

The Satsuma Mandarin¹

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Scientific Name

Citrus unshiu Marcovitch

Common Name

In most citrus producing areas, satsuma mandarin is the preferred name, but satsuma tangerine is also used (Figures 1 and 2).



Figure 1. A satsuma orchard in north Florida.
Credits: P. C. Andersen



Figure 2. Mature satsumas ready for harvest.
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Family

Rutaceae

Origin

China and Japan

Distribution

Satsumas are grown in cool subtropical regions of Japan, Spain, central China, Korea, Turkey, along the Black Sea in Russia, southern South Africa, South America, and on a small scale in central California and northern Florida. The world's largest satsuma industry is located in southern Japan where climatic conditions are favorable for the production of early ripening satsuma mandarins of high quality. Selection of slight mutations and seedlings from controlled pollinations over many years has resulted in a collection of over 100 cultivars that differ in date of maturity, fruit shape, color, and quality. 'Owari' is the primary satsuma cultivar commercially grown in Florida, but 'Brown Select', 'Early St. Ann', 'Silverhill', and 'Kimbrough' are also available.

History

Satsuma mandarin may have originated in China, but it was first reported in Japan more than 700 years ago, where it is now the major citrus species grown. The first recorded introduction into the United States was in Florida by George R. Hall in 1876. The name "satsuma" is credited to the wife of a United States minister to Japan, General Van

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Valkenberg, who sent trees home in 1878 from Satsuma, the name of a former province, now Kagoshima Prefecture, on the southern tip of Kyushu Island, where it is believed to have originated.

During the period 1908-1911, approximately a million 'Owari' satsuma trees were imported from Japan and planted throughout the lower Gulf Coast states from the northern Florida Gulf coast to Texas, where an extensive tangerine industry developed. However, occasional severe freezes have reduced satsuma acreage. It is the major commercial citrus type grown in the southern parts of the states bordering the northern Gulf of Mexico.

Importance

While this fruit is grown primarily for fresh consumption, a portion of the crop is canned as fruit segments or juice in Japan, China, and Spain. In these countries deeply colored juice is blended with orange juice to improve color or sold as single strength tangerine juice. Fresh fruit is also imported into Canada and noncitrus producing areas of the US, where it is the earliest seasonal citrus crop to reach the market.

Description

Although authorities differ as to the number of species and appropriate classification and grouping, mandarins have been divided into four groups: 1) satsuma group (*Citrus unshiu*), 2) the King group (*C. nobilis*), 3) the Mediterranean group (*C. deliciosa*), and 4) the common group (*C. reticulata*).

Tree

Budded trees are small to medium-small, low-growing, usually spreading and drooping, nearly thornless, with less foliage and a more open growth habit than other commercial citrus cultivars. Trees have a prostrate growth habit, and low lying limbs must be pruned to prevent fruit from lying on the ground. Trees are very hardy to cold and resistant to unfavorable conditions but susceptible to sour orange scab (*Elsinoe fawcetti*), a fungal disease that causes scabby, wart-like lesions on leaves, twigs, and fruit without usually affecting internal fruit quality.

Leaves

Leaves are dark green, large, lanceolate, tapering at the base and apex, and are typically broader than other tangerines. Both main and primary lateral veins are prominent above

as well as below. The petiole is slender, very long, and has narrow wings.

Flowers

Petals of the flower are white and the flowers are "perfect," containing both male and female flower parts. Satsuma flowers produce little viable pollen and have few viable ovules. However, the satsuma is highly parthenocarpic (develops fruit without fertilization, resulting in the production of seedless fruit) and does not require pollination by other citrus cultivars.

Fruit

Botanically, the fruit of tangerines and of all citrus species, is a special berry known as an hesperidium. Fruit is medium to small and shaped like a flattened sphere; sometimes slightly necked; seedless (0 to 6 seeds); has 10 to 12 segments that are loosely separable; tough carpellary membranes and a hollow axis. In areas with cool night temperatures, the flesh is a brilliant reddish orange, tender and melting, with a rich, subacid flavor. Pulp-vesicles are short and broad. Seeds, when present, have light green cotyledons.

Fruit Quality

Satsumas have consistently high quality only in regions with cool winters and hot summers (Figure 3). Fruit grown in humid subtropical areas commonly matures internally and has good eating quality before good peel color develops. Such internally mature but externally green fruit is sometimes marketed as Emerald Green satsuma tangerines (Figure 4).



Figure 3. Satsuma fruit harvesting during late November.
Credits: P. C. Andersen



Figure 4. Emeral green sastumas.
Credits: UF/IFAS

Looseness of the rind requires that fruit be clipped at harvest to avoid plugging or tearing, leading to subsequent postharvest decay. Fruit will not tolerate careless handling, does not respond well to degreening and in general, does not ship well. Fruit size is also an important quality factor.

The rind is thin and somewhat leathery; moderately smooth with large and prominent oil glands. As fruit matures, the rind surface becomes increasingly bumpy and the rind separates from the flesh somewhat.

Bearing Season

Season of maturity: October–December. Fruit hold poorly on the tree after maturity and must be picked promptly, but store well under refrigerated conditions (32°F to 36°F).

Cold Tolerance

The satsuma mandarin tree is the most cold-tolerant citrus of commercial importance. Mature dormant trees have survived minimum temperatures of 14°F to 18°F in northern Florida, northern California, and southern Alabama without serious injury. Moreover, because of their low total heat requirement, some citrus ripen earlier than oranges and most other mandarins. As a consequence, the satsuma mandarin is ideally adapted to regions with winters too cold for other citrus fruits, but with growing seasons warm enough to produce fruit of early maturity and good quality. Its range of climatic adaption for commercial culture is, therefore, narrow and restricted to the higher elevations and colder areas of the sub-tropical zones. In the United States, climatic conditions suitable for satsumas

occur in northern Florida, in a narrow strip extending along the Gulf of Mexico across Alabama, Mississippi, and Louisiana into eastern Texas and in the Sacramento-San Joaquin Valley basin of California. Although these areas are subject to severe freezes, current cold protection methods, using in-tree microsprinklers, can protect trees to a height of approximately five feet. In addition, tree trunks can be mounded with soil up to a height of two feet during early December to protect the region above the graft union. Remember to remove the mound from the base of the plant by mid-March. Commercial trunk wraps may also provide some cold protection. These cold protection strategy may be the key to at least partial revitalization of satsuma plantings in some areas.

Cultivars

‘Owari’ Satsuma

Season of maturity: October to November. Seeds: 0–6, but rarely present. As maturity passes, the neck, if present, increases in size. The rind roughens and loosens. Tree moderately vigorous but slow-growing; medium-small, spreading and drooping; very productive. Fruit of good quality that, because of the firm consistency of the flesh and tough carpellary membrances, is especially suitable for canning.

‘Silverhill’ Satsuma

Season of maturity: October to November. Seeds: 0–6, but rarely present. Fruit medium in size, slightly more oblate than most. Rind relatively thin and smooth. Abundant juice with high sugars and low acid content, hence very sweet. Tree very vigorous, productive, and more up-right than other satsuma cultivars.

‘Kimbrough’ Satsuma

Season of maturity: October to November. Seeds: 0–6, but rarely present. Introduced from Louisiana, this cultivar produces larger fruit than the ‘Owari’ satsuma, with rind thickness, internal color, taste, and fruit production comparable to ‘Owari’. Trees are large and productive with a spreading growth habit and are thought to offer 1–2°F better cold tolerance than ‘Owari’.

‘Brown Select’ Satsuma

Season of maturity: October to November (two weeks ahead of ‘Owari’). Seeds: 0–6, but rarely present. Satsuma originated from the Louisiana Citrus Research Center as an open-pollinated seedling of ‘Kimbrough’. Tree size is slightly larger than ‘Owari’. ‘Brown Select’ has a compact or

dense growth habit and is less weepy than some of the other satsuma cultivars. At harvest, the skin is leathery and easily separates from the flesh. Fruit color is yellow orange, the flesh is orange, and the fruit taste is acidic sweet.

‘Early St. Ann’ Satsuma

Season of maturity: Late September to October. Seeds: 0–6, but rarely present. ‘Early St. Ann’ is a cultivar that originated from the Louisiana Citrus Research Center. It is an open-pollinated seedling of unknown parentage. It ripens extremely early, from mid-September to mid-October. Growth habit is droopy, as is the case with most satsuma cultivars. ‘Early St. Ann’ are medium-large in size and light yellow in color. At harvest, the skin is leathery and easily separates from the flesh. Flesh color is deep orange, and the taste is juicy and mildly acidic.

Rootstocks for Satsuma Mandarin

Trifoliolate orange (*Poncirus trifoliata* (L.) Raf) is the most commonly used rootstock for satsuma mandarins, especially in cool climates where maximum cold tolerance develops. However, in Florida, where the winters can be relatively short and interrupted by brief periods of warm temperatures, trifoliolate orange does not provide consistent protection from cold south of Gainesville.

Trifoliolate orange grows well on fertile, clay to loamy type soils. It does not develop a very deep or wide-ranging root system and is poorly adapted to saline or calcareous conditions, but its resistance to foot rot, a soil-borne disease, makes it a good choice for soils with poor drainage. Trifoliolate orange is susceptible to exocortis, a virus-like disease; blight, a disease whose causal agent is unknown; and the burrowing nematode, with some selections resistant to the citrus nematode. Many selections of *P. trifoliata* are available, including a dwarfing rootstock named Flying Dragon.

‘Swingle’ citrumelo is a cross between *P. trifoliata* and ‘Duncan’ grapefruit (*Citrus paradisi* Macf.). ‘Carrizo’ citrange is a cross between *P. trifoliata* and Washington Navel (*Citrus sinensis* L.). Satsumas are often propagated on ‘Carrizo’ and especially ‘Swingle’ rootstocks. This is due to the fact that budding and early tree growth are better for satsumas on ‘Swingle’ compared to *P. trifoliata*. The performance of satsuma on ‘Swingle’ or ‘Carrizo’ rootstocks compared to *P. trifoliata* has not been adequately compared, although they are believed to be less cold tolerant than when grafted on *P. trifoliata*. We have observed ‘Navel’ on ‘Carrizo’ and ‘Owari’, and ‘Brown Select’ on ‘Swingle’ to withstand 14°F without appreciable cold injury at the North Florida

Research and Education Center in Quincy, FL, when fully cold acclimated.

Performance of Satsumas in North Florida

A 0.66 acre planting satsumas was established in 2004 at the North Florida Research and Education Center in Quincy, FL, consisting of ‘Owari’ or ‘Brown Select’ scions on either *Poncirus trifoliata* ‘Flying Dragon’ or ‘Rubidoux’ rootstocks. Each scion or rootstock was represented 19 to 28 times in a randomized block design. Citrus trees were spaced 15 feet in a row and 20 feet between rows. Soil type was an Orangeburg loamy fine sand. Irrigation was provided by microjet emitters. Fertilizer (10N-10P-10K with micronutrients) was generally applied every 6 weeks beginning in March and ending in early August. Tree height and tree width (in N-S and E-W directions) was determined in 2010, 2012, and 2014, and canopy area was calculated. Satsumas were harvested in late November through early December. Fruit weight, soluble solids, and pH were determined on a 20 fruit sample from each tree. Young (first- to fourth-leaf) trees received soil mounding up to a height of 1 ½ feet, and microjet freeze protection on young trees was deployed when temperatures dropped to less than 20°F. Freeze control methods were not used after the winter of 2008/2009.

Satsuma trees on ‘Rubidoux’ generally reached full canopy size by 2010 (sixth leaf) and fully occupied the 15 x 20 feet spacing, whereas trees on ‘Flying Dragon’ (a dwarfing rootstock) remained small (Table 1). ‘Brown Select’ trees were larger than ‘Owari’. The reduction in tree size in 2014 compared to 2012 was due to the pruning of low-lying limbs (to prevent fruit contact with ground) and the pruning of limbs between rows to allow the passage of farm equipment (for ‘Rubidoux’ only). Yield per year averaged 264 lbs/tree (19.2 tons/acre) for ‘Brown Select’/‘Rubidoux’, 218 lbs/tree (15.8 tons/acre) for ‘Owari’/‘Rubidoux’, 143 lbs/tree (10.4 tons/acre) for ‘Brown Select’/‘Flying Dragon’ and 107 lbs/tree (7.8 tons/acre) for ‘Owari’/‘Flying Dragon’. When yield was calculated on the basis of tree size, yields were often similar for trees on the two rootstocks, suggesting a high density satsuma orchard on ‘Flying Dragon’ can produce yields per acre similar to ‘Rubidoux’ planted to a standard tree density. Since trees on ‘Flying Dragon’ will seldom exceed 7 feet in height, mature trees can easily be harvested without ladders. Average fruit weight ranged from 139 to 154 g and was slightly higher for ‘Brown Select’ than ‘Owari’ and higher for ‘Rubidoux’ than ‘Flying Dragon’. The soluble solids and pH of juice was usually

about 10°Brix and 3.73, respectively. ‘Owari’ was sweeter than ‘Brown Select’. Visible symptoms of cold injury did not occur in response to minimum winter temperatures of 14°F to 15°F; however, some minor limb dieback occurred after a November 19, 2014 freeze (22°F) when trees were not cold-acclimated. In conclusion, there is potential for the expansion of a satsuma industry in north Florida.

Table 1. Average tree canopy area, yield, fruit size, fruit soluble solids, and fruit pH from 2009–2014 of ‘Brown Select’ and ‘Owari’ satsuma budded on *P. trifoliata* ‘Flying Dragon’ and ‘Rubidoux’ rootstocks.

Scion/Rootstock	Tree Canopy Area (m ²)			Yield per Year from 2009–2014 ²		Fruit Weight (g)	Fruit Soluble Solids (°Brix)	Fruit pH
	2010	2012	2014	(lbs/tree)	(tons/acre)			
‘Brown Select’/‘Flying Dragon’	7.1	6.8	5.8	143	10.4	151	10.3	3.75
‘Brown Select’/‘Rubidoux’	11.3	14.0	11.1	246	19.2	154	9.6	3.73
‘Owari’/‘Flying Dragon’	4.5	4.3	3.6	107	7.8	139	10.3	3.73
‘Owari’/‘Rubidoux’	8.3	10.0	7.7	218	15.8	144	9.8	3.70

²Trees were planted in 2004 at a spacing of 15 feet within a row and 20 feet between rows.