FUSARIUM WILT of Lettuce • Feb 2022 Update

Fusarium wilt of lettuce has been plaguing lettuce growers around the world for many years. The disease was first observed in Japan in the 1950s[1] but was not found in the US (California), until 1990[2]. Growers in Arizona first started experiencing Fusarium wilt of lettuce in 2001[3], and the disease has spread throughout desert growing regions over the intervening years.

Fusarium wilt of lettuce is caused by the soil-inhabiting fungus *Fusarium oxysporum* f.sp. *lactucae*. Impacts from this disease are economically significant in Arizona and California and are an emerging problem in Florida. Four known pathogen races have emerged worldwide since the disease was first identified. Races do not provide formal taxonomic ranking, nor is there a standard procedure for race designation for Fusarium oxysporum; races are designated based on pathogenicity to a set of lettuce cultivars. Ideally this is based on a known gene-for-gene interaction, which is an interaction between a pathogen and plant gene, but it is generally accepted that races can be based on a pattern of susceptibility and resistance by a differential set of cultivars. Each race causes a clear and unique disease pattern on the differential cultivars (Table 1). Two of the differential cultivars are being submitted to the U.S. National Plant Germplasm System[4]; Romana Romabella is not currently available from this germplasm source.

TABLE 1

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

Cultivar susceptibility indicated by +

Race 1 is the only race currently identified in the US, but breeders and growers have been observing changes in how Fusarium wilt of lettuce manifests in the field. These changes may be due to the build-up of pathogen inoculum in the soil or changing weather patterns, but it may also indicate a genetic change in the pathogen population. Several studies are in progress to identify changes in the pathogen population in Arizona and California. These studies are looking for changes in pathogenicity and genetic variation that can indicate a new race or strain of *Fusarium oxysporum* f.sp. *lactucae*. Results from the project examining the Arizona population will be available later this year.

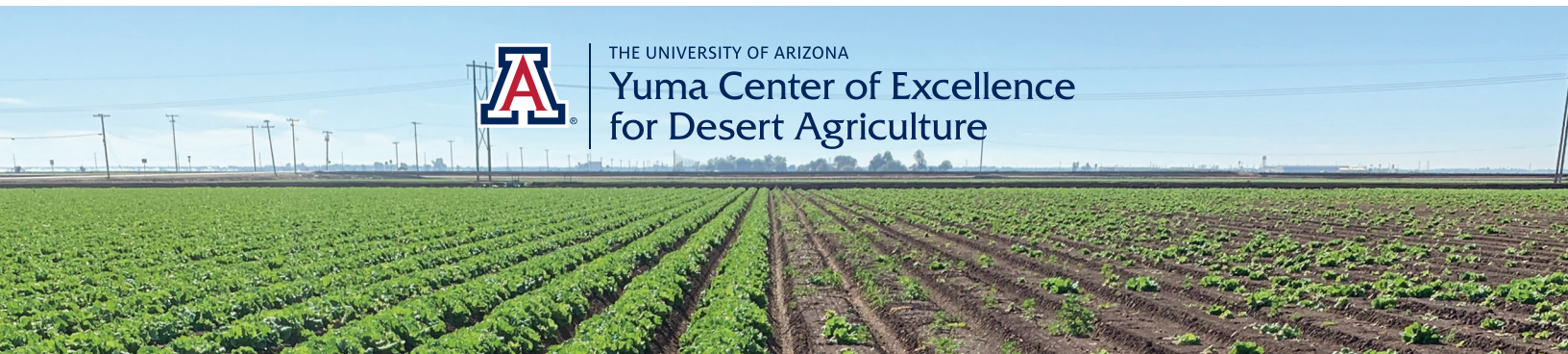
How is the Yuma Center of Excellence for Desert Agriculture (YCEDA) addressing this important problem?

1. We are conducting yearly field trials to evaluate commercial cultivars, cultural controls such as biosolarization, and chemical controls to provide management methods to growers.

2. We are conducting yearly field trials evaluating precommercial cultivars, breeding lines, newly released lines, and wild type lettuce varieties to support breeding efforts.

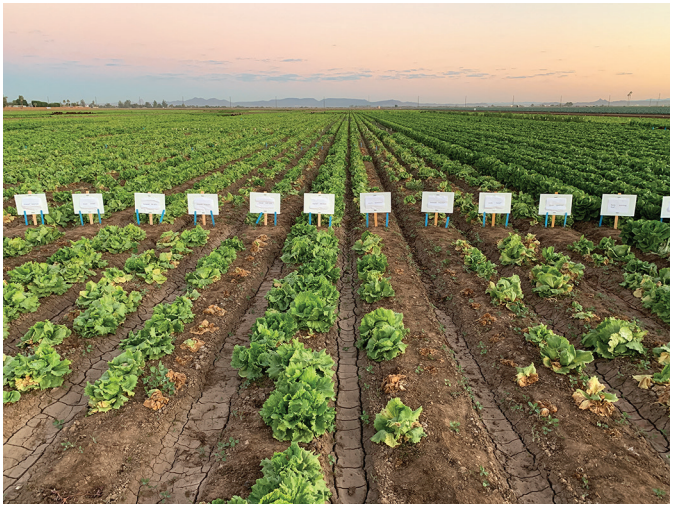
3. We are working with researchers in California and Arkansas to evaluate the population of Fusarium oxysporum f.sp. lactucae to determine if variation exists that could change how growers manage the disease and how new cultivars are developed.

4. We are facilitating discussions and project development with researchers in the US to develop a coordinated effort to address Fusarium wilt of lettuce.



The severity of the disease is influenced by how much of the pathogen is in the soil, temperature, and the level of cultivar tolerance. There appears to be a threshold level above which symptoms will develop, but not enough is known about the relationship between inoculum (mycelium and spores) levels, temperature, and disease. The pathogen may be in the soil for an extended period of time before it reaches a level that can cause symptoms. Plants are most susceptible when high temperatures occur 14-28 days post-planting rather than later in the growth cycle[5].

This pathogen was likely brought to the US by contaminated seed[6] and has likely spread in California and Arizona through the movement of soil on equipment[7]. Cleaning and sanitizing equipment is the most important method for preventing the spread of the pathogen. Other methods of control are to plant less susceptible varieties or rotation crops in fields with known disease pressure. Most iceberg cultivars appear to be susceptible to some degree, while romaine cultivars generally have a higher level of tolerance.



In a fallow field, the pathogen population will decrease significantly over a 12-month period[7]. It can, however, grow and proliferate on or in the roots of resistant cultivars or rotation crops. The pathogen has been found on the roots of broccoli, and in the roots of cauliflower, spinach, and resistant lettuce cultivars[8], and likely many other crop and weed species. This ability to survive and propagate in the absence of a susceptible host is a characteristic of many Fusarium wilt pathogens. Growth on tolerant lettuce cultivars can in some cases contribute more inoculum to the soil than a susceptible cultivar because it can grow to full size and sustain high populations of the fungus in its root system unlike a susceptible cultivar that dies back early in development[9].

Few methods for suppressing the pathogen are available. Solarization has been demonstrated to be highly disease suppressive[10] but solarization is usually conducted on a bed covered with plastic mulch, leaving the furrow untreated. This means that when the soil is later tilled, the inoculum is mixed with the solarized soil. Solarization will reduce the amount of inoculum in the field but leaving untreated sections in the field allows the pathogen to readily reestablish. Biosolarization is a method similar to solarization but, with the addition of a carbon source, uses soil bacteria to help suppress pathogens. This method may be more effective than solarization alone, but the common methods also only treat beds. Both methods can be expensive and require specialized equipment and materials. To address biosolarization's economics and limitations, YCEDA is working with researchers in California to test biosolarization in Yuma, AZ using local carbon sources, treating all field soil, and without using plastic film. A field trial will be conducted in August of 2022 to test methods currently in development.

Manipulation of the soil microbial community and managing soil health may help reduce inoculum and suppress disease. More research on soil health is needed to find additional methods to suppress Fusarium wilt of lettuce. We hope to introduce more research on soil health and Fusarium wilt suppression over the next few years.

Currently, genetic resistance is the best way to avoid disease. Several lettuce breeding programs have released highly tolerant cultivars in recent years, and more are in development. Supporting the development of tolerant and resistant cultivars is a priority of YCEDA's Fusarium wilt of lettuce program. To this end, annual field trials have taken place since 2015 to evaluate commercial and pre-commercial cultivars, breeding lines, and more recently, wild lettuce species for new sources of resistance.

YCEDA 2021 Field Trials
Commercial Cultivar Evaluations

YCEDA received funding from the Arizona Department of Agriculture/USDA Specialty Crop Block Grant Program to conduct Fusarium wilt of lettuce field trials in 2021. We planted 40 iceberg cultivars and 38 romaine cultivars on September 15th and evaluated the trial on December 1, 2021. Iceberg cultivars were evaluated using a 0-4 disease severity (DS) rating system. Table 2 shows the top-performing cultivars. The percent of marketable heads was also calculated for iceberg cultivars. Cultivars with a DS rating above 2.5 had 25% marketable heads or fewer (Table 3).

TABLE 2

Iceberg Cultivar	Disease Severity
Powerball	0.8 l[†]
Fredonia	1.4 kl
18C1230	1.7 jk
Oracle	1.7 jk
PX 1671	1.7 jk
Midway*	2.1 i-k
Blas	2.1 h-k
Desert Eagle*	2.3 h-j
Frosty	2.3 g-j
Meridian	2.3 g-j
Franchise	2.4 g-j

TABLE 3

Iceberg Cultivar	Percent Marketable Heads
Powerball	81% ab
Fredonia	68% ab
18C1230	50% bc
Oracle	43% cd
Frosty	38% c-e
Blas	37% c-e
PX 1671	35% c-f
Uppercut*	35% c-f
Desert Eagle*	31% c-g
Franchise	29% c-h
SV4204*	25% d-i
Meridian	25% d-i

[†]Means followed by same letter do not significantly differ (P=≤0.05, Tukey's HSD)

*Out of slot cultivar

Disease Severity Scale
0 = No Disease
1 = Slight chlorosis on outer leaves, stunting
2 = More extensive chlorosis & stunting
3 = Chlorosis & stunting, unmarketable head
4 = Dead

Romaine cultivars in general are significantly more tolerant to Fusarium wilt. However, all cultivars evaluated had some degree of root discoloration – indicating some level of infection. Likewise, most varieties had mild disease symptoms. This is likely because the field used for this trial has a high inoculum level, the cultivars were planted in an early (warm) planting slot, and the ambient temperature remained high throughout the growth period. Romaine cultivars were evaluated on percent disease incidence, uneven stands were not considered a symptom in out-of-slot cultivars. Only the cultivar Bondi was severely impacted by the disease. A list of cultivars tested in 2021, results from these trials, and information on YCEDA's entire Fusarium wilt of lettuce program can be found at:

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

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