ESTIMATES OF SELFED SEEDLING PRODUCTION FROM A SLASH PINE SEED ORCHARD BASED ON GENE MARKERS

John F. Krausl/

Abstract.--Ramets of slash pine clones carrying genes for chlorophyll deficiencies in the early post-germination stage were used to estimate natural selfing in grafted seed orchards. Percentages of selfed seedlings in wind-pollinated seed orchard collections averaged 2.6 and ranged from 0.0 to 8.9. Seed collected from ortets in natural stands produced an average of 5.9 percent selfed seedlings.

Additional keywords: Pinus elliottii, chlorophyll mutant, albino.

For many years geneticists have wondered how much seed resulting from self-pollination is produced in clonal pine seed orchards? The answer of course will vary from orchard to orchard. One method of estimating the amount of selfing taking place is by the use of chlorophyll-mutant gene markers, particularly those whose effects can be seen shortly after the seed germinate. In this paper data collected between 1967 and 1974 on the frequency of chlorophyll mutants in selfed and wind-pollinated progenies of slash pine seed orchard trees and wind-pollinated progeny of some ortets are used to estimate and compare selfed seedling production in seed orchards and natural stands.

Selfing is known to reduce the yield of sound, viable seed, but data on seed yields are not discussed in this paper.

METHODS

The trees from which data on the occurrence of chlorophyll mutants were collected were in the seed orchards of the Georgia Forestry Commission, or in natural stands or plantations in Georgia. Seed resulting from controlled self-pollination, or from collections of wind-pollinated cones, were sown in flats in a greenhouse, and normal and chlorophyll-mutant seedlings were counted. The wind-pollinated cones were collected from as few as one to as many as 77 ramets per clone. Single-ramet collections included cones from all crown positions, and multiple-ramet collections were usually one cone per tree picked up at random after the tree had been mechanically shaken. The percent of seedlings produced from natural self-pollination in the wind-pollinated progenies was estimated by the relationship:

$$\frac{\text{Number of self-fertilized seedlings in the wind-pollinated seedlot}}{\text{Total number of seedlings in the wind-pollinated seedlot}} \times 100$$

1/ Principal Plant Geneticist, Southeastern Forest Experiment Station, USDA Forest Service, Macon, Georgia.

where the number of self-fertilized seedlings was estimated by:

$$\frac{\text{Total number of seedlings in the selfed seedlot}}{\text{Number of mutant seedlings in the selfed seedlot}} \times \text{Number of mutant seedlings in the wind-pollinated seedlot}$$

(Franklin, 1971). For example, M-4 in table 1 is calculated as:

$\frac{29}{4} \times 1 = 7.25$ = estimated number of selfed seedlings in wind-pollinated seedlot.

$\frac{7.25}{616} \times 100 = 1.18$ = percent selfed seedlings in the wind-pollinated seedlot.

The phenotypes of the gene markers for which data were collected are:

B-9, Albino, lethal

C-4, Albino, lethal

D-11, Abnormal primary bud

J-1, Green hypocotyl, nonlethal

M-3, Pale green-yellow cotyledon, lethal before primary growth

M-4, Yellow primary needles, nonlethal

R-7, Pale green primary needles

T-37, light green cotyledon, lethal

W-13, light green cotyledon, lethal

Chi-square tests of segregation ratios of the selfed progenies indicate that all of the above, except D-11, are probable single-gene recessives. D-11 may be heterozygous for two genes, and the mutant phenotype occurs when either or both gene are homozygous recessive in the seedling.

RESULTS

Wind-pollinated seed from seed orchard ramets produced an average of less than 3 percent selfed seedlings (table 1). Seed from ortets in natural stands produced almost 6 percent selfed seedlings (table 1). A very similar estimate of selfing in natural stands of slash pine was reported by Squillace and Kraus (1963).

Table 1.--Summary of counts of seedling phenotypes used for estimation of the frequency of selfed seedlings in slash pine seed orchards and natural stands

Number	Controlled self-pollination		Wind-pollination		
	Seedlings produced		Seedlings produced		Selfed seedlings
	Normal	Abnormal	Normal	Abnormal	
	Number		Number		Percent
B-9	56	3	523	0	.0
C-4	48	11	2907	12	2.2
J-1(1972)	31	8	4257	18	2.0
J-1(1974)	113	15	574	6	8.9
M-3	13	1	2149	1	.6
M-4	25	4	615	1	1.2
T-37	380	91	6406	44	3.5
W-13	41	18	340	0	.0
Average					2.6
	Ortets				
D-11	24	22	296	5	3.5
M-4	25	4	1445	17	8.4
T-37(1967)	380	91	3984	4	.5
T-37(1971)			1254	28	11.3
Average					5.9

DISCUSSION

The low estimates of selfing in these grafted seed orchards are encouraging because it had been expected that pollination between ramets of the same clone might produce relatively high percentages of selfed seedlings. All of the clones used in this study were planted in five-ramet rows, so the chances of selfing were higher than in most seed orchards where clones are mixed to minimize selfing between ramets.

Three possible explanations for the differences between seed orchard selfing and that found in natural stands are:

1. Inbreeding in natural stands from crossing of relatives may be inflating estimates of selfing.

2. Embryonic competition favors outcrossed embryos over embryos resulting from selfing (Franklin, 1974). Embryonic competition may be especially keen in seed orchards where most, if not all, of the clones are unrelated. More of the selfed embryos may be competing with unrelated embryos in seed orchards than in natural stands.

3. Under seed orchard conditions more fertilizations per ovule may take place, further increasing the competition among embryos and eliminating the less vigorous selfed embryos.

CONCLUSIONS

Gains from tree breeding efforts will probably not be substantially affected by growth losses caused by selfing in most slash pine seed orchards. Even though there are chances of selfing among ramets as well as within ramets, the production of selfed seedlings in seed orchards is apparently no greater than it is in natural stands. Trees carrying genes for chlorophyll deficiencies are good material for monitoring self-pollination and may be worth retaining in seed orchards if their breeding values for production traits are not too low.

LITERATURE CITED

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