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Black scurf of potato

Abdessamad M. EL BAKALI[a,*], *María P. MARTÍN*[b]

[a]*Laboratori de Fitopatología. Departament de Biologia Vegetal, Facultat de Biologia. Universitat de Barcelona, Avda. Diagonal 645. 08028, Barcelona, Spain*

[b]*Real Jardín Botánico, Consejo Superior de Investigaciones Científicas, Plaza de Murillo, 2. 28014 Madrid, Spain*

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ABSTRACT

Black scurf of Potato is a serious disease commonly observed in most potato-producing areas of the world. Caused by *Rhizoctonia solani* AG-3 (teleomorph *Thanatephorus cucumeris* [Frank] Donk), this disease is favoured by the capacity of fungus to survive in soil as sclerotia and mycelium in plant debris for long periods, and environmental conditions of low soil temperature and high soil moisture. Management of the disease requires an integrated approach since no single tactic is totally effective. An effective control program combines cultural practices, fungicides, biological control, and solarization.

1. The disease

The causal organism lives in soil on organic matter and has a wide host range. Black scurf of potato caused by the fungus *Rhizoctonia solani* Kühn is a common and commercially important disease of potato tubers found in all production areas of the world. This disease affects potato development from emergence to harvest. In addition to the development of unsightly sclerotia or 'black scurf' on tubers, which affects marketability of the crop (Fig. 1), *Rhizoctonia* can affect plant emergence and cause 'stem canker' symptoms, characterised by brown and black sunken lesions on the stems and stolons. Misshapen tubers with an uneven size distribution also result. Disease can be found on all underground parts of the plant at different times during the growing season. The disease begins when sclerotia present in soil and/or on planted potato seed tubers germinate to produce hyphae. The hyphae attack developing sprouts when the soil is cool and moist, causing lesions that appear as reddish-brown and discoloured areas. The growing point of severely infected sprouts is often killed. If this happens, additional sprouts will form until a single sprout emerges from the soil. The repeated development of new sprouts to replace killed sprouts can deplete the potato seed tuber of important food reserves that are needed for future growth. Moreover, this "sprout nipping" results in delayed emergence and plant maturity, and poor and uneven plant stands. As the season progresses and the potato plant continues to grow, additional reddish-brown sunken areas called cankers may form on stems, stolons, and roots (Carling *et al.* 1989).

Cankers can reduce plant productivity and both the quality and quantity of newly formed daughter tubers by restricting the movement of water and nutrients within the plant. In many instances, infected plants with cankers appear healthy. However, above ground symptoms may appear, such as the formation of aerial potato tubers and purplish-coloured leaves, particularly when plants are severely infected and/or stressed.

Late in the growing season during periods of cool, wet weather, during midseason under a dense canopy of foliage, the teleomorph stage of the fungus may develop a white, powdery mould growth on stems, extending just above the soil line (Fig. 2). Potato plants affected at this stage are characterized by a lack of vigour because much of their energy has been used to produce secondary or tertiary sprouts before a plant emerges. Sometimes, heavily infested seed will not produce

* Corresponding author. Fax: +34 91 420 01 57.
E-mail addresses: elbakali@email.com (A. M. El Bakali), maripaz@ma-rjb.csic.es (M. P. Martín).
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Fig. 1 – Black scurf of potato (*Solanum tuberosum* L.) tuber caused by *Rhizoctonia solani* AG-3.

an above ground plant. Instead, it will produce a stolon with several small tubers. This symptom is referred to as "no top" and can be confused with the same symptom caused by physiologically old seed that has been desprouted.

Stolons and roots, like sprouts, can be killed by the pathogen. The root system is reduced when this occurs. The number, shape and size of tubers produced are also affected when the roots and stolons are attacked. However, the health of these plants can be severely compromised and they can frequently become more susceptible to other diseases, particularly early blight. Tubers are affected in many ways by this pathogen. The main symptom observed is the black sclerotia on the surface, thus the name black scurf. These sclerotia are not easily removed with water and are often referred to as the "dirt that won't wash off". They do not affect the interior of the tuber (Fig. 1). Other tuber symptoms include necrosis in stem apex, russeting, cracking, knobbiness, infected lenticels and malformed tubers. Both phases of this disease result in the reduction of marketable yield. Seed tubers infested with sclerotia and mycelium are major sources of inoculum for future crops.

Disease development on emerging sprouts is favoured by cold, wet soil conditions. These conditions slow sprout development but favour germination of sclerotia and infection causing cankers to develop on young, under-developed tissues. Tuber-borne inoculum is very important in this phase of the disease while soil-borne inoculum is believed to be generally more important in stem and stolon infections. When stolons become pruned, the secondary stolons are generally weaker and much shorter in length. Tubers produced on these shorter stolons are generally the ones that become misshapen because they tend to grow around the plant stem.

Fig. 2 – *Thanatephorus cucumeris* (Frank) Donk, the sexual stage of *Rhizoctonia solani*, seen as a white mycelium (around) on lower parts of the stems.

2. The pathogen

Rhizoctonia solani [teleomorph *Thanatephorus cucumeris* (Frank) Donk] is a destructive soilborne pathogen that causes diseases in many plant species world-wide. Isolates of the fungus are classified according to their ability to anastomose with tester isolates belonging to established AGs (Anastomosis Groups). Currently, *R. solani* isolates have been divided into 14 groups based on their anastomosis behaviour, designated as Anastomosis Group-1 (AG-1) through AG-13 and isolate AG-BI (Carling et al. 2002). Some of the AGs are quite heterogeneous and include subgroups based on ecological types, DNA homologies and Zymogram patterns. While it has been generally believed that AG-3 attacks only potato, it has been reported as occasionally attacking other crop plants, such as tobacco and sugar beet.

During the cycle of disease the perfect and imperfect form of fungi co-exist. The anamorphic *Rhizoctonia* form emerges from germination of sclerotia or mycelium on the seed tuber producing the hyphae attacking sprouts, stolons and new daughter tubers. When the temperature and moisture conditions are optimal the teleomorph appears on stems under the foliage (Fig. 2). The mycelia form a conglomerate with basidia and basidiospores. This phase is short, approximately 2 weeks.

R. solani can be either a soil-borne or a seed-borne pathogen. The fungus survives in soil as mycelium in decomposing plant tissues. It also survives as sclerotia on tuber surfaces (seed-borne) or in the soil for extended periods. Populations of *R. solani* decline in the absence of a susceptible host although the rate of decline is affected by soil type, rotational crops and possibly the amount of organic matter present in the soil.

3. Control

The management of *Rhizoctonia* disease requires an integrated approach and knowledge of each stage of the disease, because no single tactic is totally effective (Banville et al. 1997).

Some potato varieties differ in their susceptibility to *Rhizoctonia*; however, no resistant varieties are currently available. To date no variety has been found with immunity to the sprout nipping and stem lesion phase, although some varieties show varying degrees of resistance to formation of sclerotia on tubers. Seed selection is important, and growers are

advised to plant certified seed tubers that are free of *Rhizoctonia* on the skin. Tuber inoculum is more important than the soil inoculum as the primary cause of disease. Seed growers should certainly plant only sclerotia-free seed.

Research performed at our institution has shown that sclerotia coverage of as little as 5% can significantly increase disease incidence and severity (unpublished data). *Rhizoctonia* stem canker can be reduced by practices that favour rapid emergence, such as warming seed tubers before planting, avoiding planting in cold, wet, heavy, and poorly drained soils, which reduces the rate of sprout growth and encourages disease. Early irrigation, prior to emergence, should be kept to a minimum. Also seed should be covered with no more than two inches of soil to promote rapid emergence and less chance for infection of sprouts and stems.

Black scurf development on daughter tubers is minimized by harvesting quickly after vine desiccation rather than holding tubers in the soil for extended periods. The percent of tuber coverage with sclerotia increases as the interval between vine kill and harvest is lengthened. For example, harvesting seed tubers within two weeks of vine desiccation will reduce the amount of sclerotia formation. Tubers left in the soil for more than three weeks after vine desiccation will generally have significantly higher levels of black scurf, which can lead to reduced price on the fresh market.

A fungicide seed treatment may provide some relief from the sprout nipping stage, particularly when potato seed pieces are contaminated with the fungus. However, a fungicide seed treatment will usually not be beneficial if the soil is infested with high levels of the *Rhizoctonia* fungus. No seed treatment will compensate for poor quality seed. Crop rotation with corn, grasses, cereals, and non-susceptible crops for *Rhizoctonia* is helpful, as is good rotation. At a minimum, two consecutive seasons of potatoes on the same land should be avoided. If the disease has been severe, 3-5 years should elapse between potato crops; this reduces both the incidence and severity of the disease. Increasing the rate of crop residue decomposition and the amount of organic matter in the soil decreases the growth rate of *Rhizoctonia*, which does not compete well with other microbes in the soil.

Since young developing potato crops are more susceptible to injury by *Rhizoctonia*, all practices that encourage rapid emergence and plant development will reduce disease severity. Potatoes planted into soils with excessive amounts of residue from a previous crop, such as corn, tend to have serious *Rhizoctonia* problems. Soils with large amounts of residue remain cold for extended periods and are more moist, thereby favouring disease development.

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