made likely varies among states.

There is also a matter of semantics. EPA acknowledges that some products have multiple uses and that it is legal to advertise, sell, and apply a product based on its non-pesticidal uses, even if the product also has pesticidal uses. In this case, as long as someone does not claim algae control per se, they could sell or apply barley straw. The obvious alternative reason for the application of barley is that it might act as a water clarifier. Although there is little evidence that barley acts like typical clarifiers such as alum (which causes the precipitation of phosphorus or removes particles from the water), this is one way in which the direct claim or implication of "algae control " can be avoided. Is this a legitimate way to justify the use of barley? Until further clarification is obtained from EPA, this is a matter for the individual to decide.

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SePRO Corporation 11550 North Meridian Street, Suite 600, Carmel, IN 46232 Fax: 317-580-8290 response to questions about barley, please contact me by email (lembi@btny.purdue.edu) and send your FAX number.

EPA's stance on barley straw as an algaecide also has implications for future research. Since barley has not been registered as a pesticide, efficacy tests must be conducted using the same regulations that pertain to unregistered synthetic chemicals. In other words, barley cannot be field-tested on more than 1 acre of water per year. If adhered to, this ruling will restrict already limited field testing to virtually no field testing. There are two ways in which this obstacle can be overcome. One is to claim that the research is being conducted to test for water clarification. The second, and more appropriate approach, is for a company to develop the data required to place barley straw on EPA's exempted products list. Materials such as cinnamon, corn oil, garlic, mint, and soybean oil are on this list and can be used as pesticides! Why not barley?!

Use Considerations

If, given the preceding information, individuals decide to use barley as a "home remedy", they must consult their state Department of Agriculture to determine the legal status of using barley straw in their state. Some general considerations that I have taken from English recommendations (www.exit109.com/~gosta/pondstrw.sht) and guidelines published by the University of Nebraska (www.ianr.unl.edu/PUBS/wildlife/NF429.htm) are as follows:

(1) Barley bales must be broken apart and the barley loosely placed into netting so that water and air can circulate through the straw (Figures 1 and 2). Anything that increases aeration in the body of water, like an aerator, may help in the decomposition process. Inserting floats into the barley nets will insure that they remain in the upper, more oxygenated portions of the water column. Some practitioners claim that exposing the top portion of the netted barley above the water surface enhances oxygenation under static conditions.

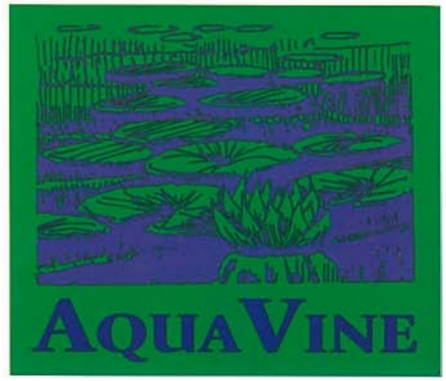
(2) A commonly recommended dosage is 225 pounds of barley per acre of water (about 5 bales). The water should be relatively shallow, perhaps 4 to 5 ft. in depth. Barley may work in deeper waters as well, but maximum depths have not determined.

(3) The installation of barley straw in larger ponds and lakes is an energy intensive process. In the Lakeville, MN example, approximately 1500 pounds of barley were repacked into 25 tubes, each 9-ft long (4). It took 2 people 1 hour/lake acre to fill and stake the tubes into the lake.

(4) If barley works as an algaestat rather than as an algaecide, it will prevent new growth but it may not kill off what is already present. Presumably early treatments, perhaps in March or April in the Midwest, applied before the algae start to grow will help this situation. The other alternative is to control existing algal populations, either manually or chemically, and to apply the barley to prevent new growth. The activity of barley builds up to a maximum at about 6 months after treatment and then ceases. At that time, new barley should be introduced into the system.

A majority of the information published in this article is available at the following website: www.btny.purdue.edu/Pubs/APM/APM-1-W.pdf

References available on request.



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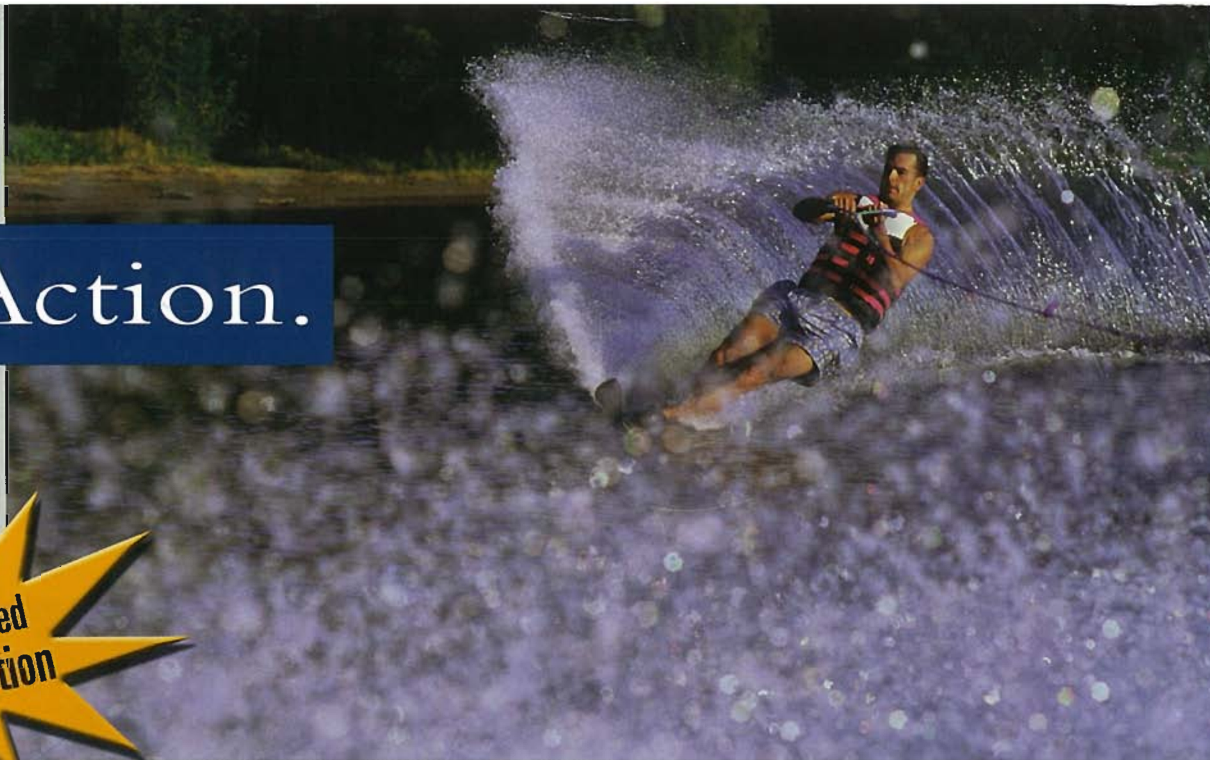

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