CONE AND SEED INSECT NEWSLETTER[1]

February 1981

1. General

Your compilor is pleased to announce that his plea for a successor was answered and that the CONE AND SEED INSECT NEWSLETTER will for the next 3 years be assembled by Scott Cameron, Texas Forest Service, Lufkin. Thanks to those of you who volunteered to take the job over, and also to all of you who continue to share your results with the rest of us each year. The NEWSLETTER has, in these increasingly structured times, an informal quality that hopefully will continue.

A pest management workshop will be conducted at the 16th Southern Forest and Tree Improvement Conference at Virginia Polytechnic Institute and State University at Blacksburg on May 27-28, 1981. For further information, contact the workshop moderator, Harry O. Yates III, at Athens, Georgia.

The IUFRO Cone and Seed Insects Working Party S2.07-01 will be meeting at the XVII IUFRO World Congress in Kyoto, Japan, from 3-19 September 1981.

(Yates, SEFES, Athens, GA)

Seed orchard managers from private and public land ownerships have formed the Northwest Seed Orchard Managers' Association. This new organization will operate in western Washington, western Oregon, and northern California. Functions of the association are:

(1) To provide a forum for informational exchange among orchard managers.
(2) To identify research needs, and to set priorities for orchard research.
(3) To function as a clearinghouse for specific orchard problems.
(4) To represent orchard managers in lobbying efforts, with specific application to problems of chemical registration and equipment development.

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[1]Contributions submitted by persons working with cone and seed insects, assembled and lightly edited by Robert Stevens, Rocky Mtn. For. & Range Expt. Sta. USFS, Ft. Collins, CO 80526. Information presented herein is unpublished and cannot be cited without the contributor's approval.

Seed orchard involvement is as follows:

	Number of Seed Orchards	Total Acres-1980
Western Washington	20	414.6
Western Oregon	27	887.5
Northern California	11	159.5
	58	1,461.6

(Meso, FPM, USFS, Portland, OR)

Julie Weatherby has replaced Neil Overgaard in cone and seed insect work at the Alexandria Field Office. Neil will be working on hardwood insects and southern pine beetle.

(Overgaard, USFS, Alexandria, LA)

Lester Gibson is again actively working with acorn insects under a study concerned with the impact of insects on oak regeneration in the Northeastern U.S. and Appalachian areas. The study will be mainly with red oak and white oak.

(Gibson, NEFES, USFS, Delaware, OH)

The studies on synthetic attractants for Barbara colifaxiana and Cydia (=Laspeyresia) youngana initiated by Al Hedlin are being continued by his replacement, Gordon Miller. Mixtures of various ratios of cis-9-dodecen-1-yl acetate and the corresponding alcohol were tested for attractiveness to B. colifaxiana, the most attractive being 25:75 and 50:50 (acetate:alcohol). Studies to determine if these chemicals are actual components of the sex pheromone (initial studies indicate they are) will be carried out in 1981. Studies of the effects of trap color, design and height on catches will also be carried out. The results of the tests for attractiveness to C. youngana were inconclusive. Hopefully, some new materials will be available for testing in 1981.

Results of field tests with flower extracts of Douglas-fir and white spruce against their respective pests were inconclusive. Tests will be carried out again in 1981 but only with spruce.

Plans for 1981 include studies on the identification of the pheromones of Contarinia oregonensis and Dioryctria spp.

(Miller, Pacific For. Res. Center, Victoria, B.C.)

Related work is underway south of the border under a new cooperative research venture between Weyerhaeuser Co. and the U.S. Forest Service to identify the sex pheromones of Dioryctria spp. infesting Douglas-fir cones.

(Daterman, Pac. N.W. For. Expt. Sta., Corvallis)

A laboratory colony of the blister coneworm, Dioryctria clarioralis, was established in Texas during 1979 and continued through 1980. More than 550 males were captured in Phercon 1C® traps baited with unmated female moths. The calling time of female moths was observed in laboratory experiments and time of male capture in traps baited with females was monitored in the field. The major components of the D. clarioralis pheromone were isolated and identified. More than 350 D. clarioralis males and 190 D. merkeli males were caught during 1980 in traps baited with synthetic pheromones.

Flight periods of D. clarioralis, D. amatella and D. merkeli have been monitored in Texas with light traps for serveral years. Light trap catches were collected at periodic intervals during several nights to determine the time of response of Dioryctria spp. moths to light.

(Cameron, Texas For. Ser., Lufkin)

A cooperative study between the Southwestern Region, USFS, Rocky Mountain Station, and Northern Arizona University was begun in 1980 to study the insects associated with second year ponderosa pine cones on the Coconino and Kaibab National Forests. Its objectives were to determine the insects associated with the cones, the time when they become associated with the cones, the percentage of cones infested with each species and the percentage of seeds damaged per cone. In May, cone bearing branches on trees in 4 locations (mostly on the Tusayan District of the Kaibab National Forest) were bagged. Throughout the summer, protected cones were unbagged every 2 weeks by Kevin Carlin, research associate, NAU, and Mike Wagner, forest entomology professor, NAU. Simultaneously, groups of cones were collected for dissection and rearing in the laboratory. At the end of August, the cones were collected. Some are being dissected and x-rayed by the Southwestern Region. The rest are being dissected by technicians at the Rocky Mountain Station. Conophthorus ponderosae appears to be an important associate. One curculionid and another unidentified species of beetle have been submitted for identification. Seed chalcid larva have been found but no adults have yet been reared. One lepidopterous larva has been found during dissection. It is being compared against larval specimens of known seed-damaging moths.

(Schmid, RM For. Expt. Sta., USFS, Ft. Collins,CO)

Sunil Ranasinghe has completed his field research on the slash pine flower thrips, Gnophothrips fuscus (Morgan), and will finish his Ph.D. dissertation on this pest during spring 1981.

Two new students, Kerry Sweckey and Alex Bustillo, are investigating the use of Trichogramm wasps as egg parasites of Dioryctria spp. coneworms in slash pine seed orchards.

The regional seed and cone insect project (S-118) will be terminated officially in September 1981, but it was decided that a group be formed to meet with the S. Forest Insect Work Conference, beginning in August 1981 at Gainesville, Florida.

(Wilkinson, Univ. Florida)

2. Biology

Laboratory and field studies of the sex pheromones of D. amatella, D. disclusa and D. clarioralis were conducted during 1980. A bioassay chamber adapted from Daterman's model was used to determine the response curve for male D. amatella to crude female extract. This procedure was also found useful for bioassaying fractions of crude female extracts.

High populations of D. disclusa were present in several seed orchards in the Southeast again this year. This provided us with the opportunity to continue work on the sex pheromone of this species. About 4,000 infested cones were collected from an orchard in Georgia during April. The larvae were set up on artificial diet and allowed to develop at a constant temperature of 30° C. Moths were available for electroantennogram (EAG) studies and bioassays in the laboratory about 2 weeks ahead of those from the field. Field tests conducted during May and June confirmed that the single component found in the EAG studies was attractive to males in loblolly pine orchards in Georgia, North Carolina and Virginia. Thus, with a lot of cooperation and a few hectic weeks of work, we were able to identify and field test the sex pheromone of this univoltine species in a single season.

In addition, the sex pheromones for D. amatella and D. clarioralis were also identified and field tested in Georgia, South Carolina and Texas. Two sex pheromone components were found for D. clarioralis, while D. amatella appeared to use only a single compound.

Work planned for the coming year includes a Southwide survey for D. disclusa using traps baited with synthetic sex pheromone, studies to relate trap catches with population size and cone damage, and preliminary trials of the use of the male disruption techniques for Dioryctria spp. control in pine seed orchards.

(DeBarr, Berisford, Cameron, Roelfs, Barber, and others, USFS and Univ. Georgia, Athens)

3. Damage

U.S. Forest Service entomologists in New Mexico sampled cones from cone lots coming into the Albuquerque Tree Nursery to determine what insect damage is occurring and what percent of the seed in the nursery is lost as a result of insects. In addtion, Forest Pest Management, in cooperation with Rocky Mountain Forest and Range Experiment Station and Northern Arizona University, established some preliminary plots in Arizona. Second-year ponderosa pine cones were bagged to determine what insects were attacking, when they attacked, and how much damage resulted. A similar plot was established in Douglas-fir in New Mexico.

(Ragenovich, USFS, Albuquerque, NM)

Entomologists monitored cone and seed insects for the third year in those seed production areas in Montana and northern Idaho that had sufficient cones to allow sampling (33 areas). Cones of Douglas-fir, grand fir, western larch, Engelmann spruce, western hemlock, lodgepole pine, ponderosa pine, and western white pine were sampled at about monthly intervals from June through mid-September. Results are being analyzed. Greatest losses (50-100 percent of the cones) occurred to Douglas-fir and western larch in areas infested with the western spruce budworm. Very heavy injury was inflicted to ponderosa pine cones by Dioryctria spp. at one location in Montana, and the mountain pine cone beetle continued to cause serious losses to western white pine cones in northern Idaho.

(Dewey, USFS, Missoula, MT)

Cone and seed insects and low seed counts, presumably due to poor pollination, impeded cone collections of Douglas-fir and interior spruces in forest stands in B.C.. All other conifers sampled were relatively free of cone and seed insects. Douglas-fir cones were unsuitable for collection at 9/10 locations sampled in the Cariboo Forest Region; at 24/71 locations sampled in the Kamloops Forest Region; at 7/13 locations sampled in the Vancouver Forest Region; and at 5/6 locations sampled in the Nelson Forest Region. Damage to the cones was caused primarily by Barbara colfaxiana, Contarinia oregonensis and Dioryctria spp. Engelmann spruce cones were unsuitable for collection at 5/5 and 7/8 of the locations sampled in the Cariboo and Kamloops Forest Regions, respectively. In the Prince Rupert Forest Region, white spruce cones at 5/6 locations sampled were unsuitable for collection. The most damaging spruce cone and seed insects were Cydia (Laspeyresia) youngana and Lassioma (Hylemya) anthracina.

In Douglas-fir seed orchards on Vancouver Island, seed losses due to cone and seed insects ranged from less than 10% to more than 90%. The most damaging species were C. oregonensis, B. colfaxiana, Dioryctria spp. and Megastigmus spermotrophus. Leptoglossus occidentalis has been visible in the orchards the last two years but damage by this insect has not been quantified.

(Miller, Pacific For. Res. Center, Victoria, B.C.)

Records at the Placerville Nursery, U.S. Forest Service, indicate that consignments of moderately to heavily infested cones comprised the following proportions of the shipments: Douglas-fir, 57%; red fir, 43%; white fir, 38%; Jeffrey pine, 31%; ponderosa pine, 25%; sugar pine, 7%. Nevertheless, cone crops generally were good in the Sierra Nevada Mountains and seed losses did not hinder most collections. Yields of seed per cone appeared to be better than in 1979.

The Douglas-fir cone crop at the Badger Hill Tree Breeding Arboretum, El Dorado County, did not incur the serious losses found there in past years. However, the cone moth, Barbara colfaxiana, and the cone midge, Contarinia oregonensis, continued to cause serious losses at many locations in Del Norte, Humboldt and Siskiyou Counties where the unseasonal spring weather did not eliminate the Douglas-fir cone crop.

(Freeman, FPM, USFS, San Francisco, CA)

Larvae of an unknown species of looper destroyed about 25 percent of the conelet crop during the spring of 1979 in a loblolly pine seed orchard at Magnolia, Arkansas. A visit to the orchard on April 2, 1980 confirmed that the larvae were again destroying female strobili (some still in the twig-bud stage). Our investigation of the distribution of the infestation revealed the source of the infestation to be two isolated sweetgum trees on the border of the orchard. Thousands of looper larvae were present in the male sweetgum flowers. Young larvae were dispersing into the crowns of the orchard trees from the sweetgum flowers on long, silk threads. The sweetgum trees were cut and removed.

(DeBarr and Bramlett, SEFES, USFS, Athens, GA)

An outbreak of Dioryctria disclusa in early spring 1980 essentially eliminated our New Kent Co. loblolly seed orchard cone crop, and damaged a significant portion of new conelets. A quickly organized aerial treatment with azinphosmethyl treatments are planned for 1981.

(Tigner, Va. Div. Forestry, Charlottesville)

1980 Collections of read oak acorns show that insect infestation was 56% at a site near Binghamton, N. Y. and 40 to 59% in areas near Ithaca, N. Y.

(Gibson, USFS, Delaware, OH)

4. Control

A study of the effectiveness of aerial vs. hydraulic sprayer applications of acephate for control of cone and seed insects in a slash pine seed orchard was installed in January, 1980 (C. W. Fatzinger, H. O. Yates, III, and J. G. Hickman). Three applications of acephate were made to study plots: one in late-January, one in late-February, and one in late-May. The aerial applications were made with a fixed-wing airplane at the rates of 3.00-, 1.50-, and 0.75-lb. a.i. in 20 gal. of water per acre. The hydraulic spray was applied as a 0.5% a.i. solution to foliage drip off. The study includes an untreated check area.

A late frost and an unusually high incidence of cone rust have created problems in analysis of the first year's results. However there were significant differences in treatments. The study will be continued in 1981.

(Fatzinger, SEFES, USFS, Oluster, FL)

An aerial pilot test test for controlling cone and seed insects in a loblolly pine seed orchard in Louisiana was conducted during 1980.

Guthion (2# a.i./acre) and Pydrin (0.67# a.i./acre) were each applied in five monthly applications (May-September) by helicopter to individual five acre blocks. Both treatments showed significantly less coneworm damage than the check treatment. Coneworm damage was 38 percent in the check compared to 18 percent in both Guthion and Pydrin treatments. Numbers of sound seeds per cone were more than doubled in both chemical treatments over the check. The test is to continue one more year.

A Furadan rate evaluation was conducted at the Ouachita Orchard, Mt. Ida, Arkansas, comparing applications of 4 and 8 ounces of Furadan/in d.b.h. by the John Deere Pow'r till seeder and Guthion (30 pint/100 gal. H_2O) by mist blower. All three treatments were significantly better than the check for coneworm damage (46% for the check versus 14% for Guthion, 6% for Furadan 4 oz. and 3% for Furadan 8 oz.) The mean number of sound seeds produced per cone was 5 in the check, 35 in the Guthion treatment, 56 in the Furadan (4 oz.) treatment and 63 in the Furadan (8 oz.) treatment.

(Overgaard, USFS, Alexandria, LA)

Field tests of 3 insecticides--Pydrin, Ambush, and Imidan--were continued in four pine seed orchards in 1980 (Table 1). The objective of this study was to determine the efficacy and establish the minimum effective rates of these insecticides for control of seedbugs and coneworms in southern pine seed orchards. The treatments tested are given in Table 2.

Randomized complete-block designs were used with clones considered to be blocks. In the Tar City, Beauregard, and Erambert orchards, each treatment was randomly assigned to one or two ramets in each of 6-9 clones.

Table 1.--Seed orchards used in field tests of insecticides--1980.

Orchard	Location	Species	Entomologist in charge and affiliation
Tar City (Union Camp Corp.)	Tatnall Co., Ga.	slash	J.C. Nord, G.L. DeBarr, SEFES; John F. Godbee, Union Camp Corp.
Beauregard (La. Forestry Comm.)	DeRidder, La.	slash	N. A. Overgaard FPM
Erambert (USFS)	Brooklyn, Miss.	loblolly	W. W. Neel Miss. State Univ.
Francis Marion (USFS)	Moncks Corners, S.C.	loblolly	J. C. Nord, G. L. DeBarr, SEFES; L. R. Barber, FPM

Table 2.--Mean percent Dioryctria-damaged cones in field tests of insecticies--1980.

Treatment	Tar City	Beauregard	Erambert	Francis Marion
	Pct. Dior. [2]	Pct. Dior.	Pct. Dior.	Pct. Dior. (D. disclusa) [2]
Pydrin .05 (.25) [1]	2.4 a	7.9 abc	18.4 a	10.1a (0)a
Pydrin .025 (.125) [1]	3.5 ab	16.9 bcd	21.0 a	7.9a (0)a
Pydrin .0125 (.0625) [1]	3.2 ab	23.4 d	----	11.4a (0.7)a
Ambush .075	2.7 a	7.1 a	27.0 a	----
Ambush .05	3.1 ab	11.7 abc	27.6 a	----
Ambush .025	3.0 ab	20.4 cd	----	----
Imidan .3	6.9 bc	16.8 cd	----	----
Imidan .2	8.0 cd	20.1 bcd	----	-----
Guthion .18	6.5 abc	8.6 ab	20.9 a	-----
Control	15.5 d	22.3 d	32.2 a	23.8b (13.7)b

[1] Rates of Pydrin in the Francis Marion mistblower test.

[2] Any two means not having a letter in common are significantly different at the 5% level according to a Duncan's New Multiple Range Test.

(Nord and DeBarr)

The insecticides were applied 5 times at monthly intervals (beginning in April or May) with a hydraulic sprayer to the point of runoff. In the Francis Marion test, 1.6-acre blocks of trees were sprayed 6 times at monthly intervals (beginning April 10) with a large John Bean speedsprayer. Several response variables relating to damage caused by seed bugs and coneworms were measured.

Dioryctira Control. Both Pydrin and Ambush at all 3 rates gave good control of coneworms in the Tar City orchard (Table 2). There was no significant differences at the 5% level between the Ambush, Pydrin and the Guthion standard treatments. Imidan at .3% was significantly different from Guthion. Although Imidan .3% was significantly less effective than Ambush and Pydrin at the upper rate, it was not at the middle and lower rates.

Efficacy of all insecticides was apparently lower in the Beauregard orchard. Only the upper and middle rates of Ambush, the upper rate of Pydrin, and the Guthion treatments had significantly less coneworm damage than the control. There was no significant difference between those rates of Ambush, Pydrin and Guthion. In the Erambert orchard, there was no difference between the control treatments.

Control of Dioryctria disclusa was excellent with all three rates of Pydrin in the Francis Marion orchard. Control of other Dioryctria was moderately good, but there were no differences between rates. Control of 1980 D. disclusa damage in trees sprayed in the Georgia Kraft orchard during 1979 was very good. Untreated trees had 27.9% damage while damage in trees treated with Pydrin, Ambush, Imidan and Guthion ranged from 0 to 2.2%.

Seed Bug Control. Seed bug damage was at such a low level in 1980 that it is unlikely that any information on insecticide efficacy will be obtained. In the 1979 tests, the results of which were not available at press time last year, good control of seed bugs was indicated by all insecticides and rates tested.

(Nord and DeBarr, SEFES, Athens, GA)

Prescribed burning tests were conducted in two New York locations to determine their effects on acorn insect populations.

(Gibson, USFS, Delaware, OH)

The effects of a moderate intensity prescribed understory fire on cone production and losses of cones and seed to insects in seral ponderosa pine is currently being investigated near Tensed, Idaho. Sample trees were located in an open stand (mean CCF = 46) with mature ponderosa pine comprising over 90 percent of the total basal area per acre. Cones were sampled from eight crown locations on each tree during late summer 1979 and 1980. The burn was conducted in early fall 1979. To date Conophthorus ponderosae Hopk. has been the only cone insect encountered in sampled cones. Preliminary indications are that fire treatment was followed by a slight increase in first year ovulate strobili production and a decline in the number of cones attacked by C. ponderosae. Final analysis of the data is in progress and a manuscript is in preparation.

(Johnsen & Schenk, Univ. Idaho, Moscow)

Encouraged by the results of a single ground application of acephate and carbaryl to protect Douglas-fir foliage and cones from western spruce budworm damage, we used double and triple applications in 1980. To reduce pre-spray damage (30 percent in 1979), the initial application was applied 12 days earlier this year. Additional applications were applied to prolong the effective period of protection.

Treatment began May 8 at which time most of the cone buds were open and erect. The remaining applications followed at approximately 17-day intervals. Post-spray sampling included young cones, mature larvae, defoliation, and mature cones. Figure 1 and Table 2 summarize the data tabulated to this point. Although our analyses are not complete, the third application for both materials improved seed production by no more than three seeds per cone.

Table 2. Project results by treatment.

Treatment Agent/# applications	Larval per 100 shoots	Defoliation percent	Mature cone Damage (%)	Total seed per cone
Acephate-2	.95	4.8	2.6	33.6
Acephate-3	.34	1.1	1.4	34.2
Acephate-3R	0	6.9	1.2	34.4
Carbaryl-2	.56	1.0	0.2	38.9
Carbaryl-3	.0	0.6	0.7	41.4
Carbaryl-3R	.14	0.6	0.3	41.4
Control	16.29	77.5	33.9	22.5

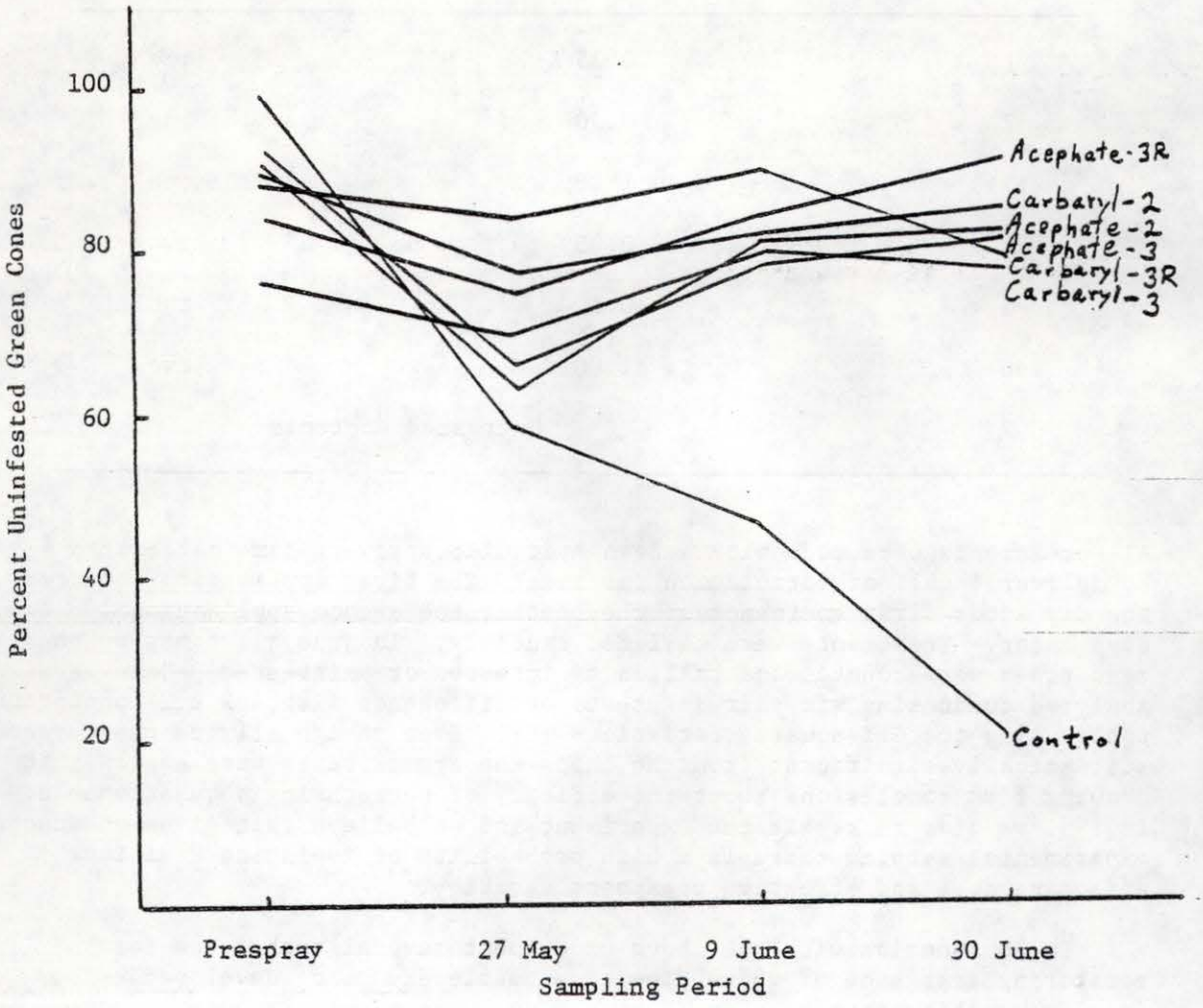

Figure 1. Cone damage by treatment

In another test Orthene Acecaps were used to protect Douglas-fir cones against the western spruce budworm. The Acecap implants were placed in a spiral pattern at four inch intervals around the base of the tree. Fifteen trees were treated on April 25, 1980 and another 15 were used as controls. Post spray cone samples were collected at 30, 60 and 90 days for residue analysis. Cone damage and larval densities were also recorded. Treatment differences appear to be not significant

(Stipe, USFS, Missoula, MT)

In April 1980, 60 cone bearing western white pine were treated with a synthetic pyrethroid insecticide, permethrin, in a field experiment for control of mountain pine cone beetle in the Sandpoint Seed Orchard, Sandpoint, Idaho. Treatments were as follows:

Treatment Number	Conc. 1 lbs/100 gal H_2O	Number of Applications
1	0.25	one
2	0.50	one
3	1.00	one
4	0.25	two
5	0.50	two
6	1.00	two
7	Untreated Controls	

All treatments were made with a Bean hydraulic sprayer, time calibrated to deliver 4 gal. of formulation per tree. The first application occurred the day after first emergence of the beetle; the second application 10 days later. Treatments were assigned randomly. In June all cones on the test trees were counted and tallied as infested or uninfested. Data were analyzed conducting six pairwise tests of difference with a 2 x 2 contingency table using the Chi-square statistic = .01. Even though all treatments were statistically significant from the check the attack rates were so low that drawing firm conclusions about the efficacy of permethrin is questionable. In 1981 we plan to repeat the experiment and we believe that given an adequate experimental setting there is a high probability of isolating a minimum effective dose and effective treatment strategy.

In conjunction with the above experiment several techniques for monitoring emergence of white pine cone beetle are being developed. They include; construction of a day/degree model, use of sticky boards, cone phenology and caged cones.

(Shea, Jenkins and Haverty, PSW For. Expt. Sta., Davis at Berkeley, CA)

Treatment of superior Douglas-fir by injection of Metasystox-R resulted in increased seed yields and permitted the North Zone Tree Improvement Program to collect badly needed seed from some areas in Siskiyou County. If data analysis substantiates present judgments, the method may be adopted for use on selected "wild" trees in order to increase seed collections by seed zones and alleviate the critical shortage of Douglas-fir seed in northwestern California.

(Freeman, USFS, San Francisco, CA)

5. Publications

Chatelain, M. P., and R. A. Goyer. 1980. Seasonal attack periods of cone-feeding insects of loblolly pine cones. Ann. Ent. Soc. Am. 73:49-53.

Chatelain, M. P., and R. A. Goyer. 1980. Seasonal development of the seedbugs Leptoglossus corculus and Tetyra bipunctata on loblolly pine in a Louisiana seed orchard. Proc. La. Aca. Sci. 43. (In press).

DeBarr, G. L., and C. W. Berisford. 1981. Attraction of webbing coneworm males to female sex pheromone. Environ. Entomol: (In press).

DeBarr, G. L., and V. H. Fedde. 1980. Contact toxicity of 17 insecticides to larvae of Dioryctria amatella (Lepidoptera: Pyralidae). Can. Entomol. 112:521-523.

Hanula, J. L., C. W. Berisford, and G. L. DeBarr. 1981. Response of Dioryctria amatella males to crude pheromone extracts in laboratory bioassays. Environ. Entomol: (In press).

Hedlin, A. F., H. O. Yates III, D. Cibrian T., B. H. Ebel, T. W. Koerber, and E. P. Merkel. 1980. Cone and seed insects of North American conifers. 122 p. Can. For. Serv., U.S. Dep. Agric. For. Serv., and Secr. Agric. Recur. Hidraul., Mexico. (Coop. Publ., Unnumbered).

Mattson, W. J., Jr. 1980. Cone resources and the ecology of the red pine cone beetle, Conophthorus resinosae (Coleoptera: Scolytidae). Ann. Ent. Soc. Am. 73:390-396.

Williams, V. G., and R. A. Goyer. 1980. Comparison of damage by each life stage of Leptoglossus corculus and Tetyra bipunctata to loblolly pine seeds. J. Econ. Ent. 73. 497-501.

By March 31, 1981, a report will be available on a pilot project, Suitability of Inject-A-Cide Metasystox-R for increasing Seed Yields of Large Superior Douglas-fir Trees by Reducing Losses Caused by Insects.

(Freeman, USFS, San Francisco)

Russ Mitchell (USFS, Bend, OR), reports that he has prepared a paper for Northwest Science on insects affecting seed production in noble fir.