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Clone Influences Maturation of Unpollinated Strobili in Southern Pines

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Introduction

The abortion of female strobili in conifers is a well-known phenomenon, variously attributed to insects, climatic conditions, insufficient nutrients, and lack of pollination. SARVAS (1962) stated in the genus *Pinus* female strobili will dry and drop to the ground if all the ovules are unpollinated. ALLEN (1941), however, reported that abortion of Douglas-fir *(Pseudotsuga menziesii* (MIRB.) FRANCO) conelets was not associated with lack of pollen since unpollinated cones showed fewer abortions than pollinated cones on test trees. A preliminary study at Pineville, Louisiana, showed that unpollinated strobili on three loblolly *(Pinus taeda* L.) clones developed into mature cones, whereas all unpollinated strobili on a fourth clone aborted. The present study was installed to determine if the retention of unpollinated conelets is a clonal characteristic.

Methods

Sample trees were 7- to 10-year-old grafted southern pines located in the Kisatchie National Forest's Stuart Seed Orchard near Pollock, Louisiana. The trees had been producing female strobili for 2 or 3 years and were 20 to 30 feet tall when the study was installed.

The two treatments consisted of unpollinated, bagged strobili and wind-pollinated, unbagged strobili (control). Both treatments were applied to 18 loblolly, 7 shortleaf *(P. echinata* MILL.), 5 slash (P. *elliottii* ENGELM.), and 5 longleaf *(P. palustris* MILL.) clones. On two ramets of each clone, 10 female strobili were bagged and 10 were tagged for observation as wind-pollinated controls. Bags were removed after 4 to 6 weeks, when strobili were no longer receptive. Conelet mortalities were determined every 2 to 4 weeks during spring and summer of the first year and twice during the second year. The arcsin $\sqrt{\text{proportion}}$ transformation was used for analyzing the percentage of losses at the 0.05 level of significance.

Results

Twelve of the 18 loblolly clones, 3 of the 5 slash clones, 1 of the 7 shortleaf clones, and 1 of the 5 longleaf clones developed mature cones from unpollinated strobili. Some of these same clones were observed for an additional year, and results were consistent. The four loblolly clones from the preliminary test responded the same way in this study: three produced mature cones from unpollinated strobili, and one aborted all such cones. Of the two slash clones observed for 2 years, one consistently produced fully developed cones, and one consistently aborted all unpollinated strobili. On the one shortleaf clone that produced unpollinated cones, cones were observed to mature during the first growing season for 2 consecutive years (MC LEMORE 1975).

Unpollinated cones were smaller than pollinated cones

Table 1. — Proportion of conelet losses in four southern pines

	Loblolly	Slash	Shortleaf	Longleaf
Clones observed, no.	18	5	7	5
Clones producing cones from unpollinated strobili, no.	12	3	1	1
Losses from all clones, percent				
Pollinated	42	51	70	55
Unpollinated	81	67	92	96
Losses from all clones, percent those aborting all unpollinated strobili, percent				
Pollinated	49	40	80	35
Unpollinated	68	44	45	80

and contained wings but no seedcoats, except in longleaf. Why seedcoats developed in longleaf cones is unknown. Pollination was previously considered necessary for seedcoat development, though the seedcoat is not a product of fertilization. None of the longleaf seeds in unpollinated cones were filled.

Overall cone losses were significantly higher for the unpollinated treatment than for controls in all species *(Table 1)*. Abortions ranged from 42 to 70 percent for pollinated cones and from 67 to 96 percent for unpollinated cones. Differences among clones were also significant for all species, and the clone × treatment interaction was significant for all species except longleaf.

When clones that aborted all unpollinated cones were excluded from consideration, however, losses from unpollinated cones and from wind-pollinated controls were not significantly different for loblolly and slash pines. In loblolly, 68 percent of the unpollinated cones and 49 percent of the pollinated cones aborted. In slash, losses were 44 percent for unpollinated cones and 40 percent for controls. A similar statistical comparison could not be made for the other two species since only one clone of each did not abort all unpollinated cones.

In all four species, insect depredations accounted for nearly all abortions of pollinated cones and for more than half the abortions of unpollinated cones. Possibly the bags protected the unpollinated strobili from some insects. The main insects observed were seed bugs *(Leptoglossus corculus* Say and *Tetyra bipunctata* H.-S.), tip moth *(Rhyacionia frustrana* Comstock) and *Dioryctria* spp. Insect losses occurred primarily during early spring when strobili were receptive and were usually indicated by discoloration at the distal tip of conelets. Abortions attributed to lack of pollination took place in early to midsummer and were distinguished by a browning of the scales at the proximal ends of conelets. Such damage was never observed on pollinated controls.

Conclusions

In the four southern pine species tested, the ability to develop mature cones from unpollinated strobili appears to be a clonal trait since some clones consistently abort all such strobili. Lack of pollination resulted in increased abortions in this test but should not be a serious problem within the species' natural range since adequate pollen clouds are typically produced in orchards or supplied from surrounding stands.

A far more serious threat to developing strobili is insect damage, which caused all abortions of pollinated cones and most abortions of unpollinated cones in this test.

Summary

Twelve of 18 loblolly *(Pinus taeda)*, 3 of 5 slash *(P. elliottii)* 1 of 7 shortleaf *(P. echinata)*, and 1 of 5 longleaf *(P. palustris)* clones developed mature cones but no filled seed from unpollinated strobili. Although abortions were more common for unpollinated cones than for pollinated cones, insect damage is apparently a much more serious threat to developing strobili than lack of pollination.

Key words: Cones, conelets, pollination, *Pinus*.

Zusammenfassung

Bei *Pinus taeda* entwickelten 12 von 18 Klonen einer Samenplantage reife Zapfen, bei *Pinus elliottii* 3 von 5 Klonen, bei *Pinus echinata* 1 von 7 Klonen und bei *Pinus palustris* 1 von 5 Klonen. Bei unbestäubten weiblichen Blüten kam es zur Zapfenentwicklung, aber es konnten nur taube Samen geerntet werden. Die Zapfen aus unbestäubten Blüten wurden z. T. abgestoßen, d. h. in größerer Anzahl als diejenigen aus bestäubten Blüten. Als Hauptursache für den Zapfenverlust wird jedoch der Befall durch Insekten angesehen.

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A model relating needleless shoots and dieback in Pinus caribaea to strobilus production and climatic conditions

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Introduction

Studies of *Pinus caribaea* (Mor) var *hondurensis* (Barr et Golf) in Malaysia (Shim, 1974; Slee, Spidy and Shim, 1976) have indicated the species is not well suited to lowland regions of the country. The species exhibits abnormalities in both reproductive and vegetative growth. Slee *et al.* (1976) considered the cause to be climatic and questioned the species suitability for other areas of the humid tropics.

It has recently been possible to examine plantings of *Pinus caribaea* in lowland regions of Kenya, Surinam, Trinidad and Venezuela. The results of these studies are reported here. Combined with results from the previous studies these have allowed a hypothetical model to be developed which relates the abnormalities found in the humid tropics to climatic conditions and in particular to the conditions controlling strobilus initiation and development.

The model is based solely on field observations allied with temperature and daylength regimes and not on physiological studies. Ideally detailed anatomical and physiological studies should be conducted. Such studies will necessarily involve international cooperation and will take con-