



DISEASES

Fusarium Wilt & Yellows of Sugar Beet & Dry Bean no. 2.950

by H. Schwartz, L. W. Panella, M. A. Brick, P. F. Byrne¹

Quick Facts...

Sugar beets are an important cash crop in northeastern Colorado with approximately 30,000 acres planted and 650,000 tons harvested in 2003.

Fusarium yellows, also known as Fusarium wilt, is a fungal disease (caused by *Fusarium oxysporum* Schlechtend.:Fr.) with presumed host-specific strains that attack sugar beet (*F. o. f. sp. betae*) or dry bean (*F. o. f. sp. phaseoli*).

Fusarium wilt losses in dry bean fields can vary from a trace to more than 30 percent crop loss; in addition seed size can be reduced 10 percent to 15 percent.

The Central High Plains (Colorado, Nebraska and Wyoming) is among the largest producer of dry edible beans and sugar beets in the United States. Sugar beets are an important cash crop in northeastern Colorado with approximately 30,000 acres planted and 650,000 tons harvested in 2003. Approximately 250,000 acres of dry bean market types (pinto, great northern, light red kidney) also are planted annually with a farm gate value that varies between \$75 and \$150 million. With both sugar and dry bean processing plants in Greeley and Fort Morgan, production is centered in northeast Colorado counties. Many growers in this area grow both sugar beets and dry beans in rotation, which may accentuate problems with soil-borne pathogens that attack both crops.

Fusarium yellows, also known as Fusarium wilt, is a fungal disease (caused by *Fusarium oxysporum* Schlechtend.:Fr.) with presumed host-specific strains that attack sugar beet (*F. o. f. sp. betae*) or dry bean (*F. o. f. sp. phaseoli*). Severely infected plants become yellowed, wilted and die prematurely, which may cause yield reduction or total crop loss. Because sugar beets and dry edible beans are commonly grown in a short rotation of less than four years in the Central High Plains, incidence and variability of the pathogens may have increased in recent years. Problems may also have been aggravated by the regional drought impact during 2001 to 2006. Fusarium wilt losses in dry bean fields can vary from a trace to more than 30 percent crop loss; in addition seed size can be reduced 10 percent to 15 percent. Reports from Wyoming indicate that the disease has been found in more than 30 percent of sugar beet fields with significant reduction in yield in various counties.

Problem and Cooperative Project

Because yield losses due to this disease vary from year to year and are not easily measured, there has been little effort to develop resistant sugar beet hybrids. Colorado State University personnel have been incorporating disease resistance to local strains of the bean pathogen into pinto bean varieties in recent years. Nonetheless, Fusarium yellows continues to be a serious problem for growers throughout the Central Great Plains, such as the Fort Morgan to Sedgwick area of Colorado. Additionally, it is difficult to identify the different species of *Fusarium* using a microscope and other laboratory procedures, and impossible to determine whether they are sugar beet or dry bean types without a greenhouse test on the plants. Screening for Fusarium yellows requires precise and laborious laboratory conditions to identify isolates and races of *Fusarium oxysporum*. Evaluations are not always repeatable or accurate, even with replication; however, recently, methods based on new biotechnologies have been used to “fingerprint” isolates.



In 1997, a multi-disciplinary and multi-agency team of scientists and industry collaborators joined to: 1) define the extent of the disease in sugar beet and dry bean production areas, 2) collect samples of diseased plants, 3) isolate and purify cultures of the pathogen, 4) conduct laboratory tests to study cultural and molecular variability, 5) initiate greenhouse studies to verify pathogenicity of fungal cultures on diverse hosts and germplasm, and (6) develop tools based on new biotechnologies to identify different isolates of the fungus. The ultimate goals of this project are to provide updated disease management educational materials for integrated pest management technology transfer and to identify resistant parents that can be most effectively utilized by researchers involved with germplasm improvement programs at Colorado State University and the USDA.

Pathogen Survival and Variability

The pathogen is a soil-borne fungus that survives as microscopic spores (chlamydospores) which germinate and infect the sugar beet or bean root under favorable conditions. The fungus invades water-conducting tissues of the root and grows upward into leaf petioles and stems of sugar beet and/or bean plants. Optimum conditions for infection are a temperature of 80 degrees Fahrenheit or greater, combined with other stress factors such as herbicide, fertilizer, salinity damage to roots, soil compaction, moisture extremes, and poor water drainage.

Recent tests with a large collection of fungal isolates from Colorado and Nebraska, detected a great deal of variability (low to high) in the ability to cause disease within fungal isolates recovered from sugar beet and dry bean plants. An isolate originally recovered from an infected dry bean plant more than 10 years ago in Colorado has caused serious disease symptoms to stressed sugar beet seedlings in a greenhouse test, suggesting that some isolates of *Fusarium* may have a broader host range than expected. This variability is being studied with various tools in the laboratory, including molecular markers developed in this project.



Figure 1: Sugar beet plant wilting caused by Fusarium Wilt (photo by E.G. Ruppel, USDA ARS-retired).

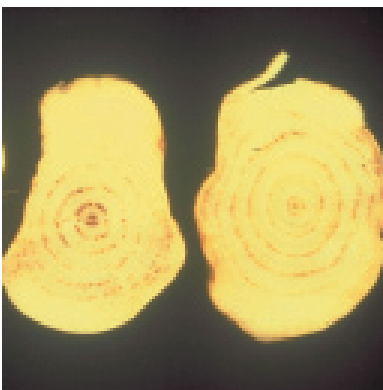


Figure 3: Sugar beet vascular discoloration caused by Fusarium Wilt (photo by E.G. Ruppel, USDA ARS-retired).

Disease Symptoms

Symptoms of *Fusarium* yellows of sugar beet include wilting of the foliage, yellowing between the veins in the leaves (interveinal chlorosis), and a darkening of the rings in the taproot. Plants can be affected at any stage from seedling until harvest; the majority of plant death appears to occur when plants are in the seedling stage to the four-leaf stage of growth. Dead plants are light brown and many remain visible until harvest. Although diseased plants may be scattered throughout the field, most occur in localized areas. Plants that were infected when young usually are stunted and show severe symptoms of interveinal chlorosis and marginal leaf browning.

Plants infected later in the season will be larger in size and usually show mild symptoms, consisting only of minor interveinal chlorosis. When plants are removed and roots sliced in cross section, many show a yellow-brown to gray discoloration of the water-conducting, vascular tissues.

Aboveground symptoms on dry bean appear on lower leaves that exhibit yellowing and wilting, which become more pronounced and progress upward into younger leaves. Stunting is evident, especially if plant infection and stress



Figure 2: Sugar beet plant yellowing caused by Fusarium Wilt (photo by E.G. Ruppel, USDA ARS-retired).



Figure 4: Soil compaction aggravates Fusarium Wilt of bean (photo by H. F. Schwartz, CSU).

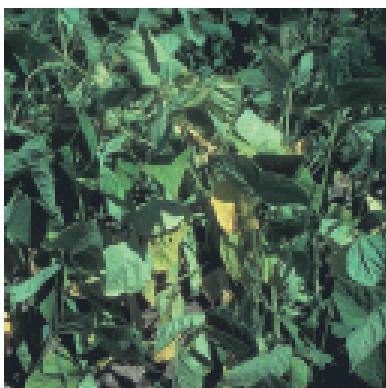


Figure 6: Fusarium Wilt yellowing and wilting of bean (photo by H. F. Schwartz, CSU).

occurred during the seedling and vegetative stages. The margins of infected leaves turn tan to brown, and diseased plants become progressively more yellow. Severely infected plants exhibit permanent wilting and premature defoliation. Vascular discoloration on the main stem is the diagnostic symptom usually evident after the initial appearance of foliar symptoms. The reddish-brown vascular discoloration of root, stem, and petiole tissue of infected plants will vary considerably in intensity, depending on variety reaction, severity of infection, and environmental conditions.

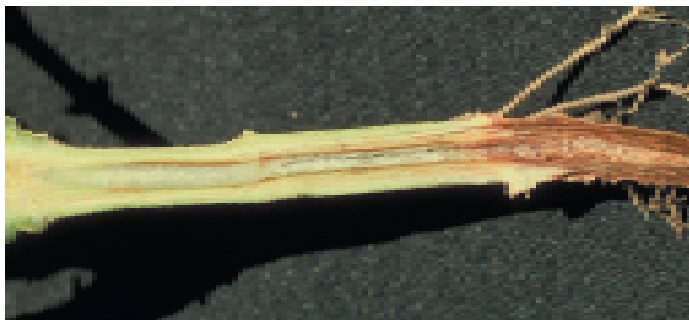


Figure 5: Fusarium Wilt discoloration of bean plant stem (photo by H. F. Schwartz, CSU).

Bean Disease Management

- Plant certified seed of Fusarium wilt-tolerant or resistant varieties , if available.
- Treat seed or furrow with recommended fungicides to delay initial infection of seedlings by Fusarium and other soil-borne pathogens, including Pythium and Rhizoctonia.
- Don't follow dry beans with sugar beets; rotate for three to five years with non-host crops such as corn, wheat, barley or alfalfa.
- Good weed management is important to reduce populations of other potential hosts such as pigweed (susceptible to sugar beet strains of Fusarium).
- Plant when the surface 2 to 6-inch soil temperature is warm (above 60 F) for rapid germination of seed to promote rapid emergence and good root vigor.
- Chiseling (sub-soiling) 10 to 20 inches deep between crop rows reduces soil compaction and promotes water movement and root penetration.
- Manage irrigation to eliminate moisture stress to the developing plant, but avoid excess water, which may deprive roots of oxygen.
- Space plants at recommended distances with crop rows to reduce plant competition for water and nutrients, without sacrificing ground cover and yield potential of the crop.
- Till soil up around the base of infected bean plants to enhance lateral root development above infected portions of the hypocotyl.

Sugar Beet Disease Management

- Plant certified seed of Fusarium wilt-tolerant or resistant varieties, if available.
- Treat seed or furrow with recommended fungicides to delay initial infection of seedlings by Fusarium and other soil-borne pathogens including Pythium and Rhizoctonia.
- Don't follow sugar beet with dry bean; rotate for three to five years with non-host crops such as corn, wheat, barley or alfalfa.

- Good weed management is important to reduce populations of other potential hosts such as pigweed (susceptible to sugar beet strains of *Fusarium*).
- Plant when the surface 2 to 6-inch soil temperature is cool (less than 60 F) for rapid germination of seed to promote rapid emergence and good root vigor.
- Chiseling (sub-soiling) 10 to 20 inches deep between crop rows reduces soil compaction, and promotes water movement and root penetration.
- Manage irrigation to eliminate moisture stress to the developing plant, but avoid excess water, which may deprive roots of oxygen.
- Space plants at recommended distances with crop rows to reduce plant competition for water and nutrients, without sacrificing ground cover and yield potential of the crop.
- Be careful during tillage operations to avoid movement of soil (contaminated with other pathogens such as *Rhizoctonia solani*) into susceptible crown tissues.
- Properly dispose of sugar beet tare soil to avoid introduction of the *Fusarium* pathogen (or new races) into the field.

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