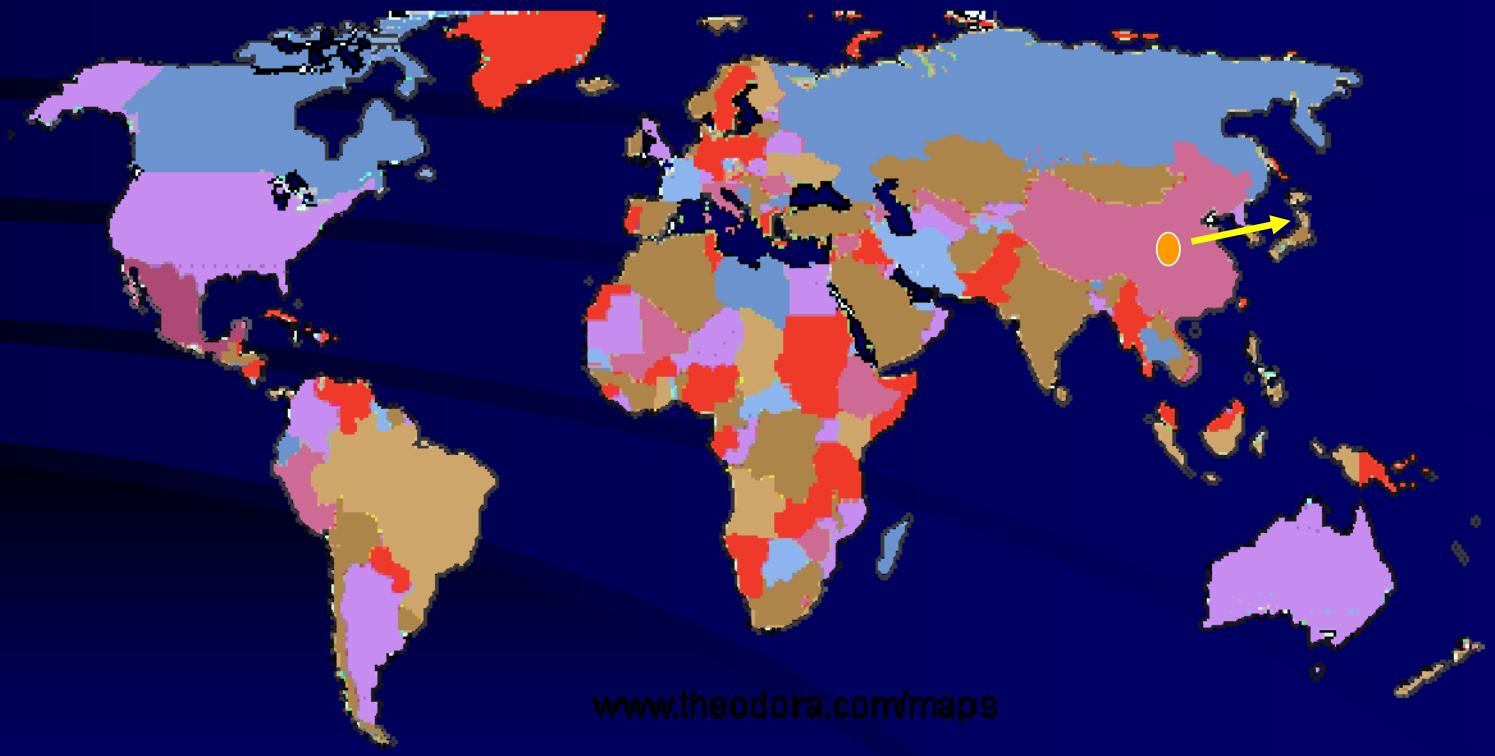
Tropical and Subtropical Fruits

Department of Horticulture
College of Agriculture
Isfahan University of Technology

Persimmon

Origin

Persimmon are native to East Asia (China)



History of Persimmons

- The persimmon is a fruit of Chinese origin. It was cultivated in China and Japan for centuries
- Since the mid 1800s, persimmons have been grown in Mediterranean countries, the Middle East, and the USA

Kingdom	Plantae
Division	Magnoliophyta
Subdivision	Magnoliophytina
Class	Rosopsida
Subclass	Dilleniidae
Super Order	Primulanae
Order	Ericales
Suborder	Ebenineae
Family	Ebenaceae
Tribe	Diospyreae
Genus	Diospyros
Species	Kaki

Composition and Uses

- Fresh Persimmon Fruit
- Dry Persimmon Fruit

Fresh Persimmon fruit contain:
Water: 79%
Carbohydrate: 18%
Protein: 0.7 %
Fiber: 0.4%
Pectin:0.7%
Vitamin A: 2710 IU/100g
Vitamin C: 11 mg/100g
Malic and citric acid are predominant in all developmental stages

Nutrition of Persimmons

- **Persimmons have many healing properties:**
- **Vitamin C** – helps the body resist infection and boosts the immune system
- **Anti-Oxidant Compounds** – play a role in promoting good health and disease prevention as we age
- **Copper** – required for the production of red blood cells
- **Fiber** – aids in digestion

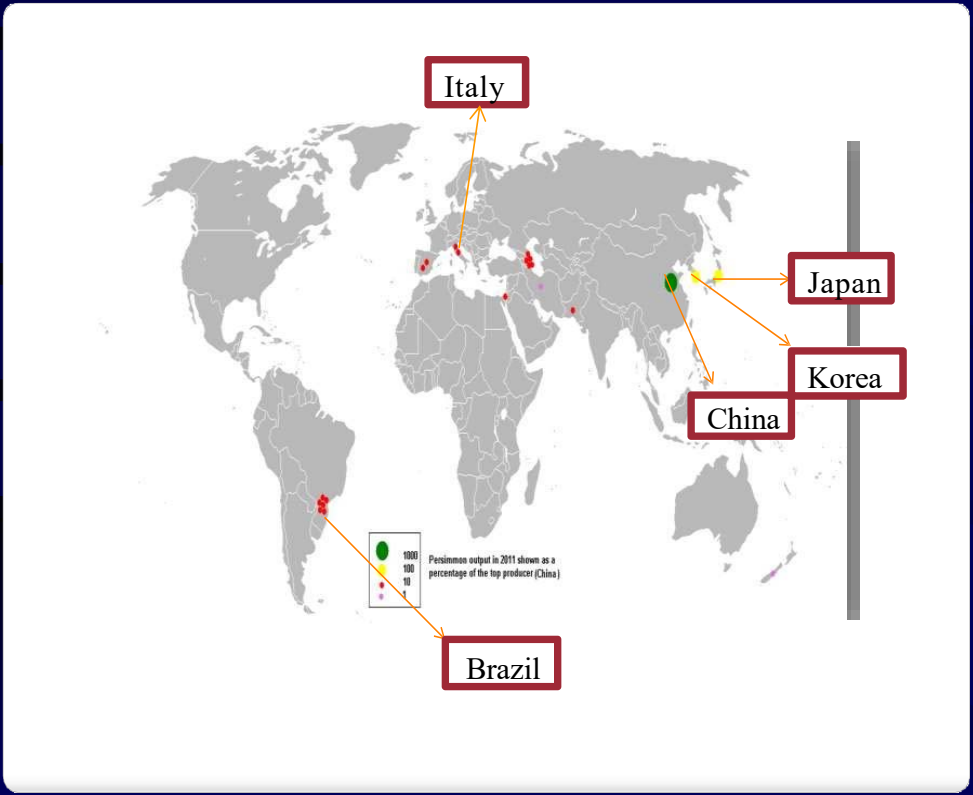
Nutrient	Units	Persimmons, Japanese, dried	Persimmons, Japanese, raw	Persimmons, native, raw
Proximates				
Water	g	23.01	80.32	64.40
Energy	kcal	274	70	127
Energy	kJ	1146	293	531
Protein	g	1.38	0.58	0.80
Total lipid (fat)	g	0.59	0.19	0.40
Ash	g	1.59	0.33	0.90
Carbohydrate, by difference	g	73.43	18.59	33.50
Fiber, total dietary	g	14.5	3.6	NA
Minerals				
Calcium, Ca	mg	25	8	27
Iron, Fe	mg	0.74	0.15	2.50
Phosphorus, P	mg	81	17	26
Potassium, K	mg	802	161	310
Sodium, Na	mg	2	1	1
Vitamins				
Vitamin C, total ascorbic acid	mg	0.0	7.5	66.0
Riboflavin	mg	0.029	0.020	
Niacin	mg	0.180	0.100	
Vitamin A, RAE	mcg_RAE	38	81	
Carotene, beta	mcg	374	253	
Cryptoxanthin, beta	mcg	156	1447	
Vitamin A, IU	IU	767	1627	

Dried Fruit

Traditionally persimmon used in dried fruit in Japan

- Sun drying for 20-24 days
- Artificial drying at 32-33 °C

Persimmon Production



Production figures in tonnes per year[10]						
Country	**1970**	**1990**	**1995**	**2000**	**2005**	**2011**
China	457,341	640,230	985,803	1,615,797	2,212,151	3,259,334
Korea	30,310	95,758	194,585	287,847	363,822	390,820
Japan	342,700	285,700	254,100	278,800	285,900	207,500
Brazil	21,659	46,712	51,685	63,300	164,849	154,625
Azerbaijan	-	-	-	96,000	108,965	146,084
Spain	-	-	-	30,000	-	70,000
Italy	59,600	68,770	61,300	42,450	51,332	50,236
Pakistan	-	-	-	19,000	19,000	19,000
New Zealand	-	972	1,600	1,352	3,000	2,526
Iran	25	925	1,000	1,331	1,748	2,123
Australia	-	329	640	759	943	642
India	-	-	-	-	220	380
Mexico	-	275	274	247	369	223

Area Code	Area	Item	Year	Unit	Value
156	China, ma	Persimmc	2020	tonnes	3272351
410	Republic c	Persimmc	2020	tonnes	198817
392	Japan	Persimmc	2020	tonnes	193200
31	Azerbaijar	Persimmc	2020	tonnes	185247
76	Brazil	Persimmc	2020	tonnes	158687
860	Uzbekista	Persimmc	2020	tonnes	105122
158	China, Tai	Persimmc	2020	tonnes	69708
364	Iran (Islam	Persimmc	2020	tonnes	30244
376	Israel	Persimmc	2020	tonnes	21908
524	Nepal	Persimmc	2020	tonnes	2574
554	New Zeala	Persimmc	2020	tonnes	1895
36	Australia	Persimmc	2020	tonnes	736
152	Chile	Persimmc	2020	tonnes	679
484	Mexico	Persimmc	2020	tonnes	198

Botanical Classification

Family: Ebenaceae

Genus: *Diospyros*

- *Diospyros kaki* (Japanese or Oriental Persimmon)

- *D. virginiana* (American Persimmon)

- *D. lotus* (Date Plum Persimmon)

Cultivars Classification

- Astringent Cultivars
- Non-Astringent Cultivars

Astringent cultivars: Astringency (soluble Tannins) is not lost until fruit is mature and ripe

Non-astringent cultivars: Astringency disappear in fruit after pollination

→ Pollination constant: No changes in flesh color after pollination

→ Pollination variant: Light color when seedless and dark reddish when seeded

DESCRIPTION

Growth Habit: The persimmon is a multitrunked or single-stemmed deciduous tree to 25 ft. high and at least as wide. It is a handsome ornamental with drooping leaves and branches that give it a languid, rather tropical appearance. The branches are somewhat brittle and can be damaged in high winds.

Foliage: Persimmon leaves are alternate, simple, ovate and up to 7 inches long and 4 inches wide. They are often pale, slightly yellowish green in youth, turning a dark, glossy green as they age. Under mild autumn conditions the leaves often turn dramatic shades of yellow, orange and red. Tea can also be made from fresh or dried leaves.

Tree

Single trunk deciduous

Grows up to 6m height

The branches are brittle

Leaves are large and glossy green

Flower Description

Flowers are born in the leaf axis of current shoot

- Female Flowers: 4 sepal (dark green), 4 petal (large and cream color), 8 staminoids, ovary (4 carpels)



- Male Flowers: Inflorescence cyme, 8 stamens



- Hermaphrodite Flowers

  Dioecious

Flowers: The inconspicuous flowers surrounded by a green calyx tube are borne in the leaf axils of new growth from one-year old wood. Female flowers are single and cream-colored while the pink-tinged male flowers are typically borne in threes. Commonly, 1 to 5 flowers per twig emerge as the new growth extends (typically March). Persimmon trees are usually either male or female, but some trees have both male and female flowers. On male plants, especially, occasional perfect (bisexual) flowers occur, producing an atypical fruit. A tree's sexual expression can vary from one year to the other. Many cultivars are parthenocarpic (setting seedless fruit without pollination), although some climates require pollination for adequate production. When plants not needing pollination are pollinated, they will produce fruits with seeds and may be larger and have a different flavor and texture than do their seedless counterparts.

Flower Development

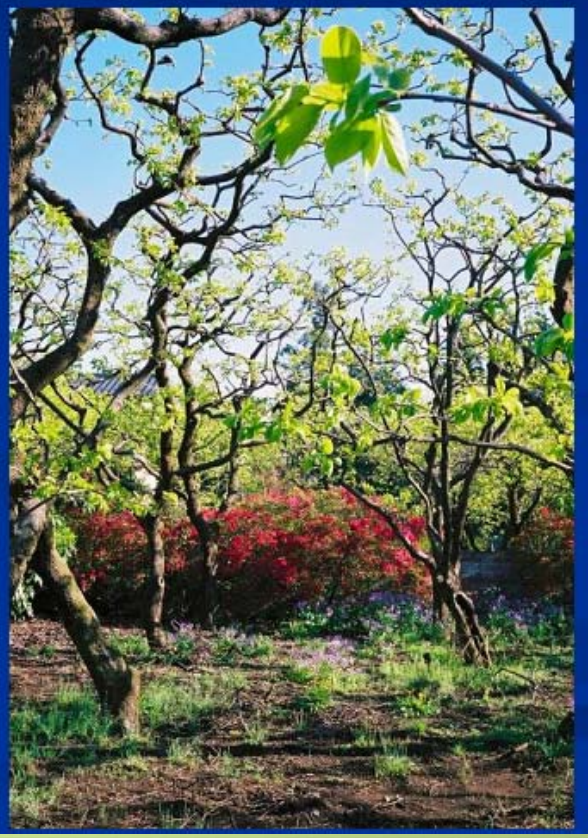
The persimmon fruit is a Berry

Fruit: Persimmons can be classified into two general categories: those that bear astringent fruit until they are soft ripe and those that bear nonastringent fruits. Within each of these categories, there are cultivars whose fruits are influenced by pollination (pollination variant) and cultivars whose fruits are unaffected by pollination (pollination constant). Actually, it is the seeds, not pollination per se, that influences the fruit. An astringent cultivar must be jelly soft before it is fit to eat, and such cultivars are best adapted to cooler regions where persimmons can be grown. The flesh color of pollination-constant astringent cultivars is not influenced by pollination. Pollination-variant astringent cultivars have dark flesh around the seeds when pollinated. A nonastringent persimmon can be eaten when it is crisp as an apple. These cultivars need hot summers, and the fruit might retain some astringency when grown in cooler regions. Pollination-constant nonastringent (PCNA) persimmons are always edible when still firm; pollination-variant nonastringent (PVNA) fruit are edible when firm only if they have been pollinated.

The shape of the fruit varies by cultivar from spherical to acorn to flattened or squarish. The color of the fruit varies from light yellow-orange to dark orange-red. The size can be as little as a few ounces to more than a pound. The entire fruit is edible except for the seed and calyx. Alternate bearing is common. This can be partially overcome by thinning the fruit or moderately pruning after a light-crop year. Astringency can also be removed by treating with carbon dioxide or alcohol. Freezing the fruit overnight and then thawing softens the fruit and also removes the astringency. Unharvested fruit remaining on the tree after leaf fall creates a very decorative effect. It is common for many immature fruit to drop from May to September

Site preferences

- Persimmon grows best on loamy soils.
- Can tolerate heavy clay soils if drainage is not severely impeded.
- Sandy soils o.k. if irrigation is available
- Soil pH of 6.0 to 6.5 is preferred.



Temperature:

When dormant tolerates up to -15 °C

Chilling requirement (100-200 hours)

Total sunshine(light) is 1400 hours

Fall:16 to 22 °C

Climatic adaptation

- Trees grown on *D. lotus* and *D. virginiana* rootstock are best for temperate regions.
- In warmer regions the rootstock *D. kaki* is used

30 -35° south latitude

Irrigation requirements

- Persimmons widely adaptable to wide range of soil moisture regimes.
- Soils should be moist in the spring to ensure leaf growth, fruit set, and fruit development.
- In dry regions trees need 36-48” (91-122 cm) of supplemental irrigation.

Irrigation requirements

- Extreme drought will cause the leaves and fruit to drop prematurely.
- Young trees are most susceptible to drought.
- Drought stressed trees will often bear sunburn fruit.

Rootstocks

Three rootstocks are used:

D. kaki : Uniform vigorous seedlings, long taproot, Compatible with all cultivars
Most preferred

D. virginiana : Tolerant to drought and waterlogging, Suckers severe and not uniform in size and vigor

D. lotus : Uniform size, Incompatible with non astringent cultivars, susceptible to crown gall

Orchard rootstocks

- *Diospyros lotus* is the primary rootstock used in northern Japan, Italy, and California persimmon orchards.
- *D. lotus* is adapted to a wide variety of soil types
- Not tap rooted
- Can tolerate the high moisture content found in many heavy soils containing hard pan.

Orchard rootstocks

- Other rootstocks occasionally found include *D. kaki*, which has a long taproot.
- *D. kaki* rootstock should be only use for very warm growing regions (southern Italy).
- Often preferred for “Fuyu” production in warm areas.

Propagation

Seed

- Obtained from firm mature or soft ripe fruit
- Firm mature fruits give better seed viability
- Stratification: 60-90 days
- Germinates best at 28 °C
- Take 2-3 weeks to germinate
- For long term storage, seeds should be dried to 45% moisture and stored at 0 °C

Vegetative Propagation

Cutting: Semi hardwood cuttings, 1000 ppm IBA, Mist, Bottom heat

Hardwood cutting (No success)

Grafting and Budding:

Whip or cleft grafting

Chip or T budding

Planting

- Best planted when dormant
- Planting after bud break cause transplanting shock
- Density depends on cultivar, rootstock and soil type
- Dwarf cultivars: 5.0 × 2.5 m (800 trees/ha)
- Semi-dwarf cultivars: 5.0 × 3.0 m (660 trees/ha)
- Vigorous cultivars: 6.0 × 4.5 m (370 trees/ha)

Planting an orchard

- Orchard spacing is determined by the variety selected.
- Both “Fuyu” and “Jiro” can be planted 3 by 4 meters or closer in sandy soils.
- “Hachiya” is a larger tree, requires 6 by 6 meters.

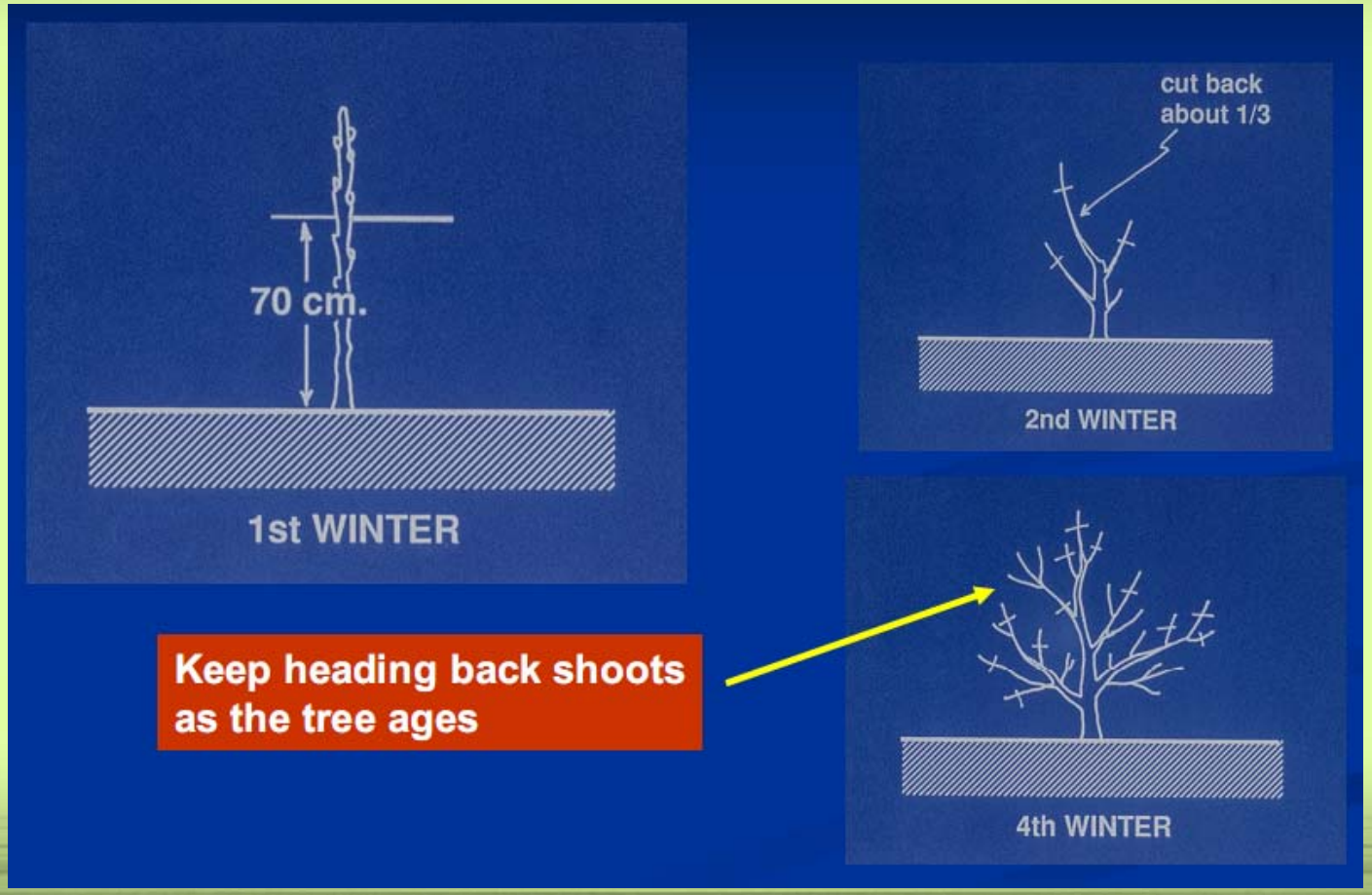
Tree training and pruning

- Tree training is either an open vase style or a modified central leader style.
- “Hachiya” is generally trained to a modified central leader.
- “Fuyu” and “Jiro” orchards use an open vase system.

Central leader training

- Stake young trees for fist 2-3 years.
- Young trees: first branches should start at 1 meter above ground.
- Select 3-5 main limbs at .3 m intervals around tree.
- Head back growth for 1-2 years.

Central leader training



Central leader training

- Upright shoots with narrow crotch angles are weak.
- Branches can break under fruit load.
- Trim back central leader.
- Head shoots to encourage branching.

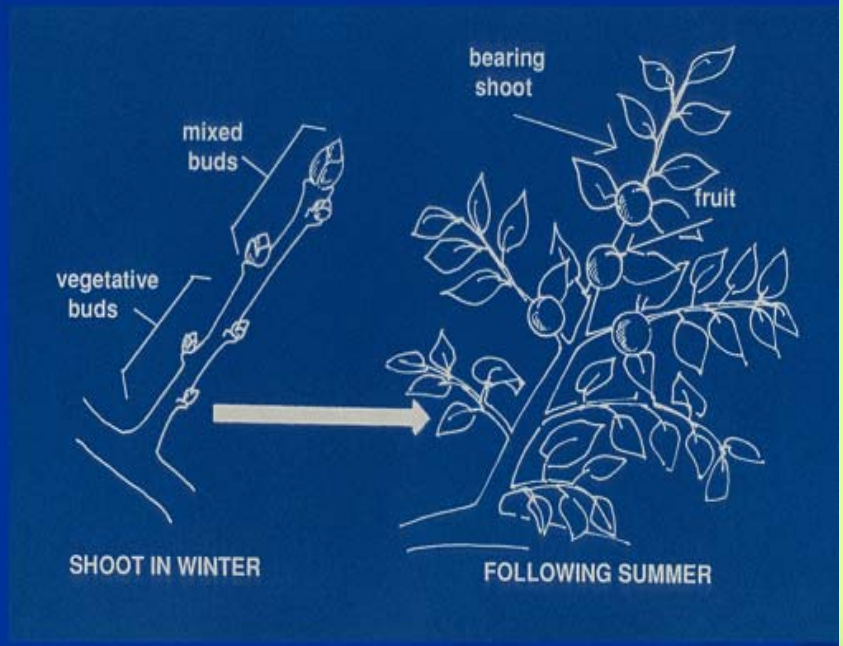
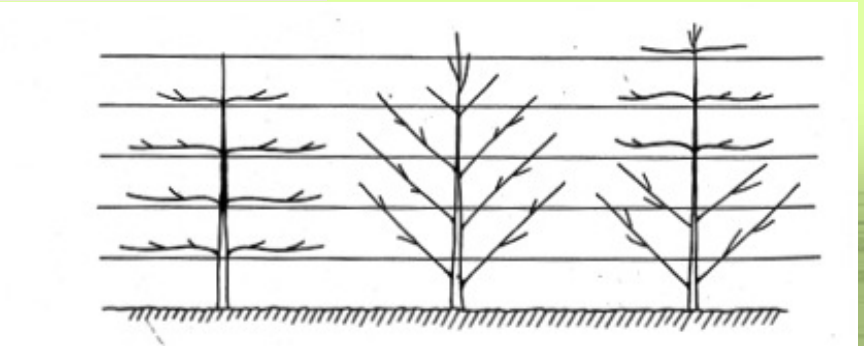
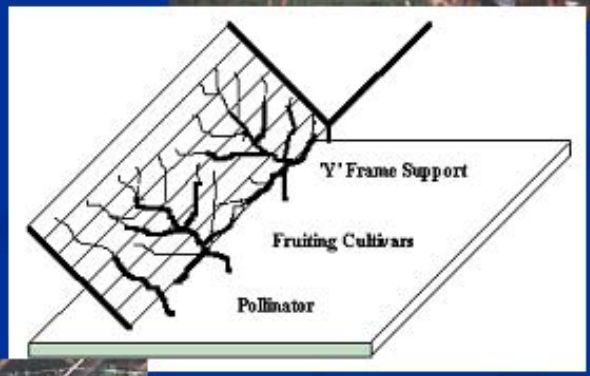


Fig: fuyu cultivars trained to a palmette system



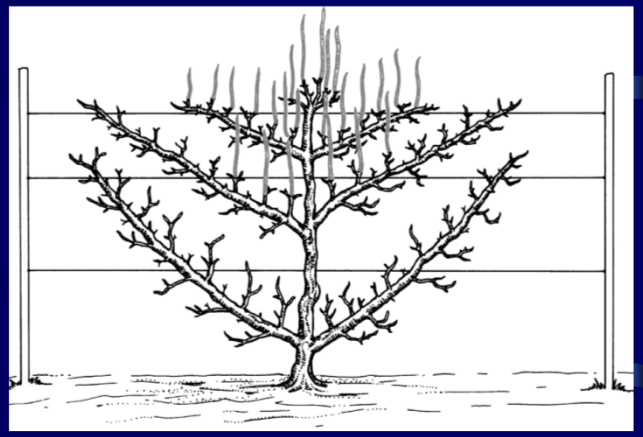
Modern pruning: Y trellis

- New Zealand industry trying to grow "Fuyu" under cooler climates.
- Will involve more hardware.
- Skilled pruning.
- Result: vigorous trees which can be kept small and easily harvested.



Pruning and Training

- Dwarf cultivars are suited to modified leader
- Vigorous and semi-dwarf cultivars suited to palmette



The advantage of palmette:

- Reduces wind damage to branches and fruit
- Earlier production
- High yields
- Greater mechanization at harvest

Table 1. Planting distances (in meters between rows and along the row) for modern persimmon orchards in relation to tree vigour, soil fertility and training system (from Bellini, 1991)

Vigour of cultivars	Soil fertility	Training systems		
		Vase	Centre leader	Palmette
Medium	Medium	5.0 × 4.0	5.5 × 4.5	4.5 × 3.0
	High	5.0 × 4.5	5.5 × 5.0	4.5 × 3.5
High	Medium	5.0 × 4.5	5.5 × 5.0	4.5 × 3.5
	High	5.0 × 5.0	5.5 × 5.5	4.5 × 4.0
Very high	Medium	5.0 × 5.0	5.5 × 5.5	4.5 × 4.0
	High	5.5 × 5.5	6.0 × 6.0	4.5 × 4.5

Pollination and Fruit set

Female flowers can set fruit as parthenocarpy

Low fruit set and fruit fall main problem

Presence of adequate pollinizers is important

1 pollinizer interpolated with every 8-10 trees

2-3 beehives per hectare is recommended

Biennial Bearing

- Observed in some cultivars
- Related to crop load, seed production, tree vigor or age, soil moisture and pollination
- Overcome by fruit thinning in the 'on year'
- Chemical agents: NAA, Ethephon

Tree fertilization

- Trees take up to 10 years to come into full production.
- Good inherent soil fertility is important.
- General recommendation of .45 kg of nitrogen for each year of tree age.
- Split application in spring, and then in early June

Fruit thinning

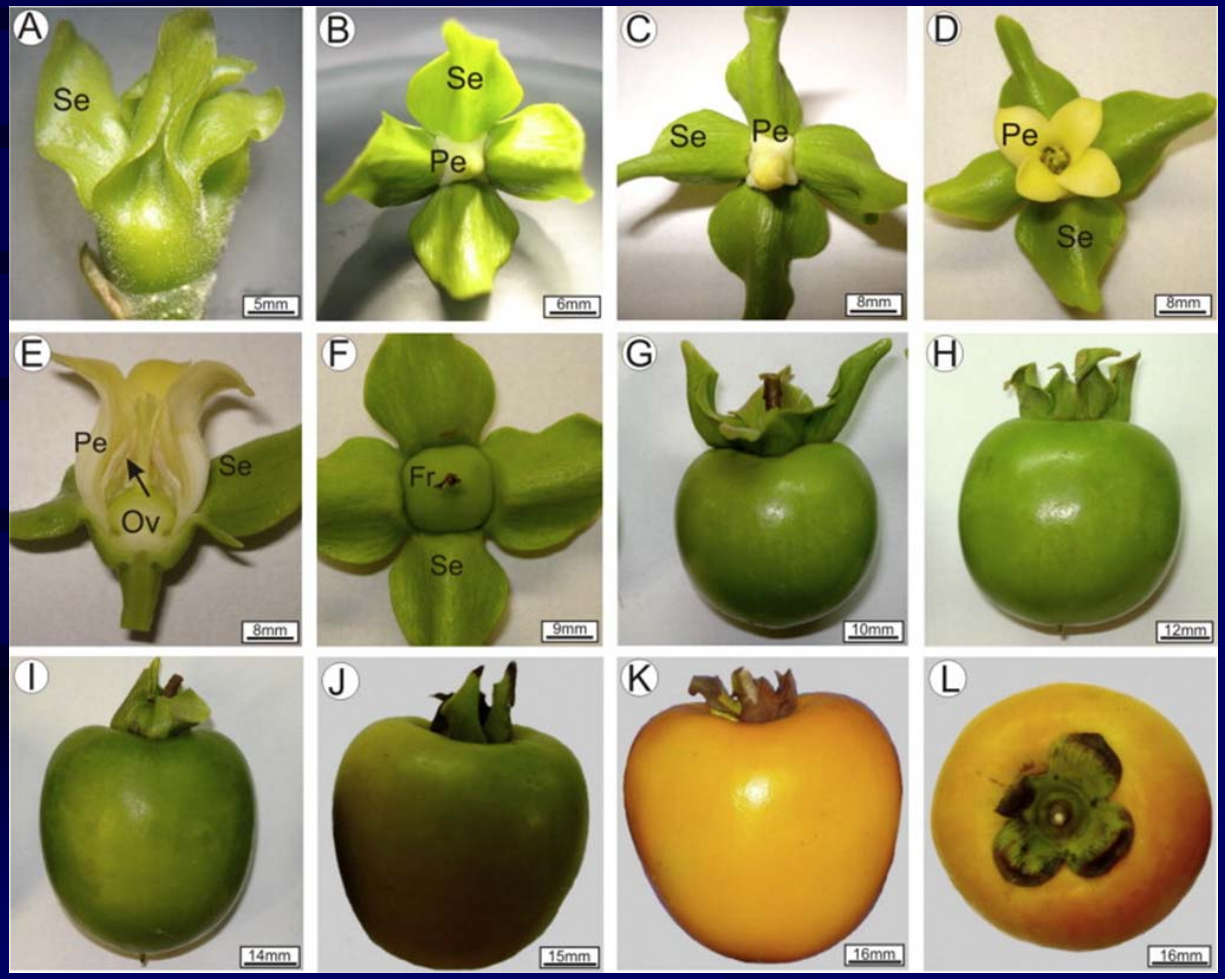
- Persimmons tend to biennial bearing.
- Mature trees still bear but yields are low.
- Hand thin in early summer 3 weeks after flowering.
- Leave 1-4 fruit per shoot.

Female flower

"Fuyu" persimmons in Florida

Fruit Growth and Development

Double Sigmoid



Harvesting

- Fruits are well developed
- Full orange to orange red with no visible green background
- TSS 14-16 ° Brix
- Avoid early and late harvesting
- Harvested by clipping, leaving the calyx and a short stem
- Handle with care so as to avoid bruising
- Two-three pickings recommended
- Yield: 30-40 t/ha

Harvesting

- Harvest non-astringent “Fuyu” and “Jiro” fruit when the they are fully colored.
- 'Jiro' ripens a week earlier than 'Fuyu‘.
- Astringent cultivars are picked when they are soft or shortly before.

Fruit ripening: non-astringent

- "Fuyus" are ripe and ready to pick in October, November and December.
- They are ripe when the fruit changes from green to orange stage.
- "Fuyu" is best eaten when orange and firm.
- They are crisp like an apple and sweet like a pear.

California "Fuyu" persimmons from southern California

Fruit ripening: astringent

- Astringency comes from water-soluble tannins.
- Decrease as the fruit softens, either before or after the fruit is picked

Fruit ripening: Astringent

- Allow “Hachiya” to sit at room temperature until astringency is lost.
- However over-ripe fruit is difficult to handle.
- In home situations set “Hachiya” fruit in a bag with apples.

Fruit ripening: Astringent

- Commercially treated "Hachiya" fruit with 10 ppm ethylene ripens in 2 days.
- But, fruit softens too much.
- Better: Treat "Hachiya" with 80% CO_2 for 24 hours.
- In Hawaii 27 kg of fruit is treated with .6 kg dry ice for 2-3 days.

"Hachiya persimmon"

Fresh fruit storage

- Non-astringent types have longer shelf-life.
- “Izu” 10 days.
- “Fuyu” maybe 20-30 days.

Fresh fruit storage: chilling injury

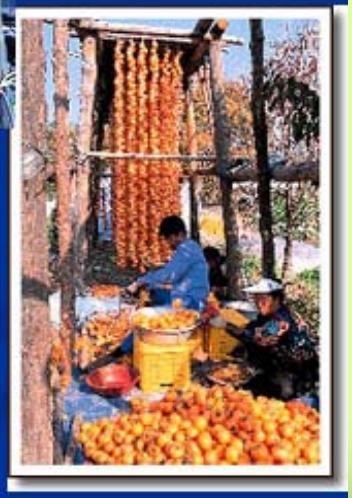
- "Fuyu" suffers with cold storage temperatures between 5 ^{0}C - 15 ^{0}C.

Fruit drying

- In Japan and China the cultivar “Hachiya” is picked when firm,
- Peeled,
- Tied to strings or poles to air dry.

Fruit drying: outside

- Dried under the eaves of the home for 30-50 days.
- Sugar crystals will form on the skin of the fruit.
- Fruit can contain 50% sugar.



Fruit drying: outside

- Drying removes astringency.
- For drying use “Hachiya”, and “Hyakume” cultivars.
- Dry fruit has to be kept in sealed containers so that they will not spoil.

“Hachiya” persimmons

Fruit drying: indoors

- Can be dried in home oven.
- Peel fruit.
- Slice into strips 6 mm thick.
- Place on wire racks in oven.

- Set oven to 60 ^{0}C.
- Dry when fruit is not sticky any longer.
- Keep dried fruit sealed, or it may spoil.

Fruit drying: not for "Fuyu"

- Do not dry "Fuyu", "Jiro", and "Suruga"
- Non-astringent types will not dry properly.
- Flesh will become very hard and tough.

Post-harvest uses

- Persimmons can be frozen.
- Pureed for use in baking, jams, cookies, pies, cakes.
- Don't use "Hachiya" fruit with black spots on peel. Peel first.

Persimmon jam from Maui Hawaii.

'Eureka' persimmon.

'Hachiya' persimmon.

'Tane-nashi' persimmon.

'Tamopan' persimmon.

'Fuyu' persimmon.

'Izu' persimmon.

'Fankio' persimmon.


cm 1 2 3 4 5 6 7 8
TSURU


cm 1 2 3 4 5 6 7 8
TAMOPAN


cm 1 2 3 4 5 6 7 8
FUJI


cm 1 2 3 4 5 6 7 8
CHOCOLATE


cm 1 2 3 4 5 6 7 8
FUYU


cm 1 2 3 4 5 6 7 8
CHOCOLATE