LONGLEAF PINE PRODUCTION --- A COOPERATIVE ENDEAVOR

by

ALBERT G. KAIS[1]

The renewed interest in the growth of longleaf pine (*Pinus palustris* Mill.), necessitates close cooperation between the nursery and research to provide a longleaf pine desirable to the grower. The primary role of the nursery is to produce a high-grade, vigorous longleaf pine seedling that can survive and grow rapidly when outplanted in the field. Longleaf pine vigor influences survival, initiation of height growth, ability to compete with other vegetation, and ability to overcome effects of brown-spot needle blight. Factors affecting longleaf seedling quality in the nursery are seed source, seedbed density, nutrition, ectomycorrhizae, disease control, cultural practices, and practices for lifting and storing seedlings.

The current role of longleaf pine research is to develop genetical, mycorrhizal-cultural, and chemical technology to stimulate rapid height growth and to control brown-spot needle blight. Select seed sources from controlled pollinations are now being field-tested for disease resistance and fast growth capability. Longleaf pine inoculated with ectomycorrhizae while growing in the nursery bed had improved survival and increased growth when outplanted in the field. A benomyl fungicidal root dip treatment of nursery seedlings improved survival, controlled brown-spot needle blight, and stimulated rapid height growth.

Additional keywords: *Pinus palustris*, *Scirrhia acicola*, *Pisolithus tinctorius*, genetics, fungicides, brown-spot needle blight.

[1]Plant Pathologist Forestry Sciences Lab, Southern Forest Experiment Station, Gulfport, Mississippi.

LONGLEAF PINE PRODUCTION --- A COOPERATIVE ENDEAVOR

by

ALBERT G. KAIS

Longleaf pine, (*Pinus palustris* Mill.), once the most abundant of the southern pines, now occupies only about 25 percent of the area it once dominated (Mann 1969). Regeneration had been severely reduced by problems in nursery production and planting, possession of an inherent trait of delayed height growth, and severe damage caused by brown-spot needle blight (*Scirrhia acicola* (Dearn.) Siggers). Consequently, many longleaf pine sites have been planted to slash (*Pinus elliottii* Engelm. var. *elliottii*) and loblolly (*Pinus taeda* L.) pine. Recent nursery production figures for these three major southern pines reveal this trend (Abbot and Eliason 1968, Abbot and Fitch 1977).

	Seedling Production - M		
	1964 (36 Southern nurseries)	1974 (40 Southern nurseries)	Percent Increase (+) or Decrease (-)
Longleaf	7,461	6,818	-8.6
Slash	153,206	182,425	+19.1
Loblolly	199,050	337,191	+69.4

Recently, increased demands for wood and the many desirable characteristics of longleaf pine have stimulated a renewed interest in the growth of longleaf. Close cooperation between nurseries, State and Private Forestry, and research organizations is needed to provide the expertise and the technology to make longleaf pine a major component of the southern pine timber industry.

The Role of the Nursery

The primary responsibility of the nursery is to produce high-quality longleaf seedlings that can survive and grow quickly when outplanted in the field. The importance of this basic fact cannot be overemphasized. Quality of the nursery-grown seedling influences survival, initiation of height growth, the ability to compete with other vegetation, and the ability to outgrow or overcome the effects of brown-spot needle blight. Juvenile growth differences attributable to nursery influences can persist up to 10 years after outplanting (Snyder and Allen 1963). The major factors influencing longleaf pine seedling quality in the nursery are: 1) seed source, 2) seedbed density, 3) nutrition, 4) ectomycorrhizae, 5) disease control, 6) cultural practices and 7) lifting and storage practices.

Seed source.--Superior seed sources with rapid growth capability and disease resistance should be used. Reports concerning the inheritance of resistance in the F1 progeny of individual longleaf pine (Derr and Melder 1970) and the gain of desired characteristics by selection (Snyder and Derr 1972) indicate that superior seed sources will soon be available for nursery use.

Seedbed density.--Low seedbed densities reduce the number of culls before lifting (Scarbrough and Allen 1954) and promote improved survival and first-year growth of outplanted seedlings (Derr 1955). Seedbed planting at the rate of 15 seedlings per square foot is recommended (Mann 1969).

Nutrition.--The successful establishment and initiation of early height growth are directly correlated with root development and the early expression of vigor (Brown 1964). Lateral roots of longleaf pine are especially important for stimulating height growth (Derr 1948). So, a fertilization regime that favors the rapid production of extensive root systems on nursery seedlings is desirable. Slow release fertilizers, customized for root growth, could be a favorable fertilization alternative.

Ectomycorrhizae.--The use of a highly beneficial ectomycorrhizal fungi such as *Pisolithus tinctorius* (Pers.) Coker and Couch, can be extremely beneficial in tree nurseries and in artificial regeneration programs (Marx 1977). Ectomycorrhizae are not only beneficial for tree growth, but actually indispensable for survival and early growth of field plantations (Marx 1975). All nurseries contain some ectomycorrhizal fungi, but their frequency and type vary from nursery to nursery. Nurseries should promote the development of existing ectomycorrhizae or, if necessary, inoculate seedbeds with ectomycorrhizal fungi such as *P. tinctorius* to build up the ectomycorrhizal population. Marx found that the inoculation of longleaf seedbeds with *P. tinctorius* resulted in larger seedlings and fewer culls.[1/]

[1/] Marx, D. H. 1977, Personal communication, The effects of different rates of vegetative inoculum of *Pisolithus tinctorius* on ectomycorrhizal development and growth of longleaf and shortleaf pines. Abstract, Third North American Conference on Mycorrhizae, Aug. 23-25, 1977, Athens, Ga.

Treatment	Percent ectomycorrhizae		Fresh weight seedlings (gm)	Percent culls
	Pisolithus	Total		
Control	3	23	12.8	23
Pisolithus 100 cc/ft^2 (1/m^2)	19	34	16.7	14
Pisolithus 200 cc/ft^2 (1/m^2)	26	40	19.9	19

Disease control.--Control of brown-spot needle blight is crucial for the successful production of longleaf pine in the nursery. Nursery control is fairly simple with fungicidal sprays such as maneb, Bordeaux mixture, and chlorothalonil (Phelps et al. 1978, Kais 1975). However, nurserymen must also be aware of possible infection after needle clipping (Kais 1978). In any case, control with fungicidal sprays must be accompanied by meticulous practices of sanitation such as 1) removal of infected pine seedlings in the vicinity of the nursery, 2) removal and destruction of infected seedlings in nursery beds, 3) avoidance of using nonfumigated pine needles as mulch in beds, and 4) removal of clipped needle tissue from beds.

Cultural practices during growth.--Needle clipping and root pruning have been used to improve the quality of longleaf seedlings. Needle clipping performed two or three times during the growing season helps prevent seedling toppling, facilitates fungicidal applications, and expedites lifting and handling of stock. More importantly, it improves seedling survival (Allen 1955, Allen and Maki 1951, Shoulders 1967).

Pruning roots to 4 to 7 inches deep 6 to 18 weeks before lifting improves field survival of outplanted seedlings (Shoulders 1963). If done properly, this treatment increases root development, including lateral roots. This promotes a greater root absorption area for the uptake of water and nutrients and for ectomycorrhizal infection.

Lifting and packaging.--Careful handling and timing are necessary considerations during lifting, packing, and storage of longleaf pine seedlings. Destruction of seedling lateral roots during lifting drastically reduces the future growth capability of the seedlings (Derr 1948). Seedlings must be maintained under proper moist and cool conditions from the nursery bed to the storage room to prevent damage due to high temperature and dessication. Nurseries should move seedlings from the nursery bed to the field as soon as possible. Seedling quality degradation occurs with increasing time of storage.

The Role of Research

The future of longleaf pine depends on the integration of various management practices such as the use of disease resistant seed sources, production of high quality seedlings by the nursery, the application of field planting practices that stimulate rapid height growth, and the use of appropriate fungicides.

Current and future research plans at the Forest Science Laboratory at Gulfport, Mississippi, are directed toward developing genetical, mycorrhizal-cultural, and chemical technology to improve growth and to control brown spot. The program should produce 1) an improved selection system for longleaf pine, 2) brown spot resistant families of longleaf pine, 3) rapid, early height growth of longleaf pine, and 4) effective systemic fungicides for use against the disease. These goals are interrelated and require cooperation and coordination between scientists skilled in phytopathology, genetics, and silviculture.

Genetical.--This aspect of the research program may eventually provide higher quality longleaf pine seed sources for nursery production. Two important studies are now in progress. One test, designed to correlate laboratory and field screening for growth and brown-spot resistance of longleaf pine, could provide the technology for the rapid and accurate screening of quality seed sources. The other test, in which we have just completed 3 years of control pollinating, was designed to cross-pollinate progeny having disease resistance with progeny having rapid growth capability, disease resistance, or both. These select seed sources will be field tested during the next 4 years in order to determine the best breeding procedures and to provide higher quality individuals for advanced generation seed orchards.

Mycorrhizal-cultural.--This portion of the program may provide the technology to stimulate rapid height growth of seedlings. Ectomycorrhizae, herbicides, fertilizers, fungicides, containers, and their interactions are the major factors that will be studied for stimulating rapid height growth. Three-year results of an ectomycorrhizal-benomyl test indicated that seedlings inoculated with the ectomycorrhizal fungus P. tinctorius in nursery beds had better survival and growth than untreated seedlings.[2/]

Treatment levels/Pt	Survival %	Root collar diam. (cm)	Height (cm)
High Pt - 25%	84.6	2.71	19.6
Medium Pt - 15%	82.5	2.71	19.6
Low Pt - 5%	72.9	2.69	18.5
No Pt - 0%	63.9	2.39	13.1

Ectomycorrhizal treatment had no effect on brown-spot needle blight

Chemical.--This phase of the research program may provide the technology for control of brown-spot needle blight. It is designed to 1) identify effective, environmentally safe fungicides, 2) determine most effective and efficient fungicidal application methods, 3) determine effect of fungicides on growth, and 4) determine duration of control by fungicides.

[2/]Kais, A. G., G. A. Snow, and D. H. Marx. 1980. The effects of benomyl and Pisolithus tinctorius ectomycorrhizae on survival and growth of longleaf pine seedlings. Unpublished manuscript.

Three benomyl fungicide studies now in progress are of particular interest to nurserymen. In one study, a benomyl seedling root dip application has effectively controlled brown spot on longleaf pine during the first 3 years after outplanting.[3/]

Pt levels	1977		1978		1979	
	+Ben.	-Ben.	+Ben.	-Ben.	+Ben.	-Ben.
	Percent infection					
High Pt - 25%	4.8	22.4	29.9	54.4	41.2	58.7
Medium Pt - 15%	6.1	23.6	26.3	50.4	39.3	54.6
Low Pt - 5%	7.7	19.6	30.8	51.8	44.5	56.8
No Pt - 0%	4.7	21.7	29.2	53.5	46.6	62.6

Both survival and rapid height growth were stimulated by disease control.

In the second study, benomyl-treated seedlings were outplanted in five different states (LA, MS, AL, GA, and FL). Benomyl controlled brown spot at each location and also stimulated higher survival.

Treatment	LA	MS	AL	GA	FL
	Percent infection				
1% Benomyl	36.2	5.9	17.7	10.6	34.7
5% Benomyl	23.4	3.2	5.9	6.4	13.0
10% Benomyl	14.8	2.7	6.1	4.2	14.1
20% Benomyl	15.4	3.0	5.6	6.9	11.0
Clay control	64.1	11.9	30.7	26.5	61.3

[3/] Kais, A. G., G. A. Snow, and D. H. Marx. 1980. The effects of benomyl and *Pisolithus tinctorius* ectomycorrhizae on survival and growth of longleaf pine seedlings. Unpublished manuscript.

The third study is evaluating how benomyl affects survival of longleaf pine seedlings after different cold storage periods.

To date, benomyl shows great promise for brown-spot control. It has been most effective when used as a root dip treatment before outplanting of nursery run seedlings. The fungicide may be registered for root dip application in the near future. With registration, nurseries will be able to treat seedlings with benomyl before packing and shipping. This treatment would not only improve survival but also provide disease control during the critical infection period when the longleaf pine seedlings are in the grass stage.

The future of longleaf pine looks very promising. However a concerted effort by research, State and Private Forestry, extension, and each nurseryman is needed. By combining existing technology with new developments, the nurseryman will be able to provide the high quality product needed by forest managers.

LITERATURE CITED

Abbot, H. G., and E. J. Eliason

1968. Forestry tree nursery practices in the United States. J. For. 66:704, 706, 708-711.

Abbot, H. G., and S. D. Fitch.

1977. Forest nursery practices in the United States. J. For. 75:141-145.

Allen, R. M.

1955. Foliage treatments improve survival of longleaf pine plantings. J. For. 53:724-727.

Allen, R. M., and T. E. Maki

1951. Foliage treatments reduce early mortality of longleaf pine planted on adverse sites. J. For. 49:115.

Brown, C. L.

1964. The seedling habit of longleaf pine. Ga. For. Res. Counc. Rep. 10, 68 p.

Derr, H. J.

1948. Keep lateral roots on longleaf planting stock. USDA For. Ser.; South. For. Exp. Stn.; South. For. Notes 54: p. 3-4.

Derr, H. J.

1955. Seedbed density affects longleaf pine survival and growth. USDA For. Serv. Tree Planters' Notes 20:28-29.

Derr, H. J., and T. W. Melder.

1970. Brown-spot resistance in longleaf pine. For. Sci. 16:204-209.

Kais, A. G.

1975. Fungicidal control of Scirrhia acicola on longleaf pine seedlings. Plant Dis. Rep. 59:686-688.

Kais, A. G.

1978. Pruning of longleaf pine seedlings in nurseries promotes brown-spot needle blight. USDA For. Serv. Tree Planters' Notes 29:3-4.

Mann, W. F., Jr.

1969. At last--longleaf can be planted successfully. For. Farmer 28:6-7, 18-19.

Marx, D. H.

1975. Mycorrhizae of forest nursery seedlings. USDA For. Serv. Agric. Handb. 470:35-40.

Marx, D. H.

1977. The role of mycorrhizae in forest production. Conf. Pap., Annu. Meeting TAPPI:151-161.

Phelps, W. R., A. G. Kais, and T. H. Nicholls.

1978. Brown-spot needle blight of pines. USDA For. Insect and Dis. Leafl. 44:8 p.

Scarbrough, N. M., and R. M. Allen.

1954. Better longleaf seedlings from low-density nursery beds. USDA For. Serv. Tree Planters' Notes 18:29-32.

Shoulders, E.

1963. Root-pruning southern pines in the nursery. USDA For. Serv. Res. Pap. SO-5, 6 p.

Shoulders, E.

1967. Longleaf field performance unimpaired by nursery clipping to facilitate brown-spot control. USDA For. Serv. Res. Note SO-60, 3 p.

Snyder, E. B, and R. M. Allen

1963. Sampling, nursery, and year-replication effects in a longleaf pine progeny test. Tree Improv. Comm. of the Soc. of Am. For., and the South. For. Tree Improv. Comm., Proc. of a For. Genetics Workshop, p. 26-27.

Snyder, E. B., and H. J. Derr

1972. Breeding longleaf pines for resistance to brown-spot needle blight. Phytopathology 62:325-329.