PINE NURSERY AND SEED ORCHARD INSECT CONTROL--
PRESENT AND FUTURE

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In many forestry organizations, the nurserymen are responsible for insect control in both the nursery and seed orchards. Very often seed orchards are established near the nursery to provide more efficient and economical management of both areas. The production of sturdy, vigorous, insect- and disease-free seedlings for grafting stock or progeny tests is a most important and critical step in successful seed orchard establishment and maintenance.

Since seed orchard insects are my primary research assignment, my talk will emphasize this problem area. I shall discuss nursery insect problems briefly.

CHEMICAL CONTROL OF PINE TIP MOTHS

Pine tip moths, Rhyacionia spp., have always been a nuisance in nurseries, but in the ever-expanding tree improvement programs they have appeared as a new threat to grafted pine scion material and more recently have been found to feed directly on first-year shortleaf pine cones and reduce potential flower production by destroying primordial flower tissue in shoots during the late summer.

In pine nurseries and severely infested plantations, DDT alone or in combination with malathion have been used for nearly two decades for tip moth control. These insecticides were effective but numerous applications were required for each tip moth generation and precise timing of sprays was a critical factor.

Within the past 5 to 10 years researchers have turned to systemic insecticides, which although hazardous to man and animals, eliminated the problem of frequent applications and careful timing. The most effective systemics used in recent years have been phorate (Thimet) and disulfoton (Di-Syston). In Louisiana, Barras et al. (1967) found that 1-year-old loblolly pines received season-long protection with a single mid-February application of 10 percent phorate granules (21 g./plant) and 5 percent disulfoton (42 g./plant). Ten percent phorate granules applied to 2-year-old pines at 42 and 84 grams per plant gave effective tip moth control during 1960 and early into the 1961 growing season. Similar success with 20 grams of 10 percent phorate granules per tree on loblolly pines up to 8 feet tall were reported by Yates (1970) in Virginia. Realizing the health hazards of handling phorate granules, Yates and Lewis (1969) developed a safe hand-operated, vehicle-mounted applicator for use in seed orchards. Wasser (1969) adapted this applicator further for operational use by the Virginia Division of Forestry in their large New Kent Seed Orchard.

Dimethoate (Cygon) shows promise as a safer alternative to phorate and disulfoton. Barras et. al. (1967) reported that a single early-June foliar drench of dimethoate, applied at the rate of 0.25-pound of toxicant per 100 gallons of water, gave about 50 percent control of larvae already established in shoots of loblolly pine. In this study, dimethoate lost its effectiveness between 20 to 70 days after treatment. The U. S. Forest Service is currently recommending for pine tip moth control a 30.5 percent dimethoate emulsifiable concentrate diluted at the rate of 3 pints in 100 gallons of water and applied as a terminal spray drench. Based on the author's experience with this chemical on sand pine in Florida, bi-monthly sprays would probably be required during the active tip moth season. Timing of dimethoate sprays does not appear to be too critical but should be made as soon as tip browning, or preferably the early bud-mining stage, is observed. Dimethoate is notoriously effective against many scale insects; so you may find it useful also for control of these insects in nurseries and seed orchards.

CHEMICAL CONTROL OF PINE SEED ORCHARD INSECTS

The only insecticide that has been granted the U. S. Department of Agriculture label registration for use in southern pine seed orchards is azinphosmethyl (Guthion) and this only for control of *Dioryctria* spp. coneworms, and the seedworm, *Laspeyresia anaranjada* on slash pine. For *Dioryctria* control on slash pine an azinphosmethyl 22 percent emulsifiable concentrate is recommended, diluted at the rate of 6 pints per 100 gallons of water. It is applied as a foliage-wetting spray at monthly intervals from early-April through early-July; the early-May application is well-timed to control the slash pine seedworm also. We hope that the U. S. Department of Agriculture registration of this insecticide can be extended to include all southern pines, but research has not been conducted to determine number and timing of spray application on other pines. Any potential users of azinphosmethyl should note that this chemical is highly toxic to mammals and all precautions must be taken to avoid breathing and skin contact with this chemical.

Other safer insecticides such as malathion, carbaryl, Gardona, and dimethoate, have shown promise in preliminary tests.

Since my last talk to you 4 years ago, I have devoted much of my research time to the development of methods for implanting systemic insecticides into seed orchard and seed production area trees for cone and seed insect control. Initial field experiments (Merkel 1969) with dicrotophos (Bidrin) were so encouraging that most of my studies have been with this systemic insecticide. However, other safer systemics are being studied.

Bidrin technical liquid, containing 8 pounds per gallon of active dicrotophos, when implanted into holes drilled into slash pine stems in early-May at dosage rates of 2 to 5 grams dicrotophos per inch of tree diameter at waist-height gave 86 to 94 percent control of *Dioryctria* spp. coneworms and 94 to 100 percent control of the slash pine seedworm, *Laspeyresia anaranjada.* Dicrotophos implanted in early-May by means of Mauget injectors at dosages of 1.5 and 3.5 grams per inch of diameter resulted in 30 to 80 percent control of *Dioryctria* spp. and 56 to 97 percent control of the slash pine seedworm.

Another field experiment showed that dicrotophos implanted at 5 grams per inch rate still gave good (88 percent) control of the slash pine seedworm when applied one month (April 3) prior to an attack of second-year cones. Implants as early as February 5 and March 5 at the same dosage rate (5 g./inch) gave 91 and 94 percent protection of second-year cones from coneworm attack until cone harvest (mid-September).

In all of the implant tests conducted on slash pine to date, moderate needle burn was observed at dosages as high as 10 grams of dicrotophos per inch of tree diameter. A few trees exhibited needle burn when implanted at 5 grams per inch in February and March. Seeds from trees implanted with dicrotophos for 3 consecutive years at 3.5 grams per inch dosage rate showed no decrease in full seed germination percent when compared with seed from untreated trees. We also have evidence that the dicrotophos implants are preventing seed losses caused by the seed bugs, *Leptoglossus corculus* (Say) and *Tetyra bipunctata* (H. +S) (DeBarr 1967).

In closing, I would like to make a few remarks concerning pesticide bans or restrictions, the environmental pollution revolution, and their impact on nursery and seed orchard insect control. More pesticides are used in nurseries and seed orchards than in any other single forestry operation. This is understandable in view of the intensive management and extremely high crop values at stake. I think I can safely predict that we will gradually see a phasing out of most, if not all, of the presently used "hard" organo-chlorine insecticides such as DDT, BHC, chlordane, aldrin, dieldrin, endrin, and others. As serious a loss as this would be, the future is not as gloomy as might first appear. It only means that researchers have an even greater challenge ahead to not only develop safer pesticides but also to use the available ones more judiciously.

The time is long overdue when we must get out of the pesticide rut and search for alternative methods for controlling our insect and disease pests. This does not mean that pesticides will be completely eliminated; but rather they will be used only when absolutely essential and they will also be integrated into a control program in combination with biological, silvicultural, and mechanical control methods. I would like to emphasize, however, that integrated insect control can only be achieved when we understand the detailed behavior of a given insect pest and its complex relationships with its environment. With such basic knowledge, the entomologist can strike at the insects' weak points. Let us look briefly into the future at a hypothetical example of an integrated control program in a seed orchard: light traps in combination with potent sex lures might be used to attract and either destroy the insects mechanically or permit them to feed on chemosterilants which would prevent natural reproduction of the insect and possibly self-annihilation. Orchards could also be flooded with sterilized male and/or female moths also resulting in insect population control as in the case of the screwworm fly. Insecticides might be applied to reduce unusually high cone moth populations to a level where parasites and predators could be released to maintain a natural control balance. Chemicals, non-toxic to man and animals, might be developed to simply either repel insects from trees or to prevent their egg laying and/or larval feeding. Thus, these and other methods would be employed either in combination or in series to accomplish the total control job with a minimum of contamination to the environment.

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