RESISTANCE OF HOUSE FLIES (DIPTERA: MUSCIDAE) TO DIMETHOATE AND RONNEL IN FLORIDA[1]

DONALD L. BAILEY, G. C. LABRECQUE, AND T. L. WHITFIELD

Entomology Research Division, Agr. Res. Serv., USDA,
Gainesville, Florida 32601

ABSTRACT

A statewide survey was made to determine the resistance to dimethoate and ronnel of house flies, *Musca domestica* L., collected from poultry or dairy farms at 32 locations throughout the state of Florida. Compared to flies from the susceptible Orlando strain, flies from dairies were 4.9 to 21.2-fold more resistant to ronnel, and flies from poultry farms were 3.8 to 54.5-fold more resistant. Also, fly strains from dairies were 3.4 to 31.0-fold more resistant to dimethoate than flies from the Orlando strain, and fly strains from poultry farms were 1.8 to 28.5-fold more resistant.

King and Gahan (1949) reported resistance in house flies, *Musca domestica* L., to DDT, the first published account of resistance to an insecticide in a field strain of house flies in Florida. Subsequently, when evidence indicated that resistance to chlorinated hydrocarbons was indeed becoming a problem, organophosphorus insecticides (primarily malathion and diazinon, but later ronnel and dimethoate) were used for control. The residual activity of the newer compounds is less than that of the chlorinated hydrocarbons, but were successful for a time. Though it has been slower in coming, resistance to most organophosphorus compounds is a reality. Thus, though Hansens and Bartley (1953), in one of the first records of the use of organophosphates against house flies, found that diazinon gave excellent control of flies for an entire season in a horse barn and 3 to 4 weeks of control in dairy barns in New Jersey, Hansens and Scott (1955) obtained only 40 to 50 days of control with diazinon in dairies, and Gahan et al. (1957) could control flies in animal barns with surface sprays of diazinon for only 3 to 49 days in Florida and 9 to 35 days in Nebraska. The lack of control in some of those tests indicated possible resistance to diazinon at that time, only 4 or 5 years after its widespread use for fly control began. By 1966, Brady et al. reported no more than 3 to 4 days of control with diazinon in Florida dairies.

Likewise, ronnel (Dow ET-14 or Dow ET-57 in earlier literature) has been very effective for fly control in the past. Hansens (1956) obtained as much as 65 days of control with it in dairy barns, but Gahan et al. (1957) reported a maximum of 28 days of control, and by 1966, Brady et al. could get no more than 3 to 4 days of control with ronnel.

Dimethoate was another promising chemical developed to replace organophosphorus compounds that were failing. However, after Brady et al. (1966) achieved good control with dimethoate in dairy barns for as much as 43 days, Bailey et al. (1967) had control for a maximum of only 14 days, and in the summer of 1968, we obtained control for only 1 day (unpublished data).

---

[1]Mention of a pesticide or a proprietary product in this paper does not constitute a recommendation or an endorsement of this product by the USDA.

The most recent survey of the resistance of house flies to organophosphates in Florida was made by LaBrecque et al. (1958) with flies collected from the southern and central parts of the state. When they compared wild flies with susceptible flies in tests with contact sprays, they found resistance in wild flies greater by 3 to 133-fold to malathion, 1.3 to 72-fold to trichlorfon, 5 to 38-fold to diazinon, and 3 to >18-fold to parathion. This information and the lack of adequate fly control in recent years in Florida suggested the need for a survey of the state to determine the current status of resistance in populations of wild house flies to ronnel and dimethoate.

Methods and Materials

A statewide survey was made in Florida by collecting flies at poultry or dairy farms located in 32 different sections of the state from Dade County in the south to Escambia County in the west. The adult flies collected were brought to the laboratory, reared to the F_1 generation, and tested when the adults were 5 days old. The flies were exposed to space sprays of dimethoate or ronnel in the wind-tunnel described by Davis and Gahan (1961). Identical tests were made simultaneously with the Orlando regular (susceptible) strain to establish a basis for comparison.

The space sprays were prepared by dissolving each insecticide in acetone at various concentrations between 0.01 and 5.0% (w/v). For the tests, 20 females were placed in cages made of metal sleeves enclosed with screen wire at each end. Then these cages were placed in the wind tunnel, 0.25 ml of spray was atomized at 1 psi into the mouth of the machine, and drawn by an air current (4 mph) through the cages. Duplicate cages of flies were treated with each concentration. Immediately after treatment, the flies were transferred to clean holding cages, and a cotton pad saturated with 10% sugar-water solution was placed on top of each cage as a source of food and water. Mortality was recorded after 24 hr at 25°C and 50% relative humidity. The data were used to compute LC_{50}'s by the probit analysis technique described by Litchfield and Wilcoxon (1949).

Results and Discussion

The LC_{50}'s and the resistance levels to ronnel and dimethoate for flies collected from dairy and poultry farms in various areas of the state are given in Table 1. Resistance to ronnel was 4.9 to 21.2-fold greater in fly strains from dairies and 3.8 to 54.5-fold greater in fly strains from poultry farms than the resistance of the Orlando regular strain. Eleven of the 32 strains tested had resistance that was less than 10-fold greater and 3 had resistance that was more than 30-fold greater. Resistance to dimethoate was 3.4 to 31.0-fold in fly strains collected in dairies and 1.8 to 28.5-fold greater in fly strains from poultry farms than the resistance of the Orlando regular strain. Ten of 20 strains tested had resistance that was less than 10-fold greater and 1 strain had resistance that was more than 30-fold greater.

Table 2 summarizes the average resistance to ronnel and dimethoate found in flies from 4 regions of the state. In dairies, in every section ex-

TABLE 1.—Resistance of field strains of house flies from Florida dairy and poultry farms to space sprays of dimethoate and ronnel.

County	Region	Ronnel		Dimethoate	
		LC_{50} (%)	Resistance level*	LC_{50} (%)	Resistance level*
		Dairy farms			
Okeechobee	South	1.78	14.8	0.08	4.0
Hendry	South	2.33	21.2	.43	4.8
Osceola	Central	1.16	12.9	.44	22.0
Lake	Central	1.68	14.0	.62	31.0
Alachua	North	.82	9.1	.29	14.5
Alachua	North	1.16	6.1	.40	13.3
Alachua	North	1.53	19.1	.42	8.4
Alachua	North	1.49	13.5	.56	14.0
Alachua	North	1.41	20.1	.32	10.7
Alachua	North	1.10	15.7	.30	10.0
Gilchrist	North	.83	9.2	.24	6.0
Marion	North	.73	6.1	.16	8.0
Marion	North	.59	4.9	.14	7.0
Escambia	West	.67	16.8	.12	6.0
Jackson	West	.72	12.0	.17	3.4
		Poultry farms			
St. Lucie	South	1.73	19.2	0.08	4.0
Hillsborough	South	1.41	10.8	.33	11.0
Indian River	South	1.42	11.8	.16	8.0
Polk	South	2.18	54.5	.57	28.5
Lee	South	1.82	20.2	.30	7.5
Dade	South	1.12	12.4	.09	2.3
Collier	South	3.05	50.8	.35	7.0
Orange	Central	1.14	11.4	.04	2.0
Orange	Central	.63	5.7	.21	7.0
Bradford	North	1.02	7.8	.68	22.7
Bradford	North	1.62	11.6	1.14	22.8
Suwannee	North	1.04	8.7	.25	8.3
Suwannee	North	1.40	12.7	.55	13.8
Suwannee	North	1.04	8.7	.25	6.3
Columbia	North	.50	3.8	.12	3.0
Bay	West	.32	5.3	.09	1.8
Leon	West	2.27	37.8	.36	7.2
Control (Orlando regular)		0.02 – 0.09	—	0.04 – 0.19	—

*Based on resistance of Orlando regular (susceptible) strain as 1.0.

TABLE 2.—AVERAGE RESISTANCE OF FIELD STRAINS OF HOUSE FLIES FROM DAIRY AND POULTRY FARMS IN 4 SECTIONS OF FLORIDA TO SPACE SPRAYS OF DIMETHOATE AND RONNEL.

	Average resistance* (at LC_{50} level) to:	
Region	Ronnel	Dimethoate
	Dairy farms	
South	18.0	4.4
Central	13.5	26.5
North	11.5	10.2
West	14.4	4.7
	Poultry farms	
South	25.7	9.8
Central	8.6	4.5
North	8.9	12.8
West	21.6	4.5

*Based on resistance of Orlando regular (susceptible) strain as 1.0.

cept the central part of the state, flies had more resistance to ronnel than to dimethoate; in poultry farms, flies were more resistant to ronnel than to dimethoate in all except the northern part of the state. However, the resistance to ronnel in flies collected from poultry farms was more erratic than in flies collected at dairy farms since both the highest (25.7 in the southern part) and lowest (8.6 in the central part) levels of resistance to ronnel were found in flies from poultry farms.

Resistance to dimethoate varied even more throughout the state. The highest level of resistance (26.5-fold) was found in dairies in the central part of the state. The lowest (4.4-fold) was found in dairies in the southern part; however, dairies in the western part (4.7), and poultry farms in the central and western parts (4.5) also had flies with low resistance. Dimethoate has not been in use as long as ronnel, which may explain the lower resistance to dimethoate in some areas. Still, even when flies from some areas had a low average resistance to dimethoate, a very high degree was present in fly strains from individual dairy and poultry farms (Table 1). Thus, resistance to dimethoate may become more widespread as it has with other compounds that were originally highly effective.

Unfortunately, alternative insecticides to replace those that are now ineffective, because of the development of resistance, are becoming hard to find. This problem is undoubtedly caused, at least in part, by cross resistance in field populations i.e., flies that develop resistance to insecticides commonly used for fly control may also be resistant to new organic phosphorus and carbamate compounds without ever being exposed to them. For example, in our laboratory, when compounds were evaluated as residual insecticides (unpublished data), 3 organophosphates [dimethoate, fenthion, and Gardona® (2-chloro-1-(2,4-trichlorophenyl)vinyl dimethyl phosphate] and 1 carbamate [Mobam® (benzo[*b*]thien-4-yl methylcarbamate)] remained toxic to susceptible house flies for 12 to 24 weeks. However, when these insecticides were tested against multiresistant house flies that had never been exposed to these 4 materials, they were toxic for only 0 to 4 weeks. Furthermore, Bailey et al. (1967) showed that these 4 insecticides were relatively ineffective when they were tested against field strains in naturally infested dairies.

The need for other means of controlling house flies in dairy and poultry farms is therefore apparent. Perhaps a combination of sanitation, one of the best methods, and chemical or biological methods may provide the degree of control needed at these installations.

LITERATURE CITED

Bailey, D. L., G. C. LaBrecque, and P. M. Bishop. 1967. Residual sprays for the control of house flies, *Musca domestica*, in dairy barns. Fla. Entomol. 50: 161-3.

Brady, U. E., Jr., D. W. Meifert, and G. C. LaBrecque. 1966. Residual sprays for the control of house flies in field tests. J. Econ. Entomol. 59: 1522-3.

Davis, A. N., and J. B. Gahan. 1961. Wind-tunnel tests with promising insecticides against adult salt-marsh mosquitoes, *Aedes taeniorhynchus* (Wied.). Mosquito News. 21(4): 300-3.

Gahan, J. B., H. G. Wilson, J. C. Keller, and C. N. Smith. 1957. Organic phosphorus insecticides as residual sprays for the control of house flies. J. Econ. Entomol. 50: 789-93.

Hansens, E. J., and C. E. Bartley. 1953. Three new insecticides for house fly control in barns. J. Econ. Entomol. 46: 372-4.

Hansens, E. J., and R. Scott. 1955. Diazinon and Pirazinon in fly control. J. Econ. Entomol. 48: 337-8.

Hansens, E. J. 1956. Control of house flies in dairy barns with special reference to diazinon. J. Econ. Entomol. 49: 27-32.

King, W. V., and J. B. Gahan. 1949. Failure of DDT to control house flies. J. Econ. Entomol. 42: 405-9.

LaBrecque, G. C., H. G. Wilson, and J. B. Gahan. 1958. Resistance of house flies in Florida to organophosphorus insecticides. J. Econ. Entomol. 51: 616-7.

Litchfield, J. T., and F. Wilcoxon. 1949. A simplified method of evaluating dose-effect experiments. J. Pharmocol. Exp. Therap. 96: 99-113.