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Brown-Spot Resistance Among F, Progeny Of A Single, Resistant Longleaf Parent

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JUVENILE longleaf pines vary considerably in their susceptibility to brown-spot needle blight. Under similar exposure to infection, a few seedlings may prove resistant while the rest are heavily attacked and many die within a few years. The extent to which resistance is genetically controlled, however, has yet to be determined.

Numerous resistant longleaf seedlings have been noticed in nurseries, plantations, and naturally seeded stands, and some have shown enough promise to merit study and progeny testing.

In the fall of 1937, Dr. Paul V. Siggers found a disease-free longleaf seedling growing in an abandoned nursery bed among other seedlings that were heavily infected. The two-year-old seedling was transplanted in December of that year to the Palustris Experimental Forest, near Alexandria, Louisiana. This paper describes the disease resistance of its open-pollinated progeny grown from seed collected in the years from 1955 to 1957. It also includes notes on the performance of selfed and crossed progeny.

The largest group of open-pollinated progeny to demonstrate brown-spot resistance came from the 1955 seed crop. Approximately 600 were planted in three separate areas. Site A was regarded, perhaps mistakenly, as being in an area of light infection. Site B was considered moderately severe; temporarily it was relatively clean of infected material, but earlier plantings had always required burning or spraying for disease control. Site C was selected for a severe test. It was in the center of a 200-acre, five-year-old seeded stand where controlled burning had failed to prevent heavy infection. The test seedlings were planted among the five-year-olds—sometimes no more than a foot away.

Plantings on A and B are on single plots containing, respectively, 244 and 200 trees at 8- by 8-foot spacing. Test C is a randomized block planted with 150 open-pollinated progenies apiece from this and eight other parent trees; the 1,200 progeny of the eight other parents serve as checks.

After the fourth growing season (which usually brings brown-spot infection to a peak), 84 per cent of the survivors on sites A and B were only lightly infected, i.e., had less than 10 percent of their foliage killed (Table 1). On most seedlings, the only evidence of infection was scattered bar lesions, which appear to be associated with brown-spot resistance in longleaf.[1] Controls were not included in these two plantings, but severe defoliation of natural seedlings (1955 seed crop) growing within test site. As indicated that there was ample opportunity for infection.

Under severe test conditions on site C, progeny of the resistant parent suffered more infection than on sites A and B, but still considerably less than the controls. At age four, 75 percent were in active height growth, as contrasted with 35 percent of the check seedlings. One-third of the survivors, but only six percent of the control group, had less than 10 percent infection. Data for the control seedlings are fairly typical of four-year-old planted or seeded stands growing under severe brown-spot conditions in central Louisiana.

Seedlings from 1956 and 1957 collections of wind-pollinated seed of the same resistant parent have also exhibited a high degree of brown-spot resistance under field conditions. Seventy percent of the trees from 1956 seed were only lightly infected at age three, while no more than eight percent of the controls in the same planting were in this low-infection category. Thirty-eight seedlings survived from open-pollinated seed collected in 1957. All exhibited high vigor and low brown-spot infection after one year in the field.

Evidence of the heritability of brown-spot resistance is provided by the performance of crosses having the resistant tree as the male or female parent. The hybridization work, completed in 1954 and 1955, also produced selfed progeny of the resistant tree. The following tabulation summarizes the proportion of disease-killed foliage at four years after planting for the 1954 hybrids, and at age three for the 1955 progeny. Estimates were made in February.

Cross	1954 progeny		1955 progeny	
	No. of seedlings	Average brown-spot infection (percent)	No. of seed lings	Average brown-spot infection (percent)
LL-3 x resistant tree	19	6	--	_
LL-3 x wind	9	18	--	--
LL-5 x resistant tree	20	5	—	--
LL-5 x wind	20	49	--	--
LL-2-8 x resistant tree	--	—	95	23
LL-2-8 x wind	-	--	49	40
LL-4-1 x resistant tree	--	—	23	5
LL-4-1 x wind	--	—	50	46
Resistant tree x LL-1	--	--	25	2
Resistant tree x wind	27	4	47	7
Resistant tree x self	26	4	24	7

When nonresistant trees were used as female parents, controlled application of pollen from the resistant tree yielded progenies that were far less susceptible than those from wind pollination. In three of the four crosses, the degree of resistance was comparable to that of open-pollinated progeny of the resistant parent. Selfed progeny displayed the same level of resistance as the open-pollinated group, but were slower to start height growth and initially

[1] Verrall, A. F. The resistance of saplings and certain seedlings of Pinus palustris to Septoria acicola. Phytopath. 24: 1262-1264. 1934.

had longer and finer-textured foliage.

Brown-spot resistance appears to be a physiological condition of the foliage that restricts movement of the pathogen within the needle tissue. Resistant seedlings are not completely free of infection. Bar lesions develop at points of infection, indicating a restriction of the pathogen's ability to affect the host. In contrast to nonresistant foliage, infected needles remain green and appear functional. However, resistance appears to break down under heavy and prolonged attacks. It is possible that when multiple bar lesions occur on each needle the physiological condition responsible for resistance is modified.

These observations on the performance of progeny from a single tree suggest that brown-spot resistance in longleaf pine is subject to genetic control and there is opportunity to develop resistant strains of this pine species. The immediate problem is to identify additional resistant trees for breeding purposes. Towards this end we have, in cooperation with the Southern Institute of Forest Genetics, started to test progeny of likely candidates. Seedlings from more than 500 such trees are now in the nursery.

Table 1.--Fourth-year survival, height growth, and brown-spot infection rates for open-pollinated progeny of a brown-spot resistant parent (1955 seed)

Item	Site A: Resistant seedlings	Site A: Controls 1/	Site B: Resistant seedlings	Site C: Resistant seedlings	Site C: Controls 2/
	Percent				
Survival at age 4	95	--	92	93	92
Survivors in height growth	96	0	83	75	35
Brown-spot infection proportion of survivors with:					
--less than 10 percent infection	84	0	84	33	6
--10-50 percent infection	10	0	5	21	18
--more than 50 percent infection	6		100 11	46	76

1/ Includes natural seedlings of the same age growing within the planted area.

2/ Sum of 8 one-parent prpgeny groups.