THE UNIVERSITY OF ARIZONA
Yuma Center of Excellence for Desert Agriculture

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FUSARIUM WILT OF LETTUCE UPDATE

Fusarium wilt of lettuce is caused by *Fusarium oxysporum* f.sp. *lactucae* (Fol). This disease was first identified in CA in 1990[1], in Arizona in the fall of 2001[2], and in Florida in 2017[3]. There are currently four races identified worldwide, but only race 1 of Fol has been found in the US.

Fol can survive in the soil without a host present by growing on plant debris or as spores. In one study using infested soil from Yuma, the number of Fol propagules (mycelium and spores) was shown to decrease dramatically in fallow, weed free conditions after one year. In the following twenty-two months the decline was at a far slower rate and at thirty-four months the propagule numbers were at a level that posed a low risk for causing disease[4]. This suggests that if the pathogen has no host to grow on, the number of spores in the soil will be reduced. However, this may not be a realistic or economical control strategy because Fol can grow on the roots of broccoli, cauliflower and spinach[5] and likely other crops and weed species. Tolerant lettuce cultivars can serve as an important source of Fol since Fol may colonize and reproduce on the roots although the plant has few above ground symptoms. The alternative of leaving a field fallow for a year often is not economically viable and may negatively affect the quality of the soil.

The number of Fusarium propagules in the soil and the average daily temperatures have a significant effect on disease incidence[6]. Fol grows best at around 77°F[7], the average soil temperature in Yuma in September[8]. The optimal growing conditions for lettuce are 45-75°F[9] and the high air temperatures in September in Yuma increase plant stress which makes the lettuce more susceptible to disease.

The quantity of propagules in the soil is important for disease development, but many factors determine the threshold for disease such as plant stress and genetic resistance. Fusarium wilt has recently been observed in later planting slots, possibly because the amount of Fol has increased to high enough levels in the soil where more spores come in contact with lettuce roots and increase the likelihood of an infection despite the sub-optimal conditions[6].

FUSARIUM OXYSPORUM, FORMA SPECIALIS AND RACES

The *Fusarium oxysporum* species complex is a group of soilborne fungal strains composed of plant pathogens that infect a wide range of plants and animals , and non-pathogens that live in the soil as part of the ecosystem. The plant pathogens produce wilt, root rot and/or crown rot symptoms. Some *F. oxysporum* strains infect only one plant species, these are grouped into a forma specialis. A forma specialis (f.sp.) is informal and it does not indicate how related strains are to other f.sp. group members. Strains within a forma specialis are classified as races based on pathogenicity to differential sets of cultivars. Unlike many fungi, *Fusarium oxysporum* does not reproduce sexually and thus, new races do not emerge frequently. Only 25 of the 106 described forma speciales of *Fusarium oxysporum* currently have described races and most of the forma speciales have less than six races[10]. *Fusarium oxysporum* f.sp. *lactucae* has four races that can be differentiated using the cultivars in the table below.

CULTIVAR	Race 1	Race 2	Race 3	Race 4
Costa Rica No. 4	-	+	+	+
Banchu Red Fire	+	-	+	-
Romana Romabella	-	-	+	+
Patriot	+	+	+	+

Cultivar susceptiblility indicated by +

FIELD TRIALS

2015-2018

Dr. Mike Matheron managed annual field trials in conjunction with the Yuma Center of Excellence for Desert Agriculture (YCEDA) from 2015-2018 evaluating lettuce cultivars for resistance, chemical and biological crop protection products, and cultural methods for control of Fusarium wilt of lettuce. These trials evaluated 47 lettuce cultivars; 15 of these were commercialized head cultivars, seven were romaine cultivars, and the remainder were pre-commercial cultivars. Several iceberg varieties have shown significant levels of genetic resistance to the disease, even in fields with high disease pressure. Chemical and biological control methods have been evaluated in past field trials, but no effective commercial products have been identified. One promising compound has been tested for several years and new products for testing are being identified for future trials. Crop protection products are most effective as preventative treatments. Once the pathogen has infected the plant, suppression of the disease is difficult.

2019

In 2019, Dr. Matheron retired and Dr. Stephanie Slinski, YCEDA Associate Director of Applied Research and Development, took over management of the field trials. Dr. Slinski is working on several fronts to advance YCEDA's Fusarium wilt of lettuce research efforts and find solutions for improved management of this challenging disease.

Three field trials were conducted in 2019. One trial evaluated a total of 95 breeding lines from public programs and pre-commercial cultivars from private breeding programs. Data from this trial supports the identification of sources of resistance for breeding programs and accelerates the release of new resistant cultivars from private companies.

A second trial evaluated four numbered crop protection compounds from agricultural chemical companies.

A third trial evaluated twelve commercial cultivars for Fusarium resistance. Results from this trial can be seen below.

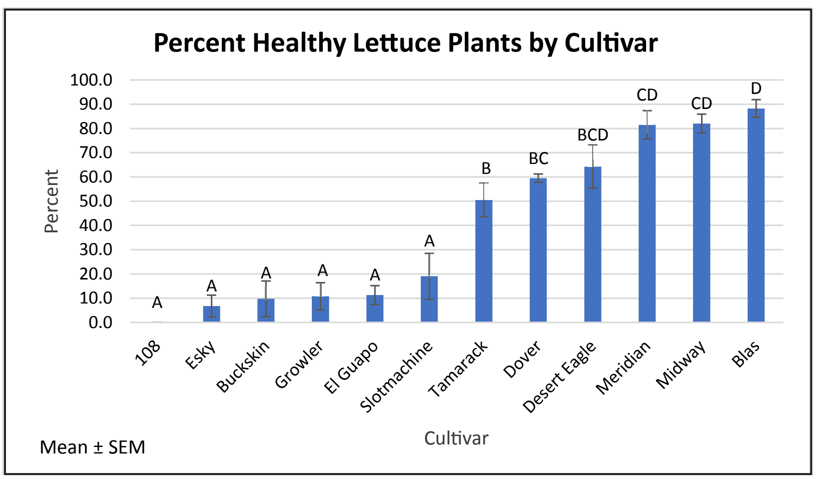
RESULTS

Percent Healthy Lettuce Plants by Cultivar

Cultivar	Mean ± SEM*			
108	0.0	±	0.0	A
Esky	6.8	±	4.5	A
Buckskin	9.8	±	7.3	A
Growler	10.8	±	5.6	A
El Guapo	11.3	±	3.9	A
Slotmachine	19.0	±	9.5	A
Tamarack	50.5	±	6.9	B
Dover	59.5	±	1.7	BC
Desert Eagle	64.3	±	8.9	BCD
Meridian	81.5	±	5.9	CD
Midway	82.0	±	3.9	CD
Blas	88.3	±	3.6	D

*Mean and standard error of the mean (SEM) for ratings of above-ground disease

Values not followed by a common letter indicate a significant difference at P < 0.05 based on Tukey-type contrasts.



RESULTS FROM THE PAST FIELD TRIALS CAN BE FOUND AT:

https://desertagsolutions.org/resource/fusarium-wilt-lettuce#publications-links

CURRENT EFFORTS

The Yuma Center of Excellence for Desert Agriculture (YCEDA) has prioritized identifying methods to control Fusarium wilt of lettuce. The only methods currently proven to be effective are avoiding infested fields, preventing the initial contamination of a field and planting resistant cultivars, but other methods are available for study. The following is a numbered list of potential control strategies with bullets indicating projects being planned by YCEDA:

1. **Plant resistant lettuce cultivars:**
   - Evaluate public breeding lines from UC Davis, USDA and University of Florida
   - Evaluate pre-commercial cultivars
   - Demonstration plot trial of newly released breeding lines from public programs
   - Evaluate the performance of wild-type lettuce species that may be used for breeding programs
   - Evaluate commercial cultivars including new releases for Fusarium wilt tolerance or resistance
2. **Eradicate the pathogen using disinfestation techniques such as biofumigation or solarization:**
   - Evaluate a method that combines solarization with biological disinfestation called biosolarization
   - Assist with evaluating mustards as a biofumigation method against Fol
3. **Protect the plant using a crop protection product:**
   - Continue to evaluate crop protection products that have evidence of activity against Fol
4. **Improve soil health to increase microbial communities that may suppress the pathogen & to decrease plant stress:**
   - Projects are being planned with University of Arizona researchers to better understand the role of soil organic matter and microbial populations on soil health and to provide management methods to growers.
5. **Avoid planting lettuce in fields with a history of Fusarium wilt**
6. **Avoid planting rotation or cover crops that will increase the level of contamination**
7. **Other disease avoidance methods:**
   - Evaluate transplanting as a method for avoiding Fusarium wilt of lettuce
8. **Prevent new fields from becoming contaminated by cleaning soil from tools and machinery when moving between fields**

OTHER PROJECTS IN DEVELOPMENT:

Evaluate the population of Fol in the Yuma growing region to confirm that only one race is active and no significant variation in pathogenicity is found.

REFERENCES:

1. Hubbard, J. C., & Gerik, J. S. (1993). A new wilt disease of lettuce incited by Fusarium oxysporum f.sp. lactucum forma specialis nov. *Plant Disease*, *77*(7), 750-754.

2. Matheron, M. E., & Koike, S. T. (2003). First report of Fusarium wilt of lettuce caused by *Fusarium oxysporum* f.sp. *lactucae* in Arizona. *Plant Disease, 87*(10), 1265-1265.

3. Murray, J., Raid, R., Miller, C. F., Kreutz, G., & Sandoya, G. V. (2019, July). First Report of *Fusarium oxysporum* f.sp. *lactucae* race 1 in Florida Lettuce. In *2019 ASHS Annual Conference*. ASHS.

4. Scott, J.C., Gordon, T.R., Kirkpatrick, S.C., Koike, S.T., Matheron, M.E., Ochoa, O.E.,Truco, M.J., Michelmore, R.W. (2012). Crop rotation and genetic resistance reduce risk of damage from Fusarium wilt in lettuce. Calif. Agric. 66, 20e24.

5. Scott, J. C., McRoberts, D. N., & Gordon, T. R. (2014). Colonization of lettuce cultivars and rotation crops by *Fusarium oxysporum* f.sp. *lactucae*, the cause of Fusarium wilt of lettuce. *Plant pathology, 63*(3), 548-553.

6. Scott, J. C., Kirkpatrick, S. C., & Gordon, T. R. (2010). Variation in susceptibility of lettuce cultivars to fusarium wilt caused by *Fusarium oxysporum* f.sp. *lactucae*. *Plant pathology, 59*(1), 139-146.

7. Scott, J. C., Gordon, T. R., Shaw, D. V., & Koike, S. T. (2010). Effect of temperature on severity of Fusarium wilt of lettuce caused by *Fusarium oxysporum* f.sp. *lactucae*. *Plant disease, 94*(1), 13-17.

8. Matheron, M. E., McCreight, J. D., & Tickes, B. R. (2005). Effect of planting date, cultivar, and stage of plant development on incidence of Fusarium wilt of lettuce in desert production fields. *Plant disease, 89*(6), 565-570.

9. Lorenz OA, Maynard DN (1988) Knott's handbook for vegetable growers. Wiley, New York

10. Edel-Hermann, V., & Lecomte, C. (2019). Current status of Fusarium oxysporum formae speciales and races. *Phytopathology, 109*(4), 512-530.