GRAFTING OF DOUGLAS FIR
AND
ESTABLISHMENT OF SEED ORCHARDS

by

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Mr. Jacobson said they have planted some five million trees and have had fairly good success. They plan to thin the stands every five to ten years, It is anticipated that in sixty-five years ' time 40 ¸000 board feeto or better to the acre will be harvested.

Mr. Jacobson called on Mr. Bent Gerdes to present his paper.

In forest-tree breeding s, propagating by grafting and cuttings is of fundamental importance because we ¸ through these operations, are able to keep exactly the same features we find an the selected tree. In other words we establish a "clone." We can move the tree to a place where we easily can work with it; we can bring it together -with other selected trees; vie can save the

tree for the future, and we can graft it in depots where we can get hold of it the day we want to use it. And lasts but not least, we can easier test our selected tree, both as a "clone," and progeny test it through free and controlled pollination.

Through grafting we are able to save time, as the twig we graft is able to retain its biological status when transferred to a young stock, so that we can expect grafts from seed-bearing trees to start flowering two to five years after the grafting.

I would like to mention, that even if tree-breeding is a new science (grafting was first used in tree-breeding in 1937 in Europe by Syrach Larsen) the art of grafting has been developed by the Chinese 6,000 years B. C.

Until a couple of years ago, grafting was done solely in. greenhouses, but experiments with grafting in the open are going on now and showing better results.

The important factors for a successful grafting are the condition and. treatment of the scion and stock, the time of the year for the grafting, the method of grafting, the skill of the grafter, and the care-taking of the graftings.

THE SCION

When the plus-tree is selected (I call it "plus-tree" until it is proven that the tree really is superior In the respect of genetics; that is, until we know about the genotype and not only the phenotype; we may then call it an "elite-tree"), the job is to get hold of a good twig, preferably from the top of the tree, where we get a scion best fit for grafting, while material for cuttings should be taken lower on the tree. Scions from the very top of the tree are usually vigorous, healthy, and in full growth. The length of last year growth is plenty for a graft (maybe even for two). On elder trees the last year's growth may not be long enough to make a good scion, but where it as possible, only one-year-old twigs should be used. Another advantage of taking the scion from the top of the tree is that up there we have usually reached the biological age for bearing seed.

How to get them down? Climb the tree, or as I have been doing, shoot them down with a shotgun (cal. 12_9 buckshot). Don't cut the branches before the grafting is to take place, and keep the scion material refrigerated at high humidity (I used the crisper in my refrigerator). The scion may be cut -while the tree is dormant, and kept under refrigeration; these scions can be used at all times, while the sap is up in the stock.

If the scions are cut when the tree is about budding they will have to be used right away, but if we collect when the tree is dormant and refrigerate, we have the advantage of being able to graft over a longer period of time. The best result is obtained when the scion is somewhat retarded in relation to the stock, a feature we get in nature when we graft high elevation trees on low elevation stock.

I cut the scion for the type of grafting I have used (side graft ing), I want to end up with a scion two to three inches long, preferably last years growth with one or more buds. These scions are not too easily obtained, and that is one of the reasons for having depots of our plus-trees - places where we graft the scions me get the hard way; here we can expect to get plenty of good scion material, when we want to start our seed orchards.

THE STOCK

Normally the stock is of the same species as the scion, and depending upon the purpose of the grafting, different sizes of stock can be used. For instance, in establishing depots of grafting material, a natural stand of Douglas fir of the age of five to twelve years can be used, but for establishing a seed orchard, I would prefer a planted four to six year old stand. In all cases the plant should be sound and **in** good growth.

I prepare the stock like this:

Saw or cut off the top of the tree to get a horizontal cut with a diameter of one-half to one and one-half inches, preferably over browsing height then smooth the cut with a sharp knife. You then cut two slits through the bark and cambium-layer, vertically and parallel, with the width between them slightly more than the width of the scion, length **one** to one and one-half inches. Next the scion is prepared by two cuts one just exposing the cambium-layer at a length of one to one and one-half inches, the second on the opposite side and exposing the wood, Insert scion in the slit, cambium to cambium, and wood to wood * Bind with raffia and then wax.

The whole operation should be done quickly to avoid drying of cambium layers, and with clean tools to avoid any infection. I have had some sad experience grafting in the rain; not only did I get wet, but all grafts died two to three weeks later. Do your grafting prefera on an overcast day. Be sure to have green limbs on the stock under the graft to stimulate the sap flow. Face the bad towards the center of the stock to avoid possible breaking loose of the scion, when the graft starts growing; finally, trim stock lightly .

THE TIME OF THE YEAR FOR. GRAFTING

The best time of the year to graft will have to be locally determined. Here is some general information as I see it from my experiments * The first and most important point is that the stock is in full growth, and that the sap is up. Secondly, the buds of the scion should not yet have opened, but have started to swell. This best grafting time for Douglas fir does not last long, in *my* opinion. It may be prolonged some by grafting the low elevation first and working up, but even then it *is* a relatively short period if any major grafting operation has to take place * In Denmark and Sweden they have had very good results by keeping the scion material under refrigeration, and thereby prolonging the grafting season. We can use more information concerning this matter*

Here are some figures from. my experiments with Douglas fir in western Washington grafted at 700 feet elevation:

Date of Grafting	Tree No.	Survival in %	
April 5	1	35	
April 12	8	0	Rain while grafting
April 13	4	25	
April 13	8	71	Refrigerated
April 13	9	50	
April 13	10	25	
April 15	11	100	
April 19	10	50	
April 20	4	86	
April 21	12	100	
April 22	7	83	
April 27	14	63	
May 3	15	92	

This spring I have made 92 grafts. 12 or 13% have died (including the ones grafted on the rainy day); 52 or 57% are doing fine and the remaining 30% have not made up their minds yet, whether they mill live or hot.

CARETAKING OF THE GRAFTS

The most important job here is to loosen up the binding materials when it becomes too tight (6 to 8 weeks after grafting). The stock can be pruned lightly; heavy pruning might result in too ranch growth of the graft and thereby endanger it from breaking loose from the stock. Shading of the grafts the first couple of weeks has proven to increase the survival.

ESTABLISHMENT OF SEED ORCHARDS

Without going too deeply into the reasons for establishing seed orchards, I would like to briefly mention the most :important s as the type of orchard will vary with the reason. of the orchard.

PURPOSES:

1) We have a stand of Douglas fir we like, but we want to get more seed than it

   a) A high elevation stands where seed years are few and germination of the seed is low.

   b) A small stand of desired qualities surrounded by poor strains.

   c) A strain that has shown up *very* well, but where the land has to be cleared.

To solve these problems we can establish seed orchards. This cannot [illegible] breeding, but it solves the problem -

Here the purpose of the seed orchard is:

To retain
To isolate
To multiply.

Through the grafting we retain the good strain. By placing our orchard *away* from other Douglas fir, and by all means from poor strains we isolate, and by making hundreds of grafts we multiply what good we already have.

This type of orchard is the simplest to establish; we don't have to tests we know what -we get; we just get more of its and we get it easier.

Seed orchard model I, II and III can be used.

2) Breeding by selection. The point here is to get something betters than we have.

   The first step is selection of trees of desired qualities (plus trees), grafting in depots, and progeny tests through free and controlled pollination.

You will see that here, besides retaining, isolating, and multiplying, *we* also combine (we hope to combine desired qualities from different trees in the next generation). The actual establishment of seed orchards for these two purposes is much alike, as we are able to start orchards of the latter type when we select our trees, and then, when the result of our progeny test shows up, we just have to eliminate the trees that did not live up to our standards.

In both cases the orchard should consist of, at the very least, eight to ten clones. There has been considerable argumentation concerning the number of clones that should go into an orchard. In Sweden they insist on 25 as a minimum, but if *we* have to include, perhaps, five or ten clones which are not the very best just to make it 25, I think we are losing out. The reason for not just having one or two good clones is the danger of getting a too homogeneous offspring.

The arrangement of the clones in the orchard can be as one of the following models show (see model *I,* III).

There are six to eight feet between the rows as well as between the trees in a ran. All rows are double rows, which enables us to cut out every second *row* as the trees grow up, without losing any of the clones.

For all seed orchards it is of great importance that they are located in a place where we can expect to get seed as often as possible (low elevation and perhaps not too high site land), and in a place, where we are sure, that only pollen from the orchard will pollinate the trees. It has been figured that 2,000 feet through another species is sufficient **isolation,** but it would be nice to have more information concerning this very important problem. We know that a small percentage of the pollen will fly a long way, and maybe we from Washington will have to work together with you from California.

3) Hybridization. Even if this does not seem of immediate interest with Douglas fir, I think this special type of breeding should be mentioned, as much more as the seed orchards for hybrids can be arranged in another manner than those already mentioned (see model for orchard for hybrids). Here is used only one clone, (which should be well known) and plants from seed of another species. Then we only gather the cones on the clone, which will have to be pollinated either by itself or by the heterogeneous trees originating from seed. If the species *is* self-fertile, the self-pollinated seed will be recognized in the nursery and so called. In this case there is no danger in using only one clone, because we pollinate from trees that originate from seed.

Finally, I want to mention that seed orchards do not necessarily have **to consist of** clones. If we have some good seedlings originating from controlled pollination of good trees, we can bring them together in an orchard.

The rotation-period in tree farming is extremely long. The capital invested *is* large, and the importance of working with the best possible strain *is* obvious. For every year we can reduce the rotation-period, and still get the same result, we can spend $3.00 to $6.00 more per acre. If this is spent on seed alone, we can pay a much larger amount per pound for the seed.

This calculation is based on:

30,000 seedlings per pound seed
800 plants per acre
80 years rotation-period

$20.00 normal planting cost
$ .50 a. year for taxes, fire protection and management per acre
50,000 bd. ft. at 80 Years o at a value of 350.00 per thousand
and 4% to 6% interest.

DISCUSSION:

QUESTION: At what temperature do you keep the grafting material?

MR GERDES: About forty degrees.

QUESTION: How long will they last?

MR. GERDES: A couple of days but do it as fast as possible.

It was moved and seconded that the next meeting be held at Wind River Nursery In the State of Washington, probably during 1956.

The meeting adjourned at 5:40 p. m.

The meeting of the Forest Tree Nurserymen at Sacramento, California, on June 17, 1954, was followed by a field trip to the Institute of Forest Genetics at Placerville, California, on June 18th.

The origin of the Institute was due entirely to the far-sightedness of a Seattle lumberman James G. Eddy. He became intensely interested in the possibilities of tree breeding at about the same time that the work of the well known plant breeder Luther Burbank was attracting world wide attention.

Eddy established the tree breeding station in 1925 and work on selection and hybridization was begun on a limited scale at that time.

In 1935 Eddy donated the station to the people of the. United States and it became part of the United States Forest Service.

Now it can be said without reservations that the Institute in the short space of 27 years has more than justified the hopes of the founder as it has conclusively shown that tree breeding is not just a dream but a definite reality with tremendous possibilities in Forestry°

The pine is the principal lumber producer of California while the genus has a wide distribution throughout the northern hemisphere making it particularly suitable for breeding w°rk. It was also decided that the tree breeders most important contribution to forestry would be to reduce the number of years needed to produce trees of merchantable size, so the primary objective of the Institute became one of producing faster growing pine. In addition it was hoped that other desirable characters such as wood quality, disease and insect resistance could be selected from fast growing strains or bred into trees by hybridizing.

In 1940 it was felt that more time should be given to the development of hybrid pine and from this date onwards the hybridization program has become of increasing importance.

The phenomenon known as hybrid vigour, or heterosis, is still little understood as there is no way of predicting which hybrids may exhibit it. It has great potential value in tree breeding works however, and it is felt that such

trees will make up the planting stock of the future.

At the present time considerable emphasis is being laid on improvement of the two most important timber producers of California, ponderosa and Jeffrey pine, and the method of incorporating several desirable characters into crosses with these species have been successful.

Many of the criticisms against hybridization and tree breeding as practical measures in forestry originate from comparisons with agriculture where to insure the uniformity adaptability of new crops long trials are necessary. The farmer himself cannot afford to risk the loss of his land and labor for a year to try out a new strain of unknown value. In forestry, however, uniformity is not only unnecessary but undesirable as inherent variability is the forest's best insurance against the attacks of disease, insects, and other deleterious factors.

One common criticism is that, even if a hybrid is proven superior to ordinary planting stock, the seed will either be completely sterile or failing that, the F2 or second hybrid generation will be worthless so that the whole area will have to be replanted in either case. Righter, however, states that with the genus Pinus these suppositions have not proven correct, and explains that in the gymnosperms there is little or no variation in the chromosome number, morphology and structure so that speciation in coniferous genera can be mostly attributed to gene mutation. Righter has also found that the F2 generation is by no means worthless, although they show great variability°

RESUME OF FIELD TRIP BY FOREST TREE NURSERYMEN

by.
Stephen N. Wyckoff, Executive Vice President

The work at the Institute was demonstrated by F. I. Righter, in charge, and. A. R. Liddicoet and E. F. Kimbrough. Over 65 pine hybrids have been produced, using many American and some foreign species as parents. Some show hybrid vigor, others indicate resistance to such insects and diseases as the Western pine beetle, the pine reproduction-weevil, and the white pine blister rust. Mr. Righter also stated that studies are under way for cheap production of hybrid seed and studies of pine chemistry and physiology.

The nurserymen were shown the methods by which pollen is collected, stored, and applied to the flowers of the seed parent tree. The special nursery techniques used to test hybrids in juvenile stage were demonstrated. Out plantings of hybrids with trees of the parent species nearby for comparison were examined and discussed°