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CONE AND SEED INSECT NEWSLETTER[1/]

February 1973

1. General

The North Carolina State University Tree Improvement Cooperative has appointed a Seed Protection Committee to investigate ways and means of reducing cone and seed losses in 3,000 acres of seed orchards now in the program. Seed from these orchards produced in 1971 over 120,000,000 seedlings. These seedlings will regenerate over 200,000 acres and at a modest estimate 10 percent increase in yield could provide 6 million more dollars at harvest than seedlings grown from regular seed. Although there are a number of objectives for the committee, the one that we have concentrated on for 1973 is to conduct a cooperative test in at least eight orchards of the efficacies of phorate as a granular application and Gardona as a 0.5 percent hydraulic spray for the control of insects in loblolly pine cones. Members of the committee are: Tom Dierauf, Virginia Division of Forestry; Claud O'Gwynn, International Paper Company; Norman E. Johnson, Weyerhaeuser Company, Chairman; Jim Martin, American Can Company; Hank Plotkin, North Carolina Forest Service; and Robert Weir, North Carolina State University. We hope that such an effort made in several orchards at the same time will produce more consistent results sooner. (Johnson - Arkansas)

Twenty forest entomologists and three biometricians, representing the U. S. Forest Service, states, and universities throughout the South, met at Olustee, Florida, November 1 - 2, 1972. The objective of this informal workshop was to discuss the development of accurate sampling procedure for evaluating insect-caused flower, cone, and seed losses in southern pine seed orchards. Eventually we hope to standardize sampling methods so that impact data will be more meaningful for the five major pine species commonly grown in seed orchards in the large 12-state southern region. Other similar workshops will be held in the future as progress is made and sampling techniques are refined. (Merkel - Florida)

Research in progress:

The bioenergetics of Douglas-fir cone and seed insects in Idaho.

The goals of this project are: (1) To identify Douglas-fir cone and seed insects in Idaho and to determine their distribution and relative abundance and damage; (2) To develop a predictive equation to estimate cone/seed production and loss; and (3) To ascertain bioenergetic relationships among insects, cones, and seeds.

1/ Contributions submitted by cone and seed insect research workers, resource managers, and tree improvement specialists. These unpublished data cannot be used without contributor's approval. Items assembled by S. W. Meso, U. S. Forest Service, Portland, Oregon.

Cones have been collected from a number of sites throughout Idaho. Analysis of insects present and damage caused is not yet complete. In contrast to the heavy cone crop year of 1971, the 1972 crop in northern Idaho was light or absent while most southern Idaho locations produced a light to moderate cone crop. A 40-acre intensive study area has been established near Potlatch, Idaho, with the cooperation of Potlatch Forests, Inc. The test stand is composed of 20 acres of high density (185 stems/acre) and 20 acres of low density (45 stems/acre) Douglas-fir, neither half produced cones in 1972. Exterior and interior cone temperatures of an open growing Douglas-fir were measured with thermocouples. A multipoint recorder enabled continuous measurements during the last three weeks of August. These cones were then collected and stores at -15°C. Cone scales, seeds and insects will be subjected to semi-micro oxygen bomb calorimetry. (Clausen, Schenk - Idaho)

Seed and cone insect research at New Mexico State University in 1972 was mainly directed toward accumulating additional information on the biology and cone attack behavior of the more important cone beetles. Preliminary work was also begun on insects attacking seeds and cones of Pinion. Permanent plots were established that, for the next five years, will be used to measure the effects of weather, insects, and rodents on seed crop fluctuations under New Mexico conditions. (Kinzer - New Mexico)

Here in North Dakota our area of research concerns insects that are pests in windbreaks and other types of protective plantings on the Great Plains. Nearly all of the coniferous and deciduous planting stock is grown in the Great Plains area. We seldom hear of cone and seed insect problems from the nurserymen, but I am sure that the losses are far greater than we know now. At present, our main concern is for the seed from the superior trees and from the genetically improved varieties selected for windbreak purposes. Other problems include the ash seed weevils, Thsanocnemis spp., in green ash, Bruchophagus caraganae in Siberian peashrub or caragana, and weevils in oak and plum. I would be especially interested in contact with anyone with experience in control of ash seed weevils. (McKnight - North Dakota)

As predicted, the 1972 cone crops for most species in the Intermountain Region were poor. The lodgepone pine crop was light and only 550 bushels of cones were collected. There were small quantities of Douglas-fir, ponderosa pine, and Engelmann spruce cones in the eastern portions of the Region and almost none in the west. Approximately five bushels of cones were collected from each of these three species.

In 1973, there should be a moderate crop of lodgepole pine cones and very light crops of Douglas-fir, ponderosa pine, and Engelmann spruce cones. (Parker - Utah)

The 1972 Douglas-fir cone crop in Oregon and Washington was light and scattered. An October survey of heavy cone producing west side areas, found only scattered trees with pollen buds. This indicates that trees producing cones will not receive sufficient pollen to produce enough seed for economical collecting. (Meso - Oregon)

Loyd E. Drake, Entomologist, U. S. Forest Service, State and Private Forestry, Forest Pest Management Group, Pineville, Louisiana, is now in charge of the section responsible for cone and seed insects in Zone 2. This zone includes the States of Alabama, Arkansas, Louisiana, Mississippi, Oklahoma, and Texas. He has previously been in charge of the section responsible for bark beetles and pine and hardwood defoliation in this area.

Loyd Drake can be contacted at 2500 Shreveport Highway, Pineville, Louisiana, 71360. Telephone 318/445-6511 Ext. 311. (Pierce - Louisiana)

Lester Gibson has transferred to Forest Disease Research at Delaware, Ohio. He is now working with leafhopper vectors of elm phloem necrosis. No one at the Northeastern Forest Experiment Station is currently active in seed insect research. (Gibson - Ohio)

Early in 1973, an article on the biology of the coneworm, Dioyctria taedae Schaber and Wood, will appear in the Proceedings of Entomological Society of Washington. As soon as I can get the data gathered, another paper should be forthcoming on Dioryctria spp. found in South Dakota. I hope to be able to publish this article in the Canadian Entomologist. (Schaber - South Dakota)

Al Hedlin is currently on a year's transfer of work in Norway. (Harris - Victoria, British Columbia)

2. Insect Identification and Biology

Studies were continued concerning the mating behavior of Dioryctria abietella. A bioassay method was developed to measure male responsiveness to the female sex pheromone and was used to locate the sex pheromone gland in the intersegmental fold between the 8th and 9th abdominal segments of female moths. The extent to which male moths passed through successive stages of precopulatory behavior was found to be dependent on the concentration of sex pheromone. Pheromone responsiveness of males and female production of the pheromone were influenced by diel cycles of 12 hours of light: 12 hours of darkness (12L:12D). The quantity of pheromone present on abdomonal tips of females decreased during photophase and was maximum 9 hours after dark during periods of peak calling activity. The duration of male responsiveness to the pheromone was about twice as long as the period of female release during 12L:12D photoperiods. Female production and release of the sex pheromone, as well as male responsiveness to the pheromone, were inhibited by light. Periods of locomotor activity and calling behavior of female moths followed a circadian rhythm that appeared to be endogenously timed but strongly entrained to imposed photoperiods.

Chemicals which stimulated feeding by larvae of Dioryctria abietella were extracted with acetone from conelets of slash pine. Ether soluble- and water soluble-fractions of the acetone extract elicited a continuous larval feeding response only when recombined. Sugars were also found to induce larval feeding and their effectiveness as feeding stimulants was increased by addition of the ether soluble fraction of the acetone extract.

Exploratory studies on the sex attractants and host attractants of Dioryctria amatella were initiated this past fall. Traps baited with live virgin female moths and with 1-inch discs cut from fusiform branch galls of slash pine were tested in a slash pine seed production area near Olustee, Florida. Males of D. amatella were captured in the traps baited with live female moths whereas only female moths were caught in the traps baited with discs cut from fusiform galls. During additional tests, D. amatella moths were not caught in traps that had been baited with one of five commercially available monoterpenes (a-pinene, B-pinene, limonene, myrcene, or phellandrene). Further field testing of traps baited with live virgin females and discs cut from fusiform galls is planned for the coming year. We are currently developing methods for identifying terpenes emitted from galls and cones of slash pine. These terpenes will be added to the field tests as they are identified. (Fatzinger - Florida)

A midge, Contarinia sp., was found infesting needles of loblolly pine throughout the Erambert Seed Orchard, Mississippi, during the late summer and fall of 1971 and 1972. The midge does not cause a basal swelling of the needles as do many other species of this genus. It feeds beneath the sheath causing lesions on tender young needles. The needle bends downward at the point of the lesion as it grows out of the fascicle. Severe infestations cause dropping of needles. Some trees were heavily defoliated by late summer 1971; however, foliage grew back the next year.

The Nantucket pine tip moth was found completing its entire larval development and pupating within loblolly pine needles at the Erambert Seed Orchard, Mississippi. This is very unusual since, in the South, tip moth larvae usually feed on small needles only during their first instar. After molting to the second instar, they migrate up the shoot, and form a web. They bore into the tip about the fourth instar and complete development there. Dr. B. F. McLemore (Southern Forest Experiment Station) has written a scientific note (Jour. of Econ. Ent., in Press) concerning discovery of the June beetle, Phyllophaga micans (Knoch) feeding on loblolly pine cones mainly during pollen reception and shortly thereafter. Numerous adults of this insect were caught in light traps in the same orchard in which conelet feeding was observed. (Pierce - Louisiana)

A list of all insect species collected from all the major conifer tree species in New Mexico over the last several years has been compiled and will be published in the next few months.

A study of Conophthorus flexilis has shown that the adults overwinter in limber pine cones in both the tree and on the ground. The females make the initial cone attack on developing cones the following spring. If a male follows the female into the cone, the female constructs an egg gallery. If the male does not enter the cone, the gallery is either not constructed or very short. An average of 1.25 cones is attacked by each female. Attacked cones have an average of 17 eggs per cone. There may be as many as three females and three egg galleries per cone. In the

pre-overwintering adult stage, populations average 13 per cone. Post-wintering adults average eight per cone, however, only 4.6 adults per cone emerge to attack the developing conelets in the spring. This survival rate per cone is 18 times greater than that of the ponderosa pine cone beetle ponderosae (Hopk.). This is attributable to the less formidable conditions affecting the portion of Conophthorus-killed limber pine cones that fall to the ground as compared to the more severe conditions affecting Conophthorus-killed ponderosa pine cones which remain on the tree.

Cross mating studies have shown that C. ponderosae and C. flexilis are distinct species and will not interbreed even in caged studies. C. flexilis will, however, attack and lay viable eggs on ponderosa pine cones under caged conditions. C. ponderosae females will attack and feed on limber pine cones but a very short or no egg gallery is constructed and no eggs are laid.

Earlier laboratory tests had indicated that myrcene and B-pinene repelled and attracted, respectively, adult female C. ponderosae.

Vapors of these materials were presented to attacking females by being liberated through a sealed polyethylene tube around the base of the conelet. In these preliminary tests, there was no increase of decrease in cone attack in the presence of either vapor. (Kinzer - New Mexico)

Cone and seed insects continue to flourish in the central Rocky Mountain area, and are even attracting some additional attention.

Seed midges have been implicated in the past 2 years as adverse factors in studies on regeneration of Engelmann spruce. Specifically losses caused by the midges are interfering with attempts to estimate seed production.

Work is continuing on the insect complex affecting ponderosa pine cones and seeds on the Front Range of the Rockies. Main species identified so far include Dioryctria cambiicola, D. rossi, D. abietivorella, D. auranticella, Conophthorus ponderosae, Conotrachelus neomexicanus, and Koerber's ubiquitous cone bug. This work is the subject of a study underway at Colorado State University, and will shortly appear in the form of a MS thesis by Judy Bodenham. (Stevens - Colorado)

The following new species of cone and seed insects were collected in the Intermountain Region:

Grand fir and Douglas-fir

Brachineura n. sp. (Cecidomyiidae: Diptera)

Ponderosa pine

Orgilus n. sp. (Braconidae: Hymenoptera)

Pinyon pine

New genus and sp. of Alomyini (Ichneumonidae: Hymenoptera)

(Moyer - Utah)

3. Damage

Our program has dropped cone and insect survey work. Incidental occurrences of seed or cone injury are reported as part of survey results for other purposes. This season we did find evidence of Eastern spruce budworm (Choristoneura fumiferana Clem.) working in spruce cones within a white spruce seed collection area in the Ottawa National Forest, Michigan. No formal evaluation of the damage or impact has been made. (Hastings - Minnesota)

Seed bugs of the genus, Leptoglossus, are in Arkansas. I found them in abundance feeding on cones of shortleaf pine in the vicinity of Hot Springs. (Johnson - Arkansas)

Conelet abortion accounts for a major portion of the mortality of first-year cones on longleaf, loblolly and shortleaf pines. Conelet losses of from 10 to 50 percent or more of the first-year cone crop have been reported. In the past, the cause(s) of conelet abortion were unknown thus leading to such terms as "physiological drop," "poop-out," etc. However, in some of our recent work we were able to show that feeding by Leptoglossus nymphs causes shortleaf and loblolly conelets to abort, while the protection of conelets from natural bug populations with screen cages prevented abortion. It is unlikely that all of the conelet abortion which occurs on the southern pines is the result of feeding by seed bugs, but our experiments have demonstrated that the potential for such destruction is inherent to these sucking insects. Conelet abortion can no longer be considered solely a tree physiology problem.

Studies of the effect of Leptoglossus on second-year cones and seed of shortleaf and loblolly pine cones and seed were made using caged cone clusters. Adult bugs were allowed to feed for specific time intervals on specific cone clusters early, mid, and late in the growing season. Seed yields and quality from infested clusters and from unprotected cones were compared with cones protected throughout the season from bug feeding. We found that bug feeding, particularly early in the season, or throughout the season by natural populations drastically reduced both seed yields and quality. Seeds damaged early in the season, before hard seed-coats developed aborted, resulting in fewer seed per cone at harvest. Protected loblolly cones yielded 2-1/2 times as many filled seed as did cones exposed to natural bug populations, and almost 6 times as many full seed as cones exposed to 2 weeks of bug feeding early in the season.

In similar work Dave Bramlett, plant physiologist at Blacksburg, Va., found that Virginia pine cones protected by screen wire cages yielded an average of 57 sound seed per cone in contrast to slightly more than 12 sound seed in unprotected cones. Caging reduced the number of unfilled seed per cone from 18 to 9. Tetyra and Leptoglossus were the primary insects suspected of causing the damage. (DeBarr - Georgia)

Populations of Leptoglossus occidentalis, conifer seed bug, moved into the Dorena Seed Orchard which produces blister rust-resistant western white pine seed and seedlings for limited reforestation. The anticipated influx was related to the lack of cones in the adjacent natural Douglas-fir stands. Fortunately, there is only one generation per year. Adults overwinter and become active in May when the second-year cones are elongating. Full cone growth is reached by late June before nymphs begin appearing. Nymphs feed during July and August mainly on the maturing second-year cones. An attempt was made to evaluate seed bug feeding impact by caging specific numbers of nymphs to individual cones, but seed set of open and hand-pollinated cones was not sufficient for significant comparisons. (Meso - Oregon)

Dan Kucera recently completed his dissertation on "Cone and Seed Losses in Loblolly Pine." Loblolly pine orchards were sampled in central Louisiana and east Texas. Major areas of study were:

Life table - greatest losses in first year cones occurred in March through May during the two-year study (1969-1970). Conelets withstood very little feeding during pollination and shortly thereafter. Greatest losses in second-year cones occurred during June-July with a lesser loss in September through October.

Causes of Cone Loss - Dioryctria spp. coneworms were the single most important cause of cone mortality and also cone damage. Next in importance were undoubtedly the cone bugs Leptoglossus corculus and Tetyra bipunctata.

Weather - During the summer months levels of rainfall can also cause numerous conelets to drop. In 1971, some loblolly pine trees dropped all their first-year cones in east Texas. (Pierce - Louisiana)

Prior to the harvest of slash pine cones in 1972, all the cones and conelets were tagged and counted on five trees (38 to 48 feet tall) in a seed production area near Olustee, Florida. This was done as an initial study to determine the effect of mechanical cone shakers on the cone and conelet crops. The same trees were shook in September 1972 to determine if there was any tendency for second-year cones to hang on the tree. This aspect was investigated because the cones removed by a shaker are sometimes used to evaluate the success of a control technique against Dioryctria moths. The cones left on the tree may hang because they are attacked, thus reducing the precision of the biological observation.

In 1971, 79 percent of the second-year cones were removed by shaking (range 70 to 85 percent) and in 1972, 64 percent were removed (range 48 to 91 percent). In 1971, 42, 3, 53, 10 and 25 percent of the conelets were removed by shaking. This resulted from the branch ends being broken by high intensity vibrations.

The following table summarizes the percent of attacks by Dioryctria in the cones removed and kept on the tree. In only one case (Tree No. 5) would the attacked cones left on the tree have made a difference. (Hertel - Florida)

	Tree Number				
	1	2	3	4	5
# Cones harvested	25	174	176	161	65
% attack	16	3	5	4	15
# Cones left on tree	24	186	17	74	43
% attack	13	6	41	4	49
% All cones attacked	14	5	8	4	29

Collections from conifers in North Dakota indicated that lepidopterous borers are well represented. With continued emphasis of planting spruce and pine on the Great Plains, species of Dioryctria have reached a new level of importance. The genus Dioryctria contains some of the most economically important moths affecting coniferous tree species. Their potential for destruction extends to existing provenance studies of ponderosa pine as well as to proposed pine seed orchards of the future. Dioryctria cambiicola, D. tumicolella, and D. gulosella were reared from ponderosa pine. An attack by D. cambiicola predisposes the tree to infestation by the Zimmerman pine moth, D. zimmermani. Dioryctria disculsa was found attacking Scotch pine, and this species could prove to be a major pest of the proposed Scotch pine seed orchard.

Siberian larch is another highly desirable tree species being evaluated to develop planting recommendations. A larch stand on the Denbigh Experimental Forest is used for seed production. During the 1971 field season Dioryctria abietivorella infested approximately 15 percent of the cone crop with a distinct preference for certain trees. Self-pollination predominates and results in low production of viable seed. A 15 percent cone infestation could result in a severe reduction in seed availability. Cone infestations ranging from 60 to 90 percent are recorded in Russian literature. (McKnight - North Dakota)

During the past three seasons, over 35 species of insects have been collected from grand fir and alpine fir cones in northern Idaho. The most destructive pests are Dioryctria abietella (D & S), Eucosma spp., Hylemya Sp., and Earomyia sp. Asynapta keeni (Foote) is found in large numbers, but damage to cones appears to be minimal. Two more cecids form galls on scales and on seeds of grand fir; one cecid feeds in the interior of alpine fir seed and can be detected by cutting open seeds or by x-ray.

Three methods were used to evaluate cone and seed damage: axial slice, followed by whole cone counts; dissection of seeds; and x-ray of seeds. Regression lines will be calculated from these data.

Three methods to count cones from the ground with binoculars were tested: Cones were counted on the largest cone bearing branch, the top whorl of the tree and the south side of the tree. These binocular counts were regressed against total cone counts obtained from climbing the tree. Regression analyses were run for each method; providing the following equations:

Largest cone bearing branch (X_1) to total count (Y):
$Y = 13.929 + 6.419X_1$ $r^2 = .2290$ mean = 60.00
std. error = 52.11

Cones on top whorl (X_2) to total count (Y):
$Y = -.0651 = 3.394X_2$ $r^2 = .719$ mean = 60.03
std. error = 31.42

Cones on south side (X_3) to total count (Y):
$Y = -5.620 + 2.994X_3$ $r^2 = .769$ mean = 59.40
std. error = 28.93

The 1972 cone crop for grand fir and alpine fir was very poor. (Kulhavy, Schenk - Idaho)

A report in the 1970 Newsletter on a pinyon pine, Pinus edulis, cone damage survey listed Hedulia injectiva Heinrich as the damaging insect (larvae were identified by D. M. Weisman). A later determination of the larvae by G. T. Okumura revealed that the insect was not this species. Adults were reared from the cones and D. R. David identified them as Melissopus latiferreanus (Walsingham). (Stipe - Utah)

4. Control

Based on the results of 1971 tests, two 0.5 percent Gardona sprays reduced Dioryctria damage from 17.5 percent to 1.9 percent, where Gardona insecticide used for operational control of Dioryctria in a loblolly pine seed orchard. Low overall Dioryctria activity in 1972 (8.2 percent second-year cones damaged) made the results less striking than in 1971. Treated trees received either two sprays (May 14 and June 14) or one spray (May 14) of a 0.5 percent Gardona spray applied hydraulically. (Copony - Virginia)

Data from the most heavily attacked clones are presented below.

Clone	Treatment	Ramets	Total Cones	% Cones Damaged
2-8	Check	24	3,999	15.1
	2 Sprays	13	2,651	5.0
6-13	Check	14	1,903	10.2
	1 Spray	16	2,044	2.7
503	Check	12	1,388	5.5
	1 Spray	8	826	1.7

Trunk implants and "paint on" bark applications of systemic insecticides were made the first week of May 1972 to seed orchard slash pine trees in an effort to reduce Dioryctria sp. infestations of cones. The results of this test were discouraging because there were no responses to the bark applications and only negligible responses to the Azodrin and Bidrin implants. Most of the bark was shaved from an 18-inch band before an insecticide was painted on a test tree. The injections this year were made in holes bored in the trunks about an inch above the ground level. The results of this test are summarized as follows:

Treatment	Total 2nd-year cones	Percent infested
	Injected into bole	
Azodrin	196	13
Bidrin	341	9
Meta-Systox-R	496	18
Control	407	18
	Applied to bark	
Azodrin	319	19
Bidrin	472	18
Meta-Systox-R	426	25
Control	407	18

The results of a test to evaluate carbofuran granules applied April 4 and June 7, 1972, in the U.S. Forest Service's Erambert Seed Orchard to reduce Dioryctria amatella infestations were inconclusive because of the low number of infested second-year cones on the untreated (control) trees. (Neel - Mississippi)

In a test of Gardona applied as 0.5 percent spray with a mist blower to the point of runoff at two dates, May 15, and June 15, Weyerhaeuser Company achieved good control of coneworms in their loblolly seed orchard at Washington, North Carolina. The infestation rate in the untreated checks was 38 percent and that from the sprayed areas 8 percent. (Johnson - Arkansas)

FURADAN® (carbofuran) 10 percent granules were applied once on May 4, 1972, at the rate of six (6) pounds per tree in a young slash pine seed orchard in northeast Florida to control Dioryctria spp. The grass was mowed immediately prior to spreading the granules on the soil surface within the crown projection; then the granules were covered with the grass clippings to minimize their exposure to birds. Dioryctria attacks on first-year cones only were used to evaluate treatment effect because the second-year cone crop was extremely low. The experimental

design consisted of a treated tree (ramet) paired with another untreated ramet of the same clone and this was replicated 15 times with each replicate representing a different clone. No differences in mean conelet survival from early May to late August, nor in percentage conelets attacked by coneworms, could be detected between treated and untreated trees. (Merkel - Florida)

Feeding damage by Dioryctria was quite serious in the Jefferson, Oregon, Seed Orchard--both in cones and frost damaged terminals. Cones were sprayed three times during the growing season with 1.0 percent Lindane. Where spraying was done, only 14 percent of the cone bearing trees and 4 percent of the cones were infested; in a nonsprayed control area, 82 percent of the cone bearing trees and 20 percent of the cones were infested. Sprayed cones averaged 22 percent more seed per cone.

A large population of Leptoglossus occidentalis was discovered on one heavy bearing tree in a nonsprayed portion of Jefferson Seed Orchard. Seed damaged by Leptoglossus was easily identified on x-rays by the shriveled appearance of the endosperm. X-ray analysis of the seed from this tree and that of another ramet of the same clone from a Lindane-sprayed portion of the orchard is as follows:

Tree	Filled Seed	Percent Empty Seed	Percent Leptoglossus-damaged Seed	Number of Cones
Known Leptoglossus present	0.2	82.9	17.0	39
Sprayed tree	88.5	11.5	0	7

Plans to test Furadan and Gardona as control agents were cancelled due to poor cone crop in 1972. These compounds will be tested in 1973 when the crop outlook is favorable. (Cade - Washington)

We have been using Guthion in place of BHC on our breeding trees in order to comply with regulations. One big drawback down here in the use of insecticides with higher mammalian toxicity is the virtual impossibility of applicators to wear protective clothing during the summer months, thereby hindering spraying operations considerably. I am beginning to believe that in view of present regulations, the best control is no control--that is, let the insects have what they will, but increase the area of seed orchards or the number of breeding trees accordingly. (Coyne - Mississippi)

Field tests comparing hydraulic and air blast speed sprayer methods for applying dimethoate insecticide for Nantucket pine tip moth control were conducted by Neil Overgaard of the Alexandria Field Office, Forest Pest Management Group, Pineville, Louisiana, during the summer of 1972.

Preliminary results at the Stuart Orchard showed 4 percent shoot mortality on the areas sprayed with the hydraulic method and 20 percent on those sprayed with the air blast method. Percent tips infested with tip moths averaged 0.7 percent on the hydraulic sprayed areas and 5.6 percent on the air blast sprayed areas.

Timing of applications was found to be critical especially during the first two generations of the insect. (Pierce - Louisiana)

5. Publications

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