SUCCESSFUL HARDWOOD GRAFTING

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The Tennessee Valley Authority's hardwood forest tree improvement program, which started about 2 years ago, involves six species--black cherry, black walnut, yellowpoplar, northern red oak, white oak, and chestnut oak. The results are encouraging.

TVA began grafting black walnut in the late thirties in connection with an early tree-crops program, and some grafting of yellow-poplar was done in the mid-forties. Until 1965 little or nothing was done with the other four species.

Review of Literature

Little has been written about the propagation of the six species. Grafting techniques are usually passed along verbally and by demonstration. Hough (1960) refers briefly to black cherry grafting. Funk (1962) and Churchwell (1965) discuss bud grafting and field grafting of yellow-poplar. Black walnut budding and grafting techniques are covered by Chase (1947) and Zarger (1957). Limstrom (1965) and Irgens-Moller (1955) indicate that one of the main reasons oaks are not grafted much is the difficulty of propagating them vegetatively. Although the results have not been published, oak grafting has almost universally failed in the United States. But Skinner (1953) indicates that oaks have been bench grafted and field grafted in Europe with some success.

Scion Collection and Storage

Hardwood scions can be collected as early as December for spring grafting.

To obtain the most vigorous scionwood, the trees must be climbed. A rifle can be used to obtain scionwood, but only lower branches with smaller diameters and less of the desirable 1-year-old wood will be acquired. Although 1-year-old wood is preferred, 2-year-old wood can be grafted if the 1-year-old portion of the scion has two or more good buds.

The cut ends are placed in a plastic bag with damp sphagnum moss immediately after collection, and these are stored in a portable refrigerator. At the end of each collection trip, scions are pruned to remove all wood older than 2 years, tied in bundles of 25 to 70, and stored in damp sphagnum moss at 35 to 40° F. With this treatment, scions can be stored successfully for up to 5 months, thus permitting collection during slack periods and later grafting when rootstocks are ready.

Bench Grafting

The whip graft (fig. 1) is the one commonly used in indoor bench grafting. It is done on 1-0 bare-rooted seedlings between February and April. Seedlings can be lifted and heeled in until grafted.

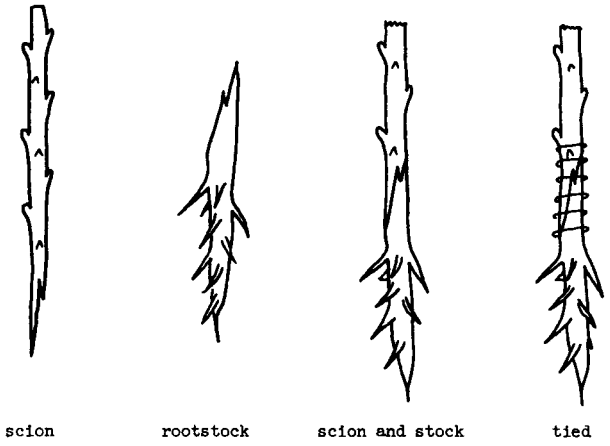

Figure 1.--Whip graft used in bench and field grafting.

The rootstock is cut diagonally at the root collar, leaving a 1- to 1-1/2-inch exposed surface. A vertical cleft is then made about midway on this cut surface. The scion is similarly cut, and the two are joined by slipping the tongue of the scion into the cleft of the stock, being sure that the cambium of scion and stock match on at least one side. The graft union is then tied with small strands of raffia, and the union and entire scion are painted with grafting wax.[1] Raffia is used because it makes a strong, effective tie, and it will disintegrate later and. will not have to be removed. The grafting wax reduces transpiration.

Grafted trees are stored in baskets of wet sphagnum moss in a cool place and are outplanted in nursery beds about mid-April or just as growth starts. They are planted with the graft union and part of the scion covered and packed with soil.

Bench grafting has proved most successful with black cherry and yellow-poplar. These are the important advantages: The grafting period is about 2-1/2 months; grafting can be done inside during bad weather; and 1-0 bare-rooted seedlings are used. The resulting plants are vigorous and well formed. The special requirements are raffia ties, complete waxing of union and scion, planting with the

[1] Raffia is fiber from the raffia palm Ra hia raffia) of the Malagasy Republic. The grafting wax is a mixture of beeswax (6 pounds), rosin (16 pounds), and linseed oil (1 pint).

graft union below ground, and irrigation during the first critical weeks after outplanting.

Field Grafting

Rootstocks for field grafting are 1-1 transplants lined out in nursery beds. Two types of grafts can be used--the whip graft just described and the side graft (fig. 2).

Whip graft.--When growth starts in the spring, the rootstock is cut back to a height of 4 or 5 inches. Oaks and black walnut bleed when cut, and grafting must be delayed until this sap flow stops. This period is usually about 2 weeks, but it depends on species, weather, vitality, and growth of the rootstocks. Sap flow is not usually a problem with yellowpoplar and black cherry; however, it may be, depending on the condition of the rootstock. To be certain it is not, it is necessary to wait at least 1 day after cutting back before grafting.

The completed graft union is bound with a rubber strip, and both the scion and union are painted with grafting wax. Protection with a polyethylene or paper bag is not needed. The rubber tie is removed in 4 to 6 weeks. Sprouts are removed from the rootstock several times during the growing season.

Side graft.--The side graft is preferred when rootstocks are exceptionally large. A diagonal cut, 1-1-1/2 inches long, is made on the side of the rootstock at a convenient height above ground. Two cuts of the same length are made on opposite sides of the scion,

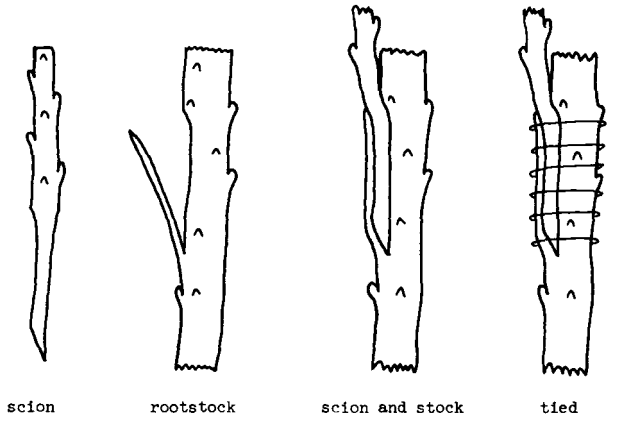

Figure 2.--Side graft used in field grafting.

and a slanting cut is then made across the end to form a chisel point (fig. 3). The scion is inserted in the cut on the stock; the cambium of scion and stock are matched on at least one side. The union is bound with a rubber strip, and both union and scion are painted with grafting wax. After the scion begins to grow, the rubber tie is removed and the top of the rootstock is cut back to the graft union. Branches on the rootstock below the union are also removed.

Bud Removal

One other technique is helpful in both field and bench grafting. If the scion begins growth too soon after grafting, the graft will usually fail. The transport system between rootstock and scion is not well enough developed to

Figure 3.--Chestnut oak side-grafted in the field (1-year growth).

supply the required water and nutrients. Removal of the terminal bud of the scion will delay the start of growth 1 week to 10 days, and this delay will significantly increase hardwood grafting success. Do not remove the terminal bud unless the scion has at least two good side buds.

Results of TVA Program

In the production of more than 23,000 black walnut ramets during a period of several years, TVA propagators have had about 60 percent success. The following tabulation indicates our success with the other five species in 1965. Scions were collected from mature parent trees, usually by shooting down branches with a rifle. They had small diameters, and many had less than 1 inch of 1-yearold wood. With better scionwood, TVA's percentage of success with these species may reach 75 percent.

Species	Clones	Grafts	Percent success
Black cherry.....	23	813	35
Yellow-poplar.....	8	467	56
Northern red oak..	9	267	54
White oak.....	4	165	50
Chestnut oak[1].....	4	179	61

[1] See figure 1.

Budding

Budding has not been discussed because it is considered a way of increasing the number of ramets after a clone has been successfully propagated by other methods. However, both chip and patch budding have been successful with all six species. Budding should be done in late July or early August when the sap is flowing. The bud will then remain dormant until the following spring, when the portion of the rootstock above the bud is removed.

Grafting Other Species

The grafting techniques described here can be used with most hardwoods. We have used them successfully on burr oak (Quercus macrocarpa), hickories and pecans (Carya spp.), chestnuts (Castanea spp.), honeylocust (Gleditsia triacanthos), hawthorn (Crataegus spp.), common and oriental persimmon (Diospyros virginiana and D. kaki), crabapple (Malus spp.), jujube (Zizyphus jujuba), and American holly (Ilex opaca).

Summary and Recommendations

Hardwood grafting is not as difficult as it seems. Based on our experience, these appear to be the important factors:

1. Scionwood can be stored for up to 5 months.
2. Bench grafting is preferred for black cherry and yellow-poplar; field grafting is best for the oaks and walnut.
3. Raffia should be used to bind bench grafts because stock is outplanted with the graft union underground and the raffia will disintegrate naturally.
4. Paint the graft union and entire scion with grafting wax. Additional protection is not needed.
5. In field grafting, wait at least 1 day after cutting back rootstocks to be sure there is no excessive sap flow from the rootstock. Delay grafting until sap flow stops.
6. If the scion has side buds, remove the terminal bud to delay growth.
7. Grafts can be transplanted bare-rooted; a ball of soil is not required.

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