ARTICLES

EFFECTIVENESS OF FOG, DUST, AND MIST APPLICATIONS OF SEVERAL ORGANOPHOSPHORUS COMPOUNDS AGAINST *AEDES TAENIORHYNCHUS*[1]

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The relative merits of fog, dust, or mist)plications in reducing adult mosquitoes 'e of much interest to mosquito control 'rsonnel. In tests conducted at Savannah, 'eorgia, over a 2-year period, these three 'pes of space treatment, as well as the 'lative effectiveness of several organophos- horus compounds, were evaluated against *'edes taeniorhynchus*. Messrs. F. Free- ıan and B. O. Smith gave valuable as- stance in the field aspects of this study.

All tests were made between 7 and 11 .m. in a sparsely populated subdivision ıaracterized by pine woods, weeds, and rush, except in the roadway areas. The ıosquitoes were exposed in cylindrical 'ire screen cages (3.25″D x 6″) suspended 'om iron supports 3 feet above the ground, ıostly at distances of 135′, 270′, 540′, and 10′ from the discharge of the machine. ı certain tests, the distances of 330′ and 60′ were used instead of 270′ and 540′. 'ages were positioned in two lines: (A) long the relatively unobstructed roadway, nd (B) parallel to the roadway but 75′ to 25′ in the interior of the block. The "A" et of cages thus were located in a rela- ıvely "open" zone as contrasted to the 'B" set located in woods, brush, or under- rowth. Approximately 200 adult mos- ıuitoes were used per cage and a single age was positioned at each distance. The test specimens were laboratory-reared *A. taeniorhynchus* derived from Chatham County sod samples and from eggs received from the United States Department of Agriculture, Agricultural Research Service, Entomology Research Division, Orlando, Florida and from the Entomological Research Center, Florida State Board of Health, Vero Beach, Florida. The age of the mosquitoes exposed varied from 3 to 7 days.

A Dyna-Fog Sr. was used for the fog treatment and a Buffalo Turbine for the mist and dust applications. (NOTE: The use of trade names for equipment or for the insecticides is for identification only and does not constitute endorsement by the Public Health Service.) Both machines were operated along a one-quarter-mile run at speeds varying from 5 to 12 miles per hour depending upon the strength of the formulation and the dosage rate desired. For all treatments, the dosage, expressed as pounds per acre, was based on an effective swath width of 300 feet. Test plots were established in four compass directions to insure suitable downwind locations for each test regardless of the general wind direction prevailing at the time of the test.

In each test, the caged mosquitoes remained in place for 10 minutes after the application of the insecticide. All cages were then collected and the specimens transferred to clean holding cages with the aid of carbon dioxide anesthesia. The specimens were held at 80° F. and 70 percent relative humidity for 24 hours and the mortality of the females was then determined.

The insecticides used were malathion,

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DDVP, Diazinon, and ronnel. For the mist and fog treatments, the toxicant was prepared at a concentration of 6.25 percent in No. 2 fuel oil. Diazinon, malathion, and ronnel were tested as dusts, prepared at a 12.5 percent strength in pyrophyllite from commercial 25 percent wettable powders. In one series of tests, a commercial 4 percent malathion dust was compared to mist sprays in which the percent toxicant ranged from 0.8 to 5 percent.

RESULTS. The principal comparison of the fog, mist, and dust applications was derived from tests with malathion. Even with the use of the same toxicant, the validity of the comparative data was influenced markedly by the environmental conditions that prevailed at the time of tests. Consequently, unless a number of tests were run so that similar conditions occurred with each type of application, it was not possible to group the data for direct comparison of the mortalities achieved with the different treatments. In Table 1, comparative data presented for tests performed on the same nights indicated that the fog and mist treatments were superior to the dust, particularly when the dosage rates were considered. Little difference was apparent in the relative effectiveness of the mist and fog treatments.

In another series of comparative tests of fog versus dust applications on the same nights at approximately 0.1 pound per acre (Table 2), dust treatments gave average mortalities of 95 and 69 percent in the "A" zone at 135′ and 270′, while fog treatments showed average mortalities of 92 and 96 percent at the same distances. At the stations in the "B" zone, or at 540′ and 810′ in the "A" zone, there was little difference in the percent kills obtained.

Table 3 shows the mortalities obtained with malathion fog and dust treatments that were run at temperatures of 78° F. and above but not on the same nights. These data reflect the same general trends as shown in Table 2, except that the dust applications gave superior results at 540′ and 810′ in the "A" zone. Dosage rat for the dust applications were slight higher than those for the fog treatments.

In comparative tests of malathion m and dust applications, six mist treatmer (concentrations 2.5 to 5 percent) gave a erage kills of 94 and 84 percent in "A and "B" zones (135′ to 660′) at 0.15–0. pound per acre as compared to 99 and percent mortalities for five malathion du (4 percent) applications in the same d age range.

Table 4 is an overall tabulation of t results obtained with the four organ phosphorus pesticides tested. As a f application, malathion was superior to t other compounds. Diazinon at 0.1 to 0. pound per acre gave kills equal to ma thion at 0.07–0.085 pound per acre but the equivalent dosage level produced po kills. DDVP gave excellent kills at 1 but performed poorly at the other d tances. As a dust or mist, malathion al gave higher mortalities than the oth compounds tested. Ronnel was relative ineffective as a fog or dust.

In tests run on the same night, mal thion fog (0.06 pound per acre) gave ki at or above 90 percent at all distances the "A" zone, whereas DDVP (0.07 lb acre) gave this level of mortality at 13 only. In the "B" zone, DDVP and mal thion gave 96 and 4 percent kills, resp tively, at 135′ but at all other distanc both compounds were ineffective. In tv similar tests, each of DDVP and Dia non fogs (0.06–0.1 pound per acre DDVP gave superior kills at 135′ in t "A" and "B" zones. At the greater d tances, neither compound was effecti in one test but in the second test DDV in the "A"/"B" zones gave percent ki of 100/100 and 1/27 at 270′ and 54 respectively; whereas with Diazinon, p cent mortalities of 87/17 and 86/7 we recorded at the same distances.

On the same nights, four tests of mal thion and Diazinon dusts yielded "A" zo kills of 80 and 48 percent for malathi at distances of 135′ and 270′, respectivel as compared to mortalities of 50 and

TABLE 1.—Average percent mortalities of caged *Aedes taeniorhynchus* exposed to malathion fog, mist, and dust treatments applied on the same nights. (Three tests each; mortalities are combined figures for "A" and "B" zones.)

tment	Lb./A.	Percent kill at 135′	270′	540′	810′
?og	0.1	98	53	38	0
Mist	0.2	94	55	32	27
Dust	0.3	63	79	3	3

TABLE 2.—Average percent mortalities of caged *Aedes taeniorhynchus* exposed to malathion fog and dust applications (0.1 lb./A.) on the same nights. (Number of tests in parentheses.)

tment	Percent kill at 135′	270′	540′	810′
(4)	92/63 [1]	96/27	79/13	35/8
t (5)	95/76	69/38	52/8	43/0

[1] "A" zone mortalities/"B" zone mortalities.

TABLE 3.—Average percent mortalities of caged *Aedes taeniorhynchus* exposed to fog or dust applications of malathion.

tment	Lb./A.	Percent kill at 135′	270′	540′	810′
(9) [1]	0.07–0.085	93/57 [2]	90/22	57/6	17/11
(4)	0.11–0.14	90/47	51/24	74/5	53/4

[1] Number of tests in parentheses.
[2] "A" zone mortalities/"B" zone mortalities.

LE 4.—Effectiveness of several organophosphorus compounds against caged *Aedes taeniorhynchus* as fog, mist, or dust treatments.

lication	Toxicant	No. test	Lb./A.	Percent mortality at 135′	270′	540′	810′
?og	Malathion	9	0.07–0.085	93/57 [1]	90/22	57/6	17/11
	Diazinon	3	0.10–0.15	93/87	96/46	57/15	11/10
		4	0.06–0.08	48/25	36/6	36/2	1/3
	Ronnel	2	0.08–0.10	14/36	7/6	1/2	2/2
	DDVP	3	0.06–0.10	97/96	44/37	2/9	2/0
Dust	Malathion	4	0.11–0.14	90/47	51/24	74/5	53/4
	Diazinon	5	0.07–0.12	53/53	28/14	23/6	3/5
	Ronnel	3	0.06–0.12	21/22	19/3	12/12	12/6
Mist	Malathion	2	0.26–0.31	100/100	100/54	52/38	52/28
		4 [2]	0.05–0.09	100/96	85/66	60/15	....
	Diazinon	2	0.06–0.11	85/78	23/22	59/4	15/1

[1] "A" zone mortalities/"B" zone mortalities.
[2] Percent concentration ranged from 0.8 to 1.6 percent.

percent for Diazinon. In the "B" zone, both compounds gave similar kills below 50 percent.

DISCUSSION. As the results show, fog treatments of malathion gave kills above those obtained with dust treatments. This difference was apparent in all tests (Tables 1, 2, and 3), particularly at distances of 135′ and 270′. However, it is possible that use of a lower dust concentration, whereby a greater amount of dust per acre would be required to obtain the same dosage, might have increased the kill. In the tests with a 4 percent dust, the effectiveness was similar to that obtained with mist applications. However, with a 4 percent dust the gross amount required per mile for the different application rates would have been approximately 110 to 220 pounds as compared to one-third that quantity for the 12.5 percent dust. Mist applications gave results similar to fog treatments.

The choice of selection of which technique to use apparently lies in other factors, such as public acceptance, prevailing environmental factors, ease of application, and cost of treatment. Local wind conditions may render impotent a dosage that was highly effective under conditions prevailing the previous night. A malathion mist applied at 0.05 pound per acre when the wind velocity was 2.2 mph gave 100 percent kills up to 660′ in the "A" zone. In contrast, a dosage of 0.1 pound per acre applied as a mist on a still night did not kill any mosquitoes even at 135′ from the machine. A dust application (0.05 pound per acre) of 4 percent malathi on the same calm night gave kills of 77, and 69 percent at 135′, 330′, and 66 respectively. Observations indicated th wind movements too low to be measur still were adequate to disseminate du but not mists. Fogs, because of their vi bility, can be observed more accurat than either dusts or mists; thus possess psychological benefit that is not necessar correlated with biological effectiveness.

The marked effect of vegetative barri on the efficacy of a treatment was evid in the various tests. In Table 3, the av age mortalities for nine malathion fog plications showed that kills of 90 to percent were obtained at "open" sites at d tances of 135′ and 270′. However, in t "B" zone where barriers (woods, etc.) fog movements were present, the effecti ness of the treatment was reduced consid ably as shown by kills of 57 and 22 perc at 135′ and 270′, respectively. The sa is evident in the four dust treatmer From these data, the presence of obstr tions at the 135′ and 270′ sites tends decrease the efficacy in the same deg as do distances beyond 270′ at the "ope sites.

On a comparative basis, malathion v the insecticide of choice of the four co pounds tested.

Despite the fact that one type of tre ment gave better results in certain exp ments, the biological data when consider in their entirety do not reflect a mark superiority of any one method of appli tion.