

International Society of Citrus Nurserymen Conference Report¹

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Abstract

This report summarizes some of the information that I gained during a trip to the Mediterranean region during Spring 1997. The first two days of the trip were spent in Murcia, Spain, as a guest of Dr. Angel García Lidón. We discussed the Spanish lemon industry. After Murcia, I traveled to Valencia, Spain to take part in an International Society of Citrus Nurserymen pre-conference tour. The conference itself took place in Montpellier, France. Following the conference, I participated in a post-conference tour to Sicily.

History and Background of the Spanish Lemon Industry in Murcia: The Arabs introduced lemons into Spain. Until 1850, lemons were raised from seed, until a *Phytophthora* outbreak destroyed most of them, and caused the introduction of rootstocks. The rootstock of choice was Sour Orange. Tristeza has forced the introduction of other rootstocks for lemon. Rough lemon is only occasionally used because of its problems with *Phytophthora*. Recently, *C. macrophylla* has been the lemon rootstock of choice.

Soil is often stony on the hillsides, but is clay and alkaline in the river bottoms. Pruning is often done by hand. Other important non-lemon citrus varieties in the Murcia region are Navelate navel orange and Fortune mandarin

Lemon Varieties. Many lemon varieties have existed in the region for several hundred years, and most could be grouped into two general categories: 1) Finos, or lemons that bloom during one part of the year, and 2) Vernas, or lemons that bloom throughout the year. During the 1960's Dr. Angel García Lidón collected the best Finos and Vernas from the wild for asexual propagation.

Fino 49 is the most popular lemon grown in Spain today. 95% of the flowering is in April, harvest begins in September. Fino 49 is similar to Eureka, Lisbon and Genova. It has a smooth peel, 8-9 seeds per fruit, symmetrical fruit, and is precocious, with 20 to 35% juice in September. Tree is thorny, and fruit is easy to de-green. Fino 95 is similar to Fino 49, but seedless and earlier. Fino 46 is similar to Fino 49, but has many chimeras.

Verna's first flowering peaks in late April, harvest begins in January of the following year. Second flowering begins in August; harvest begins September or October of the following year. Third flowering may begin in November. This can be 15 to 20% of the crop if there has been a late summer drought. This will reduce flowering by about 30% the following year. Quality of Fino is better than that of Verna. Verna tends to have elongated fruit, but with smooth peel. About 3 seeds per fruit. While, alternate bearing, the tree is only slightly thorny. Verna has lower production than Fino. Verna is incompatible with Sour Orange, as evidenced by scion overgrowth on rootstock.

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Chaparro is a tetraploid Fino 49 mutation, possibly dwarfing, early flowering and precocious. It is thorny, with shortened internodes. Possible 6 feet maximum height, suggested planting spacing of 4 x 2 meters (13 x 6 feet, or 506 trees per acre). One-year-old plants produced 8 kilograms of fruit (17.6 lbs or 148 field boxes per acre at 506 trees per acre). Two-year-old trees produced 38 kilograms of fruit per tree (84 lbs or 706 field boxes per acre at 506 trees per acre). Possible 80 to 100 kg fruit per tree when mature. Chaparro has not yet been released from the breeding program.

In the 1970's Verna accounted for 75% of total Spanish lemon production, and Fino for 25%. Now, Fino accounts for 80% and Verna for 20%. Normal lemon production is 350 tons/ha (about 31,200 lbs/ac or about 520 field boxes per acre)

Packing House Operations. Packinghouse operations before packaging the fruit, in the one house that I visited are similar to those in the US, except that fruit are graded (and juice fruit removed) prior to de-greening. The thing that was different was the wide range of fruit packing that the house did. There was no house brand, but rather fruit were packed under the brand name of the customer. Fruit is also packed according to the wishes of the customer. Some fruit are bulk packed in wooden bins; other fruit is packed individually in shrink-wrap with a bar code printed on the side. Some fruit is packed in plastic trays, usually four or six to a tray, as we might see greenhouse tomatoes, while some fruit is packed in nylon string bags with a recipe attached. All packaging methods had the customer's name prominently on the fruit. I saw no fruit packed in boxes as we do here.

General Spanish Citrus Industry Background and Research Objectives: The Spanish citrus industry comprises about 680,000 acres (1995), of which 51% is orange, 34% is mandarin and 15% is lemon. Fifty-three percent of the annual Spanish citrus crop goes for export, and 75% of the citrus imported into the rest of the EU is Spanish. Principal orange varieties are Navelina, Washington, Valencia and Salustiana. Principal mandarin varieties are Nules, Oroval, Marisol, Owari, Clausellina, Okitsu Wase, Nova, Fortune, Ortanique (tangor) and Ellendale (tangor). Most commonly used rootstocks are Carrizo, Cleopatra, Troyer, Volkameriana and Macrophylla. Typical orchard size is only 1 hectare (2.47 acres), and typical spacing is 5m x 5m (15 ft x 15 ft) or 6m x 4m (18 ft x 12 ft). Most pruning is accomplished manually, but mechanical top working is done.

Most citrus research in Spain is done at research centers in the various autonomous regions that grow citrus (Andalucia, Murcia and Valencia). The research facility at Valencia (Institución Valenciana de Investigaciones Agrícolas IVIA) is by far the most advanced and well-funded. Scion research objectives at IVIA include selection and cultivation of mutations, production of scion hybrids, and studies of cultivars recently introduced into Spain, and improving agronomic behavior (improve fruit size and reduce fruit quality problems). Rootstock research objectives include hybrid rootstock production; production of dwarfing rootstocks, disease resistance (Phytophthora, bud union overgrowth and tristeza), and overcoming limiting soil conditions (flooding and calcareous soils). Some of the recent research findings include:

- Troyer x Common mandarin #18 is a rootstock under test that appears to be tolerant of tristeza, and has large fruit size. It is not salt tolerant. Yield efficiency is 6.6 kg fruit /m² of surface area.
- Cleopatra x Trifoliate Mandarin #5 is apparently CTV resistant, nematode resistant, semi-dwarfing, tolerant of Cl⁻, and less sensitive to calcareous soils than C-35 citrange. Its yield efficiency is 8.3-kg fruit/m² surface area.
- GA₃ impairs fruit set
- When saccharose level in the tree is greater, there's less fruit abscission
- High Cl⁻ leads to defoliation.
- Kumquat disease is new to Spain. It affects kumquats on Troyer citrange, and causes limbs to break off easily.
- Triploid plants (seedless) are regenerated from aborted seed.
- Spanish lemon researchers have been working on growth regulators that may improve fruit size. The compound is known as 3,5,6 TPA. It is a close relative of 2,4-D (auxin), and is marketed by Dow AgroSciences Iberia in Spain as "Maxim". The formulation is a tablet that can be dropped in the Spray tank. It is also marketed in high concentrations as Garlon - a rice herbicide.

Spanish Budwood Protection Program. AVASA (Agrupación de Viveristas de Agrios SA) is the private organization whose purpose is to provide clean budwood to the Spanish citrus industry. AVASA was founded in

1976 by nine nurseries, now 12, and representing 85% of all citrus nurseries in Spain. AVASA was established in an isolated valley in the Castellón province, north of Valencia. There is no CTV present in the valley. All surrounding citrus groves are planted by permit only, and every tree is tested annually. There are about 130 citrus cultivars under protection at AVASA. All mother trees are in screenhouses; there are 4 trees for each variety; two on Carrizo citrange and two on Cleopatra mandarin. Each screenhouse is 23,000 m² (5.7 acres). Soil and water pH within the screenhouses is between 7.5 and 8.5. There are also budwood multiplication trees. Three million buds are produced annually, and they're sold for 50¢ each. Buds are cut from January to March, then stored at 8°C until needed. Multiplication trees are budded in August and September. All trees are tested for CTV and veinination annually, for *Citrus exocortis* every 6 years and for other viroids every 3 years.

Spanish Nursery practices. The group visited several nurseries, some of the more interesting facts are presented here:

- Seedlings are grown both in the field, and in seedling houses (60% RH and 18-20C).
- Most common rootstocks are Carrizo, Cleopatra, Macrophylla, Volkameriana, Swingle, Sunki Mandarin
- Seeds are usually stored, and treated with 1% Captan 50.
- Buds are stored under refrigeration at 3 - 5°C.
- Micronutrients are sometimes applied foliarly.
- Nitrogen applied at 1 g N per tree per day
- Seedlings are often dug mechanically (bare root from the field)
- Typical budding speed is 250 buds per hour, with a tier following.

International Citrus Nurseryman's Meeting - Montpellier, France and Subsequent Field Trips in France. Many reports were given, some of special interest include:

- Screening for Iron deficiency tolerance in Citrus rootstocks
Several rootstocks were tested, rootstocks were rated as follows, from best to worst: Volkameriana > Etrog > Eureka lemon > Sour orange > Rangpur Lime > Cleopatra > Shekwasha > Sun Chu Sha > Smooth Flat Seville > Gou Tou > Grapefruit > Pummelo > Sweet orange > Morton citrange > C-35 Citrange > Swingle Citrumelo > Trifoliate orange.
- Studies to reduce labor input and production time in the nursery
Gibberellin applications were studied to enhance stem elongation in the nursery. Fifty-ppm led to best elongation with Midnight Valencia. Results were mixed with Nules clementine. NAA was also applied to seedlings to inhibit bud sprouting. At rate of 2250 ppm NAA, only 3% budbreak occurred, compared with 49% in the control.
- Controlling citrus rootstock sprouting in the Nursery using Tre-Hold®
Tre-Hold is a commercially available product made by AmVac Chemical Corp. Field trials showed that ½ or ¾ of the recommended rate led to only one sprout per ten treated trees, compared with 50 sprouts on the non-treated trees. Applications did not affect final caliper size of the budded seedling. It is not recommended to apply Tre-Hold to the scion bud, as bud healing will be adversely affected. Best practice is to apply to seedlings while the scion bud is still under wraps.
- Early field performance of budded clonal rootstocks and rooted scion cuttings
These South African researchers have established 500,000 clonal (cuttings) rootstocks over the past 5 years. They have used a number of rootstocks, including Rough Lemon, Swingle, Carrizo, Troyer, Sacaton Citrumelo and C-35 Citrange. They report that 6-8 weeks less time in the nursery is needed using cuttings compared with seedling rootstocks. Size of cuttings used is about 1-½ inches. They report in all trials, clonal rootstocks were superior to seedlings, because of strong root systems, tree growth and stand uniformity.
- Proposed profile of the future citrus orchard: Adaptations also in the nursery?
Dr. Etienne Rabe (South Africa) suggests some radical change in the future citrus orchard. Dr. Rabe has found that topping a tree reduces the stem diameter of that tree. (Not surprising, since you are removing leaves). He suggests planting untopped trees that have been trained to central leaders. South African

nurseries have been selling untopped trees (whips) that are 5 ft tall. Dr. Rabe argues that today, a citrus grower must break even quickly, so trees should be in production as soon as possible. In his opinion, trees should also be no more than 9 to 10 feet tall at maturity, so that as little ladder work as possible can be done. Trees should also be spaced at 4 to 6 feet apart by 12 feet between rows (725 trees per acre). Ultimate tree width should be about 6 feet wide.

- Mycorrhizal fungi
Several studies noted the beneficial effects of mycorrhizal fungi upon seedling in beds or in the greenhouse.
- Use of a chlorophyll meter to evaluate the nitrogen nutritional status of Rangpur lime grown in recipients.
These Brazilian researchers were able to successfully determine N status of seedlings using a hand-held chlorophyll meter.

French Nursery practices. Most French citrus nurseries are in Provence, and under glass, because of the possibility of freezes. There is very little commercial citrus grown in France; the nurseries grow for the retail customer. We visited one nursery outside of Marseilles, France, called "Agrumes de Provence". They have 3 ha (7.5 acres) under glass (plastic). Trees are grown to commercial size, and to a dwarf size. Rootstocks used include Volkameriana, Carrizo, Troyer and trifoliolate orange. Commercial sized trees are budded at 23" height and dwarf trees are budded at 6" height. Shoots are removed manually. Smaller trees are sold in 3 liter (¾ gallon) and 7-liter (1 ¾ gallon) pots. Trees in 3-liter pots remain in the nursery for 2 years prior to sale, while trees in 7-liter pots remain in the nursery for 3 years. This nursery sells 25 to 35,000 of the 3-liter size annually at a price of about 65 francs (\$10.92), and 15 to 20,000 of the 7-liter size annually at a price of 100 francs (16.80). Less than 10,000 of the larger trees are sold annually, and the price depends on the size of the tree.

Research and the Citrus Industry in Corsica. The Corsican citrus industry is small, about 2500 ha (6200 acres). There are about 100 growers, most with less than 25 acres each. Clementines and Star Ruby grapefruit are the two varieties grown, on Sour orange, Carrizo or trifoliolate orange. Fifty percent of the crop is exported to mainland France.

Corsica is also the site of the greatest collection of citrus varieties in the world. Over 1500 varieties are maintained at the SNRA (Société Nationale de Recherche Agronomique) – Corsica. We saw several locally developed varieties, such as clementine 'Corsica 2', a good-sized easy-peeling fruit that grows in clusters, ripe about 2 weeks later than 'Caffin' mandarin (likely about mid-October in Arizona). Also, we saw 'Maltaise Bokobsa' a blood orange of Tunisian origin.

Sicilian Nursery Industry and Sicilian Varietal Research. The Sicilian lemon industry is in poor shape. Most growers cannot compete with Spanish lemons because of high costs and because their groves are too small. Average profits are about 100 lire per kilogram of fruit (\$0.13 per pound of fruit). Many groves have been abandoned. Many of the young potential farmers have moved to the city, leaving many elderly farmers. There are 7500 registered farms in Sicily, with average 7.5 acres. In reality, only about 10% are true active farms. Also, a fungal disease known as Mal Secco is a problem. This fungal disease gradually kills the trees by blocking the tree phloem. It is difficult to spray for this disease because many groves are small and on terraces, so it is difficult to move in equipment. Some varieties are resistant. There are also problems with thrips, red scale and tristeza. Thrips are more difficult to control when adjacent groves are abandoned. Some lemon varieties commonly planted include:

- Femminello Siracusano – the most important lemon grown in Sicily.
- Monachello – Poor quality lemon, but resistant to Mal Secco.
- Messina – Early lemon with elongated shape.
- Zagarabianca – Femminello lemon with none of the normal purple flower or foliage pigmentation. Tolerant to Mal Secco.
- Adamo – Seedless Femminello.
- Interdonato – large fruited, early lemon. Poor quality.
- Santa Teresa – Selection of Femminello.

Most of the Sicilian citrus industry centers on the blood orange, chiefly the 'Tarocco'. 'Tarocco' matures from November to May. It is subject to bud variation, so its color is variable. It also has a poor storage life, and is

unsuitable for export. The 'Moro' is considered to be too acid. Dr. Angelo Starrantino of the Istituto Sperimentale per l'Agrumicoltura has developed several varieties including:

- 'Tacle' -- Tarocco x Clementine hybrid, seedless, matures in December.
- 'Tapi' -- Early pigmented 'Tarocco' type.
- 'Vitale' -- blond 'Tarocco'
- 'Tarocco Rosso' -- Better coloring, late maturing, thin peel 'Tarocco'

The Sicilian nursery industry. There are 400 nurseries in Sicily. Much of the production in the northern part of the island is for the retail trade. Most trees begin as seedlings. Trifoliolate orange, 'Carrizo' and 'Macrophylla' are the most common rootstocks. After one year in the seedbed, rootstocks are potted. Budding is done at 20 inches, by law. A four-bud budstick costs about 40¢. Trees are offered for sale 1 to 2 years after budding. Trees are often dwarfed through pruning and root restriction. A dwarf lemon tree will be sold for about 20,000 lire (\$11.00), without fruit about 30% less.