

Honey bee safety of imidacloprid corn seed treatment

Heinz Friedrich SCHNIER¹, Guido WENIG¹, Frank LAUBERT¹, Volker SIMON¹, Richard SCHMUCK²

¹ Bayer CropScience, Seed Treatment Application Centre, Monheim, Germany

² Bayer CropScience, Institute for Environmental Biology, Monheim, Germany

Abstract

In 2000, beekeepers from the Italian region of Friuli reported losses of a high number of bee hives during the spring season. At the time of this bee incident farmers in Friuli had started to drill their corn fields and some of the seeds had been treated with the seed dressing product Gaucho® (active ingredient: imidacloprid). Reports by some French beekeepers on suspected impacts of seed dressed sunflowers on honeybees made some Italian beekeepers to believe that there might be a link between their bee losses and the use of Gaucho® seed dressing on corn seed. During drilling, dust particles are emitted by the pneumatic seed drilling machines which may also contain abraded seed dressing particles. In response to this concern, further investigations were conducted to examine whether corn crops, seed-treated with Gaucho® will pose a risk to honey bees.

In October 2001 and June 2002, two field trials were conducted in Germany with Italian and German commercial maize seeds to investigate the possible abrasion of Gaucho® from seed-treated maize during sowing with a pneumatic drilling machine. The results show an average emission rate of only 4% on the seed drilling rate with a standard dressing formulation. Formulations with adjuvants diminished abrasions even more.

In parallel, a replicated cage test with honey bees was conducted to examine whether the recorded abrasion rates could adversely affect honeybee colonies foraging on flowering plants with simulated deposits of emitted dust particles. From the findings of this replicated cage study it can be concluded that deposition rates which were much higher than those potentially emitted from pneumatic corn drilling machines will not have detrimental effects on honeybees.

In 2001, no hive losses were recorded in the region of Friuli. This observation in combination with the results of the presented replicated cage study make it very unlikely that the bee colony losses in 2000 were linked to the drilling of Gaucho® dressed corn seeds. Accordingly, the real causative factors (e.g. climatic conditions, bee diseases) of the bee hive losses in 2000 remain to be elucidated in order to develop appropriate preventive measure against losses in future.

Key words: honey bee, *Apis mellifera*, pesticide side effects, imidacloprid, seed dressings, ecotoxicology.

Introduction

In 2000, beekeepers from the Italian region of Friuli reported losses of a high number of bee hives during the spring season. At the time of this bee incident farmers in Friuli had started to drill their corn fields and some of the seeds had been treated with the seed dressing product Gaucho®. Reports by some French beekeepers on suspected impacts of seed dressed sunflowers on honeybees (ALETRU *et al.*, 1998) made some Italian beekeepers to believe that there is a link between their bee losses and the use of Gaucho® seed dressing on corn seeds. During drilling, dust particles are emitted by the pneumatic seed drilling machines which may also contain abraded seed dressing particles. In response to this concern, further investigations were conducted to examine whether corn crops, seed-treated with Gaucho®, will pose a risk to honeybees.

Material and methods

Determination of the amount of abraded Gaucho® seed dressing particles during drilling

Corn seeds were dressed with 143 g Gaucho® FS 350 per unit (1 Unit = 50,000 corn seeds). Besides this Gaucho® seed dressing formulation which was used in Italy in the reported case, two novel FS 350 formulations were examined which contain adjuvants for further optimizing seed loading and minimizing abrasions from

dressed seed during transport and drilling. The dressed corn seeds were drilled with a Kverneland corn drilling machine (variety „Optima“) over 8,000 m² with a partial vacuum of 80 mbar and a drilling rate of 95,000 seeds per hectare. This Northern European drilling rate results in an application rate of 95 g imidacloprid per hectare whereas in Italy only about 75,000 corn seeds are drilled per hectare resulting in an application rate of approximately 75 g imidacloprid per hectare. The outflow airstream was directed through a commercial car filter trapping any abraded dust emitted during the drilling process. The filter was exchanged after drilling of 1000 m² each at the beginning (0-1000 m²), in the middle (4000-5000 m²) and at the end of drilling (7000-8000 m²), respectively. After drilling, filters were removed and analyzed for imidacloprid, the active substance in the Gaucho® seed dressing according to Bayer method 2001-0050601-01 (HPLC).

Determination of effects of abraded Gaucho® seed dressing particles to honeybees

Honeybees may be exposed to the Gaucho® seed dressing when during drilling particles are abraded from dressed corn seeds. Pneumatic drilling machines can emit these particles which may subsequently deposit in the field and along the field margins. A replicated cage test was conducted to examine potential effects of such imidacloprid-containing dust deposits on flowering plants. Deposits of abraded imidacloprid dust particles were simulated by spraying rape plants in blossom with

different rates of Confidor SL 200 in 200 l water per hectare. Tested deposition rates were 0.6, 1.2, 2, 4, 9 and 14 g imidacloprid per hectare.

Small bee colonies consisting of 2000 worker bees, 1 sister queen and 1 brood and 1 food comb were acclimatized in 20 m² mesh cages to the testing conditions for 4 days. They were provided with untreated flowering rape plants in plant trays, and with water *ad libitum*. After bees had been acclimatized, the flowering rape plants were sprayed with the test rates of Confidor SL 200 while bees were actively foraging on these plants. After treatment bee hives were monitored for foraging activity and mortality for a further 4 day period. A methyl-parathion spray treatment (1000 g/ha) was used as a toxic reference treatment in this test.

Results

Amount of emitted Gaucho[®] seed dressing particles during drilling

The recorded rates of emitted dust particles for the different Gaucho[®] seed dressing formulations is presented in figure 1. The standard dressing formulation revealed an average emission rate of 4% which is equivalent to an emission rate between 3 and 4 g imidacloprid per hectare depending on the seed drilling rate. The new Gaucho[®] applications with adjuvants diminished abrasions by more than 50%.

Potential adverse effects of Gaucho[®] seed dressing particles emitted during seed drilling

The results of the replicated cage tests (n=4) are shown in figure 2 (foraging activity) and figure 3 (mortality). Foraging intensity of honeybees on treated plants was not affected by deposition rates of 2 g imidaclo-

prid/ha or less. At deposition rates between 4 and 9 g imidacloprid/ha foraging intensity was significantly lower during the treatment day. Most honeybees remained in their hives for that day but foraging activity completely restored the day after treatment. At 14 g a.s./ha, a significantly reduced foraging activity was observed during the treatment day and the day after. In contrast, the reference treatment suppressed the foraging activity until study termination.

As shown in figure 3, deposition rates of 14 g imidacloprid/ha or less did not cause increased honeybee mortalities. In contrast, the reference spray treatment with methyl-parathion resulted in a loss of approximately 30% of the exposed honeybees.

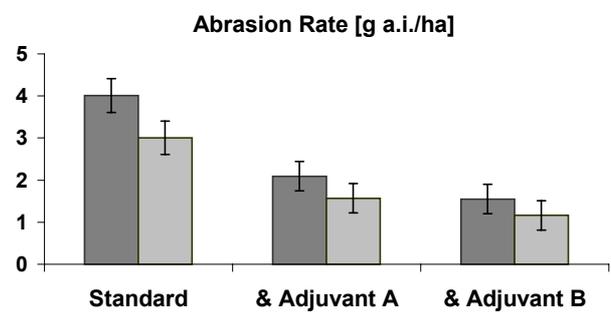


Figure 1. Amount of abraded imidacloprid from Gaucho[®] dressed corn seeds during drilling. The dark bars give experimentally determined abrasion rates for a drilling rate of 95,000 corn seeds per hectare (Northern European drilling rate). The light bars give calculated values for a drilling rate of 75,000 seeds per hectare (typical drilling rate in Italy).

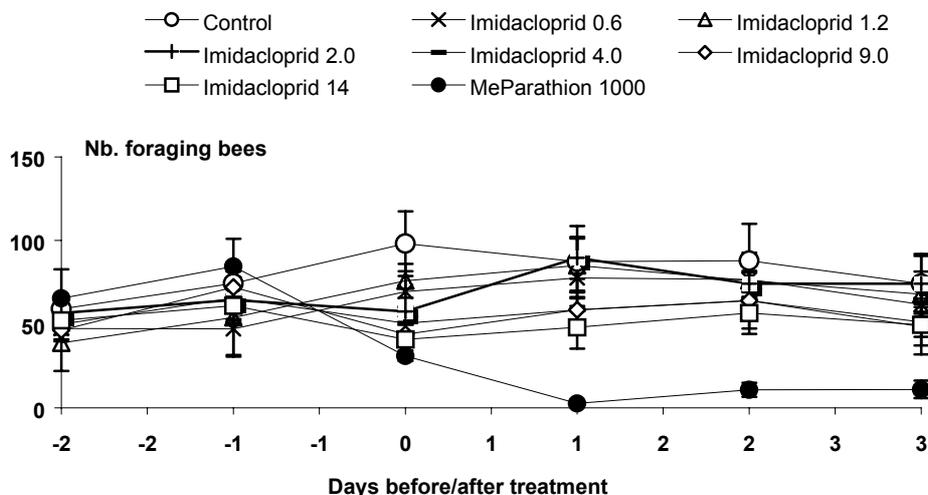


Figure 2. Effects of different spray deposition rates of imidacloprid on the foraging intensity of honeybees over a 4 day exposure period; rates in g imidacloprid / ha.

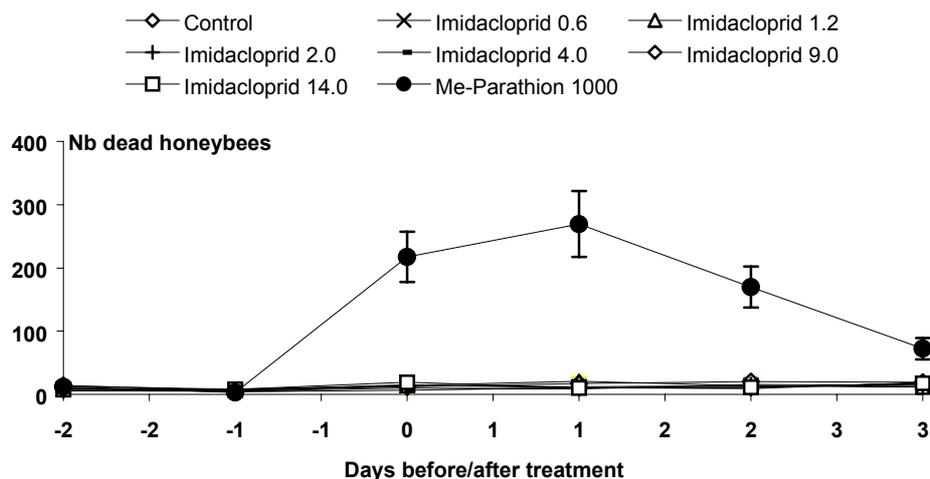


Figure 3. Effects of different plant deposition rates of imidacloprid to mortality of honeybees over a 4 day exposure period; rates in g imidacloprid / ha.

Discussion and conclusions

During drilling of seed treated corn crops dust particles can be emitted from the pneumatic drilling machine which contain also abraded particles of the seed dressing. These abraded particles subsequently deposit on the ground or on vegetation next to drilled fields. The corn seed dressing Gaucho® FS 350 contains the systemic insecticide imidacloprid which is known to be very toxic to honeybees (Pflüger and Schmuck, 1991). Accordingly, if higher amounts of abraded seed dressing particles are emitted during corn drilling, the resulting dust deposits may pose a risk to honeybee colonies foraging in the vicinity of such drilled fields.

In the present study, a maximum abrasion rate of 4% of the Gaucho® FS 350 seed dressing formulation was recorded during drilling of seed-dressed corn crops. This abrasion rate is significantly reduced when specific adjuvants are added aiming to increase the dressing adsorption capacity of corn seeds.

A replicated cage study was conducted to examine whether the recorded abrasion rates will adversely affect honeybee colonies foraging on flowering plants with simulated deposits of emitted dust particles. From the findings of this replicated cage study it can be concluded that deposition rates which were much higher than those potentially emitted from pneumatic corn drilling machines will not have detrimental effects on

honeybees.

In 2001, no hive losses were recorded in the region of Friuli although the percentage of drilled Gaucho® FS 350 dressed corn seeds was significantly increased over 2000. This observation in combination with the results of the presented replicated cage study make it very unlikely that the bee colony losses in 2000 were linked to the drilling of Gaucho® FS 350 dressed corn seeds. Accordingly, the real causative factors (e.g. climatic conditions, bee diseases) of the bee hive losses in 2000 remain to be elucidated in order to develop appropriate preventive measure against losses in future.

References

- ALETRU F., CHAUVANCY F., CLEMENT H., MARY M., VEDRENNE Y., VERMANDERE P., 1998.- Observations autour du butinage du tournesol en 1998.- *Unpublished Report*.
 PFLÜGER W., SCHMUCK R., 1991.- Ecotoxicological profile of imidacloprid.- *Pflanzenschutz-Nachrichten Bayer*, 44: 145-158.

Corresponding author: Heinz Friedrich SCHNIER, Bayer CropScience, Seed Treatment Application Centre, Alfred-Nobel Str. 50, D-40 789 Monheim, Germany.
 E-mail: heinz-friedrich.schnier@bayercropscience.com