NATURAL HISTORY AND OBSERVATIONS

First identifications of aphid and diamondback moth populations on wasabi in British Columbia

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ABSTRACT

Wasabi is a highly valued crop in the Pacific Northwest where commercial production is increasing. To date, little attention has been paid to its invertebrate pests. Two wasabi polyhouses in Agassiz, BC, were monitored for insect pests for 15 months. *Pemphigus populitransversus* Riley (poplar petiole gall aphid) recurred annually in winter months on roots throughout the polyhouses. *Lipaphis pseudobrassicae* Davis (turnip aphid) infested the leaves of a large number of plants. *Myzus persicae* Sulzer (green peach aphid) and *Macrosiphum euphorbiae* Thomas (potato aphid) were noted in very low numbers. *Plutella xylostella* Linnaeus (diamondback moth) caused shot-hole damage of the leaves. Further investigation into the role of insects as vectors and their role in pathogen pathways on this unique crop is needed.

Key words: wasabi, *Pemphigus populitransversus*, *Lipaphis pseudobrassicae, Plutella xylostella*

INTRODUCTION

Wasabi (*Wasabia japonica* (Miq.) Matsumura) (Brassicaceae) is native to Japan, where it grows in shaded stream environments (Adachi 1987). It is currently cultivated in Asia, Australasia, and North America for its valuable rhizome, which is used as a freshly-ground condiment eaten with traditional Japanese meals (Hodge 1974; Chadwick *et al.* 1993). It can fetch US$150-300/kg on the international market. Although the rhizome is the primary plant part for culinary use, the leaves can also be used to flavour soups or salads (Chadwick *et al.* 1993). In B.C., there is an estimated 5-10 acres of commercial wasabi in production using hydroponic or similar systems in polyethylene tunnels (polyhouses) or traditional glass greenhouses. Plants are typically grown in river rock substrate, as plants grown in soil are thought to produce an inferior quality rhizome (Chadwick 1993; Sultana *et al.* 2003). It takes 12 – 18 months before plants are of marketable quality, and due to the humid growing environment and propagation from axillary shoots, disease issues are the most common reason for crop loss in British Columbia (Rodríguez & Punja 2009; Punja *et al.* 2017; MacDonald & Punja 2017). To date, little research has been directed toward arthropod pests, and all reports are anecdotal. We report the first occurrence of insect pests on wasabi in North America at a research planting in Agassiz, British Columbia.

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MATERIALS AND METHODS

Two polyhouses, each planted with 500 tissue-cultured (cv. Daruma) and 500 auxiliary-shoot propagated (cv. Mazuma) wasabi plantlets, were established in January 2015 at the Agriculture and Agri-Food Canada (AAFC) Agassiz Research and Development Centre in Agassiz, BC. Prior to transplant into the polyhouses, the plants were maintained in a production greenhouse for one month. A commercial nutrient growing system was used, with overhead misters fertigating at regular intervals or when triggered by a photosensor. Plants were grown in ~20 cm of 2-3 cm diameter river-rock. From April to October, 70% shade cloth covered the polyhouses to reduce direct exposure to UV radiation. Weekly or bi-weekly inspections were conducted by trained staff to identify pests and for treatment recommendations. Aphid populations were treated with imidacloprid. Two releases of *Diadegma insulare* Cresson parasitoids were conducted weekly to manage feeding diamondback moth larvae, followed by treatment with flubendiamide.

Leaves, petioles, and roots were visually inspected at random throughout each planting. Approximately five infested plants with representative pest populations from either leaves and petioles or roots were selected for each sample. A soft paintbrush was used to gently brush specimens off of plant material into vials of 95% ethanol (EtOH) for identification. Aphids were identified by morphological determination or by sequencing mitochondrial cytochrome C oxidase, subunit 1 ("DNA barcoding"). Adult diamondback moths were identified by morphology under a binocular microscope. Assessments were carried out until harvest, after 15 months.

RESULTS AND DISCUSSION

Poplar petiole gall aphids. In January 2015, *W. japonica* 'Daruma' plantlets grown in soil-less plugs were uprooted for transplant into polyhouses and a heavy root aphid infestation was noted. Aphids were present throughout the crop and each root system, and a characteristic white waxy secretion was visible (Fig. 1A). No alates were present. The following January to March (2016) on the same crop of Daruma and a neighbouring crop of Mazuma, identical root aphid populations were again found. In both cases treatment with imidacloprid appeared to provide control. All populations were identified as *Pemphigus populitransversus* Riley by sequence matching to specimens collected from galls on *Populus deltoides* (Fig. 1A, B).

Root aphids have been implicated as pests of wasabi historically (Miles & Chadwick 2008; Chadwick *et al.* 1993) but identified only once, in New Zealand, as *P. bursarius* Linnaeus (Douglas & Follett 1992); that population was difficult to control. *Pemphigus populitransversus* is known to alternate hosts between roots of various Brassicaceae, sometimes as a significant pest (for example Chen *et al*. 2009), persisting by parthenogenesis, and a sexual stage on *Populus* spp. trees, where they overwinter as eggs and form galls on the petioles of the leaves the following spring (Jones & Gillette 1918). Aphid damage to roots and rhizomes may be an important pathway for pathogens such as *Pectobacterium carotovorum* subsp. *carotovorum*, which has been found to cause vascular blackening of the rhizome after entry through small wounds (Rodríguez & Punja 2009). This is the first published report of *P. populitransversus* in B.C. that the authors are aware of, although there are specimens of unidentified *Pemphigus* species from wasabi collected in Aldergrove and Langley in 1997 and 1998 in the Canadian National Collection of Insects, Arachnids and Nematodes.

Turnip aphids. In spring of 2016, aphids were found predominantly on leaves of one-quarter of the affected polyhouse and identified as *Lipaphis pseudobrassicae* Davis (n = 62 specimens). *Macrosiphum euphorbiae* Thomas (n = 2) and *Myzus persicae* Sulzer (n = 1) were also present in the sample.

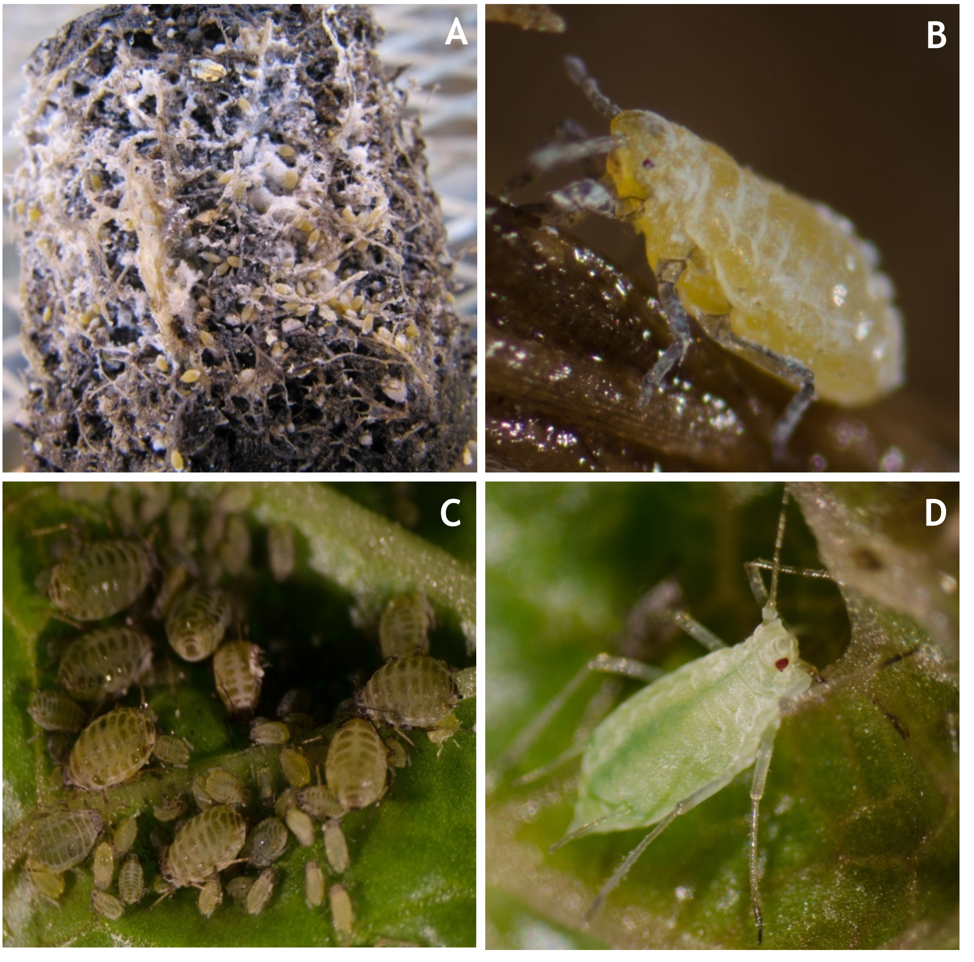

Figure 1. A) Parthenogenic *P. populitransversus* population with waxy exudate in the root mass of a *W. japonica* plant grown in a plug-tray. B) Apterous *P. populitransversus* with proboscis in *W. japonica* root. C) *L. pseudobrassicae* colony consisting of different instars on a *W. japonica* leaf. D) *M. euphorbiae* aptera with proboscis in a *W. japonica* leaf. Photos by J.L. MacDonald, with permission © Her Majesty the Queen in Right of Canada as represented by the Minister of Agriculture and Agri-Food 2016.

The most serious issue associated with aphids on wasabi is their ability to transmit viruses (Douglas & Follett 1992). Wasabi is susceptible to tobacco mosaic virus (TMV), turnip mosaic virus (TuMV), and cucumber mosaic virus (CMV) (Chadwick *et al.* 1993; Wilson 1998), and although problematic elsewhere, no viruses have been identified on wasabi in B.C. Should these diseases be reported locally, *L. pseudobrassicae* should be assessed as a potential vector of TuMV and CMV (Chan *et al.* 1991).

Diamondback moth. In June 2015, a heavy infestation of diamondback moth, *Plutella xylostella* Linnaeus, and associated 'shothole' damage on leaves was found. Adults were prevalent and flew as plants were disturbed.

Diamondback moth is the most destructive pest of Brassica crops worldwide. It has been reported on wasabi crops in Japan (Hodge 1974; Adachi 1987; Chadwick *et al.* 1993; Miles & Chadwick 2008). Due to successful management of the infestation with flubendiamide, it is unclear whether *D. insulare* releases were effective. Interestingly, a single mobile parasitoid adult was photographed almost 10 months later in a neighbouring polyhouse which had no previous biocontrol releases, suggesting the population persisted.

This first survey of insect pests of commercial wasabi production suggests that there is considerable potential for economic damage. Currently, no insecticides are registered in the United States for use on wasabi and only one synthetic insecticide is registered in Canada (permethrin). Although there are a number of biopesticides available in Canada, these may not be sufficient if the aphids are vectors for viruses. Investigations into the relationship between aphids and pathogens (such as *P. carotovorum*), or as vectors of viruses, may generate interest in an integrated management approach, as well as the registration of additional control products for resistance management for use in commercial wasabi crops.

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