SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

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The effects of pesticide mixtures on beneficial non-target arthropods

DESCRIPTION PHD PROJECT

Many arthropod species provide ecosystem services such as pollination and pest control and are therefore not targeted by pest management programs. However, beneficial arthropods can be exposed to a wide variety of pesticides in the environment. Although the effects of single pesticides have been widely studied, less is known about the impacts of complex mixtures.

SPRINT CSS → **11 pesticide mixtures** → **Ecotoxicological testing on beneficial arthropods (WP4)**

Amblyseius swirskii **–** Generalist predatory mite, feeds on pests (e.g. spider mites, thrips, whiteflies), easy to rear, highly effective biocontrol agent.
→ **Mortality**, **reproduction** (Blümel et al., 2000)

Apis mellifera **(honeybees) –** Pollinators supporting the production of crops, heavily managed, indicator of pesticide risk to other bee species (EFSA, 2023).
→ **Mortality** (OECD 213), **colony size**, **colony structure**

Bombus terrestris **(bumblebees) –** Pollinators important for crop production, represent wild bee species, often kept in greenhouses for pollination.
→ **Colony size**, **number and mass of bees**

RESULTS

Amblyseius swirskii: Contact toxicity

Significant reduction in juvenile survival for CH, ES, FR, NL, and PT mixtures

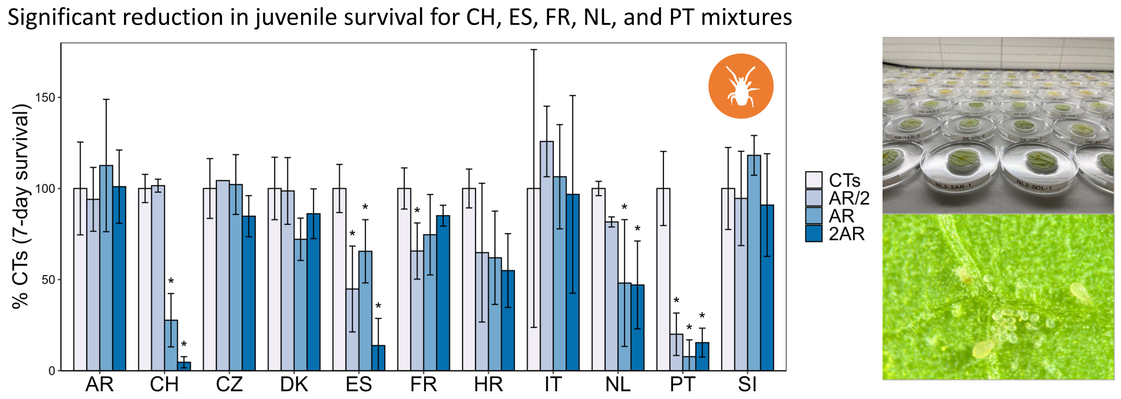


Figure 1. Left: Effects of the 11 pesticide mixtures on mean 7-day juvenile survival, expressed relative to the solvent control (mean ± sd). Asterisks indicate a significant difference from the solvent control (Dunnett post-hoc p<.05). **Top right**: Leaf disc arenas used for contact toxicity test. **Bottom right**: Magnified image of *A. swirskii* adult females and eggs. Treatments: CTs: solvent control, AR: application rate.

Honeybees: Acute oral toxicity

48-hour survival significantly lower than solvent control for CH, HR, NL, and CZ mixtures

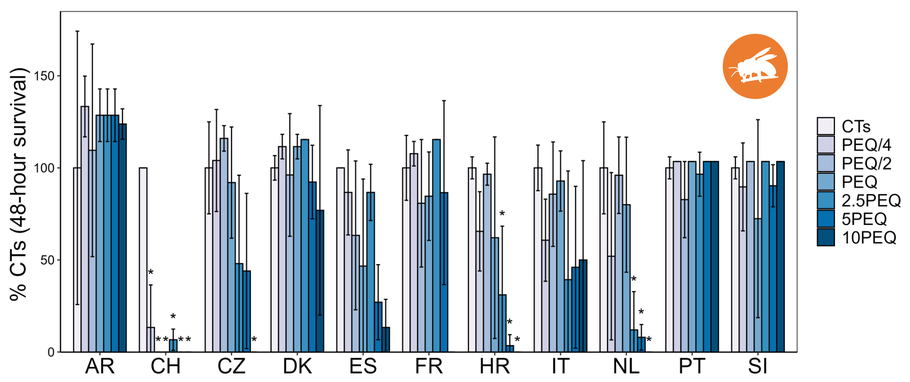


Figure 2. Effects of pesticide mixtures on survival of *Apis mellifera* 48 hours after oral exposure. Bars represent the mean survival expressed relative to the solvent control (mean ± sd). Asterisks indicate a significant difference in survival with the solvent control (Dunnett post-hoc, p<.05). CTs: solvent control, PEQ: predicted exposure quantity.

Honeybee and bumblebee colonies: 6-week exposure to NL mixture

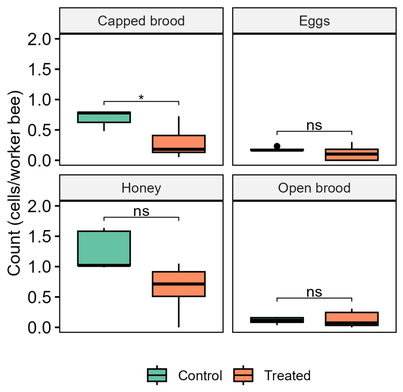
Honeybees
- Treated colonies → significantly fewer worker bees, capped brood, open brood, eggs, and honey

Bumblebees
- No significant differences in colony mass, number of bees, and mass of bees

DISCUSSION

Amblyseius swirskii
- Most sensitive to PT mixture
- Few effects on reproduction – less sensitive endpoint

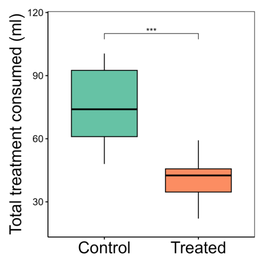
Honeybees: What drives the toxicity of the mixtures?
- CH mixture → high toxicity of emamectin benzoate
- HR and NL mixtures → doses of insecticides above LD50
- CZ mixture → Survival at 10PEQ lower than expected considering LD50 of components



Colony exposure: Is reduced food and brood a result of worker mortality?
- No significant difference in **eggs** and **open brood** when considered **relative to number of worker bees**
- **Less capped brood and honey per worker bee** in treated colonies

Figure 3. Number of *Apis mellifera* comb cells filled with capped brood, eggs, honey, and open brood, expressed relative to the number of worker bees. Treated colonies were fed sucrose solution spiked with λ-cyhalothrin, esfenvalerate, and pirimicarb (treated, NL mixture).

No differences between treated and control bumblebee colonies after 6 week exposure
- Treated colonies **consumed significantly less treatment** than controls
- **Repellent effects** observed in literature for some components (λ-cyhalothrin, esfenvalerate)



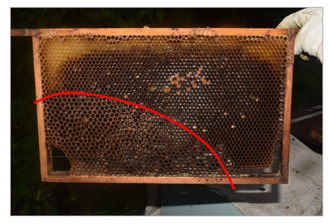
FUTURE OUTLOOK / POSSIBLE OBSTACLES

Ongoing research

How does the community of **honeybee gut microbiota** change following chronic exposure to a pesticide mixture?
- Honeybee guts collected from colonies before and after 6 week exposure

Limitations
- Full mixture approach → Need **data for single pesticides** to identify interactions
- Predicted exposure quantity (PEQ) calculated with simplified equation used for exposure screening (EFSA, 2023) → may **overestimate field conditions**

Can pesticide exposure impact comb structure?



PAPERS PUBLISHED / IN PREP

Currently in prep:
- **Honeybee individual acute oral toxicity tests:** Toxicity of CSS mixtures, comparison LD50 of mixtures with predicted LD50 (using values in literature) to identify potential interactive effects
- **Insect diversity in CSS (WP2):** Differences in carabid diversity between organic and conventional farming, while accounting for landscape characteristics

Future work:
- **Honeybee colony exposure:** Evaluate changes in colony over time and differences between control and treated colonies, including **changes in gut microbiota**
- **Predatory mite contact toxicity testing:** Effects of CSS mixtures on juvenile survival and reproduction of surviving females