

Plant Pathology and the Greenhouse

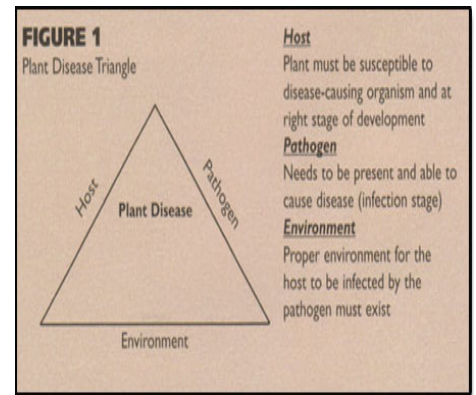
Inside this Brief

- 1 Sustainable Disease Management
- 2 Developing a Plant Disease Management Strategy
- 3 Plant Pathology Calendar
- 4 Plant Disease Management
- 5 Greenhouse Notebook Mock-up

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1. Sustainable disease management and greenhouse management in particular, has reached a critical juncture: Control is no longer an option, and the recognition that management may not even be attainable to the desired degree is changing our approach to plant health problems. In fact, our repeated attempts at controlling disease through the use of pesticides, and the temporary elimination of disease problems has left our management options limited. Fungicides once commonly used for disease control are no longer effective, and cannot be incorporated into a successful management strategy, even though management is a more realistic approach of containment rather than the past policy of zero tolerance. Today, perhaps more than ever before, is an understanding that sustainable cultural management is the foundation of good disease management, and that chemical management provides added benefits in quality and production, but cannot be relied upon for control of plant health problems. This paper focuses on our current understanding of sustainable plant disease management, and seeks to discuss currently effective and sustainable tactics in the management of major diseases of greenhouse crops.

Many people in the greenhouse industry believe that a set schedule can be developed that provides effective disease management. As wonderful as such an idea is, it cannot be done, and it simply wouldn't be sustainable. The reason it cannot be done is that there are so many factors that need to be taken into account. Plant pathologists explain this complexity through the use of a model called the disease triangle (Fig. 1). The disease triangle models plant disease as an interaction between the host, the pathogen and the environment.



It is important to remember that a set schedule cannot factor in the dynamic nature of how the host, pathogen and environment interact. Although a set schedule might work on occasion, the dynamic nature of plant disease would make such a schedule only occasionally useful, at best.

To understand and ultimately develop your own schedule to manage plant disease, it is useful to recall the plant disease triangle. Any host can be susceptible, if the environmental conditions are conducive for infection AND if disease-causing organism is present.

Plant pathogens are influenced by both the host plant (leaf age, shoot age, flower and fruit set) and the environment (temperature, humidity, leaf wetness, soil moisture). As a result, the timing of pesticide application as well as other disease management strategies requires that you take these factors into account. Keeping plants healthy is the easiest way to prevent disease. Just as there is no one product to treat the symptoms of the common cold, it is naïve to think that a silver bullet exists to treat all your disease problems. Disease management practices must be tailored to the plant species being grown AND the diseases that are present. If not, these diseases could develop into a serious threat if environmental conditions change and become conducive to disease.

2. Developing a Sustainable Plant Disease Management Strategy.

Developing an effective disease management plan can and should be done. To start, begin a notebook or folder where notes and records are kept. Information should be included on the following:

Plants: Include scientific names and cultivars. Record the appearance and health of each plant being maintained. Note unusual characteristics (variegation, branching, size, color). Remember to record any mechanical injuries; if bare-root, examine root health.

Record date of:

- Leaf and bud break,
- Flowering
- Leaf and shoot expansion.

Planting mixtures:

- Soil tests (structure, pH)

Environmental conditions:

- Relative Humidity
- Include unusual or severe events

Watering schedule:

- pH,
- Salts
- Insolubles

Disease and Insect Problems:

- Date of Occurrence
- Symptoms
- Signs

Chemicals Used:

Record the name of any pesticides or fertilizer used on or near the plants or near the general site. Remember to record the formulation, rate and method of application, applicator's name and weather conditions at the time of application as well as the time of day the material was applied.

Records such as these assist in management of problems in future years, and allows the manager to see what does and doesn't work, and how environmental conditions may

have helped or hindered with management. Careful end of season evaluations of your plans need to be adjusted and hopefully improved to increase effectiveness, reduce pesticide usage and ultimately, improve both your product and your bottom line. A sample management page can be seen at the end of this article.

Sustainable Disease Management

Disease management is a job that should be taking place throughout the year. Unfortunately, most greenhouse managers only consider disease management after the problem has reached epidemic proportions, usually in the early spring or late summer for fall plants. However, proper management on the part of greenhouse manager in the "off season," can prevent many diseases from occurring, and minimize the impacts of those that occur on a regular basis.

Planting Practices to Prevent Plant Health Problems

Your plants are chosen, you've picked out healthy specimens, now it's time to really make sure they are off to a healthy start by:

Checking Planting Depth: Follow the planting depth recommended for each species--Planting plants too deeply predisposes them to crown rot, and can result prevent flowering; Planting too shallowly can cause them to topple during watering.

Adequately Spacing Plants: Crowded plants prevent good air movement, which promotes foliar diseases. Close spacing also causes plants to compete with each other for sunlight and nutrients. With vigorous plants, the canopy that is created around the plant favors downy mildews, Rhizoctonia, and Phytophthora aerial blights.

The right mix: There are dozens of soilless mixes available. A simple rule of thumb to picking out the right mix is that larger rooted plants require a larger size mix. This facilitates drainage and reduces root rot.

Appropriate Watering: With the tremendous diversity of greenhouse plants available, it is difficult to generalize about watering needs. However, it is important to remember that water is for the roots--avoid overhead irrigation, and when watering, water plants in the morning so foliage can dry before

Disinfectants

Treatment: Steam or Dry heat

How: Heat materials to 180-200 F for 30 min. under a cover to retain the heat
Target: Bacteria, Fungi, Nematodes, Insects and Weeds.

Treatment: Bleach--Sodium hypochlorite (Clorox®)

How: 1 gal/9 gal water. Dip, spray or brush on and keep the material wet for 10 min. Let drain and rinse metal objects.
Target: Bacteria, Fungi and Nematodes

Treatment: Hydrogen peroxide, Hydrogen dioxide (ZeroTol®)

How: 2.5 oz/gal water. Dip, spray or brush on. Let drain
Target: Bacteria and Fungi

Treatment: 70% Alcohol

How: Dip or swab object and let dry
Target: Bacteria, Fungi, Nematodes and Insects

Treatment: Quaternary Ammonium Compounds (GreenShield®, Triathlon®)

How: Dip, spray or brush on and keep the material wet for 10 min.
Target: Bacteria and Fungi

nighttime.

Adequately Fertilizing: Fertilizer should only be applied when nutrient deficiencies are noted, such as yellowing (chlorosis), abnormal red coloration, stunting. Too much fertilizer predisposes plants to disease, and prevents many flowering plants from flowering.

Sanitation to Prevent Disease Cleanliness may be next to impossible, but it doesn't mean you can't try!

Maintain Plants: Regular removal of fading flowers, or infected leaves during the growing season minimizes the buildup and spread of disease-causing organisms, particularly botrytis. If foliar disease like powdery mildew, or leaf spot occurs early in the season after a plant has flowered, cut the infected plant severely--It will produce a new flush of foliage, and possibly another crop of blooms.

Remove infected plants promptly to minimize disease. After the first frost, cut plants back completely and dispose of infected tissue.

3. Disease Management Calendar Dormant Season

Evaluate Greenhouse Stock: What plants proved to be problematic for you or your clients? Research to identify what disease resistant cultivars are available. Consider increasing nursery diversity by 10% each year. Diversity reduces disease problems. Whenever possible, use disease resistant cultivars—this benefits both you and your customers.

Disease management isn't just "spray and pray." Sustainable disease management incorporates multiple techniques to reduce disease problems. A cornerstone to sustainable disease management is sanitation.

Sanitation: Clean tools, benches, and equipment to remove soil and plant debris prior to sterilization because disinfectants do not

penetrate these well. Soak clean tools in a bucket of disinfectant and dry on clean newspaper or plastic sheeting or in an empty, clean container. Hang them up so that they do not become contaminated with soil or plant debris.

Do not walk on greenhouse potting soil, benches, or on equipment that must be kept free of soil-borne plant pathogens unless your shoes have been dipped in disinfectant or are wrapped in clean plastic.

Pots, flats or other containers that are reused should be disinfested along with potting soil by covering pots and heat treatment. Recycling your pots is good—Recycling your pathogens is not.

Containers can be submerged in a liquid disinfectant for 10 minutes and then allowed to air dry. See Box 1 for disinfectant approaches.

Run soil tests to check pH and fertilizer status.

Seed Starting:

Use strict sanitation procedures for germinating seed and growing transplants. Ideally, this should be done in a specially designated and separate greenhouse.

Obtain your seeds and cuttings from reliable sources. Consider sanitizing "problem" seed (tomato, geranium, etc.) just prior to seeding, and carefully inspect any cuttings prior to bringing them into the greenhouse. If you are using started plugs from different sources keep them separate from each other in the greenhouse to avoid cross contamination. Always disinfest between groups of transplants to avoid spreading disease problems.

If not done previously, the growing medium should be checked for nutrients and pH, then monitored regularly. As always, monitor watering levels to prevent damping-off.

Summer

As soon as the crop is harvested, sanitize the greenhouse. Remove all plant material and roots from the greenhouse. Remove debris by hosing down all surfaces of the greenhouse structure, tools, and equipment prior to disinfesting. Solarize the house by watering the interior of the greenhouse, and closing it for two weeks during a hot, sunny period in the summer. The inside temperature should reach at least 145° F each day and the humidity should remain high.

These procedures are recommended for all greenhouse growers to reduce the risk of introducing plant pathogens. By starting out with little to no inoculum, pesticide dependence should be reduced.

4. Sustainable Disease Management

Sustainable disease management doesn't mean not using fungicides. It does mean that they are used...sustainably. When in doubt, make sure to obtain a professional diagnosis of any plant problem. The initial investment more than pays for itself in the costs of fungicides, time to regularly apply chemicals, or even environmental costs. It is also, quite simply, the sustainable thing to do. Think about it: Using the wrong fungicide pollutes the environment—It also wastes employee time, money (in the form of product and employee time), and the worsening condition of the crop. If you are going to invest in the time to regularly apply chemicals, and the chemicals themselves, it makes little sense to not determine if your management fits the problem.

Common Greenhouse Problems

Most problems have multiple approaches that need to be implemented to effectively manage the disease. Below are some of the most commonly encountered problems in the greenhouse.

Disease Management for Germinating Seeds: Damping-off

Symptom: Poor germination or thin seedling density, soil-line lesions, collapse.

Treatment: Proper watering, adequate temperatures and airflow are important to reduce risk of damping-off. If these underlying problems are not addressed, any chemical or biological treatment will not be effective.

Disease Management for Seedlings and Young Plants: Root and Crown Rots

Symptoms: Poor growth, pockets of empty plugs, plant separate from plug, brown roots.

Treatment: Proper watering, and evaluation of salts and pH (Some pathogens favor alkaline growing conditions), proper medium for growing plants. Incorporate good quality sphagnum in soil-less mixture. Biologicals, such as RootShield™, are only effective if the cultural conditions that prevent disease are in place. Fungicide use requires accurate diagnosis of the pathogen (Rhizoctonia, Pythium, Phytophthora, Fusarium, Cylindrocladium, etc.), so determine what type of root and crown rot is present prior to fungicide application.

Disease Management for Fungal Leaf Spots

Symptoms: Leaf lesions without water soaking.

Treatment: Adequate plant spacing is an important disease control tool. It's very important to allow foliage to dry between waterings to prevent disease. Because emerging leaves and shoots are most susceptible to foliar disease, thin seedlings

regularly, and adequately space plants. Use resistant varieties, if available. Protectant fungicide sprays (chlorothalonil) should be used where disease problems are persistent, alternated with strobilurins and/or DMI fungicides. These sustainable practices will control disease problems and minimize the risk of resistance.

Disease Management for Botrytis Blight:

Symptoms: Blights, leaf spots, blossom blast, wilt, cankers and crown rot.

Treatment: Reduce spore numbers by practicing good sanitation. Maintain the relative humidity in the house as low as possible to minimize foliar wetness and avoiding standing water. Most importantly, remember to vent! Introducing fresh air continuously into the greenhouse when the exhaust fan is off prevents botrytis infection, and other disease problems including downy mildews, leaf spots and damping-off. Use fungicide sprays as needed but remember to rotate often to prevent fungicide resistance from developing.

Disease Management for Virus Diseases.

Symptoms: Ringspots, streaking, mosaic, dwarfing.

Treatment: Inspect plants regularly and remove plants that are suspected of being infected. Monitor insect pest populations and control insect vectors (thrips, whiteflies, aphids, etc) as needed. Test samples in house or send out for conclusive diagnosis. Destroy infected plants if positive.

Remove weeds from surrounding greenhouse areas.

Place susceptible plants in the center of greenhouse, away from walls, vents and doors, thereby reducing insect vector access to the plants.

Disease Management for Bacterial Diseases of Geranium

Symptoms: Greasy, water soaked lesions, wilting, death.

Treatment: Because bacteria require leaf surface water to spread, keep foliage dry through adequate spacing and proper watering. Copper compounds can be used to protect against infection. Geranium started from seed often have fewer problems than those propagated by cuttings. Remove infected plants immediately and send to clinic for diagnosis.

Disease Management for Downy Mildews □

Symptoms: yellowing, stunting and deformity—the vagueness of these symptoms commonly leads to misdiagnosis. Key diagnostic signs can often be readily observed on the undersurface of the infected leaf, and appears as a fuzzy, whitish growth or “down.”

Treatment: Prompt removal of infected plants, coupled with fungicides to protect uninfected plants. Chemicals for management contain mefenoxam, dimethomorph, phosphorous acid, fosetyl-Al, mancozeb, strobilurins, and fenamidone.

5. Plant Disease Management Notebook Mock-up

Plant Disease Management Notebook

Host: Bud Break

Appearance: Flowering
Leaf/Shoot expansion

Site:
Soil Test/Mix used:
Location/Exposure:

Greenhouse Conditions

Watering Schedule: pH: salts: insolubles:

Disease and Insect Problems:

Chemicals Used: **Fertilizer:**

Pesticides:
Formulation:
Rate:
Method of application:
Applicator:
Greenhouse Conditions at Time of Application
Temperature at Application Time
Time of Day Applied.