TRUNK IMPLANTS OF SYSTEMIC INSECTICIDES IN SEED ORCHARD SLASH PINE TREES FOR CONTROL OF THE CONEWORM, *Dioryctria* sp. (Lepidoptera: Phycitidae)

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Trunk implants of systemics have largely been used to control insects that attack conifers. Johnson and Rediske (1965) used Bidrin and Meta-Systox-R in trunk implants to control Douglas-Fir cone and seed insects. In a trunk implant test using Bidrin at the rate of 3.4 and 1.5 grams of active ingredient per inch of dbh Merkel (1969) found the rate of *Dioryctria* sp. infestation of 2nd-year slash pine cones was 5.0% and 3.0% respectively, as compared to an untreated control rate of 18.0%. In a similar test, Merkel (1970) reported that trunk implants of Bidrin and Meta-Systox-R effectively controlled *Dioryctria* infestations in slash pine cones.

There have been no published reports of the effects, if any, of systemic implants on the germination of seed taken from these treated trees.

MATERIALS AND METHODS

This study was conducted at the Scott Paper Company slash pine seed orchard in Greene County, Mississippi, in 1970. This orchard has had a past history of heavy coneworm, *Dioryctria* sp. attacks. The cone producing area of the

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orchard consists of 20 acres of grafted slash pine, Pinus elliottii Engelmann.

Five clones, 4, 8, 16, 19, and 21, which had 10 or more cone-bearing trees were selected for this study. One of the criteria chosen for selecting a tree was the presence of at least 10 to 20 2nd-year cones. The results were based on one untreated control and 3 insecticide treatments. Each of the five clones was represented twice in each treatment, making a total of 10 trees per treatment. These test trees were all grafted in 1959, and had an average height of 25 feet and an average diameter of 8.2 inches at breast height.

All of the insecticides were tested at a dosage rate of 5 grams of actual toxicant per diameter inch of tree trunk measured at breast height. Table 1 shows the mean dosages that were applied in each treatment.

The method of trunk injection used in this study is referred to as the "drill-hole" method. With this method a carpenter's brace and bit were used to drill the holes. The injection of Azodrin and Bidrin was done with 10 ml. and 1 ml. pipettes. This rather slow method was substituted for a faster method using a 12 cc. plastic disposable syringe with Meta-Systox-R.

The total crop of 2nd-year cones was harvested in September 1970. All 2nd-year cones from each tree were sorted, counted, and the number of infested and non-infested cones recorded. A cone was considered infested when it showed an entry hole made by Dioryctria sp. larvae.

To compare the germination of seeds from infested and non-infested cones, a sample of 0-50 seeds was taken from infested and non-infested cones of each tree. Table 2 shows the mean sample size for each treatment. Each sample was placed in an individual water-filled petri dish. The seeds were allowed to soak for two days, and then the water was poured off. They were then put into plastic bags along with labels identifying them, and the tops of the bags were tied. These bags were placed in a refrigerator at 35°F. for 30 days.

The seed samples from each bag were placed in individual, clear plastic petri dishes which had a piece of moistened 4" by 4" blotter paper in the bottom. A pinch of Captan was added to each dish to inhibit the growth of mold. The trays holding the dishes were placed in a germination chamber at 25°C., 95% relative humidity, and 12-hour periods of light and darkness. The seeds were observed every 3 days,

Table 1.--Basic information in the design of the study, including treatments, size of treatments, and insecticide rates.

Treatment	No. of trees /treatment	Date treated	Ml./ tree	Active ingredient/ tree 1/
Azodrin, 3.2 EC	10	5-7-70	110.6	42.0
Bidrin, technical	10	5-7-70	35.3	38.5
Meta-Systox-R, 2 EC	10	6-2-70	172.1	41.1
Control	10	--	--	--

1/Measured in grams.

Table 2.--The mean number of samples of seed from infested and non-infested 2nd-year slash pine cones and the mean number of seed in samples per treatment.

Treatment	No. samples (infested)	No. samples (non-infested)	No. seed/sample (infested)	No. seed/sample (non-infested)
Azodrin	10	10	35	50
Bidrin	10	10	49	50
Meta-Systox-R	10	10	44	49
Control	10	10	48	50

whenever possible. Each time the seeds were checked, those which had germinated were removed from the dishes, counted, and the data recorded. A seed was considered germinated when its emerging root showed signs of geotropism. Water was added, if the blotter showed signs of drying. The duration of the germination test period was 30 days.

RESULTS AND DISCUSSION

All of the injected trees showed various degrees of phytotoxicity, chiefly needle browning and shedding, and scattered small limbs deadening for at least 9 months after the treatments. The Azodrin treated trees appeared more severely affected than trees in the 2 other treatment groups.

Cones were harvested in September 1970, and were sorted and tabulated as being infested or non-infested. Differences in the mean infestation rates of the cones collected from the 4 treatments were statistically analyzed. F tests showed that the variance in infestation rates of cones/treatment was highly significant as $p<.01$. The mean infestation rates were compared with Duncan's new multiple range test (Table 3).

Dioryctria sp. were found to cause significant losses of seed in the study trees. Some cones were damaged so badly that they failed to open, and therefore yielded no seeds. The mean differences in seed yields were analyzed and F tests showed that the differences in seed yields of infested and non-infested cones were significant at $p<.01$. The means were further tested with DNMRT, and the results are shown in Table 4.

Data, comparing the germination of seeds from infested and non-infested cones, were taken from a 30-day germination test. Table 5 shows the numbers of seeds which germinated from infested and non-infested cones when compared by treatments. The data from the seed germination tests for treatments were analyzed with a CRD. F tests showed that the differences in means of seed which germinated from non-infested cones were non-significant at $p<.05$. When compared by DNMRT the means were shown to be homogeneous. F tests performed on the germination means of the seed from the infested cones showed that the differences in means among the treatments were significant at $p<.05$. Using DNMRT the means were further analyzed and the results are shown in Table 5.

Table 3.--Total number of cones in the treatment groups, average number of infested cones per tree, and average infestation rate per treatment.

Treatment	No. sample trees	Total no. cones/tree	No. infested cones/tree	Infestation rate[1/] (percent)
Azodrin	10	199.00	14.56	10.97a
Bidrin	10	131.10	25.18	20.04a
Meta-Systox-R	10	199.80	46.00	33.81 b
Control	10	159.64	48.54	39.05 b

1/Those means that have a common small case letter arenot significantly different at the 1% level of probability as judged by Duncan's new multiple range test.

Table 4.--Seed yields from infested and non-infested cones as affected by insecticide treatments.

Treatment	Mean seed yields[1] per cone
Azodrin	55.1a
Meta-Systox-R	48.9 b
Bidrin	48.8 b
Control	39.9 c

1/Those means that have a common small case letter are not significantly different at the 5% level of probability as judged by Duncan's new multiple range test.

Table 5.--The germination of seed from infested and non-infested cones as affected by insecticide treatments.

Treatment	% germinated[1] (non-infested cones)	% germinated[1] (infested cones)
Azodrin	43.0a	62.0a
Bidrin	43.2a	44.0 b
Meta-Systox-R	51.0a	50.2 b
Control	45.4a	49.7 b

1/Those means that have a common small letter are not significantly different at the 5% level of probability as judged by Duncan's new multiple range test.

CONCLUSIONS

In this study the mean infestation rates of 2nd-year cones from two insecticide treatments, Azodrin and Bidrin, differed significantly at $p<.01$ from the untreated control. The mean infestation rate of cones in the Meta-Systox-R treatment did not differ significantly from the untreated control at $p<.01$.

The insecticide treatments affected the seed yields of the 2nd-year cones. The trees in the Azodrin treatment which had the lowest infestation rates per cones also had the highest seed yield per cone. The mean seed per cone yields of the Bidrin and Meta-Systox-R treatments were lower than that of the Azodrin treatment. The seed per cone means of the 3 insecticide treatments differed significantly from that of the untreated control at $p<.05$.

The differences in mean germination rates of seeds among treatments from non-infested 2nd-year slash pine cones was non-significant at $p<.05$. The differences in mean germination rates of seeds among treatments from infested cones was significant at $p<.05$. The mean germination rate of infested cones from the Azodrin treated trees was significantly different from the other two insecticide treatments and the untreated control.

Of the three treatments, Azodrin gave the best coneworm control and had the highest seed yields. Bidrin was second best, and Meta-Systox-R with considerably more cones infested, was third best.

LITERATURE CITED

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