Pectobacterium Carotovorum (PCC): A Bacterial Pathogen Known To Cause Soft Rot In Potatoes

Pectobacterium carotovorum (Pcc) is a bacterial pathogen known to cause soft rot in potatoes. As a staple crop, widespread Pcc infection in potatoes can be extremely devastating. Although there are many methods of avoiding soft rot, most preventative measures are only partially successful. Additionally, Pcc has a broad host range worldwide which is why biocontrol research is extremely important to help prevent crop infection.

Symptoms of soft rot include slimy, rotten, and black tissue beginning on the tuber that progressively moves inward in the potato. Early stages of soft rot in infected tissue is usually odorless but develops an unpleasant odor as other organisms invade the rotted tissue. In addition to soft rot in tubers, the bacterial pathogen can also invade its host through wounded stems and roots. Pcc favors environments that are high in soil moisture and high temperatures. It is now generally accepted that the major source for infection is the latently infected seed (mother) tubers. When the mother tuber rots, the bacteria are released into the soil and are transmitted by soil water to contaminate neighbouring offspring. However, dry conditions stunt symptoms, and cause yellowing, wilting and dehydration of stems and leaves (Pérombelon & Kelman, 1980, as cited in Czajkowski et al., 2011). Furthermore, factors such as anaerobic environments, enlarged pores, and invasion by other pathogens also make a plant more susceptible to infection (Aegerter & Nuñez). Pcc are motile, straight rods with peritrichous flagellae and propagate favorably in anaerobic conditions (Charkowsky, 2006, as cited in Czajkowski et al., 2011). Pcc produces a variety of cell?wall?degrading enzymes that allow infiltration and maceration of plant tissues on which they feed; anaerobic environments also allow for unhindered production of these enzymes (Barras et al., 1994; Fuqua et al., 2001, as cited in Czajkowski et al., 2011).

There are various methods of preventing soft rot however the first objective is to produce healthy crops by avoiding tuber contamination. To avoid contamination, classical breeding, genetic modification, and physical and chemical tuber treatments have been implemented; these methods are widely used but have been partially successful at this point. So far, breeding for resistance has failed but genetic modification shows promise (although it is still being tested). In 2013, scientists from South Korea discovered an environmentally friendly method of controlling soft rotl: bacteriophage. The scientists isolated a bacteriophage, PP1, with cell membrane degrading abilities against Pcc. PP1 phage showed high specificity for Pcc, while other species of bacteria were resistant to PP1 (Lim et al., 2013); this allowed the scientists to safely use PP1 without causing any unwanted, adverse effects. This bacteriophage showed rapid and strong effectiveness against host bacteria in a controlled environment and withstood a broad range of pH values. Various strategies have been developed to control plant diseases, such as chemical antibiotics and copper. However, copper resistance has been reported in many bacterial pathogens, few effective bactericides have been developed, and R genes are common. Recently, several bacteriocins (proteins produced by one strain that attack other strains closely related to it) have been developed, including a protein called carocin D, which was isolated from Pcc and used to control soft rot disease. Typically, upon infection with bacteriophage, the bacterium’s cell membrane disintegrates and many progeny phages are released and infect neighboring bacteria, amplifying the process. In addition, the membrane-

degrading properties of bacteriophages kill bacteria rather than just preventing growth (Lim et al. 2013). Furthermore, they are effective against metal-resistant bacteria, and have high target specificity. Bacteriophages are like natural antibiotics and nontoxic to the eukaryotic cell, and their preparation is easy and inexpensive. The results of this experiment were extremely positive; soft rot caused by Pcc was significantly reduced by PP1 treatment. As a result of these characteristics, bacteriophages are promising biocontrol agents.

After preventing infection amongst the crops, the next step is to minimize yield loss by preventing disease in storage. Proper crop storage is essential; ventilation with warm air to prevent wound healing followed by cool air to prevent the spread of Pcc and long-term storage (Wale et al., 1986, as cited in Czajkowski et al., 2011), but even this meticulous precaution has limited success. Poorly ventilated and humid storage can lead to the spread of rotting in neighboring tubers. Survival in soil is restricted to 1 week to 6 months, depending on environmental conditions such as soil temperature, moisture and pH.

In terms of biodiversity, two new subspecies of Pcc were recently discovered and caused the same symptoms as potato soft rot and blackleg (infection on the vine instead of tuber). Pectobacterium carotovorum subsp. brasiliensis, a highly aggressive bacterium, is responsible for the majority of blackleg incidences in Brazil and South Africa but have also been found in the USA, Canada, New Zealand, and South Korea (Lee et al., 2014). “Pectobacterium carotovorum subsp. wasabiae has been described as a new potato pathogen in New Zealand responsible for high blackleg levels... and was found in association with soft rot in Japanese horseradish” (Gardan et al., 2003; Pitman et al., 2010, as cited in Czajkowski et al., 2011). Although several differences in biological characteristics exist, distinguishing between the subspecies from the subspecies carotovorum is difficult.