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Managing White Mold of Soybeans

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Summary

- White mold is an annual threat to soybeans in northern and near-northern states from Minnesota and Iowa to the Atlantic coast. Wet, cool conditions favor development.
- Many yield-enhancing production practices that result in early, dense canopy formation increase disease incidence. Often, the better the establishment and growth of the crop, the more likely it will be damaged by white mold.
- Current options to control white mold or reduce disease pressure include avoidance, variety selection, changes in cropping systems (tillage/rotation), and adjusting planting practices and other production methods.
- Pioneer scientists are working to improve varieties for white mold tolerance. Both traditional and biotechnology tools are being used in this pursuit.

White mold (*Sclerotinia sclerotiorum*) is a fungal disease that can attack hundreds of plant species. Also known as Sclerotinia stem rot, it was once only a sporadic soybean disease in Minnesota, Wisconsin and Michigan. However, it has now progressed to become an annual threat to northern states from Minnesota to New York., as well as the northern areas of states bordering to the south. In some years, white mold is only eclipsed by Phytophthora and soybean cyst nematode in damage caused to soybeans in those states.

The spread of white mold is likely due to changes in soybean culture during the last two decades that have accelerated canopy development. This includes earlier planting, drilled or narrow rows and higher seeding rates. Ironically, these practices, along with improved genetics, have also been responsible for most of the yield and profitability gains over that timeframe. Maintaining those gains now depends partly on grower success in managing white mold, especially in years when disease incidence is high. This *Crop Insights* will describe white mold of soybeans and current and future options for managing this disease.

Disease Description and Life Cycle

White mold persists in soybean fields over time by production of survival structures called sclerotia. Sclerotia are dark, irregularly shaped bodies ¼ to ¾ inches long formed within the white, cottony growth on the inside and outside of the stem during the fall. These compact masses of hardened mycelia contain food reserves and as such function much like seeds, surviving for years in the soil and eventually germinating.

Figure 1. White mold on soybean stems. Sclerotia form on the inside and outside of the soybean stem (right).

In the most common form of germination, a sclerotium produces one or more dark germ tubes or stipes that grow upward from a depth of two inches or less in the soil. When it reaches the soil surface, the germ tube is triggered by light to produce a small, flesh-colored structure much like a mushroom, called an apothecium. One sclerotium can produce numerous apothecia simultaneously or sequentially throughout the growing season. Each apothecium produces millions of spores beneath the plant canopy, which are periodically released and spread to the plants.

Figure 2. Mushroom-like apothecia forming on sclerotia[1].

Spores are not able to invade plants directly, but rather, must colonize dead plant tissue before moving into the plant. Senescing flowers provide a ready source of dead tissue for preliminary colonization. From these senescing flowers in the branch axils or stuck to developing pods, the fungus spreads to healthy tissue. The first symptom of white mold infection appears as a water-soaked stem lesion originating from a node. If the lesion remains wet, it becomes overgrown with white mold. The disease can then spread directly from plant to plant by contact with this moldy tissue. Sclerotia are formed within the moldy growth and inside the stem to complete the disease cycle.

Plant damage is incurred as tissue rot and formation of sclerotia inside the stem result in rapid wilting and death of the upper part of the plant. As the disease progresses, premature death of the entire plant can occur.

Wet, Cool Conditions Favor Development

Wet, cool conditions are required throughout the white mold disease cycle, including germination of the sclerotia in the soil, spore release, infection of soybean flowers by spores and spread of white mold from plant to plant.

- Sclerotia in the soil require 7 to 14 days of high soil moisture to germinate and produce apothecia (fruiting bodies). Temperatures near 55 to 60 degrees F. are optimum for this process.
- Spores are forcibly ejected from the fruiting bodies during wet weather conditions.
- After spores are released, a wet surface on senescing flowers or other dead or dying tissue is required for spore germination. Specifically, 2 to 3 days of continuous wetness, or more than 12 hours of daily wetness for 3 to 5 days is required.
- White mycelial growth develops on stem lesions that remain wet, and spreads by contact to neighboring plants. Temperatures from 68 to 78 degrees F. are ideal for disease spread.

High-Yield Practices Often Increase White Mold

Early establishment of a dense soybean canopy increases the likelihood that the cool, high-humidity conditions required for white mold development will occur. Many common soybean management practices lead to early, dense canopy formation, including early planting, drilled or narrow rows and high plant populations. In fact, researchers and agronomists often suggest that achieving canopy closure before flowering is a key to maximizing yields. Consequently, early canopy closure is a goal for many soybean producers, especially in northern locations and where available sunlight is limited. Unfortunately, this practice also encourages white mold development.

Risk Factors for White Mold Development

The North Central Plant Health Initiative has developed the following list of risk factors for white mold[2].

Seasonal Risk Factors for White Mold Development
Weather: Moderate temperatures (<85 F), normal or above normal precipitation, soil moisture at field capacity or above, and prolonged morning fog and leaf wetness (high canopy humidity) at and following flowering into early pod development.
Early canopy closure due to early planting, high plant population, narrow rows, excessive plant nutrition and optimal climatic con-ditions creates dense canopy and increased apothecia density.
History of white mold in the field, density of the white mold pathogen, apothecia present on soil surface at flowering, distribution of pathogen/disease in field.
Soybean variety planted. Plant structure and physiological functions govern variety reaction to white mold. Varieties range from partially resistant to highly susceptible.

Long-Term Risk Factors for White Mold Development
Field/cropping history. Pathogen level will gradually increase if: - Other host crops are grown in rotation with soybean - Only 1- to 2-year intervals occur between soybean crops - White mold susceptible varieties are grown.
Weed management systems. Inoculum will increase if control of broadleaf weeds is ineffective. Some herbicides used in rotation systems may be suppressive to white mold.
Topography of field. Pockets of poor air drainage, tree lines and other natural barriers that impede air movement will create a favorable micro-environment for white mold development.
Pathogen introduction: - Contaminated and infected seed - Movement of infested soil with equipment - Wind-borne spores from apothecia from area outside fields

Management of White Mold

White mold is a disease of high yield potential soybeans. Often, the better the establishment and growth of the crop, the more likely it will be damaged by white mold. However, a strategy to control the disease by abandoning high-yield management practices is counter-productive. Instead, growers should employ other practices to reduce white mold damage.

No one practice alone will be effective in controlling white mold, but several options are available to help reduce disease pressure. Current options include disease avoidance, variety selection, changes in cropping systems including tillage and rotation, and adjusting production methods such as planting practices, chemical applications and weed control.

Disease Avoidance

White mold spreads either by movement of spores or sclerotia from field to field. Spores are airborne and may originate from any field that has had white mold in the past. Spores are thought to move only short distances – about 150 feet according to some studies – so infection by spores would progress from field edges. There is little known about stopping the spread of spores.

Sclerotia move from field to field in harvest equipment or in contaminated seed. Harvest equipment should be thoroughly cleaned when moving from infected to non-infected fields. Harvesting infected fields last provides additional safety.

Because sclerotia are roughly the size of soybean seed, they can't be easily separated by the combine. Soybeans harvested from infected fields are most likely loaded with sclerotia. Planting these soybeans would place them at the ideal depth for germination and infection of that crop and field. Growers should absolutely not save seed from infected fields.

Pioneer Hi-Bred avoids growing seed beans in fields with a history of white mold. In addition, seed is thoroughly cleaned and inspected to insure that it is disease-free. Seed cleaning with a gravity table or centrifugal tower is essential to remove sclerotia. Fungicide seed treatments can help ensure that no disease is transmitted by mycelia present on seed.

Variety Selection

At this time there is no known genetic resistance to white mold – all varieties are capable of developing white mold symptoms under severe infestations. However, there are clear varietal differences in degree of tolerance. Pioneer Hi-Bred provides white mold tolerance scores for all its varieties adapted to areas where white mold occurs. These scores reflect varietal differences in the rate at which the infection develops and the extent of damage it causes. Scores are based on Pioneer research observations of comparative white mold tolerance among the varieties across multiple locations and years. Growers should consult their Pioneer sales professional to select local white mold tolerant varieties.

Future solutions to white mold control will likely come from development of varieties with higher tolerance and resistance. Better identification of resistant germplasm is now possible as Pioneer researchers apply new screening techniques in the field and greenhouse. Pioneer's intensive white mold testing efforts in northern states and Ontario will also aid in resistant germplasm identification and characterization. In addition, resistance genes in other crops or organisms could potentially be transferred to soybeans via biotechnology. Pioneer is also investigating use of other biotechnology tools to address the white mold problem.

Cropping Systems

Tillage: Sclerotia germinate from the top two inches of soil. Below that depth, they can remain dormant for up to 10 years. Because of its longevity in the soil, it is difficult to devise a strategy to control white mold with tillage. Deep tillage buries sclerotia from the soil surface but may also bring prior sclerotia into their zone of germination. If the disease is new to a field and a severe outbreak has occurred, a deep tillage followed by no-till or shallow tillage for many years may be beneficial. Research studies have shown that no-till is generally superior to other tillage systems in limiting white mold development.

Rotation: Rotation with a non-host crop is an effective means of reducing disease pressure in a field. Non-host crops include corn, sorghum, and small grains. Susceptible crops to avoid in a rotation include alfalfa, clover, sunflower, canola, edible beans, potato and others. Depending on soybean tolerance, field history and other factors, more than one year away from soybeans may be required. Because sclerotia survive for up to ten years in the soil, rotation is only a partial solution.

Production Practices

It is well-established that many current practices that increase soybean yields also increase white mold. Whether growers should abandon their yield-enhancing practices to help control white mold is debatable. In areas with lower white mold levels or drier climate, production practices which increase yield but also increase white mold levels may still be highest yielding. However, in areas with higher white mold levels and a cool, wet climate, some change in production practices may be necessary. Production practices influence white mold levels by their effect on canopy development. Canopy management recommendations based on field history of white mold are shown in Table 1[2].

Row Width: Numerous studies over many years have demonstrated a yield advantage for narrow-row (<30 inches) soybeans. Pioneer research over a three-year period from 16 sites showed a 5% advantage for 7-inch rows over 30-inch rows. 15-inch rows yielded almost the same as the 7-inch rows. University studies have generally demonstrated a greater advantage for narrow rows in northern states, and little or no advantage in southern states.

A six-year research study in Wisconsin measured yield and white mold incidence in 7-inch (drilled) vs. 30-inch rows (Grau, 2001). Though white mold mortality was much higher in drilled beans, the yields were nevertheless equal or higher for drilled vs. 30-inch rows when average across years.

This suggests that narrow-row planting systems should not be abandoned simply to help control white mold. In fact, narrow-row systems generally increase yields each year, and white mold may not develop every year. However, because research studies have shown that 15-inch rows often yield as well as 7-inch rows, many growers in white mold areas have chosen the 15-inch row width.

Planting Date: Later planted soybeans are generally shorter and less branched, and therefore later to canopy closure. Some planting date studies show that later planting results in less incidence of white mold. However, yields are generally reduced when planting is delayed past mid-May in northern states. The tradeoff between less yield reduction due to white mold, but more yield reduction due to late planting may not be favorable, especially in years of low disease pressure.

Plant Population: Soybean yields generally increase with increased plant population within a range. Studies have demonstrated higher white mold incidence with higher plant population, but yields were not reduced. However, part of the expected increase from higher seeding rates was likely offset by losses from Sclerotinia. In fields with high risk of white mold, seeding rates should be sufficient for uniform stand establishment, but shouldn't be aggressively high. Actual rates will vary depending on planting date, seedbed conditions, row width and seed quality.

Weed Control: White mold has over 400 plant hosts, including many broadleaf weeds. Host weeds that are also common weed species throughout soybean growing areas include lambsquarters, ragweed, pigweed and velvetleaf. In addition to acting as host to the disease, weeds can also increase canopy density, which favors disease spread.

Chemical Applications: Topsin® M is a foliar fungicide labeled for white mold control in soybeans, but some studies have shown inconsistent results. Proper timing of application and penetration of the fungicide through the soybean canopy to the flowers are critical for success. For this reason, foliar fungicides are not often recommended. If used, pathologists suggest to apply when soybeans are producing flowers on the lower half of the plant. Drop nozzles may be helpful to ensure spray coverage of those flowers.

Researchers have investigated the effects of post-emergence herbicide applications to control white mold. Some studies have shown reduced white mold incidence and increased soybean yield by one application of Cobra® at the V4 or R1 growth stage.

References

Grau, C.R. and J.E. Kurle. 2001. White mold in soybean. Wisconsin Extension Bulletin A3695. University of Wisconsin, Madison. http://www.plantpath.wisc.edu/soyhealth/whitemold/wiwihitemold.pdf

[1]Image courtesy of the Plant Disease Clinic, Extension Plant Pathology, University of Minnesota. http://www.extension.umn.edu/yardandgarden/YGLNews/YGLN-Aug0101.html#blight

[2] Plant Health Initiative. North Central Soybean Research Program (content modified). http://www.planthealth.info/whitemold_basics.htm

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Table 1. Canopy management recommendations based on the field history of white mold[2].

Field History	Variety Selection	Canopy (row width and plant density)	Crop Rotation
No white mold **Monitor fields closely**	Variety of choice; plant pathogen free seed	Maintain current row width and plant population	Avoid crops susceptible to white mold
<5% diseased plants aggregated in field	Avoid susceptible varieties	Maintain current row width and plant population	Minimum of 1 year out of soybean
<5% diseased plants uni-formly distributed in field	Consider partially resistant; avoid highly susceptible varieties	Maintain current row width and lower population for less resistant varieties	Minimum of 1 year out of soybean
5-25% diseased plants	Partially resistant varieties	Maintain current row width and plant population	Minimum of 1 year out of soybean
5-25% diseased plants	Moderately susceptible varieties	Widen row width and lower plant population	Minimum of 1 year out of soybean
25-50% diseased plants	Partially resistant varieties	Maintain current row width and lower plant population	1 to 2 years out of soybean
25-50% diseased plants	Moderately susceptible varieties	Use 30 inch row width. Plant <180,000 plants/acre	1 to 2 years out of soybean
>50% diseased plants	Partially resistant varieties	Use 15 to 30 inch row width. Plant <180,000 plants/acre	2-3 years out of soybean