PP-230

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Botrytis Fruit Rot or Gray Mold of Strawberry[1]

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Botrytis fruit rot, also known as gray mold, is caused by the fungus *Botrytis cinerea* and is one of the most important diseases of strawberry worldwide. In Florida, this disease affects fruit in the field, resulting in severe pre-harvest losses. It also affects fruit after harvest, since infections of berries in the field continue to develop during storage and transit at refrigeration temperatures. *B. cinerea* is a cosmopolitan fungus that infects a wide range of fruit, vegetable, and weed species.

Symptoms

Strawberry flowers are highly susceptible to *B. cinerea*, and may be blighted directly (Figure 1). However, symptoms usually are observed later on green and ripening fruit. Lesions typically develop on the stem end of the fruit and are often associated with infected stamens or dead petals adhering to the fruit or trapped beneath the calyx (Figure 2). Lesions begin as small, firm, light brown spots that enlarge quickly (Figure 3). During periods of rainy weather, heavy dews, or high relative humidity, lesions become covered with a white fungal mycelium and gray to brown spores (Figure 4). Large numbers of spores are released as visible gray puffs when infected fruit are disturbed. Botrytis may consume and mummify the entire fruit (Figure 5).

Figure 1. Flower blighted by *Botrytis cinerea*. Credits: UF GCREC

Disease Development and Spread

B. cinerea is a common colonizer of strawberry foliage in the nursery, and is also present on dying vegetation around strawberry fields. After runner transplants are planted, spores produced on old dying leaves rapidly colonize new emerging leaves without

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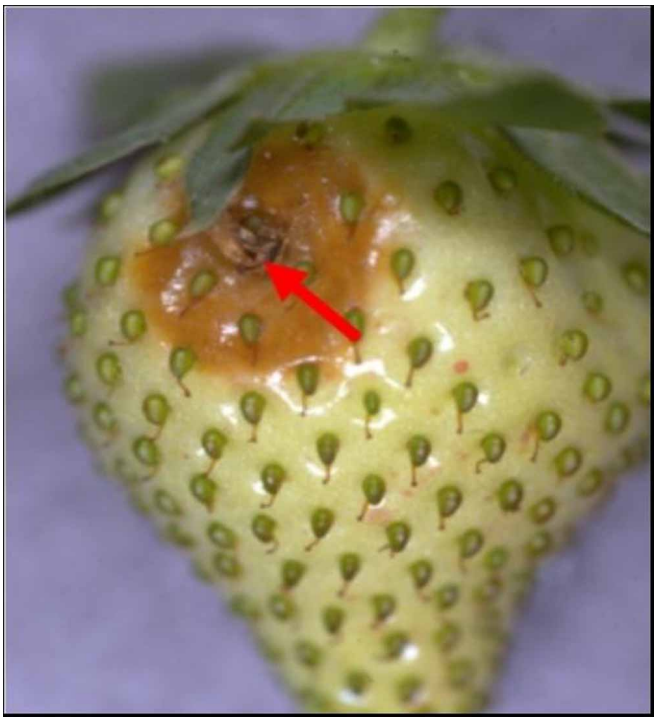

Figure 2. Botrytis lesion from colonized petal (arrow). Credits: UF GCREC

Figure 3. Botrytis lesion without spores. Credits: UF GCREC

causing visible symptoms. These spores (conidia) are dispersed by air, water, and harvesters to infect flowers during the main bloom period in January and February. Cool to mild temperatures and prolonged leaf wetness promote spore production, germination, and infection of stamens, petals, and other floral parts. Flower infections often progress slowly, with lesions becoming visible on green and ripening fruit 2 to 4 weeks after infection. Direct infection of fruit by spores is not considered important in the field or after harvest. However, the pathogen also spreads from diseased fruit to healthy fruit by direct contact (Figure 6). As the epidemic progresses, diseased fruit, mummified fruit, and decayed flowers and pedicles become important new sources of inoculum. Botrytis

Figure 4. Botrytis lesion with spores. Credits: UF GCREC

Figure 5. Botrytis-mummified fruit. Credits: UF GCREC

fruit rot is especially damaging in annual production systems characterized by prolonged flowering and fruiting cycles. In Florida, the second crop of fruit that ripen in February and March are more seriously affected than the first crop of fruit that ripen in December and January.

Figure 6. Fruit-to-fruit spread of *Botrytis cinerea*. Credits: UF GCREC

Control

Botrytis fruit rot can be controlled by both chemical and cultural measures. Cultural practices include the use of resistant cultivars and the physical removal of infected plant parts (plant sanitation). Although commercial cultivars are not highly resistant to this disease, 'Camarosa', 'Carmine', and 'Treasure' are less susceptible to Botrytis fruit rot than 'Strawberry Festival' and 'Sweet Charlie' under Florida conditions. Cultivars with large clasping calyces are generally more susceptible because moisture trapped between the calyx and the receptacle promotes spread of the pathogen from stamens and petals to the developing fruit. Removal of senescing and dying leaves after establishment helps to eliminate a potential source of inoculum. Our studies have shown that leaf pruning modestly reduces disease incidence, but does not increase marketable yield, and is not practical due to the high cost of labor. Yields may even be reduced when pruning includes the removal of partially green leaves. However, the removal of diseased and culled fruit from the plant canopy during normal harvest operations is considered vital to successful management of Botrytis fruit rot.

Fungicide applications are usually necessary to suppress sporulation and protect flowers from infection. In commercial fields in central Florida, a good disease management program is based on regular applications of a broad-spectrum protective fungicide such as captan or thiram. Applications should begin at low rates after overhead irrigation for plant establishment has ended, and continue throughout the season. Strawberries bloom from November to March in Florida, but peak blooms occur in November and January/February. Disease incidence is usually low in the first bloom and the regular protectant applications are sufficient to prevent significant early-season losses. During the second peak bloom, fungicides with good activity against Botrytis fruit rot can be substituted for protective applications. Captevate®, Elevate®, Pristine®, Scala®, and Switch® are among the most effective fungicides for control of Botrytis fruit rot (Table 1). The first application should be made at 10% bloom (usually late January). Susceptible cultivars may require up to four applications at weekly intervals to protect flowers throughout the bloom period. Applications are especially critical during periods of mild temperatures and prolonged wetness caused by rains, fog, or heavy dews. Once this critical period has ended, normal applications of captan or thiram can be resumed, usually at high label rates. Applications of protectant fungicides are usually sufficient to control Botrytis fruit rot in March, when the disease is naturally suppressed by hot weather.

Table 1. Fungicides used to control Botrytis fruit rot (BFR) of strawberry in Florida.

Trade Name	Active Ingredient	Type	PHI or REI (hours)[x]	Comments
Cabrio	pyraclostrobin	strobirulin	0	Suppresses BFR and controls anthracnose. Do not make more than 2 consecutive applications.
Captan	captan	multi-site protectant	24	Suppresses BFR and anthracnose. Do not mix with bicarbonate or sulfur fungicides.
Captevate	captan + fenhexamid	protectant + anilide	24	Captan suppresses anthracnose and fenhexamid controls BFR. Do not make more than 2 consecutive applications.
Elevate	fenhexamid	anilide	12	Controls BFR only. Do not make more than 2 consecutive applications.
Pristine	boscalid + pyraclostrobin	carboxamide + strobilurin	24	Pyraclostrobin controls anthracnose and boscalid controls BFR. Do not make more than 2 consecutive applications.
Rovral	iprodione	dicarborzimide	*[y]	Do not make more than one application per season.
Scala	pyrimethanil	anilopyrimidine	24	Controls BFR. Do not make more than 2 consecutive applications.
Serenade	*Bacillus subtilis*	biological	0	Suppresses BFR. Should be used in combination with other fungicides.
Switch	cyprodinil + fludioxonil	pyrimidine + pyrrole	12	Controls BFR and suppresses anthracnose. Do not make more than 2 consecutive applications. One month plant-back restrictions for crops other than strawberry.
Thiram	thiram	multi-site protectant	72	Controls BFR better than captan and suppresses anthracnose.
Topsin	thiphanate methyl	benzimidazole	24	Suppresses BFR and powdery mildew. Do not make more than 2 consecutive applications.

[x] PHI = Post harvest interval; REI = Restricted entry interval.

[y] Not specific in the label.

Note: To avoid the development of resistance, products such as Captevate, Elevate, Pristine, Scala, Switch, Rovral and Topsin have a limited number of applications per season. After two sequential applications of one of these those products, it is recommended that the user rotate to a product with a different mode of action.