
Identification and Control of Seedling Diseases, Root Rot, and Rhizomania on Sugarbeet

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Seedling diseases and root rot of sugarbeet occur annually in the Red River Valley (RRV) and southern Minnesota. Rhizomania, another root disease, was identified in southern Minnesota in 1996 and in one field in the RRV in 1997. Prevalence and severity of these diseases varies among regions and fields and within fields during a single growing season. Variation within the same field from one sugarbeet-growing season to the next also can occur. Disease severity is determined by: the amount of pathogen in the soil; susceptibility of the sugarbeet variety; environmental factors, especially soil moisture and temperature; and effectiveness of disease control measures in previous seasons.

This bulletin discusses the pathogens that cause seedling diseases, root rot, and rhizomania. A section on "impostors" – some problems that resemble seedling and root rot diseases – also is included.

Seedling Diseases

Sugarbeet seedlings are susceptible to fungi that cause seed rot, damping-off, and root rot. Damping-off occurs quickly (within a day or two after onset of symptoms), after which infected seedlings dry up and blow away. Unless a field is watched carefully, it is difficult to determine if poor stands occurred because seed rotted in the ground, seedlings died before emergence, or if seedlings emerged and then died.

Most seedling diseases in Minnesota and North Dakota are caused by fungi that live in soil (soilborne fungi). These fungi include *Pythium* species, *Aphanomyces cochlioides*, and *Rhizoctonia solani*. *Phoma betae* is a seedborne fungal pathogen that also infects sugarbeet seedlings, but it has not been a problem in Minnesota and North Dakota in recent years. Occurrence of rainy weather in seed production fields in Oregon favors invasion of seed by *P. betae* at harvest. If present in seed, this fungus causes damping-off of sugarbeet seedlings.

Fungi that cause seedling diseases produce similar symptoms, so positive identification of the pathogen(s) that cause stand loss should be verified. Sometimes only one pathogen causes disease in a field. In other cases, two or more pathogens attack plants in the same field, or even the same plant, and result in a seedling disease "complex." Ways to determine the cause(s) of seedling stand establishment problems include laboratory analysis of symptomatic plants, assay of soil samples, and knowledge of field history.

Laboratory analysis of symptomatic plants

Seedlings displaying the range of symptoms observed should be removed from soil with a spade. Then, soil should be carefully removed and the seedlings gently washed, blotted dry, wrapped in paper towels, and placed in a plastic bag. Samples can be stored in a cooler or refrigerator for 24 hours or transported immediately to a private or university diagnostic laboratory for analysis. Include healthy plants for comparison to unhealthy plants. A competent field advisor also should make an on-site inspection of the field.

Results of a laboratory analysis sometimes are inconclusive – that is, no pathogens are isolated. This can happen even when plants have typical symptoms of disease. Such results occur when plants have been infected for a long time or are in an advanced state of decay. Pathogens are not detected because they cannot grow in the presence of the many secondary microorganisms invading and disintegrating diseased roots.

Assay of soil samples

When a laboratory analysis of plants is inconclusive, or if producers have not confirmed the cause of stand establishment problems or root rot in previous seasons, a soil assay can be helpful. This assay, however, is recommended only when *Aphanomyces* is suspected. It is not used for *Pythium* species (they occur in all fields) or *Rhizoctonia solani* (populations usually are too low to detect). Soil samples should be collected from the portion of the field in question. The assay consists of a four to five week analysis in the greenhouse and laboratory. For information on collection and storage of soil samples and for details on the assay, contact the Plant Disease Clinic, 495 Borlaug Hall, 1991 Upper Buford Circle, University of Minnesota, St. Paul, MN 55108 (612/625-6290) or sugarbeet cooperative.

Field history

Familiarity with the history of a field can provide clues important to understanding the cause of stand establishment problems. Consider the past and present climate and production history of the field. A number of factors cause symptoms similar to seedling diseases, including insect damage, wind injury, heat, drought, frost, insecticides, soil fertility, and misapplication, drift, or carryover of herbicides.

Results of previous laboratory analyses of sugarbeet plant or soil samples can be helpful but may be misleading in diagnosing a current problem. For instance, fields with a history of disease problems may have poor stands not because of disease, but because of adverse environmental conditions or injury from pesticides. The amount of soil moisture can favor infection by one fungus and not another, although two or more fungal pathogens are present. Some fungi cause disease even after fields have been out of sugarbeet production for several years. *Pythium* species and *Aphanomyces cochlioides* survive in soil for years in the absence of a sugarbeet crop, while populations of *Rhizoctonia solani* decrease or increase depending upon length of rotation and the crop sequence.

Pythium species

This "water mold" fungus occurs in **all** fields. *Pythium* requires moist or wet soil to infect seeds and seedlings. *Pythium* can infect and rot seeds before or as they germinate. The disease is characterized by a brown, water-soaked discoloration of the seedling before or shortly after emergence (Figure 1). Commercial sugarbeet seed is pretreated with fungicides that usually control *Pythium* diseases effectively. When conditions slow or delay emergence, *Pythium* can cause seed rot (even when seed is treated with fungicide). These conditions include deep planting, cold weather, and excessive soil moisture (especially in poorly drained or fallowed fields). Under extremely wet conditions, *Pythium* also causes damping-off, usually within the first week of emergence (Figure 1).

Figure 1. Symptoms of *Pythium* damping-off include brown, water-soaked seedlings, usually within one week of emergence. (73KB color image)

Among the species of *Pythium* that are pathogenic to sugarbeet, *P. ultimum* var. *sporangiiiferum* and *P. aphanidermatum* predominate in the RRV and in southern Minnesota. Symptoms caused by *P. ultimum* are indistinguishable from those produced by *P. aphanidermatum*.

Pythium ultimum is the most common and widespread species. It attacks unprotected seed (no fungicide treatment) at the same temperatures that favor germination of sugarbeet seed (40-95 degrees Fahrenheit). The fungus grows over a temperature range from 40 to 95 F and attacks germinating seed most actively at 60-80 F.

Pythium aphanidermatum is a high temperature fungus. It attacks seeds and seedlings at temperatures from 50 to 105 F, with most infections occurring at 85-95 F.

Aphanomyces cochlioides

Damping-off caused by *A. cochlioides* is the most prevalent and serious soilborne fungal disease of sugarbeet in warm, wet seasons, especially in late-planted fields. Many fields in the southern RRV are infested with *A. cochlioides*; in recent wet years this fungus also has been active in the northern RRV. The fungus is prevalent in sugarbeet fields in southern Minnesota. In 1993, a season with abundant rainfall and warm weather, about 50% of the sugarbeet fields in southern Minnesota had symptoms of *Aphanomyces* diseases compared to about 15% of the fields in the southern RRV.

Under warm, wet soil conditions, overwintering spores (oospores) of *A. cochlioides* are stimulated to germinate by exudates from sugarbeet roots. The fungus then produces and releases motile zoospores that swim through water and infect roots. Sugarbeet plants are susceptible to infection throughout the growing season.

Aphanomyces cochlioides rarely causes seed rot, but damping-off occurs frequently in warm (68-86 F), wet soil. Infection seldom occurs when soil temperatures are less than 60 F. The fungus infects seedling roots and the hypocotyl (region between the cotyledons and seed). Symptoms include brown, water-soaked tissue that can extend up to and include the cotyledons (Figure 2). The infected hypocotyl and root rapidly turn black and shrink to a dark, slender thread (Figure 3).

Figure 2. Symptoms of *Aphanomyces* damping-off include a dark brown to black rot and thread-like appearance of the seedling. (76KB color image)

Figure 3. Young sugarbeet plants infected by *Aphanomyces cochlioides* are characterized by black roots and hypocotyls that shrink to a dark, slender thread. Healthy plant is on the left. (41KB color image)

Pythium causes damping-off most frequently **during** the first week of emergence, while *A. cochlioides* does not begin to cause damping-off until **after** the first week of emergence, at the earliest (Figure 4). Also, *A. cochlioides* causes more extensive stand losses than do *Pythium* species.

Figure 4. *Pythium* causes damping-off most frequently during the first week of emergence whereas *A. cochlioides* starts to cause damping-off after the first week of emergence. (4KB B & W image)

Seedlings infected by *A. cochlioides* occur in patches ranging in size from a few feet in diameter to extreme cases where entire fields of two- to five-week old plants are destroyed. Disease frequently occurs in portions of fields that tend to remain wet – near drainage ditches, on hill sides, in low spots, or in compacted areas. Disease develops in light-textured soils but is favored in heavy-textured soils, which tend to hold water. As soil dries, surviving seedlings resume growth and may produce numerous lateral roots (Figure 5), a symptom sometimes confused with rhizomania. Excessive production of lateral roots is a general plant response to loss of a root tip and can be caused by disease or other damage.

Figure 5. Excessive production of lateral roots on sugarbeet seedlings surviving infection by *Aphanomyces cochlioides*. This also is a general plant response to loss of a root tip caused by disease or other damage. (59KB color image)

If *Aphanomyces*-infected seedlings survive and the soil remains dry, adult roots are malformed and scarred (Figure 6). Yields are significantly reduced.

Figure 6. During dry periods, *Aphanomyces*-infected seedlings and older plants produce roots that are malformed and scarred in appearance. (52KB color image)

Aphanomyces damping-off tends to occur more frequently in fields planted to sugarbeet for many years, especially fields in short rotations. The disease, however, can occur during the first or second season of sugarbeet production. In these cases, inoculum of *A. cochlioides* likely increased on roots of susceptible weeds before a sugarbeet crop was planted.

Rhizoctonia solani

This fungus can cause seed rot but more often causes damping-off or stunting of young plants. *Rhizoctonia solani* occurs in most fields, but at low concentrations of inoculum. The damage it causes rarely warrants replanting. Occasionally, a few acres within a field are replanted because of early-season damage caused by *R. solani*.

Infections occur below the soil surface, but symptoms can extend up the hypocotyl (Figure 7). A sharp margin of demarcation develops between the brown to dark-brown lesions girdling the root and white healthy tissue. On older seedlings, infected roots sometimes are stunted, with brown, sunken lesions on lateral roots and taproots (Figure 8). Lightly infected seedlings often survive and produce roots that are nearly normal.

Figure 7. Symptoms of *Rhizoctonia solani* on a sugarbeet seedling where rot occurs on the upper root and hypocotyl. Healthy beet is on the right. (59KB color image)

Figure 8. Stunting and root tip necrosis on sugarbeet seedlings infected by *Rhizoctonia solani*. Healthy plants are on the left. (34KB color image)

Rhizoctonia solani is active over a temperature range from 54 to 95 F, but it is particularly active from 68 to 86 F. Beet

seedlings usually escape infection when soil temperatures are less than 60 F. The fungus infects seedlings when soil moisture conditions range from somewhat dry to wet. In wet soil, *R. solani* can grow from plant to plant, damaging or killing several adjacent plants. Infected seedlings occur in patches or as scattered plants.

Rhizoctonia solani is composed of several strains referred to as anastomosis groups or AGs. Four strains of *R. solani* have been isolated from diseased sugarbeet seedlings in fields throughout the RRV and southern Minnesota. The prevalent strain of *R. solani* on sugarbeet seedlings is AG-4. Other strains, including AG-1, AG-2-2, and AG-5, occur less frequently. Several crops rotated with sugarbeet also are susceptible to AG-1, AG-2-2, AG-4, and AG-5 (Table 1). Corn is susceptible to AG-2-2 in Georgia but it is unknown if corn is infected by AG-2-2 in Minnesota and North Dakota.

Table 1. Host range of anastomosis groups (AGs) of *Rhizoctonia solani* on some crops grown in the Red River Valley and southern Minnesota.

R. solani	Susceptible crops
AG-1	Sugarbeet, Soybean, Edible Beans, Flax, Alfalfa
AG-2-2	Sugarbeet, Soybean, Edible Beans, Flax, Canola, Sunflower, Corn
AG-3	Potato
AG-4	Sugarbeet, Soybean, Edible Beans, Flax, Canola, Sunflower, Alfalfa, Potato
AG-5	Potato, Soybean

In some fields, *Pythium* species, *A. cochlioides*, and *R. solani* occur together. When soil is warm and wet, *A. cochlioides* causes the most significant damage among these seedling pathogens. When soil temperatures are below 60 F, *P. ultimum* infects seedlings, but *P. aphanidermatum*, *A. cochlioides*, and *R. solani* rarely cause disease. At temperatures above 68 F, all of these fungi cause disease when soil is wet, but only *R. solani* causes disease if soil is somewhat dry.

Root Rots

In Minnesota and North Dakota, root rot of sugarbeet is caused by *Aphanomyces cochlioides* and *Rhizoctonia solani*. *Pythium* root rot on older beets is **extremely** rare. Seedling diseases caused by *A. cochlioides* and *R. solani* often are indistinguishable based on symptoms, but root rot on older plants caused by these fungi usually can be distinguished by symptoms. It is important, however, to examine roots of several diseased plants for symptoms **before** plants are severely rotted or die. Symptoms of both fungi can occur in the same field and, occasionally, on the same root. The cause(s) of root rot also can be identified by laboratory analysis of symptomatic plants, assay of soil samples, and knowledge of field history, as described in the section on seedling diseases.

Pythium

Pythium root rot is characterized by a black lesion that develops on the root surface (Figure 9). Rot may be extensive in the interior of the beet. In instances where this disease has been observed in the RRV, fields were extremely wet for about 10 to 14 days.

Figure 9. *Pythium* root rot occurs under prolonged, extremely wet soil conditions. Healthy plant is on the left. (64KB color image)

Aphanomyces cochlioides

In wet seasons, *Aphanomyces* root rot occurs throughout the summer until harvest. Root rot can develop in plants that were infected as seedlings or from new infections on sound older roots.

Disease occurs in patches ranging from a few feet in diameter to the entire field. Aboveground symptoms include undersized plants with considerable yellowing of lower leaves (Figure 10). Infected plants wilt during afternoons of hot sunny days and appear to recover overnight and on cool cloudy days. If a crop insurance adjuster will be assessing a field

for losses caused by *Aphanomyces* root rot, schedule the inspection on a hot sunny day when plants are wilted so prevalence of the disease is easy to observe.

[Figure 10](#). Sugarbeet affected by *Aphanomyces* root rot (left) compared to healthy plant (right). Note stunting and yellowing of lower leaves of diseased plant. (136KB color image)

Below ground, a brown to black rot develops at the root tip and at junctures of lateral roots (Figure 11). Infected plants can be severely stunted (Figure 12) or the basal portion of the root is fibrous or tasseled (Figure 13). Infected plants often survive, but when foliage is mechanically removed at harvest, rotted roots are easily dislodged or are too small to be harvested. Roots that recover from seedling infections or survive late-season infections ([Figure 6](#)) have reduced yield and sucrose content and higher levels of impurities (non-sucrose constituents), which makes sucrose extraction difficult and expensive. If diseased beets are mixed with healthy roots in storage piles, the quality of the entire pile can be reduced.

[Figure 11](#). Sugarbeet root severely affected by *Aphanomyces* root rot (right), with lateral root infections (middle) and a healthy root (left).

(51KB color image)

[Figure 12](#). *Aphanomyces* root rot can result in severe stunting compared to a healthy root (left). (93KB color image)

[Figure 13](#). Deteriorated, shredded root tip of a mature sugarbeet with *Aphanomyces* root rot. (51KB color image)

Rhizoctonia solani

Rhizoctonia root and crown rot is caused by *R. solani* AG-2-2. The disease begins to occur when plants are about eight weeks old (mid to late June), but roots can become infected throughout the season. Aboveground symptoms of *Rhizoctonia* root and crown rot include yellowing and sudden wilting of leaves. Petioles of the outer leaves are blackened at the point of attachment to the crown (Figures 14-17) and often lay flat on the ground. This disease frequently occurs on scattered plants or on several adjacent plants in a row (Figure 14). A dark brown-gray rot starts near the crown and spreads over the root surface. Symptoms vary from slightly sunken lesions scattered over the root to complete rotting and cracking of the surface (Figure 15). *Rhizoctonia* root and crown rot is favored when soil containing the fungus is thrown into crowns of plants during cultivation (Figure 16).

[Figure 14](#). Damage to sugarbeet foliage on plants affected by *Rhizoctonia* root and crown rot. Note darkened petioles.

(116KB color image)

[Figure 15](#). Taproot lesions caused by *Rhizoctonia solani*.

(58KB color image)

[Figure 16](#). Severe *Rhizoctonia* root and crown rot (right) caused by "hilling" of soil during cultivation; soil was not hilled around healthy plants (left). (126KB color image)

[Figure 17](#). *Rhizoctonia* root and crown rot of sugarbeet. Note damage to petioles. (64KB color image)

Rhizoctonia infections can encircle and sever the root 3 to 4 inches below the soil surface (Figure 17), so it is important to carefully remove the entire taproot with a hand trowel or shovel when diagnosing root diseases. If a rotted root is pulled from soil, a portion may remain behind, which can result in confusing symptoms of *Rhizoctonia* root and crown rot with *Aphanomyces* root rot.

In cool, wet seasons, a superficial dusty growth that is white to gray in color occasionally occurs on petioles near the beet crown (Figure 18). Disease symptoms do not appear on foliage, crowns, or roots of these plants. The dusty growth is the hymenium of *Thanatephorus cucumeris*, the sexual (spore-forming) phase of *Rhizoctonia solani*. It is of minor economic importance to sugarbeet, but in the RRV may be a source of genetic recombination in *R. solani* AG-3 (pathogenic to potato) and AG-5 (pathogenic to potato and soybean). Strains of *R. solani* (AG-2-2 and AG-4) that cause seedling diseases and root rot on sugarbeet also are reported to cause foliar blight as *T. cucumeris* in other regions of the U.S.A., but this symptom has not been observed in Minnesota or North Dakota.

[Figure 18](#). Hymenial layer of *Thanatephorus cucumeris* on petioles of a sugarbeet plant. (95KB color image)

[[NEXT](#)]

[[Control Measures for Seedling Diseases and Root Rots](#)] [[Rhizomania](#)]

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