

Phacidiopycnis Rots

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Phacidiopycnis rots are emerging postharvest diseases of apple and pear in the U.S. Pacific Northwest. These diseases have previously been reported in Europe and India and most recently in Chile. In Washington State and Oregon, Phacidiopycnis rot is common on pears, whereas speck rot is more common on apples in Washington State. Recent surveys have confirmed that these rots continue to be an emerging threat in the PNW and will require future management attention.

Causal Organisms

Two Phacidiopycnis species are known to cause Phacidiopycnis rot on apple and pear. Phacidiopycnis rot of pear is caused by the discomycete *Potebniomyces pyri* (Berk. & Br.) Dennis, anamorph (asexual) *Phacidiopycnis pyri* (Fuckel) Weindlmayr. The fungus produces macroconidia and microconidia with the later considered spermatia (male spores) in the fungus life cycle. Conidia germinate either by developing germ tubes, when enough nutrients are available, or by budding to produce secondary conidia when nutrient levels are low.

On apples, *Phacidiopycnis* rot, more commonly known as speck rot, is caused by *Phacidiopycnis washingtonensis* (C.L. Xiao & J.D. Rogers) which was first reported in 2005 in the PNW. This species has since been reported on apples in Europe and Chile. *Phacidiopycnis washingtonensis* grows slightly faster than *P. pyri* and both species can infect the other fruit but are more common on their respective hosts, apple and pear.

Symptoms

Phacidiopycnis species cause infections via three different pathways: stem-end, calyx-end, or through wounds causing respectively stem-end rot, calyx-end rot and wound rot, respectively (Fig. 1). Decayed area is spongy. In the early stage of symptom development, the decayed area appears water soaked. Color of the decayed area varies with age. As the disease progresses, the advanced decayed area turns brown and then black, but the margin of decayed area continues to have a water-soaked appearance. Under high relative humidity, the fungus forms white mycelium. Pycnidia (pimple shaped fruiting bodies) of the fungus often form on the decayed area at advanced stages, starting from the infection sites.

In the early stage of symptom development, Phacidiopycnis and speck rots can be misdiagnosed as gray mold or Sphaeropsis rot. The fruit flesh at the margin of Phacidiopycnis rots appear translucent and water-soaked, whereas internal decayed flesh of gray mold usually appears brown (Table 1). Speck rot is slightly firmer than gray mold and forms brown to black specks around lenticels, especially on red apple cultivars.

Table 1. Comparison between symptoms of Phacidiopycnis & Speck rots with gray mold

Characteristics	Gray Mold	Speck & Phacidiopycnis rots	Spheropsis rot
Texture	Spongy early, softer as decay advances, decayed tissue not separable from healthy tissue	Spongy slightly firmer than gray mold, decayed tissue not separable from healthy	Firm
Color of decayed area	Light to dark brown	Water-soaked, brown then turns black and fruit stays spongy, Brown to black specks	Brown to dark brown, advanced decayed area may turn black
Mycelia and spores on fruit	Fluffy white-gray mycelia, gray to brown spore masses under high humidity	White mycelia, rare appearance of black pycnidia at advanced decay stages	At advanced stages and under high humidity white mycelia and pycnidia may form on decayed fruit
Color of internal flesh	Light brown to brown	Brown to black	Brown, decay advances along the vascular tissue of the fruit
Odor	Not detectable generally, Cider-like on very decayed fruit	Mild, distinct	Wild-strong, bandage-like odor

Infection and disease cycle of *Phacidiopycnis* species

Phacidiopycnis pyri and *P. washingtonensis* are weak canker-causing pathogens on trees. Infection of fruit by these two pathogens occurs exclusively in the orchard, and symptoms develop during storage. *Phacidiopycnis pyri* is commonly associated with dead bark and cankers on pear trees and survives as mycelium and pycnidia, the primary inoculum for fruit infection, on diseased twigs or dead bark. *P. pyri* infects the stem and calyx of pear fruit as well as wounds caused by insects, limb rubs or harvest punctures. The stem and calyx of the fruit are more susceptible to infection by the fungus near harvest. Infections occur with warm wet conditions (optimum 68-77 °F, some growth 26-77°F, little above 86°F). Four to 8 hours of wetness duration at optimum temperature are required for infections. Wound infections develop decay symptoms within two months after harvest whereas, stem-end and calyx-end rots symptoms are usually first seen three months or more after harvest.

Under high relative humidity, the fungus produces fluffy mycelium on decayed fruit, which can infect surrounding healthy fruit, causing secondary infections (nests) through fruit-to-fruit spreading.

Phacidiopycnis washingtonensis is also associated with cankers and twig dieback on apple trees and **crabapple** pollinizers. After maturation, pycnidia are the main primary source of inoculum. Although *P. washingtonensis* can infect the fruit through wounds, infections through the stem-end and calyx-end are more common in the orchard. On rare occasions, infections via lenticels may occur on over-mature fruit showing lenticel breakdown. Like gray mold and *P. pyri*, speck rot can infect surrounding healthy fruit, causing secondary infections (nests) through fruit-to-fruit contact. The fungus can grow and germinate between -3 to 25°C (26-77°F) with optimum growth occurring between 15-20°C (59-68°F). Exact wetness duration requirement is not known, but rain preceding harvest increases infection risk and eventually speck rot incidence in storage.



A: Early stage of stem-end *Phacidiopycnis* rot on a d 'Anjou fruit. Water-soaked appearance.



B: The color of decayed area varies with age. Water soaked at the margin. Black pycnidia at aged area near stem.



C: Advanced stage of *P. pyri* infection showing black coloration of the decayed area.



D: Early stage of calyx-end *Phacidiopycnis* rot. Water-soaked appearance.



E: Early speck rot infection developing on Granny Smith under high humidity.



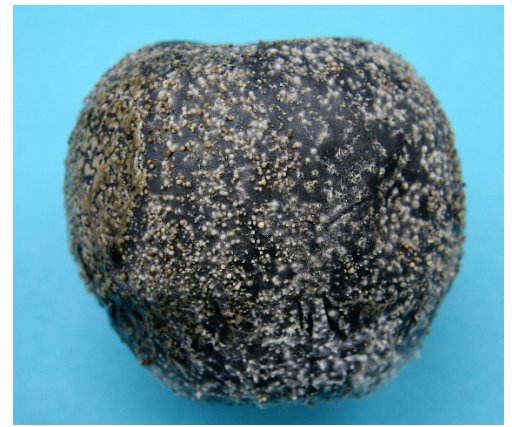
F: Twig showing dieback symptoms and pycnidia caused by *P. washingtonensis*.



G: Internal view of a rare speck rot infection on Fuji in an orchard in the Pacific Northwest after heavy rain.



H: Cross section of a speck rot lesion showing black coloration of the internal flesh of Granny Smith apple.



I: Late stage symptoms of speck rot on Granny Smith under high humidity; note abundant pycnidia.

Figure 1. Characteristic symptoms and signs of *Phacidiopycnis* and Speck rot infections on pome fruits. Photo credit to Achour Amiri (WSU-TFREC).

Control

Cultural Practices: Since both *Phacidiopycnis* species are associated with cankers and dieback, preharvest sanitation practices are key in managing Phacidiopycnis rots. On pear, good pruning and removal of pruned material is recommended to reduce the inoculum load available in the upcoming season. Inoculum of *Phacidiopycnis washingtonensis* comes mainly from crabapple pollinizers, therefore, a good pruning along with a fungicide treatment of the pollinizers is key in managing the decay preharvest.

Chemical control: Preharvest fungicide applications may prevent infections by *Phacidiopycnis* species. Among the current preharvest fungicides, Topsin-M has been found to be more effective compared to Pristine. Ziram applied within two weeks before harvest provides some control of stem-end and calyx-end rots. Because these two pathogens infect fruit through the stem- and calyx-ends, it is important to ensure good spray coverage of these potential entries to minimize such infections. Recent research has shown that current postharvest fungicides are the most effective in managing both *Phacidiopycnis* species with fludioxonil (Scholar) being the most effective (Table 2, 3). Difenoconazole (Academy) has been labeled for postharvest application on pome fruit in 2016 and has shown a strong efficacy, especially against *P. pyri*. Formulations to apply thiabendazole, pyrimethanil and fludioxonil through thermonebulization (fog) exist already. In Washington State, Academy can be applied via drench at harvest if packers can follow specific fungicide waste management practices (<https://agr.wa.gov/wastepesticide>). A formulation for a dry application of Academy is under development. Phacidiopycnis species have a medium risk for fungicide resistance development, therefore, rotation of fungicides from different FRAC groups in the orchards and warehouse is important to avoid selection for populations that are resistant to current fungicides.

Table 2. List and efficacy of fungicides registered to control Phacidiopycnis and other decay rots PREHARVEST

Active ingredient	Trade names	FRAC group	Rate/ac	PHI ^a (days)	Registered for		Efficacy against Phacidiopycnis rots
					Apple	Pear	
Thiophanate-methyl	Topsin-M 70 WSB	1	0.75-1 lb	1	+	+	Good
Boscalid	Pristine	7	18.5 oz	0	+	+	Fair
Fluxapyroxad	Merivon	7	5.5 fl oz	0	+	+	Unknown
Pyraclostrobin	Flint Extra, Pristine, Merivon	11	see labels	0	-	+	Fair
Fenhexamid	Elevate 50WDG	17	1-1.5 lb	0	-	+	NA
Ziram	Ziram 76DF	M03	6 lb	14	+	+	Fair
Captan	Captan 50 WP	M04	6 lb/ 20-400	0	+	-	Fair

Table 3. List and efficacy of fungicides registered to control Phacidiopycnis and other decay rots POSTHARVEST

Active ingredient	Trade names	FRAC group	Rate/ac	PHI ^a	Registered for		Efficacy against Phacidiopycnis rots
					Apple	Pear	
Thiabendazole	TBZ, Mertect, eFog-	1	see label	NA	+	+	Good
Pyrimethanil	Penbotec, eFog 160	9	see label	NA	+	+	Very Good
Fludioxonil	Scholar, eFog80,	12	see label	NA	+	+	Excellent
Difenoconazole +	Academy	3 + 12	see label	NA	+	+	Excellent
Captan	Captec 4L	M04	see label	NA	+	+	Fair

References

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Use pesticides with care. Apply them only to plants, animals, or sites listed on the labels. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

***YOU ARE REQUIRED BY LAW TO FOLLOW THE LABEL.** It is a legal document. Always read the label before using any pesticide. You, the grower, are responsible for safe pesticide use. Trade (brand) names are provided for your reference only. No discrimination is intended, and other pesticides with the same active ingredient may be suitable. No endorsement is implied.*