The impact of lowbush blueberry (*Vaccinium angustifolium* Ait.) and cranberry (*Vaccinium macrocarpon* Ait.) pollination on honey bee (*Apis mellifera* L.) colonies

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INTRODUCTION

Lowbush blueberries and cranberries are important berry crops in Canada that benefit from the presence of the non-native honey bee as a pollinator to ensure optimal fruit set and profitability[1,2]. Unfortunately providing pollination services has shown negative impacts on honey bee colonies due to poor nutrition associated to lower flower diversity[3]. Large monofloral croplands, such as lowbush blueberry and cranberry fields, lack pollen diversity and may not provide sufficient nutrients to ensure good honey bee health[4,5,6,7,8,9].

Honey bee on a cranberry flower *by Claude Dufour*

MATERIAL AND METHODS

We studied honey bee colonies in 4 different pollination management strategies (MS):

1) Honey producing only (control)
2) Blueberry pollination services
3) Cranberry pollination services
4) Blueberry followed by cranberry pollination services (double MS)

- Assessment of the impact of the MS on the colonies was measured with the following variables:
  - **A) Landscape description around the apiaries**
  - **B) Colony weight gain**
  - **C) Pollen harvesting (weight)**
  - **D) Brood population**
  - **E) Viruses (7 most important)**
  - **F) Nosemosis (*Nosema ceranae*)**
  - **G) *Varroa destructor***

GOALS AND HYPOTHESIS

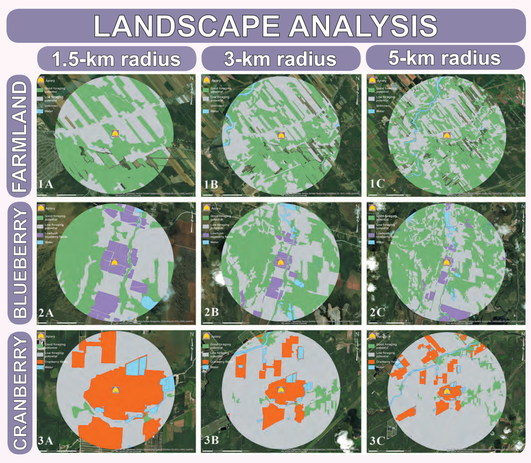
1) Compare the honey bee foraging potential of the landscape surrounding the various management strategies apiaries (farmland, blueberry field and cranberry field) using a Geographic Information System (GIS).

2) Compare honey bee colony health status and population development among different management strategies during a complete beekeeping season.

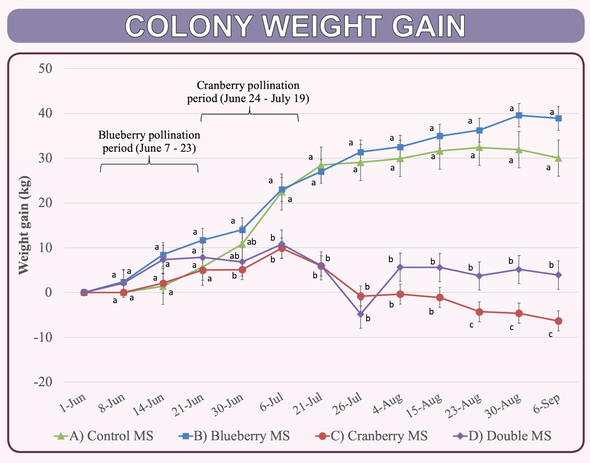
We predicted that management strategies would have a significative impact on honey bee colony development and the prevalence of parasites and pathogens in colonies would be higher in the double pollination management strategy

RESULTS

LANDSCAPE ANALYSIS



COLONY WEIGHT GAIN

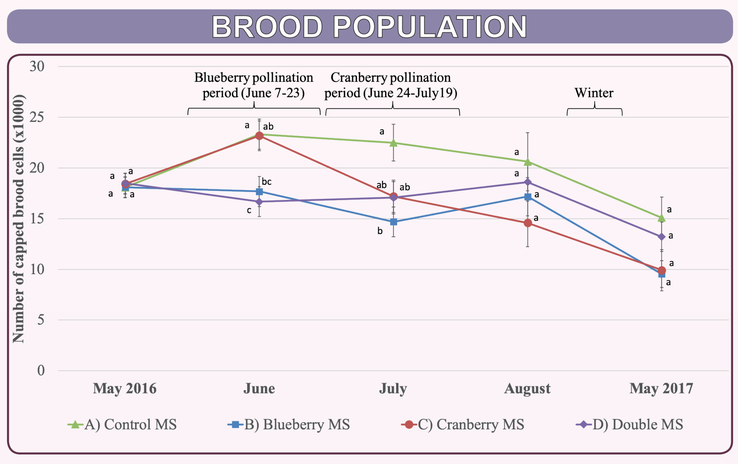


POLLEN HARVESTED (g)

Management strategies (MS)	Before pollination June 2	Blueberry pollination June 9	Blueberry pollination June 21	Cranberry pollination June 30	Cranberry pollination July 6	After pollination August 4	After pollination August 17	Spring 2017 May 24
	Sampling period (May 2016 to May 2017)							
A) Control MS	119.4^{a} ± 13.7	119.3^{a} ± 14.8	-	55.4^{b} ± 17.0	75.1^{ab} ± 14.7	96.3^{a} ± 28.1	117.9^{ab} ± 44.5	96.3^{a} ± 29.3
B) Blueberry MS	49.6^{b} ± 15.2	11.2^{b} ± 14.8	68.0^{a} ± 26.8	146.3^{a} ± 17.0	74.4^{ab} ± 14.7	87.3^{a} ± 28.1	233.6^{a} ± 44.5	108.3^{a} ± 26.5
C) Cranberry MS	67.3^{ab} ± 13.7	97.7^{a} ± 14.8	-	29.7^{b} ± 17.0	50.5^{b} ± 14.7	80.8^{a} ± 28.1	62.0^{b} ± 44.5	71.5^{a} ± 40.7
D) Double MS	36.3^{b} ± 13.7	11.2^{b} ± 14.8	49.4^{a} ± 24.4	79.3^{ab} ± 17.0	119.0^{a} ± 14.7	111.9^{a} ± 28.1	179.2^{ab} ± 44.5	96.6^{a} ± 29.3

COLONIES LOCATED AT: FARMLAND APIARY, BLUEBERRY APIARY, CRANBERRY APIARY

BROOD POPULATION



VIRUSES

Only 2 viruses, Black queen cell virus **(BQCV)** and the Sac brood virus **(SBV),** had significant differences (BQCV: $F_{3,52}=5.59$, $p=0.0021$ and SBV: $F_{3,34}=13.11$, $p<0.001$), and this for both **cranberry pollination MS and Double pollination MS**.

NOSEMOSIS

Infection levels were significantly higher for the **blueberry MS after blueberry pollination services** ($F_{3,53}=6.67$, $p<0.001$) and for the **double MS colonies** in the farmland apiary **after cranberry pollination services** ($F_{3,53}=10.49$, $p<0.001$).

Varroa destructor

The *Varroa* mite infestation was low, i.e. under the economic thresholds in May, June, July, August and September for all MS.

DISCUSSION

LANDSCAPE ANALYSIS: Our research shows that the blueberry apiary environment has good foraging potential for honey bees, similar to the farmland apiary. As expected, we found that the cranberry field of this study had insufficient resources to sustain the foraging needs of honey bees.

COLONY WEIGHT GAIN: The colonies in cranberry MS and double MS both suffered from a critical decline in weight gain due to a lack of nectar availability during cranberry pollination. The lower colony weight gain had a carry-over effect after the cranberry pollination services. At the end of the season, there was a difference of -25 kg to -45 kg in weight gain between the cranberry MS and the double MS compared to other groups. This was also observed by Martin (2009)[10], who showed that honey bees pollinating cranberries needed a sucrose syrup supplement to offset the effects of a lack of nectar.

POLLEN HARVESTED: Lower quantity of pollen harvested during the blueberry pollination was measured. We suspect that the smaller blueberry pollen pellets pass through the pollen traps and are not accounted for in the total pollen collected in our study. This was also reported by Girard et al. (2012)[11]. We also observed that plants in the vicinity offer poor pollen availability. The colonies in cranberry field gathered a significantly smaller amount of pollen than the colonies at the control farmland apiary. This may be due to the lower harvest of nectar observed during cranberry pollination. Indeed, when honey bee colonies lack nectar, they tend to harvest less pollen[12].

BROOD POPULATION: The colonies of the two MS in the lowbush blueberry field had a significantly less capped brood compared to the other groups. In another study (unpublished work), we found that pollen harvested from colonies pollinating blueberries had significantly lower protein levels compared to pollen harvested in a farmland apiary. Moreover, the pollen protein level during blueberry pollination was lower than the minimal 20% of the pollen dryweight required for colony development and maintenance[13].

PATHOGENS AND PARASITES: The cranberry pollination period was the most virulent for infection with both viruses (BQCV and SBV), which affected larvae from both treatments (cranberry MS and double MS) significantly more than those in any other MS.

CONCLUSION: Our study shows that the cranberry management strategies, with their low proportion of attractive forage, had a significant impact on colonies. There is also a significant impact of the blueberry management strategies on colonies: in spite of the diversity and attractiveness of flowers surrounding the blueberry apiary and colony weight gain, the brood population was reduced most likely due lower availability of nutritious pollen.

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