Bulletin of Insectology **56** (1): 69-72, 2003
ISSN 1721-8861

# Risk of environmental contamination by the active ingredient imidacloprid used for corn seed dressing. Preliminary results

**Moreno Greatti[1], Anna Gloria Sabatini[2], Renzo Barbattini[3], Simona Rossi[2], Antonella Stravisi[3]**
[1]*Laboratorio Apistico Regionale, Dipartimento di Biologia applicata alla Difesa delle Piante, Università di Udine, Italy*
[2]*Istituto Nazionale di Apicoltura, Bologna, Italy*
[3]*Dipartimento di Biologia applicata alla Difesa delle Piante, Università di Udine, Italy*

## Abstract

Aim of the study was to detect the possible loss of a.i. imidacloprid through the fan drain of pneumatic seed drills during corn sowing operations. The experiment regarded Gaucho® dressed corn seeds. In order to detect air contamination, paper filters were positioned at the air output of the fan; in addition grass and flower samples from green areas near fields were collected immediately after the corn had been sown. Residues of imidacloprid were found both in the paper filters and in the grass and flowers samples. Quantity of imidacloprid in the paper filters increased with increasing exposure times. The results confirm that the air is contaminated by a.i. imidacloprid during normal sowing operations using Gaucho® dressed corn seeds.

**Key words:** imidacloprid, Gaucho®, environmental contamination, corn sow.

## Introduction

Gaucho® is a systemic plant insecticide based on the a.i. imidacloprid (Elbert *et al*., 1991). The product is used for seed dressing due to its prevention properties against soil and sucking insects. In recent years, in northern Italy the use of imidacloprid dressed corn seeds has became widespread. All corn is sown by pneumatic seed drills, which distribute seeds by means of air aspiration. The air is provided by a centrifugal fan and then directed out of the seed drill through a drain. The possibility that the air expelled by the fan could be contaminated by residues (powder, small scales) of pesticide used for corn seed dressing was not yet clear for the active ingredient imidacloprid.

Previous studies on the potential toxicity of imidacloprid and its hazards to insect pollinators (i.e. honey bees and bumble bees) focused on how the presence of the active ingredient in pollen and nectar of seed dressed plants would effect pollinating activity (Tasei *et al*., 2001; Wallner, 2001; Curè *et al*., 2001; Schmuck *et al*., 2001; Ambolet *et al*., 1999; Schmuck, 1999) and on the effects of intoxication with dose-response tests (Curè *et al*., 2001; Guez *et al*., 2001; Colin *et al*., 2001; Bortolotti *et al*., 2001; Suchail *et al*., 2001a; Suchail *et al*., 2001b; Decourtye *et al*., 2001; Lambin *et al*., 2001; Nauen *et al*., 2001; Suchail *et al*., 2000; Tasei *et al*., 2000).

The aim of this study was to detect if any of the active ingredient imidacloprid was lost from the fan of pneumatic seed drills and determine subsequent contamination of flowers and grass near corn fields, that is investigate the potential risks connected with sowing operations.

## Materials and methods

The study was carried out in the experimental farm «A. Servadei» of the Udine University (NE, Italy) in 2001, during the corn sowing season. The Gaspardo SP 520 seed drill with a fan drain measuring 32 cm x 6 cm, and a working pressure of about 0.06 bar and seeding speed of about 4.5 km/h was used.

In order to verify the possible loss of active ingredient from the centrifugal fan drain of the pneumatic corn seed drill, paper filters (25 cm x 25 cm, surface 625 $cm^2$, folded four times) were placed on it for variable times during the sowing operations. The exposure time was 30 (T1), 60 (T2) and 120 (T3) seconds, repeated three times. The corn used was the commercial hybrid PR34F02 (FAO class 500) dressed with Celest® XL (a.i. Fludioxonil), Gaucho® 350 FS (a.i. imidacloprid) and Apron® (a.i. metalaxyl). After removal, filters were put in a polyethylene bag and frozen.

In a different plot, a second series of observations was carried out, on flowers and grass in the green areas near a field immediately after corn sowing. In this case the commercial corn hybrid used was the PR32W92 (FAO class 600), also dressed with Celest® XL, Gaucho® 350 FS and Apron®. Two samples of grass and two of flowers were collected from plots of one square metre each and immediately frozen. «Grass» samples included both Monocotiledonae and Dicotiledonae leaves, while «flower» samples consisted in complete headlings (Compositae) or single flowers (other families) of all the species in bloom at that moment in the sampling area.

The samples (paper filters, grass and flowers) were analyzed at the laboratories of the Istituto Nazionale di Apicoltura of Bologna, using a gascromatography method developed by Bayer (Plake and Weber, 1993), with an appropriate adjustment for the analyzed matrix. The analysis identified 6-chloronicotinic acid as the end product of the oxidation of the a.i. imidacloprid and of its degradation products; using a conversion factor it was then possible to calculate the equivalent quantity of imidacloprid.

The filter samples corresponding to the three repetitions of each test were analyzed *in toto*, while the grass and flower samples were divided respectively in four and two equal parts and each sub sample analyzed separately in order to obtain repetitions of each sample.

## Results and discussion

At first glance the paper filters, especially after longer exposure times, were pink in colour and often with small scales. This fact confirms both that the filters are effectively exposed to the outgoing air flux and that some kind of material is indeed released from the fan.

The results of the analyses of the paper filters and the grass and flower samples, are reported in table 1. There is clearly a loss of a.i. imidacloprid through the fan drain of seed drills. The data show an increase of mg imidacloprid/kg paper with increasing exposure time (figure 1). The relationship between the two variables is well explained by a 2nd order polynomial.

Grass and flower samples show comparable residual values of imidacloprid (figure 2). $LD_{50}$ values for imidacloprid relative to honey bees are often reported in the literature (Schmidt, 1996; Suchail *et al*., 2000; Nauen *et al*., 2001; Schmuck *et al*., 2001). There is significant variability in the data presented by different authors, values of $LD_{50}$ for acute oral tests range from 5 to 500 ng/bee after 48 hours and imidacloprid sensitivity seems to vary with the honey bee colonies. It is clear that imidacloprid causes neuronal damages in honey bees, which bring about behavioral, communication and motion imbalance. But since there is not full agreement on the real level of toxicity of the active ingredient in *Apis mellifera* L. under controlled conditions, an exact estimate of the effects of the environmental contamination is difficult.

Nevertheless, from these results it is possible to confirm the existence of environmental contamination during the sowing operations.

**Table 1.** Quantity of a.i. imidacloprid found in the paper, grass and flower samples.

| Paper filter | Imidacloprid/ paper (mg/kg) | Average (sd) | Grass sample | Imidacloprid/ grass (mg/kg) | Average (sd) | Flower sample | Imidacloprid/ flowers (mg/kg) | Average (sd) |
|---|---|---|---|---|---|---|---|---|
| T1/1 | 11.7 | | 1/1 | 0.029 | | | | |
| T1/2 | 53.8 | 43.5 (28.1) | 1/2 | 0.022 | | 1/1 | 0.022 | |
| T1/3 | 65.0 | | 1/3 | 0.017 | | | | |
| T2/1 | 71.7 | | 1/4 | 0.026 | | 1/2 | 0.029 | |
| T2/2 | 50.4 | 58.2 (11.7) | | | 0.021 (0.005) | | | 0.032 (0.015) |
| T2/3 | 52.5 | | 2/1 | - | | 2/1 | 0.023 | |
| T3/1 | 139.6 | | 2/2 | 0.014 | | | | |
| T3/2 | 91.8 | 125.7 (29.6) | 2/3 | 0.018 | | 2/2 | 0.054 | |
| T3/3 | 145.8 | | 2/4 | 0.022 | | | | |

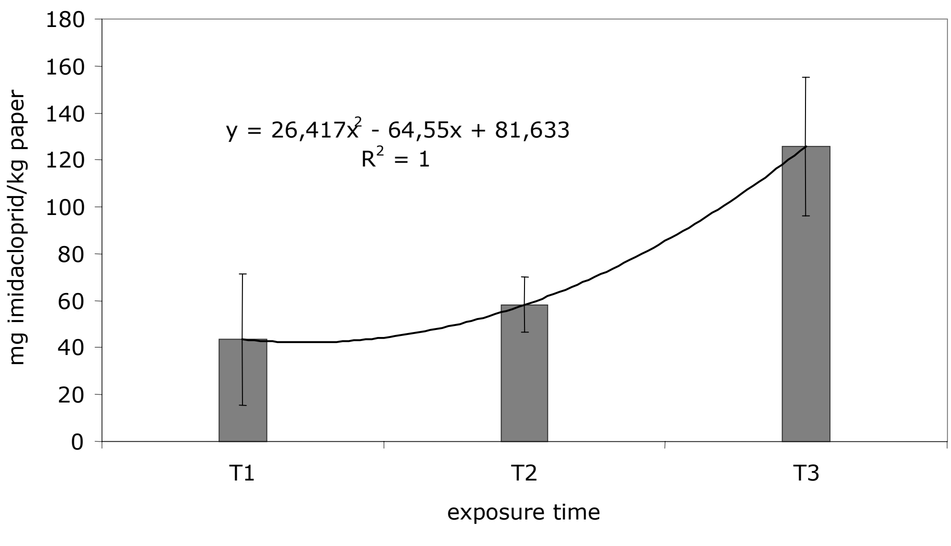


**Figure 1.** Mean quantity of a.i. imidacloprid found in the paper filters.

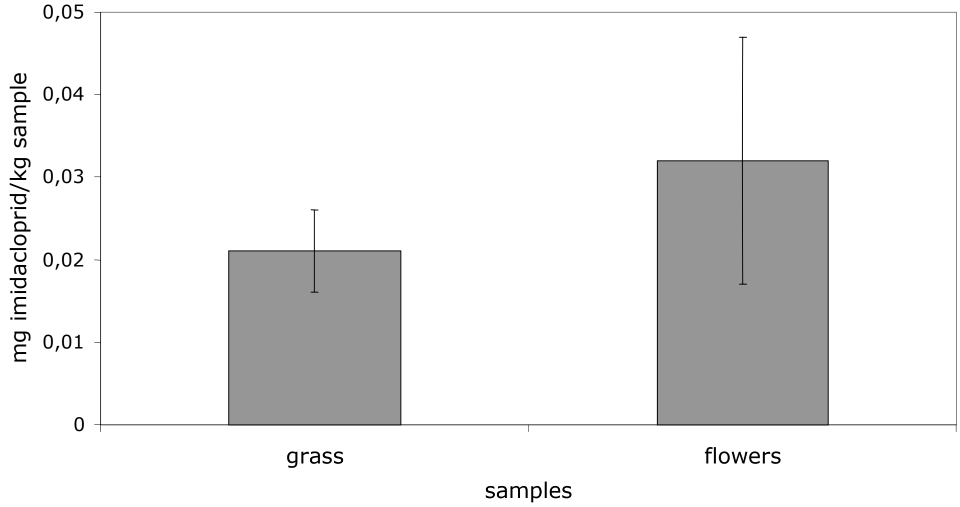


**Figure 2.** Mean quantity of a.i. imidacloprid found in grass and flower samples.

## Conclusions

The preliminary results obtained in 2001 indicate that, since both the paper filters located in the fan drain of the pneumatic seed drill and the flower and grass samples collected near the fields contain pesticide residues, then corn sowing must be considered a potentially dangerous operation in terms of general environmental pollution. It is possible that the spread of the active ingredient in the environment during sowing operations could cause serious damage in bee colonies, since bees are well known to be sensitive to this product.

These results could suggest certain practical improvements for the Gaucho® dressed corn seed production; in particular technical innovations should be introduced to optimize the adherence of the pesticide to the seeds (i.e. better gluing).

On the basis of the first results, the study was continued in spring 2002. As in the previous year paper filters were put on the fan output of a pneumatic seed drill and samples of flowers and grass were collected.

The experiment was carried out for five different corn hybrids, with four different exposure times of the filters (30, 60, 120, 240 seconds). For each thesis samples of grass and flowers were collected before sowing and until eight days after; during this period meteorological data were taken near the plots. Finally, corn leaves and pollen samples were also collected.

## References

AMBOLET B., CREVAT J. F., CURE G., SCHMUCK R., VINCINAUX C., 1999.- Etude au champ des effects de l'imidaclopride sur abeilles.- In: *Proceedings of the Fifth International Conference on Pests in Agriculture*, Part 3, December 7-9, 1999, Montpellier, France, 617-624.

BORTOLOTTI L., GRAZIOSO E., PORRINI C., SBRENNA G., 2001.- Effects of pesticides on the bumblebee *Bombus terrestris* L. in the laboratory.- In: *Proceedings of the 7th International Symposium "Hazards of pesticides to bees"*, September 7-9, 1999, Avignon, France (BELZUNCES L. P., PÉLISSIER C., LEWIS G. B., Eds). *Les Colloques de l'INRA*, 98: 217-225.

COLIN M. E., LE CONTE Y., VERMANDERE J. P., 2001.- Managing nuclei in insect-proof tunnel as an observation tool for foraging bees: sublethal effects of deltamethrin and imidacloprid.- In: *Proceedings of the 7th International Symposium "Hazards of pesticides to bees"*, September 7-9, 1999, Avignon, France (BELZUNCES L. P., PÉLISSIER C., LEWIS G. B., Eds). *Les Colloques de l'INRA*, 98: 259-268.

CURÈ G., SCHMIDT H. W., SCHMUCK R., 2001.- Results of a comprehensive field research programme with the systemic insecticide imidacloprid (Gaucho®).- In: *Proceedings of the 7th International Symposium "Hazards of pesticides to bees"*, September 7-9, 1999, Avignon, France (BELZUNCES L. P., PÉLISSIER C., LEWIS G.B., Eds). *Les Colloques de l'INRA*, 98: 49-59.

DECOURTYE A., LE METAYER M., POTTIAU H., TISSEUR M., ODOUX J. F., PHAM-DELÈGUE M. H., 2001.- Impairment of olfactory learning performances in the honeybee after long term ingestion of imidacloprid.- In: *Proceedings of the 7th International Symposium "Hazards of pesticides to bees"*, September 7-9, 1999, Avignon, France (BELZUNCES L. P., PÉLISSIER C., LEWIS G. B., Eds). *Les Colloques de l'INRA*, 98: 113-117.

ELBERT A., BECKER B., HARTWIG J., ERDELEN C., 1991.- Imidacloprid – a new systemic insecticide.- *Pflanzenschutz-Nachrichten Bayer*, 44 (2): 113-136.

GUEZ D., SUCHAIL S., MALESZKA R., GAUTHIER M., BELZUNCES L. P. 2001.- Sublethal effects of imidacloprid on learning and memory in honeybees.- In: *Proceedings of the 7th International Symposium "Hazards of pesticides to bees"*, September 7-9, 1999, Avignon, France (BELZUNCES L. P., PÉLISSIER C., LEWIS G.B., Eds). *Les Colloques de l'INRA*, 98: 297.

LAMBIN M., ARMENGAUD C., RAYMOND S., GAUTHIER M., 2001.- Imidacloprid-induced facilitation of the proboscis extension reflex habituation in the honeybee.- *Archives of Insect Biochemistry and Physiology*, 48 (3): 129-134.

NAUEN R., EBBINGHAUS-KINTSCHER U., SCHMUCK R., 2001.-

Toxicity and nicotinic acetylcholine receptor interaction of imidacloprid and its metabolites in *Apis mellifera* (Hymenoptera: Apidae).- *Pest Management Science*, 57 (7): 577-586.
PLAKE F. J., WEBER E., 1993.- Method of determining imidacloprid residues in plant materials.- *Pflanzenschutz-Nachrichten Bayer*, 46 (2): 109-182.
SCHMIDT H. W., 1996.- The reaction of bees under the influence of the insecticide imidacloprid.- In: *Proceedings of the Sixth ICP-BR International Symposium on Hazards of Pesticides*, September 17-19, 1996, BBA Braunschweig, Germany, (LEWIS G. B., Ed.) Appendix n. 12.
SCHMUCK R., 1999.- Kein Zusammenhang zwischen Saatgutbeizung mit Gaucho® in Sonnenblumen und Bienenschaden in Frankreich.- *Pflanzenschutz-Nachrichten Bayer*, 52 (3): 267-309.
SCHMUCK R., SCHONING R., STORK A., SCHRAMEL O., 2001.- Risk posed to honeybees (*Apis mellifera* L., Hymenoptera) by an imidacloprid seed dressing of sunflowers.- *Pest Management Science*, 57 (3): 225-238.
SUCHAIL S., GUEZ D., BELZUNCES L. P., 2000.- Characteristics of imidacloprid toxicity in two *Apis mellifera* subspecies.- *Environmental Toxicology and Chemistry*, 19 (7): 1901-1905.
SUCHAIL S., GUEZ D., BELZUNCES L. P., 2001a.- Discrepancy between acute and chronic toxicity induced by imidacloprid and its metabolites in *Apis mellifera*.- *Environmental Toxicology and Chemistry*, 20 (11): 2482-2486.
SUCHAIL S., GUEZ D., BELZUNCES L. P., 2001b.- Toxicity of imidacloprid and its metabolites in *Apis mellifera*.- In: *Proceedings of the 7th International Symposium "Hazards of pesticides to bees"*, September 7-9, 1999, Avignon, France (BELZUNCES L. P., PÉLISSIER C., LEWIS G.B., Eds). *Les Colloques de l'INRA*, 98: 121-126.
TASEI J.N., LERIN J., RIPAULT G., 2000.- Sub-lethal effects of imidacloprid on bumblebees, *Bombus terrestris* (Hymenoptera: Apidae), during laboratory feeding test.- *Pest Management Science*, 56 (9): 784-788.
TASEI J.N., RIPAULT G., RIVAULT E., 2001.- Hazards of imidacloprid seed coating to *Bombus terrestris* (Hymenoptera: Apidae) when applied to sunflower.- *Journal of Economic Entomology*, 94 (3): 623-627.
WALLNER K., 2001.- Test regarding effects of imidacloprid on honey bees.- In: *Proceedings of the 7th International Symposium "Hazards of pesticides to bees"*, September 7-9, 1999, Avignon, France (BELZUNCES L. P., PÉLISSIER C., LEWIS G. B., Eds). *Les Colloques de l'INRA*, 98: 91-94.

**Corresponding author:** Moreno GREATTI, Laboratorio Apistico Regionale, Dipartimento di Biologia applicata alla Difesa delle Piante, Università di Udine, via delle Scienze 208, 33100 Udine, Italy.
E-mail: moreno.greatti@aass.uniud.it