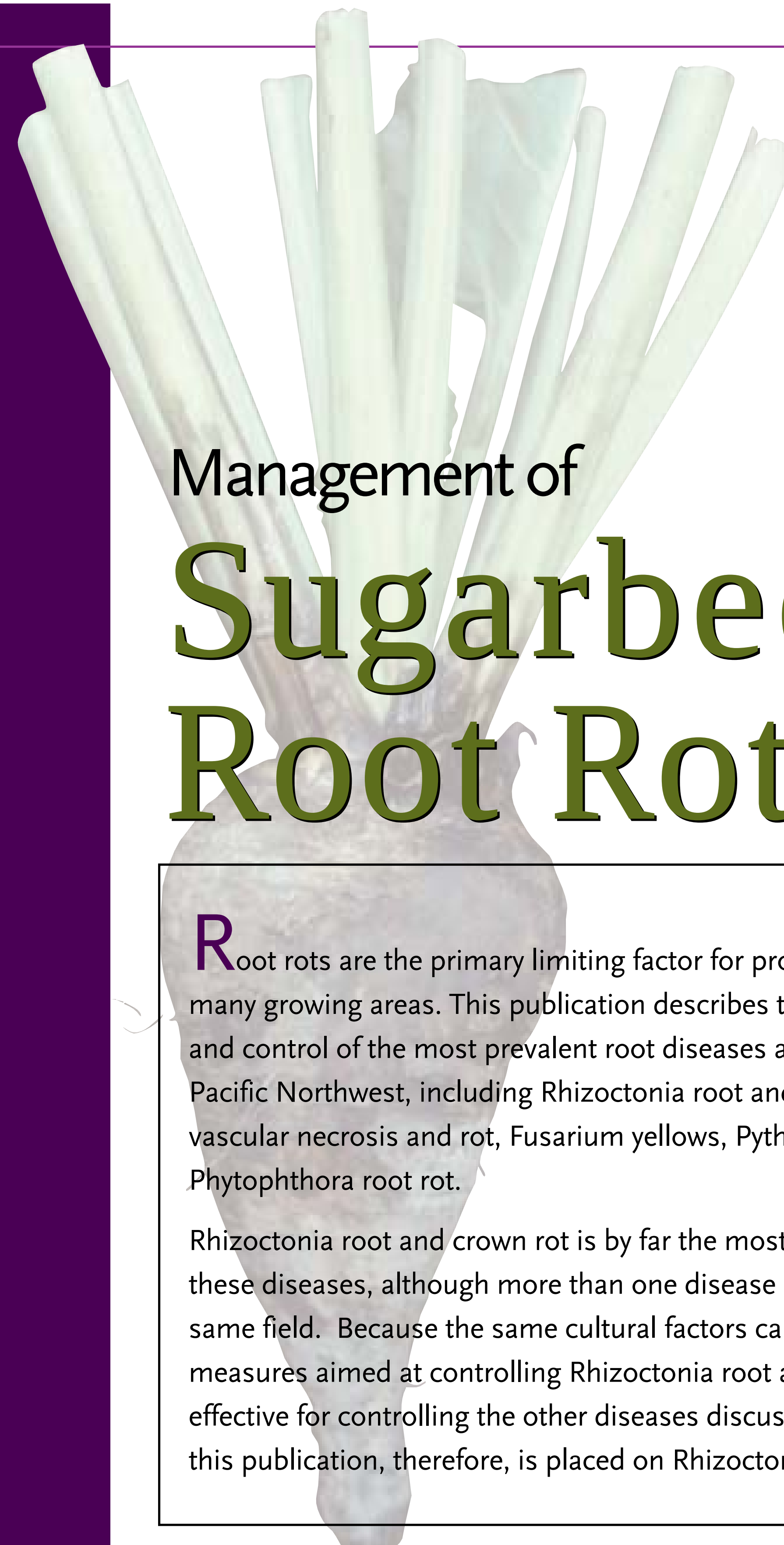

Management of Sugarbeet Root Rots

Root rots are the primary limiting factor for production of sugarbeets in many growing areas. This publication describes the symptoms, causes, and control of the most prevalent root diseases affecting sugarbeets in the Pacific Northwest, including Rhizoctonia root and crown rot, bacterial vascular necrosis and rot, Fusarium yellows, Pythium root rot, and Phytophthora root rot.

Rhizoctonia root and crown rot is by far the most common and serious of these diseases, although more than one disease can affect the crop in the same field. Because the same cultural factors can favor several diseases, measures aimed at controlling Rhizoctonia root and crown rot are usually effective for controlling the other diseases discussed here. Emphasis in this publication, therefore, is placed on Rhizoctonia root and crown rot.

A Pacific Northwest Extension Publication
University of Idaho • Oregon State University • Washington State University

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Rhizoctonia Root and Crown Rot

Root and crown rot caused by the soilborne fungus *Rhizoctonia solani* causes major losses in sugarbeets and occurs wherever the crop is grown. An estimated two percent of yield is lost to this disease annually, and it is not uncommon to observe 30 to 50 percent losses (Figure 1). Entire fields can be destroyed. In the Treasure Valley area of Idaho and eastern Oregon, the disease has traditionally caused the greatest losses, but in recent years Rhizoctonia root rot has been increasing significantly in the Magic and Upper Snake River Valleys. The disease is most severe in warm temperatures.

Rhizoctonia solani can also cause seedling disease, primarily as postemergence damping-off. Because of our normally cool soil temperatures at planting, however, other fungi are usually responsible for seedling disease in the Pacific Northwest. A foliar blight occurs in several U.S. sugarbeet growing areas with the occurrence of warm, wet weather, but it is not considered to be of economic importance.

Although *Rhizoctonia solani* has not been directly implicated as a storage rot organism, roots damaged by this fungus are predisposed to infection by bacteria and other fungi. These infections in the storage pile lead to hot spots that result in significant storage losses.

Symptoms

The first aboveground symptom of Rhizoctonia root and crown rot is wilting of the foliage, followed by yellowing and death of foliage, usually beginning on the older leaves. Petioles remain attached to the crown after they die (Figures 2 and 3). The base of the petioles will have dark brown to black lesions, and infected root tissue is dark brown to black (Figure 4). As the disease progresses, cankers and cracks may develop deep into the root, commonly on the side of the root or in the crown area. Brown fungal mycelium may be seen in the cracks. The pathogen can also attack the root in multiple areas which may lead to numerous slightly sunken lesions, with or without small cracks, on the root surface (Figure 5). The margin between healthy and diseased tissue in the interior is sharply defined. The rotted root tissue is firm but may become soft as secondary fungi and bacteria invade.

Causal organism

Rhizoctonia solani is the imperfect (asexual) stage of the sexual spore producing fungus *Thanatephorus cucumeris*. This sexual stage is rare but occasionally observed on the underside of infected petioles late in the season. *Rhizoctonia solani* occurs throughout the world in agricultural soils and infects many plant species. Although *R. solani* does not produce spores, its vegetative hyphae is quite characteristic and easily identified microscopically. Young

Figure 1. Typical appearance of a field with severe root and crown rot caused by the soilborne fungus *Rhizoctonia solani*.

Figure 2. Typical initial disease symptoms, showing wilting of the foliage and yellowing of the older leaves.

Figure 3. Plants showing advanced aboveground symptoms, with petioles remaining attached to the crown.

Figure 4. Root and petiole symptoms of Rhizoctonia root and crown rot. This root has been split longitudinally to show both interior and exterior symptoms.

hyphae are pale, becoming brown with age. They branch mostly at right angles, usually with a constriction at the branch. With age, dark brown thick-walled, barrel-shaped hyphal cells aggregate to form dry, hard, compacted structures called sclerotia. These are visible to the naked eye and allow the pathogen to survive adverse conditions.

Rhizoctonia solani is currently divided into nine strains, or types, called anastomosis groups (AG types), based on the ability of the hyphae of different cultures to fuse. The various AG types represent genetic differences within the species. Root and crown rot of sugarbeets is primarily caused by AG-2-2, while damping-off of seedlings and foliar blight diseases are generally attributed to AG-4. AG-2-2 can cause damping-off but not foliar blight, and AG-4 will not cause root or crown rot. AG-3 causes damage in potatoes but is not pathogenic to sugarbeets. AG-4 has been frequently isolated from potatoes in Idaho, but does not appear to damage potatoes.

At the University of Minnesota, Crookston, the AG-2-2 isolates most highly pathogenic to sugarbeets were isolated from pinto bean and soybean. Because there is some evidence that potatoes may be a symptomless host for AG-2-2 and can maintain inoculum levels of AG-2-2 in soil, potatoes may not be the best rotation crop when Rhizoctonia root rot has been a problem.

Disease cycle

Rhizoctonia solani survives as mycelium or sclerotia in the soil, primarily in organic debris. The fungus becomes active when soil temperatures reach 25° to 33°C (77°-91°F). The disease is favored by poor soil structure and high soil moisture. It can attack any part of the root, but most frequently starts at the crown or on petioles in contact with soil. Infected plant material left in the field after harvest provides the inoculum for subsequent crops. In addition, *R. solani* readily colonizes plant debris that has not completely decomposed in soil. The fungus is able, therefore, to survive on living plants or as a saprophyte on organic debris. Disease severity in sugarbeets is related to the population of *R. solani* in soil, which is enhanced by cropping systems that include hosts for the fungus.

Control

The most effective control measures are those that promote good crop growth. *Rhizoctonia solani* is a facultative parasite; it does not require a living host to develop, but will cause disease when conditions are favorable. Various stresses can predispose sugarbeets to infection by this pathogen, including moisture and nutritional stresses plus mechanical, insect, and nematode injury which facilitate pathogen entry. Early detection of disease development (Figure 2) may provide the grower the opportunity to alter practices and minimize loss. There is one chemical, azoxystrobin (Quadris®), registered for control of Rhizoctonia root and crown rot of sugarbeet. It has shown promising results in field experiments when applied to the petiole and crown area of the plant prior to disease development.

Rotation and cropping system – Where Rhizoctonia root rot is minor or nonexistent, sugarbeets should be grown in rotation with nonhost crops not more frequently than every third year. Crop rotations should be lengthened to 4 to 5 years where Rhizoctonia root rot has been a problem. Shortened rotations in recent years are the primary cause of the increased losses from Rhizoctonia root and crown rot. Shortening the rotation between sugarbeet crops leads to buildup of high soil populations of *Rhizoctonia solani* and other root pathogens. High pathogen populations increase the risk of root rot and render future control more difficult and costly.

Corn and/or small grains are the best crops to precede sugarbeets and are favored in the rotation for root rot management. Monoculture of sugarbeets usually results in severe disease. Severe loss can occur following beans, potatoes, and alfalfa. Beans host the same pathogen strain (AG-2-2) as sugarbeets, and potatoes support populations of AG-4 and AG-2-2. Significant losses from Rhizoctonia root rot have repeatedly been experienced in fields that have had long sugarbeet rotations but were heavily cropped to beans.

Figure 5. Numerous slightly sunken lesions resulting from multiple infections. The crown area of the root on the left displays a more common symptom of Rhizoctonia root and crown rot.

Hilling practices – The petioles and crown area are the most common entry points for *R. solani*, and hilling practices that push soil into contact with petioles or into the crowns are among the most important contributing factors to disease problems. This pathogen resides in the soil, and such practices

Figure 6. Excessive hilling on a plant in a field where sugarbeets had never previously been grown.

Figure 7. The plant pictured in Figure 6 with the soil removed showing initial infection of *R. solani* on petioles.

essentially inoculate these susceptible areas and should be avoided, especially where Rhizoctonia root and crown rot has been a problem. Figure 6 is an example of excess hilling in a field where sugarbeets had never previously been grown. Initial *R. solani* infection is evident in Figure 7 on petioles with the soil removed.

Soil compaction – Compacted soil greatly increases the incidence and severity of Rhizoctonia root rot. Soil conditions for optimum plant growth are approximately 50 percent solids and 50 percent pore space. As compaction occurs, the size and number of large pores decrease, resulting in reduced aeration, water infiltration, and drainage. Growers who reduce compaction by controlling traffic and wheel tracks, for example, have been highly successful in reducing disease.

Fall bedding reduces compaction by eliminating most or all of the soil preparation in the spring when soil may be wet. When soil is fall bedded, planting can be completed during that small window of opportunity that previously was spent in soil preparation. This practice has eliminated the Rhizoctonia root and crown rot problem for many growers and should be used wherever soil type and field topography permit. The incidence of disease is greater in years when soils are wetter than normal and many growers are forced to prepare the wet soil for planting.

Irrigation – Many fields are not uniform in soil texture and may dry more quickly in some areas. Irrigating when only a small percentage of the field requires water may result in the majority of the field being excessively irrigated, which favors root rot development. Where possible, use soil moisture sensors to monitor the majority of the field and schedule irrigations accordingly. Optimum soil moisture for sugarbeet growth is between -40 and -60 centibars (cbars) soil matric potential. Beets should be irrigated when the soil matric potential in the active root zone is about -40 cbars in a sandy soil and -60 to -80 cbars in a silt loam soil. Studies indicate that sugarbeets can be moderately stressed to about -100 cbars with only a minor yield reduction. If root rots have been a problem, scheduling irrigation when soil moisture is slightly dry is preferable. Both wet and dry soil extremes predispose plants to infection.

Handling crop residues – The manner in which crop residues are handled preceding the planting of sugarbeets can affect disease severity. Crop residues should be uniformly distributed throughout the soil profile to ensure adequate colonization and decomposition by beneficial microorganisms. Where grain straw is only plowed, resulting in large buried straw clumps, *R. solani* colonizes the undecomposed straw and increases in population. This can result in severe loss from root rot in the subsequent sugarbeet crop. The effect can be accentuated when inadequate soil moisture and nitrogen limit straw decomposition.

Balanced nutrition – Growers should carefully follow recommended fertility practices based on the soil fertility test. Nutrient stress, whether deficiency or excess, predisposes plants to infection. Excess nitrogen should particularly be avoided.

Plant density – Rhizoctonia root and crown rot is favored by high soil temperatures. A field with dense stand and good crop growth will close the rows early, shade the soil, and reduce soil temperature. An average 150 plants per 100 feet of row (9-inch spacing) with a 22-inch row spacing is considered optimum, and some growers achieve improved results with closer plant spacing and narrower rows. As plant populations decrease, the probability of *R. solani* infection and disease loss increases.

Weed control – Several weeds, including pigweed (*Amaranthus retroflexus*), are host to the pathogen. Growing a nonhost rotation crop will not be an effective control if weeds are present to support the pathogen. Good weed control in each crop in the rotation, therefore, is an important disease control measure.

Resistant cultivars– There are a few cultivars available with moderate resistance to Rhizoctonia root and crown rot that may be grown in situations with a chronic disease problem. These cultivars, however, do not have a level of resistance to curly top virus that is considered adequate for many growing areas in the Pacific Northwest. If used, greater loss could occur from curly top than from Rhizoctonia root rot. In addition, these cultivars are generally lower in yield and quality than standard cultivars under disease-free conditions. The root rot resistance is moderate, and good cultural practices such as those described above must be maintained to gain maximum benefit from the resistance.

Bacterial Vascular Necrosis and Rot

Bacterial vascular necrosis and rot, or Erwinia root rot, is caused by *Erwinia carotovora* subsp. *betavasculorum*. Erwinia root rot can occasionally be a highly destructive disease. The bacterium is endemic to many native and cultivated soils, and variants of the potato blackleg bacterium (*E. carotovora* var. *atroseptica*) can sometimes be pathogenic to sugarbeets. Symptoms of Erwinia root rot on sugarbeet include black streaks running up the petioles, froth from crowns, and blackened petiole bases and crown. Vascular bundles in the petioles and root will be necrotic, and the root tissue adjacent to the vascular necrosis will turn pink when cut and exposed to the air. In late stages, the rot can become an extensive soft or dry rot.

Bacterial infection and subsequent disease development is favored by wounds on petioles, crowns, or foliage, excessive nitrogen, excessive moisture, warm temperature (79°-82°F optimum), and increased plant spacing. Young plants are more susceptible than old plants. The disease can survive in some weeds.

Control

Most sugarbeet cultivars have resistance to Erwinia root rot, but losses can still occur. Control practices should include maintaining a 6- to 8-inch plant spacing, reducing or eliminating plant injury, avoiding excessive irrigation, and preventing soil deposit into crowns. Good weed control should be maintained throughout the rotation.

Fusarium Yellows

Fusarium yellows, caused by the soil-borne fungus *Fusarium oxysporum* f.sp. *betae*, has not been a major problem in Idaho, but has occasionally caused severe losses. The first symptom is interveinal chlorosis on older leaves that can mimic nutrient deficiency. Younger leaves may also show yellowing as the disease progresses. Frequently only one side of the leaf becomes dry, necrotic, and brittle. Under windy conditions, necrotic leaf areas may break away and leaves become tattered. Plants may become stunted and wilted, and the internal root vascular tissue will have a brown discoloration. Other than stunting, there are usually no external root symptoms. However, some strains of the pathogen rot the taproot near the tip, which may result in lateral root proliferation.

Control

The fungus is able to survive in the soil or in infected plant debris for long periods. Because it has a wide host range, lengthened rotations may not be effective without good weed control.

About the author

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Phytophthora Root Rot and Pythium Root Rot

The fungi *Phytophthora drechsleri* and *Pythium aphanidermatum* both cause a rot of sugarbeets, primarily with high soil temperatures and waterlogged soils. These root rots will often be found in low areas with standing water. With both diseases, plants wilt as a direct result of root tissue destruction by the pathogens. Root symptoms are similar for both diseases and include a brown to blackish wet rot that usually begins on the lower taproot and progresses upward. With *Phytophthora*, the rotted tissue may be brown with a dark brown to black margin between the healthy and diseased tissue.

Control

Control of both diseases can be achieved by maintaining good soil aeration and drainage. Proper water management is essential.

Further Reading

Duffus, J.E., and E.G. Ruppel. 1993. Diseases. In: *The Sugar Beet Crop*. D.A. Cooke and R.K. Scott, eds. Chapman and Hall, London.

Schneider, C. L. and E. D. Whitney. 1986. Rhizoctonia root and crown rot. In: *Compendium of Beet Diseases and Insects.* E. D. Whitney and J. E. Duffus, eds. APS Press, St. Paul, MN.

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Additional information for sugarbeets can be found on the following website:

http://www.uidaho.edu/sugarbeet/

Complete listings of current PNW publications can be found on the following websites:

http://caheinfo.wsu.edu/pub home page/pub.html

http://eesc.orst.edu/agcomwebfile/edmat/

http://info.ag.uidaho.edu/

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Published and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914, by the University of Idaho Cooperative Extension System, the Oregon State University Extension Service, Washington State University Cooperative Extension, and the U.S. Department of Agriculture cooperating.

Published January 2001 PNW 538 $3.00