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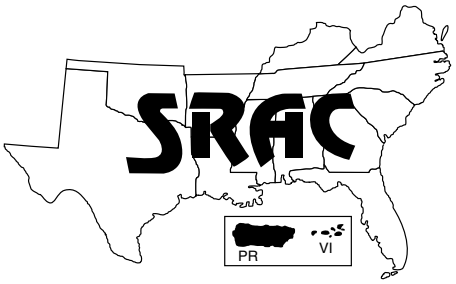

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Revision

Aquatic Weed Management
Herbicides

Michael P. Masser[1], Tim R. Murphy[2] and James L. Shelton[2]

Managers can quickly and economically control problem weeds in commercial fish ponds with aquatic herbicides. However, herbicides are just one method of managing aquatic weeds. There are also: 1) preventive methods such as proper pond site selection and construction, fertilization and periodic draw-downs; 2) biological methods such as grass carp (*Ctenopharyngodon idella*); and 3) mechanical methods such as seining and raking. Using a combination of these methods, within a comprehensive plan, is the most cost effective, environmentally safe way to manage aquatic weeds. See SRAC Publication No. 360, *Aquatic Weed Management—Control Methods*, and the Aquaplant Web site at *http://aquaplant.tamu.edu* for additional information on aquatic plant identification and various methods used to control undesirable weeds in fish ponds.

Herbicide selection

Aquatic herbicides vary in their weed control spectrum (Table 1). After a weed has been correctly identified, it is usually possible to select an appropriate herbicide. The herbicide selected must be labeled for use with food fish. Most aquatic herbicides have water-use restrictions that may prevent their use on a particular body of water (Table 2). Secondary water uses (i.e., swimming, livestock watering and irrigation) must be considered before a herbicide is applied.

Most aquatic weeds begin growing in early spring when water temperatures are 55 to 60 °F. The spring months (March, April, May), when water temperatures are between 70 and 80 °F, are an ideal time to apply herbicides to control aquatic weeds. At this time of the year weeds are small and easier to control than during the summer; dissolved oxygen levels are usually higher also. **Aquatic herbicides are not toxic to fish when applied according to label directions.** However, aquatic weeds killed by the herbicide decompose. The decomposition process consumes oxygen and can reduce the amount of dissolved oxygen available to fish. If the dissolved oxygen concentration drops too low, fish kills can occur. Fish should be observed for 1 week after treatment and emergency aeration equipment should be available in case oxygen depletion problems occur. Treating the pond with herbicides during the hot summer months is risky because dissolved oxygen concentrations tend to be lower at this time and weed biomass levels tend to be higher. Treating only one-fourth to one-third of the total surface acreage of a pond at one time can minimize the risk of herbicide-induced dissolved oxygen depletions. However, even partial pond treatments can be risky during the summer in ponds that routinely have low dissolved oxygen levels. Also, some herbicides cannot be used for partial pond treatments.

Application methods

Application methods depend on the herbicide formulation and the target weed species. Many herbicides may be applied directly from the container (ready for use), while others need to be diluted with water before application.

To treat large areas you will need to use a mechanical sprayer or spreader and a power boat to adequately distribute the chemical. Sprayable herbicide formulations can be applied with hand-held or mechanical pressurized sprayers or with a boat bailer. Injecting the chemical near the outboard motor propwash will help it disperse. Hand-operated or mechanical rotary spreaders can be used to apply granular or pelleted formulations. Soluble crystals, such as copper sulfate, can be dissolved in water and sprayed over the pond; or, the required amount can be placed in burlap bags and dragged

[1] Texas A&M University
[2] University of Georgia

behind a boat or suspended in the water near an aerator until the herbicide dissolves.

Adding a surfactant to some foliar-applied herbicides (e.g., diquat, glyphosate) will help them wet and penetrate the foliage. Use a registered aquatic surfactant according to the label directions. Using surfactants to treat submersed weeds is not recommended.

Herbicide dosage calculations

Aquatic herbicides must be applied at labeled rates. Application rates were developed from extensive research and provide effective, yet safe, weed control. Applying an excessive rate of a herbicide **does not** provide better weed control but does increase the cost of the treatment and may increase the risk of injury to fish. Applying less than the recommended rate usually results in poor weed control.

Some herbicide treatments, such as those for controlling emersed plants, are applied on the basis of the area to be treated. Other treatments, such as those for controlling certain submersed weeds, are based on the volume of water to be treated. Read the label instructions carefully because mistakes in calculating treatment rates can be costly and dangerous. (For information on calculating the area and volume of ponds, see SRAC Publication No. 103, *Calculating Area and Volume of Ponds and Tanks*.)

Surface acre treatments

The amount of herbicide needed for a surface acre treatment is determined by the following formula:

F = A x R

F = Amount of formulated herbicide product

A = Area of the water surface in acres

R = Recommended rate of product per surface acre

Acre-foot treatments

Many aquatic herbicides list their application rates in terms of the amount of product to use per acre-foot of water. An acre-foot of water is defined as 1 surface acre of water that is 1 foot deep. The number of acre-feet of water can be found by multiplying the number of surface acres times the average water depth. The amount of herbicide needed for an acre-foot treatment is determined by the following formula:

F = A x D x R

F = Amount of formulated herbicide product

A = Area of the water surface in acres

D = Average depth of the water in feet

R = Recommended rate of product per acre-foot

PPMW treatments

The treatment rate of some aquatic herbicides may be listed as the final concentration of the chemical in the water body on a parts per million weight (ppmw) basis. The amount of herbicide needed for a ppmw treatment is determined by the following formula:

F = (A x D x CF x ECC) ÷ I

F = Amount of formulated herbicide product

A = Area of the water surface in acres

D = Average depth of the water in feet

CF = 2.72 pounds per acre-foot (This is the conversion factor when total water volume is expressed on an acre-foot basis. 2.72 pounds of a herbicide per acre-foot of water is equal to 1 ppmw.)

ECC = Effective chemical concentration of the active ingredient of herbicide needed in water to control the weed

I = The total amount of active ingredient divided by the total amount of active and inert ingredients

For liquid products, I = pounds of active ingredient ÷ 1 gallon

For dry products, I = percent active ingredient ÷ 100%

Aquatic herbicides

The herbicides discussed in this section are labeled for use in commercial fish production ponds. Before using any herbicide, read and understand the label.

Copper sulfate
(Various trade names)

Copper sulfate is a contact herbicide primarily used to control algae. However, it is not effective for *Pithophora* control. Copper can interfere with gill functions and, if improperly used, can be toxic to fish and zooplankton. Fish species such as trout and koi are particularly sensitive to copper. However, most fish kills that occur after copper sulfate treatment are caused by a massive algae kill and the subsequent oxygen depletion.

Copper sulfate is also formulated as a solution made by dissolving the crystals in a sulfuric acid solution. These acidified copper solutions are registered for aquatic use and sold under various trade names (e.g., Copper Cat, EarthTec, AgriTec, etc.).

The effectiveness and safety of copper sulfate are determined by alkalinity and water temperature. In water with an alkalinity ≤ 50 ppm, the rate of copper sulfate needed to control algae can be toxic to fish. Copper treatment at water alkalinities of ≤ 20 ppm is extremely risky. In high alkalinity (≤ 250 ppm) water, copper sulfate quickly precipitates out and is not effective for algae control. The toxicity of copper sulfate to fish increases as water temperature increases. Avoid copper sulfate applications during hot summer months. (For additional information on treating with copper see SRAC Publication No. 410, *Calculating Treatments for Ponds and Tanks*.)

Chelated copper
(Cutrine®, Komeen, K-Tea®, Nautique® and other trade names)

Copper that is held in an organic complex is known as chelated copper. Chelated copper formulations do not readily precipitate in high alkalinity waters, but stay in solution and remain active longer than copper sulfate. Chelated copper is less corrosive to application equipment than copper sulfate. Because it is more soluble, chelated copper is generally used at slightly lower rates than copper sulfate. Chelated copper formulations are slightly less toxic to fish than copper sulfate. However, in waters with low alkalinity (≤ 20 ppm), or in water with an alkalinity of ≤ 50 ppm that contains trout, using chelated copper is extremely risky, particularly during the summer. Some of the chelated copper compounds work on higher plants (e.g., hydrilla, *Najas* spp., etc.). Check specific labels for activity or refer to the Aquaplant Web site at *http://aquaplant.tamu.edu*.

Diquat
(Reward®, Weedtrine-D®)

Diquat is a contact herbicide that can be sprayed or injected into water to control submersed weeds and filamentous algae. It can also be used as a foliar application to control duckweed (*Lemna minor* and *Spirodela polyrhiza*). An approved non-ionic surfactant must be added when diquat is used as a foliar application. Diquat binds tightly to clay particles and is not effective in muddy water. Diquat quickly kills plants and should be used as a partial pond treatment for dense vegetation.

Endothall
(Aquathol®, Hydrothol®)

Two salts of endothall are used for aquatic weed control. A dipotassium salt (Aquathol®) is available as a granular or liquid formulation. Hydrothol® is available as a liquid or granular formulation and is a mono-(N,N-dimethylalkylamine) salt of endothall. The two products vary considerably. Hydrothol® is more toxic to fish, so Aquathol® is generally used in commercial ponds. Hydrothol® controls algae (filamentous and stoneworts) and many submersed weeds. Aquathol® controls many submersed weeds but is not effective for algae control. Both products are contact herbicides and may be used for spot or partial pond treatments.

Fluridone
Sonar®, Avast®)

Fluridone controls most submersed and emersed weeds and is available as a liquid or pelleted formulation. Liquid formulations also control duckweed and watermeal. Fluridone is a translocated herbicide that slowly kills plants over a 30- to 90-day period. Its slow action generally prevents the depletion of dissolved oxygen. **Fluridone is not effective as a spot treatment.** The entire pond must be treated to control the target weed species.

Glyphosate
(Rodeo®, Eraser AQ®, Aquamaster®, Touchdown Pro®, AquaNeat® and other trade names)

Glyphosate is a foliar-applied, translocated herbicide used to control most shoreline vegetation and several emersed weeds such as spatterdock (*Nuphar luteum*) and alligatorweed (*Alternanthera philoxeroides*). Glyphosate translocates from the treated foliage to underground storage organs such as rhizomes. It is most effective when applied during a perennial weed's flowering or fruiting stage. An approved non-ionic surfactant should be used with glyphosate (Rodeo® formulations only). If rainfall occurs within 6 hours of application, the effectiveness of glyphosate will be reduced.

2, 4-D
(Various trade names)

2,4-D is a translocated herbicide that is available as a granular or liquid formulation. Granular 2,4-D controls submersed weeds such as coontail (*Ceratophyllum demersum*) and emersed weeds such as waterlily (*Nymphaea* spp.). Liquid formulations of 2,4-D are used to control floating weeds such as water hyacinth (*Eichhornia crassipes*) and several emersed weeds. 2,4-D is available as an ester or amine formulation. Amine formulations are slightly better for aquatic applications because they are less toxic to fish. The granular ester form is safer to use in aquatic applications than the liquid ester form. Only those formulations of 2,4-D labeled for aquaculture are legal to use in culture situations.

Imazapyr
(Habitat®)

Imazapyr is a foliar-applied, translocated, systemic herbicide used to control many floating and emersed weed species. It may be particularly effective on plants such as alligatorweed, cattails, giant reed and watershield. Imazapyr works in the meristematic tissue (i.e., rapidly growing/dividing) by inhibiting the synthesis of certain amino acids in protein production. A spray adjuvant must be used with imazapyr. Recommended spray adjuvants include non-ionic or silicone-based surfactants or methylated seed or vegetable oils. Imazapyr is rapidly absorbed by plants and is unaffected by rain 1 hour after application. The growing plant tips usually yellow and die within 1 to 4 weeks after treatment. The label for imazapyr states that it should be applied by a licensed aquatic applicator.

Sodium carbonate peroxyhydrate
(GreenClean®, PAK 27®, Phycomycin®)

Sodium carbonate peroxyhydrate is a granular contact algaecide with hydrogen peroxide as the active agent. It selectively controls blue-green algae at lower application rates and controls many types of algae at higher rates. It is not effective on the macroalgaes, *Chara* or *Nitella*, or on any higher plants. The granules should be broadcast across the surface or dis-

persed below the surface to make direct contact with the maximum amount of algae. Solutions or foams can be prepared from the granules (see the label); some liquid formulations also are available. Treat early when algal growth first appears. Sunlight and warm water temperatures enhance its efficacy. Bubbling, bleaching and/or discoloration of the algae should be evident soon after application.

Triclopyr
(Renovate 3®)

Triclopyr is a systemic herbicide used to control many floating, submersed and emersed plants. It may be particularly effective on plants such as alligatorweed, willows, water hyacinth and milfoils. It can be applied to the leaves or to cut surfaces. Triclopyr works by translocating to the roots and disrupting growth metabolism. Therefore, it should be applied while plants are actively growing and leaves are fully developed. A non-ionic surfactant should be added when treating floating and emergent vegetation. When applying by sub-surface injection, for control of submersed species, use a drop hose or add a sinking agent/adjuvant.

Precautions

The information and suggestions in this publication reflect the opinions of Extension fisheries specialists based on field tests and are generally effective. Conditions or circumstances that are unforeseen or unexpected may lead to less than satisfactory results even when best management practices are used. Neither the Cooperative Extension Service nor the Southern Regional Aquaculture Center assumes responsibility for such occurrences. **All risk shall be assumed by the applicator.**

All aquatic herbicides must be registered and labeled for use by the Environmental Protection Agency and the Department of Agricul-ture. The status of herbicide label clearances is subject to change and may have changed since this publication was printed. County Extension agents and appropriate fisheries and aquaculture specialists are advised of changes as they occur. Please check with your Extension Service if questions arise.

The applicator is always responsible for the effects of herbicide residues on livestock and crops, as well as problems that could arise from the drift or movement of herbicide from his/her property to that of others. Always read and follow carefully the instructions web site at *http://aquaplant.tamu.edu/*.

Table 1. Treatment response of common aquatic plants to registered herbicides and grass carp.[1]

	Aquatic herbicide [2]									
Aquatic group & vegetation	Copper & copper complexes algicides	Copper & copper complexes herbicides	2,4-D	Diquat	Endothall	Glyphosate	Fluridone	Triclopyr	Imazapyr	Sodium carbonate peroxy-hydrate
Algae										
planktonic	E		P	P	G [3]	P	P			G
filamentous	E		P	G	G [3] –P [4]	P	P			G
Chara/Nitella	E		P	P	G [3] –P [4]	P	P			
Floating plants										
azolla	P		F	G		F	E			
duckweeds	P		F	G	P	P	E		F	
salvinia	P		G	G		G	E			
water hyacinth	P	G [5]	E	E		G	E	E	E	
watermeal	P		F	F			G			
water lettuce	P	G [5]	F	E		G	G	G	E	
Submersed plants										
coontail	P	G [5]	G	E	E		E			
elodea	P	G [5]		E	F		E			
fanwort	P	P	F	G	E		E			
hydrilla	P	G [5]		G	G		E			
milfoils	P	G [5]	E	E	E		G	E		
naiads	P	G [5]	F	E	E		E			
parrotfeather	P	P	E	E	E		E	G	G [6]	
pondweeds	P	G [5]	P	G	E		E		G [6]	
Emersed plants										
alders	P		E	F	P	E	P	E	E	
alligatorweed			F	P		G	F	E	E	
arrowhead	P		E	G	G	E	E		E	
buttonbrush	P		F	F	P	G	P		G	
cattails	P		F	G	P	E	F		E	
common reed	P		F	F		E	F		E	
frogbit		F [5]	E	E		F		E	E	
pickerelweed		F [5]	G	G		F	P	G	E	
sedges & rushes	P		F	F		G	P		E [7] F [8]	
slender spikerush	P			G		P	G		F	
smartweed	P	F [5]	E	F		E	F	E	E	
southern watergrass	P		P			E	G		E	
waterlilies	P		E	P		G	E	G	G	
water pennywort	P		G	G		G	P	E	E	
water primrose	P		E	F	P	E	F	E	E	
watershield	P		E	P		G	G		E	
willows	P		E	F	P	E	P	E	E	

[1] Registered as of 4/06 by the U.S. Environmental Protection Agency (EPA)
[2] E = Excellent control, G = Good control, F = Fair control, P = Poor control, blank = unknown or no response
[3] Hydrothol® formulations
[4] Aquathol® formulations
[5] Specific copper complexes only—e.g., Nautique®, Komeen® (see label)
[6] Spray only emergent portion
[7] E for sedge
[8] F for rush

Product	Common trade names
Copper	Copper sulfate, Cutrine, Cutrine Plus, K-Tea, Captain, Algae Pro, Agritec, Cleargate
Endothol	Aquathol, Aquathol K, Aquathol Super K
Hydrothol	Hydrothol 191
2,4-D	Navigate, WeedRhap
Fluridone	Sonar, Avast
Diquat	Reward, Weedtrine D
Glyphosate	Rodeo, Aquamaster, AquaNeat, Eraser AQ
Triclopyr	Renovate 3
Imazapyr	Habitat (for use by licensed aquatic applicators only)
Sodium carbonate peroxyhydrate	Green Clean, PAK 27, Phycomycin

Table 2. Restrictions on the use of water after treatment with aquatic herbicides[1] (number of days after treatment before use in private waters only).

	Human use			Livestock	Irrigation	
Common name	Drinking	Swimming	Fish	Watering	Turf	Crops
copper sulfate [2]	0	0	0	0	0	0
copper complexes	0	0	0	0	0	0
2,4-D	*	*	*	*	*	*
diquat	2-3	0	0	1-3 [3]	2-3	5
endothall [4]	7-25	1	3	7-25	7-25	7-25
glyphosate [5]	0	0	0	0	0	0
fluridone [6]	0	0	0	0	7-30	7-30
triclopyr	#	0	0	0	0 [7]	120 [8]
imazapyr	@	0	0	0	120 [9]	120 [9]

[1] Aquatic vegetation control (particularly algae) can result in periods of low dissolved oxygen that can stress and/or kill fish. It is best to treat most aquatic vegetation early in the growing season when plants are rapidly growing. Treating small areas (e.g., one-fourth) of a pond at a time at 10- to 14-day intervals will allow for decomposition usually without causing an oxygen depletion.

[2] If water is for drinking, the elemental copper concentration should not exceed 1.0 ppm (i.e., 4.0 ppm copper sulfate pentahydrate).

[3] Depending on formulation - **Read label.**

[4] Length of use restriction for endothall varies with concentration used. **Read label.**

[5] Do not apply within 0.5 mile of a functioning potable water intake.

[6] Do not apply within 0.25 mile of a functioning potable water intake.

[7] No restriction on irrigating established grasses but **do not harvest hay for 14 days after application. Read label.**

[8] Or until non-detectable concentrations in immunoassay analysis.

[9] Or until <1.0 ppb

* Water restrictions on 2,4-D vary by state with formulation, rate and time of year. **Read label.**

\# Minimum setback distances from potable water intakes required and laboratory tests to determine < 0.4 ppm for use. **Read label.**

@ > ½ mile from potable water intake.

SRAC fact sheets are reviewed annually by the Publications, Videos and Computer Software Steering Committee. Fact sheets are revised as new knowledge becomes available. Fact sheets that have not been revised are considered to reflect the current state of knowledge.

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