ARIZONA ICEBERG LETTUCE RESEARCH COUNCIL

FINAL REPORT

Project title: Effect of reduced water usage during summer soil flooding to manage Sclerotinia drop on lettuce, 2014

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Introduction

Several years ago the Arizona Iceberg Lettuce Research Council helped fund research to evaluate potential cultural methods for reducing populations of *Sclerotinia minor* and *S. sclerotiorum* in soil. These fungi are the soil-borne pathogens responsible for lettuce drop. Our research demonstrated that flooding soil for at least 3-weeks in the summer destroyed virtually all of the resistant structures (sclerotia) of both pathogens, suggesting a highly effective cultural means of managing lettuce drop. This summer soil flooding technique is now being used to manage lettuce drop. However, there are concerns that extensive flooding of soil may be adversely affecting the water table and damaging drainage infrastructure.

Currently, fungicides generally reduce the number of lettuce plants lost to lettuce drop by about 50 to 60% at best compared to nontreated plants. The ability of summer soil flooding to virtually eradicate the lettuce drop pathogens from soil is a valuable disease management tool for growers. Although summer soil flooding may not be appropriate for all ground planted to lettuce, it is an important component of an effective integrated management program for lettuce drop. However, there is an urgent need to further define the method of water delivery and the duration of soil wetness required to destroy sclerotia of *S. minor* and *S. sclerotiorum* in soil.

The specific objective of this research was to examine the effect of different methods of applying water and the duration of soil wetness on the resultant proportion of sclerotia of *S. minor* and *S. sclerotiorum* that were destroyed. Specifically, for 1-, 2-, or 3-week periods of time, we compared continuous maintenance of surface water on soil to application of water for shorter time intervals. This work was initially funded by the Arizona Iceberg Lettuce Research Council (AILRC) and conducted in 2013. This report includes data from that trial as well as two additional field trials conducted in 2014 and 2015, both funded with a grant provided by AILRC in 2014 with an extension allowing a trial in 2015 as well.

Materials and Methods

Plots 10 feet wide and 60 feet long were established at The University of Arizona Yuma Agricultural Center during July-August, 2013, 2014, and 2015. Sclerotia of *S. minor* and *S. sclerotiorum* were produced in the laboratory. Packets made from shade cloth and each containing 15 sclerotia of *S. minor* or *S. sclerotiorum* were placed at depths of 0, 2, and 4 inches in soil within plots. Five replicate packets of sclerotia for each pathogen at each depth were placed into each plot listed below. The soil in plots was subjected to one of the following irrigation regimes.

1. Apply and maintain water for 1 week.
2. Apply and maintain water for 2 weeks.
3. Apply and maintain water for 3 weeks.
4. Apply and maintain water for 8 hours in the first week.
5. Apply and maintain water for 8 hours in the first and second weeks.
6. Apply and maintain water for 8 hours in the first, second, and third weeks.
7. Apply and maintain water for 8 hours twice a week (Monday & Thursday or Tuesday & Friday)

for 3 weeks.

8. No irrigation.

When water was applied to plots, at least 1-inch of free water was maintained on the soil surface for the duration of each flooding period. At the conclusion of the 3-week irrigation treatments, packets containing sclerotia were recovered from the field once soil in all plots had dried sufficiently. In the laboratory, 10 sclerotia from each packet were washed, surface-sterilized in solutions of alcohol and bleach, then placed onto acidified potato dextrose agar within pertri dishes (five sclerotia per dish) to determine the percentage of sclerotia that were able to germinate and produce mycelium and daughter sclerotia. Specific beginning and termination dates for each field trial and recorded rainfall is presented in Table 1. Soil temperatures recorded in the plot flooded for 3 weeks and in the nonflooded plot for each trial is found in Table 2. For each of the three field trials, analysis of germination data for sclerotia placed in soil at a depth of 0, 2, and 4 inches revealed no statistically significant differences due to soil depth. Therefore, for each flooding treatment as well as the nonflooded treatment, germination data for the three soil depths were combined before statistical analysis. Also, each of the three field trials was considered a replicate, and the data for each of the three years was combined before statistical analysis of the data.

Results and Discussion

The effect of the various soil flooding treatments on viability of sclerotia of *Sclerotinia minor* and *S. sclerotiorum* is summarized in Table 3. In general, sclerotia of *S. minor* were more susceptible to all tested soil flooding treatments than sclerotia of *S. sclerotiorum*. The combined data for the field trials containing *Sclerotinia minor* reveal that the viability (ability to germinate) of sclerotia from plots flooded continuously for 1, 2, or 3 weeks as well as plots flooded for a single 8-hour period per week for two or three consecutive weeks was statistically lower than sclerotia maintained in soil that was not irrigated. For *Sclerotinia sclerotiorum*, the viability of sclerotia subjected to 1, 2, or 3 weeks of continuous flooding was significantly lower than for sclerotia in all other flooding treatments and the nonflooding treatment.

Visual comparison of data among treatments from yearly trials reveals a large degree of yearly variability in sclerotia germination values for both species of *Sclerotinia*. Possible reasons for this variability may be the occurrence of rainfall in the 2013 and 2014 trials (Table 1), differences in mean soil temperatures among trials (Table 2), likely differences in microbial populations in soil from year to year, as well as other potential unknown factors.

Measured viability of sclerotia for both species of *Sclerotinia* in all field treatments, including the nonflooded treatment, was significantly lower than that recorded for sclerotia maintained in the laboratory (see footnote in Table 3). P. B. Adams noted in a paper published in 1987 that the time required to kill 50% of sclerotia of *Sclerotinia minor* at soil temperatures of 95, 104, 113, and 122°F was 624, 38, 3, and 2 hours, respectively. Maximum soil temperatures recorded in some flooded plots and especially in the nonflooded plots (Table 2) in these trials were high enough to potentially affect the viability of sclerotia. Therefore, the reduced viability of sclerotia recorded in these studies is likely a result of the combined effects of soil moisture and temperature.

Conclusions

The following conclusions can be drawn from the findings in these studies.

- The mean viability of sclerotia of *S. minor* and *S. sclerotiorum* after being in soil for 3 weeks without supplemental irrigation was 31 and 32% respectively, values significantly lower than respective viability values of 94 and 87% for sclerotia maintained in the laboratory.
- The mean viability of sclerotia of both species of *Sclerotinia* after exposure in soil to continuous flooding for 1, 2, or 3 weeks was significantly lower than that recorded for sclerotia in soil for 3 weeks in the summer and not subject to treatment with supplemental irrigation. Additionally, the viability of sclerotia of *S. minor* in plots flooded for a single 8-hour period per week for two or three consecutive weeks was equivalent to scleotia flood continuously from 1 to 3 weeks and statistically lower than sclerotia maintained in soil that was not irrigated.

Reference

Adams, P. B. 1987. Effects of soil temperature, moisture, and depth on survival and activity of *Sclerotinia minor, Sclerotium cepivorum,* and *Sporidesmium sclerotivorum*. Plant Disease 71:170-174.

Table 1. Field trial parameters and recorded rainfall.

Year	Soil flooding		Sclerotia removed from soil	Rainfall (inches)
	Start date	End date		
2013	July 29	August 19	August 27	1.08 Aug 22-26
2014	July 30	August 20	September 12	0.31 Aug 12
2015	July 21	Aug 11	August 27	No rain

Table 2. Minimum and maximum soil temperatures.[1]

Treatment	Soil temperature in °F			
	Minimum		Maximum	
	1.5 inches	3 inches	1.5 inches	3 inches
2013 Flooded plot	84	86	104	98
Nonflooded plot	91	93	120	98
2014 Flooded plot	75	77	95	93
Nonflooded plot	84	88	120	111
2015 Flooded plot	80	80	95	91
Nonflooded plot	95	93	129	115

[1] Mean daily minimum and maximum soil temperature recorded at a depth of 1.5 and 3.0 inches from 2 to 7 days after cessation of flooding in the plot flooded continuously for 3 weeks and in the plot not flooded.

Table 3. Effect of flooding treatment on viability of sclerotia of *Sclerotinia minor* and *S. sclerotiorum*.

Treatment	Percentage of sclerotia that germinated[1]							
	Sclerotinia minor				*Sclerotinia sclerotiorum*			
	2013	2014	2015	Mean[2]	2013	2014	2015	Mean[2]
Soil flooded continuously for 1 week	2.0	0	2.0	**1.0 b**	24.7	0	4.0	**9.6 b**
Soil flooded continuously for 2 weeks	0	0	0	**0 b**	2.7	0	1.3	**1.3 b**
Soil flooded continuously for 3 weeks	0	0	0	**0 b**	9.3	0	0	**3.1 b**
Soil flooded for one 8 hour period in 1st week of trial	13.3	0	6.7	**7.0 ab**	61.3	12.7	10.0	**28.0 a**
Soil flooded for one 8 hour period in 1st and 2nd weeks of trial	6.7	0	2.0	**3.0 b**	77.3	14.7	12.0	**34.7 a**
Soil flooded for one 8 hour period in 1st, 2nd, and 3rd weeks of trial	1.3	2.0	7.3	**4.0 b**	84.0	16.0	16.0	**38.7 a**
Soil flooded for 8 hours, twice a week, for three weeks	1.5	0	0	**5.0 ab**	84.0	21.3	11.3	**38.9 a**
Soil not flooded	10.0	2.7	80.0	**31.0 a**	18.7	22.0	56.0	**32.2 a**

[1] Each value is the percentage of 150 sclerotia of *S. minor* or *S. sclerotiorum* subjected to each treatment that germinated when placed on agar medium supporting their growth. **Percent germination for sclerotia of *S. minor* and *S. sclerotiorum* maintained in the laboratory at 75°F was 94% and 87%, respectively.**

[2] Each value is the mean percentage of sclerotia that germinated from the combined data from three field trials conducted in 2013, 2014, and 2015. Mean values within a column followed by a different letter are significantly different (P = 0.05) according to the Tukey Test.