Cone and Seed Yields from F_1 Crosses Involving Five and Six Year Old Open and Controlled-Pollinated Seedlings of Loblolly Pines

JAMES T. GREENE [1/]

In the establishment of breeding programs, distinct from vegetative propagation, it is apparent that any means which will shorten the time of progeny to a stage of flowering and to the increase of amount of seed production will be of great importance. Most loblolly pine (**Pinus taeda L.**) trees begin to produce strobili at an age of about 8 to 10 years.

Righter (1939) reported 'the average of the minimum ages of ovulate flower production for 55 species and varieties of pine to be 5.2 years. The earliest reported ages of flower production in loblolly pine were 5 years for o v u la te flowers and 6 years for staminate flowers.

Mergen (1961) reported on the stimulation of early flowering in 3-year-old slash **(Pinus elliottii** Engelm.) and loblolly pines in a greenhouse, by keeping them, under a high level of nitrogen nutrition. In commenting on these observations, Mergen concluded that, "(1) the ability to flower at an early age is genetically controlled, and (2) in flowering trees, the mechanism that controls the change from a vegetative shoot to a sexual one can be modified to some extent by the environment."

To determine if and how a particular characteristic is inherited, the forest geneticist must select and breed for a particular characteristic. The ultimate goal will be to incorporate desired characteristics, whatever they may be, into a particular genetic strain. By selection and controlled pollination, it should be possible to reduce "flowering" age considerably. This will save valuable years in tree improvement program as well as insuring early seed production in a grafted or a controlled-pollinated seedling seed orchard.

Greene and Porterfield (1962) located loblolly pines ranging from 21 to 30 years of age on the property of the University of Georgia which yielded seed that produced "seedlings" bearing female strobili at ages of three and four years from seed. One three-year-old loblolly pine seedling produced female strobili in 1959, after two years in the field. These strobili were crossed back to one of the early cone-producing parents. Two cones from this cross were collected in late 1960. The cones yielded 102 seeds. These seeds produced 44 normal seedlings. After five years in the field, 40 of these seedlings are growing and appear exceedingly vigorous. Approximately 75 per cent of these five-year-old seedlings are producing male and female strobili. This same seedling parent has produced female strobili for seven consecutive years.

Greene (1966) reported on the seed yield and plantable seedlings from controlled and open-pollinated four and five-year-old seedlings of loblolly and shortleaf (**Pious echinata** Mill.) pines. These young "parents" were three and four years from seed when the pollinations were made.

Greene further reported that seventy-seven per cent of the controlled pollinations made in 1963 on four-year-old loblolly pines were successful. These crosses were F_2 and backcrosses.

Progenies from controlled crosses now growing on the proper ty of the University of Georgia offer excellent opportunities to select for desired characteristics. Approximately 140 possible combinations are now growing in the field resulting from control-pollinations of loblolly, shortleaf, slash, and longleaf pine **(Pinus palustris** Mill.) trees.

RESULTS AND DISCUSSION

The following data illustrate that controlled-pollinations and seed set can be successfully accomplished on five- and six-year-old loblolly pine "seedlings." These data further indicate that "flowering" age of loblolly pines can be reduced through selection and controlled-pollinations.

The first part of the paper consists of information relative to type of cross, open- and controlled-pollinated cones and seed y ields from five-year-old "parents." The progenies had been outplanted for

1/Associate Professor of Forest Genetics, School of Forestry, University of Georgia. This research was conducted in cooperation with the Georgia Forest Research Council and the College Experiment Station.

five years when the cones were collected. This indicates the progenies were producing male and female strobili at four years from seed.

Cone and seed yields from the controlled- and open-pollinated crosses involving the five-year-old loblolly pines are summarized in Table 1. Sixty-five per cent of the controlled-pollinations made on these young F_1 parents were successful. These

Table 1. Controlled and Open-Pollinated Loblolly Pine Cones Collected in 1965 from 5-Year-Old Open- and Controlled Pollinated Seedlings.

Female	Male	Seed Parents	Type of Cross	Cones	Seeds Per Seedling	Seeds Per Cone
				NUMBER		
L-72XL-77	L-72	6	Backcross	14	43	18
L-72XL-77	Wind	2	Open	2	32	32
L-72XWind	L-72	13	Backcross	55	77	18
L-72XWind	Wind	4	Open	7	105	60
L-72XL-78	L-72	11	Backcross	15	18	13
L-72XL-78	Wind	2	Open	4	56	56
L-72XL-64	L-72	6	Backcross	17	51	18
L-77XL-72	L-77	11	Backcross	20	40	22
L-77XL-79	L-77	8	Backcross	26	40	12
L-77XL-79	Wind	1	Open	2	86	43
L-77XWind	L-77	9	Backcross	20	32	14
L-77XL-78	Wind	1	Open	1	137	137
L-77XL-78	L-77	1	Backcross	6	24	4
L-65XL-78	L-65	7	Backcross	22	68	22
L-65XL-78	Wind	2	Open	2	64	64
L-65XL-78	L-64XL-78	1	F_2	12	552	46
L-65XL-65	L-65	4	Backcross	19	73	15
L-65XL-64	L-65	2	Backcross	3	57	38
L-65XL-64	Wind	5	Open	13	149	57
L-65XWind	Wind	2	Open	5	159	64
L-65XWind	L-65	5	Backcross	12	24	12
L-79XL-79	L-79	4	Backcross	13	14	4
L-79XWind	Wind	8	Open	28	220	63
L-79XWind	L-79	2	Backcross	21	22	2
L-69XL-72	Wind	8	Open	34	300	71
L-69XL-72	L-72	14	Backcross	62	32	7
L-69XL-72	L-72XWind	2	F_2	9	510	113
L-69XWind	Wind	4	Open	11	197	72
L-69XL-72	L-69	4	Backcross	17	124	29
L-69XL-77	Wind	7	Open	19	161	59
L-69XL-77	L-77	4	Backcross	8	33	16
L-69XL-77	L-69	2	Backcross	7	19	5
L-64XL-78	Wind	3	Open	4	74	55
L-64XL-78	L-64	5	Backcross	12	35	15
L-64XL-78	L-64XL-78	2	F_2	18	540	60

Table 2. Controlled-and Open-Pollinated Loblolly Pine Cones Collected from 6-Year-Old Open-and Controlled-Pollinated Seedlings.

Female	Male	Seed Parents	Type of Cross	Cones	Seeds Per Seedling	Seeds Per Cone
				NUMBER		
L-69xL-77	L-77xL-79	5	F2	10	125	63
L-69xL-77	L-69xWind	3	F2	8	175	66
L-69xWind	Wind	5	Open	21	353	84
L-69xL-77	L-77		Backcross	1	11	11
L-69xL-65	L-65		Backcross	1	12	12
L-69xL-65	L-69	2	Backcross	2	3	3
L-69xL-64	L-69xWind		F_2	2	183	92
L-69xL-72	L-69xWind	3	F_2	11	250	68
L-69xL-72	L-72xWind	7	F_2	27	207	54
L-69xL-72	Wind	8	Open	27	236	70
L-69xL-72	L-69	6	Backcross	16	10	4
L-72xWind	L-77xL-79	4	F_2	4	153	77
L-72xL-78	L-78	3	Backcross	6	13	7
L-79xWind	Wind	4	Open	10	249	100
L-79xL-79	Wind	3	Open	16	422	79
L-79xL-79	L-79	17	Backcross	73	147	34
L-79xWind	L-79	18	Backcross	71	108	27
L-79xL-72	L-77xL-79.	2	F_2	9	69	15
L-79xL-77	L-77xL-79	4	F_2	8	56	28
L-77xWind	Wind	1	Open	4	327	82
L-77xL-72	L-77xL-79	2	F_2	5	130	52
L-77xL-78	LongleafxLoblolly	2	F_2 - interspecific	2	38	38
L-77xL-78	L-77xL-79	7	F_2	7	169	72
L-77xL-78	L-78	8	Backcross	13	15	9
L-77xL-78	L-77	2	Backcross	11	48	9
L-77xL-78	L-78xWind	4	F_2	7	101	58
L-77xL-78	L-78xL-77	2	F_2	9	239	53
L-77xL-79	Wind	3	Open	14	352	76
L-77xL-79	L-77xL-79	4	F_2	8	114	57
L-77xL-79	L-79	14	Backcross	29	58	28
L-77xL-79	L-77	8	Backcross	8	26	13
L-78xL-77	L-78xL-77	4	F_2	5	57	45
L-69xWind	LongleafxLoblolly	7	F_2 - interspecific	22	144	46
LongleafxLoblolly	LongleafxLoblolly	3	F2- interspecific	23	261	34
LoblollyxSlash	LongleafxLoblolly	4	F_2 -interspecific	8	88	44

crosses were F2 and backcrosses.

Backcrossing is the crossing of a hybrid to one of its parental types. The F2 is obtained by crossing among or selfing the F_1 individuals.

The number of open-pollinated seeds per individual "seedling" ranged from 32 to 300. The range in seeds per cone per individual parent was from 32 to 137. The range in seeds for individual F2 crosses was from 510 to 552. The range in seeds per cone per individual F_2 cross was from 46 to 113. Backcrossing for individual parents resulted in a range of of seeds numbering from 14 to 124. The range in seeds per cone per individual backcross was from 2 to 38.

The second part of the paper consists of information relative to controlled- and open-pollinated cones and seed yields involving six-year-old parents. Approximately seventy per cent of the controlled-pollinations involving the six-year-old parents were successful. The progenies had been outplanted for six years when the cones were collected, which means the pollinations were made when the seedlings had been outplanted for five years.

Cone and seed yields from the controlled- and open-pollinated crosses involving the six-year-old loblolly pine seedlings are summarized in table 2.

The range in open-pollinated seeds per individual was from 236 to 422. Range in seeds per cone per individual was from 61 to 100. The range in seeds for individual F2 crosses was from 56 to 250. The range in seeds per cone per individual F2 cross was from 15 to 91. Backcrossing for individual parents resulted in a range of seed s numbering from 2 to 147.

Some interspecies pollinations were included in Table 2 to illustrate that viable seeds can be obtained through the s e F2 multiple-species crosses. For example, (loblolly x slash) X (longleaf x loblolly) yielded 44 seeds per cone. (Longleaf x loblolly) X (longleaf x loblolly) yielded 34 seeds per cone. These parents were five-years-old when the pollinations were made. These interspecies crosses indicate the possibility of commercial potentialities in the South.

SUMMARY

These date illustrate that controlled-pollinations and seed set can be successfully accomplished on five- and six-year-old loblolly pine "seedlings." These data further indicate that "flowering" age can be reduced and fecundity rate can be improved through selection and controlled-pollinations for these desirable traits. These data prove that it is possible to produce F_2 seed in five or six years. We now have growing in the field 31 loblolly pine progeny groups from three and four-year-old parents.

An opportunity for reducing age of "flowering" and increasing fecundity rates in loblolly pines exists in the selection, control-pollination and progeny testing for these traits. This possibility has great utility in programs of tree improvement and especially from the practical aspect of producing commercial quantities of improved seed from "seedling" orchards. As someone has so aptly written, "our limitations are the limitations of our scientific insight and imagination, rather than of the biological material with which we work."

LITERATURE CITED

Greene, James T.

1966. Seed yield and plantable seedlings from controlled-and open-pollinated four- and five-year-old seedlings of loblolly and shortleaf pines. Eighth South. Conf. on Forest Tree Impr. Proc. pp. 155-157.

Greene, J. T. and H. D. Porterfield.

1962. Early cone production in loblolly pine through selection and control-pollination. Georgia Acad. Sci. Bul. 20:6.

Mergen, Francois.

1961. Natural and induced flowering in young pine trees. Proc. Sixth So. Conf. For. Tree Improvement. pp. 129-135.

Righter, F. I.

1939. Early flower production among the pines. Jour. Forestry. 37:935-938.