

Comparative Study of the Susceptibility and Residual Effectiveness of Airborne Spray Deposits of Fenitrothion 40 W.P. on *Anopheles albimanus* in Two Villages of Nicaragua in 1991¹

PEDRO RIVERA, S. VARGAS, M. PICADO AND M. MERCADO

Centro Nacional de Higiene y Epidemiología,
Ministerio de Salud de Nicaragua,
Apartado Postal 2900. Telefax 97723,
Managua, Nicaragua, C.A.

ABSTRACT

The effect of application of fenitrothion 40 W.P. 2 g/m², was evaluated during 1991 in two localities situated in two different geographic and climatic regions, northern and the pacific coast of Nicaragua.

Susceptibility as well as bioassay tests were performed. The residual effectiveness of insecticide deposits from airborne sprays was also evaluated. Results indicate that deposits from air borne sprays of fenitrothion 40 W.P., was effective for control *An. albimanus* for up to 60 days after application. There was good susceptibility (95% mortality) of *An. albimanus* to fenitrothion 1.0% and the residual activity goes beyond 60 days after application.

INTRODUCTION

Malaria is a serious public health problem in almost all of the tropical countries (Panamerican Health Organization, 1986). The problem has been accentuated due to development of resistance by mosquito vectors to almost all insecticides (Georghiou 1972, Racho et al. 1973, Bown et al. 1987).

In Nicaragua resistance of *An. albimanus* to insecticides has a general occurrence (Rachou 1961). This fact emphasizes the need for more research for develop alternative products for the control of mosquitoes. It appears that, for the control of malaria, we will continue to rely upon the use of insecticides for some time (Arata 1985). The large number of malaria cases occurred in Nicaragua in 1989 (49,922 cases), could have been due more to vector resistance to D.D.T., propoxur, chlorphoxym and malathion than to other factors especially in Chinandega, where insecticides are used heavily.

The main objectives of this study were to determine the effects of fenitrothion 40 W.P., on the *An. albimanus* population; as to stablish the residuality of the same product on different types of surfaces, and to determine the current susceptibility of *An. albimanus* to fenitrothion.

MATERIAL AND METHODS

The study was conducted in 2 small villages of Nicaragua, Amalia and Jalapa.

Amalia is located in the Department of Chinandega along the Pacific Coast of Nicaragua, while Jalapa is located in the Department of Madriz in the northern portion of Nicaragua. Both localities were selected by the following criteria: Amalia had high pressure from agricultural insecticides through many years and high resistance of *An. albimanus* to the insecticides used for vector control (DDT (90%), chlorfoxym (54.7%), deltametrina (29.1%), malathion (73.2%) and propoxur (41%)). Jalapa has received low pressure from agricultural insecticides through the same years and has low resistance of *An. albimanus* to those insecticides (DDT (12%), propoxur (19%)).

At each locality 10 houses were selected and sprayed with fenitrothion 40 W.P., at approximately 2 gr. a.i/m². All walls were treated by a Hoodson X-pert sprayer with a Hss-8002 nozzle. Susceptibility tests were performed using procedures recommended by WHO². Seven days after application,

¹This work received financial support from the Sumitomo Chemical Co., Ltd., Japan.

²WHO/VBC/81.806.

bioassay test were conducted by placing 10 mosquitoes in cones made of thin, transparent polished plastic having a flanged-base which can be lined with adhesive sponge. It was placed and fixed to the surfaces with drawing pins. This method of bioassay was continued every 15 days for the next 5 months.

Observations of the killing effects of fenitrothion 40 W.P., deposits from airborne sprays were made inside of houses. A total of 4 cages containing 10 blood-fed *An. albimanus*, were used in each test. Three were installed within sprayed houses and 1 was placed in an unsprayed house and used as a control. Cages used in these tests were nylon-screened cubes measuring 10×10×10 cm. in size. Each cage was hung at 50 cm. distance from the walls and 1.5 m. from the ground.

The time of exposure was 12 hours from 7:00 P.M. to 7:00 A.M. and holding time was 24 hours. Mortality due to residual deposits was registered at the end of each holding period. The residual effect test was performed 1 day after spraying, and the second test was carried out 7 days after spraying. The remaining tests were conducted every 15 days and continued for 150 days after spraying.

RESULTS

Table 1, shows results of susceptibility tests of *An. albimanus* to fenitrothion 1.0%. As can be noted, in Jalapa the average rate of mortality from 5 different tests was 95%, while in Amalia it was 85%.

Table 2, shows the results of 11 replicated bioassay tests on different home surfaces in Jalapa. The most common surface materials used in that locality for walls were cement, wood and mud. The mean of mortality observed was 60% on cement walls, 65% on wood walls and 69% on mud walls at 90 days after spraying. The resid-

ual effectiveness decreased continually for 150 days after spraying on all treated surfaces. The residual effectiveness resulting in about 50% mortality extended to 105 days after spraying on wood and mud walls respectively. In Amalia, on cement and mud walls the mortality rate was 65% 90 days after spraying. The mortality decreased from 56% after 105 days to 22% at 150 days post-treatment on cement walls. The mean mortality observed on wood walls was 66% at 65 days after spraying. The mortality decreased from 50% at 90 days to 25% at 150 days after spraying. On cardboard walls, the residual effectiveness of above 60% mortality lasted 45 days after spraying, while on plastic walls 64% mortality was observed up to 75 days after application (Table 3). The killing by airborne effect observed was 70% in Jalapa and 69% in Amalia respectively 45 days after spraying. But the mortality rate decreased by 55% and 57% respectively 60 days after spraying in both localities.

The observed mortality rate had decreased to less than 1% in Jalapa and zero in Amalia at 150 days after spraying (Table 4).

DISCUSSION

We used the following scale of resistance and susceptibility for *An. albimanus* survival in contact with fenitrothion after 24 hours recovery and 60 minutes of exposure: Very Resistant, when the percentage of survival of mosquitoes of any sample population is 50% to 100%. Resistant, when the percentage of survival of sample is 20% to 49%. Very Susceptible, when the percentage of survival is 0% to 5%, and Susceptible, when the percentage of surviving mosquitoes sample is 6% to 9%. It was considered, too, that an insecticide is capable of eliminating 80% of insect populations is really effective inasmuch as the

Table 1. Susceptibility of *Anopheles albimanus* to fenitrothion 1.0% in two localities of Nicaragua, 1990.

Localities	Number of Trials	Mosquitoes Exposed	Exposure Period (minutes)	% Mortality at 24 hours	Control	
					Mosquitoes Exposed	Mortality at 24 hrs
Jalapa	5	500	60	95.0	125	2.0
Amalia	5	300	60	85.0	75	0.0
Combined	10	800	—	90	200	2.0

Table 2. Results of bioassay tests of *An. albimanus* exposed 60 minutes to fenitrothion 40 W.P. on sprayed surfaces, Jalapa, province of Esteli, North of Nicaragua, 1990.

Days After Spraying	% Mortality of Mosquitoes After 24 hrs Recovery				
	Cement	Wood	Mud	Combined	Control
7	80.0	92.0	95.0	89.0	0.0
	(20)	(20)	(20)	(60)	(10)
15	80.0	85.0	90.0	85.0	0.0
	(20)	(20)	(20)	(60)	(10)
30	79.0	82.0	85.0	82.0	0.0
	(20)	(20)	(20)	(60)	(10)
45	77.0	79.0	84.0	80.0	0.0
	(20)	(20)	(20)	(60)	(10)
60	75.0	76.0	81.0	77.3	0.0
	(20)	(20)	(20)	(60)	(10)
75	68.0	71.0	77.0	72.0	0.0
	(20)	(20)	(20)	(60)	(10)
90	60.0	65.0	69.0	64.6	0.0
	(20)	(20)	(20)	(60)	(10)
105	53.0	61.0	63.0	59.0	0.0
	(20)	(20)	(20)	(60)	(10)
120	49.0	56.0	58.0	54.3	0.0
	(20)	(20)	(20)	(60)	(10)
135	50.0	50.0	45.0	48.3	0.0
	(10)	(10)	(10)	(30)	(10)
150	31.0	37.0	37	35.0	0.0
	(10)	(10)	(10)	(30)	(10)

Figures in parentheses represent the number of mosquitoes tested.

remaining population (20% in this case) Honduras for controlling malaria vectors, may be controlled by biological, ecological and physical methods. Fenitrothion has been used successfully for a long time in Honduras for controlling malaria vectors, but fenitrothion was used in Nicaragua for the first time in 1985, against *Aedes aegypti*, with very good results. In 1985 several

Table 3. Results of bioassay tests of *An. albimanus* exposed 60 minutes to fenitrothion 40 W.P. on sprayed surfaces, Amalia, province of Chinandega Pacific Coast of Nicaragua 1990.

Days After Spraying	% Mortality of mosquitoes after 24 hrs recovery					
	Cement	Wood	Cardboard	Plastic	Combined	Control
7	95.0	86.0	73.0	100.0	88.5	0.0
	(28)	(28)	(28)	(28)	(112)	(40)
15	90.0	81.0	68.0	94.0	83.2	0.0
	(28)	(28)	(28)	(28)	(112)	(40)
30	85.0	76.0	60.0	89.0	77.5	0.0
	(28)	(28)	(28)	(28)	(112)	(40)
45	80.0	76.0	60.0	79.0	60.2	3.0
	(28)	(28)	(28)	(28)	(112)	(40)
60	80.0	71.0	59.0	74.0	71.0	2.5
	(28)	(28)	(28)	(28)	(112)	(40)
75	75.0	66.0	54.0	64.0	64.8	2.5
	(28)	(28)	(28)	(28)	(112)	(40)
90	65.0	50.0	45.0	59.0	54.8	0.0
	(28)	(28)	(28)	(28)	(112)	(40)
105	56.0	48.0	40.0	47.0	47.8	0.0
	(28)	(28)	(28)	(28)	(112)	(40)
120	46.0	42.0	38.0	42.0	42.0	0.0
	(28)	(28)	(28)	(28)	(112)	(40)
135	33.0	31.0	33.0	37.0	32.8	3.0
	(28)	(28)	(28)	(28)	(112)	(40)
150	22.0	25.0	21.0	25.0	23.2	0.0
	(28)	(28)	(28)	(28)	(112)	(40)

Figures in parentheses represent the number of mosquitoes tested.

Table 4. Bioassay of the residual effect of fenitrothion deposits from airborne sprays on the wall surfaces of homes using airborne caged *An. albimanus* exposed for 12 hours.

Days After Spraying	JALAPA		AMALIA	
	Exposed	Control	Exposed	Control
1	100.0 (30)	0.0 (10)	100.0 (30)	(10)
7	96.0 (30)	0.0 (10)	95.0 (30)	(10)
15	90.0 (30)	2.0 (10)	91.0 (30)	(10)
30	85.0 (30)	0.0 (10)	84.0 (30)	(10)
45	70.0 (30)	0.0 (10)	69.0 (30)	(10)
60	55.0 (30)	0.0 (10)	57.0 (30)	(10)
75	42.0 (30)	3.1 (10)	41.0 (30)	(10)
90	38.0 (30)	0.0 (10)	36.0 (30)	(10)
105	20.0 (30)	0.0 (10)	19.0 (30)	(10)
120	18.0 (30)	1.0 (10)	15.0 (30)	(10)
135	5.0 (30)	3.0 (10)	3.0 (30)	(10)
150	1.0 (30)	4.0 (10)	0.0 (30)	(10)
TOTAL	(360)	(120)	(360)	(120)

Figures in parentheses represent the number of mosquitoes tested.

localities were sprayed in Matagalpa but during this time, assays to measure the effectiveness of fenitrothion were not carried out.

However, it was reported without basis that fenitrothion was not effective against *An. albimanus*. This study carried out in order to determine the susceptibility of *An. albimanus* to fenitrothion and did not confirm that information. We obtained about 95% mortality in Jalapa a zone ecologically similar to Sebaco, where in 1985, above mentioned susceptibility tests were carried out (Table 1).

Amalia is located in a zone of high resistance of *An. albimanus* to insecticides such as DDT, propoxur, chlorfoxym and malathion. The observed mortality rate was 85%, this suggesting that fenitrothion was effective in an area of high resistance to these insecticides as well as in areas where *An. albimanus* is very susceptible according to our susceptibility scale.

The combined mortality rate for both localities was 90% (Table 1). We found in this respect it was very similar to results

reported by other authors (Payne et al. 1976, Georghiou and Calman 1976).

In Jalapa the results of biological evaluation of fenitrothion with a 60 minutes exposure period showed a mortality rate of about 60% on cement walls up to 90 days after spraying with a dosage of 2 gr./m². However, by 150 days the rate had dropped to 31%. Bioassay on wood gave 65% mortality up to 90 days, and by 150 days after spraying, the rate of mortality had decreased to 37% (Table 2). The observed results of bioassay on mud gave 69% mortality up to 90 days and by 150 days after spraying the rate had fallen to 37%.

In Amalia the results observed in bioassay tests on cement walls, were 65% at 90 days after spraying with the same dosage (2 gr./m²), but after 150 days the rate had fallen to 22%. The bioassay test on wood gave 50% mortality up to 90% days after spraying, but by 150 days after treatment the rate had decreased to 25%. Cardboard plastic materials are little used in Amalia. However the results obtained from bioassays with the same dosage showed that

mortalities of 45% (cardboard) and 49% (plastic) up to 90 days had after 150 days, has fallen to 21% (cardboard) and 25% (plastic) (Table 3). The killing effect of deposits from airborne sprays was 70% in Jalapa and 69% in Amalia up to 60 days. The rate of mortality decreased to 1% in Jalapa and zero in Amalia at 150 days after spraying (Table 4).

Another study conducted simultaneously in localities of South and Southwest Nicaragua gave results very similar those shown above.

On the basis of all these results is to be concluded that fenitrothion is an effective insecticide for the control of *An. albimanus* population. The mosquito *An. albimanus* is susceptible to fenitrothion even in areas where *An. albimanus* is resistant to DDT, propoxur, chlorfoxym and malathion. Fenitrothion gave good effectiveness up to 90 days after spraying on cement and wood walls.

ACKNOWLEDGMENT

The authors wish to thank Dr. Mack Tidwell and Dr. Yilma Mekuria; of the School of Public Health, University of

South Carolina for their help in reviewing of this report.

REFERENCES

- Arata, A. A. 1985. El uso de Plaguicidas en la Agricultura y Salud Pública. El punto de vista de la Ecología Humana. *Folia Ent. Mex.* 59:139-85.
- Bown, D., Ch. Frederickson, A. Cabañas y J. F. Mendez. 1987. Efectos Bendiocarb y Deltaametrina en *An. albimanus* en una aldea mexicana. *Bol. Of. Sanit. Pan.* 103(5):478-89.
- Georghiou, G. P. 1971. Studies on resistance to carbamates and organophosphorous insecticides in *Anopheles albimanus*. *Amer. J. Trop. Med. Hyg.* 12(5):798-806.
- Georghiou, G. P. and J. Calman. 1976. Result of Fenitrothion selection of *Culex pipiens fatigans* and *Anopheles albimanus*. *Wied. Bull. Wld. Hlt. Org.* 40:97-101.
- Oficina Sanitaria Panamericana. 1986. Situación de los Programas de Malaria en las Americas. Wash: XXII Conferencia Sanitaria Panamericana. XXXVIII, Reunión del Comité Regional. 75 págs.
- Payne, D., B. Grab, E. Fontaine and J. H. Hempel. 1976. Impact control measures on malaria transmission and general mortality. *Bull. Wld. Hlt. Org.* 54:369-77.
- Rachou, R. 1961. Problemas relativos a la persistencia de la transmisión la Malaria. *Bol. Of. Sanit. Pan.* 51(1):1-25.
- Rachou, R., L. Schinazi and M. Moura Lima. 1973. An intensive epidemiological study of causes for failures of residual DDT. Spraying to interrupt the transmission of Malaria in Atalaya and Falla, two villages of the coastal plain of El Salvador. *Rev. Brasil. Malaria Doenças Trop.* 25:1-293.