GEOGRAPHIC RACES OF SHORTLEAF PINE NOT REPRODUCTIVELY ISOLATED IN A MIXED PLANTATION

Ronald C. Schmidtling /1

Abstract.--In a shortleaf pine (Pinus echinata Mill.) plantation in Mississippi, western sources of the species shed pollen earlier than eastern sources. Introgression with loblolly (P. taeda L.) in the western sources is proposed as an explanation. Overlap in time of shedding indicated that no source was reproductively isolated from any other.

Grafting shortleaf scions onto slash rootstocks did not influence the time of pollen shedding.

Intraspecific crossing of southern pines from widely separated locations may produce desirable progeny (Zobel and McElwee 1964), but such a procedure is impractical without synchronized reproductive phenology. Described here is a study of geographic variation in reproductive phenology in shortleaf pine. Since shortleaf scions are sometimes grafted onto slash pine rootstocks in seed orchards, the effect of such grafting on reproductive phenology also was measured.

MATERIALS AND METHODS

Pollen shedding of individual trees was observed in two shortleaf pine plantations on the Harrison Experimental Forest in southern Mississippi; one is a seed source planting and the other a grafted planting.

The first, established in January 1958, contains trees from 16 sources representing most of the range of the species. The seeds were originally collected for the southwide pine seed source study in 1955. Trees were planted in a randomized complete block design with four replications of 25-tree row plots. Spacing was 8 feet between rows and 6 feet within rows. The site was cut-over longleaf land that was burned before planting. No additional cultural treatment was carried out until the end of the ninth growing season, when scattered brush and longleaf volunteers were removed.

After 10 years in the field, the trees averaged 19 feet in height and severe crown competition necessitated thinning. Approximately 50 percent of the stems were removed, mainly on a mechanical basis.

1/ The author is Associate Plant Geneticist at the Institute of Forest Genetics, Southern Forest Experiment Station, USDA Forest Service, Gulfport, Mississippi.

Some female flowering had been noted as early as the fifth year, and beginning with the sixth year (1964) moderate numbers of female strobili were present. By 1969, a large proportion of the trees were also bearing male strobili.

The grafted planting included some of the same shortleaf geographic sources as the other planting. Scions from 1-0 seedlings from six seed sources were grafted on 1-0 shortleaf and slash pine rootstocks, and the resulting trees were planted in 1963 in single-tree plots at 11- x 11-foot spacing in a randomized complete block design of 10 replications. This plantation was fertilized initially and mowed periodically to control competition. By 1969 the trees averaged 22 feet tall and a large proportion were bearing male and female strobili.

The seed source plantation was scored for the presence of pollen in 1969 and 1970 and the grafted plantation was scored in 1970. As pollen dispersal began, those trees having pollen catkins were scored three times a week for shedding by striking the tree with a mallet. The mean start and mean end of pollen shedding were calculated for each source, and also a median date, which presumably is close to the peak shedding time for the source.

The proportion of trees flowering on each plot in the seed source plantation was normalized by arc-sine transformation, and the source means were compared by analysis of variance. Relations of proportion of each source bearing male strobili and median time of pollen shedding to latitude, longitude, and average annual temperature at the seed source were explored with linear correlations. Probability levels of 0.05 or less were considered statistically significant.

RESULTS

Fruitfulness.--The proportion of trees with pollen varied significantly by year and by seed source in the source planting (table 1). In 1969, 37 percent of the trees had pollen, as compared with only 14 percent in 1970. Individual sources varied from 77 percent for Stone County, Arkansas; in 1969 to less than 2 percent for the Alabama source in 1970. The year x source interaction was not significant.

The year x individual tree interaction was also very small. Of the 114 trees shedding in 1970, only six had not shed in 1969. Thus, pollen bearing trees could be predicted from past performance with a fair degree of accuracy.

The correlation between proportion of trees with pollen and latitude of seed source was significant but not strong, and neither the correlation with longitude nor mean annual temperature at the seed source was significant.

Table 1.--Pollen production in a shortleaf pine seed source planting in southern Mississippi

		Seed source locational data			Trees with pollen	
State	County	Latitude	Longitude	Elevation	1969	1970
		°N	°W	Feet	Percent	
Oklahoma (1)	Pushmataha	34.5	95.2	850	36	16
Texas	Cherokee	31.5	95.1	600	47	9
Oklahoma (2)	McCurtain	34.1	94.5	550	40	8
Arkansas (1)	Stone	35.5	92.3	925	77	37
Arkansas (2)	Ashley	33.0	91.9	175	40	11
Louisiana	St. Helena	30.5	90.7	60	28	18
Missouri	Dent	37.5	90.1	1250	41	20
Alabama	Tallapoosa	33.0	85.8	500	33	2
Georgia (3)	Webster	32.0	84.6	528	31	6
Tennessee	Anderson	36.2	84.1	1000	36	10
Georgia (2)	Putnam	33.4	83.5	800	20	7
Georgia (1)	Clark	33.5	83.1	700	23	4
S. Carolina	Union	34.8	81.7	500	24	2
Pennsylvania	Franklin	39.9	77.6	930	24	18
Virginia	Southampton	36.6	77.0	18	36	20
New Jersey	Burlington	39.9	74.6	105	76	52

Timing.--Pollen was shed at approximately the same time in both 1969 and 1970, and there was good agreement in individual trees as to time of shedding, i.e., trees that were late in 1969 were late in 1970, and those that were early in 1969 were early in 1970 ($r = 0.827$). Duration of shedding from individual trees varied from a maximum of 17 days to a minimum of 2 days, and appeared to be related primarily to the quantity of pollen catkins on the tree. In 1970 there were not only fewer trees with pollen, but crops from individual trees were lighter than in 1969. Primarily because of the light crop, the average duration of pollen shedding averaged only 6 days per tree in 1970 as compared to 8 days per tree in 1969.

There was not much difference between sources in time of pollen shedding (fig. 1). Considerable overlap was found between the earliest and latest sources, although the eastern sources began shedding a few days later than the western sources ($r_{time/longitude} = 0.904$). There was also a lesser trend for the northern sources to shed pollen later than the southern sources ($r_{time/latitude} = 0.578$).

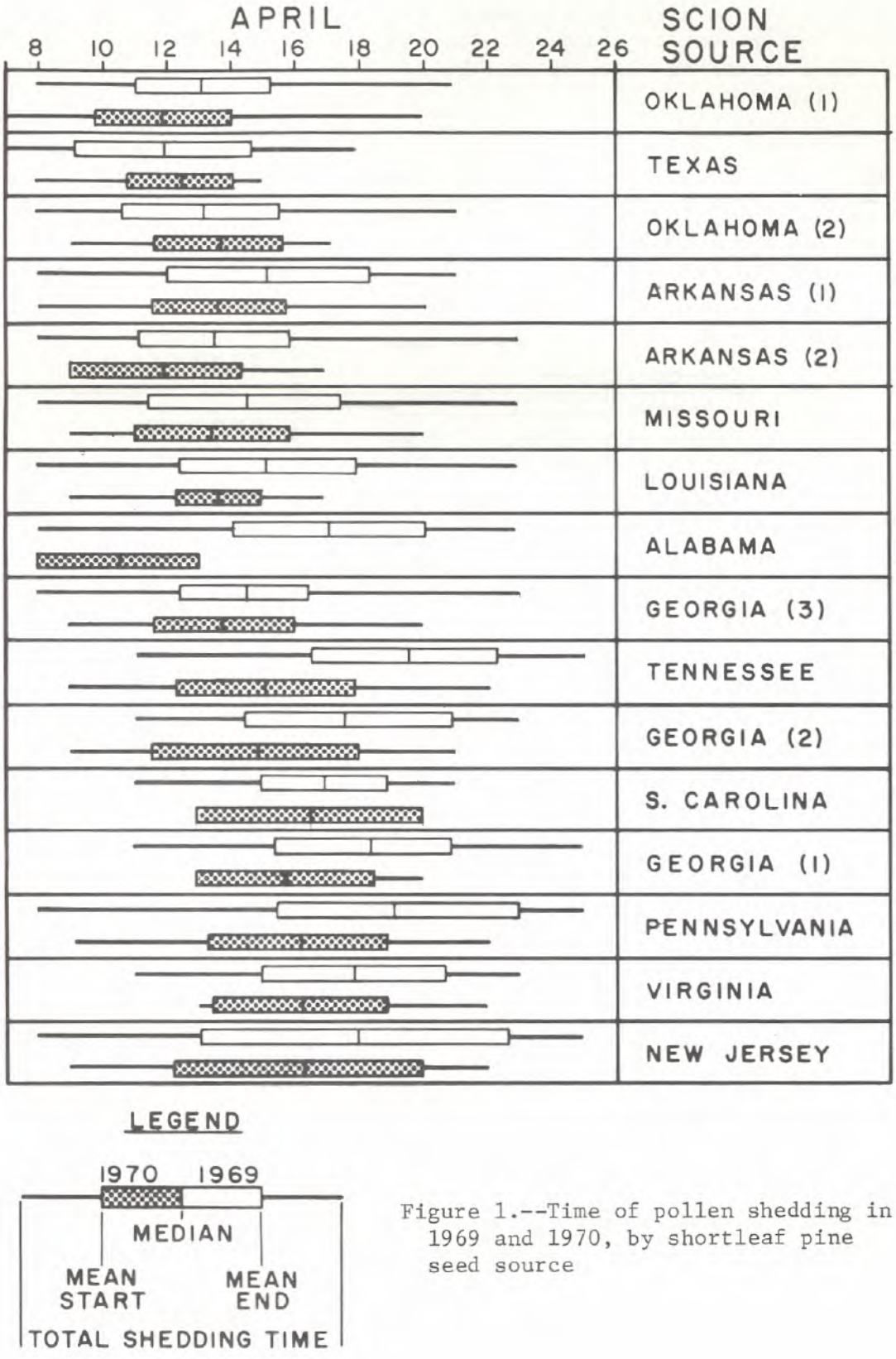

Figure 1.--Time of pollen shedding in 1969 and 1970, by shortleaf pine seed source

Rootstock/scion effects.--Scions from eastern sources also tended to flower later than western sources in the grafted planting (fig. 2). Grafting shortleaf scions on slash rootstocks had little or no effect on the time of pollen shed.

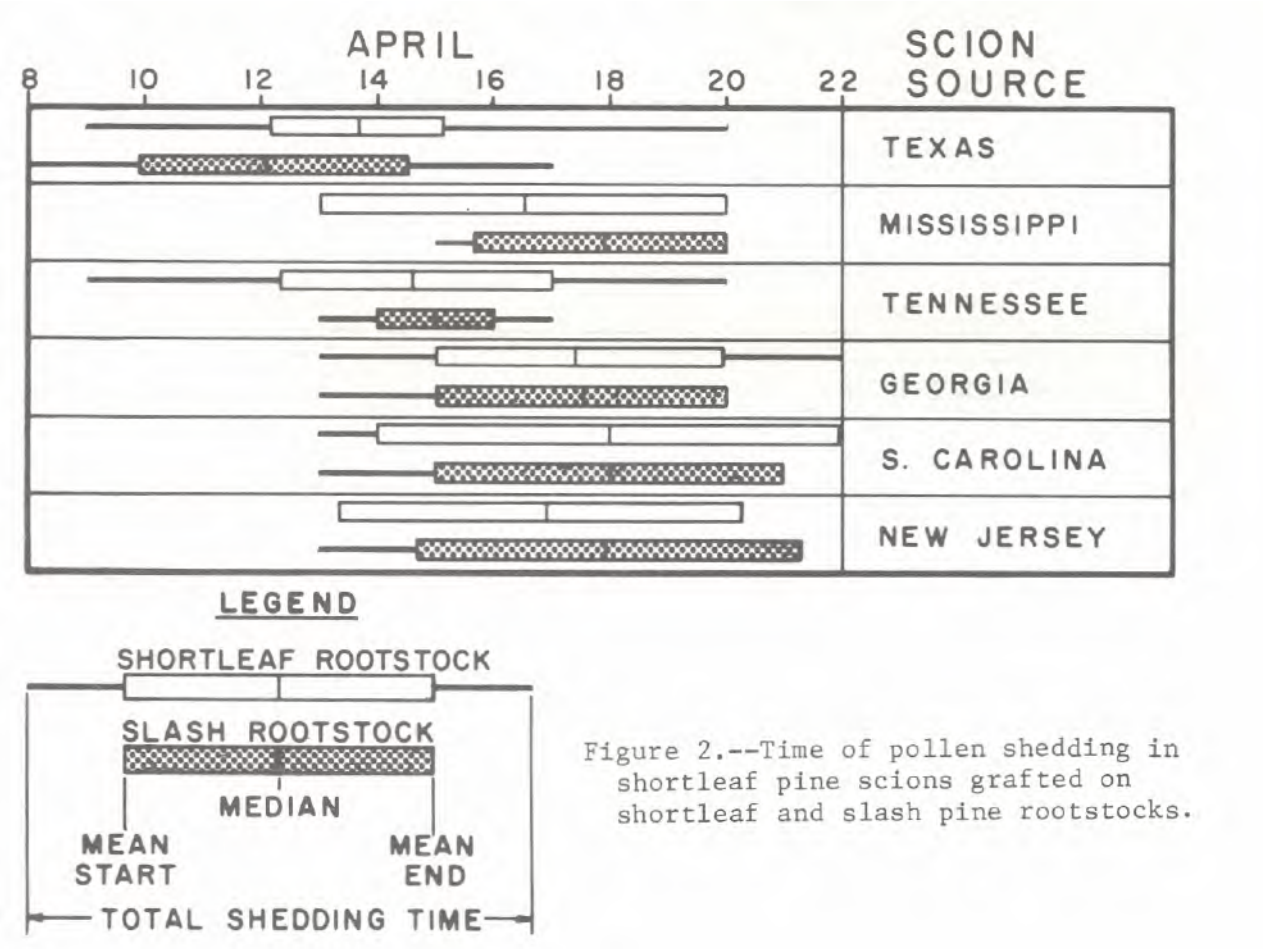

Figure 2.--Time of pollen shedding in shortleaf pine scions grafted on shortleaf and slash pine rootstocks.

DISCUSSION AND CONCLUSIONS

The close correlation of pollen shedding time with longitude is difficult to explain by climatic factors. Wells and Wakeley (1970) found that geographic variations in growth and precocity of flowering were related to the mean temperature at the seed source, which is closely related to latitude. They speculated that exceptions to this relationship could be explained by hybridization with loblolly pine in the western sources. That explanation may also apply in the present study. Loblolly pine sheds pollen earlier than shortleaf, and hybridization with loblolly at the western edge of the shortleaf range would cause pollen to be shed earlier.

The weak but significant correlation coefficient between timing and latitude of the source may be explained by a correlation between latitude and longitude (r = -0.589) within shortleaf's range; the species is distributed more or less along a southwest-northeast axis. If longitude is held constant by means of partial correlation, the correlation between latitude and timing becomes non-significant, whereas if latitude is held constant, the correlation between longitude and timing is not changed greatly: $r_{time/longitude.latitude} = -0.854$).

The variation observed in reproductive phenology in geographic sources of shortleaf pine does not appear to be large enough to prevent natural pollination between distant sources in mixed plantations. There was considerable overlap between sources and it appears that individual tree variation within sources is as great as variation between sources.

Ahlgren (1970) found that rootstock affected reproductive phenology in several northern species of pines. Rootstock has also been shown to influence growth (Allen 1967, 1969) and female strobilus production (Schmidtling 1969) in shortleaf pines, but it appears that grafting shortleaf on slash rootstocks has little effect on pollen phenology. Shortleaf scions have been grafted on slash rootstocks because of fast initial growth, and it does not appear that such practice will affect the timing of reproductive events.

LITERATURE CITED

Ahlgren, C. M. 1970. Inter- and intraspecific grafting and breeding of five-needle pines. Ninth Lake States Forest Tree Improv. Conf. Proc. USDA Forest Serv. Res. Pap. NC-47: 23-24.

Allen, R. M. 1967. Influence of the root system on height growth of three southern pines. Forest Sci. 13: 253-257.

. 1969. Contributions of tops and roots to variation in height growth of geographic sources of shortleaf pine. Silvae Genet. 18: 38-39.

Schmidtling, R. C. 1969. Influence of rootstock on flowering in shortleaf pine. Tenth South.Conf. Forest Tree Improv. Proc.: 229-230.

Wells, 0. 0., and Wakeley, P. C. 1970. Variation in shortleaf pine from several geographic sources. Forest Sci. 16: 415-423.

Zobel, B., and McElwee, R. L. 1964. Seed orchards for the production of genetically improved seed. Silvae Genet. 13: 4-11.