Rootstocks, Tree Types, Grafting and Budding

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March 19, 2010

After you have decided to plant a nursery the real work begins. The site must be prepared at least 1 year in advance to allow for the building up of organic matter, nutrient adjustment and fumigation. Plans need to be made and supplies including rootstock need to be ordered. In some cases grafting must be performed followed by planting. This chapter will describe the steps that need to be taken to successfully acquire the plant material required and start it on its way to creating a suitable tree for establishing a new orchard.

Purchase Rootstock

The first step is to grow or purchase rootstock for lining out or for immediate spring grafting. Larger operations that have a demand for many thousand stocks may want to consider establishing a stool bed for production of rootstock liners. This not the best approach for the on-farm nursery since it will take several years to establish stool beds, there is a heavy labor requirement specific to growing rootstock, many different rootstocks are available or becoming available which would require the grower to have many different rootstock stool beds, and this approach does not give the grower the flexibility to change to different rootstocks quickly. In addition, there is inherent risk in "growing your own", failure can be very expensive. Considering the risks involved and the relatively few rootstocks needed, it is best to purchase needed rootstock.

The price of rootstock is based on caliper with smaller stocks generally less expensive that larger ones. The more rootstock you buy the less expensive the per stock cost. And every rootstock clone is priced differently depending on the nursery’s production cost, any royalties imposed, and the supply and demand. In general, a ½” M.9 stock will cost approximately $0.80 apiece when 1000 are purchased, less when more are purchased. Certain M.9 clones like Pajam 2, and Nic 29 have additional royalties imposed (2 and 5 cents respectively). Current price information is always available from the World Wide Web and nursery salesmen (See the Appendix for more information about nurseries which produce rootstock; Willamette Nursery, TRECO, Willow Drive Nursery).

There are a number of other nurseries in the world where rootstock can be acquired. However, purchasing from nurseries within the United States prevents the need for special import permits, phytosanitary permits and inspections, and possible shipping delays. If there is a disadvantage from ordering stock in the US, it is that the stock may not always be formally inspected, tested, and certified using a system like the NAKB (General Netherlands Inspection Service of Woody Nursery Stock) system in the Netherlands. The main objective of the NAKB is to promote the growing of genuine and healthy stock of good genetic, internal and external quality; also to take appropriate measures to ensure that this material reaches its destination in
good condition and correct designation. All nurserymen who grow or trade in reproductive material covered by the NAKB are legally bound to join this service; besides they are obliged to present yearly all their plant material for inspection. In order to reach its objectives the NAKB has established standards and requirements and it ensures that these are observed by all the firms which grow, process and/or deal in plant material. The inspection comprises parent tree inspection, a number of field inspections during the vegetation period and finally a bulk inspection. Only reproductive material, which meets NAKB standards can be approved and certified. One of NAKB's most important activities is to make available to the Dutch nurserymen rootstock which is true-to-type, selected and free from all known viruses. Fruit tree growers have to buy their total need of bud- and scionwood each year from NAKB controlled plots (Elzenga, G. 1977). There are currently efforts underway in the United States (NCPN and FTCPN) to establish a similar program.

The rootstock picture is always changing, therefore a thorough knowledge of the planting system, spacing, and orchard soil conditions is necessary to make the proper choice of rootstock. Be sure and know all the characteristics of the rootstock you choose including its characteristics in the nursery.

Size of rootstock

For budding purposes, suitable rootstock should be 3/16” to ¼” in diameter. This size stock is easy to plant and will grow to a suitable size provided the necessary cultural practices are used. If you are going to spring bench graft, larger rootstocks that are ½” in diameter or larger and match the scion wood source should be purchased. Upon receipt, rootstock should be opened and inspected, then stored at about 34 degrees F in moist rotted sawdust or peat moss until needed. You may use material from the shipping container to store rootstock if enough is available. Just like finished trees, rootstock cannot be stored with apples or other produce since the ethylene gas given off will damage the stock.
Types of Nursery Trees

There are several methods for producing a nursery trees each with its own advantages and disadvantages. This section will describe each.

The Traditional Nursery Tree (Two Season Budded Tree): The traditional finished nursery tree has a one year old top and a two year old root. It is produced by planting a rootstock in the spring and inserting a bud later that same year. After overwintering in the nursery, the remaining top of the rootstock is removed just as growth begins in the spring. The emerging shoot is rapidly trained upright usually by fastening it to a small bamboo stake as it grows. Any shoots emerging from the rootstock or along the future trunk portion are repeatedly removed as they emerge. As side shoots reach useable height, they are allowed to remain on the tree. Some apple varieties rarely branch in the nursery without assistance. In order to produce the kind of tree needed for modern apple planting systems, cultural manipulations including growth regulator applications and/or “leaf twisting” is performed to encourage the production of side shoots. This type of tree is very reliable with a very high percentage take. Since trees are kept in the nursery for 2 growing seasons, they attain acceptable caliper and height and often have adequate but not outstanding branching.

Bench-grafted One Year Tree: Both the root and scion is one year old when dug for planting or storage and is produced in one growing season. In late winter the rootstock is prepared by removing roots and dormant scion wood collected. Then the rootstock and a 2-4 inch piece of scion is matched and either whip and tongue grafted by hand or V cut grafted by grafting machines indoors. The scion and rootstock are joined and tied with a budding rubber and coated with a low temperature wax to seal. The tree is callused at about 50 degrees F, and then stored in a cold room before planting. Grafted trees are carefully lined out when conditions permit taking care not to rupture the newly callused tissue. A single bud from the scion piece is selected as growth starts and permitted to grow. The rest of the process in the nursery is similar to that of the traditional tree. The tree is dug in the fall and either planted immediately or stored in a nursery cellar over winter. The advantages of this tree type is that it only takes one year to produce reducing land and tree costs and the risks associated with overwintering such as winter injury and vole damage is reduced. The disadvantage is that this production scheme produces a smaller finished tree that rarely has any side branches. This tree is not suitable for modern high density planting systems that require highly feathered trees.

The “Sleeping Eye” Tree: This tree is produced by budding a rootstock and digging in late fall for storage or immediate planting in the orchard. The rootstock is kept for a single season in the nursery and the scion bud has yet to grow. Rootstock tops are removed immediately after digging. Growers can buy this type of tree from the commercial nursery to avoid having to have the budding or grafting skills necessary to produce a tree. This can reduce one source of risk in producing the nursery trees. The disadvantage is that it is difficult to produce a large caliper tree since the root mass was reduced when it was dug and that roots will have to reestablish after planting, delaying and limiting tree growth. This tree may perform better than the one-year graft since the bud is already callused and cambial connections are secure. This tree is less expensive to produce and dig than any other type but delay in yield may not justify this savings.
The "Knipboom" Tree: Roughly translated the "Cut or Snip tree" has 2 or 3 year old roots with a maiden top. It takes a 3rd year in the nursery when the tree is budded. The preferred method to produce a "Knipboom" is to graft a scion to the rootstock as described in the one year graft procedure. This method will produce a tree in 2 growing seasons. After overwintering in the nursery, and just as growth begins, trees are headed 20 inches above the rootstock and all emerging buds are removed except for the single bud immediately at the top of the tree. The established root system forces vigorous growth including the production of side shoots with very flat branch angles. Since the heading height is at 20 inches, side shoots can only originate above that level and little de-shooting is necessary. Although this tree require at least 2 seasons in the nursery, the tree produced is of the highest quality with an excellent complement of side branches, all with excellent branch angles originating at the ideal height for modern orchard systems.

The Two-year Tree (Three season budded tree or Two season bench-grafted tree) - This tree type requires 2 or 3 seasons in the nursery and is produced by planting rootstock and budding or grafting in year 1 as described for the traditional or bench grafted trees above. Rootstock tops are removed the spring of year two and trees are grown vigorously. Branching manipulations such as growth regulators or leaf twisting is not needed since branches will form by making a heading cut to the nursery tree the following season. Nursery trees are headed as they would be if planted in the orchard to encourage rapid growth and side branching. Heading cuts are made according to where side branches are needed. As growth starts, leaders are singled, and branches that form that are too low are removed. This tree type always produces side branching because of the strength of the root system and the removal of growth suppressive hormones in the terminal bud. However, the side branches tend to be very upright, some with sharp crotch angles, and will require tying down when planted in the orchard. In addition, transplant shock is greater than with other tree types since the root system is well established in the nursery and a greater portion of root is removed when the tree is lifted. This will result in early bearing and more limited tree growth.

The Plant-in-place Tree – This is a variation in orchard establishment that combines nursery procedures and new orchard management practices. This variation uses a rootstock, grafted rootstock or "sleeping-eye" type tree planted in the future orchard at the final intended in-orchard spacing. Depending on the plant material used, established trees are either budded or grown out using the nursery productions techniques described for the traditional, grafted, or sleeping eye tree types described above. One advantage is that trees will not have to be lifted and replanted later saving time and labor and the Knipboom method can be used if poor 1st year tree growth results. Since nursery trees are not dug and replanted, there is no transplant shock so trees may remain juvenile taking longer to bear and becoming overly vigorous making tree management within the allotted spacing difficult.
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**Timeline for Producing Nursery Tree Types**
Grafting Rootstock

The spring or bench grafting method can be used to produce trees one year sooner than using the traditional T or Chip budding process. The disadvantages include a smaller finished tree, fewer if any side branches, the necessity to callus and store trees in a fragile state before planting and after planting, and possibly a lower percentage "take" depending on the skill and care of the grafter.

For "Bench grafting", completely dormant wood must be collected and stored in an ethylene-free storage. The wood should be examined closely for winter injury by checking a representative sample of the collected wood for cambial damage. Be sure and label the wood so you know its variety and origin.

Grafts can be made by hand using the "Whip and Tongue" graft or by using one of a number of grafting machines which are available that cut matching "V's" into the stock and the scion pieces. These top-grafters can be handheld, pneumatic, or foot pedal operated (www.gvbsinc.com and many others).

Whip and Tongue Graft: This grafting method is used for joining a scion piece on a rootstock of similar size (Figure 2). The technique is also called bench grafting since it is carried out indoors on the workbench. The whip graft is easily made and is one of the most commonly used because the several uniting edges of this graft form a strong union.

Rootstocks are first prepared before grafting by trimming back the roots to within 1/2" of the rootstock shank. This will help the roots to start out growing straight and not to be kinked or bent. Next, scion wood is matched to rootstock diameter and appropriate cuts are made.

The grafting technique requires a long sloping cut (Figure 3) be made on the rootstock with a back cut in the center of the slope as Figure 4 illustrates. Similar cuts are made on the matched scion wood piece and they are joined together (Figure 5) and wrapped with a budding rubber. The entire scion piece, budding rubber, and part of the rootstock shank are dipped in wax barely
above the melting point. If the wax is too hot it can damage or kill the scion buds and rootstock and scion cambium.

Figure 2. Schematic of the Whip and tongue graft

Scion Piece

Rootstock Piece

Figure 3. Make a long smooth sloping cut on the rootstock and a matching cut on the scion piece.

Figure 4. Match the size of the rootstock and the scion and make a back cut on each.
Figure 5. Fit the scion and rootstock pieces together matching cambial layer as closely as possible.

After the grafting process trees should be bundled and stored upright or horizontal in moist sawdust and covered with plastic to create a greenhouse type environment. Callusing occurs best at 75-80°F but for bench grafts these temperatures cause the scion buds to break before sufficient callusing has occurred. To keep the scion buds dormant callusing should be done at 50°F. Bench grafts usually require 4-5 weeks for good callusing before planting. This means that grafting should be done in late February and early March. The grafted tree will indicate good callusing when shoot growth on the scion occurs and is sustained through 2-4 inches of shoot growth without the shoots collapsing. Plants should then be moved to a cold storage to hold for later planting in the nursery.
Budding Rootstock

If all goes well in the nursery, rootstocks should reach budding size sometime in August. Budding wood should be collected as close to budding as possible. Collect healthy current season pencil-sized shoots of the variety needed. Remove the smaller caliper wood toward the tip of the shoot and the older, less well formed buds near the base. Cut off all leaf blades leaving a portion of the leaf stem as you collect shoots suitable for budding. This will prevent shoots from rapidly dehydrating and will later give the bunder a "handle" for placing the bud. The leaf petiole will also indicate whether the bud has taken or not. The leaf petiole naturally abscises if the bud takes and remains attached if it does not.

After collecting wood, bundle, wrap in wet newspaper, and store in a plastic bag. Put collected wood in a cooler to keep cold during the collection phase and transfer to an ethylene-free refrigerator or cold storage as soon as possible.

By now you have decided whether to bud using the T-Bud or Chip Bud method. We believe the chip bud method is best since it creates a straighter tree despite being slower and more expensive than T-budding.

Rootstock should be budded 4-6 inches above the soil level on the side of the prevailing wind for both budding methods.

T-Bud: The T-Bud (Figure 6) is descriptive of the appearance of the cut made on the rootstock. To make a T-bud make a transverse cut about 1/3 the diameter of the stock, followed by a vertical cut upwards to meet the transverse cut. As it reaches the transverse cut, a twist of the knife blade raises the edges of the bark just enough without tearing so that the bud may be easily inserted. Rootstock should be rapidly growing so that bark separation occurs easily. Sometimes a pre-irrigation is necessary to loosen the bark on the rootstock. A bud shield is cut
by holding the upper end of the bud-stick. Place the knife ½ inch below the selected bud and make a shallow slice beneath the bud approaching the surface 1 inch above the bud. The shield must be cut fairly thin, but not so thin that the soft growing tissue between the bark and the wood is injured. Insert the bud by grasping the leaf stem between the finger and thumb and inserting it into the t-shaped incision on the trunk. Be sure that the bud is ¾ inch below the transverse cut. Immediately after the bud is inserted, seal the bud and rootstock by tying with a budding rubber.

Figure 6. Using the T-Bud method. A) Bud stick, B) Bud Shield C) T cut, D) Bud inserted into T-cut before tying.

Chip-Bud: “Chip budding” is the process of taking a “chip” out of the rootstock piece and replacing it with an identical “chip” with a single bud cut from the scion wood stick (Figure 7). The 1st cut on both stock and scion is made at a downward angle of 45 to 60 degrees to a depth of about 1/8" below the bud. The 2nd cut is made about 3/4" higher and downward to meet the 1st cut. Care should be taken to make both chips of similar size but if a significant difference in size occurs then mate up one side as closely as possible. In chip budding there is more area of the bud exposed which requires extra care wrapping otherwise desiccation may occur.
Figure 7. Chip Budding – a) make the 1st cut on the rootstock b) make the second cut to remove the chip, c) The chip on the rootstock removed, note the notch at the bottom of the cut, d) cut a matching chip from a bud stick, e) place chip in rootstock notch by lining up cambial layer.
Immediately after budding, buds should be wrapped (Figure 8). This ensures firm cambial contact and prevents the bud from desiccation. Special “budding rubbers” that will disintegrate slowly over time are available for this. Parafilm has also been used to seal the bud to the rootstock. Only the bud itself should not be covered by the tying material. The budding rubbers have the advantage of expanding with growth of the rootstock and will rot off with exposure to the sun after the bud has calloused to the rootstock.

Figure 8. Tying (a) whip and tongue grafts and (b) using Parafilm for chip bud

Buds will generally remain dormant until the following spring although sometimes buds do begin to push with late wet and warm falls (Figure 9 and 10). Generally these buds that push survive and will grow the following spring.

Figure 9. Well-callused chip buds overwintering in the nursery. Rootstock tops will be removed just above the bud as growth starts in the spring.
Figure 10. Overwintering budded rootstock. When inserted buds start to green up, tops will be removed and finished tree management will begin.

References and Resources


Photos courtesy of Molly Shaw, Rick Reisinger, and Steve Hoying.
Rootstock Suppliers:
Treco
Oregon Rootstock and Tree Company
Woodburn Oregon
Ph# 1-800-871-5141
http://www.treco.nu

Willamette Nurseries, Inc.
25571 S. Barlow Rd.
Canby, OR 97013
1 800 852-2018
http://willamettenuerseries.com/

Willow Drive Nurseries
3539 Road 5 NW
Ephrata, WA 98823
Ph# 888 54-trees
www.willowdrive.com

Copenhagen Farms
12990 SW Copenhagen Road
Gaston, OR
Ph# 509-985-7161
http://www.copenhagenfarms.com

Cameron Nursery
1261 Ringold Rd.
P.O. Box 300
Eltopia, WA 99330
Ph #5096626931
http://www.cameronnursery.com

Carlton Plants
Dayton, OR
Ph#800-398-8733

Grafting Supplies:

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