and its formulated products in several worst-case semi-field tunnel and greenhouse trials (Dinter et al 2009).

Conclusions

When chlorantraniliprole was applied once to the soil followed by soil incorporation before *P. tanacetifolia* seeding at a predicted 20-year plateau concentration and then applied twice as foliar spray on pre-flowering or flowering *P. tanacetifolia*, all parameters assessed (mortality, flight activity, colony weight, condition of the colonies and production of young queens and males) did not have any treatment-related effects compared to the water-treated control. Also, there was no difference between the two chlorantraniliprole treatment scenarios T1 (pre-flowering exposure) and T2 (pre-flowering plus spray during flowering and during bee flight). Overall, no effects of chlorantraniliprole on bumble bee *B. terrestris* colonies including queen production and adult and larval mortality were found.

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4.5.P Sensitivity of the honey bee and different wild bee species to plant protection products – two years of comparative laboratory studies

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Abstract

Effects of active substances have been tested mainly on honey bees and occasionally on a few other commercially used bee species with regard to registration processes and risk assessment of plant protection products (PPPs). However, toxicity data are lacking for the majority of wild bee species. The aim of these

experiments was a comparative analysis of the potential effects of applied PPPs on: **a)** the mortality of different bee species; and, **b)** the uptake by and degradation in these bee species.

We investigated the effects of a pyrethroid insecticide, containing lambda-cyhalothrin, on the honey bee (*Apis mellifera*, (Am)) and different wild bee species (*Andrena vaga* (Av), *Bombus terrestris* (Bt), *Colletes cunicularius* (Cc), *Osmia bicornis* (Ob), *Osmia cornuta* (Oc) and *Megachile rotundata* (Mr)) with differing life history characteristics in a series of studies under controlled laboratory conditions. We used a spray chamber to apply the PPP at typical field application rates with standard nozzle types in order to mimic contact exposure in the field.

a) Mortality and behaviour of bees were monitored following modifications of the OECD guidelines (No. 214 and No. 246). Statistical analyses were performed in R (Version 3.5.0) using the packages survival' (2.41-3) and ‚survminer' (0.4.3).

b) After application, living bee individuals were frozen at -20°C at different time intervals. Residue levels of lambda-cyhalothrin in bees were quantified using gas chromatography/mass spectrometry (GC-MS). Statistical analyses were performed in R (Version 3.5.0).

The results over the last two years can be summazired as follows:

c) Most of the species showed similar trends in their species-specific sensitivities among the various experiments. B. terrestris appeared to be the least sensitive species, while M. rotundata was by far the most sensitive species. The survival probability of A. mellifera and C. cunicularius showed the greatest variability among experiments and between years. The former displayed a higher sensitivity than both mason bee species O. bicornis and O. cornuta. A. vaga and C. cunicularius as ground-nesting species showed intermediate sensitivities.

d) In 2018, due to a lack of knowledge time intervals were not appropriately set to cover the period of interest during which bees metabolized and degraded the main portion of lambda-cyhalothrin. Hence, we did not detect any differences in degradation between species, but only in time.
In 2019, we sampled at more and earlier time intervals. Residue levels in Osmia bicornis individuals were significantly higher in the course of the experiment than levels in the other three bee species. While honey bees (*A. mellifera*) and bumble bees (*B. terrestris*) showed similarly rapid degredation rates, *O. cornuta* demonstrated an intermediate sensitivity between the two eusocial species and *O. bicornis*.

Our study on both, **a)** mortality and **b)** residue degradation in the presence of lambda-cyhalothrin revealed some inconsistencies when comparing results of both study years. While an adjustment of sampling intervals in the second year may explain different results in residue levels between years, differences in sensitivities are likely due to variability in bee individuals and time each experiment was conducted within a year. Particularly for solitary species that by nature have an optimal window of activity in spring/early summer, trials conducted later in the year may alter naturally occurring sensitivity patterns. Likewise, summer honey bees may experience a different sensitivity than winter honey bees due to their metabolism set-up.

Despite these inconsistencies, *B. terrestris* proved to be the least sensitive species in our study, probably due to its ability to faster degrade residues. Although honey bees degraded residues at a similar speed like bumble bees, they were more sensitive and far more variable in their sensitivity response. Mason bee individuals (*Osmia* sp.) were much slower degraders of lambda-cyhalothrin than the other two social bees. Yet, there sensitivity mirrored rather the one of *B. terrestris* than of *A. mellifera*. So far, the mechanisms behind an "immunity" towards higher levels of the insecticide are not clear. For all other species data on degradation of residues have yet to be collected.

The observed trends: *B. terrestris* ➔ low mortality:high degradation; *O. bicornis* and *O. cornuta* ➔ low to intermediate mortality:low degradation; *A. mellifera* ➔ high mortality:high degradation; *A. vaga* and *C. cunicularius* ➔ intermediate mortality:no data of degradation; *M. rotundata* ➔ high mortality:no data of degradation

Our results clearly showed species-specific responses to lambda-cyhalothrin. Both ecological (life-history traits) and genetic characteristics (*e.g.*, the interaction between detoxification ability and taxonomic relationship) seem to influence bees' responses to PPPs. These factors have bee previously associated with the sensitivity of bee species. Our work highlights the importance of multi-species research with other active substances in order to answer the question whether the currently used bee species in registration processes and risk assessment of PPPs are sufficient to be able to estimate the risk for all other bee species.