

NEW ENGLAND GREENHOUSE FLORICULTURE GUIDE

A Management Guide for Insects,
Diseases, Weeds, and Growth Regulators

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SECTION E: WEEDS, ALGAE AND LIVERWORTS

WEED MANAGEMENT INSIDE THE GREENHOUSE

Maintaining weed-free growing conditions is an essential part of producing high-quality greenhouse crops. Insects and diseases can be kept to a minimum only if proper weed control practices are carried out regularly, along with other appropriate controls.

Weeds may compete with crops for light, water and nutrients; reduce the aesthetic value of crops; and create a poor impression. Weeds are also a primary source of aphids, whiteflies, leafminers, thrips, mites, slugs and diseases. Low-growing weeds help maintain moist conditions, which favor fungus gnats and shore flies. Many common greenhouse weeds such as chickweed (*Stellaria media*), oxalis or woodsorrel (*Oxalis spp.*), bittercress (*Cardamine hirsuta*), jewelweed (*Impatiens spp.*), dandelion (*Taraxacum officinale*) and ground ivy (*Glechoma hederacea*) can host tospoviruses including impatiens necrotic spot virus (INSV) and tomato spotted wilt virus (TSWV) while showing few, if any, symptoms. Thrips can vector these viruses to susceptible greenhouse crops. Weeds can also carry other plant-damaging, aphid-vectored viruses.

An integrated weed management program can help, with preventive measures such as sanitation and physical barriers, and control measures such as hand weeding and selective postemergence herbicide use.

Prevention

Weed seeds are easily blown into the greenhouse through vents and other openings. Weeds and their seeds can enter a greenhouse on plants, tools and equipment. Seeds can be moved in soil and by wind, irrigation water, animals and people. Creeping wood sorrel, (*Oxalis corniculata*), hairy bitter cress (*Cardamine hirsuta*), prostrate spurge (*Euphorbia maculata*), common chickweed (*Stellaria media*) and other weeds are persistent problems in greenhouses, reproducing primarily by seed, with several generations each year. Prevention is the grower's first line of defense.

Sanitation

Keep weed seeds, rhizomes and other propagules out of the greenhouse by using sterile media and "clean" plant materials, and by controlling weeds outside the greenhouse. Clean up spilled growing media inside

and outside the greenhouse. When moist, it provides an ideal environment for the germination of weed seeds. Screen vents and other openings to help limit the entry of wind-blown seeds as well as insects.

When scouting, identify the type of weeds (broadleaf or grass), life cycle (annual, biennial or perennial) and location. It is critical to remove weeds from pots, benches and floors before they flower and produce seeds. For example, a single plant of bittercress can produce 5000 seeds that can germinate in as little as 5 days and can propel the seeds over 9 feet from the plant. Creeping woodsorrel also expels seeds by force throughout a greenhouse.

Physical Barriers

Use a physical barrier like weed block fabric to limit weed establishment on greenhouse floors. Leave the fabric bare so it can be easily swept. Covering the weed fabric with gravel makes it difficult to remove spilled potting media, providing an ideal environment for weed growth. Regularly pull escaped weeds before they go to seed. Repair tears in the weed block fabric.

Controlling Existing Weeds

These methods may be used to control existing weeds: 1) hand pulling, and 2) a postemergence herbicide. These measures do not prevent reseeding of weeds.

Precautions on Herbicide Use

Few herbicides are labeled for use in a greenhouse due to the potential for severe crop injury or death to desirable plants. This injury may occur from 1) spray drift if fans are operating at the time of application, and 2) volatilization (changing from a liquid to a gas). Herbicide vapors are easily trapped in an enclosed greenhouse, and can injure desirable plant foliage. Use only herbicides labeled for use in the greenhouse. Carefully follow all label instructions and precautions. It is the applicator's responsibility to read and follow all label directions. Use a dedicated sprayer that is clearly labeled for herbicide use only.

Symptoms of Herbicide Injury

Herbicide injury symptoms include discolored, thickened, or stunted leaves. Sometimes the growing point of young seedlings is injured, severely stunting growth. Symptoms may be similar to those of nutrient imbalances, viral diseases or air pollutants from a

faulty heating system. Proper diagnosis is needed to determine the cause. Symptoms can be so severe that injured plants cannot be sold.

Types of Herbicides

Herbicides are generally classified by their mechanism of action (contact or translocated/systemic) and how they are used (preemergence and postemergence)

Avoid Use of Preemergence Herbicides in the Greenhouse

Preemergence herbicides are applied before weeds emerge. They provide residual control of weed seedlings and can persist for many months and in some cases over a year. Preemergence herbicides can continue to vaporize, causing crop damage.

Only one preemergence herbicide, (Marengo[®] (indaziflam), is labeled for greenhouse use on greenhouse floors in an empty greenhouse.

Selective Use of Postemergence Herbicides

Postemergence herbicides are applied after the weeds have emerged. In the greenhouse, several postemergence herbicides can be used under greenhouse benches and on floors (see Table A-1 on page A.5).

There are of two types of postemergence herbicides: contact and translocated/systemic. *Contact* herbicides kill only the portion of the plant that the herbicide contacts, so good spray coverage is needed. Contact herbicides such as Scythe[®] are best applied to small succulent seedlings. Reward[®] and Diquat SPC 2 L are also contact herbicides but have high mammalian toxicity. *Translocated/systemic* herbicides are absorbed and move through the plant. Target weeds must be actively growing for the herbicide to be effective. Translocated/systemic herbicides such as Roundup[®] (and other glyphosate products) and Finale[®] are best applied to actively growing weeds when temperatures are above 50° F. Note: Roundup[®] and other glyphosate products can only be used in an empty greenhouse between crops. Finale[®] is also a non-selective, translocated/systemic herbicide, but Finale[®] produces symptoms more rapidly (often in 2 to 4 days) than Roundup[®] (7 days or more on most perennial weeds). Translocated/systemic movement to deeper roots and rhizomes is not as complete as with Roundup[®] so some deeply rooted perennials may regrow after application of Finale[®]. Only a limited number of herbicides can be used when crops are in the greenhouse: Axxe[®], Scythe[®], Envoy Plus[®], Fusilade[®] II, Avenger™ AG Burndown Herbicide,

Reward[®] & Diquat SPC 2L, and Finale[®] (see Table E-1 on page E.5). Axxe[®], Scythe[®] Finale[®] and Weed Works Weed & Grass Killer are non-selective herbicides.

These products should not come in contact with desirable crop foliage. Irrigating crops too soon after applying an herbicide can wash it off the target weeds under the benches and reduce its effectiveness.

Natural-based Herbicides

A few natural-based herbicides can be used by organic growers in and around greenhouses. In some of these products, (such as Avenger™ AG Burndown Herbicide), the active ingredients are various plant oils. These materials are postemergence, non-selective, contact herbicides. They disrupt plant cell membranes, causing plants to desiccate. Natural-based herbicides work best on young plants. Multiple applications are often needed to prevent regrowth of annual weeds and for harder to control perennial weeds. Although bioherbicides are natural-based, they carry risks; they may burn skin and eyes or cause nausea or other ill affects. Follow all label directions and precautions.

WEED MANAGEMENT OUTSIDE THE GREENHOUSE

Managing weeds outside the greenhouse is important to 1) prevent weed seeds from being blown into the greenhouse; 2) prevent perennial weeds such as bindweed, quackgrass, etc., from growing under the foundation of the greenhouse; and 3) help reduce the unwanted entry of winged insects into the greenhouse.

Prevention

Maintain a 10- to 20-foot weed free barrier around the greenhouse. Geotextile fabric can be used outside the greenhouse to prevent weed growth. Mow beyond this area before weeds set seed, to help limit entry of weed seeds. Or, maintain a boundary of grasses, such as a mix of chewings, hard and creeping fescues. Thrips tend to not reproduce well on these grasses. Fescues are also not yet known to be hosts of tospoviruses.

Precautions on Herbicide Use

Labels should state if use near greenhouses is allowed. Close greenhouse vents and openings while applying herbicides, to prevent drift inside to sensitive crops. Soil residual and post emergence herbicides may be carefully used surrounding the greenhouse. Select effective herbicides with low volatility. SureGuard[®]

(flumioxazin), Barricade[®] (prodiamine), Pendulum[®] (pendimethalin), Marengo[®] (indaziflam) and Surflan[®] (oryzalin) are often used to prevent weed emergence. They may be tank mixed with post emergence herbicides such as Roundup[®] (and other glyphosate products) or Finale[®] to also control existing weeds. Do not use any auxin type herbicides, such as those labeled for broadleaf weed control in turf, near greenhouses. Their volatility and the extreme sensitivity of greenhouse crops to these herbicides can result in severe injury.

ALGAE MANAGEMENT

Algae are primitive organisms that lack many of the tissues that characterize plants. The greenhouse provides an ideal environment for the growth of algae.

Algae that grow on walkways, under benches, and in pots or plugs are a problem for many growers. Algae compete with desirable plants for nutrients and form an impermeable layer on the media surface that can interfere with water penetration. During plug production, slower-growing plants can be especially sensitive to algae buildup. Algae are a food source for both shore flies and fungus gnats. Excessive growth on walkways can be a safety hazard to workers. Growth of algae on greenhouse coverings can also reduce light levels in the greenhouse.

Prevention measures include sanitation, environmental modification, and frequent use of disinfectants.

For more specific information on water quality issues including water treatment technologies for control of algae, see the Water Education Alliance for Horticulture: <http://www.watereducationalliance.org>.

Also, see Purdue Extension Factsheet HO-247-W, Controlling Algae in Irrigation Ponds, by D.M. Camberato and R.G. Lopez, found on the web at: <https://www.extension.purdue.edu/extmedia/ho/ho-247-w.pdf>

Prevention

Sanitation

All surfaces should be kept free of plant debris and weeds that can be a nutrient source for the growth of algae. A physical weed mat barrier helps to prevent both weed and algae growth.

Environmental Modification

Proper ventilation reduces the amount of moisture in the greenhouse. Horizontal airflow fans help regulate greenhouse temperatures and reduce excess condensation. Retractable roof or open roof greenhouses provide superior ventilation benefits.

Proper Watering Practices

Train employees on proper watering practices. Overwatering crops frequently leads to algae and liverwort buildup on the surface of the growing media. Select a growing media with the proper drainage for your crops. Water the growing containers only as needed, to prevent excess puddling on the floor. Avoid overwatering crops, especially early in the crop cycle, to allow the upper surface of media to dry out between waterings.

Discourage algae growth by avoiding excessive fertilization, runoff and puddling on floors, benches, and greenhouse surfaces. The use of porous concrete floors limits the development of excessive moisture in the greenhouse. The greenhouse floor should be level and drain properly to prevent the pooling of water.

Disinfectants and Algaecides

A number of disinfectants and algaecides are currently registered for algae control in the greenhouse (see Table E-3 on page E.7).

Use disinfectants on a routine basis as part of a precrop clean-up program and during the cropping cycle. Disinfectants like quaternary ammonium compounds, hydrogen dioxide & peroxyacetic acid, and sodium carbonate peroxyhydrate may be used.

Controlling Existing Algae

Quaternary Ammonium Compounds

Quaternary ammonium compounds include Physan 20[®] and Green-Shield[®]. They can be applied to floors, walls, benches, tools, pots and flats as disinfectants. Before using these quaternary ammonium compounds, pre-clean all surfaces. Contact with any type of organic matter inactivates these compounds. Surfaces should remain thoroughly wet for at least 10 minutes. A fresh solution should be applied daily or when the solution becomes visibly dirty.

A fourth generation quaternary ammonium product (KleenGrow[™]) has higher organic tolerances and longer residual activity on hard surfaces. It can also be applied through drip irrigation or flood systems.

However, if applied too frequently, KleenGrow™ can be phytotoxic to plant material and cause stunting.

Hydrogen Dioxide & Peroxyacetic Acid Products

Hydrogen dioxide and peroxyacetic acid (ZeroTol® 2.0) is labeled as a disinfectant for use on greenhouse surfaces, equipment, benches, pots and trays. All surfaces should be wetted thoroughly before treatment. ZeroTol® 2.0 is also labeled for use in chemigation.

Several precautions are noted on the ZeroTol® label. Hydrogen dioxide is a strong oxidizing agent and should not be mixed with any other pesticides or fertilizers. When applied directly to plants, phytotoxicity may be of concern for some crops, especially if applied above labeled rates or if plants are under stress.

Hydrogen peroxide & peroxyacetic acid (Sanidate® 12.0) is also labeled as a disinfectant for use on greenhouse surfaces and equipment, pots, trays and walkways. It is also labeled for use in greenhouse irrigation systems.

Hydrogen Peroxide, Peroxyacetic Acid and Octanoic Acid

X3® (hydrogen peroxide, peroxyacetic acid & octanoic acid) is a strong oxidizing agent. It may be used as an algaecide on greenhouse structures, floors etc. For best results, use with water with a neutral pH and low levels of organic materials. Do not use at higher than recommended rates or leaf burn may result. It is advisable to test X3® on a few plants before treating large numbers. Take care when applying X3® as a foliar spray following applications of metal based products. It is also labeled for use in chemigation.

Sodium Carbonate Peroxyhydrate

Sodium carbonate peroxyhydrate (GreenClean® Pro) is labeled for algae control in greenhouses. Treat when growth first begins to appear. Effects of treatment are immediately apparent (bubbling and bleaching/discoloration of algae).

GreenClean® Pro is water-activated. Upon contact with water, sodium carbonate peroxyhydrate breaks down into sodium carbonate and hydrogen peroxide. Non-target plants suffer contact burn if undiluted granules are accidentally spilled on them.

LIVERWORT MANAGEMENT

Liverworts (*Marchantia* and closely related genera) are branching, ribbon-like plants that lack distinct roots, stems and leaves. They reproduce vegetatively by spores. Stalked, umbrella-like structures release spores. Small, bud-like branches produced in cup-like structures on the surface of the plant also help spread liverworts from pot to pot in water droplets during irrigation. Liverworts thrive in conditions of high fertility, moisture and humidity.



Figure 0-1: Liverwort

Inspect incoming plants for signs of liverworts and isolate infested plants. Remove contaminated plants, pots or growing media. If the growing media stays moist, small infestations of liverwort can quickly spread through an entire greenhouse. Liverworts growing on the media surface will prevent the movement of water into the growing container to the target plant roots. Clean and disinfest empty greenhouses to remove spores. Store growing media properly to prevent contamination by spores.

Avoid overwatering crops. Water according to plant need. Use coarse-textured mulch to reduce surface moisture levels. Topdressing with a slow release fertilizer contributes to increased fertility levels on the media surface and to the growth of liverworts. Proper plant spacing helps to reduce humidity levels. Liverworts lack true roots, so allowing the media to dry between watering helps reduce their vigor.

There are no preemergence herbicides labeled for use against liverworts in greenhouses or enclosed structures. However, a few non-selective postemergence herbicides such as Axxe®, Scythe® and Weed Works Weed & Grass Killer are labeled for careful use against liverworts.