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EM 9001 • January 2010

Predicting and managing gray mold rot of pear in Oregon

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Gray mold, one of the most serious decay problems for pear fruit in the Pacific Northwest, is estimated to cause about $6 million in losses to the pear industry each year due to fruit rot in storage. These losses can be minimized by recognizing the factors that contribute to disease development and treating high-risk fruit appropriately. This publication describes gray mold disease symptoms and the disease cycle and outlines a model that can help pear packers predict the relative risk of gray mold development in stored fruit before the fruit is placed in cold storage.

Cause and symptoms

Gray mold is caused by the fungus *Botrytis cinerea*. This fungus is found in soil and plant litter, where it colonizes many kinds of dead or dying plant material. The fungus also causes disease in over 200 crop species, including pears. In pear fruit, gray mold appears as a firm, brown decay without sharp margins. The fungus often grows on the fruit's surface and appears as grayish "fuzz."

Disease cycle

Gray mold spores are produced on weeds, fallen fruit, and other host plants, such as wild blackberries growing at an orchard's perimeter. The spores are dispersed by air currents, in water, and by insects. Pear fruit become susceptible to infection in the orchard as they approach maturity. Gray mold infects pear fruit at the stem, calyx, and wounds anywhere on the fruit's surface (figures 1a–1c). Initial infections occur during harvest, when spores contaminate stem ends and wounds made by stem punctures, finger nails, or sharp areas on picking bags or bins. In some production areas, such as California and South Africa, the infection of blossom parts results in calyx end decay, but this type of infection is less prevalent in the Pacific Northwest. Gray mold also spreads from fruit to fruit in storage, causing "nest" rot (figure 1d) and resulting in major losses during cold storage.

Preharvest rain generally increases the potential for gray mold infection in pears. Rain increases spore production on blackberries and weeds in or near orchards and on the fallen fruit of early-

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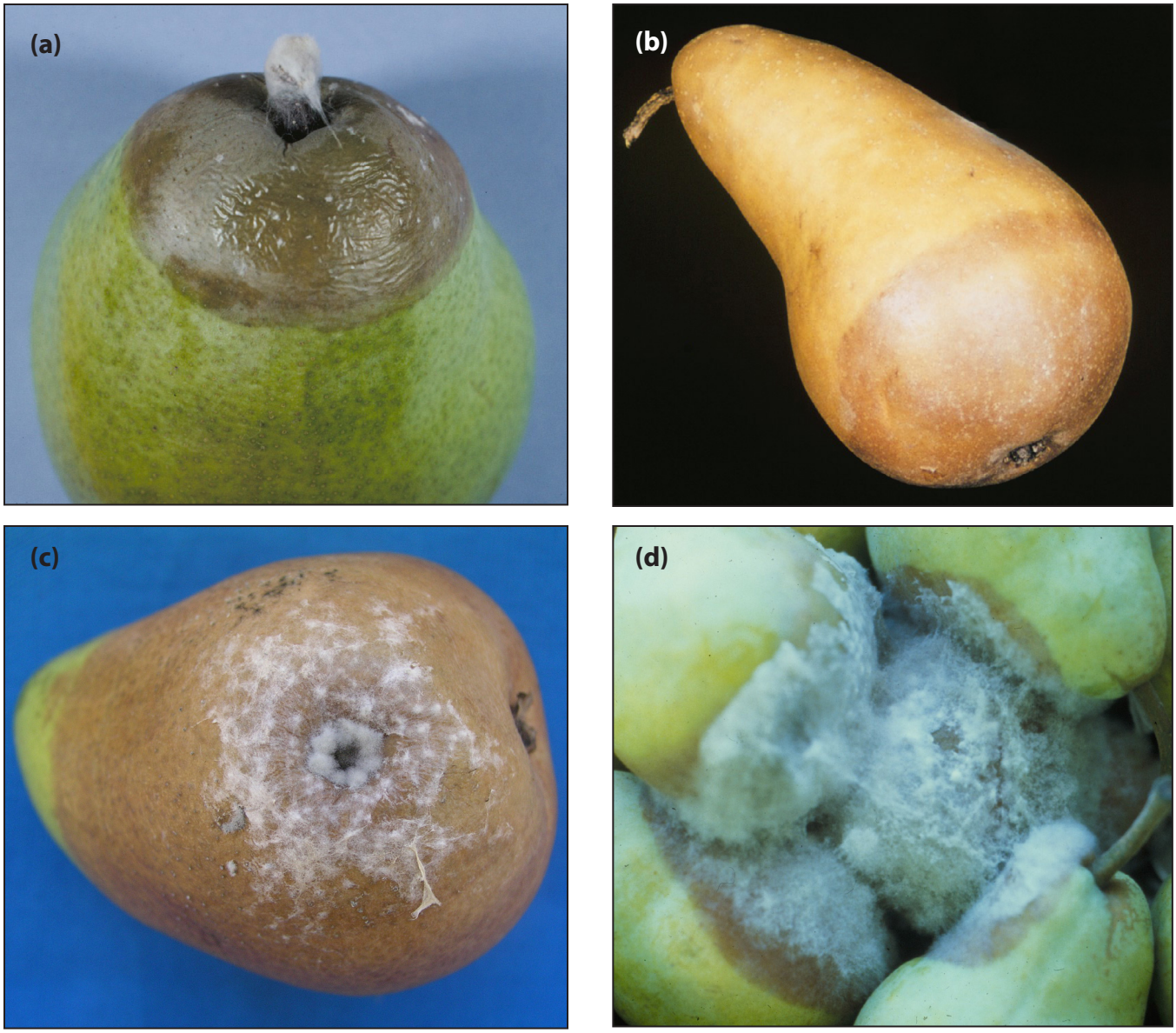

Figure 1. Gray mold starting at (a) stem end, (b) calyx end, and (c) puncture wound; (d) "nest rot." Photos by Robert A. Spotts, Oregon State University.

maturing pear cultivars interplanted with later-maturing cultivars. Additionally, spores adhere more strongly to wet fruit than to dry fruit. Picking wet fruit increases the potential for both gray mold infection and Mucor rot, another common storage rot of pears.

After harvest, the fungus persists in and around orchards on decaying plant material, including fruit on the orchard floor. In late fall, the fungus produces overwintering structures (sclerotia) that enable its survival and a renewed cycle of spore production and infection the next spring.

Risk prediction model

The model explained below was developed to predict, at harvest, the risk of gray mold infection for pear fruit in long-term cold storage. The model classifies risk as low, moderate, high, or extreme based on the following factors determined through research to be important for infection and disease development: (1) preharvest fungicide application, (2) preharvest rainfall, (3) orchard condition, and (4) amount of Botrytis DNA on the fruit surface. Each feature of the model is described below, and the model is presented in two versions: the complete model (table 1) and a simplified version without the DNA factor (table 2).

Table 1. Complete four-factor pear gray mold risk prediction model, showing risk as low, moderate, high, or extreme.

Gray mold DNA	Preharvest fungicide	Preharvest rain	Orchard condition		
			Good	Average	Poor
Low	Yes	No	Low	Low	Moderate
Low	Yes	Yes	Low	Moderate	High
Low	No	No	Low	Moderate	High
Low	No	Yes	Moderate	High	Extreme
High	Yes	No	Low	Moderate	High
High	Yes	Yes	Moderate	High	Extreme
High	No	No	Moderate	High	Extreme
High	No	Yes	High	Extreme	Extreme

Table 2. Simplified version of pear gray mold risk prediction model, without the DNA factor, showing risk as low, moderate, high, or extreme.

Preharvest fungicide	Preharvest rain	Orchard condition		
		Good	Average	Poor
Yes	No	Low	Low	Moderate
Yes	Yes	Low	Moderate	High
No	No	Low	Moderate	High
No	Yes	Moderate	High	Extreme

Model factors

1. **Preharvest fungicide**. Applying any fungicide registered for control of gray mold within four weeks of harvest lowers the risk level. The senior author found that preharvest application of either Topsin M, Pristine, or Ziram reduced the risk of gray mold infection during storage. *To avoid fungicide resistance, it is important for growers to coordinate fungicide usage with packinghouses*. For example, application of Topsin M in the orchard is acceptable only when Penbotec or Scholar, but not thiabendazole, is used in the packinghouse. See the latest edition of the *Pest Management Guide for Tree Fruits in the Mid-Columbia Area* (Castagnoli et al. 2009) for current recommendations regarding fungicides registered for pears in Oregon.
2. **Preharvest rainfall**. Any measurable rain within the two weeks before harvest is an important factor in predicting gray mold infection because rain increases spore dispersal and creates conditions conducive to infection.
3. **Orchard condition**. This factor is the most significant predictor of gray mold infection. Well-maintained orchards with excellent horticultural and pest/disease/weed control practices are rated as "good" (figure 1a). Most typical orchards use moderate-level practices and are rated as "Average" (figure 2b). Poorly maintained orchards with minimal horticultural and pest/disease/weed control practices are rated as "poor" (figure 2c). These orchards usually consist of older trees with dead and dying limbs, abundant weed growth, and fruit on lower limbs intermingled with various weeds, including grasses and blackberry plants.
4. **Botrytis DNA on fruit surface**. This factor must be determined using special laboratory equipment and highly trained personnel. The threshold value for this factor is 0.5 pg DNA per cm2 of fruit surface, and inoculum density is classified as low (< 0.5 pg/cm^2) or high (≥ 0.5 pg/cm^2). Botrytis DNA on the fruit surface is the least important factor in predicting gray mold infection and applies to only about 10% of orchards. For this reason, a simplified model without the Botrytis DNA factor is included in table 2.
5. In addition to the four factors used in the model, it can be noted that organic orchards appear to produce fruit that is generally one level of risk lower than fruit from nonorganic orchards. This factor is not included in the model but can be used if applicable.

Figure 2. Pear orchards showing examples of orchard condition ratings that help predict gray mold risk: (a) good, (b) average, and (c) poor. Photos by Robert A. Spotts, Oregon State University.

Use of the model

To determine the risk of gray mold, select the appropriate value for each factor in the table's left-hand columns and then follow the selected row across to the correct orchard rating column. In the simplified model (table 2), for example, if a fungicide was applied within four weeks of harvest (preharvest fungicide = yes) and rain occurred within two weeks of harvest (preharvest rainfall = yes), the risk of gray mold infection in fruit from an average orchard (orchard condition = average) is moderate. The complete model (table 1) works similarly but includes the Botrytis DNA factor.

Final considerations

Because the susceptibility of fruit to gray mold infection varies from year to year, the risk predictions are relative rather than absolute, and the model is most valuable when orchards are compared within one year rather than across multiple years. For example, in the senior author's research, orchards with moderate risk had 2.3%, 4.5%, and 1.3% of fruit infected with gray mold in 2004, 2005, and 2006, respectively. Postharvest treatments in the packinghouse (sanitation, fungicides, controlled atmosphere storage) combine to reduce decay by about 95%. Therefore, the model works best for field-run fruit rather than fruit run over the packing line and subjected to various postharvest treatments.

Gray mold risk prediction at harvest is a valuable tool that packinghouse managers can use to determine which fruit is most suitable for long-term storage. The prediction is also useful for helping growers understand the factors that cause fruit to be at risk of decay and to make the necessary changes in horticultural and pest management practices to lower the risk of gray mold infection.

References

Castagnoli, S., H. Riedl, R.A. Spotts, L. Long, P. Shearer, J.W. Pscheidt, J. Olsen, and E. Peachey. 2009. *Pest Management Guide for Tree Fruits in the Mid-Columbia Area*. EM 8203. Corvallis, OR: Extension Service, Oregon State University.

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Published January 2010.