Identify and Control Lettuce Fungus in Gardens and on Small Farms

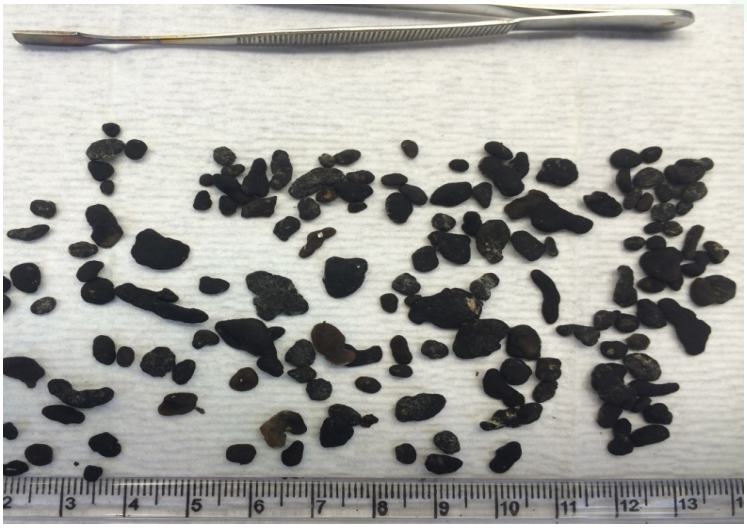

Photo 1. Initial symptoms of lettuce drop on variety 'Rex' (left) and sclerotia of *Sclerotinia sclerotiorum* (right) from heavily diseased high tunnel lettuce grown in Missouri. (All photos by Z. Mersha)

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LUCE FS#05-D-2017
01/20/2017

Biology and life cycle of the lettuce drop fungi

The fungal pathogens (harmful microbes/organisms that cause disease) in the genus *Sclerotinia* cause diseases on a wide range of crops. These diseases are difficult to cure. Lettuce is affected by two of these *Sclerotinia* species: *S. sclerotiorum* and *S. minor*. Both species can exist in the same field. A farm might have more of one or the other of these species at a given time. They grow when the weather favors them and also, more importantly, based on a farm's crop history. *S. minor* is not a common problem of lettuce in Missouri. In contrast, *S. sclerotiorum* affects many vegetables and also grain crops in Missouri, including soybeans.

On lettuce, the type of damage caused by these fungi has two phases, depending on when it starts. The first is the damping-off phase. It attacks the seedlings. The second is the field phase. It causes a watery, soft rot of the lower leaves and crown (Photo 1, above, left). This is followed by wilting and limping that leads to an obvious symptom, commonly referred to as "drop." Lettuce drop caused by *Sclerotinia* is a serious problem of lettuce production worldwide. Both species produce black, hard, seed-like resting bodies called sclerotia (singular: sclerotium) on the lower surface of the leaves touching the soil, around the crown and on the upper portion of the taproots. Sclerotia can survive in the soil for up to 8-10 years. At times, both *Sclerotinia* species can also survive as active mycelium (the branching part of a fungus) in diseased or dead lettuce plants. Sclerotia of *S. minor* are small (1/16 to 1/8 inch) and irregular in shape. In contrast, sclerotia of *S. sclerotiorum* are larger (½ to 1 inch). They are oblong or irregular, with a shape like rodent droppings (Photo 1, above, right).

What are the symptoms and signs of lettuce drop?

The first symptom of lettuce drop is that the outermost layer of leaves wilts. This is usually seen as the crop nears maturity. This symptom reveals that the crown is infected. As the infec-

tion progresses, the crown will develop a brown, soft, watery decay. This is followed by the growth of a snowy white mycelium. Over time, it destroys the tissue and causes the entire plant to wilt (Photos 2 and 3). Collapsed plants cannot be harvested (Photo 4). There are two typical signs of drop disease. One is white, fluffy, cottony mycelial growth during cool and moist weather. The other is the growth of black sclerotial bodies on the undersides of leaves and in the crown (Photo 4). With *S. minor*, only the white mycelium and small, black sclerotia are formed. *S. sclerotiorum* can also produce a mushroom-like structure called an apothecium. It emerges from the sclerotia and produces ascospores. These ascospores disperse in the air and can cause infections on the tops of lettuce plants.

Photo 2. Signs of Sclerotinia on the bottom of lettuce leaves and in the crown area.

If you are you unsure about what is killing your lettuce, check for the initial symptoms on the bottom leaves and in the crown area. Keep a suspect plant in a plastic bag with a paper towel overnight to see if fluffy mycelial growth appears (see Photo 2).

Photo 3. Typical fluffy mycelium of lettuce drop and sclerotia of *S. sclerotiorum* seen when the fluffy mass of an infected red oak leaf lettuce plant is removed.

Photo 4. Contrast of healthy red oak leaf lettuce (above, left) and green oak leaf lettuce with the symptoms of lettuce drop (above, right), both grown in a high tunnel.

Photo 5. Signs of the fluffy mycelium of the *Sclerotinia* fungus shown causing crown and stem rot on the crown and stem of high tunnel kale grown in Central Missouri.

Under what conditions does the pathogen thrive?

Sclerotia are the hard bodies produced by both *Sclerotinia* species. The sclerotia allow the lettuce drop pathogens to survive in the soil. *S. sclerotiorum* is the fungus that causes lettuce drop in Missouri. If the soil is saturated for two or more weeks, the sclerotia of *S. sclerotiorum* will germinate. Temperatures between 59° and 71°F are ideal for the growth of this fungus. Thus, cool, damp conditions help the disease develop. Lettuce is a cool season crop in Missouri. As such, plantings in protected systems (tunnels, greenhouses) from fall to early spring are at high risk.

How to manage lettuce drop

1. **Scout for and discard infected plants:** Infected plants must be detected as early as possible. Discard them before they form sclerotia. Remember that once formed, sclerotia can stay in the soil for 8-10 years.

2. **Remove and destroy crop residue:** As much as possible, remove and destroy all litter and infected plant parts from previous crops. Do not discard infected material at the field edge as it can blow back into the field.

3. **Avoid planting after other known hosts:** Where feasible, rotate with non-hosts, such as small grains. Some possible rotation crops include onion, spinach or small grains or grasses. Few examples of crop hosts highly susceptible to diseases caused by *Sclerotinia* include beans, cauliflower, celery, endive, escarole, fennel, peppers, radicchio and tomato. On tomatoes, *S. sclerotiorum* causes a disease called timber rot. Avoid the following cover crops: Australian winter pea, mustards, phacelia and vetch.

4. **Moisture management:** Manage irrigation to avoid overly wet soils that can foster *Sclerotinia* growth. The use of subsurface drip irrigation might reduce the lettuce drop severity. Level your farmland and evenly distribute water. Also, assure good drainage by having your beds as high as possible. Flooding the soil when the ground is not in production could also help to reduce the survival of sclerotia, especially those of *S. minor*.

5. **Avoid crowding plants:** Crowding lettuce plants in the field, high tunnel or greenhouse can create a fertile ground for lettuce drop outbreaks. Open up space randomly throughout the beds during harvesting to improve ventilation. This greatly reduces the plant-to-plant contact. Hence, it slows the spread of the disease. In addition, lettuce planted in narrower beds might have a lower rate of drop than lettuce planted in wide beds.

6. **Nutrient management:** Avoid overly lush growth by using the optimal fertilizer level.

7. **Deep (inversion) plowing:** You can invert and bury the top layers of the soil using moldboard plows. This might provide enough control in fields with low sclerotial densities. Some research has shown that deeply buried sclerotia will die over time. Or, it might not be able to reach the lettuce plant. This will reduce the rate of infection.

8. **Soil fumigation:** Soil-applied fumigants can reduce the number of sclerotia. However, such treatments are usually not cost-effective due to the high price of fumigants. Also, fumigants might not be the best choice because they are toxic and safety regulations must be followed.

9. **Resistant varieties:** Breeding efforts are underway, but truly resistant varieties are not yet available. Varieties with upright growth and leaves that are elevated from the soil might suffer less severe lettuce drop.

10. **Biological control:** Contans® WG at 1-4 lbs. per acre is an OMRI (Organic Material Review Institute)-approved product. It is recommended for many *Sclerotinia* diseases, including lettuce drop. It is also widely used to control white mold on beans. Contans®, whose active ingredient is the beneficial fungus *Coniothyrium minitans*, is applied with conventional spray equipment directly to the soil surface at planting. To read the product label, follow this link: http://www.cdms.net/ldat/ld5SH001.pdf. Since the active ingredient of Contans® WG is a biological organism, its effectiveness depends on how the product is stored and applied. It has a short shelf life. Also, it must be kept at a cool temperature. Prepare the area ahead of time. Success depends on a few factors. One is the proper timing of the application. Another is the optimum soil moisture; the soil cannot be too dry. The third factor is the thoroughness of the coverage.

Photo 6. Pilot projects using the biofungicide Contans® WG in high tunnels in Missouri. Left: Lettuce in a high tunnel with about 25 percent lettuce drop incidence in April 2014. Middle: Contans® WG sprayed in a high tunnel near sunset. Right: The same high tunnel after two applications of Contans® WG (2 lbs. per acre) planted with lettuce in November 2014.

11. **Conventional fungicides (for nonorganic farms):** A significant reduction in lettuce drop was reported by applying fungicides during the rosette stage (about 30-40 days before harvest). A split application of fungicides results in even better control. However, fungicides applied after thinning do not usually reduce lettuce drop caused by *S. sclerotiorum*. The Midwest Vegetable Production Guide for Commercial Growers 2016 (Egel et al. 2016) recommends the following products against lettuce drop for conventional growers: Botran® 75W or Botran® 5F (rate varies by application method), Endura® 70WG (8-11 oz. per acre), Fontelis® (16-24 fl. oz. per acre), Merivon® (8-11 fl. oz. per acre) and Switch® 62.5WG (11-14 oz. per acre). Pay attention to the pre-harvest interval (PHI) of each product. For *S. minor*, fungicides applied right after thinning and cultivation (at 4-6 true-leaf stages) have greatly reduced the amount of lettuce drop.

12. **Integrated lettuce drop management:** An integrated approach involves using the multiple strategies listed above. By doing so, the disease will be managed early and will increase productivity and profitability. *Sclerotinia* diseases are difficult to combat. Depending on the season, location and number of sclerotia, it is best to use as many compatible methods as possible. For detailed information on integrated approaches, refer to Subbarao (1998).

Before applying any product, do the following. First, read the label to be sure that the product can be used for the crop and the disease you intend to control. Second, read and understand the safety precautions and application restrictions. Finally, organic growers must make sure that the brand name product is listed in your Organic System Plan and approved by your certifier.

Note: Trade names in this publication are used solely for the purpose of providing specific information. Such use herein is not a guarantee or warranty of the products named. It also does not signify that they are approved to the exclusion of others. Mention of a proprietary product does not constitute an endorsement nor does it imply a lack of efficacy of similar products not mentioned. Do not use any of the products unless they are registered for the given crop in your state.

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