

## Susceptibility of *Haematobia irritans* (Diptera: Muscidae) to Permethrin in Dairies in Aguascalientes, Mexico

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**ABSTRACT** The purpose of this study was to conduct a survey for the susceptibility of the horn fly, *Haematobia irritans* (L.), populations to permethrin on dairy cattle from Aguascalientes, Mexico. Samples of populations of horn flies at 25 dairies were exposed to two discriminating doses (2.5 and 6.0  $\mu\text{g}/\text{cm}^2$ ) on permethrin-treated filter papers and the percentage of mortality was compared with that of a susceptible strain treated with same doses of permethrin. The results show that there was a difference in the mortality from two discriminating doses and the mortality of the susceptible strain. Therefore, horn fly populations at all dairies tested in Aguascalientes, Mexico, were susceptible to permethrin. This insecticide, as well as other pyrethroids, could continue to be used to provide satisfactory control of horn flies in the study region.

**KEY WORDS** *Haematobia irritans*, pyrethroid susceptibility, dairy herd, Mexico

THE HORN FLY, *Haematobia irritans* (L.), is an important bloodsucking pest of cattle and is widely distributed in cattle-producing areas throughout North and Latin America (Foil and Hogsette 1994, Guglielmo et al. 1997). Horn fly control is based primarily on the use of insecticides to treat fly-infested cattle. Insecticide resistance to pyrethroids has been reported from several regions of the world, including the United States, Canada, Mexico, and Argentina (Kunz and Kemp 1994, Guglielmo et al. 1998) and is a major hindrance to efforts to limit the adverse economic impact of these ectoparasites on cattle production.

Horn fly populations in northeastern Mexico have been reported to be resistant to pyrethroids and have also been identified in other regions south along the Gulf of Mexico and west to the Pacific coast (Kunz et al. 1995, Santamaría et al. 1995). The State of Aguascalientes in north central Mexico is an important milk production center with the majority of dairies concentrated in four counties, where there are  $\approx 36,800$  cows in 210 dairies. The horn fly is widely distributed in the region and is an important pest. The confinement conditions and manure management system in the dairies could be suitable for development of this parasite, but flies also breed on cattle and in manure in pastures adjacent to the dairies and migrate to the dairy cows (Cruz-Vázquez et al. 1999). In attempts to

control flies on cattle, farmers depend on the intensive use of 5% permethrin applied as a pour-on at a dosage of 50 ml per cow at  $\approx 80\%$  of the dairies, or it is sprayed in pour-on solution, although that method of application is not recommended by the drug company. At  $\approx 20\%$  of dairies it is applied at a dosage of 40 ml per cow using a back-pack hand-pump sprayer. Intervals between applications are generally 15–20 d with applications beginning in early June and ending in late September or early October. There are general four to 12 treatments per season, depending on the abundance of flies and the owner's perception of when cows need treatment. Permethrin has been used in this region for  $>12$  yr, but during the past 6 yr it has been used more intensively; and some milk producers have reported control failures. It is important to note that this region is free of *Boophilus* ticks, therefore permethrin has only been used to control biting flies.

This study was conducted to assess the degree of susceptibility to permethrin of horn fly populations on dairy cattle in Aguascalientes, Mexico.

### Materials and Methods

Twenty-five dairies in Aguascalientes that had a history of making 10–12 applications of permethrin per year were selected as sites for sampling horn flies and conducting discriminating dose mortality tests. All of the dairies selected for the study maintained their cows in a confinement system referred to as "free confinement in open corrals." This system consisted of pens with a soil floor and shaded area. A cement floor

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**Table 1.** Summary of a dose mortality analysis of an insecticide susceptible *in vitro* colony of horn flies at Kerrville, TX

LC <sub>50</sub>	95% CL	LC <sub>99</sub>	95% CL	Slope	SE	$\chi^2$
2.63	2.30-2.88	5.94	4.85-9.08	6.56	±0.441	77.39

The filter paper assay (Sheppard and Hinkle 1987) was replicated three times.

was located along a feed bunk and water dispenser. Approximately 40-50 Holsteins per corral were confined together in this manner. This allowed each cow  $\approx 45$  m<sup>2</sup> of corral space and 3.7 m<sup>2</sup> of shade.

Horn flies adults were exposed to permethrin treated filter papers (Sheppard and Hinkle 1987) with two discriminating doses of permethrin (2.5  $\mu\text{g}/\text{cm}^2$  and 6.0  $\mu\text{g}/\text{cm}^2$ ) using acetone as the diluent. Discriminating doses represented the LC<sub>50</sub> and LC<sub>99</sub> values from replicated dose-mortality analyses (Table 1) of the insecticide susceptible *in vitro* horn fly colony maintained at the Knipping-Bushland U.S. Livestock Insects Research Laboratory in Kerrville, TX. Treated filter papers (9-cm-diameter Whatman grade 1, Whatman, Hillsboro, OR) were prepared by applying 1 ml of the appropriate concentration of permethrin to each paper, which were then air dried, wrapped in aluminum foil packets, and stored at 4°C until used in tests with no more than 48 h between the preparation of treated papers and testing.

Each dairy was visited during August to October 1999 and horn flies were collected directly from the cows with a sweep net and transferred to a 1-liter holding cage made of clear plastic, as described by Kunz et al. (1995). When the cage contained  $\approx 250$ -300 flies for a test, it was taken immediately to a nearby shaded site where flies were transferred to a plastic petri dish in which a filter paper treated with permethrin had previously been placed. Tests were performed at the collection site throughout the day at ambient temperatures that ranged from 21 to 24°C. Flies were exposed to treated papers within 15-20 min of capture. Unsexed horn flies of mixed ages (20 for each petri dish) were placed into petri dishes according to the criteria of Schmidt et al. (1985). Each treatment consisted of three replicates including a control (filter papers treated with acetone). Mortality was recorded 2 h after horn flies were placed into petri dish. Each treatment was adjusted for nonspecific mortality among the untreated controls using Abbott's formula (1925).

Data were analyzed by one-way analysis of variance and the Student-Newman-Keuls mean separation test at  $P < 0.05$  (Scheffé 1953), using a random design in which there were three treatments (control, 2.5 and 6.0  $\mu\text{g}/\text{cm}^2$ ) with three replicates for each dairy (Steel and Torrie 1988).

## Results and Discussion

Results from this study indicate that horn fly populations at all dairies were susceptible to permethrin. There was a statistically significant difference be-

**Table 2.** Percentage mortality of horn flies exposed to permethrin from 25 dairies in Aguascalientes, Mexico

County/dairy	Control	Dose	
		2.5 $\mu\text{g}/\text{cm}^2$	6.0 $\mu\text{g}/\text{cm}^2$
Aguascalientes			
1	1.6	60	100
2	0	70	100
3	0	65	100
4	0	60	100
5	1.6	65	100
6	0	65	100
Jesús Maria			
1	1.6	60	100
2	0	65	100
3	1.6	60	100
4	0	70	100
5	0	70	100
6	0	65	100
San Francisco			
1	1.6	65	100
2	1.6	70	100
3	0	60	100
4	0	65	100
5	0	65	100
6	0	70	100
7	0	60	100
Pabellon			
1	1.6	65	100
2	0	60	100
3	1.6	65	100
4	0	60	100
5	0	65	100
6	0	70	100
Susceptible strain <sup>a</sup>			
	0	50	100

<sup>a</sup> Mortality recorded in the susceptible laboratory strain of USDA-ARS Insect Research Laboratory, Kerrville, TX.

tween the degree of mortality observed for horn flies treated with the two discriminating doses ( $F = 13,416.87$ ;  $df = 2, 23, 25$ ;  $P = 0.0001$ ). The mean mortality of 64.6% of horn flies exposed to the LC<sub>50</sub> dose of permethrin and of 100% for flies exposed to the LC<sub>99</sub> dose is evidence of the absence of resistance to this chemical in the flies on the dairy cattle (Table 2).

Concerns expressed by milk producers about unsatisfactory results obtained with permethrin treatments could be due to factors such as the application of an inadequate volume or concentration of the product. Because the horn fly infestations on the confined dairy cows resulted mainly from the migration of flies emerging from manure of cattle in pastures adjacent to the dairies, treatments of permethrin applied to the dairy cattle would only impact adult flies on the cattle at the time of treatment and while lethal amounts of residual insecticide remained on the animals. Any female horn flies that survived the exposure to permethrin would probably oviposit in fresh manure dropped by the cows in the corrals where they maintained. With the high concentration of cows in the corrals, any of the manure pats containing eggs and developing horn fly larvae would be unlikely to remain intact long enough for the completion of the development of larvae to pupae. Under these circumstances intensive use of permethrin on dairy cattle would not influence the rate of selection for insecticide resis-

tance in a local horn fly population breeding on pastured cattle.

We conclude that *H. irritans* control should be done on the bases of regional strategic control to reduce the dairy farm infestation from neighbors range cattle farms. The animal health authorities must be aware and employment fly control programs to decrease fly populations.

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