Effect of Pesticides Used in Greenhouse Vegetable Production on Bumble Bees (*Bombus impatiens* Cresson)

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Introduction

Bumble bees (Figure 1) are important indigenous North American pollinators. In recent years bumble bees have increasingly been used commercially for pollination in greenhouses, and now play an essential role in Canadian greenhouse vegetable production. Tomato and pepper flowers are self-pollinating, however supplemental bumble bee pollination results in larger and more attractive fruit. Effective pest control also is essential for high yields of a marketable greenhouse vegetable product, and pesticides remain an important pest management tool in integrated pest management programs. Novel products have recently been developed for management of both greenhouse disease and insect pests. While many pesticides are toxic to other bee species, such as honey bees, pesticide toxicity studies on bumble bees are lacking.

Figure 1. A colony of *Bombus impatiens*. Visible are workers, a queen, brood cells, and nectar pots.

Bumble bees are at risk of pesticide exposure in greenhouses during foraging through direct contact with spray or by consuming contaminated pollen. In order for greenhouse pollination programs to be successful, accurate information on the toxicity of pesticides to bumble bees must be available.

Objective

The objective of this study was to determine the direct contact toxicity of current and novel fungicides and insecticides used in greenhouse vegetable production on adult *Bombus impatiens*.

Materials and Methods

- Female worker bees used for bioassays
- The active ingredients (>95% purity) of two fungicides and four insecticides were tested
- Each pesticide was applied at various concentrations (% solution w/v)
- Four replicates of 9-11 bumble bees per concentration
- Bumble bees anesthetized with CO_2 and placed in a Petri dish dorsal side up
- Bees placed in a Potter spray tower (Figure 2) and sprayed with 5 ml of pesticide solution
- Post treatment containers (Figure 3 and 4) held in the dark at 25°C
- Mortality assessed at 48 h for fungicides and 72 h for insecticides

Table 1. Novel and currently registered fungicides and insecticides tested in this study.

Active Ingredient	Trade Name	Company
Fungicides		
myclobutanil	Nova® 40W	Dow AgroSciences
cyprodinil*	Switch® 62.5WG	Syngenta Crop Protection
fludioxonil*	Switch® 62.5WG	Syngenta Crop Protection
Insecticides		
imidacloprid	Intercept® 60WP	Bayer CropScience
metaflumizone*	Alverde™	BASF
abamectin	Avid® 1.9% EC	Syngenta Crop Protection
chlorantraniliprole*	Rynaxypyr™ 35WG	DuPont

* indicates a novel product

Figure 2. Anesthetized *Bombus impatiens* being placed in a Potter spray tower for treatment.

Figure 3. Treated bumble bees being placed in a post treatment container.

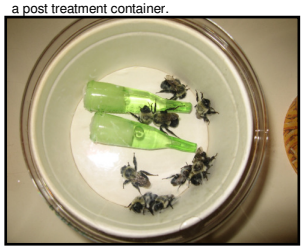

Figure 4. Post treatment container with *Bombus impatiens*, water, and sugar solution.

Results

- None of the fungicides increased worker mortality.
- At tested concentrations overlapping between insecticides, imidacloprid, metaflumizone, and abamectin caused significant worker mortality (Figure 5).
- Imidacloprid, abamectin, and metaflumizone were significantly more toxic than chlorantraniliprole (Figure 5).
- Chlorantraniliprole did not cause significant mortality at any concentration (Figure 5).

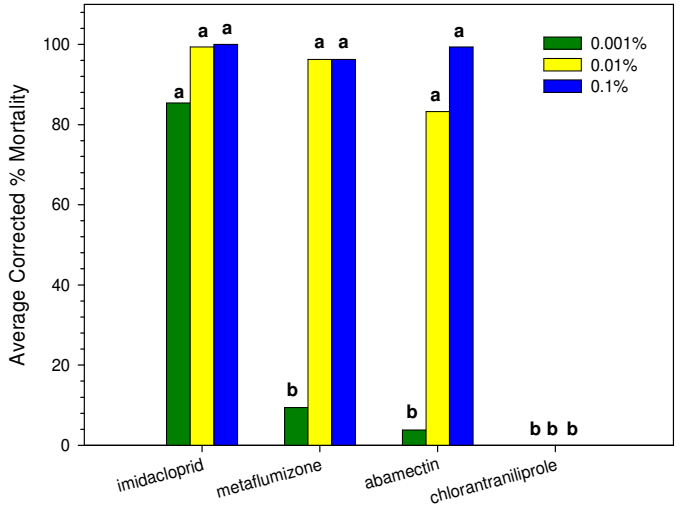

Figure 5. Average corrected percent mortality of *B. impatiens* workers 72 h after exposure to various insecticides using a PST (R^2=0.9092, SE=0.01413). Data were arcsine square root transformed prior to analysis; back transformed means are shown. Columns with the same letter are not significantly different (Tukey's, α=0.05).

Conclusions

- **The fungicides myclobutanil, cyprodinil, and fludioxonil appear compatible with bumble bees.**
- **Chlorantraniliprole is potentially a safe alternative to imidacloprid, metaflumizone, and abamectin for greenhouse insect pest management.**
- **All pesticides tested could potentially cause chronic sub lethal effects in bumble bees.**
- **Further investigation is underway to assess the impacts of these pesticides on bumble bee life span and brood production.**

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