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Detection of insect pests of grapes, *Vitis vinifera*, in vineyards of Nova Scotia through pheromone trapping

N. Kirk Hillier and José Lefebvre

ABSTRACT

The fledgling grape and wine industry within Nova Scotia represents an area of significant growth. Primarily wine grapes, production has grown from 150 tonnes in 1996 to 706 tonnes in 2005 (Anonymous 2009). Currently, the occurrence and distribution of insect fauna within the region which may pose threats to this emergent viticulture industry are relatively not documented. This study surveyed regional growers regarding the perceived incidence of pest damage and used pheromone traps and sweep nets to study the incidence of major and minor grape pests within vineyards. Grower surveys and direct inspection of grapevines during 2010 yielded few insect concerns for current, direct damage. Trap results indicated the presence of numerous minor threats to grapes, primarily generalist insect pest species which feed on neighbouring crops such as apples. Knowledge of the presence and distribution of such pest species will aid growers in future management decisions.

RÉSUMÉ

L'industrie récente du vin et du raisin de la Nouvelle Écosse est en expansion. La production de raisin destiné à la fabrication de vin est passée de 150 tonnes en 1996 à 706 tonnes en 2005 (Anonymous 2009). L'information sur la présence et la distribution des insectes pouvant potentiellement causer des problèmes à la nouvelle industrie viticole est rare. La présente étude consiste en un sondage auprès des producteurs de la région sur l'incidence des insectes ravageurs ainsi qu'une étude sur la présence d'insectes ravageurs capturés au moyen de piège à phéromone et de filet fauchoir. Selon l'avis des producteurs et de nos inspections des vignes, il n'y a eu que peu d'insectes ravageurs et de dommage en 2010. Le résultat du piégeage révèle la présence de nombreuses espèces d'insectes ravageurs secondaires qui sont généralement des insectes inféodés à d'autres cultures présentes à proximité des vignobles. Cette information relative à la présence et à la distribution de ces espèces d'insectes ravageurs seront utile pour planifier la gestion de la culture de la vigne.

INTRODUCTION

The commercial wine grape industry in Nova Scotia (NS) has been in existence since 1980 (Lewis et al. 2008). Nova Scotia wines generated sales of approximately $7.2 million from 10 wineries in 2005, with a projected growth potential to $24 million by 2020 (Anonymous 2009). The Grape Growers Association of Nova Scotia (GGANS) was established in 1982 and now consists of over 50 growers with over 160 ha of wine grapes (*Vitis vinifera* L). In 2002, the Nova Scotia Winery Association was established to promote development of the wine industry in the province. Viticulture in NS, primarily wine grapes, has grown from a production of 150 tonnes in 1996 to 706 tonnes in 2005 (Anon. 2009).

The NS wine industry has demonstrated considerable expansion in a relatively short period of time, with new commercial vineyards replacing orchard and pasture land. Grape production is concentrated within the Annapolis

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Valley of NS, though several additional production areas have been identified, including the Bear River Valley, the LaHave River Valley, the Malagash Peninsula and Marble Mountain in Cape Breton (Figure 1). Given that this is a relatively new industry to the province, care has been taken to prevent importation of arthropod species of economic concern from elsewhere in the world.

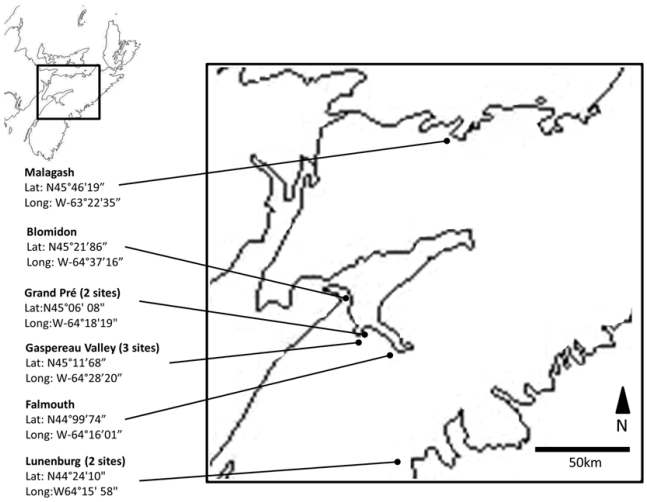
Many of the most devastating pests of grapes are native to North America and may already be present within the Northeastern United States and Canada (Isaacs et al. 2003; Vincent et al. 2009). Grape berry moth, *Endopiza viteana* Clemens (Lepidoptera: Tortricidae), is a key grape pest throughout most grape growing regions of North America (Hoffman and Dennehy 1987; Hoffman et al. 1992; Bostanian et al. 2003). Grape phylloxera, *Daktulosphaira vitifoliae* Fitch (Homoptera: Phylloxeridae), is distributed throughout North America, with growers reporting some incidence within Nova Scotia. However, it is thought that resistant rootstock may be limiting damage in NS (Fossen and Granet 2007; GGANS, personal communication). Clearwing moths, such as grape root borer, *Vitacea polistiformis* Harris (Lepidoptera: Sesiidae) also pose threats as their larvae burrow into woody vine stock (Weihman and Liburd 2006).

Finally, several grape pests are generalist feeders that feed on a wide range of plant species. This creates the potential for invasion into vineyards from other crops. Larvae of variegated or omnivorous leafroller, *Platynota stultana* Walshingham (Lepidoptera: Tortricidae), feed on an array of vines, fruits and nuts throughout North America (Flaherty et al. 1992). Cicadellids (Homoptera: Cicadellidae), particularly leafhoppers and sharpshooters, are frequent minor pests of grapes in temperate areas. Sixty species have been recorded within vineyards in Quebec, though many species were more closely associated with weeds (Bostanian et al. 2003; Bostanian et al. 2006). Along with spittlebugs (Homoptera: Cecropidae), these homopteran species pose significant threats as vectors for Pierce's disease in grapes (Weintraub and Beanland 2006). Tarnished plant bug, *Lygus lineolaris* Palisot de Beauvois (Heteroptera: Miridae), has also been reported prevalent within vineyard operations in North America (Bostanian et al. 2003). Within the Coleoptera, Asiatic garden beetle, *Maladera castanea* Arrow (Scarabaeiidae), and black vine weevil, *Otiorhynchus sulcatus* Fabricius (Coleoptera: Curculionidae), also pose potential omnivorous threats (Bostanian et al. 2003).

Few studies have been conducted regarding the incidence of vineyard insect pests in Nova Scotia, though some pest species are known to be present and have been recorded from other host plants. Pest species such as fruittree leafroller, *Archips argyrospila* Walker (Lepidoptera: Tortricidae), and red-banded leafroller, *Argyrotaenia velutinana* Walker (Lepidoptera: Tortricidae), are prevalent in North American apples and other orchard crops (Cox 1963; Roelofs et al. 1974; MacLellan 1979), and have been recorded regionally in Nova Scotia (Nova Scotia Museum Collections Unit, personal communication). These species feed on several plant species and hence could present threats to commercial grape operations as well.

The objectives of this study were to survey grower knowledge regarding pest management in the region and to assay the potential grape pest insects for which commercially-available pheromone lures and traps are available.

Figure 1: Map of Nova Scotia indicating vineyard field sites for pheromone trap monitoring in 2010.



MATERIALS AND METHODS

Grower Survey

In April 2010 an online survey was conducted wherein key producers were queried for their knowledge of and experience with regional insect pests. The survey was constructed and published online using the 'Form' tool in Google Docs™ (https://docs.google.com). Members of regional viticulture associations were contacted via email or phone and provided with the direct link to the survey. The questionnaire, which requested information based on a Likert Scale on management practices, production figures, pest and disease concerns, is available online at http://viticulture.acadiau.ca/. The Canadian National

Collection of Insects, Arachnids and Nematodes and the Nova Scotia Museum Collections Unit were also queried for existing records for the presence and distribution of insects which may be potential pests within NS.

Field Sites and Sampling

Sampling for potential insect pests and symptomatic vines occurred from May 2010 to September 2010. Several vineyards were selected from throughout the region, ranging from the Annapolis Valley, to Malagash in the north, and Lunenburg in the south (Figure 1). Characteristics of each site were recorded, including grape varieties grown, cultural control strategies, history of fungal or insect infection, and organic management strategies. Sites were visited weekly, with the exception of the Malagash and Lunenburg which were visited on a biweekly basis.

Pheromone traps were used to monitor a range of insect species known to be both major and minor threats to grapes in North America. Delta-style traps were purchased from Great Lakes IPM® (Vestaburg, MI) loaded with the following species of known major and minor grape pests (Flaherty et al. 1992; Bostanian et al. 2003): *Archips argyrospila*, *Endopiza viteana, Platynota stultana* and orange tortrix, *Argyrotaenia citrana* Fernald (Lepidoptera: Tortricidae). Lures were acquired from Contech® (Burnaby, BC) and Great Lakes IPM® (Vestaburg, MI). Two replicate Delta traps for each lure were deployed at each of the sites listed in Table 1, along with 2 hexane blanks. A single Unitrap® bucket trap was also deployed at each site and loaded with a lure for *Vitacea polistiformis* (Great Lakes IPM® Vestaburg, MI).

Traps deployed throughout the summer (24 May – 29 August, 2010). They were hung by wire from trellises and spaced in a grid a minimum of 20 m apart. Each week, or every other week for Malagash and Lunenburg sites, traps were circulated through the grid to minimize any edge effects. Trap bottoms were collected and exchanged when saturated; lures were not changed for the duration of the study unless lost or damaged.

Sweep-netting was conducted during each site visit to monitor for potential pest species in the vegetation. Two 2 m x 20 m sweeps were conducted in grape vegetation, and in vegetation on the edges of vineyards. In addition, vegetation was actively monitored and vine samples were taken from symptomatic plants. Growers were invited to participate in regular trap counting and sampling, particularly for more remote areas which were difficult to visit every other week. Growers and vineyard staff were urged to monitor and report signs of plant stress. Upon return to the lab, specimens were curated, identified and the population density of pest species analyzed.

RESULTS AND DISCUSSION

Summary of grower survey

Complete results from the grower survey, are available online at http://viticulture.acadiau.ca/. Some information remains anonymous by request.

Surveys were completed for 14 vineyards, of which almost two thirds reported using weather data as a primary tool for forecasting treatment. The highest ranked tool (64.3%) for determining treatment application was crop development, but a slight majority, 57.1%, used thresholds (type unspecified)to determine the application of a pesticide. Almost half (42.9%) of vineyards are adjacent to some form of agriculture, but the vast majority are adjacent to wooded areas. Vine ages are highly variable (0 to 31 years), with half the vineyards being over 20 years old. More than 75% of grape varieties grown were for white wines, and the three vineyards growing red grapes do not use hybrid vines. Only one vineyard was irrigated. The average surface under production was 8 ha (range = 0.4 to 24 ha), and the average yield/ vineyard was 30.75 tonnes (range = 1 to 150). The vast majority (85.7%) of vineyards are full-time operations. Although responses were highly variable, climate and birds were the most common yield-limiting factors reported. The greatest biological threats to grapes were mildew and birds, reported by 35.7% and 21.4% of vineyards, respectively. Current methods of inspection for insect pests among vineyards varied from every day to no scouting, and 50% of vineyards have observed some degree of insect activity on their grapevines in the past. There was no correlation between scouting activity and pest observation. As perceived by growers, insect pests included: *Daktulosphaira vitifoliae*; multicolored Asian lady beetle, *Harmonia axyridis* Pallas (Coleoptera: Coccinellidae); grape erineum mites, *Colomerus vitis* Pagenstecher (Acarina: Eriophyidae); European red mites, *Panonychus ulmi* Koch (Trombidiformes: Tetranychidae); and ants (Hymenoptera: Formicidae). Control measures, using fine mesh to catch insects or chemical insecticide sprays were required for 57.1% of the infestations.

All vineyards were aware of pheromone trapping, but were used only in two vineyards; one as part of a study by Agriculture and Agri-Food Canada, and one for grape berry moth. Only one vineyard surveyed was not aware of biological control strategies, such as introduction of predators or parasitoids. Field monitoring was the method of choice to assess insect infestations by 79%

of vineyards surveyed, while two vineyards actually did not monitor at all. General pesticide usage varied greatly between vineyards, with the most common being sulphur fungicide (21.4%) and the herbicide glyphosate (14.3%).

Pheromone Trapping and Sweeps

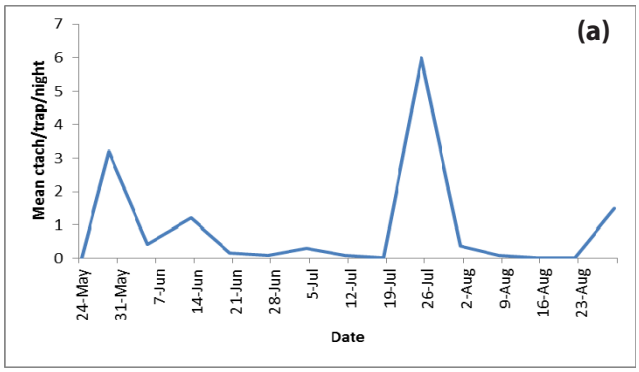
Several grape pests were collected regionally in pheromone traps, including *Archips argyrospila* and *Argyrotaenia velutinana*, in relatively higher numbers with smaller numbers of moths to *Platynota stultana* lures (Table 1). *Platynota stultana* has not been previously recorded in Nova Scotia. However, four related species of *Platynota* are present: *Platynota scotiana* McDunnough, *Platynota idaeusalis* Walker, *Platynota semiustana* Walsingham, or *Platynota rostrana* Walker (Nova Scotia Museum Collections Unit, personal communication). Specimen condition in these sticky traps unfortunately did not permit species-level identification.The pheromone traps did not capture the most devastating species such as *Vitacea polistiformi*, *Endopiza citrana* and *Endopiza viteana*.

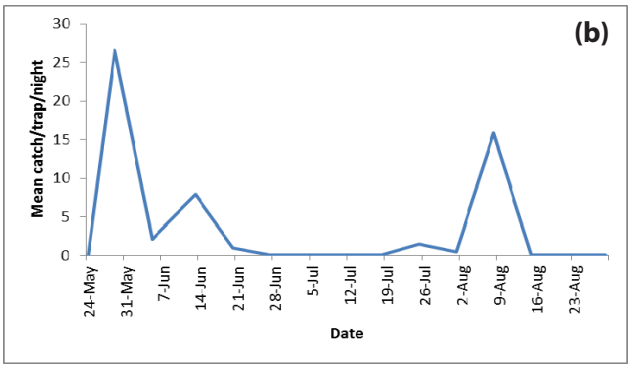
Table 1. Total pheromone trap captures in Nova Scotia vineyards from 24 May to 29 August, 2010. Catches were standardized by subtracting hexane control captures.

Location	Insect		
	Fruittree leafroller	Red-banded Leafroller	Variegated Leafroller
	Archips argyrospila	*Argyrotaenia velutinana*	*Platynota* spp.
Blomidon	4	35	4
Gaspereau #1	12	75	5
Gaspereau #2	12	204	12
Gaspereau #3	30	246	2
Grand Pre 1	33	54	0
Grand Pre 2	16	41	0
Falmouth	11	84	10
Lunenburg 1	29	0	2
Lunenburg 2	40	28	1
Malagash	0	11	1

Archips argyrospila also shows a minor surge early in the season in late May, peaking by 8 August (Figure 2A) while *Argyrotaenia velutinana* populations peak in late May to early June and exhibit a second smaller peak in the first week of August (Figure 2B). It is worth noting that all of the species collected from the pheromone traps in this study are omnivorous, largely defoliators, but can cause some direct damage to fruit, and historically are severe pests of apples (Maclellan 1979). The incidence of all of these species was greatest in Annapolis Valley vineyards, particularly the Gaspereau Valley region. These vineyards are in close proximity to active and former apple orchards which may act as reservoirs for pest insects.

Figure 2. Mean catch per trap/night pooled across all field sites of *Archips argyrospila* (a) and *Argyrotaenia velutinana* (b) from 24 May to 29 August, 2010. Catches were standardized versus hexane control captures.





Visual inspection of vines and fruit by technicians and growers resulted in collection of only two unknown leafroller larvae across all sites. Rearing and identification were unsuccessful. Sweeping transects yielded no evidence of pest species. The collected specimens were predominantly non-pest Diptera and Hymenoptera (data not shown). The grower survey reported previous incidence of a number of species not detected in the current study (specifically *Daktulosphaira vitifoliae*, *Endopiza viteana, Colomerus vitis*, *Panonychus ulmi,* and ants). This is likely due to the combination of pheromone trapping and 2 m x 20 m sweep transects being ineffective in distinguishing a number potential pest threats, and low overall pest levels during the study period. Future studies are warranted, including additional sampling techniques such as intercept, pan or pitfall traps to perceive additional species and potential threats (Bostanian et al. 2003).

By knowing the presence of these pests and their flight seasons within the region, we can apply this information for appropriate management decisions should they become problematic in the future. For example, it is clear that the peak adult flight seasons for 3 of the species present are broken into two brief periods in the year. One peak adult flight occurs in late May to early June, the second in early August, across all species sampled. Pheromone trap data could be used to assist management decisions and timing of insecticidal application, as necessary, to target the most vulnerable stages of these insects – eggs and early-instar larvae. Early-instar larvae are most susceptible to insecticides and also are not yet enclosed in refugia such as fruit or rolled leaves which might protect them from insecticide contact (Jones 1998). Furthermore, in Nova Scotia very little foliage is present on grapevines in May, which significantly decreases the likelihood that early season foliar pests such as *Platynota stultana* could easily establish in grape monocultures.

When trapping data are taken into consideration with the grower survey, several items become apparent. First, growers surveyed reported that insect pests were of relatively minor concern in comparison to grape disease management or other pests, particularly birds. The limited number of grape pests found in this study and absence of major pests such as *Endopiza viteana* or *Vitacea polistiformis* supports this statement. Furthermore, pests surveyed in this study which are present within the region indicated relatively minor impact on grapes. Negligible numbers were collected from foliage. Second, most growers were aware of the most significant grape pests, such as *Endopiza viteana*, that are present in other provinces or states in North America but had little awareness of other potential threats such as the leafroller complex evaluated in this study, or other ubiquitous species such as *Maladera castanea* and *Otiorhynchus sulcatus*. Notwithstanding limits of detection for techniques employed in the current study, this suggests not only that these pests have not yet materialized as concerns for regional viticulture, but that extension efforts should be focused more on pest threats that are present regionally, versus 'common' pest threats that are found elsewhere which may not be indicative of regional concerns.

Based upon current survey results, insect pest threats to grapes are currently minimal within NS, with many of the most significant pest species not found within commercial vineyards sampled. Several minor pest species were found in traps, though evidence in sweeps or visual inspection for damage on grapevines was insignificant. Knowing the presence/absence of particular pests will be important for economical management decisions as the industry moves forward. Vineyard operators should continue to be vigilant with regard to the minor/potential pest species found in this study, particularly in areas where vineyards are adjacent to other agricultural habitats such as apples. This may include the use of techniques such as pheromone-trapping noted in this study or other scouting procedures. Given that many more serious threats to viticulture were not found regionally, great care should be taken to prevent importation of more significant pest species through the transport of vines for propagation.

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