Development of effective management tools for Fusarium wilt of lettuce: 2005 field trial

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Introduction

Fusarium wilt of lettuce was first recognized in Arizona in 2001. Since this first discovery, the pathogen, *Fusarium oxysporum* f.sp. *lactucae*, has been recovered from infected lettuce plants from at least 30 different fields. This fungus is a soil-borne pathogen that can remain viable in soil for many years. 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 resistance to *Fusarium oxysporum* f.sp. *lactucae* would be highly desirable. As the development of such resistant cultivars will take time, more immediate disease management tools are needed. Large scale field trials were conducted during the 2002-03 and 2003-04 production seasons to evaluate existing lettuce cultivars for their relative susceptibility to Fusarium wilt. The main findings from these trials are summarized below.

1. Among virtually all tested lettuce cultivars, the severity of disease in the early-season planting window (early September) was much higher than that observed in the mid-season planting window (mid October), which in turn was higher than that observed in the late-season planting window (early December). One likely reason for the differences in severity of Fusarium wilt among planting dates was soil temperature. For example, in 2002-03 the average daily soil temperature at the 4-inch depth ranged from 65 to 85°F, 55 to 74°F, and 48 to 64°F for the early-, mid- and late-season plantings, respectively.

2. In all three plantings, differences in disease severity were detected among the different types of lettuce, with head lettuce being most susceptible and romaine demonstrating the highest level of tolerance.

3. The observed degree of disease tolerance for specific cultivars was dependent on the disease pressure experienced by the plants, which in turn was related to the time of planting. Of 11 head lettuce cultivars tested in both the first (high disease pressure) and second (moderate disease pressure) plantings during 2002-03, the lowest disease rating was 32% and 4%, respectively. Similar results were observed for romaine, green leaf and red leaf lettuce.

4. Disease development began at the seedling stage and continued up to plant maturity, demonstrating the benefit of evaluating lettuce resistance in the field compared to greenhouse studies where plants are usually not carried to maturity before final disease ratings are performed.

Cultural disease control measures, such as extended soil flooding and soil solarization, have shown promise in managing Fusarium wilt in other cropping systems. The effect of soil flooding and soil solarization on subsequent activity of *Fusarium oxysporum* f.sp. *lactucae* was examined in 2003 and in 2004. 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 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 oxysporum* f.sp. *lactucae*. In both years, the severity of foliar and root symptoms of Fusarium wilt 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. Additionally, following a 40-day solarization treatment of soil in the field in 2004, the incidence of Fusarium wilt with the cultivar 'Lighthouse' was reduced 42% compared to plants growing in nonsolarized beds.

The fungicides Topsin-M (thiophanate-methyl), Medallion (fludioxonil) and Pristine (boscalid+pyraclostrobin) were evaluated in 2003 for efficacy in reducing the incidence of Fusarium wilt in field trials. None of these compounds reduced disease levels when applied at seeding and 1- and 2-months later. On the other hand, preplant application of Vapam at rates ranging from 30 to 60 gal./acre in 2004 resulted in a 44% average reduction in disease incidence on the cultivar 'Lighthouse' compared to plants grown in nontreated soil.

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 June. Beds with 42 inches between bed centers were prepared and five 100-ft. lengths of bed were covered with clear plastic on July 7, whereas another five beds of the same length were not covered with clear plastic and served as controls. On August 4, the plastic cover was removed from a 50-ft length of each bed. On September 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 September 13. The incidence of Fusarium wilt was recorded October 12, October 24 and at plant maturity on November 18, 2005.

Results and Discussion

During the solarization treatment from July 7 to August 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 (July 7 to September 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 1). 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.

Table 1. Effect of preplant solarization of beds on subsequent incidence of Fusarium wilt on lettuce.

Treatment	Number of diseased lettuce plants [x]			Percentage of lettuce plants diseased [y]		
	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 [z]	0	6	38	0	2.9	18.6

[X] 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.

[Y] The mean stand count was 204 lettuce plants per plot.

[Z] 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.