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Biology, Yield loss and Control of Sclerotinia Stem Rot of Soybean

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ABSTRACT. Sclerotinia stem rot (also known as white mold) of soybean is a significant yield-limiting problem in the North Central production region. This disease, caused by the fungus *Sclerotinia sclerotiorum* (Lib.) de Bary, varies in incidence and severity from year to year because of its sensitivity to weather conditions. Losses because of Sclerotinia stem rot can be substantial when environmental conditions and management practices favor high yield potential. Employing a disease management plan based on knowledge of field history and best disease management practices can help reduce losses from Sclerotinia stem rot. An effective disease management plan integrates several management tactics that include cultural practices, varietal resistance, as well as chemical and biological control. Understanding how different environmental variables and management practices influence infection by *S. sclerotiorum* and disease development are important to optimize disease management and reduce losses. This profile summarizes research-based knowledge of Sclerotinia stem rot, including the disease cycle, the scope of the losses that can occur because of this disease, how to identify both the pathogen *S. sclerotiorum* and the disease, and current management recommendations.

Key Words: white mold, soybean pathogen, fungal pathogen, epidemiology

Disease Impact in the United States

Sclerotinia stem rot can cause significant yield losses in temperate climates worldwide when conditions are conducive to disease development. Based on estimated yield losses from 1996 through 2009, it was estimated that Sclerotinia stem rot caused yield losses >10 million bushels (270 million kg) in seven of the 14 yr (Wrather and Koenning 2009, Koenning and Wrather 2010, Table 1). Particularly large yield losses because of Sclerotinia stem rot occurred in 1997, 2004, and 2009, with 35, 60, and 59 million bushels (953 million, 1.63, and 1.61 billion kg) lost, respectively. Based on the market value of soybean in each of those years, producers lost ≈227, 344, and 560 million dollars, respectively (USDA/NASS 2011). The 2009 epidemic was particularly devastating in part because of the record low temperatures throughout the soybean-growing region (NOAA-NCDC 2009, Fig. 1). High levels of disease were reported over a large geographical region, leading to Sclerotinia stem rot being ranked second out of 23 diseases (Table 1).

Yield losses because of Sclerotinia stem rot are a function of reduced seed number and weight (Hoffman et al. 1998, Danielson et al. 2004). During the growing season, potential yield loss can be estimated based on disease incidence or the percentage of diseased plants. For every 10% increment in incidence of Sclerotinia stem rot observed at the R7 soybean developmental stage (beginning maturity), yield is reduced by 2–5 bushels per acre (133–333 kg/ha) (Chun et al. 1987, Hoffman et al. 1998, Yang et al. 1999, Danielson et al. 2004).

In addition to causing yield loss, Sclerotinia stem rot can reduce seed quality. Sclerotia, which are hard, melanized survival structures that resemble rodent droppings, may be observed in harvested grain (Fig. 2), may cause price discounts for foreign material delivered at the grain elevator. *Sclerotinia sclerotiorum* also can infect soybean seed and be an important source of inoculum if planted into fields with no history of Sclerotinia stem rot (Hartman et al. 1998, Yang et al. 1998, Mueller et al. 1999). Infected seeds can have reduced germination, and in some cases, oil and protein concentrations can be reduced (Hoffman et al. 1998, Danielson et al. 2004).

Pathogen Biology and Disease

Disease Cycle. For Sclerotinia stem rot to develop, an environment favorable for infection and disease development, a susceptible, flowering soybean cultivar, and ascospores of *S. sclerotiorum* must all occur simultaneously (Fig. 3). *Sclerotinia sclerotiorum* can survive for at least 5 yr in the soil as sclerotia. When soils are shaded, moist and cool (40–60°F; 4–16°C), sclerotia within the top two inches (5 cm) of the soil profile can germinate to produce apothecia (Adams and Ayers 1979, Grau and Hartman 1999, Wu and Subbarao 2008, Fig. 4). Apothecia are small (diameter: 1/8–1/4 inches; 3–6 mm), tan cup-shaped mushrooms (Fig. 5) that can produce millions of sexual spores called ascospores (Abawi and Grogan 1979). Ascospores colonize senescing flowers and the fungus then uses this nutrient source to infect the plant through the stem. Although rarer, infections of other aboveground tissues can occur through wounds or contact with other diseased plants (Grau and Hartman 1999). *Sclerotinia sclerotiorum* has a very wide host range, including cultivated crops such as edible beans, canola, cole crops (cabbage, broccoli), pulse crops (pea, chickpea, and lentil), sunflower, and potato (Boland and Hall 1994).

Infection by *S. sclerotiorum* is favored by cool to moderate maximum daily temperatures (<85°F; 29°C) and moisture from rain, fog, dew, or high relative humidity (Workneh and Yang 2000). A dense plant canopy during flowering (growth stages R1 [beginning flowering] through R3 [beginning pod]) increases the likelihood of the field having an ideal environment for Sclerotinia stem rot development (Grau and Hartman 1999). A dense canopy is favored by early planting, narrow row width, high plant populations, and high soil fertility (Grau and Hartman 1999). Sclerotinia stem rot in soybean is also favored by environments with high yield potential and by growing susceptible cultivars in fields with a history of the disease. Because of the wide host range of the pathogen, which includes many broad leaf crops and weeds, careful consideration should be given when rotating soybean with these other susceptible crops.

Signs and Symptoms of Sclerotinia Stem Rot. Typically, the first visible signs of activity by *S. sclerotiorum* are apothecia that germi-

Table 1. Estimated yield and dollar loss because of Sclerotinia stem rot, and rank of Sclerotinia stem rot in comparison to other soybean diseases in the United States from 1996 through 2009

Year	Estimated yield loss[a]	Estimated dollar loss[b]	Disease ranking[c]
	Bushels	US dollars	
1996	22,572,000	165,904,000	5
1997	35,189,000	227,673,000	3
1998	18,704,000	92,211,000	6
1999	2,699,000	12,496,000	15
2000	9,655,000	43,834,000	8
2001	2,318,000	10,153,000	17
2002	2,918,000	16,137,000	16
2003	2,081,000	15,275,000	18
2004	60,008,000	344,446,000	3
2005	5,991,000	33,909,000	11
2006	13,305,000	85,551,000	9
2007	5,114,000	51,651,000	15
2008	11,608,000	115,732,000	9
2009	59,275,000	560,149,000	2

[a] Estimated yield loss data obtained from Wrather and Koenning (2009) and Koenning and Wrather (2010).

[b] Estimated dollar loss data calculated by multiplying yield loss estimates by price received (in dollars per bushel) according to the USDA/NASS (2011).

[c] Disease ranking was obtained by comparing Sclerotinia stem rot to 23 other diseases and disease categories (virus, seed, seedling, and other disease) from 1996 through 2008 (Wrather and Koenning 2009) and 22 other diseases and disease loss categories in 2009 (seed disease category is missing; Koenning and Wrather 2010).

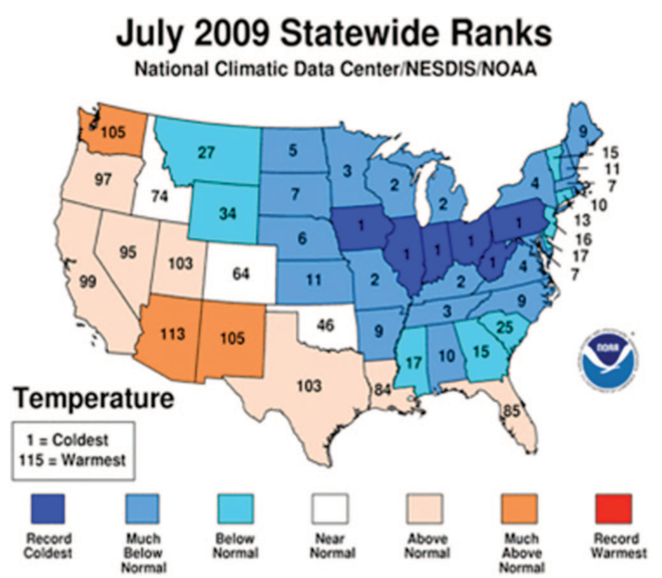

Fig. 1. U.S. statewide temperature rankings for July, 2009 (image: NOAA-NCDC 2009).

nate from sclerotia residing in the soil (Fig. 5). Thus, *S. sclerotiorum* can be visible before Sclerotinia stem rot symptoms are observed on soybean plants in the field. Apothecia may be confused with nonplant pathogenic fungi such as the common bird's nest fungus (Fig. 6).

Symptoms of Sclerotinia stem rot include water-soaked lesions (Fig. 7) that rapidly progress along and around the stem above and below infected nodes. Infected stems become bleached and stringy, and lesions also can occur on stems, pods, petioles, and occasionally leaves. Severe infection weakens the plant and results in wilting, lodging, and death (Fig. 8). Sclerotinia stem rot often occurs in patches in the field. In addition, signs of the fungus that can assist in diagnosis include white, cottony mycelia (moldy growth) and sclerotia (Fig. 9) on infected plant tissues. Sclerotia may be produced inside or outside of stems and pods (Fig. 10). These symptoms of Sclerotinia stem rot and signs of *S. sclerotiorum* usually allow it to be easily distinguished

Fig. 2. Sclerotia of *S. sclerotiorum* in harvested grain (photo: K. A. Ames).

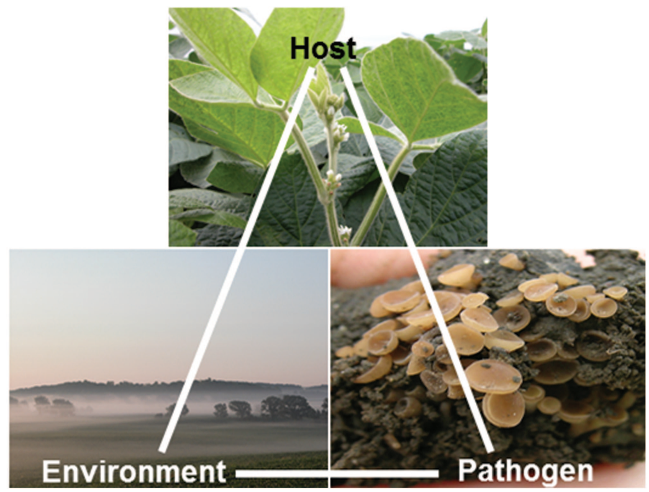

Fig. 3. The three components required for Sclerotinia stem rot to occur on soybean: a flowering, susceptible soybean cultivar, sporulating *S. sclerotiorum*, and a cool wet environment under the soybean canopy (photos: C. R. Grau and A. J. Peltier).

from other soybean diseases (Grau et al. 2004, Grau and Hartman 1999).

Disease Management

Recordkeeping. The integrated pest management practice of scouting, monitoring for disease, and taking accurate notes about where and how much Sclerotinia stem rot occurs in each soybean field from year to year, is important for disease management planning. Sclerotinia stem rot incidence can easily be estimated at late reproductive stages by scouting fields and taking counts of diseased plants in several (at least 4) representative parts of the field. For example, at each representative point in the field the number of infected plants and total number of plants in a 3 foot (0.91 m) section of a row can be counted; by dividing the number of diseased plants by the total number of plants an estimate of disease incidence for the field can be determined. Tracking disease incidence across years also will help determine the potential sclerotia (inoculum) load that may be present in a particular field. Recording disease and yield performance for different varieties will help in cultivar selection for fields with a history of Sclerotinia stem rot.

Cultural Practices. Several cultural practices have been associated with the incidence of Sclerotinia stem rot. However, the direct impact of these factors on disease incidence and yield varies because disease development is highly dependent on weather conditions during the reproductive growth stages.

Crop Rotation. A minimum of 2–3 yr of a nonhost crop such as corn or small grains (e.g., wheat, barley, or oats) can reduce the number of

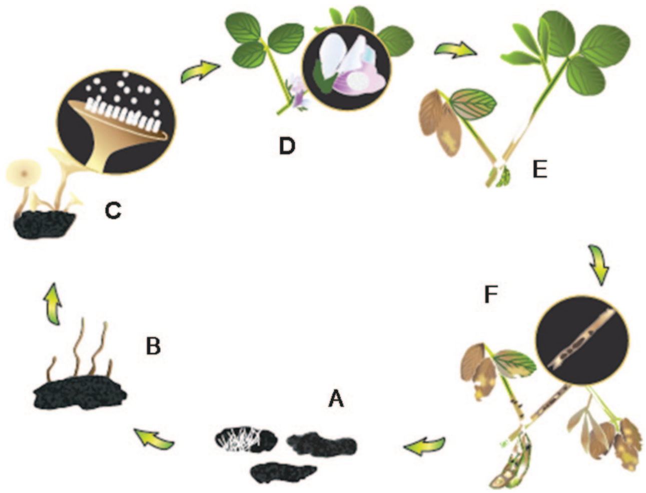

Fig. 4. Sclerotinia stem rot disease cycle. (A) Sclerotia of *Sclerotinia sclerotiorum* survive in the soil. (B) Under cool, wet environmental conditions sclerotia germinate to produce apothecia. (C) Apothecia produce sexual spores called ascospores, which are forcibly discharged from the apothecium into the air. (D) Ascospores colonize senescing flowers and infection can spread into the stem at the node. (E) Signs of *S. sclerotiorum* include sclerotia and tufts of white mycelium. Symptoms can include bleached stem lesions, wilt, lodging and plant death resulting in no seeds or poor pod fill. (F) Sclerotia form in and outside stems and pods and are dropped to the soil during harvest (illustration: Renée Tesdall).

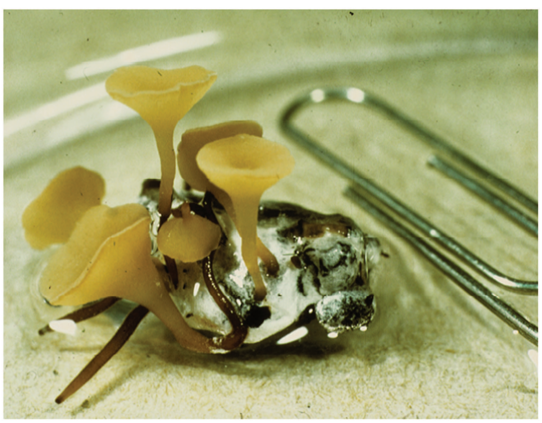

Fig. 5. Apothecia of *S. sclerotiorum* emerging from a sclerotium. (photo: James Venette).

sclerotia in the soil (Gracia-Garza et al. 2002, Rousseau et al. 2007). Forage legumes, such as alfalfa (*Medicago sativa* L.) and clovers, are less susceptible to infection than soybean and some other crops, but still can be infected by *S. sclerotiorum*. In fields with a history of Sclerotinia stem rot, susceptible broadleaf crops should not be grown more frequently than 3 yr apart (Boland and Hall 1994).

Tillage. The impact of tillage on Sclerotinia stem rot development is inconsistent, although several studies have indicated fewer apothecia (Kurle et al. 2001, Gracia-Garza et al. 2002) and lower disease severity in no-till fields (Workneh and Yang 2000, Kurle et al. 2001). Deep tillage initially may reduce disease incidence by removing sclerotia from the upper soil profile, which will reduce the number of apothecia produced (Mueller et al. 2002b). However, sclerotia can remain viable for >3 yr if buried 8–10 inches (20–25 cm) in the soil, and may be returned to the soil surface with subsequent tillage operations. Although more sclerotia are found near the soil surface in no-till systems, sclerotia may degrade faster in no-till soils compared with tilled soils.

Fig. 6. Bird's nest fungi, in the family Nidulariaceae, are common and harmless saprophytes sometimes confused with *S. sclerotiorum* that grow on the soil surface in crop fields (photos: M. I. Chilvers).

Fig. 7. Stem lesions, typical of Sclerotinia stem rot and signs of *Sclerotinia sclerotiorum* including mycelium and sclerotia can help in diagnosis (photo: D.S. Mueller).

Fig. 8. Symptoms of Sclerotinia stem rot can include bleached stems, wilting, lodging and plant death (photo: C. R. Grau).

Canopy Management. Early planting, narrow row width, high plant populations, and high soil fertility accelerate canopy closure and favor disease development. However, changing these practices also may

Fig. 9. Symptoms of Sclerotinia stem rot and signs of *Sclerotinia sclerotiorum* (photo: D.S. Mueller).

Fig. 10. Sclerotia of *S. sclerotiorum* inside of a soybean stem (photo: D.S. Mueller).

reduce yield potential. The history and severity of Sclerotinia stem rot in a field should be considered before adopting practices that reduce canopy closure.

Plant Populations. High plant populations (e.g., ≥175,000 plants $acre^{-1}$; 432,100 plants ha^{-1}), contribute to dense, closed canopies and increased Sclerotinia stem rot incidence (Kurle et al. 2001, Lee et al. 2005). Soybeans should be planted at recommended minimum seeding rates that maintain regional yield potential, and high plant populations should be avoided, especially in fields with a history of Sclerotinia stem rot.

Row Spacing. Soybeans planted on narrow row spacing may lead to faster and more complete canopy closure. Wider row spacings (≥20 inch; 51 cm) may reduce levels of Sclerotinia stem rot in some situations (Grau and Radke 1984), but this does not always result in increased yield.

Planting Date, Relative Maturity, and Plant Characteristics. Early planting, late-maturing cultivars, and cultivars with a bushy architecture or a tendency to lodge can contribute to a more closed canopy and greater Sclerotinia stem rot (Kim and Diers 2000).

Fertility and Plant Nutrition. High soil fertility, especially the use of nitrogen-rich manures and fertilizers, favors Sclerotinia stem rot development by promoting lush plant growth and early canopy closure (Wallace et al. 1990, Schmidt et al. 2001). Having soil fertility tests conducted on a regular basis will help avoid over-fertilizing fields with a history of Sclerotinia stem rot.

Weed Control. Many common weeds found in fields used for soybean production also are hosts of *S. sclerotiorum* (Boland and Hall 1994). Some weed hosts are listed in Table 2. High weed populations of any kind in a soybean field also may increase the density of the total plant canopy and promote a moist microclimate that favors disease development.

Cover Crops. The use of small grain cover crops such as oat, wheat, or barley grown with soybean can stimulate earlier emergence of apothecia compared with soybean grown alone (Maloney and Grau 2001). This can potentially lower Sclerotinia stem rot incidence. However, the effect of cover crops on soil moisture, soil nutrients, and shading of the primary crop should be considered. Many dicotyledonous cover crops can act as hosts of *S. sclerotiorum*, and should thus be avoided if there is any concern of Sclerotinia stem rot.

Irrigation Management. Excessive irrigation above what is needed to maintain yield potential during flower should be avoided to minimize moisture at the soil surface and in the crop canopy. Low moisture levels within the soybean canopy are critical for reducing the potential for Sclerotinia stem rot. Infrequent, heavy watering is better than frequent, light watering (Grau and Radke 1984). Avoiding excessive irrigation is especially important during the critical periods of infection from early flowering (R1) to early pod development (R3). Soybean development can take 0–7 d to progress from R1 to R2 (full flowering), and 5–15 d to move from R2 to R3 (Pedersen 2004).

Cultivar Selection

Selecting soybean cultivars with resistance to Sclerotinia stem rot is an important part of a disease management plan. Although no soybean cultivars are completely resistant to *S. sclerotiorum*, partially resistant cultivars are available (Grau et al. 1982, Boland and Hall 1987, Kim and Diers 2000). In a growing season conducive to disease, a partially resistant cultivar will have significantly lower disease incidence than a susceptible cultivar. Breeding for Sclerotinia stem rot resistance is difficult, as resistance is believed to be controlled by multiple genes (Hoffman et al. 1999, Arahana et al. 2001). Screening for resistance also is complicated because infection and disease development in field plots often is inconsistent. Differences in plant maturity also can influence infection and disease development (Kim and Diers 2000). Ideally, cultivar selection should be based on resistance ratings determined across multiple locations and years. Some soybean seed companies provide easily accessible, online Sclerotinia stem rot disease data for their cultivars (Fig. 11); however, testing conditions and resistance scoring methods vary within the seed industry.

Chemical Control

Chemical applications can be a component of an integrated management system for Sclerotinia stem rot. Some foliar-applied fungicides and herbicides have efficacy against *S. sclerotiorum*, although none offer complete control. Products currently registered for suppression or control of Sclerotinia stem rot on soybean in the United States are listed in Table 3.

Table 2. Common weed hosts of *Sclerotinia sclerotiorum*

Canada thistle	Common vetch	Redroot pigweed
Catchweed bedstraw	Curly dock	Shepard's purse
Common burdock	Dandelion	Sow thistle
Common chickweed	Field pennycress	Toothed spurge
Common cocklebur	Henbit	Velvetleaf
Common lambsquarters	Hemp	Venice mallow
Common purslane	Jerusalem artichoke	Wild carrot
Common ragweed	Jimsonweed	Wild mustard
Common sunflower	Prickly lettuce	Wild parsnip

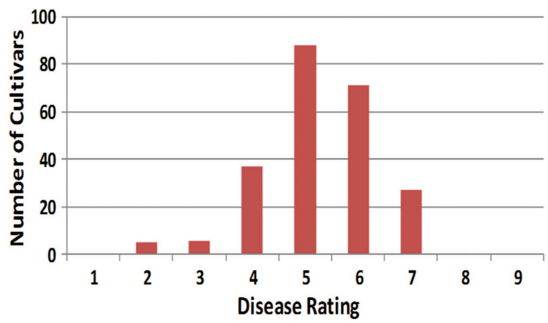

Fig. 11. Frequency distribution of Sclerotinia stem rot disease ratings among commercial soybean varieties from four soybean seed brands (Pioneer, Channel, FS HiSOY, and Asgrow; n = 235). Rating scale ranges from 1 to 9, where 1 = excellent and 9 = poor.

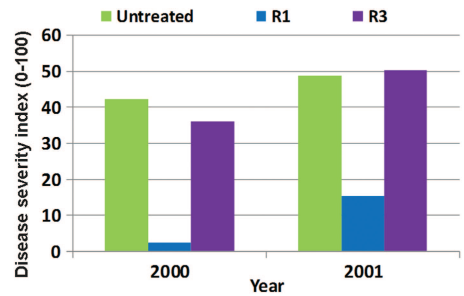

Fig. 12. The effect of thiophanate methyl application timing on Sclerotinia stem rot disease severity in 2000 and 2001; 2000: least significant difference (LSD)(0.05) = 16.5 and 2001: LSD(0.05) = 20.8 (adapted from: Mueller et al. 2004).

Fungicides. Fungicides inhibit infection and growth of *S. sclerotiorum*, but inhibition occurs in different ways depending on the specific fungicide. Currently, fungicides from three different chemistry classes are registered for Sclerotinia stem rot control in soybean (Table 3). Fungicides in the methyl benzimidazole carbamate class inhibit cell division of the fungus, whereas those in the succinate dehydrogenase inhibitor class inhibit respiration of the fungus. Demethylation inhibitor fungicides inhibit sterol production in the fungus, which is essential for the development of functional cell walls. These fungicide chemistry classes have limited movement (systemicity) in the plant; and none move downward in the plant (Mueller and Bradley 2008). The lack of ability to move upward and downward in plants likely contributes to the inconsistent efficacy on Sclerotinia stem rot observed in field settings with currently registered fungicides.

Herbicides. The labels of herbicides containing lactofen as their active ingredient (Cobra or Phoenix; Valent U.S.A. Corp., Walnut Creek, CA) indicate that they may suppress Sclerotinia stem rot. The herbicides do not directly inhibit *S. sclerotiorum*, but may reduce Sclerotinia stem rot incidence. Lactofen can modify the soybean canopy and delay or reduce flowering, which may result in a less suitable environment or alter the availability of potential infection sites for *S. sclerotiorum* (Nelson et al. 2002a). Lactofen also can induce a systemic acquired resistance response that increases production of antimicrobial chemicals known as phytoalexins (e.g., glyceollin) by the soybean plant (Dann et al. 1999; Nelson et al. 2002a,b; Landini et al. 2003). Phytoalexins can inhibit growth of *S. sclerotiorum* (Sutton and Deverall 1984). Although these herbicides have potential benefits, their use also may result in crop damage that can reduce yields, particularly in those years not conducive for disease (Dann et al. 1999).

Timing. A fungicide should be applied at the proper growth stage to maximize efficacy for Sclerotinia stem rot control. Fungicide applications at the R1 growth stage provide a higher level of control than applications made at the R3 growth stage (Mueller et al. 2004, Fig. 12). Efficacy of fungicides for Sclerotinia stem rot management declines greatly after symptoms are visible on the plants.

Coverage. Adequate plant coverage deep in the soybean canopy where infections start is important for managing Sclerotinia stem rot with foliar fungicides. Flat-fan spray nozzles that produce high-fine to midmedium droplets (0.008–0.016 inches; 200–400 μm) provide the best fungicide coverage of soybean plants (Ozkan et al. 2007). Manufacturers' recommendations for spray volume should be followed. Wind speed and temperature can influence coverage, and spray volume may need to be increased to improve coverage in soybean fields with a thick canopy.

Control Expectations. Complete control of Sclerotinia stem rot by using only chemical management strategies is not attainable, and therefore, it should be considered as only one potential component of an integrated Sclerotinia stem rot management program. Reduction of Sclerotinia stem rot incidence achieved by fungicides in university field trials ranged from 0 to ≈60% (Mueller et al. 2002a, 2004).

Biological Control

Biological control can also be part of an integrated system to manage Sclerotinia stem rot. Biological control agents can be used for both conventional and organic soybean production systems.

The fungus *Coniothyrium minitans* was identified as a pathogen of *Sclerotinia sclerotiorum* in 1947 (Campbell 1947) and is the most widely available and tested biological control organism for managing Sclerotinia stem rot (Fig. 13). It is commercially available as Contans (PROPHYTA Biologischer Pflanzenschutz GmbH; Malchow/Poel, Germany) or KONI (Belchim Crop Protection; Londerzeel, Belgium). *Coniothyrium minitans* should be incorporated into soil as thoroughly as possible to a depth of two inches (5 cm). Application of *C. minitans* should occur a minimum of 3 mo before Sclerotinia stem rot is likely to develop (Crop Data Management Systems, Inc. 2011). This allows adequate time for the fungus to colonize and degrade sclerotia. Degraded sclerotia will not produce apothecia, and therefore will not produce ascospores to initiate infection of soybean. Additional tillage that can bring uncolonized sclerotia to the soil surface should be avoided.

There are limited data available from field studies that document the efficacy of *C. minitans* for management of Sclerotinia stem rot in

Table 3. Products registered in 2011 for suppression or control of Sclerotinia stem rot on soybean

Product type	Chemistry class	Active ingredient	Product name[a]
Fungicide	Methyl benzimidazole carbamate	Thiophanate methyl	Topsin[b] and others
Fungicide	Succinate dehydrogenase inhibitor	Boscalid	Endura
Fungicide	Demethylation inhibitor	Tetraconazole	Domark
Fungicide	Demethylation inhibitor	Prothioconazole	Proline

[a] Check with your local Extension Service or State Department of Agriculture to determine whether a product is registered in your state.

[b] Listing or not listing a particular product or manufacturer is neither an endorsement or a disavowal. Manufacturers: Topsin, United Phosphorus, Inc., King of Prussia, PA; Endura, BASF AgProducts, Research Triangle Park, NC; Domark, Valent U.S.A. Corporation, Walnut Creek, CA; Proline, Bayer Crop Science, Research Triangle Park, NC.

Fig. 13. *C. minitans* has completely enveloped a sclerotium of *S. sclerotiorum* on an agar medium; arrows indicate droplets of *C. minitans* spores (photo: A. J. Peltier).

soybean. Most studies published to date have focused on crops other than soybean. From the limited research, sclerotia numbers have been reduced by as much as 95% and Sclerotinia stem rot incidence has been reduced from 10 to almost 70% (Sesan and Csep 1992, Boland 1997, Zeng 2010, Zeng et al. 2012a). Biological control will not eliminate all sclerotia; plants in fields heavily infested with sclerotia may continue to become infected by *S. sclerotiorum* until the number of sclerotia in the soil is further reduced.

Additional biological control agents such as the bacterium *Streptomyces lydicus* (ActinovateAG; SipcamAdvan, Inc., Durham, NC) and the fungus *Trichoderma harzianum* (PlantShieldHC; BioWorks, Inc., Victor, NY) also have demonstrated promise in the management of Sclerotinia stem rot in limited field trials and growth chamber studies (Zeng et al. 2012a,b). More studies are needed to measure the efficacy of biological control products and their potential to reduce Sclerotinia stem rot of soybean, especially in fields with native populations of biological control fungi.

Overall Recommendations for Managing Sclerotinia Stem Rot

In years such as 2009, where there are large yield losses because of Sclerotinia stem rot over a broad geographical area in the midwestern United States, the number of management-related questions for this disease increases. An overarching challenge for managing Sclerotinia stem rot is that although certain areas of the main soybean production regions of the United States experience some level of the disease annually, the effects are not yield-limiting over large areas in most years. Thus, soybean producers have a tendency to ignore managing this disease until the next epidemic occurs. Two scenarios likely describe the position of many producers that have experienced yield losses because of Sclerotinia stem rot: 1) Those that do not want to change their management system in the attempt to reduce this disease, and 2) Those that have decided to plant a particular variety that is susceptible to Sclerotinia stem rot. Producers in scenario one should work to choose a partially resistant soybean cultivar and those in scenario two should work to adapt their management practices to reduce disease potential.

Core management for Sclerotinia stem rot begins with maintaining good field records of disease incidence over time. Soybean cultivar is critical and should be selected based on the best available level of resistance and maturity group for the production region. Cultural management practices such as reducing plant populations, increasing row width, rotating crops to nonhosts, altering tillage practices, and using cover crops can help to reduce the risk of disease development. Foliar-applied chemicals (fungicides, herbicides, or both) may be warranted in some years, especially in fields with a history of Sclerotinia stem rot. However, efficacy of foliar fungicides can be variable. Long-term management can include the use of biological control. The use of an integrated strategy for Sclerotinia stem rot offers the best chance for reducing yield loss because of this disease.

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