The Natural Variability of Honey Bee Colonies

How To Meet the Requirements of The New EFSA Bee Guidance

Meet us at booth 109!

tier3 solutions

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Introduction

Plant protection products (PPPs), especially insecticides, may cause lethal or sublethal effects in bees depending on the exposure scenario, mode of action, application method, and dosage. Thus, a risk assessment is required when substances that potentially affect pollinators will be applied on crops and the exposure of bees cannot be excluded. In the risk assessment, a tier1 approach applies thresholds that ensure to be sufficiently conservative to detect effects on the level of laboratory studies. If thresholds are exceeded and a risk cannot be excluded, higher-tier studies have to be conducted to assess whether a PPP has adverse effects under more realistic use conditions, including acute mortality, colony and brood development. Under the framework of the revised EFSA guidance document on the risk assessment of plant protection products on bees [1] a specific protection goal (SPG) is defined for honey bees (*Apis mellifera*). It requires that following exposure to PPPs the colony size reduction must not exceed 10 %. EFSA proposed to use the equivalence test to identify a potential risk. Here, we discuss several proposed measures to reduce the variability among the colonies and show how the variability in honey bee colony size under natural conditions can cause some uncertainties [2].

Methods & Results

- five published large-scale field studies with 18 to 48 control colonies [3 - 5]
- variability around the mean of untreated control colonies for the initial colony strength
- natural variability of honey bee colonies ranged between 10 % and 53 % (Ø 31 % ± 19 %)
- 4 out of 5 studies would not have enough replication and would likely fail the equivalence test under the new requirements of the EFSA bee guidance [1]

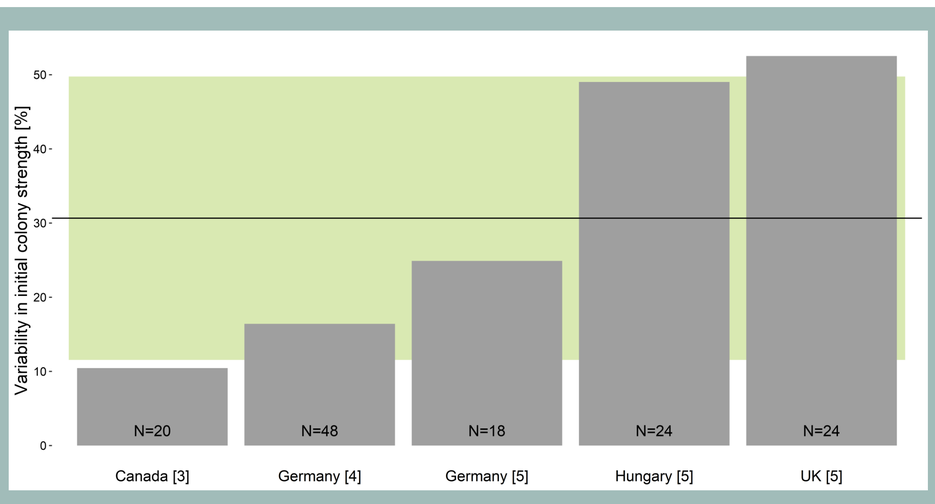

Fig.: Variability in initial colony strength in five studies. Black line: mean, green area: SD

Discussion

- reduction of the colony size of 10 % or less hardly detectable if it is below the natural variability
- several measures proposed to reduce natural variability

Increasing the number of colonies in the study

- prolongs time needed for each colony assessment
  - climate/weather might change during time needed for the assessments
  - different environmental conditions and continued colony development over the period of the assessments adds variability
- increases spatial extend of study due to the minimum distance requirements between study fields and blocks
  - different landscape characteristics, local climate and different food supply increase variability
- by continuing the study in the following year to increase power
  - Different weather conditions and surrounding crops increase natural variability
- Using adequate statistics that incorporate the spatial and temporal study design like e.g. GLMMs can help to some extent.

Equalizing colony strength

- colonies develop differently despite (or due to) their initial equalization
  - disturbance of the colonies by removing brood or adult bees causes stress
  - removal of adult bees poses a major factor of uncertainty because removal of a representative proportion of each age class is impossible
  - changes in the age composition of a hive lead to cascading effects that impact a colony's continued growth
    - removal of predominantly young bees leads to a rapid decline in worker bees due to aging
    - removal of old bees leads to a decline in colony strength as young bees cannot immediately take over the task of collecting food
- Modern standard statistical analyses such as GLMMs are able to handle different initial colony strengths in the subsequent evaluation of the data, which may also reduce the effort to equalize the initial colony size.

Conclusion

Under realistic conditions, a 10 % reduction in the colony size is likely within the natural variability of the colonies. Even though the revised bee guidance [1] proposes several measures to reduce the natural variability in honey bee field studies, these options possibly increase the natural variability and/or are not practicable in a field study. When using an equivalence test as suggested by the guidance [1], this makes it almost impossible to exclude a high risk in a field study and thus hardly possible to carry out field studies that can be accepted by authorities.

References

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