

CITRUS SINENSIS

MONOGRAPH



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INTRODUCTION

Citrus Sinensis L. is the scientifically name for the orange. This fruit is produced in Colombia, with the world's major producer being United States. It is an important crop in the Far East, the Union of South Africa, Australia, throughout the Mediterranean area, and subtropical areas of South America and the Caribbean. It is produced in many countries around the world especially in warm and tropical weathers. Sweet orange has a world production of 49.6 million metric tones for the year 2016-2017 (USDA, 2017). It is used in many commercial applications because of its sweet flavor, sweet aroma, and abundant source of Vitamin C but, It's main uses are for food and beverages, and cosmetics. It grows as a tree with white flowers and it takes about six years for fruit to grow from seed.

In this monograph the topics that are going to be expanded upon are: chapter one will discuss the ecology of orange focusing on distributional context, environmental factors in distribution, and citrus sinensis as a vegetation component. Chapter two will focus on biology of the plant including chromosome complement, life cycle and phenology, reproductive biology, and ecophysiology. Chapter three will focus on propagation and management, especially in topics as natural regeneration, nursery propagation, planting and management. Chapter four will focus on the commercial importance, principally in exports and imports of the product and the importance in the economy. The final chapter is devoted to the commercial production and uses which is divided into food uses, medical uses and traditional uses of the orange.

1 ECOLOGY

1.1 DISTRIBUTIONAL CONTEXT

1.1.1 Affinities

Citrus sienesis is a member of the Rutaceae, which are herbs, shrubs, and trees with glandular punctate, commonly strongly smelling herbage comprising about 150 genera and 1,500 species that are further characterized by the common occurrence of spines and winged petioles. It is divided into small species such as: Ambersweet which give fruits between October to December, Blood which give fruits between February to April, Hamlin and Navel which gives fruits between October and January, Ortanique which gives fruits between January and April, Page and Parson Brown which give fruits between October and February, Pineapple which give fruits between December and February, Red Navel which gives fruits between October and January, Temple which give fruits between January and March and Valencia which give fruits between March and June. Since this fruit descend from mandarin and pomelo, their taxonomy keys are almost identical. *Citrus Sinensis* can be found in the entire America, but is more concentrated in the U.S.A.

Taxonomy of *Citrus Sinensis*:

- Domain: Eukarya
- Kingdom: Plantae
- Subkingdom: Tracheobionta
- Division: Magnoliophyta
- Class: Magnoliopsida
- Subclass: Rosidae
- Order: Sapindales

- Family: Rutaceae
- Genus: Citrus
- Species: *sinensis*
- Generic group: Citrus Fruit

1.1.2 Fossil Record

Carl Linneaus in 1753 referred to *Citrus* as the genus of the orange specie. Also he determine *Citrus Sinensis* as the most important fruit of the world due to its benefits to humanity conservation. Even though presently there is missing lot of data about *Citrus Sinensis* past, Its history of cultivation is really extensive; more than 4000 of research and experiments to get final results. The putative wild progenitors of these fruit according to RAPD and SCAR markers hybrid of pummelo and mandarin, but also Protein data also supported that *C. reticulata* was a parent of sweet orange. But latter reports confirm that Chloroplast DNA analyses revealed that the chloroplast genome of sweet orange was derived from pummelo, which is the maternal parent of these fruit, and the most close paternal parent is mandarin.

1.1.3 Origin

The join up between the Pomelo and the Mandarin in 314 b.c. create two different types of citrus: bitter orange and sweet orange. Both of this are native to southern Asia 7,000 years ago and spread through the Silk Road until reaching west Asia and finally ending in Europe, where their main purpose was to help with medicine during the 15th century. By the 16th century, Spanish explorers start popularizing them and brought them to the “New World” (America) where missionaries planted many orange trees in Florida and then on California which presently are known for their orange plantations. Before the 20th century *Citrus Sinensis* were already prestigious and popular, that much that they were only used in important holidays as Thanksgiving of Christmas. Presently

oranges are really popular all around the world not only because of its nutrients, but because has lots of vitamins that help humans gain defenses.

1.1.4 Present distribution

The orange has become the most commonly grown tree fruit in the world. It is an important crop in the Far East, the Union of South Africa, Australia, throughout the Mediterranean area, and subtropical areas of South America and the Caribbean. The United States is the biggest producer, having an annual yield of more than 200 million boxes, except when freezes occur which may reduce the crop by 20 or even 40% (Figure 1.1). California, Texas and Arizona follow in that order, with much lower production in Louisiana, Mississippi, Alabama and Georgia. Other major producers are Brazil, Spain, Japan, Mexico, Italy, India, Argentina and Egypt. In Brazil, oranges are grown everywhere in the coastal plain and in the highlands but most extensively in the States of Sao Paulo and Rio de Janeiro. Mexico's citrus industry is located largely in the 4 southern states of Nuevo Leon, Tamaulipas, San Luis Potosi and Veracruz. The orange crop is over one million MT and Nuevo Leon has 20 modern packing plants, mostly with fumigation facilities. Large quantities of fresh oranges and orange juice concentrate are exported to the United States and small shipments go to East Germany, Canada and Argentina. However, it has generate markets to overproduce due to these prices has lowered. The top ten countries that produce oranges are: Brazil, U.S.A, China, India, Mexico, Spain, Egypt, Italy, Turkey and South Africa (Figure 1.2). *“Present world production of citrus is about 98.7 million tons of fresh fruit, of which 62 percent is orange, 17 percent mandarin and tangerine, 5 percent citron, 11 percent is lime and lemon and 5 percent grapefruit”*(FAOSTAT, 2001).

Table 1.1. Production Classification of *C. Sinensis* (Top Ten Orange Producing Countries. (2016, February 9). Retrieved from <http://www.mapsofworld.com/world-top-ten/orange-producing-countries.html>

Rank	Area	Production (Int 1000)	Production (MT)
1	Brazil	3481071	18012560
2	United States of America	1578237	8166480
3	China, mainland	1256177	65000000
4	India	966290	50000000
5	Mexico	708636	3666790
6	Spain	566980	2933800
7	Egypt	538493	2786397
8	Italy	342163	1770503
9	Turkey	321194	1662000
10	South Africa	311691	1612828

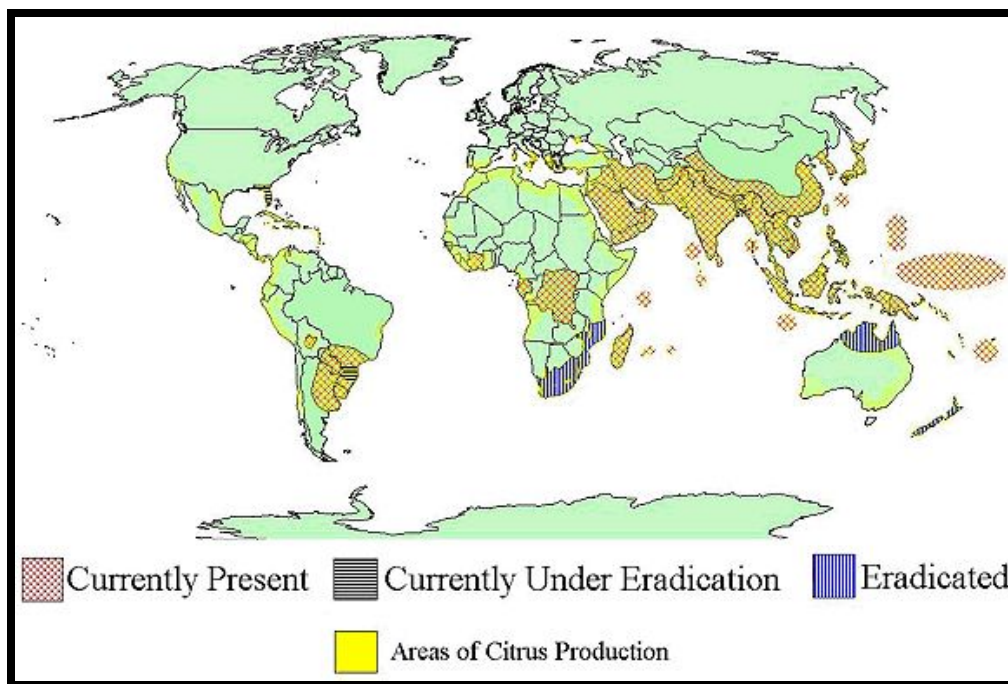


Figure 1.1. Present distribution of *C.sinensis* (*Orange Fruit. (2015). Retrieved from <http://www.fruitvs.com/en/orange-fruit/model-3-0>*)

1.2 ENVIRONMENTAL FACTORS IN DISTRIBUTION

1.2.1 Elevation and Climate

Citrus Sinensis is constituted of low elevation, between 40°N and 40°S. Usually 1800 meters altitude in the tropics and up to 750 meters altitude in the subtropics. Yield decreases due to soil salinity are: 0% at ECe 1.7, 10% at 2.3, 25% at 3.3, 50% at 4.8, and 100% at ECe 8 mmhos/cm.

In relation to climate *Citrus Sinensis* originally best survives in tropical and subtropical environments where summers predominate over winters. This occurs mainly because as FAO water says, “*Citrus originates from the wet tropics in Southeast Asia, but large-scale commercial production is found in the subtropics under irrigation*” (FAOSTAT 2015). Some types of citrus are more cold-tolerant than others, and oranges have an intermediate cold resistance and thrive in subtropical climates (SFGATE 2014).

1.2.2.1 Rainfall, potential evapotranspiration and water deficits

The minimum annual precipitation for *Citrus Sinensis* is between 5 to 20 inches, but the perfect one is between 40 to 60 inches. For example Lower Bengal because of its damp climate, the fruits lack juice and are usually very sour. In the other hand, because California's climate is generally dry, the orange has an intense color peel. For these species, depending on the altitude the temperatures vary over the year which creates a disorganized rainfall in many countries with seasons (Figure 1.3).

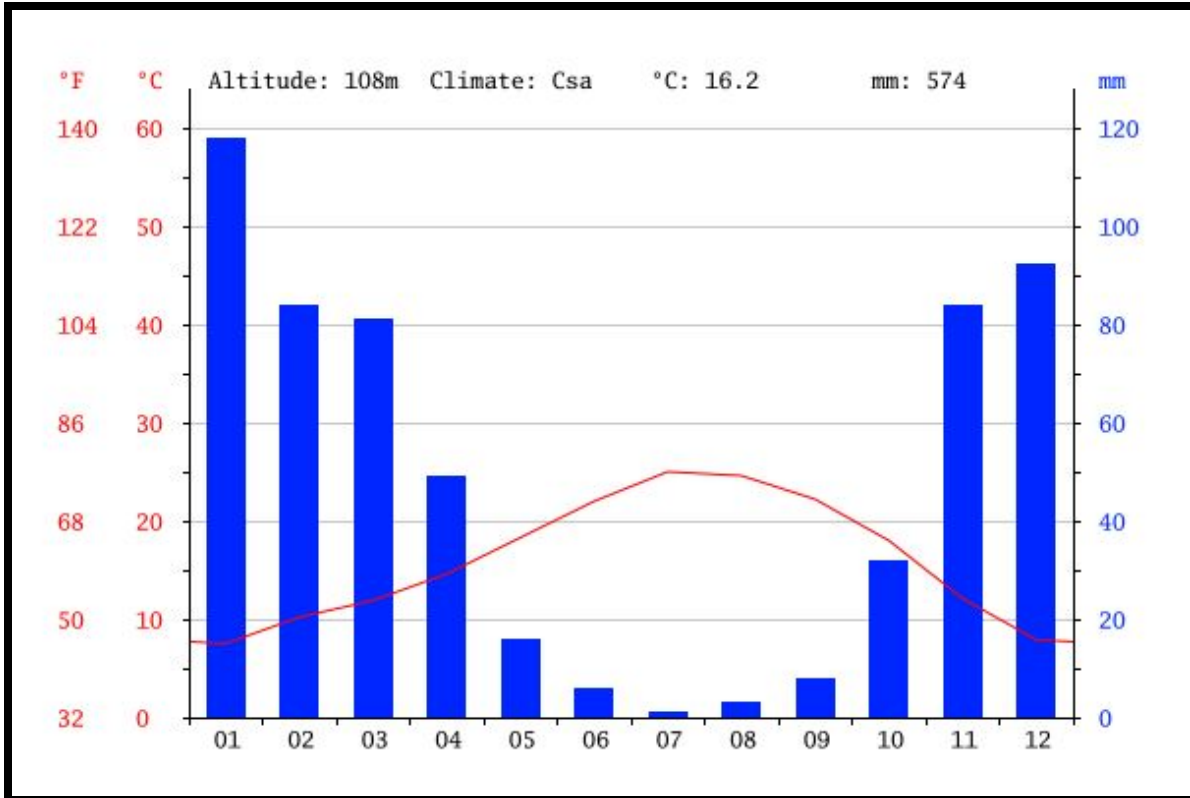


Figure 1.2 Rainfall temperatures of *C. Sinensis* (Willow Springs. (n.d.). Retrieved from <http://en.climate-data.org/location/631471/>)

1.2.2.2 Temperature regime

Oranges grow in temperatures between 12° to 38° degrees Celsius during summer and 1° to 10° C in winter. Mature oranges trees are the exception, they can survive with temperatures of -3° C over winter dormancy. “Trees bearing fruit can withstand about three to five hours below or at -3° C, but ice forms after longer periods, damaging the twigs and fruits of trees” (SFGATE 2014). Successful root growth occurs when soil temperatures are higher than 12° C. In temperatures of -8° C branches start to wither and in -10° C the *Citrus Sinensis* tree dies. Places where seasons arrive intensely affect drastically the production of this specie, since there isn't a constant temperature.

1.2.2 Geology and soils

The best soil for the growth of oranges is fine sand, well-drained, and often identified as high hammock or high pineland soil. That's why according to FAO water, "*Soil physical structure is of greater importance than the chemical properties, provided sufficient magnesium and minor elements such as zinc, copper and manganese are present in an available form*" (FAO 2015). *Citrus Sinensis* are commonly grown on soils sufficient aerated and deep so that the roots are able to penetrate. It is important to select the appropriate rootstock for particular soil conditions, due to this hallow soils of high water-holding ability, are avoided. For *Citrus Sinensis* is preferable that soils have a pH between 5 and 8 but tolerates a pH in the range 4.3 to 8.3. During prolonged periods of water deficit, soil water in a well-drained soil may be utilized up to a soil depth of 2 or 3 m (FAO 2015).

1.2.3 Toposequences

The *Citrus Sinensis* tree grows successfully in every type of ground, but the clayey and sandy soils with a pH of 6 to 6.5 are the ones with best conditions for the development of the plant. The preparation of the soil should be organize by putting first sand in the bottom, 5 to 10 liters of organic fertilizer, 250 grams of NPK fertilizer mixed with the soil to prevent the roots from burning. The hedge fertilization should be done in winter or at the beginning of the rains to get a more healthy plant (Soc, 2010).

1.2.4 Evapotranspiration

For an adequate maintenance *Citrus Sinensis* need a water evapotranspiration ranged from 76 to 124 centimeters annually. Normally 100 percent of the water is extracted from the first 1. 2 to 1. 6 m but, under dry conditions the depth of water increases. During large periods of water deficit, soil

water in a deep and well-drained soil may be utilized up to a soil depth of 2 or 3 m. In general total water requirements vary between 900 and 1200 mm per year.

1.3 CITRUS SINENSIS AS A VEGETATION COMPONENT

1.3.1 Associated Species

Since *Citrus Sinensis* belong to the citrus family, they have lot in common with other citrus. Most citrus fruits originated from crosses between two or more other citrus varieties. There are four wild true-breeding species from which all the others are derived: *Citrus aurantifolia*, *Citrus maxima*, *Citrus medica*, and *Citrus reticulata*.

Table 1.2. Associated Species of *C. Sinensis* (Orange Varieties. (n.d.). Retrieved from <http://www.mycitrus tree.com/citrus-varieties/orange.html>.)

Variety	Season of maturity	Seeds/Fruits	Comments
AMBERSWEET	OCT-DEC	MANY 10 – 20	Moderately thick rind, easily peeled. Flesh tender, deep orange color, good juice. When fruit gets too ripe starts to dry. Tree upright, dense foliage. Moderately cold hardy.
BLOOD	FEB-APR	FEW 4 – 10	Unique sweet flavor. Rind orange with pink blush. Red pigment in flesh is dependent upon cooler temperatures; darker in colder areas. Medium size tree, very productive. Fruit can be round, oval or oblate in shape. <u>Sanguinelly</u> : Streaks of blood, taste similar to Valencia, fruit appearance same as Valencia.
HAMLIN	OCT-JAN	FEW 0 – 6	Most commonly grown early season orange in FL. Excellent juicy fruit, low acid. Rind is smooth, thin, pale orange, easily peeled. Medium to large tree, moderately vigorous growth, very heavy producer. More cold-tolerant
NAVEL	OCT-JAN	FEW 0 – 6	Lower acid content than most orange varieties. Easily peeled, sections well with excellent flavor. Not good for juicing as juice is more sour. Light producer; use pollinator for more fruit. Earliest maturing

Variety	Season of maturity	Seeds/Fruits	Comments
ORTANIQUE	JAN-APR	VARIABLES 1-10	Extremely juicy and sweet. Used for fresh fruit (breakfast, salads). Rind is smooth, pale orange color, thin & oily. Pulp deep orange color. Large size tree w/ vigorous growth. Closely resembles Temple.
PAGE	OCT-FEB	VARIABLES 0 – 25	High fruit quality, very sweet, excellent for juice. Peel thin, easily peeled & excessively oily. Moderately vigorous, thornless, heavy producer. Noticeable leaf drop in winter. Cold hardy.
PARSON BROWN	OCT-FEB	MANY 10-20	Produces a good crop of high quality fruit. Excellent juice fruit, juicy and sweet. Large upright, vigorous tree, bears heavy crop. Fruit is round w/ smooth, fairly thin, well-colored rind.
PINEAPPLE	DEC-FEB	MANY 15-25	Juice orange: Sweet juice flavor. Med-large tree, heavy producer. Subject to alternate year bearing & pre-harvest drop. Fruit sensitive to frost.
RED NAVEL	OCT-JAN	FEW 0-6	Red colored flesh, very sweet. Attractive in salads, easily peeled. Excellent eating fruit. Tree has compact growth habit.
TEMPLE	JAN-MAR	MANY 15-20	Excellent eating quality fruit with pebbly, thin rind that peels easily. Peel deep orange to red-orange. Pulp is orange. High sugars. Very good mid-season orange. Medium vigor, bushy, thorny, good producer. Cold sensitive.
VALENCIA	MAR-JUN	FEW 0-6	Juice orange. Represents 50% of the oranges grown in FL. Very juicy and sweet. Excellent for eating or juice. The last orange variety for the season. Rind remains somewhat greenish when mature w/ thin & tightly adhering rind. Vigorous upright, large & very prolific but some tendency to alternate bear.

1.3.1.1 Family prominence and floristic elements

Orange trees generally flower in May depending on the weather, temperature and soil type. If they are grown in a close environment they may flower many times throughout the year. *Citrus Sinensis* are known as self-pollinating, but very few of the flowers will turn in fruit.

1.3.3 Interactions involving Citrus Sinensis within communities

1.3.3.1 Root system

Root development is largely dependent on the type of rootstock used and on the characteristics of the soil profile (FAO 2015). Spanish citrus production has grown from sustainable management in the traditional orchards of alluvial plains and fluvial terraces of Júcar, Turia and Segura basin in Murcia and Valencia, to plantation on slopes without terraces. By doing these they have replaced the traditional production systems that were based on flood irrigation and dry farming on terraced hillsides. Most citrus species develop a single tap root and dislike root disturbance and so should be placed into their permanent positions when young. Desires depths for *Citrus Sinensis* are from 1-2 meters, “ *In general 60% of the roots are found in the first 0.5 m, 30% in the second 0.5 m, and the 10% below 1m*” (FAO 2015).

1.3.3.2 Pests and diseases

Several pest have been recorded on *Citrus Sinensis* as citrus rust mites, which cause external blemishing and, in extreme infestations, smaller fruits, pre-mature falling and even shedding of leaves. In summer pests as red mites (purple mites) and Texas citrus mites, disfigure the surface of the fruit and the foliage mainly in the winter and during drought. But the most harmful enemy is citrus snow scale infesting the woody portions of the tree.

The most common disease in *Citrus Sinensis* is the fungal disease which affects the roots, the trunk, the branches, the foliage and the fruits. “*Greasy spot, caused by Cercospora citri-grisea, is seen, 2 to 9 months after severe infection, as yellow-brown, blistery, oily, brown or black spots on the foliage*”(MORTON 2015). Also exists viruses and viroids named for the syndromes they cause—crinkly leaf; gummy bark; exocortis (scaly butt) transmitted by budwood and by tools;

psorosis, xyloporosis (cachexia), transmitted only by budwood. Tristeza has been a major problem in Florida in the past and still is in Brazil. Since 1953, Florida has maintained a Citrus Budwood Registration program for the production of virus-tested citrus trees.

1.3.3.3 Relations with others

Oranges are not only rich in flavor, but also in health benefits. For example dietary flavonoids which reduce risk of adverse cardiovascular events for example heart attacks and stroke. In addition women that consume them has 19% lower risk of having ischemic stroke than women who ate the least. *Citrus Sinensis* also contain carotenoids that are associated with reduced risk of developing rheumatoid arthritis.

- NOTABLE N U T R I E N T S ORANGES, (1 C U P =1 8 0 G)
 - Calories: 85
 - Dietary fiber: 4 g (17% DV)
 - Vitamin C: 96 m g (1 6 0 % DV)
 - Thiam in: 0.2 mg (10% DV)
 - Folate: 5 4 meg (14% DV)
 - Potassium: 326 m g (9% DV)

2 BIOLOGY

2.1 CHROMOSOME COMPLEMENT

Citrus Sinensis has a set of nine chromosome traced, $2n= 18$, $3n= 27$, and $4n=36$. Usually is identified as a polyploid but other species of citrus are triploids. From the citruses, *Citrus Sinensis* has the highest number of cultivars. “From these data, we hypothesized that there are at least two

rDNA sites in the chromosome complement of *C. Sinensis*, one in the proximal region and another one located in the medium- size located in the metacentric/ submetacentric (Bruce Reid, n.d.).

2.2 LIFE CYCLE AND PHENOLOGY

2.2.1 Life cycle

Germination times can be as long as six to eight weeks. Oranges has many blooming periods during the year depending on many factors such as climate or soils, but the best seasons for it to bloom are between spring and fall. “They tend to flower and fruit during periods of relatively abundant rainfall and becomes dormant if a pronounced drier period occur during the summer”(“Citrus Trees- The Sweet Orange,” 2016). Only a small proportion of flowers will produce fruit because the tree will drop many of its flowers or young oranges so it can support the ones it does keep. *Citrus Sinensis* take between three and five years to start flowering and five and eighteen months to develop the fruit. The secret to grow orange is sun exposure and water, needs a minimum of six hours a day in the sun. Lack of less sun will lead to smaller oranges of poor quality. They will continue to become sweeter on the tree but that process stops as soon as you pick them. Oranges do not continue to ripen off the tree. It is best to harvest your ripe fruits before the heat of summer arrives because the heat may harm the fruits and stress the entire tree (“The Life Cycle of an Orange Tree,” 2014).

Oranges begin to develop flower buds in early winter. They develop slowly through the late winter into spring, many flowers are produced that up to 99 percent of them fall off without setting fruit. Many of the small fruits fall off during the "June drop" period in late May and June. The remaining oranges continue to grow, maturing seven to 15 months after fruit set, depending on the variety and growing conditions. Fruit color doesn't always indicate ripeness. Some oranges develop some green

on the skin, called re-greening, due to cooler winter temperatures, but they are ready to harvest (Chaney, 2007). Pollination occurs between winter and spring depending on latitude and elevation.

2.2.2 Phenology

2.2.2.1 Deciduousness

Oranges are not deciduousness but, they loose leaves because of freezy injury. Loss of leaves can cause crop reduction because leaves are the ones that produce the tree's energy and food, therefore less leaves equals less flowering (The Flower Expert, 2017).

2.2.2.2 Flowering and fruiting

Citrus Sinensis flowering depends on temperature and water availability, usually the tree chooses its time based on when the fruit has more possibilities on maturing. Rising temperatures signal the tree that is time to start developing seeds. In more tropical regions, this citrus blooming season may follow the heavy rains after summer's drought. Flowering season in orange trees does not guarantee fruit. During winter periods, low- temperatures cause the inactivity of buds while inducing them to flower. A period of low temperature induces many buds to grow out, and most of these are floral. Floral development, is better defined, as transfer to high temperature prevents flower formation even after a period of 'inductive' low temperature treatment (Rhoades, 2015).

2.2.3 Year-to-year variation in flowering and fruiting

Flower and fruit production of *Citrus Sinensis* is constant year to year and variates depending on the place it is, for example if is plant in a place with seasons then spring is a period of rest or reduced growth needed (Moss, 1976). During the flowering called the June drop in the northern or the December drop in the southern hemisphere, all the weaker younger fruits fall naturally (Figure 2.1).

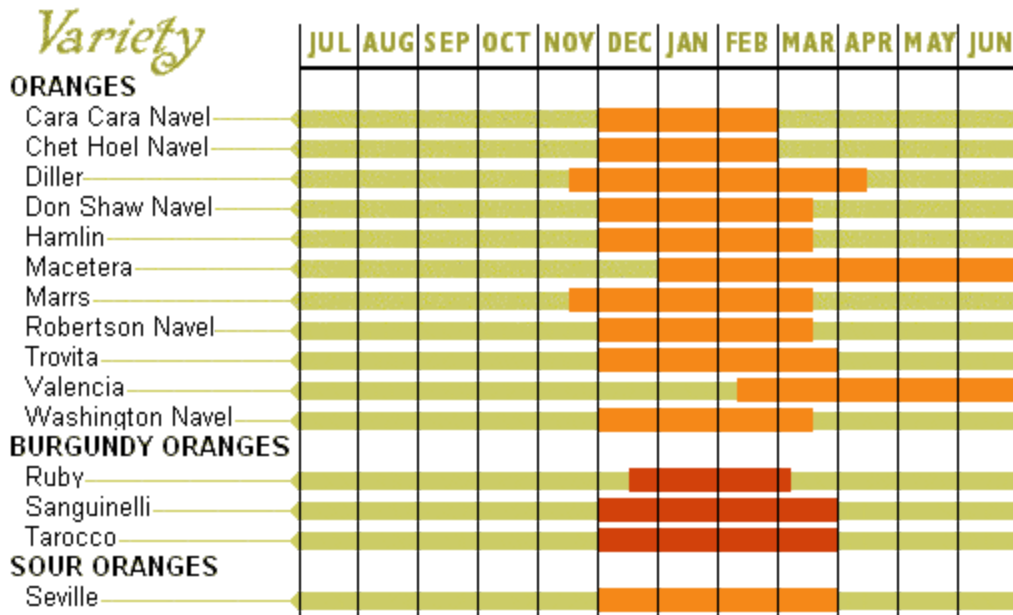


Figure 2.1. *Citrus Sinensis* year to year variation in flowering and fruiting (Eric Carney. (n.d.). *Citrus Manor Lanscape* [Article]. Retrieved May 27, 2017, from <http://citrusmanorcommunity.com/Landscaping/index.htm>).

2.3 REPRODUCTIVE BIOLOGY

2.3.1 Pollen

Citrus Sinensis flowers release pollen when the stigma is receptive. Pollen grains for oranges are radially symmetrical with a circular-elliptical shape. Also they are generally medium in size with a subprolate shape. The range of polar axis varies from 25-30 x 20-27 μm and the range of the equatorial axis is 20-27 μm . The pollen morphology of *Citrus Sinensis* P/E ratio equals to 1.20, has an monocolporate and tetracolporate aperture type and has a thicknesses ranged between 1-1.5 μm . The exine sculpturing of *Citrus Sinensis* is macroreticulate at equatorial section and perforate at polar section called type I, this structure is shown in Figure 2.2.

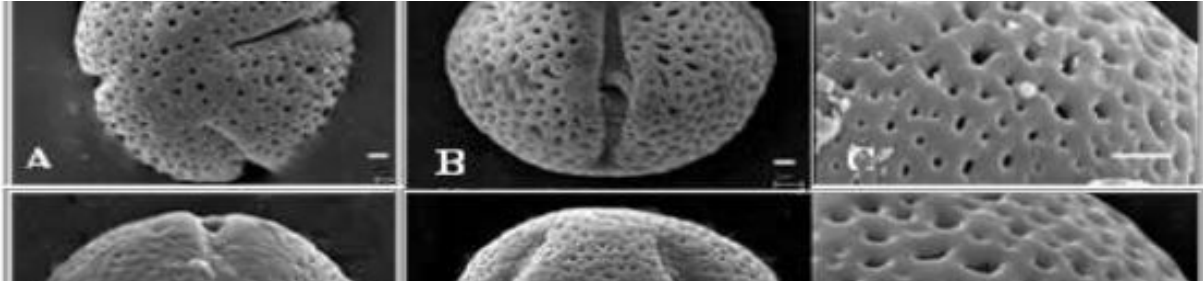


Figure 2.2 Micrographs of *C. Sinensis* (Lumpur, K. (2015, January 2). *Pollen grain morphology of Citrus (Rutaceae)* [PDF]. Retrieved from <http://iicbe.org/upload/6911C0115048.pdf>).

2.3.2 Sexuality

Citrus Sinensis gender is associated with the flower and not the fruit, they are self-fertile plants pollinated by apomictic (asexual reproduction) insects. Also these species is identified as hermaphrodite, meaning that has both male and female organs. They have a female sex organ called the pistil in the center of the flower, and some fruits need seeds to make growth hormones so that the fruit will develop normally, however there are a few fruits which develop without seeds such as Oriental persimmons and navel Oranges.

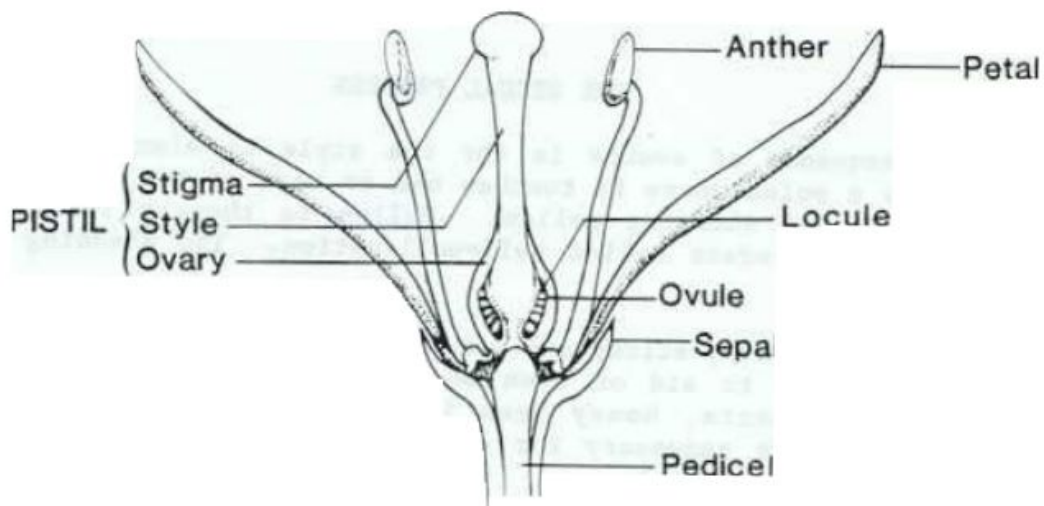


Figure 2.3 Diagrammatic portrait of open *Citrus Sinensis* flower

(Aust, J. (2014, May 15). *Temperature Effects on Flower Initiation in Sweet Orange [PDF]*. Retrieved from http://www.crec.ifas.ufl.edu/academics/classes/hos6546/materials/aust_j_agric_res_27_399-407.pdf).

2.3.3 Anthesis

Citrus Sinensis has a flowering period approximately of two to four weeks of open blooms following the winter dormancy periods. Bloom occurs with the onset of rain following a pronounced dry season in the tropics. Flower induction, meaning the period when biochemical factors induce a change from vegetative to floral bud, normally occurs during low temperatures (winter). The anatomical changes on the flower takes place when the vegetative growing points transform to florals ones. Buds can't be recognize by shape and size,

2.3.4 Pollination and potential pollinators

Citrus Sinensis produces heavy, sticky and not wind-blown pollen; however, the shaking of the flower by wind appears to aid or even be necessary in causing the anthers and stigma to touch. Insects, honey bees in particular, aid in bringing about self-pollination and are necessary for cross-pollination (the transfer of pollen from. flowers of another variety). "The pollen on the stigmatic surface is caught in the sticky stigmatic fluid where it germinates and grows" (Lumpur, 2015). Each germinating grain extends a pollen tube through the style, into the ovary and ultimately into the ovule where it discharges 2 spera (male) nuclei. Where cross-pollination is required, honeybees are typically the most important insect pollinators (Sanford, 1992).

2.3.5 Fruit development and seed set

The development of fruit structures in *Citrus Sinensis* depends on the leaves strength. Research in California with seedless navel oranges indicates the great majority of fruit that sets, come from the last part of the bloom after the new leaves attain full size. In developing seeds, embryo initial cells first formed thick walls, which isolated them from surrounding maternal tissue, then, the cell walls

thinned in some initial cells and embryogenesis became asynchronous. Generally, ovary growth and cell division are temporarily reduced during the period of anthesis until pollination and fertilization occur, since the presence of fertilized ovules normally reactivates cell division, triggering fruit development

2.3.5.1 Ovule development

There are ovules in Oranges, which become the seeds, attached to the interior walls of the ovarian locules. The ovule consists of an embryo sac surrounded by tissues known as integuments which at maturity become the seed coat.

2.3.5.2 Ovary wall development

Oranges are produced from a single- ovary.

2.4 ECOPHYSIOLOGY

Citrus plants have a seasonal variation of the potential quantum efficiency of PSII depending on the environmental conditions of its habit. *Citrus Sinensis* plants exhibit the lowest PSII values during the summer.

3 PROPAGATION AND MANAGEMENT

Citrus Sinensis occurs better in tropical and subtropical areas which experience high temperatures and low elevation. These plant are not cold tolerant: they grow in temperatures from 12° to 38° celsius. In addition, the best soils for the growth of oranges should be fine sand, well-drained, and often identified as high hammock or high pineland soil. *Citrus Sinensis* are commonly grown on soils sufficiently aerated and deep so that the roots are able to penetrate and grow.

3.1 NATURAL REGENERATION

In vitro somatic embryo induction in *Citrus Sinensis* was developed, which is a viable method for rapid propagation of this plant. The high somatic embryo induction and transplant survival rates suggest that this reproducible, affordable, and efficient in vitro plant regeneration can be used for the conservation of this plant.

3.2 NURSERY PROPAGATION

Orange seedlings are usually produced by grafting or budding to an appropriate rootstock. Grafting is the process by which a scion from one plant is joined to the rootstock of another to produce a new tree. Budding is a special type of grafting where the scion that is joined to the rootstock consists of a single bud. Budding is commonly used in citrus propagation as it is the easier of the two processes and works very well.

3.2.1 Propagation from seed

The seed is usually polyembryonic, two or more seedlings arise from each seed and they are genetically identical to the parent but they do not usually carry any virus that might be present in the parent plant. Orange trees can be purchased as seedlings which have already been grafted and only require planting in the garden or orchard. The best time to plant citrus trees is in Spring after all danger of frost has passed in your area. Standard sized trees should be spaced 3.7–7.6 m (12–25 ft) apart in an area that receives full sunlight, but is protected from strong winds which can damage the trees. Planting against a south facing wall will help protect the tree in cooler climates. When planted from seed, an orange tree can take up to seven years to mature into a fruit-producing tree.

3.2.1.1 Pre- preparation and implications for germination

Before the process of *Citrus Sinensis* germination is important to follow this process:

- From the orange remove the seed and wash off any fruit residue.
- Place the clean seed into a glass of water and take out all the ones that immediately float to the surface.
- Storage the selected seeds
- Soak the seeds one or two hour before planting.

Should be planted into 2-3 inch pots. One seed per pot using a good quality, free draining soil based compost and then water in. Is better if the pots are placed into a heated propagator at a temperature of 13 to 16 degrees Celsius, otherwise should be put in a warm, bright position.

Germination normally occur any time from 4 to 6 weeks, but depending of the circumstances it may take a little longer.

3.2.1.2 Sowing and germination process

Orange seeds should be planted in early spring indoors or in a greenhouse where the soil can be kept consistently at 55 degrees Fahrenheit. Regular moisture is critical during germination, so be sure to mist the soil as soon as it starts to feel dry. Look for emerging seedlings within two to three weeks after planting. Three seedlings will emerge from a single orange seed. Keep one of the two strong outer seedlings and remove the weaker central one and one outer seedling.

3.2.1.3 Storage

Citrus Sinensis are better stored in the three than in cold storage. Once harvested, fruit quality will not improve. Before placing into storage, fruit should be pre-cooled to slow respiration and treated with an approved fungicide to reduce decay. Oranges can be stored for up to 12 weeks. Storage-life depends on cultivar, maturity, pre-harvest conditions, and postharvest handling. During storage,

fruit should be inspected often for signs of decay or disorders. Such problems will advance rapidly once the fruits are removed from cold storage.

3.2.2 Vegetative propagation

Vegetative propagation in oranges is done by budding, which is the most common grafting that is done with Orange trees, because has quick growth and high yielding. The budding should be done when the rootstock is $\frac{3}{8}$ of an inch thick.

3.2.2.1 Grafting

A grafted tree of *Citrus Sinensis* can combine the best traits of the aboveground part of the tree with the best adapted rootstock for the particular soils and conditions of the area. A seedling will tend to grow upright, tending toward a single trunk, and becoming quite thorny. A grafted tree will be more highly branched. The seedling tree will not fruit for 6-7 years, contrasted to the 3-4 years for a grafted tree. The earlier fruiting of the grafted tree is partly responsible for the more highly branched form of growth. Apparently the weight of the fruit after about 3 years bends the branches and causes new buds to begin growing, resulting in a more highly branched tree. But not all of the reasons for the differences between seedling and grafted trees are known.

3.2.2.2 Cuttings

A cutting grows quicker than seeds and produces a strong plant with more disease resistance when grafted onto hardy rootstock. Rooting an orange tree cutting ensures the fruit produced matches the same tree genetics as the parent tree. Grafting a rootstock onto the cutting doesn't change the genetics or affect the fruit production. Softwood cuttings are pieces of new branch growth cut from the tree from late spring through early summer. The growth is soft, may have a green tinge and should be about 6 to 8 inches long with at least two growth nodes. This cutting is grafted, or attached, to a rootstock cutting that is $\frac{3}{8}$ - to $\frac{1}{2}$ -inch diameter and about 6 inches long. Tree

cuttings can be stored in a refrigerator by wrapping them in moist paper towel for up to three weeks, until there is time to properly plant them.

3.3 PLANTING

Citrus Sinensis trees should be planted in a sunny and wind-protected area, usually in spring after the danger of the frost has passed .Orange trees can grow to a height of 6–15 m (16–49 ft) and can live for periods in excess of 100 years. Most plantations have an economic lifespan of around 30 years. Standard-size trees should be spaced 3.7 to 7.6 meters (12-25 ft) apart in areas that receives full sunlight. The exact distance depends on the variety. The bigger the fruit, the farther the distance. To plant oranges trees inside from seeds, remove the seeds from the desired fruit. Soak the seeds overnight in water and plant them ½ inch deep in moist potting soil. Cover the pot with a plastic bag or wrap and let it sit in a warm and sunny spot for a few weeks until the seeds start to grow. Then, remove the plastic but keep the pot near a warm and sunny window.

3.4 MANAGEMENT

3.4.1 Tending

Citrus Sinensis grows best in not humid areas and are usually tropical or subtropical. Young plants can not resist winters or cold temperatures. Oranges doesn't grow in hot weathers, but do need direct sunlight to grow and bloom. Wind does not affect directly the orange growth, but is preferably to protect the plant from strong winds, since they may break roots, dry out leaves and reduce blooming.

Oranges grow in soils that has good drainage. These citrus trees tolerate dry soil conditions, but do not survive wet clay-heavy soils. Since most of the tree's roots are in the top 2 to 3 feet of ground, it

is sensitive to excess water. Dry out the soil between waterings to improve tree growth and lengthen the tree's lifespan.

3.4.2 Fruiting

Citrus Sinensis grow from seed takes about six years to produce their first fruit. The grafted orange takes a year to become established after transplanting and three to four years to reach useful fruit-bearing size. Remove any fruits that form during this time to help the tree grow larger. Grafted oranges grow faster and more uniformly and bear earlier than seedlings. Flowers set fruit in mid-April to May, with many more young fruit than a tree can support. Many of the small fruits fall off during the "June drop" period in late May and June. *"The remaining oranges continue to grow, maturing seven to 15 months after fruit set, depending on the variety and growing conditions. Fruit color doesn't always indicate ripeness. Some oranges develop some green on the skin, called re-greening, due to cooler winter temperatures, but they are ready to harvest"* (SFGATE, 2016).

3.4.3 Pest and disease control

Citrus Sinensis diseases are caused by fungi, bacteria, and virus. Pests are caused leaf miner, citrus psylla, citrus fruit sucking moth, and citrus stem borer (Table 3.1).

Table 3.1 Pests and diseases of *Citrus Sinensis*

Pest/ disease	Symptoms/ damage	Natural Control
Gummosis disease	Exudation of gum from bark of the tree trunk. Leaves turn yellow.	The trunk should be painted with Bordeaux paste up to 50-75 cm height from the ground level at least once a year.
Powdery Mildew disease	White, cottony or powdery growth on all aerial parts of the affected plant. The affected leaves show yellowing and crinkling.	The affected parts should be removed and destroyed carefully.
Citrus Canker disease	Leaves appear as yellowish, small, raised translucent spots/ lesions, which gradually enlarge 2-4 mm in diameter and appear as raised rough brownish	The disease incidence can be reduced at farmers' field by pruning all the canker affected twigs before monsoon and burning them.

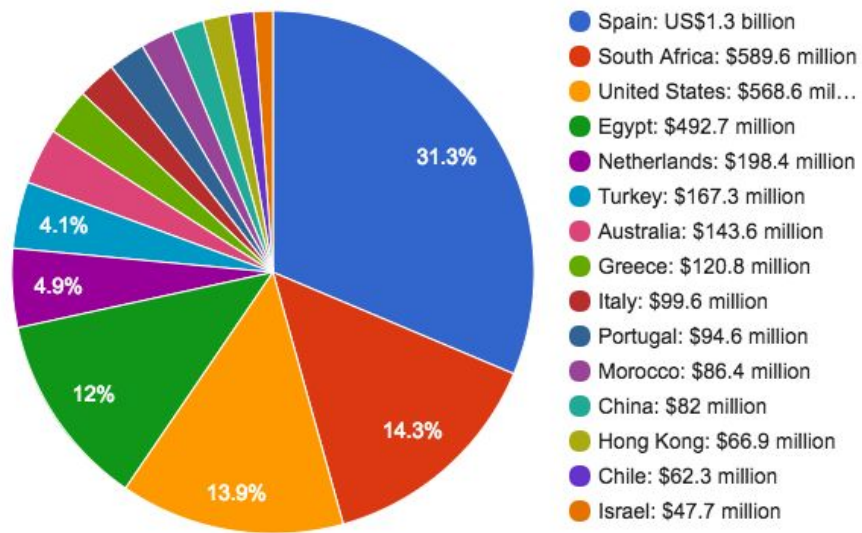
	pustules.	
Citrus Tristeza disease	Dieback of small branches and twigs, yellowing of leaves and heavy bearing of small fruits.	Healthy and certified bud-wood should be used.
Citrus Leaf Miner pest	Tender leaves are attacked and leaf miner larvae feed on the epidermis, producing silver coloured serpentine mines, generally on the lower surface.	Chipping and destruction of mined leaves in the primary stage reduces insect infestation.
Citrus Fruit flies pest	The fruit flies lay eggs under the ripening fruit rind by means of its piercing ovipositor.	Infested fruits should be collected and burnt so that the maggots are killed. The maggots must not be allowed to emerge out from the fruits and pupate in the soil.
Lemmon Butterfly pest	Considerable damage is caused to citrus plants by this insect in the nursery and young orchards. In severe cases, they completely defoliate the plants.	Picked up and destroyed mechanically in larval (caterpillar) and pupal stages when their population is low or when the attack has just started.

4. CITRUS SINENSIS COMMERCIAL IMPORTANCE

4.1 EXPORTING AND IMPORTING OF THE PRODUCT

Oranges exports by country totaled US\$4.5 billion in 2015, down by an average -6.3% for all oranges shippers over the five-year period starting in 2011 when oranges shipments were valued at \$4.8 billion. Year over year, the value of global oranges exports appreciated 0.3% from 2014 to 2015. Approximately these are the 15 major countries that exported highest dollar value of oranges in 2015 (Table 4.1).

Table 4.1 Exporters of *Citrus Sinensis*



Spain, South Africa and Egypt represent almost 60% of *Citrus sinensis* international trade. Spain, globally is the major and more important exporter of oranges to Germany, Italy, France and Netherlands. In the other hand, the more important importers is Netherlands followed by Germany, Russia, the Gulf States and China. All EU import 2.8 tons of oranges per year. In 2015 the Netherlands imported about 500,000 tons of *Citrus sinensis*(Harold A. Roth, 2004).

Table 4.1 Top 5 World's Leading Orange Producers

Country	Totality
Brazil	17618500
U.S.A	8280780
India	5201350
China	4864959
Spain	2617700

4.2 IMPORTANCE IN THE ECONOMY

Citrus Sinensis is one of the world's major fruit crops with global availability and popularity in human diets (Table 5.1). Albert Lasker invented orange juice as the solution for *Citrus Sinensis* overproduction, years later people start seeing the juice as a commercial product and start to sell it. Currently in Florida, natural orange juice costs between 5 and 6 US dollars. This means that approximately the economy gets 9 billion US dollars from orange juice. Brazil is the largest producer of orange juice in the world, followed by the United States.

5 COMMERCIAL PRODUCTION AND USES

5.1 FOOD USES

Oranges had become famous in the warm places due to its refreshing flavour. Today, they are distributed in plastic bags and sold to motorists by Latin American street vendors not only in Miami, but also in Latin America especially Colombia. The hand-labor of peeling oranges has limited the production of sliced oranges for use by restaurants and orange-salad packers.

5.1.1 Fruit

For example, oranges are sliced, dried and pulverized, and the powder is added to baked goods as flavoring.

5.1.2 Skin

The peel of the *Citrus sinensis* is used for making perfume and soaps, its biggest quality taken out of oranges skin is its fragrance. In addition, orange peels are used to clear, detoxify, and tone the skin and have found widespread use in skin care products.

5.1.3 Juice

At home, *Citrus sinensis* are commonly utilized in fruit cups, salads, gelatins and numerous other desserts, and as garnishes on cakes, meats and poultry dishes. Its pulp is used for preparing fresh juice which is rich in protein content. *“In South America, a dozen whole, peeled oranges are boiled in 3 pints (1.41 liters) of slightly sweetened water for 20 minutes and then strained and the liquid is poured over small squares of toast and slices of lemon and served as soup”* (Morton J, 1999). Dehydrated orange juice, developed in 1963, is sold for use in food manufacturing, adding flavor, color and nutritive elements to bakery goods and many other products.

Additionally, the juice extracted from sweet orange leaves is commonly used to control ulcers and sores. While the juice extracted from the fruit is edible, the one extracted from its leaves work as a remedy.

5.2 MEDICAL USES

5.2.1 Nutrients

The *Citrus Sinensis* fruit is low in calories, contains no saturated fats or cholesterol, but rich in dietary fiber, pectin. Pectin helps to protect the mucosa of the colon by its virtue as a bulk laxative. Oranges, especially the juice is rich Vitamin C (provides 48.5 mg per 100 g, about 81% of DRI) which helps in the antioxidant protection and Immune Support because helps the body develop resistance against infectious agents that come from the blood. Also, compounds in orange peel can lower the Cholesterol and act as a cleaner of the interior of the human body. Orange fruit also contains some minerals as potassium and calcium, potassium is an important component of cell and body fluids that helps control heart rate and blood pressure through countering pressing effects of sodium.

5.2.1.1 Skin

The skin of sweet orange is used to increase appetite, reduce phlegm and treat coughs, colds, intestinal gas, acid indigestion and cancerous breast sores (Morton J, 1999).

5.2.1.2 Juice/ Nectar

One orange provides about 7% of the daily requirement of potassium needed of the body. Especially *Citrus sinensis* juice are excellent to remove phlegm and clear the congestion in the nasal and chest passages (Sweet Orange,2015).

5.2.2 Diseases

Intake of vitamin C is associated with a reduced risk of colon cancer. Vitamin C also prevents us from asthma, osteoarthritis, and rheumatoid arthritis. Oranges are rich in citrus limonoids, proven to help fight a number of varieties of cancer including that of the skin, lung, breast, stomach and colon.

5.3 TRADITIONAL USES

Citrus Sinensis was initially introduced to Europe and was spread in the Mediterranean. Japanese believed that citrus blossoms symbolize chastity and Arab women used it to color gray hair. In other places blossoms and the pulp of Oranges were used to create cosmetics.

5.3.1 Magic/ Ritual Significance

The high-energy scent of *Citrus sinensis* is said to communicate the joy of angels to human beings. Orange peel is great for embodying the Sun in a mixture, whether pot pourri, tea, sachet and charm. Like the Sun, orange peel lifts those who are down, helps the confused find direction, and gives new life to spiritual yearnings (Freshdeal, 2016) .

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