SEED ORCHARD MANAGEMENT[1/]

J. P. van Buijtenen, Texas Forest Service
College Station, Texas
(Panel Moderator)

Since this will be an introductory paper, I will try to keep my presentation rather general, drawing largely on our experience in Texas. I will interpret seed orchard management rather broadly, assuming that it includes everything from establishment of the orchards to making the crosses for progeny tests. Some of the most critical phases are the selection of the seed orchard site, the grafting phase of seed orchard establishment, seed orchard maintenance procedures, and progeny testing. I'll devote some time to each of these major phases.

SEED ORCHARD ESTABLISHMENT

One of the most critical decisions to make is the selection of the seed orchard site. Our knowledge of the requirements for a good seed orchard site is rather spotty since it stems from experience rather than experiment, but there are a number of lessons we have learned the hard way.

We found that geographic location is very important. Some locations are undesirable because the orchard may be subject to damage caused by weather conditions. For instance, damage from ice storms was extremely serious in an orchard in the northern portion of the State. I vividly remember one ice storm which broke eighteen 15-foot-tall grafts at ground level.

Also, we know that seed production varies greatly with geographic area. We have some slash pine clones of the same age planted north of Lufkin and just south of Jasper. At the northern location, these clones produced cones for the first time last year, and then only very few. At the southern location, these same clones produced 30 pounds of seed per acre.

Soils also can make a great deal of difference. Both extremely light and extremely heavy soils have presented problems. If anything, the lighter soils are preferable. Survival and growth may be a problem but by use of irrigation and fertilization they can be made to give acceptable results. Don Viele summed up the problems of heavy soils quite well at the last meeting. Survival is low and the soil will not support heavy equipment in wet weather.

Once the site has been selected, thorough site preparation, including stump removal, and level of the land pays off. Removal of stumps and roots will cut down on the chances of infection of the

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1/ Panel presentation. Papers of panel participants are included.

grafts by Fomes annosus. In combination with leveling of the land, it will permit equipment to be moved through the orchard, which is absolutely essential.

Although seed orchards can be established either from grafts or seedlings, our experience has been mostly with grafts. We tried pot grafting, nursery bed grafting, and field grafting. Of these, field grafting is unquestionably the best in terms of survival and growth of the grafts. In our case, it has also been the most expensive. This is due to the fact that a larger number of grafts need to be made to insure that at least one successful graft is present at each location. More time is lost in moving from tree to tree, and--at least in our case--the grafters need to travel much greater distances from one area to another in order to do the necessary grafting. For these reasons, we prefer to graft in nursery beds. This also gives a vigorous graft with a well developed root system. It is necessary to root prune the grafts early in the season since in good years they grow up to 3 and 4 feet tall, and are difficult to transplant. We apply root pruning when the grafts are about 18 inches tall. This severely restricts further growth and also results in a much better developed root system. Our practice is to transplant the grafts bareroot during the dormant season. Preferably, this is done in mid-December in order to give the grafts a longer period to establish a root system. Others have had good success transplanting grafts with a ball of soil during the growing season.

Seedling seed orchards have not worked out very satisfactorily for us. We have tried setting up a seedling seed orchard of loblolly pine selected for drought resistance. This seemed a good application for the seedling seed orchard approach, since it gave us a chance to select twice for drought resistance: first by selecting the most hardy parents and then the most hardy seedlings within their progenies. It turned out being very slow due to the difficulty in obtaining the necessary crosses and the time involved in testing. In addition, seed production of the seedlings was found to be below that of grafts.

SEED ORCHARD MAINTENANCE

During the first 2 years after transplanting, we irrigate the grafts when the available soil moisture level drops to more than 6 inches below the surface. We also fertilize the grafts with 12-12-12 during this period to keep them growing rapidly. After the trees are firmly established we no longer irrigate. Fertilization is continued, however, but is aimed at increasing flower production. We've carried out a number of studies on this. The results are somewhat at variance with those obtained on the east coast. This may very well be due to differences in soils and climate. In our studies, we have found that phosphorus is the most critical element in flower production. In one study on a sandy soil (Independence loamy sand)

phosphorus stimulated flowering, while nitrogen actually depressed it. In a second study on an alluvial sandy loam, most fertilizer combinations we tried stimulated flowering, but the best treatment was 10-20-10 at a rate of 1400 pounds of P205 per acre.

We have tried disking to stimulate flowering. It did not seem to have much effect of female flower production, but caused a dramatic increase in production of pollen. On many soils, however, disking is not practical because of erosion. Since the benefit of disking is usually offset by erosion, we prefer to keep the orchards in grass and mow them at frequent intervals.

Although most studies have shown that pruning in general reduces flowering, pruning from below appears to have a slightly beneficial effect on both male and female flower production. For this reason, and to facilitate moving equipment through the orchards, we prune grafts up to a height of about 7-foot once they are 20-foot or higher.

One of our more serious problems in the seed orchards are insects. We have tried spraying, mist blowing, and systemic insecticides. At young ages of the orchards, spraying gave us a fair degree of insect control. When the grafts became too tall for this, we switched to mist blowers. Results of this have generally been unsatisfactory because of the high cost and low degree of control achieved. Recently, we have done some experimenting with Thimet. It has given us good control of tip moth, but the control of cone insects has been disappointing and is still our number one seed orchard problem.

SEED PRODUCTION

Our orchards range in age from 1 to 12 years. In our oldest (11 years) slash pine orchard we have obtained a seed production of 30 pounds per acre. In the loblolly pine orchards, yields have been lower, averaging about 10 pounds per acre on the producing orchards. The average age of these orchards is about 10 years.

When the grafts are small we collect the cones from a platform mounted on top of a pickup or a microbus. When they get over 20-foot tall we use a trailer-mounted ladder. This year we will try out a pecan shaker on our slash pine seed production area and seed orchards. We are also looking into the possibility of using a device similar to a cherry picker for loblolly pine.

PROGENY TESTING

Progeny testing methods vary greatly and we have tried most of them. Open-pollinated progenies from the field selections give an early indication of the potential of a tree. They should be established as soon as possible if seed can be obtained. Similarly, open-

pollinated seed from the grafts in the orchards, kept separate by clones, is of considerable value since this is the seed which actually will be used in commercial planting. Open-pollinated tests have proven of great value to us by giving us early information on the performance of our clones and the inheritance of growth rate, form, and wood specific gravity.

Progenies obtained by crossing with a pollen mixture are of questionable value since they combine most of the disadvantages of both open-pollinated and cross-pollinated progenies with very little of the advantages of either one. They estimate only general combining ability, they are of limited value in further breeding because of the possibility of inbreeding occurring, yet they involve the cost inherent in making controlled crosses.

Cross-pollinations are extremely valuable as a means of thoroughly evaluating the parent trees. Equally or more important, they serve as a source of material for second generation orchards. We have been using the four-tester scheme in which four clones are used as testers and all the other clones are crossed with them. We are presently re-evaluating this procedure since we feel that we can come up with a design that is both more efficient as a progeny test and also gives us a better basis for selection.

SECOND GENERATION ORCHARDS

Pretested orchards.--We are now at the point where we feel that we can make several improvements on the procedure followed in setting up seed orchards. We feel that the way we are setting them up now is basically a stop-gap measure until we have a continuous breeding system developed. It may well be that our present system is close to the most efficient that can be devised, but this is rather unlikely. We are, therefore, looking closely at the various schemes that can be adopted for tree breeding and evaluating different alternatives in terms of cost and improvement that can be obtained. One very attractive idea is the use of pretested orchards as a second step. With this I mean setting up a new orchard from the best clones of the orchards we have at present. It is relatively cheap, since we have already paid for progeny testing. We can reduce our problems with incompatibility since we already know which clones suffer from this. We can also achieve a more balanced productivity of our clones. So far we have found that the bulk of our seed in each orchard is produced by very few clones. By setting up a new orchard so that productivity is more balanced we can both increase the cone production per acre and also provide a broader genetic base in the material produced.

New selections .--One of the most logical places to look for new selections is in progeny tests which are at half rotation age or older. Also, larger scale plantations of improved material may be a good source when they become available. It has been suggested that small seed lots, let's say 1 pound to several pounds of seed for each clone, be kept separate and handled individually to provide plantations of known parentage of sufficient size to practice intensive selection. If one chooses to follow this route, it is necessary to keep the location of the plantings and the identity of the parents well documented. The more information is available on the selection and its relatives, the more accurate one can judge its breeding value.

Also, some new materials from unknown parentage might be added to the breeding stock to keep the genetic base wide. The handling of this is rather critical since combining such material with stock of known parentage might cause a dilution of the improvements already obtained.

Early testing.--Since progeny testing is time consuming and costly, it is very urgent that we develop methods to evaluate the genetic potential of seedlings at a much earlier age. For characteristics such as drought resistance and wood specific gravity this can be done already. For other characteristics such as volume production, early measurements are still very unreliable. A very fruitful and unexplored area of research is opening up here which we are planning to get into.

DATA HANDLING

In the past we have put all our progeny test data on IBM cards and analysed them one plantation at a time, but this is no longer satisfactory. To give you an idea of the scope of the problem, we have about 100,000 trees and grafts in the field now which are derived from about 1,000 parents and ortets. We are getting measurements on these every 5 years. With all these data coming in from progeny tests, we are getting completely "swamped". We are, therefore, putting all our cards on tapes and disks and are developing a generalized data retrieval system which we hope will ease the burden considerably.

CONCLUSION

This is a birds-eye-view of some of the problems and promises in seed orchard management in its broadest sense. I feel strongly that forest tree improvement in the South has arrived at a critical period. We are getting so much information and experience from our earlier tests and oldest seed orchards that, in the next 10 to 15 years, we will see an even more rapid development than we have in the past.