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PrePub-Article

Lethal and oxidative stress side effects of organic and synthetic pesticides on the insect scale predator *Rhyzobius lophanthae*

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With 3 figures and 2 tables

Abstract: Although pesticides are the most widely used method for the control of agricultural pests, natural insect enemies can successfully suppress pest populations. However, side effects of pesticides can have strongly deleterious impacts on these biocontrol agents. In this context, lethal (mortality over time) and sublethal (oxidative stress) effects of organic and synthetic pesticides (seven of each) on the insect scale predator *Rhyzobius lophanthae* Blaisdell (Coleoptera: Coccinellidae) were evaluated. Adults of *R. lophanthae* were exposed to pesticide residues every seven days over a period of 49 days following pesticide application. Oxidative stress was measured only in the insects surviving the first day of pesticide application. We found that most organic pesticides were harmless, causing less than 30% mortality in *R. lophanthae,* whereas the majority of the tested synthetic pesticides led to 100% mortality, which was persistent over time. Some organic pesticides, however, caused significant oxidative stress in *R. lophanthae*. Overall, the results showed that organic pesticides were less harmful than synthetics, resulting in low mortality over time in *R. lophanthae*, although some may result in sublethal effects in biological control agents. Our findings offer useful insights into general impacts of organic versus synthetic pesticides on beneficial insects, suggesting that they could provide a safer and effective alternative to synthetics for the control of agricultural pests.

Keywords: toxicity, pesticide residues, lipid peroxidation, Coccinellidae, IPM, organic pesticide

1 Introduction

Despite a common perception that organic pesticides are safer and more environmentally friendly than synthetic alternatives, studies comparing lethal and sublethal toxicities have produced widely varying results (Garcia et al. 2009; Bahlai et al. 2010; Echeverri-Molina & Santolamazza-Carbone, 2010; Ndakidemi et al. 2016; El Aalaoui et al. 2019). Of these, some have found that organic pesticides can be as effective or even more effective than synthetic pesticides and less environmentally damaging (Lundgren et al. 2002; Garcia et al. 2009; Echeverri-Molina & Santolamazza-Carbone, 2010; El Aalaoui et al. 2019). In contrast, other studies have shown that organic pesticides are not necessarily safer for non-target insects (Gomiero et al. 2011; Biondi et al. 2012a; Biondi et al. 2013; Puech et al. 2014; Tomé et al. 2015). Bahlai et al. (2010), for example, compared toxicities of two organic pesticides versus two synthetics on aphids as well as their natural enemies, showing that the former were less effective than synthetics in controlling this pest, yet were indistinguishable from synthetics in terms of their deleterious impacts on its natural enemies.

Conventional tests focus mainly on mortality rates as an indicator of pesticide efficacy, but these tests are usually insufficient to formulate a prediction of their overall impact (Stark & Banks 2003), since sub-lethal effects are overlooked (Desneux et al. 2007). It is known that pesticide intoxication produces oxidative stress in insects, thus, the organism reacts and metabolizes the pesticide active ingredient, inducing lipid peroxidation (Hasspieler et al. 1990; Zaman et al. 1995;

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