

## Red Stele of Strawberry

*Phytophthora fragariae* (Hickman)

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Red stele is a destructive disease in most strawberry-producing regions of the world in which soils tend to be cool and wet. Although red stele does not occur on all farms in New York, it is common on poorly drained soils, particularly during wet spring seasons or those following a rainy autumn.

### Symptoms

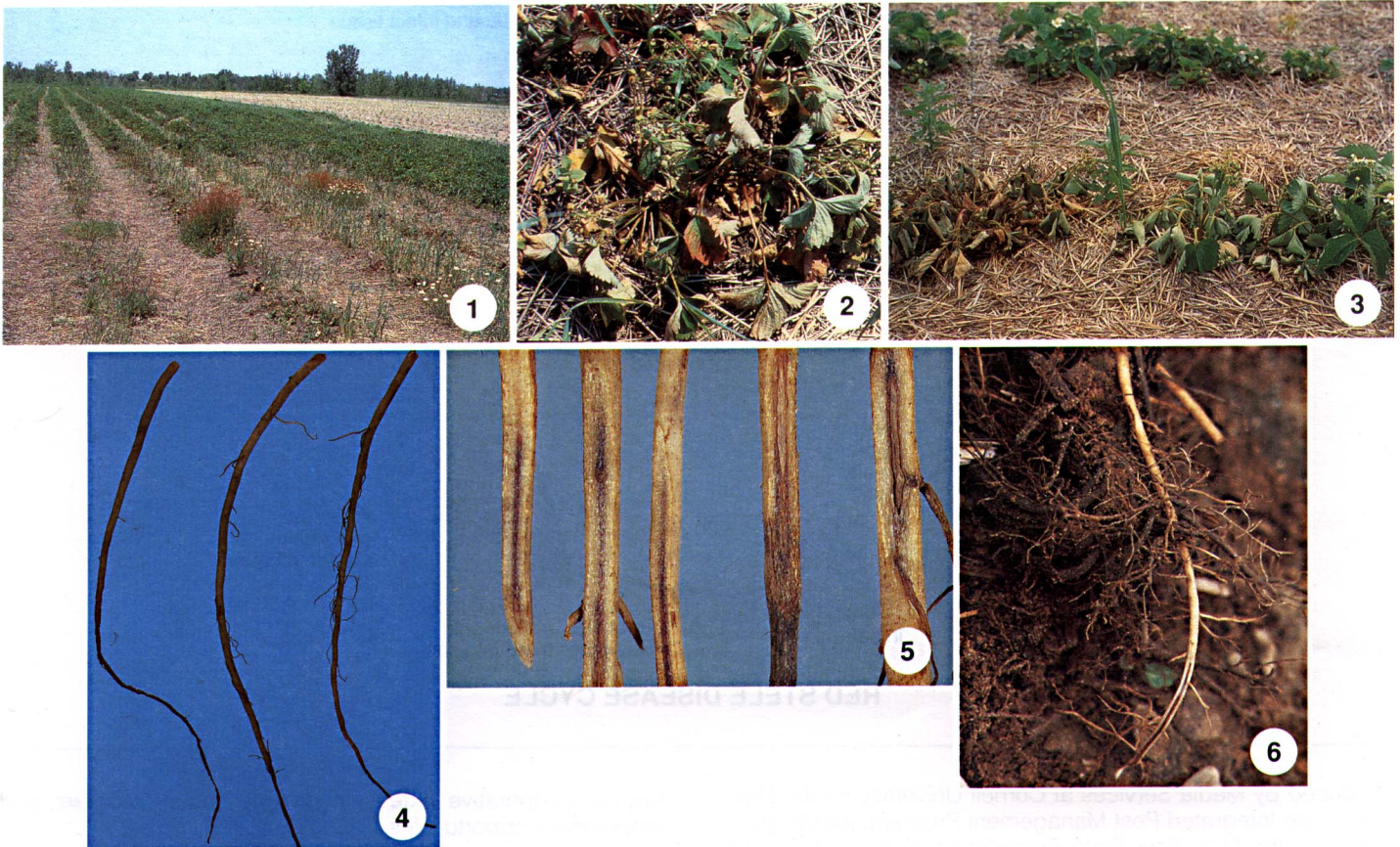
Symptoms are most pronounced in the spring between bloom and harvest. Infected plants usually occur in patches in portions of the field where the soil is wettest (fig. 1). Diseased plants are stunted and produce few runners. New leaves may be a dull bluish green in color, whereas older leaves sometimes turn red, orange, or yellow (fig. 2). The leaves begin to wilt when the

weather turns warm, and severely infected plants may collapse and die before harvest time (fig. 3).

These foliar symptoms are typical of red stele but may also be caused by other root disorders and therefore are not diagnostic. The most reliable symptom of red stele is found within the roots and may be observed by gently digging up a few plants that are just beginning to wilt, taking care to preserve the root system. Plants with red stele usually have few fine lateral roots so the main fleshy roots have a "rat-tail" appearance. During intermediate stages of disease development, these fleshy roots will be white near the crown of the plant but will show a dark rot progressing upward from the tips (fig. 4). When the white outer portion of the root just above this rotten zone is peeled off or sliced through, the root core (or stele) will appear to be dark red (figs. 5 and 6). It may be necessary to examine several rotting roots before finding a red stele, but this symptom is very distinctive and is diagnostic for the disease. Reddened steles are relatively difficult to find after harvest because most infected roots have died and begun to decay by then.

### Disease Cycle

Red stele is caused by the soilborne fungus *Phytophthora fragariae*. This fungus is not a natural inhabitant of most agricultural soils but probably is introduced on nursery stock or by the



movement of infested soil and runoff water from fields in which the disease occurred previously. *P. fragariae* is very persistent and can survive in a field for many years once it has become established, even if no strawberries are grown during that time. The organism that causes red stele of strawberry is not known to cause disease on any other crop, with the possible exception of loganberry.

*P. fragariae* persists in the soil as thick-walled resting spores (oospores). When the soil is moist or wet, some of the oospores germinate and form structures called sporangia, which are filled with the infectious spores of the fungus (zoospores). These microscopic zoospores are released into the soil when it becomes completely saturated with water (flooded or puddled) and use tail-like structures to swim short distances through water-filled soil pores to the tips of strawberry roots, to which they are chemically attracted. Zoospores also may swim to the soil surface, where surface runoff water may carry them relatively long distances. Zoospore activity may occur at soil temperatures ranging from about 38° to 77° F (4° to 25° C), but is most significant from 44° to 59° F (7° to 15° C). Thus infection is most likely in the spring and fall.

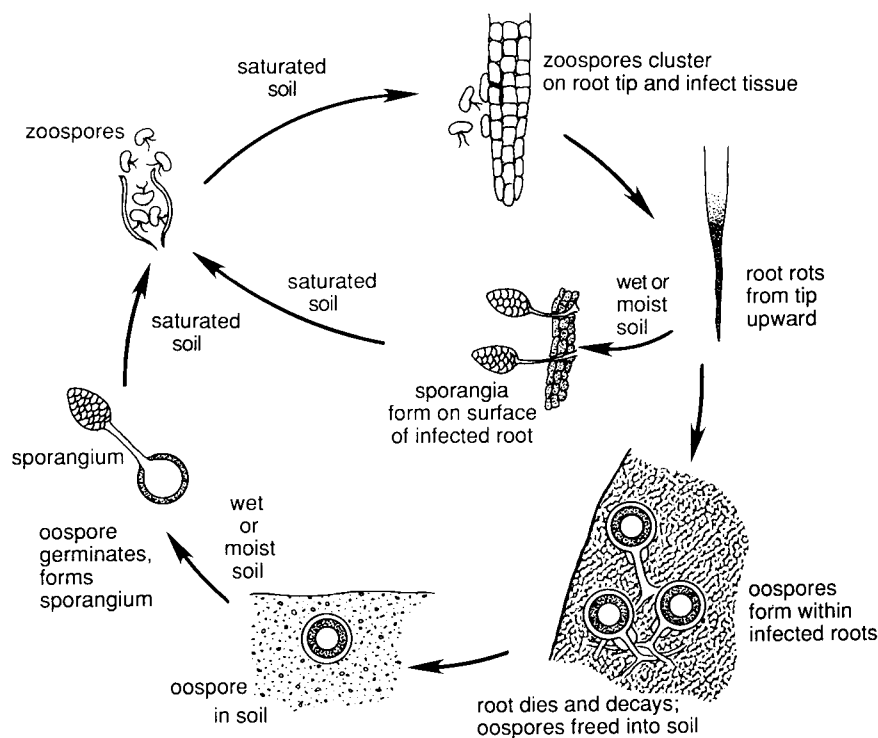
Once zoospores have infected the root tip, the fungus begins to grow up into other parts of the root, causing the characteristic dark rot and red stele symptoms. New sporangia are formed along the outside of infected root tissue and release additional zoospores whenever the soil is saturated, thereby continuing to spread the disease. The fungus produces oospores within infected roots as they begin to rot and die, and these oospores are released into the soil when the roots decay, thus completing the disease cycle.

## Control

Since significant production and movement of infective zoospores occurs only during periods when the soil is completely saturated, the key to control is drainage. Strawberries should not be planted in low-lying or heavy soils where water accumulates or is slow to drain. On marginal soils, planting strawberries on beds raised at least 10 inches high will bring much of the root system above the zone of greatest pathogen activity and the severity of red stele root rot will be significantly reduced.

Strawberry varieties highly resistant to red stele should be seriously considered for planting in a marginally drained site or a field in which red stele has been suspected of occurring in the past. Only resistant varieties should be planted in a field where red stele is known to have caused losses within the last 5 to 10 years. Resistant varieties include Allstar, Earliglow, Guardian, Midway, Redchief, Scott, Sparkle, Surecrop, and the day-neutral cultivars Tribute and Tristar. Many new varieties currently under evaluation, particularly those from the U.S. Department of Agriculture breeding program, also are resistant to red stele. All "resistant" varieties, however, are resistant only to certain common races of the red stele fungus and can become diseased if exposed to other races of the pathogen.

It is important to minimize the chance of introducing the red stele fungus into a field where it does not already exist. Buy nursery stock only from a reputable supplier, and take care not to transfer soil on farm implements from an infested field into a clean one. New fungicides active against red stele also help in controlling this disease but are most effective when used in combination with good soil water management practices. Check current recommendations for availability and restrictions.



**RED STELE DISEASE CYCLE**