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report on
PLANT
DISEASE

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FUSARIUM YELLOWS OF CABBAGE AND RELATED CROPS

Fusarium yellows is a warm-weather disease caused by the soilborne fungus *Fusarium oxysporum* f. sp. *conglutinans*. Five strains or races of the fungus are known and described: Strain 1 infects cabbage, Brussels sprout, cauliflower, collard, and kale; strain 2 attacks radish; strains 3 and 4 are found on flowering stock; and strain 5 is found on cabbage. The fungus is closely related to, but distinct from, fungi causing Fusarium wilts of melons, peas, pepper, potato, sweet potato, tomato, carnation, China aster, gladiolus, cotton, and numerous other plants.

Figure 1. Partially grown cabbage plant showing distortion of the lower leaves caused by Fusarium yellows.

The disease is common on cabbage in home gardens throughout the Midwest but is of lessening importance to commercial growers, because most of them now plant highly resistant varieties. In thoroughly infested soils, susceptible cabbage and radish varieties may be completely destroyed.

Many crucifers, or members of the cabbage family, are susceptible to Fusarium yellows or wilt. They include cabbage, broccoli, Brussels sprout, cauliflower, Chinese cabbage, collard, kale, kohlrabi, mustards, radishes, rape, rutabaga, seakale, turnips, and watercress.

Figure 2. Leaves affected by Fusarium yellows dropping away from plant.

SYMPTOMS

Since cabbage is the most commonly affected crucifer in Illinois, the symptoms of yellows on this crop are the ones described here. The symptoms on related crucifer plants are similar.

The first and most apparent symptom is a dull green to yellowish green color of the leaves of plants in the seedbed or in the field within a month after transplanting. Young plants may be stunted, turn yellow, and die rapidly in warm soils. The lower leaves develop a one-sided warping or curling (Figure 1), with the yellow color being more intense on one side of the leaf midrib than on the other. The stem may be twisted toward one side. Yellowing, browning, and withering of the leaves progresses up the plant. Affected

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leaves drop prematurely (Figure 2), and growth is retarded. Very susceptible plants may die within a few weeks, while others in the same field or garden may live for a month or more. Some even survive the season, but head imperfectly. Resistant plants, or susceptible plants growing in cool soil, may show symptoms on the lowest leaves but produce normal heads. Early varieties planted early may escape the disease until they approach maturity.

A yellow to dark brown discoloration can be seen in the water-conducting vessels (xylem) in the stem, petioles, and veins of the leaves when they are cut through. Fusarium yellows is often confused with black rot, a bacterial disease in which the vascular bundles and the smaller veins in diseased leaves are black, while those affected by Fusarium yellows are yellow to brown. On radish, symptoms include a yellowing of the lower leaves starting on one side of the plant. Later, all the leaves turn yellow and fall prematurely, leaving a bare stem.

DISEASE CYCLE

The *Fusarium* fungus survives and may actually increase in a number of soil types for many years, independent of any host plants. This ability to survive eliminates any normal rotation program or general sanitation as an effective control measure. Fusarium yellows is, however, almost completely checked when the average soil temperature is below 61°F (16°C). The appearance and severity of the disease are increased when air and soil temperature averages rise above this point. The fungus grows most rapidly and the disease is most severe at temperatures from 80° to 85°F (26° to 29°C). Growth is inhibited at 90° to 95°F (32° to 35°C). Soil moisture and soil reaction (pH) have little effect on Fusarium yellows. However, soil nutrient status can critically affect symptoms expression; potassium deficiency leads to a much intensified syndrome.

The *Fusarium* fungus invades the plant through the young rootlets or wounds in the older roots at transplanting time or later. The fungus then moves directly to the water-conducting tissues (xylem) and then progresses up the stem into the leaves. The fungus colonizes the xylem tissues and does not invade other tissues until part or all of the plant dies. The fungus then produces its spores both inside and outside affected stems (Figure 3).

Dissemination of the fungus takes place from seedbed to field or from one field or garden to another by infected transplants, infested soil clinging to transplants, farm equipment, plant refuse, animals, surface-drainage water, and wind. Occasionally, the yellows fungus is carried long distances in seeds.

The *Fusarium* fungus produces three kinds of microscopic spores: small, colorless, one-celled, oval to elliptical microconidia; large, slightly curved, septate macroconidia; and rounded, thick-walled chlamydospores (Figure 3) that can survive long periods in the soil being resistant to unfavorable environmental conditions.

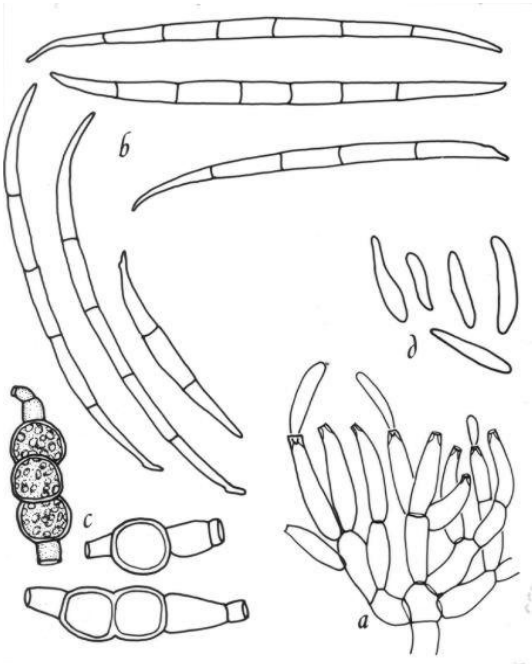

Figure 3. Fusarium oxysporum, the fungus that causes Fusarium yellows of cabbage and unrelated plants, as it would be seen under a high-power laboratory microscope: (a) conidiophores, many bearing macroconidia; (b) macroconidia; (c) microconidia; (d) thick-walled chlamydospores (drawing by L. Gray)

CONTROL

1. Once the Fusarium yellow fungus is present in a field or garden, the only successful control in cabbage is to grow yellows-resistant varieties. There are two types of resistance, A and B. Cabbage varieties with type A are uniformly resistant regardless of the soil temperature. Varieties with type B show a relatively high degree of resistance when average soil temperatures are below 70°F (21°C) and when grown at optimum soil fertility levels. As the soil temperature increases, type B resistance breaks down. At about 77°F (25°C) or above, type B-resistant plants become infected and killed while type A-resistant plants remain unaffected. Type B resistance is found principally in the older, late-maturing cabbage varieties such as 'Bugner', 'Red Hollander', 'Resistant Flat Dutch', 'Wisconsin All Seasons', and 'Wisconsin Hollander'. Most of the modern Fusarium-resistant cabbage varieties carry type A resistance. For information on recommended varieties for Illinois read Illinois Extension Circular 1331, Vegetable Gardening in the Midwest, and Circular 1373, Midwest Vegetable Production Guide for Commercial Growers, available from Information Technology and Communication Services, University of Illinois, P345, 1917 S. Wright St., Champaign, IL 61820.

2. Radish yellows is also effectively controlled through the use of resistant varieties. Refer to the publications listed above for recommended varieties. Radish usually escapes infection if planted in early spring or in the fall when soil temperatures are low.

3. Most varieties of broccoli, Brussels sprout, and cauliflower have a high degree of natural resistance to yellows except in hot, dry seasons. Kale, kohlrabi, and collard are generally very susceptible while Siberian kale is resistant.

4. Susceptible crucifers should not be planted in areas that are likely to receive surface-drainage water from infested fields.

5. Grow transplants in soil that has been disinfested by steam or a soil fumigant.

6. Rotate the field or garden to nonhost crops such as lettuce, peppers, or tomatoes for several years to prevent buildup fo the *Fusarium* fungus in the soil.

7. In fields and gardens where the disease has not appeared, extreme caution is needed to exclude infected crucifer transplants. Purchase only certified, disease-free seed or transplants of resistant varieties. Keep the fungus out of yellows-free fields and gardens by preventing the spread of infested soil carried on equipment, tools, feet, and running water. Do not put crop debris in compost or manure piles.