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ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Western Pine Tip Moth Reduced in Ponderosa Pine Shelterbelts by Systemic Insecticides

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A spring application of 40 grams of phorate granules (Thimet 15G) raked into the soil beneath the tree crown effectively protected young ponderosa pine in a Great Plains shelterbelt from damage by western pine tip moth for two growing seasons. Dimethoate (Cygon[267]) sprayed in the spring and summer provided immediate control of the tip moth during the first larval generation but not the second. Data suggests precise timing of dimethoate application to emergence of larval stage is necessary, and that it has less carryover effect than phorate.

KEY WORDS: *Pinus ponderosa*, *Rhyacionia bushnelli*, phorate, dimethoate, insecticides.

The Problem

Ponderosa pine (Pinus ponderosa var. scopulorum Engelm.) has been used since pioneer days in protective tree plantings on the Great Plains. It was the most widely used pine species in the shelterbelts and windbreaks planted throughout the central and northern Great Plains during the Prairie States Forestry Project of the late 1930's and early 1940's. Even more conifers are being used currently in protective tree barriers in the central Great Plains, and ponderosa pine is one of the most widely planted species.

Ponderosa pine is susceptible to attack, however, by the western pine tip moth (Rhyacionia bushnelli Busck) (Lepidoptera: Olethreutidae) (Miller 1967). Damage by this insect was reported in young ponderosa pine soon after the first plantations were established in early 1900's on the Nebraska National Forest in the Sandhills grasslands. This pest is now likely to be found in practically all shelterbelts and windbreaks containing ponderosa pine in the central Plains. In fact, the problem is now so serious in some localities that new plantings of ponderosa pine are being discouraged. This Note reports the successful results of a study designed to determine the effectiveness of two systemic chemicals for control of tip moth on ponderosa pine.

Literature Review

Swenk (1927) studied the western pine tip moth and found the insect has two complete, but overlapping, generations annually in the Nebraska National Forest. The first and second larval generations occur, respectively, in late May to late July, and in early July to late August.

Infestation and damage apparently are most severe on trees 2 to 12 feet tall. Damage is caused by tip moth larvae which bore into and feed on the inner tissues of needle fascicles,

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buds, and shoots. Evidences of infestation are discoloration and browning of needles near branch or leader tips, resin and fecal accumulation at the base of buds, and dead buds and branch tips. Height growth may be slowed as a result of repeated attacks and die-back of the terminals (Boyd et al. 1968).

Control measures in the past included pruning and destroying infested tips containing larvae and pupae, and cutting and burning infested trees. DDT and other organic insecticides were also used (Fenton and Afanasiev 1946).

Systemic insecticides have been widely tested recently for effectiveness in control of the pine tip moth. Since these chemicals are highly toxic to mammals, however, they must be applied with caution. Wasser (1969) and Yates and Lewis (1969) developed equipment and techniques for safe application of certain of these systemic insecticides to trees in seed orchards.

Schuder (1960) applied phorate, phosphamidon, and dimethoate at rates of 1 pound active ingredient per 100 gallons of water to infested pines. Phorate reduced the number of trees infested with the Zimmerman pine tip moth from 18 to 5, and phosphamidon and dimethoate reduced the infestation from 18 to 1 and 0, respectively. Kulman and Dorsey (1962) controlled the European pine shoot moth on red pine with spring applications of granular phorate and disulfoton at rates up to 1.2 ounces active ingredient per tree. They found phorate superior to disulfoton in all tests. Cade and Heikkenen (1965) found phorate and disulfoton granules, at 50 pounds per acre (actual) to be 96 and 100 percent effective in controlling second and third generations of tip moth in loblolly pine seed orchards.

Barras et al. (1967) achieved effective control of tip moth on 2-year-old loblolly pine seedlings for one and one-half growing seasons by using 42 grams of 10 percent granular phorate (4.2 g. actual ingredient) per tree. Yates (1970) obtained effective control of third generation pine tip moths (presumably one season) on 8-foot-tall loblolly pine seed orchard trees with 20 grams of 10 percent granular phorate (2 g. actual) per tree.

Boyd et al. (1968) found either band or broadcast soil treatments of phorate granules applied within the drip-line of the tree crowns to be equally effective. Results were similar whether granules were incorporated into the soil or applied to the surface. Surface applications were more effective when wetted to obtain quicker uptake of the chemicals into the plants. Although both formulations were effective, the granules were safer, easier to handle, and gave more extended control than drenches, which gave quicker but less lasting control.

Materials and Methods

A study was established in 1964 on a sandy loam site in north-central Nebraska, to determine how species composition and tree spacing affects the development of single-row field shelterbelts. The young ponderosa pine in these shelterbelts had become heavily infested with the western pine tip moth by 1968. Damage to terminal and lateral shoots was extensive. Control measures were necessary to maintain the trees for the original experiment. It was decided, therefore, to superimpose a short-term tip moth control study over the original study in such a manner as to minimize any confounding effects.

Two rows in the study contained ponderosa pine. In one of these the pines were planted alternately with eastern redcedar (Juniperus virginiana L.) at 6- and 8-foot spacings and alternately in groups of two at 4-foot spacing. The other row was exclusively ponderosa pine. The pines were 5 years old in the field, and averaged about 3.5 feet tall.

Two systemic insecticides were chosen for the tests: (1) phorate granules (0,0-diethyl S-(ethylthio) methyl phosphorodithioate) known under the trade name of Thimet 15G,[3] and (2) dimethoate spray (0,0-dimethyl S- (N-methylcarbamoylmethyl phosphorodithioate), known under the trade name of Cygon[267]. Four treatments were used:

1. 40 grams phorate (6 grams active) per tree.
2. 80 grams phorate (12 grams active) per tree.
3. Dimethoate spray at 1 quart per 50 gallons of water (0.166 percent active).
4. Check - no treatment.

Two hundred forty ponderosa pine trees were randomly designated for treatments in the two rows. The 40-gram phorate treatment was applied to 60 trees in the mixed pine-redcedar row (Row II). The 80-gram phorate treatment was applied to 60 trees in the all ponderosa pine row (Row I).

Granular phorate was applied April 22, 1969. It was sprinkled by means of a plastic tube held downwind, over the previously raked soil.

[3] *Trade names are used for the benefit of the reader, and do not imply endorsement or preferential treatment by the U. S. Department of Agriculture.*

It was applied out to the crown drip-line beneath each tree, and then raked in. Dimethoate was applied with a high-pressure sprayer to the point of runoff to 60 trees on May 27 and again on July 1. The aim was to control the insect during both the first and second larval stages as suggested by Swenk (1927).

All other ponderosa pines not selected for treatment evaluation in the two rows were also sprayed with dimethoate. Care was taken to keep the dimethoate spray away from both the untreated checks and the phorate-treated trees.

To minimize the possibility of phorate uptake by trees of the other treatments, the phorate-treated trees were selected so that they were never directly adjacent to trees of other treatments. Thus, the study trees, except for a few dimethoate-sprayed trees being adjacent to a few check trees, were always separated either by intervening eastern redcedar trees or non-study trees sprayed only with dimethoate. The principal disadvantage of this scheme was reduction of the sensitivity of the check treatment in that random location throughout the study could have lessened the overall probability of attack on check trees.

Infestation on the study trees of record was evaluated four times:

1. July 1969, after completion of the first generation and prior to the second application of the dimethoate spray.
2. December 1969, after completion of the second generation.
3. July 1970.
4. October 1970, two growing seasons and four generations of tip moths after treatment.

Results

Terminal Infestation [4]

Data are discussed separately for each shelterbelt in terms of Rows I and II, since different rates of phorate were applied and species composition was different (fig. 1).

Infestation of the terminal shoots before treatment was 75 and 94 percent, respectively, in Rows I and II. Percentages of infestation among groups of trees to be treated within each row were not significantly different.

Evaluation, July 1969.—Percentage infestation on check trees in July 1969 remained relatively high—60 and 53 percent, respectively, in Rows I and II. The dimethoate-sprayed trees, however, showed only 2 percent terminal infestation in Row I and none in Row II.

The phorate treatments had 48 and 27 percent infested terminals in Rows I and II, respectively. While differences in infestation between the check and the phorate treatment were not significant in Row I, they did attain significance when data from both rows were combined.

[4] *Infestation means either the presence of living larvae in the shoots during the growing season or the presence of damaged tissue caused by larvae having been in the shoots earlier. Terminal refers only to the dominant (tallest) shoot of the trees.*

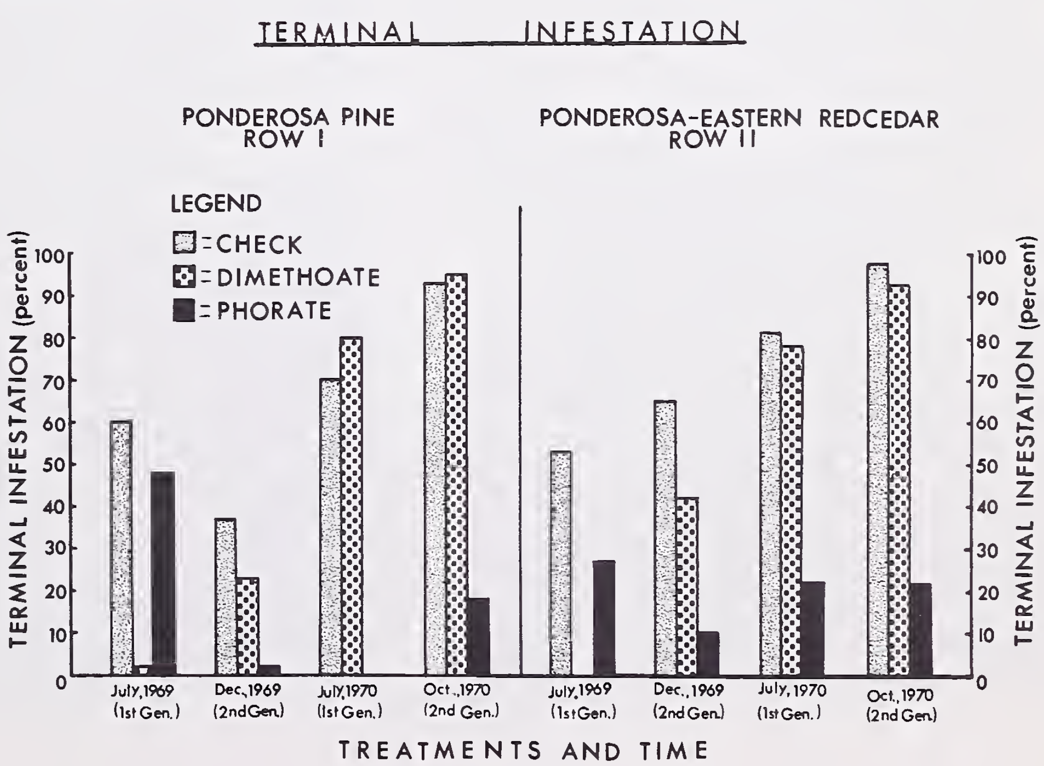


Figure 1.--Percent terminal infestation on ponderosa pine during two growing seasons following treatment with systemic insecticides phorate (Thimet 15G, 12 grams active ingredient per tree, Row I; and 6 grams active ingredient, Row II) and dimethoate (Cygon 267, 1 quart per 50 gallons of water, 0.166 percent active ingredient).

Evaluation, December 1969.—Phorate treatments showed increasing effectiveness in controlling the second-generation infestation of terminal shoots. Percentage of infested terminals had dropped to 2 percent in Row I and 10 percent in Row II. At the same time percentage infestation had increased to 23 and 42 percent, respectively, in Rows I and II on dimethoate-sprayed trees. The check trees still showed a relatively high infestation—37 and 65 percent in Rows I and II. The difference in infestation between dimethoate-treated and check trees in Row I did not quite attain significance, but all treatments were significantly different when data for both Rows I and II were pooled.

Evaluation, July 1970.—Evaluation of treatments after one and one-half growing seasons, three tip moth generations after treatment, revealed no residual effect on the previous year's application of dimethoate. Check and dimethoate-treated trees showed similar infestation percentages of 70 and 80 percent in Row I and 81 and 78 percent in Row II (fig. 1). Phorate-treated trees, on the other hand, showed significantly lower infestation percentages of 0 and 22 percent in Rows I and II, respectively. The 22 percent in Row II suggests the 40-gram rate of phorate was weakening somewhat—but was still satisfactorily effective relative to the other treatments.

Evaluation, October 1970.—Two growing seasons after treatment, the dimethoate-treated trees were as heavily infested as the check trees, 95 and 93 percent and 93 and 97 percent infestation in Rows I and II, respectively (fig. 1). In contrast, the percentage infestation on terminals of all phorate-treated trees was significantly less than either the check or dimethoate-treated trees, but had increased to 18 percent in Row I—the 80-gram-per-tree rate—and remained at 22 percent in Row II.

Lateral Branch Infestation

Infestation on lateral branches was initially evaluated only on the main shoots of the lateral branches. In the two shelterbelts in April 1969 before treatment, 84 and 89 percent of the main lateral branch tips were infested. Differences among the groups of trees within each row prior to treatment were not significant.

Subsequent evaluations of lateral branch infestation in December 1969 and thereafter, however, included all tips on each lateral branch, not just the main shoots. Data are expressed in numbers rather than percentage. While the initial and subsequent data are not directly comparable, the lack of differences among the study trees prior to treatment, the prominent differences among groups of trees after treatment, and the strong correlation of lateral and terminal branch infestation data are obvious.

Evaluation, December 1969.—Numbers of lateral branches infested on check trees averaged about 20 per tree. In contrast, the dimethoate-spray treatment had 10 to 13 infested lateral tips per tree, while the phorate treatment showed only 3 to 4 infested lateral tips per tree (fig. 2). Differences among all treatments were significant in combined data for both shelterbelts.

Evaluation, July 1970.—Tip moth infestation of lateral branches on check and dimethoate-treated trees was five to seven times greater than on phorate-treated trees (fig. 2). This

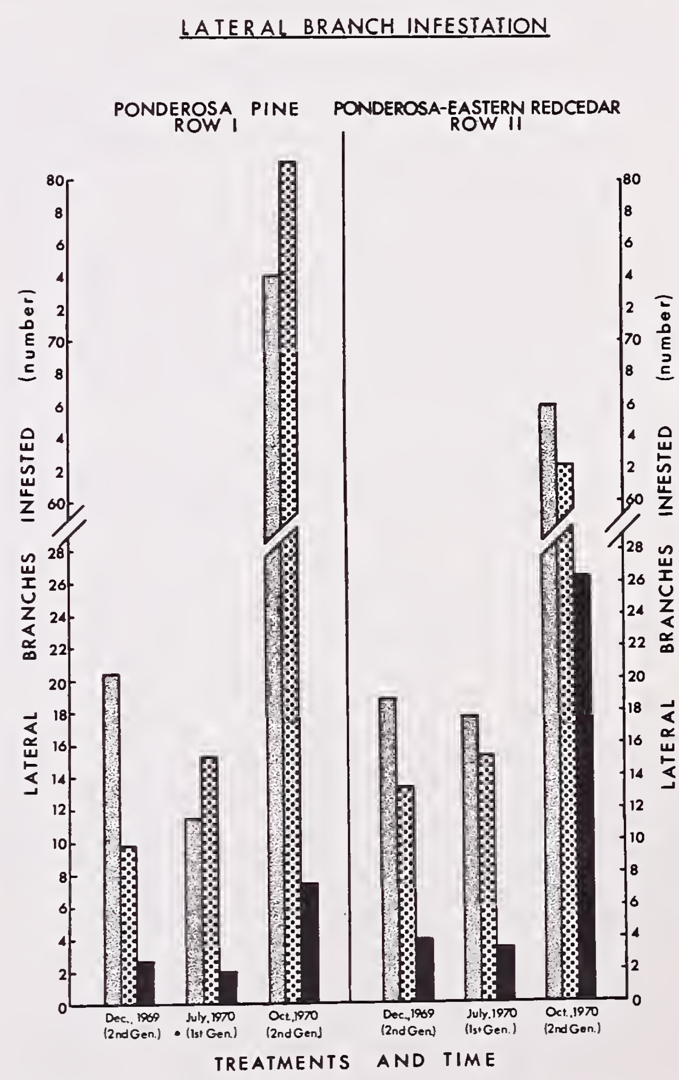


Figure 2.--Number of lateral branch tips infested on ponderosa pine during two growing seasons following treatment with systemic insecticides phorate (Thimet 15G) and dimethoate (Cygon[267]).

demonstrated the continued effectiveness of both phorate treatments and no carryover effect of dimethoate.

Evaluation, October 1970.—A marked increase was evident in the incidence of attack on all trees during the second generation. The data clearly showed, however, a residual effect of the phorate treatment. Infestation incidences of 74 and 66 on check trees, 81 and 62 on dimethoate-treated trees, and 7 and 26 on phorate-treated trees were recorded (fig. 2). Although the phorate-treated trees showed an increase in incidence of lateral branch infestation, especially at the 40-gram-per-tree rate, they were still significantly and acceptably less infested than the check and dimethoate-treated trees.

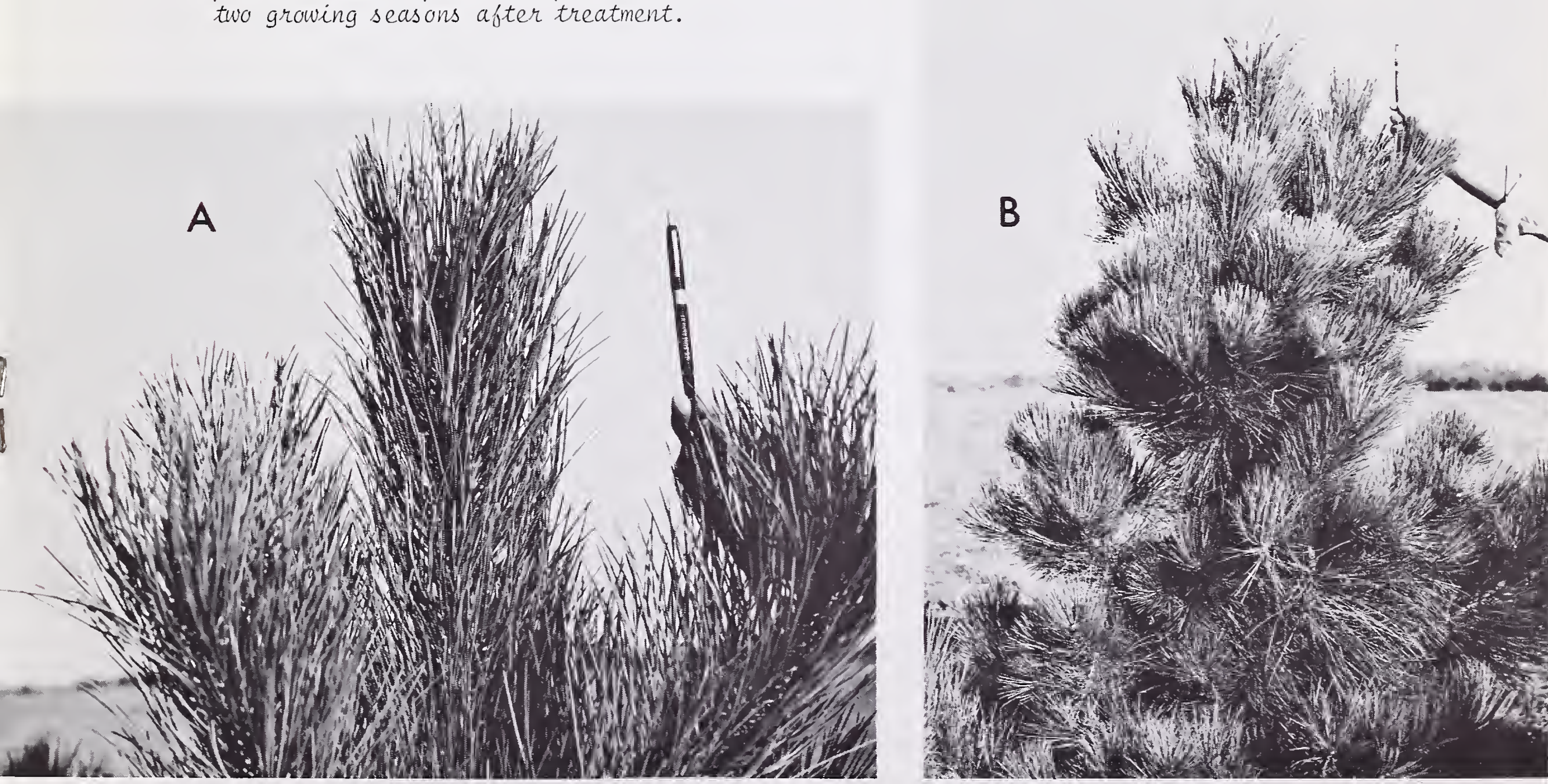
Height Growth

Trees averaged 3.8 and 3.2 feet tall in Rows I and II, respectively, before treatment. Differences among groups of trees by treatment within each row were not significant. Measurements to the nearest live part of the terminal in December 1969 revealed that trees in Row I had grown an average of 1.0 foot during the first growing season following treatment, while trees in Row II had grown 0.7 foot. Treatments had no significant effect on height growth in 1969, however.

By October 1970, phorate-treated trees averaged 0.5 foot taller in both shelterbelts than the dimethoate-treated and check trees. While height differences between treatments have not yet achieved significance, it is presumed that they would in another year if the treatments were repeated.

No foliage burn or other visible symptom of phytotoxicity was noticed on any trees during the study. On the contrary, by October 1970, the shiny, dark green foliage and healthy appearance of the phorate-treated trees contrasted markedly with the pale green foliage and dead shoots of dimethoate-treated and untreated check trees (figs. 3, 4).

Figure 3.--Vigorous, healthy terminal and lateral branches (A), and renewed, robust development (B), of phorate-treated ponderosa pine trees two growing seasons after treatment.



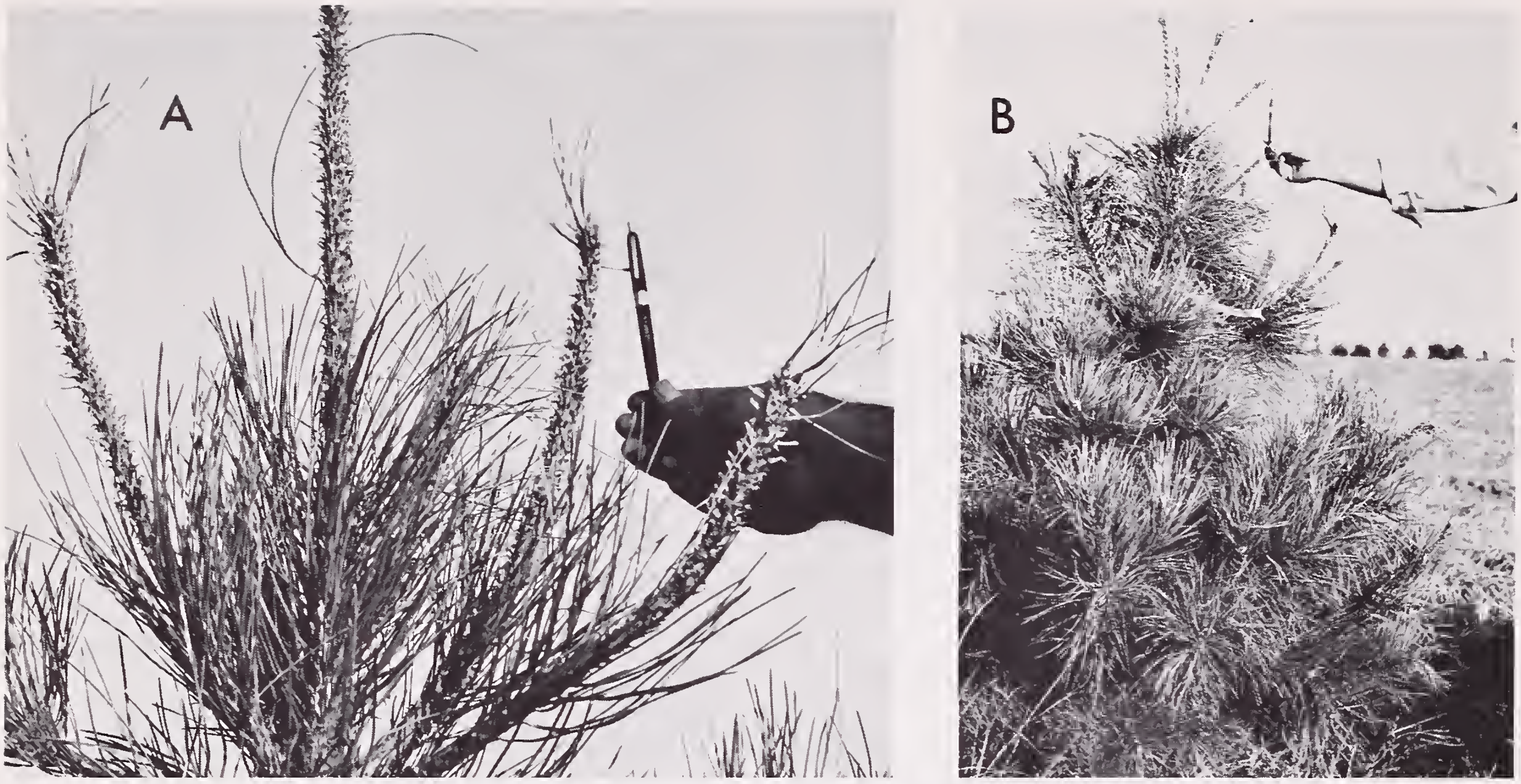


Figure 4.--Dead terminal and lateral branch tips (A), and less vigorous, more chlorotic and multi-branched untreated check and dimethoate-treated trees (B), 2 years following treatment.

Interpretation

The first application of dimethoate spray was apparently effective and well timed, for it gave excellent control of the first generation of tip moth. However, it apparently had little carryover effect on the second generation, a result similarly experienced by Boyd et al. (1968).

The second application of dimethoate apparently was either not as effective as the first application, or its application was not timed with occurrence of the second-generation larval stage of the tip moth. Thus, as in the earlier spray programs which used DDT and other chlorinated hydrocarbons, repeated sprayings and a precise knowledge of life cycle stages for specific localities are necessary to obtain effective control with this chemical.

The April applications of dry, granular phorate apparently were not absorbed into the trees in time to be completely effective during the first generation of the tip moth. Boyd et al. (1968) found that it usually requires 46 to 56 days for granular applications of systemic insecticides to become effective. They recommended October and November as the best time to apply granular phorate in Oklahoma. In view of the possible danger to foraging wildlife during the winter, however, a late winter or early spring application would seem equally effective. Late winter snows and early spring rains would carry the insecticide into the soil for translocation through the roots and into the trees in time to be effective. Applications of granular phorate are not dependent upon critical timing to life cycle stages of the tip moth, and can be made when other farm work is relatively light.

Both rates of phorate (Thimet 15G) tested provided very effective control in 1969 and through the first generation of tip moths in July 1970, and acceptable control through the second (1970) growing season. Examination of the individual tree data revealed that only occasional trees in the 40-gram treatment (fig. 2, Row II) had become highly vulnerable to attack. Thus, the increase to 26 lateral branch tips infested was due to relatively few trees. The majority of phorate-treated trees remained conspicuously "clean" at the end of the 1970 growing season.

Dimethoate (Cygon 267) spray also provided effective control of the pine tip moth. Applications, however, required precise timing to emergence of larval stages and had less carryover effect than granular phorate.

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NOTICE

This Note describes research on the use of phorate (Thimet) to protect trees. Because registration for this use of phorate was withdrawn after the research was completed, the results presented here cannot be interpreted to be recommendations for its use.

USE PESTICIDES CAREFULLY

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key -- out of the reach of children and animals -- and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: *Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U. S. Department of Agriculture, consult your county agricultural agent or State Extension specialist to be sure the intended use is still registered.*

PROTECT

Use Pesticides Safely

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