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Note

Control of *Musca domestica* L. adults with pyrethroid treatments applied to glass and wallpaper

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Cypermethrin (CP), cypermethrin+trans-tetramethrin (CT), prallethrin (PR) and diazinon (DI) were applied to wallpaper or glass to evaluate the control of adult houseflies of up to 60 days; immediate mortality from direct spraying and dry residues was also determined. Mortality from fresh residues was greater on glass for all pyrethroids. CP was toxic by direct spraying, but its effect on glass was brief. Adding trans-tetramethrin extended CP activity up to 60 days (mortality >77%). Negligible activity on wallpaper was probably due to insecticide absorption. PR and DI had little effect on wallpaper. The results recommend CT applied to glass windows to achieve extended control.

Keywords: housefly control, cypermethrin, diazinon, *Musca domestica*, prallethrin, trans-tetramethrin.

The housefly, *Musca domestica* L. (Diptera: Muscidae), is a cosmopolitan pest that affects the quality of life of people by invading homes, particularly in areas near livestock.[1-3] Indoors, insecticide use against houseflies is restricted to chemicals with a low effect on humans and pets. Pyrethroids are a logical choice as they are broad-spectrum pesticides with minor toxicity to mammals; however, there have been many reports of the development of resistance to pyrethroids and other insecticide groups by houseflies.[4–7] Thus, there is a need to develop methods for housefly control indoors, including new pyrethroids. The objective of this study was to evaluate the efficacy of four commercial insecticides in Chile, Cyperkill Plus (cypermethrin 25%, CP), Cyperkill 25 EC (a 5 : 3 mixture of cypermethrin 25% and trans-tetramethrin 15%, CT), Anasect 2.5 EC (prallethrin 2,5%, PR), and Greenline conchuelas (diazinon 50%, DI) (ANASAC, Chile) on adult houseflies, and to determine immediate mortality from direct spraying and dry residues on two surfaces, wallpaper and glass, as well as residual action up to 60 days after application.

1. Short-term effect of residues

Adult house flies were collected in several locations of the Metropolitan Region of central Chile to start a colony, as in Khalequzzaman *et al*.[8] Flies were collected from small farms without any insecticide management; thus, they had not been exposed and were reared for three generations before using them for the study. Insecticides were diluted in water at the maximum dosages recommended on the labels (30, 30, 50, and 60 mL commercial products in 5 L water, for CP, CT, PR, and DI, respectively), and were sprayed with an ST-4 Potter Tower (2 mL solution each time) onto both the lid and bottom of Petri dishes lined with or without vinyl-coated wallpaper. The treated dishes were kept at 25°C and under a 14 : 10 light:dark regime. Prior to exposure, the caged flies were anesthetized with chloroform in a cotton wick for 5–10 min. Then, groups of 30 flies were placed in untreated and covered Petri dishes for 24 h with sugar water embedded in a cotton wick to allow them to recover, or to remove them if they seemed affected. They were then exposed to 0°C for 6 min and transferred to the treated dishes. Flies were always handled in covered dishes to prevent them from escaping. Earlier observations had shown that this short exposure to cold had no adverse effects on adult houseflies. All experiments had 4 replicates of 25–30 individuals per treatment. Results of mortality were transformed by arcsin√% and then subjected to ANOVA; significant differences were identified ($P<0.05$) using Tukey's test.

CT achieved >97% mortality, significantly greater than the other insecticides evaluated over time up to 60 minutes (Table 1a); however, CP alone had maximum mortality close to 25% at 5 min after exposure, which was subsequently even lower. PR and DI always achieved <14% mortality at the three evaluation times. CP alone, PR, and DI had no significantly different mortality among them and also with the control at both 30 and 60 min evaluation times (only CP alone was different from PR and DA at 5 minutes). When comparing mortality within evaluation times, no significant differences were found for any insecticide.

On both surfaces, CT achieved mortality greater than 96% within the first hour after exposure, significantly better than the other treatments (Table 1b). When comparing the mortality from fresh residues applied to wallpaper and glass, results were greater on glass for all pyrethroids.

2. Residual contact action

To evaluate the effect of insecticide treatments over a longer period of time, the flies were treated as indicated and were exposed to 1-day-old residues. CT on glass had a highly lethal effect 60 days after spraying, with >77% mortality (Table 2). Among the other insecticide treatments, only CP applied to glass was different from the untreated control at day 1. PR and DI were not different from the control on both surfaces during the whole study. Only CT treatment on glass caused significant mortality, with

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Table 1. Mortality of *M. domestica* adults exposed to dry residues of insecticides at 5, 30, and 60 min after exposure (a) and on two surfaces within the first hour after exposure (b)[a)]

Treatments	Mortality (%)				
	5 min	30 min	60 min	Wallpaper	Glass
	a) from both surfaces			b) from 5, 30, and 60 min	
Cypermethrin+trans-tetramethrin, CT	100 cA	98.1bA	97.6bA	96.2cB	100 dA
Cypermethrin, CP	24.9bA	19.3aA	13.3aA	7.7bB	33.6cA
Prallethrin, PR	7.40aA	7.4aA	10.2aA	0.1aB	27.4cA
Diazinon, DI	8.50aA	11.8aA	13.7aA	7.9bA	15.1bA
Control	0.25aA	7.1aB	7.4aB	3.9bA	3.9aA

[a)] Different small letters in a column indicate significant differences between treatments, and different capital letters in rows indicate significant differences between a) evaluation time periods ($F=2.31$; $P=0.026$; $SD=3.35$), and b) between surfaces evaluated ($F=8.86$; $P<0.001$; $SD=2.73$).

residues acting for a maximum of 60 days, while mortality on wallpaper was negligible after day one.

3. Direct insecticide spray effect

To evaluate this effect, the flies were anesthetized with chloroform, subduing them while spraying with 0.5 mL solution in the Potter tower. The flies were then transferred to a clean Petri dish. Mortality was evaluated 30 and 60 min after application (Table 3). Mortality levels by CT and CP alone were almost total with no significant differences between them. PR and DI had poor results and mortality did not increase over time, with levels similar to the control at both evaluation times. By ANOVA, the treatment factor showed significant differences that did not occur with the time factor, or for the treatment×time interaction.

CP is a stomach and contact insecticide, used widely in public health and animal husbandry. Our results clearly demonstrate the importance of contact exposure. Despite its rapid degradation, CP is used to impregnate mosquito bed nets to prevent malaria, and extensively against indoor pests.[9] Our results showed long-lasting activity (particularly on glass) only when used with trans-tetramethrin (t–t onwards), suggesting a possible degree of synergism. We have found no information on the persistence of CP and/or t–t residues on either glass or wallpaper. Tetramethrin is used in aerosol formulations, emulsifiable concentrates, and mosquito coils for indoor pest control.[10] Our results clearly support the use of t–t in combination with CP to improve the performance of the mixture significantly. Further studies should evaluate t–t alone against houseflies. PR, a relatively recent type I

Table 2. Mortality of adults of *M. domestica* exposed to 1-, 10-, 20-, 30-, 40-, 50-, and 60-day-old insecticide residues on glass (G) Petri dishes or lined with vinyl wallpaper (P)[a)]

Treatments	Mortality (%) from insecticide residues of the indicated age (days)									
	1		10		20		30	40	50	60
	P	G	P	G	P	G	G[b)]	G[b)]	G[b)]	G[b)]
Cypermet.+trans-tetramethrin, CT	4.9aA	99.8cB	2.9aA	98.2bB	2.7abA	77.5bB	93.4b	99.8b	86.0b	88.3b
Cypermethrin, CP	0.8aA	16.2bB	0.0aA	7.2aB	2.1abA	5.7aA	1.9a	—	—	—
Prallethrin, PR	0.0aA	1.9aA	0.0aA	1.1aA	6.8aA	0.5aA	—	—	—	—
Diazinon, DI	0.4aA	3.1aA	0.2aA	0.2aA	0.0bA	1.9aA	—	—	—	—
Control	0.2aA	0.2aA	0.2aA	0.2aA	1.2abA	1.2aA	0.0a	10.5a	0.0a	0.0a
SD	3.3		3.2		4.4		7.4	5.1	7.7	5.0
F	42.0		34.0		15.3		123	360	158	392
P	<0.001		<0.001		<0.001		<0.001	<0.001	<0.001	<0.001

[a)] Different small letters in a column indicate differences between treatments, and different capital letters in rows indicate significant differences between surfaces evaluated, within each evaluation period. [b)] One-way ANOVA.

Table 3. Mortality of adult *M. domestica* from direct insecticide spray after 30 and 60 min exposure[a)]

Treatments	Mortality (%)	
	30 min	60 min
Cypermethrin+trans-tetramethrin, CT	100aA	99.8aA
Cypermethrin, CP	100aA	100aA
Prallethrin, PR	9.4bA	9.4bA
Diazinon, DI	11.4bA	17.5bA
Control	8.1bA	7.8bA

[a)] Different small letters in a column indicate significant differences between treatments, and different capital letters in rows indicate significant differences between exposure time periods ($F=177$; $P<0.001$; SD=2.9).

pyrethroid mosquito repellent,[11)] has fast knock-down activity against household insects, and is used in insecticide products against indoor pests;[12,13)] however, our results do not support the use of this insecticide alone against houseflies indoors on wallpaper or glass, although PR has been found to be active against Culicidae.[14)] It is unclear if its reduced activity is related to the dosage used, short residual activity, resistance, or other unknown effects. DI is a broad-spectrum organophosphate insecticide that has been used against home pests. It was used here as a standard treatment given the information available, but we observed very poor activity on adult houseflies. As with PR, the reasons for this reduced activity are unknown, although resistance of houseflies to DI has been reported.[15)] When designing pest control strategies, it must be considered that the effectiveness of an insecticide is influenced not only by its toxicity but also by the response of the insect to its mode of application.[16)] Our results demonstrate that spraying glasses is a way to extend the activity of some insecticides against houseflies, so it is advisable to recommend treatments on indoor windows instead of wallpaper to improve their performance. Wallpapers are made of a continuous, lightweight flexible vinyl film applied to a paper (or cloth) backing. Based on our results, wallpaper had reduced insecticide activity compared to glass; it is possible that the vinyl cover results in insecticide absorption.[17,18)] In fact, the surface under the wallpaper looked wet after spraying, but not the outside. This might limit direct contact between the flies and insecticide residues on wallpaper, which in turn may explain the reduced mortality when insecticides were applied to this surface. On the other hand, residues on glass are not absorbed and remain there longer after water evaporation (at least up to 60 days herein), and act on adult flies by direct contact.

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