Bedding Plant Diseases

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Over the past 20 years, bedding plant production has changed from nursery production of outside bedgrown, bare rooted transplants to containerized transplants grown in soilless media. This change has greatly reduced the impact of diseases, particularly damping-off and crown and root rots, on bedding plant production.

The two most important diseases in bedding plant production are damping-off plus the related root rot diseases and Botrytis blight or gray mold.

Damping-Off

Damping-off has been the most important disease problem in bedding plant production. This disease complex can occur on any species of plant grown from seed. If the pathogen or pathogens are present and conditions are favorable for disease development, plant losses can be extensive in the seedling and plug flats and transplanted surviving seedlings may later develop root rot and die. Losses include the high cost of hybrid seed, cost to replant, cost of pesticides, cost of labor for applying pesticides, delayed production, and so on.

Pathogens. Damping-off may be caused by many different fungi, but the following are the most common: *Rhizoctonia solani, Pythium* spp., *Phytophrhora* spp., *Sclerotinia sclerotiorum, Sclerotium rolfsii, Fusarium* spp., and *Botrytis cinerea.*

Through a thorough understanding of the requirements for disease development--**(1) presence of pathogen; (2) environment favorable for the pathogen; and (3) susceptible host**--damping-off should seldom be a serious problem of bedding plants grown on raised benches in containers with sterile media.

Symptoms. Damping-off can cause plant losses on bedding plants from the seedling flat until sales. The disease often attacks plants in seedling flats and plug flats in circular areas up to a foot in diameter. Preemergence damping-off appears as seed decay or seedlings die before they emerge from the soil. This type loss may be blamed on low-quality seed. Postemergence damping-off occurs after the seed has germinated and the seedlings have emerged from the soil.

Pathogens such as *Rhizoctonia solani, Sclerotium rolfsii,* and *Sclerotinia sclerotiorum* attack the seedling stem at or near the soil surface. The stem tissue at this point shrivels, dies quickly, and turns a tan, brown, or black color. Such seedlings may be stunted and yellow, but generally wilt, fall over, and die. Seedlings with this type of damping-off that do not die may be transplanted and later the disease is called wire stem. Such plants will be stunted and off color. Stems of such plants are often discolored and slightly constricted or shriveled at or just below the soil line.

Water-mold pathogens such as *Pythium* spp. and *Phytophthora* spp. attack the seedling root tips, and may eventually rot the entire root system. Seedlings will be stunted, light green to yellow in color and soon die. Damping-off caused by the water-mold pathogens is favored by high soil moisture. Under moist conditions, particularly early in the morning, the mycelium of some water-mold pathogens may be observed on the diseased stem or on the media surface near dying seedlings. Mycelin of *Rhizoctonia* consists of tan to brown threads that grow between invaded plants parts and media particles. Media particles, particularly sand, may cling to or dangle from diseased seedlings. This may be used to aid in disease diagnosis. *Sclerotinia sclerotiorum* grows as a white fluffy or cottony mass of mycelium. Numerous strands of mycelium may fuse to produce small black, hard-resting structures called sclerotia. *Sclerotium rolfsii* may be seen as white to tan coarse strands on the media surface around diseased seedlings. Round tan to brown sclerotia may be formed in later stages of the disease.

Presence of Pathogen. Most bedding plants are seeded in clean or pasteurized soilless media in new or sterilized containers on sterile raised benches. This should eliminate the pathogen(s) in the media. Afterwards, growers must

avoid introducing the pathogen(s) on the seed or through careless cultural practices. Numerous pathogens are known to be carried on or in seed, transplants and cuttings. Only the highest quality propagation material should be used. This will minimize recontamination via seed, but not guarantee freedom from future introduction of pathogens. Since many of the pathogens that caused damping-off have no airborne spores, they must be physically moved into the seedling flats through careless cultural techniques. Media can also be contaminated through poor storage conditions prior to use.

Environment Favorable on the Pathogen. High moisture and low temperatures are the critical, favorable environmental factors for development of Botrytis blight. Slow germinating seed and slow growing seedlings remain susceptible to damping off for a longer period of time than those growing under optimum conditions. Therefore, much care should be taken to provide environmental conditions most favorable for optimum seed germination and growth of seedlings. Media, temperature and moisture are major factors to consider. High energy costs have encouraged growers to reduce greenhouse temperatures. If the greenhouse temperature is not ideal for seed germination or rooting, special seed germination chambers should be constructed so that optimum conditions can be provided to speed up this process. Media drainage, water-holding capacity, frequency of watering, and quantity of water applied in each application influence the water to air space ratio within the media. Excess water in the media generally favors the development of damping-off, particularly by species of *Pythium* and *Phytophthora*. Some growers germinate seed on top of the media with mist rather than in the media. This speeds up the germination process. Adequate light must be provided for seedling growth. Too little light causes seedlings to be more succulent and more susceptible to damping-off fungi. Proper fertilization during the propagation process also influences development of damping-off. Too little fertilizer reduces the rate of seedling growth. Excess fertilizer may reduce growth rate, increase seedling succulence, or injure the seedlings. Both extremes increase the chances of damping-off. Excessively thick seedling stands or multiple seeding per plug cells increases seedling succulence and reduces air movement around the seedlings thus keeping them wet for longer periods of time; these conditions favor development of damping-off. Cold water used on seed flats can reduce media temperature and seedling growth. This may be particularly important in northern areas.

Susceptible Host. All seedlings are susceptible to damping-off fungi. Little can be done in this area except to provide growing conditions for optimum growth to minimize the length of time seedings remain susceptible and to avoid increasing seedling susceptibility by causing stress or injury such as excessively high soluble salts.

Damping-Off Control. The best control of any disease is to completely avoid its occurrence. Every bedding plant grower should thoroughly understand damping-off, factors that favor it development, and potential sources of contamination. Damping-off must be avoided through a complete continuous sanitation and cultural program. Fungicides should be used to control damping-off only as a last resort.

Most fungicides used to control damping-off also cause some injury to seedlings. The younger the seedling, the more severe the injury. Fungicide rates higher than recommended must be avoided. If damping-off is a continual problem, much effort should be made to determine the source of the pathogen and correct the sanitation or cultural problems rather than continue to use or increase the use of fungicides.

Many fungicides are registered for control of damping-off and some are widely recommended, but no single fungicide is highly effective against the major damping-off fungi, *Pythium* spp. and *Rhizoctonia solani*. Since damping-off is caused by a wide variety of pathogens, and since early treatment is essential, it is necessary to remove diseased seedlings and infested media promptly and (1) use one less effective broad-spectrum fungicide (example, Captan); (2) use a combination of two different highly effective fungicides [example, etridiazole (Truban) plus benomyl

(Benlate), or one produce containing two different fungicides such as etridiazole plus thiophanate methyl (Banrot)]; or (3) quickly identify the pathogen and use one highly effective, specific fungicide (example, etridiazole for *Pythium* spp. or benomyl for *Rhizoctonia solani*). Pathogens also can be introduced on or in seeds. This often can be prevented by preplant seed treatments with chlorine bleach diluted 1:10 with water or fungicides.

Botrytis Blight

Casual Organism. Botrytis blight or gray mold is caused by the fungus *Botrytis cinerea*. This disease can cause severe losses of bedding plants late in the production program. Occasionally, this fungus also can attack germinating seed or seedlings, particularly if they are injured or excessively crowded. As the seedlings get large or overgrown so that flats are very full, Botrytis blight can spread rapidly. With warmer day time temperatures in the spring, the growth rate of bedding plants increases which increases the frequency of watering making conditions more favorable for disease development. High rates of fertilization, death of lower leaves, low light intensity, frequent watering, early flower production, and crowded plants all favor Botrytis blight development.

Symptoms. Botrytis blight can develop on any aboveground plant parts and usually appears as a soft tan to brown necrotic area that enlarges rapidly under moist conditions. The fungus produces brown to fuzzy masses of airborne spores on the surface of necrotic tissue. The presence of the spore masses is the key diagnostic character. Botrytis blight is most commonly observed on flower petals but is also common on dying or injured leaves. The fungus generally does not invade a healthy green leaf or stem. It can, however, grow from a diseased leaf or petal into an adjacent healthy leaf or stem. Botrytis blight can develop on bedding plants at any time during the production cycle.

Control of Botrytis Blight on Bedding Plants. The following steps should be followed for best control success:

1. Control relative humidity by ventilation and heating to avoid condensation on plant surfaces during the night.
2. Time seeding and transplanting to avoid holding any longer than necessary before selling.
3. Practice good sanitation to reduce inoculum production on dead and dying plant parts on bedding plants and other plants growing in the same house.
4. Avoid watering during slow drying conditions.
5. Avoid injury to foliage and flowers to reduce incidence of Botrytis infection.
6. Use fungicides if conditions favor the development of Botrytis blight, particularly late in the production program.

Complete coverage of all plant surfaces is a necessity. Do not allow the disease to build up before starting fungicide applications. Fungicides can be applied as a spray such as benomyl or chlorothalonil (Daconil 2787) or fumigated with a thermal dust, such as chlorothalonil (Exotherm Termil). If narrow-spectrum fungicides are repeatedly used to control Botrytis blight, steps should be taken to prevent the development of fungicide resistance in *Botrytis cinerea*. This is the most frequently reported fungal species with fungicide resistance.

IMPORTANT: If the first five steps are followed, fungicides may not be needed.

Diseases of Specific Bedding Plants

Numerous pathogens are listed in the *Index of Plant Diseases of the United States* on some of the minor bedding plant species but little or no literature is available on most of them. With the exception of commonly occurring pathogens like *Pythium* sp., *Rhizoctonia solani, Botrytis cinerea*, and powdery mildew, most of these pathogens are rarely observed by the author and then they occur in the landscape rather than a production greenhouse.

Begonia. Fibrous rooted begonia grown from seed are very susceptible to damping-off. Powdery mildew, caused by the fungus *Erysiphe cichoracearum*, is frequently observed on numerous cultivars of begonia. The fluffy white to tan fungus growth on leaf, stem and petal surfaces is characteristic of this disease. *Botrytis cinerea* commonly occurs on begonia flowers and leaves. Bacterial leafspot, caused by *Xanthomonas campestris pv. begoniae* occurs on many begonia cultivars. The leafspots are small, circular, blisterlike, and later become more angular with a water-soaked margin. The bacteria often penetrate at the leaf margin and spread through the veins blighting entire leaves.

Growers have experienced severe losses of seedling dahlias due to smut. The fungus is seed borne. The disease moves very fast and control is often not practical. Tomato spotted wilt virus (TSWV) is often carried in dahlia grown from roots.

Geranium. From a production standpoint, seedling geraniums are a more typical bedding plant crop than the traditional geranium crop grown from cuttings. The production of seedling geraniums has increased tremendously over the past few years.

While seedling geraniums are reported to be susceptible to all the diseases of the standard geraniums, disease losses are generally low on seedling geraniums grown under a good sanitation program. This probably is due to the fact that most of the serious, difficult-to-control diseases common to standard geraniums--Pythium black leg, bacterial blight, verticillium wilt, and viruses--are caused by soilborne or systemic pathogens that are not or only rarely are carried from one crop to another crop on or in seed. TSWV has only been found on ivy type geraniums.

Botrytis Blight. The most common disease problem on seedling geranium during commercial production is Botrytis blight caused by *Botrytis cinerea*. This fungus disease becomes increasingly common as the early flowers begin to senesce. The disease appears as a rapid rotting of the petals with the characteristic brown-to-gray fuzzy sporulation of *Botrytis cinerea* on the blighted tissue. As these blighted petals fall onto the leaves, leaf spot develops.

Control. Botrytis control on seedling geraniums is the same as for any other flowering crop. Sanitation in the entire greenhouse and removal of the senescing geranium flowers to reduce Botrytis spore production and leafspot development is critical. Moisture control and regular fungicide applications after flower production begins should provide adequate control.

Damping-off. Seedling geraniums are susceptible to damping off, particularly by *Pythium* spp. The disease will appear as stunted, wilted, or dead seedlings with black roots. The pathogen generally invades seedling geranium roots and eventually can grow throughout the root system into the lower part of the stem.

Impatiens or Sultana. Impatiens are very susceptible to damping-off caused by *Pythium* spp. and *Rhizoctonia solani*. Impatiens are susceptible to tobacco ringspot virus (TRSV), tomato spotted wilt virus (TSWV), and tobacco streak virus (TSV) in the greenhouse. TRSV causes impatiens plants to be stunted with small leaves exhibiting typical chlorotic ring spots and line patterns. TSV causes plants to be stunted with small leaves with the margins rolled up. TSWV caused plants to be stunted,

have black rings in the leaves, black lesions on the stems and may kill some plants.

Marigold. Marigolds ar every susceptible to damping off and Botrytis blight during bedding plant production. Marigolds are also very susceptible to leafspot diseases caused by *Alternaria* sp. and *Pseudomonas tagetis*. The Pseudomonas bacterial leafspot is more common in the greenhouse. It is seed borne and controls are not effective.

In the landscape, Botrytis blight on the flowers is the most commonly occurring disease on marigold. Southern bacterial wilt caused by *Pseudomonas solanacearum*, however, is the most serious and common disease in North Carolina according to The Plant Disease and Insect Clinic records at North Carolina State University. Infected plants wilt within a few days and die. A dark discoloration can be observed in the vascular tissue in the lower stem.

Southern bacterial wilt can be controlled on marigold by avoiding infested planting sites and through the use of resistant cultivars. Table 4 lists the relative tolerance of marigold cultivars to Southern bacterial wilt.

Pansy or Viola. Pansy is very susceptible to damping-off particularly by *Pythium* spp. and root rot caused by *Aphanomyces cladogamus* and *Thielaviopsis basicola* plus root rot and wilt caused by *Fusarium oxysporum*. Black Root Rot caused by *Thielaviopsis basicola* has been a serious problem in pansy production in the Southeast for the past 5 years. It appears to be related to production in August and September when it is too hot for pansy. Pansy also is susceptible to leafspot diseases caused by *Alternaria violae, Cercospora violae, Phyllosticta rafinesquii, Phyllosticta violae, Ramularia agrestis*, and *Ramularia lacetea*. Anthracnose, caused by *Colletotricum violae-tricoloris*, and scab or spot anthracnose, caused by *Sphaceloma violae*, are also common foliar diseases of pansy. The leafspots vary in color from white to brown to black and often have a water-soaked margin. The spots may or may not have concentric rings and spore producing structures. Pansy foliage and roots develop a soft watery rot very quickly and therefore must be examined promptly to diagnose the primary pathogen correctly. Three rust diseases (*Puccinia ellisiana, P. violae*, and *Uromyces androponis*) plus a seed smut (*Urocystis kmetiana*) have been reported on pansy. Pansy also is susceptible to *Botrytis cinerea*.

Petunia. Petunias are one of the most popular bedding plants. They are very susceptible to damping-off. The large petals and early flowering characteristics of petunias make them very susceptible to Botrytis blight. Even though petunia is a host for tomato spotted wilt virus, the virus does not move systematically in petunia and thus causes little or no damage.

Portulaca. Portulaca is susceptible to damping-off caused by *Rhizoctonia solani*. Damping-off and leafspot caused by *Helminthosporium portulacae* has been observed causing severe disease problems in North Carolina. The fungus was found to be seed-borne.

Zinnia. Zinnias are occasionally grown as bedding plants. The primary diseases are powdery mildew caused by *Erysiphe cichoracearum*, bacterial blight caused by *Xanthomonas campestris pv. zinniae*, and leafspot caused by *Alternaria zinniae*. Powdery mildew appears as a white fluffy growth on leaf and stem surfaces. Bacterial blight appears as brown to black angular spots often starting on the lower leaves but can occur on any leaves, stems, and petals. Dwarf cultivars can be severely damaged by this disease. The bacteria can be eradicated from zinnia seed by a 30-minute soak in 10,500 ppm sodium hypochlorite (Clorox) with no reduction in germination. Alternaria leafspot appears as round to angular red or purple to black spot frequently with a tan to white center. The spots may develop on leaves, stems or petals. Individual spots range up to 1/4 inch in diameter. Several spots may coalescence to produce large blighted areas. This fungus also is seed-borne.

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Table 1. Additional pathogens reported on begonia.

Pathogen	*Disease*
Agrobacterium tumefaciens	Crown gall
Aphelenchoides fragariae	Foliar nematode
Armillaria mellea	Root rot
Gloeosporium begoniae	Anthracnose
Meloidogyne sp.	Root knot nematode
Omphalia flauida	Leafspot
Phyllosticta sp.	Leafspot
Pythium spp.	Root rot
Rhizoctonia solani	Root rot
Sclerotinia sclerotiorum	Stem rot
Sclerotium rolfsii	Southern stem rot
Sphaeropsis begoniicola	Leafspot
Thielaviopsis basicola	Root rot
Verticillium albo-atrum	Wilt

Table 2. Additional pathogens reported on coleus .

Pathogen	*Diseases*
Alternaria sp.	Leafspot
Aphelenchoides fragariae	Foliar nematode
Botrytis cinerea	Leafspot
Meloidogyne sp.	Root knot nematode
Phyllosticta sp.	Leafspot
Pythium sp.	Root rot
Rhizoctonia solani	Damping off
Verticillium sp.	Wilt

Table 3. Additional pathogens reported on impatiens.

Pathogen	*Disease*
Cercospora fukushiana	Leafspot
Meloidogyne sp.	Root knot nematode
Phyllosticta sp.	Leafspot

Table 7. Additional pathogens reported on petunia.

Pathogen	*Disease*
Ascochyta petuniae	Leafspot
Cercospora petuniae	Leaf blotch
Fusarium sp.	Wilt
Meloidogyne sp.	Root knot nematode
Oidium sp.	Powdery mildew
Phytophthora parasitica	Crown rot
Puccinia aristidae	Rust
Rhizoctonia solani	Damping-off
Sclerotinia sp.	Wilt
Stemphylium botryosum	Black stem
Viruses	
Tobacco Ring Spot Virus	
Tomato Spotted Wilt	
Tobacco Mosaic Virus	
Alfalfa Mosaic Virus	
Potato Mottle Virus	
Potato Severe Mosaic Virus	
Tobacco Etch Virus	
Tobacco Veinbanding Virus	
Turnip Mosaic Virus	
Mycoplasma	
Aster Yellows Disease	

Table 8. Additional pathogens reported on portulaca.

Pathogen	*Disease*
Meloidogyne sp.	Root knot nematode
Phymototrichum omnivorum	Root rot
Rhizoctonia solani	Damping-off
TSWV	Tomato spotted wilt

Table 9. Additional pathogens reported on zinnia.

Pathogen	*Disease*
Aphelenchoides ritzema-bosi	Foliar nematode
Botrytis cinerea	Flower blight
Cercospora zinniae	Leafspot
Choanephora sp.	Blossom rot
Fusarium sp.	Stem rot, wilt
Macrophomina phaseoli	Charcoal stem rot
Meloidogyne sp.	Root knot nematode
Phymatotrichum omniuorum	Root rot
Phytophthora cryptogea	Stem rot
Pseudomonas solanacearum	Bacterial wilt
Rhizoctonia solani	Root rot
Sclerotinia sclerotiorum	Stem rot
Sclerotium rolfsii	Southern stem rot
Mycoplasma	
Aster yellows disease	

and leafspot caused by *Alternaria zinniae*. Powdery mildew appears as a white fluffy growth on leaf and stem surfaces. Bacterial blight appears as brown to black angular spots often starting on the lower leaves but can occur on any leaves, stems, and petals. Dwarf cultivars can be severely damaged by this disease. The bacteria is seed borne in zinnia. The bacteria can be eradicated from zinnia seed by a 30-minute soak in 10,500 ppm sodium hypochlorite (Clorox) with no reduction in germination. Alternaria leafspot appears as round to angular red or purple to black spot frequently with a tan to white center. The spots may develop on leaves, stems or petals. Individual spots range up to 1/4 inch in diameter. Several spots may coalescence to produce large blighted areas. This fungus also is seed-borne.

Table 4. Susceptibility of marigold cultivars to southern bacterial wilt caused by Pseudomonas solanacearum.

Very Highly Resistant	*Highly Resistant*	*Resistant*
Cupid Mix	Cupid	Bonanza Yellow
Irish Lace	Fort Knox	Bonita Mix
Janie Flame	Goldie	Boy Scout
Legal Gold	Guys and Dolls Mix	Brocade Mix
Rusty Red	Gypsy Dancer	Choice Mix
Sparky	Naughty Marietta	Cinnebar
	Orange Boy	Copper Canyon
	Orange Lady	Dainty Marietta
	Papaya Crush	Double Eagle
	Pineapple Crush	Fiesta
	Pumpkin Crush	Gingersnap
	Sparky Mix	Glowing Embers
		Gold Coins Mix
		Golden Harmony
		Goldfinch
		Guys and Dolls
		Harvest Moon
		Honeycomb
		Nell Gwyn
		Pagan Moon
		Petite Yellow
		Queen Bee
		Red Brocade
		Royal Crested F Mix
		Senator Dirksen
		Sovereign
		Spanish Brocade
		Tangerine Gem
		Victor Gold

Table 5. Additional pathogens reported on marigold.

Pathogen	*Disease*
Cercospora sp.	Leafspot
Cercospora tageticola	Leafspot
Coleosporium madiae	Rust
Fusarium sp.	Wilt, stem rot
Helminthosporium sp.	Flower spot
Macrophomina phaseoli	Charcoal stem rot
Meloidogyne sp.	Root knot nematode
Phytophthora cryptogea	Stem rot, wilt
Puccinia tageticola	Rust
Pythium ultimum	Root rot
Sclerotinia sclerotiorum	Stem rot, wilt
Sclerotium rolfsii	Southern stem rot

Table 6. Additional pathogens reported on pansy.

Pathogen	*Disease*
Meloidogyne spp.	Root knot nematode
Peronospora violae	Downy mildew
Rhizoctonia solani	Damping-off
Sclerotium rolfsii	Southern blight
Sphacerotheca humuli	Powdery mildew