Evaluation of tactics to optimize control of Sclerotinia drop and other lettuce diseases initiated by soil-borne fungi

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Sclerotinia drop, caused by the fungi *Sclerotinia minor* and *Sclerotinia sclerotiorum*, is an annual concern to Arizona lettuce producers. As with most diseases caused by fungi, disease severity and resultant crop losses are dependent on environmental conditions. Management strategies for Sclerotinia drop on lettuce are heavily reliant upon conventional fungicides, such as Endura (boscalid) and Rovral (iprodione), and products containing biologically active ingredients, such as Contans (*Coniothyrium minitans*). The labels for these products usually recommend two applications of products to the soil bed for optimum disease control. *Sclerotinia minor* and *S. sclerotiorum* reside in the soil and efforts to achieve consistently high levels of Sclerotinia drop control have been elusive. In field trials conducted from 2001 through 2006, the average reduction of dead lettuce plants in plots infested with *S. minor* was 53, 35 and 32% with two applications of Endura, Rovral and Contans, respectively. For plots infested with *S. sclerotiorum*, the average reduction in diseased (dead) plants was 33, 38 and 52% with two applications of Endura, Rovral and Contans, respectively. Can we do better than this? Results from our 2007 Sclerotinia drop trial suggest that the answer is yes. For example, a single application of Omega (fluazinam), a new fungicide expected to be registered for use on lettuce in the near future, resulted in disease control of 76 and 72% in plots infested with *S. minor* and *S. sclerotiorum*, respectively. Also, incorporation of Endura into beds reduced the incidence of disease caused by *S. minor* and *S. sclerotiorum* by 69 and 66%, respectively, compared to a 64 and 59% reduction in disease for this product applied to the soil surface without incorporation. Building on the preliminary disease control results from the 2007 trial, an additional experiment was conducted during the 2008 lettuce production season to further evaluate these promising treatments for Sclerotinia drop.

Previous studies funded by the Arizona Iceberg Lettuce Research Council have demonstrated the ability of soil solarization to significantly reduce the incidence of Fusarium wilt when a lettuce field is heavily infested with this pathogen. Soil solarization in other regions has been shown to effectively control *Sclerotinia minor* and *Rhizoctonia solani*, respective causal agents for Sclerotinia drop and bottom rot. It is unclear or unknown how soil solarization would affect sclerotia of *Sclerotinia sclerotiorum*, the other pathogen responsible for causing Sclerotinia drop in Arizona. Since soil solarization incurs costs in terms of time and money, data relating to the efficacy of this soil treatment on subsequent development of Sclerotinia drop caused by both species of *Sclerotinia* as well as bottom rot would be extremely useful not only to growers that may use soil solarization as a management tool for Fusarium wilt but also for those that may want to consider using this soil treatment to control soil-borne disease pathogens when *Fusarium* is not present. A solarization trial was conducted in the summer of 2008 to evaluate the effectiveness of soil solarization in reducing the populations of the soil-borne pathogens *Sclerotinia minor*, *S. sclerotiorum*, and *Rhizoctonia solani*. Additionally, we examined the effect of soil solarization on the subsequent growth of lettuce in treated and nontreated plots.

Managing Sclerotinia drop with fungicides. This study was conducted at the University of Arizona Yuma Valley Agricultural Center. Lettuce 'Winterhaven' was seeded, then irrigated to germinate seed on Nov 3, 2008 on double rows 12 inches apart on beds with 40 inches between bed centers. Treatments were replicated five times in a randomized complete block design. Each replicate consisted of 25 ft of bed, which contained two 25 ft rows of lettuce. Plants were thinned at the 3-4 leaf stage to a 12 inch spacing Dec 12, followed by the addition of sclerotia of each species of *Sclerotinia* into test plots. For plots infested with *Sclerotinia minor*, 0.13 oz (3.6 grams) of sclerotia were distributed evenly on the surface of each 25-ft-long plot between the rows of lettuce and incorporated into the top 1 inch layer of soil. For plots infested with *Sclerotinia sclerotiorum*, 0.5 pint of a dried mixture of sclerotia and infested barley grain was broadcast evenly over the surface of each 25-ft-long lettuce plot, again between the rows of lettuce on each bed, and incorporated into the top 1-inch layer of soil. Treatment beds were separated by single nontreated beds. Product application methods included spraying onto the bed surface, spraying onto the bed surface followed by incorporation of the material into the soil to a depth of 1 inch by a cultivation tool, or application as a drench between the two rows of lettuce in 1.0 gallon of water. Test materials were applied to the plots on Dec 15, 2008 and after the last bed cultivation on Jan 5, 2009. Furrow irrigations supplied water for crop growth. The severity of disease was determined at plant maturity (Mar 2) by recording the number of dead and dying plants in each plot. The original stand of lettuce was thinned to 50 plants per plot.

Compared to nontreated plots in this 2008 trial, the mean number of diseased plants in plots containing *S. minor* was reduced 82% by one application of fluazinam to the soil surface, 68% by two applications of boscalid incorporated into soil to a depth of 1 inch, and 58% after two applications of boscalid applied to the soil surface without incorporation. With *S. sclerotiorum*, disease reduction was 73% for one application of fluazinam, 66 and 64% after two applications of boscalid and iprodione, respectively, incorporated into soil, and 51 and 48% after two respective applications of boscalid and iprodione to the soil surface. When applied to the soil surface and incorporated into the soil with water as a drench, *Coniothyrium minitans* reduced the number of plants infected by *S. minor* and *S. sclerotiorum* by 38 and 90%, respectively.

The results from the 2008 field trial are similar to the findings from the trial in 2007. Considering the two trials together, one application of fluazinam reduced the incidence of Sclerotinia drop by at least 70%, suggesting that this compound will be a very effective disease management tool when it becomes registered on lettuce. Incorporation of boscalid into beds reduced the incidence of disease caused by *S. minor* and *S. sclerotiorum* by 68 and 66%, respectively, compared to a 61 and 55% reduction in disease for boscalid applied to the soil surface without incorporation. Finally, two applications of the biological material Contans reduced Sclerotinia drop caused by *S. minor* and *S. sclerotiorum* by 43 and 76%, respectively. Products and methods of application have been identified that potentially can raise the level of control of Sclerotinia drop from the range of 32 to 52% achieved in older trials to levels approaching or exceeding 70%. This should be welcome news to lettuce growers contending with this economically important disease on lettuce.

Solarization as a disease management tool. A one-acre field at the University of Arizona Yuma Agricultural Center contained beds that were naturally infested with sclerotia of *Sclerotinia minor* or *S. sclerotiorum* as a result of an earlier research project. Beds used to grow the previous crop of lettuce were cultivated and shaped, then sclerotia of the two species of *Sclerotinia* as well as inoculum of *Rhizoctonia solani* on barley grain were buried in plots within nylon mesh bags 2- and 4-inch depths on July 30, 2008, followed by a furrow irrigation to totally wet the beds. On August 4, five 100-ft lengths of bed infested with *S. minor* and other five beds infested with *S. sclerotiorum* (containing sclerotia from an earlier research project as well as *Sclerotinia* and *Rhizoctonia* within nylon mesh bags) were covered with a 1-mil thick sheet of plastic film routinely used for soil solarization. Five additional beds of the same length infested with either pathogen were not covered with plastic and served as controls. The solarization treatment period ran from August 4 to October 15. After the plastic was removed, sclerotia of *Sclerotinia* and inoculum of *Rhizoctonia* buried in nylon mesh bags were recovered and tested for viability in the laboratory. Solarized and nonsolarized beds then were planted to lettuce, which was grown to maturity. Development of Sclerotinia drop in solarized and nonsolarized plots was recorded. Soil temperature at the 2- and 4-inch depth was recorded for the duration of the solarization period and soil moisture was assessed on September 21.

The objective of this trial was to compare the viability of *S. minor* and *S. sclerotiorum* sclerotia and inoculum of *Rhizoctonia solani* in solarized compared to nonsolarized plots. In this experiment, none of the sclerotia of either species of *Sclerotinia* or inoculum of *R. solani* on barley grain germinated after burial in solarized or nonsolarized plots for a 10-week period of time. In comparison, 100% of the sclerotia of both *Sclerotinia* species as well as inoculum of *R. solani* germinated when maintained in the laboratory at 75EF. Soil temperature in solarized beds at the 2-inch depth during August and September ranged from 80 to 128EF (mean of 105EF), whereas soil temperatures at the same depth in nonsolarized beds ranged from 65 to 102EF (mean of 85EF). The average soil moisture content on September 21 at the 2- to 4-inch depth was 22 and 11% in solarized and nonsolarized beds, respectively. Furthermore, Sclerotinia drop did not develop on any of the lettuce planted in solarized and nonsolarized plants. Young developing lettuce plants in solarized beds were visually larger than plants in nonsolarized beds; however, this difference diminished as plants reached maturity.

Data from this trial suggest that soil temperature and moisture levels in nonsolarized plots were sufficient to bring about complete destruction of sclerotia of *S. minor* and *S. sclerotiorum* and inoculum of *R. solani* and subsequently prevent development of Sclerotinia drop in the subsequent crop of lettuce. This is the first trial in which the viability of inoculum of *R. solani* was assessed; however these results are in line with earlier studies that demonstrated a progressively increasing reduction in viability of sclerotia of *S. minor* and *S. sclerotiorum* as the duration of time in irrigated soil increased from 2 to 8 weeks during the summer. The results of this trial as well as the earlier work would suggest that the extra effort and expense of solarization using a plastic film is not required to destroy sclerotia of *S. minor* and *S. sclerotiorum* remaining in soil following an outbreak of Sclerotinia drop in southwestern Arizona lettuce production fields. On the other hand, results with *R. solani* should be considered preliminary in nature until confirmed by additional studies.