
Cleaning and Disinfecting the Greenhouse

If you have had re-occurring problems with diseases such as *Pythium* root rot or insects such as fungus gnats, perhaps your greenhouse and potting areas need a good cleaning. Over the course of growing a crop, infectious microbes accumulate and algae flourish on moist surfaces harboring fungus gnats and shore flies.

Attention to greenhouse sanitation and disinfecting are steps that growers can take between crop cycles. Some growers wait until the week before opening a greenhouse before cleaning debris from the previous growing season. It is better to clean as early as possible to eliminate over-wintering sites for pests to reduce their populations prior to the spring growing season. Pests are much easier to prevent than to cure.

Although disinfecting should be done routinely, timing does not always permit this extra effort. Take the opportunity to thoroughly clean greenhouses between crop cycles when greenhouses are totally empty.

Cleaning

Cleaning involves physically removing weeds, debris and soil and is the first step prior to disinfecting a greenhouse and equipment. Some growers use a “Shop Vac” on concrete and covered floors to remove debris. Soil and organic residues from plants and growing media reduce the effectiveness of disinfectants. There are some cleaners specifically developed for greenhouse use, for example Strip-It, that is a combination of cleaning and wetting agents formulated to remove algae, dirt and hard water deposits. High pressure power washing with soap and water is also an option. Soap is especially useful in removing greasy deposits however, thorough rinsing is needed because soap residues can inactivate certain disinfectants such as the Q-salts.

Begin at the top and work your way down. Sweep down walls and internal structures and clean the floor of soil, organic matter and weeds. Disease causing organisms can be lodged on rafters, window ledges, tops of overhead piping and folds in plastic. Extra care is needed to clean these areas and also textured surfaces such as concrete and wood which can hide many kinds of organisms.

Install physical weed mat barriers if floors are bare dirt or gravel and repair existing mats. Weed barriers prevent weeds and make it easier to manage algae. Avoid using stone on top of the weed mat that will trap soil and moisture, creating an ideal environment for weeds, diseases, insects and algae.

Benefits to Disinfecting the Greenhouse

Many pathogens can be managed to some degree, by the use of disinfectants. For example, dust particles from fallen growing medium or pots can contain bacteria or fungi such as *Rhizoctonia* or *Pythium*. Disinfectants will help control these pathogens. In addition to plant pathogens, some disinfectants are also labeled for managing algae which is a breeding ground for fungus gnats and shore flies.

Managing Algae

Algae are a diverse grouping of plants that occur in a wide range of environments. Algae growth on walks, water pipes, equipment, greenhouse coverings, on or under benches and in pots is an ongoing problem for growers. Algae form an impermeable layer on the media surface that prevents wetting of the media and can clog irrigation and misting lines, and emitters. It is a food source for insect pests like shore flies, and causes slippery walkways that can be a liability risk for workers and customers. Recent studies have shown that algae are brought into the greenhouse through water supplies and from peat in the growing media. Once in a warm, moist environment with fertilizer, the algae flourish.

Proper water management and fertilizing can help to slow algae growth. Avoid over-watering slow-growing plants and especially crops early in the production cycle. Allow the surface of the media to dry out between watering.

Avoid excessive fertilizer runoff and puddling water on floors, benches, and greenhouse surfaces. The greenhouse floor should be level and drain properly to prevent the pooling of water prior to installing a physical weed mat barrier.

Algae management involves an integrated approach involving sanitation, environmental modification and frequent use of disinfectants.

Irrigation water can also be a source for pathogens and algae. For information on water treatment technologies for control of algae see the Water Education Alliance for Horticulture: <http://www.watereducationalliance.org/> [3]

Greenhouse Benches and Work Tables

If possible, use benches made of wire that can be easily disinfected. Wood benches can be a source for root rot diseases and insect infestations. Algae tend to grow on the surface of the wood creating an ideal environment for fungus gnats and shore flies, and plant pathogens can grow within the wood. Plants rooting through containers into the wood will develop root rot if conditions are favorable for pathogen activity. Disinfect benches between crop cycles with one of the labeled products listed below. Keep in mind that disinfectants are not protectants. They may eradicate certain pathogens, but will have little residual activity.

Bench tops and work tables should be made of a non-porous surface such as a laminate that can be easily disinfected. Avoid using bare wood for these tasks.

Cleaning Containers

Plant pathogens such as *Pythium*, *Rhizoctonia* and *Thielaviopsis* can survive in root debris or soil particles on greenhouse surfaces. If a crop had a disease problem, then avoid re-using containers. It is also a good idea to avoid planting crops that are prone to *Thielaviopsis* problems, such as pansies, in containers that have been previously used. Research has shown that *Thielaviopsis* spores are capable of surviving on recycled plug trays and infecting new crops.

Containers to be reused should be washed thoroughly to remove soil particles and plant debris before being treated with a disinfectant, even if there is no evidence of disease in the crop. Debris and organic matter can protect pathogens from coming in contact with the disinfectant solution.

Disinfectants for Greenhouses

There are several different types of disinfectants that are currently used in the greenhouse for plant pathogen and algae control. They are quaternary ammonium compounds (Green-Shield®, Phisan 20®, and KleenGrow™), hydrogen dioxide (ZeroTol® 2.0, Oxidate® 2.0), hydrogen peroxide & peroxyacetic acid (Sanidate®), hydrogen peroxide, peroxyacetic acid and octanoic acid (X™-3), odium carbonate peroxyhydrate (GreenClean Pro Granular Algicide) and chlorine bleach. Alcohol, although not used as a general disinfectant is mentioned here because it is used by growers to disinfect propagation tools. All these products have different properties. If possible, disinfectants should be used on a routine basis both as part of a pre-crop clean-up program and during the cropping cycle.

Quaternary ammonium chloride salts (Green-Shield®, Phisan 20®, KleenGrow™). Q-salt products, commonly used by growers are quite stable and work well when used according to label instructions. Q-salts are labeled for fungal, bacterial and viral plant pathogens, and algae. They can be applied to floors, walls, benches, tools, pots and flats as disinfectants. Phisan 20® is also labeled for use on seeds, cut flowers and plants. Carefully read and follow label instructions. Recommendations may vary according to the intended use of the product. For example, the Green-Shield® label recommends that objects to be sanitized should be soaked for 10 minutes, and walkways for an hour or more. Instructions recommend that surfaces be air-dried after treatment except for cutting tools. The label recommends soaking cutting tools for 10 minutes before use, then using the wet tool on plants. One way to do this is by having two cutting tools, one pair to use while the other is soaking. KleenGrow has higher organic tolerances and longer residual activity on hard surfaces.

Q-salts are not protectants. They may eradicate certain pathogens, but will have little residual activity. Contact with any type of organic matter will inactivate them. Therefore, pre-clean objects to dislodge organic matter prior to application. Because it is difficult to tell when they become inactive, prepare fresh solutions frequently (twice a day if in constant use). The products tend to foam a bit when they are active. When foaming stops, it is a sign they are no longer effective. No rinsing with water is needed.

Hydrogen Dioxide and Peroxyacetic Acid (ZeroTol® 2.0, OxiDate® 2.0, SaniDate®12.0) Hydrogen dioxide kills bacteria, fungus, algae and their spores immediately on contact. It is labeled as a disinfectant for use on greenhouse surfaces, equipment, benches, pots, trays and tools, and for use on plants. Label recommendations state that all surfaces should be wetted thoroughly before treatment. Several precautions are noted. Hydrogen dioxide has strong oxidizing action and should not be mixed with any other pesticides or fertilizers. When applied directly to plants, phytotoxicity may occur for some crops, especially if applied above labeled rates or if plants are under stress. Hydrogen dioxide can be applied through an irrigation system. As a concentrate it is corrosive and causes eye and skin damage or irritation. Carefully read and follow label precautions. Note that OxiDate® and SaniDate are organic products.

Hydrogen Peroxide, Peroxyacetic Acid and Octanoic Acid (X™-3) is a strong oxidizing agent used as an algicide on greenhouse structures and floor and is labeled for use in chemigation. Follow label rates and precautions.

Sodium Carbonate Peroxyhydrate (GreenClean Pro Granular Algaecide®) is a granular and activated with water. Upon activation, sodium carbonate peroxyhydrate breaks down into sodium carbonate and hydrogen peroxide. GreenClean is labeled for managing algae in any non-food water or surfaces. Non-target plants suffer contact burn if undiluted granules are accidentally spilled on them.

Chlorine bleach. There are more stable products than bleach to use for disinfecting greenhouse surfaces. Chlorine bleach may be used for pots or flats, but is not recommended for application to walls, benches or flooring. When used properly, chlorine is an effective disinfectant and has been used for many years by growers. A solution of chlorine bleach and water is short-lived and the half-life (time required for 50 percent reduction in strength) of a chlorine solution is only two hours. After two hours, only one-half as much chlorine is present as was present at first. After four hours, only one-fourth is there, and so on. To ensure the effectiveness of chlorine solutions, it should be prepared fresh just before each use. The concentration normally used is one part of household bleach (5.25 percent sodium hypochlorite) to nine parts of water, giving a final strength of 0.5 percent. Chlorine is corrosive. Repeated use of chlorine solutions may be harmful to plastics or metals. Objects to be sanitized with chlorine require 30 minutes of soaking and then should be rinsed with water. Some would say that rinsing is not necessary.

Bleach should be used in a well-ventilated area. It should also be noted that bleach is phytotoxic to some plants, such as poinsettias.

Alcohol (70 percent) is a very effective sanitizer that acts almost immediately upon contact. It is not practical as a soaking material because of its flammability. However, it can be used as a dip or swipe treatment on knives or cutting tools. No rinsing with water is needed.

Disinfectants should be used on a routine basis both as part of a pre-crop clean up program and during the cropping cycle.

Organic Disinfectants that are listed by the Organic Material Review Institute include OxiDate 2.0, SaniDate 12.0 and PERpose Plus. Ethyl or isopropyl alcohol is used to disinfect tools. *Organic growers should always check with their certifying organization before using any material new in their growing practices.* For list of products see: Organic Material Review Institutes (OMRI), www.omri.org [4].

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Steps to Prevent Disease Contamination

- Disinfect benches, preferably made of wire. Pots, flats and trays should be new or disinfected. Wood benches can be a source for root rot diseases and insect infestations. Algae growing on wood surfaces create an ideal environment for fungus gnats and shore flies. Plant pathogens such as *Pythium* can grow within the wood and plants rooting into the wood can become infected.
- Disinfect potting tables preferably made of a non-porous surface such as a laminate.
- Set up washing stations for hand washing and foot baths at the entrances of each greenhouse, especially propagation houses.
- Keeping hands and fingernails clean can help reduce the spread of diseases. If wearing latex or other protective gloves, clean as you would your hands and change periodically. Change the disinfectant daily in foot baths and wash floor mats weekly.
- Keep pets off of benches and potting areas.
- Provide supports throughout the greenhouse to hang hose nozzles. Keep all containers and hose nozzles off the floor to prevent contamination with pathogens.
- Keep growing media in a clean area and covered.
- Avoid carrying over plant material.
- Avoid accumulating dirty pots, old growing media or plant debris in the media mixing area.

- Make sure trash bins in the greenhouses are covered so that disease spores do not spread to the crop.
 - Use horticultural oil on vegetation/weeds outside, around the greenhouse perimeter to smother over-wintering pests.
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