Comparative Toxicity of Some New Insecticides to Beet Leafhoppers on Sugar Beets in Idaho, 1947[1]

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THE DEVELOPMENT of varieties of sugar beets resistant to curly top has made it profitable to grow beets again in areas of the western part of the United States that are affected by the beet leafhopper, *Circulifer tenellus* (Bak.). These resistant varieties are susceptible to curly top during the early stages of growth. The beet leafhopper is the vector of the virus of this disease. When a large spring movement of beet leafhoppers has coincided with the seedling stage of the plant, serious losses from curly top have occurred in California, Idaho, Montana, Nevada, Utah, Washington, and Wyoming. Although the losses have been local in extent, they have dealt hard blows to growers in affected areas.

In the mechanized program of sugar beet production the development of segmented, or sheared, seed is important in reducing hand labor in thinning. The use of sheared seed has materially reduced the number of plants per acre as compared with the number obtained with the conventional seedball method of planting. Consequently, with fewer plants available, a given number of leafhoppers will infect a larger proportion of plants with curly top.

Giddings (6)[3] showed that resistance of the sugar beet to curly top increases rapidly with the size and age of the plant. Annand *et al.* (1) and Douglass *et al.* (4) showed that the magnitude and time of spring movement of the leafhoppers into beet fields are important factors that influence the extent of curly-top epidemics. Hills (8) found that leafhoppers entering the beet fields late in the season are relatively unimportant in causing damage by curly top. Douglass *et al.* (5) showed that most of the incoming beet leafhoppers enter the beet fields in continuous movements over a period of several days or during heavy flights of short duration.

In 1947 the initial movement of the spring generation into beet fields on the western edge of the Twin Falls, Idaho, irrigation tract started on May 7. The peak of the movement was reached on May 26, when the average adult population recorded was 1,615 per 100 square-foot samples.

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[3]Numbers in parentheses refer to literature cited.

Seventy-six percent of the leafhoppers entered the fields between May 19 and 26. It is impossible to determine the period between the peak and the end of the spring movement, as there is no practical method of distinguishing incoming leafhoppers from those already there. Apparently, if the young, susceptible plants were kept free from beet leafhoppers for approximately 2 or 3 weeks during the spring movement in outbreak years, curly-top infection would be reduced sufficiently to make control operations profitable. With this thought in mind, we shall confine our discussion to the control of the spring populations.

For years various workers have tried to control curly top by controlling the beet leafhopper. Cook (2), Douglass *et al.* (3), *and* Romney (9) showed that pyrethrum killed beet leafhoppers but did not have any residual effect. De Coursey[4] found that pyrethrum extract could be used with sulfur without decreasing the effectiveness of either material. Sulfur had a residual effect upon the eggs and young nymphs, but was not effective against the adults and larger nymphs. Experiments with pyrethrum mixed with various sulfurs showed that these materials reduced both adult and nymphal populations present at the time of treatment, but were not effective against adults coming later.

Many materials have been tested at the Twin Falls laboratory of the Bureau of Entomology and Plant Quartine in order to develop an insecticide that would give protection to plants against curly-top infection. The results of field experiments in 1947 are presented herein. These experiments were designed to compare the toxicity of several new insecticides, including their residual effect, when applied in different formulations as dusts, sprays, or mists. Therefore, the work was delayed until high populations of leafhoppers were present in the fields. No curly-top control was planned, as the object was to determine the most effective material in its most efficient formulation.

Methods

Thirteen experiments were conducted between June 6 and July 18, 1947, in cooperation with Harry A. Elcock, Idaho manager of the Amalgamated Sugar Company, and beet growers of Buhl and Castleford, Idaho. The fields selected for treatment were located on the western edge of the Twin Falls irrigation tract, and were close to the leafhopper spring-breeding grounds that lie to the west of this cultivated area.

The effectiveness of the materials was determined by comparing pre-treatment and post-treatment numbers of adult beet leafhoppers. The counts were made with the Hills (7) square-foot sampler, which traps the insects in a circular cage. The samples, which were taken at random along the beet rows, included more than one plant in unthinned fields but single

[4]De Coursey, J. D. Studies on the effect of certain insecticides on the beet leafhopper with special reference to lime sulfur. Thesis on file at University of Illinois, 1941.

plants in thinned fields. Pre-treatment counts were made either just prior to treatment or the day before, by taking 100 samples in each field, 25 samples in each quarter. Post-treatment counts were made 1, 7, and 15 days after treatment, except in experiment 7, when counts were made after 2, 8, and 14 days. Either 10 or 15 samples per plot were taken, depending on the post-treatment population.

The randomized-block method was used in setting up the experiments. The fields were divided into 16-row parallel plots. The number of plots determined the number of treatments and replications in each field. The number of treatments in each experiment ranged from 3 to 6 and the number of replications from 2 to 9.

Figure 1.—Spraying beets for the control of the beet leafhopper, Castleford, Idaho, June 19, 1947.

All materials were applied with power equipment. The water sprays were applied with a 24-nozzle sprayer mounted on a tractor, as shown in figure 1. This sprayer covered 8 rows at a time. The spray was applied at the rate of approximately 90 gallons per acre except in cases where it was considered advisable to vary the dosage. The pressure was 400 pounds per square inch. The dusts were applied with an 8-nozzle duster mounted on

Figure 2.—Dusting beets for the control of the beet leafhopper, Castleford, Idaho, June 15, 1947.

a trailer and attached to a tractor, as shown in figure 2. This duster covered 8 rows at a time and was equipped with a 24-foot trailer-type hood. The mists, or vapor sprays, were applied with a vapor sprayer mounted on a trailer and pulled by a tractor, as shown in figure 3. This sprayer also covered 8 rows with 2 nozzles directed at each row. A pressure of 5 pounds per square inch was used on the liquid side of each nozzle and 12 pounds on the air side. An adjustable wire-glass hood was constructed to reduce the drift of the mist sprays.

Figure 3.—Applying concentrated materials with a vapor sprayer for the control of the beet leafhopper, Castleford, Idaho, June 19, 1947.

Before each treatment, the plots were marked by a white flag placed near the plot stake. As a double check, the numbers of the plots to be treated were given to the spray operator.

The emulsions and vapor sprays were made at the laboratory in steel cans immediately preceding application. The other materials were taken to the fields and either measured or weighed out and added directly to the spray tanks as they were being filled from irrigation ditches. The dusts were used as prepared by the manufacturer.

The weather conditions during the treatments were recorded by instruments located in the fields. Rains fell almost daily from May 27 to June 11 and totaled 2.67 inches. This period of inclement weather delayed the work.

Insecticides Tested

The following materials were tested, alone or in combination, as dusts, sprays, or mists:

Benzene hexachloride	Hexaethyl tetraphosphate
Chlordane	Pyrethrum
Chlorinated camphene	Sulfur
DDT	TDE

The wettable powders, as well as the oil-soluble and water-miscible chlorinated camphene and pyrethrum extract, were proprietary preparations. The chlordane and DDT were technical grade. The hexaethyl tetraphosphate preparation was stated by the manufacturer to contain 100 percent of hexaethyl tetraphosphate; however, the content of tetraethyl pyrophosphate in this preparation is unknown. The pyrethrum extract contained not less than 2 grams of pyrethrum in each 100 cubic centimeters. The summer oil No. 2, light-medium, contained a minimum of 92 percent of unsulfonated residue and had a viscosity of 60-65 seconds Saybolt. The solvents used were toluene, xylene, and a proprietary nonvolatile solvent, chiefly di- and tri-methylnaphthalenes. The proprietary emulsifiers are hereinafter referred to as emulsifiers A and B. Emulsifier A contained 80 percent of polyakyl aryl polyether alcohol and 20 percent of isopropanol, and emulsifier B consisted chiefly of a phthalic glyceryl alkyd resin. The "depositor" referred to in table 1 was a proprietary "colloidal depositor containing petroleum sulfonates and combined fatty acids." The spreader-sticker listed in the table was a proprietary product, the principal functioning agents being "sodium sulfate of mixed long chains, alcohol--fatty acid esters, and diethylene glycol abietate."

The four emulsions listed in table 1 as A, B, C, and D were as follows (all formulations for 100 gallons of spray): A contained 1.5

pounds of technical DDT, 1,200 milliliters of non-volatile solvent, and 100 milliliters of emulsifier A; B contained 1.5 pounds of technical DDT, 850 milliliters of toluene, and 85 milliliters of emulsifier B; C contained 1 pound of technical chlordane, 450 milliliters of non-volatile solvent, and 126 milliliters of emulsifier A; D contained 1 pound of water-miscible chlorinated camphene, 900 milliliters of non-volatile solvent, and 126 milliliters of emulsifier A.

Results

Factors influencing control of the beet leafhopper have been discussed (Douglass *et al.* 3). It has also been shown (Douglass *et al.* 5) that cool, cloudy, rainy, and windy weather affect the activity of this leafhopper. In bad weather leafhoppers hide under clods, in cracks, in trash, and between beet-leaf petioles, where they are not hit by the spray. The same factors may also affect the accuracy of the population counts, because the adult beet leafhopper is an extremely active insect.

The results obtained with 41 treatments in 13 experiments on 353 plots totaling 143 acres are given in tables 1, 2, and 3. Although the differences required for significance are given at two levels in the tables, the discussion of the data is based on the 1-percent level.

The data obtained from the sprays and mists are presented in table 1. At the 1-percent level the DDT emulsions gave better reduction in beet-leafhopper populations 1 day after treatment than the DDT suspensions. However, after 7 and 15 days there was no difference between emulsions and suspensions. The addition of pyrethrum, wettable sulfur, or hexaethyl tetraphosphate did not increase the effectiveness of the DDT emulsions. Wettable DDT plus a spreader-sticker or benzene hexachloride was significantly better than wettable DDT plus wettable sulfur after 1 day but not after 7 and 15 days. Generally speaking, all the DDT treatments were significantly better than chlordane, chlorinated camphene, or hexaethyl tetraphosphate.

As mist sprays all the DDT formulations were more effective than the chlordane and chlorinated camphene formulations. There is some indication, however, that chlorinated camphene is more effective than chlordane. In experiment 12, generally speaking, DDT sprays were just as effective when applied at 80 gallons (1.2 pounds DDT) per acre (treatment 33) as when applied at 140 gallons (2.1 pounds) per acre (treatment 30).

Table 2 shows that DDT dust mixtures were significantly better than the chlordane and chlorinated camphene dusts after 1 and 7 days (experiment 5), but that there were no differences after 15 days. Experiment 9 was designed to apply 10-percent TDE dust at 5, 10, 20, and 40 pounds per acre and to compare the effectiveness of this material with a 10-percent-DDT-sulfur dust applied at 40 pounds per acre. The TDE dust was not very effective after 1 day, but after 7 and 15 days it showed a residual effect which, in most cases, was equal to that of the DDT dust.

In experiment 10 the 38-pound-per-acre application was significantly better than the 10-pound rate after 1 day, but after 7 and 15 days there were no significant differences. All the treatments showed an increase in population over the pre-treatment counts after 15 days.

In experiments 7 and 8 (table 3) the DDT formulations that had previously shown the greatest promise were used. All the formulations were effective against the leafhopper, whether applied as a dust, a mist, or a spray. Since the amount of DDT actually applied per acre was not the same with each type of equipment, a complete evaluation of the three types of applications cannot be made.

The results with outstanding DDT sprays, dusts, and mists applied in two or more fields are compared in table 4. After 1 day, treatment 1 was significantly more effective than treatment 18. After 7 and 15 days there was no significant difference between the two treatments. The addition of pyrethrum extract to the DDT formulations did not increase their effectiveness, as there was no significant difference between treatments 1 and 2 or between 13 and 25 after 7 or 15 days. There was no significant difference between treatments 7 and 8 or between 13 and 14 after 1, 7, and 15 days. The DDT-xylene emulsion was just as effective as the DDT-oil-pyrethrum formulation. Treatment 13, a DDT-oil spray containing pyrethrum extract, was no more effective than treatment 25, a DDT-oil emulsion.

Summary

In 1947 experiments were conducted in southern Idaho with several new insecticide against the beet leafhopper, *Circulifer tenellus* (Bak.), the vector of curly top on sugar beets. These experiments were designed to compare the toxicity of these materials, including their residual effect, when applied in different formulations as dusts, sprays, or mists. There were 143 acres of beets including 353 parallel plots, 16 rows wide, arranged in randomized blocks.

In general, emulsions of DDT were more toxic than suspensions of this insecticide after 1 day but not after 7 and 15 days. The addition of pyrethrum extract, wettable sulfur, or hexaethyl tetraphosphate did not increase the toxicity of the DDT emulsion.

Chlordane, TDE, hexaethyl tetraphosphate, and chlorinated camphene were relatively ineffective against this leafhopper. DDT was the most effective insecticide tested, whether applied as a water spray, dust, or mist.

Table 1.—Change in beet leafhopper population on sugar beet plots after treatment with various insecticides applied as mists and sprays.[1]

Treatment No.	Materials applied[2]	Plot size (acre)	Rate of application (gallons per acre)	Percent reduction or increase at indicated time after treatment[3] 1 day	7 days	15 days
	Experiment 1, June 6, 6 replicates (Pre-treatment population 803 per 100 square feet)					
	DDT, 1.5 lb. (emulsion A):					
1	Alone	0.34	95	98	79	23
2	Plus pyrethrum extract, 1 qt.	.34	91	98	83	50
3	Plus wettable sulfur, 10 lb.	.34	93	99	80	26
4	Plus hexaethyl tetraphosphate, 1 qt.	.34	91	99	80	45
	Difference required for significance at 5-% level			[4]	[4]	[4]
	Experiment 2, June 6, 6 replicates (Pre-treatment population 803 per 100 square feet)					
	DDT, 50% wettable:					
5	3 lb., plus spreader-sticker, 8 oz.	0.41	87	55	83	47
6	3 lb., plus wettable sulfur, 10 lb.	.43	90	41	86	56
17	2 lb., plus wettable benzene hexachloride (6% gamma isomer), 3 lb.	.43	92	55	84	49
18	DDT, 1.5 lb. (emulsion B)	.42	89	92	85	59
	Difference required for significance:					
	At 5-% level			12	[4]	[4]
	At 1-% level			17		
	Experiment 3, June 13, 8 replicates (Pre-treatment population 1,660 per 100 square feet)					
	DDT, 1.5 lb.:					
1	Emulsion A	0.30	97	78	84	55
18	Emulsion B	.30	95	68	74	62
19	DDT, 50% wettable, 3 lb.	.30	92	33	76	59
20	DDT, 50% wettable, 3 lb.	.30	95	30	80	61
	Difference required for significance at 5-% level			[4]	[4]	[4]

Table 1—(Cont.).— Change in beet leafhopper population on sugar beet plots after treatment with various insecticides applied as mists and sprays.[1]

Treatment No.	Materials applied[2]	Plot size (acre)	Rate of application (gallons per acre)	Percent reduction or increase at indicated time after treatment[3] 1 day	7 days	15 days
	Experiment 4, June 13, 5 replicates (Pre-treatment population 963 per 100 square feet)					
21	Chlordane, 1 lb. (emulsion C)	0.36	91	+6	+33	+47
22	Chlorinated camphene, 1 lb. (emulsion D)	.35	98	11	+56	+42
23	DDT, 50% wettable, 3 lb. plus summer spray oil, 1 gal., emulsifier B, 8 oz., and "depositor," 1 lb.	.35	92	73	30	+20
24	Hexaethyl tetraphosphate, 1 pt.	.36	90	+8	+32	+62
	Difference required for significance:					
	At 5-% level			26	57	[4]
	At 1-% level			37	81	
	Experiment 6, June 18, 4 replicates (Pre-treatment population 698 per 100 square feet)					
	DDT, 4.5 lb. plus:					
11	Xylene, 1 gal., and spray oil, 11 gal.	0.64	2.8	90	23	0
12	Xylene, 1 gal., emulsifier A, 100 ml., spray oil, 4 gal., and water, 7 gal.	.64	3.0	97	49	40
13	Pyrethrum extract, 3 qt., xylene, 1 gal., and spray oil, 10.25 gal.	.64	2.4	99	33	11
14	Xylene, 1 gal., emulsifier A, 100 ml., and water 11 gal.	.64	3.0	98	50	32
15	Chlorinated camphene, 25% oil-soluble, 18 lb. plus xylene, 1 gal., and spray oil, 11 gal.	.64	4.3	78	36	8
16	Chlordane, 4.5 lb. plus xylene, 1 gal., and spray oil, 9 gal.	.64	2.8	47	6	+58
	Difference required for significance:					
	At 5-% level			14	49	54
	At 1-% level			19	68	75
	Experiment 11, July 3, 8 replicates (Pre-treatment population 1,362 per 100 square feet)					
	DDT:					
1	1.5 lb. (emulsion A)	0.42	86	89	63	26
2	1.5 lb. (emulsion A), plus pyrethrum extract, 1 qt.	.42	86	74	68	40
13	4.5 lb., plus pyrethrum extract, 3 qt., xylene, 1 gal., and spray oil, 10.25 gal.	.42	3	95	57	41
18	1.5 lb. (emulsion B)	.42	89	2	65	42
25	4.5 lb., plus xylene, 1 gal., emulsifier A, 100 ml., spray oil, 1 gal., and water, 10 gal.	.42	4	97	56	46
26	1.5 lb., plus non-volatile solvent, 1,200 ml., emulsifier A, 100 ml., and water, 11.5 gal.	.42	3	79	53	43
	Difference required for significance:					
	At 5-% level			12	13	18
	At 1-% level			16	17	23

Table 1—(Cont.).—Change in beet leafhopper population on sugar beet plots after treatment with various insecticides applied as mists and sprays.[1]

Treatment No.	Materials applied[2]	Plot size (acre)	Rate of application (gallons per acre)	Percent reduction or increase at indicated time after treatment[3]		
				1 day	7 days	15 days
	Experiment 12, July 5, 6 replicates (Pre-treatment population 1,050 per 100 square feet)					
	DDT, 1.5 lb. (emulsion A) plus:					
30	Pyrethrum extract, 2 oz. Tractor speed, 2nd gear	0.45	140	93	75	23
31	Pyrethrum extract, 2 oz. Tractor speed, 3rd gear	.45	121	92	73	20
32	Pyrethrum extract, 2 oz. Tractor speed, 4th gear	.45	82	88	70	13
33	Pyrethrum extract, 2 oz. (Normal amount of stock emulsion doubled per 100 gal.) Tractor speed, 4th gear	.45	80	86	75	35
	Difference required for significance:					
	At 5-% level			7	9	15
	At 1-% level			9	13	20
	Experiment 13, July 18, 5 replicates (Pre-treatment population 1,222 per 100 square feet)					
	DDT, 50% wettable, 2 lb., plus:					
39	Spreader-sticker, 8 oz., and pyrethrum extract, 1 qt.	0.42	114	--	47	--
40	Spreader-sticker, 8 oz., pyrethrum extract, 1 qt., and sulfur wettable, 10 lb.	.42	89	--	28	--
41	Sulfur, wettable, 10 lb., plus spreader-sticker, 8 oz., plus pyrethrum extract, 1 qt.	.43	88	--	27	--
	Difference required for significance:					
	At 5-% level				26	
	At 1-% level				38	

[1]Treatments applied at more than 80 gallons per acre are sprays; those applied at less than 5 gallons are mists.
[2]In 100 gallons of water unless otherwise indicated.
[3]Reduction unless preceded by plus (+) sign.
[4]Not significant according to the F test.

Table 2.—Change in beet leafhopper population on sugar beet plots after treatment with various insecticidal dusts in 1947.

Treatment No.	Materials applied[1]	Plot size (acre)	Rate of application (pounds per acre)	Percent reduction or increase at indicated time after treatment[2] 1 day	7 days	15 days
	Experiment 5, June 15, 7 replicates (Pre-treatment population 928 per 100 square feet)					
7	DDT-pyrophyllite	0.28	20	92	53	6
8	DDT-sulfur	.28	19	86	57	+ 4
9	Chlorinated camphene	.28	22	14	+24	+50
10	Chlordane	.28	18	5	+16	+55
	Difference required for significance:					
	At 5-% level			15	45	49
	At 1-% level			21	61	67
	Experiment 9, June 24, 9 replicates[3] (Pre-treatment population 1,291 per 100 square feet)					
34	TDE-sulfur	0.25	3	+29	+13	45
35	TDE-sulfur	.24	7	+ 6	14	34
36	TDE-sulfur	.24	25	35	32	43
37	TDE-sulfur	.23	41	9	55	18
38	DDT-sulfur	.25	41	74	40	44
	Difference required for significance:					
	At 5-% level			21	36	17
	At 1-% level			28	49	24
	Experiment 10, July 1, 6 replicates (Pre-treatment population 1,112 per 100 square feet)					
27	DDT-talc	0.42	10	40	44	– 6
28	DDT-talc	.42	18	65	37	+11
29	DDT-talc	.42	38	72	55	+17
	Difference required for significance:					
	At 5-% level			18	13	26
	At 1-% level			26	19	37

[1]Dust mixtures contained 10 percent of active ingredient.
[2]Reduction unless preceded by plus (+) sign.
[3]Treatment 37, 2 replicates; treatment 38, 7 replicates.

Table 3.—Change in beet leafhopper populations on sugar beet plots after treatment with various insecticides applied as dusts, mists, and sprays.[1]

Experiment 7, June 19, 6 replicates[2]
(Pre-treatment population 1,335 per 100 square feet)

Treatment No.	Materials applied[3]	Plot size (acre)	Rate of application (per acre)	Percent reduction or increase at indicated time after treatment[4] 1 day	7 days	15 days
	DDT:					
1	1.5 lb. (emulsion A)	0.61	87 gal.	96	95	66
18	1.5 lb. (emulsion B)	.61	90 gal.	95	89	66
7	In pyrophyllite	.65	15 lb.	98	90	62
8	In sulfur	.61	18 lb.	96	94	65
13	4.5 lb., plus pyrethrum extract, 3 qt., xylene, 1 gal., and spray oil, 10.25 gal.	.61	3 gal.	98	93	54
14	4.5 lb., plus xylene, 1 gal., emulsifier A, 100 ml., and water, 11 gal.	.61	4 gal.	93	83	67
	Difference required for significance:					
	At 5-% level			5	7	13
	At 1-% level			6	9	18

Experiment 8, June 23, 4 replicates
(Pre-treatment population 908 per 100 square feet)

Treatment No.	Materials applied[3]	Plot size (acre)	Rate of application (per acre)	1 day	7 days	15 days
	DDT:					
1	1.5 lb. (emulsion A)	0.35	90 gal.	86	69	15
18	1.5 lb. (emulsion B)	.34	91 gal.	68	37	9
7	In pyrophyllite	.36	20 lb.	86	75	2
8	In sulfur	.36	28 lb.	86	75	+2
13	4.5 lb., plus pyrethrum extract, 3 qt., xylene, 1 gal., and spray oil, 10.25 gal.	.35	2 gal.	88	70	+13
25	4.5 lb., plus xylene, 1 gal., emulsifier A, 100 ml., spray oil, 1 gal., and water, 10 gal.	.34	4 gal.	87	75	15
	Difference required for significance:					
	At 5-% level			5	26	47
	At 1-% level			7	36	65

[1]Treatments applied at more than 80 gallons per acre are sprays; those applied at less than 5 gallons are mists. For dust treatments the rate of application is given in pounds per acre.
[2]Post-treatment population counts were made 2, 8, and 14 days after treatment.
[3]In 100 gallons of water unless otherwise indicated, dust mixtures at 10-percent strength.
[4]Reduction unless preceded by plus (+) sign.

Table 4.—Comparative data on the average results of outstanding treatments applied in two or more experiments.

Treatment No.	Materials applied[1]	Number of replications	Percentage decrease on indicated days after treatment		
			1 day	7 days	15 days
	DDT, 1.5 lb.:				
1	Emulsion A (spray)	24	86	84	45
18	Emulsion B (spray)	24	75	74	52
	Difference required for significance: At 5-% level		8	8	11
	At 1-% level		11	11	15
	DDT, 1.5 lb.:				
1	Emulsion A (spray)	14	91	67	22
2	Emulsion A plus pyrethrum extract, 1 qt. (spray)	14	81	72	41
	Difference required for significance: At 5-% level		14	8	23
	At 1-% level		20	11	32
7	DDT-pyrophyllite dust	17	93	72	29
8	DDT-sulfur dust	17	90	77	26
	Difference required for significance: At 5-% level		3	8	18
	At 1-% level		5	10	25
	DDT, 4.5 lb.:				
13	Plus pyrethrum extract, 3 qt., xylene, 1 gal., and spray oil, 10:25 gal. (mist)	10	98	76	39
14	Plus xylene, 1 gal., emulsifier A, 100 ml., and water, 11 gal. (mist)	10	93	72	55
	Difference required for significance: At 5-% level		7	16	17
	At 1-% level		9	24	24
	DDT, 4.5 lb.:				
13	Plus pyrethrum extract, 3 qt., xylene, 1 gal., and spray oil, 10:25 gal. (mist)	12	92	57	23
25	Plus xylene, 1 gal., emulsifier A, 100 ml., spray oil, 1 gal., and water, 10 gal. (mist)	12	94	58	34
	Difference required for significance: At 5-% level		3	11	17
	At 1-% level		4	15	25

[1]In 100 gallons of water unless otherwise indicated; dust mixtures contained 10 percent of active ingredients.

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