EFFECT OF AN INSECTICIDE SPRAY PROGRAM ON

SLASH PINE SEED ORCHARD EFFICIENCY

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Abstract.--The efficiency of slash pine production was compared in Guthion®[3/] sprayed vs. unsprayed plots in the Georgia Forestry Commission's Horseshoe Seed Orchard. Guthion was applied monthly from April to September for 1975 and 1976. The primary losses were from pre-harvest mortality of flowers, conelets, and from the abortion of ovules before seed maturity. Guthion increased cone and seed efficiencies to 58 and 39 percent, respectively, compared to values of 38 and 24 for the unsprayed plots. Extraction and germination efficiencies were 90 and 83 percent for the Guthion® plots compared to 88 and 78 for the unsprayed plots. Overall production was evaluated by combining separate efficiencies for cone survival, filled seed/cone, seed extraction, and seed germination. On this basis, the seed orchard to nursery efficiency was 17 percent in Guthion® spray plots, and only 6 percent for the unsprayed plots.

KEYWORDS: Azinphosmethyl, cones,conelets, ovules, insects.

Seeds from southern pine seed orchards are the vital link between selected parents and a newly established pine plantation of improved genetic capability. Consequently, the seed has high economic value as the sources of increased growth, wood quality and pest resistance. This high value and importance of the seed crop justifies considerable effort to protect the seed crop in the orchards from flower initiation through seed germination.

In 1965, Merkel and Yandle first reported that Guthion applied by a mist blower effectively controlled Dioryctria spp. (Lepidoptera: Pyralidae: Phycitinae) and the slash pine seed worm, Laspeyresia anaranjada Miller (Lepidoptera: Olethreutidae), in cones of slash pine, Pinus elliottii Engelm. Subsequent tests on longleaf pine P. palustris Mill, were conducted by DeBarr and Merkel (1971). Additional data on Dioryctria spp. control and on the effectiveness of Guthion in protecting maturing seed within the cone from losses caused by the seedbugs Leptoglossus corculus (Say) (Hemiptera: Coreidae) and Tetyra bipunctata (Hemiptera: Pentatomidae) was obtained by Merkel and others 1976. This study evaluated an operational test of Guthion in increasing seed orchard efficiency.

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3/ Guthion - registered trade name for azinphosmethyl.

METHODS AND MATERIALS

The Horseshoe Bend Slash Pine Seed Orchard, Wheeler County, Georgia was divided into four blocks, each containing four plots (seed orchard block). The orchard is approximately 35 acres in size with trees averaging 18 years of age. Treatments were randomly selected with one control and three sprayed plots located in each block. A mist blower was used to apply Guthion 2L as a .24 percent water emulsion with the addition of 8 ounces per 100 gallons of Security spreader-sticker. The mist blower was calibrated to deliver 58 gallons per acre. All sprayed treatments received operational orchard insecticide spray at approximately monthly intervals (varied from 22-43 days depending on weather, equipment, etc.) from April-September of each year.

Two ramets each of three clones were chosen at random from each plot for a total of 96 sample trees. Initial counts of female strobili (flowers) produced on each sample tree were made in February, 1975. A subsample of approximately 25 percent of the total flowers produced was selected by systematically tagging 10 sample branches distributed throughout the flower production area. Periodic sample counts were made in February, April, May, July, and September, 1975 and February, May, July, and September, 1976. The causes of strobili mortality were recorded if insect damage was evident (DeBarr and Barber 1975). If no evidence of insect damage was distinguishable, mortality was classified as unknown.

All mature cones were collected in September, 1976. Three healthy cones were chosen at random from each tree. The selected cones were analyzed with the cone analysis procedure (Bramlett 1974, Bramlett and others 1977) to determine the seed potential, aborted ovules, developed seed, filled seed, and types of seed losses. Germination tests were conducted on all seed for 30 days. Analyses of variance were used to evaluate the effect of the Guthion treatment on the cone and seed variables.

RESULTS

Cone Efficiency and Mortality

The survival from flowers to cones was directly related to the Guthion treatment (table 1). The overall yield of sound cones indicated an increased survival from flowers to cones in treated trees. An average of 71 sound cones was produced per tree in Guthion treated plots compared to 60 per tree in the control. Cone efficiency (CE), the ratio of harvested healthy mature cones to pollinated flowers increased from 38 percent in the control to 59 percent when test trees were sprayed with Guthion. The effect of the Guthion treatment on cone efficiency was significant at the 0.05 percent level.

Table 1.--Survival of slash pine conelets and cones on sample branches in Guthion versus control treatments over a two-year period

Sample date	Cone survival		Analysis of variance
	Guthion[1/]	Control[2/]	
	Percent		
2-75	100	100	ns
4-75	93	91	ns
5-75	92	89	ns
7-75	91	85	ns
9-75	86	79	ns
2-76	78	64	*
5-76	72	48	**
7-76	72	44	*
9-76	59	38	*

1/ 72 trees in sample averaging 33 flowers tagged.
2/ 24 trees in sample averaging 32 flowers tagged.

* Treatment differences in an analysis of variance were significant at the 0.05 level. Degrees of freedom to test treatment effects were one for treatments and twelve for error term plot (block x treatment) .
** Significant at the 0.01 level.
ns Non-significant.

First year losses of 21 percent of the total flower crop in the control and 14 percent in the Guthion treated plots were recorded from flower to conelets. Thrips destroyed 1 percent of the total flowers in both control and Guthion treatments. This loss occurred from February to April or before insecticide sprays were initiated. Dioryctria spp. damaged 1 percent of the total flowers in both control and Guthion treatments. Losses attributed to the pine conelet looper, Nepytia semiclusaria (Walker), May beetles, Phyllophaga spp., pitch canker, Fusarium spp., and mechanical accounted for 5 and 3 percent in the control and Guthion treatment respectively. Seven percent of the control and 4 percent of the Guthion treated conelets were dead without visible insect damage. Seven percent of the control and 5 percent of the Guthion treated conelets were recorded as missing. Cone efficiency of the first year conelets was 79 percent in the control and 86 percent in the Guthion treatments. This difference was non-significant in an analysis of variance.

Second year cone losses were 41 percent of the original total flower crop in the control and 27 percent in the Guthion treated plots. Initial counts in February, 1976 showed cone efficiencies of 64 and 79 for control and Guthion treatments respectively. Late fall and overwintering losses combined with first year mortality were significant at the 0.05 percent level.

Dioryctria spp. damage amounted to approximately 6 percent of the second year cones lost in the controls and 5 percent in the Guthion treatment. Seven percent of the damaged cones in the control and 3 percent in the Guthion treated plots showed no evidence of insect damage. Missing cones accounted for the largest category of losses with 28 percent of the control and 18 percent of the Guthion treated cones in this category.

Seed Efficiency

Seed efficiency (SE) measured the seed production of a cone in relation to the biological capacity. This value was expressed as the ratio of filled seed to potential seed and is the single most important value when measuring seed production.

Average seed production per cone in the control increased from 64 out of a seed potential of 176 to 92 of a possible 166 when Guthion was used as a spray. The average number of filled seed per cone increased from 43 in the control to 66 in the Guthion treatment (table 2). This difference was significant at the 0.01 percent level and reflects an increase from 24 to 39 percent in seed efficiency.

Table 2.--Mean number of seed and ovules per cone as classified in cone analysis in control versus Guthion treated plots

Seed and ovule classification	Average per cone		Analysis of variance
	Guthion 1/	Control 2/	
Aborted 1	64	91	**
Aborted 2	11	21	**
Total seed	92	64	**
Filled seed	66	43	**
Empty	18	15	ns
Seed bug	2	1	ns
Fungus	3	3	ns
Laspeyresia	1	1	ns
Abnormal	3	1	ns

1/ 216 cones in sample.
2/ 72 cones in sample.

** Significant at the 0.01 level. Degrees of freedom to test treatment effects were one for treatments and twelve for error term, plot (block x treatment) .

ns Non-significant.

Major loss categories were identified as aborted ovules or developed seed that were not classified as filled. First year aborted ovules accounted for the majority of seed losses in both treatments. An average of 91 first year aborted ovules per cone was found in controls as compared to 64 per cone in the Guthion treatment. The average number of second year aborted ovules decreased from 21 for the control to 11 when Guthion was applied. The effect of the Guthion treatment on total seed, seed efficiency, first and second year aborted ovules, was significant at the 0.01 percent level. Differences in other losses were attributed to empty seed, seedbug, fungus[4/], Laspeyresia spp. and abnormal seed and were non-significant when controls were compared to Guthion treatment (table 2).

Extraction Efficiency

Extraction efficiency (EE) was expressed as the ratio of developed seed which are removed by the drying and extracting procedure to the total seed in the cones. The cones evaluated in this study opened well with an average of 89 percent of the seed per cone extracted. Averages of 88 and 90 percent were found when comparing cones from control to those from treated blocks. Analysis of variance showed no significant difference between treatments.

Germination Efficiency

The germination efficiency (GE) evaluated the viability of filled seed. It is expressed as a ratio of the number of germinated seed to the number of filled seed produced by a cone. Germination increased from 78 percent in the control to 83 percent in the sprayed plots. This difference was non-significant in an analysis of variance.

DISCUSSION

Seed Orchard to Nursery Efficiency

The seed orchard to nursery efficiency (SO-NE) was used to evaluate the cone, seed, and seedling efficiency of the sprayed and unsprayed plots in the Horseshoe Seed Orchard. The SO-NE was calculated as a product of the four separate efficiency values as follows:

$$SO\text{-}NE = CE \times SE \times EE \times GE$$

This evaluation procedure allowed the orchard manager to monitor the overall seed orchard performance by comparing the cumulative efficiency to the biological reproductive potential for the orchard. On this basis, the SO-NE for the sprayed plots was 17 percent compared to only 6 percent for the control plots (fig. 1).

4/ Seed with evidence of fungal mycelium identified as Diplodia spp. and Fusarium spp. by Tom Miller, USFS, SEFES, Athens, Georgia, Personal Communication.

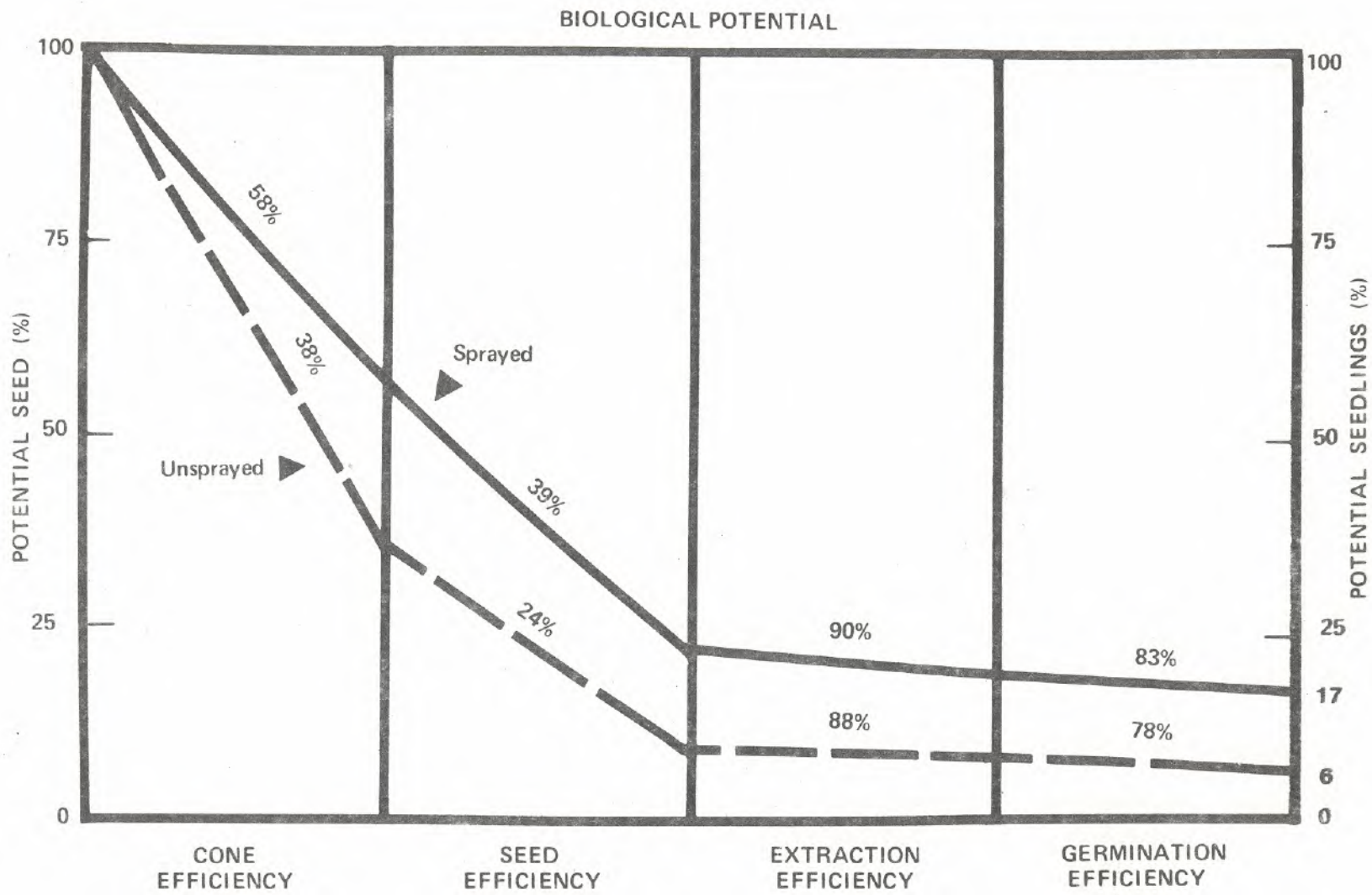

Figure 1.--Seed orchard to nursery efficiency of slash pine cones in Guthion® vs. control treatments.

In this study, the two primary stages of seed losses were identified. First the loss of flowers, conelets, and cones before maturity greatly reduced the cone efficiency. From the observed dates and insect damage, the losses were primarily from the apparent seedbug damage of conelets that were missing or aborted during late summer and fall. Secondly, the high number of aborted ovules in the mature cones reduced the seed efficiency to relatively low values. The insecticide spray program significantly reduced the losses but cones from both areas had a low seed efficiency.

Both the extraction efficiency and germination efficiency were relatively high and were not related to the insecticide spray program. Unfortuantely, the high EE and GE had only limited benefit in the seed orchard because the cone and ovule losses that occurred early in the seed development cycle had already reduced seed yields to low levels.

Certainly the seed production process cannot be expected to reach 100 percent efficient. Yet, it is obvious that seed orchards can produce at much higher efficiency values than were recorded in the study. Although the upper biological limits have not been set for seed orchard to nursery efficiency, values of 45 to 50 percent may be possible for operational seed orchards.

Seed orchard to nursery efficiency can be used in evaluation of seed orchard performance. By using the seed orchard to nursery efficiency, the orchard manager can identify the critical times and probable causes of seed losses. This information can then be directed toward management practices that reduce the losses. Seed orchard to nursery efficiency can also be used to evaluate the cost of seed orchard management in terms of increased production of seed or seedlings.

LITERATURE CITED

Bramlett, David L. 1974. Seed potential and seed efficiency, p. 1-7, In John Kraus (Ed.), Seed yield from southern pine seed orchards, Colloquium Proceedings. Ga. For. Res. Council, Macon, Ga.

Bramlett, D. L., E. W. Belcher, Jr., G. L. DeBarr, G. D. Hertel, R. Karrfalt, C. W. Lantz, T. Miller, K. D. Ware, and H. 0. Yates, III. 1977. Cone analysis of southern pines--A guidebook. USDA, For. Serv. Gen. Tech. Rep. SE- . Southeast. For. Exp. Stn., Asheville, N. C. and Southeast. Area, State and Private Forestry, Atlanta, Ga. (In Press).

DeBarr, G. L., and L. R. Barber. 1975. Mortality factors reducing the 1967-1969 slash pine seed crop in Baker County, Florida--A life table approach. USDA, For. Serv. Res. Pap. SE-131, 16 p. Southeast. For. Exp. Stn., Asheville, N. C.

DeBarr, G. L., and E. P. Merkel. 1971. Mist blower spraying of longleaf pine for cone and seed insect control. USDA, For. Serv. Res. Pap. SE-76, 7 p. Southeast. For. Exp. Stn., Asheville, N. C.

Merkel, E. P., and D. 0. Yandle. 1965. Mist blower application of insecticides for cone insect control on slash pine. U.S. For. Serv. Res. Note SE-52, 4 p. Southeast. For. Exp. Stn., Asheville, N. C.

Merkel, E. P., Gary L. DeBarr, and Claude H. O'Gwynn. 1976. Mist blower application of Guthion for cone insect control in slash pine seed orchards. USDA, For. Serv. Res. Pap. SE-148, 8 p. Southeast. For. Exp. Stn., Asheville, N. C.