THE WORLD CITRUS INDUSTRY

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Summary

This chapter deals with the key citrus crops and is divided into two broad sections: production and marketing. In the section related to citrus production, citrus varieties and rootstocks are identified. Common grove management practices are presented. Issues related to new grove establishment are discussed. The main pests and diseases that affect citrus production are identified. The issue of climate and its effect on the location and quality of citrus production is also briefly discussed.

The marketing section includes a discussion of fresh versus processed citrus production. Marketing arrangements are discussed. Differences in marketing channels across major production zones are highlighted. Globalization of world citrus markets is also addressed and its implication for further trends in citrus production is highlighted.

Citrus production takes place throughout the tropical and sub-tropical countries of the world. Orange juice is the largest fruit juice product consumed in the world. There are also important markets for grapefruit and lemon juice.

Citrus production can be divided among four primary groups: sweet oranges, mandarins (also known as tangerines), grapefruit, and lemons and limes. Brazil has become the largest citrus producing country and dominates world trade in orange juice. The citrus industry of China has grown rapidly over the past decade. It is still mostly focused on its domestic market; among the main citrus products China is a world player in production of mandarins, both fresh and canned.

1. Introduction

Citrus production takes place throughout the tropical and sub-tropical countries of the world. Citrus products play an important role in human diets as citrus fruits are high in Vitamin C and contain other important nutrients including folate and potassium, and in fresh form, are good sources of dietary fiber.

The original home of citrus was probably the warm southern slopes of the Himalayas in northeastern India (Ziegler and Wolfe). Production eventually spread to China. Rome was known to import oranges probably from Palestine and Egypt. Ziegler and Wolfe suggest that orange trees may have been grown in Southern Italy in 300 AD, but with the fall of Rome, those orchards were likely lost.

With the conquest of Spain by the Moors, oranges were introduced there around 900 AD. The Spanish introduced citrus to the new world in the 16th century, and soon citrus spread to many countries in both North and South America with Mexico and Florida, USA being important suppliers in the colonial period. With perishability somewhat of an issue, world growth in citrus production began in the 19th century with the advent of railroads and steamships. Still citrus was primarily purchased fresh form until frozen concentrated orange juice was developed in the late 1940s. This development spurred first the expansion of orange production in Florida and later the establishment and rapid growth of a processed orange industry in Sao Paulo, Brazil. First, the United States and Canada, later followed by the countries of the European Union have changed a large proportion of their consumption of citrus from fresh to processed form. Orange juice is the largest fruit juice product consumed in the world. There are also important markets for grapefruit and lemon juice.

2. World Citrus Production

Citrus production can be divided among four primary groups: sweet oranges, mandarins (also known as tangerines), grapefruit, and lemons and limes. Citrus production in the main producing countries for the 2007-08 season is shown in Table 1. Brazil is by far the largest citrus producing country and is the dominant producer of sweet oranges. China and the United States follow with China being the largest producer of mandarins, while the United States leads in grapefruit production. The European Union is also a major producer of sweet oranges, lemons, and mandarins. Mexico is the fifth largest orange producing country. Although not shown in Table 1, Mexico is also a leading

producer of limes.

Country	Oranges	Grapefruit	Tangerines	Lemons
	1,000 Metric Tons			
Argentina	800	220	350	1,100
Australia	350	--	--	--
Brazil	15,912	--	--	--
China, Peoples Republic of	5,450	2,230	9,720	--
EU-27	5,999	--	2,744	1,136
Israel	162	245	160	--
Japan	--	--	1,115	--
Korea, Republic of	--	--	634	--
Mexico	4,000	380	--	--
Morocco	659	--	421	--
Other	8	--	--	121
South Africa, Republic of	1,280	290	--	205
Turkey	1,472	182	739	500
United States	9,237	1,421	506	655
Total	45,329	4,968	16,389	3,717

Source: Foreign Agricultural Service, United States Department of Agriculture

Table 1. Citrus Production, 2007-08 Season

3. Overview of this Chapter

Since citrus production encompasses a wide array of varieties, production zones, and marketing systems, this chapter cannot provide an in-depth presentation of the nuances of citrus production. It is divided into two broad sections: production and marketing. In the section related to citrus production, citrus varieties and rootstocks are identified. Common grove management practices are presented. Issues related to new grove establishment are discussed. The main pests and diseases that affect citrus production are identified. The issue of climate and its effect on the location and quality of citrus production is also briefly discussed.

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4. Production of Citrus

4.1. Citrus Propagation

Similar to most tree fruit crops grown for commercialization, citrus trees are propagated by grafting a scion (the variety) to a rootstock. In this way, a hybrid tree is produced which offers characteristics of both the rootstock and the scion. The process is begun by planting a seed from a desired rootstock. Once the seeding reaches 50 to 70 centimeters in height, a cut is made and a bud from the desired scion is inserted. The bud forms a

union with the rootstock and the canopy of the plant takes on the characteristics of the scion. It generally takes approximately 12 months for the seedling to reach a size suitable for planting in the field. After planting, the rule of thumb is that the tree will not bear fruit until its fourth year, although trees in their second year are known to produce small amounts of fruit in certain circumstances. With the possibility of transmitting disease through nursery trees, many countries have adopted a certified budwood program, where buds are provided by a central entity which guarantees that the planting material is disease free.

4.2. Grove Establishment

Citrus trees require a well-drained soil. Soil type seems to be a less important issue as most citrus production in Florida takes place on sandy soils with low organic content. Soils in Sao Paulo and Mexico are generally heavier with clay. If drainage is an issue, a variety of measures can be employed to facilitate drainage by either taking advantage of the natural contour of the land or creating ditches to facilitate drainage from the root zone of the tree.

Tree density varies widely by production region and citrus variety. While densities of less than 250 trees per hectare were common until the mid 1980s, it has been determined that higher densities offer economic advantages. Most new plantings in Florida are at least 375 trees per hectare, with some plantings over 500 trees per hectare. Sao Paulo growers have also moved to higher densities. In Asia, dwarfing rootstocks are more common and tree densities may be even higher.

The advantages that higher tree densities offer is that more fruit can be produced per unit of land area early in the life of a particular orchard thereby moving forward in time the income realized from a new planting. The disadvantages associated with higher densities include higher grove establishment costs (more trees must be purchased and planted) and as trees age, crowding will likely become an issue. Hedging can be used to control tree size, but there are reports of per hectare yields declining as aggressive hedging programs are initiated.

Therefore, at the time of grove establishment, a clear plan should be established which considers soil type, drainage, rootstock/scion selection, and tree density. While all of these factors are not discussed here, rootstocks vary widely in the size of mature tree. Scion selection also affects mature tree size with mandarin and lime giving smaller trees and grapefruit larger trees compared to sweet oranges.

The use of irrigation varies widely across countries. In the United States, nearly all commercial plantings of citrus are irrigated using either surface or ground water sources. In Florida, the predominant system is micro-sprinkler. In Sao Paulo, no more than 20 percent of citrus plantings are irrigated. While this percentage is growing, Sao Paulo citrus production is based primarily on a rain-fed system of production. Irrigation is Sao Paulo uses drip or flood systems. Elsewhere in the Americas, little irrigation is used. Irrigation is common in the EU producing countries. Data is not available regarding the use of irrigation in China. Given the dry climate of both Australia and South Africa, irrigation is necessary to economically produce citrus there.

The availability of irrigation affects selection of rootstock. The most dominant rootstock used in Sao Paulo is Rangpur lime which is a rough lemon selection. Rangpur lime is highly tolerant to drought; it produces a relatively large tree, and has high fruit productivity. It is, however, susceptible to blight (also known as decline) which tends to affect citrus trees once they exceed 12 years of age. Therefore the choice of Rangpur lime means that the grove will likely have a life of less than 20 years. In the United States, trifoliate rootstocks such as Swingle are widely used which are not drought tolerant, produce a smaller tree compared to Rangpur lime, but with good fruit productivity and is less sensitive to blight. Groves tend to have a longer life.

In Mexico and other Central American producing countries, sour orange is the rootstock of choice. Sour orange produces a large tree with very high fruit yields. It is also tolerant of most diseases except tristeza, a disease that causes rapid decline and eventual death of the tree. Tristeza is spread by the brown citrus aphid which can be found in the United States, Brazil, and Europe. Therefore, sour orange has been almost completely eliminated in those production regions.

	Rootstock Influence				
Rootstock	**Brix**	**Acid**	**Ratio**	**Tree Life**	**Fruit Size**
Rough lemon group					
Rough lemon	Lowers	Lowers	Raises	Decreases	Increases
Macrophylla	Lowers	Lowers	Raises	Decreases	Increases
Volkamer lemon	Lowers	Lowers	Raises	Decreases	Increases
Milan lemon	Lowers	Lowers	Raises	Decreases	Increases
Rangpur lime	Lowers	Lowers	Raises	Decreases	Increases
Sweet lime	Lowers	Lowers	Raises	Decreases	Increases
Sour orange and trifoliate group					
Sour orange	Raises	Raises	Lowers	Increases	Standard
Cleopatra mandarin	Raises	Raises	Lowers	Increases	Decreases
Sweet orange	Raises	Raises	Lowers	Increases	Standard
Carrizo citrange	Raises	Raises	Lowers	Increases	Standard
Troyer citrange	Raises	Raises	Lowers	Increases	Standard
Swingle citrumelo	Raises	Raises	Lowers	Increases	Standard
Trifoliate orange	Raises	Raises	Lowers	Increases	Variable

Source: Krezdorn (1979).

Table 2. Rootstock Influence on Citrus Fruit Quality, Tree Longevity, and Fruit Size

Rootstock	**Tristeza**	**Exocortis**	**Footrot**	**Blight**	**Cold**
Rough lemon	T	T	S	HS	S
Sour orange	HS	T	T	S	T
Cleopatra mandarin	T	T	S	S	T
Sweet orange	T	T	HS	S	T
Trifoliate	T	N	N	S	T
Carrizo citrange	T	S	T	S	S
Milam lemon	T	T	HS	S	S

Rangpur lime	T	S	S	S	S
Sweet lime	T	S	S	S	S
Macrophylla	HS	T	T	S	S
Swingle citrumelo	T	T	T	N	T
Volkamer lemon	T	T	T	S	S

R = resistant, T = tolerant, S = susceptible, HS = highly susceptible, N = not known
Source: Adapted from Price (undated).

Table 3. Reactions of Rootstocks to Diseases and Cold

A partial list of rootstocks with their attributes is shown in Table 2. In Table 3, another list of rootstocks is presented with the susceptibility to certain diseases and cold weather.

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Biographical Sketch

Thomas H. Spreen is Professor in the Food and Resource Economics Department at the University of Florida. He received his formal training from Purdue University in West Lafayette, Indiana. He holds a B.S in Mathematics (Summa cum Laude), an M.S. in Applied Statistics, and a Ph.D. in Agricultural Economics. After graduation, he immediately joined the faculty at the University of Florida in 1977.

During his academic career, Dr. Spreen has conducted research related to the economics of beef and dairy cattle, citrus, bananas, sugarcane, and fresh vegetables. Over the past 15 years, he has established himself as a leading researcher on the world citrus industry. He has served as a consultant to the Food and Agricultural Organization and has made presentations related to citrus on four continents. He has authored or co-authored over 300 publications including more than 50 refereed journal articles.

During his tenure as a faculty member in the Food and Resource Economics Department, he has taught courses in mathematical programming, optimal control methods, and mathematics for economists. He has supervised a large number of graduate students having chaired 20 Ph.D. dissertation committees and served on total of120 graduate committees. He served as coordinator of graduate programs for the department from 1987-90 and again from 1996-2000. He was chair of the department from 2002-08. He received a lifetime achievement award from the Southern Agricultural Economics Association in 2007. He appeared in *Who's Who in America* in the 2009 edition.