LD_{50} data sets (of which 11 were insecticides), discrete LD_{50} values were determined for both honeybees and bumblebees. For all of those 18 data sets the ratio of honeybee contact LD_{50} values divided by bumblebee contact LD_{50} value was lower than one, demonstrating that honeybees were more sensitive to the test substances than bumblebees.

Similarly, lower or similar oral sensitivity of bumblebees vs. honeybees was determined (Figure 2). Where the endpoint was the maximum dose tested, a ratio of 1:1 was rare because the endpoint is adjusted according to actual dose consumption. For 12 (and 11 of those were insecticides) of the 52 acute oral LD_{50} data sets, discrete acute oral LD_{50} values were determined for both honeybees and bumblebees. Only for one insecticide a higher acute oral bumblebee sensitivity compared to honeybees was determined (for two different formulations). For this insecticide, higher tier semi-field data with *B. terrestris* is available and results do not indicate any negative impact on bumblebees or their colony development at the maximum intended use rate.

B. terrestris worker bees are about 3-times heavier in terms of body weight than *A. mellifera* worker bees. Therefore, lower or similar contact and oral sensitivity of the bumblebee species vs. the honeybee was also found in terms of body weight.

Conclusions

Overall, the ECPA company data evaluation indicates for a wide range of plant protection products that bumblebees are not more sensitive than honeybees based on acute toxicity assessment supporting similar previous findings[2, 3].

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4.12 Impact of pesticide residue on Japanese Orchard Bees (Osmia cornifrons) development and mortality

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Introduction

Pollinators are crucial to high value crop production such as apples. Pesticide use in these crops can sometimes reduce pollinator populations. Some pesticide use is necessary to control insects and disease which threaten farm profitability and sustainability. A new approach to this problem is Integrated Pest and Pollinator Management (IPPM) which maintains adequate pest management while protecting pollinator health. Several pieces of information are needed in order to construct an IPPM program. An important piece of information is the toxicity of pesticides to various pollinator species, including wild solitary bees. To better understand the effects of pesticide application on the wild pollinators, we will evaluate the impacts of pesticide residue on the Japanese Orchard Bee (JOB), *Osmia cornifrons*, a promising alternative pollinator for the fruit industry.

Our previous work has shown that a shift in application timing to 10 days before apple bloom can reduce the pesticide levels that moves into the nectar and pollen, but still effectively control pre-bloom pests. Present study evaluates the toxicity pesticide-contaminated pollen on the development and mortality of JOB. We have already examined the acute contact and ingestion toxicity on JOB adults, but we need to fully understand the impacts of pesticide residues in pollen stores on larval developmental stages. This research is crucial to developing an apple IPPM program that allows the safe use of pesticides for pests control without harming pollinators.

Materials and Methods

Larval JOB bioassays were conducted based on field-realistic pesticide concentrations found in flowers taken in previous years at 0.1x dose, 1x dose, and 10x dose. Treatments were mixed with homogenized provision thoroughly before partition by 0.3 grams per well. Eggs would be placed on top of prepared provisions.

Treatments for application were:

- Assail 30SG (acetamiprid) at 1.8 ppb, 18 ppb, and 180 ppb;
- Syllit (dodine) at 1.1 ppb, 11 ppb, and 110 ppb;
- Closer SC (sulfoxaflor) at 4.4 ppb, 44 ppb, and 440 ppb;
- Beleaf 50SG (flonicamid) at 51.2 ppb, 512 ppb, and 5120 ppb.

16 bees were used per replication, and there were 3 replications per treatment. A total of 672 eggs were collected from nest straws, then reared at 25oC, RH 65%. Each larva was kept separately in different clear plastic wells (12mm in diameter, 12mm in depth). Daily observations made of all individuals from egg-hatching until cocoon completion. The stages easily observed and recorded were: eggs, 1st instar (inside egg corion), 2nd instar (starts to feed on provision), 5th instar (begins defecation), inititation of cocoon spinning, and cocoon completion. Growth rate and development time were accessed. Data on the 5th instar larvae's weights were collected daily.

a) Larva feeds on corion.

b) Larva starts to feed on pollen.

c) Mandibles develop.

d) Head capsule develop. Hairy body.

e) Larva starts to defecate.

f) Larva starts spinning cocoon.

Fig. 1 Development stages of Osmia cornifrons: (a) 1st instar, (b) 2nd instar, (c) 3rd instar, (d) 4th instar, (e) 5th instar, (f) cocoon initiation.

Results

Preliminary analysis indicates the relevant doses that occur from pre-bloom pesticide applications were not directly toxic to the larvae, but did significantly delay larval development. These larvae are now being evaluated for pupal mortality, adult emergence from diapause and adult weight as further effects from these field relevant doses.

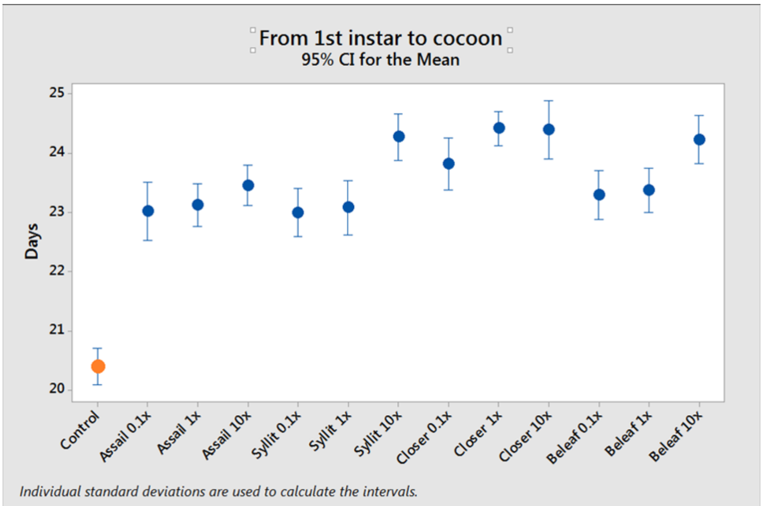

Fig. 2 Average development time from 1st instar to cocoon of Treatments vs. Control (N = 48 each group).

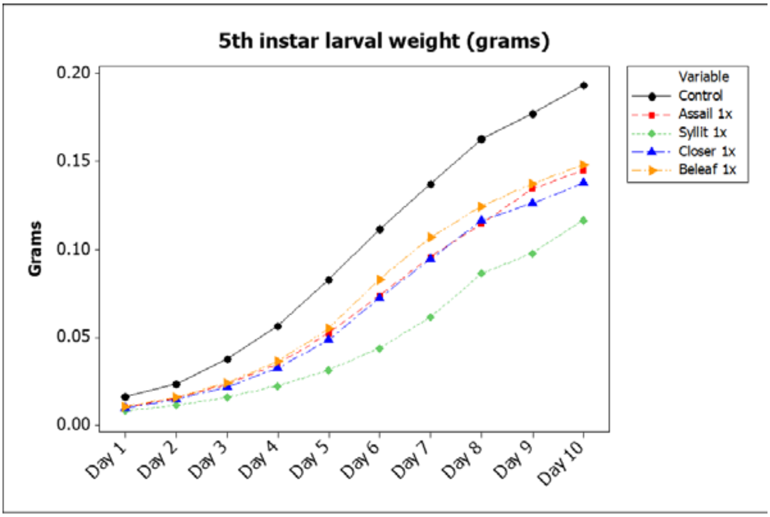

Fig. 3 Changes in average weights of 5th instar on the first 10 days (N = 48 each group)

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