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White Mold of Beans in Idaho caused by *Sclerotinia sclerotiorum*

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Contents

- 1 Introduction
- 1 The Pathogen
- 2 Symptoms and Signs
- 3 Disease Cycle
- 4 Disease Management
- 5 Further Reading

Introduction

IDAHO USUALLY RANKS FIFTH in total dry bean production in the United States. It is the country's top bean seed-producing state, with around 70% of its bean acreage grown for seed. White mold, caused by *Sclerotinia sclerotiorum* (Lib.) de Bary, is one of the most serious and destructive diseases of beans in Idaho. The pathogen infects over four hundred different plant hosts, the majority of which are dicotyledonous plants. If the environment is conducive for disease development, yield and quality of dry beans and seed are reduced. Yield losses can exceed 30% and in severe cases the entire crop may be lost.

The Pathogen

Sclerotinia sclerotiorum is a soilborne fungus that forms hard, black survival structures called sclerotia on or in infected plant parts (Figure 1). Sclerotia can be irregularly shaped and range in size from less than 1/8 inches to 1/4 inches in diameter and up to 1 inch in length. They fall to the soil in crop debris and can survive for at least five years in the plow layer of soil. These structures germinate to form either mycelia (fungal strands) or small, mushroom-like cup-shaped structures called apothecia on the soil surface (Figure 2).

At maturity, apothecia are tan with a sponge-like feel, range in size from 1/4 to 1/2 inches, and release microscopic, airborne ascospores.



Figure 1. Black sclerotia on mature bean pod.



Figure 2. Apothecia of *Sclerotinia sclerotiorum*.



Figure 3. Lesions on beans can occur on upper plant parts..

Symptoms and Signs

Sclerotinia sclerotiorum affect any aboveground part of a plant (Figure 3). Lesions start out small and water-soaked in appearance; over time they may expand into larger, water-soaked areas. Eventually, lesions girdle the stem and cause wilting and the death of entire plants (Figure 4). Lesions may eventually dry out and bleach to a white or pale brown appearance (Figure 5).

Often, the fungus produces white, matted mycelia on infected tissue (Figures 3–5). Portions of the mycelia



Figure 4. Advanced white mold lesions and matted white mycelia on young green bean pods.



Figure 5. More advanced symptoms on stems that cause plant death. Notice the white matted mycelium of the pathogen on the stem.

may form dense growths that melanize to form the characteristic black sclerotia (Figure 1). Sclerotia form on or in infected plant tissue.

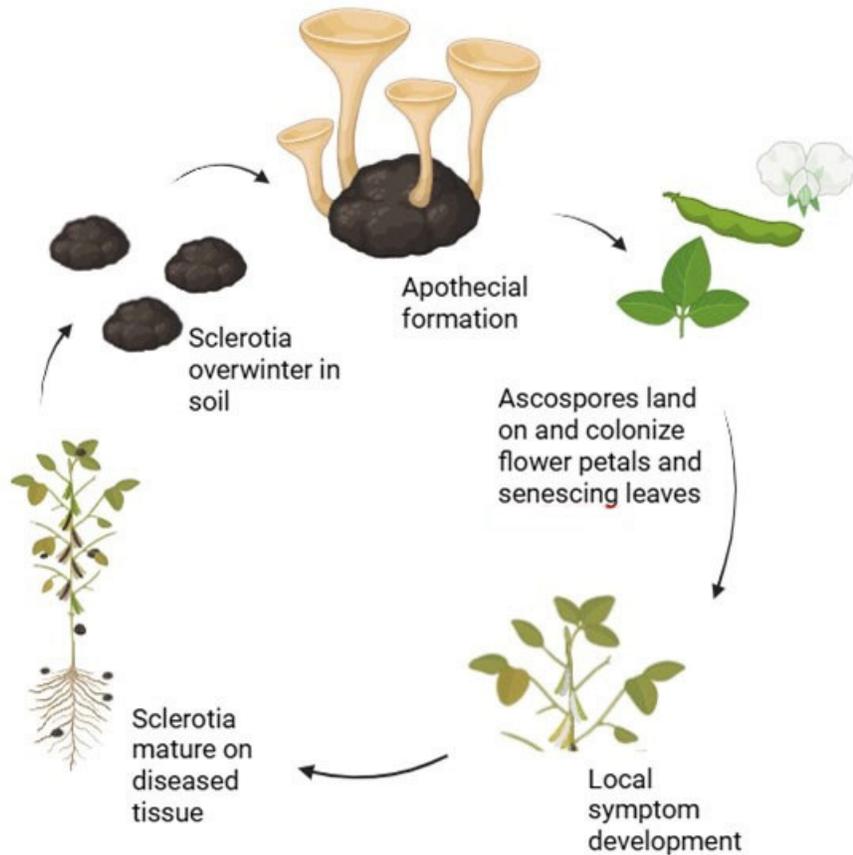


Figure 6. White mold disease cycle.

Disease Cycle

White mold is considered a monocyclic disease, meaning it has one primary infection period (Figure 6). The pathogen survives winter as sclerotia (Figure 1). Sclerotia contain melanin, a dark pigment that makes them resistant to unfavorable soil conditions, allowing them to survive in a dormant state for several years in soil and plant debris even without a living host plant.

In spring or early summer, sclerotia germinate and produce apothecia (Figure 2). Apothecia form under the canopy after a period of time with relative humidity of at least 90%, in saturated or near-saturated soils, and amid soil temperatures of 50°F–70°F. Each apothecium may then liberate millions of airborne ascospores. Ascospores are the primary inoculum for white mold of dry bean. This pathogen is somewhat unusual in that its ascospores are not strong enough to directly infect healthy tissue. They must first land on and colonize weaker tissue, such as flower petals or dying leaves. Air

temperatures between 54°F and 75°F and exposure to long dew periods or other free moisture for 16–48 hours are optimal for ascospores to infect and colonize the weaker tissue.

Following the colonization of flower petals or senescing tissue, the fungus then directly infects healthy tissue, leading to symptom development and subsequent formation of new sclerotia. In addition to airborne ascospores, mycelia from an infected plant may infect adjacent plants that are in direct contact with the infected tissue, but this type of secondary spread is rare. Mycelia from sclerotia on the soil surface also directly infect healthy plant tissue at the soil line, but for beans, this method of infection does not appear to be as important as those from flower petals or dying leaves that have been colonized by the airborne ascospores.

The pathogen can move from field to field via infected seed, sclerotia mixed with seed, contaminated soil on agricultural equipment, and irrigation runoff water.

Disease Management

Best agronomic practices like site selection, the timing of planting, irrigation management, plant density, and varietal development characteristics are all part of an effective disease management plan. Though implementation of an integrated program is required for optimal disease management, properly timed fungicide applications are the most effective tool to manage white mold.

Cultural Control

Keep track of the history of white mold pathogens in the fields. Avoid small fields enclosed by dense trees with limited air circulation. Plant rows in the direction of the prevailing winds.

Reduce disease risk by implementing cultural measures that limit excessive vine growth. Thick, dense growth leads to lower temperatures and excessive dew periods beneath the plant canopy, conditions that promote disease development. To avoid excessively dense canopy development, avoid the application of excessive fertilizer.

White mold development is also influenced by high plant populations and narrow row widths, especially in fields with a history of the disease. To avoid dense canopies, stick to the recommended planting rates and row widths and remove weeds.

Idaho bean production requires irrigation, but excessive overhead sprinkler irrigation increases the occurrence of white mold. Monitor soil moisture regularly, because the pathogen requires saturation to field capacity for ten days to produce apothecia and ascospores. Keep the soil surface as dry as possible during pod filling and maturation to considerably reduce white mold infection.

Other tips: Plow fields immediately after harvest and rotate crops with nonsusceptible hosts. Indeed, these cultural measures help to reduce the amount of sclerotia. When infested fields are rotated to cereal crops and other grasses like corn or switchgrass (*Panicum virgatum*), inoculum levels in the soil gradually decline, resulting in lower white mold incidence in later years. However, crop rotation alone does not prevent infection because white mold sclerotia can live in the soil for many years. Thus to optimize crop rotation as a tool to manage white

mold, implement a long-term crop rotation system that includes nonsusceptible hosts.

Cultivar Resistance

The use of disease-resistant cultivars is critical for integrated disease management. While no commercial fresh or dry bean variety has high resistance to white mold, some types are more tolerant than others. Upright bean cultivars with a more open plant canopy generally exhibit more tolerance to white mold.

Some accessions of *Phaseolus coccineus*, commonly known as scarlet runner beans, have a higher level of tolerance than other beans. There are no commercially marketed white mold-resistant snap bean cultivars. Because genetic resistance in beans likely requires many different genes, breeding for resistance has not yet been successful.

Chemical Control

Effective fungicides are available to manage white mold of bean. However, correct timing of application is critical. Since ascospores are considered the most important inoculum source for white mold of bean, fungicide application efforts target the period when beans are in bloom. Some fungicide applications begin at 10% bloom (when 10% of plants have one or more flowers), while others begin at 30% bloom. But some fungicides offer acceptable control at 50%–100% bloom. For some fungicides, adequate results can be attained when plants have pods up to 1 inch long. Endura, Topsin, Proline, Cannonball, and Fontelis are fungicides that are classified as offering acceptable to excellent white mold control (Table 1).

To protect as many blooms as possible from infection, the timing of fungicidal application is crucial. Apply the fungicide with enough spray volume to cover all blooms, developing pods, stems, and leaves, particularly those closest to the soil surface where environmental conditions are most conducive for disease development. Beans with indeterminate growth habits, which flower over a longer period, may require a second application if weather conditions promote disease development. Farmers should avoid “revenge spraying” after a dense canopy has formed, since fungicides are unlikely to penetrate fully and reach infected tissues; most

Table 1. Fungicide recommendations for white mold management. Note: This table is not necessarily complete and registrations may change without notice. Always read, understand, and follow pesticide labels to ensure compliance with state and federal laws.

Common Name	Active Ingredient	FRAC Code*	Label Rate/Acre	Timing of Application
Endura	Boscalid	7	5.5–11 oz	Apply the chemical when 50%–100% of the plants have one or more flowers and small pods—less than ¼-inch long.
Topsin	Thiophanate-methyl	1	1½–2 lb	Apply two fungicide sprays back-to-back. Start early (at 10% bloom), followed by a second spray 4–5 days later.
Proline	Prothioconazole	3	5.7 fl oz	Apply at 30% flower and 7 days later.
Cannonball	Fludioxonil	12	28 oz	Apply within 7 days of harvest interval. Do not apply more than 28oz/acre/season.
Fontelis	Penthiopyrad	7	14–20 fl oz	Apply at 30% flower and 7 days later.
Fluazinam	Fluazinam	29	8–2 fl oz	Apply at 10%–30% if the plants have at least one open blossom; repeat 7–10 days later.
Tetraconazole	Tetraconazole	3	4–6 fl oz	Apply at early bloom; repeat if conditions are favorable for disease.
Propulse	Fluopyram + Prothioconazole	7 + 3	8.0–13.6 fl oz	Apply at early bloom to full flower; repeat 7–14 days later.
Delaro	Prothioconazole + Trifloxystrobin	3 + 11	8–12 fl oz	Apply at early bloom to early pod formation when conditions favor white mold.

*A number assigned by the Fungicide Resistance Action Committee (FRAC).

systemic fungicides move primarily through the xylem, not the phloem. For plants with upright growth habits, fungicide treatment provides the most effective disease control. Fungicide treatment effectively reduces losses due to white mold when used in conjunction with an overall disease management strategy that includes adequate crop rotation, cultural practices, efficient fertilizer use, and irrigation management.

Further Reading

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ALWAYS read and follow the instructions printed on the pesticide label. The pesticide recommendations in this UI publication do not substitute for instructions on the label. Pesticide laws and labels change frequently and may have changed since this publication was written. Some pesticides may have been withdrawn or had certain uses prohibited. Use pesticides with care. Do not use a pesticide unless the specific plant, animal, or other application site is specifically listed on the label. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

Trade Names—To simplify information, trade names have been used. No endorsement of named products is intended nor is criticism implied of similar products not mentioned.

Groundwater—To protect groundwater, when there is a choice of pesticides, the applicator should use the product least likely to leach.

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