A clinical case of honey bee intoxication after using coumaphos strips against *Varroa destructor*

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The mite *Varroa destructor*, a parasite of honey bees (*Apis mellifera* L.) can attack both adult bees and brood, and beekeepers are frequently compelled to use acaricides to avoid colony death. Acaricides should be minimally harmful to the bees, whilst maintaining toxicity to mites.

In the summer 2010, a commercial beekeeper in the Gorenjska region, Slovenia, with approximately 60 National back load hives at one apiary populated with *A. m. carnica* colonies claimed problems four hours after the insertion of coumaphos strips (CheckMite+; Bayer). Each colony treated with coumaphos had ten National Standard AŽ frames, an average of 7 (± 2) with sealed brood, larvae and eggs in the brood chamber and the same number of combs with capped honey stores were in the upper compartment. Compartments were separated using a queen excluder. Each colony had approximately 55,000 bees and all colonies were queen right. Colonies in this apiary had never been treated with coumaphos before. The previous control against *V. destructor* had been performed by trickling 2.9% (w/w) oxalic acid in sugar solution in the previous autumn. Two coumaphos strips were inserted between two brood frames in each colony. The treatment was performed around noon on 2 August 2010 with an outside temperature of 29°C. The flight activity was normal at that time. The colonies were left untouched for four hours after the coumaphos treatment, when the beekeeper observed abnormal worker bee behaviour. Bees started to leave the hives, fly extensively around them, cluster on the front hive wall, and drop down in the grass in front of the hives. Workers also gathered into small clusters with 10 to 40 bees, and were dying around the treated hives with extended wings, and curved, shortened and tremoring abdomens. Bees were also clustered on the back side of the hives, on the hive entrance, and the inside walls. Brood combs were not adequately covered by workers and dead workers were found on the hive bottom board (Fig. 1.). Dead workers were collected from the hive bottom boards, a second sample of live workers was collected from the honey combs from the upper hive compartments and a third group of workers was collected whilst crawling on the grass in front of the hives. A fourth sample of workers was collected from the neighbouring untreated colonies. Each sample contained approx. 500 workers and was put in to 1 l plastic bags, and immediately frozen at -20°C. Chemical analyses were performed in the Central Laboratory of the Agricultural Institute of Slovenia. Sampled workers were prepared for GC analyses (Martel and Zeggane, 2002). Quantification of coumaphos was conducted using Gas Chromatography - Electron Capture Detection (GC-ECD). The limit of quantification (LOQ) was 30 ppb.

Quantities of coumaphos in workers sampled from the brood chambers, honey compartments, and in front of the hives were 1,771; 606 and 514 µg/kg respectively. Workers from honey compartments from untreated colonies were coumaphos negative. The treated colony populations were reduced by approximately one third of their previous adult bee population. Two months after the coumaphos application, however, colony development in the treated hives was normal, and the worker population in the brood chambers was comparable to the untreated colonies.

Fig. 1. Dead bees on floor of colony below combs.
Sub-lethal doses of acaricides applied to bees in a colony can also induce elevated cell death in the larval midgut, salivary glands of larvae and hypopharyngeal glands of adult bees (Smodiš Škerl and Gregorc, 2010). Queens chronically exposed to 100 mg/kg coumaphos incorporated in the wax failed to develop (Collins et al., 2004). The mean concentration of coumaphos residues in honey bee samples collected in 120 French hives maintained under field conditions was 1,545.6 ppb, but there was no direct relationship between detected residue levels in bees and other matrices and colony mortality (Chauzat et al., 2009). The low toxicity to bees of coumaphos in Perizin was established by the manufacturer (Bayer) (LD$_{50}$: 14.39 µg/bee; 143.9 ppm) (Klochko et al., 1994). Bees generally have lower pesticide residues than pollen (Chauzat et al., 2009) and potential residues in bees may thus be indicator for exposure to high pesticide concentrations in food or comb sources. Coumaphos in the quantities detected in workers in our samples seems therefore to initiate a stress induced response in the treated colonies. Hives stacked in a traditional pavilion style, together with other potential factors such as high ambient temperature and potential secondary pathogens induced stresses can interact to cause sudden worker mortality in CheckMite+ treated colonies. No single factor is likely to have been responsible for the observed abnormal worker behaviour and mortality. A pesticide dose given to the National Standard hives in these conditions can induce acute toxic effects in individual bees and consequently reduce colony populations. Acaricide treatment in closely placed bee hives with strong colonies should therefore be performed with great caution and also considered as a potential source of acute toxicity. The involvement of coumaphos strips has to be further investigated in order to minimize the potential negative effects to colonies in future.

References


