Powdery Mildew of Peach in California – What Happened in 2000?

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In the summer of the 2000-growing season, most growers became familiar with peach powdery mildew. The disease reached epidemic proportions in central California. With low rainfall in March and early April, growers and pest control advisors were caught off guard when symptoms started to show up in late May and June. The disease usually occurs on leaves but in 2000 it also developed on fruit and young twigs. Fruit infections resulted in crop off-grades for growers and in the case of severe infections entire orchards were not harvested. Powdery mildew diseases seem to be well known; after all they can be seen almost year-round on some plants like roses. The situation, however, left many advisors, consultants, and researchers wondering what happened.

In California, *Sphaerotheca pannosa* is the only confirmed fungal pathogen to cause peach powdery mildew. Two other powdery mildew fungi that occur in California on other crops have been reported on peach elsewhere. *Podosphaera clandestina* is commonly found on sweet cherry, whereas *P. leucotricha* is found on apple and is suspected to occur on peach in California causing the disease rusty spot. Thus, potentially all three species could be present on peach in the state. Young green fruit are susceptible to infection by *S. pannosa* but only until pit hardening. The mid-season occurrence of the disease in 2000 left many agricultural advisors concerned if a new strain of *S. pannosa* or another powdery mildew like a *Podosphaera* species was present, because these latter fungi can cause infection on older fruit later in the season. *S. pannosa*, however, may still be found on more mature fruit, because fruit were infected at an earlier stage and the infection continued to develop. Infected fruit are usually deformed and have a generally circular, whitish colony typical of powdery mildews. Infections caused by *P. leucotricha* are circular and rusty brown on peach, therefore the disease is known as rusty spot. Susceptibility varies among peach cultivars. Non-glandular varieties are the most susceptible, whereas glandular varieties are least susceptible. In 2000, Dr. Davis, Heath, Klampt, Ross, Starn, and Sullivan were the most susceptible cling peach varieties, whereas among the freestone varieties Fay Elberta and Fairtime were severely affected.

Powdery mildew of peach is a disease of leaves, twigs, and fruit. In general, unlike many other diseases, powdery mildew is most severe with less rainfall and with high relative humidity. Wetness is only required for spore germination. The disease develops with white mycelial growth on the leaf surface that becomes powdery with the production of masses of spores (conidia). The short-lived conidia are wind-dispersed in a decreasing gradient of infection outward from the inoculum source. Conidia easily germinate on a favorable host surface. Secondary infections continue to occur on leaves throughout the growing season. Initially the infected tissue appears to be unaffected, because the fungus mainly grows on the plant surface. Plant tissues, however, eventually become chlorotic and then necrotic. Severe infections tend to cause leaves to curl upward and dehisce, whereas less severe infections remain as localized lesions and leaves do not drop. Infected green shoots are stunted and terminal shoots may be destroyed. On current-year shoots, mildew is often white to gray and felt-like even in winter.

Fruiting bodies of powdery mildew fungi are called cleistothecia. These are small, spherical, dark structures that are embedded in the fungal mycelium and are easily visible by using a 10X hand lens. Their appendices can differentiate cleistothecia of *Sphaerotheca* and *Podosphaera* species: they are hair-like in *Sphaerotheca* and terminally branched in *Podosphaera*. Cleistothecia are produced late in the growing season and are considered survival structures of the fungus. Those of *Sphaerotheca* and *Podosphaera* species contain a-single sac-like structure (the ascus) that contain typically eight sexually produced spores (ascospores). Cleistothecia of *P. clandestina* are common on sweet cherry, but those of *S. pannosa* have never been found on peach until this past December in Stanislaus Co. and only occasionally on rose in California. Thus, for the first time, cleistothecia typical of *S. pannosa* were found on peach in California. This confirms that the disease observed on mature fruit and the epidemic in the 2000 growing season were most likely caused by *S. pannosa.* The epidemiological significance of this finding is that the fungus has another survival structure in addition to overwintering as mycelium in infected buds and branches of peach or rose in the milder climates of California. Because ascospores are produced by sexual mechanisms that include genetic recombination it is possible that new strains of the pathogen will appear. Potentially, powdery mildew of peach could become a more serious disease in the future. For designing a management program, the biology of the pathogen has to be considered. For management of *S. pannosa*, important factors include the presence or absence of cleistothecia, additional hosts (e.g., roses) close to a peach orchard, and environmental conditions before bloom and up to pit hardening.

Until now, fungicide management programs for powdery mildew of sweet cherry were different from those for peaches and other stone fruits. The absence of overwintering cleistothecia of peach powdery mildew caused by *S. pannosa* made a dormant application unnecessary. The primary inoculum in the spring was thought to be conidia that are produced mostly from infected buds or twigs of peach or rose. These types of infections cannot be eradicated by any fungicide. On sweet cherry, however, the primary inoculum of *P. clandestina* is the ascospores from the cleistothecia. Thus, pre-bloom treatments with sulfur have been shown to be beneficial on sweet cherry. For peach the concept used to be that fungicide applications have to start before disease symptoms occur. Thus, based on research done in the 1950s, excellent control of peach powdery mildew was obtained with three spray applications: the first at 2 wk after petal fall, the second at dehiscence of the floral tube from the developing fruit, and the third before pit-hardening. In addition, the removal of rose plants nearby orchards was recommended. With low rainfall and sunny weather in late March and early April and with little previous history of powdery mildew causing epidemics on peach in California, many growers and orchard managers decided not to apply any preventative fungicide treatments, including those for other diseases. Thus, with favorable conditions for powdery mildew in the spring of 2000, the disease became established and developed uncontrolled into this major epidemic. With the discovery of cleistothecia of peach rust caused by *S. pannosa* the management strategies in the future will be similar to those for *P. clandestina* on sweet cherry. Thus, a pre-bloom application of sulfur followed by a normal brown rot program and powdery mildew program as outlined above should provide a very effective management strategy. The grower should remember that sulfurs are incompatible with oils, thus enough time should be allowed between applications with dormant oils and pre-bloom sulfur treatments.

Although there is not a tremendous amount of data on the use of fungicides for management of powdery mildew of peach, there are a number of fungicides registered that should be very effective against the disease. Sulfur compounds (e.g., wettable sulfur, liquid lime sulfur), sterol biosynthesis inhibitors (e.g., myclobutanil - Rally 40W, propiconazole – Break 3.6EC), benzimidazoles (benomyl - Benlate 50WP), and the strobilurins (e.g., azoxystrobin - Abound 2F) all are registered for powdery mildew control on peach in California (research is planned to evaluate selected materials in 2001). Other materials registered on peach such as tebuconazole (Elite 45WP) and thiophanate-methyl (Topsin-M) should also be effective. Timing of applications is critical as outlined above and rotation between classes should provide effective control and minimize the risk of resistance developing to any one class of these fungicides. Beginning the management program with a pre-bloom sulfur, a multi-site mode of action fungicide, should also be beneficial in resistance management by reducing the total population of the pathogen before single-site mode of action fungicides are used (e.g., benzimidazoles, SBI fungicides, and strobilurins). Thus, although the industry was caught off-guard last year, with effective management tools available, the outlook for 2001 and beyond looks good for managing powdery mildew of peach.