POLLINATION IN A SLASH PINE SEED ORCHARD

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Abstract.--Sample conelets from a slash pine seed orchard were collected 4-7 months after pollination. The conelets were dissected and the ovules on each fertile scale classified as healthy or aborted on the basis of macroscopic appearance. An average of 159 ovules per conelet (96%) were healthy in the 216 conelet sample. Microscopic examination of a subsample of ovules indicated that all ovules classified as healthy had one or more germinating pollen grains present. The high percentage of healthy ovules in the conelet stage indicates that both adequate pollination and excellent insect control were evident in this orchard. High seed yields per cone can be expected at cone maturity if the cones and seeds are adequately protected from insects during the second year of development.

Additional keywords: Pinus elliottii, aborted ovules, insect control

Mortality of ovules before cone maturity can seriously reduce the seed yield in pine seed orchards. For example, mature cones sampled from a Georgia slash pine (Pinus elliottii Engelm) seed orchard in 1972 had a seed efficiency of only 16 percent (Bramlett 1974). Large seed losses were attributed to ovule abortion during the first year of development (110 ovules/cone) and to a lesser degree ovule abortion during the second year (17 ovules/cone). Thus the 1972 study identified first year ovule abortion as a major factor in the poor seed yield of this slash pine seed orchard.

Two separate causes of first-year abortion in pine ovules are known. McWilliam (1959) and Sarvas (1962) have reported that unpollinated ovules abort during the first growing season. In addition, DeBarr and Ebel (1973) reported first year aborted ovules in southern pines from feeding damage of seed insects.

Therefore, studies to evaluate first-year ovule abortion in southern pines must take into account both insect damage and the adequacy of pollen. In the study reported here, insect attack was minimized by spraying the orchard trees, and pollination of ovules was observed microscopically. In another paper at this Conference, DeBarr et al. (1975) estimate the impact of seed insects from the seed yields of screened and unscreened cones.

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METHODS AND MATERIALS

Six conelets on each of 3 ramets from 4 slash pine clones were collected June 4, July 24 and September 18, 1974 from the Arrowhead Seed Orchard Pulaski County, Georgia. The seed orchard was sprayed for insect control with 1% Guthion (R)[1/] at 3-4 week intervals from April-September 1974. All the scales on each conelet were removed and the ovules on the fertile scales classified as aborted or healthy on the basis of macroscopic appearance. Sample scales and ovules for microscopic examination were fixed in FAA. Following dehydration with tertiary butyl alcohol the ovules and scales were embedded in Fissuemat (mp 55-56°C.). Serial sections were cut at 12 to 20p on a rotary nicrotome and stained with Safranin 0 and Aniline Blue.

RESULTS

:onelet Development

The conelets had attained full size by June 4 and showed no increase in size or change in seed potential by the September 18 collection (table 1). differences between clones and between ramets nested in clones were evident For both conelet size and seed potential (table 2).

Table 1.--Conelet length and seed potential for slash pine conelets collected June, July and September

Clone	Conelet length			Seed potential		
	June 4	July 24	Sept 18	June 4	July 24	Sept 18
	- - - - - Inches - - - - -			- - - - - Number - - - - -		
30	.88	.88	.88	169	171	172
56	1.08	1.06	1.05	164	170	159
92	1.08	1.06	1.06	171	172	172
134	1.11	1.13	1.13	162	157	151
Average	1.04	1.03	1.03	167	167	163

Ovule Development

Healthy ovules.--Ovules classified as healthy from macroscopic appearance greatly outnumbered aborted ovules in the dissected conelets (table 3). Averages for the three collection dates ranged from 156 to 160 and showed no statistical differences (table 2). The high number of healthy ovules also represented a high percentage of the seed potential (table 1) and averaged 96% for the dates observed.

[1/] Guthion is registered for cone and seed insect control in southern pine seed orchards.

Table 2.--Results from analyses of variance for variables from 216 slash pine conelets

Source of variance	Mean squares for variable[1/]			
	Length	Seed potential	Aborted ovules	Healthy ovules
Clones	5835.9**	2652.9*	2222.9**	9361.5**
Ramets in clones	180.8**	518.1**	180.8	853.7**
Collection dates	5.3	320.7	10.5	443.4

1/ Averages significantly different at the 0.01(**) and 0.05(*) level of probability.

Table 3.--The number of healthy and aborted ovules in June, July and September collections of slash pine conelets

Clone	Healthy ovules			Aborted ovules		
	June 4	July 24	Sept 18	June 4	July 24	Sept 18
	- - - - - - - - - - - -	- - - - - - - - - - - -	- - - - - - - - - - - -	Number	- - - - - - - - - - - -	- - - - - - - - - - - -
30	167.0	163.9	170.9	2.4	6.7	.9
56	163.3	166.4	150.2	.9	3.2	8.9
92	170.7	170.2	165.8	.4	2.2	5.9
134	139.4	143.1	138.2	22.1	13.9	12.8
Average	160.1	160.9	156.3	6.5	6.5	7.1

Microscopic examination indicated that all sample ovules classified as healthy contained one or more pollen grains. Furthermore, all healthy ovules showed pollen germination and pollen tube growth that had penetrated about one-half of the nucellar tissue. Morphological development during the summer was similar to that described by Ferguson (1904).

Aborted ovules.--Unlike in 1972 cones, very few ovules were aborted in the 1974 conelets. The observed aborting ovules appeared discolored, with necrotic or resinous areas near the center of the ovule. The number of aborted ovules for each collection date was very similar averaging from 6.5 to 7.1, per conelet (table 3). The number of aborting ovules per conelet ranged from 0 to 77. Clonal and ramet differences were evident for aborted ovules per conelet but differences due to ramets or collection dates were not significant (table 2).

Prepared slides of aborting ovules indicated complete breakdown of the interior of the ovule. The integument was usually collapsed and large portions of the ovule were completely missing. In several ovules a portion of the nucellus with pollen grains remained although the rest of the ovule was completely missing. This type of damage was reported by DeBarr and Kormanik (1975) in which the missing portion of the ovule was caused by digestive action of enzymes of the feeding insects.

A few aborted ovules were observed that were not necrotic or resinous but lacked the color of healthy ovules and were typically smaller than normal ovules. Sections of these ovules showed that they had poor development of the female gametophyte. In addition, no pollen grains or pollen tube development were noted. Further observations are needed to accurately correlate this type of muroscopic ovule classification with microscopic evaluation.

CONCLUSIONS

The high percentage of healthy ovules in sample conelets from the Arrowhead Slash Pine Seed Orchard is encouraging. These healthy ovules consistently showed evidence of abundant and viable pollen. Thus, if the seed crop can be protected from insects until cone maturity, a high seed efficiency is expected.

It appears that the rigorous spray schedule in the orchard is the major factor responsible for the low numbers of aborting ovules.

The procedures used here to evaluate first year ovule abortion may be useful to the orchard manager. Routine sampling and macroscopic examination of conelets from the orchard can be used to quantify the first-year ovule loss. If this mortality is high, inadequate insect control should be suspected and the current spray program evaluated. Screen cages or microscopic tests can confirm the separation of insect from non-insect related mortality.

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