INCIDENCE ON BEES, HIVES AND THEIR PRODUCTIONS OF AERIAL APPLICATIONS WITH DELTAMETHRIN ON RAPE

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SUMMARY

Three field trials aiming at determining whether in the long term, deltamethrin has adverse effects on hives settled in or near treated plots were carried out. Blooming rapeseed was sprayed by helicopter. Deltamethrin (5 g/ha a.i.) was compared to water. Residues were analyzed on pollen and dead bees. Hives were observed until the next spring following the application. No change was observed concerning the hives activity or production, in the reproduction and the behaviour of the colonies.

No residual long-term effect was stated.

INTRODUCTION

In France, the first applications of deltamethrin to flowering crops or crops likely to be visited by foraging bees (Apis mellifera) dated from 1983 and 1984, years during which registration was obtained for the control of cabbage seed weevils at 5 g/ha a.i. and cereal ear aphids at 6.25 g/ha a.i., respectively.

In order to comply with the strict registration requirements concerning the protection of bees, these registrations were only granted after detailed investigation of the possible toxicity of deltamethrin for the domestic bee, under practical agricultural conditions. These studies, initiated in 1978 were continued until 1989 according to various techniques.

The results of these various experiments, prove that deltamethrin can be used without any adverse effects on domestic bees, under practical agricultural conditions : the first signs of toxicity, compared to controls treated with water, only appeared on doses 3 to 4 times greater than the normally used ones.

These findings confirm Dr. Stevenson's theoritical approach (STEVENSON and al. 1982) who related the laboratory toxicity to the doses used in the field.

Concerning deltamethrin, its non-systemic nature, its repellent effect during the hours following treatment, also induce a reduction of toxicity under natural conditions.

In order to assess whether in the long-term deltamethrin has any adverse effects on the development and the production of hives placed in or close to treated fields, ROUSSEL UCLAF conducted three open-field trials, in 1985, 1986 and 1989, on flowering rape with helicopter low volume treatments.

In addition to the usual assessments of behaviour and mortality performed during the days following the application, the honey harvest was measured troughout the season and the hives were submitted to detailed follow-up until the following spring. Analyses of residues were carried out on the bees found dead after treatment, on the pollen collected by the bees.

Deltamethrin, at the registered dose against cabbage seed weevils (5 g/ha a.i.), was compared to pure water.

MATERIAL AND METHODS

1) Experimental protocol

Aerial prospection was undertaken to select fields acreage of which varied from 5 to 18 hectares depending upon the years, in an area located north - west of Paris.

The history of previous insecticides applications of each field was also recorded.

In each field, five to six 50 m^2 plots were delimited with poles to assess the behaviour of the bees, the foraging activity and the mortality in the crop.

A place was set aside at the edge of each field to settle the experimental apiaries. The ground was cleaned and compacted in order to be able to collect the dead bees on the soil.

Eight hives were installed on each place at least one week before the application in order to give the bees time to get used to their new foraging area. The hives belonged to a professional bee-keeper and contained about 40,000 bees each. The queens were two to three years old.

Two hives per apiary were fitted with pollen traps and two others with dead bees traps.

Meteorological data were recorded.

2) **Treatments, products and doses.**

The products were sprayed by helicopter fitted with a 15 m spraying boom delivering 25 l/ha in 1985 and 20 l/ha in 1986 and 1989.

The applications were carried out on May 18, 1985; May 20, 1986 and April 28, 1989 at a dose of 5 g/ha deltamethrin.

3) **Assessment.**

31) On the apiary.

Before the application, dead bees were collected daily and counted in the dead bees traps and on the ground in order to evaluate the natural mortality.

After the application, these countings were performed twice a day during 4 days (1985) and 7 days (1986, 1989) in the morning and late in the afternoon to avoid predation of dead bees.

Pollen and dead bees were collected daily and deep-frozen for further residue analysis.

The behaviour of the bees was observed in the hives.

32) In the crop.

Foraging bees were counted daily, at 2.00 p.m. throughout the test period on the specially designed sub-plots.

These countings were intensified the day of the application in order to gather data immediatly before spraying, during the flight of the helicopter, 15, 30, 45, 60 and 120 minutes after application.

33) Hives monitoring.

(production - sanitary estate until the following spring)

* Following the rapeseed blooming, the hives were pooled after identification, and the apiary maintained normally in an acacia and then in a sunflower crop by the beekeeper. Throughout the rest of the season, hives were carefully observed in order to detect any abnormal behaviour in the colonies. Successive honey yields were also measured.

* After overwintering, the estate of the colonies was evaluated in presence of the beekeeper during the normal spring visit, in order to detect a possible residual effect of the previous experimental treatments.

* Precise measurement of the area of honeycomb per frame (1986, 1989)

* Estimation of the number of honeycomb frames (1985, 86, 89).

* Qualitative evaluation of the honeycomb by the beekeeper.

34) Residues.

Samples of pollen and dead bees were analyzed at the University of Montpellier (Pr. Mestres). In 1986 and 1989, dead bees collected on day "D" and day "D + 1" morning were pooled together in order to constitute a large enough sample as the mortality was actually very low.

RESULTS - DISCUSSION

1) Mortality of bees.

Table 1 : Cumulated number of dead bees found in the viscinity of the apiary and in the dead bees traps.

	1985	1986	1989
WATER			
4 days before application	237	718	687
4 days after application	432	546	738
DECIS 5 g/ha a.i.			
4 days before application	301	367	420
4 days after application	532	206	360

No abnormal mortality was observed in none of the 3 trials deltamethrin sprayed plots as it was similar to the one observed in the corresponding water controls. Treatment with deltamethrin applied by air at 5 g/ha a.i. does not present an higher risk for foraging bees than a neutral spray of water in the same conditions.

2) Behaviour and pollen gathering

Treatment with deltamethrin induces a flying away behaviour before a return to normal activity 2 to 3 hours later whithout any economically significant disruption of pollen gathering.

3) **Residues analysis.**

31) **Pollen - 1985, 1989.**

No deltamethrin residue was detected in the pollen.

32) **Dead bees.**

Table 2 : Maximum residues found on dead bees : 1 to 4 DAA in ng/bee.

1985	1986	1989
2	2	4

No residue was found in the dead bees sampled in the water control plots.

Residues of deltamethrin detected in the dead bees collected in the treated plots did not overpass 0.02 ppm. This corresponds to approximately 0.004 micrograms per bee which is about 15 times lower than the contact LD 50. Deltamethrin is unlikely playing any part in the mortality observed on the treated plots.

4) **Honey production.**

Table 3 : Honey production during the whole season after application.

In kg honey per hive	1985	1986	1989
WATER	28.90	41.25	44.2
Decis 5 g/ha a.i.	25.33	43.35	43.9

Total honey harvested per hive varied in the water control beetween 29 kilograms in 1985, 41 kilograms in 1986 and 44 kilograms in 1989 while the corresponding figures for the treated plots were respectively 25, 43 and 44 kilograms. Therefore no impact of deltamethrin on honey production has been observed.

5) Honeycomb estate after overwintering.

Table 4 : Brood comb production estimated by the bee keeper after overwintering.

	Nr of brood-comb frames per hive			Brood-comb surf. / hive (cm^2)	
	1985	1986	1989	1986	1989
Water	1.75	5.5	5.37	4007	5370
Decis 5 g/ha	1.50	5.9	5.37	4759	5370

Honeycomb from hives standing in treated plots did not present any abnormality and developed normally when compared with hives coming from water control areas.

Finally, populations of bees coming from "treated" hives were carefully examined by the beekeeper and declared to be as healthy as the "untreated" ones (1985 and 1986).

CONCLUSIONS

The three trials presented here above were conducted in a carefully prospected environment and according to a well defined methodology sticking as much as possible to good beekeeping practices. The most relevant factors were actually under control, so that the insecticide aerial treatment could be considered as the main source of possible differences with a water sprayed control.

In these conditions we can conclude as follows :

1) No mortality was observed in the field and in its surroundings after an aerial spray with deltamethrin at a dosage rate of 5 g/ha a.i..

2) Absence of residue of deltamethrin in the pollen.

3) The levels of residues found in dead bees were much lower than the contact LD 50, and therefore, deltamethrin cannot be considered as responsible for the death of these bees when sprayed at 5 g/ha a.i. by aerial means in these conditions.

4) Eventually the activity of the hives or their production and the development, the reproduction and the health of the colonies were not found to be affected by these aerial sprays of deltamethrin either in the short or in the long term.

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