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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 to stimulate a phytoplankton bloom, periodic draw-downs, or using an aquatic dye to reduce light penetration; 2) biological methods, where legal, such as grass carp (*Ctenopharyngodon idella*) or tilapia (*Oreochromis* spp.); and 3) mechanical methods such as seining and raking. Using a combination of these methods within a comprehensive, integrated management 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. All aquatic herbicides must be registered and labeled for use by the U.S. Environmental Protection Agency and individually approved by the state agency charged with pesticide registration. The herbicide selected must be labeled for use in ponds with 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 as part of the herbicide selection process. Most aquatic weeds begin growing in early spring when water temperatures are 55 to 60 °F (12.8 to 15.5 °C). The spring months (March, April, May), when water temperatures are between 70 and 80 °F (21.1 and 26.7 °C), 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. Not following label directions can result in fish kills.** Aquatic weeds killed by the herbicides often decompose rapidly. The decomposition process consumes oxygen and can reduce the amount of dissolved oxygen available to fish, particularly at night. 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 (see SRAC Publication No. 3700, *Pond Aeration*). 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 tends 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. **In a growing number of cases aquatic plants are developing herbicide resistance. For this reason it is prudent to rotate herbicides used on a specific weed in specific ponds and not use the same or cheapest herbicide over and over again.** If a specific treatment no longer appears to work, then herbicide resistance could be the reason.

Application methods

Application methods depend on the herbicide formulation and the target weed species. See SRAC Publication No. 3601, *Aquatic Weed Management: Herbicide Safety, Tech-*

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

Table 1. Treatment response of common aquatic plants to registered herbicides.

Aquatic group & vegetation	bispyribac	carfentrazone	copper & copper complexes - algecides	copper complexes - herbicides	diquat	endothall	flumioxazin	fluridone	glyphosate	imazamox	imazapyr	penoxsulam	sodium carbonate peroxyhydrate	triclopyr	2,4-D
	Aquatic herbicide[1]														
Algae															
Chara/Nitella	P		**E**		P	**G**[2]-P[3]	P	P	P						P
filamentous			**E**		**G**	**G**[2]-P[3]	**G**	P	P				**G**[6]		P
planktonic			**E**		P	**G**[2]	F	P	P				**G**[6]		P
Floating plants															
azolla		**G**	P		**G**			**E**	F			**E**			F
duckweeds		**E**	P		**G**	P	**E**	**E**	P		P	**E**			F
salvinia	F	**G**	P		**G**		**G**	**E**	**G**	**E**		**E**			
water hyacinth	**E**	**G**	P	**G**[4]	**E**		P	**E**	**G**	**E**	**E**	**E**		**E**	**E**
watermeal	F	**G**	P		F		**E**	**G**				**G**			F
water lettuce	**E**	**E**	P	**G**[4]	**E**		**E**	**G**	**G**		**E**	**E**		**G**	F
Submerged plants															
coontail	P		P	**G**[4]	**E**	**E**	**G**	**E**							**G**
elodea			P	**G**[4]	**E**	F	**E**	**E**				**G**			
fanwort			P	P	**G**	F	**G**	**E**				**G**			F
hydrilla	**E**		P	**G**[4]	**G**	**G**	**G**	**E**		**G**		**E**			
milfoils	**G**	**E**	P	**G**[4]	**E**	**E**	**G**	**G**		**G**		**E**		**E**	**E**
naiads			P	**G**[4]	**E**	**E**	**E**	**E**				**G**			F
parrotfeather			P	P	**E**	**E**	**G**	**E**		**G**	**G**[5]	**G**		**G**	**E**
pondweeds	**G**		P	**G**[4]	**G**	**E**	**G**	**E**		**E**	**G**[5]	**G**			P

[1] E = Excellent control, G = Good control, F = Fair control, P = Poor control, blank = unknown or no response
[2] Hydrothol formulations
[3] Aquathol formulations
[4] Specific copper complexes only—e.g., Nautique, Komeen (see label).
[5] Spray only emergent portion
[6] Best on blue-green algae (higher concentrations for green algae)
[7] E for sedge
[8] F for rush

(continued on next page)

Table 1 continued.

Aquatic group & vegetation	bispyribac	carfentrazone	copper & copper complexes - algecides	copper complexes - herbicides	diquat	endothall	flumioxazin	fluridone	glyphosate	imazamox	imazapyr	penoxsulam	sodium carbonate peroxyhydrate	triclopyr	2,4-D
	Aquatic herbicide[1]														
	Emergent plants														
alders			P		F	P		P	**E**		**E**			**E**	**E**
alligatorweed	**E**	**F**			P		**G**	F	**G**	**G**	**E**			**E**	F
arrowhead	**E**		P		**G**	**G**	**G**	**E**	**E**	**E**	**E**				**E**
buttonbrush			P		F	P		P	**G**		**G**				F
cattails	P		P		**G**	P	P	F	**E**	**E**	**E**				F
common reed			P		F		P	F	**E**	**G**	**E**				F
frogbit	**E**			F[4]	**E**		**G**		F	**E**	**E**			**E**	**E**
pickerelweed	F			F[4]	**G**		P	P	F	**E**	**E**			**G**	**G**
sedges & rushes	F		P		F		F	P	**G**		**E**[7] F[8]	**G**			F
slender spikerush			P		**G**		P	**G**	P		F				
smartweed	**G**		P	F[4]	F		P	F	**E**	**E**	**E**	**G**		**E**	**E**
southern watergrass			P					**G**	**E**		**E**				P
waterlilies	F		P		P		F	**E**	**G**	**G**	**G**	**G**		**G**	**E**
water pennywort	**G**		P		**G**		**G**	P	**G**		**E**	**G**		**E**	**G**
water primrose		**F**	P		F	P	**G**	F	**E**	**E**	**E**			**E**	**E**
watershield			P		P		**G**	**G**	**G**	**G**	**E**				**E**
willows	P		P		F	P	P	P	**E**		**E**			**E**	**E**

Active ingredients	Commonly available trade names
bispyribac	Tradewind
carfentrazone	Stingray
copper & complexes	Copper Sulfate, Cutrine, Cutrine Plus, K-Tea, Captain, Agritec, EarthTec, Clearigate
copper - herbicides	Komeen, Nautique
diquat	Reward, Harvester, Tribune, Tsunami DQ, Diquat SPC 2L, Weedtrine D
endothall	Aquathol K, Aquathol Super K, Hydrothol 191
flumioxazin	Clipper
fluridone	Sonar, Avast, WhiteCap, Restore, Fluridone
glyphosate	Rodeo, Aquamaster, AquaNeat, Eraser AQ, Refuge
imazamox	Clearcast
imazapyr	Habitat, Arsenal, Polaris
penoxsulam	Galleon
sodium carbonate peroxyhydrate	Green Clean, PAK 27, Phycomycin
triclopyr	Renovate, Navitrol, Ecotriclopyr
2,4-D	Navigate, Weedar 64

Table 2. Aquatic vegetation herbicide control water use restriction (number of days after treatment before use in private waters only).[1]

	Human use			Livestock	Irrigation	
Common name	Drinking	Swimming	Fish	Watering	Turf	Crops
bispyribac	0	0	0	0	30	30
carfentrazone	0 - 1[2]	0	0	0 - 1[2]	0 - 14[2]	0 - 14[2]
copper complexes[3]	0	0	0	0	0	0
diquat	1 - 3[4]	0	0	1	1 - 3[4]	5
endothall[5]	7 - 25	1	0	7 - 25	7 - 25	7 - 25
flumioxazin	0	0	0	0	0 - 3[4]	5
fluridone[6]	0	0	0	0	7 - 30	7 - 30
glyphosate[7]	0	0	0	0	0	0
imazamox	0	0	0	0	1	1[8]
imazapyr	*[9]	0	0	0	120[10]	120[10]
penoxsulam	0	0	0	0	0	*[11]
SCP[12]	0	0	0	0	0	0
triclopyr	*[13]	0	0	0	0[14]	120[15]
2,4-D	*[16]	*[16]	*[16]	*[16]	*[16]	*[16]

[1] Aquatic vegetation control can cause a period of low dissolved oxygen, which can stress and/or kill fish. It is best to treat most aquatic vegetation early in the growing season when the plant is rapidly growing. Treating small areas (e.g., ¼) of pond at a time at 10- to 14-day intervals usually will allow for decomposition without causing an oxygen depletion.

[2] Varies if 20% or more of surface area is treated.

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

[4] Depending on formulation or rate. **Read label.**

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

[6] Do not apply within ¼ mile of a functioning potable water intake.

[7] Do not apply within ½ mile of a functioning potable water intake.

[8] Do not use treated water to irrigate greenhouses, nurseries or hydroponics.

[9] Greater than ½ mile from potable water intake.

[10] Or until <1.0 ppb.

[11] Do not use water from any treated site for food crop irrigation until residues are determined to be less than or equal to 1 ppb.

[12] Sodium carbonate peroxyhydrate.

[13] Minimum setback distances from potable water intakes required and laboratory tests to determine < 0.4 ppm. **Read label.**

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

[15] Or until non-detectable concentration in immunoassay analysis.

[16] Water restrictions on 2,4-D vary with formulation, location, rate and time of year. **Read label.**

nology, and Application Techniques. 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. Submersed plant treatments from boats often require the use of weighted trailing hoses to distribute the herbicide directly on the target plants. Hand-operated or mechanical rotary spreaders can be used to apply granular or pelleted formulations. Soluble crystals, such as copper sulfate, should be dissolved in water and sprayed over the pond. While not ideal, the required amount can be placed in burlap bags and dragged behind a boat or suspended in the water near an aerator until the herbicide dissolves.

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

Herbicide dosage calculations

Aquatic herbicides must be applied at labeled rates. **The label is the law.** 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 emergent plants, are applied on the basis of the surface 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:

$F = A \times R$

Where: 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:

$F = A \times D \times R$

Where: 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 on a parts per million weight (ppmw) basis.

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

$F = (A \times D \times CF \times ECC) \div I$

Where: 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 = Total amount of active ingredient divided by the total amount of active and inert ingredients
For liquid products, I = pounds of active ingredient per 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. Some herbicides can be mixed together to increase their effectiveness. For example, a contact herbicide can be tank mixed with a systemic-type herbicide. Refer to the product labels for specific mixing and application recommendations.

Bispyribac-sodium

(Tradewind®)

Bispyribac-sodium is a selective, systemic herbicide that comes in a soluble powder formulation and is packaged in water-soluble packets. It is effective on many floating and submerged aquatic plants. Its mode of action is by inhibiting acetolactate synthase (ALS), which is a key plant enzyme in the synthesis of certain amino acids. It is slow acting and requires 30 to 60 days contact time for submerged plant control. For submerged species, treat whole lakes, ponds or closed-off coves for best results. It can be applied either subsurface or foliar, depending on the target plant. An approved non-ionic surfactant should be added when it is used as a foliar application. It should not be used in crawfish ponds.

Carfentrazone-ethyl

(Stingray®)

Carfentrazone is a liquid contact herbicide that is light-dependent in its activity. Its mode of action promotes the formation of peroxides, which disrupts cell membranes. It can control many floating and some submerged (e.g., watermilfoil) and emergent species (e.g. alligatorweed). Carfentrazone is relatively new aquatic chemistry and not all target species have been evaluated, but it appears to have some selectivity. It degrades rapidly in high pH water (pH > 9), which may result in reduced efficacy, as will murky water conditions. An approved non-ionic surfactant or methylated seed oil should be added when it is used as a foliar application.

Copper sulfate

(Various trade names)

Copper sulfate is a contact herbicide primarily used to control algae. However, there are some species of algae (e.g., *Pithophora*) that copper does not control effectively. Copper can interfere with gill functions and, if improperly used, can be toxic to fish and zooplankton. In ponds culturing young fish or fry, copper will often kill the zooplankton that fish need for food and they will starve. 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 due to decomposition.

Copper sulfate is also formulated as a solution made by dissolving the crystals in an acid. 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 the alkalinity, hardness, pH, dissolved and particulate matter, and temperature of the water. 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. Copper is less effective in cold water (< 60 °F) and treatments should be delayed until temperatures rise. (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 others)

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 such as Komeen and Nautique 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®, Harvester®, Tribune®, Tsunami DQ®, Diquat SPC 2L®, Weedtrine-D®, WeedPlex Pro®, and others)

Diquat is a contact herbicide that can be sprayed or injected into water to control submersed weeds and filamentous algae. Its mode of action is the destruction of cell membranes. It can also be used as a foliar application to control duckweeds (e.g., *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. Mixing diquat with liquid chelated copper has proven to provide better control of many submersed weeds and algae than either chemical alone.

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 granular or liquid formulation and is a dimethylalkylamine salt of endothall. The two products vary considerably. Hydrothol® is more toxic to fish, so the manufacturer recommends applications above 0.3 ppm be made only by commercial applicators as marginal or sectional treatments. 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.

Flumioxazin

(Clipper®)

Flumioxazin is a broad-spectrum contact herbicide that is available as a dry flowable formulation. It is fast acting and may be applied either subsurface or as a foliar spray. It controls certain floating weeds (e.g., duckweed, watermeal and salvinia), submerged plant species (e.g., coontail, pondweeds and hygrophila), and macrophytic filamentous algae (e.g., *Pithophora* and *Cladophora*). Its mode of action is by inhibiting synthesis of an enzyme required in chlorophyll production. An aquatically approved non-ionic surfactant should be added when it is used as a foliar application. It should be applied to actively growing plants. **Flumioxazin degrades more rapidly in high pH water (pH > 8.5), which may greatly reduce efficacy.** It should not be used in crawfish aquaculture ponds. It may be used in whole lake or spot treatments in slow-moving or quiescent waters. When making applications to submersed weeds, the label recommends using weighted hoses to distribute the herbicide within the plant bed.

Fluridone

(Sonar®, AVAST®, WhiteCap®, Restore®, and Fluridone)

Fluridone controls most submersed and emersed weeds and is available as a liquid or pelleted formulation. Liquid formulations also control floating species such as salvinia, duckweed and watermeal. Its mode of action is to inhibit the synthesis of carotenoid pigments that protect chlorophyll from photo-degradation; thus, plants turn white as chlorophyll degrades after a fluridone treatment. Fluridone is translocated within the plant and slowly kills the plant over a 30- to 90-day period. Because of fluridone's slow uptake, it is not appropriate for ponds with significant flow-through or excessive runoff. 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 weeds.

Glyphosate

(Rodeo®, Eraser AQ®, Aquamaster®, AquaNeat®, Refuge®, and others)

Glyphosate is a foliar-applied, systemic herbicide used to control most shoreline vegetation and several emersed weeds. Glyphosate translocates from the treated foliage to underground storage organs (e.g., rhizomes). Its mode of action is to inhibit the synthesis of certain amino acids and other secondary metabolites. It is most effective when applied during a perennial weed's flowering or fruiting stage (e.g., cattails). On annual species it is most effective when applied during active plant growth. An aquatically approved non-ionic surfactant should be used with glyphosates that do not contain a surfactant. If rainfall occurs within 4 to 6 hours of application (depending on formulation—read the label), the effectiveness of glyphosate will be reduced.

2, 4-D

(Navigate®, Weedar 64®, Weed Rhap A-4D®, and others)

2,4-D is a systemic herbicide that is available as a granular or liquid formulation. Its mode of action is to stimulate uncontrolled growth in the meristematic tissue (i.e., rapidly growing/dividing), which ultimately causes plant death. Granular 2,4-D controls submersed weeds such as coontail and emersed weeds such as waterlily. Liquid formulations of 2,4-D are used to control floating weeds such as water hyacinth (*Eichhornia crassipes*) and several emergent 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. Some states have specific restrictions on the use of 2,4-D (e.g., county-by-county regulations) because of concerns with drift to non-target species, so check with your county Extension agent before considering 2,4-D applications.

Imazamox

(Clearcast®)

Imazamox is a selective, systemic herbicide that is available in both liquid and granular formulations. It is effective in controlling many floating, submerged and emergent plants. Its mode of action is to inhibit the enzyme acetohydroxyacid synthase (AHAS), which is involved in the synthesis of certain amino acids. It may be particularly effective on plants such as cattails, Chinese tallow, duckweed, mosquito fern, water hyacinth and water lettuce. It is a slow-acting herbicide that takes 60 to 120 days or longer to completely kill the target plants. An aquatically approved surfactant must be added when it is used as a foliar application. A methylated seed oil surfactant is preferred.

Imazapyr

(Habitat®, Arsenal®, Polaris®, and others)

Imazapyr is a foliar-applied, translocated, systemic herbicide used to control many floating and emergent 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.

Penoxsulam

(Galleon®)

Penoxsulam is a selective, systemic herbicide that is available in a liquid formulation. It can be absorbed through emerged leaves and submerged shoots or roots. Penoxsulam is currently the only aquatic herbicide that can be applied to exposed sediment after drawdown to inhibit the regrowth of susceptible weeds. Its mode of action is by inhibiting acetolactate synthase (ALS), which is a key plant enzyme in the synthesis of certain amino acids. It is effective in controlling many floating and submerged aquatic plants. Rapid dilution of in-water application will reduce its effectiveness. It is a slow-acting herbicide that takes 60 to 120 days or longer to completely kill the target plants, so any condition resulting in rapid dilution of treated water will reduce its effectiveness. A non-ionic surfactant should be added when treating floating and emergent vegetation.

Sodium carbonate peroxyhydrate

(GreenClean®, PAK 27®, Phycomycin®)

Sodium carbonate peroxyhydrate is a contact algaecide that is available as a granular or liquid formulation 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. It should be applied to make direct and immediate contact with the maximum amount of algae. Solutions or foams can be prepared from the granules (see the label). Treat early when algal growth first appears. Sunlight and warm water temperatures enhance efficacy. Bubbling, bleaching and/or discoloration of the algae should be evident soon after application. It is a strong oxidizing agent and should not be brought into contact with other pesticides or oxidative agents (e.g., bleach and potassium permanganate).

Triclopyr

(Renovate 3®, Navitrol®, Ecotriclopyr®, and others)

Triclopyr is a systemic herbicide used to control many floating, submersed and emergent plants. Its mode of action is to stimulate uncontrolled growth in the meristematic tissue (i.e., rapidly growing/dividing), which ultimately causes plant death. 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 to control submersed species, use a weighted trailing hose or add a sinking agent/adjuvant.

Precautions

The information and suggestions in this publication reflect the opinions of Extension fisheries and aquaculture specialists and applicators 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 Extension Services 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 U.S. Environmental Protection Agency. Once a herbicide receives a national registration, it also has to receive approval by the state agency charged with pesticide registration. 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 on the label. Many labels can be found on the Aquaplant web site at *http://aquaplant.tamu.edu/.*

New NPDES regulations

Due to a federal court ruling, all applications of herbicides into or over waters of the U.S. fall under the Environmental Protection Agency (EPA) National Pollution Discharge Elimination System (NPDES) as of 2011. The regulation reads, "You are required to obtain a permit if you discharge biological pesticide or chemical pesticide that leaves a residue in water when such applications are made into, over, or near waters of the United States." The EPA has permitting authority over six states (Alaska, Idaho, Massachusetts, New Hampshire, New Mexico, and Oklahoma), Washington, D.C., most U.S. territories and Indian lands, and many federal facilities. In the remaining 44 states (and the Virgin Islands), public agencies have developed and will issue the NPDES pesticide permits within their state boundaries. Contact your state environmental regulatory agency for more information on permits. **A directory of state agencies for NPDES pesticide permits is available at *http://cfpub.epa.gov/npdes/contacts.cfm?program_id=410&type=STATE* .**

USDA United States Department of Agriculture National Institute of Food and Agriculture

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