HOP PESTS AND THEIR CONTROL

1941

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INTRODUCTION

The results of the 1940 season demonstrated that DN Dusts (DN Dust, DN Dust D-3, and DN Dust D-4) were satisfactory for commercial hop red spider control. An experimental duster was constructed which deposited these dusts to the undersurface of hop foliage in a satisfactory manner. There were, however, certain definite objections to this unit which could be overcome by further research.

Adequate commercial control of the hop red spider was obtained with the above mentioned dusts when applied at the rate of 50 pounds per acre. The DN Dusts had no apparent aphicidal value but preliminary studies indicated that they might have value in control of sooty mold.

DN Dust D-4 and DN Dust D-7 were shown to have less toxicity to foliage than DN Dust. DN Dust D-4 was indicated to have more value in control of spiders than DN Dust D-7 but was not superior to DN Dust in this quality.

It was also indicated that there was a decided lag in build-up of red spider populations when hops were dusted with DN Dust and that one application of these materials would be sufficient for control. These results were obtained during the season of 1940 and led to the formulation of the following 1941 objectives.

1941 Objectives

1. Improvement of Experimental duster.
2. Seasonal development of the hop aphis and hop aphis control.
3. Sooty mold control investigations in the field.
4. Seasonal development of hop red spider.
5. Further tests to determine the amount of DN Dusts necessary for commercial control.
6. Efforts to follow the efficiency of the grower's application of DN Dusts.

7. Small plot testing of new and untried toxicants.
8. Studies on build up of red spider populations on dusted and undusted hops.
9. Continued phytocidal studies of DN Dusts and the associated control of red spiders on these plants.
10. Miscellaneous studies.

1. The Improvement of the Experimental Duster

The experimental duster which was used during 1940 (Figure 1) was satisfactory in depositing dusts to the undersurface of hop foliage. It was, however, very unwieldy and greatly overpowered. Dusts could not be applied lower than 50 pounds per acre because materials became clogged in the airstream. There was considerable variation in the division of the dust in the airstream which resulted in unequal deposits of dusts on the foliage.

Work was accordingly started during the fall of 1940 and winter of 1941 toward the elimination of these objections. The cooperation of Mr. John Bursik and Mr. F. E. Price was enlisted in this endeavor.

The old unit was discarded entirely and replaced by a Dryfog Hardie duster. This duster was powered by a 3 horsepower gasoline motor (Briggs and Stratton - 4 cycle - Model K). Other equipment included an aluminum cast blower (10 inches in diameter x 3.75 inches width), a large (200 lb. capacity) hopper, and a sturdy corkscrew type agitator.

The mushroom type of air distribution was used. This was developed by the Hardie Manufacturing Company for pea aphis and pea weevil dusting and was used very successfully by Mr. Ben Hilton of Grants Pass, Oregon for hop dusting during 1940.

The nozzles (3 inside diameter gradually flaring to a 3/16 x 10 inch outlet in an overall length of 12 inches) were a decided improvement

over the type nozzle which had sharp angle of flare. Dusts were deposited in an even uniform flow through the hop vine.

The unit was mounted on a two wheel trailer which was underslung in order to give proper balance. The adjustable frame assumed in the 1940 experimental duster was simplified and made more durable. This frame was telescoped for heighth and width adjustments and made it possible to dust hopyards of various width of rows and height of trellis.

Static pressure (measured by the Ellison U gauge) was very uniform at each nozzle. This varied from 2.4 to 6.8 inches of water from low to high speed setting of the motor. The duster capacity was measured at 800 cubic feet per minute but satisfactory dusting could be accomplished at ½ to 3/4 of this figure.

This experimental duster made it possible to apply dusts in quantities of 10 to 150 pounds to the acre when driving at 4 miles per hour. The deposit in general was uniformly distributed on the hop foliage. The unit was very compact and easily maneuvered in the field.

Units according to the above description were made available to hop growers by commercial companies. Growers possessing old type dusters could readily modify their units into efficient machines at costs of $40.00 to $75.00.

2. The Seasonal Development of the Hop Aphis and Its Control

Detailed data were collected in many hop growing sections of the Willamette Valley during 1941. These will be included in a separate report on the seasonal development of the hop aphis, which covers data over a period of 4 years.

The hop aphis during 1941 developed very early in the season on plums. Migration to hops also occurred very early and spring migrants were noted as early as May 17. Their development was rather slow during rainy weather at this time but by June 11, they had developed to very heavy populations. Very severe damage was effected to many hopyards. On July 25 and 26, very hot weather occurred and temperatures in hopyards at Corvallis rose to 110 degrees F. Inspections in hopyards immediately after showed that the hop aphis were effectively destroyed on all of the lower hop leaves and only a few survivors remained on leaves at the top of the vine. Temperatures at this location probably were considerably lower than 110° F.

The aphis populations did not effect a recovery until the latter part of September and the beginning of October. The crops were harvested by this time and no serious damage resulted. Fall migrants were found on plum trees adjacent to hopyards during the latter part of October. One generation of aphis built up on these trees and eggs were found during the middle of November. Fall migrants were noted on peach, plum, prune, cherry, and chestnut. Colonies were started on all of these hosts but eggs could be found only on the plum and prune trees.

Hop Aphis Control

The experimental duster involved the use of the dusting unit which was also used for pea aphis and pea weevil dusting. This unit was in use during the critical point of aphis development and was not made available for usage after the hot weather in July. Aphis at this time were not present in sufficient numbers for control work. Populations of the hop aphis again were present in sufficient numbers after

the crops were harvested and the vines were on the ground.

Activities were accordingly limited to observations of the effectiveness of Growers' Control. Nicotine sulfate (40%) lime dusts were quite effective when properly applied. In most instances control was limited to the lower portion of the hop vine while the tops remained heavily infested.

The practice of driving through the hopyard with dusters at the rate of 15-20 miles per hour resulted in poor control and necessitated redusting 5 to 6 times in some instances. In nearly every case, very poor control was noted along the edges of the yard. This may be associated with the lack of hovering of dusts along the edges of the yard.

It was evident that most growers depended too much on weather conditions to aid them in control of hop aphis. The experimental duster was designed to contact red spiders on the undersurface of hop foliage and should be quite effective in hop aphis control. It was unfortunate that there was no hop grower in the Willamette Valley equipped with this type of dusting unit in order to verify this possibility.

Several laboratory tests were made in the fall of the year. The data are submitted on the following pages. The various nicotine sulfate combinations offered most promise. The mixture of DN dusts with nicotine sulfate did not reduce the toxic action of the nicotine against the hop aphis. The nicotine sulfate lime mixture as will be discussed later did reduce the toxicity of DN to the hop red spider.

Several of the most promising laboratory materials were applied in the field by means of a small bulb dust atomizer. The weather conditions at this time were cold and rainy, and may be credited with the unfavorable results which were obtained.

Laboratory Insecticide Tests on Phorodon humuli Sch.

September 22-24, 1941

Treatment Number	Treatment		Percent Dead Aphis Replication 1	2	3	Mean
1	Nicotine sulfate (40) Hydrated lime	2.00 98.00	100	100	99	99.7
2	Nicotine sulfate Hydrated lime	2.88 97.12	99	100	100	99.7
3	Rotenone (Derris) Methyl isobutyl ketone Soyabean oil Talc	.75 2.00 3.00 94.75	51	83	89	74.3
4	Rotenone (Derris) Methyl isobutyl ketone Talc	.75 2.00 97.25	70	95	72	79.0
*5	Dicyclohexylamine salt of dinitro-o-cyclohexyl phenol Dinitro-o-cyclohexyl phenol Rotenone (Derris) Soyabean oil Talc Frianite	1.00 .50 .375 1.50 48.125 48.50	27	76	71	58.0
*6	Dinitro-o-cyclohexyl phenol Rotenone (Derris) Soyabean oil Frianite Talc	.50 .375 1.50 49.50 48.125	52	75	73	66.7
7	Dichlorethyl ether Bentonite	6.00 94.00	21	27	54	34.0
8	Rotenone (Derris) Loro Talc	.75 2.00 97.25	86	83	80	83.0
9	Rotenone (Derris) Soyabean oil Talc	.75 3.00 96.25	79	97	90	88.7
10	Triethanolamine salt of Dinitro-o-cyclohexyl phenol Redwood flour	1.00 99.00	13	87	80	60.0

Laboratory Insecticide Tests (Continued)

Treatment Number	Treatment		Percent Dead Aphis Replicated 1	2	3	Mean
*11	Dicyclohexylamine salt of Dinitro-o-cyclohexyl phenol	1.00				
	Dinitro-o-cyclohexyl phenol	.50				
	Nicotine sulfate (40%)	1.00				
	Dormant oil (Heavy)	1.00				
	Lime (Hydrated)	48.00				
	Frianite	47.50	100	100	100	100.0
*12	Dicyclohexylamine salt of Dinitro-o-cyclohexyl phenol	1.00				
	Dinitro-o-cyclohexyl phenol	.50				
	Nicotine sulfate (40%)	2.00				
	Hydrated lime	48.00				
	Frianite	48.50	100	100	100	100.0
*13	Dinitro-o-cyclohexyl phenol	.50				
	Nicotine sulfate (40%)	2.00				
	Lime	48.00				
	Frianite	49.50	100	100	100	100.0
14	213- DN- H.	1.00				
	Frianite	99.00	56	96	64	72.0
15	213-DN-A	1.00				
	Frianite	99.00	44	68	62	58.0
16	213	1.00				
	Frianite	99.00	16	20	24	20.0
17	Dinitro-o-cyclohexyl phenol	1.00				
	Frianite	99.00	23	18	23	21.0
18	213-DN	1.00				
	Frianite	99.00	48	32	16	32.0
19	213 DN-B	1.00				
	Frianite	99.00	36	15	41	31.0
20	213 DN-C	1.00				
	Frianite	99.00	27	46	37	37.0
21	Nicotine sulfate (40%)	4.00				
	Frianite	96.00	83	66	68	72.0
22	Dinitro-o-cyclohexyl phenol	4.00				
	Frianite	96.00	19	36	26	29.0

Laboratory Insecticide Tests (Continued)

Treatment Number	Treatment		Percent Dead Aphis Replicated 1	2	3	Mean
23	213 DN-Frianite	4.00 96.00	31	25	64	40.0
24	213 DN-H Frianite	4.00 96.00	17	19	38	25.0
25	213 DN-A Frianite	4.00 96.00	9	14	15	12.0
26	213 DN-B Frianite	4.00 96.00	13	12	12	12.0
27	213 DN-C Frianite	4.00 96.00	11	14	17	11.0
28	Check		9	6	18	11.0
29	Check		4	19	2	8.0
30	Check		2	5	14	7.0
31	Check		9	6	24	13.0
32	Check		2	5	8	5.0

* Mechanical dilutions (50-50 by weight) of proprietary dusts.

Treatments 14 to 27 inclusive were dusts prepared by Prof. C. E. Callaway of the Chemistry Department. The code to these treatments is given as follows:

213.....Free nicotine
DN.....Dinitro-o-cyclohexyl phenol
A.....Amyl nicotine
B.....Benzyl nicotine
C..... Cyclohexyl nicotine
H.....Hydrated nicotine

The mean number of adult aphis per leaf which were used for test purposes..... 72

3. Sooty Mold Investigations in the Field

Very late in the season after hops had been harvested, the Department of Farm Crops cooperated with the Department of Entomology and allowed a few hop plants to stand unpicked in the field. These plants were watched closely for aphis infestation and sooty mold development. The first observation of mold in the cones occurred September 8 and the plants were immediately dusted with several treatments (dusting sulfur, DN Dust D-7, Dinitro-Dust, DN Dust, 1% dichlorethyl ether dust, DN Dust-Zinc). A number of plants were allowed to stand undusted for check purposes.

Samples of hops were taken at the time of treatment and at regular intervals for a period of 18 days after dusting. They were brought into the laboratory, dried and examined for amount and degree of sooty mold. The percentage of cones having mold was used as a unit of measurement for amount of mold present. The degree of mold present was measured by setting an arbitrary numerical scale of 0, 1, 2, 3 and 4 which designated no, slight, moderate, severe and very severe infestation.

Laboratory tests were made during the 1940 season which indicated that several dusts showed promise in control of sooty mold and these field trials were made in an attempt to test these results under natural conditions. Complete data from these trials are given in pages 54 to 116* of the appendix. The following summary shows that the 1941 field trials were in direct contrast to the 1940 laboratory results. Close study of these figures shows that there was considerable variance between samples and within samples. This suggests that a statistical study of the distribution of mold in the field would be of interest.

* See report in Department of Entomology

Percentage of Moldy Hops

Treatment	Days After Treatment 0	2	4	7	9	11	14	16	18
Dusting sulfur	6	4	22	4	18	48	51	94	31
DN Dust D-7	2	14	48	4	22	25	91	28	90
Dinitro-dust	10	19	2	11	32	64	69	4	98
DN Dust	2	16	16	14	77	57	76	72	99
Dichlorethyl ether	8	25	37	11	52	73	62	71	43
DN Dust-Zinc	6	13	20	6	37	18	68	64	70
Check	8	16	8	5	34	43	58	38	100

Degree of Mold in Hops

Treatment	Days After Treatment 0	2	4	7	9	11	14	16	18
Dusting sulfur	.09	.03	.39	.06	.33	1.01	.85	2.57	0.55
DN Dust D-7	.016	.15	.64	.058	.29	.46	2.24	.59	2.36
Dinitro-dust	.14	.27	.024	.19	.67	1.29	1.77	.08	2.81
DN Dust	.03	.48	.29	.23	1.99	1.16	1.36	1.43	2.77
Dichlorethyl ether	.08	.34	.56	.22	.85	1.57	1.20	2.00	.68
DN Dust-Zinc	.08	.24	.32	.09	.69	.27	1.52	1.85	1.80
Check	.11	.20	.11	.06	.60	.85	1.02	.77	3.31

Code to above figures:

0.....No mold per cone
1.....Slightly moldy (10% of bracts)
2.....Moderately moldy (20-30% of bracts)
3.....Severely moldy (30-50% of bracts)
4.....Very severely moldy (50-100% of bracts)

4. Seasonal Development of the Hop Red Spider

The hop red spider, Tetranychus telarius Linn, was noted very early, May 17, on hop foliage and it was expected that a severe infestation would develop during 1941. Cool weather and the development of hop aphis were probably responsible in holding this pest in check. Several examinations of hop leaves showed that many spiders had perished while encased on the sticky honey dew which was secreted by hop aphis.

Populations did not begin to increase until the middle of July and at this time they increased very rapidly. Many growers suffered injury because they were unable to equip themselves with proper dusting machinery. The labor shortage induced a number of hop growers to pick early before hops were fully mature. This prevented additional red spider damage to the hop cones. Seasonal history data will be incorporated in a special report which covers their development throughout 1937 to 1941.

5. Further Tests to Determine the Amount of DN Dusts Necessary for Commercial Control

The new experimental hop duster was used in these dusting trials. Three materials were applied to the experimental hopyard, East Farm, Corvallis, Oregon, on August 9, 1941, and mortality data were collected August 11. The materials consisted of the proprietary DN dust, DN dust D-4 and DN dust D-8. They were applied at rates ranging from 10 to 60 pounds to the acre. DN dust D-8 was quite heavy and could not be applied at rates higher than 50 lbs. per acre when traveling at 4 miles per hour. Dusting sulfur was applied at the rate of 60 pounds per acre as a standard check.

The hopyard consisted of a number of different varieties of hops and all material was not applied to every variety. This variety factor probably manifested itself in the efficiency of deposit but no attempt was made to correct for this source of variance.

The red spider population varied considerably from one section of the yard to another. Heaviest populations occurred in the northern section of the yard and very light populations were noted on the south side. This factor also introduced a source of error which could not be corrected. DN Dust D-8 was, therefore, subjected to tests of a heavy red spider population while DN Dust was tested on light populations. The effectiveness of DN Dusts appears to be greater on heavy infested plants, particularly those plants which have become webbed.

It is of interest to recall former tests in which several varieties of Russian hops were severely burned with DN Dusts. These same varieties were again dusted with no apparent injury.

The method of evaluation of acaricidal efficiency was similar to that employed in previous experiments. Five leaves were selected at random from 10 different plants and the number of living and dead red spiders were counted by means of a binocular microscope. Two individuals divided these efforts in order to reduce errors due to the personal equation. Complete data of these experiments are given on pages 117 to 180* of the appendix and summary of the results are shown on the following pages.

* See report in Department of Entomology

Summary
Rates of Application of DN Dusts
Plants as unit of evaluation

Pounds per acre	DN Dust D-8			DN Dust D-4			DN Dust		
	Percentages dead red spiders								
	Mean	Stand. Deviation	S.E.M.	Mean	Stand. Deviation	S.E.M.	Mean	Stand. Deviation	S.E.M.
10	30	26.76	8.46	47	24.41	7.72	61	21.78	6.89
15	37	24.20	7.65	53	12.02	3.80	79	16.54	5.23
20	78	18.31	5.79	78	15.35	4.85	87	15.43	4.88
25	87	9.27	2.93	83	17.30	5.47	86	13.51	4.27
30	92	6.39	2.02	89	5.17	1.63	87	12.47	3.94
35	93	7.29	2.30	94	6.59	2.08	92	10.82	3.42
40	94	3.86	1.22	97	4.04	1.27	96	3.39	1.07
45	96	2.79	0.94	99	1.70	0.53	92	10.62	3.36
50	97	1.76	0.55	97	4.29	1.36	97	3.91	1.23
55				97	3.26	1.03	98	5.81	1.84
60				98	3.29	1.04	98	2.90	0.92
Dusting sulfur at 60 lbs./acre.....				38		13.58	4.29		

Number of plants used in sample..... 10

Summary
Rates of Application of DN Dusts
Leaves as unit of evaluation

Pounds per acre	DN Dust D-8			DN Dust D-4			DN Dust		
	Percentages dead red spiders								
	Mean	Stand. Deviation	S.E.M.	Mean	Stand. Deviation	S.E.M.	Mean	Stand. Deviation	S.E.M.
10	24	24.45	6.00	49	30.68	4.34	58	35.36	5.00
15	38	31.69	4.48	54	31.82	4.50	81	27.49	3.89
20	78	25.77	3.64	79	24.13	3.41	90	16.87	2.39
25	87	12.81	1.81	83	24.06	3.40	87	21.74	3.07
30	93	8.41	1.19	91	12.63	1.79	90	14.62	2.07
35	94	11.38	1.60	95	12.31	1.74	92	17.64	2.49
40	94	7.12	1.00	96	9.18	1.30	96	5.78	0.82
45	96	5.51	0.78	99	3.94	0.56	93	13.59	1.92
50	97	3.56	0.50	98	5.46	0.77	96	6.04	0.85
55				97	7.05	0.99	98	4.55	0.64
60				98	4.74	0.67	98	2.92	0.41

Dusting sulfur at 60 lbs./acre.....40 77.67.....10.98

Number of leaves in sample..... 50

Discussion of Results

Both hop leaves and hop plants were employed as units of evaluation of the acaricidal efficiency of DN dusts as applied with this experimental duster. Both units of measurement show similar results but the use of hop leaves is somewhat more critical. The results of these tests are summarized as follows:

1. Adequate commercial control was obtained with each material (DN dust, DN dust D-4 and DN dust D-8) at the rate of 40 pounds to the acre. This reduced the rate of application 10 pounds to the acre (a material savings of $1.00 per acre) over 1940 results. Credit for this saving must be given to the efforts of Agricultural Engineering for development of a more efficient duster.
2. The proprietary product DN dust D-8 was quite heavy and some difficulty was experienced in feeding it through the duster. It is probable that most Oregon growers will experience similar difficulties because the dust was designed for more powerful equipment. It is possible that a reduction in the amount of oil or the use of a different viscosity of oil may eliminate this disadvantage without detracting from the sticking quality of the dust.
3. It may be argued that the standard deviation (a measurement of central tendency) may be used as a measurement of efficiency of depositing DN dusts on the undersurfaces of hop leaves. It is so considered in the graphs which are shown on the following pages. It will be noted that the sharp

break in percentage kill and efficiency curves occur at the 35 to 40 pound per acre portion of the abscissa.

4. Considerable success in reducing the amount of DN dusts per acre has been achieved by this season's work. It is believed, however, that more progress could be made along these lines according to the following objectives:

   A. Continued improvement in dusting machinery with emphasis being placed on different types of fans.

   B. Development of a more efficient diluent. Frianite as used in the proprietary DN dusts is lacking in bulkiness and does not lend itself readily to reduction in amount per acre. Walnut shell flour is superior to Frianite in this respect, gives better deposit but is considerably more expensive.

6. Efforts to Follow the Efficiency of Growers' Applications of DN Dusts

Considerable effort was made to serve hop growers in the problem of obtaining satisfactory applications of DN dusts for hop red spider control. It was learned that few Oregon growers had equipped themselves with satisfactory dusting units and there was little attempted control of this pest. There was a decided shortage of hop pickers and many growers began picking hops prematurely. This enabled many of them to escape from serious cone injury. The seasonal development of the hop red spider also aided the growers because populations did not become severe until near harvest time.

It was evident from correspondence of Yakima, Washington that control recommendations of the Oregon State Department of Entomology were

more generally accepted and adopted by Washington hop growers than by Oregon hop growers. A fairly high acreage of Washington hops were dusted with DN dusts with approved dusters and good control was effected.

Only two checks were made on applications of DN dusts as made by Oregon hop growers. These were made in the yards of Mr. Harricott and Mr. Chittenden near Independence, Oregon.

The application of DN Dust D-8 was made in the Harricott yard on August 19 and counts were made on August 29. A makeshift duster was employed in this yard and only fair controls were obtained.

The application in the Chittenden Yard is of interest. This yard was blown down by a severe wind and electric storm during midseason and only averaged 8 to 10 feet in height after it was again raised. It was not possible to drive the duster along the rows because of overhanging vines. A commercial hop aphis duster was accordingly used to drive across the rows and to apply DN Dust D-8. Very good control was obtained in this yard. Complete data from these counts are given on the following pages.

Population Counts - Hop Red Spider

Efficiency of Growers' Application of DN Dusts

Grower: Harricott
Location: Independence, Oregon

Date applied: 8/19/41
Date counted: 8/29/41

Treatment: DN Dust D-8
45 to 55 lbs./acre

Leaf No.	Number of Red Spiders Dead	Alive	Total	% Dead
1	75	20	95	78.9
2	47	0	47	100.0
3	150	3	153	98.0
4	25	0	25	100.0
5	47	3	50	94.0
6	16	0	16	100.0
7	23	5	28	82.1
8	13	0	13	100.0
9	24	0	24	100.0
10	60	140	200	30.0
11	0	5	5	0.0
12	13	4	17	76.5
13	25	73	98	25.5
14	73	51	124	58.9
15	40	0	40	100.0
16	8	0	8	100.0
17	14	0	14	100.0
18	10	0	10	100.0
19	33	0	33	100.0
20	27	0	27	100.0
21	14	3	17	82.4
22	30	26	56	53.4
23	24	0	24	100.0
24	29	7	36	80.6
25	14	0	14	100.0
Total	834	340	1174	
Wt. Mean				71.3
Arith. Mean				82.4

Population Counts - Hop Red Spider

Efficiency of Growers' Applications
of
DN Dusts

Grower: Chittenden
Location: Independence, Oregon

Date applied: 8/17/41
Date counted: 8/23/41

Treatment: DN Dust D-8
50 lbs./acre

Leaf No.	Number of Red Spiders Dead	Alive	Total	% Dead
1	63	1	64	98.4
2	82	0	82	100.0
3	89	0	89	100.0
4	142	1	143	99.3
5	67	5	72	93.1
6	209	6	215	97.2
7	47	3	50	94.0
8	318	20	338	94.1
9	41	8	49	83.7
10	147	15	162	90.7
11	229	6	235	97.4
12	348	27	375	92.8
13	93	8	101	92.1
14	216	0	216	100.0
15	147	5	152	96.7
16	49	0	49	100.0
17	184	3	187	98.4
18	76	0	76	100.0
19	51	0	51	100.0
20	19	0	19	100.0
21	318	8	326	97.5
22	212	0	212	100.0
23	73	6	79	92.4
24	19	1	20	95.0
25	229	1	230	99.6
Total	3468	124	3592	
Wt. Mean				96.5
Arith. Mean				96.5

7. Small Plot Testing of New and Untried Toxicants

A number of new or comparatively new dinitro-compounds have appeared on the market and some of these were given small plot field trials in the Entomology section of the Experimental Hopyard, East Farm, Corvallis, Oregon. Proprietary compounds such as DN Dust, DN Dust D-4, DN Dust D-8, DN Dust-Zinc and Dinitro-dust were used and compared with Dicyclohexylamine salt of dinitro-o-cresol, triethanolamine salt of dinitro-o-cyclohexyl-phenol and the ammonium and guanadine salts of dinitro-o-cresylate. Mixtures of the standard pea aphis dust (Rotenone .75 and soyabean oil 3%) were mechanically diluted with the proprietary products DN Dust, DN Dust D-4 and DN Dust D-8. These mixtures were made on a 50-50 basis of the proprietary compounds. DN Dust D-4 and DN Dust were likewise mechanically mixed with a 4% nicotine sulfate dust on a similar basis.

The dust mixtures were allowed to age ten days before using and attention was given to their effect on both red spiders and hop aphis.

The technique of application and collecting of data were similar to that of previous years. Dusts were applied July 18 and data were collected July 21. The following is a list of the materials used.

Treatment No.	Treatment and Materials		Percent by Weight
1.		Check - No treatment	
*2.	50-50 mixture of DN Dust and 4% Nicotine sulfate dust	Dinitro-o-cyclohexyl phenol	0.50
		Nicotine sulfate (40%)	2.00
		Lime	48.00
		Frianite	49.50
*3.	50-50 mixture of DN Dust and Rotenone-Soyabean oil dust	Dinitro-o-cyclohexyl phenol	0.50
		Rotenone (Derris)	0.375
		Soyabean oil	1.50
		Frianite	49.50
		Talc	48.125
***4.	DN Dust	Dinitro-o-cyclohexyl phenol	1.00
		Frianite	99.00

Treatment No.	Treatment and Materials		Percent by Weight
*5	50-50 mixture of DN Dust D-4 and 4% nicotine sulfate dust	Dicyclohexylamine salt of Dinitro-o-cyclohexyl phenol	1.00
		Dinitro-o-cyclohexyl phenol	0.50
		Nicotine sulfate (40%)	2.00
		Lime	48.00
		Frianite	48.50
*6	50-50 mixture of DN Dust D-4 and Rotenone-soyabean oil dust	Dicyclohexylamine salt of Dinitro-o-cyclohexyl phenol	1.00
		Dinitro-o-cyclohexyl phenol	0.50
		Rotenone (Derris)	0.375
		Soyabean oil	1.50
		Talc	48.125
		Frianite	48.50
***7.	DN Dust D-4	Dicyclohexylamine salt of Dinitro-o-cyclohexyl phenol	2.00
		Dinitro-o-cyclohexyl phenol	1.00
		Frianite	97.00
***8.	DN Dust D-8	Dicyclohexylamine salt of Dinitro-o-cyclohexyl phenol	2.00
		Dinitro-o-cyclohexyl phenol	1.00
		Dormant oil (Heavy)	2.00
		Frianite	95.00
9.		Check - No treatment	
***10.	DN Dust-Zinc	Dinitro-o-cyclohexyl phenol	1.00
		Zinc	
		Frianite	
*11.	50-50 mixture of DN Dust D-8 and 4% nicotine sulfate dust	Dicyclohexylamine salt of Dinitro-o-cyclohexyl phenol	1.00
		Dinitro-o-cyclohexyl phenol	0.50
		Nicotine sulfate (40%)	2.00
		Dormant oil (Heavy)	1.00
		Lime	48.00
		Frianite	47.50
***12.	Dinitro Dust	Dinitro-o-cresol	1.00
		Frianite	99.00
**13.		Dicyclohexylamine salt of Dinitro-o-cresol	2.00
		Dinitro-o-cresol	1.00
		Redwood flour	97.00
**14		Ammonium salt of Dinitro-o-cresol	1.00
		Redwood flour	99.00

Treatment No.	Treatment and Materials	Percent by Weight
**15	Guanadine salt of Dinitro-o-cresol	1.00
	Redwood flour	99.00
**16	Triethanolamine salt of Dinitro-o-cyclohexyl phenol	1.00
	Redwood flour	99.00

* Mechanical dilutions of proprietary products

** Toxicant atomized into diluent.

*** Proprietary products.

Discussion of Results

Complete data from these tests are given in pages 181 to 308* of the appendix, but they are summarized at this point. There are several items of interest which are worthy of comment.

1. The percentage dead red spiders of the two check plots was unusually high and indicated that some of the hop leaves from these plots became contaminated by drift from adjacent plots.
2. The three plots receiving applications of mechanical dilutions of the proprietary DN Dusts with nicotine sulfate dusts were no better than check or untreated plots. The nicotine-lime combination must, therefore, be considered incompatible with DN Dusts.

This is not strictly at variance with results of previous years. DN Dust was mechanically diluted with hydrated lime in 1940 and used immediately without reducing toxicity. Lime was observed to possess undesirable physical properties for hop dusting. Free nicotine and nicotine sulfate were atomized into proprietary DN Dusts in 1940 and used within a few days

* See report in Department of Entomology

afterward. Again there was no noticeable reduction in toxicity. These mixtures contained 5% nicotine and were somewhat heavy and difficult to feed through the duster.

The presence of lime and nicotine during these tests (1941) greatly lowered the toxic value of DN Dusts. There was no resultant plant injury from these dusts. Nicotine sulfate-lime dusts have been used on occasion both before and after applications of DN Dust without difficulty.

3. There was no difference between the proprietary DN Dusts and mechanical dilutions of these dusts with Rotenone-Soyabean oil dusts. It must be emphasized that dinitro-o-cyclohexyl phenol concentration of the mixed dusts was reduced to .5% and compared to 1.% of the proprietary dusts.

The rotenone content of the diluted dusts was reduced to .375% and at this concentration was of no value against the hop aphis.

These results again indicate that DN Dusts may be successfully diluted with a neutral or slightly acid carrier without effecting reduction in toxicity. It is possible that growers may be able to reduce the material cost of application by this practice. This may be illustrated more clearly by the following example:

Present cost of dusting with DN Dusts -

40 pounds of DN Dust per acre at $0.10 per pound - $4.00

Possible reduction of cost of dusting with DN Dusts -

1 lb. of DN Dust.....at.....$0.10
1 lb. of Diluent.....at.....$0.02
2 lbs. mixture.....at.....$0.06
and applied at the rate of 50lbs./acre.....$3.00

This possibility requires further investigation with large scale field tests and some study is contemplated during 1942.

4. The dinitro-o-cresol dusts were somewhat inferior to the proprietary DN Dusts and the dilution of the proprietary dusts with rotenone-soyabean oil dusts.

5. The guanadine and ammonium salt of dinitro-o-cresol were very difficult to atomize into the diluent and the resultant mixture was unsatisfactory. Carbon tetrachloride, toluene, xyol were used as solvents but these salts were apparently insoluble. The percentage kills obtained with these materials were surprisingly high and they must be considered as promising.

6. The water soluble triethanolamine salt of dinitro-o-cyclohexyl phenol gave encouraging results. No injury was noted in the plots receiving this dust but it is possible that injury may result during wet or humid conditions.

7. Redwood flour was used as a carrier on hops for the first time and although it possessed excellent bulkiness, it was inferior to frianite and walnut shell flour in adhesive properties to hop foliage.

8. The use of DN-Zinc was very effective against the hop red spider. This was also found to be true of DN sulfur combinations during 1940. These materials may be of promise against downy mildew.

Summary of Small Plot Field Trials
1941

East Farm — Corvallis, Oregon

Treatment No.	Percentage Dead Red Spiders — Replication Number								
	1	2	3	4	5	6	7	8	Mean
1	46.1	10.8	13.1	30.7	61.3	81.1	6.5	76.6	40.8
2	53.0	55.2	29.5	22.8	38.2	54.9	38.0	41.6	41.7
3	99.1	97.2	91.7	74.2	99.7	99.5	97.6	93.3	94.0
4	75.0	100.0	98.6	100.0	97.8	99.1	100.0	98.4	96.1
5	48.6	4.5	36.5	48.5	43.6	8.5	74.5	28.6	36.7
6	79.0	97.1	94.8	100.0	97.6	100.0	99.1	99.4	95.9
7	98.4	97.9	100.0	97.5	100.0	94.5	100.0	100.0	98.5
8	100.0	100.0	100.0	93.0	73.9	100.0	70.5	100.0	92.2
9	26.2	14.1	6.4	90.0	3.6	16.2	10.2	50.4	27.1
10	100.0	97.4	100.0	100.0	100.0	95.0	89.4	100.0	97.7
11	70.9	55.6	36.2	27.1	40.1	52.6	57.3	53.5	49.2
12	69.6	79.7	46.6	77.9	73.8	93.1	80.1	81.9	75.3
13	95.6	73.1	93.6	80.3	83.6	74.3	98.6	79.6	84.8
14	47.7	83.8	41.2	96.3	99.4	88.2	74.8	97.7	78.6
15	91.3	98.1	84.7	94.2	35.3	93.8	80.5	80,9	82.3
16	73.6	99.8	99.5	96.2	85.4	98.8	99.4	91.1	93.0

Differences necessary for significance
For 16 treatments
At odds of 19-1 ..... 17.5
49-1 ..... 21.5
99-1 ..... 24.4

Differences necessary for significance
Excluding Check and DN-Nicotine treated plots
(Treatment Nos. 1, 2, 5, 9, and 11)

At odds of 19-1 ..... 13.1
49-1 ..... 16.1
99-1 ..... 18.3

Differences necessary for significance
Excluding check, DN Nicotine, Dinitro-o-cresol and ammonium salt of dinitro-o-cresol (Treatment Nos. 1, 2, 5, 9, 11, 12 and 14)

At odds of 19-1 ..... 11.1
49-1 ..... 13.6
99-1 ..... 15.5

Differences necessary for significance
Comparing only DN Dust, DN Dust D-4 and DN Dust D-8 with mixtures of DN Dust and DN Dust D-4 with Rotenone-soyabean oil dust (Treatment Nos. 3, 4, 6, 7 and 8)

At odds of 19-1 ..... 9.4
49-1 ..... 11.5
99-1 ..... 13.1

8. Studies on Build Up of Red Spider Populations on Dusted and Undusted Hops

Data were collected during the latter part of the 1940 season which indicated that there was a decided lag in population increase on hops which had been dusted with DN Dusts. These results were not conclusive and plans were made to study this problem in more detail during 1941. The small plots of the Entomology section of the experimental hopyard were used in this investigation.

The original population and the number of living red spiders 3 days after dust applications were taken from the data which were used to measure percentage kill. The number of living spiders was later measured in each replicate of each treatment at intervals of 10, 35, and 50 days after dust application. These counts were made by counting the number of living spiders from random samples with the aid of a binocular microscope.

The problem became somewhat complex because of differences in initial population of the respective plots and because of the added variance of differences in kill which resulted from applications of the dusts.

An attempt was made to correct these sources of variance by adopting an arbitrary initial population (per leaf). This figure (30) was chosen because this was the average population per leaf of the entire yard. Regression lines were then extended from the initial population to the population 3 days after dusting; from the 3rd day to the 10th day; from the 10th day to the 35th day and from the 35th day to the 50th day point. This practice was carried out for each material.

Detailed data from these counts are found in pages 309 to 451* of the appendix but are summarized in graphic form at this point. The results were very striking and are discussed as follows:

1. The nicotine sulfate-lime-DN Dust mixtures showed a very poor initial kill but residual action was noted to ten days after treatment. After this point, the rate of increase was very rapid and paralleled that of the untreated plots.

2. The proprietary DN Dusts (DN Dust + DN Dust D-4; DN Dust D-8; DN Dust-Zinc) were identical in residual action and were effective in holding red spider populations in check for 50 days. Check plot populations had increased 22 to 96 red spiders per leaf during this period while the DN treated plots had increased from an average of 3 to 6 spiders per leaf during the same period. This approximates a 94 percent control over a 50 day period. The rate of increase of red spider populations in DN dusted plots was outstandingly low.

3. The triethanolamine salt of Dinitro-o-cyclohexyl phenol treated plots closely paralleled that of the DN dusted plots.

4. The mixtures of DN Dust and Rotenone-soyabean dust also showed excellent residual action and closely paralleled the action of the proprietary DN Dusts.

5. The ammonium salt and guanadine salts of dinitro-o-cresol coincided in their residual action and were less effective than DN Dusts in retarding red spider population increases. These dusts, it will be remembered were poorly mixed and must be considered as promising.

6. Dinitro-o-cresol and its dicyclohexyl amine salt produced phenomenal results in their residual action. The initial kill was good,

*See report in Department of Entomology

but by ten days after dusting the rate of increase of red spiders was significantly more rapid than that of the check plots. This rate of increase manifested itself until after populations had again equalled that of the check plots (approximately 20 days after dusting). After this point, the rate of increase paralleled the rate of increase of the check plots. At harvest time the populations in these plots exceeded the check populations. The following reasons have been advocated for the explanation of this phenomenon:

A. The dinitro cresol dusts may have controlled disease or predators of the hop red spider and allowed the populations to increase unchecked by natural factors.

B. The toxic action of the dinitro cresol dusts may have been spent a short while after application, while this same action of the DN Dusts may have carried over a considerable period of time. One objection to this possibility is that illustrated by the immediate rapid rate of increase of red spiders which was significantly more rapid than that of untreated plots. It must be admitted that drift of dusts to check plots probably accounted for the initial number of dead red spiders, and that the normal rate of increase of these spiders was not measured in these studies.

C. Either DN dusts or dinitro cresol dusts may have affected the cell sap concentration of the hop plants and aided or retarded the development of the red spiders. The example of the change of cell sap concentration of cotton after being treated with calcium arsenate and the subsequent

rapid rate of increase of the cotton aphis is cited in support of this theory.

This matter is one of speculation and should be studied more closely in the laboratory where closer checks can be placed on the many and complex field variables.

7. A practical observation from these studies resulted in the conclusion that only the proprietary DN compounds, mixtures of DN Dusts with Rotenone-soyabean oil and the triethanolamine salt of dinitro-o-cyclohexyl phenol treated plots resulted in cones free from injury by the hop red spider. Populations of 40 red spiders per leaf at the end of the season were sufficient to cause serious damage to hop cones.

8. Still another practical and technical observation should be made. The employment of percentage dead spiders as a unit of measurement of acaricidal efficiency has been demonstrated as a fallacy because of the difference in residual action of the different dusts. It is fortunate that this problem did not manifest itself adversely in previous tests on hop red spider control.

9. Continued Phytocidal Studies with DN Dusts and the Associated Control of Red Spiders on These Plants

A. Strawberries

Red spiders have caused considerable damage to a strawberry planting of Mr. E. A. Jones, East Farm, Corvallis, Oregon. It was thought advisable to carry on preliminary studies on the phytocidal action of various DN Dusts to these plants. It will be recalled from the 1940 report that strawberries were found very susceptible to injury from all DN Dusts.

The first trials were made on May 14 when DN Dust, DN Dust D-4, DN Dust D-3, DN Dust D-8, and DN Dust D-7 were applied to a few plants. These applications were made with a hand duster. A spray application (DN Dust D-4; 3 lbs.: SS-3½ pt.; water 100 gal.) was made on the same day with a small power sprayer. Temperatures reached 85 degrees F. the day these trials were made.

The resultant kills of these tests were very disappointing. Several facts were indicated however.

1. Hand dusters were not adequate for dusting the undersurfaces of strawberry plants. These plants were of the variety Corvallis #12 and planted in hills 3 feet apart. They were very large in size averaging approximately 2 feet x 2 feet x 2 feet in dimensions. The foliage was very dense and large in surface area. The standard deviation in the kills obtained was very high and serves as an index of the variance in coverage of the foliage.

2. Walnut shell flour was used as a carrier in DN Dust D-3. This carrier is more satisfactory than Frianite on hop foliage. The opposite was found to be true on strawberry foliage.

3. The sprayed foliage was very severely damaged but the blossoms and fruit were uninjured. This foliage burn resulted in decided lowering of the flavor of the fruit but the size of the fruit was not seriously impaired.

4. All dusts resulted in severe foliage burn with the proprietary DN dust showing this injury to a greater extent. The injury was most severe on the south and west sides of the plants. These sides were exposed to the direct rays of the afternoon sun.

5. It was evident that temperatures of 85 degrees F. were unsafe for dusting of strawberries with DN Dusts.

Several other preliminary trials were undertaken to study the phytocidal action of these dusts to strawberries. No attention was given the spider mortality in these trials. It was learned that:

1. The application of dusts to strawberries in the evening after the sun had set resulted in lessening of foliage injury. The critical point in plant injury occurs the first three days after dusting with DN Dusts. The greatest injury to plants occurs during the first 24 hours. The application of the dusts in the evening made it possible to expose the plants during 15 of the most critical hours at a time when temperatures were low and not exposed to direct sun rays.

2. Dusts were applied in the morning and the surface of the ground was stirred with a small garden cultivator. This resulted in lessening of foliage injury even though temperatures reached 87 degrees F. The breaking of the soil probably resulted in the absorption of heat waves from the sun. The subsequent reduction in radiation of heat waves probably was responsible for this lessening of foliage injury.

3. Long range weather forecasts were watched closely and various dusts were applied during a predicted cool period. Temperatures during this time did not go over 70 degrees F. No foliage injury resulted from these tests and the critical temperature of DN Dusts on strawberries was accordingly set at this point.

The aid and cooperation of the Department of Agricultural Engineering were obtained in solving the problem of application of DN Dusts to the undersurfaces of strawberries. A small Niagara power

duster was used as a dusting unit and was attached to a hood which was formerly used for spittle bug dusting was employed. It was found that this hood required enlargement and that dusts applied from the top and sides of the hood did not give satisfactory coverage. Pipes were accordingly run along the sled runners of the hood. Small 1/8 inch openings in the pipe did not allow sufficient volume of dust-laden air for satisfactory coverage. The use of four 3/4 inch openings remedied this problem. Two of the pipes were directed horizontally and two of them were directed at approximately 30 degree angle. Counts from these applications showed that the smaller plants were adequately covered but that satisfactory kills were not obtained on the larger plants. Modification of the direction of the air blasts within the hood resulted in satisfactory kills of the red spiders.

Mr. Jones was anxious to dust his entire yard and to attempt control on a commercial scale. Long range weather forecasts were again studied and on May 31, ten acres of strawberries were dusted with DN Dust D-7, DN Dust D-3, DN Dust D-8, and DN Dust D-4 at the rate of 100 pounds to the acre. The resultant kills with each of these dusts were satisfactory. DN Dust D-8 again proved too heavy for satisfactory feeding through the duster. Best results were obtained with DN Dust D-4 and the poor adherence of the walnut shell flour (DN Dust D-3) was again noted. No foliage injury resulted from these applications.

The seasonal development of red spiders on strawberries is of interest. The pest was found overwintering on these plants in the adult form during the winter months. They increased very slowly until the latter part of April when decided increases in population were noted.

The rapid rate of increase is indicated by the following summary which was taken from counts of over 128,000 spiders from 740 strawberry leaves.

Date	Mean population per leaf
May 14	34
May 21	61
May 24	37
May 31	227

Conclusions

The results of these preliminary tests showed that strawberries could be dusted with DN Dusts but that the critical temperature was about 70 degrees F. The rate of application (100 lbs./acre) necessary for coverage of the undersurfaces of the foliage was due largely to the lack of bulkiness of the Frianite. Walnut shell flour was decidedly more bulky than Frianite but was lacking in sticking qualities. It is possible that further investigations into improvement of the dusting unit and in substitute carriers could reduce the amount of dust necessary for control. The material cost of application approximates $11.50 per acre.

It is possible that a combination dust could be developed which would control both spittle bug and red spider. No evidence of the toxicity of spittle bugs to DN Dusts is at hand. Mechanical dilutions of Rotenone dusts and DN Dusts are known to be compatible. It is possible that mixtures of this kind may serve to control these two pests as well as increase the bulkiness of the diluted mixture. Complete data of these studies are found in pages 40 to 53 of the appendix and only a summary is included at this point.

Summary

Applications of DN Dusts to Strawberries (Corvallis #12)

Preliminary trials: May 14, 1941
Dust applied with: Hand duster
Spray applied with: Small power sprayer

Material	% dead spiders	Remarks
DN Dust	73.4 ± 29.1	Very severe burn
DN Dust D-4	75.0 ± 23.3	Severe burn
DN Dust D-8	64.5 ± 25.0	Severe burn
DN Dust D-3	56.4 ± 41.6	Severe burn
DN Dust D-7	61.3 ± 36.0	Severe burn
DN Dust D-4... 3 lbs. SS-3 ½ pt. Water 100 gal.	99.0 ± 1.6	Very severe burn

Preliminary trials: May 21
Dusts applied with experimental power duster
Material used: DN Dust D-8, 100 lbs./acre

Size of Plant	% Dead Red Spiders, Plant Number 1	2	3	4	Mean
Large	32.3	92.3	91.2	91.9	76.9 ± 25.5
Medium	93.3	94.4	94.3		94.0 ± 0.5
Small	98.9	97.3	97.6		97.9 ± 1.2
Mean					88.4 + 5.9

Preliminary trials: May 24
Dusts applied with experimental power duster
Materials used: DN Dust D-8, 100 lbs./acre

Size of Plant	% Dead Red Spiders, Plant Number 1	2	3	4	5	Mean
Large	78.2	81.5	49.5	77.8	81.7	73.7 ± 12.2
Medium	77.8	81.4	84.6	79.3	83.3	81.3 ± 2.5
Small	94.2	92.8	96.8	99.2	97.1	96.0 ± 2.2
Mean						83.6 + 11.8

Note - Large designates plants 2 ft. x 2 ft. x 2 ft.
Medium " " 1½ ft. x 1½ ft. x 1½ ft.
Small " " 1 ft. x 1 ft. x 1 ft.

Summary

Final Applications of DN Dusts to Strawberry Plants (Corvallis #12) May 31, 1941

Rate of application: 100 lbs./acre

Material	Size of Plant	Percent Dead Red Spiders — Plant Number 1	2	3	4	5	6	Mean
DN Dust D-8	Large	86.2	98.3	89.9	83.1	86.4	72.2	86.0 ± 7.8
	Medium	81.4	77.9	81.2				80.2 ± 1.6
	Small	81.4	94.7					88.1 ± 6.6
							Mean	84.7 ± 2.2
DN Dust D-3	Large	97.2	90.1	95.6	82.9	91.4		91.4 ± 4.5
	Medium	96.3	99.2	90.1				95.2 ± 3.8
	Small	93.3	95.7	97.0				95.3 ± 1.5
							Mean	93.5 ± 6.1
DN Dust D-7	Large	90.6	94.3	86.9	93.5			91.3 ± 2.7
	Medium	91.2	97.0	90.6				92.9 ± 2.7
	Small	90.8	89.4	86.7				89.0 ± 1.7
							Mean	91.1 ± 3.0
DN Dust D-4	Large	96.3	93.4	92.7	98.2	100.0		96.1 ± 2.7
	Medium	94.1	98.3	96.4				96.3 ± 1.7
	Small	99.1	100.0	98.2				99.1 ± 0.7
							Mean	96.9 ± 2.4

Large designates plants 2 ft. x 2 ft. x 2 ft.
Medium designates plants 1½ ft. x 1½ ft. x 1½ ft.
Small designates plants 1 ft. x 1 ft. x 1 ft.

B. Pansies

On July 24, the experiment station received a call from Mr. Taylor for information on control of red spiders on assorted varieties of pansies. This plant had not been tested with any DN Dusts and there was no information on plant tolerance.

This patch of pansies was dusted very heavily with DN Dust D-4 by means of a hand duster. Some difficulty was experienced in obtaining

satisfactory coverage because of the prostrate habit of growth of this plant.

The infestation of red spiders was very heavy but satisfactory kills were obtained. There was no evidence of foliage injury.

Applications of DN Dusts
on Pansies

Cooperator: Mr. Taylor — South Corvallis, Oregon
Date applied: July 24 — Data collected: July 28

Rate of application: Very heavy
Dust used: DN Dust D-4
Varieties tested: Assorted

Leaf No.	Number of Red Spiders			
	Dead	Alive	Total	% Dead
1	160	4	164	97.6
2	227	1	228	99.6
3	45	3	48	93.8
4	12	1	13	92.3
5	148	2	150	98.7
6	870	35	905	96.1
7	40	10	50	80.0
8	80	0	80	100.0
9	547	52	599	91.3
10	15	0	15	100.0
11	13	6	19	68.4
12	180	17	197	91.3
13	10	0	10	100.0
14	170	2	172	98.8
15	234	16	250	93.6
16	120	5	125	96.0
17	270	12	282	95.7
18	327	18	345	94.8
19	923	27	950	97.1
20	48	5	53	90.6
21	520	17	537	96.8
22	850	23	873	97.4
23	240	0	240	100.0
24	538	0	538	100.0
25	187	10	197	94.9
Total	6774	266	7040	
Wt. Mean				96.2
Arith. Mean				94.6

10. Miscellaneous Studies

The California Prionid (Prionus Californicus) has been causing considerable damage to both hop roots and hop poles in the yard belonging to Mr. Miller, Salem, Oregon. Tests were made during the fall of 1940 to kill the larvae in the roots of hop vines. It was thought probable that various concentrations of chloropicrin or chloropicrin emulsions might serve for this purpose. There was no possibility of saving the crowns of the hops which were already largely destroyed. Plots were accordingly laid out and a number of soil fumigants were injected into the soil in close proximity to the hop hill. No data were collected from this experiment because the grower later plowed all hop hills out and replanted the infested yard.

Early in the season of 1942, Mr. Miller again asked for aid in controlling this insect which was feeding on hop poles below the surface of the soil. Chloropicrin Methyl isobutyl ketone and dichlor ethyl ether were injected at various concentrations about a number of hop poles on April 3. One week later April 11, these poles were dug up and the number of prionid larvae collected. None of the fumigants were satisfactory in effecting kills of this pest. Data are assembled as follows:

Material	Dosage	Live Larvae	Dead Larvae	Kind of pole
Chloropicrin	18 cc.	8	0	Cedar
"	12 cc.	7	0	"
"	6 cc.	4	1	"
"	24 cc.	0	0	"
"	30 cc.	0	1	"
"	18 cc.	2	0	"
"	18 cc.	4	0	"
"	24 cc.	3	0	"
"	30 cc.	0	0	"
"	12 cc.	4	0	"
"	3 cc.	0	0	"
Total		32	2	
Methyl isobutyl ketone	30 cc.	2	0	Cedar
"	60 cc.	5	1	"
"	120 cc.	6	2	Poplar
"	30 cc.	1	1	Cedar
"	12 cc.	3	0	"
"	18 cc.	1	0	"
"	30 cc.	4	0	"
"	30 cc.	0	0	"
"	12 cc.	1	0	"
"	6 cc.	6	0	"
"	24 cc.	7	0	"
"	30 cc.	4	0	"
"	12 cc.	5	0	"
"	60 cc.	8	0	"
"	60 cc.	3	0	"
"	18 cc.	6	0	"
"	9 cc.	29	0	Poplar
Total		91	5	
Dichlorethyl ether	18	1	0	Cedar
"	12	6	0	"
"	42	2	0	"
"	12	4	0	"
"	30	1	0	"
"	12	10	0	"
"	60	1	0	"
"	18	13	0	"
"	18	8	0	Poplar
"	6	1	0	Cedar
"	30	3	0	"
"	120	2	0	"
"	60	3	0	"
"	18	1	0	"

(Continued)

Material	Dosage	Live Larvae	Dead Larvae	Kind of pole
Dichlorethyl ether	30	10	0	Poplar
"	60	8	0	"
"	60	3	0	"
Total		77	0	
Check		3	0	Cedar
"		3	0	"
"		13	0	"
"		7	0	"
"		1	0	Poplar
"		15	0	"
"		15	0	"
"		14	0	"
"		32	0	"
Total		103	0	

APPENDIX

Preliminary Applications of DN Dusts and Sprays to Strawberry Plants (Corvallis #12)

Cooperator: E. A. Jones — East Farm, Corvallis, Ore.
Date applied: May 14 — Data collected: May 15

Rate of application: Heavy
Dusts applied with hand duster
Spray applied with small power sprayer

DN Dust

No. of Red Spiders	Leaf Number 1	2	3	4	5	6	7	8	9	10	Total
Dead	60	87	43	97	31	55	18	78	52	20	541
Alive	48	37	59	0	0	0	0	88	0	104	336
Total	108	124	102	97	31	55	18	166	52	124	877
% Dead	55.6	70.2	42.2	100.0	100.0	100.0	100.0	47.0	100.0	19.2	61.7

DN Dust D-4

Dead	37	29	39	85	38	65	73	12	21	17	416
Alive	84	0	0	12	17	8	0	15	15	7	158
Total	121	29	39	97	55	73	73	27	36	24	574
% Dead	30.6	100.0	100.0	87.6	69.1	89.0	100.0	44.4	58.3	70.8	72.5

DN Dust D-8

Dead	11	49	145	18	65	141	42	77	98	67	713
Alive	78	39	0	0	85	40	37	51	54	19	403
Total	89	88	145	18	150	181	79	128	152	86	1116
% Dead	12.4	55.7	100.0	100.0	43.3	77.9	53.2	60.2	64.5	77.9	63.9

DN Dust D-3

Dead	15	39	73	0	66	49	0	27	16	106	391
Alive	71	19	0	43	37	0	18	0	88	0	276
Total	86	58	73	43	103	49	18	27	104	106	667
% Dead	17.4	67.2	100.0	0.0	64.1	100.0	0.0	100.0	15.4	100.0	58.6

DN Dust D-7

Dead	45	33	18	0	52	105	73	0	34	56	416
Alive	21	0	32	18	0	44	42	67	0	19	243
Total	66	33	50	18	52	149	115	67	34	75	659
% Dead	68.2	100.0	36.0	0.0	100.0	70.5	63.5	0.0	100.0	74.7	63.1

DN Dust D-4 (3 lbs.) SS-3 (½ pt.) Water 100 gal.

Dead	116	79	12	88	105	97	185	6	19	66	773
Alive	0	2	0	0	2	0	1	0	1	0	6
Total	116	81	12	88	107	97	186	6	20	66	779
% Dead	100.0	97.5	100.0	100.0	98.1	100.0	99.5	100.0	95.0	100.0	99.2

Note: All of the above dusts produced severe burn and that of DN Dust was more severe of any of the dusts. Temperatures reach 85 the day of dusting. Most severe burn resulted from the DN Dust D-4 spray. All leaves were severely burned in this instance but blossoms and berries were uninjured. The loss of leaves in this instance resulted in inferior flavor of the ripe berries. Most severe burn on dusted plants was on the south and west sides of the plants (that portion exposed to afternoon sunlight)

Preliminary Application of DN Dust D-8 to Strawberry Plants (Corvallis #12)

Cooperator: E. A. Jones — East Farm, Corvallis, Ore.
Date applied: May 21 — Data collected: May 22

Rate of application: 100 lbs./acre
Size of plants: Large (2 ft. x 2 ft. x 2 ft.)

Plant Number 1

No. of Red Spiders	Leaf Number 1	2	3	4	5	6	7	8	9	10	Total
Dead	1	1	0	0	0	2	17	19	0	1	41
Alive	2	0	1	1	8	17	55	0	1	1	86
Total	3	1	1	1	8	19	72	19	1	2	127
% Dead	33.3	100.0	0.0	0.0	0.0	10.5	23.6	100.0	0.0	50.0	32.3

Plant Number 2

Dead	7	1	2	2	3	3	3	2	8	5	36
Alive	0	0	0	0	0	1	0	0	2	0	3
Total	7	1	2	2	3	4	3	2	10	5	39
% Dead	100.0	100.0	100.0	100.0	100.0	75.0	100.0	100.0	80.0	100.0	92.3

Plant Number 3

Dead	13	8	15	118	145	30	1120	3	30	85	1567
Alive	1	0	0	41	1	0	104	0	0	5	152
Total	14	8	15	159	146	30	1224	3	30	90	1719
% Dead	92.9	100.0	100.0	74.2	99.3	100.0	91.5	100.0	100.0	94.4	91.2

Plant Number 4

Dead	187	71	111	73	365	612	261	44	36	44	1804
Alive	4	0	18	26	7	69	12	3	18	2	159
Total	191	71	129	99	372	681	273	47	54	46	1963
% Dead	97.9	100.0	86.0	73.7	98.1	89.9	95.6	93.6	66.7	95.7	91.9

Preliminary Application of DN Dust D-8 to Strawberry Plants (Corvallis #12)

Cooperator: E. A. Jones — East Farm, Corvallis, Oregon
Date applied: May 21 — Data collected: May 22

Rate of application: 100 lbs./acre
Size of plants: Medium (1.5 ft. x 1.5 ft. x 1.5 ft.)

Plant Number 1

No. of Red Spiders	Leaf Number 1	2	3	4	5	6	7	8	9	10	Total
Dead	32	11	96	52	120	203	3	628	171	135	1451
Alive	0	0	0	0	1	54	0	28	0	21	104
Total	32	11	96	52	121	257	3	656	171	156	1555
% Dead	100.0	100.0	100.0	100.0	99.2	79.9	100.0	95.7	100.0	86.5	93.3

Plant Number 2

Dead	359	2271	1500	2	56	6	81	41	6	242	4564
Alive	91	150	1	0	0	0	6	1	0	23	272
Total	450	2421	1501	2	56	6	87	42	6	265	4836
% Dead	79.8	93.8	99.9	100.0	100.0	100.0	93.1	97.6	100.0	91.3	94.4

Plant Number 3

Dead	16	18	136	62	8	263	313	173	211	29	1229
Alive	7	1	18	7	0	9	23	8	1	0	74
Total	23	19	154	69	8	272	336	181	212	29	1303
% Dead	69.6	94.7	88.3	89.9	100.0	96.7	93.2	95.6	99.5	100.0	94.3

Size of plants: Small (1 ft. x 1 ft. x 1 ft.)

Plant Number 1

Dead	305	65	8	4	56	9	128	67	20	37	699
Alive	0	2	6	0	0	0	0	0	0	0	8
Total	305	67	14	4	56	9	128	67	20	37	707
% Dead	100.0	97.0	57.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	98.9

Plant Number 2

Dead	59	46	467	15	54	44	115	123	14	3	940
Alive	7	0	8	0	0	2	3	5	1	0	26
Total	66	46	475	15	54	46	118	128	15	3	966
% Dead	89.4	100.0	98.3	100.0	100.0	95.7	97.5	96.1	93.3	100.0	97.3

Plant Number 3

Dead	0	10	291	25	23	47	20	47	2	197	662
Alive	1	0	2	8	0	0	0	0	3	2	16
Total	1	10	293	33	23	47	20	47	5	199	678
% Dead	0.0	100.0	99.3	75.8	100.0	100.0	100.0	100.0	40.0	99.0	97.6

Preliminary Applications of DN Dust D-8 to Strawberry Plants (Corvallis #12)

Cooperator: E. A. Jones — East Farm, Corvallis
Date applied: May 24 — Data collected: May 26

Rate of application: 100 lbs./acre
Size of plants: Large (2 ft. x 2 ft. x 2 ft.)

Plant No. 1

No. of Red Spiders	Leaf Number 1	2	3	4	5	6	7	8	9	10	Total
Dead	3	11	3	31	8	48	18	3	16	6	147
Alive	2	15	0	1	0	14	3	1	4	1	41
Total	5	26	3	32	8	62	21	4	20	7	188
% Dead	60.0	42.3	100.0	96.9	100.0	77.4	85.7	75.0	80.0	85.7	78.2

Plant No. 2

Dead	29	70	120	75	74	140	261	59	59	53	940
Alive	0	49	23	33	47	17	8	28	8	1	214
Total	29	119	143	108	121	157	269	87	67	54	1154
% Dead	100.0	58.8	83.9	69.4	61.2	89.2	97.0	67.8	88.1	98.1	81.5

Plant No. 3

Dead	0	25	1	4	14	10	0	3	1	36	94
Alive	3	0	0	7	9	23	2	2	4	46	96
Total	3	25	1	11	23	33	2	5	5	82	190
% Dead	0	100.0	100.0	36.4	60.9	30.3	0.0	60.0	20.0	43.9	49.5

Plant No. 4

Dead	12	5	8	13	36	147	128	8	89	27	473
Alive	5	5	10	1	11	38	2	52	3	8	135
Total	17	10	18	14	47	185	130	60	92	35	608
% Dead	70.6	50.0	44.4	92.9	76.6	79.9	96.9	13.3	96.7	77.1	77.8

Plant No. 5

Dead	175	257	205	23	121	23	22	342	422	162	1752
Alive	60	80	19	14	50	10	8	56	78	18	393
Total	235	337	224	37	171	33	30	398	500	180	2145
% Dead	74.5	76.3	91.5	62.2	70.8	69.7	73.3	85.9	84.4	90.0	81.7

Preliminary Applications of DN Dust D-8 to Strawberry Plants (Corvallis #12)

Cooperator: E. A. Jones — East Farm, Corvallis, Oregon
Date applied: May 24 — Data collected: May 26

Rate of application: 100 lbs. per acre
Size of plants: Medium (1.5 ft. x 1.5 ft. x 1.5 ft.)

Plant No. 1

No. of Red Spiders	Leaf Number 1	2	3	4	5	6	7	8	9	10	Total
Dead	7	12	0	1	8	8	1	3	1	50	91
Alive	1	0	2	7	4	0	1	5	6	0	26
Total	8	12	2	8	12	8	2	8	7	50	117
% Dead	87.5	100.0	0.0	12.5	66.7	100.0	50.0	37.5	14.3	100.0	77.8

Plant No. 2

Dead	297	7	548	23	249	257	54	8	35	9	1487
Alive	143	2	20	9	74	40	3	1	47	2	341
Total	440	9	568	32	323	297	57	9	82	11	1828
% Dead	67.5	77.8	96.5	71.9	77.1	86.5	93.0	88.8	46.7	81.8	81.4

Plant No. 3

Dead	19	47	53	175	34	131	141	97	11	36	744
Alive	0	0	0	3	2	6	0	116	7	1	135
Total	19	47	53	178	36	137	141	213	18	37	879
% Dead	100.0	100.0	100.0	98.3	94.4	95.6	100.0	45.5	61.1	97.3	84.6

Plant No. 4

Dead	16	77	1	19	9	2	78	30	3	40	275
Alive	1	18	4	6	0	0	20	23	0	0	72
Total	17	95	5	25	9	2	98	53	3	40	347
% Dead	94.1	81.1	20.0	76.0	100.0	100.0	79.6	56.6	100.0	100.0	79.3

Plant No. 5

Dead	108	122	42	83	4	170	62	27	68	85	771
Alive	0	70	66	1	1	0	4	4	9	0	155
Total	108	192	108	84	5	170	66	31	77	85	926
% Dead	100.0	63.5	39.9	98.8	80.0	100.0	93.9	87.1	88.3	100.0	83.3

Preliminary Application of DN Dust D-8 to Strawberry Plants (Corvallis #12)

Cooperator: E. A. Jones — East Farm, Corvallis, Oregon
Date applied: May 24 — Data collected: May 26

Rate of application: 100 lbs./acre
Size of plants: Small (1 ft. x 1 ft. x 1 ft.)

Plant No. 1

No. of Red Spiders	Leaf Number 1	2	3	4	5	6	7	8	9	10	Total
Dead	163	470	69	96	305	169	184	49	13	152	1670
Alive	3	19	2	2	58	4	6	2	0	8	104
Total	166	489	71	98	363	173	190	51	13	160	1774
% Dead	98.2	96.1	97.2	97.9	84.0	97.7	96.8	96.1	100.0	95.0	94.2

Plant No. 2

Dead	13	26	11	21	8	12	14	7	14	3	129
Alive	0	3	0	0	0	0	0	0	0	7	10
Total	13	29	11	21	8	12	14	7	14	10	139
% Dead	100.0	89.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	30.0	92.8

Plant No. 3

Dead	55	172	8	26	205	30	109	55	6	26	692
Alive	2	0	0	0	3	1	5	12	0	0	23
Total	57	172	8	26	208	31	114	67	6	26	715
% Dead	96.5	100.0	100.0	100.0	98.6	96.8	95.6	82.1	100.0	100.0	96.8

Plant No. 4

Dead	398	29	38	28	31	48	27	29	397	428	1453
Alive	3	3	0	5	0	0	0	0	0	1	12
Total	401	32	38	33	31	48	27	29	397	429	1465
% Dead	91.3	90.6	100.0	80.0	100.0	100.0	100.0	100.0	100.0	99.8	99.2

Plant No. 5

Dead	31	16	18	4	24	47	13	18	22	12	205
Alive	1	1	0	0	0	1	1	0	2	0	6
Total	32	17	18	4	24	48	14	18	24	12	211
% Dead	96.9	94.1	100.0	100.0	100.0	97.9	92.9	100.0	91.7	100.0	97.1

Final Application of DN Dust D-8 to Strawberry Plants (Corvallis #12)

Cooperator: E. A. Jones — East Farm, Corvallis, Oregon
Date applied: May 31 — Data collected: June 2

Rate of application: 100 lbs./acre
Size of plants: Large (2 ft. x 2 ft. x 2 ft.)

Plant Number 1

No. of Red Spiders	Leaf Number 1	2	3	4	5	6	7	8	9	10	Total
Dead	359	80	263	301	250	267	93	383	53	236	2285
Alive	160	30	1	90	40	2	2	17	1	22	365
Total	519	110	264	391	290	269	95	400	54	258	2650
% Dead	69.2	72.7	99.6	77.0	86.2	99.3	97.9	95.8	98.1	91.5	86.2

Plant Number 2

Dead	516	208	429	398	471	460	389	255	464	512	4102
Alive	3	0	15	0	1	25	19	0	0	7	70
Total	519	208	444	398	472	485	408	255	464	519	4172
% Dead	99.4	100.0	96.6	100.0	99.8	94.8	95.3	100.0	100.0	98.7	98.3

Plant Number 3

Dead	420	351	222	405	338	515	106	112	248	424	3141
Alive	15	13	40	36	108	92	0	3	6	39	352
Total	435	364	262	441	446	607	106	115	254	463	3493
% Dead	96.6	96.4	84.7	91.8	75.8	84.8	100.0	97.4	97.6	91.6	89.9

Plant Number 4

Dead	70	127	275	145	212	128	79	123	185	58	1402
Alive	1	50	48	14	3	2	50	44	70	4	286
Total	71	177	323	159	215	130	129	167	255	62	1688
% Dead	98.6	71.8	85.1	91.2	98.6	98.5	61.2	73.6	72.5	93.5	83.1

Plant Number 5

Dead	247	498	249	343	265	193	500	143	156	268	2862
Alive	139	41	87	35	26	31	14	50	14	13	450
Total	386	539	336	378	291	224	514	193	170	281	3312
% Dead	64.0	92.4	74.1	90.7	91.1	86.2	97.3	74.1	91.8	95.4	86.4

Plant Number 6

Dead	98	137	79	144	141	157	252	211	203	187	1609
Alive	78	11	82	36	57	34	50	59	206	8	621
Total	176	148	161	180	198	191	302	270	409	195	2230
% Dead	55.7	92.6	44.9	80.0	71.2	82.2	83.4	78.1	49.6	95.9	72.2

Final Application of DN Dust D-8 to Strawberry Plants (Corvallis #12)

Cooperator: E. A. Jones — East Farm, Corvallis, Oregon
Date applied: May 31 — Data collected: June 2

Rate of application: 100 lbs./acre
Size of plants: Medium (1.5 ft. x 1.5 ft. x 1.5 ft.)

Plant Number 1

No. of Red Spiders	Leaf Number 1	2	3	4	5	6	7	8	9	10	Total
Dead	56	118	2	232	17	121	117	297	229	286	1475
Alive	2	23	1	75	0	5	15	139	9	67	336
Total	58	141	3	307	17	126	132	436	238	353	1811
% Dead	96.5	83.7	66.7	77.5	100.0	96.0	88.6	68.1	96.2	81.0	81.4

Plant Number 2

Dead	108	182	231	54	120	162	49	122	83	42	1153
Alive	25	20	81	37	60	31	14	46	14	0	328
Total	133	202	312	91	180	193	63	168	97	42	1481
% Dead	81.2	90.1	74.0	59.3	66.7	83.9	77.8	72.6	85.6	100.0	77.9

Plant Number 3

Dead	20	92	5	21	23	207	175	149	52	330	1074
Alive	15	0	1	4	0	84	24	58	18	45	249
Total	35	92	6	25	23	291	199	207	70	375	1323
% Dead	57.1	100.0	83.3	84.0	100.0	71.1	87.9	72.0	74.3	88.0	81.2

Size of Plants: Small (1 ft. x 1 ft. x 1 ft.)

Plant Number 1

Dead	428	308	554	327	205	219	158	152	167	101	2619
Alive	125	37	59	16	42	6	60	98	154	2	599
Total	553	345	613	343	247	225	218	250	321	103	3218
% Dead	77.4	89.3	90.4	95.3	83.0	97.3	72.5	60.8	52.0	98.1	81.4

Plant Number 2

Dead	164	913	312	175	240	83	564	152	99	287	2989
Alive	32	4	12	54	33	9	3	2	8	9	166
Total	196	917	324	229	273	92	567	154	107	296	3155
% Dead	83.7	99.6	96.3	76.4	87.9	90.2	99.5	98.7	92.5	96.9	94.7

Final Application of DN Dust D-3 to Strawberry Plants (Corvallis #12)

Cooperator: E. A. Jones — East Farm, Corvallis, Ore.
Date applied: May 31 — Data collected: June 2

Rate of application: 100 lbs./acre
Size of plants: Large (2 ft. x 2 ft. x 2 ft.)

Plant Number 1

No. of Red Spiders	Leaf Number 1	2	3	4	5	6	7	8	9	10	Total
Dead	116	44	277	260	290	98	76	315	47	312	1835
Alive	0	4	14	12	0	5	1	15	0	2	53
Total	116	48	291	272	290	103	77	330	47	314	1888
% Dead	100.0	91.7	95.2	95.6	100.0	95.1	98.7	95.5	100.0	99.4	97.2

Plant Number 2

Dead	208	228	196	114	85	242	194	116	177	96	1656
Alive	23	15	28	10	11	34	17	20	15	9	182
Total	231	243	224	124	96	276	211	136	192	105	1838
% Dead	90.0	93.8	87.5	91.9	88.5	87.7	91.9	85.3	92.2	91.4	90.1

Plant Number 3

Dead	316	116	36	144	177	160	214	81	95	144	1483
Alive	5	18	2	3	10	0	22	0	3	5	68
Total	321	134	38	147	187	160	236	81	98	149	1551
% Dead	98.4	86.6	94.7	97.8	94.7	100.0	90.7	100.0	96.9	96.6	95.6

Plant Number 4

Dead	195	375	215	81	281	200	166	312	48	313	2186
Alive	67	41	23	15	71	37	53	43	12	89	451
Total	262	416	238	96	352	237	219	355	60	402	2637
% Dead	74.4	90.1	90.3	84.4	79.8	84.4	75.8	87.9	80.0	77.9	82.9

Plant Number 5

Dead	218	150	87	225	105	93	144	50	319	135	1526
Alive	12	23	4	19	19	3	0	2	57	5	144
Total	230	173	91	244	124	96	144	52	376	140	1670
% Dead	94.8	86.7	95.6	92.2	84.7	96.9	100.0	96.2	84.8	96.4	91.4

Note: Walnut shell flour used as carrier.

Final Application of DN Dust D-3 to Strawberry Plants (Corvallis #12)

Cooperator: E. A. Jones — East Farm, Corvallis, Oregon
Date applied: May 31 — Data collected: June 2

Rate of application: 100 lbs./acre
Size of Plants: Medium (1.5 ft. x 1.5 ft. x 1.5 ft.)

Plant Number 1

No. of Red Spiders	Leaf Number 1	2	3	4	5	6	7	8	9	10	Total
Dead	313	69	296	409	218	184	97	188	262	140	2176
Alive	12	2	5	21	8	0	16	2	18	0	84
Total	325	71	301	430	226	184	113	190	280	140	2260
% Dead	96.3	97.2	98.3	95.1	96.5	100.0	85.8	98.9	93.6	100.0	96.3

Plant Number 2

Dead	285	272	238	87	213	316	212	210	78	50	1961
Alive	1	0	5	3	0	0	4	0	1	2	16
Total	286	272	243	90	213	316	216	210	79	52	1977
% Dead	99.7	100.0	97.9	96.7	100.0	100.0	98.1	100.0	98.7	96.2	99.2

Plant Number 3

Dead	144	318	395	314	152	91	40	321	205	88	2068
Alive	33	27	19	15	53	12	8	40	16	4	227
Total	177	345	414	329	205	103	48	361	221	92	2295
% Dead	81.4	92.2	95.4	95.4	74.1	88.3	83.3	88.9	92.8	95.7	90.1

Size of plants: Small (1 ft. x 1 ft. x 1 ft.)

Plant Number 1

Dead	247	193	156	75	258	188	137	142	395	192	1983
Alive	35	0	27	0	19	20	3	14	22	2	142
Total	287	193	183	75	277	208	140	156	417	194	2125
% Dead	87.6	100.0	85.2	100.0	93.1	90.4	97.9	91.0	94.7	98.9	93.3

Plant Number 2

Dead	202	209	231	298	132	55	129	73	261	91	1681
Alive	8	6	0	9	15	0	6	12	20	0	76
Total	210	215	231	307	147	55	135	85	281	91	1757
% Dead	96.2	97.2	100.0	97.1	89.8	100.0	95.6	85.9	92.9	100.0	95.7

Plant Number 3

Dead	191	133	122	111	466	187	63	193	277	304	2047
Alive	8	9	5	0	22	3	1	5	0	10	63
Total	199	142	127	111	488	190	64	198	277	314	2110
% Dead	96.0	93.7	96.1	100.0	95.4	98.4	98.4	97.5	100.0	96.8	97.0

Note: Walnut shell flour used as carrier.

Final Application of DN Dust D-7 to Strawberry Plants (Corvallis #12)

Cooperator: E. A. Jones — East Farm, Corvallis, Oregon
Date applied: May 31 — Data collected: June 2

Rate of application: 100 lbs./acre
Size of plants: Large (2 ft. x 2 ft. x 2 ft.)

Plant Number 1

No. of Red Spiders	Leaf Number 1	2	3	4	5	6	7	8	9	10	Total
Dead	216	151	73	91	167	407	214	314	122	55	1810
Alive	27	29	14	5	31	16	29	12	15	10	188
Total	243	180	87	96	198	423	243	326	137	65	1998
% Dead	88.9	83.9	83.9	94.8	84.3	96.2	88.1	96.3	89.1	84.6	90.6

Plant Number 2

Dead	113	73	316	97	145	108	266	321	58	127	1624
Alive	12	0	16	0	29	0	33	5	2	1	98
Total	125	73	332	97	174	108	299	326	60	128	1722
% Dead	90.4	100.0	95.2	100.0	83.3	100.0	89.0	98.5	96.7	99.2	94.3

Plant Number 3

Dead	79	63	149	267	136	205	97	278	333	85	1692
Alive	2	0	81	39	9	44	0	68	5	7	255
Total	81	63	230	306	145	249	97	346	338	92	1947
% Dead	97.5	100.0	64.8	87.3	93.8	82.3	100.0	80.3	98.5	92.4	86.9

Plant Number 4

Dead	145	271	87	319	77	63	142	108	51	93	1356
Alive	9	7	3	12	11	5	18	27	0	2	94
Total	154	278	90	331	88	68	160	135	51	95	1450
% Dead	94.2	97.5	96.7	96.4	87.5	92.6	88.8	80.0	100.0	97.9	93.5

Final Application of DN Dust D-7 to Strawberry Plants (Corvallis #12)

Cooperator: E. A. Jones — East Farm, Corvallis, Ore.
Date applied: May 31 — Data collected: June 2

Rate of application: 100 lbs./acre
Size of plants: Medium (1.5 ft. x 1.5 ft. x 1.5 ft.)

Plant Number 1

No. of Red Spiders	Leaf Number 1	2	3	4	5	6	7	8	9	10	Total
Dead	202	75	169	94	187	144	322	243	111	145	1692
Alive	16	12	41	0	3	19	47	15	0	10	163
Total	218	87	210	94	190	163	369	258	111	155	1855
% Dead	92.7	86.2	80.5	100.0	98.4	88.3	87.3	94.2	100.0	93.5	91.2

Plant Number 2

Dead	116	367	47	145	167	213	262	125	150	118	1710
Alive	8	5	0	0	13	6	0	21	0	0	53
Total	124	372	47	145	180	219	262	146	150	118	1763
% Dead	93.5	98.7	100.0	100.0	92.8	97.3	100.0	85.6	100.0	100.0	97.0

Plant Number 3

Dead	155	242	305	65	241	417	285	215	233	192	2350
Alive	3	41	13	3	15	77	28	9	42	13	244
Total	158	283	318	68	256	494	313	224	275	205	2594
% Dead	98.1	85.5	95.9	95.6	94.1	84.4	91.1	96.0	84.7	93.7	90.6

Size of Plants: Small (1 ft. x 1 ft. x 1 ft.)

Plant Number 1

Dead	203	309	197	300	88	144	171	169	203	89	1873
Alive	16	23	7	40	0	23	14	6	61	0	190
Total	219	332	204	340	88	167	185	175	264	89	2063
% Dead	92.7	93.1	96.6	88.2	100.0	86.2	92.4	96.6	76.9	100.0	90.8

Plant Number 2

Dead	142	372	208	416	19	273	147	86	44	297	2004
Alive	66	21	4	37	0	28	14	7	8	53	238
Total	208	393	212	453	19	301	161	93	52	350	2242
% Dead	68.3	94.7	98.1	91.8	100.0	90.7	91.3	92.5	84.6	84.9	89.4

Plant Number 3

Dead	307	212	188	235	241	150	198	93	179	40	1843
Alive	47	63	22	49	30	15	35	4	10	8	283
Total	354	275	210	284	271	165	233	97	189	48	2126
% Dead	86.7	77.1	89.5	82.7	88.9	90.9	85.0	95.9	94.7	83.3	86.7

Final Application of DN Dust D-4 to Strawberry Plants (Corvallis #12)

Cooperator: E. A. Jones — East Farm, Corvallis, Oregon
Date applied: May 31 — Data collected: June 2

Rate of application: 100 lbs./acre
Size of plants: Large (2 ft. x 2 ft. x 2 ft.)

Plant Number 1

No. of Red Spiders	Leaf Number 1	2	3	4	5	6	7	8	9	10	Total
Dead	523	217	197	614	278	371	262	184	406	387	3439
Alive	8	12	19	31	16	15	8	13	6	4	132
Total	531	229	216	645	294	386	270	197	412	391	3571
% Dead	98.5	94.6	91.2	95.2	94.6	96.1	97.0	93.4	98.5	99.0	96.3

Plant Number 2

Dead	427	316	274	304	222	140	166	303	219	305	2676
Alive	32	27	18	21	11	8	23	9	12	28	189
Total	459	343	292	325	233	148	189	312	231	333	2865
% Dead	93.0	92.1	93.8	93.5	95.3	94.6	87.8	97.1	94.8	91.6	93.4

Plant Number 3

Dead	95	42	613	197	319	214	504	612	213	124	2933
Alive	4	6	43	18	12	19	61	30	19	19	231
Total	99	48	656	215	331	233	565	642	232	143	3164
% Dead	95.6	87.5	93.4	91.6	96.4	91.8	89.2	95.3	91.8	86.7	92.7

Plant Number 4

Dead	176	329	66	181	247	804	90	163	129	78	2263
Alive	0	18	1	5	0	12	4	0	1	0	41
Total	176	347	67	186	247	816	94	163	130	78	2304
% Dead	100.0	94.8	98.5	97.3	100.0	98.5	95.7	100.0	99.2	100.0	98.2

Plant Number 5

Dead	420	600	527	437	212	97	168	427	182	202	3272
Alive	0	0	0	0	0	0	0	0	0	0	0
Total	420	600	527	437	212	97	168	427	182	202	3272
% Dead	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Final Application of DN Dust D-4 to Strawberry Plants (Corvallis #12)

Cooperator: E. A. Jones — East Farm, Corvallis, Oregon
Date applied: May 31 — Data collected: June 2

Rate of application: 100 lbs./acre
Size of plants: Medium (1.5 ft. x 1.5 ft. x 1.5 ft.)

Plant Number 1

No. of Red Spiders	Leaf Number 1	2	3	4	5	6	7	8	9	10	Total
Dead	216	40	91	317	191	374	221	73	95	416	2034
Alive	19	12	4	21	0	42	16	2	0	12	128
Total	235	52	95	338	191	416	237	75	95	428	2162
% Dead	91.9	76.9	95.8	93.8	100.0	89.9	93.2	97.3	100.0	97.2	94.1
Plant Number 2											
Dead	316	204	66	213	404	122	277	169	381	305	2457
Alive	0	2	0	21	5	5	9	0	0	0	42
Total	316	206	66	234	409	127	286	169	381	305	2499
% Dead	100.0	99.0	100.0	91.0	98.8	96.1	96.9	100.0	100.0	100.0	98.3
Plant Number 3											
Dead	108	217	289	336	413	507	63	97	188	271	2519
Alive	18	1	3	15	12	9	5	0	19	12	94
Total	126	218	292	381	425	516	68	97	207	283	2613
% Dead	87.7	99.5	99.0	96.1	97.2	98.3	92.6	100.0	90.8	95.8	96.4

Size of Plants: Small (1 ft. x 1 ft. x 1 ft.)

Plant Number 1											
Dead	239	118	63	21	148	75	104	47	196	74	1085
Alive	0	1	5	0	3	0	1	0	0	0	10
Total	239	119	68	21	151	75	105	47	196	74	1095
% Dead	100.0	99.2	92.6	100.0	98.0	100.0	99.0	100.0	100.0	100.0	99.1
Plant Number 2											
Dead	361	207	149	305	229	63	91	205	311	67	1988
Alive	0	0	0	0	0	0	0	0	0	0	0
Total	361	207	149	305	229	63	91	205	311	67	1988
% Dead	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Plant Number 3											
Dead	99	142	209	314	249	88	141	75	84	161	1562
Alive	2	0	9	5	4	1	0	1	5	2	29
Total	101	142	218	319	253	89	141	76	89	163	1591
% Dead	98.0	100.0	95.9	98.4	98.4	98.9	100.0	98.7	94.4	98.8	98.2

Fig. 1 - Experimental Hop Duster
As Used During 1940

Fig. 2 - Rear View of the Improved Experimental Duster
1941 Station Field Day

Fig. 3 - Improved Experimental Duster in Operation
1941 Station Field Day

Fig. 4 - Rear View of the Improved Experimental Duster in Operation
1941 Station Field Day

Fig. 5 - View of the Experimental Hop Duster Using a Bean Dual Unit. This unit did not have adequate capacity for hop dusting.

Fig. 6 - Bean Dual Hop Dusting Unit in Operation.
Note dust does not reach tops of hop vines.

Fig. 7 - Rear View of Bean Dual Hop Duster.
Note dust does not reach tops of hop vines.

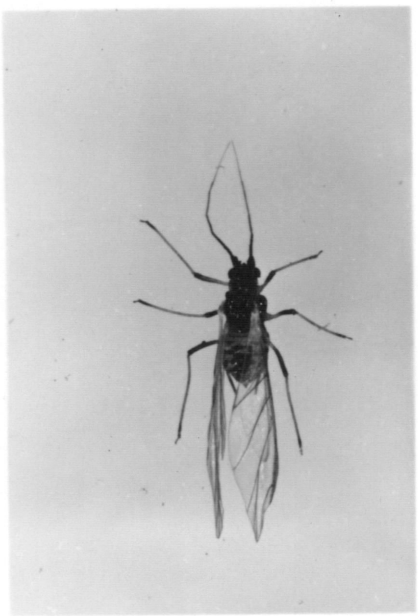


Fig. 8 - The Hop Aphis Phorodon humuli Schrank
Winged adult

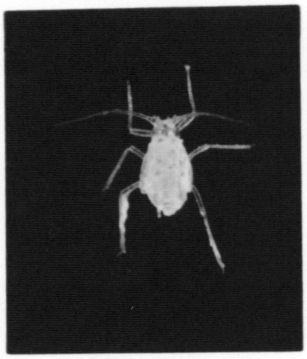
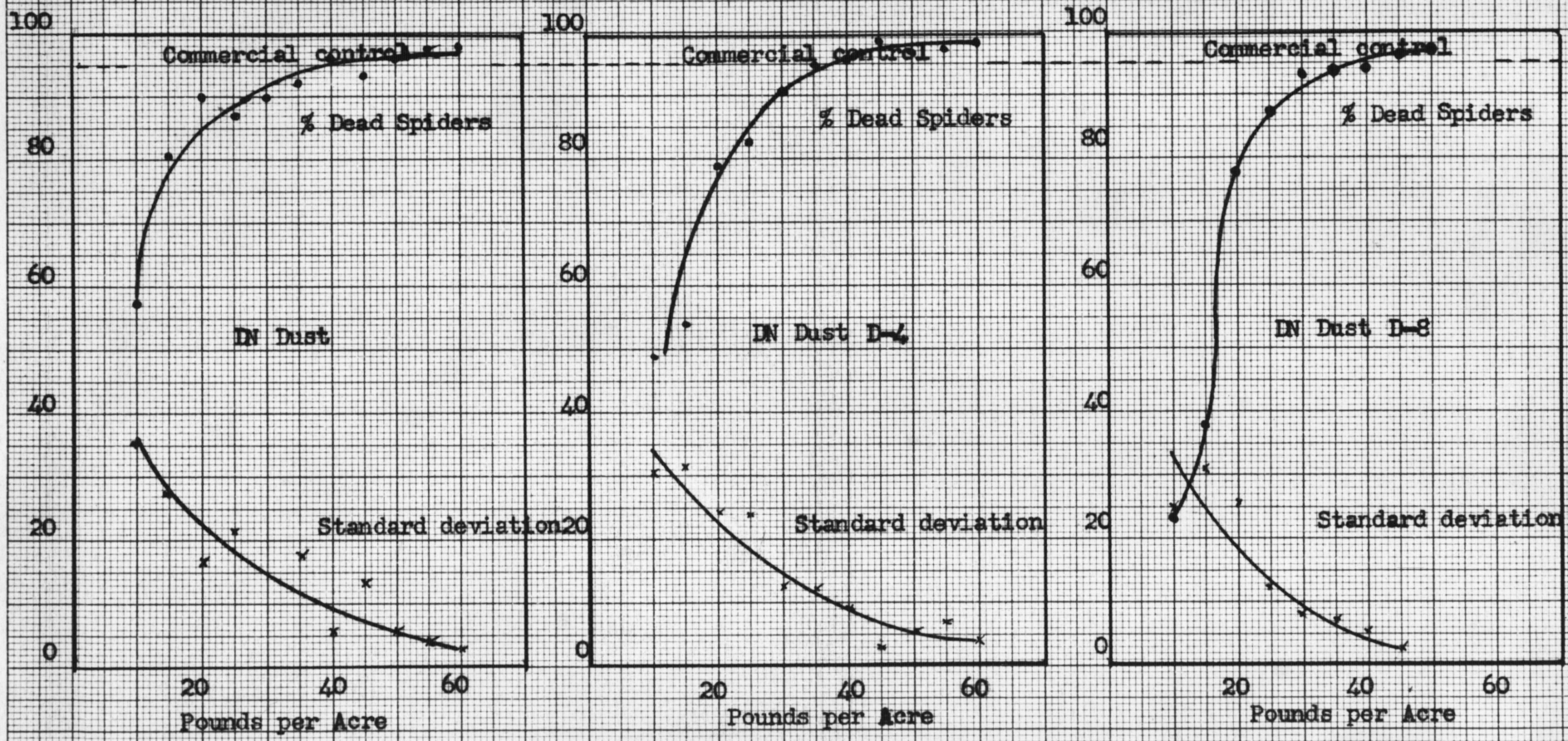


Fig. 9 - The Hop Aphis Phorodon humuli Schrank
Nymph

RATES OF APPLICATION OF DN DUSTS
WITH
HOP LEAVES AS A UNIT OF MEASUREMENT



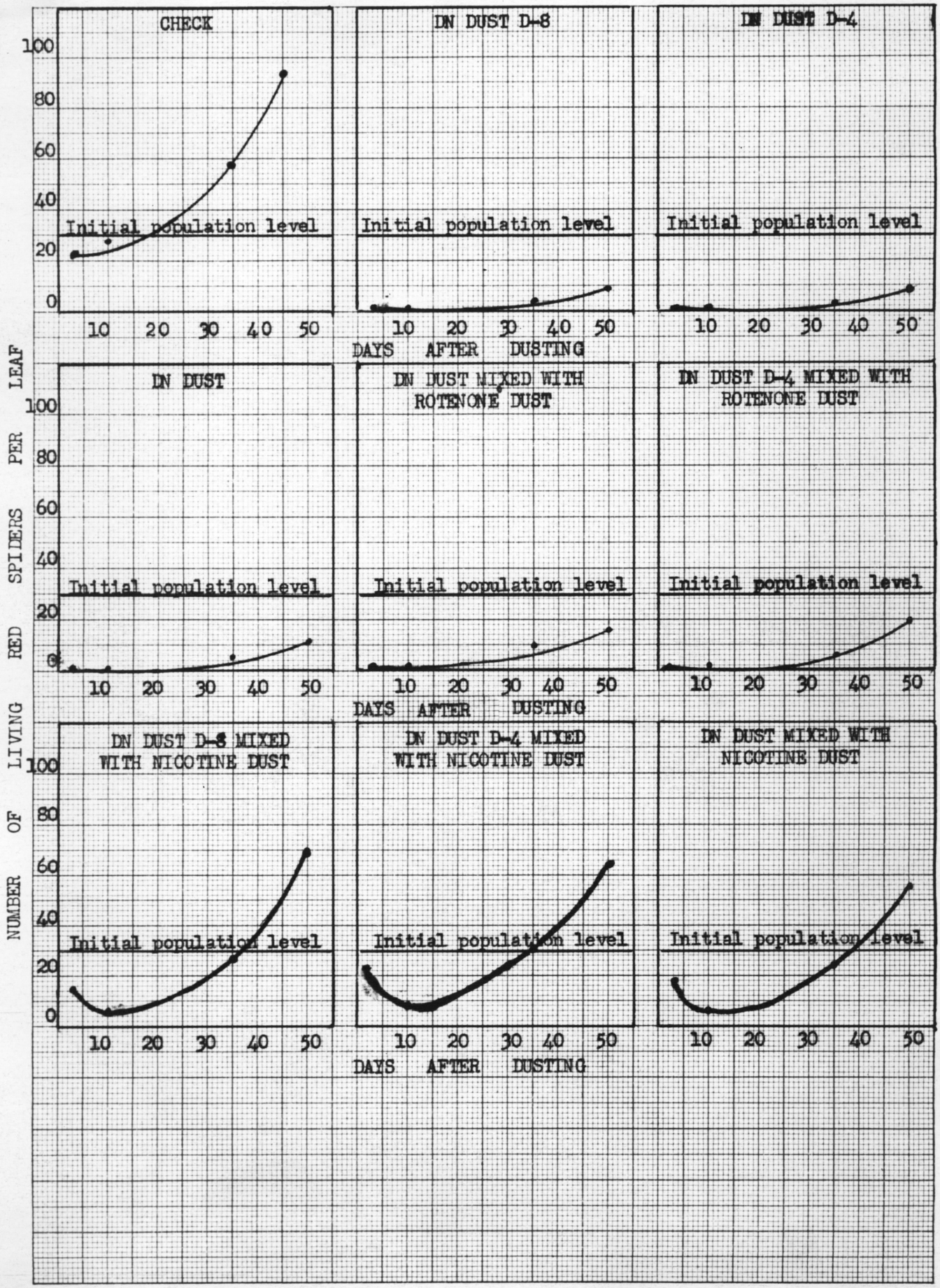
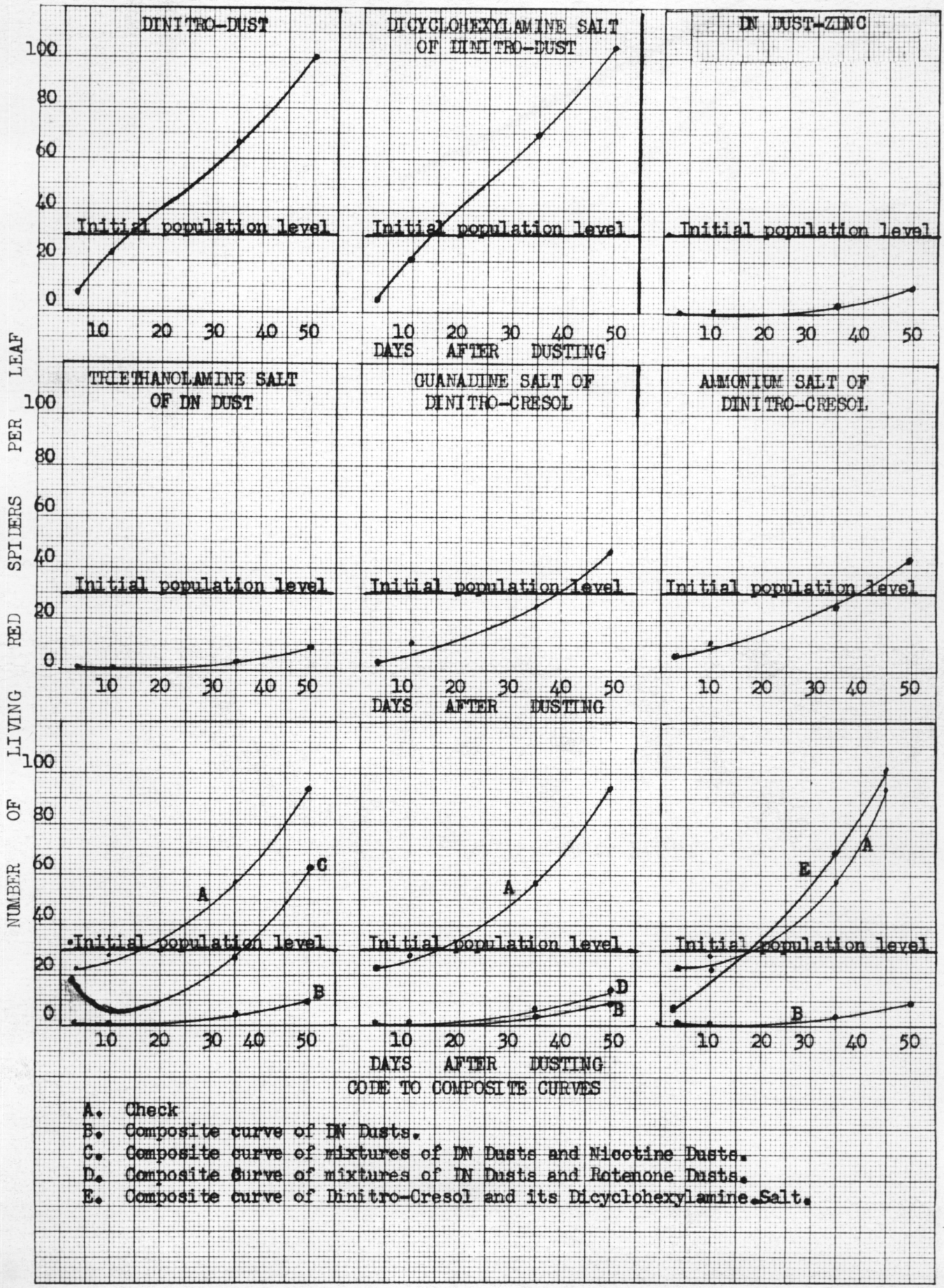

CHECK
DN DUST D-8
DN DUST D-4
DN DUST
DN DUST MIXED WITH ROTENONE DUST
DN DUST D-4 MIXED WITH ROTENONE DUST
DN DUST D-8 MIXED WITH NICOTINE DUST
DN DUST D-4 MIXED WITH NICOTINE DUST
DN DUST MIXED WITH NICOTINE DUST
Initial population level
NUMBER OF LIVING RED SPIDERS PER LEAF
DAYS AFTER DUSTING
0
20
40
60
80
100
10
20
30
40
50

Fig. 11



CODE TO COMPOSITE CURVES

A. Check
B. Composite curve of DN Dusts.
C. Composite curve of mixtures of DN Dusts and Nicotine Dusts.
D. Composite curve of mixtures of DN Dusts and Rotenone Dusts.
E. Composite curve of Dinitro-Cresol and its Dicyclohexylamine Salt.

Fig. 12

Fig. 13 - Discussion of Experimental Results
Station Field Day, 1941

Fig. 14 - Examination of Display
Station Field Day, 1941

Fig. 15 - Side View of New Dusting Unit for Strawberries
Note: - Both axel and hood are arranged to meet various widths of rows.

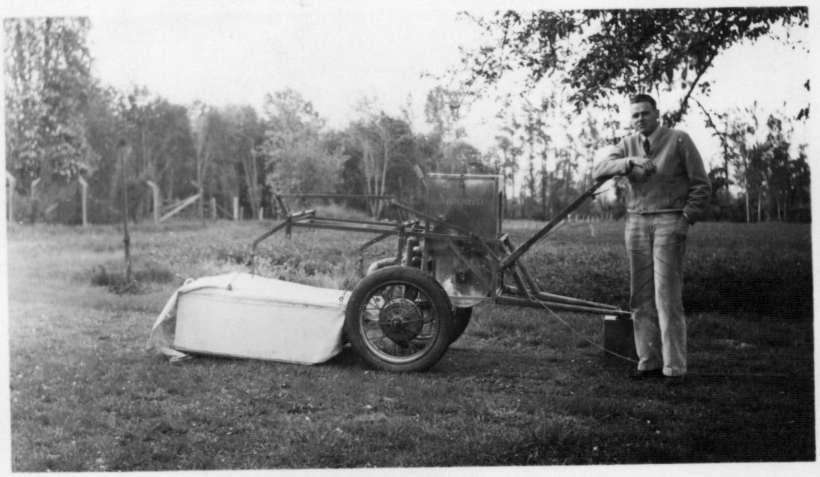


Fig. 16 - Side View of New Dusting Unit
This model was designed for dusting upper and lower foliage surfaces of most row crops.