Guttation and risk for honey bee colonies (*Apis mellifera* L.): Use of guttation drops by honey bees after migration of colonies - a field study

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Background: The aim of this experiment was to investigate whether honeybees from colonies that are not familiar with their surrounding landscape, due to short-distance migration to a new location, are more at risk by guttation drops from seed-treated plants than bee colonies which are already familiar with alternative water sources in the surrounding of their apiary.

Results: The mean mortality of bees, which occurred after moving beehives to a new location, increased only slightly from 6 bees/day (-1 day before moving) up to a maximum of 21 bees/day (1 day after moving). No significant differences in the mean number of dead bees between bee colonies that were familiar with all sites of water sources in the surrounding area and bee colonies that were only recently moved to the field were observed.

Conclusion: There was no indication that honey bee colonies which were not familiar with the surrounding landscape are more at risk by guttation drops from seed-treated plants than bee colonies which are already familiar with the alternative water sources in their surrounding landscape.

Keywords: guttation, seed treatments, transport beehives, pesticides, honey bee, water foragers

Introduction

Ensuring a good nectar flow is essential for good honey yields and successful beekeeping. However, sometimes flowering crops providing nectar are out of reach for the bees. Therefore, the migration of beehives to flowering crops is a well established procedure in beekeeping[1]. Short-distance transport for example to widely grown crops like oilseed rape mainly occurs to enhance the honey or pollen yield of the bee hive, but also long-distance transports for example to obtain special types of honey or for pollination services are possible. Regardless of the travelled distance, relocated bee colonies are facing similar problems, they are not familiar with their new surrounding and therefore have to reorient themselves[2]. In addition, due to the transport, the food supply to the beehive which consists of nectar, pollen and water is interrupted. However, contrary to nectar and pollen, water is not stored in the bee hive and therefore has to be actively collected by the bees whenever needed[3]. During the time of transport bees have no access to any water sources from outside. Therefore, there may be a shortage of water in the beehive after the transport. Depending on the new location, various water sources may be available for the bee colonies. These sources can be permanent ones such as lakes or not permanent available water sources like dew, rain or guttation drops. However, little is known about the water collecting behaviour of honeybees particularly after a transport to new locations. Due to energetic reasons it is assumed that honeybees usually collect water near and around their hive[4, 5]. This could particularly apply to bees which are not familiar with their surrounding landscape. In addition it can be assumed that after the migration of bee hives the bees use the easiest accessible water source in their proximity and if these colonies are placed next to seed treated crops, they may be exposed to residues in guttation droplets.

Since 2009[6, 7], it has been subject of discussion whether guttation drops of crops grown from seeds treated with systemic insecticides may constitute a relevant route of exposure. To address this question it is necessary to gain more information about the water-collecting behaviour of bees. Therefore, the present study was focused on the water collecting behaviour of honey bee colonies in the first days after transport to a new location. However, the hypotheses was that bees which are not

familiar with their surrounding landscape after short-distance transportation, are more at risk by toxic guttation drops from seed-treated plants than honey bees which are already familiar with every site of water sources in their surroundings.

Experimental methods

The experiment was conducted from the 18th of May until 28th of June 2011. Overall, four locations in the surrounding of Brunswick (Lower Saxony/Germany) were used for placing colonies. The main experimental field was located in Lucklum and consisted of one plot planted with seed-treated maize (a.s. clothianidin, Poncho Pro®, 1.25 mg/kernel) and one plot with untreated maize. The environment of the remaining locations was various (grassland, forest etc.). All these sites were at least 6 km away from the experimental field. The essential part of the trial – placing of bees unfamiliar with the surrounding and potential exposure to guttation droplets containing insecticidal residues - took place on the maize field. It started on a day with guttation events in both plots (16th June), approximately 4 weeks after emergence of the plants when high residues are expected in guttation droplets of seed treated plants[8]. During this period the climatic conditions (relative air humidity, air and soil temperature) and the presence of guttation or dew drops were recorded. In addition, on several days guttation drops were collected for subsequent chemical analysis including all seed treatment ingredients.

In total, 18 identical bee hives (approximately 10.000 bees/hive) were used with three bee hives for each of three variants at each of the two different plots of the experimental field. The bee hives in the first and second variant (V1, V2) were moved to the field border of the two experimental fields before starting of the main experiment and had the chance to get familiar with the field and its surrounding landscape (including all sites of water sources). The first variant was located permanently in the experimental field. The second variant was set up for six days in the experimental field and then moved to the three various locations in the surrounding of Brunswick, at least 6 km far from the experimental field. They were moved back to the experimental field at the beginning of the main study (absence from experimental fields < 9 days). The third variant (V3) was located at the same three various locations as the second variant at the start of the whole experiment and moved for the first time in the experimental field at the start of the main experiment. The beehives were moved to new locations to get more information on the normal bee mortality occurring after transport. To guarantee a period of less than 9 days of absence of the bees of V2 from the experimental fields these bees were placed for another period of 6 days at the experimental field and moved away 8 days before the main study started. This was necessary because guttation occurred only rarely in 2011. In the main study all bee colonies were placed directly at the field border with the hive entrance pointing towards the maize crop. The population development of the beehives was assessed three times by using the Liebefelder method[9] and the bee mortality was observed daily using modified Gary beetraps[10]. Starting a few days before the main experiment of this study two semi-field studies were carried out in the same experimental field (Frommberger et al.[11]) on guttation and the risk for honey bees.

Results

The mean mortality of bees, which occurs by moving beehives to nearby locations only slightly increased from 6 bees/day one day before moving up to a maximum of 21 bees/day one day after moving (Fig.1).

During the main study guttation occurs only five times before and six times during the main study. As expected, especially in the early development stages of maize high residues were found (Fig. 2). In addition, also in the untreated maize plot low residues of active ingredients were found in guttation drops.

In the main study no significant differences in the mean number of dead bees between bee colonies that were familiar with all sites of water sources in the surrounding or bee colonies that were recently moved to the field were observed (Fig. 3).

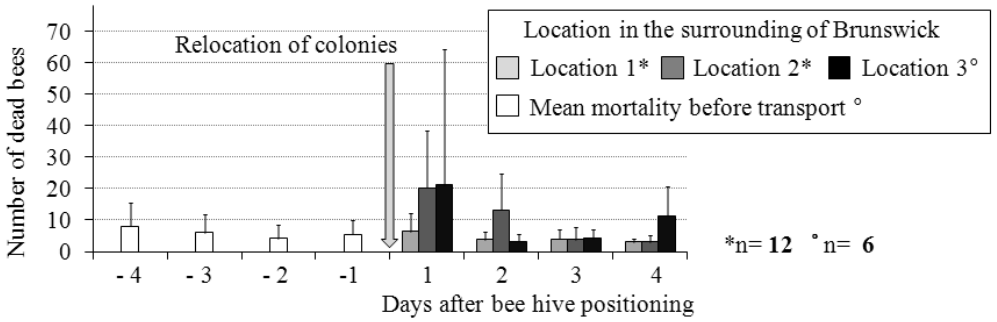

Fig. 1 Bee mortality four days before and after moving beehive to a new location.

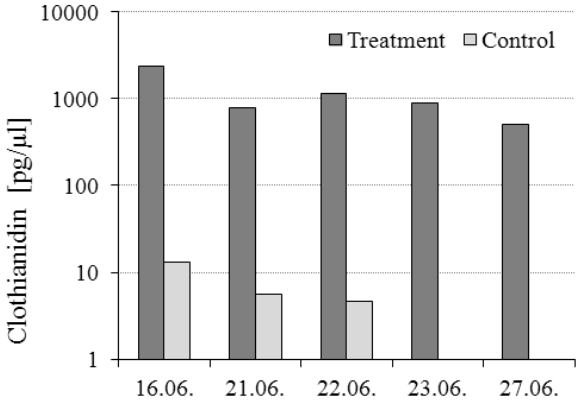

Fig. 2 Range of residues in the guttation drops of treated and untreated maize (BBCH 15-19).

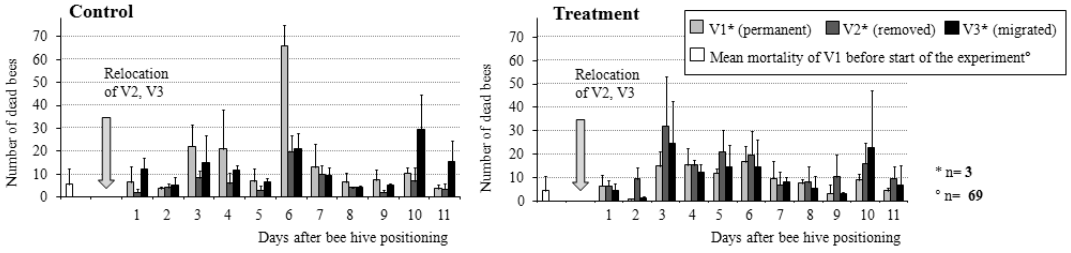

Fig. 3 Bee mortality after moving hives to clothianidin treated and untreated maize (Guttation took place on day 0, 4, 5, 6, 7 and 11)

In addition no adverse effects on the development of all bee colonies were detected.

Conclusions

The hypotheses was that bees not familiar with their surrounding landscape after short-distance transport may be more at risk to collect toxic guttation drops from seed-treated plants than honey bees which are already familiar with every site of water sources in their surroundings. Although several bees were seen scanning the leaf surface of maize plants, high residues were present in the guttation droplets no adverse effects on the development of the beehives or the bee mortality were observed. Frommberger et al.[11] showed at the same time in worst case semi-field experiments (on the same field as the field experiment reported here) without additional water supply in the tents a high impact on adult mortality and also on the brood development which was not detected any more if water was provided within the tents. Also in this study reported here, no effects on adult mortality were detected in the realistic field exposure scenario of this experiment.

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