bee care

Science For A Better Life

Bee Safety of Neonicotinoids - Evidence from Studies Conducted Under Realistic Field Conditions

Dr. Christian Maus

Global Pollinator Safety Manager – Bayer AG

Introduction

- Neonicotinoid insecticides are used as seed treatment in various crops. Among these there are bee-attractive crops like oilseed rape, sunflower, and maize
- After neonicotinoid seed treatment, traces of systemic residues can be found in nectar and pollen of treated crops
- This has led to concerns about their safety to bees and other pollinators
- Although monitoring data do not suggest a systematic correlation between the exposure of bees to neonicotinoids and bee health issues, the use of neonicotinoids in bee-attractive crops has been restricted in the EU in 2013
- In order to complement existing field data, a large scale field study with neonicotinoid-treated oilseed rape (treatment with Elado®-10 g clothianidin & 2 g β-cyfluthrin/kg seed) was conducted in Northern Germany

Setup and Purpose of the Study

Conceptual approach of the monitoring study in Mecklenburg

Monitoring potential adverse effects at landscape level

- Comparable landscapes for „control“ und „treatment“
- Spatial proximity of both landscapes: close enough to ensure comparable climatic and topographical conditions distant enough to avoid honeybees to cross-forage
- Agricultural landscapes with significant oilseed rape cultivation and low abundance of other flowering crops or wild plants distracting bees from the target crop
- Common oilseed rape cultivation practice with pre-agreed and defined crop protection measures
- Large-scale farm operations required to ensure regulated crop protection regimen

Study design

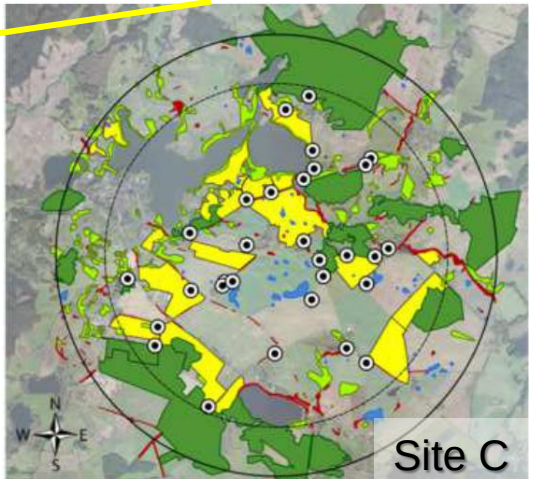
- Monitoring of the clothianidin residue levels in nectar and pollen during bloom
- Monitoring potential adverse effects on pollinators which differ in life history traits

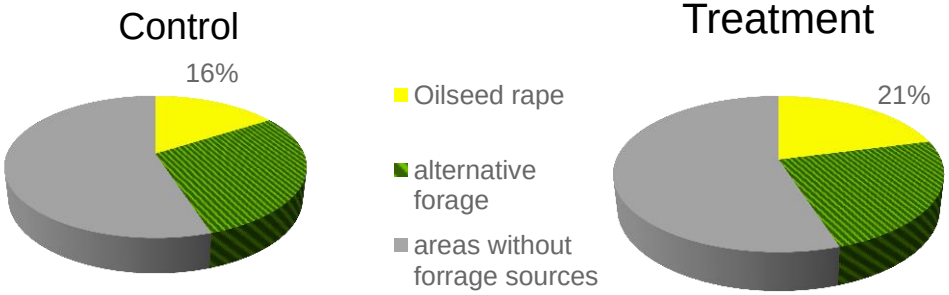
Similarity of Control and Treatment Sites

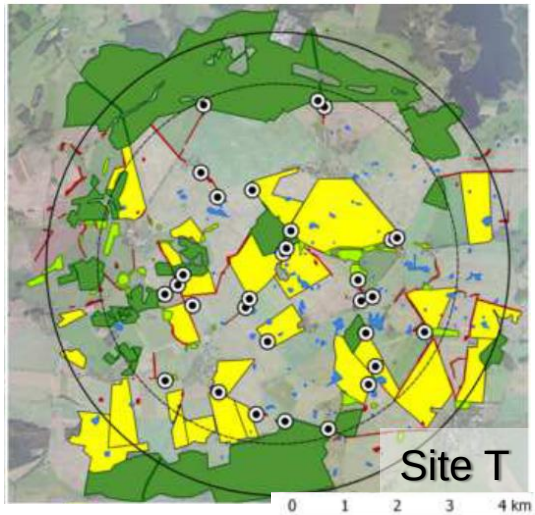
Attractiveness for Bee Pollinators

Two sites of approx. 65 km^2 each were selected according to field cropping area, statistic and land cover data

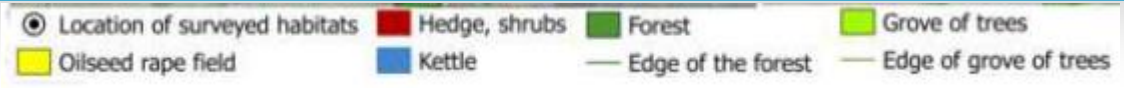
Study area





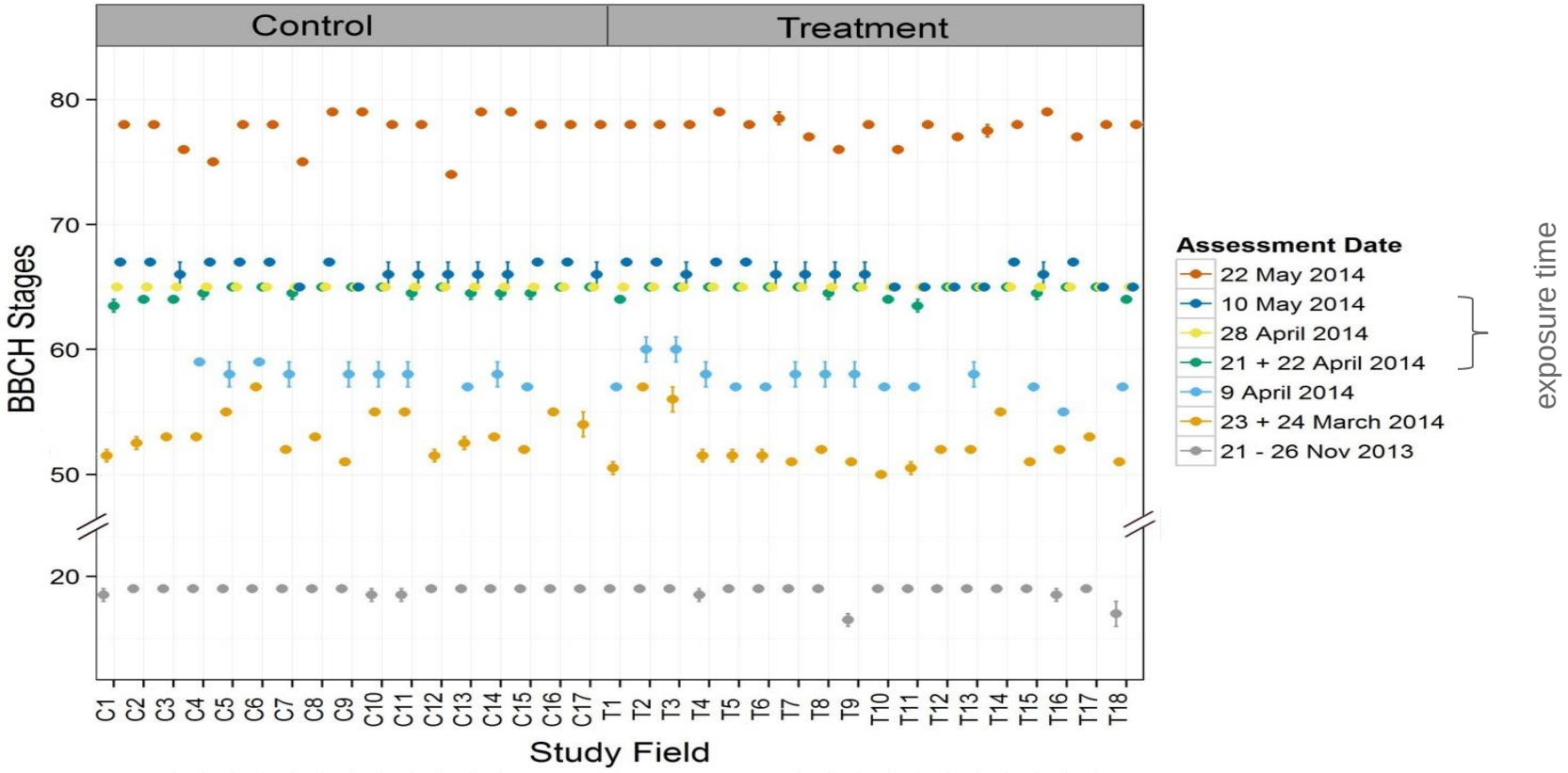


	Control Site	Treatment Site
Study Fields	17	18
Area Study Fields	615 ha	792 ha
% Study Fields of arable land	32 %	29 %
Median Study Field Size	34 ha	35 ha



Similarity of Control & Treatment Sites

Crop phenology

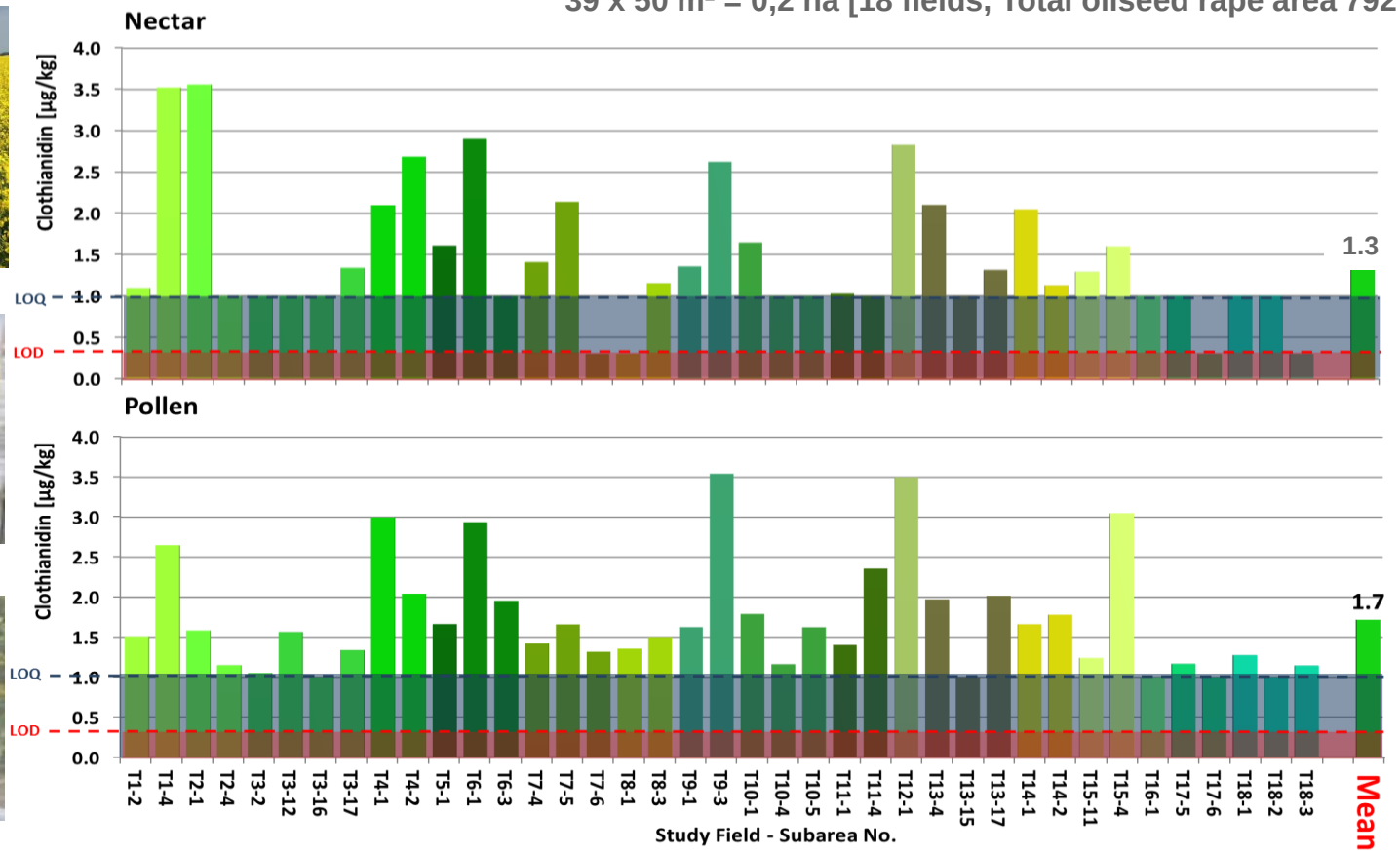


Control fields received 1 – 2 additional pyrethroid applications to ensure comparable oilseed rape emergence

Characterization of Exposure

Residue levels in nectar and pollen of oilseed rape during bloom

39 x 50 m² = 0,2 ha [18 fields, Total oilseed rape area 792 ha]



No residue detects in oilseed rape pollen or nectar in “control” landscape (n = 34)

Investigation of Potential Adverse Effects

Three bee pollinator species with different life history traits

Honeybee (*Apis mellifera*)

Life history traits:

- complex social community with task share
- Comb cells of wax
- Hives with 50.000+ workers
- Thermoregulation
- Full colony overwintering
- Winter food stores

Bumblebee (*Bombus terrestris*)

Life history traits:

- Less complex social structure and task share
- Comb cells of wax
- Hives with 500+ workers
- Thermoregulation
- Only queens overwinter
- Limited food storage

Red Mason bee (*Osmia bicornis)*

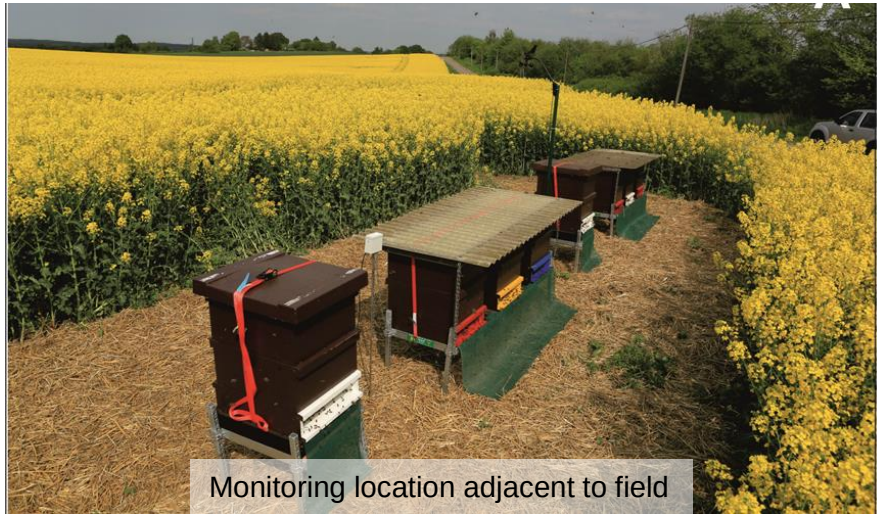
Life history traits:

- Solitary bee
- Nests in tube-shaped structures e.g. in deadwood
- Overwinter as pupa (cocoons)

Monitoring Results

Honey Bees (*Apis mellifera*)

- Eight bee colonies per monitoring location (=1 replicate)
- Six replicates per site (treatment and control)
- Distribution of replicates per site: 3 replicates adjacent to oilseed rape fields, 3 replicates in 400 m distance.



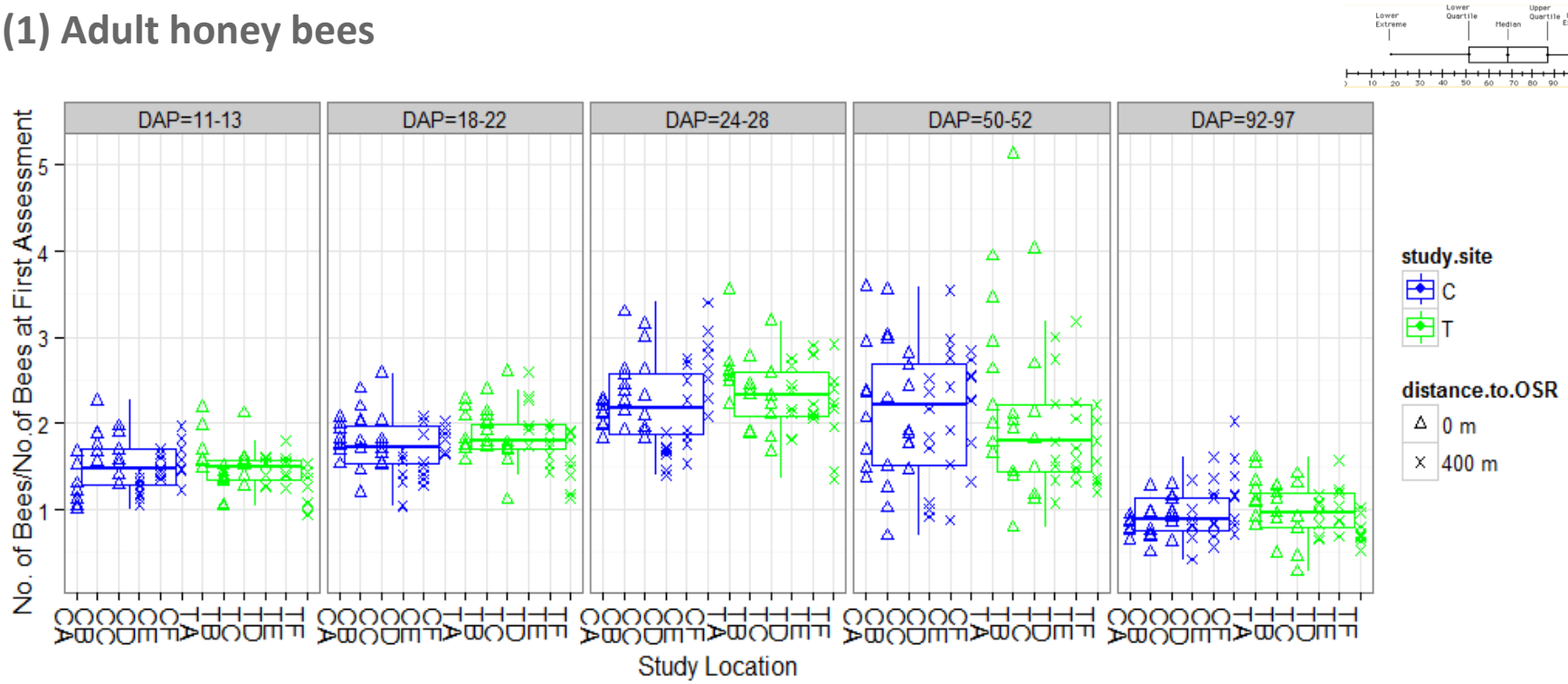
Monitoring location adjacent to field

Post-exposure phase: west-central Germany

Monitoring Results

Honey Bees (*Apis mellifera*)

(1) Adult honey bees



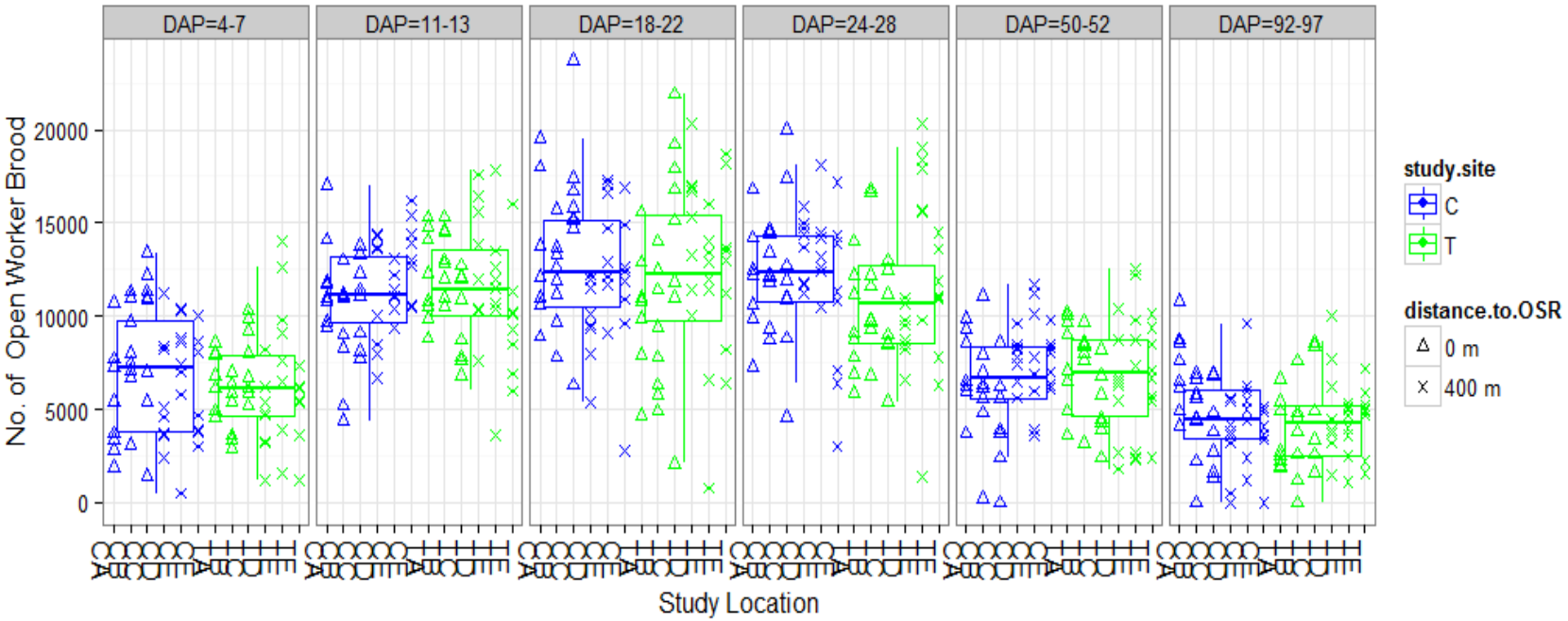
- Typical seasonal colony development pattern
- No statistically significant impact of treatment or distance to fields[1]

[1] (GLM Model, $p > 0.05$)

Monitoring Results

Honey Bees (*Apis mellifera*)

(2) Bee brood



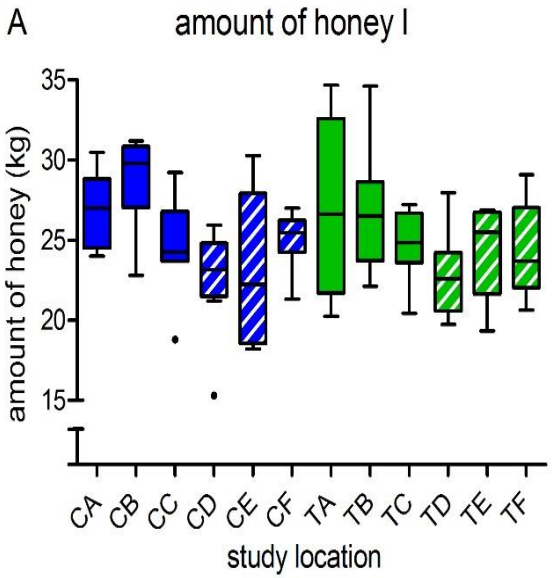
- Typical seasonal growth pattern
- No statistically significant impact of treatment or distance to fields[1]

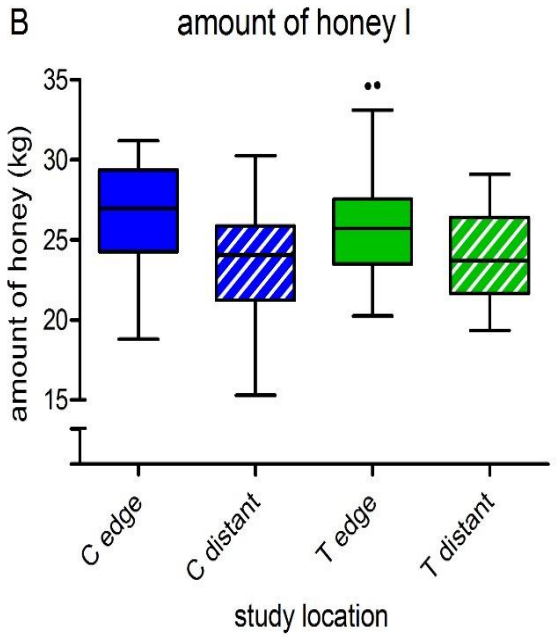
[1] (GLM Model, p > 0.05)

Monitoring Results

Honey Bees (*Apis mellifera*)

(3) Honey yield (Spring)





- No statistically significant impact of treatment
- **Statistically significant impact of distance to oilseed rape fields**

Monitoring Results

Honey Bees (*Apis mellifera*)

(4) Residue levels in pollen and nectar

		Nectar (x)		Pollen (x)		Spring Honey (x)
		sampling 1	sampling 2	sampling 1	sampling 2	
Control	**Clothianidin**	< LOD	< LOD*	< LOD	< LOD*	< **LOQ****
	TZNG	< LOD	< LOD	< LOD	< LOD	< LOD
	TZMU	< LOD	< LOD	< LOD	< LOD	< LOD
Treatment	**Clothianidin**	< LOQ	1.04 kg/µg	< LOQ	1.14 µg/kg	1.4 µg/kg
	TZNG	< LOD	< LOD	< LOD	< LOD	< LOD
	TZMU	< LOD	< LOD	< LOD	< LOD	< LOQ

- Trace residue levels in few of control pollen & nectar samples
- Residue levels in treatment landscape comparable to tunnel samples

* 1/96 Pollen- & 3/96 Nectar samples with detects < LOQ

** 42/48 Honey samples with detects < LOQ

Conclusions

Honey Bees (*Apis mellifera*)

- Honey bees intensively foraged in treated fields

  (73-83% oilseed rape pollen found in honey)

- Residue levels in nectar, pollen and honey ranged between Limit of Detection (< LOQ) and 1.4 µg Clothianidin/kg

- There were no treatment-related adverse effects observed on:
  - colony strength and development (adults, brood)
  - honey yield
  - pollen composition
  - infestation with parasites and diseases

Monitoring Results

Bumblebees (*Bombus terrestris*)

- Three Tripols (= 3 bumblebee colonies) per monitoring location (= 1 replicate)
- Six replicates per site (treatment and control)
- Distribution of replicates per site: 3 replicates adjacent to oilseed rape fields, 3 replicates in 400 m distance.

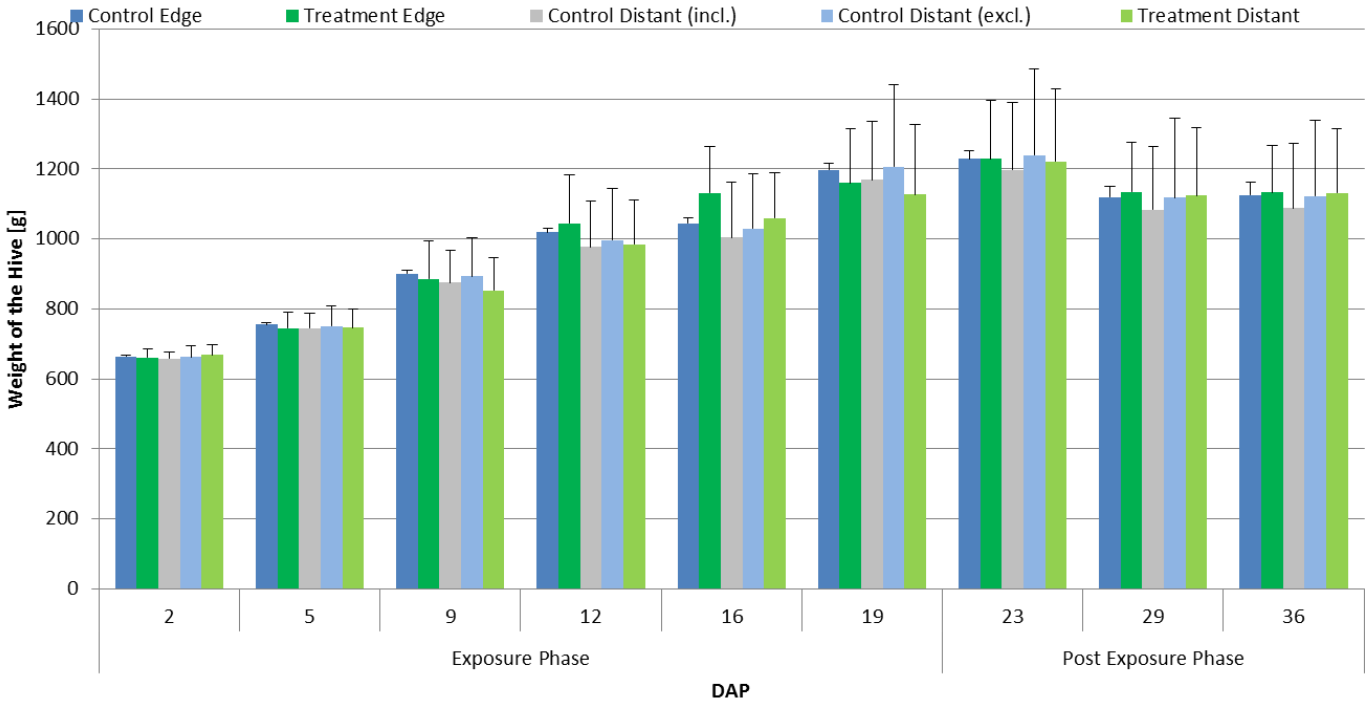
Monitoring location adjacent to field

Collection of bumblebee workers for pollen sampling

Monitoring Results

Bumblebees (*Bombus terrestris*)

(1) Hive weight development

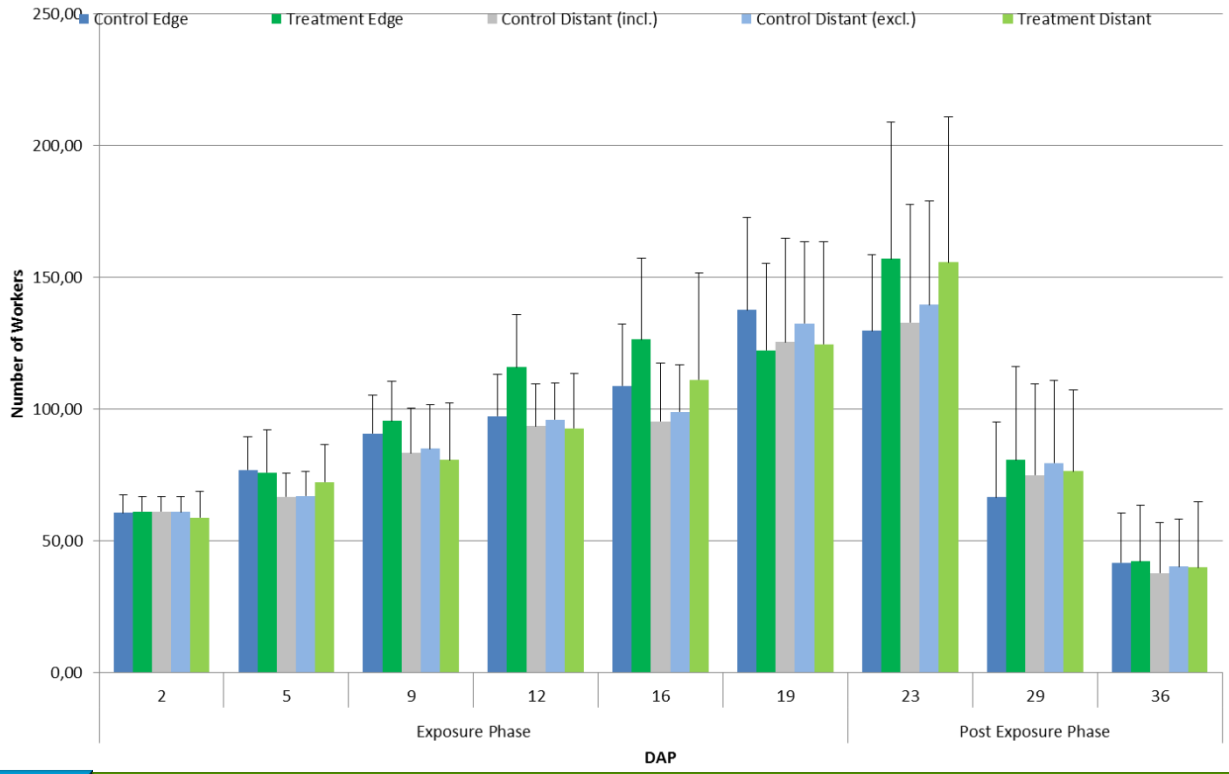


No statistically significant impact of treatment or distance to oilseed rape fields

Monitoring Results

Bumblebees (*Bombus terrestris*)

(2) Number of worker bees per colony

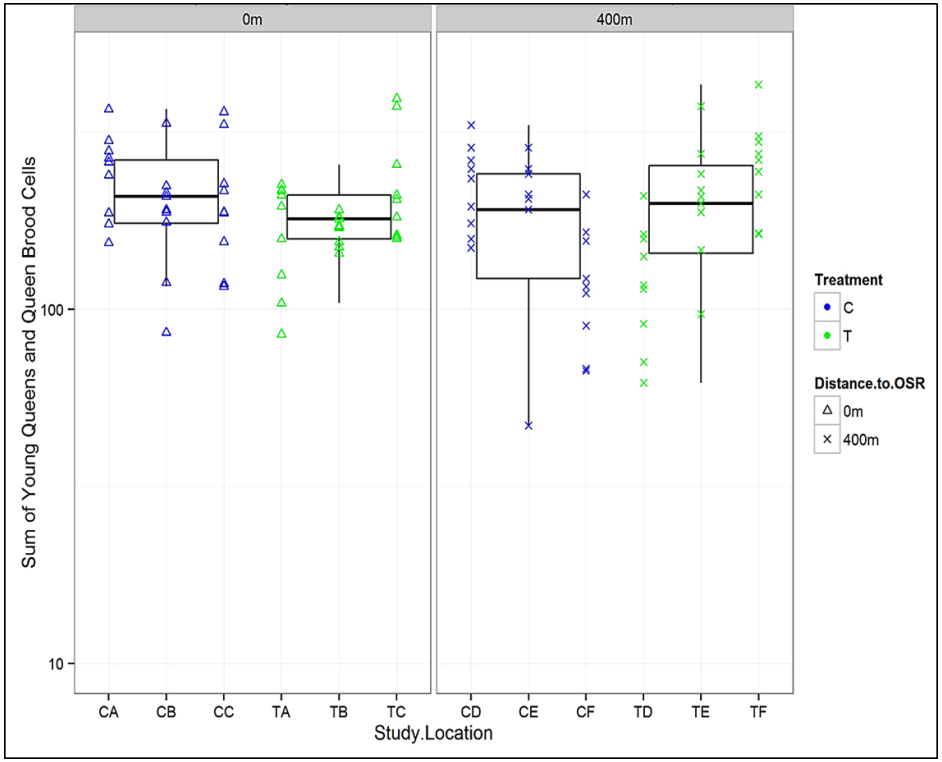


No statistically significant impact of treatment or distance to oilseed rape fields

Monitoring Results

Bumblebees (*Bombus terrestris*)

(3) Number of queens (including queen brood cells)



No statistically significant impact of treatment or distance to oilseed rape fields

Monitoring Results

Bumblebees (*Bombus terrestris*)

(4) Residue detects

Study Location	Residues in Pollen Pellets [µg/kg] (14.05.2014)		
	Clothianidin	Metabolite TZNG	Metabolite TZMU
CA	< LOD	< LOD	< LOD
CB	< LOD	< LOD	< LOD
CC	< LOD	< LOD	< LOD
CD	< LOD	< LOD	< LOD
CE	< LOD	< LOD	< LOD
CF	< LOD	< LOD	< LOD
TA	< LOQ	< LOD	< LOD
TB	< LOQ	< LOD	< LOD
TC	1.0	< LOQ	< LOD
TD	1.0	< LOD	< LOD
TE	< LOQ	< LOD	< LOD
TF	1.3	< LOD	< LOD

Oilseed Rape Pollen:
25–100%

- No residues in control pollen samples
- Residue levels in treatment landscape comparable to tunnel samples

Conclusions

Bumblebees (*Bombus terrestris*)

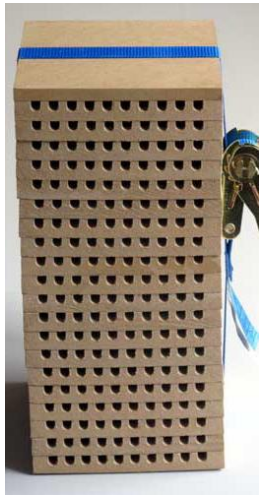
- Bumblebees intensively foraged in treated fields
- Besides oilseed rape pollen, pollen from willow, chestnuts and wild berries were identified
- Residue levels pollen ranged between Limit of Detection (< LOQ) and 1.3 µg Clothianidin/kg

- There were no treatment-related adverse effects observed on:
  - Colony development (workers, drones, queens)
  - Seasonal growth pattern (turning point to queen production)

Monitoring Results

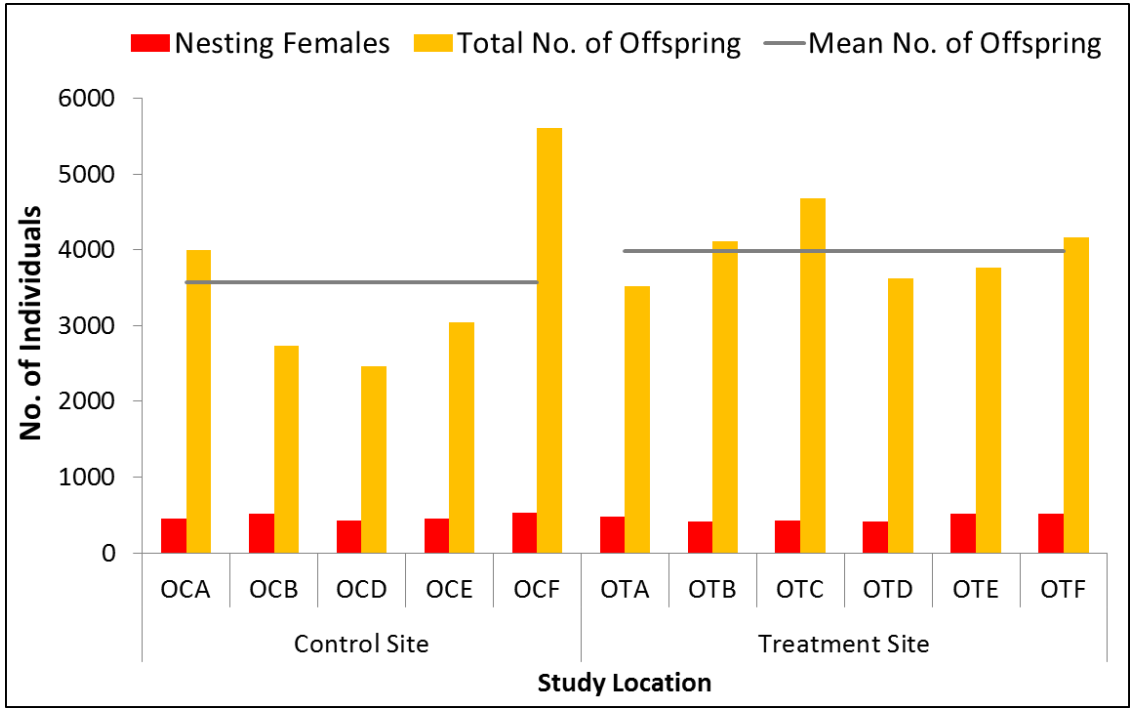
Red Mason Bee (*Osmia bicornis*)

- Six Replicates per Control and Treatment with 3 nesting units adjacent to the oilseed rape field and 3 nesting units in 100 m distance
- 750 cocoons per nesting unit = **1500 cocoons per replicate released** (sex ratio 6:5 m:f)



Monitoring Results

Red Mason Bee (*Osmia bicornis*)



- No adverse effects on the number of nesting females
- No adverse effects on the number of offspring

Conclusions

Red mason bees (*Osmia bicornis*)

- Red mason bees collected up to 32% of their pollen from oilseed rape fields (avg: 14%)
- Besides rape pollen, they collected pollen of roses and buttercups
- Residue levels in pollen ranged between Limit of Detection (< LOQ) and 1.7 µg Clothianidin/kg

- There were no treatment-related adverse effects observed on:
  - Reproductive performance (nesting activity, offspring production)
  - Hatching success

Summary of Key Results

- Bee pollinators in the treatment site were exposed to low and representative levels of systemic Clothianidin residues
- Bee pollinators used oilseed rape pollen to different extent (honeybees > bumblebees > solitary bees)

Honeybee (*Apis mellifera*)

- No effects on colony development (adults & brood)
- No effects on honey yield and pollen composition
- No effects on infestation by parasites and diseases

Bumblebee (*Bombus terrestris*)

- No effects on colony development (no. of workers, drones, queens)
- No effects on seasonal growth pattern (switch point to queen production)

Red Mason bee (*Osmia bicornis*)

- No effect on reproductive performance (nesting activity, offspring production, hatching success)

Overall Conclusions

- The chosen landscapes “control” and “treatment” were sufficiently similar in terms of topography, climate, soil types and crop phenology to deliver a robust conclusion on whether or not Clothianidin poses an unacceptable risk to populations of insect pollinators
- Residue levels in pollen and nectar of oilseed rape in the treatment landscape were in the range of residue levels found in previous studies, i.e. highly representative exposure situation
- There were no treatment-related short- or long-term adverse effects recorded for the Clothianidin seed treatment to three bee species with different life history traits

Overall Conclusions

- The chosen lan … vere sufficiently similar in terms … nd crop phenology to deliver a rob … othianidin poses an unacceptable r … rs
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Ecotoxicology
DOI 10.1007/s10646-016-1725-8

CrossMark

Large-scale monitoring of effects of clothianidin-dressed oilseed rape seeds on pollinating insects in Northern Germany: effects on honey bees (*Apis mellifera*)

Daniel Rolke[1] · Stefan Fuchs[1] · Bernd Grünewald[1] · Zhenglei Gao[2] · Wolfgang Blenau[1]

Accepted: 2 September 2016

Abstract Possible effects of clothianidin seed-treated oilseed rape on honey bee colonies were investigated in a large-scale monitoring project in Northern Germany, where oilseed rape usually comprises 25–33 % of the arable land. For both reference and test sites, six study locations were selected and eight honey bee hives were placed at each location. At each site, three locations were directly adjacent to oilseed rape fields and three locations were situated 400 m away from the nearest oilseed rape field. Thus, 96 hives were exposed to fully flowering oilseed rape crops. Colony sizes and weights, the amount of honey harvested, and infection with parasites and diseases were monitored between April and September 2014. The percentage of oilseed rape pollen was determined in pollen and honey samples. After oilseed rape flowering, the hives were transferred to an extensive isolated area for post-exposure monitoring. Total numbers of adult bees and brood cells showed seasonal fluctuations, and there were no significant differences between the sites. The honey, which was extracted at the end of the exposure phase, contained 62.0–83.5 % oilseed rape pollen. *Varroa destructor* infestation was low during most of the course of the study but increased at the end of the study due to flumethrin resistance in the mite populations. In summary, honey bee colonies foraging in clothianidin seed-treated oilseed rape did not show any detrimental symptoms as compared to colonies foraging in clothianidin-free oilseed rape. Development of colony strength, brood success as well as honey yield and pathogen infection were not significantly affected by clothianidin seed-treatment during this study.

Keywords Colony development · Field study · Neonicotinoid · Plant protection product · Pollinator · Seed-treatment

Introduction

The Western honey bee, *Apis mellifera*, is economically the most valuable pollinator of crop monocultures worldwide and yields of some fruit, seed and nut crops are estimated to decrease by more than 90 % without these pollinators (Klein et al. 2007). As abundance of wild bees in agricultural fields is often insufficient, managed honey bee hives are indispensable to ensure sufficient crop pollination. Furthermore, the global stock of domesticated honey bees is growing more slowly than agricultural demand for pollination (Aizen and Harder 2009). In recent years, honey bees have suffered from high colony mortality, including colony collapse disorder, overwinter or seasonal colony losses (vanEngelsdorp et al. 2008; Neumann and Carreck 2010; Smith et al. 2013). Honey bee colonies are exposed to multiple and varying stressors (Potts et al. 2010) including habitat loss, malnutrition, parasites and pathogens, and plant protection products (PPPs). In particular, systemically acting PPPs of

Electronic supplementary material The online version of this article (doi:10.1007/s10646-016-1725-8) contains supplementary material, which is available to authorized users.

Current address: Zoological Institute, Cologne Biocenter, University of Cologne, Cologne, Germany.

✉ Wolfgang Blenau
wblenau@uni-koeln.de

[1] Institut für Bienenkunde (Polytechnische Gesellschaft), Goethe University Frankfurt, Oberursel, Germany

[2] tier3 solutions GmbH, Leverkusen, Germany

Published online: 19 September 2016

Further Large-Scale Field Studies

Examples for other large-scale field studies under realistic field conditions:

- Studies in canola in Canada (2005 and 2012). Evaluation of colony health over one season and after overwintering
- Multi-site field study in maize in France. Locations in four different regions, study conduction over three consecutive years (2008-2010)
- Field study in Southwestern Germany (2008). Evaluation of colony health over one season and after overwintering.

In none of these studies, adverse effects of neonicotinoid seed treatment products to honey bee colonies have been observed.

Since field studies provide a direct insight into the interaction of pesticides with bee colonies, they provide highest-tier evidence for the ecotoxicological risk assessment

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Thank you for your attention!