



Lemon cultivation

by Henri Vannière

The absence of ancestral lemon trees in the foothills of the Himalayas (in south-west China and north-east India), where the citron originated, makes accurate locating of the zone of origin impossible. Like many citrus species, they migrated westward over the centuries, associated with the history of human activities, via Persia and Middle East before reaching the Mediterranean area. The cultivation of lemons started in the second millennium BC in the Mediterranean, first following the Arab conquests on the southern shores of the sea and in the south of the Iberian Peninsula and subsequently, under the influence of the crusaders, in Italy and on the northern shores of the Mediterranean.

General features

Lemon, *Citrus limon* Burm. f., has a special place among citrus fruits. Together with the limes *Citrus aurantifolia* and *Citrus latifolia* and citron, *Citrus medica*, to mention only the best-known edible species, they form a group of sour citrus fruits. All have certain common features:

- greater susceptibility to cold in comparison with mandarin, orange, shaddock and grapefruit;
- purple flower buds and young leaf shoots, resulting from anthocyanin pigments in tissues, and multiple staggered flowering during the vegetative season. A picking date corresponds to each flowering. For this reason, lemon trees are referred to as being everbearing;
- great susceptibility to parasite attacks caused by *Phytophthora*.

Lemon is a hybrid citrus with citron as the male parent and sour orange as the female parent. Sour orange is in turn a hybrid between shaddock and mandarin.



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Description of the plant

Lemon is a vigorous tree with large lanceolate pale green leaves. The petiole is short, articulated, unwinged and simply marginated. The young leaf shoots are flushed with purple. The leaf laminae contain essential oil glands whose oil has a characteristic aroma. The flowers are in blossom clusters. The buds are also purple. Flowers may be male in some cases as a result

of aborted pistils. This phenomenon varies strongly from one flowering to another and from one season to another. The everbearing character is more or less marked according to the variety.

The oval fruit often has a very characteristic nipple. Lemon peel is slightly coarser than that of limes and surface irregularities—slight grooves or small ridges—can be seen. The peel clings strongly. The epidermis contains numerous glands that produce oil with very characteristic aroma. The pulp is pale yellow, contrasting distinctly with lime, whose pulp is always greenish.

Fruits from the same tree often differ in shape and appearance both during the same production cycle and from one season to the next. As the main varieties are fairly similar, the characteristics of the plant are used in addition to those of the fruits in order to distinguish between them visually. Features are habit, colour of the foliage, flowering behaviour, dates of the main harvests, susceptibility to diseases, etc.



Effects of climate

The two fruit species lemon and lime are fairly close. Their respective climatic requirements differ in certain respects and in particular in behaviour with regard to temperature. They are particularly sensitive to cold—lime more than lemon, strongly limiting its cultivation in more northern zones like the Mediterranean region. Lime is better adapted to higher temperatures, or large fluctuations during a day. Lime trees are fairly plentiful in Sahel and semi-desert zones whereas lemons are more sensitive to very high temperatures and are much more rare or not present at all. Overall, lime is more suited to dry and humid tropical climates while lemon prefers Mediterranean types climates and more specifically the more temperate coastal zones. In addition to biotic constraints (pests and diseases), these differences in adaptation to climatic constraints go a long way towards explaining the world distribution of the cultivation areas of the two species.

The effect of temperature on fruit peel colour is well known. The two species react in a similar manner. A Mediterranean climate features schematically high summer temperatures combined with dry atmosphere and low winter temperatures, often not if at all affected by frost, combined with a more humid atmosphere. Under these conditions, the pigmentation of the fruits changes at the end of the growth cycle. Chlorophyll pigments disappear, revealing the yellow colour. In a tropical climate, the absence of a fall in temperature moderates or even inhibits this phenomenon. The fruits remain green for longer and the green is intense.

Lemon growing is suited to regions with no climatic extremes. Citrus zones where the temperature can fall to -4°C are unsuitable as lemon is less resistant to cold than other citrus.

Humid tropical conditions are unfavourable for lemon, mainly because:

- it has great susceptibility to the fungal diseases strongly present in these environments;
- growth and vegetative growth are exuberant;
- the fruits grow too large and they do not match market requirements.

Lemon is well suited to subtropical climates that are both warm and comparatively dry. Most lemon production is in these regions—in coastal areas in the southern and eastern Mediterranean (Sicily, southern Spain, Greece, Turkey, etc.), the coast of southern California and semi-tropical foothill zones (e.g. the lower Himalayas and Andes). The everbearing character of lemon is at its maximum in these areas and production is possible for a very large part of the year. However, successive flowerings do not have the same intensity and each results in a specific type of lemon. The Italians identify four according to harvesting dates:

- **primofiori** from September to November;
- **limoni** from December to May;
- **bianchetti** from April to June;
- **verdelli** from June to September.



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Forcing lemons



In a Mediterranean climate, the trees with the most marked everbearing feature can flower four times in succession in the same year:

- **in March**, when there are generally few flowers; the lemons are ready in October or in September with the earliest varieties;
- **from the end of March to early June**, often abundant flowering with the largest harvest from November to the end of May for a classic variety;
- **at the end of June**, a small flowering giving lemons that reach maturity a year later;
- **in August-September**, for the fruits harvested in the following summer; these are known as verdelli because of the slight greenishness of the peel.

Without human intervention and without exceptional external constraint, the second flowering period is generally the most intense. The resulting fruits thus form the great majority of the fruits harvested.

Sicilian growers were the first to use special lemon management techniques to amplify the intensity of certain waves of flowering and thus achieve a marked staggering of harvest dates. The technique is known as forcing. It can only be attempted successfully with everbearing varieties. An important part of the technique is the good water management of the trees with the gradual drying of the soil and then a planned recovery with watering. Light, sandy shallow soils are the most suitable. Tillage is performed in the spring to enhance evaporation. No other cultural operation is performed and, above all, irrigation is halted completely.

The trees suffer the effects of drying and display the distinct beginnings of wilt throughout the spring until early summer. Pruning is carried out in early August and chemical fertiliser applied. This is followed by a partial return to irrigation with half-doses in one row in two. These practices result in a moderate recovery of vegetation followed by abundant flowering in September. The end-of-summer flowering gives the verdelli lemons picked during the following summer. The technique is traumatic for the lemon trees and so it is advised that it should only be applied to trees in good vegetative condition and to alternate in the same plantation to achieve at least one rotation every four years. The degree of water stress can be modulated to allow for the intensity of the everbearing character of a cultivar; those that reflower more readily require less severe stress.

Storage

Lemon is the citrus fruit that keeps best. Given the sensitivity of the fruits to low temperatures, they cannot be stored at less than 10°C. In practice, depending on the varieties and the development of maturity, storage temperatures range from 12 to 14°C, with relative humidity of between 90 and 95% to keep weight loss to a minimum. The air is replaced regularly to prevent any accumulation of CO₂ and ethylene that would cause a bad taste, peel ageing and an increase in rots.

Storage duration depends greatly on the colour of the epidermis. Lemons with very green peel keep longer—for about six months. Those with intense yellow peel will not keep for long—for a few days to one or two weeks.

During extended storage under optimum conditions lemons undergo changes in appearance and composition that are often beneficial for their quality. Lemons are picked mainly according to their size, regardless of peel colour or internal quality. Sorting according to colour gives homogeneous batches. When placed in chambers with controlled temperature and humidity (temperature from 12.8 to 15.6°C and relative humidity 75 to 85%), the fruits

can be kept for several months, and all the longer if the peel is green. During storage, the lemons undergo a kind of curing, with their characteristics evolving well:

- gradual yellowing of the peel,
- marked increase in juice content (as much as + 16%) and acidity (as much as + 24%),
- the rind becomes thinner,
- the epidermis firms, becoming less susceptible to postharvest fungal attacks.

This feature has been used in certain citrus growing regions to manage the flows released on to the market. Modern equipment is used in California and systems of natural caves in Turkey for example.



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