# Root Diseases of Greenhouse Crops

## Introduction

The two most common causes of root impairment of greenhouse crops are fertilizer toxicity and plant pathogenic fungi. In some cases, fertilizer toxicity predisposes plants to pathogenic fungi. An accurate diagnosis is necessary to manage the problem effectively.

## Abiotic Causes

Abiotic (non-living) causes of root disease include excessive soluble salts, ammonium toxicity, and suffocation. Most commercially available fertilizers are in the form of salts. When excessive amounts of salts accumulate in the soil solution, they desiccate plant roots. Ammonium toxicity may occur when fertilizers containing urea or ammonium sulfate are used. Excessive levels of ammonium may also occur following steaming of organic soils, especially those containing manure. The conversion of ammonium to nitrate is carried out by soil microorganisms which are non-existent or in low numbers in soil-less media. The conversion can be inhibited by certain pesticides, cool wet soil, low pH, excessive soluble salts and poor aeration.

Roots must have oxygen or suffocation will occur. Soil composed of very fine particles is dense and has few air spaces. Similarly, a waterlogged soil contains little air. Plant pathogenic water molds thrive under saturated conditions.

## Root Diseases Caused by Fungi and Fungus-like Organisms

Extensive root decay will result in wilt but earlier symptoms can be seen by removing the pot and examining the roots. Healthy roots are generally white and firm; decayed roots may be water-soaked in appearance and/or darkened and easily macerated between the fingers. Some root colonizing fungi will move into the stem and cause canker or "black leg".

*Pythium* is one of the most common pathogens found in the roots of greenhouse crops and is often associated with excessive nutrient levels or ammonium toxicity. The genus includes about 125 species which vary in their pathogenicity to plants and sensitivity to fungicides. *Pythium* species can also cause damping-off, crown and/or stem rot and most species of *Pythium* have wide host ranges. *Pythium* is favored by high fertility and high moisture and is a natural inhabitant of the soil

where it can survive indefinitely. It can also persist in soil and debris in the greenhouse and on greenhouse floors. Many greenhouse isolates of *Pythium* are resistant to Subdue.

*Phytophthora*, a related organism, is generally more pathogenic than *Pythium* but is encountered less frequently. The pathogen causes root and crown rot as well as foliar blighting. *Phytophthora* like *Pythium* is favored by excess moisture and excess nitrogen fertility. Unlike *Pythium*, species of *Phytophthora* are more aggressive, more likely to be host specific, and less frequently found in greenhouses. The most likely source of origin is plant material. *Phytophthora* species are soil-borne where they can survive many years in the soil. Optimum conditions for disease development are saturated soil and high nitrogen fertility. The pathogen is not likely to be seed-borne in commercial seed, and it does not travel easily through the air for long distances. It is possible that contaminated irrigation water can introduce the fungus to new sites. Prevention is the key to managing *Phytophthora* because the pathogen is difficult to suppress with fungicides once it develops.

Both *Pythium* and *Phytophthora* are most destructive when soil moisture is abundant. They are not considered to be true fungi, but rather members of the Oomycetes and as such are controlled by completely different fungicides than the true fungi like *Rhizoctonia* and *Thielaviopsis*.

*Rhizoctonia* is also a common cause of root disease and stem canker. *Rhizoctonia solani* causes damping-off, root rot, crown rot, web blight, and stem canker in numerous greenhouse grown crops. Unlike *Pythium* and *Phytophthora*, dry soil is more favorable for disease development. For this reason, *Rhizoctonia* is more active in the upper portion of the soil. *Rhizoctonia* is a natural inhabitant of the soil and can survive there indefinitely. This pathogen is usually a problem in the cuttings and small transplant stage and the presence of wounds caused by insects or mechanical damage can predispose plants to *Rhizoctonia* infection. Other plant pathogens occasionally encountered include *Thielaviopsis, Fusarium, Sclerotinia* and *Cylindrocladium.* A laboratory diagnosis is necessary to determine the cause of root rot.

*Thielviopsis* root and stem rot, often called Black rot, is caused by *Thielaviopsis basicola*. The fungus can survive in infested soil for years as dark colored chlamydospores. These dark colored spores give an infected plant parts a black coloration which has resulted in the common name, Black rot. The pathogen has a wide host range among ornamental and vegetable crops, with pansy and Calibrachoa being particularly susceptible. Black root and stem rot is most severe in cold, wet soils. *Thielaviopsis* is favored by alkaline pH and can be managed by keeping the pH of the media at 5.5.

# Sources of Root Disease Fungi

Fungi that attack root systems are natural inhabitants of the soil and thus, have the ability to survive there indefinitely. They are easily introduced into the growth medium by soiled hands, tools, flats and colonized transplants. Greenhouse floors may also harbor pathogenic fungi so it is important to keep the hose-ends off the floor. When a soil-less medium is amended with field soil, it must be treated to prevent the introduction of plant pathogens, nematodes, insects and weeds. Fumigation or steaming of soil-less media is not recommended. However, when a soil-less medium becomes contaminated with plant pathogens, root rot can develop quickly. Fungus gnats and shore flies may introduce and spread these pathogens within a crop. Biological and chemical methods are available for controlling these insects.

# Management

Pots or flats that have been used should be washed with soap and disinfested in 10% household bleach or a similar agent. If field soil is used wholly or as an amendment to a soil-less medium, it must be treated. Steam is the least expensive, safest, and most effective method. The whole soil mass must reach a temperature of 180 F for at least 30 minutes.Various fumigants such as Basamid® (dazomet) may also be used. Fumigants can be hazardous and must be handled cautiously. Residual fumigant in the treated medium may be phytotoxic. Be sure to follow the directions closely. For some crops, protectant fungicides should be used from the beginning of the planting cycle and repeated at regular intervals. Banrot® or other appropriate combinations of fungicides will provide a broader spectrum of activity.

### Fungicides* for *Pythium* and *Phytophthora*

| Common name | Trade name | Rate | Comments |
|---|---|---|---|
| foestyl-Al | Aliette® WDG | 0.4 to 0.8 lb/100 gal; 2 pts/sq ft. | Drench; however, foliar applications of 2.5-5 lb/100 gal will control root rot of some plants. |
| etridiazole | Truban® WP, EC and G | See label | Rates vary depending on the formulation. |
| dimethomorph | Stature | 3.2-6.4 oz/50 gal | Not effective for *Pythium*. Apply only when roots are well established. |
| fluopicolide | Adorn | 1-4 fl oz/100 gal | Apply as a soil drench at seeding or transplanting. |
| fludioxonil plus mefenoxam | Hurricane | See label. | Test plants for phytotoxicity. Stunting and chlorosis have been reported on Impatiens, New Guinea impatiens, Pothos, |

| Common name | Trade name | Rate | Comments |
|---|---|---|---|
| | | | Geranium and Easter lily. |
| mefenoxam | Subdue® Maxx | See label. | Rates vary depending on the plant. Subdue has broad crop clearance for ornamentals. Many greenhouse isolates of *Pythium* are resistant to Subdue. |
| phosphonates | Alude, Fosphite, Vital | See labels. | Plant defense activator. Systemic. |
| propamocarb | Banol | 20-30 fl oz/100 gal; see label for details. | Drench at 3 to 6 week intervals. May be tank mixed with thiophanate methyl for control of *Rhizoctonia*. |
| thiophanate methyl plus etridiazole | Banrot® 40WP | 4-12 oz/100 gal; apply to 400 sq. ft (about 0.5 pt/6" pot) | Irrigate immediately with additional water equal to at least half the volume of the fungicidal drench. Also controls *Rhizoctonia*, *Fusarium*, *Thielaviopsis* and *Cylindrocladium* |

## Fungicides* for *Rhizoctonia* and some other fungi

| Common name | Trade name | Rate | Comments |
|---|---|---|---|
| azoxystrobin | Heritage | 1-4 oz/100 gal | Broad crop clearance. Do not make consecutive applications or alternate with Compass. |
| thiophanate methyl | Cleary's 3336, T-Storm, Allban Flo | See label. | Cleary's has broad crop clearance for ornamentals. Use experimentally for plants not on the label. Rates vary depending on the formulation. |
| iprodione | Chipco 26019®, 26GT, Iprodione Pro | 6.5 oz/100 gal; 1-2 pts/sq ft. | Active primarily against *Rhizoctonia*. Do not apply to impatiens, Spathiphyllum, or Pothos. |
| PCNB | Terraclor® 75WP | 4 oz/100 gal; apply to 800 sq ft. | Broad crop clearance for ornamentals. Active primarily against *Rhizoctonia* and *Sclerotinia*. May cause |

| Common name | Trade name | Rate | Comments |
|---|---|---|---|
| | | | phytotoxicity to some foliage plants. |
| pyraclostrobin plus boscalid | Pageant | 12-18 oz/100 gal. | For drench applications, use enough solution to wet the root zone of plants. |
| thiophanate-methyl plus chlorothalonil | Hurricane | 1.5 oz/100 gal or 2 packets/200 gal | Test on plants not on label. See label. |
| thiophanate-methyl plus etridiazole | Banrot® 40WP | 4-12 oz/100 gal; apply to 400 sq ft (about 0.5 pt/6" pot). | Irrigate immediately with additional water equal to at least half the volume of the fungicidal drench. Also controls *Pythium*, *Phytophthora*, *Fusarium*, *Thielaviopsis* and *Cylindrocladium*. |
| flutolanil | Contrast | 3-6 oz/100 gal. | Test on plants not on label. |
| fludioxonil | Medallion | 1 to 2 oz packets/100 gal. | For *Rhizoctonia*, apply sufficent water to wet the top half of the growing medium. For other pathogens, completely drench the growing medium. |
| trifloxystrobin | Compass | 0.5 oz/100 gal | Ensure that the upper half of media is wet. May be phytotoxic to petunia, violet or New Guinea impatiens. |
| triflumizole | Terraguard 50 W | 4-8 oz/100 gal; 4 fl oz/6 inch pot. | For best results do not irrigate with additional water until 24 hr after application. Apply at 3-4 week intervals as needed. Do not use on impatiens plugs. On impatiens transplants, do not exceed 2 oz/100 gal. |

* ***Avoid consecutive applications of fungicides within the same chemical class; rotate among different active ingredients' mode of action for best results.***