

BREEDING AND TESTING PITCH X LOBLOLLY PINE
HYBRIDS FOR THE NORTHEAST

S. Little and I. F. Trew¹

ABSTRACT

In 1964 the Northeastern Forest Experiment Station and Westvaco - with the cooperation then and later of many organizations and individuals - selected pitch pines in several sections of the Northeast and loblolly pines in Maryland and Delaware, collected scions from these trees, and established breeding orchards. Controlled pollinations in the Station's orchard between individual clones of the two species have produced enough hybrid seed and resulting seedlings so that 19 test plantings in 8 states have been established--all within the last 5 years. Initial results indicate that seedlings of certain crosses between the two species have good form, grow about as rapidly as loblolly pine and appreciably faster than pitch pine, and are sufficiently hardy for at least some sections of the Northeast outside of loblolly pine's natural range.

¹ Principal Silviculturist, Northeastern Forest Experiment Station, Pennington, New Jersey, and Research Forester, Westvaco, Ivy, Virginia.

INTRODUCTION

Pitch pine (*Pinus rigida* Mill,) is a hardy yellow pine, the range of which includes outlying stands in Quebec and southeastern Ontario, and near Bar Harbor, Maine. Its main range extends from central Maine to New York and south to Virginia and southern Ohio, and in the mountains of eastern Tennessee, northern Georgia, and western South Carolina (Fowells 1965). Pitch pine is found usually on poor soils, especially on sites that have been frequently burned by wildfires. Many of the existing stands started as sprouts, or their crowns have been deformed by wildfires--so most people have a poor impression of the species. Seedlings of pitch pine may develop into well-formed trees, although their height growth is slower than that of loblolly pine (*P. taeda* L.). Pitch pine does reach a maximum height of about 100 feet (Little 1959).

Loblolly pine is the principal commercial species of pine in the southeastern United States. Its natural range extends southward from central Delaware, although the species is either native or naturalized in Cumberland and Cape May Counties, New Jersey (Little et al. 1967). In Delaware and Maryland loblolly pine grows mostly in the lower Coastal Plain, but the belt widens southward to include more than half of North Carolina and almost all of Alabama (Fowells 1965).

For wood products the two species tend to be comparable--both being used for lumber, pulp, and piling. However, the quality of products from the usual loblolly stand is far higher than that from the usual stand of pitch pine,

Loblolly pine also outgrows pitch pine in the places where both occur. Differences are usually similar to those between loblolly and pond pines (*P. serotina* Michx.)--the latter sometimes considered to be a variety of pitch pine. Except on the poorest sites, loblolly pines are both taller, often by 10 to 15 feet, and larger in diameter at 50 years than either pitch pine or pond pine (Little et al. 1967).

For several years foresters have been interested in the possibility of combining loblolly pine's rate of growth and pitch pine's winter hardiness. For example, in 1945 the Station established test plantings of pitch x loblolly pine hybrids produced from seed that came from controlled pollinations at the U. S. Forest Service's Institute of Forest Genetics at Placerville, California. However, these hybrids resembled pitch pine in both growth rate and form, and were not even intermediate between the two species (Little and Somes 1951, Little et al. 1967). The poor results may have been due to inappropriate geographic sources or more likely to poor genotypes of parent trees, because selections of both proper provenance and trees within a provenance seem important. Observations of natural hybrids between pitch and loblolly pines indicate that some hybrids grow nearly as fast, and with nearly as good form, as loblolly pine seedlings (Little et al. 1967).

About 1963 personnel of westvaco became interested in the possibility of fast-growing, winter-hardy yellow pines for company lands in such sections as western Virginia, west Virginia, southern Ohio, and western

Kentucky. Pitch x loblolly pine hybrids were one good possibility, so research foresters of Westvaco and of the Northeastern Station agreed to cooperate in the study we are describing in this paper.

STUDY PROCEDURES

Selection of Orttets.--In late 1963 and early 1964 Westvaco and Station personnel--with the help of state foresters and other interested people in several states--started to select apparently superior trees. Westvaco was responsible for selections of pitch pine in Virginia, West Virginia, north-central Pennsylvania and south-central New York, and later in the Ausable Forks section of New York. Station personnel were responsible for selecting pitch pines in southern New Jersey, northwestern New Jersey and the Pennsylvania Poconos, southeastern Massachusetts, and the New Hampshire-Maine area, as well as for selecting loblolly pines in Maryland and Delaware.

Selections were based mostly on height and form--trees that seemed outstanding when compared to nearby trees of the same age and species. Most of the chosen trees were taller than their associates by 3 to 15 feet. Selected pitch pines were relatively old--mostly 65 to 160 years old. Selected loblolly pines were usually younger, many being 30 to 60 years old.

Establishment of Orchards.--Through using hired tree climbers, scion material was collected from the branch tips of all selected trees.

In the spring of 1964 Westvaco personnel did all the initial grafting--on pitch and loblolly pine seedlings that they had planted in 1963 near Charlottesville, Virginia. For the establishment of an orchard by the Northeastern Station at New Lisbon, New Jersey, Westvaco dug many of the successfully grafted seedlings in the fall of 1964, wrapped the root systems and soil balls in burlap, and loaded the seedlings on vans for shipment. Westvaco did some additional grafting to add a few clones in 1965, and again supplied the Station with grafted seedlings in the fall.

Since 1965 there has been additional grafting done by Station personnel in the New Lisbon orchard, partly to add a few clones and partly to replace trees that died. As you know, in certain grafts scion and rootstock turn out to be incompatible, and stems develop overgrowths and eventually die. Such incompatibility has occurred much more frequently in our loblolly clones than in our pitch pine clones.

At present there are 32 clones of pitch pine and 33 clones of loblolly pine in the 5-acre New Lisbon orchard, planted so the trees of a clone are usually in one part of one row. Although there are differences among clones, many trees have grown well. Ten years after grafting in 1964 the loblolly stems were up to 28 feet tall, pitch pines up to 22 feet tall.

Controlled Breeding.--Many of the pitch pines in the New Lisbon orchard started to flower within a year or two after grafting, and in 1968, 4 years after grafting, there was sufficient flowering on branches that could be bagged so that 109 pollination bags were used. The subsequent record of pollination bags used in that orchard is 204 in 1969, 351 in 1970, 433 in 1971, 729 in 1972, 451 in 1973, 185 in 1974, and none in 1975. Only in 1972 was there sufficient flowering of loblolly cones so that many bags, 208 in that year, were installed on loblolly pine stems.

During most years, but especially before 1972, we had to go back to loblolly octets and obtain male flowers for their pollen, because grafted loblolly pines in the New Lisbon orchard were slower and less prolific in flowering than the pitch pines. In some years loblolly pine pollen that Westvaco sent from clones selected in South Carolina or Virginia was also used in the New Lisbon orchard.

Practically all of the controlled pollinations to date have been between clones of the two species: pollen of one clone, usually but not always loblolly, being applied to certain bagged, female flowers of the other species.

Progeny Trials.--Even though our initial crosses involved relatively few of the selected pitch and loblolly clones, we decided to start progeny trials. If we had delayed until we had seeds available from crosses between most of our selected clones, we could have been dealing with 800 to 900 lots or crosses, and outplanting trials of that many stocks are not feasible for our staffs and cooperators. In our progeny trials we've been using row plots, usually 10 trees (5 trees in 1971, in later plantings sometimes 6 to 9 if the number of available trees in a stock was low) per row plot, and three or six blocks in a planting. In each planting there are check stocks of both parent species, and a buffer strip at least one tree wide surrounds the study trees of a planting.

Seedlings are grown in a state nursery to 1-0 stock. For the first plantings in 1971 the seedlings were grown by the New Jersey Bureau of Forestry in its Washington Crossing nursery. Since then the Maryland Forest Service has grown our seedlings in its nursery where 1-0 seedlings tend to reach a somewhat larger size than at Washington Crossing.

To date nineteen test plantings have been established. The following tabulation shows year of establishment, location, planter or principal cooperator, and number of stocks. Hybrid stocks mentioned are the ones produced from controlled pollinations in the New Lisbon orchard. In many of the plantings one of the check stocks is pitch x loblolly pine from Korean seed, probably F2 stock from wind pollination.

Year	Location	Planter or Principal Cooperator	Number of stocks
1971	Monroe County, W. Va.	Westvaco	32 hybrids + 4 checks
	Livingston County, Kentucky	Westvaco	11 hybrids + 5 checks
1972	Greenbrier County, W. Va.	Westvaco	38 hybrids + 2 checks
	'Livingston County, Kentucky	Westvaco	28 hybrids + 7 checks
	Cecil County, Maryland	Maryland Forest Service, NE Station	19 hybrids + 2 checks

Year	Location	Planter or Principal Cooperator	Number of stocks
1973	Ritchie County, W. Va.	Westvaco	43 hybrids + 7 checks
	Cecil County, Maryland	Maryland Forest Service, NE Station	39 hybrids + 7 checks
	Ocean County, N. J.	N, J. Div. Parks & Forestry, NE Station	21 hybrids + 6 checks
1974	Ritchie County, W, Va.	Westvaco	57 hybrids + 5 checks
	Ocean County, N. J.	N, J. Div. Parks & Forestry, NE Station	37 hybrids + 5 checks
	Huntingdon County, Pa.	Glatfelter Pulp Wood Co., NE Station	45 hybrids + 5 checks
1975	Patrick County, Virginia	Va. Polytechnic Institute & State University	51 hybrids + 6 checks
	Howard County, Maryland	Md. Park Service, Md. Forest Service, NE Station	103 hybrids + 8 checks
	Ocean County, N. J,	N. J. Div. Parks & Forestry, NE Station	102 hybrids + 8 checks (inc. 8 hybrids in only one block)
1975	Mifflin County, Pa.	Glatfelter Pulp Wood Co., NE Station	48 hybrids + 6 checks
	Sussex County, N. J.	N. J. Div. Parks & Forestry, NE Station	36 hybrids + 7 checks
	Dukes County, Mass.	Mass. Div. Forests & Parks, NE Station	80 hybrids + 7 checks
	Worcester County, Mass.	Mass. Div. Forests & Parks, NE Station	38 hybrids + 7 checks
	Saratoga County, N. Y.	N. Y. Div. Lands & Forests, NE Station	45 hybrids + 6 checks

Additional plantings of stock now in the Maryland nursery are planned for 1976--probably in Virginia, northern New Jersey, upstate New York, and southern New Hampshire.

Planting sites vary, of course, in elevation, climate, and soil, but most of them are on relatively poor soils--sites that might grow pitch pine. All are outside of the natural range of loblolly pine. Some examples of the differences being sampled are:

- (1) Elevations of 2,350 feet in the 1971 west Virginia planting, of 3,250 feet in the 1972 west Virginia planting, compared to 580 feet in the 1971 Kentucky planting and 140 in the 1973 New Jersey site.
- (2) Climates that vary in length of growing season probably by 90 days or so--possibly 195 days in the growing season in western Kentucky, only 100 to 110 days at the 1972 site in west Virginia. Minimum temperatures may vary by at least 23°F.
- (3) Soils vary from relatively shallow and rocky to deep Coastal Plain sands. The 1971 west Virginia site had a shallow soil, only 14 to 18 inches deep, and the 1972 site was so rocky it was difficult to plant. In contrast, the 1973 New Jersey site has a deep Evesboro sand soil.

RESULTS

Even though all the plantings have been made within the last five years, there are already several results of interest.

First, seedlings of certain crosses equal or exceed regular loblolly pine seedlings in height just after planting--even though all lots are grown in the same nursery. For one example, in the 1972 Maryland planting seedlings of five of our crosses had the same average height, 0.4 foot, just after planting as did regular loblolly seedlings, while seedlings of five more hybrid stocks had slightly taller seedlings--by 0.1 or 0.2 foot. In contrast, in the 1945 study hybrid seedlings were 0.1 to 0.3 foot shorter than regular loblolly pine seedlings just after planting (Little and Somes 1951),

Second, results do vary among plantings, probably because of differences in climate and soil. Tables 1 to 6 show some of the data so far obtained in the older plantings of four geographic areas--3- and 4-year data from west Virginia and Kentucky, 3-year data from Maryland, and 2-year data from southern New Jersey. Note that at the end of the 1974 growing season the tallest stock in 1972 plantings had an average height of 4.7 feet in western Kentucky, 4.2 feet in Maryland, and 3.8 feet in west Virginia (tables 3-5). One hybrid, 62 x 11-9, had the greatest average height in the Kentucky planting, was second in the Maryland planting, but was tied with three other hybrids for ninth place in the west Virginia planting.

In sections where loblolly pines from eastern Maryland or other northerly sources grow well--even though these sections are outside of loblolly's natural range--seedlings of some hybrid stocks grow at least as well for the first few years. Examples of such sections are western Kentucky, Cecil County, Maryland, and southern New Jersey (see tables 2, 4, 5, 6 for data on relative growth).

Table 1.--Survival and average height of surviving trees four growing seasons after 1971 planting in Monroe County, West Virginia.

Stock ¹	Geographic source	Survival percent ²	Average height	
			Feet	Meters
New Lisbon pitch	Mixed orchard clones	100	5.7	1.74
West Virginia pitch	White Sulphur Springs	87(100)	6.3	1.92
Pitch x loblolly (Korea)	Unknown	87(100)	6.7	2.04
62 x 23	N. J. x Md.	92(100)	7.1	2.16
78 x 18	Maine x Md.	100	7.2	2.19
77 x 18	N. H. x Md.	73(93)	7.3	2.22
(etc. through 20 more clonal crosses)				
77 x 22	N. H. x Md.	100	8.4	2.56
Loblolly	Maryland	53(87)	8.4	2.56
77 x 23	N. H. x Md.	100	8.5	2.59
78 x 15A	Maine x Md.	73(93)	8.5	2.59
57 x 15A	W. Va. x Md.	77	8.6	2.62
62 x 15A	N. Y. x Md.	100	8.8	2.68
65 x 22	N. J. x Md.	100	8.9	2.71
58 x 15A	W. Va. x Md.	93	8.9	2.71
62 x 22	N. Y. x Md.	73	9.0	2.74
66 x 15A	N. J. x Md.	100	9.1	2.77

¹ 63 x 23 is pitch pine clone 63 pollinated by loblolly pine clone 23

² values in parentheses exclude stems girdled by mice.

Table 2.--Survival and average height of surviving trees four growing seasons after 1971 planting in Livingston County, Kentucky.

Stock	Geographic source	Survival percent	Average height	
			feet	meters
58 x 15A New Lisbon pitch	W. Va. x Md. Mixed orchard clones	100	5.29	1.61
West Virginia pitch	White Sulphur Springs	93	5.59	1.70
66 x 19 Korean pitch x loblolly	N. J. x Md. Unknown	100	5.75	1.75
77 x 23	N. H. x Md.	100	5.82	1.77
78 x 18	Maine x Md.	93	6.06	1.85
71 x 23	Mass. x Md.	100	6.21	1.89
72 x 18	Mass. x Md.	100	6.31	1.92
78 x 15A	Maine x Md.	100	6.77	2.06
Loblolly	Unknown (Kentucky Nursery)	100	6.92	2.11
78 x 22	Maine x Md.	87	7.10	2.16
70 x 15A	Pa. x Md.	100	7.15	2.18
72 x 15A	Mass. x Md.	100	7.24	2.21
62 x 22	N. Y. x Md.	100	7.27	2.22
Loblolly	Maryland	100	7.47	2.28
			7.70	2.35

Table 3.--Survival and average height of surviving trees
three growing seasons after 1972 planting in
Greenbrier County, West Virginia.

Stock	Geographic source	Survival percent	Average height	
			feet	meters
Loblolly	Maryland	53	1.4	0.43
63 x 23	N. J. x Md.	93	1.8	0.55
65 x 11-20	N. J. x S. C.	72	1.8	0.55
New Lisbon pitch	Mixed orchard clones	97	1.9	0.58
65 x 11-10	N. J. x S. C.	92	2.1	0.64
64 x 11-10	N. J. x S. C.	84	2.2	0.67
54 x 11-20	Va. x S. C.	85	2.3	0.70
65 x 4-32	N. J. x Md.	92	2.3	0.70
(etc. through 24 clonal crosses)				
58 x 11-10	W. Va. x S. C.	95	3.0	0.91
59 x 11-10	Pa. x S. C.	95	3.0	0.91
67 x 22	N. J. x Md.	97	3.0	0.91
71 x 15A	Mass. x Md.	98	3.1	0.94
70 x 23	Pa. x Md.	98	3.2	0.98
77 x 22	N. H. x Md.	98	3.3	1.01
62 x 7-56	N. Y. x S. C.	97	3.5	1.07
77 x 4-32	N. H. x Md.	97	3.8	1.16

Table 4.--Survival and average height of surviving trees
three growing seasons after 1972 planting in
Livingston County, Kentucky.

Stock	Geographic source	Survival percent	Average height	
			feet	meters
58 x 11-10	W, Va. x S, C.	100	3.01	0.92
56 + 57 OP ¹	W, Va. x ?	95	3.16	0.96
New Lisbon pitch	Mixed orchard clones	83	3.21	0.98
78 x 23	Maine x Md.	90	3.23	0.98
60 x 7-56	Pa. x S. C.	93	3.29	1.00
(etc. through several clonal crosses)				
70 x 23	Pa. x Md.	96	4.32	1.32
62 x 11-10	N. Y. x S, C.	100	4.32	1.32
59 x 11-10	Pa. x S, C.	97	4.33	1.32
62 x 7-56	N. Y. x S, C.	93	4.33	1.32
62 x 11-20	N. Y. x S, C.	90	4.35	1.33
59 x 7-56	Pa. x S. C.	100	4.38	1.34
77 x 22	N. H. x Md.	94	4.38	1.34
54 x 11-9	Va. x S, C.	92	4.39	1.34
Loblolly	Maryland	97	4.49	1.37
Loblolly	Virginia seed orchard ²	94	4.54	1.38
62 x 11-9	N. Y. x S. C.	100	4.71	1.44

¹ open- or wind-pollinated seed from two pitch pine clones in the New Lisbon orchard.

² wind-pollinated seed from four clones--each used as a separate check.

Table 5.--Survival and average height of surviving trees three growing seasons after 1972 planting in Cecil County, Maryland.

Stock	Geographic sources	Survival <u>percent</u>	Average height	
			<u>feet</u>	<u>meters</u>
New Lisbon				
pitch	Mixed orchard clones	87	1.83	0.56
71 x 4-32	Mass x Md.	90	2.12	0.65
78 x 22	Maine x Md.	87	2.28	0.69
67 x 23	N. J. x Md.	87	2.31	0.70
58 x 11-20	W. Va. x S. C.	90	2.48	0.76
78 x 23	Maine x Md.	80	2.51	0.77
54 x 7-56	Va. x S. C.	53	2.61	0.80
54 x 11-20	Va. x S. C.	70	2.65	0.81
58 x 11-10	W. Va. x S. C.	97	2.66	0.81
58 x 11-9	W. Va. x S. C.	83	2.68	0.82
71 x 23	Mass. x Md.	97	2.81	0.86
54 x 11-10	Va. x S. C.	80	2.98	0.91
71 x 22	Mass. x Md.	93	3.00	0.91
54 x 11-9	Va. x S. C.	80	3.06	0.93
70 x 23	Pa. x Md.	97	3.15	0.96
67 x 22	N. J. x Md.	90	3.22	0.98
77 x 4-32	N. H. x Md.	100	3.38	1.03
Loblolly	Maryland	93	3.56	1.09
62 x 11-10	N. Y. x S. C.	93	4.05	1.23
62 x 11-9	N. Y. x S. C.	97	4.08	1.24
62 x 7-56	N. Y. x S. C.	100	4.16	1.27

Table 6.--Survival and average height of surviving trees two growing seasons after 1973 planting in Ocean County, New Jersey.

Stock	Geographic source	Survival <u>percent</u>	Average height	
			<u>feet</u>	<u>meters</u>
54 x 7-56 New Lisbon	Va. x S. C.	62	1.36	0.41
pitch	Mixed orchard clones	100	1.40	0.43
56 + 57 OP ¹	W. Va. x ?	100	1.50	0.46
76 x 23	N. H. x Md.	100	1.55	0.47
Korean pitch x loblolly	Unknown	95	1.64	0.50
78 x 23	Maine x Md.	100	1.64	0.50
(etc. through 15 more clonal crosses)				
62 x 23	N. Y. x Md.	83	2.16	0.66
24 OP ¹	Maryland x ?	100	2.20	0.67
62 x 7-56	N. Y. x S. C.	96	2.30	0.70
Loblolly	Virginia (Div. of Forestry)	95	2.30	0.70
Loblolly	Maryland	100	2.36	0.72
62 x 11-10	N. Y. x S. C.	96	2.38	0.73

Open- or wind-pollinated seed from orchard clones:
56 and 57 are pitch pine clones 24 is a loblolly clone,

In other sections regular loblolly pine seedlings tend to fall behind the best hybrid stocks, For example, at 2,350-foot elevation in Monroe County, West Virginia, regular loblolly pine was in ninth position for average height after four growing seasons--its trees still suffering some dieback each year (table 1), At 3,250 feet in nearby Greenbrier County survival of regular loblolly was only 53 percent after one less growing season, and surviving trees had the shortest average height of the test stocks (table 3),

Pitch pine checks tend to be the shortest stocks in the test plantings (tables 1-6) although a few hybrids may grow as slowly (in particular, tables 2, 3, 4, 6).

One of the checks included in most test plantings is pitch x loblolly pine hybrids from Korean seed, presumably the F2 generation from wind pollination in an F1 orchard, In our plantings this hybrid stock has so far grown only slightly faster than the pitch pine checks and our poorest hybrids (tables 1, 2, 6).

Hybrid seedlings resulting from the use of South Carolina pollen tend to be taller as 1-0 stock than hybrid seedlings having a Maryland loblolly pine as a parent, but are not so winter-hardy. In the 1973 Maryland planting only 7 of our 39 hybrid stocks had South Carolina pollen parents, but four of these were among the six hybrid stocks having seedlings taller than 0.44 foot in average height after planting. However, in the 1972 planting at 3,250 feet in elevation in west Virginia, seedlings of all hybrid stocks having a South Carolina loblolly parent suffered severe winter injury (killing of foliage) during the first winter, as did regular loblolly seedlings. After three growing seasons only one of the top-five stocks in average height had a South Carolina pollen parent (table 3), while in the Maryland and Kentucky plantings of the same year three or four of the top-five hybrids have such a pollen parent (tables 4, 5). We surmise that hybrids involving a South Carolina parent may be fast-growing and sufficiently winter-hardy only in the sections just outside of the natural range of loblolly pine--as southern New Jersey, central Maryland, much of western Virginia, and western Kentucky, However, results from test plantings already established or scheduled should relatively soon verify or disprove our hypothesis.

In at least some of the northerly plantings hybrids having a Maryland loblolly as one parent may be rapid-growing and sufficiently winter-hardy, although we expect there may be differences due to geographic source of the pitch pine parent as well as to individual parents of both species. That surmise has yet to be proved, but the site at 3,250 feet in West Virginia has a very short growing season and has had frosts in early June.

Relative rank in growth and thus the most desirable hybrids for specific areas will apparently vary with geographic locations of the planting sites. For example, seedlings of the 58 x 15A hybrid hold third position for average height in the 1971 west Virginia planting, but last position in the Kentucky planting (tables 1 and 2).



Figure 1.--Trees in the 1971 West Virginia planting in the fifth growing season after planting. Left: pitch pine from wind-pollinated cones of the pitch pine clones in the New Lisbon orchard. Pencil marks the beginning of the 1975 growth. Right: a pitch x loblolly pine hybrid, New Hampshire pitch (clone 77) x Maryland loblolly (clone 22). Note the superior height and form of the hybrid.

The best hybrid stocks in all plantings have far better form than pitch pine checks, and have appreciably outgrown them. At four growing seasons after planting, differences in average height are 3 feet in the West Virginia planting, 2 feet in Kentucky (tables 1 and 2). After three growing seasons differences are about 2 in Maryland and West Virginia, and 1.5 feet in Kentucky (tables 5, 3, 4). Even two years after planting the best hybrids may be about a foot taller than the pitch pine checks (table 6).

Loblolly pine, the more rapidly growing parent under favorable conditions, also falls behind the best hybrid stocks under more rigorous conditions. Present results suggest that the farther planting sites depart from conditions suitable to loblolly pine, the greater are both the number of hybrid crosses outgrowing loblolly and the difference in growth between the best hybrid stocks and loblolly seedlings.

CONCLUSION

Results obtained so far in the test plantings offer the promise that certain hybrids between pitch and loblolly pines will be rapid-growing, well-formed yellow pines--of sufficient winter hardiness for some sections of the Northeast. Just which crosses do the best in specific sections of the Northeast remains to be determined from our test plantings.

If some of these hybrids continue to thrive and seem worthy of inclusion in the stocks produced by state nurseries, we will have to develop procedures for supplying the needed seeds in bulk. At present the only hybrid-pine seeds we have are the result of controlled pollinations and are being reserved for test plantings.

LITERATURE CITED

- Fowells, H. A. 1965. Silvics of forest trees of the United States. U. S. Dept, Agric, Agric. Handb. 271, p. 762,
- Little, E. L., Jr., S. Little, and W. T. Doolittle. 1967. Natural hybrids among pond, loblolly, and pitch pines. USDA For. Serv, Res. Pap. NE-67 p. 22. U. S. Dep. Agric. For. Serv. Northeast. For. Exp. Stn., Upper Darby, Pa.
- Little, S., and H. A. Somes. 1951. No exceptional vigor found in hybrid pines tested, USDA For. Serv., Northeast. For, Exp. Stn. Res. Note 10. p 4.
- Little, S. 1959. Silvical characteristics of pitch pine (*Pinus rigida*). USDA For. Serv. Northeast. For. Exp. Stn., Stn. Paper 119, p. 22.