Bontera Research

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Contents

1 Potatoes

1.1 Soft Rot

1.1.1 Description

Bacterial soft rot affects a number of fruits and vegetables, including potatoes. It is a post-harvest disease, occuring while the crop is stored or in transit (Rich, 2013). It is characterized by a watery soft spot on the side of the crop and an strong odor.

1.1.2 Geography and Soil Type

Soft rot arises worldwide, from South Africa (Ngadze et al., 2012) to the northeastern United States (Ge et al., 2021). Pérombelon notes that the soil has to be both nutritionaly deficient and over-watered for soft rot to spread. Some bacterium are specific to potato soft rot because of the cool, temperate climate where they are grown (Pérombelon, 2002). Soft rot favors warm temperatures and high moisture levels in the soil and during storage (Rich, 2013).

1.1.3 Cause

Two main genera cause soft rot: *Pectobacterium* and *Dickeya* (Youdkes et al., 2020). Bacterial growth is accelerated by any wound or puncture of the potato skin, especially a tender spot formed by standing water or insect bites breaking the outer layer (Rich, 2013).

1.1.4 Biosolution

Historically, farmers have used water-management and sanitation to control soft rot, but the bacterial predator *Bdellovibrio bacteriovorus* and similar organisms have shown considerable promise as well, according to a recent study by Youdkes et al. (2020). All the strains tested were effective in reducing *Pectobacterium* and *Dickeya* greatly. Strains introduced in the tubers before the onset of soft rot were much more effective in fighting it later on, possibly because glucose consumption by the prey was not inhibiting growth (Youdkes et al., 2020). A second study also determined that a mixture of *Pseudomonas putida* and *Pseudomonas fluorescens* decreased the severity of the disease and prevented transmission to child potatoes.

A third study found that certain varieties of rhizosphere bacteria could also be used to control soft rot caused by *Pectobacterium* strains (Krzyzanowska et al., 2012). The results indicate that 18 various rhizobacteria were effective in inhibiting the spread of soft rot, out of the 1165 tested. The study noted, however, that the bacteria's ability to control *Pectobacterium in vitro* may not reflect the true results *in vivo*.

1.2 Golden Nematode Disease

1.2.1 Description

Nematodes are nearly invisible worms that attack potato plants and tubers (Rich, 2013). Rich also reports that some nematodes cause disease directly, while others act as vectors or catalysts for viral and fungal illnesses. Plants affected by golden nematode disease have necrotic and wilting leaves with stunted growth; many do not recover, resulting in severely reduced crop yeilds (Rich, 2013).

1.2.2 Geography and Soil Type

The golden nematode is native to Peru, but has spread all throughout the world (Rich, 2013). They can survive in any climate that potatoes can grow, but very strict quarantine and sanitation guidelines have prevented further spread (Evans & Brodie, 1980).

Mimee et al. (2015) found that optimal nematode egg hatching occurs when soil temperatures are between $59°F$ and $80°F$. The determined that increasing temperatures in cooler climates could lead to accelerated spread of golden nematode disease. Both dry weather and light soil favor the disease (Rich, 2013).

1.2.3 Cause

The golden nematode (*Globodera rostochiensis*) is the main cause of Golden Nematode Disease (Rich, 2013). The disease gets its name from the golden or brown cysts containing nematode eggs present after an infestation (Rich, 2013). This is how the the disease spreads: the cysts cling to containers, equipment, and tubers and are transferred between fields or farms.

1.2.4 Biosolution

Some farmers have reported the natural decline of nematode populations because of fungi parasitism (Evans, 1993). 10 species were isolated from the soil, *Cylindrocarpon destructans* being the most promising (Evans, 1993). That same study found that "when an inoculum of straw colonised by *C. destructans* was placed around potato seed tubers planted in [nematode] infested soil ... the numbers of juvenile stages of *G. rostochiensis* ... decreased by 62%."

1.3 Brown Rot

1.3.1 Description

Brown rot, also known as bacterial wilt, is a very destructive bacterial disease (Rich, 2013). It was first reported it in the United States in 1896. Potatoes afflicted with brown rot excrete a "slimy ooze" at the base of the stem and eyes, although infected plants may also produce healthy tubers (Rich, 2013). In the early stages of the disease, the shoot system may wilt and the tubers will turn brown (Kabeil et al., 2008).

1.3.2 Geography and Soil Type

Brown rot heavily favors warmer climates; so much so that it is virtually eraticated in Canada and the northern United States (Rich, 2013). If it does infect potatoes in cooler climates, brown rot is harder to detect early on (Kabeil et al., 2008). The plants may not show any signs of infection until later stages of infection.

In a study by van Elsat et al. (2000), a steady decline of brown rot was observed in loamy sand soil. They also found that severe drought drastically reduced brown rot infections across the board. The disease prefers moist, slightly acid, netral, and alkaline soil (Rich, 2013).

1.3.3 Cause

Pseudomonas solanacearum is the bacterium that causes brown rot (van Elsas et al., 2000). There are three races, each of which attack different crops and have different optimal climates (Rich, 2013):

Race 1: Attacks eggplant, tobacco, tomato, and potatoes

Race 2: Attacks banana

Race 3: Attacks mainly potato, but is weakly pathogenic to tobacco

P. solanacearum usually enters a host through a wound on the skin or roots (Rich, 2013). Rich (2013) also reports that the aflicted crops may infect the soil, transfering brown rot to any new plants grown afterwards.

1.3.4 Biosolution

One effective way to combat brown rot is to add sulfur to sandy soil, followed by limestone in the summer (Rich, 2013). Furthermore, a number of potato variants are resistant to *P. solanacearum*; planting these cultivars will help minimize losses (Rich, 2013).

A study was also conducted by Fujiwara et al. in 2011 that experimented with using bacteriophages to control brown rot. While many of the viruses they tried were effective, application of ϕRSL1 (from family *Myoviridae*) was the best method. Although it did not kill all the bacterial cells, it was successful in preventing the onset of disease. ϕRSL1 worked much better when it was introduced before *P. solanacearum* as a preventative measure, although it did also have an effect when it was introduced after (Fujiwara et al., 2011).

1.4 Common Scab

1.4.1 Description

Common scab is a fungal disease that shows no symptoms above ground in potato plants (Rich, 2013). While not effecting yeild, common scab makes the infected tuber less appealing to look at, effecting marketability to consumers (Rich, 2013). Symptoms include scabs and lesions of varying shapes and sizes on the skin of the tuber (Dees & Wanner, 2012).

1.4.2 Geography and Soil Type

Common scab occurs on every continent except Antarctica (Rich, 2013). In the United States, it is concentrated around the northwest, midwest, and northeastern portions (Braun et al., 2017). The disease prefers “a pH higher than 5.2, temperatures of 20–22 °C, and a soil moisture below field capacity during early tuberization.” (Archuleta & Easton, 1981; Braun et al., 2017)

1.4.3 Cause

The main cause of common scab in potatoes is various species of *Streptomyces* (Flores-González et al., 2008). It is disputed whether *Streptomyces* is a fungus or bacterium because it demonstrates characteristics of both (the USDA considers it a fungus) (Rich, 2013). The responsible strains synthesize thaxtomins and phytotoxins, chemicals required for the scabs to form (Flores-González et al., 2008). Flores-González et al. also report that the toxins exhibit properties similar to those of an infection.

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