Incidence and Potential Impact of Bacterial Soft Rot in Steckling-Planted Carrot Seed Fields

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Abstract

Bacterial soft rot can be an important disease of carrots, including carrot stecklings used for hybrid carrot seed production. The objectives of this study were to: 1) identify the causal agent of soft rot in carrot stecklings; and 2) determine the incidence and potential impact of soft rot in two steckling-planted carrot seed fields. Three bacterial isolates obtained from symptomatic carrot stecklings were identified as *Pectobacterium carotovorum* subsp. *carotovorum* (syn. *Erwinia carotovora*) using DNA sequencing. Approximately 16 to 22% of male plants and 12 to 22% of female plants were dead by the time of the first survey in early June, presumably due to soft rot. By early August, between 22 and 43% of female plants exhibited soft rot symptoms in the two fields. Although yields data was not collected, these results suggest that soft rot can have a major impact on field stands, and subsequently yield, in certain steckling-planted carrot lines.

Introduction

Bacterial soft rot is an important disease of fleshy fruits, vegetables, and ornamentals throughout the world. Although soft rot can be caused by several species of bacteria, the disease is often caused by species and subspecies of *Pectobacterium* and *Dickeya*, bacteria which were formerly classified as soft rot Erwinias. In spring of 2014 carrot stecklings exhibiting a wet, slimy decay were submitted to the Central Oregon Agricultural Research Center along with information that several steckling-planted carrot seed fields were exhibiting similar symptoms. Although the disease has been reported in the area in previous years, the causal agent, incidence, and potential impact of the disease on steckling-planted carrot seed crops were not clear and this information would be useful in developing and justifying efforts to control this disease. The objectives of this study were to: 1) identify the causal agent of soft rot in carrot stecklings; and 2) determine the incidence and potential impact of soft rot in steckling-planted carrot seed fields.

Materials and Methods

Carrot stecklings exhibiting decay were submitted to the Central Oregon Agricultural Research Center on May 15, 2014. Symptoms included a soft, watery decay of xylem tissue that appeared to start at the collar of the root and progressed downward. In some cases, the rot began at the tip of the steckling. Decayed tissue sometimes darkened to a near black color and lacked an odor. Three bacterial isolates were obtained from diseased stecklings and tested for pectolytic and soft rot ability on crystal violet pectate agar and surface-sterilized slices of potato. Molecular identification of the three isolates was performed by sequencing the 16S rRNA coding region of DNA.

A series of field surveys were conducted in two fields to determine the incidence of soft rot and collect baseline data to establish the potential impact of the disease on carrot seed crops.

Field A consisted of 85 sets of female plants. Field B consisted of 59 sets of female plants. Each set of female plants consisted of 4 rows and were paired with 2 rows of male plants. Rows were spaced 36” apart and plants spaced 5 to 6 inches apart within rows. A total of 8 female and male rows were surveyed in field A on June 4 (one day before drip-irrigation was initiated) and a total of 6 female and male rows of were surveyed in field B on June 5 (two days after drip-irrigation was started). Surveyed rows were between 625 and 1520 feet long. The total number of plants in each row was estimated using the length of the row and an average spacing of 5.5 inches between plants. In the first survey, the number of missing and symptomatic plants was determined for each row of males and females. Symptomatic plants were periodically pulled to verify that aboveground symptoms were caused by bacterial soft rot and not white mold or abiotic factors. One half of the previously surveyed rows were surveyed on July 2 and the remaining rows were surveyed on August 4. Symptoms did not appear to progress further in male plants so only female plants were surveyed.

Results and Discussion

The three bacterial isolates exhibited pectolytic ability on crystal violet pectate agar and potato slices, indicative of soft rot bacteria. Partial sequences of 16S rRNA coding DNA sequences were identical for the three isolates and exhibited 100% shared identities with seven strains of *Pectobacterium carotovorum* subsp. *carotovorum*. *P. carotovorum* subsp. *carotovorum* (syn. *Erwinia carotovora* subsp. *carotovora*) is known to cause carrot core soft rot symptoms and can cause soft rot in many other crops, including potato and onion, both in the field and in storage.

Approximately 16 to 22% of male plants and 12 to 22% of female plants were dead or missing by the time of the first survey in early June (Figure 1). The dead and missing plants may have been due to bacterial soft rot, white mold, or other biotic or abiotic factors, and a survey earlier in the season would have been required to determine the exact cause. Foliar symptoms of bacterial stem rot in the field included chlorosis of leaves, necrosis along the leaf margins, wilting, and premature senescence. In some cases, a dark brown to black discoloration was observed at the base of the plant stem which originated from the decaying steckling. Only 1.7 to 2% of male plants exhibited foliar symptoms of soft rot in the first survey (data not shown), compared to approximately 10% of female plants (Figure 2). Between 13 and 20% of female plants exhibited foliar symptoms of soft rot in early July and this number increased to between 22 and 43% of symptomatic female plants by early August (Figure 2). Missing and symptomatic plants tended to occur in runs along rows (personal observations).

Although yields were not measured, the results from these surveys indicate that bacterial soft rot may have a significant impact on field stands and subsequent yield in certain steckling-planted lines. The incidence of soft rot infection in stecklings at the time of receipt by seed growers in central Oregon is not known, nor is the potential impact of plant-to-plant spread during hand planting or during the season. Future work may focus on using chemical treatments, before or after the vernalization of stecklings, to reduce the incidence of soft rot bacteria prior to planting. Additional research may also be warranted to reduce plant-to-plant spread during or after planting.

Acknowledgements

The researchers would like to Madras Farms for providing access to fields for these surveys.

Figures

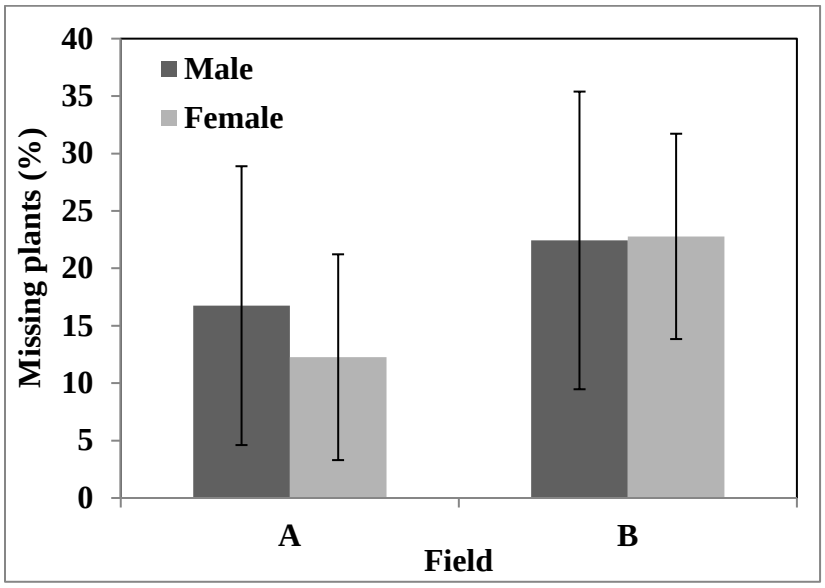

Figure 1. The percentage of missing male and female plants in two steckling-planted carrot seed fields on June 4 (field A) and June 5 (field B). Error bars indicate standard deviation values.

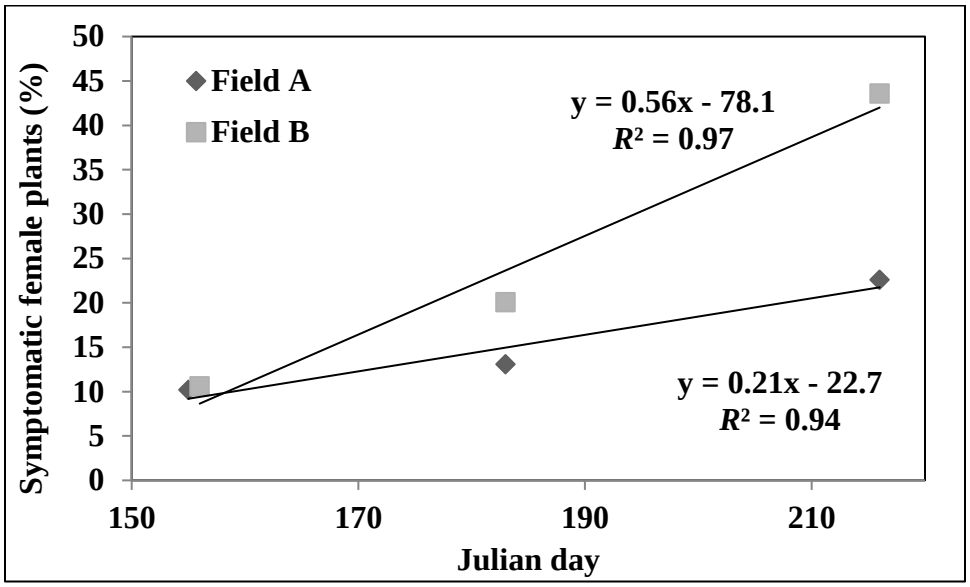

Figure 2. Mean increase in female carrot plants exhibiting soft rot symptoms in two steckling-planted carrot seed fields over time.