Update on Bacterial Diseases of Onion: Detecting Bacterial Pathogens, Bacteria in Soil and Water, Suppressive Soil, Varietal Susceptibility and the Effect of Actigard® on Bacterial Decay

Steven Beer, Jo Ann Asselin, and Jean Bonasera, Plant Pathology and Plant-Microbe Biology, Cornell University and Christy Hoepting, CCE Cornell Vegetable Program

Introduction to Bacterial Diseases and their Peculiarities

Bacteria are very common organisms. They live in and on most living things and in most environmental niches. Bacteria can be used to the benefit of humankind, in making cheese, yogurt and sauerkraut, in sewage treatment, and in beneficial natural processes like nitrogen fixing and cellulose digestion. Bacteria can also be very destructive. Animal pathogenic bacteria cause diseases like cholera, bubonic plague, and syphilis. Plant pathogenic bacteria cause diseases that affect quality and yield of crops, including onions. Whatever they do and wherever they are there, all bacteria share many characteristics. They are very small and generally single cells; perhaps 100 to 200 could be laid end to end across this period. They multiply by dividing. They are highly responsive to their environments. Most grow best in warm, moist conditions. Under ideal conditions of temperature, moisture and food, bacterial numbers can double every 20 minutes and reach billions per drop in a short time. They absolutely need moisture to thrive. They get around passively, being carried by living organisms, wind, or water, but many also can move on their own by swimming short distances.

The bacteria that infect plants need wounds or special natural openings in plant tissue in order to enter and cause disease. Even small wounds are effective, like those made by sucking or chewing insects, because the bacteria themselves are so small. Once infection begins, the bacteria multiply between plant cells, in contrast to fungi and oomycetes that penetrate into plant cells. Nevertheless, through several mechanisms, plant cells and tissues are killed, and the plant itself is often killed or its value drastically reduced.

Through recent research, we know that at least four different bacteria can cause rot and render onions unsalable in New York. These include *Burkholderia spp.* (sour skin)*, Enterobacter cloacae* (Enterobacter bulb decay*), Pantoea ananatis* (center rot) and *Rahnella spp.* Each bacterial pathogen likely behaves differently from the others. Inoculum sources, disease initiation, and the conditions favoring or not favoring disease are likely to differ for each pathogen, aspects that are referred to as the disease cycle. The key to control or management of plant disease is to interfere with the disease cycle, thus, details of the cycle should be known. Unfortunately, we know precious little about the disease cycles of the different bacterial pathogens of onion. That's a major reason that bacterial diseases persist as challenges to disease control.

Recent Progress on Bacterial Disease of Onion at Cornell

1. Identification and Detection of Bacterial Pathogens:

   We developed two distinct methods to identify the bacteria associated with cull onions. In one, a method of analyzing a portion of a specific gene was developed. That particular gene is grossly similar in all bacteria, but it is distinct in all onion-associated bacteria that we examined. Using a special means of analyzing that gene portion allowed for identification of a dozen different bacteria (pathogens and non-pathogens) associated with cull onions.

   For the four specific bacterial pathogens mentioned above, we designed, developed, and tested pairs of primers that can be used in the Polymerase Chain Reaction (PCR) to detect the presence of one or more of the stated important bacterial pathogens. The method is applicable to the detection of bacteria in cull onions, onions growing in the field, water collected from the environs of onion fields and for the soils in which onions have been grown.

   We developed methods to “tag” laboratory strains of the several important bacterial pathogens that allow for their easy identification and detection when associated with onions or onion-related materials. The tagged bacteria are particularly valuable to our laboratory studies to enable us to follow the growth and development of the bacteria artificially inoculated into onions of different ages, growing conditions and genotypes in our efforts to determine aspects of the disease cycles.

   These methods are valuable for use in many other studies.

2. Analysis of Soil and Water from the Vicinity of Onion Fields:

   Most of the important bacterial pathogens of onion were detected in soils collected from onion fields prior to or soon after onions were planted in muck-land fields in the spring.

   Several of the bacteria of interest were detected in some, but not all, the water samples collected from the vicinity of onion fields, including drainage ditches, creeks, cisterns and shallow wells. The importance of these preliminary findings are unclear. However, it appears that growers should be wary of the use of waters taken from the vicinity of onion fields for application to growing onions by spraying or sprinkler irrigation.

3. Suppressive Soil:

When some tagged bacterial pathogens were added to a particular sample of muck-land soil, and incubated for some days in the laboratory, the population of the tagged bacteria fell precipitously. In contrast, when the same experiment was done with other soil samples, the populations of tagged bacteria increased. Further analysis of the first soil suggested that the suppressiveness was based on the presence of a biological entity in the soil. Further characterization of that soil is in progress.

4. Varietal Susceptibility of Onions to the Center Rot Pathogen:

An environmental control chamber outfitted with highly specialized lighting and controls facilitated our evaluation of the susceptibility of several onion cultivars to leaf lesions induced by inoculation with *Pantoea ananatis.* Significant differences were noted. However, when mature bulbs of several of the same cultivars were inoculated with the pathogen, no differences in the development of bulb symptoms were noted. Thus, further work is needed to develop a reliable assay for the relative susceptibility of different genotypes to bacterial pathogens.

5. Effect of Actigard® on Bacterial Decay of Onion:

In 2013, we organized extensive trials of sprays of Actigard®, a resistance-inducing chemical, applied by spraying during the growing season, on resulting bacterial decay. Ten trials were carried out in Orange County and on the Elba Muck-land (Orleans and Genesee Counties). Four or five sprays were applied in each 2- to 5-acre field. In the “control” plots, no resistance inducer was applied, but all other aspects of crop management were similar. At harvest, three to five replicate samples of 100 bulbs each were hand-harvested and bagged. After typical storage for 6 to 12 weeks, each harvested bulb was examined and rated for the presence of bacterial decay; most were cut to reveal any evidence of decay. On analysis of the data, there was no evidence that the sprays of Actigard® resulted in differences in the percentage of bacterial decay in any of the 10 trials.

IPM-Based Tactics to Reduce Losses from Bacterial Decay of Onions

Although there are no “silver bullets” that can be fired at bacterial disease problems, there are several tactics that data suggest are often at least somewhat effective in reducing losses from bacterial decay based on research and grower experience. We list them here as an aid to growers who ask, “what can we do now about bacterial decay?”.

1. Choose less susceptible cultivars.
2. Limit amount of pre-plant applied nitrogen fertilizer. Many feel that 100 pounds or less N per acre of muck soil is appropriate.
3. Use water free of bacterial pathogens for spraying or sprinkler irrigation.
4. Avoid sprinkler irrigation, especially late in the season.
5. Maintain effective control of thrips, especially late in the season.
6. Pull/undercut onions when at least 50% of the leaves are down and during dry weather.
7. Do not top onions until neck tissue is completely dry (not green).
8. Harvest during dry conditions.
9. Harvest and handle bulbs gently
10. Maintain dry conditions during curing.
11. Pre-grade suspect lots of onions to eliminate rotten bulbs prior to storage.
12. Store bulbs at 32 °F to 37 °F (0 °C to 2 °C).
13. Avoid condensation forming on onions by circulating warm air over cold onions.

Several tactics require more data before justifying inclusion on the list above:

1. Plant more, rather than fewer seeds, per area to avoid lush bushy plants.
2. Spray early in the day to reduce over-night leaf moisture.
3. Choose less susceptible cultivars --

Soon, we will organize an intensive survey to ascertain grower experience.