Effects of insecticide and tolerant alfalfa cultivars on potato leafhopper (*Empoasca fabae*) populations and forage yields in Quebec (Canada)

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Abstract

The potato leafhopper [PLH, *Empoasca fabae* (Harris)], which affects several crops including alfalfa (*Medicago sativa* L.), is a recurrent problem in several regions of Quebec. The objective was to evaluate alfalfa management tools in order to reduce yield losses caused by this pest. An experiment was conducted at two sites in Quebec over three field seasons to evaluate the impact of insecticide applications and the use of PLH-tolerant cultivars on forage yield and PLH populations. Foliar insecticide applications in the seeding year reduced PLH populations but generally failed to impact alfalfa yields compared to untreated alfalfa. However, in one experiment at one site, applications done in the seeding year resulted in increased first-cut alfalfa yields in the post-seeding year compared to untreated alfalfa, even if PLH populations were low. Differences in yields between PLH-tolerant and PLH-susceptible cultivars were minimal in the seeding and post-seeding years regardless of the PLH population levels. However, two PLH-tolerant cultivars produced lower yields compared to other cultivars in the post-seeding year at one site. Preliminary results suggest that foliar insecticide applications could be a more effective way to reduce PLH populations than PLH-tolerant cultivars. However, more data will be required to confirm these results and determine the impact of these management tools on alfalfa yields.

Introduction

Forage plants are the most important crops in Quebec, being grown on almost 900,000 hectares across the province, alfalfa (*Medicago sativa* L.) being the predominant species (Institut de la Statistique du Québec, 2020). Until recently, alfalfa has locally rarely been affected by insect pests. However, potato leafhopper [PLH; *Empoasca fabae* (Harris)] has become a recurrent problem in several regions of Quebec, however, most producers have little knowledge regarding this insect.

The PLH migrates every spring from the Gulf of Mexico (Bullas Appleton et al., 2003). It causes damage to alfalfa by sucking phloem sap on leaves, stems and petioles, plant growth can be severely reduced. There is currently no data on yield losses caused by PLH in Quebec, but losses of 50% have informally been reported locally (C. Duchesneau, quoted by Ménard, 2017). Similar yield losses have been reported in different studies conducted in the United States (Sulc et al., 2015). The PLH can also affect forage nutritive value and persistence of affected plants.

Strategies available to reduce the effects of PLH mainly include insecticide applications and the use of tolerant cultivars. Alfalfa cultivars tolerant to PLH have glandular trichomes which limit leafhopper mobility and food intake (Ranger and Hower, 2001). To our knowledge, no study has compared the performance of PLH-tolerant cultivars to susceptible ones in Quebec. The specific objectives of the project are to quantify yield losses associated with the presence of PLH in alfalfa fields and to compare the effectiveness of insecticide applications and use of PLH-tolerant cultivars.

Methods and Study Site

Experimental plots were established in 2021 at two sites: Ste-Anne-de-Bellevue (45° 25' N lat., 73° 55' W long.) and La Pocatière (47° 21' N lat., 70° 1' W long). A total of 7 cultivars (5 tolerant: FSG421LH, P55H94, Safeguard PLH, SW315LH, WL358LH; and 2 susceptible: Eclipse and Dominator) were seeded at a rate of 15 kg ha^{-1}. For each cultivar, a control (no treatment) and an insecticide treatment (cyhalothrin-lambda - 83 mL ha^{-1}) was done when the PLH population reached the recommended threshold (RAP, 2020). The 14 treatments were assigned to a randomized complete block design with four replications with insecticide treatments assigned to main plots and cultivars to sub-plots. Subplots varied in size depending on the site, but measured at least 1.3 × 5 m. Borders at least 4.5 m were established all around the main plots using an alfalfa cultivar susceptible to PLH, as described by Sulc et al. (2001).

Populations of PLH were monitored weekly at both sites, in borders and main plots from June to September using sweep nets. Forage from each plot was harvested at the late-bud stage of alfalfa resulting in two harvests in 2021 and four in 2022 at Ste-Anne-de-Bellevue, and one harvest in 2021 and three in 2022 at La Pocatière. Botanical composition was also determined at each harvest by hand-separating alfalfa and weeds from a sample taken in each plot. Alfalfa plant height was also determined at each harvest by randomly measuring the height of ten plants in each plot.

A two-way analysis of variance was conducted using PROC GLM of the SAS software (SAS institute, Cary, NC). Replicates at each site were considered a random effect, whereas insecticide and cultivar effects were considered fixed effects. Using the least square mean difference (LSD) differences among means were determined and considered significant at the $P \leq 0.05$ level.

Results

In the seeding year (2021) the threshold for which insecticide treatment is recommended was reached three times at Ste-Anne-de-Bellevue (June 9, June 23 and July 23; Figure 1) and once at La Pocatière (July 27; data not shown). Foliar insecticide applications and forage harvests in the seeding year both reduced PLH populations at both sites (e.g., Figure 1). These reduction in PLH populations, however, generally failed to impact alfalfa yields in the seeding year compared to untreated alfalfa (data not shown). Despite a lack of yield difference among treatments, differences were observed between plots treated or not with insecticides in terms of plant height which was 29% greater with insecticides for the first cut at Ste-Anne-de-Bellevue (data not shown). Differences among cultivars were minimal at both sites and no insecticide by cultivar interactions were observed at both sites. It is important to note, however, that weed pressure was high at both sites despite herbicide applications and that 2021 was an extremely dry year, for example only 3 mm of rain was measured during the entire month of May at Ste-Anne-de-Bellevue.

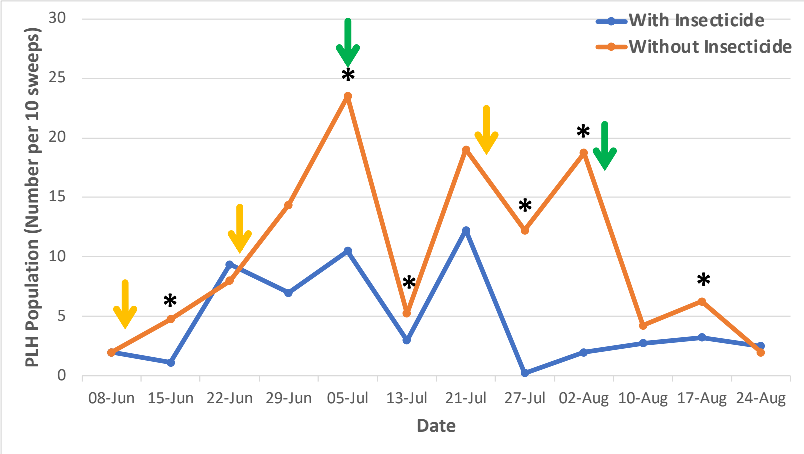

Figure 1. Adult potato leafhopper populations (PLH) at Sainte-Anne-de-Bellevue in the seeding-year. Yellow arrows indicate insecticide applications, green arrows forage harvests, asterisks indicate differences between insecticide treatments (P<0.05) at specific dates.

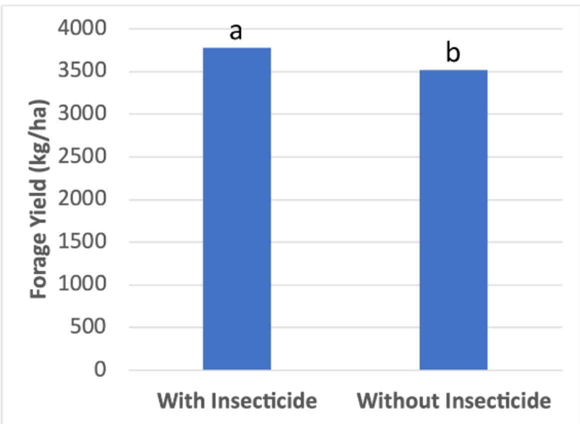

Figure 2. Alfalfa yields at the first harvest in the post-seeding year at Sainte-Anne-de-Bellevue. Means followed by different letters are significantly different (P<0.05). Insecticide applications were done in the seeding year.

In the post-seeding year (2022), although PLH were observed, the application threshold was never reached at both sites and thus no insecticides were applied. However, at Ste-Anne-de-Bellevue, applications done in the seeding year resulted in 7% greater first-cut alfalfa yields compared to untreated alfalfa. Differences in yields between PLH-tolerant and PLH-susceptible cultivars were minimal, however, two PLH-tolerant cultivars (i.e., SW315LH, WL358LH) produced lower annual alfalfa yields compared to other cultivars (data not shown).

Conclusions

Preliminary results suggest that PLH had limited effects on alfalfa yield in the seeding year even with high populations. Foliar insecticide applications could be a more effective way to reduce PLH populations than PLH-tolerant cultivars. Insecticide applications in the seeding year, however, had minimal effects on alfalfa performance but it had a residual effect at the first harvest in the post-seeding year when PLH populations were low. More data will be required to confirm these results and determine the impact of insecticide and PLH-tolerant cultivar use on alfalfa yields. It is important to note that treatments were not evaluated with high PLH populations in post-seeding years.

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References

Bullas Appleton E.S., C. Gillard, and A.W. Schaafsma AW. 2003. Biology and management of the potato leafhopper, *Empoasca fabae* (harris) (homoptera: cicadellidae) on field crops in Ontario. *Journal of the Entomological Society of Ontario* 134:3-17

Institut de la Statistique du Québec. 2020. Superficie des grandes cultures, rendement à l'hectare et production, par regroupement de régions administratives, Québec, 2007-2020.

Ménard M. 2017. Un insecte ravageur mange la luzerne des vaches. *La Terre de Chez Nous*. https://www.laterre.ca/actualites/insecte-ravageur-mange-luzerne-vaches.

Ranger C.M., and A.A. Hower. 2001. Role of the glandular trichomes in resistance of perennial alfalfa to the potato leafhopper (Homoptera: Cicadellidae). *Journal of Economic Entomology* 94:950-957.

RAP (Réseau d'Avertissements Phytosanitaires). 2020. La cicadelle de la pomme de terre dans la luzerne. https://www.agrireseau.net/documents/Document_95755.pdf.

Sulc R.M., E. van Santen, K.D. Johnson, C.C. Sheaffer, D.J. Undersander, L.W. Bledsoe, D.B. Hogg, and H.R. Willson. 2001. Glandular-haired cultivars reduce potato leafhopper damage in alfalfa. *Agronomy Journal* 93:1287-1296.

Sulc R.M., J.S. McCormick, R.B. Hammond, and D.J. Miller. 2015. Forage yield and nutritive value responses to insecticide and host resistance in alfalfa. *Crop Science* 55:1346-1355.