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Deltamethrin application on colonized olive logs: Effect on the emergence of the olive bark beetle *Phloeotribus scarabaeoides* Bernard 1788 (Coleoptera: Scolytidae) and its associated parasitoids

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Abstract

The olive bark beetle, *Phloeotribus scarabaeoides*, is a pest of olive trees causing severe injuries near inhabited foci. The pyrethroid insecticide, deltamethrin, has been tested at different doses during 3 years in olive logs already colonized by this scolytid, by monitoring the emergence of *P. scarabaeoides* adults and their parasitoids. In 2005 due to unusual low winter temperatures, the insect population was very low, precluding drawing any conclusion. The insecticide doses in 2004 and 2006 affected the emergence of the olive bark beetle, with a reduction ranging from 1% to 13%. The doses of 2006 also controlled the emergence of another olive pest, *Leperisinus varius*. The incidence on the hymenopteran parasitoids was, in general, high at all the tested deltamethrin doses, ranging from 0.0025% to 0.01% active ingredient. The lowest dose employed in 2006, corresponding to 0.00125%, reduced pest emergence without a significant effect on the hymenopteran parasitoids population, except for *Cheiropachus quadrum*.

Keywords: Insect control; Pyrethroid insecticide; Beneficial insects; Hymenoptera

1. Introduction

Two major insect pests affect olive culture, the olive fly (*Bactrocera oleae* (Gmelin 1790)) and the olive moth (*Prays oleae* (Bernard 1788)). Among other so-called minor pests, the olive bark beetle, *Phloeotribus scarabaeoides* Bernard 1788 (Coleoptera: Scolytidae) is acquiring an increasing importance. This scolytid is a species spread in the entire Mediterranean zone, as well as in Syria and Asia Minor (Arambourg, 1984; de Andrés, 1992; Civantos, 1999).

In Spanish olive orchards the olive bark beetle adults overwinter on the living olive trees in which they excavate subcortical feeding galleries. In spring the adults disperse from overwintering sites to reproduce in olive logs coming from the annual pruning (Arambourg, 1984; Campos and Lozano, 1994). In late spring the emerging brood adults disperse from the logs towards the olive trees. The pest damage is mainly produced when the new adults fly to the olive trees to dig feeding galleries. In adult olive groves, the damages can reach up to a 75% of the final crop (González and Campos, 1994), while in young groves the tree survival is sometimes endangered.

The olive bark beetle can also affect olive oil quality (Humanes and Civantos, 1992) as well as induce considerable economic losses in a culture of high socio-economic importance, since it constitutes 11% of the Spanish agricultural surface, representing about 2.44×10^3 ha. In Andalusia, with ca. 60% of the total national production, olive oil in the 2003 campaign accounted for ca. 1.45×10^3 Mg. Similarly, the problem described here is even worse in olive groves in countries from North Africa (Morocco, Tunisia, etc.) where high temperatures favour the existence of multivoltinism (Benazoun, 1992; Lozano et al., 1998).

The control of this pest can be approached with cultural methods such as the advance of pruning, so that the logs lose water content and become unsuitable for insect

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reproduction, logs destruction or their use as a lure and their consequent destruction when the colonization is completed (Civantos, 1998). Olive logs, however, have an economic value as domestic and industrial source of energy and sometimes are stored without care, becoming a focus of pest dispersion and infestation.

Nevertheless, the main control method is the application of insecticides, both to the olive logs and to the living olive trees. In general, organophosphorous insecticides are applied to the olive trees in a band of 200–250 m around the population nuclei (Civantos and Sánchez, 1993; Civantos, 1999). In this sense, the treatment of logs with synthetic insecticides is a better approach than the treatment of trees, since a negligible effect on health or environment would be derived if logs are secluded in an appropriate place. In olive logs the olive bark beetle can be controlled by avoiding the start of reproduction galleries (Peña et al., 1998) or by treating the logs once the galleries have been initiated but before the emergence of brood adults. One of the advantages of the latter strategy is that no repulsion occurs, because the insect pest is already inside them. A repulsion effect has already been reported for various pyrethroid insecticides in the control of different coleopteran (Kohnle et al., 1992; Peña et al., 1998; Rodríguez et al., 2003; Rose et al., 2005). Therefore, the treatment when log colonization is completed, avoiding the repellency from the pyrethroid insecticide, would reduce the spread of *P. scarabaeoides* to other non-protected logs.

Pyrethroid insecticides, such as deltamethrin, are being applied for the control of the antophagous generation of the olive moth, *P. oleae* and the olive fly, *B. oleae.* According to Metcalf (1994) conservation of natural enemies could be attained when applying more selective pesticides, less toxic to natural enemies, with lower residual activity and in minimal doses. Hence, the use of deltamethrin at low doses, even lower than those recommended, may be sufficient to control the insect pest and at the same time have less impact on beneficial insects (Longley and Jepson, 1997). Finally, the use of experimental conditions as similar as possible to the field provides a useful tool to approach more natural conditions (Rodríguez et al., 2003; Santos et al., 2007). Bioassays in the laboratory generally represent a worst-case situation, in which insects are confined without the possibility of escaping, which is definitely the opposite to field scenarios (Longley and Jepson, 1997). Incorporation of more realistic features into laboratory and semi-field tests will certainly increase the realism of risk prediction for parasitoid population in the field.

The aim of this paper is to study the effect of reducing deltamethrin concentration for the control of the olive bark beetle, monitoring at the same time the impact on the parasitoids associated with the scolytid. The experiments were carried out on olive logs once colonization was complete, to avoid the repellent effect demonstrated by some pyrethroid insecticides.

2. Material and methods

2.1. Treatment of the olive logs

The log treatments were carried out for 3 years (2004–2006). The logs were sprayed to runoff with a formulation containing deltamethrin at 2.5% as an emulsifiable concentrate (EC) (Decis, Bayer CropScience). Each year an experimental design was independently carried out. Each experiment consisted in four different insecticide concentrations applied to an experimental unit (five olive logs) with four replicates.

Treatments were applied when the emergence of *P. scarabaeoides* from olive logs was first detected in the field. In 2004, the logs were treated on the 24th of June, in 2005, on the 20th of June and in 2006, due to the higher temperatures, the treatment was shifted to the 2nd of June. Table 1 shows the doses employed through the years.

Olive logs colonized by *P. scarabaeoides* with similar attack levels were collected in different log piles placed in the vicinity of Granada (southern Spain). Before the treatment, the logs were taken to the laboratory and numbered. Reproduction galleries were counted and the surface of the logs was calculated by measuring their length and diameter and considering them as a cylinder. No statistical differences were found ($P > 0.05$) among the number of initial galleries or among the surface of the olive logs neither for any of the years nor for the different treatments (Table 2).

Logs corresponding to a single insecticide concentration, i.e. a treatment, were placed at random in PVC tubes, closed at one of its ends and the other one connected, through a plastic funnel, to a transparent plastic vial. Emerging insects, i.e., olive bark beetles, parasitoids and predators, moved by phototaxis to the plastic vials, where they were periodically collected. The insects were counted and conserved in Eppendorf vials with alcohol until their identification was finished.

To verify what stages of *P. scarabaeoides* were primarily affected by the insecticide, the logs were inspected at the end of the experiment. The bark was separated with a knife, the number of the holes corresponding to emerged beetles was counted, as well as the non-emerged individuals which had died before emergence.

2.2. Insecticide analysis

Each year and once the experiment was over, about 4 months after the treatment had elapsed, samples from the

Table 1
Deltamethrin dosages (% a.i.) employed along the different years

	Control	LD[a]	MD[a]	HD[a]
2004	Water	0.0025	0.005	0.01
2005	Water	0.0006	0.00125	0.0025
2006	Water	0.00125	0.0025	0.005

[a]LD: low dosage; MD: medium dosage; HD: high dosage.