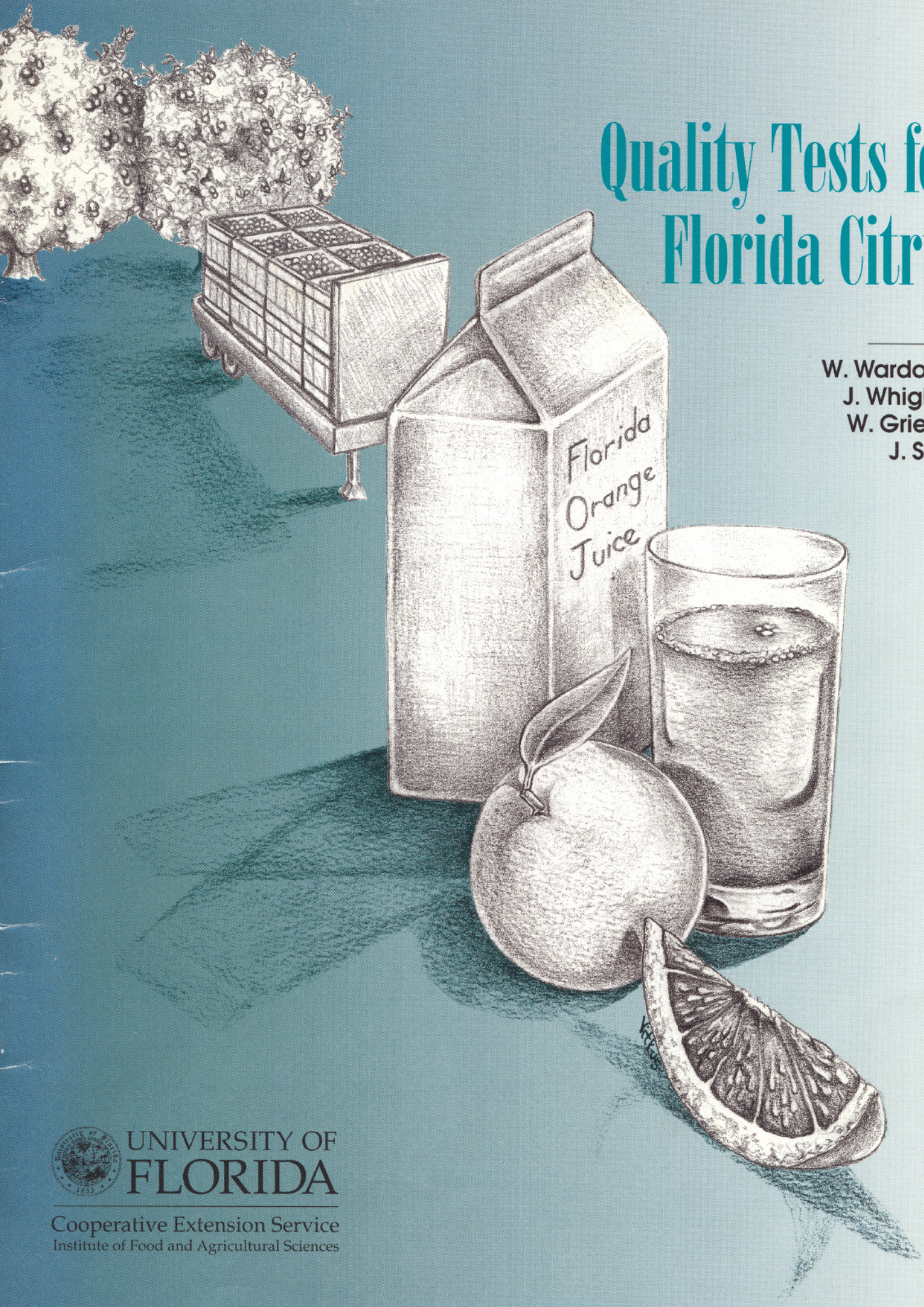
SP 99

Quality Tests for Florida Citrus

W. Wardowski
J. Whigham
W. Grierson
J. Soule



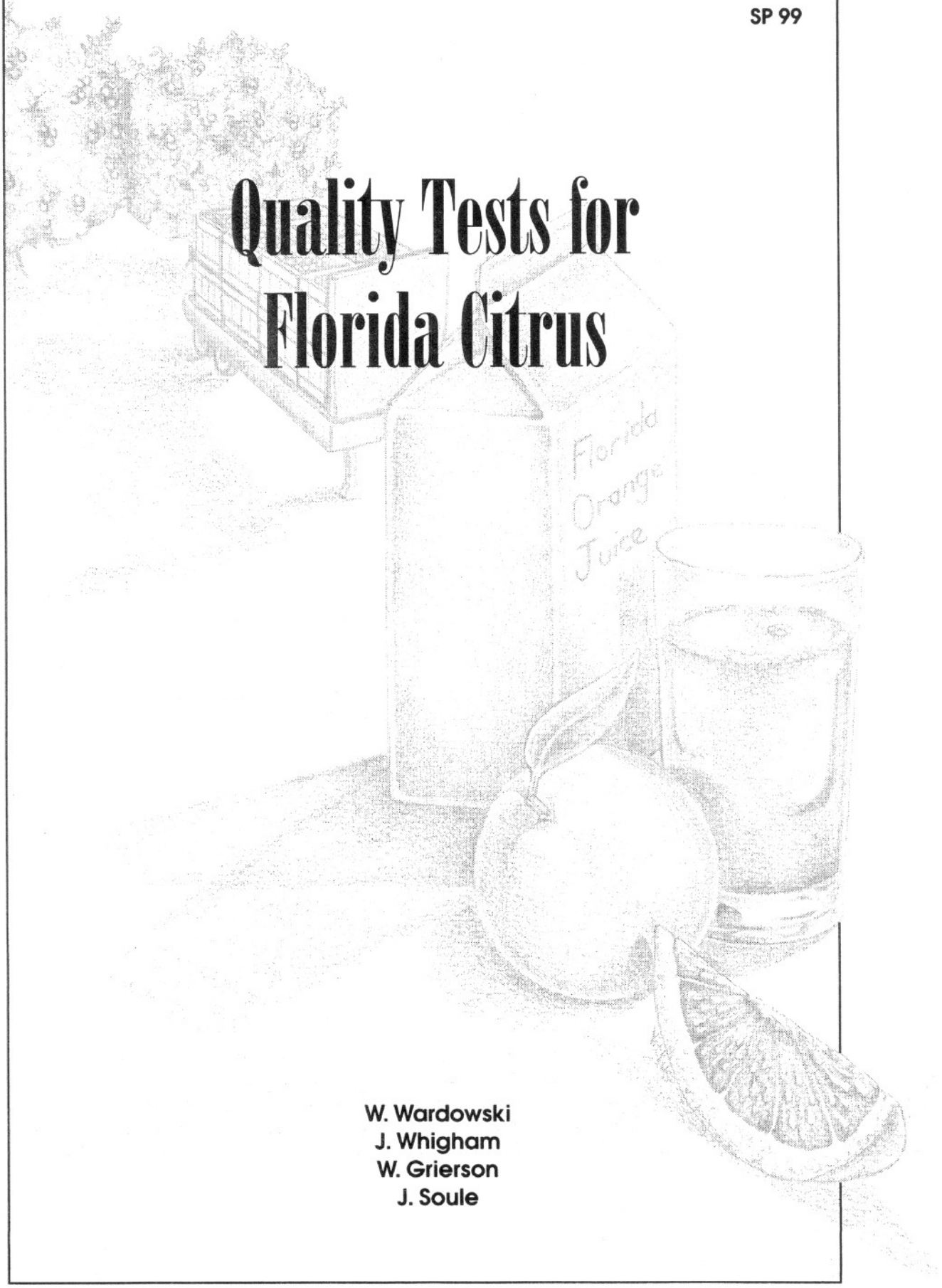
UNIVERSITY OF FLORIDA
Cooperative Extension Service
Institute of Food and Agricultural Sciences

The use of trade names in this publication is solely for the purpose of providing specific information. It is not a guarantee or warranty of the products named, nor does it signify that they are approved to the exclusion of others of suitable composition.

Figure 3 and Figure 4 photographs by Joseph Whigham, Florida Division of Fruit and Vegetables, Winter Haven.

SP 99

Quality Tests for Florida Citrus



W. Wardowski
J. Whigham
W. Grierson
J. Soule

Quality tests for Florida citrus / by W. Wardowski ... [et al.].
p. cm.
ISBN 0-916287-16-5
1. Citrus fruits--Florida--Quality. 2. Citrus fruits--Standards--Florida. 3. Citrus fruit industry--Florida--Quality control.
I. Wardowski, Wilfred W.
SB369.2.F6Q35 1995
634'.304567--dc20 95-48875
CIP

Table of Contents

List of Tables

List of Figures

More than 13 million tons of oranges, grapefruit, tangerines, Temples, tangelos, lemons, and limes are harvested annually in Florida. About 85 percent is processed. The remainder is marketed in fresh form. All Florida citrus fruits, with minor exceptions, are subject to inspection for minimum acceptable quality (maturity) before they can be utilized at a processing plant or shipped from a packinghouse. Additional grade standards (largely external) apply to fresh fruit.

Tests for minimum acceptable quality of citrus in Florida are utilized in three ways. First, as the shipping season of a variety approaches, the grower or member of the organization that will pick the fruit first collects samples periodically in the grove. Tests of these samples provide information on the progress of maturity. This information, along with certain other factors such as market condition and weather, is used to determine when part or all of the crop may be harvested. Second, official tests are run on each lot delivered to a packinghouse or cannery to see that the fruit meets minimum legal standards. Third, tests for juice and sugar content (Brix) are run on a sample of each truckload of fruit received at a processing plant. This provides an equitable and legally sound basis for buying and selling processing fruit.

Quality (Maturity) Standards

Legal Basis

With the exception of those for lemons and limes, all of the laws pertaining to Florida citrus minimum acceptable quality standards are found in the Florida Citrus Code of 1949, as amended, Chapter 601, Florida Statutes. The code can be changed—as it frequently has been—only by legislative action. These legal requirements, commonly called maturity standards, are in reality minimum internal quality standards, which are designed to keep immature fruit off the market. Before these standards were developed, selling immature fruit proved detrimental to the interest of citrus growers, handlers, and processors. Certain requirements such as the total soluble solids and grapefruit juice content start higher early in the maturity season of a given variety and progressively decrease as the season progresses. This is because it is recognized that citrus fruits undergo favorable changes in juice content, sugars, acidity, flavor, and aroma as they mature to prime quality on the tree. Unlike apples, pears, or bananas, citrus fruits contain little or no starch and do not continue ripening after harvest. Thus, quality must be attained while the fruits are still on the trees.

Provisions of the code relating to minimum internal quality and other matters are delegated to the Florida Citrus Commission and its Florida Department of Citrus. The commission, a body of 12 citrus growers, handlers, fresh fruit shippers, and processors appointed by the governor, issues rules to carry out the intent of the code on a day-to-day basis. These rules, unlike the code, can be, and often are, changed as circumstances require during the season. To this extent, the Florida citrus industry is self-regulated. An example of the rule is Chapter 20-34, Fresh Fruit Maturity Tests.

The Florida Citrus Code, as amended, and the rules of the Florida Department of Citrus are enforced by the Division of Fruit and Vegetables, Florida Department of Agriculture. Inspectors of the Division of Fruit and Vegetables test samples of citrus fruit for minimum internal quality under provisions of the code. In cooperation with the United States Department of Agriculture, the same inspectors also enforce U.S. standards for grade and regulations issued by the (U.S.) Secretary of Agriculture in compliance with Citrus Marketing Order 905 and other applicable federal laws. Each lot shipped as fresh fruit is thus inspected for two standards, one for minimum internal quality and a second for external quality (grade). Processed products are inspected for minimum internal quality and grade. Fruit for processing must be mature and wholesome.

Lemons and limes are in a special category with respect to minimum quality standards. At present, there are no legal standards for lemons under the

Florida Citrus Code because production is small and there are few fresh fruit handlers and processors. Eventually, standards will be established, probably in the same manner as for Honey tangerines by rules of the Florida Department of Citrus, until the volume warrants legislative action and inclusion in the Citrus Code.

Limes were removed from the Citrus Code in 1957 and are now under the Avocado and Lime Administrative Committee. Sections 603.151 and 603.152, Florida Statutes, provide that maturity standards for limes shall be set by regulations issued under the Federal Marketing Order 911 and enforced by state inspectors.

U.S. grade standards for Florida oranges and tangelos (including Temples and other mandarin-type hybrids not classified as tangerines), grapefruit, and tangerines specify that fruits must be mature according to the Florida Citrus Code of 1949, as amended. Florida standards apply to fruit within the state. There are separate U.S. and Florida standards for processed citrus products.

Factors and Terms

Standard box. The former unit of measure in the Florida citrus industry was the "standard packed box" (no longer in existence as a shipping container) of $1\frac{3}{5}$ bushel (56 liters) capacity. The two-compartment, jumble-filled Florida field box was designed to pack a "standard packed box" and has 4800 cubic inches or 2.23 bushels (79 liters) and a legal weight of 90 pounds (41 kg) for oranges, Temples, and tangelos, 85 pounds (39 kg) for grapefruit, and 95 pounds (43 kg) for tangerines. The standard unit of measure in the Florida lime industry is 1 bushel or 55 pounds (25 kg). Limes for the domestic market are packed in containers of three different sizes: $\frac{1}{5}$ bushel (7 liters) [10 pounds (5 kg)], $\frac{2}{5}$ bushel (14 liters) [20 pounds (9 kg)], and $\frac{4}{5}$ bushel (28 liters) [38 pounds (17 kg)]. Limes for export may be packed in other sized containers.

In the field, fruit may be handled either on a volume basis in field boxes (rarely used today) or larger pallet bins, which hold multiples of the field box, or on a weight basis, where the weight of a lot is divided by the legal per box weight for the fruit in question to give the number of equivalent standard boxes. The latter system is widely used in the industry, especially for bulk or processing fruit. The standard fresh fruit shipping container, $\frac{4}{5}$ bushel (28 liters), is the current legal measure for packed fruit in the packinghouse industry.

Crop year. The administrative crop year for oranges, grapefruit, tangerines, Temples, tangelos, and lemons is from August 1 to July 31 and for limes April 1 to March 31.

Samples for maturity tests. A standard sample for fresh fruit maturity tests (exclusive of color break) consists of 20 oranges, Temples, tangelos, or tangerines, or 10 grapefruit, lemons, or limes. Each sample is usually composed of average fruit of a packed size, with a few exceptions such as the composite early-season ratio test on oranges, grapefruit, and tangerines. Processing fruit is usually tested on a minimum 40-pound composite sample basis.

Color break. Although legal requirements for preharvest color break are still in effect, they are not commonly enforced due to improved degreening methods in citrus packinghouses. Fruit must be examined for color by the inspector after being brought into the packinghouse and also at a time of packing in connection with U.S. grade inspection. In practice, if the fruit will degreen sufficiently to meet U.S. grade standards, it is considered to have adequate color break for harvest. Market acceptance also influences minimum color.

Juice content. Quantity of juice in citrus fruits is expressed in three different ways: as gallons per box for oranges, cubic centimeters per fruit for grapefruit, and percentage by volume for limes and lemons. To obtain the first two, average fruit of a specified size are cut in half across the stem-to-blossom axis. Juice is extracted by hand, either with the official reamer and orange burr or, more commmonly, with a mechanical extractor. It is strained through a double layer of cheesecloth, wire strainer, or colander, with sufficient pressure applied to squeeze out the juice while leaving the juice sacs, pulp, seeds, and "rag" behind. Too little pressure will result in a lower volume of juice; too much will introduce particles that may interfere with the Brix hydrometer reading. Strained juice is then measured in a graduated cylinder. Conversion of cubic centimeters of juice per 20-fruit orange sample to gallons per box is given in Table 1.

The values in Table 1 are used in Florida, but citrus juice content in most countries is expressed as percent juice, volume to volume (v/v, as in Florida lemons and limes below), or more commonly

Table 1. Conversion of Cubic Centimeters (Milliliters) of Juice Per 20-Fruit Orange Sample to Gallons per 1 3/5 Bushel Box.[1]

Directions: To use the table, find the closest figure (under the size column of fruit being tested) that corresponds to the actual cubic centimeter reading on the graduated cylinder in which the juice is measured, then trace the line beneath the number to the gallons per box column on right or left. The figure above the line followed will show the computed number of gallons per box to the nearest tenth gallon. For example, if 20 oranges of size 100 gave 1967 cubic centimeters of juice, a 1 3/5 bushel box of this size would contain 5.2 gallons of juice. For a 10-fruit sample, multiply the juice extracted by 2.

Gal. Per Box	Fruit Size or Count Per 4/5 Bushel Box									Gal. Per Box
	32	40	48	56	64	80	100	125	163	
4.0	4732	3785	3155	2704	2366	1893	1514	1211	929	4.0
4.1	4850	3880	3233	2771	2425	1940	1552	1242	952	4.1
4.2	4968	3975	3312	2839	2484	1987	1590	1272	975	4.2
4.3	5087	4069	3391	2907	2543	2035	1628	1302	999	4.3
4.4	5205	4164	3470	2974	2602	2082	1666	1332	1022	4.4
4.5	5323	4259	3549	3042	2662	2129	1703	1362	1045	4.5
4.6	5442	4353	3628	3109	2721	2177	1741	1393	1068	4.6
4.7	5560	4448	3707	3177	2780	2224	1779	1423	1091	4.7
4.8	5678	4542	3785	3245	2839	2271	1817	1454	1115	4.8
4.9	5796	4637	3864	3312	2898	2319	1855	1484	1138	4.9
5.0	5915	4732	3943	3380	2957	2366	1893	1514	1161	5.0
5.1	6033	4826	4022	3447	3016	2413	1931	1544	1184	5.1
5.2	6151	4921	4101	3515	3076	2461	1968	1575	1208	5.2
5.3	6270	5016	4180	3583	3135	2508	2006	1605	1231	5.3
5.4	6388	5110	4259	3650	3194	2555	2044	1635	1254	5.4
5.5	6506	5205	4337	3718	3253	2602	2082	1666	1277	5.5
5.6	6624	5300	4416	3785	3312	2650	2120	1696	1301	5.6
5.7	6743	5394	4495	3853	3371	2697	2158	1726	1324	5.7
5.8	6861	5489	4574	3921	3431	2744	2196	1756	1347	5.8
5.9	6979	5583	4653	3988	3490	2792	2233	1787	1370	5.9
6.0	7098	5678	4732	4056	3549	2839	2271	1817	1393	6.0
6.1	7216	5773	4811	4123	3608	2886	2309	1847	1417	6.1
6.2	7334	5867	4889	4191	3667	2934	2347	1878	1440	6.2
6.3	7453	5962	4968	4259	3726	2981	2385	1908	1463	6.3
6.4	7571	6057	5047	4326	3785	3028	2423	1938	1486	6.4
6.5	7689	6151	5126	4394	3845	3076	2461	1968	1510	6.5

[1] Adapted from Fruit and Vegetables Division, Florida Department of Agriculture. Based on 3785.4 cubic centimeters per gallon.

percent juice, weight to weight (w/w). Table 2 shows the minimum Florida fresh orange standards for juice of 4.5 gallons per box as percent juice on both a volume and a weight basis. Florida oranges have the distinction of having a higher percent juice than the same varieties from most other citrus producing areas. There would be an advantage to Florida if this standard were expressed in terms that people in world markets could better understand and easily compare to standards for fruit from other production areas. For this, juice content needs to be stated as percent w/w, which is always a higher value than v/v because the specific gravity of juice is always over 1.0 and that of the whole fruit is almost always less than 1.0.

Table 2. Florida Fresh Orange Minimum Juice Standards.[1]

Florida Gal./box	% Juice[2]	
	V/V	W/W
4.5	38	43

[1] European (Organization for Economic Cooperation and Development) Standards require a minimum of 30 to 35% W/W.

[2] Assumptions: Specific gravity of whole orange = 0.9
Specific gravity of 8°Brix juice = 1.03

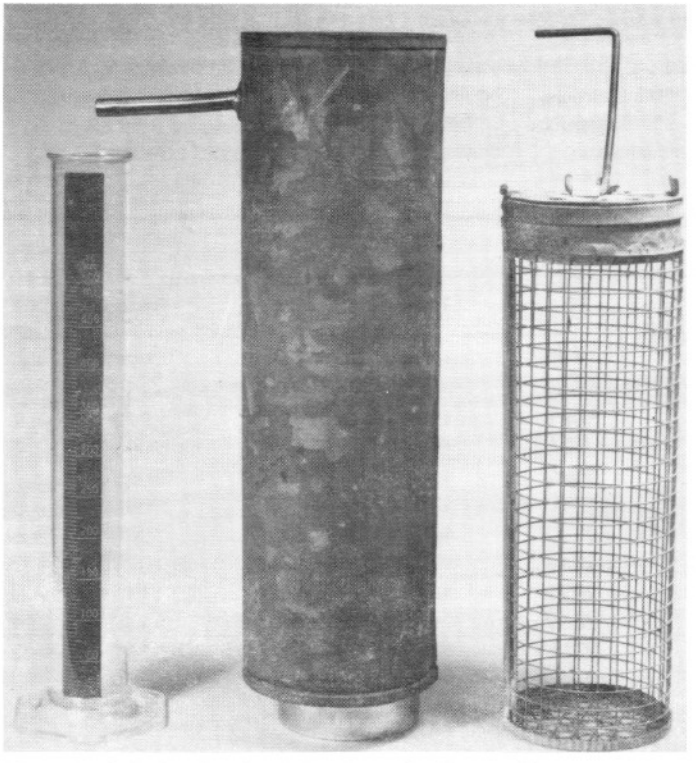


Figure 1. Cylinder for determination of volume of lemons or limes.

The volume of whole limes or lemons is found by water displacement of 10 fruit. The simplest device is a cylinder with a side spout as shown in Figure 1. The cylinder is first filled to overflowing. Then the sample is introduced, with care that all of the fruits are submerged. The water displaced is collected and measured. The quantity of juice is found as for oranges or grapefruit above, measured in cubic centimeters, and converted to percentage by dividing by the cubic centimeters of water displaced times 100.

Brix (total soluble solids). Citrus fruit juices contain a large number of soluble constituents, chiefly sugars, with smaller amounts of organic acids, vitamins, proteins, free amino acids, essential oils, and glucosides. Other compounds are also present in minute quantities. Approximately 85 percent of the total soluble solids are sugars. They are measured in official tests by means of a Brix hydrometer (see Figure 3B, p. 11). This instrument, which actually measures specific gravity, is calibrated to read directly in degrees Brix, or percent pure sucrose, at a temperature of 20°C. In citrus testing, the term "Brix" or "degrees Brix" is synonymous with total soluble solids and is used throughout this publication to avoid confusion with "pounds-solids."

The test for Brix may be run on the same juice that was measured previously for juice content or on a separate sample of fruit of the same size. The Brix hydrometer and a thermometer are inserted into a tall cylinder filled with juice. Samples squeezed by hand or with the official reamer contain comparatively little trapped air so that the hydrometer and thermometer can be read after a few moments. (If a high-speed reamer is used, the juice should be de-aerated with an aspirator prior to insertion of the hydrometer into the cylinder.) Temperature corrections for Brix readings to the standard 20°C are given in Table 3.

Unofficial readings of Brix content may be obtained with a refractometer. Refractive index expressed in terms of pure sucrose may be measured in seconds with a single drop of juice. Handheld

Table 3. Temperature Correction for °Brix to Standard Temperature 20°C.[1]

Temperature °C	Correction Factor °Brix	Temperature °C	Correction Factor °Brix
10.0	-0.45	24.0	+0.25
10.5	-0.45	24.5	+0.25
11.0	-0.40	25.0	+0.30
11.5	-0.40	25.5	+0.35
12.0	-0.40	26.0	+0.35
12.5	-0.35	26.5	+0.40
13.0	-0.35	27.0	+0.45
13.5	-0.30	27.5	+0.45
14.0	-0.30	28.0	+0.50
14.5	-0.25	28.5	+0.55
15.0	-0.25	29.0	+0.55
15.5	-0.25	29.5	+0.60
16.0	-0.20	30.0	+0.65
16.5	-0.20	30.5	+0.70
17.0	-0.15	31.0	+0.70
17.5	-0.15	31.5	+0.75
18.0	-0.10	32.0	+0.80
18.5	-0.10	32.5	+0.85
19.0	-0.05	33.0	+0.85
19.5	-0.05	33.5	+0.90
20.0	0.00	34.0	+0.95
20.5	+0.05	34.5	+1.00
21.0	+0.05	35.0	+1.05
21.5	+0.10	35.5	+1.10
22.0	+0.10	36.0	+1.10
22.5	+0.15	36.5	+1.15
23.0	+0.15	37.0	+1.20
23.5	+0.20	37.5	+1.25

[1] For hydrometers calibrated to 17.5°C, shift the values in this table by 2.5°C so that the zero correction factor corresponds to 17.5°C.

models, which can be read to the nearest 0.1 percent Brix, or more accurate table models are available. At present, neither instrument is approved for official tests.

Total (titratable) acid. The acid in citrus juices is principally citric acid. Smaller amounts of malic, tartaric, and succinic acids are also present. Twenty-five cubic centimeters of the same juice used for the Brix test are sampled by a pipette and drained into an Erlenmeyer flask. Three or four drops of phenolphthalein indicator solution are added. A burette is filled with a solution of 0.3125 N sodium hydroxide (standard alkali) and adjusted to the zero mark. Alkali is added slowly to the constantly agitated flask until the distinct pink (but not red) endpoint is reached. Titration may be carried out with one of three methods:

1. With a special "direct reading" burette, acid is read to the nearest 0.01 percent on the burette.
2. If an ordinary burette is used with 0.3125 N alkali, the quantity consumed must be converted to percent acid by means of Table 4.
3. Another method, which cannot be used for official tests, is titration with "direct reading alkali." In this case, each cubic centimeter of 0.4063 N sodium hydroxide in an ordinary burette corresponds to 0.1 percent citric acid. Titration with this stronger alkali does sacrifice a little accuracy, but it is rapid and requires neither a conversion table nor a special burette.

Although it is universally called "total acid," strictly speaking the amount of acid found by titration should be termed "titratable acid" since some additional acids, not ordinarily titratable, are present in juice. In maturity testing, acid found by titration is always expressed in terms of percent anhydrous citric acid.

Although low acid levels are usually desirable (except for lemons and limes), a minimum acid level of 0.40% is required for fresh fruit oranges to prevent shipping of insipid-tasting fruit late in the season.

Ratio of Brix to total % acid. The proportion of Brix to total % acid, or "ratio," is found by simple division, reference to a ratio book, or using the nomograph for ratio (Figure 2, p. 8).

There is a sliding scale for ratio requirements of oranges, grapefruit, Temples, tangerines, and tangelos. Fruit with higher Brix can have higher acid, or a

Table 4. Conversion of Standard (0.3125 N) Alkali Solution to Percent Anhydrous Citric Acid. (For Method 2 only; do not use with either Method 1 or Method 3. See "Total (titratable) Acid," above.)

Standard (0.3125 N) Alkali CC	Citric Acid Anh. Pct.	Standard (0.3125 N) Alkali CC	Citric Acid Anh. Pct.	Standard (0.3125 N) Alkali CC	Citric Acid Anh. Pct.
1.0	0.08	5.0	0.385	6.9	0.53
2.0	0.15	5.1	0.39	7.0	0.54
2.5	0.19	5.2	0.40	7.1	0.545
3.0	0.23	5.3	0.41	7.2	0.55
3.5	0.27	5.4	0.415	7.3	0.56
3.6	0.28	5.5	0.42	7.4	0.57
3.7	0.285	5.6	0.43	7.5	0.58
3.8	0.29	5.7	0.44	7.6	0.585
3.9	0.30	5.8	0.445	7.7	0.59
4.0	0.31	5.9	0.45	7.8	0.60
4.1	0.315	6.0	0.46	7.9	0.61
4.2	0.32	6.1	0.47	8.0	0.615
4.3	0.33	6.2	0.48	8.1	0.62
4.4	0.34	6.3	0.485	8.2	0.63
4.5	0.345	6.4	0.49	8.3	0.64
4.6	0.35	6.5	0.50	8.4	0.645
4.7	0.36	6.6	0.51	8.5	0.65
4.8	0.37	6.7	0.515	8.6	0.66
4.9	0.38	6.8	0.52	8.7	0.67

(Continued on next page)

(Table 4 continued)

Standard (0.3125 N) Alkali CC	Citric Acid Anh. Pct.	Standard (0.3125 N) Alkali CC	Citric Acid Anh. Pct.	Standard (0.3125 N) Alkali CC	Citric Acid Anh. Pct.
8.8	0.68	14.2	1.09	19.6	1.51
8.9	0.685	14.3	1.10	19.7	1.515
9.0	0.69	14.4	1.11	19.8	1.52
9.1	0.70	14.5	1.115	19.9	1.53
9.2	0.71	14.6	1.12	20.0	1.54
9.3	0.715	14.7	1.13	20.1	1.545
9.4	0.72	14.8	1.14	20.2	1.55
9.5	0.73	14.9	1.145	20.3	1.56
9.6	0.74	15.0	1.15	20.4	1.57
9.7	0.745	15.1	1.16	20.5	1.58
9.8	0.75	15.2	1.17	20.6	1.585
9.9	0.76	15.3	1.18	20.7	1.59
10.0	0.77	15.4	1.185	20.8	1.60
10.1	0.78	15.5	1.19	20.9	1.61
10.2	0.785	15.6	1.20	21.0	1.615
10.3	0.79	15.7	1.21	21.1	1.62
10.4	0.80	15.8	1.215	21.2	1.63
10.5	0.81	15.9	1.22	21.3	1.64
10.6	0.815	16.0	1.23	21.4	1.645
10.7	0.82	16.1	1.24	21.5	1.65
10.8	0.83	16.2	1.245	21.6	1.66
10.9	0.84	16.3	1.25	21.7	1.67
11.0	0.845	16.4	1.26	21.8	1.68
11.1	0.85	16.5	1.27	21.9	1.685
11.2	0.86	16.6	1.275	22.0	1.69
11.3	0.87	16.7	1.28	22.1	1.70
11.4	0.88	16.8	1.29	22.2	1.71
11.5	0.885	16.9	1.30	22.3	1.715
11.6	0.89	17.0	1.31	22.4	1.72
11.7	0.90	17.1	1.315	22.5	1.73
11.8	0.91	17.2	1.32	22.6	1.74
11.9	0.915	17.3	1.33	22.7	1.745
12.0	0.92	17.4	1.34	22.8	1.75
12.1	0.93	17.5	1.345	22.9	1.76
12.2	0.94	17.6	1.35	23.0	1.77
12.3	0.945	17.7	1.36	23.1	1.775
12.4	0.95	17.8	1.37	23.2	1.78
12.5	0.96	17.9	1.38	23.3	1.79
12.6	0.97	18.0	1.385	23.4	1.80
12.7	0.98	18.1	1.39	23.5	1.81
12.8	0.985	18.2	1.40	23.6	1.815
12.9	0.99	18.3	1.41	23.7	1.82
13.0	1.00	18.4	1.415	23.8	1.83
13.1	1.01	18.5	1.42	23.9	1.84
13.2	1.015	18.6	1.43	24.0	1.845
13.3	1.02	18.7	1.44	24.1	1.85
13.4	1.03	18.8	1.445	24.2	1.86
13.5	1.04	18.9	1.45	24.3	1.87
13.6	1.045	19.0	1.46	24.4	1.88
13.7	1.05	19.1	1.47	24.5	1.885
13.8	1.06	19.2	1.475	24.6	1.89
13.9	1.07	19.3	1.48	24.7	1.90
14.0	1.08	19.4	1.49	24.8	1.91
14.1	1.085	19.5	1.50	24.9	1.915

(Table 4 continued)

Standard (0.3125 N) Alkali CC	Citric Acid Anh. Pct.	Standard (0.3125 N) Alkali CC	Citric Acid Anh. Pct.	Standard (0.3125 N) Alkali CC	Citric Acid Anh. Pct.
25.0	1.92	27.5	2.115	30.0	2.31
25.1	1.93	27.6	2.12	30.1	2.315
25.2	1.94	27.7	2.13	30.2	2.32
25.3	1.945	27.8	2.14	30.3	2.33
25.4	1.95	27.9	2.145	30.4	2.34
25.5	1.96	28.0	2.15	30.5	2.345
25.6	1.97	28.1	2.16	30.6	2.35
25.7	1.98	28.2	2.17	30.7	2.36
25.8	1.985	28.3	2.175	30.8	2.37
25.9	1.99	28.4	2.18	30.9	2.375
26.0	2.00	28.5	2.19	31.0	2.38
26.1	2.01	28.6	2.20	31.1	2.39
26.2	2.015	28.7	2.21	31.2	2.40
26.3	2.02	28.8	2.215	31.3	2.41
26.4	2.03	28.9	2.22	31.4	2.415
26.5	2.04	29.0	2.23	31.5	2.42
26.6	2.045	29.1	2.24	31.6	2.43
26.7	2.05	29.2	2.245	31.7	2.44
26.8	2.06	29.3	2.25	31.8	2.445
26.9	2.07	29.4	2.26	31.9	2.45
27.0	2.075	29.5	2.27	32.0	2.46
27.1	2.08	29.6	2.28	32.1	2.47
27.2	2.09	29.7	2.285	32.2	2.48
27.3	2.10	29.8	2.29	32.3	2.485
27.4	2.11	29.9	2.30	32.4	2.49
				32.5	2.50

lower ratio, than one with lower Brix. The proportion of sugars to acid plays a large part in palatability; hence, when sugars are low, ratio requirements are increased so that acid is proportionately even lower. This makes the sugars more perceptible to the taster's palate. Note, however, that maturity requirements of most varieties also include a minimum ratio, which must be met regardless of the Brix content of the juice. There is no maximum ratio. However, the minimum acid requirement effectively sets an upper ratio limit of approximately 20:1 for late season oranges.

Pounds-solids

Each season, processors in Florida convert about 85 percent of the citrus crop into frozen concentrate, chilled juice, single-strength juice, sections, salads, blends, and other products. Fruit of the highest possible internal quality is desired for frozen concentrate since, in addition to having a better flavor and aroma, profitability rises rapidly as the values for juice volume, Brix, and ratio increase. Most processing plants buy their fruit for concentrate, chilled juice, etc., on the basis of pounds-solids. This is a good arrangement for the grower and processor alike because higher internal fruit quality is rewarded by a commensurate return. Today, the grower who sends fruit to the processor is no longer producing merely boxes of citrus but rather juice and pounds-solids per acre.

Pounds-solids is calculated as follows:

$$\text{Pounds-solids} = \text{Pounds of juice per box} \times \frac{\text{Brix}}{100.}$$

For example, if a box of oranges contained 45.0 pounds of juice and the Brix was 10.0 percent, the pounds-solids per box would be

$$45.0 \times \frac{10.0}{100} = 4.50.$$

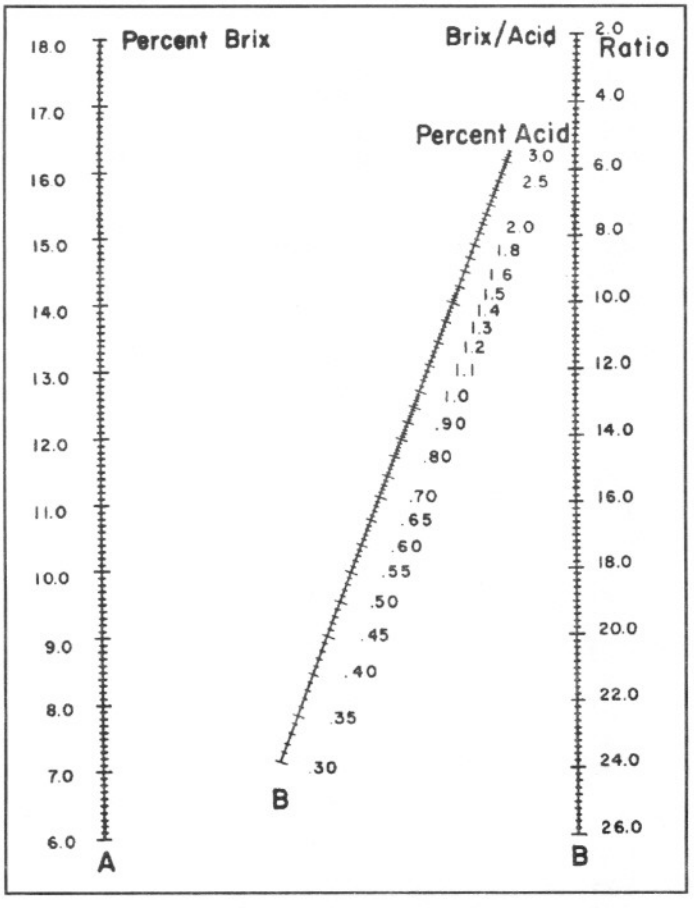


Figure 2. Conversion of Brix and percent acid to Brix-acid ratio.

Application of Quality (Maturity) Requirements

Minimum acceptable quality requirements prescribed in the various laws, standards for grade, and lime marketing agreement apply throughout the year. Tests may be made at any time after the fruit is harvested, except in cases where violation of arsenic provisions of the Florida Citrus Code, as amended, is suspected. Samples then may be taken from the trees. *(Use of arsenic in any form on bearing citrus trees is illegal and renders the fruit liable to seizure.)*

The laws, standards for grade, and lime marketing agreement have been amended numerous times. For this reason, the legal requirements for each type of fruit are not included with this bulletin. These minimum quality requirements for oranges, grapefruit, tangerines, Temples, and tangelos may be obtained from the Florida Division of Fruit and Vegetables, P.O. Box 1072, Winter Haven, Fla. 33882-1072, telephone (941) 291-5820; the Appendix contains the quality requirements for lemons and limes.

Requirements for quality are based on color break, juice content, Brix, % acid, and Brix-to-acid ratio, but not all of these are applied to every type of fruit. Factors that apply to fresh fruit are summarized in Table 5, and to cannery fruit, in Table 6. Information is current as of August 1, 1995.

Check Current Requirements

Requirements for quality, standards for grade, and marketing agreements are constantly being revised. Check with the Division of Fruit and Vegetables to be sure that the standards you are using are up to date. The Division of Fruit and Vegetables supplies a wall chart with the current standards.

Representative Samples: When, How, and Where to Harvest Test Fruit

Sampling

At the beginning of the crop season, no fruit should be harvested without first checking maturity. A test for maturity is no more accurate than the sample that it is taken from, a group of trees or lot of fruit. To be useful, a sample must be *representative*, that is, it must represent as nearly as possible actual conditions of the fruit on the trees or throughout the lot brought to the packinghouse or cannery.

Some years ago, all of the fruit on a large, heavily laden Valencia orange tree at the Citrus Research and Education Center, Lake Alfred, Florida, were picked and tested individually. Findings are summarized in Table 7.

This study showed that fruits on the south side of the tree were higher in Brix and had a higher Brix-to-acid ratio than those on the north side of the tree. There was an increase in Brix and Brix-to-acid ratio as fruits were picked from successively greater heights. Fruits on the outside portion of the tree were brighter in color and higher in Brix and Brix-to-acid ratio than those partially shaded, in the canopy, or fully shaded near the trunk. Fruits in the top of the tree, whether in full sunshine or partially shaded, were more brightly colored and higher in Brix and Brix-to-acid ratio than either outside or canopy fruits. Titratable acidity (total acid) tended to be lowest in fruits from

Table 5. Factors Used in Minimum Quality Requirements for Florida Fresh Citrus Fruit, as of August 1, 1995.

Fruit	Color Break	Juice Content	Brix	Acid	Brix/Acid Ratio	
					Required[1]	Minimum
Oranges	Yes	Yes[2]	Yes	Yes	Yes	Yes
Grapefruit	Yes	Yes[3]	Yes[4]	No	Yes	Yes
Tangerines	Yes	No	Yes	No[5]	Yes	Yes
Temples	Yes	No	Yes	Yes	Yes	Yes
Tangelos	Yes	No	Yes	Yes	Yes	Yes
Lemons[6]	No	Yes[7]	No	No	No	No
Limes[8]	No	Yes[7]	No	No	No	No

[1] For appropriate Brix.
[2] Gallons per 1 3/5 bushel box.
[3] Cubic centimeters per fruit.
[4] Separate standards for seeded, white seedless, and pink and red seedless varieties.
[5] Honey tangerines maximum acid 1.0% or minimum ratio of 12 to 1.
[6] No specific Florida standards; California standards are quoted in Appendix.
[7] Volume basis.
[8] Restrictions on size of fruit.

Table 6. Factors Used in Minimum Quality Requirements for Florida Processing Fruit, as of August 1, 1995.[1]

Fruit	Color Break	Juice Content	Brix	Acid	Brix/Acid Ratio	
					Required[2]	Minimum
Oranges[3]	No	No	Yes	No	Yes	Yes
Grapefruit[3]	No	No	Yes	No	No	Yes
Tangerines[3]	No[4]	No	Yes	No	Yes	Yes
Temples[3]	No	No	Yes	No	Yes	Yes
Tangelos[3]	No	No	No	No	No	Yes
Lemons	No	No	No	No	No	No
Limes	No	No	No	No	No	No

[1] December 1 through July 31, unless noted otherwise.
[2] Required ratio applies until January 1.
[3] From August 1 through November 30, processing fruit must meet fresh fruit standards (Table 5).
[4] No color break requirement after November 15.

the northeast side of the tree and to increase in inside fruits picked from successively greater heights. A systematic pattern was not encountered with juice content, although large, coarse textured, poorly colored inside fruit tended to have less juice. A sample taken from the outside on all sides at a height of 3 to 6 feet was representative of the entire tree, which is the reason that field samples are collected at this height.

Citrus is harvested in two ways, spot picking when only certain fruit or portions of a tree are taken and clean picking when all of the fruit are picked. Early in the season, some varieties may be spot picked for size, color, or maturity to obtain higher prices for the fruit. Specialty fruits, such as tangerines, Temples, and varieties for the gift trade are best spot picked if suitable labor is available. Oranges, grapefruit, and other varieties going to a cannery or when fully mature are clean picked as a rule.

No fruit should be harvested for the early fresh fruit market without first checking that it will degreen in 72 hours or less. Early fruit (before processing plants open) that will not degreen is worthless.

Spot Picking

Spot picking involves selection of certain fruit from the trees; hence, samples should be harvested with the knowledge that fruit from the top outside and outside portions, especially on the south and

Table 7. Effect of Position on the Tree on Various Quality Factors in Valencia Oranges.[1]

Quality Factor	Light Classes[2]	Height on Tree	Direction of Exposure	Rind Color
Total soluble solids (Brix)	Highest in outside fruit. Lowest in inside fruit. Canopy fruit almost identical with average for all fruit.	Strong tendency to increase with height of tree.	Highest in SW quadrant. Lowest in NE quadrant.	Very strong tendency; green—lowest solids; breaking—medium solids; orange—highest solids.
Titratable acidity (Acid)	Very variable. No well defined trend.	Inside fruit tends to increase in acid with height on tree. For other fruit, no correlation with height.	Acid tends to be low in NE quadrant.	Slight tendency to be lowest in green fruit and higher in orange fruit.
Brix/Acid ratio	Strong tendency to be higher in outside fruit.	Increases with height on tree.	Lowest in NE	No correlation quadrant.
Juice volume	Inside and top lower than the average.	No correlation.	No correlation.	No correlation.

[1] Adapted from J.W. Sites and H.J. Reitz, *Proc. Amer. Soc. Hort. Sci.* 54:1-10; 55:73-80; 56:103-110, 1949, 1950.
[2] Outside—exposed, clearly visible fruit.
Canopy—fruit embedded in the leafy canopy.
Inside—fruit borne among the inner, largely leafless, main limbs.

southwest sides, will be the most brightly colored and have the higher Brix and Brix-to-acid ratio. Fruit from the canopy or inside portions will be less well colored and lower in Brix and Brix-to-acid ratio than the average for the entire tree. Enough samples should be taken to insure that variations within a grove are included. Twenty to 50 fruit properly chosen will be more representative than several times that number casually picked without regard for location on the trees.

Systematic sampling will help to take the guesswork out of when to harvest. Where clean picking is contemplated or when checking the development of internal quality is the objective, samples of outside fruit taken from all sides of the trees at a height of 3 to 6 feet from the ground should be representative of the entire crop. When maturity is marginal, and any error may mean that the picked fruit must be destroyed, it is wise to "weight" the sample by deliberately picking low and reaching into the leafy canopy to obtain a maturity test sample. A number of samples representative of the block should be taken from the trees, taking into consideration variety, rootstock, soil, drainage, cultural factors, and size of fruit.

Facilities and Equipment

Field Tests

Facilities and equipment required for maturity testing by the grower and picking crew depend largely upon the extent of their operation and their need or desire to have results for minimum quality tests (see Figure 3A). Growers with large holdings generally have access to fruit testing facilities at the packinghouses and processing plants (see Figures 3C and 3D) where they normally deliver their fruit. Several of the large picking and hauling organizations have their own testing facilities. For growers and picking crews who have need for, and interest in, making occasional fruit quality tests, the equipment listed in Table 8 for oranges, grapefruit, tangerines, Temples, and tangelos or in Table 9 for lemons and limes would be the minimum required. A simple, unofficial field test kit using a refractometer and acid titration became available in 1995. This field kit was designed for growers to estimate maturity before taking samples in for official testing.

Packinghouse Tests

Official Rules of the Florida Department of Citrus stipulate that each packinghouse shall provide a suitable place for official minimum quality (maturity) tests. Each shipment of fruit must be tested and certified by an inspector of the Fruit and Vegetables Division, Florida Department of Agriculture. The testing place consists of a small, laboratory-type room, conveniently located to the receiving area, with a sink, running water, drain, counter, cabinet space, power outlets, and desk space, where the inspector can comfortably carry out maturity tests. The room must be well lighted, heated in the winter, well ventilated in the summer, and screened against flying insects. Equipment and chemicals used by the inspector are furnished by the Fruit and Vegetables Division.

Packinghouses wishing to make their own unofficial minimum quality tests need similar facilities. Equipment, indicator solution, and standard alkali listed in Tables 8 and 9 may be purchased from citrus supply houses.

The official juice extraction equipment for Florida citrus packinghouses shipping more than 200,000 $^{4}/_{5}$-bushel containers of fruit per season is an Automatic Machinery Corp. Model 2700 fresh citrus juice extractor (Figure 4) or its equivalent. Smaller volume packinghouses may use a reamer with two burrs, the larger for grapefruit and the smaller for other types. The reamer is turned by hand or motor, provided the burr speed does not exceed 400 rpm. Reamers operated at more than 400 rpm introduce so much air into the juice that it should be de-aerated before attempting to obtain a Brix reading. For many years, it was the custom to strain juice through fine mesh cheesecloth to remove juice sacs, seeds, rag, and other solid materials that would clog the fine tip of the pipette used to draw juice samples and create a

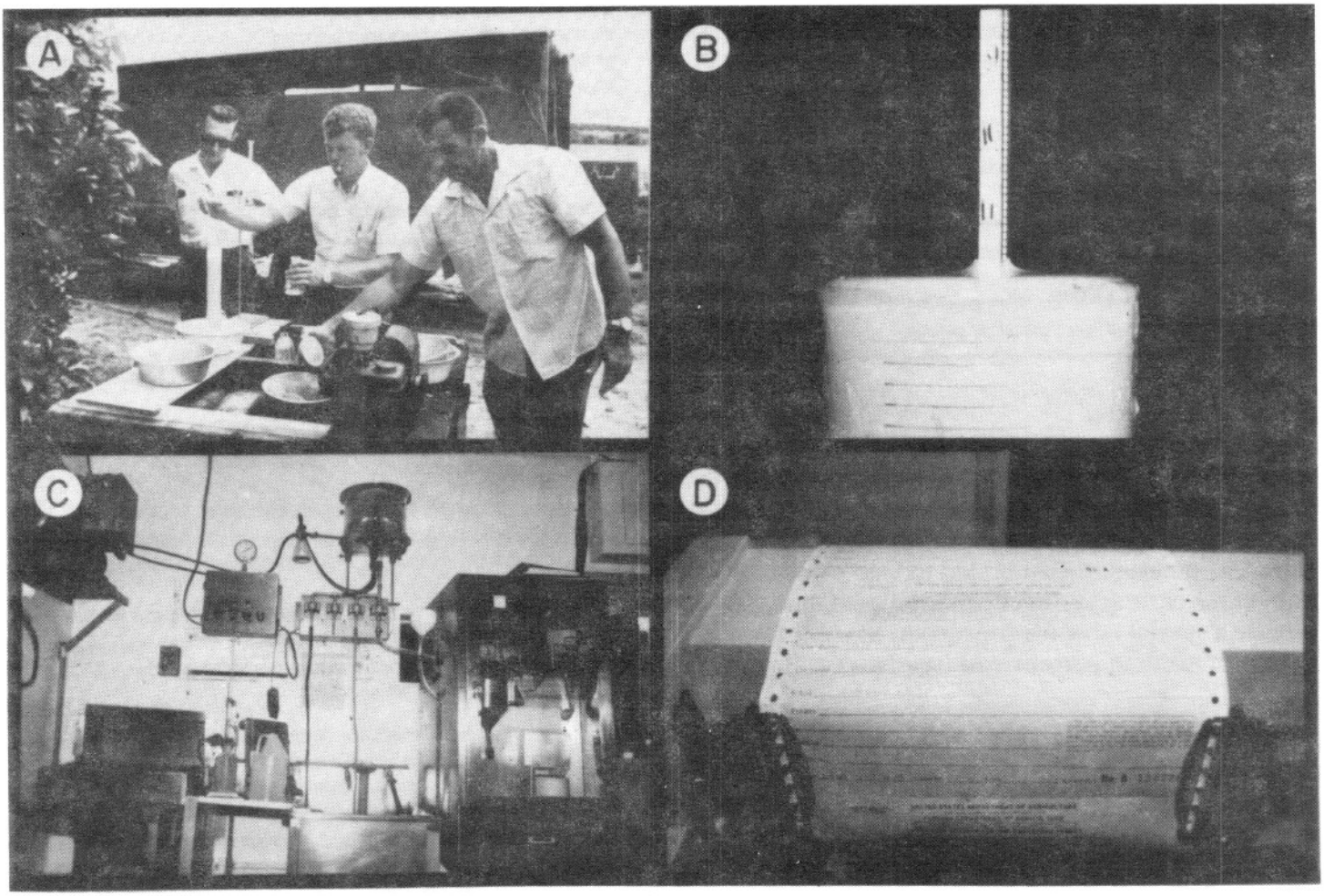


Figure 3. Citrus quality testing. (A) Testing in the field, (B) Brix hydrometer in juice reading 11.7, (C) State test laboratory in a citrus plant, (D) Automatic printer of test data.

Table 8. Equipment for Minimum Quality (Maturity) Tests of Oranges, Grapefruit, Tangerines, Temples, and Tangelos.

Hand reamer, with orange and grapefruit burrs or prescribed automatic extractor for large packing houses (See Figure 4)[1]
Cheesecloth, #60 or #80 mesh; colander; or strainer
Pans (2)—0.5 gal. (1.9 liter), metal or plastic, round
Graduated cylinder—400 or 500 cc, with smooth lip
Graduated cylinder—1000 cc, with pouring lip
Hydrometer—scaled from 5 to 15 °Brix in 0.1 ° divisions
Thermometer—centigrade—scaled from 0 to 50 ° in 0.1 ° divisions
Erlenmeyer flasks (2)—125 cc
Burette, direct reading—calibrated to read percent anhydrous citric acid, scaled in 0.01 percent divisions, capacity 2.85 percent
Pipette—25 cc
Burette stand
Funnel, small
Official fruit caliper
Medicine dropper and dropping bottle
Maturity chart (from Florida Division of Fruit and Vegetables)
Juice chart for oranges (See Table 1)
Standard sodium hydroxide solution (0.3125 N)
Phenolphthalein indicator solution

[1] Houses shipping more than 200,000 4/5 bu. equivalent must use mechanical extractor (Automatic Machinery Corp. Model 2700 Serial 2702 or its equivalent).

Table 9. Equipment for Minimum Quality (Maturity) Tests of Lemons and Limes.

Juice extractor, Hamilton Beach No. 32 or equivalent
Cylinder for fruit volume (See Figure 1)
Graduated cylinder, 1000 cc, with pouring lip
Pans (2), 0.5 gal. (1.9 liter) metal or plastic

problem with the Brix hydrometer reaching its proper level. Now a colander or dipper-type strainer is used to eliminate large particles from the juice. A special pipette with a large bore is used to draw acid samples. Burettes not calibrated to read percent anhydrous citric acid directly may be used, but they require a special table for conversion of cubic centimeters of alkali to percent acid (see Table 4).

Processing Tests

All fruit going to a processor to be processed into frozen concentrate, chilled juice, single-strength juice, and other products must be inspected for minimum internal quality. In addition to the regular tests required by law, the Fruit and Vegetables Division also certifies certain additional information with respect to juice yield, Brix, and pounds of solids per box on every lot of fruit. Facilities and equipment for testing of processing fruit, additional to those mentioned above for packinghouses, are listed in Table 10.

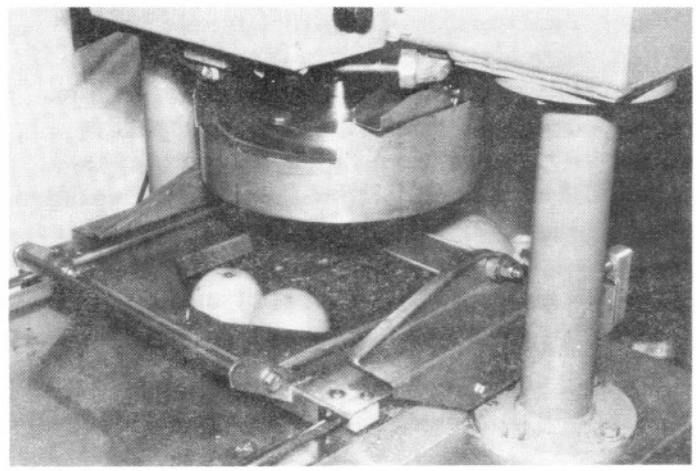


Figure 4. Official juice extraction equipment for Florida citrus packinghouses shipping more than 200,000 4/5 bushel containers of fruit per season: Automatic Machinery Corp. Model 2700 fresh citrus juice extractor. Smaller volume packinghouses may use this or less complex equipment.

Table 10. Equipment for Processing Fruit Quality Tests.

Equipment listed in Table 8 (except hand reamer or extractor) plus:
A. Items furnished by processor Truck scale—platform, capacity 73,222 lb. Mechanical sampler—Kinsey type Extractor—FMC Model 091 B Scale—60 or 75 lb. capacity, with 1 oz. or 0.05 lb. graduations
B. Items furnished by Fruit and Vegetables Division Sample baskets, wire gauge—60 lb. capacity Juice buckets—plastic with bail and pouring spout, 5 gal. capacity Juice aspirator flask—8 in. diameter, round bottom, long neck (2 in. diameter) Water aspirator or vacuum pump to produce 25 in. vacuum in 30 seconds
C. Alternate equipment for semiautomatic determination of the quality factors is now available through contractual arrangements with the Toledo Scale Company. Load cell type scales, Brix by specific gravity instrumentation, and automatic titration, all tied into a computer and printer are in use on a voluntary basis at several processing plants. All larger plants are involved in this program. Some of this equipment is shown in Figure 3.

Evaluation of Maturity: Making a Test for Internal Quality

Fresh Fruit

Samples for official tests may be drawn from a lot any time after the fruit is picked and before it is shipped. Testing of an individual fruit rather than a composite sample is permitted. Fruit of a specified size is used unless only the ratio is being checked. Composite samples are drawn from the largest, the smallest, and one or more intermediate packable sizes of fruit in a lot. If any of the samples fail to pass, at least two additional samples may be drawn. If the average of the three tests still falls below the minimum requirements, that size of fruit or the lot is considered immature and is liable for seizure. Drawing of samples and tests subsequent to the first sample may be witnessed by the owner or manager of the packinghouse, but official tests must be run without interference of any sort.

Between August 1 and October 15, immediately upon arrival of fruit, a packinghouse composite sample of unsized fruit will be tested. If the ratio fails the minimum requirement by more than 0.5 point, two additional samples shall be tested. If the average of the three composite samples fails the minimum requirements by more than 0.5 point, the fruit shall be condemned and destroyed. Mixing of varieties or lots of fruit for the purpose of securing a lot that will pass minimum quality requirements is prohibited.

Processing Fruit

From August 1 through November 30, all oranges, grapefruit, tangerines, Temples, and tangelos for processing must meet fresh fruit requirements, unless otherwise noted. From December 1 through July 31, there are no requirements for color break, juice content, or minimum acid.

All Florida citrus processors avail themselves of the service provided by the Fruit and Vegetables Division. Facilities and equipment are considerably more complex than those required for the packinghouse. Both the number of tests run and the desired accuracy require high speed and complicated machinery. The selection of the sample, for example, must be completely mechanical, with a minimum bias so as to assure a representative sample. The size of the sample should be the same regardless of the size of the load or the rate of unloading. A universal sampler, as noted below, was developed for this purpose. To discourage tampering with the sample selection, all troughs, chutes, conveyors, and belts used for collecting and transporting samples must be enclosed or covered with wire to make the sample inaccessible except at point of delivery.

The first requirement for state inspection of processing fruit is a sampler that will mechanically select a representative sample of approximately 50 pounds from each load of fruit received and deliver this sample to the inspector in the test room in a condition for further analysis.

Average unloading time is not more than 10 minutes at most processors. The number of unloading positions is generally two or more. It is thus necessary to be able to make a complete analysis approximately every five minutes. To accomplish this, something faster than a hand reamer for extracting juice is necessary. A modified commercial extractor, the FMC Corp. 091B, is used for this purpose.

Under the Citrus Code, the determination of minimum quality and wholesomeness are required; however, the Fruit and Vegetables Division, as an impartial agency, also furnishes information on pounds-solids for each lot. Weight of fruit is very important for yield control purposes in this determination, so computer recorded scales are generally used for all fruit and juice sample weighings.

Yield of juice is affected by a large number of factors, among them variety, rootstock, soil type, cultural practices, and temperature. Tables for determining pounds of juice per box for oranges, grapefruit, and tangerines are available from the Florida Division of Fruit and Vegetables. Juice yield factors for grapefruit (Table 11) used to determine pounds juice and pounds-solids per box are promulgated by the Florida Citrus Commission under the authority of the Florida Citrus Code Chapter 601.10.

The juice is strained in the extraction operation to exclude unwanted pulp, seeds, and juice sacs. Great care is taken by inspection personnel to maintain uniformity of juice extraction within a processing plant and between processors. The variation in juice yield of carefully drawn samples extracted with machines in proper adjustment is approximately plus or minus 1.0 percent. The normal tolerance for a Brix determination would be plus or minus 0.1 degree

before the temperature correction. The effect on pounds-solids would be as follows:

1. Actual yield is 51% = 45.9 lb. juice per box.
2. If the true Brix is 10°,

   then $\frac{10^{\circ}\text{Brix}}{100}$ X 45.0 lb. juice = 4.5000 lb. solids per box.
3. But the Brix measured is 10.1°,

   thus $\frac{10.1^{\circ}\text{Brix}}{100}$ X 45.9 lb. juice = 4.6359 lb. solids per box.
4. The difference would be 4.6359 - 4.5000 = 0.1359 lb.
5. If the pounds-solids price is $0.50 per pound, this difference becomes 0.1359 X $0.50 = $0.06795 per box, or $27.18 for a 400 box load.

This example shows clearly the importance of minimizing minor errors in the measurement of Brix determinations.

Quantity of juice per box can be expressed either as weight (pounds) or volume (gallons). Although gallons/box is a valuable measure of fruit maturity, as a standard for cannery payments it is inappropriate because it measures water, rather than "solids." Weight of juice extracted varies with Brix (percentage of soluble solids present) as shown in Table 12. The yield of juice per standard box is therefore commonly calculated as follows:

1. Weight of fruit sample (oranges) = 50.0 lb.
2. Weight of juice = 25.0 lb.
3. Pounds (yield) of juice per box =

$$\frac{\text{weight of juice X weight of std. box}}{\text{weight of fruit sample}}$$

$$\text{E.g.,}\ \frac{25.0 \text{ X } 90}{50.0} = 45.0 \text{ lb./box.}$$

   Note: For tangerines use 95 lb. as the weight of a standard box.
4. To obtain the gallons of juice per box (which is used as a maturity standard) divide, by the weight per gallon (from Table 12). Presuming that this juice has 12° Brix (= 12% soluble solids), then one gallon weighs 8.724 lb.; hence,

$$\frac{45 \text{ lb. juice/box}}{8.724 \text{ lb./gal.}} = 5.16 \text{ gal./box.}$$

Table 11. Variable Grapefruit Yield Factors for the 1995-96 Season.[1]

Load Date	% Factor	Calculating Factor[2]
Sep 01 - Dec 31	89	75.65
Jan 01 - Feb 14	91	77.35
Feb 15 - Feb 29	90	76.50
Mar 01 - Mar 14	89	75.65
Mar 15 - Apr 30	88	74.80
May 01 - Aug 31	85	72.25

[1] From: Official Rules Affecting the Florida Citrus Industry Pursuant to Chapter 601, Florida Statutes. Part III, 20-61.071 and 20-61.072.

[2] Calculating Factor is the % Factor times the weight of a Florida field box of grapefruit (85 lbs.).

5. But canneries usually pay for "pounds solids." At 12° Brix and 45 lb. juice/box (from no. 3. above), each box of oranges contains

$$\frac{45 \text{ X } 12}{100} = 5.4 \text{ "pounds-solids" per box.}$$

In commercial practice, there is always a discrepancy between the juice extracted by the small test-room extractors and the large high-volume extractors in the canneries. For this reason and using experience gathered over the years, the Florida Citrus Commission has adopted a 100% yield factor for oranges and tangerines. The Official Rules carefully state, "The pounds solids determination made under this rule may be used whenever the seller and buyer mutually agree, as the trading unit for the oranges/grapefruit being sold" (Rules 20-61.071 para (2) and 20-61.072 para (2)). In actual practice, these yield factors are universally accepted within the Florida citrus industry.

Variable citrus yield factors are used to calculate the pounds of juice per box (Table 11). The factors for oranges and tangerines are constant, while that for grapefruit varies with the date the load is delivered to the processor. The % Factor times the weight of a standard Florida field box of grapefruit (85 lbs.) equals a Calculating Factor.

$$\frac{\text{weight of juice}}{\text{weight of sample}} \text{ X calc. factor = lbs. juice per box}$$

E.g., for grapefruit in late February, the calculating factor is 76.50 (Table 11).

$$\frac{25.0 \text{ X } 76.50}{50.0} = 38.25 \text{ lbs. juice per box}$$

Certification[2]

Fresh Fruit

Each shipment of packed fresh fruit from a packinghouse must be accompanied by a certificate of inspection for maturity and grade. The certificate shows the date, location, packinghouse registration number, car or truck identification, time when inspection was made, destination, kind and type of fruit, whether color-added, number of packages, type and size of containers, size of fruit, label, grade, where samples were taken, and number of equivalent standard boxes, for the collection of revenue fees. Two copies of the certificate go to the Fruit and Vegetables Division office in Winter Haven; one is given to the truck driver, one is given to the shipper, and one is retained by the inspector. Inspection and certification insures that only mature, wholesome fruit is shipped within or out of the state.

Processing Fruit

Each lot of fruit received by a processor must be inspected and certified before it can be processed. The processing certificate of inspection shows information on internal quality as well as maturity: pounds of juice per box, Brix, total acid, Brix-to-acid ratio, and pounds-solids per box. Thus, in addition to the mandatory requirements for minimum quality, the Fruit and Vegetables Division customarily supplies each processor with the information necessary for pounds-solids evaluation. Copies of the inspection certificate go to the processor, Fruit and Vegetables Division, and the supplier or grower.

Evaluation of Fruit: What Is Your Fruit Worth?

Fresh Fruit

Fresh fruit is usually sold on a box basis. The buyer and seller agree on terms such as on delivery to the packinghouse, on the tree, by contract, on consignment, or by other arrangement. The grower generally receives a price depending on the buyer's estimate of what proportion he can pack. Since fruit graded out for surface blemishes goes to the

Table 12. USDA Sucrose Solution Conversion Table.

% Sucrose or °Brix	Wt. as lbs./gal in Air at 20°C	% Sucrose or °Brix	Wt. as lbs./gal in Air at 20°C
6.5	8.536	11.3	8.700
6.6	8.539	11.4	8.703
6.7	8.542	11.5	8.707
6.8	8.546	11.6	8.710
6.9	8.549	11.7	8.714
7.0	8.552	11.8	8.717
7.1	8.556	11.9	8.721
7.2	8.559	12.0	8.724
7.3	8.563	12.1	8.728
7.4	8.566	12.2	8.731
7.5	8.569	12.3	8.735
7.6	8.573	12.4	8.738
7.7	8.576	12.5	8.742
7.8	8.580	12.6	8.745
7.9	8.583	12.7	8.749
8.0	8.586	12.8	8.752
8.1	8.590	12.9	8.756
8.2	8.593	13.0	8.759
8.3	8.597	13.1	8.763
8.4	8.600	13.2	8.766
8.5	8.603	13.3	8.770
8.6	8.607	13.4	8.773
8.7	8.610	13.5	8.777
8.8	8.614	13.6	8.781
8.9	8.617	13.7	8.784
9.0	8.620	13.8	8.788
9.1	8.624	13.9	8.791
9.2	8.627	14.0	8.795
9.3	8.631	14.1	8.798
9.4	8.634	14.2	8.802
9.5	8.638	14.3	8.805
9.6	8.641	14.4	8.809
9.7	8.644	14.5	8.812
9.8	8.648	14.6	8.816
9.9	8.651	14.7	8.820
10.0	8.655	14.8	8.823
10.1	8.658	14.9	8.827
10.2	8.662	15.0	8.830
10.3	8.665	15.1	8.834
10.4	8.669	15.2	8.837
10.5	8.672	15.3	8.841
10.6	8.675	15.4	8.845
10.7	8.679	15.5	8.848
10.8	8.682	15.6	8.852
10.9	8.686	15.7	8.855
11.0	8.689	15.8	8.859
11.1	8.693	15.9	8.863
11.2	8.696	16.0	8.866

[2] These brief comments barely touch on the important legal implications of certification. For full information, see, Citrus Fruit Laws, Chap. 601, Florida Statutes 601.49 through 601.52, and Official Rules Affecting the Florida Citrus Industry, Chap. 20-2 *in toto*.

processor as "eliminations, pounds of juice or pounds-solids sales still contribute to the value of the crop, though to a lesser extent than with crops that go directly to the processor.

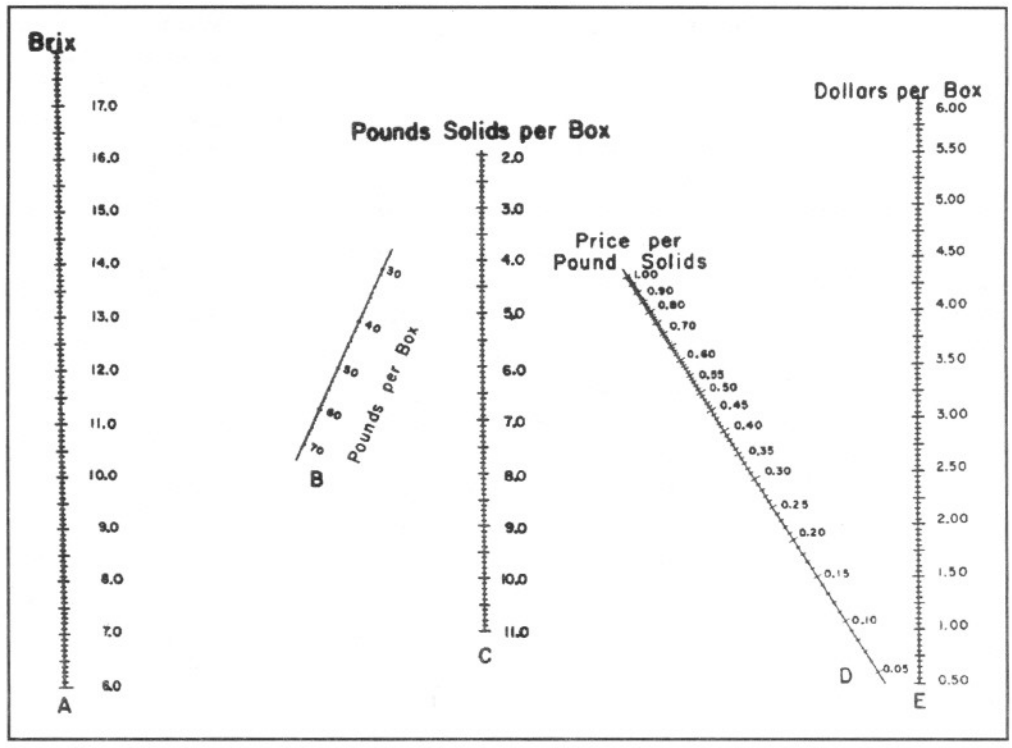


Figure 5. Conversion of Brix and pounds of juice per box into pounds of solids per box and price per box of oranges.

Processing Fruit

Inspection of a representative sample insures that only wholesome citrus fruit that meet legal requirements for minimum quality are processed. At the same time, the information provided by the tests is utilized by the cannery to determine whether the fruit is suitable for concentration purposes, how the load should be blended with other oranges as they are processed in order to maintain a uniform product, and finally, the basis upon which payment to the seller shall be made.

Processing fruit may be sold in two ways, pounds-solids or pounds of juice per box. Both afford the grower a return commensurate with the internal fruit quality. In the case of pounds-solids, the price is calculated by multiplying the total pounds-solids by the price per pounds-solids, as shown in the following example:

1. Pounds-solids per box: 5.4 lb.
2. Price per pound of solids: $0.90
3. Price per box = 5.4 x 0.90 = $4.86

Similarly, the price, based on pounds of juice per box, is computed by multiplying pounds of juice by the price per pound, as shown in the following example:

1. Pounds of juice per box: 45.0 lb.
2. Price per pound of juice: $0.10
3. Price per box (pounds juice basis): 45 X 0.10 = $4.50

The nomographs (Figures 5 and 6) can be used to obtain price per box for pounds-solids and pounds of juice, respectively.

With today's buying and selling of fruit in bulk loads, it is no longer necessary to go through the stage of calculating a price per box, though that is commonly done. Once the juice yield and percent solids are known, a price can be calculated per trailer load, or any other convenient unit.

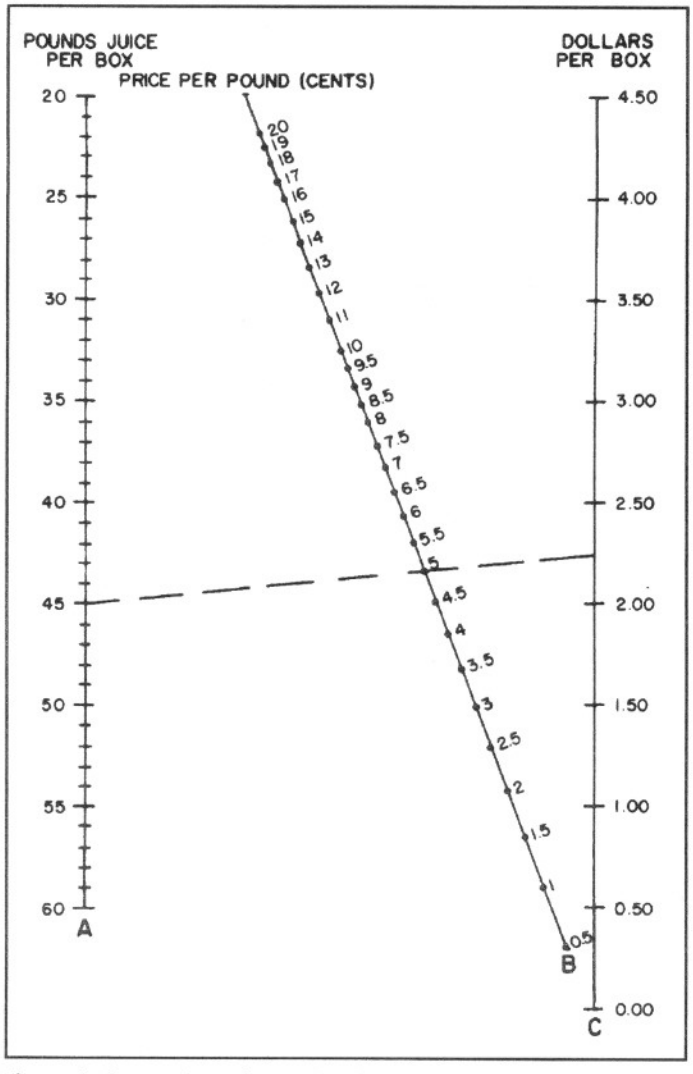


Figure 6. Conversion of pounds of juice per box into price per box.

Appendix. Quality (Maturity) Standards

A current copy of standards for oranges, grapefruit, tangerines, Honey tangerines, tangelos, and Temples may be obtained from the Florida Division of Fruit and Vegetables, P.O. Box 1072, Winter Haven, Fla. 33882-1072, telephone (941) 291-5820.

Standards for Lemons and Limes as of June 30, 1966

Lemons[1]	
Sample:	10 fruit
Juice Content:	30% by volume for U.S. No. 1, U.S. Combination, and U.S. No. 2; 28% by volume for export grades. (Sec. 51.2801, U.S. grade standards for lemons. Effective Sept. 1, 1964.)
Limes[2]	
Persian (Tahiti, Bearss, Pond, Idemor) Type	
Sample:	10 fruit
Juice Content:[3]	42% by volume
Size:	1 7/8 inches (4.76 cm) in diameter

Variations in these requirements have occurred from time to time over a period of years.

Key (Mexican, West Indian) Type	
Sample:	10 fruit
Juice Content[3]	42% by volume
Size:	None

[1] No specific Florida standards; California standards are quoted.

[2] Standards listed are under the Lime Marketing Agreement, Federal Marketing Order No. 911.

[3] If a Federal Marketing Order is not in force, limes must contain an average of 42% juice by volume, with no fruit having less than 38% (Sec. 603.152, Florida Statutes).

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF FLORIDA, INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES, Christine Taylor Stephens, Director, in cooperation with the United States Department of Agriculture, publishes this information to further the purpose of the May 8 and June 30, 1914 Acts of Congress; and is authorized to provide research, educational information and other services only to individuals and institutions that function without regard to race, color, age, sex, handicap or national origin. The information in this publication is available in alternate formats. Information on copies for purchase is available from C.M. Hinton, Publications Distribution Center, University of Florida, PO Box 110011, Gainesville, FL 32611-0011. Information about alternate formats is available from Educational Media and Services, University of Florida, PO Box 110810, Gainesville, FL 32611-0810. This is a revision of Extension Circulars 184 and 191 by James Soule and F. P. Lawrence; Circular 315 by J. Soule, W. Grierson and J.G. Blair; and Bulletin 188 by W. Wardowski, J. Soule, W. Grierson and G. Westbrook. This information was published October 1991 as SP 99, Florida Cooperative Extension Service. Revised October 1995.