Proceedings of the Fifth International Conference on Urban Pests
Chow-Yang Lee and William H. Robinson (editors), 2005.
Printed by Perniagaan Ph'ng @ P&Y Design Network, Malaysia.

SYSTEM FOR FLY CONTROL IN PUBLIC AREAS OF URBAN WASTE IN BRAZIL

[1]JEAN-FRANÇOIS GRAF, [2]ADAIR F.M. TEIXEIRA, [2]ADHEMAR A. A. FILHO, [2]BIANCA R. QUINTAES, [2]ELISABETH C.L. SANTOS, [2]GISELE C. SURLIUGA, [3]CONSTANCIO CARVALHO, [1]RAUL V. CORTADA AND [1]KAI SIEVERT

[1]Novartis Animal Health Inc, CH-4002 Basel, Switzerland
[2]Departamento de Pesquisas Aplicadas-Companhia Municipal de Limpeza Urbana (COMLURB), Rio de Janeiro, Brazil
[3]Novartis Saude Animal Ltda., BR-04706-900 Sao Paulo SP, Brazil

Abstract A *Musca domestica* (L.) control method in final solid waste disposal areas (recycling and composting facility and waste transfer station) was developed. The application of two fly control products based on azamethiphos (Alfacron 10 Plus, a wettable powder containing 10% a.i. and Snip, a ready-to-use granular bait containing 1% a.i., both from Novartis Animal Health Inc.) was done on different surfaces. On vertical surfaces, represented by boards painted with diagonal red, yellow and white stripes, the wettable powder was used as spray or paint-on. The granular bait was used on horizontal surfaces, such as walls, floors and windowsills. Fly infestation was evaluated with Scudder Fly Grills. In the pile areas, reductions of 98.5% and 100% were achieved 18 and 30 days respectively after application. In the waste transfer station 85.6% and 98.7% reduction was achieved over the same period of time. A survey among employees of the plant revealed a high level of satisfaction with the achieved control. The present study showed that one application of azamethiphos in different formulations was effective against *M. domestica* for 30 days. Since the area is subject to continuous waste accumulation and management, it is fundamental that regular and monitored fly control is performed.
Key Words *Musca domestica*, azamethiphos, solid waste

INTRODUCTION

Waste created by man is the prevailing condition for house fly *Musca domestica* (L.) survival and breeding. Flies present a wide range of ecological diversity, living in different habitats and breeding on several substrates, from decaying organic material to living tissues (Oliveira et al., 1999). Proliferation of synanthropic flies is a frequent problem in solid waste disposal areas like composting and recycling facilities. Composting units are a suitable place for feeding, oviposition and larval development (Labud et al., 2003). The presence of flies is annoying and stressful, leading to economic losses and poor working conditions. Flies are able to spread from 2.3 to 11.8 km a day (Thomas and Skoda, 1993) and act as potential vectors of over 100 different pathogens ranking from viruses to parasitic worms (Vignau et al., 2003). A number of pathogens found in the fly's bodies are implicated in food poisoning and can easily be dispersed in the urban environment. They are directly related to diarrhea outbreaks, especially in children (Schuller, 2000).

Many factors contribute in maintaining and growing of synanthropic fly populations: climatic conditions (high temperature and humidity), poor sanitary development, inadequate waste storage, people's lack of concern and difficulties in insect control, impaired by misuse of insecticides. The control of synanthropic flies is related to adequate storing practices, good food production, proper shelving and disposal of solid residues, as well as on preventive measures able to decrease the insect reproduction rate. Therefore, chemical control, although not the only solution, is one of the important tools for integrated fly control.

In Brazil, fly control in the majority of municipalities is missing or inefficient, executed with unsuitable methods. Particularly in Rio de Janeiro, the lack of fly control in waste areas is evident and huge infestation levels are observed in the composting facilities and waste dumps. The development and implementation of fly monitoring techniques and control will help to keep this important vector in check, reducing therefore the economic losses caused by food contamination, the disease dispersion and the annoyance related to the presence of flies in the environment

The objective of this study was to determine a strategy to control *M. domestica* in temporary and final solid waste disposal areas, by using the organophosphate azamethiphos in two different presentations: Alfacron 10 Plus, a wettable powder containing 10% a.i. and Snip, a ready-to-use granular bait containing 1% a.i. Both products contain the sexual attractant (Z)-9-tricosene and are manufactured by Novartis Animal Health Inc. Application was done by paint-on, spray, and bait.

MATERIALS AND METHODS

The present study was performed in the Waste Recycling and Composting Unit and the Waste Transfer Station of the suburb of Caju, Rio de Janeiro. The prevailing conditions (average temperature 24.5ºC, average relative humidity 79%) offer favorable conditions for fly proliferation. The experimental area comprises 113.000 m^2 and receives 70% of all solid residues collected in the municipality, about 3,900 tons daily. Out of this volume, 7.6% is being recycled and 13.5% is transformed in organic compost after a period of storage in windrows. The remaining 79% is stocked in a transfer station for a maximum of 12 h before being transported to a final disposal site.

For this study, four sites were selected for monitoring: windrows, transfer station, plant offices and canteen, recycling unit. Fly preference for different surfaces and colors was assessed with a quantitative method based on the counting system Scudder Fly Grill (Erbendruth, 1978; Raybould, 1966). Thereto 3 sets of 2 wooden boards (0.25 m^2) with smooth, grid and dented surfaces were painted in white and yellow colors. The boards were placed on the floor in heavily infested, sunny areas and treated with a mixture of water and sugar. Fly counts were made after 1 and 15 min of exposure. The different attractiveness of the panels was compared using a X^2 test (Costa Neto, 1977). A survey was done among employees of different sectors of the facilities, in order to obtain a subjective impression of the infestation levels before and after azamethiphos treatment.

Chemical fly control was performed using different methods adapted to the treatment areas. Products were applied on vertical mobile and fixed wooden panels, on vertical concrete walls, on windrows and on horizontal surfaces like floors and windowsills. On vertical surfaces, the 10% formulation of azamethiphos was applied as a paint-on, on horizontal surfaces; the 1% formulation was used as a scatter bait. Windrows were treated by spray application. Wooden panels, 2.2 m x 1.1 m wide, were painted on both faces with alternate red and yellow diagonal stripes measuring 15 cm each. The panels were placed in different areas of the Unit (along the windows, in the solid waste separation area, around the employee's canteen and on the truck's tarpaulins). The fixed panels were placed two meters above the floor, the mobile ones one meter. In the waste transfer station, squares of 1 m x 1 m, 1 m apart from each other, were painted with alternate red/yellow and white/yellow diagonal strips on the internal and external walls.

The wooden panels and the painted squares were treated with a mixture of 250 g azamethiphos 10% dissolved in 200 ml water, using a paint roller. Due to differential absorption of the paint by the various surfaces, this resulted in a concentration of approx. 12 g/m^2 of product on the wooden panels and 19 g/m^2 for the concrete walls.

The windrows were treated with the same formulation, at a concentration of 250 g azamethiphos 10% in 2 liters water, and applied with a long-range sprayer fitted with a flat nozzle. The spraying resulted in a concentration of approximately 2 g/m^2 of product.

On horizontal surfaces (floors, window sills and walls), the granular 1% bait was applied manually at a dose of 2 g/linear meter. The product was reapplied whenever bait inefficiency was detected or when it was removed by rain or washing.

The number of flies per m^2 counted after a 15 minutes exposure at the most attractive sites was used to evaluate the efficacy of the trial. A statistical evaluation, using the X^2 test, was used to assess the attractivity of different surfaces and different colors. The significance level was set at $p < 0.05$.

RESULTS

The statistical test confirmed the different attractivity of various types of boards and colors (Table 1). The grid structure combined with the yellow color showed to be significantly more attractive than other combinations. The plain and smooth wooden boards presented less attractivity regardless of the color. In shadow areas, fly counts on yellow and white boards were very similar. Mortality was registered soon after the first treatment and assessed by dead fly counts on sustaining frames and around the exposition place. Because of the continuous sun incidence on the panels, it was necessary to wet the painted product by spraying water with a backpack sprayer, assuring the necessary humidity required for the product action maintenance.

Fly assessment was done on a daily basis during the first two weeks and in 3-day intervals for up to 30 days. At this period, four infestation level evaluations were made, using monitoring boards. The evaluation of infestation level in different experimental areas showed a decrease of the number of flies during the whole observation time of 30 days, based on counts done after 15 min on yellow grid panels. The number of flies was significantly lower after treatment (Table 2). In the internal areas of the Unit, like the recycling division and near the residue well, fly reduction was up to 97.1% 30 days after treatment (Table 3). Fly reduction in the windrows area was of 92% after 10 days and 100% after 30 days. Effective control was maintained for 30 days, when a small number of flies was detected, making a new application necessary.

In the waste transfer station, dead flies were observed on the horizontal surfaces of the walls, as well as under the boards painted with the wettable powder formulation. In the first week after treatment, fly population reduction was up to 70% and reached 98,7% after 30 days. In the same way, the application of the granular bait inside the canteen and offices as well as the panels placed around this area resulted in good efficiency with up to 100% control and a high level of satisfaction among the employees.

Table 1. Initial evaluation of infestation in plant; fly counts per m^2 / 15 min. exposure

Area			Boards type			Total	Color		Total
			grid	dented	smooth		yellow	white	
Windrow			2.860	1.852	1.712	6.424	4.232	2.192	6.424
Transfer Station			1.360	900	304	2.564	1.360	900	2.260
Recycling unit			720	592	288	1.600	720	592	1.312
Office and canteen			60	184	12	256	60	184	244
		Total	5.000	3.528	2.316	10.844	6.372	3.868	10.240
Predicted figures	Total 1	Windrow	2.962,0	2.090,0	1.372,0		3.997,4	2.426,6	
	Total 2	Transfer Station	1.182,2	834,2	547,6		1.406,3	853,7	
	Total 3	Recycling unit	737,7	520,5	341,7		816,4	495,6	
	Total 4	Office and canteen	118,0	83,3	54,7		151,8	92,2	

Table 2. Final evaluation of infestation in areas of the plant; fly counts per m^2

Area	Days after treatment	Yellow Boards			White Boards			Total
		grid	dented	smooth	grid	dented	smooth	
Windrows	0	2.120	1.080	1.032	740	772	680	6.424
	30	0	0	0	0	0	0	0
Transfer Station	0	920	576	240	440	324	64	2.564
	30	12	0	0	20	20	4	56
Recycling Unit	0	412	336	140	308	256	148	1.600
	30	12	16	0	12	4	4	48
Offices and canteen	0	44	152	8	16	32	4	256
	30	0	0	0	0	0	0	0
Total 1	0	3.496	2.144	1.420	1.504	1.384	896	10.844
Total 2	30	24	16	0	32	24	8	104
Predicted figures	Total 1	3.486,6	2.139,5	1.406,5	1.521,4	1.394,6	895,4	
	Total 2	33,4	20,5	13,5	14,6	13,4	8,6	

Table 3. Reduction of flies in areas of the plant during 30 days; fly counts per m^2/15 min. exposure

Area	Days after treatment	Yellow Boards						White Boards					
		grid		dented		smooth		grid		dented		smooth	
		Σ	%	Σ	%	Σ	%	Σ	%	Σ	%	Σ	%
Windrows	0	2.120	0,0	1.080	0,0	1.032	0,0	740	0,0	772	0,0	680	0,0
	10	172	91,9	40	96,3	20	98,1	160	78,4	24	96,9	20	97,1
	18	32	98,5	28	97,4	4	99,6	16	97,8	12	98,4	4	99,4
	30	0	100,0	0	100,0	0	100,0	0	100,0	0	100,0	0	100,0
Transfer Station	0	920	0,0	576	0,0	240	0,0	440	0,0	324	0,0	64	0,0
	10	276	70,0	52	91,0	68	71,7	236	46,4	80	75,3	88	-37,5
	18	132	85,7	36	93,8	4	98,3	100	77,3	184	43,2	60	6,3
	30	12	98,7	0	100,0	0	100,0	20	95,5	20	93,8	4	93,8
Recycling unit	0	412	0,0	336	0,0	140	0,0	308	0,0	256	0,0	148	0,0
	10	48	88,3	32	90,5	4	97,1	56	81,8	44	82,8	12	91,9
	18	12	97,1	56	83,3	4	97,1	12	96,1	44	82,8	4	97,3
	30	12	97,1	16	95,2	0	100,0	12	96,1	4	98,4	4	97,3
Offices and canteen	0	44	0,0	152	0,0	8	0,0	16	0,0	32	0,0	4	0,0
	10	8	81,8	0	100,0	0	100,0	8	50,0	0	100,0	0	100,0
	18	0	100,0	8	94,7	4	50,0	0	100,0	16	50,0	4	0,0
	30	0	100,0	0	100,0	0	100,0	0	100,0	0	100,0	0	100,0

DISCUSSION

Waste disposal and recycling separation areas are the ideal breeding ground for domestic fly populations. There, humid waste, vehicles losing waste while maneuvering, the separation process, as well as high temperature and humidity, particularly in Rio de Janeiro, are responsible for fast fly population proliferation and spreading.

The high fly infestation in the recycling and composting unit of the Caju suburb caused severe nuisance and is likely to lead to economical losses and disease transmission. Labud et al. (2003), characterizing Diptera of sanitary significance, revealed the role of flies as main disease vector, stressing the need of controlling the populations and guarantee adequate sanitary conditions for the composting unit employees. Many papers deal with the control of domestic flies in farms and poultry breeding facilities with the aid of organophosphate adulticides, thiamethoxam, (Kristensen and Jespersen, 2004), growth inhibitors like cyromazine (Silvestri and Lazo, 1990; Kristensen and Jespersen, 2003), diflubenzuron (Kristensen and Jespersen, 2003) and methoprene (Vignau et al., 2004). The initial challenge, however, was to determine the best control strategy and identify insecticides with better activity and longer residual protection than those used before.

In the present study, azamethiphos, combined with the sexual attractant (Z)-9-tricosene, proved to be an efficient tool for controlling house flies. Keiding et al. (1992) state that the use of bait insecticides is a promising treatment strategy, allowing little selection pressure, explained by the amount of population that is not in contact with the bait, preserving a reservoir of susceptible flies. As in other parts of the world, azamethiphos, an acethylcholine inhibitor, is widely used in Denmark for fly control in poultry facilities (Kristensen et al., 2000) and was used in studies on development and possibly spreading of resistant house fly populations. (Learmount et al., 2002)

Attractivity of different surfaces and colors for flies was investigated. According to Keiding (1991), plain and smooth surfaces are generally avoided by house flies. Our experiments revealed that the surface texture is fundamental for the resting place choice. The insecticide formulation formed a rough layer on the vertical board surface, improving the attractant action the pheromone.

Preference for yellow and white surfaces was detected, when compared to red. This preference was confirmed in sunlit and sheltered areas, in opposition to Keiding's (1976) findings, saying that flies avoid light reflecting surfaces. Therefore, it is necessary to undergo more investigation towards other colors, including black. In flies, the sensorial appendixes, responsible for the olfactory sense, are highly developed, orientating the insect to feeding and oviposition places. The insects agglomerate in areas with organic matter, disseminating different odors resulted from decay. During the experiment, it was found out that even in the presence of competitive food sources, the baits remained fully attractive, proving the effectiveness of (Z)-9-tricosene. The attractant concept was the differentiating factor between these fly control products and other insecticides used before.

Solid residues in open spaces showed to be the main breeding source for *M. domestica.* At the beginning of the pile's treatments, when infestation level was high, the utilization of mobile boards led to high fly mortality, demonstrating the excellent attractivity of the wettable powder formulation. Surface treatment on piles by spraying was effective, helped by the presence of different materials (plastics and metals) contained in the piles, offering good landing and feeding surfaces. The mobile boards proved to be helpful for fly monitoring and controlling at the piles, but did not substitute, however, the surface treatment. Therefore, treated boards may be more effectively used as control barriers, in heavily infested areas, especially at the beginning of the treatment.

The waste transfer unit of Caju, being a residue reloading point, with massive vehicle traffic, demanded specific attention on treatments and cleaning maintenance. Although a problematic place, the used methodology showed to be efficient with simple adjusting. All wall sides were used for color painting and treatment with the wettable powder, the granular bait was placed on sills or wall bases.

The use of painted boards on walls and pillars produced excellent results in fly controlin areas with intense pedestrian and vehicle circulation The system required less material and manpower. On the waste separation and recyclable residues storing areas of the unit, the use of hanging boards was a good option for fly control. Mobile boards installed outside the canteen acted as control barrier, minimizing fly dispersal.
Inside the canteen and offices, the granular bait, placed on horizontal surfaces (sills and floors close to windows) complemented the treatment, giving total fly control in these places.

The opinion survey, made with the employees before and after treatment, proved to be an excellent source of information to complement the study. Control efficacy was appreciated by all surveyed employees and attributed to the joint actions of the program. The degree of engagement of the employees in all sectors was reflected in the improvement of the overall sanitary conditions. The technician's instructions on integrated fly control were well accepted and the benefit of the project was unanimously recognized among the employees. Worker's tolerance against fly presence decreased and the conjunction "waste equals flies", formerly tolerated, became unacceptable.

The insecticide azamethiphos, combined with (Z)-9-tricosene, in association with the above described methods, proved to be a valuable aid for an integrated domestic fly control program in waste disposal areas. However, preliminary surveys of the infested areas are necessary and the success of such a program depends on the understanding, the motivation and the active participation of all people involved.

ACKNOWLEDGMENTS

The authors thank Viviane Quintaes for statistical analysis and support and Sérgio de Oliveira Cordeiro for secretarial assistance.

REFERENCES CITED

Collins, P. J., M.K. Nayak and R. Kopittke. 2000. Susceptibility of Spinosad in *Musca domestica* (Diptera: Muscidae) field populations. J. Econ. Entomol. 97:1042-1048.

Costa Neto, P. L. O. 1977. Estatística. Edgard Blücher, São Paulo, Brazil.

Erbendruth, W. 1978. Fly density determination in cow-sheds. Angew Parasitol. 19: 115-121.

Keiding, J. 1976. The house fly biology and control. Training and information guide, 1st ed. World Health Organization (W.H.O.), Geneva, Switzerland.

Keiding, J. 1991. The house fly biology and control. Intermediate level, 1st ed. World Health Organization (W.H.O.) Geneva, Switzerland,.

Keiding, J., A.S. El Khodary and J.B. Jespersen. 1992. Resistance risk assessment of two insect development inhibitors, diflubenzuron and cyromazine for control of the house fly *Musca domestica* L. Part II: Effect of selection pressure in laboratoty and field populations. Pestic. Sci. 35: 27-37.

Kristensen, M., M. Knorr, A.G. Spencer and J.B. Jespersen. 2000. Selection and reversion of azamethiphos-resistance in a field population of the housefly *Musca domestica* (Diptera: *Muscidae*), and the underlying biochemical mechanisms. J. Econ. Entomol. 93: 1788-1795.

Kristensen, M. and J. Jespersen. 2003. Larvicide resistance in *Musca domestica* (Diptera: *Muscidae*) populations in Denmark and establishment of resistant laboratory strains. J. Econ. Entomol. 96: 1300-1306.

Kristensen, M. and J. Jespersen. 2004. Susceptibility of Spinosad in *Musca domestica* (Diptera: *Muscidae*) field populations. J. Econ. Entomol. 97: 1042-1048.

Labud, V. A., L.G. Semenas and G. Laos. 2003. Diptera of sanitary importance associated with composting of biosolids in Argentina. Rev. Saúde Pública. 37: 722-728.

Learmount, J., P. Chapman and A. Macnicoll. 2002. Impact of an insecticide resistance strategy for house fly (Diptera: *Muscidae*) control in intensive animal units in the United Kingdom. J. Econ. Entomol. 95: 1245-1250.

Oliveira, V. C., J.M. D'almeida, M.J.P. Santos and A. Sanavria. 1999. Dinâmica populacional dos dípteros Calliphoridae na fundação Rio-Zoo, Rio de Janeiro, RJ, Brasil. Entomol. y Vect. 6: 264-276.

Raybould, J. N. 1966. Further studies on techniques for sampling the density of African house fly populations. 1. A field comparison of the use of the Scudder grill and the sticky-flytrap method for sampling the indoor density of African house flies. J. Econ. Entomol. 59: 639-44.

Schuller, L. 2000. The filth flies and its importance in the transmission of food-borne diseases. Hig. Aliment.147: 28-38.

Silvestri, R. and J. Lazo. 1990. Control of domestic fly with the association azamethiphos-cyromazine in a farm of commercial layers. Rev. Fac. Cienc. Vet. 37: 67-72.

Thomas, G. D. and S.R. Skoda. 1993. Rural flies in the urban environment. Res. Bull. No. 317. Agric. Res. Div., Institute of Agric. And Natural Resources, University of Nebraska-Lincoln, NE. North Central Regional Research Pub.No. 335.

Vignau, M. L., J.R. Romero, A. Baldo, M.A. Risso and M.P. Silvestrini. 2003. The effect of methoprene on *Musca domestica*: laboratory bioassays. Anal. Vet. 23: 11-14.