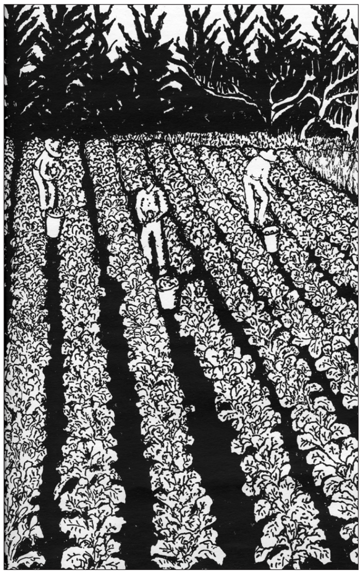

Forrest Cook

News & Notes
of the UCSC Farm & Garden

Issue 128, Winter 2011

For the Home Orchardist

Rootstock Basics

— Orin Martin

Note to readers: This article complements Scion Basics, Fall 2008 News & Notes, Issue 119, available online at http://casfs.ucsc.edu/publications (select the New & Notes link).

What Is It?

The rootstock describes the basal portion of the tree, the trunk below the graft/bud union* and of course the root system. The rootstock is a genetically distinct "individual" from the scion, or bearing portion of the tree. Different species of fruit (apple, pear, plum, peach, etc.) have a number of rootstocks to which scions can be grafted or budded (see rootstocks chart, page 6).

Rootstock choice is probably the most critical and dominant factor influencing the type of fruit tree you'll end up with, as it influences both tree size and the ratio of tree canopy to pounds of fruit. This is referred to as cropping efficiency. It "rolls" like this: While a bigger tree produces more pounds of fruit, per tree, the dwarf tree produces more fruit per area of canopy. As dwarf trees can be spaced closer together, they out-yield bigger trees on a per-area basis (note that in this article the term "dwarf" also refers to semi-dwarf trees).

Where Do They Originate?

Similar to scions, rootstocks result from naturally occurring seedlings or chance mutations. They are also the result of conscious breeding programs. After a rootstock, regardless of its origin, has been recognized as having redeeming qualities, it is thereafter reproduced asexually or clonally.

A classic example of a naturally occurring rootstock from antiquity: Alexander the Great, 400 B.C.E., sent back to Macedonia a rootstock found in Persia (now Iran). This apple rootstock was naturally very dwarfing, productive, self-rooting, and thus easy to maintain and propagate. It came to be knows as the 'Paradise' rootstock (paradise derives from the Sanskrit *paradeca*, meaning garden).

What Do They Give You?

Rootstocks impart a number of genetic characteristics to the whole tree. These fall largely (but not exclusively) into two broad categories: control and adaptations.

The control issues are –
- Tree size
- Roots/root system
- Transport
- Yield efficiency (precocity)
- Partitioning of resources
- Longevity

The adaptations are to –
- Soil
- Pests
- Diseases
- Cold (not applicable to mild regions)

See chart on page 6 for summary of rootstocks and their adaptations

Rootstocks control overall tree size, from full size (20–30' tall) to mini-dwarf (3–5'), and have more influence on tree size than do scions. They do this largely by two mechanisms: the roots–root system, and the transport of materials for growth (water, nutrients, and growth regulators).

continued on page 2

*The bud union is the point at the base of the trunk where rootstock and scion are fused together either by budding or grafting. On young trees there is a noticeable swelling at this point owing to the constricting amassing of lignin, a complex chemical compound found in cell walls that acts to stiffen the cell.

The nature, type, extent and function or efficiency of a rootstocks' roots and root system are major determinants of tree size: the more dwarfing the rootstock, the smaller the extent of the root system (often only 1–2 square meters versus 10–12 square meters on full-size trees). Keep in mind, fruit trees do not actually have square, but radial root systems that are somewhat asymmetrical. With the exception of a taproot that serves primarily to anchor the tree, most of a fruit tree's roots are shallow, superficial, and fibrous or branched. They generally extend out to or beyond the "drip line," defined as the imaginary circle around the circumference of the tree canopy, i.e., the outer extent of the branches, where rain or irrigation water drips off the leaves and onto the ground. Dwarf rootstocks feature an effective feeding root depth of 1–2′, while full-size trees probe 2–3′ deep.

The nature of size-controlling, dwarf rootstocks' roots is different from that of full-size trees. They tend to be brittle, constantly breaking off at the feeding tips. They are narrower in diameter (and thus have less conductive tissues) and most notably are less efficient at taking up and transporting water and nutrients to the top part of the tree. These factors, coupled with the roots' limited extent and thus ability to explore and forage for nutrients and water, contribute to the dwarfing effect.

Roots are also winter storage sites for carbohydrates, which are then shuttled to leaves, flowers, fruits, and shoots. These carbohydrates fuel enormous demands in early spring–summer, before the tree can manufacture carbohydrates as a byproduct of early-season photosynthesis. Dwarf rootstocks manufacture and store fewer carbohydrates. In the intra-tree battle for resources, fruit is a huge "sink" and always outcompetes leaves, shoots and roots for resources, causing dwarf trees to grow less and fruit more.

Another manner in which dwarfing rootstocks limit tree vigor has to do with transport of growth-promoting substances (mostly hormones) from roots to shoots and vice versa. Trees have hormone production/synthesis sites, action sites, and a means of transport, from one to the other. Production sites are largely apical meristems—the tips of roots and shoots. When they arrive at action sites, plant hormones—which are highly effective in small quantities—produce large-scale, striking changes. For example, the hormone gibberelin is produced in tree roots and transported to shoots where it spurs shoot elongation.

Basically, with dwarf rootstocks, less of the chemical messages that promote vegetative growth and vigor are manufactured and transported to and from the "antipodes." In essence the tree gets the message: Grow less rampantly, fruit earlier in life and more abundantly as life goes on and, oh yeah, exhaust your reserves and live less long. Granted, this statement is both reductive and anthropomorphic, but nonetheless graphic and true.

Jeff Rosendale

Matthew Sutton gives tips on planting a bareroot, dwarf fruit tree at a public workshop at Sierra Azul Nursery & Gardens.

The actual makeup of transport vessels (xylem—moving water, nutrients, and growth regulators upward, and phloem—moving sugars and growth regulators downward) in dwarf trees features fewer cells, narrow diameter sieve tubes and often both slightly misaligned cells and a constriction or partial blockage of those cells from the production of lignin at the bud union. Again, all this restricts the flow of growth-promoting substances, limiting tree size.

While all of the above is obvious to growers, it has basis in research. Forshey and McKay (Cornell University, 1970) compared carbohydrate (sugars and starches) distribution in dwarf apples (M7 rootstock, 3.1 meters in height) with full-size apples (seedling rootstock, 8.4 meters in height). They found that the smaller trees distributed carbohydrates at a rate slightly greater than 3:1 fruit over wood and leaves. The larger trees allocated resources at a rate that slightly favored wood and leaf production over fruit. Stated another way, dwarf trees allocated >75% of their total resources to fruit production.

Advantages of Dwarfing Rootstock

With fruit trees, size manageability has its benefits. From a management perspective dwarf trees come into bearing (precocity) early in life (3–5 years), yield more efficiently, and are easier, quicker, and safer to care for. The requisite operations—observation, pruning, training, spraying, thinning, and picking—can be done without the use of ladders (hence the term "pedestrian orchard") and thus accomplished more efficiently.

continued on page 6

Apple Rootstocks

Type	Height	Other Characteristics and Features
Semidwarfing		
MM 111	15–20 feet	Adapted to a variety of soil conditions; tolerates drought. Rootstock has fibrous roots—produces a heavy-bearing, well-anchored tree. Excellent for spur-type cultivars.
M 106	14–18 feet	Adapted to a wide range of soil temperatures. Should not be planted on poorly drained soils
M 7	11–16 feet	One of the most popular rootstocks. Exceptional winter hardiness; performs best on deep, fertile, well-drained soils that retain constant moisture. Susceptible to woolly apple aphid; moderately resistant to fire blight. May lean with heavy crops on windy sites—advisable on such sites to support lower trunk to a height of 3′ in early years.
Dwarfing		
M 26	8–14 feet	Roots well and better anchored than M9, though still needs support. Very productive and early bearing; recommended for use on all but badly drained soils. Rather shallow-rooted—careful attention must be paid to irrigation management.
M 9	8–12 feet	Very precocious with high yield efficiency; susceptible to fire blight and woolly apple aphid. Most extensively planted rootstock worldwide.
Mark	8–10 feet	Very precocious with high yield efficiency. Trees on Mark require support to produce a full-canopied tree. Extremely hardy, tolerates numerous soil types. More resistant to fire blight than M 26. Heavy bearing in early years stunts tree—thin fruit to avoid.
Extremely Dwarfing		
M 27	4–6 feet	Very precocious with high yield efficiency. Requires support. Less susceptible to fire blight than M 9 and M 26. Well suited for growing in a container or a small yard. Fruit should be thinned or removed for the first year or two to encourage growth. Very exacting—requires frequent inputs of water and nutrients because of restricted root system.

Stone Fruit Rootstocks

Type	Height	Other Characteristics and Features
Lovell	>15–20′	Seedling rootstock compatible with all peaches, plums and some almonds and aprictors. Susceptible to root knot and root lesion. Susceptible to oak root fungus, crown rot, bacterial canker. While it good drainage, it tolerates wet soils better than other peach stocks.
Nemaguard	>15–20′	Compatible with peaches, plums and some nectarines. Resistant to root knot but not root lesion nematodes.* Susceptible to oak root fungus, crown rot, bacterial canker. Avoid wet soils. Likes well-drained loams.
Citation	10–15′	Semi-dwarf, compatible with peaches, nectarines, plums, apricots, pluots, and apriums. Resists root knot nematodes. Susceptible to oak root fungus, crown rot, bacterial canker. High tolerance for wet soils, not drought tolerant.
Marianna 2624	10–15′	A plum rootstock that can be used for some almonds and apricots, but not peaches, nectarines. Pest susceptibility unknown. Moderately resistant to oak root fungs, crown rot. Susceptible to bacterial canker. Does very well in wet soils and tolerates a variety of soil types, including heavy soils.
Krymsk1	8–12′	Semi-dwarf, a plum stock. Imparts precocity to peaches, nectarines, plums. apricots. Pest and disease susceptibility unknown. Grows well in heavy soils with drainage issues.

Pear Rootstocks

Pears tolerate wet soils better than most other fruit trees. Most pears are subject to fireblight (a bacterial disease). There are no effective, truly dwarfing rootstocks for pears. The pyrodwarf series reportedly keeps pears at 6–10′, although my experience with it is 10–15′. This roostock does not promote heavy fruit set and is somewhat susceptible to fireblight. It is weak rooted and intolerant of water fluctuations. Plus it's almost impossible to source. But other than that it's great.

Winter Nella, Betulaefolia, Calleryiana, Bartlett Seedling	25–40′	Don't even think about it. These are monstrous trees that can take 5–8 years to even begin fruiting.
Old home Farmingdale 333 and 513 (they perform similarly by 513 is slightly more precocious)	10–18′	These roostocks are about as semi-dwarf as pears get. An exception: the variety (scion) Seckel, which produces a naturally dwarf (6–8′) tree on old home rootstocks. Resists woolly apple aphid. Resists collar rot, pear decline. Tolerates wet, heavy soils.

continued on page 7

*Nematodes are microscopic, non-segmented worms that infect roots of stone fruits that either compromise growth or kill trees. They are mostly a problem in warm inland situations with clay soils.

By growing fruit trees on dwarfing rootstocks the home gardener can fit more trees into a small area, and thus grow a wider variety of fruit, grow a size-manageable tree that is easier and safer to care for, and start eating fruit sooner after planting than with standard-size trees.

Addressing Trees' Needs

As a general rule, fruit trees do not produce fruit until they are physiologically mature and all of their structural needs (roots, wood, leaves) have been met. At that juncture they then allocate resources to fruit production. With dwarf trees, there is less wood structure and root mass to establish, so they more quickly reach the fruit production stage.

The home gardener can aid tree establishment and early fruit production by being attentive to irrigation and fertilization. The goal with young trees is to double the canopy size from planting through year 1—and then to double that size in year 2. If the above is in order, the dwarf tree should produce a light crop in years 3 and 4 and achieve full production in years 5–8.

At no time should a young tree go through water stress (water deficit). This is particularly true of dwarf trees: because of their restricted and less efficient root system, water needs to be applied more frequently and less deeply than on a full-size tree.

In general—and not just with young trees—a fruit tree's greatest nutrient demand period is in early spring (approximately the spring equinox) through early summer (summer solstice). This is the time when roots grow the most, shoots extend (they shut down in mid summer), and resources are needed for flowering, fruit set, and fruit sizing. Additionally, nutrients are required in this period to manufacture *next year's* flowers internally.

The upshot of all this is that trees need nutrients as early in the growing season as possible, and with dwarfing (less efficient) rootstocks this is paramount. The emphasis for fruit tree fertilization is on nitrogen. Any granular/meal-powder source of organic fertilizer containing >4% nitrogen appied to the young tree at the rate of ½–1 lb per 1–3 year old tree should suffice. This should be accompanied by ½–1 lb of compost per square foot of root area, applied from 4" away from the trunk to just beyond the drip line.

Some good sources of organic fertilizer include:

	N-P-K
Dr. Earth	4 - 7 -3
Sustane	4 - 6- 4
Sustane	8 - 4 - 4
Blood Meal	12 - 0 - 0
Bat Guano*	10 - 6 - 2

**bat guano comes in two formulations, one high in N, one high in P. In this case, use the former.*

Apprenticeship Updates

Award-Winning Apprentices

Several of the graduates of the six-month CASFS Farm & Garden Apprenticeship training course were recently honored for their work in organic farming and gardening programs –

Karen Washington, a 2008 Apprenticeship graduate, was honored at the White House on December 17 for her work with urban gardens in the Bronx.

First Lady Michelle Obama presented Washington and Gregory Long, director of the New York Botanical Garden, with a 2010 National Medal for Museum and Library Service. The National Medal is the nation's highest honor for museums and libraries that make extraordinary civic, educational, economic, environmental, and social contributions.

A lifelong New Yorker, she is a member of the botanical garden's board. She has been a community activist in the Bronx since 1985 where she has helped turn empty lots into community gardens as head of Bronx Green-Up.

As a member of La Familia Verde Garden Coalition, Karen launched City Farms Market, bringing garden-fresh vegetables to her neighbors. She is also on the board of Just Food, an all-volunteer effort promoting a holistic approach to food, hunger, and agriculture issues, and she leads workshops on food growing and food justice for community gardeners all over New York City. She was recently hired as an instructor in the new Farm School NYC: the New York City School of Urban Agriculture, which began this January.

Doron Comerchero (2004) was selected for a "NEXTie" award from Santa Cruz Next, a group that seeks to encourage and connect new generations of local leaders. Doron was recognized for his work with local teens through "Food, What?!," a Life Lab-affiliated food justice and youth empowerment group based at the UCSC Farm. You can read more about Doron's work and the NEXTie award at www.goodtimessantacruz.com/good-times-cover-stories/2093-and-the-nextie-goes-to.html.

Corey Block (2008) is the Urban Farm Coordinator for the Treasure Island Job Corps Farm Project, which just received the Best Green Community Project from San Francisco's Neighborhood Empowerment Network. Read more about the Treasure Island Urban Farm project at www.jobcorpsnews.org/treasureisland/treasure-island-job-corps-urban-farm-an-introduction.