UNIVERSITY OF ILLINOIS EXTENSION
College of Agricultural, Consumer and Environmental Sciences

report on
PLANT
DISEASE

RPD No. 615
February 1988

DEPARTMENT OF CROP SCIENCES
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

DAMPING-OFF AND ROOT ROTS OF HOUSE PLANTS AND GARDEN FLOWERS

All species of plants grown as house plants, greenhouse plants, or garden flowers are susceptible to one or more soilborne fungi capable of causing damping-off of seedlings and root or crown (foot) rots of established plants. Because it is difficult to recognize the problem, determine the causal factor, and control the fungal pathogens, this type of disease is potentially the most serious to the grower.

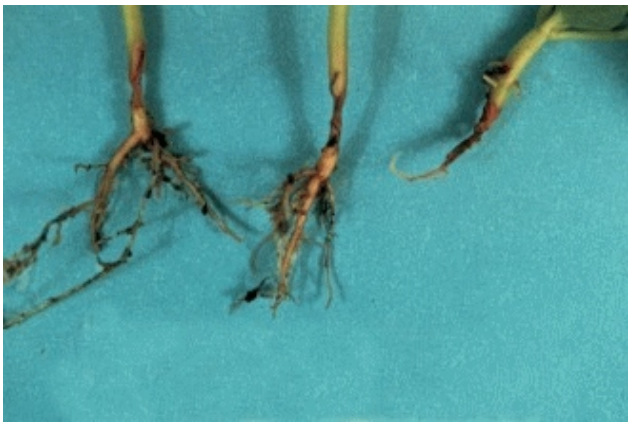

Figure 1. Rhizoctonia solani on brassica actinophylla seedling damping-off.

Entire seed flats of house plants, bedding annuals, and perennials are often lost to damping-off. Seedlings that survive mild infection are usually weak and nonproductive. Seeds sown directly into the garden or bedding area are also subject to attack, making stand establishment difficult.

Damping-off is most often associated with the fungus *Rhizoctonia solani* and species of *Pythium*. Other fungi that occasionally cause damping-off include *Sclerotinia sclerotiorum, Sclerotium rolfsii, Macrophomina phaseoli*, species of *Botrytis*, and species of *Aphanomyces, Fusarium, Cylindrocladium*, and others. Any one or more of these fungi may be present in soils and seedbeds in the Midwest.

The most common root-rotting fungi of established house or greenhouse plants and garden flowers are *Rhizoctonia solani*, species of *Pythium* and *Phytophthora*, and *Thielaviopsis basicola*. Species of *Pythium* and *Phytophthora* are most likely to cause damping-off and root rot in cool to cold, wet, poorly aerated soils, whereas the majority of the other fungi usually cause disease under warmer and drier conditions. The characteristic symptoms produced by major pathogens are given below.

SYMPTOMS

Damping-Off

A root-rot problem may first appear as damping-off shortly after planting. The seed may rot in the soil before germination or the new sprouts may be killed before reaching the soil surface (pre-emergence

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Figure 2. Root and rhizome rot of calla. Healthy calla plants (left) were grown from disease-free rhizomes; two rows at the right were not (IL Nat. Hist. Survey).

damping-off). Pre-emergence damping-off results in a poor, uneven stand, a condition that is often attributed to low seed viability. Young seedlings also may be killed shortly after emergence (postemergence damping-off). Infection results in a water-soaked lesion at or below the soil line (Figure 1A). The lesion enlarges, girdling and constricting the stem, causing the seedling to discolor, wilt suddenly, collapse, and die (Figure 1B). A tan, gray, pink, cottony, or other type of mold may grow over affected plant parts in moist weather. Woody seedlings often wilt and remain upright (wirestem). Damping-off may be caused by a variety of seed- and soilborne fungi. Germinating seed and seedlings, especially weak ones, are vulnerable to attack by one or more fungi during periods of unfavorable growing conditions. True damping-off may be confused with plant injury caused by insect feeding, excessive fertilization, high levels of soluble salts, "drowning" in overly wet soil, desiccation in very dry soil, and death of seedlings from excessive heat or cold, flue fumes, or chemical toxicity.

Root Rot

All established house plants, greenhouse plants, or garden flowers are affected by one or more root rots. Such plants may show a variety of aboveground symptoms. They may be stunted or low in vigor, and they may grow slowly or wilt easily on a warm day. The foliage of such plants may turn yellow to brown and fall prematurely, starting with the bottom or oldest leaves and moving up the plant until only the youngest tuft of leaves remains. If severely affected, plants eventually die when the roots can no longer supply sufficient water and nutrients to the aboveground parts (Figure 2). The severity of root rot depends upon the fungal pathogen, the susceptibility of the host plant, and the soil conditions.

If a root rot is suspected, the plant should be carefully removed, and its roots should be washed off and examined for indications of rotting. A healthy plant has numerous white roots that appear fibrous. A diseased plant's roots will show various degrees of water-soaking and will usually be some shade of brown or black.

Figure 3. (A) Rhizoctonia stem canker or rot of chrysanthemum (U. of Wisconsin). (B) Rhizoctonia crown (foot) and root rot of stock. The dark, reddish-brown, girdling lesions form near soil line (IL Nat. Hist.. Survey).

Other pest problems that may have aboveground symptoms similar to root rot are stem and crown (foot) rots; Fusarium and Verticillium wilts; bacterial soft rot or wilt; root-feeding by nematodes and insects; a severe infestation of mites, aphids, or soft-bodied scales; and rots of bulbs, corms, rhizomes, or tubers.

Aboveground symptoms similar to those of root rot may also be caused by such environmental factors as a lack or excess of water, poor drainage, too deep planting, accumulated salts in the soil, insufficient light or nitrogen, potbound roots, and a sudden change in the environment (e.g., a cold draft, or a change in temperature, lighting, or humidity). In garden flowers, environmental conditions that most often cause symptoms similar to those of root rot are an excess or lack of water or insufficient nitrogen. Plants are more susceptible to root-rotting fungi in soils infested with plant-parasitic nematodes and root-eating insects.

DISEASES AND PATHOGENS

Rhizoctonia Root Rot (*Rhizoctonia solani*)

In its most severe form, this disease causes damping-off of seedlings and a firm basal (or foot) rot of cuttings. Under favorable conditions it may produce a root rot of mature plants. Infection is favored by an intermediate moisture range and warm to hot temperatures. Plants infected with *rhizoctonia solani* have sunken, well-defined, reddish brown to dark brown lesions on the stem at or below the soil line and on the roots (Figure 3). Under moist conditions the weblike brown mycelial growth of the fungus can be seen coming from the lesions.

Rhizoctonia solani is found in all natural soils. It can survive indefinitely in the soil through saprophytic mycelial growth or as small, hard (1/16 to 3/16 inch), round to egg-shaped, brown to black bodies called sclerotia.

Pythium Root Rot (*Pythium* spp)

Species of *Pythium* are primarily a problem in the damping-off of seedlings and a basal rot of cuttings, but they also may be associated with root rots of established plants. Pythium root rot is favored by cool, wet, poorly-drained soils and by overwatering. *Pythium* infects the younger, feeding roots and often advances into the rest of the root system. Pythium infection results in a wet, odorless rot. The roots later take on a light brown to black coloration. The soft to slimy rotted outer portion of the root (cortex) usually can be easily separated from the inner core (stele). If severe, the disease may move up into the lower portion of the stem, which then becomes slimy and black (Figure 4).

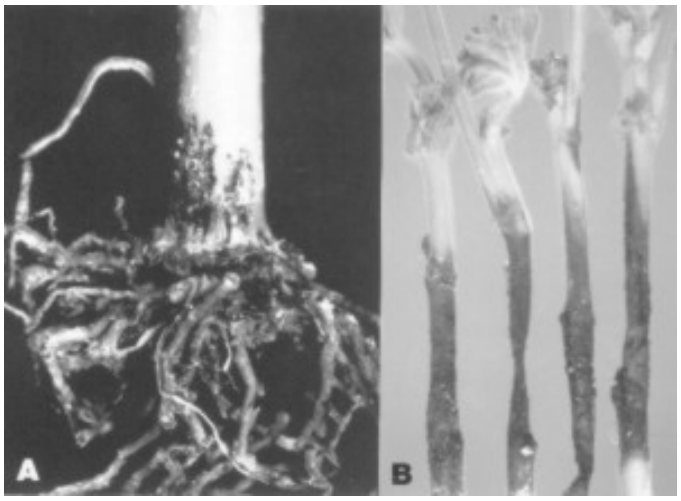

Figure 4. Blackleg or Pythium stem and root rot of geranium. (A) Crown and root rot (Cornell University). (B) Cutting rot (U. of Wisconsin).

Species of *Pythium* survive for several years in soil and plant refuse as saprophytes or as thick-walled resistant spores (chlamydospores or oospores).

Phytophthora Root Rot (*Phytophthora* spp)

Species of *Phytophthora* are usually associated with root rots of established plants but may be involved in damping-off and a basal rot of cuttings. Like *Pythium*, species of *Phytophthora* spp. enter the root tips

and cause a watersoaked, odorless, brown to black rot very similar to Pythium root rot (Figure 5). Because of the similarity, it may be necessary to send a diseased specimen to a plant clinic where the pathogen can be isolated and identified. Fortunately, Pythium and Phytophthora root rots are controlled by the same treatments (Table 1).

Thielaviopsis or Black Root Rot *(Thielaviopsis basicola*)

This fungus, which does not have as large a host range as the previous pathogens, is primarily a problem of established plants. The disease is favored by heavy, cold, wet, slightly acid to alkaline soils. The disease is not a problem in soil adjusted to a pH of 4.5 to 5.5. The fungus infects the plant where the lateral roots emerge from the taproot. The diseased area is very dry and soon turns a dark brown because of the abundant production of chlamydospores by the fungus (Figure 6).

Thielaviopsis basicola survives in soil and plant debris as a saprophyte or for 10 years or more as thick-walled, resistant black chlamydospores.

Figure 5. Phytophthora rot of peperomia, soft black rot of the stem, petioles, and base of the leaf blades (IL Nat. Hist. Survey).

CONTROL

A control program should be based on preventing the introduction of the fungal pathogens and on maintaining the plants in a vigorous state of growth.

1. Buy **only** top-quality seed of well-adapted species and cultivars. If the seed does not come treated, coat it with captan (sold as Captan or Orthocide) plus metalaxyl (sold as Apron) to give protection against seed decay and damping-off. Add to the seed packet the amount of captan and metalaxyl that will stay on the flat end of a toothpick, fold the packet closed, and shake vigorously until the seeds are covered with a thin layer of fungicide. For larger amounts of seed, fill a Mason jar about one-half full of seed, add a level teaspoonful of captan and the suggested amount of metalaxyl, and then roll the jar on the floor for 5 minutes to uniformly coat the seed. Excess fungicide can be removed by shaking the treated seed in an old tea strainer or a piece of cheesecloth. Seed treatment is good insurance for better stands of more vigorous seedlings, especially if the soil is cold and wet after planting.

2. Buy disease-free, vigorously growing plants from a commercial propagator, reputable nursery, or florist. Vigorous growth is indicated by the presence of newly formed buds, leaves, or shoots. Knock the plants out of their containers and inspect the root ball for indications of a root rot. The purchase of cultured, virus-indexed (CVI) cuttings of carnations, chrysanthemums, and geraniums will cost more but are well worth the extra expense as they are as free as possible of disease.

3. Plant house plants at the proper depth in a light, well-drained, pasteurized soil mix. Commercial and homemade soil mixes can be pasteurized by heating moist (not wet) soil 2 to 3 inches (5 to 7.6 cm) deep in a shallow pan and baking the soil in an oven at 180°F (82°C) for 30 minutes or 160°F (71°C) at the **coolest** spot for 1 hour or until a small potato buried in the soil in the middle of the pan is

cooked. The growth medium should be free of chemicals and other toxic residues. Use plant containers with one or more openings in the bottom to provide proper drainage. Avoid excess watering. Place the plants in the best site possible for maximum growth.

4. Sow the seed of garden flowers in a light, well-drained, well-prepared, fertile soil. Or sow in a layer of screened sphagnum moss, vermiculite, perlite, peatlite mix, or other presumably sterilized medium before transplanting. Avoid overcrowding and deep planting of seeds. Plant in a desirable location at the time recommended for the area. Provide the proper amount and duration of light to keep plants growing vigorously. Keep plants growing steadily by proper watering and fertilizing. Avoid overfeeding, especially with a high-nitrogen fertilizer. Water in the morning and keep it off the foliage. Avoid excess watering.

5. Avoid watering before taking cuttings or otherwise handling plants. The chances of transmitting pathogens is reduced when only dry plants are handled. Cuttings should be made as far from the soil surface as practical to minimize contamination.

6. Avoid spreading soil from infested areas. Carefully dig up diseased plants, remove them from growing areas, and place them in a covered trash container.

7. Disinfect tools and old containers after working with diseased plants or infested soil. Soak or swab them with a solution of household bleach (1 part Clorox or similar liquid bleach in 4 parts of water) or 70 percent rubbing alcohol.

8. If damping-off or root rot does occur, diagnose the problem and apply the proper fungicide(s) to protect other plants in the immediate area. The common and trade names of suggested fungicides and the pathogens they control are given in the Illinois Homeowner's Guide to Pest Management. Generally, 1 to 2 level tablespoons of fungicide in a gallon of water, applied at rates of 1 pint to 1 quart per square foot (1/2 pint per 6-inch pot), will check the advance of damping-off and root and crown rots.

   Recommendations for controlling diseases of house plants and garden flowers can also be found in the above mentioned publication.

9. If **not** using "sterile" soil mixes or steaming the soil, rotate plantings for 2 or 3 years or more with unrelated annual flowers to help prevent the buildup of a pathogen in one area or crop. Most disease-causing fungi persist in soil or decaying plant refuse from one year to the next. Proper rotation helps to "starve out" many of these pathogens.

10. If the soil in flower beds becomes severely infested with one or more pathogens, fumigate the soil. Effective fumigants include methyl bromide, chloropicrin, Vorlex, and SMDC or Vapam. These compounds are general biocides and kill not only fungi in the soil but also bacteria, nematodes, insects, mites, germinating weed seeds, and most other forms of life in the area, including the roots of trees and shrubs. Since methyl bromide, chloropicrin, and mixtures of the two are restricted pesticides, they should be applied by a certified pesticide applicator trained in soil-fumigation techniques. Methyl bromide and chloropicrin require the use of a gas-proof cover (such as polyethylene or vinyl) over the treated area for 48 to 72 hours or more. Vorlex and Vapam work best when applied under a gas-proof cover, but these chemicals can be "sealed in" by a water seal of about 1/2 to 1 inch of water (300 to 600 gallons per 1,000 square feet). Carefully follow the directions on the manufacturer's label when using any pesticide.

11. Because it is less likely to be contaminated with fungal pathogens, adding composted hardwood bark as a growing medium can help to suppress disease-causing organisms (such as *Rhizoctonia*). Composted hardwood bark is popular in the commercial production of bedding plants.

12. Avoid recontaminating pasteurized or fumigated soil and commercial soilless mixes. This is critical! Tools used in untreated soil should not be used in treated soil unless they have been disinfected (see number 7). The nozzles of watering hoses should not be stored on surfaces where they can pick up soilborne pathogens and later transfer them to sterilized areas. Treated soil should be placed directly into clean pots or other containers or stored in decontaminated bins or carts and covered with clean plastic. Soilless mixtures can be contaminated easily because no organisms that are antagonistic to pathogens are present.

    Use tap water or deep well water, which is usually free of fungal pathogens, to water plants. Do **not** use water from drainage ponds, ditches, or other surface areas—these areas are usually contaminated with root-rotting fungi and other pests.

    Avoid using contaminated covers over bins of treated soil. Containers, flats, labels, soil bins, potting benches, and so forth can be decontaminated using heat (180°F for 30 minutes or 160°F for 1 hour) or chemicals. Soaking or scrubbing them with 1 part of bleach to 4 parts of water for 15 minutes or longer is effective as is fumigation with methyl bromide or chloropicrin. The use of nonporous materials (such as corrugated fiberglass, tranzite, slate, or "Formica") will aid decontamination efforts. Wash hands thoroughly with soap and running hot water after touching a diseased plant and before touching healthy plants. If you see a diseased plant during plant-handling operations, work around it until the end of the job. Then discard it directly into a trash container with a lid.

Table 1. Soil fungicides useful in controlling damping-off and roots rots

Common name	Trade name	Fungal pathogens controlled
PCNB or quintozene, 75% WP (and captan-PCNB mixtures)	Terraclor PCNB	*Rhizoctonia solani, Sclerotinia sclerotiorum, Sclerotium rolfsii, Botrytis* spp, and other sclerotia–forming fungi.
fosetyl-Al	Aliette	Water molds (*Pythium, Phytophthora, Aphanomyces*)
etridiazole (or ethazole), 30-35% WP	Truban Terrazole	Water molds (*Phytophthora, Pythium, Aphanomyces)*
metalaxyl/mefenoxam	Sudue, Subdue Maxx Apron[a]	Water molds (*Phytophthora, Pythium, Aphanomyces)*
propamocarb	Banol	Water molds (*Phytophthora, Pythium, Aphanomyces*)
captan, 50% WP	Captan	Controls most pathogens, but **not** *Rhizoctonia solani*
iprodione, 50% WP	Chipco 26019	Controls most pathogens, but not water molds
thiophanate-methyl, 70% WP	Topsin-M	*Rhizoctonia solani, Sclerotium rolfsii, Sclerotinia sclerotiorum, Fusarium* spp., *Botrytis* spp., *thielaviopsis basicola*, *Cylindrocladium* spp., and other root-rotting fungi (but **not** water molds)
etridiazole (or ethazole), 15% WP and thiophanate-methyl, 25% WP	Banrot	*Rhizoctonia solani, Sclerotium rolfsii, Sclerotinia sclerotiorum, Thielaviopsis basicola, Botrytis* spp., *Fusarium* spp., *Pythium* and *Phytophthora* spp., and other root-rotting fungi. Good general-purpose soil fungicides to use if you do not know the causal fungi.

[a]Apron is applied as a seed treatment before planting to aid in control of water molds (*Pythium* and *Phytophthora*).

NOTE: These fungicides may be applied as a soil drench after planting or may be incorporated into the soil before planting as a dust or drenching spray. For an all-purpose drench, use Banrot (also available as 8% granules), SA-Terraclor Super-X, or a combination of either PCNB or benomyl plus etridiazole (ethazole), fosetyl-Al, or metalaxyl. For timing and rates of application carefully follow all manufacturer's directions.

The fungicides listed in the Table represent the best information available. No criticism of fungicides not listed is intended, nor is endorsement given to compounds listed.