PILOT TEST RESULTS OF SEVIN, PHOSPHAMIDON, AND DDT ON THE WESTERN HEMLOCK LOOPER, Lambdina fiscellaria lugubrosa Hulst, In Southwest Washington In 1963

by

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FOREST SERVICE

MAY 1964

96263

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SUMMARY

Effects of Sevin, Phosphamidon, and DDT on the western hemlock looper were field-tested in southwest Washington during July 1963 by the U. S. Forest Service. All applications were made by helicopter. Plots were established systematically in each test area and plot trees sampled for larval mortality. Spray cards and filter papers were distributed on each plot the day before spraying and collected the day after spraying. Collection trays were placed beneath plot trees in each area to catch dead looper larvae and other arthropods affected by the treatments.

All test areas were sprayed on July 5-7. Spray coverage and deposit were variable. Larval mortality averaged 86 and 87 percent for Sevin, 80, 93, and 99 percent for Phosphamidon, and 99 percent for DDT. Mortality caused by Sevin was not directly related to spray deposit. Mortality was directly related to spray deposit on one line of plots treated with Phosphamidon. Increasing the amount of Sevin did not increase larval mortality. Looper mortality on the DDT-treated plots was sufficient to prevent subsequent tree mortality Larval kill in heavily infested areas treated with Sevin was not adequate to prevent tree mortality. Results with Phosphamidon were below, at, and above the desired larval mortality level.

Many different arthropods besides the hemlock looper were obtained in the collection trays. Recoveries indicated that some insects and spiders were adversely affected by the insecticides.

Small-scale test results indicate that Sevin in fuel oil or in water with the spreader-stickers Ucar and Rhoplex as additives may produce the desired level of control.

Recommendations are made for future pilot tests.

INTRODUCTION

Outbreaks of the western hemlock looper, Lambdina fiscellaria lugubrosa Hulst, occur periodically in coastal western hemlock stands in Oregon, Washington, and British Columbia. Here, salmon and steelhead spawning streams, oyster and clam beds, crab-producing areas, wild game habitats, dairy farms, mink farms, and watersheds are abundant. The forest manager must protect these interests when attempting to control widespread tree killing by voracious forest defoliating insects. To do this, he must have control tools available that are toxic to forest insects but relatively non-toxic to other organisms.

Past western hemlock looper epidemics have been controlled by aerial applications of pesticides. The first chemicals used were the arsenicals, lead and calcium arsenate. These were applied at rates of 10 and 20 pounds per acre (14, 16). Next, DDT at the rate of one pound per acre was tested and proved satisfactory (14). In 1962, one-half pound of DDT per acre was applied to a 33,000-acre infestation in Clatsop County, Oregon. Larval mortality was insufficient on heavily infested areas to prevent subsequent tree mortality (4).

The arsenicals are no longer used for forest pest control. Use of DDT on a forest-wide basis is presently being questioned because of its deleterious effects on other organisms. DDT is toxic to young salmon, steelhead, trout, aquatic insects, and other marine organisms. Also, some terrestrial animals store and accumulate this chemical.

A 70,000-acre looper outbreak in southwest Washington in 1962-63 afforded a good opportunity to field test some promising pesticides. An efficient insecticide safe to organisms other than the hemlock looper could then be substituted for DDT. U. S. Forest Service personnel decided that two chemical insecticides, the carbamate Sevin and the organic phosphate Phosphamidon, and a microbial insecticide Bacillus thuringiensis should be tried. Sevin had been applied during a small-scale test in Clatsop County, Oregon in 1962, but results were inconclusive (4). Phosphamidon had been laboratory-tested against the hemlock looper. Bacillus had been laboratory-tested against the hemlock looper with variable results (7, 13).

In July 1963, field tests of Sevin and Phosphamidon were made by the U. S. Forest Service, Pacific Northwest Region, Portland, Oregon, in cooperation with the Washington State Department of Natural Resources. Bacillus was tested by the Pacific Northwest Forest and Range Experiment Station with the assistance of the Region. Results of the Sevin and Phosphamidon tests are reported in this paper. Operational procedures used during the pilot tests are reported elsewhere (9).

Results of the Bacillus tests and the operational project administered by the Washington State Department of Natural Resources using Sevin and DDT will be reported separately (5).

Effects of the insecticides on aquatic and terrestrial organisms other than the hemlock looper are being studied by representatives of private industry and state and federal agencies under the chairmanship of the Washington State Pollution Control Commission, Olympia, Washington. Results of the Committee's findings will be reported in a joint release.

METHODS AND PROCEDURES

Similar sampling methods were designed by Regional Office and Experiment Station entomologists for the pilot tests so that results could be compared (3, 7). Sevin and Phosphamidon were tested and their results compared with that of DDT, the proven controllant of the hemlock looper. Sample plots were established and spray cards, filter papers and collection trays distributed before spraying. Cards and filters were collected immediately after treatment and larval mortality plot trees and collection trays sampled at various intervals after spraying.

TREATMENTS

All applications were made by helicopters flying at an average of 30 feet above the tree tops, at 30 miles per hour, using a 60-75-foot swath width. All insecticides were applied within a three-day period under similar conditions.

The following dosage rates were used:

1. 2 pounds of 80 percent sprayable Sevin (1.6 pounds active ingredient) in 1-1/2 gallons of water per acre.

2. 1 pound of Phosphamidon technical in 1-1/2 gallons of water per acre.

3. 3/4-pound of DDT emulsifiable concentrate in 1-1/2 gallons of solvent and fuel oil per acre.

Sevin was tested on an area near the North Nemah River and Phosphamidon and DDT in the Jim Crow Creek area located south of K-M Mountain. A hemlock stand in the Jim Crow Creek area was withheld from treatment to determine the effects of natural control.

PLOT ESTABLISHMENT

In each test area, plots were established systematically, generally at 300-foot intervals along a compass line. Lines were brushed out and marked to provide access to the plots. At each 300-foot interval, three plot trees were selected. Trees were codominant, intermediate, or suppressed western hemlocks with lower crowns within 10-35 feet of the ground.

Twenty sample plots were established in the DDT and Sevin test areas and 10 plots in the check (non-sprayed) area. Because of a light looper population in the Jim Crow Creek Phosphamidon test area, an area near Naselle was also sprayed with Phosphamidon and sampled for larval mortality.

PRE-SPRAY SAMPLING FOR LOOPER LARVAL DEVELOPMENT

Prior to spraying, looper larvae were collected periodically from understory and overstory foliage in and adjacent to the test areas to determine developmental trends. All pilot test areas were to be sprayed when most of the larvae were in the second instar and when no very small first instars were present--indicating that all fertile, non-parasitized looper eggs had hatched.

Larvae were collected from overstory foliage using an aluminum pole pruner with a muslin basket (figure 1) and from understory foliage using a three-foot-square muslin beating sheet. Loopers were placed in alcohol-filled vials for later separation into instars by head capsule width measurements.

PRE- AND POST-SPRAY LARVAL MORTALITY SAMPLING

Each plot tree was sampled one to two days before spraying and at periodic intervals thereafter to determine the effects of treatment. At each sampling time, five 18-inch branches were clipped from the living crown of each plot tree (figure 1). A muslin basket attached to the cutting head of the pruner caught each branch. Branches were lowered to the ground and shaken over a muslin sheet to dislodge the larvae. Number of larvae per sample was counted and recorded. Mortality was calculated using the following formula:

$$\text{Percent mortality: } \frac{\text{Pre-spray count - post-spray count}}{\text{Pre-spray count}} \times 100$$

Figure 1.--Sampling overstory foliage for western hemlock looper larvae using an aluminum pole pruner.

DETERMINATION OF SPRAY COVERAGE AND DEPOSIT

Spray cards and filter papers were distributed in each area the day before it was sprayed and collected immediately after spraying. Cards were used to determine spray coverage and to obtain immediate estimates on spray deposit. Filter papers were used to determine actual spray deposit by laboratory analysis. Ten cards and ten filters were placed along a line on each three-tree plot (figure 2). They were mounted in wire holders (11) and distributed 20 to 100 feet apart in pairs of one card and one filter. Generally the line passed through the plot center.

Oil-sensitive 4x5-inch cards made specifically for detecting oil-based sprays were used on plots in the DDT test area to determine spray distribution, and in the non-sprayed area to determine if any drift reached the plots during treatment of nearby DDT-sprayed areas. Black 5x7-inch cards made from 25½x30½-inch index card stock (1,000 sheets weigh 220 pounds) were used as spray cards in Sevin test areas. Phosphamidon has a purple to blue dye additive, so 5x7-inch cards made from 5x8-inch white index card stock were used. Filter papers were 5x7 inches in size and were designed and analyzed for actual spray deposit by the U. S. Agricultural Research Service, Yakima, Washington.

COLLECTION TRAY SAMPLING

Wooden-framed two-square-foot trays with muslin bottoms were placed beneath plot trees to catch hemlock looper larvae and other arthropods affected by the different insecticides (figure 3). Trays were also installed under plot trees in the check area to catch arthropods killed by natural means. Trays were distributed a few days before spraying and examined the day before and at various intervals after spraying. Each tray was painted with Magic Circle deer repellent to repel elk and deer and prevent animal damage to the trays.[1/] Specimens of hemlock loopers and other arthropods were counted, recorded and preserved. Miscellaneous insects were identified to family, in most cases, using insect keys (2).

1/ Use of trade names here and elsewhere in this report does not imply endorsement by the U. S. Forest Service.

Figure 2.--Placing spray cards and filter paper in wire holders. Left to right, 5x7-inch filter paper, 5x7-inch black card, and 4x5-inch oil-sensitive card.

Figure 3.--Examining contents of a 2-square-foot collection tray.

RESULTS

On June 25, 69 percent of the looper larvae collected were in the first instar and 31 percent in the second instar. No newly hatched first instars were present, but some third instars were collected. Therefore, the Project Entomologist estimated that most of the looper larvae would be in the second instar by July 5. Between June 25 and July 5, helicopters and insecticides were transported to the spray area, test plots established, plot trees sampled, spray cards, filter papers and collection trays distributed, and all other preparations made.

Spraying began on July 5 as planned. The Sevin and DDT test areas were sprayed first, followed by treatment of the Phosphamidon areas. Weather during application was fairly good, although the threat of rain was always present. Heavy rains occurred in all areas within 12-48 hours after treatment. However, insecticides probably had ample time to dry on the foliage before precipitation began.

SEVIN PILOT TEST

The Sevin test area of 1,200 acres near the North Nemah River was sprayed during the morning of July 5. A small block of adjacent timber was sprayed with two pounds of 80 percent sprayable (1.6 pounds of active ingredient) in two gallons of water per acre, to test the effect of increasing the carrier. A 2,700-acre area near Naselle was also treated with Sevin the first day. Larval mortality and spray deposit were not sampled on this area.

Spray Coverage and Deposit

Spray deposit estimations made from cards distributed in the 1,200-acre test area indicated that coverage was good except on plots 17-20. These four plots obviously did not receive direct treatment. However, some drift probably reached the trees according to the results of the analysis of filter papers from these plots (table 1).

Spray deposits were variable both between and within plots (figure 4). Actual spray deposit on the plots ranged from 0.005-pound per acre to 1.031 pounds per acre and averaged 0.355, an amount approximately one-fourth that supposedly released by the spray helicopters (1)(table 1). On plot 3, actual spray deposit on the ten papers ranged from 0.11 to 3.00 pounds per acre and averaged 1.03 pounds per acre. These papers were in fairly large canopy openings, therefore, most of the variation probably was due to the flying pattern of the spray helicopters.

A. Light to Moderate Application

B. Moderate Application

Figure 4.--Sevin spray deposit on 5x7-inch black deposit cards.

Spray deposit on the two-gallon-per-acre test area was generally quite heavy. Fourteen filter papers and 14 black cards were distributed in a small clearing at a right angle to the flight lines prior to spraying. Each card and paper was open from above, so results should reliably indicate the amount of insecticide reaching the trees. Deposit on the filter papers ranged from 0.01 to 3.06 pounds of Sevin per acre and averaged 1.14 pounds per acre (1). Five of these 14 papers had actual spray deposits over 1.6 pounds per acre, the amount to be applied.

Application of two gallons of solution per acre was attempted by applying the 1-1/2 gallon per acre formulation in overlapping swaths. Actually, the spray nozzles should have been recalibrated to deliver two gallons per acre and a new batch of solution mixed to contain 1.6 pounds of actual Sevin in two gallons of water. Unfortunately, the Project Entomologist did not find out that recalibration and remixing had not been done until after the area was treated. Dr. K. C. Walker, Agricultural Research Service, Yakima, Washington, and the Project Entomologist observed the spraying from the ground. It appeared to them that some of the area was sprayed once, some twice, and some three times. For all practical purposes, the application tested the effect of an increased amount of Sevin per acre rather than the effect of increasing the carrier.

Estimates were made of spray deposits on each of the black cards to serve as relative measures until spray analyses could be obtained. Spray deposit was estimated ocularly and placed in four categories, none (no visible deposit), light, moderate, and heavy. When the results of the filter paper analyses were received, an effort was made to relate actual deposits on the filters with estimated deposit on the black card next to each filter. Estimated and actual deposits were fairly close for the none and light categories (table 2). However, some estimates in the moderate to heavy categories were quite inaccurate. The estimator found that he was sometimes inadvertently estimating categories by plot rather than by overall composite of cards from all plots.

Looper Larval Mortality

Plot trees were sampled for looper larval populations 1 and 2 days before and 3, 5, 7, and 13 days after spraying. Original plans were to sample the plots 19 days after treatment, but the area was sprayed with DDT on the 19th day by Weyerhaeuser Company and Crown Zellerbach Corporation before biologists had completed sampling. Trees in the two-gallon-per-acre area were sampled one day before treatment and at intervals of 4, 7, 13, 19, 21 and 26 days after spraying.

Looper larval mortality 13 days after treatment on plots 1-16 ranged from 72-98 percent and averaged 86.7 percent (table 1). Data from plots 17-20 were not used because the area was not directly sprayed on July 5. However, larval reduction figures indicate that the area was treated directly at a later date. Mortality data were not corrected for the effects of parasitism, predation and infection, but the effects of these factors were probably quite low during the study period.

Larval mortality was not directly related to spray deposit (r= 0.08). This observation agrees with Maksymiuk's (12) work with spruce budworm mortality on DDT-treated areas but disagrees with Johnson's (10) findings for western hemlock looper in DDT-sprayed areas.

Most of the larval mortality occurred by the third day after treatment (table 3). The small difference between the 3-day and 13-day larval mortality figures could be due to sampling error and/or natural mortality but is probably insignificant.

Larval mortality on the 2-gallon-per-acre area was similar to that on the 1-1/2 gallon-per-acre plots (table 3). Mortality per tree based on a 20-tree sample ranged from 25-100 percent and averaged 85.6 percent 19 days after treatment. Results of this test indicate that increasing the amount of active ingredient did not increase larval mortality.

Tray Collections

The two-square-foot trays beneath each plot tree were examined periodically to help determine the residual effect of Sevin in killing hemlock looper larvae. Because the area was resprayed with DDT before the 19-day count could be taken, only data from 3-13 days after spraying are available. Almost 70 percent of the total dead looper larvae collected during this period dropped into the trays by the third day (table 4). Over 86 percent of the total was present by the 6th day. These figures agree fairly well with those obtained from the larval mortality counts taken from crowns of each plot tree (table 3).

PHOSPHAMIDON PILOT TEST

Phosphamidon was applied to 2,276 acres in two looper-infested areas. One area, located in the Jim Crow Creek drainage, had a light population of looper larvae. Twenty-two mortality plots were established here. Plots 1-13 were about one mile from plots 14-22. These plots were treated on July 6-7. The other area was in a moderately infested stand, located near the town of Naselle, where 20 trees were sampled for larval mortality. This area was treated on July 6.

Spray Coverage and Deposit

Spray coverage and deposit were variable. Plots 10-13, 15, 17, and 20 in the Jim Crow Creek area received only very light amounts of Phosphamidon ranging from 0.005 to 0.020 pound per acre (tables 5 and 6). Actual deposit on the other plots was relatively good (0.107-0.289 pounds per acre). Overall deposit per filter ranged from <0.01-1.03 pounds per acre and averaged 0.123 pounds per acre (1). Spray coverage on the 20-tree Naselle test plot was heavier than in the Jim Crow Creek area. Actual deposit ranged from 0.01-1.03 pounds per acre and averaged 0.361 pounds per acre.

Spray deposit on some filter papers in the Jim Crow Creek area may have been heavier than recorded. Filters on the Jim Crow Creek plots sprayed on July 7 were wet from a heavy rain that occurred during the evening of July 6. Dry filters could not be substituted for the wet filters before the area was sprayed in the early morning of July 7. Phosphamidon hydrolyzes rapidly, so some of the chemical might have broken down before analyses could be made.

Spray deposit on the white cards was ocularly estimated and divided into four categories, none (no visible deposit), light, moderate, and heavy. Estimates were compared with actual deposits on filter papers next to the white cards. Light spray deposit was very hard to detect with the naked eye. Most of the cards in the "none" category actually had deposits of 0.01-0.09 pound of Phosphamidon per acre (table 7). Estimates in the other three categories were more indicative of actual spray deposits.

Looper Larval Mortality

Plots in the Jim Crow Creek and Naselle areas were sampled 1 and 2 days before spraying and 7, 13, 19, and 25 days after treatment to determine Phosphamidon-caused larval mortality.

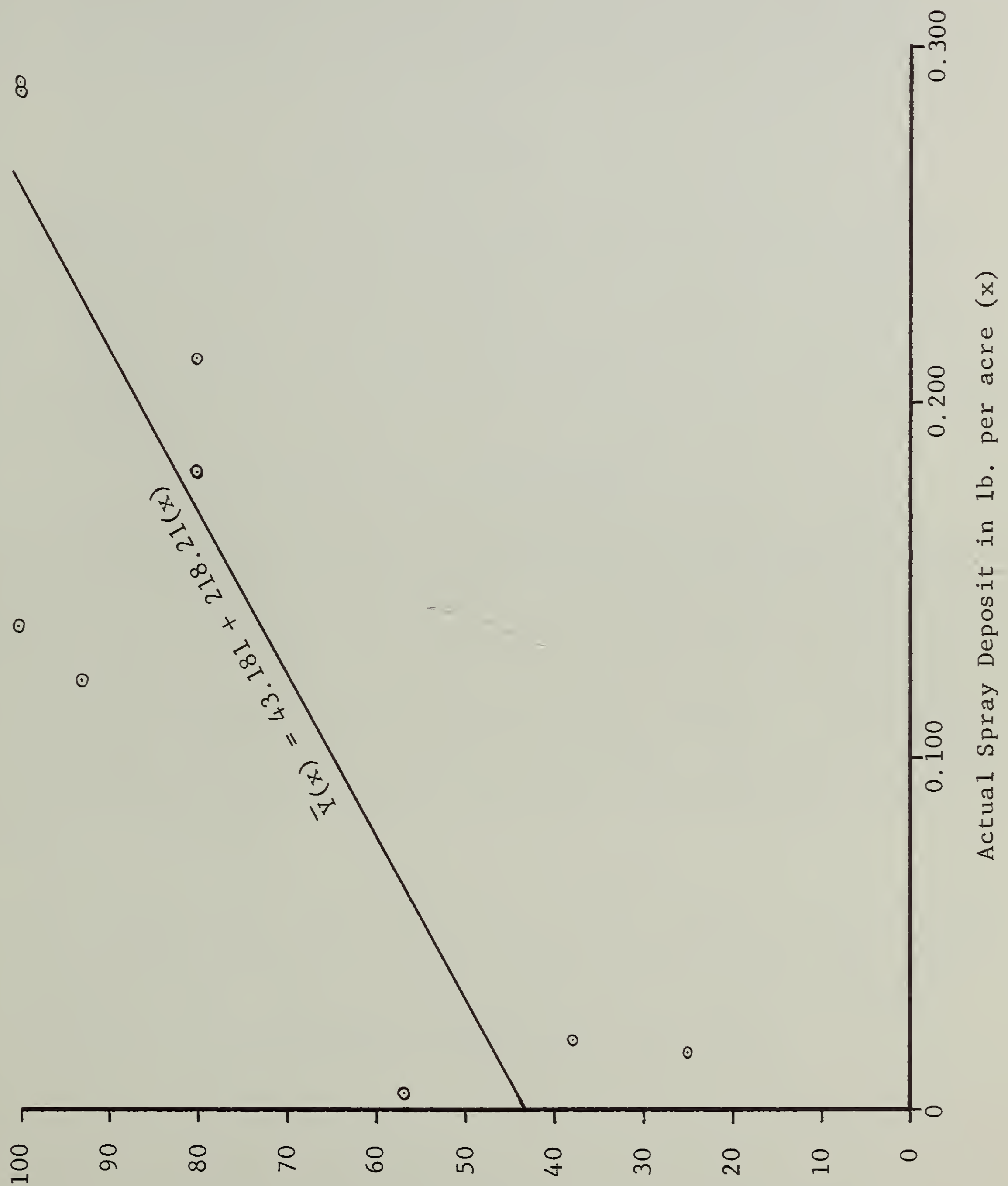
Data from the two lines of plots in the Jim Crow Creek area were analyzed separately. Larval mortality 25 days after spraying on plots 1-13 ranged from 92-100 percent and averaged 99 percent (table 5). Mortality was not directly related to spray deposit (r=0.01). Looper reduction on plots 14-22 averaged 80 percent and ranged from 25-100 percent (table 6). Mortality was directly related to spray deposit (r=0.82). The relationship between actual spray deposit and looper mortality on plots 14-22 is shown in figure 5 (a=43.181; b=218.21). According to the regression line, mortality should be 100 percent when spray deposit is 0.260 lbs. per acre or more. At 0.0 lbs. per acre per spray deposit, larval mortality is about 42 percent. This could be the effect of natural mortality during the 25-day sampling period.

Stand composition could have had some effect on the results obtained on the two lines of plots. Plots 1-13 were in a fairly young, closed hemlock stand, while plots 14-22 were in a mature stand with relatively widely spaced trees. It was difficult to find large openings in which to place the filters on plots 1-13. More spray might have reached the plot trees than reached the filters, thus possibly explaining the low spray deposit on the filters and high larval mortality in the trees on plots 9-13. Filters on plots 14-22 were placed in relatively large openings. Deposits on these papers are probably more indicative of the amount reaching the plot trees.

Looper reduction on the 20 trees in the Naselle area ranged from 50-100 percent and averaged 93 percent. Spray deposit and looper mortality could not be compared in this area because a single line of filters was distributed through the spray area to determine the overall deposit and not the deposit at each tree.

Most of the mortality in both areas occurred within 19 days after treatment (table 3). The original looper population knockdown was less for Phosphamidon than Sevin, but the final figures were greater on Jim Crow Creek plots 1-13 and the Naselle plot.

Figure 5.--Relationship between spray deposit and hemlock looper larval mortality on Phosphamidon pilot test plots 14-22.



Tray Collections

Trays were placed beneath each of the 66 trees in the Jim Crow Creek area and beneath 10 of the 20 trees in the Naselle test site. About 83 and 89 percent of the dead looper larvae collected in the trays on plots 1-13 and 14-22, respectively, in the Jim Crow Creek area were present 8 days after treatment (table 4). Some 83 percent of the loopers in the Naselle area trays dropped to the ground by 7 days after spraying. No dead larvae were collected after 13 and 19 days in the Jim Crow Creek area and in the Naselle area, respectively.

DDT PILOT TEST

An area in Jim Crow Creek scheduled for operational treatment was intensively sampled to determine the effects of 3/4-pound of DDT per acre on looper populations. Study results served as an index for comparing other treatments because DDT was the standard controllant during the last looper project. Plots were systematically established in two looper-infested areas less than two miles apart. Both areas were sprayed on July 5-6, the same dates that the Sevin and Phosphamidon pilot test areas were treated.

Spray Coverage and Deposit

Most oil-sensitive spray cards and all filter papers were collected in the afternoon of July 5. Twenty-three oil-sensitive cards were left on four plots to determine if the area had been directly treated. These cards were examined on July 6 and found to be well covered with spray. When the results of the filter paper analyses were reviewed, it was fairly obvious that most of the plots had not been directly sprayed on July 5. Actual spray deposit on individual filters ranged from <0.01-0.14 pound and averaged 0.009 pound per acre (1). These figures are extremely small compared to the average and range of deposits obtained during the Sevin and Phosphamidon tests (tables 1, 5 and 6).

The 23 oil-sensitive cards collected from plots 4, 5, 11, and 13 after spraying was completed on July 6 were compared with standards for oil-based DDT sprays to obtain estimated spray deposit (8). Estimated deposit ranged from 0.04-1.10 pounds and averaged 0.32 pound per acre (figure 6). Spray deposit on the other 16 plots was probably comparable because larval mortality was comparable.

Looper Larval Mortality

Effects of DDT upon looper larvae were observed almost immediately after spraying. Larvae dropped from trees and shrubs and laid writhing in the collection trays. Within an hour after treatment, nearly all of the larvae that had dropped were dead.

Looper larval mortality was excellent on all plots. Counts were taken 1 and 2 days before and at 3, 5, 7, 13, and 19 days after treatment. Larval reduction 19 days after treatment was 99.4 percent (table 8). Very little larval mortality occurred more than three days after spraying, so natural mortality probably had very little effect on final mortality figures (table 3). Larval reduction on the 20 plots ranged from 95-100 percent with mortality less than 100 percent on only three plots.

Tray Collections

Looper larvae were collected periodically after spraying from trays beneath each of the 60 plot trees. Trays on plots 13-20 were examined three days after spraying and dead specimens collected. Trays on plots 1-12 were not examined until five days after treatment. Most of the larvae dropped into the trays by the third day after spraying, but some were collected at 13 days (table 4). Some of the dead or dying organisms undoubtedly get caught in tree foliage and do not drop to the ground until a strong wind moves the branches. This may account for some of the late drop.

CHECK AREA

Ten three-tree plots were established in a hemlock stand within one-half mile of a DDT-sprayed block in the Jim Crow Creek area to determine the effects of predators, parasites and disease on looper populations during the spray period. Plots were sampled 2 days before and 5, 7, 13, 19 and 26 days after the adjacent DDT block was sprayed. This adjacent area was treated on July 6.

Spray Coverage and Deposit

Spray deposit cards and filter papers were collected after all adjacent areas were sprayed with DDT. No spray could be seen on the oil-sensitive cards, but they were wet, bleached and very hard to rate. Results of filter paper analyses showed that cards on at least one plot received small amounts of DDT (<0.01 lb./acre). Because the spray would have drifted in from the side, crowns of some or most of the plot trees in the check area could possibly have intercepted the drift before it reached the filters.

A. Light Application

Figure 6.--DDT deposit on 4x5-inch oil-sensitive spray deposit cards.

B. Moderate Application

Figure 6 ... (Continued)

C. Very Heavy Application

Figure 6 ... (Continued)

Looper Larval Mortality

A definite reduction in looper numbers occurred by seven days after the adjacent DDT block was sprayed (table 3). This mortality was probably too great to be caused by natural agents. At 19 days after spraying, larval mortality averaged 54.2 percent and ranged from 33-100 percent (table 9). This degree of population reduction is thought to be due at least in part to DDT drift. Therefore, results in the check area are probably not representative of natural mortality.

Tray Collections

Collection trays yielded very few hemlock loopers and associated arthropods. Only five loopers were found in the trays, and these appeared during the first 13 days after the adjacent area was treated (table 4).

MORTALITY OF OTHER ARTHROPODS

Many different arthropods other than western hemlock loopers were collected in the two-square-foot muslin trays (table 10). Some probably died of natural causes and fell into the trays. However, specimens of some were fairly abundant, so they were probably adversely affected by the sprays. Fungus gnats (Mycetophilidae), crane flies (Tipulidae), ichneumon flies (Ichneumonidae), bark lice (Corrodentia) and spiders (miscellaneous Arachnida) were relatively abundant in trays in the Sevin, Phosphamidon, and DDT areas. Plant bugs or leaf bugs (Miridae), midges (Chironomidae), and gall gnats or gall midges (Itonididae) were more abundant in trays in the Sevin area than in either the Phosphamidon or DDT areas. Sawflies (Tenthredinidae) were more abundant in trays in the Sevin and DDT areas than in the Phosphamidon area. Stink bugs (Pentatomidae) and loopers or measuring worms (Geometridae) were more abundant in Phosphamidon and DDT trays. Miscellaneous flies (Diptera) were most abundant in the trays in the DDT area.

A few miscellaneous flies and spiders dropped into the trays in the check area, but the numbers were insignificant.

SMALL-SCALE FIELD TESTS OF SEVIN

Efforts were made during the operational spray program administered by the Washington State Department of Natural Resources to increase the effectiveness of Sevin in killing the western hemlock looper. Test plots of 5-25 trees each were established in the North Nemah River area where moderate to heavy looper larval populations prevailed. The following treatments using the standard 1.6 pounds of active Sevin per acre were applied to these small-scale test plots:

1. Sevin in fuel oil applied at the rate of 1-1/2 gallons per acre.

2. Sevin in water applied at the rate of 1-1/2 gallons per acre with 3 ounces each of the spreader-stickers Ucar and Rhoplex as additives.

3. Sevin in water applied at the rate of 1-1/2 gallons per acre with 0.15 ounce of a colloidal multifilm as an additive.

4. Sevin in water applied at the operational rate and then the same treatment applied again 5-7 days after the first application.

Results give only indications of the effectiveness of the treatments because sampling was limited (table 11). Also the two areas where spreader-sticker agents were tested were sprayed with DDT before 10-day counts could be made. Sevin in fuel oil and in water with Ucar and Rhoplex as additives showed some promise. These mixtures should be further tested. Larval mortality on the double-sprayed area was variable but high on two of the three plots. However, the cost will be doubled.

DISCUSSION

In 1962, a 33,000-acre western hemlock looper infestation in northwest Oregon was treated with 1/2-pound of DDT in solvent and fuel oil at the rate of 1-1/2 gallons per acre. Average looper larval mortality for the project was 88 percent (4). Defoliation and some tree mortality occurred after spraying. These results indicate that spray-induced larval mortality must be greater than 88 percent to successfully reduce looper populations below the tree-killing level in heavily infested areas.

Results from 1963 pilot tests in southwest Washington showed that DDT applied at 3/4-pound per acre reduced looper populations well below this level. Test results indicate that Sevin will give either marginal or ineffective control where looper populations are heavy. Mortality below 88 percent can be tolerated on lightly infested areas. Results with Phosphamidon were too variable to use in drawing conclusions--mortality was below the required level at one location, near it at another and above it at another. Inadequate spray deposit appears to have been the reason for the low mortality figure on Phosphamidon plots 14-22. Deposit appeared to be adequate on all but 4 of the 20 Sevin test plots. Thus, the reason for the inadequate mortality figure was probably due to the formulation itself or the size of droplet in which it was applied.

Sevin showed up well on the 5x7-inch black cards. Spray could also be seen on stump tops, foliage, old logs, etc. in the Sevin-treated areas. The 5x7-inch white cards used to detect Phosphamidon spray deposit were not very satisfactory. The purple dye in the spray showed up well on the cards, but the droplets spread out a great deal, especially when cards were damp. A stiffer board-type card similar to the one used for Sevin might be preferable for future Phosphamidon trials.

Cost of the analytical work would prevent widespread use of filter papers on an operational basis. Cost of analyzation for Sevin, Phosphamidon and DDT was $1.74, $1.90 and $1.63 per filter, respectively, including the cost of the filters and tabulating, writing and reproducing the data. Filters should be used on future pilot tests to determine if a relationship exists between spray deposit and larval mortality.

Variation in spray deposit and coverage on the filters and cards was quite noticeable on the Sevin and Phosphamidon plots. Differences could be due to several things: (1) Placement of the filters and cards may not have been ideal in all cases; (2) density of some stands prohibited filter and card placement in large openings; (3) skips and overlaps probably occurred during application since pilots had no markers to follow to keep them on course; (4) wind often causes small droplets to drift, allowing only the larger droplets to settle.

No animal damage occurred to the collection trays although deer and elk populations were plentiful in all areas. The Magic Circle repellent probably attributed to this lack of damage. The scent of the material was so strong after application that trays could be located by smell. Tags and tape used to mark plot trees were not painted with repellent. Many of these were ripped from the trees by animals.

A survey was made in December 1963 and January 1964 in southwest Washington to sample overwintering looper egg populations. No eggs were recovered from samples collected in the DDT or Phosphamidon test areas. Only a few eggs were collected in the Sevin pilot test area, but it was re-treated with DDT by Crown Zellerbach Corporation and Weyerhaeuser Company in late July. However, looper eggs were abundant in samples collected from three areas treated with Sevin during the operational spray program and one area treated with DDT by Crown Zellerbach Corporation and Weyerhaeuser Company (6).

Again on this project DDT proved its value as a forest pest controllant. Using helicopters, perhaps even smaller dosage rates would be effective. Phosphamidon should be tested again either in the same formulation or in different formulations before this organic-phosphate can be recommended for future widespread use against the looper. The formulation of Sevin used during this test did not cause enough looper mortality to prevent tree mortality in areas heavily infested with loopers. Either new formulations of active material or the same active material in fuel oil or in water with sticker and spreader additives should be tested in the future. Other promising old and new pesticides should be laboratory-tested and field-tested against the looper in the future; however, at the present time the most effective and least expensive controllant is DDT.

RECOMMENDATIONS

The following recommendations should be considered on future pilot tests:

1. Pilot test areas should have near-equal looper larval populations, so that differences will not influence the results obtained.

2. Pilot test areas should be close to each other without being in danger of contamination.

3. Non-treatment areas should be far removed from any spray area, so that danger from drift is minimal. However, looper populations must be adequate.

4. Spray cards and filter papers should be placed on all four sides of each plot tree to obtain a truer picture of spray deposit reaching the tree. A direct relationship between spray deposit and looper mortality per tree can then be tested.

5. Spray cards and filter papers should not be collected from an area until the aircraft has sprayed directly over the plots. One or several biologists should be stationed on the pilot test plots to observe spraying progress.

6. Direct radio contact should be maintained between the spray pilot, helispot and Project Entomologist during pilot test spraying, so that the correct areas will be sprayed and over- and under-spraying will be minimized.

7. Insecticides or different formulations of insecticides should not be tested unless intensive plans have been developed well in advance. Small-scale tests can give only indications of the efficiency of a formulation and tend to take up time needed for other duties.

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A P P E N D I X

Table 1.--Larval mortality and actual spray deposit on the Sevin pilot test plots

Plot number	Larval count: Before spraying	Larval count: 13 days after spraying	Larval reduction	Actual average spray deposit per acre
	- - - Number - - -		Percent	Pounds
1	184	39	79	0.076
2	143	23	84	0.328
3	104	14	87	1.031
4	77	16	79	0.840
5	96	27	72	0.587
6	88	10	89	0.391
7	186	11	94	0.466
8	195	29	85	0.374
9	180	4	98	0.864
10	43	6	86	0.353
11	196	13	93	0.111
12	312	7	98	0.341
13	210	22	90	0.468
14	257	62	76	0.623
15	116	20	83	0.104
16	154	35	77	0.083
17	216	35	84	0.008
18	138	23	83	0.006
19	187	90	52	0.006
20	161	70	57	0.005
Total	3,243	556	82.9	0.355

Table 2.--Comparison of estimated spray deposit on cards and actual spray deposit on filters, Sevin pilot test 1/

Estimated deposit on cards	Number of cards	Actual deposit on filters	
		Range	Average
		- Pounds/Acre -	
None	53	$<0.01 - 0.01$	0.007 ± 0.0025
Light	21	$<0.01 - 0.19$	0.064 ± 0.0477
Moderate	43	$0.05 - 0.67$	0.209 ± 0.130
Heavy	82	$0.08 - 3.00$	0.730 ± 0.512
Total	199	$<0.01 - 3.00$	0.355 ± 0.468

1/ Sevin was applied at the rate of 1.6 pounds active ingredient per acre.

Table 3.--Looper larval mortality on plots sprayed with Sevin, Phosphamidon, and DDT and on unsprayed plots

Treatment	Pre-spray larval count	Percent mortality by days after treatment								
		3	4	5	7	13	19	21	25	26
Sevin--1½ gals./ac. (16 plots)	2,541	83.2	--	84.3	81.5	86.7	--	--	--	--
Sevin--2 gals./ac. (20 trees)	745	--	79.3	--	80.1	78.0	85.6	85.2	--	86.6
Phosphamidon (Plots 1-13)	88	--	--	--	72.7	89.8	89.8	--	98.9	--
Phosphamidon (Plots 14-22)	107	--	--	--	78.5	77.6	76.6	--	80.4	--
Phosphamidon (20 trees)	181	--	--	--	63.5	78.5	97.2	--	92.8	--
DDT (20 plots)	705	98.3	--	99.3	99.7	99.0	99.4	--	--	--
Check--unsprayed (10 plots)	59	--	--	28.8	66.1	44.1	54.2	--	--	67.8

Table 4.--Summary of looper larval collections made from trays in the Sevin, Phosphamidon, DDT, and check areas during the pilot test

Treatment	Average number of looper larvae per 2-square-foot tray by number of days after areas were sprayed											Total
	2	3	4	5	6	7	8	10	13	19	25	
Sevin (20 plots)	--	51.4	--	--	12.7	--	--	5.6	4.6	--	--	74.3
Phosphamidon (Plots 1-13)	0.9	--	0.3	--	--	--	0.6	--	0.3	0.0	0.0	2.1
Phosphamidon (Plots 14-22)	2.3	--	--	1.4	--	--	1.7	--	0.7	--	--	6.1
Phosphamidon (20-tree plot)	7.9	--	4.2	--	--	2.0	--	--	2.6	0.3	0.0	17.0
DDT (20 plots)	--	16.3 1/	--	18.3 2/	2.8	--	--	0.1	0.2	0.0	--	20.6
Check--unsprayed (10 plots)	--	--	--	0.1	--	--	--	--	0.1	0.0	--	0.2

1/ Only plots 13-20 collected.

2/ Only plots 1-12 collected.

Table 5.--Larval mortality and actual spray deposit on Phosphamidon pilot test plots 1-13

Plot number	Larval count: Before spraying	Larval count: 25 days after spraying	Larval reduction	Actual average spray deposit per acre
	- - - Number - - -		Percent	Pounds
1	5	0	100	0.111
2	12	1	92	0.107
3	8	0	100	0.184
4	11	0	100	0.289
5	4	0	100	0.122
6	13	0	100	0.210
7	4	0	100	0.144
8	12	0	100	0.108
9	3	0	100	0.012
10	5	0	100	0.005
11	8	0	100	0.005
12	0	0	--	0.005
13	3	0	100	0.006
Total	88	1	98.9	0.109

Table 6.--Larval mortality and actual spray deposit on Phosphamidon pilot test plots 14-22

Plot number	Larval count: Before spraying	Larval count: 25 days after spraying	Larval reduction	Actual average spray deposit per acre
	- - - Number - - -		Percent	Pounds
14	10	2	80	0.211
15	8	5	38	0.020
16	4	0	100	0.289
17	4	3	25	0.017
18	10	0	100	0.136
19	5	0	100	0.289
20	7	3	57	0.040
21	29	2	93	0.117
22	30	6	80	0.184
Total	107	21	80.4	0.145

Table 7.--Comparison of estimated spray deposit on cards and actual spray deposit on filters, Phosphamidon pilot test[1]

Estimated deposit on cards	Number of cards	Actual deposit on filters	
		Range	Average
		- Pounds/Acre -	
None	20	<0.01 - 0.09	0.025 ± 0.028
Light	44	<0.01 - 0.07	0.024 ± 0.018
Moderate	56	0.01 - 0.60	0.093 ± 0.089
Heavy	79	0.03 - 1.03	0.348 ± 0.188
Total	199	<0.01 - 1.03	0.172 ± 0.194

1/ Actual amount of Phosphamidon applied was 1 pound per acre.

Table 8.--Larval mortality on the DDT pilot test plots

Plot number	Larval count: Before spraying	Larval count: 19 days after spraying	Larval reduction
	- - - - Number	- - - -	Percent
1	32	0	100
2	34	0	100
3	37	0	100
4	25	0	100
5	39	2	95
6	49	1	98
7	29	0	100
8	22	0	100
9	25	1	96
10	28	0	100
11	22	0	100
12	21	0	100
13	46	0	100
14	42	0	100
15	30	0	100
16	59	0	100
17	31	0	100
18	56	0	100
19	30	0	100
20	48	0	100
Total	705	4	99.4

Table 9.--Larval mortality on the check (unsprayed) pilot test plots

Plot number	Larval count: Before spraying	Larval count: 19 days after spraying	Larval reduction
	- - - - Number	- - - -	Percent
1	16	10	38
2	4	2	50
3	8	3	63
4	5	3	40
5	6	3	50
6	4	0	100
7	4	2	50
8	3	2	33
9	5	1	80
10	4	1	75
Total	59	27	54.2

Table 10--Collections of arthropods other than the western hemlock looper from 2-square-foot trays beneath mortality plot trees in the Sevin, Phosphamidon, and DDT pilot test areas[1/]

Classification of Arthropoda				Number of dead specimens collected in 2-square-foot trays following treatment		
Class	Order	Family	Life stage	Sevin test	Phosphamidon test	DDT test
Insecta	Coleoptera	Anthribidae	Adult	1	0	0
		Cantharidae	Adult	2	0	1
		Cucujidae	Adult	0	1	0
		Curculionidae	Adult	1	1	1
		Dermestidae	Larva	1	2	0
		Elateridae	Adult	1	4	3
		Erotylidae	Adult	0	2	0
		Lagriidae	Adult	1	1	1
		Lampyridae	Adult	1	0	0
		Melandryidae	Adult	0	5	4
		Meloidae	Adult	5	4	2
		Melyridae	Adult	1	0	0
		Scarabaeidae	Adult	0	0	1
		Scolytidae	Adult	0	2	0
		Staphylinidae	Adult	5	0	0
		Tenebrionidae	Adult	1	0	0
Insecta	Corrodentia	Polypsocidae	Adult	4	3	1
		Psocidae	Adult	11	4	6
		Miscellaneous	Adult	0	28	22

Table 10.--Collections of arthropods other than the western hemlock looper ...(Continued)

Classification of Arthropoda				Number of dead specimens collected in 2-square-foot trays following treatment		
Class	Order	Family	Life stage	Sevin test	Phosphamidon test	DDT test
Insecta	Diptera	Agromyzidae	Adult	3	6	3
		Anthomyiidae	Adult	1	0	0
		Asilidae	Adult	0	3	2
		Chironomidae	Adult	26	4	1
		Conopidae	Adult	0	0	4
		Culicidae	Adult	1	1	0
		Dixidae	Adult	1	0	0
		Dolichopodidae	Adult	1	0	0
		Empididae	Adult	3	0	0
		Ephydridae	Adult	1	0	0
		Heleomyzidae	Adult	0	0	2
		Itonididae	Adult	10	2	1
		Lauxaniidae	Adult	0	5	1
		Mycetophilidae	Adult	81	35	17
		Phoridae	Adult	4	5	0
		Phyllomyzidae	Adult	2	2	0
		Psychodidae	Adult	4	1	0
		Rhagionidae	Adult	2	0	1
		Sarophagidae	Adult	1	1	0
		Simuliidae	Adult	5	0	0
		Syrphidae	Adult	3	0	1
		Tabanidae	Adult	1	0	1
		Tachinidae	Adult	0	1	1
		Tanyderidae	Adult	1	0	0
		Tipulidae	Adult	12	17	6
		Trypetidae	Adult	0	1	0
		Miscellaneous	Adult	0	0	16

Table 10.--Collections of arthropods other than the western hemlock looper ... (Continued)

Classification of Arthropoda				Number of dead specimens collected in 2-square-foot trays following treatment		
Class	Order	Family	Life stage	Sevin test	Phosphamidon test	DDT test
Insecta	Ephemeroptera	Ephemeridae	Adult	0	1	1
		Miscellaneous	Adult	1	0	1
Insecta	Hemiptera	Aleyrodidae	Adult	0	1	1
		Cercopidae	Nymph	0	0	1
		Cercopidae	Adult	5	3	2
		Cicadellidae	Adult	5	3	2
		Miridae	Adult	13	4	4
		Pentatomidae	Adult	1	13	16
		Miscellaneous	Adult	0	2	0
Insecta	Hymenoptera	Braconidae	Adult	1	0	0
		Chalcidae	Adult	1	0	0
		Ichneumonidae	Adult	9	19	8
		Tenthredinidae	Larva	8	1	12
		Trichogrammatidae	Adult	1	2	0
Insecta	Isoptera	Rhinotermitidae	Adult	0	0	1
Insecta	Lepidoptera	Geometridae	Larva	5	10	25
		Miscellaneous	Adult	2	4	2

Table 10.--Collections of arthropods other than the western hemlock looper ... (Continued)

Classification of Arthropoda				Number of dead specimens collected in 2-square-foot trays following treatment		
Class	Order	Family	Life stage	Sevin test	Phosphamidon test	DDT test
Insecta	Orthoptera	Tettigoniidae	Adult	0	1	1
Insecta	Plecoptera	Nemouridae	Adult	0	0	1
		Perlidae	Adult	1	0	0
		Pteronarcidae	Adult	5	1	3
Insecta	Thysanura	Lepismatidae	Adult	1	0	0
		Machilidae	Adult	1	0	0
Insecta	Tricoptera	Hydropsychidae	Adult	0	0	0
		Leptoceridae	Adult	3	0	0
		Limnephilidae	Adult	1	3	0
Arachnida	Miscellaneous	Miscellaneous	Adult	25	28	25
Chilopoda	Miscellaneous	Miscellaneous	Adult	0	0	1

1/ Figures for Phosphamidon were obtained from 76 trays over a period of 25 days after treatment; for Sevin, 60 trays for 13 days after; and for DDT, 60 trays for 19 days after.

Table 11.--Results of small-scale spray tests on the 1963 western hemlock looper spray project in southwest Washington

Treatment	Pre-spray larval count	Estimated spray coverage	Percent mortality by days after treatment: 4 days	Percent mortality by days after treatment: 10 days
Sevin in fuel oil	396	Moderate - heavy	--	76.3
Sevin in water and Ucar and Rhoplex	95	Moderate	69.5	--
Sevin in water and colloidal multifilm	169	Heavy	53.8	--
Double spray of Sevin in water	132	Heavy (Both times)	--	87.9
Double spray of Sevin in water	155	Heavy (Both times)	--	52.3
Double spray of Sevin in water	347	Moderate - heavy (Both times)	--	97.1