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Short communication

Abundance of weed hosts as potential sources of onion and potato viruses in western New York

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ABSTRACT

A season-long survey of common weeds was taken near onion and potato fields located within a large vegetable production region in western New York in 2008 and 2009. The objective was to determine the abundance of weed species known as hosts for *Iris yellow spot virus* (IYSV), a serious pathogen of onion, *Potato leafroll virus* (PLRV) and *Potato virus Y* (PVY), which are major pathogens of potato. Ninety-eight weed species were identified, 17 of which are known hosts for IYSV, PLRV and PVY. Common lambsquarters, redroot pigweed, shepherd's purse, horseweed and dandelion were among the most abundant species known as hosts for these viruses. This information could be useful for studying the role that these weed species have on the epidemiology of the major viruses in onion and potato production systems and for developing future virus management strategies.

1. Introduction

Onion, *Allium cepa* L., and potato, *Solanum tuberosum* L., are two of New York State's most valuable crops, typically grossing $50–60 million (NASS, 2010) and $55–85 million (NASS-NY, 2009) annually, respectively. While nearly all onions grown in NY are grown in highly organic muck soil, a relatively small portion of New York's potato crop is grown in muck. However, muck acreage devoted to potato is highest in the Elba Muck vegetable production region in western New York (NASS-NY, 2008). The Elba Muck region is an area of approximately 2225 contiguous hectares of muck soils and is almost entirely devoted to vegetable crops, especially onion and potato.

Iris yellow spot virus (IYSV) (*Bunyaviridae*: *Tospovirus*) is a yield-reducing pathogen of onion and other *Allium* crops (Gent et al., 2004). IYSV is primarily transmitted to onion by onion thrips, *Thrips tabaci* Lindeman (Kritzman et al., 2001). IYSV is found in many areas of onion production worldwide (Gent et al., 2006), and at least 46 plant species have tested positive for IYSV, many of which are weeds (Smith et al., 2011). For example, redroot pigweed, *Amaranthus retroflexus* L., common burdock, *Arctium minus* Bernh., common lambsquarters, *Chenopodium album* L., chicory, *Cichorium intybus* L., curly dock, *Rumex crispus* L. and dandelion, *Taraxacum officinale* G.H. Weber ex Wiggers have been identified as hosts of IYSV (Sampagni et al., 2007; Hsu et al., 2011) and all occur in New York. These weeds are also hosts for *T. tabaci* (Smith et al., 2011).

Potato leafroll virus (PLRV) (Luteoviridae: *Polerovirus*) and *Potato virus Y* (PVY) (Potyviridae: *Potyvirus*) are the two most important viruses infecting potato crops in the US (Hooker, 1981; Johnson, 2008; Singh et al., 2008; Gray et al., 2010). These viruses are transmitted to potato by many different aphid species (Hemiptera: Aphididae), but the most important vector of both viruses is the green peach aphid, *Myzus persicae* (Selzer) (Harrison, 1984; Sigvald, 1984). There are also common weed species known as hosts for both PLRV and PVY including shepherd's purse, *Capsella bursa-pastoris* (L.) Medik. (Ellis, 1992; Kazinczi et al., 2004), and common lambsquarters (Kazinczi et al., 2004). Redroot pigweed is a host for PLRV (Natti et al., 1953) and other hosts likely exist as well.

Weed species that host IYSV, PLRV and PVY occur where onion and potato are grown in western New York, but their relative abundance in this vegetable producing region is not known. A comprehensive survey of common weed species, including known

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hosts for IYSV, PLRV and PVY, may be valuable for understanding the epidemiology and future management of these viruses in cropping systems where onion and potato are grown. The objective of this study was to estimate densities of the most common weed species in the Elba Muck region of Western New York, and of special importance, species known to be hosts for IYSV, PLRV and PVY.

2. Materials and methods

2.1. Sampling location and period

Weed population densities were recorded from five sites located in the Elba Muck region of New York (43.1N, 78.1W) in 2008 and 2009. Sites were separated from one another by >1.5 km. Each site was a 10 m by 90 m area of fallow land directly adjacent to a muck field that was currently in vegetable production. The same sites were sampled in both years of this study. In 2008, data were collected every 2 wk from 9 May to 30 August and again on 26 September (10 sampling dates). In 2009, data were collected every 2 wk from 18 May through 5 October (11 sampling dates). Data were recorded by the same observer each year. This schedule was chosen to ensure that weed species encompassing all four main growth habits would be encountered in the sampling (e.g. summer annuals, winter annuals, biennials and perennials).

2.2. Weed survey and density/cover estimates

On each sample date, weed densities or percentage cover at each of the five sites were determined for each species by recording the number of individuals or visually estimating the percentage cover in a 0.25 m^2 quadrat every 10 m over a 90 m linear transect for a total of 10 quadrats sampled per sample date at each site (Daubenmire, 1959; Smith et al., 2011). Quadrats were not permanent but were located within permanent transects. Transects at each of the five sites were located <50 m from vegetable crop fields, were parallel to their respective field edges and occurred in the same locations throughout the duration of this study. Plants were categorized as either broadleaf weeds whose density could be easily quantified by counting individual plants or tillers, or plants whose growth habit necessitated quantification on a percentage cover basis. This latter group of species included mostly (but not exclusively) grasses and broadleaf weeds that had cespitose, prostrate or creeping growth habits.

2.3. Weed densities or percent cover data

For each weed species, densities of plants in the 10 quadrats were totaled at each site and again across all five sites on each sampling date. Thus, the total abundance or percent cover of species was divided by the total area sampled per date to estimate the number of plants or % cover per m^2 (12.5 m^2 = 0.25 m^2 × 10 quadrats/site × 5 sites) and per hectare. Values for all sampling dates were averaged to determine the estimated mean plants or percent cover per hectare for each weed species over the course of the season.

3. Results

Ninety-eight weed species were identified in this study, including 37 annuals (summer and/or winter annuals), 7 biennials, 40 perennials (simple or creeping), 12 species known to exhibit more than one life history and 2 unidentified species (Tables 1 and 2). Fifty percent of all species identified were members of the Asteraceae, Brassicaceae and Poaceae, accounting for 22, 9 and 18 weed species, respectively. Species from these families were also among the most abundant. Seven of the 11 most abundant species quantified by individual counts were members of the Asteraceae, including the three most abundant species: dandelion, Canada goldenrod, *Solidago canadensis* L. and Canada thistle, *Cirsium arvense* (L.) Scop. (Table 1). Five of the 10 most abundant species quantified by percent cover were members of the Poaceae, including the three most abundant species: fall panicum, *Panicum dichotomiflorum* Michx, Canada bluegrass, *Poa compressa* L. and timothy, *Phleum pratense* L. (Table 2).

Seventeen of the 98 weed species are hosts of viruses known to infect onion and potato (Table 3). Ten species are hosts of IYSV, four species are hosts for PLRV and at least 13 species are known to be susceptible to PVY. Some of these species are hosts for more than one virus. For example, common lambsquarters is a host for all three viruses. Common lambsquarters, redroot pigweed, shepherd's purse, horseweed and dandelion were among the most abundant weeds observed in this study (Table 1) and are known hosts of one or more of these viruses (Table 3).

4. Discussion

The relative epidemiological importance of these weed species is not known. Factors that likely influence their importance include prevalence of the weed host, abundance and phenology of the vector, dispersal capability of the vector, modes of transmission of the virus and acquisition and transmission efficiencies of the virus by the vector.

While weeds have not been documented as major sources contributing to IYSV epidemics in onion crops, studies of other *Tospovirus* spp. suggest that weeds are likely important sources of inoculum (Groves et al., 2002). Weeds that are important sources for IYSV and other *Tospovirus* spp. must also serve as reproductive hosts for their respective vectors (Culbreath et al., 2003). *T. tabaci* is the primary vector of IYSV in onion fields (Gent et al., 2004, 2006) and is the major pest of onion crops worldwide (Lewis, 1997), including New York. As with all *Tospovirus* spp., IYSV is persistent and propagative in its vector, meaning that individuals remain viruliferous for life and that the virus replicates itself within the vector (Moritz et al., 2004). Due to internal morphological transformations that occur during short periods of their development, *Thysanoptera* spp. can only acquire *Tospovirus* spp. as first instars, and can only transmit as second instars and adults (Ullman et al., 1993; Moritz et al., 2004). As such, an important epidemiological source of IYSV must also be a host of *T. tabaci* larvae. IYSV-susceptible weeds that cannot support populations of *T. tabaci* larvae are said to be epidemiological "dead-ends" as the vector cannot acquire the virus as an adult.

At least six of the ten IYSV-susceptible species reported in our study have been confirmed as hosts of *T. tabaci* larvae, and all six species have been commonly observed in New York (dandelion, common lambsquarters, redroot pigweed, chicory, common burdock and curly dock) (Table 3) (Smith et al., 2011). These six species may be important in the epidemiology of IYSV in the Elba Muck and similar agricultural ecosystems in the Great Lakes region of North America, but factors such as host suitability and transmission efficiency likely impact their role. Weed host suitability for the major thrips vectors of *Tomato spotted wilt virus* (*Bunyaviridae: Tospovirus*) (Groves et al., 2001, 2002; Chatzivassiliou et al., 2007) and their transmission efficiencies (Groves et al., 2002; Stumpf and Kennedy, 2005; Chatzivassiliou et al., 2007) were both important factors in the epidemiology of this disease in solanaceous crops.

In contrast to the relative vector-specificity of IYSV, many species of aphids are known to transmit PLRV and PVY; however, the green peach aphid has been identified as the most important vector of both viruses (Harrison, 1984; Sigvald, 1984). While