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COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

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SCLEROTINIA STEM ROT (WHITE MOLD) OF SOYBEAN

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Sclerotinia stem rot, or white mold, of soybean is a disease most commonly reported in high-yield soybeans in the North Central Region of the United States. Overall disease incidence and severity vary from year to year and from field to field. In Ohio, growers have faced localized outbreaks of this disease every year since 2009. Infection and disease development are favored by wet conditions and cool temperatures (less than 70 degrees Fahrenheit) prior to, during and following the flowering stage.

The Fungus

Sclerotinia stem rot of soybean is caused by the fungus *Sclerotinia sclerotiorum*. This pathogen has a very wide host range with more than 400 plant species. Alfalfa, canola, edible beans, cole crops (cabbage, broccoli), peanuts, pulse crops (peas, chickpeas and lentils) and sunflowers are some other examples of host plants. This fungus produces a survival structure called a sclerotium (pl. sclerotia), which is black, hard and irregular in shape with a pink to white center (Figure 1A). The sclerotium is able to survive for many years in the soil, but under moist and cool conditions, the fungus can resume growth as myceliogenic (mycelium growth through the soil) or carpogenic (germination through formation of an apothecium). An apothecium is a small mushroom-like structure ranging from 0.5 to 2 millimeters in diameter, light-tan to brown in color (Figure 1B). The primary means by which the fungus infects a soybean plant is through carpogenic germination, where ascospores formed on the top of the apothecia are released and land on aging flower blossoms.

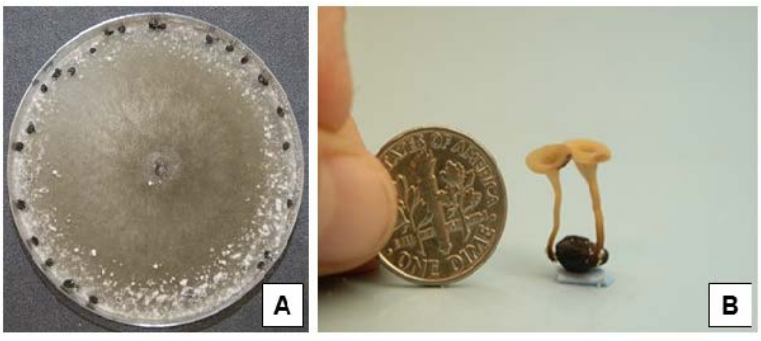

Figure 1. Sclerotinia sclerotiorum cultured under laboratory conditions (A). Note the white mycelia and the production of sclerotia (black structures); Apothecia development from sclerotia (B).

Figure 2. Soybean plants affected by Sclerotinia stem rot appear wilted and present leaves that turn brown to tan. (*A. Dorrance, OSU*).

Symptoms and Signs

Diseased plants first appear wilted and with grayish green leaves that later turn brown to tan (Figure 2). The stems also have grayish to bleached white lesions that are covered by white fluffy mycelia under conditions of high moisture (Figures 3A and 3B). In later stages, sclerotia can be observed inside or outside of the stems and pods (Figures 3C and 3D). If the seeds were infected during the early stages of development, they may have a flat and shriveled appearance, or may be replaced by sclerotia. The amount of yield loss due to Sclerotinia stem rot depends on the number of infected plants in the field and how early in the season the plants became infected, as well as the number of plants that died prematurely.

Disease Cycle

Under favorable conditions in the spring and summer, sclerotia that are present in the soil germinate forming either mycelia or apothecia. When apothecia development occurs, ascospores are produced and forcibly ejected into the air where they are spread by wind or splashing rainwater to stems, branches, flowers and pods. Blossoms serve as an initial source of nutrients and subsequent infections occur on the soybean stem near a node where the fungus has colonized dead flowers. Later, contact between healthy and diseased adjacent plants may cause infection as mycelia can grow through leaves, stems and petioles. Sclerotia produced outside or inside the stem can be mixed with seed during harvest, becoming a source of inoculum for other fields.

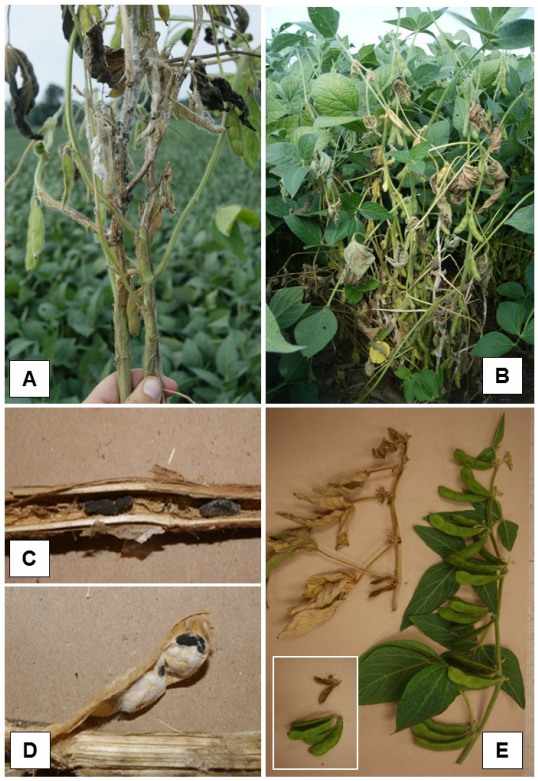

Figure 3. Symptoms and signs of Sclerotinia stem rot on plants in a soybean field (A and B); Sclerotia produced inside stems (C) and inside pods (D); Representation of the effect of the disease on pod filling: a branch from an infected plant on the left and a healthy plant on the right (E).

Disease Management

Management of Sclerotinia stem rot is very challenging in Ohio for two key reasons: the pathogen can survive in the soil for several years, and disease development is greatly affected by environmental conditions. There is no single tactic that can be used to manage the disease effectively; therefore, multiple strategies including cultural, chemical and biological methods should be applied to reduce yield losses. Management should be targeted towards those fields with a history of this disease.

Host resistance: There is no complete resistance reported for Sclerotinia stem rot of soybean. However, cultivars with high levels of partial resistance are commercially available. Soybean growers should talk to dealers and evaluate which cultivars have the highest levels of resistance to the disease. Overall, the selection of a soybean cultivar should take into account an open canopy of upright leaves, which would minimize a favorable environment.

Use of long crop rotation: It is important to note that the pathogen has a very broad host range and infects crops such as alfalfa, canola, edible beans, cole crops, peanuts, pulse crops and sunflower. In addition, good weed management is recommended because several weeds are hosts for the pathogen. Corn and wheat can be used in crop rotation with soybean to minimize inoculum build-up over time. Some sclerotia germinate and

produce apothecia even with non-host plants, therefore, several years of rotation will be required to reduce inoculum in a field.

Tillage is recommended for fields with first occurrence of Sclerotinia stem rot in order to bury the sclerotia, while **reduced tillage** is preferred for fields with a long history of the disease. It does appear that one year of moldboard plowing will bury sclerotia at least 10 centimeters in soil, delaying the production of apothecia. Sclerotia located within 5 centimeters from the soil surface may germinate and produce apothecia.

Reduction of seeding rate may improve air circulation, reducing the humidity and increasing the temperature within the soybean canopy. Overall, factors that accelerate canopy closure or practices that result in dense canopies will favor carpogenic germination. Others have found that increasing row spacing to 30 inch rows may avoid complete canopy closure. However, growers should be aware that this practice also reduces soybean yields.

Chemical control with fungicides: Fungicides are available for management of Sclerotinia stem rot, however, none of them provide complete control of the disease. They should be used when a moderately to highly susceptible cultivar is planted in a field with history of the disease in the past few years. There is a very narrow window for fungicide application targeting the disease, which must take into account development of apothecia, ascospore release and crop flowering. In addition, since the fungus has medium risk of development of resistance, rotation of active ingredients should be considered. In recent field experiments in Ohio, thiophanate methyl has not provided good efficacy in reducing disease incidence and severity. Also, strobilurin fungicides, such as pyraclostrobin, should not be used as an increase in disease severity occurred following the fungicide application. Boscalid has provided good efficacy in reducing disease incidence and severity compared to the untreated control.

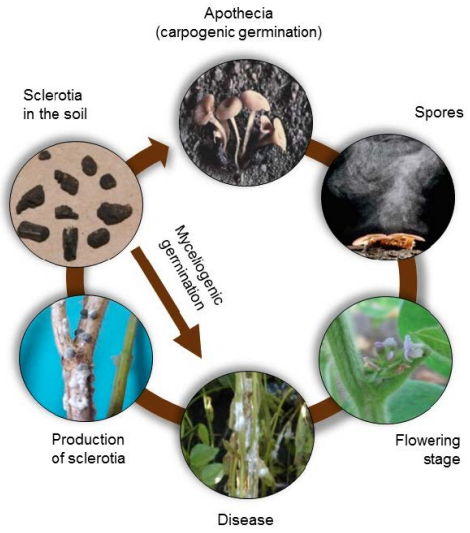

Figure 4. Disease cycle of Sclerotinia stem rot of soybean.

Chemical control with herbicides: Lactofen is an herbicide able to modify soybean canopy, delay flowering and induce systemic acquired resistance response with an increase in the production of phytoallexin production such as glyceollin. Some of these herbicides may reduce overall disease severity, but they can also cause substantial yield loss on their own.

Biological control with the fungus Coniothyrium minitans has been used in other crops systems to reduce inoculum levels in the field. To improve contact with sclerotia and degradation, it is necessary to incorporate this material to a depth of 2 inches (5 centimeters).

Avoid introduction of sclerotia in the field: This is very important because once the pathogen is introduced in the field, it is able to survive in the soil for many years and management becomes more and more difficult. The fungus can be introduced in a field through sclerotia present in seed-lots, equipment and flooding. Seed-lots can be cleaned by spiral separators and gravity tables. Avoid harvesting heavily infested fields until the end of the season as equipment, especially combines, can become contaminated with sclerotia. Seed treatments with fungicides could be used to treat infected seed.