

Management of Seed Orchards

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Managing seed orchards in the South today is big business. The size of the seed orchard establishment increases from year to year; 2,380 acres are now devoted to producing forest seed from elite sources in the region extending from Virginia to Texas, 1,500 acres are scheduled to be producing by 1966, and another 750 acres are now in planning stages.

The development and management of seed orchards tasks the abilities of many foresters and forest workers. Interest in the program reaches high levels because of possible future benefits in forest growth and quality. This fact, plus the lack of full answers to the many involved problems which arise, provides common ground for valuable communication between seed orchard workers.

This presentation provides evidence of the cooperative work by foresters in tree improvement. The results of a questionnaire, answered by many of you in the audience, are summarized to give an overall picture of present-day seed orchard management and development. The answers come from 37 out of 38 organizations which received the questionnaires. Among the respondents were 34 companies or agencies having orchards installed or planned as of May 15, 1963.

Size and Design

Apparently the first grafting work for possible commercial seed orchards began during the winter of 1954-1955. Seed orchards have been started each year since 1955. The year 1956 marked the high spot in initiation of orchards with 11 orchards begun.

Today, individual orchards range in size from 4 acres to over 600 acres. The 40- to 70-acre size class has the largest number of orchards. The average size of all orchards approximates 65 acres.

Orchard outplanting design varies considerably. Rectangular, diagonal, square, and combinations of these designs plus random or mechanical location of clones furnish the patterns for outplanting. The majority of the orchards have a square design with random location of clones. Included in the orchards are subsections for species or geographic sources.

Loblolly pine is grown by 26 organizations; slash pine is grafted in 18 orchards; Virginia pine is included in 6; shortleaf pine in 4; and pond pine in 2. Two orchards plan to produce seed from plus

sand pine trees, and four orchards plan to develop longleaf pine seed. The average orchard has three subsections for species or geographic sources.

The number of clones and trees planted per acre varies somewhat from orchard to orchard, as shown in the following tabulation:

	Orchards (number)
Clones per acre:	
1-9	5
10-14	0
15-25	22
26-40	5
41-60	2
Ramets per acre:	
0-50	18
51-100	8
101-150	1
151-200	8
201-250	2

Orchard Sites

The majority of seed orchards are located on old field sandy loams or sandy clays. Two orchards are on clay land, and two orchards are on alluvial soils. Clear-cut and site-prepared forest areas make the base sites for 10 orchards. Seven areas are located on deep sands. The average site index for all orchards falls around 75 feet for slash pine and 85 feet for loblolly.

Grafting

Most orchard managers use the cleft and side graft methods for propagating their elite material. Two organizations supplement their normal grafting with bottle grafting and three orchards include attempts by air-layering. Grafting from outplanted trees in the orchard to root stock (inarching) takes place in eight orchard organizations. The grafting parties use 22 shade houses of sorts, 20 field areas, and 12 nursery beds as their locations for grafting work.

Grafting success varies from orchard to orchard and from man to man. Table 1 is a compilation of grafting and transplanting success by species.

Individual clone grafting success varies from 100 percent failure to almost 100 percent success.

TABLE 1.—Success of grafting and transplanting, based on orchard totals

Species	Grafting success		Grafting success	
	Range	Average	Range	Average
	Percent	Percent	Percent	Percent
Loblolly pine	41-80	64	60-97	85
Slash pine	60-95	72	60-97	85
Virginia pine	52	55	90-95	92
Shortleaf pine	51-90	65	90-95	94
Sand pine	76	76	90	90

¹ Unweighted.

Growth

The growth of grafts from select trees definitely shows the vigor associated with the parent material. The unweighted average age of all trees in all orchards approximates three growing seasons. The average grafted tree has a stem diameter of 3 inches and is 12 feet tall. The largest tree in the southern orchards stands over 31 feet tall and reaches 9 inches d.b.h. after seven growing seasons. It is at Georgetown, S. C., and has had top pruning. Table 2 gives you an inkling of the growth of plus grafted material.

TABLE 2.—Average growth of largest trees in seed orchard

Growing seasons (number)	D. b. h.	Height
	Inches	Feet
7	6.1	27
6	5.5	24
5	3.9	19
4	4.1	20

Phenology

The initiation and amount of strobili development has an important bearing on early progeny testing and seed production for all orchards. The questionnaire answers give the impression that loblolly pine has a somewhat earlier seed production potential than slash. The following tabulation indicates year of first "flowering," as reported by individual orchards:

	Loblolly (year)	Slash (year)
Earliest reported		
Male	Within year planted	1
Female	do.	1
Average of orchards		
Male	2	3
Female	2	3
Latest reported		
Male	3	4
Female	3	4

To date, clonal "flowering" varies by orchards from 1 to 100 percent of the clones in the orchard for male strobili production (averaging 44 percent of clones) and from 20 to 100 percent (averaging

59 percent) for female strobili production. The "sexiest" clonal orchards, excluding the Georgia Forestry Commission, are (1) Western Region, International Paper Co., (2) College Station, Texas Forest Service, (3) Georgetown Region, International Paper Co. The first two of the three preceding loblolly pine seed orchards lie west of the Mississippi River. Individual ramet "flowering" as measured by the number of ramets having more than 100 male clusters or female strobili separates the men from the boys in the following manner:

Male strobili.-1. University of Florida, + 300 slash pine ramets, 2. College Station, Texas Forest Service, + 200 loblolly pine, 3. Savannah, Union Bag-Camp Paper Corp. + 200 slash pine.

Female strobili.-1. Chesapeake Corp., + 400 loblolly pine, 2. Gulf Region, International Paper Co., 80 slash pine, 3. College Station, Texas Forest Service, 62 loblolly pine.

Almost half of the orchards do not have ramets with more than 100 hundred male clusters or female strobili as yet. However, controlled pollination for progeny material is taking place in 27 orchards. Six orchard organizations pollinate for hybrid study, and one orchard makes crosses for disease resistant material. Buckeye Cellulose Corp. experiments with ultra violet ray treatment of plus seed to obtain possible mutations having worthwhile characteristics.

Mortality After Outplanting Success

Hottes (1934) quotes Dr. L. H. Bailey (circa 1890) saying, in essence, that grafting accomplishes one of the four following things: (1) increases flowering, (2) decreases flowering, (3) has no effect, (4) shortens the life of the plant.

We notice the fourth rule today in the considerable mortality apparently caused by phloem blockage due to stock-scion incompatibility and/or poor grafting technique. The questionnaire results show that an average of 11 percent of the clones in the present orchards suffer from phloem blockage and about 7.5 percent of the total ramets are dead due to graft union incompatibility (excluding the Georgia Forestry Commission). Bailey's axiom apparently holds for the mortality angle. I wonder what influence grafting has on increasing or decreasing "flowering" in our southern pines.

Drought (480 trees), insects (+ 430), wind (+ 400), disease (+ 360), and temperature (+ 260), reduce the survival rate of grafted trees by about 2 to 5 percent overall. Ice (19 trees) and lightning (6) add some insult to the mortality picture. Again, data from the Georgia Forestry Commission is not included and could change the information as presented.

Cultural Practices

Orchard culture varies with the site and problems of each individual orchard. The following information and some side comments give an idea

of the different current practices of orchard organizations (number of organizations in parentheses):

1. Mulching (14): sawdust (8), pine straw (5), hay or straw (2), plastic (2), used papermakers felt (1), paper (1).

Most of the mulching is done for the first 1 or 2 years after outplanting.

2. Watering (17): mostly during critical periods in the first year of outplanting.

The Panama City Region, International Paper Co., supplements rainfall to insure a minimum of 1 inch of water per week on 2 acres in an attempt to evaluate the effect of balanced rainfall.

3. Mowing (28): frequency is shown in the following tabulation:

Mowings per year (number)	Organizations (number)
1	2
2	6
3	4
3-4	13
4	3
None	4

4. Weed control (14) : Weeds can be a problem in certain areas and increase fire hazard if not checked. Seven organizations use chemicals to combat weeds, seven apply the old proven method of hoeing by hand, one scalps once a year to remove vegetation. Most orchards rely on mowing and grass invasion to keep weeds under control.

5. Discing (4) : Four orchard managers disc their areas with harrows or furrow discs every year to till the soil and turn in the vegetation.

6. Cover Crops (11): crimson clover (3), Bermuda grass (3), Bahia grass (2), Dutch clover (1), hairy indigo (1), Korean lespedeza (1), ryegrass (1). Cover crops reduce the frequency of moving, can choke weeds to some extent, and provide nutrients to the soil.

7. Pruning (most orchards): Many orchard managers prune a portion or all of the stock branches of each outplant to force scion growth. Disease infected branches are removed or pruned in all orchards. Two small orchards have a pruning study underway to determine the effect of various pruning techniques on "flower" production.

8. Fertilizers—The value of fertilizing orchard trees is still nebulous, except for height growth, according to the 26 answers from orchards using fertilizers. Balanced NPK fertilizers are applied by 21 orchards; ammonium nitrate-limestone is applied by 7 organizations. Muriate of potash (1), lime (1), 0-14-14 NPK (1), and dolomite (1) are also applied in certain orchards.

Fertilizer quantities per application range from 1 ounce to 2 pounds per tree depending on tree size and fertilizer type. One pound of balanced fertilizer per 100 square feet of horizontal crown surface is in use as a guide for fertilizer amounts

in quite a few orchards. Heaviest application in any one orchard amounts to 2,000 pounds of balanced fertilizer per acre, per year. The average dosage per orchard seems to be 400 pounds of 8-8-8 or 10-10-10 NPK per acre spread around each tree area once or twice a year.

Only seven orchard managers make mention of any noticeable tree response to nutrient additives. The following tabulation lists the results of the answers on fertilizer for 8 orchards out of the 26 that use them.

	Organizations (number)
Clonal	2
Individual trees	2
Increased flowering	7
Increased height growth	5
Decreased height growth	1

9. Fire Protection (24): Most orchard men maintain fire lines around their orchards as a preventive fire measure. Four managers strengthen the fire lines with strip burning. One organization burns the orchard each year, a practice, although hazardous, offering maximum security.

Insect Problem and Control

The following insects listed in order of magnitude make seed orchards their habitat and pose a sometimes serious or nuisance problem for the orchard manager: 1. Nantucket pine tip moth, 2. coneworms (*Dioryctria* spp.), 3. red spider mites, 4. aphids (*Cinara* spp.), 5. thrips (mostly Gnaphothrips *piniphilus*), 6. midges (gall midge larvae), 7. seedworms (*Laspeyresia* spp.), 8. scale insects (*Chionaspis* spp.), 9. ants, 10. sawfly (*Neodiprion* spp.), 11. black turpentine beetle, 12. grasshoppers, 13. Japanese beetle.

Table 3.—Use of insecticides in seed orchards

Insecticides	Organizations	Range in Strength
	Number	Percent
Malathion	22	0.1-1.0
DDT	18	.5-1.0
BHC	17	.25-.75
Guthion	3	.2
Heptachlor	2	.1
Sevin	1	
Di-syston	1	10
Thimet	1	10
Kelthane	1	
Aldrin	2	.2-.5
Volck	1	

Experience to date seems to indicate that malathion, DDT, and Guthion give excellent control of tip moth when applied at the proper times. Guthion appears to have a longer residual effect but is much more dangerous to use. Heptachlor, Gu-

thion, and BHC appear effective on "flower" insects but not much is known about their phytotoxic effects. BHC works well in controlling bark beetles, coneworms and seedworms, depending again on the right time for application. Aldrin should be effective against most larvae and beetles but has a high human toxicity number. The systemics, Di-syston and Thimet, seem to hold some promise for tip moth control.

Application times for chemicals range from once a week to once a year depending on the need and the chemical. Eighteen orchards spray on a regularly scheduled basis. Several orchard workers rear Nantucket pine tip moth in small enclosures and spray their orchards when the captive adults emerge and begin flight. I think the same thing can be done with other insects, especially *Dioryctria* spp.

A number of orchard managers feel that the coneworms, thrips, and red spider mites pose a large problem for the future. Eight orchards list *Dioryctria* spp. today as their number one insect problem. I think the Nantucket pine tip moth will continue to plague the orchards because of its affinity for fresh branchlets which could produce "flowers."

Disease

Fusiform rust (*Cronartium fusiforme*) heads the list of diseases striking seed orchards with cone rust (*Cronartium strobilinum*) far down in second place. Most of the fusiform rust infection appears in the branches on the stock of the grafted material with some attacks occurring in the graft unions. Cone rust strikes conelets in seven orchards located in Georgia and Florida. One orchard finds a problem with needle cast. *Fomes annosus* in one or possibly two orchards causes concern.

Pruning infected areas and spraying with ferbam (usually at the rate of 2 pounds ferbam per 100 gallons water during periods of high telial spore formation and flight) for containing and preventing fusiform rust and cone rust forms the basic control practice in the majority of orchards. Radical surgery of the stem canker of fusiform rust seems to be successful in certain instances. At least the trees involved either survived, or died very quickly instead of slowly. Champion Paper Co. applies phytoactin and grafting wax to the cut area of the bole in their radical surgery method. Ferbam sprays are in use for the control of needle cast. In dealing with *Fomes annosus*, Hiwassee Land Co. treats the area around each uprooted tree with methyl bromide gas at the rate of 11 pounds per square inch.

A recent recommendation of considerable worth calls for applying borax powder or spray to freshly cut pine stumps within the orchard area. The complete lifting of the dead stem and root system is suggested as a sanitation procedure for *Fomes annosus* in orchards where dead grafts or failures in the field are problems.

Birds

Two orchards have dealt with the yellow-bellied sapsucker who enjoyed nibbling on elite material. Several orchards have placed poles or bamboo canes as bird perches in an attempt to reduce pine leader breakage or disfigurement by bluebirds and other winged orchard visitors. I am not sure if the results were impressive.

Equipment

Apparently tractors and mowers form part of the basic equipment of each orchard. Sixteen organizations furnish trucks for use in their orchard programs. Supplemental water is applied to 13 orchards from portable tanks. Two orchards have sprinkler systems and six orchards make use of ditches or dikes for irrigation or drainage. Pressure sprayers of varied manufacture, including homemade, furnish the means of distributing chemicals for 15 orchards. Eight orchards use backpack mist blowers and two orchards rely on the truck-mounted mist blower.

The development of rigs for reaching high branchlets is quite interesting and needs more study and design.

The types of reaching equipment now in use (and the number of orchards using them) are: ladder (7 plus others not answering questions); ladder with bicycle wheels (2); ladder, truck mounted (4); ladder, trailer mounted (3); ladder, tractor mounted (4); and elevated platforms on truck (4).

Costs

The costs of managing seed orchards can be hidden from view by the simple expediency of not mentioning them. The limited number of answers furnished by the questionnaires prove that seed orchard costs are too trivial to list, too high to recall, or simply unknown. The range of rough cost estimates furnished by the questionnaires is from 15 to 350 dollars per acre per year. My estimate of annual expenses for the average seed orchard would be in the neighborhood of 40 to 50 dollars per acre which, in turn, could be higher depending on the size of the spraying and cross pollination programs.

Research

Research aids the seed orchard manager in finding answers to some of his problems. For your consideration and thought the following is a partial listing of some specific areas needing basic or applied research:

A. Physiology

1. Stimulation of "flowering"

- a. Water requirements
- b. Nutrient requirements
- c. Other physiological developments or requirements
 - (1) Climate

- (2) Mechanical bending, girdling or pruning
- (3) Catalysts (biochemical)
- d. Genetic influences
- 2. Graft incompatibility
 - a. Healing process and tissue development
 - (1) Translocation of water and nutrients
 - (2) Genetic influence
 - (3) Catalysts (biochemical control)
 - b. Graft techniques
 - (1) Effects of different types of grafts
 - (2) By-pass methods
- B. Phenology
 - 1. Reasons for seasonal variations in time and amounts of "flowering"
 - a. Climatic
 - b. Soil
- C. Propagation
 - 1. Improvements in propagation and transplanting methods
 - a. Rooting
 - b. Grafting
 - c. Catalysts (hormones)
- D. Methods of breeding
 - 1. Efficient and simple handling, extraction, and storage of pollen

- 2. Efficient low cost isolation material
- 3. Development of equipment to mix and distribute large quantities of pollen if necessary
- 4. Development of multi-use equipment for reaching
- E. Insect and disease control
 - 1. Continued research for non-phytotoxic chemicals with high residual effects
 - 2. Systemic chemicals for insects or disease
 - 3. Application systems
 - 4. Natural enemies of insects and disease
 - 5. Knowledge of genetic control of insects and disease.

Perhaps, in time, enough answers and developments will furnish aid to the orchard manager for maximum yearly seed harvests. A conservative estimate, based on the 4,500 acres of seed orchards which will exist after 1967 and a future yield of 15 bushels of cones per acre per year, will forecast the availability of enough plus seedlings to plant almost 700,000 acres per year in 20 to 30 years or less.

The answers to the questionnaires definitely emphasize the fact that we are entering the large scale area of elite forest seed production. Forest seed orchards are big business now.