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Phytoplasma diseases and insect vectors in potatoes of the Pacific northwest of the United States

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Abstract

Potato growers in the Columbia Basin of Washington and Oregon experienced an outbreak of the potato purple top disease in the 2002 growing season. This outbreak caused significant yield losses and reduced tuber quality. The disease was also observed during ensuing years, especially in potato fields not treated with insecticides. Using polymerase chain reaction, it was determined that the beet leafhopper-transmitted virescence agent (BLTVA) phytoplasma was the causal agent of the disease and that *Circulifer tenellus* was the major vector of the phytoplasma in this important potato growing region of the United States.

Key words: purple top disease, BLTVA phytoplasma, *Circulifer tenellus*, potato.

Introduction

In recent years, diseases caused by phytoplasmas have become increasingly important in vegetable crops of the Pacific Northwest of the United States. An epidemic of purple top disease of potato occurred in the Columbia Basin of Washington and Oregon in 2002 and caused significant yield losses reducing tuber quality. The disease was also observed during ensuing years, especially in potato fields that were not treated with insecticides (Munyaneza, 2005). In addition, similar disease outbreaks were observed in several vegetable crops in the same area, including dry beans and radish grown for seed.

Symptoms in affected potato plants include a rolling upward of the top leaves with reddish or purplish discoloration, moderate proliferation of buds, shortened internodes, swollen nodes, aerial tubers, and early plant decline. In response to this disease outbreak, a multidisciplinary team made of entomologists and plant pathologists from the US Department of Agriculture, universities, and private industry in the Pacific Northwest, was formed to investigate various aspects of the problem, including disease causal agent(s) identification and insect(s) vectoring the disease.

Materials and methods

Samples of diseased plants were collected from potato fields throughout the Columbia Basin and tested for phytoplasmas using the polymerase chain reaction (PCR) assay (Lee *et al*., 2004b; Crosslin *et al*., 2005; 2006). Also, leafhoppers, planthoppers, and psyllids were collected from several sites in the Columbia Basin and identified (Munyaneza, 2005). The collected insects were tested for phytoplasmas by PCR (Crosslin *et al*., 2005; 2006). Transmission studies using leafhoppers were further conducted to determine the vector of the phytoplasmas (Munyaneza *et al*., 2006).

Results

Results indicated that all phytoplasmas detected from the diseased plants belong to the clover proliferation group (16SrVI), subgroup A (16SrVI-A) (Lee *et al*., 2004b; Crosslin *et al*., 2005). This subgroup currently consists of three phytoplasmas: clover proliferation (CP); potato witches'-broom (PWB); and vinca rosette (VR), a strain of beet leafhopper-transmitted virescence agent (BLTVA). The 16S rDNA sequence analysis indicated that the detected phytoplasmas were most closely related to VR with 99.7% gene sequence homology compared to 99.2% with CP and PWB. Also, the results pointed out that the phytoplasmas detected were nearly identical (99.8%) to phytoplasma strains associated with dry bean phyllody disease that had occurred in the Columbia Basin during the same season (Lee *et al*., 2004a). Furthermore, a similar phytoplasma was identified in infected carrots (Lee *et al*., 2006) and radish seed from the area (J. M. Crosslin, unpublished data).

Several leafhopper species were found in the Columbia Basin during the survey and included *Amblysellus* spp., *Balclutha* spp., *Ballana* spp., *Ceratagallia* spp., *Circulifer tenellus* (Baker), *Colladonus geminatus* (Van Duzee), *Colladonus montanus* (Van Duzee), *Dikraneura* spp., *Empoasca* spp., *Erythroneura* spp., *Exitianus exitiosus* (Uhler), *Latalus* spp., *Macrosteles* spp., *Paraphlepsius* spp., and *Texananus* spp. Also, unidentified delphacids were collected. In addition, potato psyllids [*Bactericera cockerelli* (Sulk)] were collected; however, these psyllids typically appeared in potatoes late in the season after symptomatic plants had already been observed. Testing results showed that BLTVA was detected in 52% of *C. tenellus* samples of groups of 5 insects each and only one sample of *Ceratagallia* tested positive for the phytoplasma. All other leafhoppers, delphacids, and psyllids tested negative for the phytoplasma, including *Macrosteles*, the well known vector of aster yellows phytoplasma. Further transmission studies conducted in the laboratory confirmed that *C. tenellus* transmits BLTVA to potato,

beet (*Beta vulgaris*), and selected weeds (Munyaneza *et al*., 2006). Moreover, *C. tenellus* was found to be abundant throughout the Columbia Basin (Munyaneza *et al*., 2007) and it was concluded that this leafhopper is the most important vector of the potato purple top phytoplasma in this major potato producing region of the United States.

Discussion

The findings reported herein verified that the phytoplasma (16SrVI) associated with potato purple top in the Columbia Basin is different from the potato purple top phytoplasma reported from the north central United States (Banttari *et al*., 1993) and Mexico (Leyva-López *et al*., 2002), which is related to the aster yellows group (16SrI). This shows that a similar disease can be caused by different pathogens in different geographic areas. To distinguish the potato purple top phytoplasma in the Pacific Northwest from the one found in Mexico, it was identified by J. M. Crosslin as the "Columbia Basin purple top disease phytoplasma" (GenBank accession AY692280), which is closely related to, or synonymous with, BLTVA. *C. tenellus* is the major vector of the potato purple top phytoplasma in the Columbia Basin; this is in contrast to *Macrosteles* which is the major vector of purple top phytoplasma in the north central United States. Management of this potato disease requires development of effective strategies to control *C. tenellus* in the Pacific Northwest. More research on the epidemiology and management of this potato disease in the Columbia Basin is underway. Research includes investigating the importance of weeds as hosts to both *C. tenellus* and BLTVA, determining the sources and proportions of infective leafhoppers, investigating the susceptibility of different potato cultivars and plant growth stages to BLTVA, determining the effects of BLTVA on potato tubers, and establishing action thresholds for this insect pest.

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