University of Idaho Extension

CIS 1198

Rhizoctonia stem canker and black scurf of potato

Phillip Wharton and Elisabeth Wood

Introduction

Rhizoctonia stem canker and black scurf diseases of potato are caused by the fungus *Rhizoctonia solani* Kühn (teleomorph *Thanatephorus cucumeris* [A. B. Frank] Donk) and can be found on all underground parts of the plant at various times during the growing season. *Rhizoctonia solani* (*Deuteromycetes*, *Mycelia Sterilia*) is a species complex of 13 anastomosis groups (AGs), which are categorized according to the ability of their hyphae to anastomose (fuse) with one another.

Rhizoctonia solani AG3 is most commonly associated with potato. However, recently in Idaho several AGs, including AG2-2, AG4, and the binucleate *Rhizoctonia* AG-A, have been recorded causing disease in potato. Although AG3 is the main causal agent of disease in potato, AG2-2 and AG4 are more prevalent on sugar beet and cause sugar beet crown and root rot and seedling damping-off, respectively. Sugar beet is often rotated with potato in Idaho and this may account for the occurrence of AG2-2 and AG4 causing disease on potato. *Rhizoctonia solani* AG-3 is relatively specific to potato, and sclerotia on tubers belong almost exclusively to AG3.

In Idaho, *R. solani* causes black scurf on tubers (figure 1) and stem and stolon canker on underground stems and stolons (figure 2), and it occurs wherever potatoes are grown. Losses from Rhizoctonia mainly occur when the weather is cold and wet in the weeks following planting. Poor stands, stunted plants, reduced tuber number and size, and misshapen tubers are symptoms of *R. solani* infection.

Symptoms

The symptoms of the disease are found on both above- and belowground portions of the plant. Black scurf

Figure 1. *Rhizoctonia solani* sclerotia on the surface of tubers.

Figure 2. Brown, sunken lesions on underground stems and stolons are caused by *R. solani.*

(figure 1) is the most obvious sign of Rhizoctonia disease. In this phase of the disease, the fungus forms dark brown to black, hard masses on the surface of the tuber. These are called sclerotia and are resting bodies of the fungus (figure 1). *Rhizoctonia* sclerotia are usually irregularly shaped and range from small, flat,

Figure 3. Germinating sprouts may be killed by *R. solani* before they emerge from the soil.

Figure 4. Small aerial tubers may form aboveground if stolons and underground stems are severely infected.

barely visible blotches to large, raised lumps. Although these structures adhere tightly to the tuber skin, they do not penetrate or damage the tuber, even in storage. However, they will perpetuate the disease, and if infected tubers are used as seed, the risk of infection to the developing plant is increased.

Although black scurf is the most noticeable sign of Rhizoctonia, stem canker (figure 2) is the most damaging component of the disease. Stem canker occurs on underground portions of plants and often goes unnoticed. Early in the season, the fungus attacks germinating sprouts underground before they emerge from the soil (figure 3). Sprouts may be killed outright if lesions form near the growing tip. Damage at this stage results in delayed emergence and is expressed as poor and uneven stands with weakened plants. Reduction in crop vigor results from expenditure of seed energy to produce secondary or tertiary sprouts to compensate for damage to primary sprouts.

Occasionally, heavily infested potato seed tubers are unable to produce stems. Instead, the tubers produce stolons with several small tubers. This symptom, referred to as "no top," can be confused with the same symptom caused by physiologically old seed that has been desprouted.

Poor stands may also be mistaken for seed tuber decay caused by Fusarium. However, in contrast to Fusarium, Rhizoctonia does not cause seed decay, damaging only sprouts and stolons. Poor stands and stunted plants can also be caused by blackleg, a bacterial disease that originates from seed tubers and progresses up stems, causing a wet, sometimes slimy rot. In contrast, Rhizoctonia lesions are always dry and usually sunken.

Early in disease development, infected stolons, roots, and stems have reddish-brown to brown lesions. As red to brown lesions mature, they become cankers that are rough and brown and can have craters, cracks, or both. Damage varies and can be limited to a superficial brown area that has no discernible effect on plant growth to severe lesions that are large, sunken, and necrotic.

If cankers are severe, they may girdle the stem, interfering with the normal movement of water and carbohydrates throughout the plant. Stolon cankers also affect the shape, size, and numbers of tubers produced. If stolons and underground stems are severely infected, the flow of sucrose from the leaves to the developing tubers is interrupted. This results in small, green tubers, called aerial tubers, forming on the stem above the soil (figure 4). Formation of aerial tubers may indicate that the plant has no tubers of marketable quality belowground. Interruptions in carbohydrate flow may also result in a stunting or rosetting of the plant. A leaf curl, which can be confused with symptoms of the potato leafroll virus, has also been reported in severely infected plants.

Disease cycle

Rhizoctonia stem canker and black scurf can be initiated by seed-borne or soilborne inoculum. The pathogen overwinters as sclerotia and mycelium on infected tubers, in plant residue, or in infested soils (figure 5). When infected seed tubers are planted in the spring, the fungus grows from the seed surface to the developing sprout, and infection of root primordia, stolon primordia, and leaf primordia can occur. Seed-borne inoculum is particularly effective in causing disease because of its close proximity to developing sprouts and stolons.

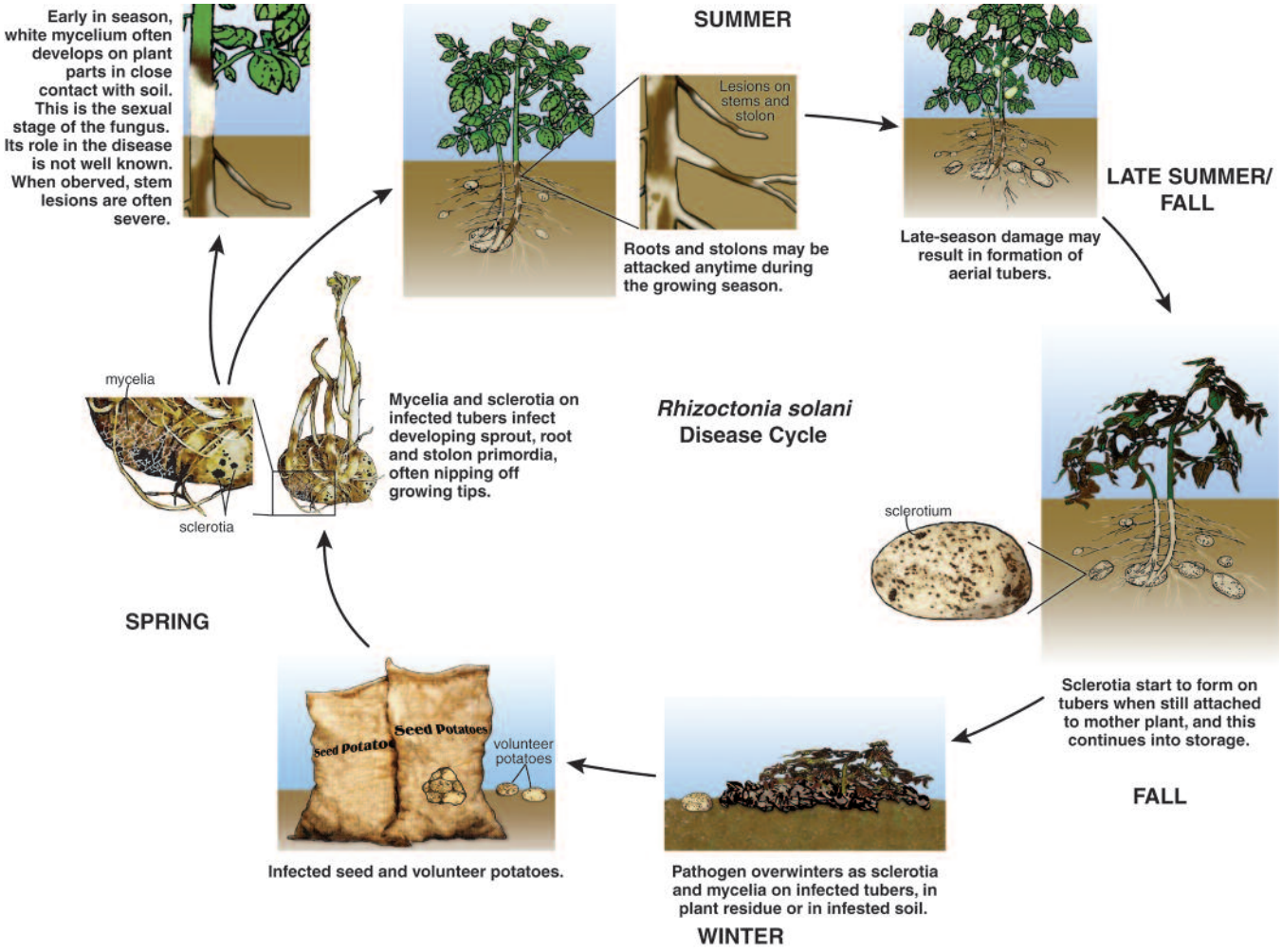

Figure 5. The disease cycle of the stem canker and black scurf pathogen, *Rhizoctonia solani.*

Mycelia and sclerotia of *R. solani* are endemic to Idaho soils, living on organic debris, and can cause disease independently of or in conjunction with seed-borne inoculum. Soilborne inoculum can be as damaging as seed-borne inoculum, especially when tubers are planted in infected soil. However, infection can only occur when the sprouts develop in proximity to the *Rhizoctonia* mycelia. Infection may occur anytime during the growing season, although most infections probably occur early in the growing season because the plant's resistance to stem and stolon infection increases after emergence, eventually limiting expansion of lesions.

Previous research has shown that soil temperature is a critical factor in the initiation of Rhizoctonia disease in potato, with disease severity being positively correlated with the temperature that is most favorable for pathogen growth. The temperature range for the growth of *R. solani* AG-3 is 41° to 77°F, so plants will be most susceptible to infection when the soil temperatures are within this critical range.

Cool temperatures, high soil moisture, organic matter, and a neutral to acid soil (pH 7 or less) are thought to favor development of Rhizoctonia stem canker. Damage is most severe at cool temperatures because of reduced rates of emergence, and growth of stems and stolons is slow relative to the growth of the fungus. Wet soils warm up more slowly than dry soils, which exacerbates damage because excessive soil moisture slows plant development and favors fungal growth. Research has shown that high soil temperatures, especially during emergence, tend to minimize the impacts of *R. solani*, even when inoculum is abundant.

Sclerotia start forming on daughter tubers late in the season, mainly after vine death. The mechanisms that are involved with and trigger sclerotial formation on daughter tubers are not well understood, but they may be triggered by products related to plant senescence. However, daughter tubers produced from infected mother plants do not always become infested with sclerotia.

Table 1. Product name, active ingredient and FRAC[a] resistance management grouping, type and rate of application, and activity of products currently registered for control of Rhizoctonia diseases of potatoes.

Product[b]	Active ingredient [Chemical group]	Type of application	Rate of application[c]	Activity against *Rhizoctonia*[d]
Quadris	azoxystrobin (22.9%) [11]	In-furrow	6.2–15.4 fl oz/acre	+++
Moncut 70DF	flutolanil (70%)[7]	In-furrow	0.7–1.1 lb/acre	+++
Serenade Soil	QST 713 strain of *Bacillus subtilis*	In-furrow	1–2 qt/acre	++
MonCoat MZ	flutolanil (1.5%) [7] mancozeb (6%) [M3]	Seed treatment (dry)	0.75–1.0 lb/100 lb	+++
Maxim 4FS[e]	fludioxinil (40.3%) [12]	Seed treatment (liq.)	0.08–0.16 fl oz/100 lb	+++
Maxim Potato Seed Protectant	fludioxinil (0.5%)[12]	Seed treatment (dry)	0.5 lb/100 lb	+++
Maxim MZ	fludioxinil (0.5%)[12] mancozeb (6%) [M3]	Seed treatment (dry)	0.5 lb/100 lb	+++
Nubark Mancozeb	mancozeb (6%)[M3]	Seed treatment (dry)	1 lb/100 lb	+++
Tops MZ	thiophanate-methyl (2.5%) [1] mancozeb (6%) [M3]	Seed treatment (dry)	0.75 lb/100 lb	+++

[a] Fungicide Resistance Action Committee. See (http://www.frac.info) for more information.

[b] Specific instructions are included on the labels of all of the products, and these must be adhered to.

[c] Rate of application is per acre at 34-inch spacing between rows (in-furrow) and per 100 lb of tuber seed pieces (seed treatment, wet or dry).

[d] + signifies excellent activity against seed-borne *Rhizoctonia*.

[e] If Maxim 4FS is used on potatoes intended for seed production, a labeled rate of mancozeb seed treatment dust must be applied to seed tubers after Maxim 4FS treatment. Alternatively, an in-furrow application of Quadris at 0.4 fl oz /1000 ft of row must be applied over the Maxim-treated seed tubers.

Monitoring and control

Currently, it is not possible to completely control Rhizoctonia diseases, but following a combination of cultural and crop protection strategies may limit their severity. Effective management requires implementation of an integrated disease management approach and knowledge of each stage of the disease. Although the most important measures are cultural, chemical controls should also be utilized. To date, there have been no comparisons of the relative susceptibility of potato varieties currently grown in Idaho.

Cultural control

One of the keys to minimizing disease is to plant certified seed free of visible sclerotia. If more than 20 sclerotia are visible on one side of washed tubers, consider using a different seed source. In some areas, tuber inoculum is more important than soil inoculum as the primary cause of disease.

Following practices that do not delay emergence in the spring minimizes damage to shoots and stolons and lessens the chance for infection. Shallow planting of seed tubers in warm soil (above 46°F) and gradual hilling up speeds sprout and stem development and emergence and reduces the risk of stem canker. Plant fields with coarse-textured soils first because they are less likely to become waterlogged and will warm up faster.

Rhizoctonia does not compete exceptionally well with other microbes in the soil. Increasing the rate of crop residue decomposition decreases the growth rate of *Rhizoctonia*. Residue decomposition also releases carbon dioxide, which reduces the competitive ability of the pathogen. The fungus is not an efficient cellulose decomposer, so soil populations are greatly reduced by competing microflora, and less disease is observed.

Potatoes should be harvested as soon as skin is set to reduce black scurf and minimize bruise damage. The percentage of tubers covered with sclerotia increases as the interval between vine kill and harvest increases. Do not dump infested tubers on future potato fields, as they can become sources of inoculum.

Crop rotation is recommended to reduce *Rhizoctonia* inoculum in the soil. However, as some AGs survive on alternative crops, crop rotation may not always be fully effective in reducing soil inoculum levels. In Idaho, potatoes are often planted in rotation with sugar beet. Recently, it has been shown by research at the University of Idaho that AG2-2 and AG4, which are predominantly sugar beet pathogens, can cause disease on potato. Thus, planting potatoes after sugar beet may expose the crop to a higher disease risk. A knowledge of the AGs present in the soil before planting can give a good indication of disease risk. However, environmental factors and soil type may also influence disease severity.

Chemical control

Seed treatment. Several products have been developed specifically for control of seed-borne potato diseases (table 1) and offer broad-spectrum control for Rhizoctonia, silver scurf, Fusarium dry rot, and to some

extent, black dot (*Colletotrichum coccodes*). These include Tops MZ, Maxim MZ (and other Maxim formulations + mancozeb), and Moncoat MZ. The general impact of these seed treatments is improved plant stand and crop vigor, but, occasionally, application of seed treatments in combination with cold and wet soils can result in delayed emergence. The delay is generally transient and the crop normally compensates. The additional benefit of including mancozeb is prevention of seed-borne late blight.

In-furrow fungicide application. In-furrow application of fungicide at planting has resulted in significant improvement in control of Rhizoctonia disease of potatoes. Products such as flutolanil (Moncut) and azoxystrobin (Quadris) applied in-furrow at planting have given consistent and excellent control of Rhizoctonia diseases of potatoes in trials at the University of Idaho Aberdeen Research and Extension Center. However, both seed treatments and in-furrow applications have on some occasion resulted in poor control of Rhizoctonia. This sporadic failure may be due to extensive periods of wet and cold soil shortly after planting or planting in fields with plentiful inoculum. Quadris applied in-furrow has been reported to reduce the symptoms of black dot on lower stems and tubers.

There are also several biological control agents labeled for control of Rhizoctonia diseases in Idaho. In potato fungicide spray trials at the University of Idaho Aberdeen Research and Extension Center the biological control fungicide Serenade Soil (QST 713 strain of *Bacillus subtilis*) showed promising results in the control of Rhizoctonia stem canker and black scurf.

For more information, please visit: http://www.idahopotatodiseases.org

About the Authors:

Phillip Wharton, Assistant Professor of Plant Pathology, and **Elisabeth Wood**, Graduate Research Assistant, Aberdeen Research and Extension Center, University of Idaho.

Issued in furtherance of cooperative extension work in agriculture and home economics, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Charlotte V. Eberlein, Director of University of Idaho Extension, University of Idaho, Moscow, Idaho 83844. The University of Idaho provides equal opportunity in education and employment on the basis of race, color, national origin, religion, sex, sexual orientation, age, disability, or status as a disabled veteran or Vietnam-era veteran, as required by state and federal laws.

Published September 2013