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Powdery Mildew of Strawberry[1]

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Powdery mildew, *Podosphaera aphanis* (syn. *Sphaerotheca macularis*), occurs in most areas of the world where strawberries are grown. Many commercially grown cultivars are susceptible, and the pathogen has been shown to develop resistance to multiple fungicide classes.

Pathogen and Symptoms

P. aphanis infects leaves, flowers, and fruit. Early foliar infections are characterized by small white patches of fungus growing on the lower leaf surface. On susceptible cultivars, dense mycelial growth and numerous chains of conidia (spores) give these patches a powdery appearance (Figure 1). Under favorable conditions, the patches expand and coalesce until the entire lower leaf surface is covered (Figure 2). In some strawberry cultivars, relatively little mycelium is produced, making it difficult to see the white patches. Instead, irregular yellow or reddish-brown spots develop on colonized areas on the lower leaf surface and eventually break through to the upper surface (Figure 3). The edges of heavily infected leaves curl upward (Figure 4). At times, dark round structures (chasmothecia) are produced in the mycelia on the undersides of leaves (Figure 5). Chasmothecia are initially white but turn black as they mature. The fungus also infects flowers, which may produce aborted or malformed fruit. In addition, *P. aphanis* colonizes older fruit, producing a fuzzy mycelial growth on the seeds (Figure 6). Both types of infection may reduce fruit quality and marketable yields.

Figure 1. *Podosphaera aphanis* mycelia on strawberry leaf surface.
Credit: UF/IFAS GCREC

Figure 2. Lower leaf surface of strawberry covered with powdery mildew.
Credit: UF/IFAS GCREC

Figure 3. Reddish-brown spot reaction caused by *Podosphaera aphanis* in some cultivars.
Credit: UF/IFAS GCREC

Figure 4. Curling leaves on plants severely infected with powdery mildew.
Credit: UF/IFAS GCREC

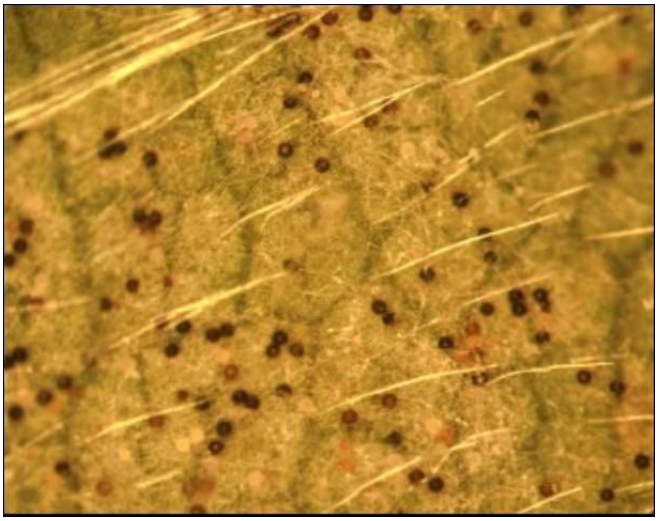

Figure 5. Micrograph of *Podosphaera aphanis* chasmothecia on leaf surface.
Credit: UF/IFAS GCREC

Figure 6. *Podosphaera aphanis* on strawberry achenes.
Credit: UF/IFAS GCREC

Disease Development and Spread

P. aphanis is an obligate parasite that only infects living tissue of wild or cultivated strawberry. The fungus readily infects living, green leaves in the nursery. Thus, infected transplants are normally the primary source of inoculum for fruiting fields in Florida. When conditions are favorable, conidia produced on infected plants are wind dispersed. Powdery mildew development and spread are favored by moderate to high humidity and temperatures between 60°F and 80°F. Rain, dew, and overhead irrigation inhibit fungal development. The disease is typically more severe in plantings under greenhouse or plastic tunnels. In open fields in Central Florida, the disease is typically most severe in November and December, usually subsides in January and early February, but may reappear in late February and March.

Control

Using powdery mildew-free transplants would be a good method to control the disease, but these are difficult to find, and even disease-free fields can become infected by conidia blown in from neighboring fields. Cultivars differ in their resistance to powdery mildew. 'Florida Brillance' and the newly released ‘Florida Ember’ and ‘Florida Encore’ are moderately resistant, whereas 'Sensation® Florida127','Florida Beauty' and ‘Florida Medallion’ are highly susceptible to powdery mildew. Fields with susceptible cultivars should be surveyed regularly for powdery mildew, especially early in the season. Fungicides should be applied preventively or at the first sign of disease to control powdery mildew on susceptible cultivars. This is especially important when using protectant fungicides, such as elemental sulfur. Systemic fungicides have some limited curative action. Quintec (quinoxyfen) and Torino (cyflufenamid) have not been as effective in our recent trials, likely due to resistance. Prolivo (pyriofenone) has been recently registered and belongs to a novel chemical group. Miravis Prime (fludioxonil + pydiflumetofen) has shown activity but should be saved for periods when other diseases, such as Botrytis and Neopestalotiopsis, are also a concern. Another group of products include Rally® (myclobutanil); Procure® (triflumizole); Orbit® (propiconazole); Mettle (tetraconazole); and Rhyme (flutriafol). These products are treated as a group since they belong to the same fungicide class and have similar properties. For this reason, they should be rotated with other fungicides with different properties to avoid the development of resistance. Other rotational options include Merivon® (pyraclostrobin + fluxapyroxad), Luna (fluopyram) and Fontelis™ (penthiopyrad). None of these products should be applied more than four times per season. Usually, controlling foliar infection helps to prevent fruit infection.

Table 1. Fungicides recommended for control of powdery mildew of strawberries in Florida.

Product name (active ingredient)	Fungicide group[a]	Maximum rate per acre		Minimum days to harvest	Remarks
		Application	Season		
(Sulphur) Many brands[b]	M2	Varies	Varies	1	Do not use when temperatures exceed 85°F.
Rally® 40 WSP Sonoma® 40 WSP (Myclobutanil)	3	5 oz.	30 oz.	0	Do not plant rotational crops until 30 days after last application.
Orbit® Tilt® Bumper® 41.8 EC (propiconazole)	3	4 fl. oz.	16 fl. oz.	0	Do not make more than two consecutive applications.
Procure® 50WS (triflumizole)	3	8 oz.	32 oz.	1	Do not plant leafy vegetables within 30 days, root vegetables within 60 days, or rotational crops not on label for 1 year after application.
Mettle® 125 ME (tetraconazole)	3	5 fl. oz.	20 fl. oz.	0	Do not apply same product within 14 days; do not make more than four applications per season.
Rhyme (flutriafol)	3	7 fl. oz.	28 fl. oz.	0	Do not apply more than four applications per year.
Quilt Xcel® (propiconazole + azoxystrobin)	3 + 11	14 fl. oz.	56 fl. oz.	0	Do not make more than two consecutive applications and no more than four applications/crop.
Fontelis™ (penthiopyrad)	7	24 fl. oz.	72 fl. oz.	0	Do not make more than two sequential applications before alternating to a fungicide from a different group.
Luna Tranquility (fluopyram + pyrimethanil)	7 + 9	27 fl. oz.	54.7 fl oz	1	Do not make more than two sequential applications before rotating with a fungicide from a different group.
Meviron® (boscalid + fluxapyroxad)	7 + 11	11 fl. oz.	33 fl. oz.	0	Do not make more than two consecutive applications before alternating to another non-group 7 or non-group 11 fungicide.
Quintec® (quinoxyfen)	13	6 fl. oz.	24 fl. oz.	1	Do not make more than two consecutive applications or more than four applications per crop; do not plant crops not on label for 30 days after application.
Prolivo (pyriofenone)	50	5 fl. oz.	16 fl. oz.	0	Do not make more than two sequential applications of group 50-containing fungicides before rotating to a fungicide with a different mode of action.

Product name (active ingredient)	Fungicide group[a]	Maximum rate per acre		Minimum days to harvest	Remarks
		Application	Season		
Torino® (cyflufenamid)	U6	3.4 oz.	6.8 oz.	0	Do not make more than two applications per year; do not apply more than once every 14 days.

[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 when making decisions about how to manage fungicide resistance. M = multisite inhibitors; fungicide resistance risk is low. Source: https://www.frac.info/ (FRAC = Fungicide Resistance Action Committee).

[b]For example, Kumulus® DF, Micro Sulf®, Microfine Sulfur, Microthiol® Disperss®, Sulfur 90W, Wettable Sulfur, Wettable Sulfur 92, Yellow Jacket Dusting Sulfur, Yellow Jacket Wettable Sulfur.

Always read a current product label before applying any chemicals.

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