Apple Leaf Curling Midge, *Dasineura mali* (Keif.): Infestation, Impact and Modeling in Quebec Province

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INTRODUCTION

- The apple leaf curling midge (ALCM), *Dasineura mali* (Keif.) is a new pest of apple tree in Quebec.
- *Dasineura mali* larvae infests mostly the young leaves of shoot tips (Barnes, 1948; Galanihe and Harris, 1997).
- Females lay eggs on leaf margins. Upon emergence, larvae feed on the cell epidermis and contents, causing the leaf margins to curl tightly towards the mid vein (Galanihe and Harris, 1998).
- On newly planted apple trees, high levels of infestation may cause the leaves to fall from the trees.
- The objectives of this study were to evaluate the infestation level on shoots, their impacts on newly-planted apple trees over a three-year period and to model the adult populations in apple orchards.

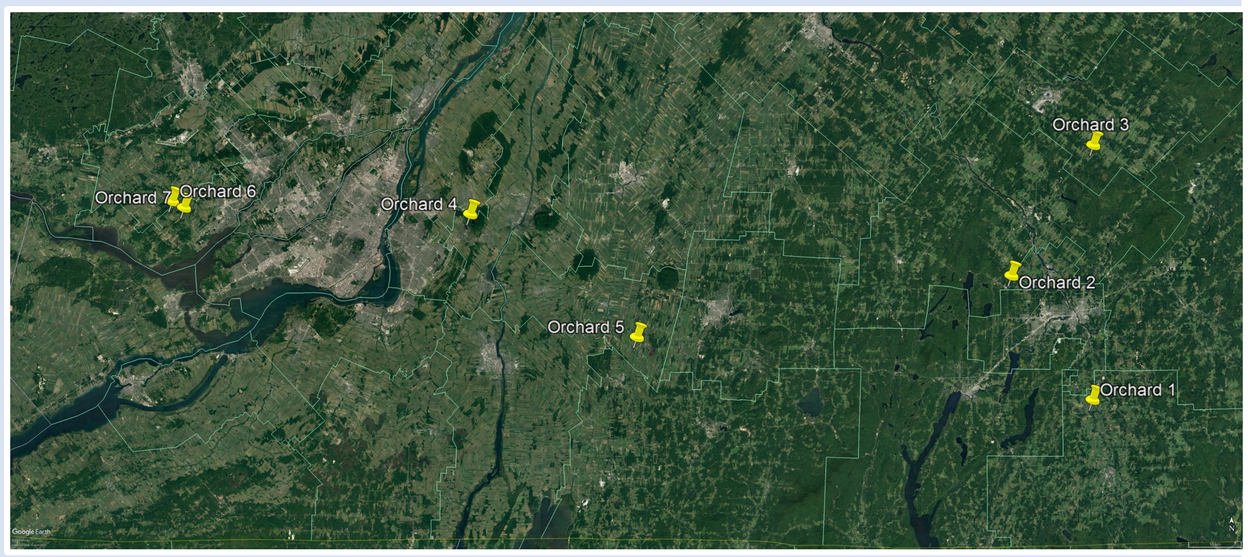
MATERIALS & METHODS

- Evaluations of Infestation and Impact
  Experimental plots:
  Cortland Apple trees established in 2013
  Cortland Apple trees established in 2015
  1 Scentry® LP Delta Traps baited with Agralan® ALCM pheromone/ plot.
  3 years monitoring of 25 trees/ plot.

  Infestation Data collection :
  - Weekly collected trap, ALCM males were identified and counted.
  - Weekly evaluation of number of leaves with galls/ 1500 leaves .
  (6 youngest leaves of shoot tips x 10 shoots x 25 trees)
  Severity of infestation was the rate of leaves infested by ALCM out of 1500 leaves/ week.
  Correlations between male catches and severity of infestation.

  Impact Data collection :
  - Growth evaluation : Trunk diameter at 30 cm from the ground/ tree/ each year.
  - Yield evaluation : Number of fruits harvested/ tree in the third year after planting.

- Adult Modeling
  7 Cortland apple tree orchards :
  Orchard 1 (45°14'12"N 71°51'20"W)
  Orchard 2 (45°26'48"N 72°02'59"W
  Orchard 3 (45°40’09"N 71°51'14"W)
  Orchard 4 (45°32’31"N 73°20’26"W)
  Orchard 5 (45°20’18"N 72°56’23"W)
  Orchard 6 (45° 33’9”N 74 3’13”W)
  Orchard 7 (45°32’32"N 74°1’29"W)



  1 Scentry® LP Delta Traps baited with Agralan® ALCM pheromone/ orchard.
  3 years monitoring.
  Abundance data collection:
  Weekly collected trap, ALCM males were identified and counted using a stereo microscope.

RESULTS AND DISCUSSION

- **Evaluations of Infestation**

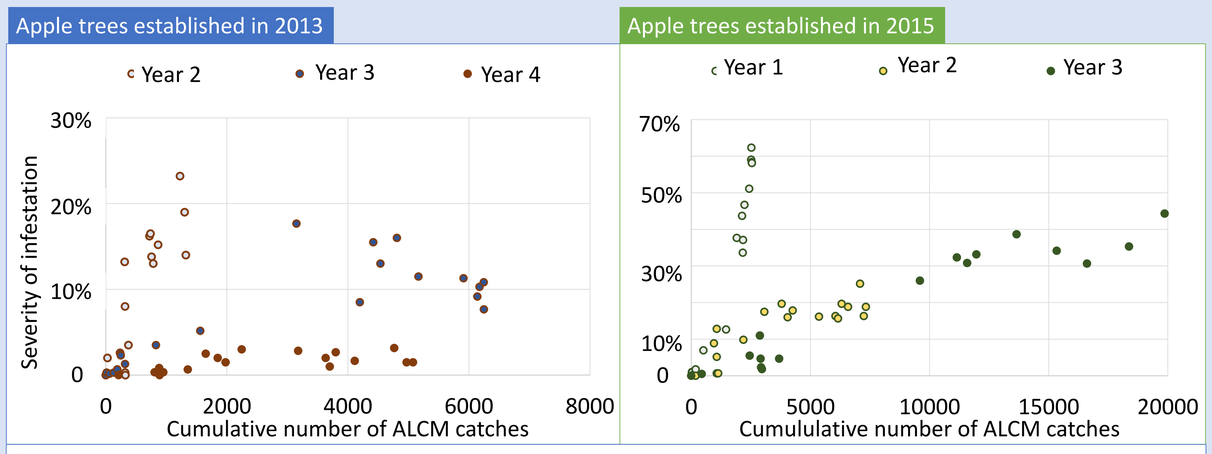


Figure 1. Cumulative number of ALCM weekly catches vs. severity of infestation 1 week later for each young apple trees plots monitored from 2014 to 2017.

The highest severity of infestation was observed in the youngest trees (figure 1). This was expected because young leaves are the most adequate oviposition site for females (Galanihe and Harris, 1997). Moreover, infested leaves produce volatile chemicals that attract mated females (Galanihe and Harris, 1997; Harris et al., 1999), causing increased infestation levels.

Table 1. Spearman’s rank corelation coefficient between cumulative number of ALCM weekly catches and severity of infestation 1 week later for each young apple trees plots monitored from 2014 to 2017.

Years since establishment	2013 establishment	2015 establishment
1		Rs = 0.94; P < 0.0001; n = 16
2	Rs = 0.76; P = 0.0006; n = 16	Rs = 0.77; P < 0.0001; n = 19
3	Rs = 0.76; P < 0.0001; n = 21	Rs = 0.88; P< 0.0001; n = 17
4	Rs = 0.66; P = 0.0019; n = 19	

ALCM catches was a good indicator of the severity of infested leaves observed the following week (table 1). Cross et al. (2009) determined that each ALCM male caught in a trap corresponds approximately 137 galls/ ha. Our results showed that beyond the absolute number of galls, the severity of infestation depended on the ALCM population size but also on the maturity of the apple trees. We observed on young trees, the highest levels of severity even when adult ALCM population density was low.

- **Impact**

Infestation levels failed to highlight the impact of ALCM on Growth and yield for this 3 years monitoring

- **Adult modeling**

A First DD model was developed based on the 9°C *Dasineura oxycoccana* temperature threshold (Roubos et Liburd, 2010).

Table 2. ALCM model statistics for the percentage threshold of 1rst generation (G1), 2nd generation (G2) and 3rd generation (G3).

Threshold	DJ_9	RMSE	E	EF	N	N tot
5%G1	93	**6.73**	-0.76	-0.12	25	226
50%G1	159	**5.86**	-0.46	-0.26	26	
95%G1	242	**5.91**	-0.12	0.15	26	
5%G2	441	**5.71**	-0.54	0.29	26	
50%G2	599	7.65	-0.65	0.21	26	
95%G2	794	10.72	-0.85	0.30	26	
5%G3	932	11.68	-0.89	-0.06	19	
50%G3	1078	11.28	0.12	0.23	26	
95%G3	1251	13.81	-1.73	-0.09	26	

Model predicted accurately the first generation (G1) but not the G2 et G3 predictions (table 2).

Since rain and relative humidity are important factors in the development time of the last immature stages (last larval stage and pupa) (Barnes, 1948), these parameters will have to be considered to improve the model.

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