

Assessment of Chronic Sublethal Effects of Imidacloprid on Honey Bee Colony Health

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Abstract

Here we present results of a three-year study to determine the fate of imidacloprid residues in hive matrices and to assess chronic sublethal effects on whole honey bee colonies fed supplemental pollen diet containing imidacloprid at 5, 20 and 100 $\mu\text{g}/\text{kg}$ over multiple brood cycles. Various endpoints of colony performance and foraging behavior were measured during and after exposure, including winter survival. Imidacloprid residues became diluted or non-detectable within colonies due to the processing of beebread and honey and the rapid metabolism of the chemical. Imidacloprid exposure doses up to 100 $\mu\text{g}/\text{kg}$ had no significant effects on foraging activity or other colony performance indicators during and shortly after exposure. Diseases and pest species did not affect colony health but infestations of *Varroa* mites were significantly higher in exposed colonies. Honey stores indicated that exposed colonies may have avoided the contaminated food. Imidacloprid dose effects was delayed later in the summer, when colonies exposed to 20 and 100 $\mu\text{g}/\text{kg}$ experienced higher rates of queen failure and broodless periods, which led to weaker colonies going into the winter. Pooled over two years, winter survival of colonies averaged 85.7, 72.4, 61.2 and 59.2% in the control, 5, 20 and 100 $\mu\text{g}/\text{kg}$ treatment groups, respectively. Analysis of colony survival data showed a significant dose effect, and all contrast tests comparing survival between control and treatment groups were significant, except for colonies exposed to 5 $\mu\text{g}/\text{kg}$. Given the weight of evidence, chronic exposure to imidacloprid at the higher range of field doses (20 to 100 $\mu\text{g}/\text{kg}$) in pollen of certain treated crops could cause negative impacts on honey bee colony health and reduced overwintering success, but the most likely encountered high range of field doses relevant for seed-treated crops (5 $\mu\text{g}/\text{kg}$) had negligible effects on colony health and are unlikely a sole cause of colony declines.

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