



# Biology and Management of Fusarium Wilt of Lettuce

Michael E. Matheron

## Characteristics of the plant pathogen

Fusarium wilt of lettuce (Figure 1) is caused by the soil-borne fungus *Fusarium oxysporum* f. sp. *lactucae*. This particular form of *Fusarium oxysporum* is known to cause disease and visible symptoms only on lettuce. There are over 100 known "forma speciales (f. sp.)" or "special forms" of *Fusarium oxysporum*, each causing disease on one to a few specific plant species. For example, *Fusarium oxysporum* f. sp. *spinacia* and *Fusarium oxysporum* f. sp. *asparagi* are respective pathogens of spinach and asparagus. There are three reported races of *Fusarium oxysporum* f. sp. *lactucae*. All three races of the lettuce pathogen are present in Japan, whereas only race 1 is known to occur in the United States (Arizona and California), as well as in Argentina, Brazil, Iran, Italy, Portugal, and Taiwan. The plant pathogenic forms of *Fusarium oxysporum* can also live on dead plant tissue when living host plants are not available, enabling the pathogens to survive in soil indefinitely. Forms of *Fusarium oxysporum* that are not plant pathogens also reside in soil, living only on dead plant tissue.

## Disease development on lettuce

*Fusarium oxysporum* f. sp. *lactucae* invades lettuce plants through small roots, then grows within the xylem tissue, which transports water and nutrients from roots to plant foliage. As the pathogen advances into the plant taproot and lower stem, the xylem tissue becomes plugged by the fungus and byproducts of its presence, resulting in restricted water uptake, stunting, wilting, and often plant death. Plants infected when older may survive but are usually stunted. Taproots of infected plants look normal externally; however, examination of internal tissue usually reveals the presence of a reddish-brown discoloration (Figure 2). Fusarium wilt was first found in 2001 in six lettuce fields in Yuma County, AZ. The number of fields known to be infested with *Fusarium oxysporum* f. sp. *lactucae* in Yuma County had increased to 50 by 2010, with further increases thereafter.



Figure 1. Foliar symptoms of Fusarium wilt include yellowing and necrosis of leaves as well as stunting and wilting of plants.



Figure 2. Reddish-brown to black necrosis of internal taproot and crown tissue is a common symptom on lettuce infected with *Fusarium oxysporum* f. sp. *lactucae*.

## Disease management considerations

**Disease resistant plants.** The most effective management tool for *Fusarium* wilt of most hosts is to grow plants with genetic resistance to the pathogen. Unfortunately, 88 crisphead, 6 green leaf, 5 red leaf, and 4 butterhead varieties tested in Arizona in 2002 and 2003 were susceptible to *Fusarium* wilt (Matheron et al. 2005). On the other hand, some of the 20 romaine varieties in the same trials, especially BOS 9021, King Louie, and Slugger, were resistant or tolerant to the disease.

**Sanitation.** The goal of implementing sanitation procedures is to minimize the movement of *Fusarium oxysporum* f. sp. *lactucae* from infested to noninfested fields. Any farming operation or activity that can move infested soil or plant material may spread the pathogen, such as seedbed preparation activities, cultivation, harvesting operations, use of contaminated irrigation pipe, workers' footwear, tractors and other farm equipment. To be successful, these sanitation procedures must remain in effect even when the contaminated field is planted to crops other than lettuce. Effectively preventing the spread of *Fusarium oxysporum* f. sp. *lactucae* from infested to noninfested fields requires thoroughly removing contaminated soil from tractors, farm equipment, irrigation pipe, harvesting equipment, and footwear before leaving the infested field.

**Crop rotation.** Research has shown that the lettuce *Fusarium* pathogen can colonize roots of living tomato, cantaloupe, watermelon, cotton, broccoli, cauliflower, and spinach plants without causing disease symptoms (Hubbard and Gerik, 1993; Scott et al. 2013). Also, pathogenic *Fusarium oxysporum* can grow on organic matter such as crop residue. The importance of nonhost plants and organic matter in sustaining the population of *Fusarium oxysporum* f. sp. *lactucae* in soil is unknown; however, the value of crop rotation as an effective management tool for *Fusarium* wilt on lettuce is questionable.

**Bare soil fallow.** In an Arizona/California microplot study (Scott et al. 2012), when soil containing *Fusarium oxysporum* f. sp. *lactucae* was maintained free of plants and not irrigated, the pathogen population decreased over time, with an estimated half-life of  $5.9 \pm 0.7$  months (time interval required for pathogen population to decline to 50% of the original level). Using this estimate, a one to two year bare soil fallow period may reduce the pathogen population by about 75 to 93%, respectively. These results should be considered preliminary findings until confirmed by further research.

### Treatment of soil with fumigants and fungicides.

In one Arizona field trial, a preplant application of metam sodium (Vapam) reduced disease incidence at crop maturity by 44% in a subsequent planting of a susceptible lettuce variety. In another Arizona field trial, an at-seeding application of thiophanate-methyl (Topsin M), fludioxonil (Cannonball), or boscalid+pyraclostrobin (Pristine) had no suppressive effect on development of *Fusarium* wilt of crisphead lettuce.

**Cultural practices.** Soil temperature has a profound effect on development of *Fusarium* wilt of lettuce. In two Arizona field trials, the proportion of 11 different lettuce varieties that were diseased or dead was 83.2, 10.0, and 1.5% when seeded in September, October, and December, respectively (Matheron et al. 2005). When lettuce plantings were started in these respective months, the mean soil temperature at the 4-inch depth during crop growth was 78, 59, and 57°F. **Planting late in the lettuce production season can dramatically reduce disease incidence and crop loss in infested fields.**

Disease incidence on romaine lettuce generally was much lower than that on crisphead lettuce. In the same two field trials mentioned earlier, the mean incidence of diseased or dead crisphead lettuce plants sown in September, October, and December was 94.0, 23.0, and 1.3%, respectively. On the other hand, the incidence of diseased or dead romaine plants for the same planting months was 34.0, 0.7, and 0.2%, respectively. The romaine variety 'Slugger' in particular exhibited only 3.0, 0.2, and 1.0% disease incidence when sown in September, October, and December, respectively. **Romaine lettuce in general, and some romaine varieties in particular, such as BOS 9021, King Louie, and Slugger, were significantly more tolerant to *Fusarium* wilt compared to crisphead lettuce. Since these romaine varieties may no longer be available, evaluation of current varieties is planned.**

**Summer soil solarization.** In four separate field trials in Arizona, summer solarization of soil (covering moist soil with clear plastic) for 30 days reduced the incidence of *Fusarium* wilt on a subsequent crisphead lettuce planting from 42 to 91% compared to nonsolarized plots (Matheron and Porchas, 2010). This procedure can significantly reduce the population of *Fusarium oxysporum* f. sp. *lactucae* in soil and the resulting incidence of *Fusarium* wilt in a subsequent lettuce crop; however, care must be taken to avoid incorporating untreated soil from the furrow into the treated bed.

**Final comments.** There is no single magic bullet that will eliminate *Fusarium* wilt as a disease of concern for lettuce growers in Arizona. However, implementing an Integrated Disease Management (IDM) program using proven strategies outlined above can provide a meaningful level of disease control. Possible future development of resistant crisphead varieties and validation of other potential disease management tools through additional research may provide new IDM strategies in the future.

## References

- Hubbard, J. C., and Gerik, J. S. 1993. A new wilt disease of lettuce incited by *Fusarium oxysporum* f. sp. *lactucum* forma specialis nov. *Plant Dis.* 77:750-754.
- Matheron, M.E., McCreight, J. D., Tickes, B. R., and Porchas, M. 2005. Effect of planting date, cultivar, and stage of plant development on incidence of *Fusarium* wilt of lettuce in desert production fields. *Plant Dis.* 89:565-570.
- Matheron, M. E., and Porchas, M. 2010. Evaluation of soil solarization and flooding as management tools for *Fusarium* wilt of lettuce. *Plant Dis.* 94:1323-1328.
- Scott, J. C., Gordon, T. R., Kirkpatrick, S. C., Koike, S. T., Matheron, M. E., Ochoa, O. E., Truco, M. J., and Micheltore, R. W. 2012. Crop rotation and genetic resistance reduce risk of damage from *Fusarium* wilt in lettuce. *California Agriculture* 66:20-24.
- Scott, J. C., McRoberts, D. N., and Gordon, T. R. 2013. Colonization of lettuce cultivars and rotation crops by *Fusarium oxysporum* f. sp. *lactucae*, the cause of *Fusarium* wilt of lettuce. *Plant Pathology* 63:548-553.



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COLLEGE OF AGRICULTURE AND LIFE SCIENCES  
TUCSON, ARIZONA 85721

MICHAEL E. MATHERON  
Extension Plant Pathologist and Professor

CONTACT:  
MICHAEL E. MATHERON  
matheron@cals.arizona.edu

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