Section 5 – Other

5.1 Applying the mechanistic honey bee colony model BEEHAVE to inform test designs of Large-Scale Colony Feeding Study (LCFS)

Silvia Hinarejos[1], Farah Abi-Akar[2], Nika Galic[3], Amelie Schmolke[2]

[1]Sumitomo Chemical Co. Ltd, Saint Didier au Mont d'Or, France

[2]Waterborne Environmental, Inc., Leesburg, Virginia, USA

[3]Syngenta Crop Protection LLC, Greensboro, North Carolina, USA

E-Mail: silvia.hinarejos@sumitomo-chem.fr, abi-akarf@waterborne-env.com, schmolkea@waterborne-env.com, nika.galic@syngenta.com

DOI 10.5073/jka.2020.465.034

Abstract

In 2017 a new subgroup was established within the ICPPR Semi- and Full-field Testing Workgroup. This new subgroup was tasked to develop guidance for designing and conducting large-scale colony feeding studies (LSCFS). LSCFS are one type of Tier II studies designed to determine potential effects of pesticides on free-foraging whole colonies during and after dietary intake of a known pesticide concentration. Recently, regulatory authorities in North America have used the LSCFS in their pollinator risk assessments for neonicotinoid insecticides on honey bees and other active ingredients. The LSCFS design involves a relatively large number of replicates, treatment levels, and colony condition assessments, including overwintering. Despite its high cost and use in regulatory risk assessments, no formal regulatory protocol exists for conducting these studies. High overwintering losses of control hives have been observed in some LSCFS. Loss of control colonies indicates that stressors other than pesticides, e.g. resource availability, weather, diseases and beekeeping activities, likely influence colony overwintering survival, confounding the assessment of impacts caused by pesticides. Honey bee colony models have been gaining interest as tools in pesticide risk assessment to inform study design and ultimately, colony-level risks to honey bees. In the current project commissioned by the Pollinator Research Task Force, we assessed the study design and environmental conditions experienced by the untreated colonies of seven LSCFS. We applied the mechanistic colony model BEEHAVE to systematically assess the impact of study design and environmental conditions on control colonies. We first calibrated BEEHAVE to a subset of the studies, validated it with the remaining studies, and then used it to run simulations that changed only one variable at a time. The goal of the project was to inform study design that leads to increased likelihood of control colony overwintering success in LSCFS. From the simulations, the initial status of the colonies as well as the sugar feeding pattern were more important for fall colony condition than resource availability control colonies across seven LCFSs. Overwintering success in these control colonies differed considerably among the studies. In addition, the studies differed with respect to initial colony conditions, amount and timing of sugar feeding, landscape composition around study apiaries and weather in the landscape and weather. Larger honey stores present in the colonies at study initiation, greater feeding amounts and earlier supplemental feedings (beginning in late summer to early fall) were the main factors that led to larger colony sizes and honey stores in the fall. This information can be used to inform the standardization of a study design, which in turn can increase the likelihood of overwintering survival in untreated controls and help ensure that studies are comparable. This project demonstrates how a mechanistic model can be used to inform study designs for higher-tier effects studies. Mechanistic models like BEEHAVE could further be applied to supplement higher-tier risk assessments, for instance, by extrapolating to non-tested exposure scenarios and environmental conditions and therefore potentially reducing the number of higher-tier studies.