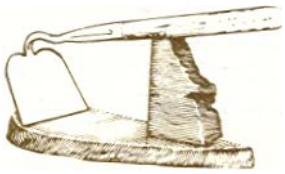

California Weed Science

Information on Weeds and Weed Control from the California Weed Science Society

Volume 1, number 2
May 2005

California Weed Science Society News

President's Message

Robert Leavitt, President CWSS

The 2006 California Weed Science Society's (CWSS) annual conference will be in the Marriott Ventura hotel in beautiful Ventura. The hotel is adjacent to San Buenaventura State Beach and near the marina. Downtown Ventura has numerous antique stores, which are a big draw, and the Mission. Great golf is not far away. Vice President Shatley and the Session Chairs are putting together a great program for you. The theme of the 2006 conference will be *Improvise, Adapt, and Overcome*. Mark your calendars now to attend the conference, January 16-18, 2006!

At the 2004 CWSS Business Luncheon, the members voted to restructure and expand the CWSS Board of Directors. I can say that this new Board structure is exceeding expectations. Each officer and director has a specific portfolio of duties, as well as the general responsibility for the society as a whole. I would like to highlight Director Steve Fennimore's duties in this newsletter.

Steve is responsible for our newly renamed and expanded newsletter, *California Weed Science*. This newsletter has been in the planning for a long time, and is now coming to fruition. Carl Bell had included the premier issue of the new newsletter in your registration packets at the 2005 conference, where it was well received. You can see how the format and contents have continued to evolve. Steve has worked hard on this new and updated edition, and both Steve and the Board are dedicated to making this newsletter a meaningful contribution to your professional life. Please help by submitting articles and updates to Steve (safennimore@ucdavis.edu)!

The CWSS is reaching out to the weed science community by sponsoring activities in addition to the annual conference. In 2005, for the first time, the society sponsored a representative to the National Invasive Weed Awareness Week which was held February 27-March 4 in Washington, D.C. Director Carl Bell was our representative, and carried the banner of the CWSS to various meetings and functions with federal officials involved with weed control. Specifically, NIWAW participants petitioned various officials to fully fund the Noxious Weed Control and Eradication Act of 2004, which would provide funding to weed management entities.

In addition, the CWSS is sponsoring the *Invasive Plant School* to be presented by the University of California Cooperative Extension, featuring Carl Bell and Nelroy Jackson, in June 2005. The CWSS is also sponsoring the proposed *California State Weed Action Plan*, a comprehensive state

weed plan spearheaded by the Integrated Pest Control Branch of the Department of Food and Agriculture. The CWSS continues to sponsor the (in my opinion) best aquatic and riparian weed book there is, *Aquatic and Riparian Weeds of the West* (California Weeds 530-297-6932); and to publish our own weed science text *Principles of Weed Control, Third Edition*.

Truly, I can say that the CWSS is looking toward the future!

National Invasive Weeds Awareness Week,
Feb. 27-Mar. 4, 2005, Washington D.C.

Carl E. Bell, Secretary, CWSS.

The sixth National Invasive Weeds Awareness Week (NIWAW VI) has become an important event in the nation's capitol for weed science and weed management, and I was privileged to be the first CWSS representative to attend. NIWAW is an opportunity for weed experts from around the country to educate congressional representatives about invasive weeds and to hear what federal agencies are doing about non-native plants on the lands they manage. NIWAW VI was the largest so far; attracting 160 participants from 35 states. California had nine representatives from CDFA, Farm Bureau, the California Invasive Plant Council, and the California Native Plant Society.

For me, the most interesting part was the visits on the hill, the offices of congress. Our purpose was to complete a task started years ago by Senators Craig and Daschele. In the last congress, the Noxious Weed Control and Eradication Act was passed and signed into law as public law 108-412. But, because the law was passed late in the congressional year, it came without funding. The NIWAW VI participants visited their state representatives and senators; urging them to fund this law at the full amount allowed, $15 million per year for five years. We also asked that the law be modified to increase the funding to the $100 million per year that was in the language of the original legislation and that the member of congress also support the National Aquatic Invasive Species Act during this session of congress. The California delegation talked to legislative staffers in 23 congressional offices and dropped off informational packets at 30 other offices. In general, the reception was good, some were even enthusiastic. As one person in our group remarked, we went from "who are you?" in previous years to "We know who you are, what can we try to do for you". We do not know if our efforts are going to be successful in the upcoming federal budget, it is a difficult year to get funding for a new cause. But, we will continue and seem to have broad support.

The briefings provided to the NIWAW VI participants by the various federal agencies that manage public lands or conduct research on invasive plants were very interesting. According to others in our California delegation, the level of federal administrator that took the time to visit with us keeps getting higher each year. We had a full morning session with both the Department of Agriculture and the Department of Interior. Shorter briefings were presented by Army Corps of Engineers, Department of Transportation, and Office of Pesticide Programs of EPA. Each session included a lot of interaction; they informed us and we asked them challenging questions. Again, I would like to thank the Board of Directors of CWSS for having the chance to participate in NIWAW

VI. Your board has already committed to send a delegate the NIWAW VII

Student Papers: Call for Abstracts

Brad Ramsdale, Student Session Chair

All weed science graduate and undergraduate students are invited to submit one paper for the 58th Annual Conference of the California Weed Science Society, January 17-19, 2006, in Ventura. Student papers can cover any aspect of weed science, should be scientific in nature, and should not be sales or marketing tools.

The society has initiated a new format for the Undergraduate/Graduate Student Paper Contest. Four time slots are available for student papers, which will be presented during one of the current sessions of the conference. A panel of CWSS members will evaluate all abstracts submitted and select the top four in terms the required components listed below. The four papers selected will each be awarded a $200 stipend. Students not selected for the Paper Contest will be encouraged to present their research as part of the Student Poster Contest. More information on the Student Poster Contest is forthcoming.

Papers will still be judged and prizes awarded as done in previous conferences. Abstracts will also be published in the CWSS Proceedings. Prizes for the three best student papers and three best student posters will be awarded as follows: 1st place - $500; 2nd place - $300; 3rd place - $200.

In order to meet the society's deadline for establishing the conference agenda, **abstracts must be received by July 31**. In addition to the paper title and author(s), the body of the abstract should include the following: justification for the research; clear statement of research objectives; brief description of experimental design and research methods; discussion of significant results; and the overall conclusions including the significance of the findings to weed science in California. A maximum of 300 words is allowed for the abstract.

Abstract Deadline: July 31

Please email your abstract as a MS Word Document to:
Brad Ramsdale, Student Session Chair
Dept. of Plant Science, California State University, Fresno
bramsdale@csufresno.edu

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Weed Management Information

Weed of the year 2005:ancient weeds.

Steve Fennimore & Matt Elhardt, Session chairs

Most weeds are flowering plants. However, some weeds are not flowering plants and have characteristics that make them difficult to control. For example, some mosses and liverworts have no roots or vascular system, horsetails have no leaves, bracken fern doesn't produce seeds. All of these plants are descendents of ancient plants many of which have been around for millions of years. Because these plants are very diverse and don't play by the same rules as most weeds they can be a challenge to control with herbicides. The purpose of this section is to identify make us more familiar with these weeds and how to control them.

These presentations were divided up into four sections: a general introduction to nonvascular and lower vascular plants by

Jodie Holt of UC Riverside. For nonvascular plants, Cheryl Wilen, UC Area IPM Advisor, San Diego, addresses control of liverworts in container ornamentals, and Mark Mahady of Mahady and Associates, address control of mosses on putting greens. Finally Bob Parker from Washington State University provides practical suggestions for control of horsetails and ferns.

Biology of Nonvascular and Lower (Seedless) Vascular Plants

Jodie S. Holt
University of California, Riverside, CA

With the exception of algae, including seaweeds, all of the organisms that are considered weeds are in the plant kingdom (Kingdom Plantae). Organisms in the plant kingdom can be divided into four categories, each of which includes several Divisions (Phyla):

1. Nonvascular plants (3 divisions)
2. Seedless vascular plants (4 divisions)
3. Gymnosperms (plants with "naked seeds", 4 divisions)
4. Angiosperms (flowering plants, 1 division)

These four categories are thought to have evolved in the numerical order presented, with nonvascular plants being the most ancient and flowering plants being the most recent to evolve. Within each of the four groups, each division contains anywhere from one to several hundred plant families and each family contains a few to several tens of thousands of plant species. Most weeds are angiosperms. However, a few plants in the nonvascular and seedless vascular plant categories can be weedy, as well.

Nonvascular Plants

There are three divisions of nonvascular plants—mosses (Division Bryophyta), liverworts (Division Hepatophyta, named for the resemblance of some to small livers), and hornworts (Division Anthocerotophyta, named for the horn-like appearance of their reproductive structures). Nonvascular plants have no vascular tissue and no organs (stems, roots, leaves, or flowers). Although some appear to have leaves, these are not true leaves because they possess no vascular tissue; rather they are just outgrowths of tissue from the main axis of the plant. Nonvascular plants have no roots; instead, they are lightly anchored to the soil with rhizoids (tissue outgrowths from the base of the plant). These plants consist of parenchyma (generalized) cells, meristems (where cell division occurs), and a cuticle on their top surfaces. In the life cycle the gametophyte is the dominant stage while the sporophyte is very small and not free-living. The gametophyte is perennial, photosynthetic, and can reproduce asexually (without sexual recombination) by vegetative tissue fragments.

There are over 9,500 species of mosses and they are found throughout the world. Mosses can be one of three types—peat mosses (*Sphagnum*), granite mosses, and leafy mosses. Peat mosses are found covering vast acreages in the northern hemisphere where they are harvested for fuel and other commercial uses (including planting mixes). Granite mosses are found at high elevations and are less common than the other two types. Leafy mosses are found throughout the world and in some situations, such as in greenhouses and landscapes, they can be weedy. Like mosses, liverworts are also very small plants. There are approximately 6,000 species of liverworts in the world and all are one of two types—liver shaped (thallose) or leafy. Some liverworts,

like some mosses, are weedy in greenhouses, where they can be found growing on the surface of the potting medium. Hornworts are extremely rare and rarely encountered.

Seedless Vascular Plants

There are four divisions of seedless vascular plants, also called lower vascular plants to reflect their less complex anatomy and morphology relative to seed plants (gymnosperms and angiosperms, also called higher vascular plants). These divisions include the whisk ferns (Division Psilophyta), club mosses (Division Lycophyta), horsetails (Division Arthrophyta), and ferns (Division Pteridophyta). Seedless vascular plants arose on land approximately 420 to 500 million years ago as the first vascular plants and are thought to be ancestral to seed plants. In addition to vascular tissue (xylem, which transports water, and phloem, which transports carbohydrates), as a group they possess true stems, roots, and leaves (but no flowers or seeds). In the life cycle of seedless vascular plants the sporophyte is the dominant stage while the gametophyte is very small and free living. The sporophyte is perennial, photosynthetic, and can reproduce asexually.

Whisk ferns are the simplest of the seedless vascular plants, possessing only stems, rhizomes, and sporangia (structures in which spores are produced). They have no true roots or leaves; rather they have rhizomes and leaf-like structures that are just tissue outgrowths from stems. This small division consists of one family and two genera, the most well-known of which is *Psilotum*. Species of this genus grow in the gulf coast states and Hawaii. Club mosses are somewhat more advanced than whisk ferns, possessing stems, rhizomes, sporangia in cones, and true roots (but no true leaves). The most well-known of the three genera in this division is *Selaginella*, some species of which can be weedy in greenhouses. In the Division Arthrophyta are the horsetails, which all occur in one family and one genus of 15 species, *Equisetum*. These plants have stems, rhizomes sporangia in cones, roots, and true leaves (although the leaves are quite small in some species). *Equisetum* plants are known for the high levels of silica in their stems, which give them an abrasive feel and resulted in their use by indigenous people for scouring purposes. These plants can be weedy in some situations.

Ferns are the most advanced and most numerous of all the seedless vascular plants. As a group ferns possess all the plant organs except flowers (stems, roots, and leaves), although in many ferns the stem is not elongated and upright. All ferns are herbaceous and perennial. In most ferns the sporangia are located in clusters (sori) on the underside of the leaves in distinctive patterns, such as rows. There are over 10,000 species of ferns in existence today and they grow around the world in many different habitats. Some ferns, such as bracken fern, can be very weedy.

Summary

Nonvascular and seedless vascular plants are botanically and evolutionarily important. Nonvascular plants represent the simplest and the earliest to evolve land plants. Seedless vascular plants, as a group, represent the steps in evolution from the very simplest vascular plants to the most highly advanced seed plants that possess all the true plant organs—stems, roots, leaves, and in angiosperms, flowers. Although a few of the plants in these two categories can be weeds under certain circumstances, most are an integral part of their natural landscape

and do not escape, spread, or cause adverse effects on human activities.

Controlling and Management of Mosses and Liverworts in Nurseries

Cheryl A. Wilen, University of California Cooperative Extension San Diego, CA

Liverworts and mosses are primitive plants that lack true roots; water and nutrients are absorbed by the vegetative organs of the plant. They can be propagated and spread vegetatively or sexually by spores. Spores have been found in air and recycled irrigation water and are likely also in potting mix if stored uncovered near a liverwort or moss infestation. It is unlikely that the common disinfecting systems used in recycling nursery irrigation water (chlorination, bromine injection, ozonation) are effective in killing the spores.

Liverwort is a problem in nurseries because they rapidly cover the container surface and compete with the crop for water and nutrients. Additionally, heavy infestations limit the penetration of water and fertilizer into the growing substrate resulting in the failure of irrigation water to reach the plants' roots. This results in water runoff and additional need for irrigation to keep the plants healthy. An indirect effect of a liverwort infestation is that it they create a favorable environment for fungus gnats to breed. Mosses present the similar problems but the competitive effect is not as pronounced.

The nursery is an ideal environment for liverworts and mosses to become established. Because these plants lack roots, they do not have an efficient method of acquiring water and therefore grow best in areas where water is constantly available. Liverworts are nitrophilous (nitrogen loving), growing best when nitrogen is between 75 and 250 ppm. Nitrogen is often a limiting nutrient in nursery production so it is usually applied at high rates. These two conditions are probably the most significant factors in the establishment of liverwort in a nursery. Nitrogen is not as crucial to moss proliferation but water is necessary for spore fertilization. Therefore an integrated program of irrigation and fertility management, supplemented with physical and chemical controls is necessary to reduce and possibly eliminate liverwort and moss.

Cultural control: It is important to prevent the introduction of liverwort into an area. Covering potting mix components will help prevent the infestation of spores during the canning process or in liner production. Sanitize all greenhouse surfaces with a disinfectant registered for greenhouse or nursery use. Containers that have been infested should be thrown away as it is likely that spores are on the plastic. At the very least they should be sterilized with a disinfectant. Media mixes should also be properly stored to prevent contamination.

Once plants are in the production phase, do not overwater the crop. If at all possible, allow the surface of the growing medium to dry between irrigation cycles or use a coarse mulch which will dry quickly. Subbirrigating will allow the plants to take up water but the potting medium surface will be drier.

Continually monitor fertilizer applications and adjust to use only the amount required by the crop. As noted above, excess N is conducive to liverwort growth. Surface applied fertilizers tend to encourage more liverwort growth than if the fertilizer is incorporated. However, surface applications of slow-release iron sulfate or copper sulfate combined with reduced irrigation levels can decrease liverwort infestations.

Chemical control: There few herbicides registered for control of liverwort and fewer

specifically for control of mosses. The label must be consulted carefully to determine if the product can be used in greenhouses or nurseries. Many products are contact herbicides and can damage the crop if not washed off the foliage. Heavy irrigation often reduces the effectiveness of herbicides because they are either diluted or washed away. In general preemergent herbicides containing oxadiazon have been shown to be effective in reducing liverwort pressure. Flumioxazin (Broadstar and Sureguard) are registered for controlling liverwort. In trials conducted in Irvine, CA we found that Broadstar was slow to injure liverwort but effective in the long run. It had much faster activity on moss. Terryacyte was also particularly effective in moss control but is not yet registered in California. Other products which can be effective in some situations include those containing cinnamic aldehyde (Cinnamite). No-Moss is a contact herbicide derived from garlic and clove oil which has shown good control of liverwort of moss. Again, avoid contact the crop foliage to reduce the possibility of phytotoxicity. Hydrogen dioxide (Zero-tol), a disinfectant, can be applied to the potting medium surface twice weekly to control spore germination.

Another product under testing for possible U.S. registration by Crompton-Uniroyal is quinoclamine. In recent studies this material provided excellent liverwort control.

The table above shows the results of a test conducted to examine different cultural and chemical controls for preemergent liverwort management.

Preemergent liverwort control using various cultural and chemical controls 4 and 7 weeks after treatment (WAT).

Treatment	% cover 4 WAT		%cover 7 WAT		Rate
Untreated	10	bc[1]	28.5	cd	
Broadstar (flumioxazin)	0	a	0	a	2 oz ai/A
Broadstar	0	a	0	a	1 oz ai/A
GC Mite (garlic and cinnamon oil)	0.3	a	4	a	6T/gal
GC Mite	0	a	2.8	a	12 T/gal
Ironite	2.8	a	6.3	a	50 lb/1000 ft^2
Ironite	10.8	cd	22.5	bc	25 lb/1000 ft^2
Coir mulch_fine	0	a	0	a	
Coir mulch_med	0	a	0	a	
Coir mulch_coarse	1.8	a	3.3	a	
Ronstar 2G (oxadiazon)	3.5	a	2.3	a	100lb/A
Ronstar 2G	3.8	a	2.5	a	200lb/A

[1]Means followed by the same letter are not significantly different at the P=0.05 level using SNK means comparison.

Control of Silvery Thread Moss *(Bryum argentium)* in Putting Greens

Mark M. Mahady, President
Mark M. Mahady and Associates, Inc.

Introduction. In the pursuit of faster putting greens and higher levels of surface quality, golf course superintendents often lower mowing heights and reduce fertilizer inputs. Over extended periods of time such cultural practices may lead to an overall reduction in vigor and plant density of bentgrass and *Poa annua* putting greens. Under these conditions moss can easily invade putting green surfaces. Isolated moss colonies can rapidly spread into more serious infestations that can be more difficult to control.

Silvery thread moss *(Bryum argentium)* is a significant problem on golf course putting greens in California and on many golf courses throughout the country. This very competitive moss species creates a fine textured mat on putting green surfaces and under favorable conditions can develop into a thick, dense layer that creates a barrier

against air and water movement, ultimately out competing desirable grasses.

Silvery thread moss is adapted to a wide range of environments and can be found growing just about anywhere, from the mortar between patio bricks to the shingles on your roof. Silvery thread moss can grow on either USGA sand profile greens or push-up soil greens and has been observed growing in many different grasses including *Poa annua* and Penncross, Pennlinks, A4 and G2 creeping bentgrass. It is also well adapted to both shade and full sunlight conditions. Silvery thread moss has also been shown to survive long periods of desiccation, in some cases up to two years, and can withstand high temperatures in a dormant state. Research information provided by Dr. Larry Stowell, PACE Consulting, San Diego, California shows that mosses can survive extended periods of dormancy by living symbiotically with blue-green algae. In some ways algae may be viewed as a precursor to moss encroachment.

Mosses exhibit a two-stage life cycle. The green leafy phase most frequently observed on golf courses is called the 'gametophyte'. In this phase a germinating spore gives rise to a green filament called the protonema from which the moss plant with its stems, leaves and rhizoids develops. Upon maturity the production of egg and sperm give rise to a fertilized egg or zygote. With germination the zygote produces a slender stalk with a capsule containing spores. The spores are then released from the capsule and give rise to new moss plants, thus completing the life cycle.

Over the years a significant amount of field research and quality field observations have developed a 'best practices management program' for the suppression or control of silvery thread moss in putting greens. The key concepts within this program are directly primarily toward the enhancement of vigorous turfgrass growth and review of proper agronomic perspectives including drainage, height of cut, fertilizer use, irrigation practices and topdressing programs.

While strong cultural programs are essential to aid in the prevention of moss encroachment, what types of chemical control strategies are available for golf course superintendents who already have significant moss problems? A tremendous amount of university field research has been conducted over the years in the hope of finding a 'silver bullet' for control of moss in putting greens. A wide range of products and program concepts have been reviewed for moss control including the use of iron products such as ferrous sulfate, different fertilizer sources such as ammonium sulfate or urea, soap or fatty acid products, preemergent and postemergent herbicides as well as fungicides. The results of this work have been highly variable. In some cases treatments that performed well in research evaluations did not perform as well under actual golf course management use or the best performing products/treatments for control of moss also exhibited unacceptable injury levels on desirable turf.

Over the last several years field research trials conducted by Professor Thomas Cook at Oregon State have shown high levels of moss control on bentgrass putting greens with multiple applications of Junction™ (Fore + copper hydroxide: Griffin Corporation). Results of moss control field trials conducted in Southern California by Dr. Larry Stowell, PACE Consulting, have shown acceptable levels of control with the use of Dawn Ultra (2.0 oz/gal) detergent at very high drench volumes (60 gal/M).

TerraCyte (sodium percarbonate: BioSafe Systems, Glastonbury, Connecticut) is a new granular product that has shown potential for moss control in field trials when applied with a drop spreader at rates of 8 to 16 pounds of product/1000 ft^2. Field research was conducted on a *Poa annua* putting green at Carmel Valley Ranch Golf Club in Carmel, CA by Mark M. Mahady & Associates, Inc. to evaluate the performance of multiple applications of these products for control of silvery thread moss. The key question was: can silvery thread moss be controlled without injuring or reducing the surface quality of annual bluegrass putting greens?

Moss Control Programs on Putting Greens

Three replicated field research trials for moss control on putting greens were conducted at Carmel Valley Ranch Golf Club in Carmel, California from1999 to 2002. During January of 2002 a new product, TerraCyte (sodium percarbonate: BioSafe Systems), was evaluated in a replicated field trial at Carmel Valley Ranch Golf Club for control of silvery thread moss.

TerraCyte performed well for control of silvery thread moss when applied with a drop spreader at rates of eight to twelve pounds of product per thousand square feet (lb/1000 ft^2). Pre and post application irrigation is required for activation of TerraCyte. The three-treatment sequence applied at five-day intervals showed the best level of moss control. Three 8.0 lb./1000 ft^2 treatments of TerraCyte applied at five-day intervals showed 66% moss control and three 12.0 lb./1000 ft^2 treatments applied at the same interval showed 90% control. Although the 12.0 pound rate showed a higher level of control (90%) with three repeat applications than the 8.0 pound rate (66%), the degree of injury and color loss observed on annual bluegrass at the 12.0 lb./M rate may be too severe for most golf course superintendents. Creeping bentgrass exhibited more tolerance than *Poa annua* to TerraCyte applications.

TerraCyte aids in the suppression and control of moss in annual bluegrass and bentgrass putting greens by dynamically shifting the competitive balance between moss and turf. Unfortunately, TerraCyte is not yet registered in California. Registration is anticipated by spring of 2005. Once registered, TerraCyte will be a very valuable tool to control slivery thread moss in creeping bentgrass putting greens. If TerraCyte is presently not available, what other products and agronomic strategies are available to reduce silvery moss invasion and promote the growth of creeping bentgrass?

Many superintendents have achieved acceptable burn down of moss with soaps such as Dawn Ultra. However, it is illegal to use this product for moss control on putting greens because it is not registered for this use. Soap applications do burn down moss rapidly. Spiking and seeding bentgrass back into these thin areas may speed recovery. Unfortunately, in our experience, soaps do not prevent regrowth of moss or enhance the competitive balance of creeping bentgrass.

Another program option to consider is the use of Daconil (chlorothalonil) Weather Stick. Several researchers throughout the country have reported positive results with multiple treatments of Daconil applied at 5.3 ounces per 1000 ft^2 at seven-day intervals. A minimum of four applications is necessary for effective control. Daconil is effective for algae control with multiple applications and

many researchers believe there is a symbiotic relationship between moss and algae. Other researchers have reported that **the key to successful moss control with Daconil is multiple applications during hot summer days (85 degrees+).**

Research from Professor Tom Cook at Oregon State University has shown that multiple applications of copper hydroxide products such as Kocide (copper hydroxide) or Junction (copper hydroxide and mancozeb) reduce infestations following 5 to 7 treatments at two-week intervals. Unfortunately, these products have not performed well in our moss control trials. We are suspicious that the high pH of our well water precipitates much of the copper out of solution, thus reducing efficacy. Professor Cook has also found that multiple applications of Quick Silver (Carfentrazone, FMC**)** selectively injure moss with minor injury potential on creeping bentgrass. Spring use is recommended.

Baking soda (sodium bicarbonate) is not registered for moss control. However, reports show that carefully sprinkling the dry product on moss patches with a small-holed spice dispenser, or mixing 6.0 ounces of product in one gallon of water and spraying with back pack sprayers every 14 days discolors moss (brown) and reduces infestations.

Moss is susceptible to metal ion toxicity. Research has shown that high rates of iron, copper and zinc will discolor moss and reduce infestations. Research conducted by Mark Mahady in 1984 showed that lawn moss could be successfully controlled in the Pacific Northwest by applying 12.0 ounces of ferrous sulfate/1000 ft^2 at a spray volume of 4.0 gallons/1000 ft^2. During the cool wet winter months from January through March two treatments applied at six-week intervals on home lawns mowed at a cutting height of 2-3 inches provided a very high level of control. Because conditions were cool and wet there was no turf injury and the greening effect on lawns was dynamic within 24 hours.

This concept can be extrapolated to the golf course industry for moss control on greens. Increase spray volumes to a minimum of 4.0 gallons/1000 ft^2 in order to reduce the potential for turf injury. TeeJet Turbo FloodJet nozzles (TF-VS10, wide angle flat fan spray tips) set at 40 psi and 20 inch nozzle spacing will deliver 4.5 gallons per 1000 ft^2 at a speed of 3 mph. The higher the spray volume the less potential there is for turf injury. If the boom is changed to 10 inch spacing and pressure and speed remain the same the spray volume increases to 6-9 gallons/1000 ft^2 depending on the size of the intake hose.

Choose the highest spray volume that can be delivered consistently with a single pass from a standard spray boom system equipped with 10-inch nozzle spacing (6-9 gallons/1000 ft^2). Choose two ferrous sulfate rates of 8 and 16 ounces of product/1000 ft^2. Conduct a simple evaluation on a practice green at this high spray volume and test these two rates during winter, spring and late summer to evaluate potential turf injury, moss control and surface quality. A 7-day interval is recommended.

Establish a monthly soil and tissue testing program prior to and during the test program. Each test green site should also have an untreated area as a check comparison. Monitor soil and tissue nutrients to ensure that these additional nutrient programs do not detrimentally influence plant growth and surface quality. Always schedule these high spray volume

applications when tissue and soil moisture is adequate.

Moss control is in most cases a long-term program. Moss control programs should be a combination of those agronomic practices that encourage vigorous growth of desirable grasses plus a selective suppressant or control product that will place the moss under additional stress.

Today in California there are two program concepts that have shown encouraging potential to control silvery thread moss in Poa annua and creeping bentgrass putting greens. On Poa annua greens three repeat applications of TerraCyte showed by far the best reactive control of silvery thread moss. For bentgrass greens either the TerraCyte program or high rates of ferrous sulfate applied at high spray volumes dynamically reduced moss cover while greatly enhancing bentgrass growth.

The following cultural practices should also be considered to reduce the incidence of moss on putting greens. Check the green surround and green irrigation uniformity. Make sure that the green surround irrigation is not overlapping onto green surfaces. Water deeply. Keep surfaces as dry as possible, while still maintaining adequate moisture for good turf vigor. Hand water hot spots. Increase mowing heights to between 160/1000ths to 170/1000ths of an inch. Maintain sound fertility programs to improve turfgrass vigor. Use hollow tine aeration as frequently as possible to disrupt the surface. Pursue an aggressive light and frequent sand topdressing program. Check sand profile depths in problem greens to determine if variation in sand depth is contributing to moss problems. If wet areas exist around green perimeters use smile drains to enhance water movement away from the green.

Control and Management of Horsetail and Ferns

Robert Parker
Washington State University, Prosser,WA

Horsetail (*Equisetum arvense*) control is not an easy task. If possible it is best to prevent horsetail from being established. This includes avoiding light tillage in areas where horsetail occurs. If tillage occurs be sure to clean the equipment to assure rhizomes don't get transported to new areas. Also improve drainage in poorly drained areas near ditches, bodies of water and low spots. Mechanical control is difficult. In a study conducted in Quebec Canada, horsetail was removed by hoeing 16 times during one growing season, but this did not have any impact on regrowth.

Horsetail's impact as a weed might be considered marginal as most crops with proper growing conditions and proper drainage can compete with the weed. There are few chemical control options. The lack of efficacy of many herbicides, specifically contact herbicides, is partially due to the fact that horsetail is a perennial with a deep root system complete with rhizomes, and herbicide uptake is minimal because of the lack of leaf area. The siliceous nature of its stem may inhibit the movement of herbicides into the plant. Glyphosate is often used to suppress horsetail, however, regrowth should be expected. Frequently after glyphosate applications horsetail increases since glyphosate often eliminates competing vegetation. Amitrole (Amitrol) is the only postemergence herbicide that will control the plant, however where available, it can only be used in noncrop situations. MCPA and 2,4-D are sometimes used in tolerant crop systems, however, they will only burn the above ground foliage off and have little effect on the root system.

Dichlobenil (Casoron) is effective in the Pacific Northwest particularly when applied during midwinter just prior to an anticipated cold rain. Dichlobenil can be used in a number of perennial ornamental species and in many trees and vines. The other two effective herbicides that can only be used on noncropland at the rates required to control horsetail are sulfometuron (Oust) and chlorsulfuron (Telar). Trial results obtained at the Washington State University Mount Vernon Research and Extension Center with both sulfometuron and chlorsulfuron found November applications were more effective in controlling horsetail than those applied in the early summer.

Controlling western brackenfern *(Pteridium aquilinum)* is considerably easier than controlling horsetail. Brackenfern is not a serious weed of most annual row crops. A single mowing is not effective, however, a publication from the University of Minnesota reports frequent mowing throughout the growing season is effective. Frequent tillage is also reported to be effective.

There are several herbicides that will control the plant. In cropland and pastures where the following foliage applied herbicides are labeled: glyphosate, metsulfuron (Ally/Escort/Cimarron) MCPA, and dicamba (Banvel/Clarity) and will control the weed. Picloram (Tordon) will also control brackenfern, but be extremely cautious where it is used. Dichlobenil can be used in certain ornamentals and orchards and vineyards. Asulam (Asulox) has been used successfully in Christmas tree production. Australian information suggests burning the old growth when the plants are dormant and treating the later, new growth when the fronds are fully developed will enhance control. Soil applied dichlobenil will also control the plant and in Michigan, bromacil (Hyvar) applied postemergence has been reported effective.

The best control of either horsetail or brackenfern is to prevent their introduction, and if introduced, to control the plants before they become established. As with most perennial weeds, controlling horsetail and brackenfern before they become established will prevent a lot anguish later on. When the plants are established, control is much more difficult. Once the weeds are established, using an integrated approach of incorporating all the known control methods is more effective than using one method alone to obtain long term control.

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To contribute items of interest for future issues of *California Weed Science*, please contact Editor Steve Fennimore at safennimore@ucdavis.edu or at 831-755-2896.