Interactions of different pesticides and N. ceranae infection in the honey bee Apis mellifera



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A CLINE

INTRODUCTION

Worldwide, bees face many threats including pesticides and pathogens which are considered two of the main factors in bee decline (1). Nosema ceranae is a widespread pathogen in Apis mellifera that causes lifespan shortening, increased energy stress (2) and immunosuppression (3). In addition, several studies have found that the combination of *N. ceranae* infection with certain pesticides is particularly harmful, increasing the prevalence and virulence of the parasite (4, 5).

OBJECTIVES

To analyse the effect and interactions of three common pesticides with *N. ceranae* on the physiology of *A. mellifera iberiensis*. The hypotheses to be tested are:

- 1) *N. ceranae* increases honey bee food consumption leading to increased pesticide intake
- 2) Pesticides impair the immune response of honey bee against *N. ceranae* by increasing its level of infection
- 3) Intake of several pesticides overwhelms the detoxification system and causes a synergistic effect on worker mortality

MATERIALS AND METHODS

Seven days-old workers were placed in microcolonies and exposed to combinations of azoxystrobin (A, 0.2 mg/kg), sulfoxaflor (S, 0.01 mg/kg), glyphosate (G, 5 mg/kg) and *N. ceranae* (100 000 spores) for 14 days. Exposure to pesticides was chronic with minimum field-realistic concentrations. Sugar water consumption and mortality were recorded daily and spores counted at the end of the experiment. Effects of every pesticide with *N. ceranae* were analysed independently.

RESULTS & DISCUSSION



Fig. 1. Boxplot of immune and detoxification gene expression in workers exposed to sulfoxaflor and infected with *N. ceranae*. Control: pesticide control; S: sulfoxaflor.

Fig. 2. Sugar-water consumption in workers exposed to different combinations of pesticides and *N. ceranae.* Control: pesticide control, Ac: acetone control, A: azoxystrobin, G: glyphosate, S: sulfoxaflor, AGS: azoxystrobin + glyphosate + sulfoxaflor N: *N. ceranae.*

Fig. 3. Survival in workers exposed to different combinations of pesticides and *N. ceranae.* Control: pesticide control, Ac: acetone, A: azoxystrobin, G: glyphosate, S: sulfoxaflor, AGS: azoxystrobin + glyphosate + sulfoxaflor, N: N. ceranae.

- N. ceranae infection decreased CYP9Q1 expression and increase sugar-water consumption in workers exposed to sulfoxaflor (Figs. 1, 2). Both interactions might increase the toxicity of the pesticide.
- Only sulfoxaflor significantly decreased worker survival, highlighting the toxicity of this pesticide even at very low concentrations (Fig. 3).
- None of the pesticides altered *N. ceranae* spore load in worker guts
- The lack of interaction effects between N. ceranae and the pesticides on worker mortality could be explained by the low concentrations used and a genotypic resistance of the



colonies to *N. ceranae* in comparison with the virulence observed in other studies.

CONCLUSION

Only sulfoxaflor decreased worker mortality and showed interactions with *N. ceranae* on food intake and gene expression.



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