Fruit production and climate change: does genetic and species diversity improve resilience for Quebec agroecosystems?

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Context of the study

Climate change could have negative consequences on agroecosystems. In Québec, rise in temperature between 2 and 4°C is expected between 2041 and 2070, with high reduction in frost days during winter (Ouranos, 2015). These change could have many impacts on pest outbreaks and productivity in agriculture. Crop diversification has been shown to improve resilience in many agroecosystems by a greater ability to suppress pest outbreaks, reduce pathogen transmission and buffering crop production from the effects of greater climate variability (Altieri et al. 2015; 1999; Cardinale et al. 2012; Liebman and Schulte-Moore 2015; Lin 2011). In Quebec, fruit production (orchards, vineyards, small fruits) are economically important and are not immune to future climate changes. We need to understand how diversity could help producers to face the changes that will occur and how resilient their farm could be.

Objectives

The principal objective of this project is to evaluate how genetic and species diversity influence productivity in Quebec orchards, vineyards and raspberry farms and how they could be resilient face to climatic changes.

Specific objectives:

1- Evaluate the effects of genetic and plant species diversity on pests and natural enemies;

2- Evaluate the impacts of plant and arthropod diversity on yield; and

3- Determine the global impact of diversity on fruit production in main production area of Quebec.

Methodology

Picture 1. A station with pitfall, yellow sticky and yellow pan traps (5 stations/site)

Picture 2. Climatic (temperature, relative humidity) data logger station (one/site)

Experimental sites:

- 9 apple orchards, vineyards, small fruits (raspberries) in 2 principal areas of Qc, N = 27 - Three complexity levels: low, medium and high, which correspond to plant species diversity on the farm.

Data collection :

- Five stations/field with yellow sticky trap, yellow pan trap and pitfall traps to collect pest and natural enemies (Picture 1)
- Soil sample once/summer on each site for microbiodiversity (DNA identification)
- Climatic conditions (data logger for temperature and relative humidity) 1/site; Picture 2)
- Pesticides use for each producers
- Yield (2014-2022)

Next steps

- Continue identification of pitfall traps, pan traps and sticky traps.
- Collect data on pesticides application and yields
- Analyse data with different indices (Simpson, Shannon, functional groups…) in function of complexity of fields, agronomic and climatic data.
- Insects will be collected and identified each year until September 2022.
- Biological control trials will be put in place between 2020 and 2022 to evaluate the impact of diversity on IPM

Preliminary Results

Table 1. Total abundance and arthropod species number in pitfall traps for the first visit in May 2019.

Crop	Complexity	City	Total abundance	Number of different species*
Orchard	Low	St-Joseph-du-Lac	27	4 (4)
		Mont St-Grégoire	14	10 (1)
		Rougemont	67	13 (3)
	Medium	Oka	137	13 (2)
		Dunham	78	6 (3)
		Rougemont	35	7 (2)
	High	St-Joseph-du-Lac	199	5 (4)
		Mirabel	47	7 (3)
		Saint-Paul-D'Abbotsford	10	1 (2)
Vineyard	Low	St-Joseph-du-Lac	187	23 (2)
		St-Eustache	689	20 (5)
		Dunham	110	9 (3)
	Medium	Oka	89	7 (2)
		Dunham	29	5 (3)
		Rougemont	149	19 (4)
	High	Oka	151	14 (4)
		Rougemont	12	5 (3)
		Saint-Paul-D'Abbotsford	189	8 (5)
Small fruits	Low	Oka	128	14 (5)
		Oka	245	5 (3)
		Sainte-Anne-des-Plaines	62	11 (4)
	Medium	Sainte-Anne-des-Plaines	95	14 (4)
		Rougemont	99	25 (4)
		sainte-Cécile-de-Milton	47	12 (2)
	High	St-Joseph-du-Lac	258	8 (3)
		Mirabel	45	11 (2)
		Saint-Paul-D'Abbotsford	54	16 (3)

*Identification at morphotypes for Coleoptera and Hymenoptera only. Number in parenthesis indicate the number of stations counted and identified until August 15th 2019.

Table 2. Arthropod identification to family in the pitfall traps for the 1st visit

Order	Family	Abundance
Acarina		818
Araneida		146
Chilopoda		19
Cicadellidae		1
Coleoptera	Anthicidae	480
	Carabidae	141
	Chrysomelidae	16
	Corylophidae	1
	Cryptophagidae	8
	Curculionidae	49
	Elateridae	31
	Latrididae	7
	Nitidulidae	144
	Scarabaeidae	13
	Scolytidae	1
	Staphylinidae	44
	Tenebrionidae	1
	Throscidae	5
	Unidentified	13
Collembola		639
Diplopoda		164
Diptera		110
Hemiptera	Cercopidae	5
	Cicadellidae	13
	Miridae	1
	Nabidae	1
	Other	11
		27
Hymenoptera	Apidae	24
	Chalcidoidae	11
	Diapriidae	1
	Formicidae	776
	Tenthredinidae	1
	Other	7
		820
Isopoda		32
Lepidoptera		6
Orthoptera		5
Phalangidae		1
Total		**3272**

Until now, a total of 3272 arthropods have been counted and identified to morphotype for the first sampling period (Table 1). Main insect families observed belong to Formicidae, Anthicidae and Nitidulidae (Table 2).

Identification to species level will allow to identify some bioindicators species, pests and natural enemies, and the influence of diversity of the sites on their presence and abundance. For example, one of the biggest species of carabids, *Carabus nemoralis*, which is a great predator of slugs, have been observed only on three sites, which are medium to high diversified sites. However, other characteristics could be involved in the presence of this species on these sites and will be analysed further.

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