

# Vinegar Fly Control Treatments

effectiveness of insecticide formulations and of inert dust diluents assayed in laboratory studies using fruit crop pest

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**Thirty-six insecticides**, used both as emulsifiable concentrates and wettable powders—when both were available—and 19 types of inert dust diluents were included in laboratory studies on their immediate and residual effectiveness in the control of vinegar flies—*Drosophila melanogaster* Meigen.

In recent years vinegar flies have been steadily increasing in importance as pests of California fruit crops, particularly figs, tomatoes, and Thompson seedless grapes for raisins. However, no extensive laboratory evaluation with a wide variety of insecticides and formulations had been attempted until the present laboratory investigation.

A Fresno strain of vinegar flies—reared on canned pumpkin pie mix—and three types of insecticide application were used in the experiments.

A fly was considered dead when it could no longer move its entire body, even though movements of the appendages might still be discernible.

For a topical—direct application—treatment, adult flies were aspirated into an uncovered 4-ounce jar and anesthetized with carbon dioxide gas. They were immediately placed—still in the jar—in a settling tower, where a mist formed from 1% or 3% of toxicant was allowed to settle on the flies for three minutes while the jar revolved on a turntable. Then the flies were tapped into a clean 4-ounce jar which was placed in a room with a maintained mean temperature of 73°F and a mean relative humidity of 64%. Light was regulated for an intensity of about 120 foot candles throughout the day. A 30-mesh screen over the mouth of the jar was held in place by an iron washer. Three jars containing upwards

of about 50 flies each were used for each insecticide or formulation.

A continuous current of air was blown over the jars by an electric fan—during the period the mortality counts were made—to avoid mortality that might be attributable to the accumulation of insecticide vapors in the jars. The period required for 100% mortality was recorded for each of the three lots of insects.

The large table on the next page shows the relative effectiveness of 28 proprietary insecticides—the majority as emulsifiable concentrates and as wettable powders—tested by topical applications. There was a wide variation in effectiveness. Four of the formulations did not result in 100% mortality in seven hours. The most effective insecticides—Lethane 384 and TEPP—resulted in the death of all the flies in one minute for Lethane 384 and three minutes for TEPP.

With all the tested insecticides, the emulsifiable concentrate was superior to the wettable powder.

## Freshly Deposited Residues

To test freshly deposited insecticide residues, the venturi equipment of the settling tower was used to atomize one milliliter of emulsions or suspensions of 1% of toxicant upward into 4-ounce jars—held in place with a clamp—resulting in an even dispersion of tiny droplets over the interior of the jar, but not to the point of runoff of liquid. Thus the wetting agents in the proprietary insecticide formulations could have no effect on deposit.

Spray deposits were dried with an electric fan and a current of air was

blown over the jars during the course of the experiment. Approximately 50 flies were aspirated into each of three jars for each insecticide. The jars were covered with screens as in the topical application experiments. Counts of dead flies at

Time Required for 50% Mortality of Adult Vinegar Flies Exposed to Fresh Insecticide Residues

No. Insecticide <sup>1</sup>	M.L.P. <sup>2</sup> Minutes
1 Lethane 384-E	1
2 TEPP-E	1
3 Mathieson 1770-E	4
4 Pirazinon-W	12
5 Sulfotepp-E	15
6 Thanite-E	18
7 Malathion-W	20
8 Lindane-E	20
9 Malathion-E	22
10 Bayer L 13/59	22
11 Diazinon-E	23
12 Parathion-W	27
13 Am. Cyan. 12008-E	27
14 Am. Cyan. 4124-W	40
15 Parathion-E	43
16 Metacide-E	45
17 Demeton-E	50
18 DDT(A)-E	54
19 Diazinon-W	56
20 Dilan-W	62
21 Lindane-W	64
22 Pyrethrins-E	69
23 EPN-W	81
24 EPN-E	83
25 Heptachlor-W	90
26 Heptachlor-E	91
27 Dieldrin-W	95
28 Perthane-E	101
29 Aldrin-W	105
30 Aldrin-E	105
31 DDT(B)-E	108
32 TDE-E	112
33 Endrin-E	120
34 Chlorthion-E	120
35 Isodrin-W	122
36 DDT(B)-W	124
37 DDT(A)-W	136
38 Chlordane-E	136
39 Dieldrin-E	137
40 Isodrin-E	143
41 Pyrethrins and MGK 264 at 1:9	160
42 Chlordane-W	161
43 Perthane-W	165
44 TDE-W	182
45 Chlorthion-W	193
46 Allethrin-E	194
47 Methoxychlor-W	198
48 Rotenone-E	230
49 Toxaphene-W	305
50 Methoxychlor-E	420
51 Toxaphene-E	420

<sup>1</sup>The insecticides were used in the form of emulsifiable concentrates (E) or wettable powders (W) except for Bayer L 13/59, which was used as an aqueous solution. All insecticides were used at 1 wt./vol. % of actual toxicant.

<sup>2</sup>Median Lethal Period. (Average period for 50% kill.)

Minutes Required for 50% Mortality after Insecticide Weathering

Insecticide	Formulation	% Conc.	Weathering period in weeks							
			0	1	2	3	4	5	6	7
Malathion	Suspension	1	14	28	58	306	400	>420	...	...
Parathion	Suspension	1	17	29	63	323	>420	...	...	...
EPN	Suspension	1	45	35	60	101	131	312	399	>420
DDT (A)	Emulsion	1	48	212	>420	...	...	...	...	...
Dieldrin	Suspension	1	87	109	240	300	>420	...	...	...
DDT (B)	Suspension	2	94	102	140	164	190	181	295	390
DDT (B)	Suspension	1	126	151	200	168	208	357	>420	...
DDT (B)	Emulsion	1	131	240	>420	...	...	...	...	...
DDT (A)	Suspension	1	147	211	360	385	>420	...	...	...
Least Significant Difference			1	2	38	152	90	122	78	

<sup>1</sup> For values < 50 = 6.1; for values > 50 = 18.9.

<sup>2</sup> For values < 50, no significant difference; for values > 50 = 27.

the bottoms of the jars were made periodically and the time required for 50% mortality or median lethal period—MLP—was determined.

Lethane 384 and TEPP again were the two most effective insecticides. However, the flies must be placed in the jars treated with Lethane as soon as possible after the residues are dried because a delay of 10 minutes may greatly prolong the

period for 50% kill and a delay of 20 minutes may render the residues practically ineffective.

In contrast to the results with topical treatments, only about half of the freshly deposited residues of the emulsifiable concentrates were superior to the wettable powders.

## Weathered Residues

In the experiments with residues weathered in the laboratory—by passing a current of air from electric fans over the sprayed jars for one week before flies were placed in the jars—the majority of the residues were ineffective.

The seven most effective formulations, after a week of weathering, were selected for further testing with four jars, instead of three, for each of the seven formulations.

Only five of the seven insecticides remained reasonably effective after a week of weathering. Those were—in decreasing order of effectiveness—malathion, parathion, EPN, dieldrin, and DDT. The wettable powder formulations of all five insecticides were superior to the emulsifiable formulations after one week of weathering.

At weekly intervals—with jars continuously in a current of air—the dead flies of the tests made the previous week were removed and more flies were placed in the jars.

Two brands of DDT—designated as Brand A and Brand B—were used in the investigations. The only discernible difference in the brands was that the solvent in the emulsifiable concentrates of Brand B volatilized much more rapidly than the solvent in Brand A. The only discernible difference between the two brands of wettable powder formulation was in particle size of the diluent, that of Brand B being the smaller.

It is not known whether other factors may have influenced the relative effectiveness of the two brands of DDT.

In one test the concentration of DDT was doubled to compare the effectiveness of the 2% with the 1% concentrations.

Relative Effectiveness of 28 Insecticides in Topical Applications against Vinegar Fly Adults as Based on Period Required for 100% Kill

No.	Insecticide <sup>1</sup>	Concent. % actual	100% kill Minutes
1	Lethane 384-E	1	1
2	TEPP-E	1	3
3	Mathieson 1770-E <sup>2</sup>	1	3
4	Bayer L 13/59	1	7
5	Sulfotepp-E	1	11
6	Pirazinon-W	1	13
7	Malathion-E	1	14
8	Demeton-E	1	14
9	Diazinon-E	1	15
10	Am. Cyan. 12008-E	1	17
11	Malathion-W	1	19
12	Diazinon-W	1	19
13	Mathieson 1769-E <sup>3</sup>	1	22
14	Parathion-E	1	28
15	Metacide-E	1	29
16	Am. Cyan. 4124-E	1	31
17	Lindane-E	1	35
18	Parathion-W	1	37
19	Pyrethrins-E	1	46
20	Thanite-E	1	52
21	DDT(A)-E	1	62
22	Allethrin-E	1	77
23	EPN-E	1	87
24	EPN-W	1	103
25	DDT(B)-E	1	134
26	DDT(B)-W	1	142
27	DDT(A)-W	1	200
28	Pyrethrins and MGK 264-E	1	284
29	Allethrin and MGK 264-E	1	315
30	DDT (A)-E	3	24
31	Isodrin-E	3	41
32	Chlorthion-E	3	52
33	Dilan-E	3	73
34	Methoxychlor-E	3	79
35	Rotenone-E	3	125
36	Dilan-W	3	157
37	Lindane-W	3	162
38	Endrin-E	3	179
39	Perthane-E	3	188
40	Toxaphene-E	3	220
41	TDE-E	3	234
42	Chlorthion-W	3	295
43	Chlordane-E	3	313
44	DDT(B)-W	3	336
45	TDE-W	3	348
46	Heptachlor-E	3	390
47	Aldrin-E	3	400
48	Isodrin-W	3	409
49	Methoxychlor-W	3	412
50	Dieldrin-E	3	>420 <sup>4</sup>
51	Chlordane-W	3	>420
52	Toxaphene-W	3	>420
53	Heptachlor-W	3	>420
54	Aldrin-W	3	>420
55	Dieldrin-W	3	>420
56	Perthane-W	3	>420

<sup>1</sup> The insecticides were used in the form of an emulsifiable concentrate (E) or wettable powder (W), except for Bayer L 13/59, which was used as an aqueous solution.

<sup>2</sup> 4-Nitro-2-chlorophenyl diethylphosphate.

<sup>3</sup> 4-Nitro-2-chlorophenyl diethylthionophosphate.

<sup>4</sup> The per cent of kill in seven hours for numbers 50 to 56 ranged from 96 for dieldrin-E to 89 for Perthane-W.

Relative Effectiveness of the Five Most Persistent Insecticides<sup>1</sup>

Insecticide	Topical application	Fresh residues	Weathering period in weeks					
			1	2	3	4	5	6
Malathion	1	1	1	1	4	3	.	.
Parathion	2	2	2	3	5	2	.	.
EPN	3	3	3	2	1	1	1	1
Dieldrin	4	4	4	5	3	.	.	.
DDT	5	5	5	4	2	2	.	.

<sup>1</sup> All insecticides were wettable powders and were used in a concentration of 1 wt./vol. per cent of actual toxicant. The data for DDT refer to Brand B. The numbers, from 1 to 5, indicate the decreasing order of effectiveness of the insecticides, based on the numerical differences in median lethal period, which are not in all cases statistically significant.

<sup>2</sup> More than 7 hours required for 50% kill.

In two weeks, the residues of the DDT emulsifiable concentrates required more than 420 minutes to effect a 50% kill of flies, but with all the other residues the median lethal period—MLP—was never as high as 420 minutes. On the other hand, the residual effectiveness of the wettable powders of DDT was greatly prolonged. The more effective of the two DDT wettable powders—Brand B—surpassed the effectiveness of dieldrin after the second week and remained effective two weeks longer than dieldrin. A 2% concentration of DDT wettable powder—Brand B—was significantly inferior to dieldrin wettable powder at 1% concentration in the freshly deposited residues. However, after one week of weathering the two were about equal in effectiveness and in two weeks the DDT was greatly superior. This treatment remained effective longer than any of the others, although EPN at 1% concentration had nearly the same degree of persistence as an active residue.

The superiority of DDT Brand A as an emulsion and DDT Brand B as a suspension was apparent. With the freshly deposited residues the difference between the two brands was extreme with the emulsions, but slight with the suspensions. After a week of weathering, the difference between the emulsions had disappeared. Differences in the suspensions became accentuated and continued to increase during the following weeks. The residues from the DDT Brand B wettable powder persisted for a period two weeks longer than the residues from the DDT Brand A.

## Inert Dust Diluents

Highly sorptive clays, diatomaceous earths, and silica aerogels—inert dusts—can kill some insects, such as termites, cockroaches, and house flies, by adsorbing the very thin protective layer of wax, or a combination of wax and oil, that normally prevents their desiccation. The effectiveness of inert dusts against those insects led to trials with vinegar flies because they too become well covered with dusts as they crawl about on a residue. One or two representatives of each of 19 different types of dust diluents—that had proved most effective in previous tests with drywood termites—were selected for tests on vinegar flies.

When vinegar flies were placed in 4-ounce jars dusted with certain inert dust diluents and then completely closed, there were unmistakable signs of irritation within a few minutes. At a temperature of 75°F and a relative humidity of 60%, one of the silica aerogels, SG 77, resulted in 100% mortality in 28 minutes. This was slightly

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## VINEGAR FLIES

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less time than required with 2.5% dieldrin dust. SG 77 was the most effective of the inert dusts. Also it deposited well on the vertical walls of the jars in which the flies were contained. This was also true of the dieldrin dust. However, the other silica aerogels, as well as most of the other inert dusts, deposited little or no residue on the vertical glass surfaces, so a great amount of dust was allowed to accumulate on the bottoms of the jars so that the flies would become completely covered with it.

Two other silica aerogels—Hi Sil and Santocel C—as well as the more effective clays—Attaclay and Olancha Clay—resulted in 100% mortality in periods

ranging from one and one half hours to three hours.

When samples of botanical diluents, sulfur, slaked lime, pyrophyllite, talc, Celaton NN-41—a diatomite—Friarite, and road dust were tested, they had little or no effect on the flies. The relative ineffectiveness of some diluents, such as Barden clay, is compensated to some extent by their ability to deposit a heavy layer of dust.

The effectiveness of dust deposits is greatly enhanced if sufficient material is present so that much of it is readily picked up by the insect and becomes widely distributed over its body. Certain diluents that are inherently highly effective—such as Attaclay, Olancha Clay, and silica aerogels—would probably be greatly improved by an additive that

would increase their ability to deposit well on smooth surfaces.

When heavy dust deposits of Attaclay and Olancha Clay were wet by atomizing water on them, and were then dried, they were not so effective in killing vinegar flies as the initial dry deposits because they were not picked up in an adequate amount by the insects. However, when the dust deposits were so light that excess dust could not be removed from the glass surfaces by tapping the dusted jars on the table, wetting and subsequent drying of the dust did not adversely affect their effectiveness.

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## MEATS

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In Alameda County these stores were largely nonaffiliated independent stores with one or two employees. They accounted for 31% of the independent stores—36% of the nonaffiliated and 18% of the affiliated ones—and for 40% of the stores with one or two employees. Four of the eight isolated stores surveyed in Alameda carried frozen meats and cold cuts and 25% of the downtown stores and those in neighborhood-secondary shopping areas did so.

In San Diego where one fifth of the stores were limited to frozen meats and cold cuts, those stores were—for the most part—nonaffiliated independents with one or two employees. In this county the stores carrying frozen meats and cold cuts accounted for 23% of the independents—26% of the nonaffiliated and 12% of the affiliated stores. They constituted over 29% of the stores with one or two employees and almost 12% of those with 3-6 employees. They accounted for 21% of the stores in neighborhood-secondary shopping areas, 18% of the isolated stores, and only 7% of the downtown stores.

### Fresh Meats and Cold Cuts

Stores carrying fresh meats and cold cuts were slightly fewer in number than those stocking frozen meats and cold cuts. Most of these stores were in Fresno and Los Angeles and were largely nonaffiliated independents with less than six employees.

In Fresno, where such stores were most common, about 30% of the nonaffiliated independents but only 9% of the affiliated ones carried this combination of meats. Over 29% of the stores with one or two employees and 17% of

those with 3-6 employees likewise carried these meats. Stores carrying these meats constituted 20% of the downtown stores, 23% of the isolated stores, and 24% of those in neighborhood-secondary shopping areas.

In Los Angeles the combination of fresh meats and cold cuts was available in 12% of the isolated stores and in about the same proportion of stores in neighborhood-secondary shopping areas. The two types of meat were carried by 22% of the nonaffiliated independents and by only 7% of the affiliated ones. They were available in over 19% of the stores with one or two employees and in 10% of those with 3-6 employees.

### Stores Offering Fresh Meat

Fresh meats were somewhat more commonly available in urban than in rural stores. From 67% to 87% of the rural stores in Butte, Fresno, and San Diego counties carried them. From 77% to 94% of the urban stores in four counties had them but in Alameda only 64% of these stores carried fresh meats.

There was not much difference in the availability of fresh meats in downtown stores and in those in neighborhood-secondary shopping areas in the different counties although there was variation from county to county. These meats were carried by 65% of the downtown and neighborhood-secondary stores in Alameda, 84% to 87% in Los Angeles, 90% to 94% in Butte, and 90% to 100% in Fresno, and 76% to 79% in San Diego. In most counties the proportions of isolated stores carrying them were slightly smaller than stores in other areas.

Fresh meats were almost always carried by chain stores—96% to 100%—except in Fresno where 90% carried them. Smaller proportions of independent stores—from 57% in Alameda to

92% in Fresno—carried fresh meats. From 82% to 100% of the affiliated independents in each county and from 47% to 89% of the nonaffiliated carried fresh meats.

In each of the counties almost all of the stores with seven or more employees carried fresh meats. Over 90% of the stores with 3-6 employees carried them except in San Diego where 86% did so. The proportions of stores with one or two employees which carried fresh meats were considerably lower than the proportions of those with three or more employees. In Alameda 45%, San Diego 64%, Los Angeles 73%, Butte 75%, and Fresno 87% of the stores with one or two employees carried fresh meats.

### Stores Offering Frozen Meats

The proportions of each type of store which carried frozen meats were similar to the proportions carrying fresh meats. The proportions carrying them were higher in urban stores than in rural stores in Butte and Fresno. From 72% to 92% of the urban stores carried frozen meats in the five counties.

Frozen meats were available in 79% to 100% of the downtown stores, in 70% to 94% of those in neighborhood-secondary shopping areas, and in 70% to 88% of the isolated stores.

In each of the counties 96% to 100% of the chain stores carried frozen meats but only 69% to 92% of the independents carried them. From 90% to 100% of the affiliated independents had frozen meats, but only 62% to 89% of the nonaffiliated.

Practically all the stores with seven or more employees carried frozen meat. The proportions of those with 3-6 employees were also high—83% to 100%. However, the proportions of stores with one or two employees which had frozen