Examination of Soil Solarization as a Management Tool for Fusarium Wilt of Lettuce: 2005 Field Trial

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Abstract

Fusarium wilt of lettuce was first recognized in Arizona in 2001. Since this first discovery, the pathogen, Fusarium oxysporum f.sp. lactucae (Fol), has been recovered from infected lettuce plants from approximately 30 different fields. This fungus is a soil-borne pathogen that can remain viable in soil for many years. Cultural disease control measures, such as extended soil flooding and soil solarization, have shown promise in managing Fusarium wilt in other cropping systems. The specific research objective during the 2005 growing season was to further evaluate the effect of preplant solarization of planting beds on subsequent development of Fusarium wilt on lettuce. There was no significant difference between the short (28 days) and long (56 days) solarization period in the subsequent number of diseased lettuce plants; therefore, the disease incidence values for both solarization periods were combined and compared to nonsolarized plots. At each data collection date, the number of lettuce plants showing symptoms of Fusarium wilt was significantly lower in solarized beds compared to nonsolarized beds. At plant maturity (Nov 18), Fusarium wilt had claimed virtually all lettuce plants of the cultivar 'Lighthouse' growing in nonsolarized soil; however, only 19% of lettuce plants of the same cultivar growing in solarized soil showed disease symptoms. This equates to an 81% reduction in diseased plants in solarized soil compared to nonsolarized soil. The results of this field trial suggest that a 30-day summer solarization treatment of lettuce beds can significantly reduce the inoculum of Fusarium oxysporum f. sp. lactucae to levels that would allow substantial growth of a susceptible lettuce cultivar. Additional field studies are needed to refine the solarization process to potentially achieve further increases in efficiency of destroying propagules of Fusarium oxysporum f. sp. lactucae in infested fields.

Introduction

Fusarium wilt of lettuce was first recognized in Arizona in 2001. Since this first discovery, the pathogen, *Fusarium oxysporum* f.sp. *lactucae* (*Fol*), has been recovered from infected lettuce plants from approximately 30 different fields. This fungus is a soil-borne pathogen that can remain viable in soil for many years. Development of disease management strategies for Fusarium wilt will be a formidable challenge. Historically, Fusarium wilt on crops other than lettuce, such as tomatoes and melons, has been successfully managed by developing and planting cultivars resistant to the fungal pathogen. In the long term, development of lettuce cultivars with

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resistance to (*Fol*) would be highly desirable. As the development of such resistant cultivars may take considerable time, more immediate disease management tools are needed.

Cultural disease control measures, such as extended soil flooding and soil solarization, have shown promise in managing Fusarium wilt in other cropping systems. A preliminary evaluation of soil flooding and soil solarization on subsequent activity of (*Fol*) was conducted in 2003. Naturally infested soil was placed in containers (5-gallon buckets) that were buried in a field at the Yuma Mesa Agricultural Center so that the upper lip of each bucket was level with the soil surface. In the soil saturation trial, the soil in the buckets was maintained in a saturated state (flooded) for 15, 30, 45 or 60 days, then bioassayed for the presence of *Fusarium oxysporum* f.sp. *lactucae* by sowing and growing lettuce plants within treated soil. For the soil solarization trial, soil in each bucket was thoroughly irrigated, covered with clear plastic for15, 30, 45 or 60 days, then bioassayed for the presence of *Fusarium*. The severity of foliar and root symptoms were significantly lower, whereas the fresh weight was significantly higher for lettuce plants grown in soil that was flooded or solarized, compared to plants grown in soil not subjected to these treatments.

The specific research objective during the 2005 growing season was to further evaluate the effect of preplant solarization of planting beds on subsequent development of Fusarium wilt on lettuce.

Materials and Methods

The effect of a preplant treatment of planting beds with soil solarization was studied in a five-acre field in Wellton, AZ, previously cropped to lettuce during the 2004-05 season and naturally infested with *Fusarium oxysporum* f.sp. *lactucae*. After the lettuce crop, wheat was grown in this field. After harvest, the wheat residue was incorporated into the soil and the field was irrigated during the last week in Jun. Beds with 42 inches between bed centers were prepared and five 100-ft. lengths of bed were covered with clear plastic on Jul 7, whereas another five beds of the same length were not covered with clear plastic and served as controls. On Aug 4, the plastic cover was removed from a 50-ft length of each bed. On Sep 1, the remaining plastic was removed from all plots. Soil temperature was recorded at a depth of 2 and 9 inches in beds covered with plastic as well as in beds without plastic. All beds subsequently were planted to lettuce (cultivar Lighthouse) on Sep 13. The incidence of Fusarium wilt was recorded Oct 12, Oct 24 and at plant maturity on Nov 18, 2005.

Results and Discussion

During the solarization treatment from Jul 7 to Aug 4, the range (and mean) of soil temperatures at a depth of 2 and 9 inches was 89 to 146°F (120°F) and 92 to 103°F (96°F), respectively. For the longer solarization period (Jul 7 to Sep 1), the range (and mean) of soil temperatures at a depth of 2 and 9 inches was 89 to 146°F (110°F) and 87 to 103°F (96°F) respectively. By comparison, in beds not covered with plastic, the range (and mean) of soil temperature from July 7 to September 1at a depth of 2 and 9 inches was 77 to 125°F (101°F) and 88 to 108°F (100°F), respectively.

There was no significant difference between the short (28 days) and long (56 days) solarization period in the subsequent number of diseased lettuce plants. The mean number of diseased lettuce plants in the 28 day and 56 day solarization plots was 3.6 and 2.2, respectively, on Oct 24 and 19.8 and 18.2, respectively, at plant maturity on Nov 18; therefore, the disease incidence values for both solarization periods were combined and compared to nonsolarized plots (Table). At each data collection date, the number of lettuce plants infected with Fusarium wilt was significantly lower in solarized beds compared to nonsolarized beds. At plant maturity (Nov 18), Fusarium wilt had claimed virtually all lettuce plants of the cultivar 'Lighthouse' growing in nonsolarized soil; however, only 19% of lettuce plants of the same cultivar growing in solarized soil showed disease symptoms. This equates to an 81% reduction in diseased plants in solarized soil compared to nonsolarized soil.

The results of this field trial suggest that a 30-day summer solarization treatment of lettuce beds can significantly reduce the inoculum of *Fusarium oxysporum* f. sp. *lactucae* to levels that would allow substantial growth of a susceptible lettuce cultivar. The 81% reduction in diseased plants achieved this year is an improvement over the 42% disease reduction recorded in the solarization trial conducted in 2004. Additional field studies are needed to refine the solarization process to potentially achieve further increases in our efficiency of destroying propagules of *Fusarium oxysporum* f. sp. *lactucae* in infested fields.

Effect of preplant solarization of beds on subsequent incidence of Fusarium wilt on lettuce.

Treatment	Number of diseased lettuce plants [1]			Percentage of lettuce plants diseased [2]		
	Oct 12	Oct 24	Nov 18	Oct 12	Oct 24	Nov 18
Nonsolarized beds	25	74	203	12.2	36.3	99.5
Solarized beds [3]	0	6	38	0	2.9	18.6

1	Each plant within a plot was determined to be diseased if the plant was dead or stunted and displayed the typical wilting and yellowing associated with Fusarium wilt of lettuce. Each value is the mean number of diseased lettuce plants from five 100-ft long lengths of bed. For all three data collection dates, Oct 12, Oct 24 and Nov 18 (plant maturity), the number of plants infected with Fusarium wilt was significantly lower in solarized beds compared to nonsolarized beds.
2	The mean stand count was 204 lettuce plants per plot.
3	These are the combined values from plots solarized for 28 and 56 days, as there was no significant difference between the two solarization periods on the subsequent number of diseased lettuce plants.