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. The disease affects fruit in the field, resulting in severe pre-harvest losses. It also affects fruit after harvest, since infections that begin in the field continue to develop during storage and transit at refrigeration temperatures.

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 masses of tan to gray 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).

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 transplanting, spores produced on old dying leaves rapidly colonize new emerging leaves without 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 fruit rot is especially damaging in annual production systems characterized by prolonged flowering and fruiting cycles. In Florida, the second crop of fruit

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that ripens in February and March are more seriously affected than the first crop of fruit that ripen in December and January.

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 there are no commercial cultivars highly resistant to this disease, 'Camarosa', 'Carmine', and the newly released 'FL Radiance' and 'FL Elyana' are less susceptible to Botrytis fruit rot than 'Strawberry Festival', 'Treasure' and 'Sweet Charlie'. The Californian cultivar 'Camino Real' has been proven highly susceptible 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. However, 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.

In commercial fields in Central Florida, fungicide applications are usually necessary to suppress sporulation and protect flowers from infection. A good disease management program is based on regular applications of a broad-spectrum protective fungicide such as captan or thiram. Applications at low rates should begin 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.

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

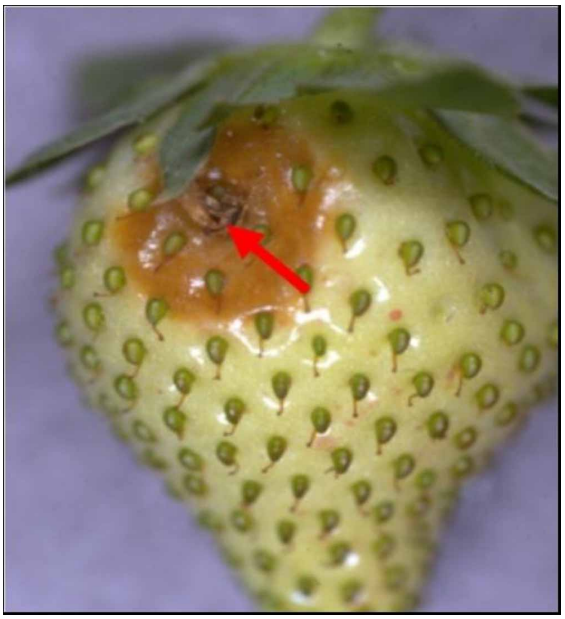

Figure 2. Botrytis lesion from colonized petal (arrow). Credits: UF GCREC

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

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

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

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

Table 1. Fungicides registered for control of Botrytis fruit rot of strawberries in Florida*.

Product name (active ingredient)	Fungicide Group	Maximum Rate Per Acre Per Application	Maximum Rate Per Acre Per Season	Min. Days To Harvest	Remarks
Abound (azoxystrobin)	11	15.4 fl oz	1.92 qt	0	For suppression of Botrytis on the foliage. Do not make more than 2 sequential applications of Group 11 fungicides and no more than 4 applications of Group 11 fungicides per crop year.
Cabrio EG (pyraclostrobin)	11	14 fl oz	70 fl oz	0	For suppression of Botrytis on the foliage. Do not make more than 2 sequential applications of Group 11 fungicides and no more than 5 applications of Group 11 fungicides per crop year.
Captan 80 WDG (captan)	M4	3.75 lb	30 lb	1	Rate per treated acre.
Captec 4L (captan)	M4	3 qt	24 qt	1	Rate per treated acre.
Captevate 68 WDG (captan + fenhexamid)	M4 + 17	5.25 lb	21 lb	0	Do not make more than 2 consecutive applications of Group 17 fungicides and no more than 4 applications of Group 17 fungicides per crop year.
Elevate 50 WDG (fenhexamid)	17	1.5 lb	6 lb	0	Do not make more than 2 consecutive applications of Group 17 fungicides and no more than 4 applications of Group 17 fungicides per crop year.
Iprodione 4L AG (iprodione)	3	2 pt	2 pt	N/A	Do not make more than 1 application per season. Do not apply after first fruiting flower.
Pristine (pyraclostrobin + boscalid)	11 + 7	23 oz	115 oz	0	Do not make more than 2 sequential applications of Group 11 fungicides and no more than 5 applications of Group 11 fungicides per crop year.
Rovral 4 Flowable (iprodione)	2	2 pt	2 pt	N/A	Do not make more than 1 application per season. Do not apply after bloom initiation.
Scala SC (pyrimethanil)	9	18 fl. oz	54 fl. oz	1	Do not make more than 2 consecutive applications of Group 9 fungicides. Do not use more than 2 of 6 applications of Group 9 fungicides in any one season.
Serenade ASO	44	6 qt.	-	0	For improved performance, use in a tank mix or rotational program with other registered fungicide.
Serenade Max	44	3 lb.	-	0	For improved performance, use in a tank mix or rotational program with other registered fungicide.

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Switch 62.5 WG (cyprodinil + fludioxonil)	9 + 12	14 oz	56 oz	0	Do not make more than 2 consecutive applications. Do not plant crops not on the label for 30 days after last application.
Thiram 65 WSB (thiram)	M2	5 lb	25 lb	3	Do not rotate treated crops with other crops for which Thiram is not registered
Thiophanate-methyl 85 WDG (thiophanate-methyl)	1	0.8 lb	3.2 lb	1	Should always be tank-mixed or alternated with a product of a different fungicide group.
T-Methyl 70 W WSB (thiophanate-methyl)	1	1 lb	4 lb	1	Should always be tank-mixed or alternated with a product of a different fungicide group.
Topsin 4.5 FL (thiophanate-methyl)	1	20 fl. oz	80 fl. oz	1	Should always be tank-mixed or alternated with a product of a different fungicide group.
Topsin M 70 WP Topsin M WSB (thiophanate-methyl)	1	1 lb	4 lb	1	Should always be tank-mixed or alternated with a product of a different fungicide group.

[a] Fungicide group (FRAC Code): Numbers (1-37) and letters (M) are used to distinguish the fungicide mode of action groups. All fungicides within the same group (with same number or letter) indicate same active ingredient or similar mode of action. This information must be considered for fungicide resistance management decisions. M = Multi site inhibitors, fungicide resistance risk is low. Source: http://www.frac.info/ (FRAC = Fungicide Resistance Action Committee).
*Recommendations given in this fact sheet are based on experimentation and statements from the manufacturer. Consult the product label for specific use requirements and restrictions.