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VEGETABLE CROPS
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Botrytis Gray Mold of Greenhouse and Field Tomatoes

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Botrytis blight, or gray mold, as it is commonly known, has an exceptionally wide host range with well over 200 reported hosts. The fungus can occur as both a parasite and a saprophyte on the same wide range of hosts. This fungus disease is intriguing in that it can cause a variety of plant diseases including damping-off and blights of flowers, fruits, stems, and foliage of many vegetables and ornamentals. It is a major cause of postharvest rot of perishable plant produce, including tomatoes at harvest and in storage. The disease can occur both in the greenhouse and in the field. Besides tomato, gray mold is of concern to other vegetables including snap and lima beans, cabbage, lettuce and endive, muskmelon, pea, pepper, and potato.

Cause

Gray mold is caused by the fungus *Bolrylis cinerea.* One-celled spores are borne on branched conidiophores, and the arrangement of the spores gives the fungus its name, from the Greek *bolrys,* meaning "a bunch of grapes". Use of a hand lens may reveal the characteristic grape-cluster arrangement of spores. As the conidiophores dry out, they gently move and liberate the spores; usually air movements are sufficient to get the spores airborne. The fungus often establishes itself on injured tissues and can persist as a saprophyte for long periods. Upon occasion, black sclerotia of variable size form on, or just below, the host surface. The sclerotia have a black rind and a light interior composed of a dense mass of hyphae, or threads, of the fungus. Sclerotia measure up to 3 mm (occasionally 5 mm) in length and are usually smaller and thinner than those of the white mold fungus *Scleralinia scleraliorum* The sclerotia germinate to produce conidiophores or, rarely, give rise to small cup-shaped structures (apothecia), which are the sexual stage of the fungus. Sclerotia are resistant to environmental extremes and act as overwintering resting bodies.

Symptoms

Slem lesions on seedling tomatoes can occur at, or just below, the soil level. Entry to the stem may occur through senescent cotyledons or damaged tissue. Stem lesions can also occur later during the growth of the crop. Stems can become infected through leaf scars, dead leaves, or any form of stem damage. Stem lesions often partially girdle the stem, but sometimes the whole stem is affected and the plant is killed. *Peliole lesions* appear very similar to those on the stem and often result from infection and colonization of a leaflet. *Leaflellesions* often start from senescent tissue or any physical or chemical damage. The pathogen can grow along a petiole to the main stem and can eventually form a lesion there. Flower parts that have fallen onto leaves are a common starting point for leaflet colonization. Pollen from flowers and the flower parts can act as a stimulant to *B. cinerea* spores, not only stimulating germination, but also increasing the virulence of the isolate. In the field the fungus appears as a gray, velvety covering of spores on *dying flowers* (fig. 1) and on the *calyx* of fruit (fig. 2). Senescent flowers are frequently colonized by *Penicillium* spp. (blue mOld), and this fungus may be confused with gray mold. Infections spread from flowers and fruit back toward the stem; the stem turns beige to white and develops a canker, which can girdle the entire flower hand (fig. 1). Immature green *fruit* turn light brown or white, starting at the point where they touch other infected plant parts. A soft rot may develop with the fruit


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The photographic work of Kent Loeffler is gratefully acknowledged.

skin remaining intact, but the inner tissue becomes mushy and watery (fig. 3). Later, a gray fuzzy mold develops (fig. 4), and sclerotia may appear (fig. 3, note under dead calyx or sepals). If this stage occurs in the greenhouse, the floor of the house will be littered with fruit that have fallen off the plant. In the field, the alleyways will be filled with discarded fruit (fig. 5). Green fruit can also become infected directly by airborne spores instead of by contact with other infections. White circular (halo) spots appear on the fruit and have been termed "ghost spots." These spots will persist and can appear on green, breaker, and mature fruit (fig. 6). As fruit ripens, the color of the halos changes from white to yellow. The "ghost-spot" symptom results from spore germination and penetration of the fruit, which is only susceptible to attack up to cherry size. As soon as the surface of the fruit is shiny, it is no longer susceptible. Penetration of the mycelium of *Botrytis* into the fruit produces a host reaction preventing any further mycelial growth and results in localization of the pathogen. The halo forms around the point of entry.

Epidemiology

The fungus overwinters as sclerotia or as mycelium in plant debris and may be seed borne as spores or mycelium in a few crops. Other crops may also serve as sources of the pathogen and are likely to cross-infect. Conidia are airborne and may also be carried on the surface of splashing rain drops. High relative humidities are necessary for prolific spore production. In the field, spores landing on tomato plants germinate and produce an infection when free water from rain, dew, fog, or irrigation occurs on the plant surface. Optimum temperatures for infection are between 65° and 75° F (18° and 24° C), and infection can occur within 5 hours. High temperatures, above 82° F (28° C), suppress growth and spore production. Dying flowers are a favorable site for infection, but infections can also result from direct contact with moist infested soil or plant debris. In the greenhouse, stem lesions develop either by direct colonization of wounds or through infected leaves. The presence of external nutrients, such as pollen grains in the infection droplet, can markedly increase infection. The type of wound is said to influence stem lesion development; breaking off leaves is reported to give a lower incidence of stem lesions than cutting off leaves with a knife, leaving a stub.

Control

Cultural. There is no known resistance to B. *cinerea* in tomato cultivars. During a recent epidemic of gray mold in a grower's field in upstate New York where a variety trial was in place, the following observations were made: the most susceptible varieties present were Castleking, Mountain Pride, Pik-Red, and Pirate; intermediate susceptible varieties were Freedom, Revolution, Horizon, and Sunny; lower infections were noted for FloraTom, Duke, and Jackpot. It should be noted that these results are from one year, and environmental conditions favoring gray mold may not occur every year. In greenhouse operations, effective control can be achieved by preventing predisposing conditions (high relative humidity and cool temperatures), by adequate spacing and pruning to promote ventilation, by careful handling to prevent wounding, and by removing inoculum sources through adequate plant sanitation.

FungiCides. Most fungiCides registered for use on tomato are protective in their action and will not suppress an established infection. Because of this, treat the crop before infections build up and especially when cool and humid or wet conditions are prevalent. Refer to the most recent issue of Cornell Vegetable Recommends for registered fungicides, rates and methods of application. A special note is required on the development of fungicide-resistant isolates of *Botrytis.* Repeated use of benomyl (Benlate) can result in the development of benomyl-resistant strains of *Botrytis,* rendering the material ineffective. Pathogen resistance is thought to be related to the development of chemicals with site-specific modes of action. Many new chemicals vary in their chemical structure, but have similar modes of action that appear to result in cross-resistance. Thus benomyl-resistant *Botrytis* is cross-resistant to other chemicals including thiophanate-methyl, thiabendazole, and carbendazim. Some evidence suggests that alternating benomyl with other registered materials may slow the buildup of benomyl-resistant strains.

Brand names and varieties are mentioned for clarity. No endorsement or discrimination is intended.

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