



for the Gardener

CENTER FOR AGROECOLOGY
& SUSTAINABLE FOOD SYSTEMS,
UC SANTA CRUZ

Citrus Offers Year-Round Options

Orin Martin, manager of the Center's Alan Chadwick Garden, offers ideas for choosing and growing a variety of citrus in the home garden.

The genus *Citrus* is undoubtedly the premier genus in the *Rutaceae* (Rue) family. This family features 150 genera and 1600 species and consists largely of evergreen shrubs and trees from the Mediterranean, subtropical, semitropical and tropical zones of the world. Table 1 lists the prominent species of the genus *Citrus* (and *Fortunella*), their hardiness, and place of origin. Among the other significant food and ornamental genera in the family are –

<i>Choisya</i>	(Mock orange)
<i>Correa</i>	(Coral bells)
<i>Dictamnus</i>	(Burning bush)
<i>Casimiroa</i>	(White zapote)
<i>Fortunella</i>	(Kumquats and their hybrid forms)
<i>Poncirus</i>	(Trifoliolate orange and flying dragon)
<i>Ruta</i>	(Rue)

Members of the Rue family feature strong oil glands in both the leaves and fruit. The bruised leaves of Rue (dubbed the 'Herb of Grace' in medieval herbals for some inexplicable reason) yield a foetid, aromatic oil that can trigger a poison-oak like skin rash. In citrus, the glands are primarily located in the brightly colored outer portion of the rind (the flavedo, or epicarp). By rolling a freshly picked, tree-ripened citrus fruit between your palms before peeling, you can rupture the oil glands and release the essential oils into the pulp—this enhances both the flavor and vitamin C content.

Home gardeners willing to cultivate an appreciation for a wider range of citrus tastes beyond sweet oranges, acid lemons, and grapefruits can have a succession of citrus fruits on almost every day of the year (Table 2).

Table 1. Genus *Citrus*: Prominent Species and Places of Origin, from Least Cold Hardy to Most Cold Hardy

32° F*	<i>Citrus medica</i>	India	Citron/Etrog, Buddha's Hand Fruit
32° F	<i>C. aurantiifolia</i>	India, S.E. Asia	Limes: Mexican, Bears, Key Lime, Tahitian Lime
28° F	<i>C. limon</i> or <i>limonia</i>	S.E. Asia	Lemons
26° F	<i>C. paradisi</i>	Caribbean	Grapefruit: natural hybrid between lemon and Pummelo (Pomelo)
24° F	<i>C. maxima</i> or <i>grandis</i>	Malaysian peninsula	Pummelo or Pomelo
24° F	<i>C. paradisi</i> (grapefruit) x <i>reticulata</i> (Mandarin)		Tangelo: bred cross of grapefruit and Mandarin
24° F	<i>C. sinensis</i>	S.E. China, Vietnam	Oranges: sweet, sour, blood
24° F	<i>C. nobilis</i> (King) <i>reticulata</i> x <i>sinensis</i>		Florida oranges: Temple, sweet
22° F	<i>C. reticulata</i>	S.E. Asia	Mandarins, Tangerines
22° F	<i>C. limon</i> cv. 'Improved Meyer Lemon'		Natural cross, orange x lemon
20° F	<i>C. mitis</i>	Philippines	Calamondin
18° –	<i>Fortunella</i>	S.E. China	Kumquat, Limequat, Orangequat,
20° F	<i>margarita</i> and hybrids		Citrangequat

*approximate temperature at which frost damage begins to occur (flowers are the most cold-sensitive, followed by fruit, leaves, and wood)

THE WORLD'S CITRUS CLIMATES

Citrus is native to the tropics of Asia: South China, Vietnam, the Philippines, India, and the Malaysian Peninsula. Citrus-growing regions include Mediterranean, subtropical, semitropical, and tropic zones within the approximate boundaries of 40° latitude (north and south of equator). The northern boundary encompasses (west to east) California, Florida, Spain, Italy, Turkey, Iran, India, South China, and southern Japan. On the southern limit are Argentina, Brazil, South Africa, Australia (east and south coast), and the northern island of New Zealand. In the United States the best citrus regions are (20°–40° N): Central Florida, California's

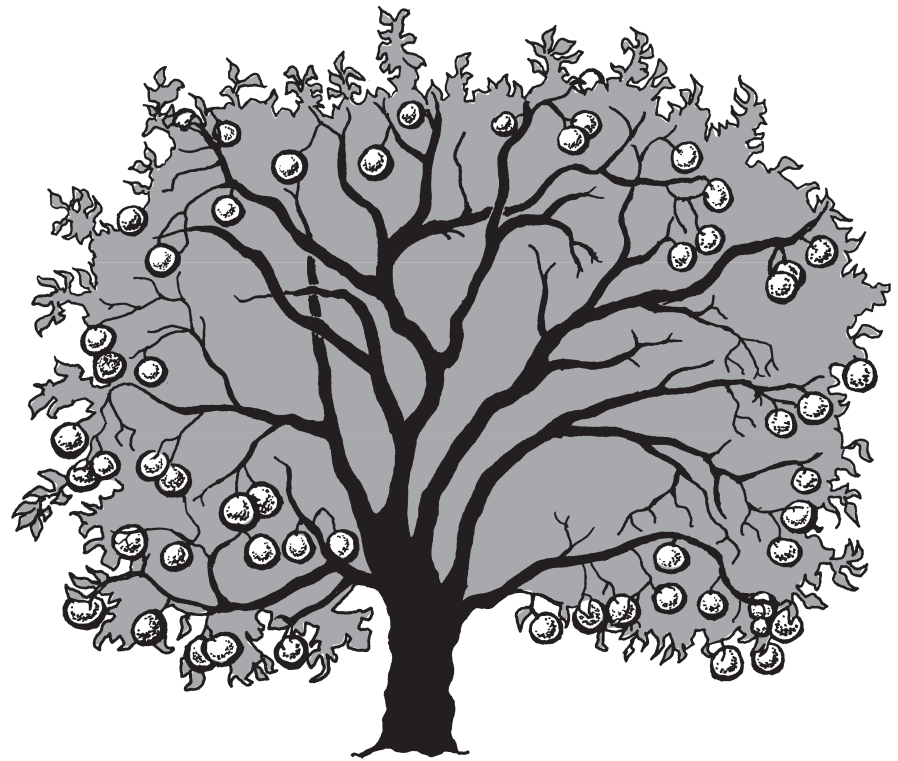
central and south coasts, interior valleys, and low desert areas: 1) the lower Rio Grande Valley, 2) the Gulf Coast of Texas, and 3) S.W. Arizona (low desert).

While citrus grows well in the tropics, the highest quality fruit is produced in subtropical, semitropical, and Mediterranean areas. In the tropics, citrus skin stays green and trees have a constant flowering-fruiting cycle, thus making it difficult to distinguish mature fruit from immature fruit. Also, tropical fruit does not hold well on the tree.

In semitropical climates such as Florida and the Gulf Coast of Texas, with their hot, humid summers and mild winters, citrus will develop the largest

Table 2. Citrus Harvest Seasons

January – June	Navel Oranges and Navel clones
February – April	Tangelos (Minneola)
February – April	Clementine and Dancy Mandarins
February – May	Blood Oranges
May – September	Grapefruit
July – September	Encore Mandarin
August – April	Bearss Lime
October – December	Rangpur Lime
December – March	Owari Satsuma Mandarin
December – September	Lemons, Calamondin
December – March	Kumquat and hybrids



Citrus bear their fruit toward the periphery of the canopy. The “skirt,” or lower portion of the tree, is very productive and should not be pruned.

and sweetest fruit and a high juice quality and content—in fact, it can be overly sweet. Acid fruits such as lemons tend to be undesirably sweet and lower in acid taste in semitropical climates.

Subtropical and Mediterranean climates, like those found in parts of California, feature seasonal changes in daylength plus some considerable day/night temperature fluctuations. These climate factors produce citrus with the brightest fruit color, smooth skin, and an optimal blend of sweetness and acidity, giving it the richest, fullest flavor for fresh eating. The main disadvantage of citrus grown in these conditions is the danger of cold and frost. In cool coastal climates, sweet citrus (oranges, mandarins, and grapefruit) may have a lower sugar content than desirable. The further north citrus is grown, the more gardeners fear the specter of frost. These areas will prob-

ably experience severe frost (25°–30°) every 10 years. Recently, California has experienced killing frosts in 1962–1963, 1973, and in December 1990 and January 1991.

CULTURAL CONSIDERATIONS

Citrus exhibits all stages of growth simultaneously throughout the year, although this phenomenon is more pronounced (and problematic) in the tropics. Lemons (especially in cooler climates) are the most extreme in this regard, having succulent new growth, flowering (especially on new wood), young, and mature fruit ever present on the tree. Citrus are rambunctious, even exuberant growers, making multiple growth spurts during the growing season. Typically, they throw long, gawky shoots in the spring—it then takes a while for leaf growth to catch up and fill in. So, although many citrus have pleasing shapes—columnar (Calamondin), pyramidal (Tangelos), or dome-shaped (oranges, most Mandarins, and Meyer lemons)—it takes a while to get there.

Because the tip of the shoot is often growing faster than nitrogen can flow to it, new growth can be chlorotic (yellow), although eventually it greens up. A true nitrogen deficiency usually shows up in the lower, older growth as the plant prioritizes new growth over old, and shuttles nitrogen to the new growing points.

The planting season for citrus is mid spring through early summer. Optimum growth in the first year is linked to spring planting, which gives the tree the maximum amount of time to develop during the warm months. Planting nursery-purchased budded/grafted 5-gallon trees will produce the best and easiest results (see sidebar on page 3 for site recommendations).

While citrus have moderate care and input needs once established, this is not the case at the outset. Unless they receive good ground-based fertility and supplemental liquid fertility (every 3–5 weeks) and frequent, shallow waterings (as often as every 2 weeks), the trees are likely to sit still or even slip backwards. As with deciduous fruits,

Choose the Optimal Planting Site in Your Garden

Especially in cool or marginal growing areas, choosing successful planting sites for citrus on your property will involve some common-sense use of microclimates and cultural practices.

- By using south-facing slopes and even south sides of buildings and fences, gardeners can maximize heat absorption. Planting at the top of a south-facing slope and avoiding low spots will reduce the risk of frost damage. Remember that, like water, cold air seeks its own level, i.e., it flows downhill and accumulates in low-lying areas called “frost pockets.”
- To increase the heat available to citrus in the summer, choose a wind-free site.
- Dark background surfaces (walls, buildings) and dark mulches absorb and re-radiate more heat than light-colored surfaces.
- Culturally, raised beds warm more quickly than compacted soil. Minimize nitrogen inputs from mid summer onward to reduce frost-susceptible new growth in fall and winter. Higher moisture levels in the soil also help reduce frost damage.
- There may be times when some sort of frost blanket makes the difference between life and death for a citrus tree.

To be sure of success, choose varieties whose heat requirements (see Table 3) and cold tolerance are appropriate for your growing region. Note that a variety may be cold-tolerant enough to withstand a region’s low temperatures, but its heat requirements may preclude it from setting fruit in that same region.

Table 3: Citrus Heat Requirements

(from highest to lowest)

Limes (true Mexican)*

Kumquat*

Pummelo*

Grapefruit

Sweet Lime

Tangelo

Mandarin Oranges

Sour Orange

Blood Orange

Sweet Orange

Lemons and Bearss Lime

Meyer Lemon

*marginal in Santa Cruz

the aim is to establish the tree canopy quickly and move the tree into the fruiting phase. The aggressive and realistic goal is to double or triple the canopy area in *each* of the first two years.

NUTRIENT NEEDS

Citrus (particularly young trees) respond readily to nitrogen and to a lesser degree to phosphorous and potassium (Table 4 on page 4 lists recommended inputs). Nitrogen assists in establishing the vegetative canopy. At maturity, nitrogen is important because citrus bear flowers and fruit on new wood and nitrogen promotes new growth. Too much nitrogen too late in the season encourages sappy growth that is prone to frost damage; it can also delay fruit maturation. Phosphorous is a great tool for encouraging flowering, fruit set, and sweetness. Phosphorous-deficient trees can have rough fruit with thick skins. Thick rinds are also an environmental response to cooler-than-optimal temperatures. Potassium fosters root development and fruit quality.

Micronutrient deficiencies, especially iron, zinc, and manganese, tend to express themselves during cold, wet periods of the year. They are often tied to a lack of nutrient transport due to suppressed soil temperatures rather than to soil-borne deficiencies.

If the trees don’t green up by spring, an application of composted horse manure with bedding and kelp products will usually do the trick. In this instance and in general, citrus respond to foliar nutrient sprays (compost, manure teas, guanos, and sea products).

GROWTH PARTITIONING

Roots

Citrus roots are fibrous (branching), shallow, and extensive, displaying a vibrant burnt-orange color. Most of the effective feeding roots occur from very near the surface down to a depth of one to two feet. They often extend one to two times beyond the distance from the trunk to the drip line. Thus surface applications of nutrients and more

frequent, shallow waterings beget the best growth response. Minimum tillage or cultivation and a mulch (raised beds and dark-colored mulches afford a little more frost protection than lighter colored mulches) help foster healthy root growth. This type of root system requires excellent drainage. Lighter-textured soils (sands and silts) as well as improved, well-drained clays grow good citrus trees.

Leaves

The evergreen nature of citrus leaves give them a slightly different function than that of deciduous leaves. Nutrient production and storage occur almost exclusively in the leaves and young twiggy branches. In deciduous trees, production and storage occur in both the roots and leaves. Winter storage is primarily in the roots and branches.

The maximum nutrient storage period for citrus is late winter–early spring, just prior to the spring bloom, fruiting, and growth cycle. Therefore, this is not an ideal time to prune the trees—late

Table 4. Citrus Nutrient Needs and Sources

Nitrogen needs: 0.25 lb, year 1
0.50 lb, year 2
0.75 lb, year 3
1.00 lb, year 4 (and beyond)

Sources and amounts:*

- 1/2–1 wheelbarrow* chicken manure/year
- 1–2 barrows compost/year
- 1–2 barrows horse manure/year
- Blood meal, 12–15% N by weight: 7–8# = approximately 1 lb. actual N

Phosphorous sources:

- chicken manure (highest manure source of N+P)
- bat guano

Potassium sources:
• granite-based rock powders
• horse manure (with bedding) is an excellent source of potassium

Unlike deciduous trees that grow primarily April–June, citrus responds to incremental applications of fertilizer during the growing season. For example:

- 1/3 April 1-15
- 1/3 June 1
- 1/3 July 1-15

*Assume 0.50–0.75% N content for compost and horse manure, 1.5–2.0% N for chicken manure. 100 lbs = 5 cubic feet (contractor’s wheelbarrow). Note that not all N put on will be available in that year.

Rangpur lime, kumquats and their hybrids, pummelo

Sour or Bitter – Seville oranges, calamondin citron, chinotto, bouquet des fleurs

The following varietal descriptions offer an idea of the wide range of citrus available to the home orchardist. Evaluation criteria for choosing among the many citrus varieties should include—

1. Scion vigor and growth characteristics
2. Flavor and juice content
3. Season of harvest
4. Ability of mature fruit to hold on the tree
5. Ease of peeling
6. Seediness
7. Climate zones

summer is better. Pruning in citrus is confined to shaping the trees’ general form rather than creating articulated tree forms as with deciduous trees. (Note – the lower portion or “skirt” of the tree is a very productive and accessible portion of the tree and should not automatically be pruned off.)

The “dormant” season for evergreen citrus occurs when temperatures drop below 55°F for a good portion of the 24-hour daily cycle. At these temperatures, there is virtually no growth and the tree hardens itself to deal with the threat of frost.

TREE SIZE CONTROL

Unlike deciduous trees, where tree size is controlled by a combination of rootstock, scion, and pruning and training systems, citrus tree size is primarily a function of rootstock and secondarily of scion vigor. Citrus on standard (full size) rootstocks are large trees, often 30 feet tall with a spread of 20 feet. Riverside and Orange Counties in Southern California still sport isolated plantings of 80- to 100-year-old Valencia and Washington Navel oranges on standard rootstock. While they are a sight to behold and offer much-appreciated dense shade, they are not practical trees.

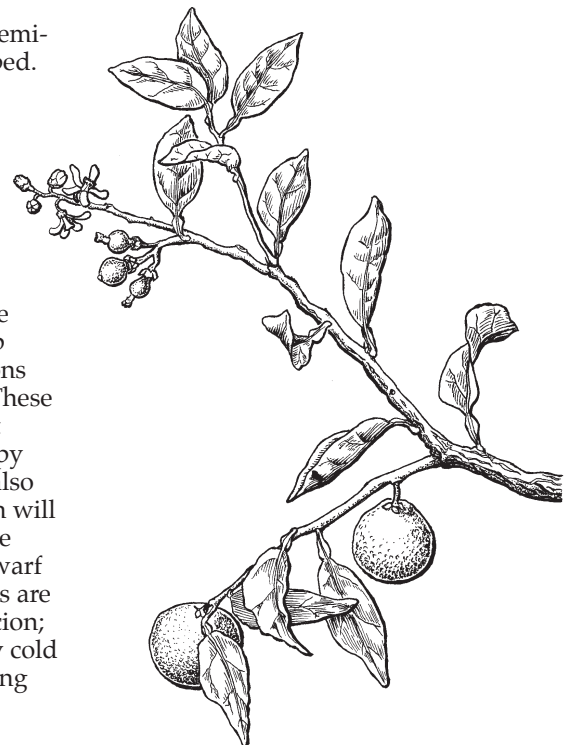
Sometime after World War II, semi-dwarfing rootstocks were developed. The most commonly used semi-dwarf stock is the seedling-raised trifoliolate orange (*Poncirus trifoliata*). A Valencia orange that is 30 feet tall on standard rootstock will top out at 12–15 feet on trifoliolate semi-dwarf rootstock.

Truly dwarfing citrus rootstocks have been introduced in the last 15 to 20 years. These will keep oranges at 6–8 feet and dwarf scions of Mandarin oranges at 4–6 feet. These dwarf stocks offer far greater fruit productivity per area of tree canopy than larger rootstocks. They will also impart precocity to the tree, which will bear fruit in the first 2–3 years. The major drawbacks to these truly dwarf rootstocks are: 1) rootstock suckers are frequent and often overtake the scion; 2) they are more easily stressed by cold and drought, which cause suckering and die-out.

CITRUS OFFER A VARIETY OF FLAVORS, SHAPES, SEASONS

Citrus fruit flavors can be divided into three basic categories:

- Sweet – oranges, tangelos, Mandarins
- Acid – lemons, limes, grapefruit,



Citrus bear their flowers and fruit terminally (apically) and on young wood (current or last season). Blooms and young fruit occur in clusters. The fruit self-thins to one per cluster.

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VARIETIES OF NOTE

Sour/Bitter Fruit – The Unsung and Under Appreciated

Citrus mitis, Calamondin (semi-dwarf, 15-20 feet; dwarf, 8-10 feet) – A very attractive upright, columnar tree that is amazingly productive and very cold hardy (20° F). Loose-skinned fruit with very sour pulp; the preferred citrus for marmalade. High juice content. Good mixed with oranges to sweeten. Fruit hangs on tree almost year round.

Citrus limon x reticulata, Rangpur Lime (semi-dwarf, 6-8 feet; dwarf, 4 feet) – Not a true lime, but a natural cross between a lemon and a mandarin. A naturally dwarf tree with a drooping habit. The small fruit has the appearance and loose peel of a Mandarin. Taste and acidity are somewhere between a lemon and a lime. Great in lemonade-like drinks. A good lime substitute in cool growing areas.

Citrus aurantium, Bouquet des Fleurs (semi-dwarf, 6-8 feet; dwarf, 3-4 feet) – A very sour fruit for marmalades. High essential oil content make this a truly bitter fruit. Strongest scent of any citrus flowers. Dark green, waxy leaves.

Citrus aurantium, Seville Orange (semi-dwarf, 15-20 feet; dwarf, 8-10 feet) – This large, upright tree makes a striking ornamental. Deep orange fruit is rough-skinned, bitter, and juicy—great for marmalades.

Citrus myrtifolia, Chinotto, Myrtle Leaf Citrus (semi-dwarf, 4-6 feet; dwarf, 3-4 feet) – A very dwarf, dark-foliaged shrub, always covered with small, bitter fruit which holds on the shrub year round. Can be used as a hedge. Native to Italy.

Citrus medica, Etrog and Fingered Citron (Buddha's Hand) – An ancient species, the first citrus introduced to Europe from the Mideast. A rangy shrub that has oblong, lemon-like fruit (Citron), or a warted, finger-like fruit (Etrog). Fruit is very fragrant, sour and virtually all pulp and no juice. Used in Jewish Feast of the Tabernacles.

Acid Fruit

Fortunella margarita, Kumquat (semi-dwarf, 6-8 feet; dwarf, 3-4 feet) – Small to medium shrub from China with small (1-2 inch), oblong orange fruit. Flavor is opposite of normal citrus: sweet, edible rind and sour, acidic flesh. While it is the most cold hardy of citrus (18°-20° F and even down to 8°-10° F), it also has nearly the highest heat requirement for flowering and fruiting and generally does not set fruit in cool regions such as California's Central Coast.

Kumquat hybrids – Bred crosses between kumquat x lime = limequat; kumquat x orange = orangequat; triple cross: kumquat x orange x citrange (sour orange) = citrangequat. These hybrids are very dwarf (3 x 3 feet), spreading shrubs. Fruit is small and kumquat-like, and the rinds taste similar to non-kumquat parent. Flesh is sour/acid like kumquat. Hardiness is midway between kumquat and other parent. Very productive and attractive.

Citrus limon x sinensis, Improved Meyer Lemon (semi-dwarf, 6-8 feet; dwarf 3-4 feet) – The Meyer lemon is a bred cross between an orange and a lemon. A spreading shrub almost always covered with flowers, young fruit, and mature fruit. Thin skinned and mild (some say insipid) lemony taste. Among the most cold hardy of citrus and one of the few successfully propagated from stem cuttings (loses its dwarfness, 8-12 feet).

Citrus limoni, Lemon (semi-dwarf, 12-18 feet; dwarf, 6-8 feet) – Because they are an acid fruit, these vigorous growers have a low heat requirement (heat = sugar content). They are also extremely frost sensitive. *Eureka* – rangy, open growth habit, few thorns, moderate vigor. *Lisbon* – thorny, vigorous tree, fruit indistinguishable from *Eureka*.

Citrus maxima or *C. grandis*, Pummelo (Shaddock) – Tall, stately parent to the grapefruit. Largest-fruited of all citrus. Sour with low juice content. Marginal in cool growing areas—will fruit, but quality is variable.

Citrus aurantiifolia, Limes – Along with lemons, limes are the most commonly known acid citrus fruit. In general, limes are the most cold-sensitive citrus, with flower damage occurring at 30°-32° F. True limes, along with kumquats, have the highest heat requirement of all citrus; they also need high humidity and high night-time temperatures to produce a vibrant tree and quality fruit. There are two types of limes: 1) True Lime, Mexican, or Bartender's Lime, and 2) Bearss or Sweet Lime.

True limes are small shrubs (semi-dwarf, 6-8 feet; dwarf, 3-4 feet) that have a limited successful range which includes Florida, the Caribbean, and Mexico. They will not grow and fruit in cool citrus areas—there they are a chlorotic, twiggy, often fruitless shrub that defoliates in cold weather.

The Bearss or Sweet Lime (sweet being a relative term—they are slightly less acidic than lemons) is a vigorous tree (semi-dwarf, 8-12 feet; dwarf, 6-8 feet) that performs handsomely in any area where lemons thrive. Like lemons, they have a low heat requirement to ripen fruit, are productive and almost constant cropping. The large fruit can be harvested green to light yellow. The juice content increases dramatically as color turns green to yellow but the acidity decreases to slightly less than that of a lemon.

On the downside, the fruit doesn't hang well on the tree at maturity and must be harvested frequently. This is a tree worth growing, with its pleasing round shape and dark green foliage contrasting with the abundant yellow fruit—it is a presence in the landscape.

Citrus paradisi, Grapefruit (semi-dwarf, 8-12 feet; dwarf, 6-8 feet) – The grapefruit is a natural hybrid between a lemon and a pummelo. These are large trees with a high heat requirement. The fruit can (and should in cooler areas) be left on the tree to sweeten up to 18 months. Trees often carry 2-3 crops simultaneously. The main varieties are—

- Marsh seedless (from Florida) – white flesh
- Redblush or Ruby – pink flesh
- Duncan – grown primarily in Florida
- Oro Blanco – a sweeter variety that produces passable fruit in cooler areas.

Sweet Fruit

Citrus paradisi x *C. reticulata*, Tangelo (semi-dwarf, 8-12 feet; dwarf, 6-8 feet) – Tangelos are a bred hybrid cross between a grapefruit and a mandarin orange. The trees are vigorous and productive, but tend to be heavily alternate bearing (bearing a large crop one year and a small crop the next). Fruit hangs on the tree well for three to four months. Depending on the variety, the taste is closer to one parent or the other—

- Orlando and Minneola – sweet like a Mandarin
- Seminole and Sampson – sour like a grapefruit

Citrus reticulata, Mandarin Orange – Probably the largest group of citrus, *C. reticulata* also has the most common names—Satsumas, tangerines, slip skin or kid glove oranges (a reference to puffy, loose skin that makes peeling literally child’s play). Dwarf to medium tree vigor is the rule in this grouping with Owari Satsuma being the most dwarf scion. Mandarins are very cold hardy, tolerating temperatures into the low 20°s before frost damage starts. While they perform adequately in coastal areas they also can tolerate desert heat. By selecting three or four varieties, the home gardener can have a six- to eight-month harvest period. Varieties of note—

- Owari Satsuma – Matures early: late November - March 1. Hold on tree adequately for 1-2 months. Easiest to peel because of loose skin. Sections easily too; no seeds. Taste is mild/sweet, moderate juice content. A naturally dwarf scion (semi-dwarf, 6-8 feet; dwarf, 4-6 feet).
- Clementine or Algerian – Harvest December - April. Moderate vigor. Fruit held toward periphery of tree, making it an attractive landscape plant. Moderately easy to peel. Sweet

and juicy with seeds. Prefers higher heat but ripens adequately in warm coastal areas. Performs better with pollinators: Valencia orange, Dancy Mandarin, or Kinnow Mandarin.

- Kara – Large tree; fruit has full flavor and high juice content. Extends the ripening season March - June. Does best in interior valleys (although not in the desert) and is adequate on the coast.
- Encore – Truly a summer-ripening Mandarin, ripens July - September. Tight skin that is difficult to peel, but the reward is a very juicy, sweet, aromatic fruit. Skin is often green speckled. Fruit holds on tree 3-4 months and tree is vigorous and spreading (semi-dwarf, 12-15 feet x 8 feet; dwarf, 8 feet x 6 feet). Performs very well in cool summer areas.

Citrus sinensis, Sweet Orange – The best known of all citrus. Varieties of note—

- Washington Navel – A chance mutant from a seeded fruit in Bahia Brazil in 1860s introduced to Riverside, California (where one of the three parent trees still lives) in 1873, thus starting the citrus industry in California. Ripens December - May. It is the classic eating orange. It fruits poorly in high heat of desert and only adequately in cooler areas. It reaches its peak in interior valleys of California.
- Trovita – A navel-less seedling of the Washington navel, it reportedly does better on the coast (but that has not been this writer’s experience).
- Skaggs Bonanza – An early ripening navel type.
- Summer Navel – Extends ripening season March - May.
- Valencia – The classic juice orange. A very vigorous, round-headed tree. Better sliced than peeled for eating out of hand. Fruit holds on the tree almost endlessly—up to six months. This ability makes it easier to sweeten up in cool growing areas than navels. Ripens April - September.

Blood Oranges – A unique, attractive and tasty orange. Depending on cultivar and climate (heat causes more intense coloring), pulp is colored red. Taste is rich and distinctive. Varieties of note—

- Tarocco – Large tree and large fruit with high juice content.
- Sanguinelli – Small tree with small fruit. Best external rind coloring, best on coast.
- Moro – Medium spreading tree, does well in interior and on coast, fruit in clusters.

—Orin Martin,
Alan Chadwick Garden manager

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Monterey Bay Region Tree Sources

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