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# Management of White Mold of Beans

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White mold is caused by the fungus *Sclerotinia sclerotiorum*. Since the first report of white mold in beans in the United States, in 1915, it has become widespread and destructive throughout most bean production areas in the world. In Idaho, seed yields may be reduced 50 percent or more under favorable environmental conditions, and a healthy, potentially high-yielding crop in late July may be reduced to a sickly, low-yielding crop by mid August (fig. 1). Dry edible beans tend to sustain the highest losses, but garden (snap), lima, and bush beans are also susceptible.

## SYMPTOMS

The fungus may invade the stem near the soil line, causing a rapid wilting and death of the entire plant, or it may invade pods or branches, particularly if they are in contact with the soil. Initial symptoms appear as water-soaked spots (lesions) on stems and pods, starting about a week after row closure and/or flowering. Lesions expand rapidly under moist conditions, and the affected parts become a watery and rotten mass covered by white fungal growth.

After several days, the fungal growth on external plant surfaces forms a white, cushion-shaped structure called a sclerotium (fig. 2), which develops a black exterior and white to beige interior (fig. 3) several days later. Sclerotia are typically ⅛ to ¼ inch in diameter and are made up of compact masses of fungus threads, or hyphae, and can be relatively hard, particularly when dry. Sclerotia may also form in the interior parts of the pods and stems, in which case they assume the shape of the space they occupy, i.e., crescent-shaped if formed around a seed or cylindrical if formed inside the stem. The white, moldy growth and black sclerotia are characteristic of this disease.

If climatic conditions within the plant canopy become dry after infection, sclerotia and mycelia on plant surfaces may be sparse or absent. However, infected tissue will appear off-white due to bleaching by oxalic acid produced by the fungus (fig. 4), and the epidermis will rub off easily.

## DISEASES WITH SIMILAR SYMPTOMS

Three other bean diseases, Pythium blight, Pythium pod rot, and gray mold, produce symptoms similar to those of white mold and may cause some confusion in identification. Because the control measures and economic losses for these other diseases can differ considerably from those for white mold, it is important to be able to identify them correctly.

**Figure 1.** White mold damage appears after flowering, and diseased fields can suffer substantial yield losses.

**Figure 2.** White, cushion-shaped structures (immature sclerotia) and a single black mature sclerotium at the base of the branch indicate infection by *Sclerotinia sclerotiorum*.

**Figure 3.** Sclerotia of the white mold fungus have a black rind (exterior) and a white to beige interior. Their shape is determined by where they form in or on the plant.

**Figure 4.** White mold-infected bean plant with stems bleached by oxalic acid produced by the pathogen.

**Figure 5.** Beans with Pythium blight may be mistaken for having a white mold infection but will have no sclerotia present.

**Figure 6**. Beans with Pythium pod rot may be mistaken for having a white mold infection but will have no sclerotia present as in this rot-infected pod stuck to a clump of soil.

**Figure 7.** Gray mold (pod on top) damage caused by *Botrytis cinerea* appears as a gray-brown powdery mass, which helps distinguish it from the white fungal growth and bleached beige-to-white tissue associated with white mold (pod on bottom).

Pythium blight generally appears well before row closure, which is several weeks earlier than white mold is expected to appear. Infection occurs on the stem at the soil line, and the lesion may extend up 2 to 3 inches into the lower branches (fig. 5). Some plants may have white fungal growth near the soil line, but the lack of sclerotia helps separate this problem from white mold. Plants usually wilt and die 7 to 10 days after infection, leaving the stem dry, shrunken, and tan. Infected plants are usually scattered throughout the field, but may be concentrated in wet areas such as at the center of a pivot sprinkler or where water tends to pool. Generally, yield losses from Pythium blight are negligible.

The second disease, Pythium pod rot, most commonly affects pods that are touching the ground (fig. 6). It can be mistaken for white mold because of the production of white fungal growth. Yield losses due to Pythium pod rot may reach 5 to 10 percent in severe cases, but significant economic losses are uncommon. The primary distinguishing feature of both Pythium diseases in the field is the lack of sclerotia. No specific control measures are recommended for either of these diseases.

Lastly, gray mold also attacks aboveground portions of the bean plant. The causal agent for gray mold, *Botrytis cinerea*, is most prevalent on beans produced west of the Cascade Range. On beans produced in drier areas of the Pacific Northwest, such as southern Idaho, gray mold tends to occur only at trace levels and is of no economic concern. Gray mold forms a slimy, water-soaked lesion and then, as tissues dry, becomes covered with spores forming a gray-brown powdery mass (fig. 7). The gray mold fungus may also form sclerotia on stems and pods. The presence of gray-brown powdery spore masses distinguishes gray mold from white mold.

## DISEASE CYCLE AND EPIDEMIOLOGY

The white mold fungus can infect more than 360 species of plants. Common hosts include broccoli, cabbage, canola, carrots, cucumber, lettuce, peas, potatoes, radish, squash, sunflowers, tomatoes, turnip, and zinnia. Some weed species (chickweed, redroot pigweed, dandelion, and wild clover) are also susceptible. Grasses and cereals are not affected.

White mold sclerotia that have been in or on moist soil for several months can produce a fungal structure called an apothecium under moderately cool and moist conditions (fig. 8). Apothecia are mushroom-like bodies ⅛ to ⅜ inch in diameter that produce millions of spores that are dispersed by air currents (Fig. 9). Free moisture permits the spores to germinate and colonize mature and senescent blossoms, thus providing an energy source for subsequent infection of stems and pods.

During harvest, sclerotia formed on or in plants may fall to the soil surface, remain in crop debris, or be moved with seed. Sclerotia can survive for three or more years, but only sclerotia located within 2 inches of the soil surface form apothecia.

Although technically seedborne, the fungus in bean seed is unlikely to be of epidemiological significance in the United States. The pathogen is most active between 60° and 70°F and ceases to grow when the temperature reaches 86°F.

## MANAGEMENT

Management of white mold is difficult and requires an integrated approach to minimize the risk of yield losses. Some measures, such as choice of variety, must necessarily be made before planting, whereas others, such as foliar fungicide application, must wait until the crop reaches the proper growth stage during the growing season.

### Preplanting considerations

1. Know the white mold history of your fields; some fields historically develop less white mold than others and will not require as intensive control measures.

**Figure 8.** Fruiting bodies (apothecia) of *Sclerotinia sclerotiorum* arise from sclerotia. They are about ¼ inch in diameter, nearly flush with the soil surface, and often difficult to see.

2. Use at least a 4-year rotation between bean crops. Good non-host rotational crops are wheat, barley, and corn. Avoid rotating with crops such as potatoes, peas, etc. (see list above) that are also hosts of the pathogen.
3. Select a variety that has an upright architecture, i.e., one that is determinate or has a short vine; avoid varieties that produce a heavy vine growth in disease-prone fields.
4. Avoid fields with high residual nitrogen, which will stimulate vegetative growth, induce dense plant canopies, and favor white mold development.
5. Deep plowing to bury sclerotia may be beneficial, but may also bring up viable sclerotia that were buried in previous years.
6. Planting on wide row spacing (greater than 30 inches) reduces white mold severity by permitting better air circulation and drying of the plant canopy and soil surface but may not be economical or feasible.

### Post-planting considerations

**Cultural control—**White mold generally does not develop until rows have closed, plants have bloomed, and the soil surface remains wet. Thus, rain and irrigation practices, particularly late in the season, have profound effects on disease development.

Irrigate on a normal schedule through flowering (i.e., July 20 in the Treasure Valley and July 31 in the Magic Valley of

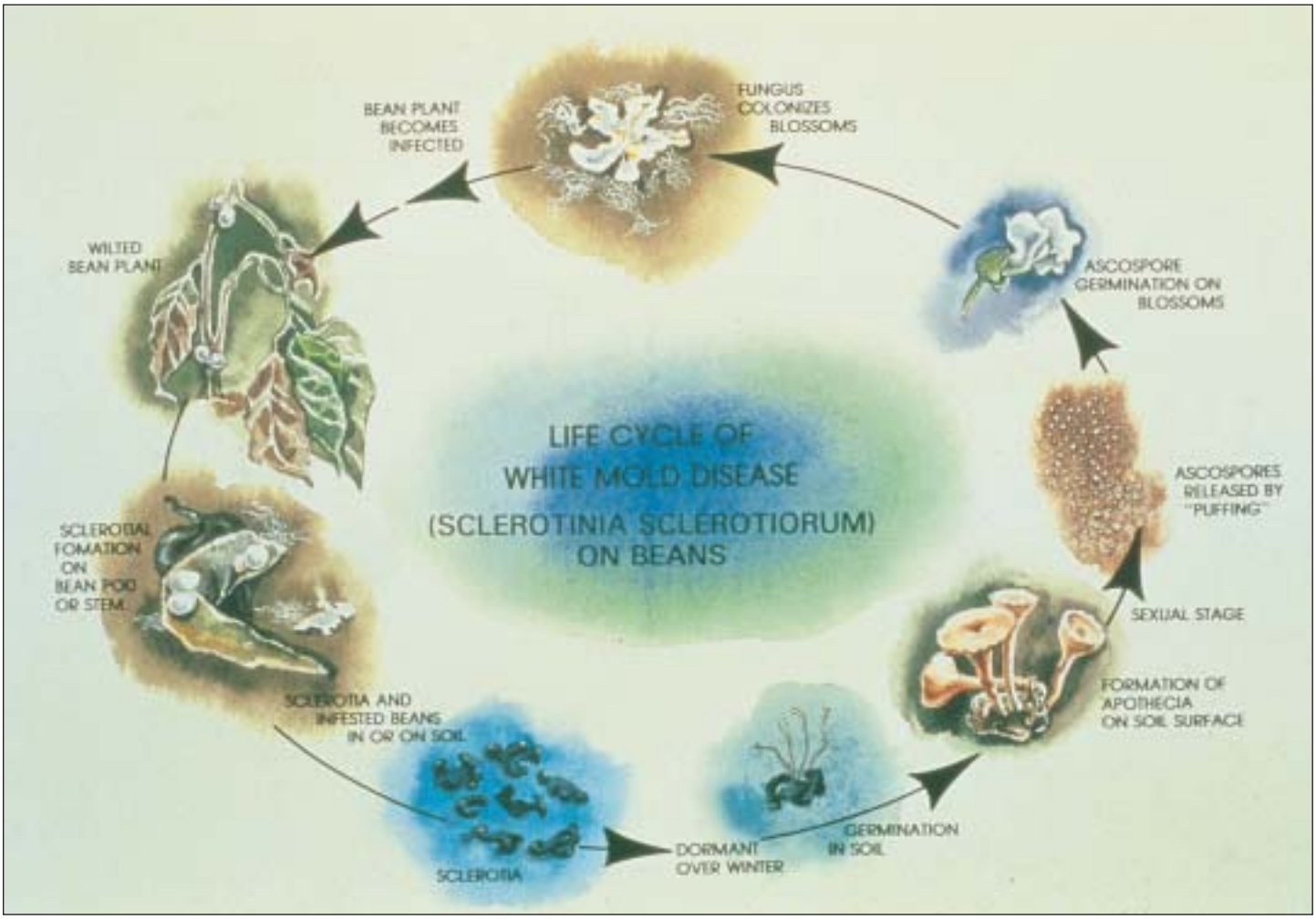


**Figure. 9.** Life cycle of white mold on beans (figure courtesy of Jim Steadman, University of Nebraska).

Idaho) and strive to maintain good soil moisture in the top several feet of soil through this period. Extending irrigation intervals prior to these dates in an effort to dry out the crop and minimize white mold development may result in loss of blossoms and poor pod set and serves no useful purpose in controlling white mold.

By maintaining high levels of soil moisture in the root zone through flowering, one may have the option of eliminating the last one or two anticipated irrigations, which would reduce conditions that favor disease. Beans with reasonably healthy root systems have the ability to produce a good crop even when irrigation water is withheld after the bloom period.

The best advice to growers trying to decide whether or not to make one more irrigation after peak bloom is: "When in doubt, don't!" Too often, a grower who sees small pods at the plant top irrigates in hopes of filling them, which sacrifices his biggest pods low on the plant to white mold. Those small pods near the top of the plant probably will not fill anyway, due to shorter day lengths, competition from developing pods within the plant, and natural senescence.

**Chemical control—**The use of a fungicide spray may be cost-effective in fields with a history of white mold if the following procedure is followed closely. Apply fungicide prior to disease development for maximum benefit. If applied prior to bloom, however, the fungicide may provide only limited control. Our recommendation is to begin fungicide application when 100 percent of the plants have their first open blossom. Satisfactory results have been obtained when only 50 percent of the plants have their first open blossom or when plants have pods up to 1 inch long. Applications made outside of this window are unlikely to provide optimal control.

Apply the fungicide either by ground sprayer with drop pipes so that the spray is directed into the lower, interior part of the plant on both sides of the row, or, if the fungicide label permits, by chemigation. Spraying over the row or onto the soil surface is not efficient. Aerial application, even if permitted on the label, is not recommended due to the inability of the spray to reach the lower, interior parts of the plant.

If chemigation is permitted, insure that as much fungicide as possible remains on the foliage instead of washing onto the ground. Thus, center pivot sprinklers should operate at 100 percent speed while applying fungicide. With wheel lines, hand-move lines, and solid set sprinklers, inject the fungicide into the line near the end of the irrigation period.

Be aware that excessive irrigation late in the season may diminish the effectiveness of the fungicide. Furthermore, fungicide applications made after the disease is widespread in the field should not be expected to control this disease. For a selection of products registered for control of white mold on beans, consult the annually revised *Pacific Northwest Disease Management Handbook* or the online guide to plant disease control at http://plant-disease.orst.edu/.

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