

Evaluation of Lettuce Cultivars for Resistance to Fusarium Wilt

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Abstract

In the 2001-2002 production season, Fusarium wilt was observed for the first time in six different lettuce fields in the Gila and Dome Valley production areas of Yuma County, Arizona. The disease was found in 11 additional sites during 2002-2003. Fusarium wilt presents a serious threat to the health of the lettuce industry in Arizona. The only effective means of controlling Fusarium wilt of lettuce at this time is to avoid infested fields. On the other hand, Fusarium wilt in other crops, such as tomatoes and melons, is controlled effectively by planting cultivars resistant to the pathogen. The relative resistance of lettuce cultivars grown in the Arizona desert production region is unknown; therefore, a cultivar evaluation trial was established in a field known to contain the wilt pathogen, Fusarium oxysporum f.sp. lactucae. Tested cultivars were grouped into three different planting dates: Sep 7, Oct 17 and Dec 6, 2002. A majority of the cultivars within each planting date were those that would be planted in the desert at that time. Fusarium wilt was severe in the early planting of lettuce (Sep 7), moderate in the second planting (Oct 17) and very mild in the third planting (Dec 6). Disease severity was low in some lettuce cultivars in the second planting and most cultivars in the third planting. Among the types of lettuce tested, head lettuce was usually least resistant whereas romaine was most resistant. The data presented in this report are preliminary findings, subject to confirmation in another study planned for the next lettuce production season.

Introduction

In the fall of 2001, a new disease was observed in six different lettuce fields in the Gila and Dome Valley production areas of Yuma County, Arizona. Symptoms included wilting, yellowing of leaves and a red-brown to black discoloration of internal taproot and crown tissue. Affected plants were stunted and often died. This wilt disease affected lettuce plants of all ages, from seedling to mature plant. A *Fusarium* species was consistently recovered from discolored internal taproot and crown tissue.

Fusarium wilt is new to Arizona lettuce fields; however, the disease was first discovered on this crop in Japan in 1955. The first discovery of Fusarium wilt of lettuce in the United States occurred during 1990 in Fresno County near Huron, California. Most recently, the disease was reported in Italy in 2002. Researchers in Japan named the pathogen *Fusarium oxysporum* f.sp. *lactucae*. This fungus is a soil-borne pathogen that can remain viable in soil for many years.

A research paper published in 1993 by Hubbard and Gerik (1) is the current primary source of

information concerning the disease cycle and epidemiology of Fusarium wilt of lettuce. Hubbard and Gerik determined in the laboratory that the fungus can grow between 46 and 89EF, with optimum growth at 82EF. Lettuce was not susceptible to any of the Fusarium wilt pathogens from other crops, including tomatoes and melons. Likewise, no other hosts have been found for *Fusarium oxysporum* f.sp. *lactucae*. In seedling inoculation experiments, the researchers found that the lettuce cultivars Autumn Gold, Empire, Excell, Salinas, Vanguard, Vanguard 75, Vanmax, Viva and Winterset were susceptible to the disease in varying degrees, with Salinas demonstrating the most disease tolerance.

Fusarium wilt presents a serious threat to the health of the lettuce industry in Arizona. The only effective means of controlling Fusarium wilt of lettuce at this time is to avoid infested fields. On the other hand, an effective method of managing Fusarium wilt in other crops, such as tomatoes and melons, is by planting cultivars resistant to the pathogen. In the long term, development of lettuce cultivars with resistance to *Fusarium oxysporum* f.sp. *lactucae* would be highly desirable. In the short term, we need to evaluate existing lettuce cultivars for their relative susceptibility to the disease. This was initiated this past lettuce production season by establishing a replicated planting of lettuce cultivars in a field known to contain *Fusarium oxysporum* f.sp. *lactucae*.

Materials and Methods

A large field trial was established on a commercial lettuce field farmed by Coronation Peak Ranches in Wellton, Arizona. Plots were planted and managed using current commercial practices. Each of the four replicate plots for each head lettuce cultivar contained 600 lettuce plants for a total of 2,400 plants evaluated per cultivar. For romaine and leaf lettuce cultivars, replicate plots each contained 300 plants for a total of 1,200 plants evaluated per cultivar. Tested cultivars were grouped into three different planting dates: Sep 7, Oct 17 and Dec 6, 2002. A majority of the cultivars within each planting date were those that would be planted in the desert at that time. The remainder of the cultivars were included for comparison of disease on the same cultivar within different planting dates or for evaluation of cultivars not grown commercially in the desert. Termination dates for each planting and the number of cultivars of each lettuce type within each planting are listed in Table 1. Disease evaluations were performed three times during crop development in each planting. Only the final disease rating at crop maturity is presented in this report. Each plant within a plot was determined to be diseased if the plant was dead or stunted and displayed the typical wilting and yellowing symptoms of Fusarium wilt of lettuce.

Table 1.

| Planting number | Planting date | Maturity date | Days to maturity | Number of cultivars tested of each lettuce type. | | | | |
|-----------------|---------------|---------------|------------------|--|---------|------------|----------|--------|
| | | | | Head | Romaine | Green leaf | Red leaf | Butter |
| 1 | Sep 7 | Nov 8 | 62 | 41 | 15 | 3 | 4 | 2 |
| 2 | Oct 17 | Jan 11 | 86 | 40 | 9 | 4 | 3 | 1 |
| 3 | Dec 6 | Mar 22 | 107 | 40 | 4 | 1 | 1 | 1 |

Results and Discussion

The complete list of tested lettuce cultivars and their respective disease assessments at crop maturity are presented in Table 2. Several cultivars were present in two and occasionally in all three plantings, which allowed for comparison of disease intensity among different planting dates (see Table 3). Among virtually all tested cultivars of lettuce, the severity of disease in the first planting was much higher than that observed in the second planting, which in turn was higher than that observed in the third planting. One possible reason for the differences in severity of Fusarium wilt among planting dates was soil temperature. The average daily soil temperature at the 4-inch depth ranged from 65 to 85EF, 55 to 74EF, and 48 to 64EF for the first, second and third plantings, respectively. In all three plantings, differences in disease severity were detected among the different types of lettuce, with head lettuce being most susceptible whereas romaine demonstrated the highest level of tolerance. Observed disease tolerance for specific cultivars was dependent on disease pressure. Of the 11 head lettuce cultivars tested in both the first (high disease pressure) and second (moderate disease pressure) plantings (see Table 3), the lowest disease rating was a 32% loss in the first planting, whereas three head lettuce cultivars had disease ratings at or below 4% in the second planting. Similar results were observed for romaine, green leaf and red leaf lettuce.

Fusarium wilt was first recognized in the Yuma area during the 2001-2002 season, when *Fusarium oxysporum* f.sp. *lactucae* was recovered from diseased head lettuce plants in six different fields. During the just completed 2002-2003 season, the pathogen was recovered from 11 additional head lettuce plantings. Disease was detected in these fields from October through December; therefore, head lettuce fields in production during this time that exhibited no evidence of Fusarium wilt can be assumed to be free of the pathogen. On the other hand, lettuce fields in production during January through March and showing no evidence of Fusarium wilt still may harbor the pathogen, since disease development during this time is greatly reduced and could be overlooked.

Recommendations

Keeping in mind that the data presented in this report are preliminary findings and subject to confirmation by further studies, there are some recommendations that can be made concerning the management of Fusarium wilt of lettuce.

1. Every effort should be made to prevent the spread of contaminated soil from known locations of *Fusarium oxysporum* f.sp. *lactucae* to “clean” fields by workers and equipment. These precautions should be maintained even when crops other than lettuce are grown in infested fields.
2. Avoidance. The best way to avoid Fusarium wilt on lettuce is to not plant this crop on sites known to contain the pathogen.
3. Based on the preliminary data presented in this report, one could choose a late planting date (early December) and select a cultivar that sustained little to no disease at this planting time.
4. For the vast majority of lettuce production fields where *Fusarium oxysporum* f.sp. *lactucae* is not known to occur, maintain vigilance to prevent the introduction of the pathogen into your fields and use your normal criteria for cultivar and planting time selection.

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Reference

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.

Table 2. Comparative susceptibility of lettuce cultivars to Fusarium wilt.

| Cultivar | Lettuce | Producer | % of plants dead or diseased |
|----------|---------|----------|------------------------------|
|----------|---------|----------|------------------------------|

| | Type | | First planting | Second planting | Third planting |
|---------------|-----------|---------------------|----------------|-----------------|----------------|
| Acacia | Head | Synergene | 100 | ----- | ----- |
| Annie | Head | Seminis | 100 | ----- | ----- |
| AZ 90 | Head | Central Valley | ----- | 67 | ----- |
| AZ 2000 | Head | Central Valley | ----- | ----- | 10 |
| Beacon | Head | Paragon | 100 | 72 | ----- |
| Big Green COS | Romaine | Synergene | ----- | ----- | 0 |
| Big Star | Greenleaf | Synergene | ----- | 0.8 | ----- |
| Big Sur | Head | Synergene | ----- | ----- | 0 |
| BOS 9021 | Romaine | Orsetti | 10 | ----- | ----- |
| Bubba | Head | Seminis | ----- | 50 | ----- |
| Buccaneer | Head | Central Valley | 92 | 1 | 0 |
| Cavalier | Head | Progeny | 100 | ----- | ----- |
| Cibola | Head | Paragon | ----- | 62 | ----- |
| Clemente | Romaine | Seminis | 14 | 0.8 | ----- |
| Climax | Head | Jim McCreight, USDA | ----- | ----- | 0.1 |
| Coastal Star | Romaine | Coastal | 32 | 2 | ----- |
| Cochise 47 | Head | Central Valley | ----- | 59 | ----- |
| Colossus | Head | Shamrock | ----- | 16 | ----- |
| Conquistador | Romaine | Seminis | 13 | 0 | ----- |
| Coolgreen | Head | Harris Moran | ----- | ----- | 5 |
| Coolguard | Head | Pybas Seeds | ----- | 41 | ----- |
| Connick | Butter | Sun Seeds | ----- | 66 | 0.3 |
| Costa Rica #4 | Romaine | Jim McCreight | ----- | ----- | 0 |
| Coyote | Head | Seminis | ----- | 16 | ----- |
| Crusader | Head | Progeny | 95 | ----- | 0.2 |
| Daneberg 66 | Head | Progeny | ----- | ----- | 0.2 |
| Darkland COS | Romaine | Central Valley | 20 | 0.7 | ----- |
| Del Oro | Head | Seminis | ----- | 38 | ----- |
| Del Rio | Head | Seminis | ----- | 6 | 0 |
| Desert Heat | Head | Central Valley | 100 | 47 | 11 |
| Desert Queen | Head | Seminis | 86 | ----- | ----- |
| Desert Spring | Head | Seminis | ----- | ----- | 3 |
| Desert Storm | Head | Harris Moran | 100 | ----- | ----- |
| DF 7 | Romaine | Pybas | 13 | 0.2 | ----- |
| Diamond | Head | Coastal | ----- | ----- | 0 |
| Diamond Back | Head | Central Valley | 100 | ----- | 0 |
| Domingos 67 | Head | Progeny | ----- | ----- | 0.1 |

Table 2 (continued). Comparative susceptibility of lettuce cultivars to Fusarium wilt.

| Cultivar | Lettuce | Producer | % of plants dead or diseased |
|----------|---------|----------|------------------------------|
|----------|---------|----------|------------------------------|

| | Type | | First planting | Second planting | Third planting |
|-----------------|-----------|----------------|----------------|-----------------|----------------|
| Durango | Head | Coastal | ----- | ----- | 0 |
| Emperor | Head | Harris Moran | 100 | ----- | ----- |
| Encanto | Butter | Synergene | 66 | ----- | ----- |
| EXP 411 | Cos/head | Paragon | 18 | ----- | ----- |
| EXP 7542 | Head | Paragon | 100 | ----- | ----- |
| EXP 9145 | Head | Paragon | 100 | ----- | ----- |
| Fallgreen | Head | Harris Moran | 100 | ----- | ----- |
| Fiorette | Head | Rijk Zwaan | ----- | ----- | 0 |
| Fresheart | Romaine | Orsetti | 18 | ----- | ----- |
| Fortuna | Head | Synergene | 100 | ----- | ----- |
| Gabilan 1315 | Head | Paragon | ----- | ----- | 18 |
| Grand Max | Head | Progeny | 98 | ----- | ----- |
| Green Forest | Romaine | Central Valley | 26 | ----- | ----- |
| Green Lightning | Head | Progeny | ----- | ----- | 0.2 |
| Green Pack | Head | Central Valley | 70 | 3 | ----- |
| Green Towers | Romaine | Harris Moran | 19 | ----- | ----- |
| Grizzly | Head | Seminis | ----- | 30 | ----- |
| Headmaster | Head | Progeny | ----- | ----- | 0 |
| Heatmaster | Head | 3 Star | 100 | ----- | ----- |
| HMX 1527 | Head | Harris Moran | ----- | ----- | 4 |
| HMX 1528 | Head | Harris Moran | ----- | ----- | 4 |
| Honcho II | Head | Seminis | ----- | 47 | ----- |
| Husky | Head | 3 Star | 100 | 16 | 0.5 |
| Icon | Head | Progeny | ----- | ----- | 0.4 |
| Jackal | Head | Seminis | ----- | ----- | 0.2 |
| Javelina | Head | Seminis | 98 | ----- | ----- |
| Kahuna | Head | Synergene | 100 | ----- | ----- |
| King Louie | Romaine | Paragon | 7 | 0.9 | ----- |
| Kofa | Head | Synergene | ----- | 40 | ----- |
| Laguna Fresca | Head | Central Valley | 100 | ----- | ----- |
| La Quinta | Head | 3 Star | 82 | ----- | ----- |
| Lighthouse | Head | Paragon | 100 | 66 | ----- |
| Marin | Greenleaf | Orsetti | 89 | 0.8 | ----- |
| Milestone | Head | Paragon | 100 | ----- | ----- |
| Mohawk | Head | Seminis | 100 | ----- | ----- |
| Monarch | Head | Paragon | 100 | ----- | ----- |
| Monolith | Head | Shamrock | ----- | 28 | ----- |

Table 2 (continued). Comparative susceptibility of lettuce cultivars to Fusarium wilt.

| Cultivar | Lettuce | Producer | % of plants dead or diseased |
|----------|---------|----------|------------------------------|
|----------|---------|----------|------------------------------|

| | Type | | First planting | Second planting | Third planting |
|--------------|-----------|----------------|----------------|-----------------|----------------|
| North Star | Greenleaf | Paragon | 27 | 2 | ----- |
| Optima | Butter | Vilmorin | 86 | ----- | ----- |
| Palma | Head | Central Valley | 100 | ----- | ----- |
| Paragon PIC | Romaine | Paragon | 24 | 1 | ----- |
| Patriot | Head | J. McCreight | ----- | ----- | 0.5 |
| PIC | Romaine | Pybas | 29 | ----- | ----- |
| PRO 1839 | Head | Progeny | ----- | ----- | 0 |
| PX 843 | Head | Progeny | 97 | ----- | ----- |
| PYB 251 | Head | Pybas | ----- | ----- | 8 |
| Raider | Head | Seminis | 93 | ----- | ----- |
| RC 74 | Head | Paragon | ----- | 67 | ----- |
| Red Fox | Red leaf | Central Valley | 50 | 2 | ----- |
| Red Tide | Red leaf | Seminis | 100 | 88 | 10 |
| Rivergreen | Head | J. McCreight | ----- | ----- | 0 |
| Robusto | Romaine | Paragon | 22 | 0.9 | ----- |
| Sahara | Head | Seminis | 100 | ----- | ----- |
| Salinas 88 | Head | J. McCreight | ----- | 0.8 | ----- |
| Sharpshooter | Head | Seminis | 32 | 2 | 0 |
| Silverado | Head | Coastal | ----- | ----- | 0 |
| Sniper | Head | Seminis | 85 | 4 | 0 |
| Slugger | Romaine | Coastal | 5 | 0.4 | 0 |
| Snowbird | Head | 3 Star | 100 | 16 | 0.8 |
| Spector | Head | Seminis | 82 | ----- | ----- |
| Spring Pac | Head | Synergene | ----- | ----- | 0 |
| Sunbelt | Romaine | Central Valley | ----- | 0.4 | 0 |
| Sun Devil | Head | Progeny | 93 | ----- | ----- |
| Supercoach | Head | Progeny | ----- | 40 | ----- |
| Syn 352 | Head | Synergene | ----- | 40 | ----- |
| Target | Head | Seminis | ----- | ----- | 0.1 |
| Telluride | Head | Coastal | ----- | ----- | 0 |
| Toronto | Head | Rijk Zwaan | ----- | ----- | 0 |
| Tradition | Head | Pybas | 100 | 10 | 2 |
| Tres Equis | Head | Synergene | 98 | ----- | ----- |
| Triton | Romaine | Harris Moran | 16 | ----- | ----- |
| Two Star | Greenleaf | Orsetti | 85 | 3 | 0 |
| Valley Green | Head | Harris Moran | 100 | ----- | ----- |
| Valley Queen | Head | Paragon | 100 | 38 | ----- |

Table 2 (continued). Comparative susceptibility of lettuce cultivars to Fusarium wilt.

| Cultivar | Lettuce | Producer | % of plants dead or diseased |
|----------|---------|----------|------------------------------|
|----------|---------|----------|------------------------------|

| | Type | | First planting | Second planting | Third planting |
|--|----------|---------------------|----------------|-----------------|----------------|
| Valley Queen +T-22 | Head | Paragon | ----- | 32 | ----- |
| Vulcan | Red leaf | Sakata | 20 | 3 | ----- |
| Vanguard 75 | Head | Jim McCreight, USDA | ----- | 49 | ----- |
| Van Max | Head | Pybas | ----- | 48 | 10 |
| Van Mor | Head | Harris Moran | ----- | 54 | ----- |
| Wellton | Head | Paragon | 100 | ----- | ----- |
| Westlands | Head | Orsetti | ----- | 52 | ----- |
| Western Red | Red leaf | Orsetti | 39 | ----- | ----- |
| Wintergold | Head | Progeny | ----- | 30 | ----- |
| Winterhaven | Head | Orsetti | ----- | 60 | ----- |
| Winterhaven BOS | Head | Orsetti | ----- | 58 | ----- |
| Winterking | Head | Paragon | ----- | 46 | ----- |
| Wolverine | Head | Seminis | ----- | 4 | ----- |
| Yuma | Head | Harris Moran | ----- | 46 | ----- |
| # 106 | Head | Paragon | ----- | ----- | 6 |
| # 203 | Head | Paragon | ----- | ----- | 0.2 |
| 3SS106 | Head | 3 Star | ----- | ----- | 3 |
| Least Significant Difference; LSD ($P = 0.05$) | | | 5.3 | 9.3 | 3.0 |

Table 3. Disease assessments on lettuce cultivars tested in more than one planting date.

| Cultivar | % of plants dead or diseased | | |
|---|------------------------------|------------|----------|
| | Sep 7 | Oct 17 | Dec 6 |
| | | | |
| Head lettuce | | | |
| Beacon | 100 | 72 | ----- |
| Buccaneer | 92 | 1 | 0 |
| Crusader | 95 | ----- | 0.2 |
| Del Rio | ----- | 6 | 0 |
| Desert Head | 100 | 47 | 11 |
| Diamond Back | 100 | ----- | 0 |
| Green Pack | 70 | ----- | 3 |
| Husky | 100 | 16 | 0.5 |
| Lighthouse | 100 | 66 | ----- |
| RC 74 | 67 | 80 | ----- |
| Sharpshooter | 32 | 2 | 0 |
| Sniper | 85 | 4 | 0 |
| Snowbird | 100 | 16 | 0.8 |
| Tradition | 100 | 10 | 2 |
| Valley Queen | 100 | 38 | ----- |
| Van Max | ----- | 48 | 10 |
| Mean for head lettuce cultivars tested in multiple planting dates. | | | |
| All three dates | 87 | 14 | 2 |
| First and second dates | 89 | 32 | ----- |
| Second and third | ----- | 17 | 3 |
| First and third | 87 | ----- | 3 |
| | | | |
| Romaine | | | |
| Clemente | 14 | 0.8 | ----- |
| Coastal Star | 32 | 2 | ----- |
| Conquistador | 13 | 0 | ----- |
| Darkland COS | 20 | 0.7 | ----- |
| DF 7 | 13 | 0.2 | ----- |
| King Louie | 7 | 0.9 | ----- |
| Paragon PIC | 24 | 1 | ----- |
| Robusto | 22 | 0.9 | ----- |
| Slugger | 5 | 0.4 | ----- |
| Sunbelt | ----- | 0.4 | 0 |
| Mean for romaine cultivars tested in multiple planting dates. | | | |
| First and second dates | 17 | 0.8 | |

Table 3 (continued). Disease assessments on lettuce cultivars tested in more than one planting date.

| Cultivar | % of plants dead or diseased | | |
|---|------------------------------|-----------|-------|
| | Sep 7 | Oct 17 | Dec 6 |
| | | | |
| Green leaf | | | |
| Marin | 89 | 0.8 | ----- |
| Northstar | 27 | 2 | ----- |
| Two Star | 85 | 3 | ----- |
| Mean for green leaf cultivars tested in multiple planting dates. | | | |
| First and second dates | 67 | 2 | |
| | | | |
| Red leaf | | | |
| Red Fox | 50 | 2 | ----- |
| Red Tide | 100 | 88 | 10 |
| Vulcan | 20 | 3 | ----- |
| Mean for red leaf cultivars tested in multiple planting dates. | | | |
| First and second dates | 57 | 31 | |
| | | | |
| Butter | | | |
| Connick | ----- | 66 | 0.3 |