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starvation. One stocking of grass carp may give up to 10 years of weed control. This makes the use of grass carp highly competitive with other control methods, in spite of the apparently high initial cost ($7 to $8 per fish, depending upon quantity required and availability). The use of grass carp is the preferred alternative for management of most species of submersed vegetation in small species of impoundments.

You may purchase up to 150 triploid grass carp and stock ponds up to 10 acres in size in North Carolina without a permit. If you need more than 150 grass carp or plan to stock them in larger bodies of water, you will have to obtain a permit. Grass carp must be certified as triploid (sterile) and be purchased from an approved supplier. Contact the Division of Boating and Inland Fisheries in Raleigh at (919) 733-3633 for information on suppliers of triploid grass carp or to obtain a stocking permit application.

Grass carp are usually stocked at a minimum size of 10 to 12 inches to avoid predation by large fish, such a bass. Stocking 15 to 20 per vegetated acre is generally sufficient to control most problems with submersed weeds, whereas 50 or more may be necessary for even temporary suppression of algae or floating plants, such as duckweeds. Because of the high stocking rates, frequently unreliable results, loss of fish because of starvation and the high cost of the fish, grass carp are rarely stocked for control of duckweeds or algae. For additional information on the use of grass carp, see AG-456, Using Grass Carp for Aquatic Weed Management.

Chemical Control

Diquat, endothal, glyphosate, and copper compounds are EPA-registered aquatic herbicides. They are safe for application in water that is used to irrigate crops when applied according to the label. These compounds are also safe for use in water used for other purposes provided that the applicator and those who use the water comply with all water use restrictions specified on the label.

Fluridone (and in some cases 2, 4-D), may have limited use for controlling aquatic weeds in irrigation water. Use these two compounds with extreme caution in waters used for irrigation of very sensitive crops, such as tobacco, tomatoes, peppers, and potatoes.

Water-Use Restrictions. Irrigation restrictions for aquatic herbicides are based upon extensive research on persistence, crop sensitivity, residues in crops and animal feeding studies. There are no restrictions for use of water for irrigation or other purposes following application of copper compounds for control of algae, because the recommended concentrations are not phytotoxic to crops and toxic concentrations do not accumulate in crop plants. Table 2 shows the length of time you must wait after applying an aquatic herbicide before you can use the water for irrigation and other purposes.

Studies conducted in North Carolina piedmont farm ponds demonstrated that concentrations of diquat decreased from 1 part per million (ppm) to nearly zero in less than two days after application. Endothall (Aquathol K) concentrations decreased from 2 ppm to 1 ppm within 14 days after application and to 0.5 ppm

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within 20 days after application. Crop plants are tolerant of higher concentrations of these compounds than those present after the required waiting periods, and toxic concentrations have not been found to accumulate in test plants. Therefore, there is a wide margin of safety in using these compounds in irrigation sources.

The half-life of glyphosate is about 14 days in water. Although glyposate is a broad spectrum herbicide, it is recommended only for emergent aquatic weed control; therefore, only very low concentrations should occur in the pond water after application. The glyphosate that does enter the water is quickly and tightly bound to organic compounds. Therefore, when used according to label instructions, glyphosate is safe for control of emergent aquatic weeds in irrigation supply ponds.

Fluridone (Sonar) is more persistent in pond water than either diquat or endothall. It takes two months or longer before the residue diminishes to an undetectable level, depending upon water temperature and the rate of inflow and outflow from the pond. Even though fluridone is moderately persistent in water, only very low concentrations (maximum labeled rate is only 0.9 and 0.15 ppm for ponds and lakes, respectively) are required to control aquatic weeds. Most established crop plants have demonstrated tolerance at concentrations higher than those expected to occur in irrigation water, but seedling crops are quite sensitive and should not be irrigated with fluridone-treated water.

Results of field tests suggest that concentrations of fluridone toxic to crops may occasionally persist in pond water well beyond the 30-day waiting period specified on the label for irrigation. This information and the results of subsequent greenhouse testing suggest that the 30-day water use restriction for irrigation after fluridone application may be insufficient, especially for seedlings and new transplants of sensitive crops, such as tobacco, tomatoes and peppers. Therefore, use extreme caution if fluridone is required for weed control in pond water used for irrigation.

If fluridone has been applied to an irrigation pond and there is any question whether or not the water is safe for irrigation of a particular crop (after the end of the specified waiting period) a simple field bioassay may be used to assess the safety of the water. Water a very small area daily (use a sprinkling can to apply the water to a few plants) for 7 to 10 days and carefully observe the new growth (new leaves and the bases of young, immature leaves that are still growing) each day, beginning about 3 or 4 days after you begin irrigation. The appearance of new growth that is either white or pinkish instead of the normal green is a sign of fluridone toxicity. Symptoms usually appear within seven to 10 days after irrigation of sensitive crops. In this case, the pond water is not yet safe to use for irrigation of that crop.

Choosing the Correct Herbicide

The first consideration in choosing the most effective aquatic herbicide for a particular situation is to identify the weeds correctly. Several publications may aid in weed identification:

Aquatic and Wetland Plants of South Carolina by Cynthia A. Aulbach-Smith and Steven J. de Kozlowski, available from the South Carolina Department of Natural Re-sources, 1201 Main Street,

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Suite 1100, Columbia, SC 29201, (803) 737-0800.

Florida Freshwater Plants. A Handbook of Common Aquatic Plants in Florida Lakes by M.V. Hoyer, D.E. Canfield, C.A. Horsburgh, and K.P. Brown, available from IFAS Publications, University of Florida, P.O. Box 110011, Gainesville, FL 32611, (800) 226-1764.

How to Identify and Control Water Weeds and Algae, 4th edition, edited by James C. Schmidt, available from Applied Biochemists, Inc., 5300 West County Line Road, Mequon, WI 53092.

Identification and Control of Weeds in Southern Ponds by George W. Lewis and James F. Miller, available from the Cooperative Extension Service, University of Georgia, College of Agriculture, Athens, GA.

A Manual of Marsh and Aquatic Vascular Plants of North Carolina by Ernest O. Beal, available from Agricultural Communications, Publications Office, Box 7603, Raleigh, NC 27695-7603.

It is necessary to know the weed species so that you can select the proper management procedures. Wrap samples of the weeds in a damp (not wet), absorbent paper towel, place them into a sealed plastic bag, and take it to your county Extension office. The agent will identify the weed and recommend an appropriate management strategy.

If the pond is used for fish production, consider the toxicity of the herbicide to fish. Two common aquatic herbicides, copper and Hydrothol 191 (amine formulation of endothall) are toxic to fish and should be used with extreme caution or avoided entirely. Copper sulfate (sometimes called Bluestone) is relatively toxic to many species of fish at or near the concentrations necessary for algae control. When copper sulfate enters the water, it immediately breaks down into its component copper ion (Cu ++) and sulfate ion (SO4 --) . The free copper ion makes copper toxic. This effect is especially pronounced in the soft water found in most North Carolina ponds. If copper is required, one of the organic copper complexes, such as Cutrine-Plus, Komeen, or K-Tea, is much safer for the fish and more effective as an algicide. In the organic copper complexes, an organic molecule binds the copper ion so that free copper ions are not present in the water, thereby substantially reducing the toxicity to the fish. Hydrothol 191 (either the liquid or granular formulation) is very toxic to fish; avoid using it in small impoundments where fish mortality is a concern. In larger impoundments, Hydrothol 191 may be used safely if only a small portion of the body of water is to be treated (for example, a cove or a localized, marginal weed mat). To avoid fish kills in this situation, apply the herbicide slowly, beginning at the back of the cove and at the bank and working outward toward open water. Fish can sense the herbicide and will swim away from the area of application. However, if a herbicide is applied from open water toward the bank or from open water into the cove, a fish kill will result. Fish kills caused by direct herbicide toxicity usually occur within a few hours after pond treatment.

Fish mortality also can occur because of the lowered oxygen concentration (oxygen depletion) in the water after application of an aquatic herbicide. This phenomenon occurs because bacteria and fungi use up the oxygen during decomposition of the dead plants. Fish kills resulting from oxygen depletion occur usually 2 to 3 days after pond treatment and are more likely to occur after applications of copper, Hydrothol 191, or diquat, because these compounds are active on the oxygen producing phytoplankton as well as the higher plants. Therefore, in small ponds where fish mortality is a concern, use Aquathol (potassium salt of endothall) or fluridone if it is rated effective on the problem plant. These compounds are not active on phytoplankton, so this source of oxygen production remains viable. To prevent oxygen depletions in small impoundments, treat no more than one-fourth of the weed infestation at one time, especially if the weeds are dense and the water is warm (summer conditions). In large impoundments, the potential for fish mortality can be reduced by treating only one-third to one-half of the lake at one time; however, reduced weed control may result. If all or most of the pond or lake is covered with weeds, fish kills resulting from reduced oxygen levels may be avoided by postponing the herbicide application until the following year. The best time to apply most herbicides and to avoid fish kills is early in the spring when the water temperature is about 65 degrees F. The weed density is also lower at this time, and less vegetation is present to decay.

A third consideration in choosing a herbicide is cost. Aquatic weed control with herbicides may be relatively expensive. The cost depends upon the specific herbicide chosen, the problem plant (species), weed density and other variables, such as water depth and current. Costs range from $50 to more than $300 per acre for filamentous algae and submersed weeds and generally increase in the order of copper sulfate, complexed copper, diquat, endothall and fluridone.

Calculating the Amount of Herbicide to Use. Recommendations for application of herbicides are based on surface acreage (SA) or the final concentration of herbicide in the water. The surface acreage of rectangular pounds is easily calculated:

$$SA = \frac{\text{Length in feet x Width in feet}}{43{,}560}$$

For irregularly shaped ponds, the surface acreage must be estimated by inscribing a sketch of the pond in a rectangle, measuring the dimensions of the rectangle, estimating the percentage of the rectangle occupied by the pond and calculating:

$$SA = \frac{\text{Length in feet x width in feet x (\% Occupied by pond)100}}{43{,}560}$$

The amount of herbicide needed for specific concentrations for ponds of differing average depths is usually indicated on the label. To measure the average depth, prepare a pole marked in 1-foot intervals. (Black electrical tape works well for this.) Lower this pole into the water at least four times at equally spaced intervals, going form one side to the other, and record the depths. Add the values together and divide by the number of measurements plus one. Repeat this procedure in at least three different directions and average these values for the average depth (D). The average depth of the area to be treated should be measured. In some cases, this may be the whole pond – for example, a Sonar treatment for duckweed or watermeal; in other cases, only a portion of the pond or lake may be treated (such as a marginal treatment with copper to control algae mats along the bank or in a cove). Although the required amount of herbicide often can be determined from a chart on the herbicide label, it is sometimes necessary to calculate it. If the label specifies treatment in terms of parts per million, gallons per acre-foot, or pounds of active ingredient (ai) per acre-foot and does not provide a chart, you will have to

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calculate the amount of herbicide to use. Acre-feet is an expression of pond or lake volume (of the area to be treated). One acre-foot of water weighs approximately 2.7 million pounds. To calculate the amount of active ingredient (ai) required on a weight basis (pounds), use the following equation:

lb ai = SA x D x Desired Concentration (ppm) x 2.7

To calculate the amount of granular herbicide formulation, which is not 100 percent active ingredient, or to calculate the number of gallons of a liquid formulation, use the following formulas:

Granular formulation:

$$\text{lb} = \frac{\text{lb ai required} \times 100}{\text{percent ai}}$$

Liquid formulation:

$$\text{gal} = \frac{\text{lb ai required}}{\text{b ai per gallon}}$$

Application Methods

Aquatic herbicides recommended for use in irrigation supplies are available in liquid, granular, or pellet formulations. Sophisticated equipment is not necessary to apply these herbicides to small impoundments or protected coves of larger lakes.

For control of submersed plants, pour liquid formulations, such as diquat, directly from the container while moving around the pond in a boat. The herbicide will disperse rapidly in the water. If the pond contains very dense vegetation, which will reduce mixing of the herbicide, or if the pond has a high flushing rate, the herbicide should be diluted and dispersed more evenly. Spraying the diluted herbicide on the surface ensures better coverage of dense mats of filamentous algae or submersed weeds that have reached the surface. Use a rake, paddle or similar tool to break up dense surface mats of filamentous algae during spraying to allow penetration of the herbicide into the mats.

The herbicide may also be applied by placing the end of the spray wand beneath the surface and delivering the chemical just above the growing weeds. Injecting the herbicide in this manner is quite effective for controlling weeds that are in deeper water and have not yet reached the surface. If you use the injection method, carefully deliver the herbicide without stirring up the mud on the bottom, as suspended mud particles may absorb and inactivate the herbicide. Granular or pelletized herbicides can be broadcast by hand or with a hand-held spreader.

For control of floating or emergent plants, such as duckweed and cattails, apply the herbicide to the plants in a fine spray with a hand-held or backpack sprayer. Applying herbicides to floating and emergent vegetation usually requires the use of a nonionic surfactant (such as X-77, Cide-Kick, or Induce) to ensure good coverage and penetration through the waxy cuticle on the surface of the leaves. Check the label and follow the instructions carefully. Failure to include the required surfactant may result in ineffective weed control and unnecessary expenditures for retreatment. Surfactants are not needed for application of herbicides to algae and submersed vascular aquatic weed infestations because they have no waxy cuticle.

Whenever applying herbicides, always follow the recommended precautions regarding contact and handling of these chemicals. Wear protective clothing as indicated on the product label.

ASSISTANT'S ANGLE

What's in Your Cart?

By Nate Uselding
Dellwood Hills Golf Club

Growing up, I climbed the ranks in the Boy Scouts and ultimately earned the highest rank within scouting of an Eagle Scout. One of the many things I took from scouting and use in my daily endeavors is the Boy Scout motto, be prepared. I try and live by this motto because it really gets under my skin when I haven't prepared for everything and it comes back to bite me.

How do I go through the day being prepared? I start with my cart. One way I prepare myself for what the job entitles is what I carry with me. How do you get the entire shop in the back of your cart? I wish I could have everything and the kitchen sink back there but I must carry an abbreviated version of it because it is only so big. There is nothing worse than being on the other side of the course and having to run back to the shop for something you don't have. In our profession, time is money and you have to be efficient with your time in order to get the job done. Especially when a simple run back to the shop can easily take 30 minutes or more and you lose the gap you were working in.

What is in my cart? Here is a list of everything: golf balls, tees, scorecard, pencil, duct tape, work gloves, hacksaw, pin flags, white and green turf paint, spray gun, soil probe, divot repair tool, a 1' x 2' piece of plywood, cart blocks, a bucket for garbage, towel, quick coupler key and my tool box filled with an adjustable wrench, pliers, screwdrivers, utility knife, file, zip ties, wire cutter, hammer, irrigation key and a tape measurer.

What is the most important? I use a combination of my knife, pliers and soil probe everyday. Just in case I hand out my knife to someone, I carry an extra one because you never know when you need to cut something. There are times when my cart gets raided and the one thing that always goes missing is my knife, so I keep my extra one hidden. My pliers is like an extra set of fingers, and the soil probe is not only useful for testing the soil but it is also known to pull a serious weed now and then out on the course.

My favorite tool has to be a screwdriver due to its versatility. That sucker is used for everything but screwing. I use it for poking, scraping, scratching, prying and whatever else I can imagine. It's the best tool ever! That is why I have four of them and in all different sizes.

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What's in Your Cart?

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What don't I have in my cart that I would like? It would definitely have to be a mini shovel and my clubs. If I could get a three-foot shovel that fit in the back of my cart I would have it all. It would make my day much easier because I could use it for a lot of important daily tasks. Also, my clubs would allow me to play a round of golf every day. This would never happen of course, but I do grab a couple clubs now and then to see how a couple of holes play.

The one thing I would like to say good-bye to would be my paint gun. It is stored in back with everything else, but as I drive around, things move and the gun goes off. Oh yea, I have tons of paint spots all over the inside of my cart, but where else do I put the can of paint? I tried to put it in the cup holder but it gets in the way of my morning cup of coffee. I also have tried to pull it out of the gun a little ways thinking if the trigger gets bumped I will be ok, but it always seems to find its way back in and again and all over my cart. I'll admit, it is handy and I enjoy using it but it sure is a pain in the rear when it is not in use.

What does your cart look like? Is your cart clean and organized or do you collect everything in the back of your cart? I try and keep mine clean but I am always picking up something on the course and throwing it in the back of my cart. To help keep my cart clean, I carry an empty 2 fi gallon bucket to throw all the trash in. It works pretty well and it helps me keep my cart more organized. It is usually all the sticks and branches I pick up that build up and always cause a mess. When I do wash my cart, I go all out. I'm talking with a power washer and soap and then detailing it with Armor All to get the perfect shine. I like to think I'm riding around in style after it is all shined up. A word to the wise though, don't shine the seat; it tends to get a bit slippery.

I am a task manager and I pride myself on finishing each job effectively and efficiently. One of the best ways for me to accomplish this is by being prepared at all times. I will never forget my childhood memories of scouting and all the lessons I learned throughout the years. The way I prepare my cart helps me tackle anything that is thrown my way. So, I ask you, what is in your cart?

An Adventure in Life

By Randy Witt, CGCS
Senior Superintendent
Hong Kong Golf Club

People, the constant in life unless you are a recluse. In our lives, be it at home or at work, or out and about, we are in contact with and deal with people. People have a tremendous affect on our lives. One of the more interesting parts of my adventure has been meeting and dealing with people of different backgrounds and cultures. A large part of the successes we all enjoy as superintendents has been and is due in large part to the people on our golf course maintenance staffs. We may have the best equipment and products that money can buy, but people still are the key to a successful operation

I have found the Asian people to be very hard workers, but largely lacking in many skills that are important to maintaining a golf course. One source of this lack of skill is the lack of knowledge that the middle class Chinese population has for the game of golf. Soccer is king. The World Cup is a major happening for many in the Asian world. In Wisconsin, some people spend their vacation days attending the Green Bay Packers summer training camp. In Hong Kong, there are no public golf courses because land is so valuable and controlled by the government. Hence, an individual must come from wealth to have been involved with golf at a young age, or even as they have become older. You must be a member of a private club to be able to play golf. Memberships are extremely expensive and hard to come by as the clubs have extensive waiting lists. Other than myself, only two other people on my staff really play golf. Television is not popular in Asia, so very few people have the opportunity or take the time to watch golf on television. Thus, the exposure to the game for the general population is minimal. This presents challenges when trying to explain various aspects of maintaining a golf course when the staff basically does not understand the game of golf. As an example, trying to teach basic golf course set-up is a challenge in itself. The staff member needs to understand what a fairway and tee is before we can progress to the importance of tee markers to spacing, alignment to the fairway, etc. Now we must progress to doing this process for 18 holes correctly, and understanding why set-up is important. So what if the tee blocks may point towards the left or right

rough. Mow the tee, put the tee markers back and on to the next tee, that's assuming the tee markers are placed back onto the tee. This lack of familiarity carries over into all aspects of maintaining the golf course. It's important to explain the game of golf and how a particular maintenance task relates to and affects the game of golf. This type of education is a daily, ongoing process. Reinforcement of ideas and concepts is constant.

Teaching the Chinese people to operate golf course equipment can be a difficult and frustrating experience. Very few middle class people are able to own vehicles; most travel by bicycles or walk. For many, getting onto a gas or diesel powered piece of equipment is a very frightening experience. Most have never been around power equipment until they started working on the golf courses. Once on the equipment, they don't have the coordination or judgment skills for operating equipment. Patience and a lot of practice are essential, especially on larger pieces of equipment. A clutch and standard shift - watch out!!

The standard work week in Asia is based on 48 hours per week. Overtime begins after 48 hours. All permanent employees work on a 2-year contract, which is renewable, if the employee has done a good job. The pay scale begins at $5,000 HK per month and increases yearly based on the employee's job performance. The monetary exchange rate is $1 US is equal to $7.8 HK, so the monthly beginning rate is about $640 US. After 60 days of employment, the employee is entitled to 12 days of Holiday pay and two weeks of Annual Leave. All full-time employees receive benefits such as health insurance, clothing, transportation reimbursement and noon meals.

Forty percent of the maintenance staff is comprised of females. These ladies are hard working, strong, and many can perform hard physical labor equally well as the male members of the staff. The Special Projects or Construction staff has 12 members of which eight are females. In the Asian world, it is considered undesirable and unattractive for a female to have a dark tan. The accompanying photo shows the typical dress of a female staff member. No matter the weather, this is the standard dress. Many times all that is visible is the ladies eyes.

It is extremely important to understand the Chinese culture when dealing with the staff members.

When reprimanding or disciplining any staff member, it must be done in private, and never raise your voice. Reprimanding someone in public causes that person to loose face in front of their peers and is a definite no. Also, speaking to an Asian in a raised voice is a sign of extreme disrespect and a good way to create an enemy and disgruntled employee forever. The Chinese are hard workers, diligent and will work in any type of weather. They seem to be immune to rain. I believe that is due to the fact that the summer is the rainy season and people are used to rain. They go about work as if it is 80 degrees and sunny. The only time they are taken off the golf course is for a Black Rain or Typhoon warning, or lightning. Otherwise, work just continues.

People's day-to-day living is much different than in the United States. The family is the center of the Chinese people's

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