

ACTIVITY OF DELTAMETHRIN ON DIFFERENT SURFACES AGAINST *PLODIA INTERPUNCTELLA* LARVAE (LEPIDOPTERA PYRALIDAE)

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Abstract The knockdown activity after 1, 24 and 48 hr and mortality after 24 and 48 hr against 4th instar larvae (female, male) of *Plodia interpunctella*, were evaluated on glass, ceramic tile and porous tile. Groups of 20 larvae were placed for 5 or 15 minutes in an artificially lighted environment at 25±2°C and 60±10% RH. Tests were carried out 24 hr after the treatment. Five replicates were carried out for each test as well as for the control. The highest mean percentages of the knockdown activity were observed, for both sexes, after 1 hr from the contact with the different surfaces. After 15 minutes the highest mean percentage of mortality was observed in female larvae rather than in male (glass: 23% female, 20% male; ceramic tile: 16% female, 10% male).

Key words Indian meal moth, pyrethroids, exposure time

INTRODUCTION

Confectionary industry presents food surfaces and environmental conditions that favour the development and the settling of Lepidoptera *Pyralidae* (Williams, 1964; Cox and Bell, 1991; Meaney, 1998; Lepri et al., 1998; Süß et al., 1999; Trematerra, 2003). In particular during the cooling process the intense flavours of food can attract the females, present in the environments, which can lay eggs on the product not yet packed. Consequently the most severe methods of prevention and monitoring have to be adopted in the industry. Sometimes insecticidal treatments are carried out in stores and production departments on machinery and walls as larvae, in particular 4th instar larvae of *Plodia interpunctella* and *Cadra* spp., tend to move looking for refuges where pupate. These surfaces are usually treated with photo-stable pyrethroids that have a good residual activity.

In most of tests reported in literature, contact periods, during which the insect is obliged to stay on the surfaces treated with pyrethroids, generally last some hours (Subramanyan and Cutkomp, 1987; Bengston et al., 1987; Arthur, 1997a, 1997b, 1999; Perez-Mendoza and Aguilera-Peña, 2004) but in industry, the exposure time is shorter. In fact many of these active ingredients show repellent activity and the insects tend to move from the treated surfaces. Moreover, because of the knockdown activity, larvae and adults can fall down from walls and ceilings in untreated areas; individuals, not enough intoxicated, can survive and, sometimes, reproduce, increasing the risk of resistance.

In this work the efficacy, for short contact periods, of deltamethrin distributed on surfaces commonly used in food industries against 4th instar larvae of *P. interpunctella* was tested.

MATERIAL AND METHODS

Insects

Plodia interpunctella was reared on an artificial diet (Locatelli and Limonta, 2004) in a thermostatic room (26±1°C; 70±5% RH; L:D 16:8.) at Istituto di Entomologia

agraria - Università degli Studi di Milano, Italy. Tests were carried out on 4th instar larvae (male: 14.8±1.2 mg; length: 9.08±0.46 mm - female: 19.7±1.8 mg; length: 9.90±0.58 mm). Larvae were tested after 14-15 days after egg laying.

Insecticide and Surfaces

Tests were carried out on different types of surface: glass (dia 10 cm), ceramic tile (side: 20 cm), porous tile (side: 20 cm). Concentrated emulsifiable formulations (100 g solution/m²) based on deltamethrin (15 mg a.i./m²) were distributed on the surfaces from a distance of 30 cm. Deltamethrin is photo-stable pyrethroid, non-systemic insecticide with contact and stomach action. Tests were carried out 24 hr after the treatment at 23±2°C and 30±5% RH under a fume hood.

Tests were carried out 24 hours after the treatment by placing on different surfaces for 5 and 15 min in an artificially enlightened environment (25±2°C and 60±10% r.h.) groups of 20 4th instar larvae (males and females), after being anesthetized with CO₂ insufflated for 30 seconds. The area occupied by larvae was delimited by a polypropylene cylinder with an open base (dia 6 cm; h: 8 cm) and with the top closed with a net (120 mesh).

Evaluation

At the end of the tests individuals were placed in a polypropylene cylinder (dia. 6 cm; h: 8 cm), with 1 g of artificial diet, and then transferred to a thermostatic room (25±1°C; 70±5% RH; L:D 16:8). Knockdown activity after 1, 24 and 48 hr and mortality after 24 and 48 hr against larvae were evaluated. Individuals were counted with a stereoscopic microscope. Individuals which showed signs of intoxication, such as uncoordinated movements or difficulty to move, were considered knocked down. The ones which, touched with a paint brush, did not show contraction of abdominal legs, abdomen or head were considered dead (Lloyd and Hewlett, 1959).

Data Analysis

Five replicates were carried out for each test as well as for the control. Mean percentages were arc-sen transformed, then subjected to ANOVA and to Duncan's multiple range test (P<0.05) (SPSS 13.0 for Windows).

RESULTS

In the control more than 95% of untreated 4th instar larvae of *Plodia interpunctella* survived. Mean percentages of knockdown activity and mortality of 4th female and male larvae, on the 3 different surfaces, are reported in Figures 1-2. The highest mean percentages of the knockdown activity were observed, for both sexes, after 1 hour from the contact with the different surfaces for 5 and 15 minutes. After 48 hr the mean percentage of knockdown activity observed on female and male larvae, with an exposure time to the a.i. of 5 minutes, was respectively of 50 (female) and 37 (male) on glass, of 38 (female) and 24 (male) on ceramic tile, while it was of 25 (female) and 16 (male) on porous tile.

With the longest contact period (15 minutes) the mean percentage of knockdown activity observed on glass was 90 (female) and 85 (male), on ceramic tile was 94 (female) and 96 (male), while on porous tile was 88 (female) and 51 (male). A mean percentage of mortality lower respectively than 22% and 14% was observed for both sexes, on glass and ceramic tile, after 48 hr from the contact with the treated surfaces for an exposure time of 15 minutes; on the contrary the mean percentage of mortality was lower than 15% on porous tile.

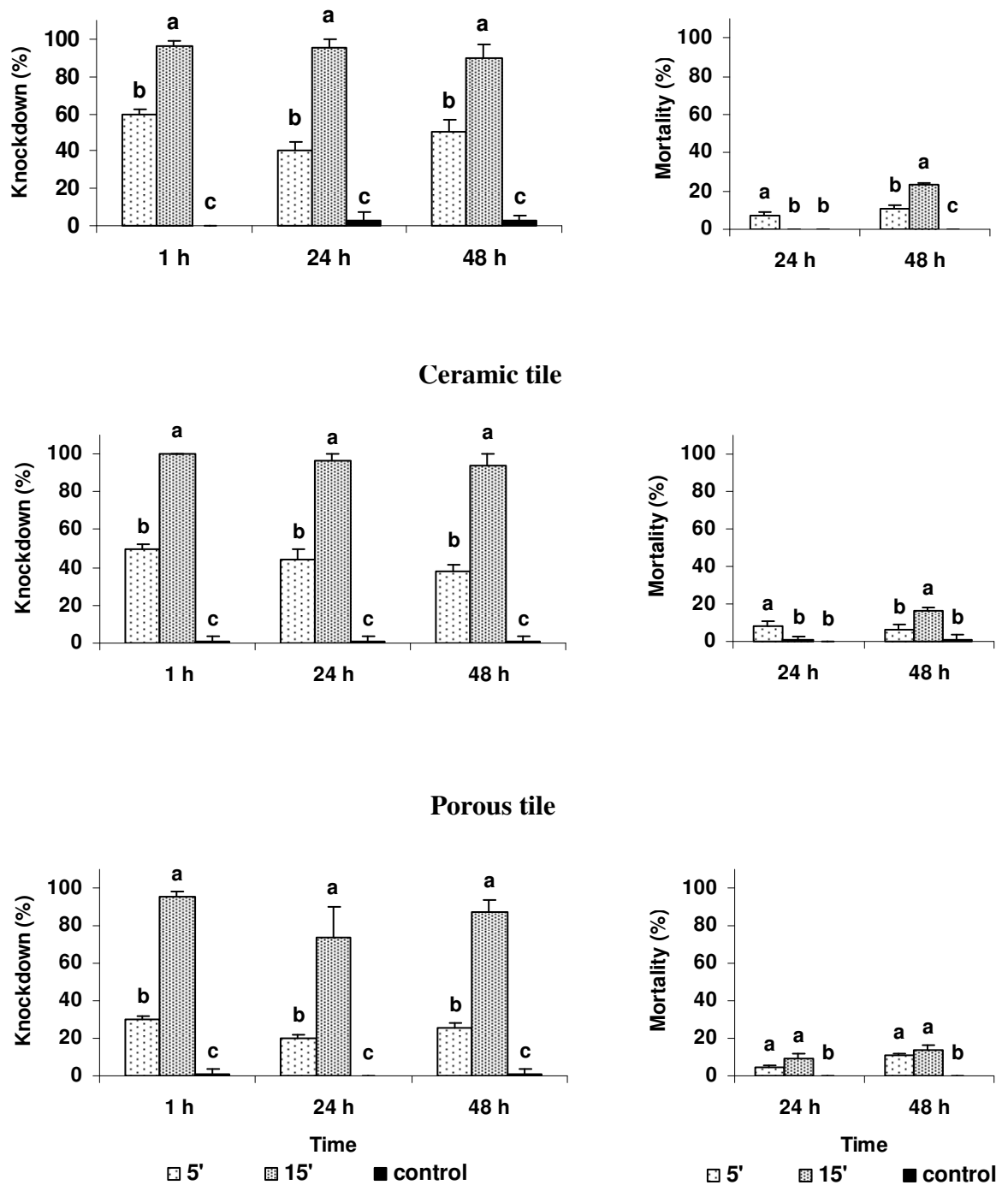


Figure 1. Mean percentages of knockdown (\pm S.E.) and mortality (\pm S.E.), observed after 1, 24 and 48 hours, on 4th instar larvae (♀♀) of *Plodia interpunctella* placed, for 5 or 15 minutes of contact, on different surfaces treated with deltamethrin. The same letters shown homogeneous subsets for a confidence interval of 95% (Duncan's multiple range test; $P < 0.05$).

*The same letters shown homogeneous subsets for a confidence interval of 95% (Duncan's multiple range test; $P < 0.05$).

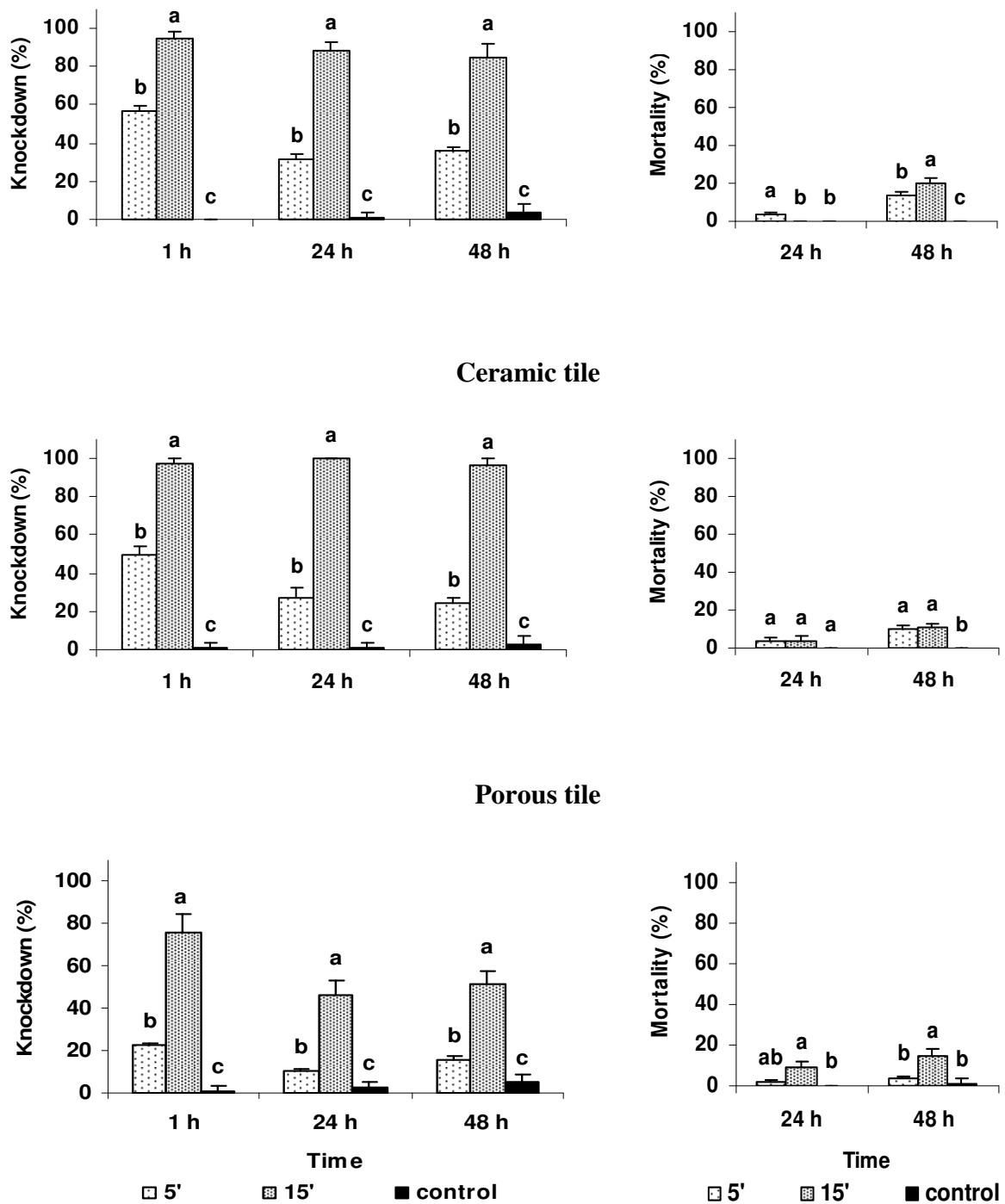


Figure 2. Mean percentages of knockdown (\pm S.E.) and mortality (\pm S.E.), observed after 1, 24 and 48 hours, on 4th instar larvae ($\sigma\sigma$) of *Plodia interpunctella* placed, for 5 or 15 minutes of contact, on different surfaces treated with deltamethrin. The same letters shown homogeneous subsets for a confidence interval of 95% (Duncan's multiple range test; $P < 0.05$).

*The same letters shown homogeneous subsets for a confidence interval of 95% (Duncan's multiple range test; $P < 0.05$).

CONCLUSIONS

Most of 4th instar larvae of *Plodia interpunctella* survived after 24-48 hours with an exposure of 5 or 15 minutes on ceramic tile or porous tile, treated with deltamethrin at a concentration of 15 mg a.i./m². After 48 hr from the contact, for an exposure time of 15 minutes with the different surfaces treated with deltamethrin, the mean percentage of knockdown observed was between 50-96 for both sexes; the mean percentage of mortality was lower than 16%. The contact periods used in these tests didn't allow the larvae to absorb enough pesticide to cause the death of all the individuals. Some of the knocked individuals, in fact, were able to recover afterwards, thanks to oxidase and esterase, which can inactivate the active ingredient (Yamamoto, 1970; Elliott et al., 1978; Chadwick, 1985).

Similar results were observed on 3rd instar larvae of *P. interpunctella* placed on different surfaces treated with deltamethrin for 5 minutes (Locatelli et. al, 2006). As observed by Arthur (1997b) "when *P. interpunctella* increase in age and size, they may become less susceptible to insecticides, and concentrations that would kill early instars may not be effective against the wandering phase fifth instars". It was observed in a previous work that, for a contact period of 5 minutes, on surfaces treated with deltamethrin at the same concentration of the one used in these tests, the mean percentage of emerging, recorded on larvae survived to the treatment, varied from 60 to 85, according to the surface (Locatelli et al., 2006).

On porous surfaces such as concrete, a loss of activity of the active ingredient was more rapid compared to not absorbent surfaces such as ceramic. Moreover, the porous surfaces are sometimes characterized by an alkaline pH which favours a rapid degradation of insecticide molecule. Similar observations were made also on active ingredient belonging to the group of organophosphate (Burkholder and Dicke, 1966) and of carbamate (Williams et al., 1982). Undoubtedly it would be better to underline in label the necessity of increasing the concentration of the active ingredient when the treatment is carried out on absorbent surfaces. This indication is not always reported by producers of pesticides in the direction for use.

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