GRAFTING NORTHERN CONIFERS WITH SPECIAL REFERENCE TO WHITE SPRUCE

By
Hans Nienstaedt

In my talk to you today, I wish to discuss with you the grafting of northern conifers. My comments will be limited to techniques that might be useful under the climatic conditions of the Lake States. Much of what I have to say will specifically refer to spruce grafts, since spruce is the group with which we at the Institute of Forest Genetics have had the greatest experience.

My talk will cover four major subjects. I shall discuss first, the place of grafting in a tree improvement program; second, the advantages and disadvantages of grafting; third, the techniques that we have found most successful with the spruce, with emphasis on the do's and don'ts; and finally, the type of crews we have found handy in our grafting program, and the outputs you can expect.

The Use of Grafts in a Tree Improvement Program

We might consider four uses of grafts in tree breeding programs. First of all, it will always be convenient to propagate selected phenotypes, simply to increase the number of individuals available for breeding and to assemble selected phenotypes at locations where they are handy to the tree breeder.

Secondly, grafts are essential to the establishment of seed orchards. Personally, I see absolutely no reason why the use of grafting in the establishment of orchards should be controversial. For some of our species, I am certain it is to our advantage to establish a first generation of orchards on the basis of grafted clones of select phenotypes. It is a matter of expediency--a way in which we can get some improvement without a long delay between the establishment of seedlings and the first harvest of seed. Furthermore, I feel very strongly that the seedling seed orchard is an unrealistic concept. Consider a seedling seed orchard--so called- established from selections within an initial assembly of 300 seedling progenies, each replicated 15 times and each plot consisting of 4- tree plots. To select the five best seedlings in the 15 best families probably would be a reasonable selection differential. In other words, an original planting of more than 15 acres (18,000,seedlings) would be reduced to 75 trees. Obviously, 75 trees will not produce the amount of seed required for a tree improvement program of any size. The 75 trees selected would definitely have to be propagated vegetatively in order for us to obtain the seed production required.

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The two last uses of grafts are of less importance. One method was at one time strongly advocated by Dr. Syrach Larsen. He used vegetatively propagated material as part of the testing procedures, which he called "the estimation of the genotypes" from clonal material. Some information can be obtained from clones, but recent work has shown that the clonal test has very definite limitations. Therefore, we will probably find a use for tests using clonal material in only some special instances.

Lastly, we might consider the propagation of superior types for actual commercial use. This, of course, is the foundation of most of the fruit industry with which we are familiar--apples, pears, plums, cherries, citrus fruit, etc., all are propagated vegetatively and most of them by means of grafting. Possibly, we can find similar uses for grafts in forestry. Poplar clones rooted from cuttings constitutes the use of vegetatively propagated material in forestry. As we shall see, rooted cuttings are to be preferred when we are talking about such uses of clones. However, we might speculate that someone some day will be able to use grafted stock in special cases in forest management.

Advantages and Disadvantages of the Use of Grafts and Cuttings

Any comparison of grafts versus cuttings will show rooted cuttings to be the most advantageous. Not only are they much cheaper to produce than grafts, but also they are established on their own roots, which very definitely is an advantage. Unfortunately, however, we today are unable to root successfully most of our northern conifers and hardwoods. It is possible to root material from young seedlings, but trees of greater physiological maturity cannot be rooted with any degree of success.

We therefore have to accept the use of grafts and the problems associated with the relationship between the rootstock and the scion. These problems are not well understood. In the simplest cases, the scions do not become established on the stock but die shortly after grafting. More insidious and much more of a problem is the type of incompatibility in which the graft becomes well established initially, but then after several years of apparently healthy growth suddenly succumbs for reasons unknown. Partial incompatibility resulting in dwarfing of the scion growth may be a problem in some cases but can, perhaps, be utilized to advantage. We might be able to grow seed on dwarfed trees. It would require that seed production be not too drastically decreased and that seed development be normal.

Grafting Procedures

Scion Collection and Handling

A good healthy scion is essential to successful grafting. The ideal scion from spruce and pine is a 3- to 4-inch branchlet between 1/8 and 1/4 inch in diameter and consisting entirely of current growth. Such scions are easily obtained from healthy spruces up to 60 to 80 years old and from younger pines. Often, however, the tree breeder is forced to collect from

mature and even over-mature trees. Scions from such individuals are short and very spindly, and the results from grafting, therefore, are much less satisfactory. If grafting scions from 30- to 50-year-old trees results in 70- to 80- percent take, grafting from mature trees is likely to yield only 40 percent successful grafts.

Scions should be collected from the upper fourth of the crown, and they should be from the terminals of second- and third-order branches. If this rule is not adhered to, the resulting grafts might retain branch characteristics for an indefinite period.

Immediately after removal from the ortet, the scions are placed in polyethylene bags. During the winter they can be stored out-of-doors in the snow for several weeks without marked reduction in the percent take. During the spring and summerfield-grafting, scions can be transported in an ice chest; but long-term storage should be avoided at all costs.

Rootstock and Rootstock Handling

For greenhouse grafting, a potted rootstock is used; 2-2 white spruce transplants, 2-1 red pine, and 2-0 or 2-1 jack pine plants are the best size. The plants should be well formed and approximately pencil thickness at the point of grafting 4 inches above the soil line. The plants are lifted in the nursery in late April and potted in 4-inch pots. This necessitates some crowding of the roots in the pots, but the smallest possible container size should be used to save greenhouse space. During the summer, the stock plants are grown in the lath-house; they are maintained under a regular watering schedule and fertilized with a 10-10-10 granular commercial fertilizer once or twice after transplanting.

Most greenhouse grafting is done in the late winter. The rootstock plants should have received the complete chilling necessary for the plant to start normal growth after it is brought into the house. For white spruce, this means that stock plants should be exposed to outdoor conditions until at least the middle of December.

The stock plants are moved in a frozen condition into the greenhouse from the lath-house or cold frames. They are left in the house at moderate temperatures (55 to 60 F.) for a few days until the pots are thawed. Then the temperature is raised to 70°F. during the day and 60 F at night. The day-length of the plants is maintained at 18 hours. This long-day treatment is important. An extension of normal daylight with low-intensity incandescent light is sufficient. After 2 to 3 weeks the stock plants show signs of bud swelling and are ready to be grafted.

Grafting in established plantations can be quite successful. We have found it convenient to work in 5- to 7-year old white spruce plantations. Vigorous trees 31 to 5* feet tall make excellent rootstock.

Grafting Technique

I shall not go into any detail on the grafting technique itself. It is enough to say that the standard side-graft method is successful on both spruce and pine. The important things are: (1) that the cuts are made with a sharp knife--no whittling, please, (2) that the scion is tied securely to the stock, and (3) that the graft union is carefully sealed. The material used in tieing is unimportant; we have used raffia, cotton string, or special plastic grafting tape. Rubber budding strips can also be used, but are more cumbersome to handle. Various grafting compounds are available. The water soluble emulsion, TREEKOTE, which can be applied cold, is one of the better ones available. After grafting, the grafts are returned to the greenhouse bench and maintained on the 70° and 60°F. alternating temperature and long-day conditions. The important maintenance at this stage is a careful watering schedule, the gradual snagging--cutting-back--of the stock, and the release of the tie. Usually, the tie must be cut 6 to 10 weeks after grafting.

Spruce is field-grafted best by using a side graft at the base of the leader. The tip of the leader is removed at the time of grafting, and all but one of the lateral shoots above the grafts are removed about one month after grafting. We have determined, through experimentation, that no form of cover is required for spruce spring or summer grafting. Kraft paper bags used as covers actually decrease the percent take. Pine can also be grafted without the use of covers.

Time of Grafting

Let me now briefly describe some of the research we have done at the Institute attempting to extend the grafting seasons. Indoor grafting in late winter coincides with many other greenhouse activities, and so greenhouse space is at a premium. As I have mentioned, field grafting, which takes place the last week of April and the first week of May, also falls at the time of maximum nursery activity. Therefore, an extension of the grafting period would be very helpful. One research indicates that grafting can be done at practically any time of the year.

Greenhouse grafting can be performed successfully in September on potted stock. The grafting technique is the one already described. The grafts are maintained on long-day for four to six weeks after grafting; they are then transferred to short-day conditions for a couple of weeks and finally transferred to cold storage for a period of six to eight weeks. This treatment at 40F. is essential to fulfill the chilling requirements. Thereafter, the plants can be returned to the greenhouse where they should start growing in three to five weeks.

The period of field grafting also can be considerably extended. On 6- to 7-year old transplants in the nursery, we have grafted from the last week of March until the first week of May with very good success. Survival ranged from 90 to 100 percent (in unreplicated tests), and subsequent growth was excellent. On potted rootstock handled as already described, we have grafted in an unheated lath-house as early as the last week of March. Grafting again was successful up until the scion began to show signs of activity. The best results were reached around the middle of April with 80 to 90-percent success:

In one extensive field test, we determined that scion material from 60-year-old and 30-year-old trees can be grafted with good success from the middle until the end of July. Towards the end of the third summer after grafting 60- and 30-year-old scion material, survival was 50 and 63 percent respectively from grafts made on July 17, 30 and 33 percent for grafts made on July 31, and only 27 and 13 percent for those made on August 14. All grafts done after this date failed completely. These figures compare to the 70-percent survival resulting from spring grafting on comparable material in the field. Generally, union formation and growth was good on the July grafts.

Crew Organization and Output

The three-man crew has worked out efficiently for grafting indoors. One man does nothing but graft; he cuts the scion and stock and ties the graft. Two men handle the stock and the scion; they prune up stock plants, trim scions, and transfer stock from the greenhouse to the grafter and back to the greenhouse bench. They are also responsible for painting the graft union and for labeling. With a crew of this size, an output of 20 to 30 grafts per hour can be expected from an experienced grafter.

A 2-man crew is usually efficient in the field. Both men trim scions in advance for several hours of grafting work. One man then does the actual grafting and trims the stock plant while one man paints the prepared graft. With this organization, 10 to 15 grafts per hour can be produced, depending on the amount of travel the crew has to do from one graft to the next.

Summary

Grafting, to the layman, seems to be surrounded by an aura of witchcraft. This feeling is entirely unwarranted. Anyone possessing average dexterity can graft and graft successfully. The really important factors which determine success or failure are:

(1) The quality of the scion. Poor scion material invariably means poor grafts.

(2) The quality of the stock plants. Stock plants should be well established and maintained at a good level of fertilization. If stock plants are potted immediately prior to grafting, success will be low.

(3) If the above two items are carefully adhered to and if reasonably well matched grafts are made and maintained, high survival and good subsequent growth should be the result.