UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

August 14, 2007

MEMORANDUM

SUBJECT: Crop Grouping – Part V: Analysis of the USDA IR-4 Petition to Amend the Crop Group Regulation 40 CFR § 180.41 (c) (10) and Commodity Definitions [40 CFR 180.1 (g)] Related to the Crop Group 10 Citrus. MRID 468340-01.

FROM: Bernard A. Schneider, Ph.D., Senior Plant Physiologist
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Health Effects Division (7509P)

THRU: William Donovan, Ph.D. and Michael Doherty, Ph.D., Chairpersons
HED Chemistry Science Advisory Council (ChemSAC)
Health Effects Division (7509P)

TO: Barbara Madden, Minor Use Officer
Risk Integration, Minor Use, and Emergency Response Branch (RIMUERB)
Registration Division (7505P)

cc: IR-4 Project, Hong Chen, Jerry Baron, Dan Kunkel, Van Starner

REQUEST:

Dr Hong Chen, Crop Grouping Project Coordinator, USDA Interregional Research Project No. 4 (IR-4), State Agricultural Experiment Station, Rutgers University has submitted a petition (May 11, 2006) on behalf of the IR-4 Project, and the Citrus

Fruits Workgroup of the International Crop Grouping Consulting Committee (ICGCC) to amend the Crop Group Regulation 40 CFR § 180.41 (c) (10) Crop Group 10, Citrus Fruits Group, and Commodity Definitions 40 CFR 180.1 (h) for citrus fruits and tangerines.

The above mentioned Citrus crop group petition requested the following five amendments:

1. Amend the name of the crop group in 40 CFR 180.41 (c) (13) from "Crop Group 10, Citrus Fruits Group (Citrus spp., Fortunella spp.)", to "Crop Group 10, Citrus Fruits Group".

2. Amend the existing crop group in 40 CFR 180.41 (c) (10) that consists of the following 12 commodity entries:

1. Calamondin, *Citrus mitis* x *Citrofortunella mitts*
2. Citrus citron, *Citrus medica*
3. Citrus hybrids, *Citrus* spp.[includes chironja, tangelo, tangor]
4. Grapefruit, *Citrus paradisi*
5. Kumquat*, Fortunella* spp.
6. Lemon, *Citrus jambhiri, Citrus limon*
7. Lime, *Citrus aurantiifolia*
8. Mandarin (tangerine), *Citrus reticulata*
9. Orange, sour, *Citrus aurantium*
10. Orange, sweet, *Citrus sinensis*
11. Pummelo, *Citrus grandis*, *Citrus maxima*
12. Satsuma mandarin, *Citrus unshiu*

To an expanded crop group that consists of the following 27 commodity entries with updated scientific names:

1. Australian desert-lime, *Eremocitrus glauca* (Lindl.) Swingle
2. Australian finger-lime, *Microcitrus australasica* (F. Muell.) Swingle
3. Australian round-lime, *Microcitrus aust*ralis (A. Cunn. ex Mudie) Swingle
4. Brown River finger-lime, *Microcitrus papuana* Winters
5. Calamondin, *Citrus madurensis* Lour.
6. Citrus citron, *Citrus medica* L.
7. Citrus hybrids, *Citrus* spp., *Eremocitrus* spp., *Fortunella* spp., *Microcitrus* spp., and *Poncirus* spp.
8. Grapefruit, *Citrus x paradisi* Macfad.
9. Japanese summer grapefruit, *Citrus natsudaidai* Hayata
10. Kumquat, *Fortunella* spp.
11. Lemon, *Citrus limon* (L.) Burm. f.
12. Lime, *Citrus aurantiifolia* (Christm.) Swingle
13. Mediterranean Mandarin, *Citrus nobilis* Loureiro var. *deliciosa* Swingle
14. Mount White-lime, *Microcitrus garrowayae* (F. M. Bailey) Swingle
15. New Guinea wild lime, *Microcitrus warburgiana* (F. M. Bailey) Tanaka

16. Orange, sour, *Citrus aurantium* L.
17. Orange, sweet, *Citrus sinensis* (L.) Osbeck
18. Pummelo, *Citrus maxima* (Burm.) Merr.
19. Russell River-lime, *Microcitrus inodora* (F. M. Bailey) Swingle
20. Satsuma mandarin, *Citrus unshiu* Marcow.
21. Sweet lime, *Citrus limetta* Risso
22. Tachibana orange, *Citrus tachibana* (Makino) Tanaka
23. Tahiti Lime, *Citrus latifolia* Tan.
24. Tangelo, *Citrus x tangelo* J.W. Ingram & H.E. Moore
25. Tangerine (Mandarin), *Citrus reticulata* Blanco
26. Tangor, *Citrus reticulata* × *Citrus sinensis*
27. Trifoliate orange, *Poncirus trifoliata* (L.) Raf.

And varieties and/or hybrids of these

3. Amend the representative commodities from the current crop group which are sweet orange, lemon, and grapefruit to orange or tangerine/mandarin, lemon or lime, and grapefruit in the proposed expanded group:.

4. Establish the following three new subgroups under the Citrus fruit group as follows:

<u>Subgroup 10A: Orange Subgroup 10A (rep crops: Orange or tangerine/mandarin)</u>

1). Calamondin, *Citrus madurensis* Lour.
2). Citrus citron, *Citrus medica* L.
3). Citrus hybrids, *Citrus* spp., *Eremocitrus* spp., *Fortunella* spp., *Microcitrus* spp., and *Poncirus* spp.
4). Mediterranean Mandarin, *Citrus nobilis* Loureiro var. *deliciosa* Swingle
5). Orange, sour, *Citrus aurantium* L.
6). Orange, sweet, *Citrus sinensis* (L.) Osbeck
7). Satsuma mandarin, *Citrus unshiu* Marcow.
8). Tachibana orange, *Citrus tachibana* (Makino) Tanaka
9). Tangerine (Mandarin), *Citrus reticulata* Blanco
10). Tangor, *Citrus reticulata* × *Citrus sinensis*
11). Trifoliate orange, *Poncirus trifoliata* (L.) Raf.

And varieties and/or hybrids of these

<u>Subgroup 10B: Lemon/Lime Subgroup 10B (rep crop: Lemon or lime)</u>

1). Australian desert-lime, *Eremocitrus glauca* (Lindl.) Swingle
2). Australian finger-lime, *Microcitrus australasica* (F. Muell.) Swingle
3). Australian round-lime, *Microcitrus australis* (A. Cunn. ex Mudie) Swingle
4). Brown River finger lime, *Microcitrus papuana* Winters
5). Kumquat, *Fortunella* spp.
6). Lemon, *Citrus limon* (L.) Burm. f.
7). Lime, *Citrus aurantiifolia* (Christm.) Swingle
8). Mount White lime, *Microcitrus garrowayae* (F. M. Bailey) Swingle

9). New Guinea wild lime, *Microcitrus warburgiana* (F. M. Bailey) Tanaka
10. Russell River-lime, *Microcitrus inodora* (F. M. Bailey) Swingle
11).Sweet lime, *Citrus limetta* Risso
12). Tahiti Lime, *Citrus latifolia* Tan.
And varieties and/or hybrids of these

Subgroup 10C: Grapefruit Subgroup 10C (rep crop: Grapefruit)
1). Grapefruit, *Citrus x paradisi* Macfad.
2). Japanese summer grapefruit, *Citrus natsudaidai* Hayata
3). Pummelo, *Citrus maxima* (Burm.) Merr.
4). Tangelo, *Citrus x tangelo* J.W. Ingram & H.E. Moore
And varieties and/or hybrids of these

5. Delete the Citrus fruits Commodity Definition and revise the Tangerines Definition in 40 CFR 180.1 (g), and establish Commodity Definitions for Grapefruit, Lemon, Lime, and Orange as described below:

1). Grapefruit Definition: Tolerances and exemptions established for pesticide chemicals in or on Grapefruit apply to the following commodities: Grapefruit, Japanese summer grapefruit; Pummelo, Tangelo, and varieties and/or hybrids of these.

2). Lemon Definition: Tolerances and exemptions established for pesticide chemicals in or on Lemon apply to the following commodities: Australian desert-lime, Australian finger-lime, Australian round-lime, Brown River finger lime, Calamondin, Kumquats, Lemon, Lime, Mount White lime, New Guinea wild lime, Russell River-lime, Sweet lime, Tahiti Lime, and varieties and/or hybrids of these.

3). Lime Definition: Tolerances and exemptions established for pesticide chemicals in or on Lime apply to the following commodities: Australian desert-lime, Australian finger-lime, Australian round-lime, Brown River finger lime, Kumquats, Lemon, Lime, Mount White lime, New Guinea wild lime, Russell River lime, Sweet lime, Tahiti Lime, and varieties and/or hybrids of these.

4). Orange Definition: Tolerances and exemptions established for pesticide chemicals in or on Orange apply to the following commodities: Calamondin, Citrus citron, Mediterranean mandarin, Satsuma mandarin, Sour oranges, Sweet oranges, Tachibana orange, Tangerine (Mandarin), Tangor, Trifoliate orange, and varieties and/or hybrids of these.

5). Tangerines Definition: Tolerances and exemptions established for pesticide chemicals in or on Tangerine apply to the following commodities: Tangerines (Mandarins or Mandarin oranges), Mediterranean mandarin, Satsuma mandarin, and varieties and/or hybrids of these.

Each of these proposals will be reviewed in the following analysis:

BACKGROUND:

The current established Crop Group 10, Citrus fruits Group in 40 CFR 180.41 include 12 Citrus and Fortunella commodity entries in the botanical family of Rutaceae (40CFR40 Part 180.41(10), May 17, 1995. Three representative commodities for this group are sweet orange, lemon, and grapefruit. There are also two Crop Definitions in 40 CFR 180.1 (g), Citrus fruits and Tangerines, which include commodities and their hybrids within the Citrus Fruits Group.

The Citrus Fruits Group and the two crop definitions have been successful in establishing several tolerances on citrus fruits. Since this group was established in 1995, the world production of citrus fruits has increased. Based on FAO agriculture statistics, the total hectare for citrus fruits has increased by over one million hectares from 1995 to 7,605,363 in 2005 and the total production has increased from 93,799,450 Mt (metric ton) in 1995 to 105,431,984 Mt in 2005 as the world total (FAO 2005, see Table 5). Some "minor" citrus fruit commodities have also become more popular today than they were 10 years ago. There are several "orphan citrus crops" grown commercially, cultivated in small scale or harvested wild, and are sold and consumed in the U.S. and/or other regions or countries. Many of these are economically important, or have great potential to be grown in larger scale in the future due to their nutritional value and increased market demand. It is important to update this crop group to include commodities that recognized by growers, researchers and market experts. Without doubt the inclusion of these commodities in crop groups will benefit growers and consumers, save time and tax payer's money on residue studies, save time and money for government agencies to review residue data, and facilitate the establishment of import tolerances.

During the USDA/IR-4 Crop Grouping Symposium in Washington, DC, October 2002, the Oilseeds Workgroup, Chaired by IR-4 Coordinator Michael Braverman and Co-Chaired by Nancy Dodd, William Donovan, Maria Rodriquez, and Jonathan Crane, University of Florida and Edith Lurvey, IR-4 recommended adding over 20 citrus fruit commodities to the citrus fruit group. The recommendations from the Symposium was further discussed and developed within the Citrus Fruit Workgroup of the International Crop Grouping Consulting Committee (ICGCC), which consists of more than 200 U.S. and international crop or regulatory experts from agriculture commodity groups, universities, agrichemical industry, IR-4 Project, and regulatory agencies representing over 40 countries. Another important aspect is the harmonization with the Codex crop classification. The Codex Classification of foods and animal feeds for Citrus Fruits Group is also undergoing revision. The IR-4/EPA Crop Grouping Working Group and the International Crop Grouping Consulting Committee (ICGCC) are making every effort to collaborate with the revision of the Codex crop classification (see Table 28 for citrus fruits crop groups established by Codex, proposed by this petition, and listed by EU regulation.

This IR-4 his petition proposes "Citrus fruits Group 10" with 27 commodity entries. Besides the commodities in the genera *Citrus* and *Fortunella*, several commodities in genera *Eremocitrus*, *Microcitrus*, and *Poncirus* have also been included. Comparing with many other crop groups, commodities in this group are all closely related as they are all in the same botanical family and share similar morphological and cultural characteristics. Commodities and their varieties, cultivars and/or hybrids proposed in this group have included all the commodities in the Codex Classification of Citrus Fruits Group and EU Crop List of Citrus Fruits with several additions. Commodity entry "Citrus fruits" has been deleted from the group since it is rather a collective name of many citrus fruit commodities instead a specific commodity entry. Representative commodities selected for this crop group, orange or tangerine/mandarin, lemon or lime, and grapefruit, are revised from the existing citrus crop group, and are comparable with the commodities that the subgroups are based on in Codex Citrus Fruits Group, and MRL consideration are based on in EU List. In the EU Crop List of Regulation oranges and mandarins are also listed as representative crops large and small citrus fruits, respectively (Muller 2006a). The expanded Citrus Fruits Group and the representative commodities proposed in this petition would facilitate the harmonization of the US and the Codex crop classification systems.

RECOMMENDATIONS:

Each of the five proposals and recommendations will be discussed below, followed by a series of other recommendations on terminology, database development, and harmonization with CODEX. The EPA would like to commend the valuable and high quality input of the ICGCC, all its members, and the Workgroup Chairperson Dr Hong Chen, as well as Dr. Yuen-Shaung, Biologist and Jessie Cordova, Information Technical Specialist, EPA for their input and development of various databases in this report and Dr. Paul Schwartz, USDA, Office of Minor Use Pesticides for his advice and peer review.

IR-4 Proposal 1:

1. "Amend the name of the crop group in 40 CFR 180.41 (c) (10) from "Crop Group 10, Citrus Fruits Group (*Citrus* spp., *Fortunella* spp.)", to "Crop Group 10, Citrus Fruits Group".

HED Recommendation for Proposal 1:

I recommend that ChemSAC concur to amend the Crop Group Regulation [40 CFR 180.41 (c) (10)] to revise the name of the Citrus fruit crop group to delete references to Citrus spp. and *Fortunella* spp.

IR-4 Proposal 2:

2. "Amend the existing crop group in 40 CFR 180.41 (c) (10) that consists of the following 12 commodity entries:"

1. Calamondin, *Citrus mitis* x *Citrofortunella mitts*
2. Citrus citron, *Citrus medica*
3. Citrus hybrids, *Citrus* spp. [includes chironja, tangelo, tangor]
4. Grapefruit, *Citrus paradisi*
5. Kumquat, *Fortunella* spp.
6. Lemon, *Citrus jambhiri*, *Citrus limon*
7. Lime, *Citrus aurantiifolia*
8. Mandarin (tangerine), *Citrus reticulata*
9. Orange, sour, *Citrus aurantium*
10. Orange, sweet, *Citrus sinensis*
11. Pummelo, *Citrus grandis*, *Citrus maxima*
12. Satsuma mandarin, *Citrus unshiu*

To an expanded crop group that consists of the following 28 commodity entries with updated scientific names:

1. Australian desert lime, *Eremocitrus glauca* (Lindl.) Swingle
2. Australian finger lime, *Microcitrus australasica* (F. Muell.) Swingle
3. Australian round lime, *Microcitrus australis* (A. Cunn. ex Mudie) Swingle
4. Brown River finger lime, *Microcitrus papuana* Winters
5. Calamondin, *Citrus madurensis* Lour.
6. Citron, *Citrus medica* L.
7. Citrus hybrids, *Citrus* spp., *Eremocitrus* spp., *Fortunella* spp., *Microcitrus* spp., and *Poncirus* spp.
8. Grapefruit, *Citrus* x *paradisi* Macfad.
9. Japanese summer grapefruit, *Citrus natsudaidai* Hayata
10. Kumquat, *Fortunella* spp.
11. Lemon, *Citrus limon* (L.) Burm. f.
12. Lime, *Citrus aurantiifolia* (Christm.) Swingle
13. Mediterranean Mandarin, *Citrus nobilis* Loureiro var. *deliciosa* Swingle
14. Mount White lime, *Microcitrus garrowayae* (F. M. Bailey) Swingle
15. New Guinea wild lime, *Microcitrus warburgiana* (F. M. Bailey) Tanaka
16. Orange, sour, *Citrus aurantium* L.
17. Orange, sweet, *Citrus sinensis* (L.) Osbeck
18. Pummelo, *Citrus maxima* (Burm.) Merr.
19. Russell River lime, *Microcitrus inodora* (F. M. Bailey) Swingle
20. Satsuma mandarin, *Citrus unshiu* Marcow.
21. Sweet lime, *Citrus limetta* Risso

22. Tachibana orange, *Citrus tachibana* (Makino) Tanaka
23. Tahiti Lime, *Citrus latifolia* Tan.
24. Tangelo, *Citrus x tangelo* J.W. Ingram & H.E. Moore
25. Tangerine (Mandarin), *Citrus reticulata* Blanco
26. Tangor, *Citrus reticulata* × *Citrus sinensis*
27. Trifoliate orange, *Poncirus trifoliata* (L.) Raf.
28. Uniq fruit, *Citrus aurantium* Tangelo group

And varieties, cultivars and/or hybrids of these

HED Recommendation for Proposal 2:

Based on similarities and characteristics of the *Rutaceae* or Rue plant family which includes all the citrus fruits, cultural practices, edible food and animal feed portions, residue levels, geographical location, pest problems, established tolerances, and for international harmonization purposes, I recommend that ChemSAC concur to amend the Citrus Crop Group 10 from twelve commodities to 28 commodities with the inclusion of Uniq fruit, which is a cross between tangerine and pummelo also called Ugli® fruit mostly imported from Jamaica.

A comparison of established tolerances on citrus fruit oilseed commodities also supports that residue levels will be similar between members of the crop group and subgroups (See Tables 19, 20, 21, and 22). The common name for Citrus citron should be changed to Citron to simplify its tolerance expression. The scientific name for Citrus hybrids, *Citrus* spp. and *Fortunella* spp. should be revised to include the following genus: Citrus hybrids, *Citrus* spp., *Eremocitrus* spp., *Fortunella* spp., *Microcitrus* spp., and *Poncirus* spp. Also, varieties and/or hybrids of these should be changed to, "varieties, cultivars and hybrids, of these commodities" to avoid all confusion with terminology regarding whether they are varieties cultivars or hybrids of citrus.

IR-4 Proposal 3:

3. "Amend the representative commodities from the current crop group which are sweet orange, lemon, and grapefruit to orange or tangerine/mandarin, lemon or lime, and grapefruit in the proposed expanded group:".

HED Recommendation for Proposal 3:

I recommend ChemSAC concur to adopt orange or tangerine/mandarin, lemon or lime, and grapefruit as the representative commodities for the amended Citrus Fruit Crop Group 10. These three representative commodities account for > 99 % of the harvested acres for the members of the amended Citrus Fruit Group. The representative commodities are based on similarities in fruit and cultural practices and geographical locations, as well as their high production (both acres and yield) and consumption.

IR-4 Proposal 4:

4. "Establish the following three new subgroups under the Citrus fruit group as follows:

Subgroup 10A: Orange Subgroup 10A (rep crops: Orange or tangerine/mandarin)

1). Calamondin, *Citrus madurensis* Lour.
2). Citrus citron, *Citrus medica* L.
3). Citrus hybrids, *Citrus* spp. and *Fortunella* spp.
4). Mediterranean Mandarin, *Citrus nobilis* Loureiro var. *deliciosa* Swingle
5). Orange, sour, *Citrus aurantium* L.
6). Orange, sweet, *Citrus sinensis* (L.) Osbeck
7). Satsuma mandarin, *Citrus unshiu* Marcow.
8). Tachibana orange, *Citrus tachibana* (Makino) Tanaka
9). Tangerine (Mandarin), *Citrus reticulata* Blanco
10). Tangor, *Citrus reticulata* × *Citrus sinensis*
11). Trifoliate orange, *Poncirus trifoliata* (L.) Raf.
And varieties and/or hybrids of these

Subgroup 10B: Lemon/Lime Subgroup 10B (rep crop: Lemon or lime)

1). Australian desert lime, *Eremocitrus glauca* (Lindl.) Swingle
2). Australian finger lime, *Microcitrus australasica* (F. Muell.) Swingle
3). Australian round lime, *Microcitrus australis* (A. Cunn. ex Mudie) Swingle
4). Brown River finger lime, *Microcitrus papuana* Winters
5). Kumquat, *Fortunella* spp.
6). Lemon, *Citrus limon* (L.) Burm. f.
7). Lime, *Citrus aurantiifolia* (Christm.) Swingle
8). Mount White lime, *Microcitrus garrowayae* (F. M. Bailey) Swingle
9). New Guinea wild lime, *Microcitrus warburgiana* (F. M. Bailey) Tanaka
10). Russell River-lime, *Microcitrus inodora* (F. M. Bailey) Swingle
11). Sweet lime, *Citrus limetta* Risso
12). Tahiti Lime, *Citrus latifolia* Tan.
And varieties and/or hybrids of these

Subgroup 10C: Grapefruit Subgroup 10C (rep crop: Grapefruit)
1). Grapefruit, *Citrus* x *paradisi* Macfad.
2). Japanese summer grapefruit, *Citrus natsudaidai* Hayata
3). Pummelo, *Citrus maxima* (Burm.) Merr.
4). Tangelo, *Citrus x tangelo* J.W. Ingram & H.E. Moore
5) Uniq fruit, *Citrus aurantium* Tangelo group
And varieties and/or hybrids of these"

HED Recommendation for Proposal 4A – Orange subgroup 10A:

I recommend that ChemSAC concur to establish three new subgroups, and the first subgroup will be the Orange subgroup 10A with orange or tangerine/mandarin being the representative commodity.

This subgroup is based on the botanically recognized horticultural group which combines the oranges and includes the sweet orange types that are the most commonly grown citrus in the world as well as the tangerines or mandarins that have over 100 cultivars and are increasing in popularity because they are easy to peel and eat out of hand and some are processed into juice. They are very similar to the sweet oranges. They are also likely to have similar pest problems. This subgroup will include the seedless mandarin like clementines and various tangerine hybrids such as tangor a hybrid of mandarin and orange ('Murcott') and tangelos which are hybrids of mandarin and grapefruit ('Minneola').

The twelve members of this subgroup will include:

Calamondin, Citron, Citrus hybrids, Mediterranean Mandarin, Orange, sour, Orange, sweet, Satsuma mandarin, Tachibana orange, Tangelo, Tangerine (Mandarin), Tangor, Trifoliate orange, and varieties, cultivars, and/or hybrids of these crops.

HED Recommendation for Proposal 4B – Lemon/Lime Subgroup 10B:

I recommend that ChemSAC concur to establish the second new subgroup, which will be the Lemon/lime subgroup 10B, with lemon or lime being the representative commodity.

This second Crop subgroup is based on the recognized horticultural group that includes lemons and limes. Lemons are widely used for their acid juice content, slices and for processing into juices. Limes have a distinctive flavor and aroma and are small fruited such as the Key lime or large fruited types such as Tahiti lime that are marketed as fresh seedless fruit. The Key limes are small, round, and seedy, and turn yellow under Mediterranean conditions, while the Tahiti limes are larger, green, and shaped like lemons. The sweet limes are not as popular because they lack a distinctive taste.

The EPA Crop Production Regions reported in the OPPTS 860.1000 Residue Chemistry Guidelines are Region 3 and 10 with most of the acreage in Region 3. However, due to Hurricane Andrew in 1992, citrus greening, and citrus canker the lime and lemon industries in Florida has practically disappeared and production statistics in Florida for lemons and limes has not been reported since 2002. There are less than 800 acres of lemons and limes left in Florida.

The twelve commodities in this subgroup will be Australian desert lime, Australian finger lime, Australian round lime, Brown River finger lime, Kumquat, Lemon, Lime, Mount White lime, New Guinea wild lime, Russell River-lime, Sweet lime, Tahiti Lime, and varieties, cultivars, and/or hybrids of these commodities.

HED Recommendation for Proposal 4C – Grapefruit Subgroup 10C:

I recommend that ChemSAC concur to establish the third new subgroup, which will be the Grapefruit subgroup 10C, with grapefruit being the representative commodity. The grapefruit are distinct enough based on size and use to be the made into a third subgroup. This third grapefruit subgroup is also based on a widely recognized horticultural class, which include several commodities that are grouped based on their rind or flesh colored pulp pigments. The common or white fleshed grapefruit have the 'Marsh' seedless as the main cultivar and 'Duncan' as the seeded variety and the pigmented varieties that are either pink or red fleshed is also seedless. Pummelo are also included in the grapefruit group and the pummelo or shaddock species originates from Southeast Asia where it is as common as grapefruit is in the U.S. They are much larger and thicker-peeled than grapefruit, and have a milder flavor. Utilization of all these grapefruit citrus fruit crops is similar in that they are grown for their fresh fruit, juice, molasses, syrups, oil, essence, and marmalade. The representative commodity for this proposed subgroup is the grapefruit. Uniq fruit is also added since it is a distinct type of grapefruit grown mostly in Jamaica. Also, varieties and/or hybrids of these should be changed to, varieties, cultivars, of these commodities" will avoid all confusion with these terms, and the tangelo being a cross between tangerine and grapefruit will be added both to the Orange/tangerine subgroup 10A and the Grapefruit subgroup 10C.

The five commodities in this subgroup will be Grapefruit, Japanese summer grapefruit, Pummelo, Tangelo, and Uniq fruit, and varieties, cultivars, and/or hybrids of these commodities.

IR-4 Proposal 5 for Commodity Definitions:

5. In 40 CFR 180.1 (g) delete the Citrus fruits Commodity Definition item 5a; and revise the Tangerine Definition item 5b, and establish new Commodity Definitions for Grapefruit (5c); Lemon (5d); Lime (5e); and Orange (5f) as described below:

a). Citrus fruits Commodity Definition: Citrus fruits, Grapefruit, lemons, limes, tangelos, tangerines, citrus citron, kumquat and hybrids of these.

b). Tangerines Definition: Tolerances and exemptions established for pesticide chemicals in or on Tangerine apply to the following commodities: Tangerines (Mandarins or Mandarin oranges), Mediterranean mandarin, Satsuma mandarin, and varieties and/or hybrids of these.

c). Grapefruit Commodity Definition: Tolerances and exemptions established for pesticide chemicals in or on Grapefruit apply to the following commodities: Grapefruit, Japanese summer grapefruit; Pummelo, Tangelo, Uniq fruit, and varieties and/or hybrids of these.).

d). Lemon Definition: Tolerances and exemptions established for pesticide chemicals in or on Lemon apply to the following commodities: Australian desert lime, Australian finger lime, Australian round lime, Brown River finger lime, Calamondin, Kumquats, Lemon, Lime, Mount White lime, New Guinea wild lime, Russell River-lime, Sweet lime, Tahiti Lime, and varieties and/or hybrids of these.

e). Lime Definition: Tolerances and exemptions established for pesticide chemicals in or on Lime apply to the following commodities: Australian desert lime, Australian finger lime, Australian round lime, Brown River finger lime, Kumquats, Lemon, Lime, Mount White lime, New Guinea wild lime, Russell River lime, Sweet lime, Tahiti Lime, and varieties and/or hybrids of these.

f). Orange Definition: Tolerances and exemptions established for pesticide chemicals in or on Orange apply to the following commodities: Calamondin, Citrus citron, Mediterranean mandarin, Satsuma mandarin, Sour oranges, Sweet oranges, Tachibana orange, Tangerine (Mandarin), Tangor, Trifoliate orange, and varieties and/or hybrids of these.

HED Recommendation for Proposal 5a Citrus Fruit Commodity Definition:

a). Citrus fruits Grapefruit, lemons, limes, tangelos, tangerines, citrus citron, kumquat and hybrids of these.

I recommend ChemSAC **reject** the established commodity definition [40 CFR Part 180.1(g)] and proposed updated commodity definition for citrus fruits. It is essentially a repeat of the commodities in the Citrus fruit group 10, and while it may be useful for labeling citrus fruits is no longer a tolerance term, because we have an expanded citrus fruit group and several other commodity definitions such as tangerine are more specific to certain citrus. The term citrus fruits should not be used for setting a tolerance.

HED Recommendation for Proposal 5b Tangerine Commodity Definition:

I recommend establishing a revised Tangerine commodity definition under 40 CFR Part 180.1(g) as follows:

Tangerine.....Tangerine (mandarin or mandarin orange), clementine, Mediterranean mandarin, Satsuma mandarin, tangelo, tangor, and cultivars, varieties, or hybrids of tangerines with other fruits.

This will help in clarifying what other citrus fruits the tangerine will cover.

HED Recommendation for Proposal 5c Grapefruit Commodity Definition:

I recommend establishing a new a Grapefruit commodity definition under 40 CFR Part 180.1(g) as follows:

Grapefruit.....Grapefruit, Japanese summer grapefruit, pummelo, shaddock, tangelo, Uniq fruit, and cultivars, varieties, or hybrids of grapefruit with other fruits.

This will also clarify what commodities are covered by grapefruit tolerances and follows the EPA Commodity Reviewer's Guide approved by ChemSAC, 2006. The inclusion of cultivars, varieties and hybrids will leave no doubt which specific related varieties are covered.

HED Recommendation for Proposal 5d Lemon Commodity Definition:

I recommend establishing a Lemon commodity definition under 40 CFR Part 180.1(g) as follows:

Lemon.....Lemon, lime, and cultivars, varieties, or hybrids of lemon with other fruits.

This commodity definition is mainly to show lemons also can cover limes. The list of many of the limes is not necessary for lemon because they are included in the lime commodity definition.

HED Recommendation for Proposal 5e Lime Commodity Definition:

I recommend establishing a Lime commodity definition under 40CFR Part 180.1(g) as follows:

Lime.....Lime, Australian desert lime, Australian finger lime, Australian round lime, Brown River finger lime, lemon, Mount White lime, New Guinea wild lime, Russell River lime, Sweet lime, Tahiti lime, and varieties and/or hybrids of these limes with other fruits.

HED Recommendation for Proposal 5f Orange Commodity Definition:

I recommend establishing an Orange commodity definition under 40 CFR Part 180.1(g) as follows:

Orange.....Orange, sweet orange, sour orange, tachibana orange, tangelo, trifoliate orange, and cultivars, varieties and/or hybrids of these oranges with other fruits.

Additional HED Recommendations/Conclusions:

Recommendation 6:

The ICGCC considered whether white sapote should be added to the Citrus fruit group 10 and decided it would be better placed in a Tropical fruit – inedible peel group that will be considered at a future date. This will help harmonize with CODEX that classifies white sapote in the "Assorted tropical/subtropical fruits – inedible peel." The original review was conducted in 1998 (Schneider, 1998b) and included in the 2006 Reviewer's guide. It will be removed from the next revision of the Reviewer's Guide.

Recommendation 7:

Guidance for HED SOP 99.6 - "Classification of Food Forms with Respect to Level of Blending" issued August 20, 1999, and HED SOP 2000.1 – "Guidance for Translation of Field Trial Data from Representative Commodities in the Crop Group Regulation to Other Commodities in Each Crop Group/Subgroup" issued September 12, 2000 can be updated to reflect the amendment to the Citrus fruit group 10.

Recommendation 8:

Guidance on expressing tolerance terminology for the Citrus fruit crop group 10 and the three proposed subgroups (Orange subgroup 10A; Lemon/lime subgroup 10B; and the Grapefruit subgroup 10C) are discussed under the "Tolerance expression guidance section of this analysis.

Recommendation 9:

The Health Effects Division Dry Matter and Seeding Rate Database prepared by Dr's. Yuen-Shaung NG and B. A. Schneider, was updated on June 2006 and updated June, 2007 in Table 37 for the Citrus Fruit Group.

Recommendation 10:

New lookup and preferred EPA terms for the members of the Citrus Fruit Crop Group are listed in the EPA Food and Feed Commodity Vocabulary section of this report and these terms should be added to the updated EPA Food and Feed Commodity Vocabulary website.

ANALYSIS OF THE USDA IR-4 PROPOSAL TO ESTABLISH AN AMENDED CITRUS FUIT GROUP 10

BOTANICAL CHARACTERISTICS OF PROPOSED COMMODITIES:

Citrus fruits are all members of the family *Rutaceae*. The family *Rutaceae or Rue family* has six subfamilies of which the orange family is contained in the *Aurantioideae*. Within this subfamily is the tribe *Citrinae* of which there are three closely related genera, the *Citrus*, *Fortunella*, and the *Poncirus*. The genera *Microcitrus* and *Eremocitrus* are genera native from Australia. There are over 100 genera and 200 species in the *Rutaceae* family.

Citrus fruits were first introduced into the U.S. in Florida by the Spanish explorers and colonists in the 16th century. Citrus fruits are grown worldwide in arid subtropical and humid tropical areas with adequate moisture and suitable soils and lack of frost. The citrus is grown in a narrow region in the U.S. that extends from Northern California south into southern California; eastward through the low elevation areas of Arizona, into southern Texas along the Gulf Coast and south through Florida. Many other countries like Japan, China, India, and Mexico have important local varieties that are important in their markets.

The citrus fruit belt follows the equator and spreads on both sides at approximately 35° north latitude and 35° south latitude. Citrus fruits produced commercially in the U.S. are of 5 major and 3 minor kinds. Major kinds are lemon (*Citrus limon*), sweet orange (*C. sinensis*), Mandarin orange (*C. reticulata*), grapefruit (*C. x paradisi*), and the lime (*C. aurantiifolia*). Minor fruits are pummelo (*C. maxima*), sour or Seville orange (*C. aurantium*), and the citron (*C. medica*). All are produced on relatively small, evergreen trees or tall shrubs. Grapefruit trees are the largest, and limes the smallest stature trees of the group. Trees may reach 20 – 30 ft in height, but most cultivated trees are < 15 ft. Stems are often armed with long thorns, particularly the limes, and in all types when young. Leaves are relatively thick with winged petioles of various widths depending on species for example grapefruit has wide leaves and tangerine has narrow leaves. Citrus trees normally take four years before they can set fruit. All citrus are injured by winter temperatures below about 25° F. Ichang papeda is known as a subzero citrus (Citrus ichangensis) is known as a most extraordinary plant which grows wild in southwestern China, reportedly surviving subzero temperatures. The fruit is oblong in shape, much like a lemon, with rough, pale orange rind and meaty flesh packed with seeds.

Citrus can grow well in a wide range of soils; however they are highly sensitive to overly moist conditions. Citrus need grow best when the rainfall is at least 1200 mm. The leaves and the peel of the fruit contain oil vesicles. Most are trees or shrubs with evergreen leaves with white and fragrant flowers, and most cultivars are self-pollinated. Some are parthenocarpic (e.g., 'Tahiti' lime, and some Navel oranges and tangelos). Cross pollination is necessary only for some tangerines and tangerine hybrids. Citrus fruits range in size from 2.5 cm for calamondin or kumquats to more than 12 - 18 cm in diameter grapefruit or pummelo.

The fruit of the citrus are so important that they have received a special name - a hesperidium. A hesperidium is basically a leathery rinded berry. This fruit is unique to six genera in the Rutaceae family. These genera are: *Citrus, Fortunella, Poncirus, Microcitrus*, and *Clymenia*. The endocarp is the edible portion, divided into 8 - 18 segments or occasionally up to 18 for grapefruit and pummelo, 6- 8 for trifoliate orange and 3 – 5 for kumquat that separated by thin septa, each containing up to 8 seeds, but usually only one. Seeds vary in number depending upon cultivar from zero to 40 – 50 for grapefruit. Citrus fruits are either seedy or seedless. Seedless are those citrus with < 2 seeds/fruit. Each segment is composed of juice vesicles ("pulp"), with long stalks attached to the outer wall, containing juice, which may vary from sweet to very acid. The citrus fruits can range in size from < 2.5 cm for calamondin and kumquats to more than 12 – 18 cm diameter for grapefruit and up to 30 cm for pummelo and some citrons.

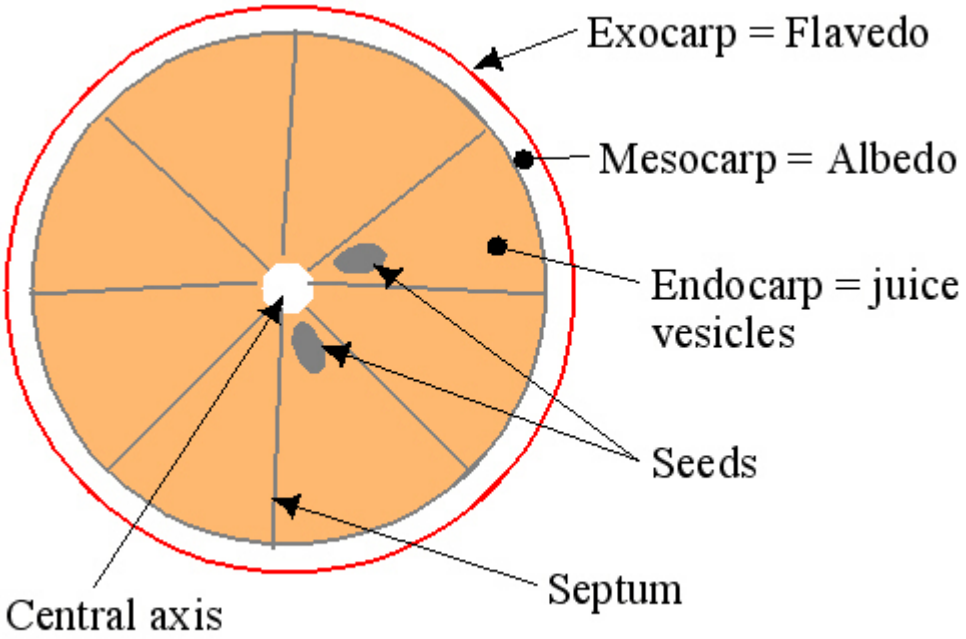
Citrus fruits have three fundamental parts: the flavedo which is the external colored part of the peel, the albedo which is the white internal part of the peel, the pericarp containing the flavedo and albedo, and the pulp that is subdivided into segments and vesiacs that contain the juice and seeds called the endocarp (Figures 1 and 2). Most fruit peels are relatively thick, consisting of a white, spongy endocarp, and with the surface epidermis containing numerous oil vesicles (see Figures 1 and 2). The fruit peel has many oil glands. The outer layer of the fruit is the rind or peel and includes the flavedo or epicarp as the outer colored portion, and the albedo the inner colorless or sometimes tinted like pink in grapefruit portion. The flavedo is rich in pigments (chloroplasts and chromoplasts) consists of the epicarp (a single layer), hyprodermis (first colorless layer under the epicarp), outer monocarp, and the oil glands. Both the hypodermis and monocarp layers contain essential oil glands. Oil glands range in size from 10 to 100 μm or more. The internal part of the rind is the albedo which ranges from 1 – 2 mm thick in some fruit such as the ‘Honey’ tangerine and a centimeter or thicker in grapefruit. This layer is attached to the flavedo layer. Pectin is manufactured from the albedo layer. Most citrus fruits rinds are considered inedible because of the oil content, except for kumquats which have a sweet rind and pulp. Citrus peel is also scraped in small amounts and added to some dishes to provide a zest. The approximate composition of an orange is shown in Table 1 below:

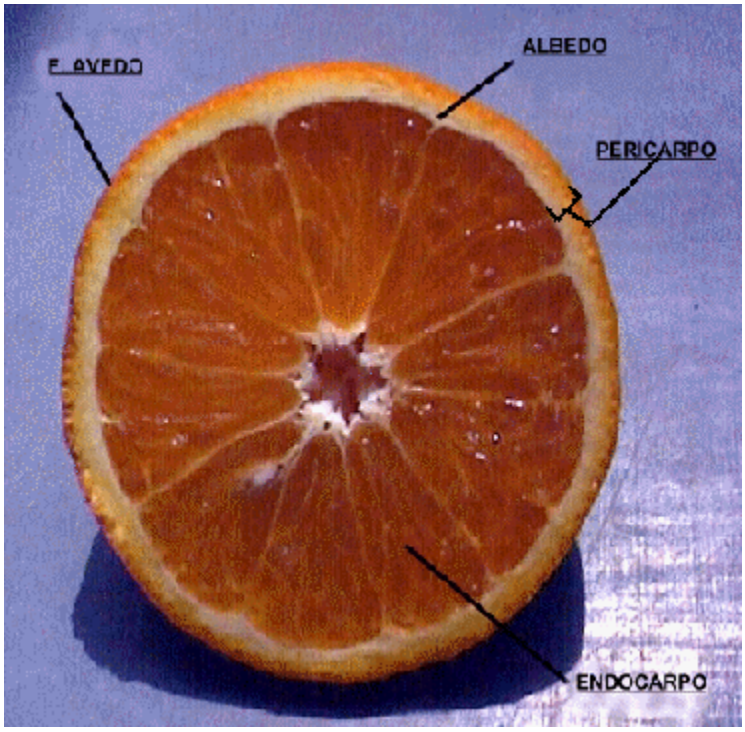
Table 1. Approximate Composition of an Orange.

Component	Percent	Notes
Juice	40.0 – 50.0 %	
Albedo	15.0 – 20.0 %	
Fiber	0.5 – 1.0 %	
Dry Matter	5.0 – 12.0 %	
Juice pH	pH 3.5	The pH is due primarily to the organic acid – citrus acid.

Considering citrus fruit grouping, the size has the oranges as medium – small to medium size, with tangerines being small to medium, the grapefruits medium large to large, the lemons medium - small, acid limes being very small to small, pummelos large to very large, citrons medium - large to very large. The size within these types can vary widely based on varietal differences.

Figures 1 and 2. Cross Section of a Citrus Fruit.





CITRUS HYBRIDIZATION:

All citrus fruits will cross or hybridize with each other producing literally hundreds of cultivars and hybrids. Many such crosses have been made by plant breeders and some have originated by chance. As a result, we now have in commerce Mandarin orange x grapefruit crosses called tangelos, sweet orange x Mandarin crosses called tangor, and others. A description of the citrus hybrids is in the 'Comparison of Citrus Fruit Cultural Practice' section of this report. There are also hybrids among Citrus species and between *Citrus, Eremocitrus, Microcitrus,* and *Poncirus* or *Fortunella*, that have been produced either naturally or through controlled breeding. A series of prefixes and suffixes is used to denote the parents of such hybrids: Some examples of citrus hybrids include:

Cicitrange (citrange x trifoliate orange)
Citradia (sour orange x trifoliate orange)
Citrandarin (tangerine × trifoliate orange)
Citrangedins (citrange × kumquat x calamondin)
Citrangelo (citrange x grapefruit)
Citrangequat (citrange × kumquat)
Citrangeremos (citrange × Australian desert lime)
Citrange (sweet orange × trifoliate orange)
Citrangor (sweet orange × citrange)
Citremon (trifoliate orange x lemon)
Citrumelo (trifoliate orange x grapefruit)
Citrumquat (trifoliate orange x kumquat)

Eremolemon (Australian desert lime × lemon)
Eremoradias (Australian desert lime × sour orange)
Eremorange (Australian finger lime x × sweet orange)
Faustrimedin (Australian finger lime x calamondin x kumquat)
Lemonage (lemon × sweet orange)
Lemondarin (lemon × mandarin)
Lemonime (lemon × limes)
Lemonquat (lemon x kumquat)
Limequat (lime × kumquat)
Orangelo (sweet orange x grapefruit)
Orangequat (Satsuma orange x kumquat)
Ortanique (tangelo x tangor)
Procimequat (limequat x kumquat)
Segentranges (trifoliate orange x sour orange)
Sydney hybrid (Australian finger lime x Australian desert lime)
Tangor (tangerine x sweet orange)
Tangelo (tangerine x grapefruit)
Tangtangelo (tangerine x tangelo)
Tangelolo (tangerine x grapefruit)

HORTICULTURAL CLASSIFICATION OF THE CITRUS:

The citrus fruits are commonly arranged into four separate groups for horticultural purposes based on fruit characteristics. These are: the (1) oranges; the (2) tangerines or mandarins; the (3) grapefruit and pummelo; and the (4) common acid groups which include the citron, lemon and lime. They are marketed as fresh or desert fruits such as the sweet oranges, grapefruit, and tangerines, and as processed products such as juice, syrups, candid, rind oil or essence. There is a wide range of citrus of regional or local significance that may have potential to become important commodities in trade seasonable. Also, considering citrus fruit grouping, the size of the fruit generally has the oranges as medium – small to medium size, with tangerines being small to medium, the grapefruits medium large to large, the lemons medium-small, acid limes being very small to small, pummelo to large to very large, citrons medium - large to very large. The size within these types can vary widely based on varietal differences. Shapes of the citrus fruits vary and range from round through subglobose and oblate to obovoid on one extreme and from broadly pyriform to ovoid, oblong, elliptical, and cylindrical on the other (See Figure 3 for the citrus fruit shapes). Oranges are usually round, tangerines are oblate, grapefruits and pummelos are subglobose, lemons are elliptical, and the limes oval, while citrons are highly variable but mostly cylindrical and some pummelos may be pyriform (See Figure 3).

Figure 3. Citrus Fruit Shapes.

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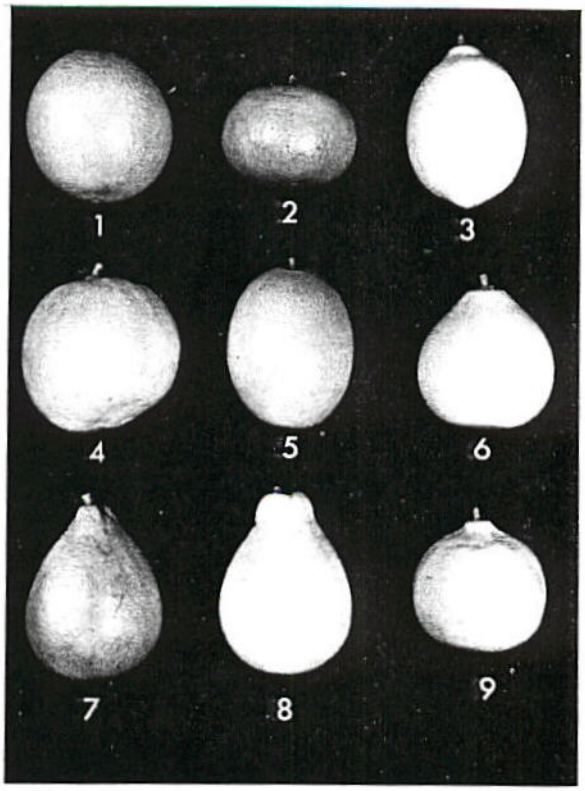


Fig. 4–1. Fruit forms in citrus: *1*, globose (spheroid); *2*, oblate; *3*, ellipsoid; *4*, oblique; *5*, ovoid; *6*, obovoid; *7*, pyriform; *8*, collared; *9*, necked.

The first horticultural group is the oranges which includes the sweet orange types that are the most commonly grown citrus in the world. The ‘Valencia’ is the main sweet orange cultivar grown worldwide. Navel oranges are also widely grown as a seedless orange and used for either fresh fruit or processing into juice. Blood or pigmented oranges are popular in Mediterranean countries for their flavor and rind, flesh, and juice pigments. The term "orange" is used rather loosely, sometimes for fruits that look like oranges but are not *C. sinensis*. Examples include: 'Temple' and ‘Page' oranges (tangerine hybrids), Satsuma mandarin (a cold hardy variant of tangerine), and trifoliate orange (*Poncirus trifoliata*).

The second horticultural group includes the tangerines or mandarins that have over 100 cultivars and are increasing in popularity because they are easy to peel eaten out of hand and some are processed into juice. They are very similar to the sweet oranges. This group includes the seedless Clementine and various tangerine hybrids such as tangor a hybrid of mandarin and orange (‘Murcott’) and tangelos which are hybrids of mandarin and grapefruit (‘Minneola’).

The third horticultural group includes lemons and limes. Lemons are widely used for their acid juice content, slices and for processing into juices. Limes have a distinctive flavor and aroma and are small fruited such as the Key lime or large fruited types such as Tahiti lime that are marketed as fresh seedless fruit. The Key limes are small, round, and seedy, and turn yellow under Mediterranean conditions, while the Tahiti limes are larger, green, and shaped like lemons. The sweet limes are not as popular because they lack a distinctive taste. Kumquats are also listed with lemons and limes were originally classified with citrus genus, but kumquats were then moved to their own genus (*Fortunella* spp.). They are evergreen shrubs or small trees (8 - 15 ft), native to southern China, but can be grown around the world into subtropical areas. Unlike citrus fruits, the peel of the fruit is edible, and usually sweeter than the pulp. Citron is a lemon-like fruit that may be the original species of modern lemons and limes. The peel is very thick, and the white, spongy portion of the peel is edible.

The fourth horticultural group is the grapefruit which have several groups based on their rind or flesh colored pulp pigments. The common or white fleshed have the 'Marsh' seedless as the main cultivar and 'Duncan' as the seeded variety and the pigmented varieties that are either pink or red fleshed are also seedless. Cultivars include "Flame', 'Star Ruby', 'Rio Red', and 'Ruby Red'. Pummelos are also included in the grapefruit group. This, the largest citrus fruit, is known in the western world mainly as the principal ancestor of the grapefruit. Grapefruit is thought to be a hybrid of pummelo and sweet orange that occurred naturally somewhere in the Caribbean between the time of Columbus' voyages and its introduction to Florida in 1809. The pummelo or shaddock species originates from Southeast Asia where it is as common as grapefruit is in the U.S. It is much larger and thicker-peeled than grapefruit, and has a milder flavor.

The three proposed subgroups are based on the above four horticultural classes with the oranges and tangerines combined into one group and lemons and limes in another. The grapefruit are distinct enough based on size and use to be the third subgroup. Utilization of all these citrus fruit crops is similar in that they are grown for their fresh fruit, juice, molasses, syrups, oil, essence, and marmalade. The representative commodities for the proposed subgroups are the same as the current crop group (sweet orange and lemon and grapefruit) except that choices are given for orange or tangerine and lemon or lime.

GROWTH AND DEVELOPMENT OF THE CITRUS FRUIT CROPS

Understanding how the citrus fruit crops grow and develop is a key part of developing a pest control strategy for optimum fruit yield and quality and a helpful reference for analysis of residue field trials by EPA scientists. Proper timing of pesticide applications, based on crop growth stage and pest growth cycle can improve a product's efficacy and prevent crop injury and yield losses. Pesticide labels often use crop growth stages and codes to identify when to apply a pesticide. Some of the recognized growth stages for the citrus fruits are discussed in the below Table 2 as well as selected growth

stages for pesticide spray schedules in Florida for insect pests (Table 3) and plant diseases (Table 4).

Table 2. Selected Growth Stages of Citrus (*Citrus* spp.). BBCH Identification Codes (Adapted from Agusti et al., 1995).

BBCH Code	Principal Growth Stage	General Description
00	Sprouting/Bud development	Dormancy: leaf and inflorescence buds undifferentiated, closed and covered by green scales.
01	Sprouting/Bud development	Beginning of bud swelling.
09	Sprouting/Bud development	Green leaf tips visible.
10	Leaf development	First leaves separating: green scales open, leaves emerging.
11	Leaf development	First leaves visible.
19	Leaf development	First leaves fully expanded.
31	Shoot development	Beginning of shoot growth; axes of developing shoots visible.
39	Shoot development	Shoots about 90% of final length.
51	Inflorescence emergence	Inflorescence buds swelling: buds closed, light green scales visible.
53	Inflorescence emergence	Bud burst: scales separated floral tips visible.
55	Inflorescence emergence	Flowers visible still closed (green bud).
56	Inflorescence emergence	Flower petals elongating; sepals covering half corolla (white bud).
59	Inflorescence emergence	Most flowers with petals forming a hollow ball.
60	Flowering	First flowers open.
65	Flowering	Full flowering, about 10% of flowers open.
69	Flowering	End of flowering, all petals fallen.
71	Development of Fruit	Fruit set, beginning of ovary growth, beginning of fruitlets abscission.
72	Development of Fruit	Green fruit surrounded by sepal crown.
74	Development of Fruit	Fruits about 40% of final size.
79	Development of Fruit	Fruits about 90% of final size.
81	Maturity of fruit	Beginning of final fruit coloring called color break.
83	Maturity of fruit	Fruit ripe for picking, has not developed variety specific color.
89	Maturity of fruit	Fruit ripe for consumption, fruit has typical taste and firmness, beginning of senescence and fruit abscission.
91	Senescence, beginning of dormancy	Shoot growth complete; foliage fully green (91).
93	Senescence, beginning of dormancy	Beginning of senescence and abscission of older leaves.
97	Senescence, beginning of dormancy	Winter dormancy period.

Table 3. Selected Growth Stage Timing for Control of Insect Pests of Citrus (*Citrus* spp.) for Pesticide Spray Schedules in Florida. (From Shipp, 2002 and Browning, 2007).

Timing	Citrus Crop	Comments
Pre-bloom Jan.15 - Feb. 15	Satsuma Grapefruit Temple Valencia Round Oranges	For control of spider mites and rust mites.
Post-Bloom Satsuma mandarin when 75% petals have fallen, other oranges when pea size.	All citrus	For control of scale, thrips, mealybugs, mites, aphids, and whiteflies.
Post-Bloom 80% petal fall	All citrus	For mite, leafminer, and thrips control.
April	All citrus	Broadcast control for Fire ants when ants are actively foraging.
June 15 - July 15	All citrus	For control of scale, thrips, mealybugs, mites, aphids, and whiteflies.
Aug. 14 - Sept. 15	All citrus	For control of scale, thrips, mealybugs, mites, aphids, and whiteflies.
Oct. 15 - Nov. 15	All citrus	For mite, leafminer, and fire ant control.

Table 4. Selected Growth Stage Timing for Control of Plant Disease Pests of Citrus (*Citrus* spp.) for Pesticide Spray Schedules in Florida. (From Shipp, 2002, and Browning, 2007).

Time	Citrus Crop	Comments
Pre-bloom	Satsuma Grapefruit Temple	For control of Scab and Melanose..
Bloom	All citrus	
Post-Bloom	All citrus	For control of Scab and Melanose. Do not use in full bloom or where shrimp or crawfish may be affected. Make first application at pea-size fruit, and the second 14 - 21 days later. Time applications to follow rain, if possible. May require 200 - 300 gallons per acre for large trees.
June 15 – July 15	All citrus	For control of Scab and Melanose.
Oct. 15 – Nov. 15	All citrus	For control of Brown rot, apply foliar spray when disease conditions develop.
Soil Treatment	All citrus, including new plantings and nursery stock	Control of Phytophthora foot rot. Rate depends on tree size.

Climate and Soils Affect Citrus Adaptation to Certain Regions:

Citrus fruits are adapted to a wide variety of soil types and conditions from almost pure sand in central Florida, to organic muck near the Everglades, to loamy, heavy, high pH soils in the San Joaquin Valley of California, tolerant of high or low pH and salinity. Citrus species generally do not tolerate soil flooding for more than a few days without injury. In the United States citrus are grown in a narrow area from northern and southern California, east through the low elevation deserts of Arizona, into southern Texas, along the Gulf Coast and south into Florida. Most citrus perform best in subtropical climates,

where there is a slight change of season but little or no chance of freezing weather. Cold hardiness is the major limiting factor for citrus production in subtropical areas. Flowers and fruit are killed at about 28° F. Leaves and stems are killed by a few minutes at 20°F - 28°F, depending on stage of acclimation, species, and age of tissue. Cold hardiness varies with the following list from least to most cold-hardy: citron, lime, lemon, grapefruit and pummelo, most tangerine, sour orange, Satsuma mandarin, kumquat, and trifoliate orange. Flowering is induced following emergence from quiescence, and sometimes by relief from drought. Most citrus are self pollinated and cross pollination is necessary for only some of the tangerines and tangerine hybrids. Internal and external quality differs greatly between humid subtropical and Mediterranean climates with the temperature and humidity being the main environmental factors controlling quality. One change affects the thickness of the peel since they become thicker and have more pebbly or rough texture in Mediterranean climates than in subtropical climates. The peel color is best in Mediterranean climates in California and Arizona due to cool winters enhancing chlorophyll destruction and fewer pests that blemish the peel. The juice content is higher in subtropical than Mediterranean climate, and the acid content is higher and sugar content generally lower in Mediterranean than subtropical climates, due to warmer temperatures during ripening. Acids break down faster when the nights are warm, and warmer day temperatures allow greater photosynthesis. Therefore, the sugar: acid ratio is higher in Florida, and fruit is said to be richer in flavor. Within arid climates, rate of fruit maturation is faster in hot, desert areas of California and Arizona than in the cooler, coastal areas. On-tree storage is generally better in Mediterranean than subtropical climates. ‘Valencia' oranges maintain color and quality well into the summer if left on trees in California, but not in Florida.

U.S./NAFTA AND WORLD PRODUCTION AND GEOGRAPHICAL DISTRIBUTION OF THE CITRUS FRUIT COMMODITIES:

Proposed members of the citrus fruit crop group find widespread distribution throughout the world. Citrus fruits are the largest fruit crop produced in the world. Table 5 provides a list of the hectares and production in metric tons from various countries that are members of the International Crop Grouping Consulting Committee (ICGCC) as countries that grow grapefruit, pummelo, lemon, lime, and oranges. Based on FAO agriculture statistics, the total hectare for citrus fruits has increased from 6,733,019 ha in 1995 to 7,605,363 in 2005 and the total production has increased from 93,799,450 Mt (metric ton) in 1995 to 105,431,984 Mt in 2005 as the world total (FAO 2005, see Table 5). Worldwide, the orange is by far the most harvested citrus at 47% followed by lemon and limes at 10.6% and by grapefruit at 3.5%. The average yields in Mt/ha for the major citrus fruits is 13.96 for grapefruit, 15.5 for lemon, and 16.6 for oranges. In the Mediterranean climates in Spain, Italy, and California, production of lemons dominates; whereas in the tropical and subtropical regions of Mexico, Brazil, and Florida lime production dominates. The United States has 5.5% of the total citrus hectares and about 9.8% of the total production (MT) and produces 13% of the orange world supply, 24% of the grapefruits and 5% of the lemons and limes.

Table 5. Major Citrus Fruits Production in 2005
(FAO 2005; NAGASAWA 2006a, NAGASAWA 2006b)

Countries/ regions	Grapefruit & Pomelos	Lemons & Limes	Oranges	Citrus fruits Total
Africa	36,333 *ha*[1] 463,373 *Mt*[2]	51,512 *ha* 813,231 *Mt*	374,261 *ha* 5,030,211*Mt*	1,392,117 *ha* 11,625,666 *Mt*
C. America	18,381 *ha* 345,897 *Mt*	150,500 *ha* 2,039,067*Mt*	421,493 *ha* 5,101,231*Mt*	631,386 *ha* 7,920,195 *Mt*
NAFTA	63,000 *ha* 1,172,151 *Mt*	168,005 *ha* 2,570,390 *Mt*	630,000 *ha* 12,236,080 *Mt*	920,585 *ha* 16,792,611 *Mt*
S. America	24,436 *ha* 359,412 *Mt*	157,366 *ha* 3,042,463 *Mt*	1,010,987 *ha* 20,418,307 *Mt*	1,342,477 *ha* 26,194,100 *Mt*
Asia	101,721 *ha* 1,199,642 *Mt*	327,323 *ha* 4,320,033 *Mt*	1,133,860 *ha* 13,861,195 *Mt*	3,180,502 *ha* 37,146,921 *Mt*
Australia	800 *ha* 12,000 *Mt*	1,200 *ha* 35,000 *Mt*	22,000 *ha* 500,000 *Mt*	28,230 *ha* 643,000 *Mt*
Europe	2,810 *ha* 50,200 *Mt*	74,285 *Ha* 1,467,035 *Mt*	263,280 *ha* 5,902,655 *Mt*	504,412 *ha* 10,237,513 *Mt*
Japan	529 *ha* 10,086 *T*	285 *ha* 4,020 *T*	68,210 *ha* 1,298,557 *Mt*	81,100 *ha* 1,504,702 *Mt*
New Zealand	70 *ha* 1,600 *Mt*	360 *ha* 3,700 *Mt*	600 *ha* 6,000 *Mt*	2,930 *ha* 29,800 *Mt*
U.S.	50,000 *ha* 914,440 *Mt*	27,000 *ha* 745,500 *Mt*	300,000 *ha* 8,266,270 *Mt*	397,080 *ha* 10,317,200 *Mt*
World Total	262,817 *ha* 3,667,862 *Mt*	806,008 *ha* 12,554,879 *Mt*	3,598,389 *ha* 59,858,474 *Mt*	7,605,363 *ha* 105,431,984 *Mt*

In the U.S citrus fruits are widely consumed with the per capita consumption in 2004 for the following citrus fruits reported as grapefruit at 7.9 lb (48% juice), lemon at 6.7 lbs of lemons (54% juice), lime at 2.6 lb (28% juice), oranges and temples at 78.8 lbs (86% as juice), and tangerines and tangelos at 3.9 lbs of tangerines (28% juice). Citrus fruit juice consumption at single strength gallon/capita/year include grapefruit at 0.24 gal, lemon at 0.14 gal, lime at 0.03 gal, and oranges at 5.4 gal (USDA ERS, 2005; Buzby, J., 2005). Based on the USDA CSFII 1994 – 1996, 1998 survey, using two day individual consumption for determined oilseed consumption (g/day) is listed in Table 6 Americans derive about 26% of total Vitamin C from citrus fruits, the highest proportion from any single food group (Reiger, 2005). Per capita consumption of citrus is higher than any other fruit crop when juice and fresh consumption are combined. Consumption over the past 30 years has been constant for most citrus fruits, except lime which has increased and grapefruit, which has decreased. The dietary value of the citrus fruits, per 100 gram edible portion is listed in Appendix I: Tables A – E.

[1] *ha* = hectare
[2] *Mt* = Metric ton

Table 6. Consumption of the Citrus Fruits Based on USDA CSFII 1994 – 1996, 1998 survey.

COMMODITY	CONSUMPTION (g/day)
Citron	0.0067
Citrus hybrids	0.045
Grapefruit	2.83
Grapefruit, juice	3.09
Lemon	0.27
Lemon, juice	2.26
Lemon, juice, babyfood	0.00068
Lime	0.05
Lime, juice	0.41
Lime, juice, babyfood	0.00006
Orange	6.60
Orange, juice	58.0
Orange, juice, babyfood	0.026
Orange, peel	0.004
Tangerine	0.038
Tangerine, juice	0.16

IMPORTS/EXPORTS OF THE CITRUS FRUITS:

Despite the U.S. being a major producer of citrus fruit (Tables 5 and 7) significant amounts of some of the citrus fruits are still imported. The amount of a commodity can vary widely from year to year based on differences in U.S. production, weather effects, and consumer demand. The USDA Foreign Agriculture Trade Statistics (FATUS) reported that in 2005 over 4,322 MT of fresh tangerines were imported from other countries with Mexico accounting for 93% and Chile for 6%. Mandarins as clementines were imported at over 90,641 MT with 69.5 from Spain, Republic of South Africa at 66%, 12% from Mexico, and 8.4% from Chile. Over 69,030 MT of fresh oranges were imported from Republic of South Africa at 41%, Australia at 40% and 16% from Mexico. Over 279,300 MT of Tahiti limes were imported from Mexico at 98.6% and Guatemala at 0.6%. Greater than 99% of the grapefruit 1,403 MT imported in 2005 was from Mexico. Fresh lemons were imported from Chile at 58.8%, Mexico at 36.1% and Spain at 2.8% and totaled 34,651 MT. Over 97% of the fresh limes were imported from Mexico at 27,838 MT. Over 76% of the grapefruit juice was imported from Mexico. Argentina and Mexico accounted for over 99% of the imported lemon juice and Mexico accounted for over 92% and Argentina for 7% of the imported lime juice. All imported grapefruit juice was from Mexico in 2005. Over 1,200,000 kl of orange juice was imported from Brazil at 65%, 17% from Mexico, and 8% each from Belize and Costa Rica.

The U.S. is also a major exporter of citrus fruit commodities. For example, in 2005 (USDA FATUS) approximately 44,368 MT of fresh temple oranges was exported with the Republic of Korea accounting for 39%, Japan for 19%, Taiwan for 10% and Hong Kong and Mexico both at 9%. Exports of lemons, limes, and grapefruit juice have not been reported since 2001. Mandarins were exported at over 6,700 MT to Republic of Korea at 49% and Canada at 40%. Over 12,800 MT of fresh Tangerines were exported with 63% to Canada and 3% to Japan. Exports of oranges at over 534,000 MT were to Canada at 32%, Republic of Korea at 19%, Japan at 14%, Hong Kong at 12%, and Peoples Republic of China at 6%. Grapefruits were e exported at over 256,309 MT to Japan at 44 %, Republic of Korea accounting for 17%, Canada at 14%, and France and the Netherlands at 7%, respectively. Frozen orange juice concentrate was exported at more than 151,000 KL to the Netherlands, 18% to Belgium-Luxembourg, 13% to the Republic of Korea, and 8% to Japan.

U.S. CITRUS FRUIT PRODUCTION AND GEOGRAPHICAL PRODUCTION:

Production in the U.S. is based on the USDA 2006 Agricultural Statistics, FAO Statistics, 2005, USDA ERS 2005 Citrus Fruits 2005 Summary, USDA NASS Crop Production, 2006, and the U.S. Agricultural Census, 2002: According to the 2002 AgCensus citrus were grown on over 1,279,324A. The planted acreages for the citrus fruits in the United States are listed in Table 7. Orange and grapefruit acres account for 90% of the whole citrus fruit group. Oranges have the highest acreages at 998,871A or 78% of the total citrus group. Yields of Florida frozen concentrated orange juice (FCOJ) for 2006-7 season was forecasted to be 1.58 gallons/box at 42° Brix. Florida produced all of the limes in the USA, but hurricane and plant disease damage has all but eliminated the Florida industry. Acreage estimates showed 1,000 acres in 2002 and less than 400 in 2003. The yields per acre of oranges averages 15,000 lb/A, grapefruit 16,700 lb/A, tangerine 10,600 lb/A, and lemon 13,500 lb/A. Maps showing the harvested acres of the major citrus fruit crops are found in Appendix II, Figures 1 to 4.

Table 7. U.S. Citrus Fruit Planted Acres in 2002 (AgCensus, 2002) and Domestic Production for 2006 (USDA NASS, 2006b).

CITRUS FRUIT	PLANTED ACRES (A)	PERCENT OF TOTAL CITRUS ACREAGE	Domestic Citrus Production (MT) 2006
Orange	998,871	78.0 %	8,101,160
Grapefruit	157,358	12.0 %	1,117,650
Lemon	81,021	6.0 %	854,570
Tangerine (Mandarin)	31,419	2.0 %	378,300
Tangelo	14,534	1.0 %	57,150
Lime	1,491	0.1 %	NR**
TOTAL	1,279,324	99.0 %	

*Based on Food and Feed Crops of the United States and the USDA Agricultural Statistics, USDA NASS, 2006, and USDA AGCENSUS, 2002.
** NR – Not Reported.

The U.S. bearing acres and production utilization (fresh + processed) is shown in Table 8 for oranges, Table 9 for tangerines, Table 10 for grapefruits, Table 11 for lemons, and Table 12 for limes, and Table 13 for kumquats, respectively (USDA AGCensus, 2002, NASS Crop Production, 2006).

The percent of the total produce sales for the citrus fruits sold in grocery store for the years 2004 – 2005 is shown in Table14 (The Packer, Fairchild, 2006).

Table 8. United States Orange Bearing Acres and Utilized Production – 2005 – 2006 (USDA AGCensus, 2002, USDA AG STATISTICS, 2005, USDA NASS, 2006b). Orange production includes early, midseason, and Navel varieties and also Valencia.**

State	Bearing Acres - 2002	Utilized Production (1,000 boxes)*- 2006 - 2007	Percent of Utilized Production
AZ	5,804	350	0.2%
CA	229,242	46,000	24.5
FL	680,327	140,000	74.4
LA	192		
TX	9,313	1,780	0.9
Total	925, 635 A	188,130	

* Net lb/box = AZ and CA – 75; FL – 90; and TX – 85.
** Valencia accounts for 44 % of the total orange crop.

Tangelo production (700,000 boxes) and temple oranges (1,000 are reported only for Florida.

Table 9. United States Tangerine Bearing Acres and Utilized Production – 2005 – 2006 (USDA AGCensus, 2002, USDA AG STATISTICS, 2005, USDA NASS, 2006b).

State	Bearing Acres	Utilized Production (1,000 boxes)* - 2006 – 2007	Percent of Utilized Production
AZ	2,605	400	5 %
CA	7,087	3,800	43
FL	19,025	4,600	52
HI	51		
LA	113		
TX	158		
Total	29,040 A	8,800	

* Net lb/box = AZ and CA – 75; FL – 95.

Table 10. United States Grapefruit Bearing Acres and Utilized Production – 2005 – 2006 (USDA AGCensus, 2002, USDA AG STATISTICS, 2005, USDA NASS, 2006b).

State	Bearing Acres	Utilized Production (1,000 boxes)* - 2006 – 2007	Percent of Utilized Production
AZ	-	100	0.3 %
CA	14,541	5,700	14.8
FL	113,929	26,000**	67.5
TX	18,966	6,700	17.4
Total	149,416 A	38,500	

* Net lb/box = AZ and CA – 67; FL – 85; and TX – 80.

** FL production for colored seedless is 17,000 boxes and white seedless is 9,000 boxes.

Table 11. United States Lemon Bearing Acres and Utilized Production – 2005 – 2006 (USDA AGCensus, 2002, USDA AG STATISTICS, 2005, USDA NASS, 2006b).

State	Bearing Acres	Utilized Production (1,000 boxes)* - 2006 – 2007	Percent of Utilized Production
AZ	14,721	2,800	12 %
CA	57,675	19,700	88
FL	762		
TX	84		
Total	73,275	22,500	

* Net lb/box is 76.

Table 12. United States Lime Bearing Acres – 2002 – 2003 (USDA AG STATISTICS, 2005).

State	Bearing Acres	Percent of Bearing Acres
CA	494	39.0 %
FL	644	51.0
Total	1258 A	

Table 13. United States Kumquat Bearing Acres – 2002 – 2003 (USDA AG STATISTICS, 2005).

State	Bearing Acres	Percent of Bearing Acres
CA	116	61 %
FL	73	39 %
Total	189 A	

Table 14. The Packer (Fairchild, 2006) list the percent of the total grocery store produce sales for the citrus fruits sold for the years 2004 – 2005.

Commodity	Percent of Total Produce Sales - 2004	Percent of Total Produce Sales - 2005	Notes
Citrus specialties	0.1	0.1	Includes Tangelo, tangerine, Satsuma mandarin, Clementine, Minneola, temple orange, honey and murcott orange.
Grapefruit	0.7	0.6	Includes white, pink, and red varieties.
Lemon	0.9	1.0	
Lime	0.6	0.6	
Orange	2.5	2.5	

Specific Citrus Fruit Crop Production:

Australian desert lime:

The Australian desert lime is native to Australia. It is a true citrus, with blue-grey leaves and prickles along the branches. These limes are common in the southern and western Darling Downs, especially in Brigalow, or cleared Brigalow County. Limes also grow further west, e.g., in the Longreach, Blackall and Tambo districts where they are often found along creek lines and on slightly scalded country areas.

Australian finger lime:

The Australian finger lime is native to Australia and is found wild as an under-storey shrub in the Australian rainforests of Queensland and northern New South Wales. It grows naturally in heavy shade in areas of high rainfall, but also appears at the edge of cleared forest where there is more sunlight.

Australian round lime:

The Australian round lime is native to Australia and occurs as a shrub or tall narrow tree, with glossy, dark-green leaves, on the more open and drier rainforest margins of southeast Queensland, from Brisbane northwards.

Brown River finger lime:

The brown river finger lime is native to tropical Asia. It is a curious citrus-like shrub growing naturally in the transition area between eucalyptus savanna and tropical rainforest at the Forestry Station, Brown River, and Central District, Papua New Guinea.

Calamondin:

The Calamondin is widely grown in India and throughout southern Asia and Malaysia and an important citrus juice source in the Philippine Islands. It is also grown in California and Arizona and popular in Florida and Texas

Citron:

This citron is a citrus fruit in which the peel or rind makes up most of the fruit volume. The origin is unknown but seeds were found in Mesopotamian excavations dating back to 4000 B.C. The Etrog, used by Jewish people in rites of the Feast of the Tabernacles, is a small citron a little larger than lemons. Commercial citron culture and processing began in California in 1880. In the U.S. there were 1,018 acres with 1,514 tons from Puerto Rico and it is adapted to EPA Crop Production Region 13. Other production regions are in the Mediterranean region.

Citrus hybrids:

A number of citrus hybrids, in addition to tangelos and calamondin are listed separately and have been developed by plant breeding. These include Tangors which are a hybrid between Mandarin orange x sweet orange, and are generally intermediate in characteristics. Some of these other citrus hybrids are Citrange (sweet orange × trifoliate orange) and the orangelo (sweet orange x grapefruit).

Grapefruit:

In 2006, about 1,117,650 metric tons were produced from 157,358 bearing acres (USDA NASS 2006). The top three grapefruit states reported Florida (113,929 bearing acres), California (14,541), and Texas (18,966) (See Table 10). The EPA Crop Production Regions are 3, 6 and 11.

Japanese Summer Grapefruit:

Japanese summer grapefruit is cultivated in India and Japan. There is no reported production yet in the U.S.

Kumquat:

Kumquats are believed native to China and in 1712 kumquats were included in a list of plants cultivated in Japan. They have been grown in Europe and North America since 1850, mainly as ornamental dooryard trees and as potted specimens in patios and greenhouses. They are grown mainly in California, Florida and Texas and to a lesser extent in Puerto Rico, Guatemala, Surinam, Colombia and Brazil. There is limited cultivation in Australia and South Africa. Kumquats are small, citrus-like fruits, which will hybridize readily with citrus. The fruits are small and deeply colored, produced on small, evergreen trees that are somewhat hardier than citrus. Fruit shape is round or distinctly oval, the latter being about 1 inch in diameter by 2 inches long. The rind is thin and edible, so the whole fruit may be eaten out of hand. In the United States, kumquats are grown mainly in home gardens as ornamentals. *Fortunella obovata* is cultivated in SE China, it is also known as Fukushu kumquat, and sometimes ‘Changshou’ kumquat. The ‘Fukushu’ kumquat bears edible round to obovate fruits, with an acidic pulp and a sweet rind. It is a relatively vigorous tree with more rounded leaves than other kumquats. Flowers are simple, white and very fragrant. The fruit is round to obovate. *F. polyandra* is native to Asia. The various kumquats are distinguished as botanical species rather than as cultivars. The following cultivars are those most utilized for food: 'Hong Kong', or ‘Hong Kong Wild’ (*F. Hindsii* Swing.), called chin chü, shan chin kan, and chin tou; 'Marumi', or ‘Round Kumquat’ (*F. japonica* Swing. syn. *Citrus maduremis* Lour.); 'Meiwa', or ‘Large Round Kumquat’ (*F. crassifolia* Swing.), called ninpo or neiha kinkan; 'Nagami', or ‘Oval Kumquat’ (*F. margarita* Swing.). Kumquats are available from November to March from Southern California and Florida. They are grown in EPA Field Trial Crop Production Regions 3 and 10.

Lemon:

The acidic lemons are the only type grown for commercial purposes in the U.S. and with 'Eureka' and 'Lisbon' cultivars in California and Arizona. Florida grows the Sicilian types. The true home of the lemon is unknown, though some have linked it to northwestern India. In 2006 over 854,570 MT were produced on 81,021 A (USDA NASS, 2006). In 2006, the top two states reported as California (57,675 bearing acres) and Arizona (14,721 A). Due to hurricanes and plant diseases, lemon acreage in Florida has declined from over 1986 A in 1986 to less than 800 A in 2002. The EPA Field Crop Production Regions are Region 3 and 10 with 97% of the acreage in Region 10.

Lime:

EPA Crop Production Regions include Region 3 and 10 with most of the acreage in previously grown in Region 3. Limes grow on relatively small, much branched citrus trees. Fruits are of several types. The Mexican or Key lime is near round 1 to 2 inches diameter, with thin rind and acid pulp. Tahiti limes are larger, 2 to 21/2 inches diameter and usually seedless. Low acid or sweet limes are available and grown in some countries, but rarely in the U.S. Limes have been crossed with other types of citrus. Cultivars of Tahiti lime are 'Bearss', 'Idemor', and 'Pond'. Tahiti limes are harvested 8 to 12 times per year with the peak period July to September. The Tahiti lime is presumed to be a hybrid of the Mexican lime and citron. It is widely cultivated in tropics and subtropics, probable origin tropical Asia. The Mexican lime is native to the Indo-Malayan region. Largest importer of Tahiti limes is from Mexico. The tree, its foliage, and the form and size of the fruit resemble the Tahiti lime. Sweet lime is thought to be a hybrid between lime (Mexican-type), and a sweet lemon or sweet citron. Production in U.S. is limited to culture in California, and other production regions are in West Indies, Central America, India, northern Vietnam, Mediterranean Region and tropical America. The only major EPA Field Crop Production Region is Region 10. The EPA Crop Production Regions were 3 and 10 with most of the acreage in Region 3. However, due to Hurricane Andrew in 1992, poor fruit prices, and trees lost to citrus canker the lime industry in Florida has practically disappeared and production statistics in Florida for limes has not been reported since 2002. Yields of limes were about 16,000 lb/A.

Mediterranean mandarin:

The Mediterranean mandarin is widely cultivated in subtropics, origin from cultivars in Italy. Its principal importance is in the Mediterranean basin and it is classified as a tangerine. The fruits are generally small and seeded.

Mount white lime:

The mount white lime is native to tropical Asia and Australia. The species is endemic to foothills and upland rainforest of the Cook District, Mt White on Cape York Peninsula in Australia and Goodenough Island in Papua New Guinea. It grows in deciduous vine thickets as an under-storey shrub and has been recorded at a height of 15 m. Due to its limited distribution, this species is now classified as rare and is protected under the Queensland Nature Conservation Act.

New Guinea wild lime:

The New Guinea wild lime is native to tropical Asia. This New Guinea species is very clearly from the other species of Microcitrus, and this is the only species of the genus outside of Australia, and it occurs nearly a thousand miles away from *M. garrawayi*, the Australian species of *Microcitrus* growing nearest to New Guinea

Orange, sour:

The sour orange is native to southeastern Asia. The sour orange was widely used as a rootstock for other varieties prior to the appearance of the Tristizia virus disease, which affects trees on this rootstock. It is still used in areas where Tristizia is not important. The Bergamot oranges are grown in Mediterranean areas for oil, belong in this group. They are not grown commercially in the U.S. There are no orchards of sour orange, but numerous plantings of a few trees serve as seed sources for rootstocks. The sour orange flourishes in subtropical, near-tropical climates, yet it can stand several degrees of frost for short periods. Generally it has considerable tolerance of adverse growing conditions. It is grown in EPA Crop Production Regions 3, 6, and 10.

Orange, sweet:

Sweet oranges are the most important of the subtropical citrus fruits. Although 73 varieties are recognized (Reuther, 1967) the major production in U.S. consists of six varieties: ‘Valencia’, ‘Washington Navel’, ‘Hamlin’, ‘Parson Brown’, ‘Pineapple and Temple’. ‘Valencia’ has few seeds is available from Florida, California, Arizona and Texas. Navel is seedless and available from Arizona, California, and Texas, ‘Hamlin’ is nearly seedless and ‘Pineapple’ is seedy. Blood orange (pigmented orange or Sanguine orange) has few seeds with deep burgundy interior and available from California. Chinese navel oranges are also grown in California. The ‘Jaffa’ or ‘Shamouti’ is a popular eating sweet orange which is easy to peel and has no navel and it is grown in the western U.S. In 2006 the total orange production in the U.S. was planted on 998,871 acres and produced 8,101,160 MT (USDA NASS). In 2002, the top four states for ‘Navel’ and ‘Valenica’ oranges were reported as Florida (680,327 bearing acres), California (229,242 A), Arizona (5,804 A) and Texas (9,313 A). Tangelos were produced on 14, 534 A. The sweet oranges are grown in the EPA Field Crop Production Regions 3, 6 and 10.

Orange, trifoliate

The genus *Poncirus* is closely related to the citrus, but the small, thorny trees are not evergreen but deciduous. Trees are considered hardier than citrus. They will hybridize with citrus, and such hybrids have been made in efforts to increase hardiness in edible citrus fruits. Poncirus is grown as an ornamental dooryard tree in areas too cold for citrus, and occasional trees may be maintained by nurserymen as seed sources. Fruit appears valueless in the U.S., but can be used for flavoring or marmalade in other countries. The trifoliate orange is important as a rootstock for citrus, especially in Japan, although the fruit is scarcely edible. It is used as a male parent in production of citrange (sweet orange x trifoliate orange) rootstocks. It has a deciduous habit in cooler areas, and can tolerate more freezing than any other citrus relative. It is native to northern China, and is grown as far north as Philadelphia in the Eastern US.

Pummelo:

The pummelo is an important fruit in the Orient, but only scattered trees are found in the United States. The pummelo is tropical or near-tropical and flourishes naturally at low altitudes close to the sea. It is native to southeastern Asia and all of Malaysia; grows wild on river banks in the Fiji and Friendly Islands. The variety 'Tresca' is grown in Florida, where it is marketed as grapefruit. 'Oro blanco' is a cross between pummelo and grapefruit. Pummelos are available from California (mid-January through mid-February). In 1995, almost 500 acres were produced in the San Joaquin Valley of California. The pummelos are grown in EPA Field Crop Production Regions 3 and 10.

Russell river lime:

The Russell river lime is native to Australia. It has a limited distribution in the north of Queensland, Australia, growing in lowland rainforest at the foot of the Bellenden Ker range, not far from Cairns. This new species of Citrus is well worthy of cultivation for its fruit, which is juicy and of equal flavor with the West Indian Lime.

Satsuma mandarin:

Satsuma mandarin probably originated in Japan, it is widely cultivated in tropics and subtropics. This is one of the most important types of citrus grown world-wide, especially in China and Japan. It is also produced in California from mid-October to January. It is commonly called mikan in Japan, satsuma mandarin in the United States and the UK, and clementine or tangerine in Canada. It is less commonly called satsuma tangerine or satsuma orange. The tree is believed to have originated from a mutation in Japan, recorded as early as 1429. In the UK, mikan are commonly eaten at Christmas. In Canada, they are a popular snack at any time of the year, and fruit grown in Morocco are commonly sold in supermarkets.

Tachibana orange:

The tachibana orange is native to Asia and is also grown in the U.S. and are adapted to the U.S. plant hardiness zones 7 – 11.

Tahiti lime:

The Tahiti lime tree origin is still unknown, but it is presumed to be a hybrid of the Mexican lime and citron, or, less likely, the lemon. Florida had produced over 90% of the national crop, but production has declined because of hurricane damage and devastating diseases. The Tahiti lime is hardier than the Mexican lime and better adapted to the mainland of Florida.

Tangelo and Uniq Fruit:

The tangelo is a hybrid produced by crossing grapefruit and tangerine oranges. . Some cultivars are 'Minneola' ('Honeybell'), 'Orlando', 'Nova', 'Early K' (Sunrise tangelo), and 'Sampon'. The 'Uniq' or 'Ugli®' tangelo of Jamaica is believed to be a chance hybrid between mandarin orange and grapefruit. EPA Crop Production Region includes Region 3 and some in Region 10.

Tangerine:

Tangerines are characterized by a loose skin which separates readily from the pulp, and by segments which separate readily from each other. Tangerines are grown in all citrus areas of the U.S. Two main types are grown in the U.S. are the Satsuma group, characterized by a small tree hardier than other citrus, and early ripening fruit of yellow or light orange color; and the tangerine group, characterized by deep orange color and later ripening. Some Satsuma plantings are along the Gulf States, in areas too cold for other citrus. 'Dancy' is the leading variety of Tangerine and Owari of Satsuma. About ten other varieties occur occasionally. Clementine is a cultivar of *C. reticulata*. Tangerine cultivars are 'Dancy', 'Algerian', 'Fairchild', 'Honey' (Murcott), 'Robinson', and 'Sunburst'. Mandarin cultivars are 'Royal mandarin', 'Honey', 'Satsuma', 'Clementine', and 'Kara'. The U.S. production in 2006 was 378,000 MT on 31,419 planted acres (USDA NASS, 2006). In 2002 the top 3 tangerine producing States were reported as Florida (19,025 bearing acres), California (7,087 A), and Arizona (2,605 A). Tangerines are grown in EPA Crop Production Regions 3 and 10 with 66% of the acreage in Region 3.

Tangor:

Tangors are deliberate or accidental hybrids of the mandarin (*Citrus reticulata*) and the sweet orange (*C. sinensis*). Varieties include 'King' (King of Siam), it was believed to be originated in Malaya. They are most similar to tangerines.

COMPARISON OF CITRUS FRUIT CULTURAL PRACTICES:

General Planting Design, Training, and Pruning (adapted from Rieger, 2006 and USDA Crop Profiles, 2003):

In the nursery, citrus scions and rootstock are grafted together. A scion is the detached shoot or twig containing buds from a desired citrus tree, used in grafting. Since a plant produced from seed from any commercial citrus will have a prolonged period of juvenility (eight to twelve years), commercial production is delayed since no flowers are produced. Consequently, since the 1800's, this juvenility has been overcome by taking budwood from the desired scion and budding or grafting it into the stem of a young seedling of a different variety, the rootstock. Rootstock is selected for tolerance to pressures such as pests or cold, in addition to how well it influences the final tree's vigor, size, and fruit quality. Citrus fruit trees are generally, small, spreading evergreen trees or small shrubs. The citrus orchards are usually in rectangular arrangements which eventually become tall hedge rows with the tree spacing typically 20 x 25 ft for grapefruit and navel oranges, 15 x 20 ft for oranges and tangerines, and 12 - 15 x 18 - 20 ft for limes and smaller citrus cultivars. Tree densities vary from about 100 - 110 trees/acre for grapefruit, 87 – 116 trees/A for lemon, 290 – 294 trees/A for kumquat, and 130 - 140 trees/acre for sweet orange. A common spacing pattern for commercial citrus is 15-feet square, which equates to 194 trees per acre. While spacing greater than this has been used historically, the recent trend has been toward higher density planting, even to the extent that the mature tree canopies ultimately form a continuous hedgerow. Higher density plantings also maximize the use of land, water, and energy.

Bearing citrus trees are mechanically hedged to keep row middles open for harvesting operations and allow maximum light penetration. The trees are hedged and topped after harvest. They are topped to a height that allows pickers to access all fruit with 20-foot ladders. Small branches from the hedging are left in row middles and eventually mulched into the soil. Hand pruning is only done after catastrophic incidents like a hurricane.

Grapefruit trees are the largest in height and limes are the smallest. Very little training of the trees is needed. Young trees may be topped at 30 inches to induce branching, and stripped of trunk sprouts and suckers for the first 2 years. They may be defruited for a year or two to induce vegetative growth. Trees may reach 20 - 30 ft in

nature but cultivated trees are maintained to less than 15 ft. At maturity, trees are mechanically hedged and topped to form hedges about 12 ft tall and wide. Almost no hand pruning is done. Mature citrus orchards in Yuma, Arizona seen from the air look like parallel hedgerows. Grapefruit orchards in the Indian River district of Florida are hedged and topped mechanically to control size.

Specific Individual Citrus Cultural Practices:

Australian desert lime:

The Australian desert lime is a true citrus, with blue-grey leaves and prickles along the branches. It is usually found growing on clay or heavy clay soils, often as clumps of short bushes up to 2 – 3 m in height. They are occasionally found as single large trees to 5 – 6 m in height. Older trees have a weeping appearance and have few, or no, prickle. The fruit can be picked when still green, and has a pleasantly refreshing and tangy taste. Desert lime fruit is extremely popular and becoming very well known within the bush food industry. The fruit is used in a variety of sauces and jams. Fruit is also used within restaurants. The plant has even been investigated overseas as a potential source of drought hardy rootstock for citrus trees. *C. gracilis* is a close relative of the native Australian citrus varieties formerly classified as *Microcitrus* and *Eremocitrus*. Is was described as armed straggling tree to 4 m high, often coppicing and suckering; bark cracks into irregular squares; flowers usually solitary; and the fruit are spherical and about 8 cm diameter.

Australian finger lime:

The Australian finger Lime is found wild as an under-storey shrub in the Australian rainforests of Queensland and northern New South Wales. It grows as a tall shrub or small tree naturally in heavy shade in areas of high rainfall, but also appears at the edge of cleared forest where there is more sunlight. The fruit is cylindrical, up to 10 cm long and can be green, yellow, red, purple or black when ripe. Oil seeps from the rind into the pulp, giving the fruit a very acidic flavor and lingering turpentine-like aftertaste. The pulp is usually greenish yellow although there is a variety - Sanguinea - that is red fleshed. Unlike other citrus the Fingerlime flesh consists of tiny, slightly sticky globules, which burst open in the mouth. The taste is quite acidic and slightly lime-like. Its spiny foliage makes it an attractive Australian ornamental.

Australian round lime:

The Australian round lime occurs as a shrub or tall narrow tree, with glossy, dark-green leaves, on the more open and drier rainforest margins of southeast Queensland. The round fruits, about 2 cm to 5 cm in diameter have a thick, green to lemon-colored skin and pale green pulp. It looks very similar to a small, bumpy lime.

Brown River finger lime:

The brown river finger lime is a curious citrus-like shrub, growing naturally in the transition area between eucalyptus savanna and tropical rainforests. The fruits are cylindrical, slightly curved, abruptly beaked at apex and abruptly narrowed at base, 5-8 cm long, 1.0 - 1.3 cm thick at broadest part, green to yellow at full maturity, 3-5-celled, each cell usually containing 5 seeds. The brown river tree lime is a shrub ranging from 1.0 – 2.4 m tall. It has been successfully grown in the U.S.

Calamondin:

The calamondin originated in China and was introduced into Florida around 1900 as an acid orange. It grows wild in Asia and the Philippines and closely resembles the mandarin with its small, oblate shape and flattened or depressed ends. The calamondin is a small, slightly oblate fruit, 3 - 3.5 cm long, and generally not more than 1 1/2 inches in diameter, with a deep orange color and weighs 17.2 g/fruit. The tree is relatively hardy for a citrus and may reach 20 feet in height. It is rather widely grown as an ornamental. Fruit is somewhat intermediate between the kumquat and tangerine and is orange red in color with 2 – 5 small seeds. Peel is tender, thin, and edible like the kumquat, and separates from the flesh like a tangerine when fully mature. The fruit makes an excellent marmalade, and an acceptable acid drink. The crop blooms to maturity in 8 to 12 months. The fruit maybe made into marmalade or juice. It is grown in EPA Production Region 10.

Citron:

The citrus citron or citron is a citrus fruit in which the peel or rind makes up most of the fruit volume. The sweet or Corsican citron fruit is large and elliptical in shape with a diameter 3 to 5 inches, length 4 to 7 inches, and the rind about 1 inch thick. The acid citrons are similar in size, shape and rind thickness. The citron is borne by a slow-growing shrub or small tree reaching 8 to 15 ft (2.4 - 4.5 m) high. The leaflets are evergreen, the flower buds are large and white or purplish, the fragrant flowers about 1 1/2 in (4 cm) wide pinkish or purplish on the outside, with 30 to 60 stamens. The fruit is fragrant, mostly oblong, obovoid or oval but highly variable. Various shapes including smooth or rough fruits sometimes occur on the same branch. The Buddha hand is thought to be a mutant variety that flower carpels fuse ands resemble fingers. The peel is yellow when fully ripe, usually rough and bumpy but sometimes smooth, mostly very thick, fleshy, tightly clinging. Pulp pale-yellow or greenish divided into as many as 14 or 15 segments, firm, not very juicy, acid or sweet, containing numerous monoembryonic seeds. Bloom to harvest takes 8 to 10 months. The citron tree blooms nearly all year, but mostly in spring and the spring blooms produce the major part of the crop. The citrus citron is highly sensitive to frost, and it does not enter winter dormancy as early as other Citrus species. Foliage and fruit easily damaged by very intense heat and drought. Citron trees are grown readily from cuttings taken from branches 2 to 4 years old and

quickly buried deeply in soil without defoliation. The trees begin to bear when 3 years old and reach peak production in 15 years; die in about 25 years.

Citrus hybrids:

A number of citrus hybrids, in addition to tangelo, tangor, Uniq fruit, and calamondin listed separately, and have been developed by plant breeders. These include (1) Tangors ('King Orange', 'Tankan' mandarin) are: Mandarin orange x sweet orange, and are generally intermediate in characteristics. Several varieties are grown to a limited extent. Temple, generally listed as a sweet orange, is probably of such parentage. (2) The citranges are crosses of trifoliate orange and sweet orange. Several varieties are in cultivation to a limited extent. The juice is tart, and makes an acceptable drink. Trees are hardier than lemons or limes. Fruit varies from $\geq$ 2 1/2 inches in diameter, and is rather thin-skinned. (3) Citrangequats are crosses of citranges and kumquats. These trees are relatively hardy. Fruits are useful for drinks and marmalade. It is a trigenic hybrid cross between the trifoliate orange, sweet orange, and kumquat. In Florida, it is grown as the 'Thomasville' variety. It is pear-shaped, with a blaze-orange rind that is quite pebbly. The flesh is golden and seedy and it has a acidic flavor unless fully mature, when it becomes sweet enough for eating fresh. (4) Citrangedins are hybrids of citrange and calamondin. The one named variety is hardy, and suitable for culinary use. (5) Limequats (x citrofortunella sp.) are crosses of lime and kumquat, and resemble limes except they are much hardier. (6) Lemandarin (*Citrus limonia* Osbeck) ('Rangpur' lime, Mandarin lime, 'Otaheite' orange) are crosses of lemon and tangerine. (7) Natsudaidai and small or medium sized tangelos are possibly cross of mandarin and shaddock. (8) Tangelolo is cross of grapefruit and tangelo. (9) Chironja is a cross of sweet orange and grapefruit as an orangelo which is sweeter than a grapefruit and grown in Puerto Rico. (10) Oro blanco is a cross of pummelo and grapefruit. (11) Calamondin is a cross of kumquat and tangerine. (12) Tangelos (*Citrus x tangelo* J.W. Ingram & H.E. Moore) (Uniq fruit, Ugli® fruit) are a cross of grapefruit and tangerine, (13) Lemonquat is a cross between lemon and kumquat, and (14) Procimequat is a cross between the 'Eustic' limequat and the 'Hong Kong' kumquat. None of the above hybrids, except tangors, tangelos, Uniq fruit, calamondin, oro blanco, and chironja, are in commerce, but are useful for home gardens in areas too cold for other citrus. Citranges are important as rootstocks for other kinds of citrus. Some of the citrus have been discovered by breeders and some have originated by chance. As a result, we now have in commerce Mandarin orange x grapefruit crosses called tangelos, sweet orange x Mandarin crosses called tangor, and others.

Grapefruit:

Grapefruit is one of the important citrus fruits. The tree tends to be more vigorous than orange, especially when young, with larger and thicker leaves. In the early years of growing, the customary citrus rootstocks were utilized. Cultural method is similar to that of the orange except that wider spacing is necessary. Fruit is near round to oblate, 3 to 4 1/2 inches in diameter with a rather thick rind. Varieties may be seeded or seedless, and

flesh may be white, red or pink. Fruit sets in small clusters on vigorous trees. Cultivars are Red type (‘Henderson’, ‘Ray’, ‘Rio red’, ‘Flame’, ‘Star ruby’, ‘Marsh ruby’) and White type (Marsh seedless). The grapefruit tree reaches 15 to 20 ft (4.5 - 6 m) or even 45 ft (13.7 m) with age, has a rounded top of spreading branches. The twigs normally bear short, supple thorns. The evergreen leaves are ovate. Flowers are white, 4-petalled. The fruit is nearly round or oblate to slightly pear-shaped, 4 to 6 in (10 - 15 cm) wide with smooth, finely dotted peel, up to 3/8 in (1 cm) thick, pale-lemon, sometimes blushed with pink, and aromatic outwardly; white, spongy and bitter inside. The center may be solid or semi-hollow. The pale-yellow, nearly whitish, or pink, or even deep-red pulp is in 11 to 14 segments with thin, membranous, somewhat bitter walls, very juicy, acid to sweet-acid in flavor when fully ripe. While some fruits are seedless or nearly so, there may be up to 90 seeds about 1/2 in (1.25 cm) in length. Unlike those of the pummelo, grapefruit seeds are usually polyembryonic. The number of fruits in a cluster varies greatly; a dozen is unusual but there have been as many as 20. Grapefruit bloom to harvest varies from 8 to 14 months, depending on location. In Florida, all commercial cultivars reach legal maturity in September or October if sprayed after blooming with lead arsenate to reduce acidity. Grapefruit yields range from 8,000 lb/A in Arizona to 38,000 lb/A in Florida.

Japanese summer grapefruit:

The Japanese summer grapefruit is cultivated mostly in India and Japan.

Kumquat:

Kumquats are small, citrus-like fruits that will hybridize readily with citrus, but are not now classified botanically as citrus. The fruits are small and deeply colored, produced on small, evergreen trees that are somewhat hardier than citrus. Fruit shape is round or distinctly oval, the latter being about 1 inch in diameter by 2 inches long. Rind is thin and edible, so the whole fruit may be eaten out of hand. In the United States, kumquats are grown mainly in home gardens as ornamentals. Clusters of the highly colored, attractive fruits are frequently placed in gift packages for the ornamental effect. A few trees may be found in citrus orchards, especially of growers catering to gift package trade. Whole fruits, except for seeds, are sometimes made into marmalade. F. obovata is cultivated in SE China, it is also known as Fukushu kumquat, and sometimes ‘Changshou’ kumquat. The ‘Fukushu’ kumquat bears edible round to obovate fruits, with an acidic pulp and a sweet rind. It is a relatively vigorous tree with more rounded leaves than other kumquats. Flowers are simple, white and very fragrant. The fruit is round to obovate. *Fortunella polyandra* is native to Asia. The various kumquats are distinguished as botanical species rather than as cultivars. The following are those most utilized for food: 'Hong Kong', or ‘Hong Kong Wild’ (F. Hindsii Swing.), called chin chü, shan chin kan, and chin tou; 'Marumi', or ‘Round Kumquat’ (F. japonica Swing., syn. *Citrus maduremis* Lour.); 'Meiwa', or ‘Large Round Kumquat’ (*F. crassifolia* Swing.), called ninpo or neiha kinkan; 'Nagami', or ‘Oval Kumquat’ (*F. margarita* Swing.). The kumquat tree is slow-growing, shrubby, compact, 8 to 15 ft (2.4 - 4.5 m) tall, the branches light-green

and angled when young, thornless or with a few spines. The apparently simple leaves are alternate, lanceolate, 3.25 - 8.6 cm long, dark-green, glossy above, sweetly fragrant, white flowers are borne singly or 1 to 4 together in the leaf axils. The fruit is oval-oblong or round, 1.6 - 4 cm wide; the edible peel is golden-yellow to reddish-orange, with large, conspicuous oil glands, fleshy, thick, tightly clinging, the outer layer spicy, and the inner layer sweet; the pulp is scant, in 3 to 6 segments, not very juicy, acid to subacid containing small seeds or sometimes none; they are green within. Kumquats are believed native to China. In 1712, kumquats were included in a list of plants cultivated in Japan. They have been grown in Europe and North America since the mid-19th Century, mainly as ornamental dooryard trees and as potted specimens in patios and greenhouses. They are grown mainly in California, Florida and Texas; to a lesser extent in Puerto Rico, Guatemala, Surinam, Colombia and Brazil. In South India, they can be grown only at high elevations. There is limited cultivation in Australia and South Africa. Season: bloom to harvest: 8 to 10 months. Cultivation: As other kumquats, the 'Fukushu' kumquat should be relatively frost hardy. It needs well-drained soil. Generally propagated by cuttings, air layers, or grafted. Kumquats are available November to March in the marketplace and are grown in Southern California and Florida. Other production regions: Native to China, also grown in Central and South America and South India.

Lemon:

Lemons are one of the important acid citrus fruits. Young lemon trees grow rapidly, and tend to be more spreading than oranges or grapefruit. Trees are slightly less hardy than oranges. Fruits are generally oval in shape, about 2 1/4 inches in diameter and 2 1/2 to 4 3/4 inches long. Most are picked when they reach a certain size and are still green in color. The peel is 6 – 10 mm thick with the pulp is pale-yellow and in 8 – 10 segments. They may be stored up to several months prior to marketing. Major harvest is during the spring months, while major demand is during mid and late summer. Acidic lemons are the only type grown for commercial purposes in the U.S. and with Eureka and Lisbon cultivars in California and Arizona. Florida grows the Sicilian types of lemons ('Avon', 'Harney' and 'Villofranco'). The lemon prefers a soil pH ranging from 5.5 – 6.4. Lemon trees are not adapted to mechanical harvesting. The true home of the lemon is unknown, though some have linked it to northwestern India. The tree reaches 10 to 20 ft (3 - 6 m) in height and usually has sharp thorns on the twigs. Leaves are alternate, mildly fragrant flowers may be solitary or there may be 2 or more clustered in the leaf axils. Bloom to harvest is from 9 to 14 months, depending on temperatures. Florida lemons were picked from mid-July to October for shipping fresh, and the balance in November was harvested for processing. The lemon is more sensitive to cold than the orange and less able to recover from cold injury. In the U.S. Florida lemon orchards are repeatedly destroyed by freezes. Lemons are grown in both dry and humid atmospheres, the latter being a disadvantage mainly in the processes of curing and storing. The lemon tree has the reputation of tolerating very infertile, very poor soil. The rough lemon is widely grown from seed. The 'Meyer' lemon is easily reproduced by rooting large cuttings in the nursery and planting them directly in the

grove. They fruit 2 to 3 years sooner than the budded trees and have a long life, remaining in full production for over 30 years, perhaps much longer. Lemon trees should be spaced 25 ft (7.6 in) apart each way. One tree can produce 500 – 600 lemons a year. Lemon yields range from 16,000 lb/A in Arizona to 32,000 lb/A in California. One thousand lemons yield between 1 - 2 lb oil, and lemon juice yields are from 6.7 – 8.6 % citric acid.

Lime:

Limes grow on relatively small, much branched citrus trees. Fruits are of several types. The Mexican or Key lime fruit is near round to egg shaped 1 to 2 inches diameter, with thin rind and acid pulp. Tahiti limes are larger, 2 to 2 ¾ inches in length and 1 7/8 – 2 ½ inches in diameter (4.7 – 6.3 cm) and usually seedless. Low acid or sweet limes are available and grown in some countries, but rarely in the U.S. The lime is considered the most tropical of all the citrus fruits. Limes have been crossed with other types of citrus to make hybrids. Cultivars of 'Tahiti' lime are 'Bearss', 'Idemor', and 'Pond'. Tahiti limes are harvested 8 to 12 times per year with the peak period July to September. The Tahiti lime is presumed to be a hybrid of the Mexican lime and citron. It is widely cultivated in tropics and subtropics, probable origin tropical Asia. Lime groves are planted in rows 20 – 25 ft (6 – 3.7 m) apart and hedged to a width of 6 – 8 ft (2 – 3 m). The Mexican or Key lime is native to the Indo-Malayan region. The tree is exceedingly vigorous, may be shrubby or range from 6 1/2 to 13 ft (2 - 4 m) high, with many slender, spreading branches, and usually has numerous, very sharp, auxiliary spines to 3/8 in (1 cm) long. The evergreen, alternate leaves are pleasantly aromatic, densely set. Faintly fragrant or scentless flowers white but purple-tinged when fresh, and 20-25 bundled white stamens with yellow anthers. The fruit, borne singly or in 2's or 3's (or sometimes large clusters), at the twig tips, is round, obovate, or slightly elliptical, 1 to 2 in (2.5-5 cm) in diameter. Peel is green and glossy when immature, pale-yellow when ripe, somewhat rough to very smooth, 1/16 to 1/8 in (1.5 - 3 mm) thick. Pulp is greenish-yellow in 6 to 15 segments which do not readily separate, aromatic, juicy, very acid and flavorful, with few or many small seeds, green inside. The Tahiti lime can yield 400 – 3500 lb fruit/year, and good groves will produce 30,000 – 40,000 fruit/A/year. Bloom to harvest: 9 months for Mexican limes; 12 months for Tahiti lime type. Seedlings will begin to fruit in 3 to 6 years and reach full production in 8 to 10 years. The Tahiti lime tree grows to 20 ft tall (5 m) but can be pruned to any size. The fruits ripen and fall 4 to 6 months after flowering. The key lime will drop off the tree when they ripen and do not have to be picked. Trees grown from air layers or cuttings tend to fruit the first year and then cease fruiting until they have attained some growth. On the Florida Keys, the trees produce some fruits more or less the year around, but there are two main seasons – May/June and November/December. The trees are best set 25 ft (7.5 m) apart each way, which allows for 70 trees per acre (28/ha). The EPA Crop Production Regions are 3 and 10 with most of the acreage in Region 3. However, due to Hurricane Andrew in 1992 and citrus canker the lime industry in Florida has practically disappeared and production statistics in Florida for limes has not been reported since 2002. Yields of limes at that time were about 16,000 lb/A.

Lime, sweet:

The sweet lime tree and its foliage, and the form and size of the fruit resemble the Tahiti lime. Sweet lime is thought to be a hybrid between lime (Mexican-type), and a sweet lemon or sweet citron It is propagated from cuttings. The EPA Crop Production Region 10 is the only growing region for sweet limes in the U.S.

Mediterranean mandarin:

The Mediterranean mandarin is a small tree 2 - 6m in height; it has a rounded crown, frequently without thorns. The leaves are narrowly elliptical or lanceolate, 4 – 8 cm long and 1.5 – 4 cm wide and light green in color. The petioles have a very short wing. The flowers are white and fragrant. The fruits are small, 5 - 7.5 cm in diameter, with thin skin which comes off easily; they are slightly flattened and orange in color.

Mount white lime:

The mount white lime is native to tropical Asia and Australia. The species is endemic to the foothills and upland rainforest of the Cook District, Mt White on Cape York Peninsula in Australia and Goodenough Island in Papua New Guinea. It grows in deciduous vine thickets as an under-storey shrub and has been recorded at a height of 15m. Due to its limited distribution, this species is now classified as rare and is protected under the Queensland Nature Conservation Act 1992. It is similar to the finger lime, but has broader leaves. The flowers are single, auxiliary and the tree bears fruit from April to November. The fruits are also 'finger-shaped', with a green skin and greenish-white pulp on maturity. The fruit have fewer cells than the finger lime, a thicker skin (up to 2mm) containing large oil glands and weigh an average of 25g and re oblong in shape. Oil glands large, giving a tuberculose appearance to the fruits; ultimately these glands sink, and the fruit appears then to be lacunose; rind very thin; cells 4 or 5; pulp of a sharp agreeable acid; seeds 3-angular, white, free, with more or less very short hairs, about 3 lines long and 2 lines thick in the center.

New Guinea wild lime:

The New Guinea wild lime has small globular fruits, the elongate-elliptical, crenulate leaves, and the narrowly subcrenulate-margined, very short petioles separate this New Guinea species very clearly from the other species of *Microcitrus*. This is the only species of the genus outside of Australia, and it occurs nearly a thousand miles away from *M. garrawayi*, the Australian species of *Microcitrus* growing nearest to New Guinea. The fruit has a deep green rind covers a pale green flesh and the interior pulp has several seeds. It has no individual segments. This is the only species of the genus *Microcitrus* outside of Australia.

Orange, sour:

The sour orange is similar to the sweet orange in tree and fruit appearance, but is characterized by a very acid pulp and by a hollow axis or core in the fruit. Cut fruits and crushed leaves have a characteristic, very strong odor. Fruit is too acid for fresh use but is used for marmalade. Sour oranges are thought to be a hybrid between the pummelo and the tangerine. The sour orange was widely used as a rootstock for other varieties prior to the appearance of the Tristizia virus disease, which affects trees on this stock. It is still used in areas where Tristizia is not important. The Bergamot oranges, grown in Mediterranean areas for oil, belong in this group. They are not grown commercially in the U.S. There are no orchards of sour orange, but numerous plantings of a few trees serve as seed sources for rootstocks. Yuzu is a distinctive hybrid citrus fruit most likely a variety of bitter orange. It is one of the most cold-resistant of the citrus fruits; it grows wild in Tibet and the interior of China. It is cultivated on a small scale in parts of China and Japan. The yuzu tree bears fruit from late autumn, and the sight of ripe golden you suggests to the Japanese that winter is approaching. The fruit is the size of a mandarin orange and has a thick uneven skin and paler flesh containing many seeds. It smells something like a lime, but its fragrance is unique. The Japanese often wrap several of the fruits in cheesecloth and float them in a hot bath so they will give off a relaxing scent. Other sour orange trees range in height from less than 10 ft (3 m) to 30 ft (9 m) is more erect and has a more compact crown than the sweet orange. It has smooth, brown barks, green twigs, thorns from 1 in to 3 1/8 in (2.5 - 8 cm) long. The evergreen leaves are aromatic, alternate, on broad-winged petioles much longer than those of the sweet orange. The highly fragrant flowers, borne singly or in small clusters in the leaf axils, are about 1 1/2 in (3.75 cm) wide, with 5 white, slender, widely-separated petals surrounding a tuft of up to 24 yellow stamens. From 5 to 12 % of the flowers are male. The fruit is round, oblate or oblong-oval, 2 3/4 to 3 1/8 in (7 - 8 cm) wide, rough-surfaced, with a fairly thick, aromatic, bitter peel becoming bright reddish-orange on maturity and having minute, sunken oil glands. There are 10 to 12 segments with bitter walls containing strongly acid pulp and from a few to numerous seeds. The center becomes hollow when the fruit is full-grown. The bloom to harvest varies from 8 to 12 months. The sour orange flourishes in subtropical, near-tropical climates, yet it can stand several degrees of frost for short periods. Generally it has considerable tolerance of adverse conditions, but the ‘Bergamot’ orange is very sensitive to wind and extremes of drought or moisture. Sour oranges are sometimes used in marmalades and liqueurs. Unlike its sweet relative, the sour orange does well on low, rich soils with a high water table and is adapted to a wide range of soil conditions. Sour orange trees volunteer readily from self-sown seeds. As generally grown for rootstock for sweet oranges, they are raised in nurseries for 1 or 2 years and then budded. Growth of the seedlings, especially in diameter, has been expedited by weekly applications of gibberellic acid to the stems, making it possible to bud them much earlier.

Orange, sweet:

Sweet oranges are the most important of the citrus fruits. Varieties vary from early ripening, about 8 months from bloom to late, up to 16 months from bloom. There are three main groups: (1): the normal fruited, without navels and with light orange colored flesh; (2) the navel oranges, with a distinct navel development at the stylar end; and (3) blood oranges with red flesh and juice. The latter are little grown commercially in the U.S. Sweet oranges vary in size from 2 inches upward in diameter, are generally round to oblong in shape, and have a medium thick and tough rind. Although 73 varieties are listed by Webber in 1967, the major production in U.S. is mainly based on six varieties: 'Valencia', 'Washington Navel', 'Hamlin', 'Parson Brown', 'Pineapple' and 'Temple'. 'Valencia' has few seeds and available from Florida, California, Arizona and Texas. 'Navel' is seedless and available from Arizona, California, and Texas, 'Hamlin' is nearly seedless and 'Pineapple' is seedy. Blood orange (pigmented orange, Sanguine orange) has few seeds with deep burgundy interior and available from California. Chinese navel oranges are grown in California. The 'Jaffa' ('Shamouti') is a popular eating sweet orange which is easy to peel and has no navel. It is grown in the western U.S The sweet orange bloom to harvest time varies from 8 to 16 months depending on variety and area of production. The only variety of oranges in Florida that usually has two crops of fruit on the tree after bloom is the 'Valencia'. Flowering of oranges in Florida begins in March. While the orange will often come true from seed because of nucellar embryos, the common means of assuring the reproduction of cultivars of known quality is by budding onto appropriate rootstocks. A spacing of 25 x 25 ft (7.5x7.5 m) was standard in the past. However, many orange groves today are being close-planted and hedged to facilitate both manual and wide enough to accommodate mobile machinery for fertilizing, spraying, pruning and harvesting. Common spacing for oranges in Florida is 15 feet square to 194 trees/A. Orange trees are self-forming and do not need to be shaped by early pruning. Bearing citrus trees are mechanically hedged to keep row middles open for harvesting operations. Yields of oranges range from 10,000 lb/A in Arizona to over 30,000 lb/A in Florida. Majority of oranges in Florida are produced by practices that maximize fresh fruit production even though 90 % of those harvested are processed for juice.

Orange, trifoliate:

The genus *Poncirus* is closely related to citrus, but the small, thorny trees are deciduous. Trees are hardier than citrus, in mid-winter enduring temperatures to near 0 degrees F. Fruits are globose, up to 1 1/2 inches in diameter, and very acid and bitter. *Poncirus* will hybridize with citrus, and such hybrids have been made in efforts to increase hardiness in edible citrus fruits. Trifoliate orange seedlings are used as rootstocks for citrus, particularly for Mandarin oranges. Hybrids of Poncirus with sweet orange, called Citranges are now widely used as rootstocks. Poncirus is grown as an ornamental dooryard tree in areas too cold for citrus, and occasional trees may be maintained by nurserymen as seed sources. Fruit appears valueless in the U.S., but may be used for flavoring or marmalade in other countries. Bloom to maturity varies from 8 to 10 months. The commercial root stock group variety is 'Rubidoux' hybrid cultivated

variety is ‘Carrizo’ and are very widespread. The ornamental variety is ‘Flying Dragon’ or the ‘Japanese hiryo’, this plant was introduced to the US in 1915. Although it bears large and fragrant blossoms in the spring, it is mostly considered a curious monstrosity with its severe-looking limbs and jagged thorns. The botanical variety is ‘Monstrosa of Tokutaro Ito’ and bears golf-ball sized fruit having a rough orange rind. Its flesh is pale yellow with six to eight sections and many seeds

Pummelo:

Pummelo are important fruits in the Orient, but only scattered trees are found in the United States. Quality of the fruit has been disappointing in this country as compared to that of grapefruit, which the pummelo resembles. The fruit is oblate to globose in shape and of large size, 4 to 7 inches, or more, in diameter. The rind is generally thick over one-half inch or more. Juice vesicles separate from peel and segment fibers readily. The variety ‘Tresca’ is grown in Florida, where it is marketed as a grapefruit. ‘Oro blanco’ is a cross between pummelo and grapefruit. The pummelo is tropical or near-tropical and flourishes naturally at low altitudes close to the sea. It is native to southeastern Asia and all of Malaysia; grows wild on river banks in the Fiji and Friendly Islands. The pummelo tree may be 16 to 50 ft (5 - 15 m) tall, with a somewhat crooked trunk 4 to 12 in (10 - 30 cm) thick, and low, irregular branches. Its growing season is similar to the grapefruit. Pummelo may flower 2 to 4 times a year. The main crop matures in November but it is said that fruits that ripen at other seasons have fewer seeds and superior quality. In Florida, the fruits ripen from November to February and there may be a small crop in the spring. Most of the pummelo in the Orient are grown from seed. The seeds can be stored for 80 days at 41ºF (5ºC) and 56 – 58% relative humidity. In Thailand and elsewhere in Southeastern Asia growers like the swampy land, dig the ditches and canals for drainage and as routes of transportation, and build the raised beds for the orchards. In the 3 to 5 - year period before the beds are ready for the pummelo trees, quick crops such as bananas, sugarcane and peanuts are grown on them.

Russell River lime:

The Russell river lime has a limited distribution in the north of Queensland, Australia, growing in lowland rainforest at the foot of the Bellenden Ker range, not far from Cairns. This new species of Citrus is well worthy of cultivation for its fruit, which is juicy and of equal flavour with the West Indian Lime. In general appearance the tree resembles the orange, having the same dark green foliage. The fruit is described as oblong or elliptical, somewhat lemon-shaped, 5 - 6.5 X 3 - 3.5 cm and green when ripe.

Satsuma mandarin:

The Satsuma mandarin is one of the most important types of citrus grown world-wide, especially in China and Japan. The tree is believed to have originated from a mutation in Japan, recorded as early as 1429. It is also produced in California from mid-October to January. It is commonly called mikan in Japan, satsuma mandarin in the United States and the UK, and clementine or tangerine in Canada. It is less commonly called satsuma tangerine or satsuma orange. Its fruit is sweet and usually seedless, about

the size of a mandarin orange (*Citrus reticulata*), smaller than an orange. The skin can be peeled easily. Fruits are usually larger than other tangerines. This fruit is grown primarily for the fresh market.

Tachibana orange:

The tachibana orange grows to about 8 - 10 ft. (2.4 - 3 m) tall. Whitish blooms. Evergreen leaves are aromatic and shiny glossy-textured and the flowers are white. It is hardy to USDA Zones 7 – 11. It is a cold hardy type of loose-skinned fruit, and is described by the plant taxonomist Tanaka as a very primitive type of native citrus of Japan. It blooms in mid spring to early summer.

Tahiti lime:

The Tahiti lime is a moderately vigorous growing tree that is medium to large, up to 15 to 20 ft (4.5 - 6 m), with nearly thornless, widespread, drooping branches. The leaves are broad-lanceolate, with winged petioles; young shoots are purplish. Flowers, borne off and on during the year but mainly in January, are slightly purple-tinged. The fruit is oval to oblong or short-elliptical, usually rounded at the base, occasionally ribbed or with a short neck; the apex is rounded with a brief nipple; 1 1/2 to 2 1/2 in (4.0 - 6.25 cm) wide, 2 to 3 in (5.0 - 7.5 cm) high; peel is vivid green until ripe when it becomes pale-yellow; smooth, thin, tightly clinging; pulp is light greenish-yellow when ripe, in 10 segments, tender, acid, but without the distinctive bouquet of the Mexican lime; usually seedless, rarely with one or a few seeds, especially if planted among a number of other Citrus species. The Tahiti lime flowers have no viable pollen. The origin of the Tahiti lime is still unknown, but it is presumed to be a hybrid of the Mexican lime and citron, or, less likely, the lemon. Florida has produced over 90% of the national lime crop. Tahiti limes are harvested 8 to 12 times a year and once a month in winter, but 70% of the crop matures from May to fall. The peak period is July to September. The Tahiti lime is hardier than the Mexican lime and better adapted to the mainland of Florida. The plantings in southern Florida are on limestone. Those grown further north are on deep sand. The soil must be well drained. In lowland areas subject to standing water, lime trees are planted on elevated beds. Spacing may be as close as 10 or 15 ft (3 - 4.5 m) in rows 20 ft (6 m) apart, which permits about 150 to 200 trees per acre (60 - 80/ha). When the trees overlap, they are mechanically hedged and topped. Greater yields will result if the trees are spaced at 20 ft (6 m) and hedging and topping are performed at 2 -to 3 -year intervals

Tangelo and Uniq fruit:

Crosses of grapefruit and tangerine oranges have resulted in several varieties, termed tangelos, which are increasing in production and popularity in the United States. These hybrids are intermediate in character between the parents. Fruits are similar in size to sweet orange, but with a tendency to be necked at the stem end. They are extremely juicy and intermediate in acidity between the parents. Peel is relatively thin and tender. General characteristics are similar to sweet orange, except for more tender peel and juicier and tarter flesh. The bloom to harvest: 8 to 14 months. Some cultivars are 'Minneola' ('Honeybell'), 'Orlando', 'Nova', 'Early K' ('Sunrise tangelo'), and 'Sampon'. The 'Uniq' or 'Ugli®' tangelo of Jamaica is believed to be a chance hybrid between mandarin orange and grapefruit. They range in size from a navel orange and a large grapefruit.

Tangerine:

Tangerines are characterized by a loose skin which separates readily from the pulp, and by segments which separate readily from each other. Fruit is generally oblate and smaller than sweet or round oranges. Diameter is mostly 2 l/2 inches or less, though some varieties average larger. Tangerines are grown in all citrus areas of the U.S. and are considered the hardiest of the citrus fruits. Unlike other citrus, tangerines cannot be pulled off the tree since the peel will be broken and they must have their stems clipped to protect the fruit. Tangerines must be two main types are grown in the U.S.: The Satsuma group, characterized by a small tree hardier than other citrus, and early ripening fruit of yellow or light orange color; and the tangerine group, characterized by deep orange color and later ripening. Some Satsuma plantings are along the Gulf States that are in areas too cold for other citrus. 'Dancy' is the leading variety of Tangerine and 'Owari' of Satsuma. About 10 other varieties occur occasionally. 'Clementine' is a cultivar of Citrus reticulata. Tangerine cultivars are 'Dancy', 'Algerian', 'Fallglo', 'Fairchild', 'Honey' ('Murcott'), 'Robinson', and 'Sunburst'. Mandarin cultivars are 'Royal mandarin', 'Honey, 'Satsuma', 'Clementine', and 'Kara'. Tangerine yields range from 9,000 lb/A in Arizona to 25,000 lb/A in Florida.

Tangor:

Tangors are deliberate or accidental hybrids of the mandarin (Citrus reticulata) and the sweet orange (*C. sinensis*). Varieties include 'King' (King of Siam), a medium size tree formerly identified as *Citrus nobilis* Lour. It was believed to be originated in Malaya. Fruit is large about 6.25 - 9.5 cm wide and 5.7 - 9 cm high with thick and rough peel; 'Murcott' (or Honey Murcott'; 'Murcott' 'Honey Orange'; 'Red'; 'Big Red'; 'Honey Bell' tangelo) is medium size about 7.0 - 8.0 cm wide, 4.7 - 5.2 cm high with a glossy smooth and thin peel; 'Temple' (believed identical to the 'Magnet' of Japan) is medium to large about 6.6 - 8.25 cm wide, 5.7 - 6.25 cm high with glossy, slightly

rough, loose, and thick peel, 'Umatilla' is much like 'King', large about 8.25 - 12 cm wide, 6.25 - 7 cm high with smooth, glossy, medium-thick peel; 'Ortanique' is believed to be a chance cross of sweet orange and tangerine and was discovered in Jamaica. The name is an amalgam of OR(ange)TAN(gerine)(un)IQUE. Climate affects the look, feel, and taste of this fruit dramatically. In tropical Jamaica, the fruit is seedless and a pale orange in color, with juicy, sweet orange flavor and a thin rind. In Mediterranean Israel, the fruit has some seeds, a fairly thick rind, and a mid-orange color, while in semitropical Cyprus, is has a deep orange color, many seeds, and a thicker rind. The Temple tangor fruit matures from January to March. Temple has been propagated on many rootstocks but does best on the less vigorous ones which tend to produce fruit of best quality. Their flowers produce abundance of pollen often being used as pollenizers for self-incompatible varieties such as ‘Orlando’, ‘Nova’, and ‘Minneola’ tangelo and ‘Robinson’ and ‘Sunburst’ tangerines.

Worker Activities (Adapted from USDA Citrus Crop Timelines)

Development of Rootstock

Rootstock seeds are treated with a fungicide. Following treatment seeds are cold stored until sold to nurseries. Seeds are planted in multi-cell trays and grown in greenhouses. Pest management is performed on an as needed basis. These rootstock seedlings, called liners, are very thorny. After about three months, liners are pulled from the germinating trays using heavy leather gloves and either transplanted into pots or the field. Transplanters use latex gloves. Transplanted liners are then held in either the greenhouse or field for an additional three months, and pest management is the same as that for the germinating trays.

Certified virus-free mature citrus trees (mother or budwood trees) are used as a source for budwood (scions). Budsticks six to twelve inches in length are cut by hand and all leaves removed. In the process of budding, all leaves are stripped from the rootstock seedling by hand and the strippers wear heavy leather gloves for protection against thorns. Budders will make knife cuts in liner stem and insert the budwood. The budder is followed by wrappers who tie plastic wrap around the bud union. There are usually two wrappers per budder. The wraps are removed after three weeks. There is no contact with foliage as all leaves have been removed by strippers. A team of one stripper, one budder, and two wrappers can bud 1,000 to 2,000 plants per day. This operation is usually conducted over a 40-hour work week throughout the year. Nurseries generally grow 30,000 to 100,000 seedlings annually, and the statewide inventory of seedlings is approximately 25 million.

After the wrapper is removed, the bud is "forced" to grow by one of three methods:

1. Liner is cut off above bud. The plant trash remaining is removed from the greenhouse/field by workers using leather gloves. Approximately 60 percent of the nurseries use this method.
2. Stem above bud is cut half through. The stem is bent over and will eventually be cut off and carried off by gloved workers. Approximately 30 percent of nurseries use this method.
3. The stem above the bud is bent over and tied to the base of the plant. Heavy leather gloves are worn as protection from thorns.

Once the bud begins to grow, the plant is staked and new growth periodically tied. There is minimal contact with plant parts during this process. Seedlings grown in a greenhouse are periodically moved to maximize utilization of light and water. The seedlings are ready for sale and planting within six to nine months of wrap removal. There is little foliar contact during pesticide applications during this period.

Establishment of the Grove:

Grove establishment in a "normal" grove situation would be done when plants are too mature to be profitable, or when new land is to be planted to citrus. This process is done rather infrequently with respect to total citrus acreage in Florida. More common are "resets" which are used to fill spots in the grove where previous trees have died out or become unproductive. Both of these procedures involve the use of methyl bromide or some other fumigant/sterilant to sterilize the soil. Land is tarped and sealed during entire grove establishment and holes are fumigated as needed for resets. Since groves don't sterilize on a yearly basis as do some other agricultural commodities, the entire grove sterilization process is contracted to certified applicators. The teams that perform the reset operation are often two or three-man, equipped with a back-hoe. Once grove soil is prepared and micro-irrigation has been laid, seedlings are planted by gloved hand.

Irrigation

Micro-irrigation is set at grove establishment. For this type of irrigation, there is no worker contact, except during construction, when pesticides would not be expected to be present. If high-rise irrigation is not permanently set in northern groves, it may require a number of workers working nonstop to set it up for one or more nights of freezing weather. However, these conditions are during periods where pest management is not active, and includes little of the main citrus crop acreage.

Cultivation/Weed Control

Although cultivation is not used in the grove setting, mowing row middles does occur on a large percentage of the citrus producing acreage. Chemical weed control is generally used under the tree canopies to maximize fertilizer and water efficiency. In the row middles, vegetative strips are mowed as needed. This process requires one person on a mower-equipped tractor, no hand labor is required. The operator can cover approximately 25 to 40 acres per day.

Scouting and Pesticide Applications

Scouting is conducted for pest pressures which are variable, such as insects and plant pathogens. Ninety-seven percent of Florida citrus acreage was scouted for pests in 2003 and the results were used to make decisions for approximately half of the citrus acreage. Prophylactic programs are used for pressures such as weeds, nematodes, and post-harvest diseases. The intensity of scouting is correlated to key pest emergence times and conditions. Certified crop advisors and their assistants review their counts and consult on crop protection methods, if so needed by the grower. No workers are used for scouting.

A survey conducted in the early 90s revealed that most growers use air-blast sprayers for field application of foliar insecticides and fungicides, while boom equipment is used for herbicides and soil-applied insecticides, nematicides, and fungicides. (Crop Profiles, Florida) In addition to the tractor driver (the applicator), there is a second worker used as the mixer/loader. The make up of the team varied among growers from one or two applicators plus one mixer/loader (the most common), to seven applicators plus four mixer/loaders. The total number of spray employees thus ranged from two to 40 workers. The range of acres serviced per employee was 140 to 767. Crews worked a 9.5 - to 14-hour workday, five to six days a week, for three to 25 weeks of spraying per year. A single applicator normally applied four to 30 tanks (500 gallon) per workday, covering an area of eight to 55 acres per workday. Approximately half of the surveyed growers reported using enclosed cabs.

Grapefruits have a spray program of 4 – 8 sprays beginning at bloom (March – April) and continuing through late summer. There are five basic periods throughout the year during which pesticides are applied. The post-bloom spray commences sometime between March 1 and April 15 and takes from two to seven weeks to complete. Target pests for this spray period are melanose, scab, and citrus rust mite. Nutritional materials

are often added to this spray as well. The second, supplemental, application is often the same as the first application, and usually is applied over the six weeks between mid-April and the end of May. The summer spray occurs in June or July. This is the petroleum oil spray and it may also contain other active ingredients to control greasy spot, mites, or scales. The fall spray is conducted between mid-august through year end, and there maybe a supplemental sprays in addition, on an as-needed basis. These sprays are often miticides to control rust and/or spider mites on fresh market fruit.

Survey results revealed that about ten % of growers used aerial application on about 40 percent of their acreage. When aerial application is used, it is largely for micronutrients. However, the remaining respondents said infrequent use of aerial application was not uncommon when a rapid application was necessary (especially in fresh market citrus). Pilots operated for 14 to 23 weeks per year, with wind velocities of five to ten MPH precluding spraying on 15 % of those days.

Approximately a third of the survey respondents reported using hand-gun application for citrus resets. Additionally, most of the sprays occurring in the nursery setting are either with hand-gun or pump-up sprayers.

Hedging/Pruning

Hedging and topping are carried out after fruit harvest so that fruit is not affected (except Valencia). This process is conducted by a dedicated crew of people who follow after the harvest and mechanically hedge and top throughout the year. Some managers hedge and top every tree row each year, while others hedge every other year (Valencia). The crop residue from this process is eventually mowed into mulch when the row middles are mowed for weeds.

Rind color and quality are crucial only to the fresh fruit market. Such fruit, destined for packinghouses following harvest, must have cosmetic appeal to consumers even though apparent imperfections in the outer rind usually do not adversely affect the internal quality of the fruit. Greater pest management inputs are required for fresh fruit production. Approximately 60 - 65 % of the fruit passes the fresh fruit quality tests. Failure of quality tests is due mainly to poor color, rind blemish caused by citrus rust mites, scab, melanose and greasy spot, or inadvertent puncturing of fruit as it is picked. Rejected fruit is usually processed. Approximately 95 % of oranges are processed, and 50 % of grapefruit is processed. Generally, very little grapefruit is produced with the intention of it being processing, so fruit quality and finish must be maintained which requires precise season-long management of citrus pests such as citrus rust mites, scab and melanose. As mandated by law, fresh citrus fruit is treated with postharvest fungicides to inhibit decay.

COMPARISON OF HARVESTING, JUICE PROCESSING, POSTHARVEST HANDLING, RAW AGRICULTURAL COMMODITY (RAC), EDIBLE PORTIONS, AND PROCESSED FOOD ITEMS FOR THE CITRUS FRUITS:

Harvest Method

Citrus is usually hand harvested, whether processed or marketed fresh. Mechanical harvesters have been used for processed fruit in Florida and are increasing in popularity due to high labor costs and lack of labor availability.

Unlike most fruits citrus matures on the trees. All citrus are nonclimacteric fruit, meaning that they ripen gradually over weeks or months and are slow to abscise from the tree. External color changes during ripening, but is a function of climate more than ripeness, and a poor indicator of maturity. The best indices of maturity for citrus are internal: Brix (sugar), acid content, and the Brix/acid ratio. .

Grove managers take representative samples of oranges from a particular block of trees, about 40 pieces of fruit for a 40 acre block. The juice is squeezed from the sample fruit and the juice is tested for two main attributes – brix (sugar content) and acid. From these two attributes, the sugar: acid ratio is used to determine the flavor of the juice. Juice must meet minimum standards in order for it to be sold as 100% Florida Orange Juice. The minimum maturity for oranges varies during the season, but generally it is a minimum of 8.5 brix with a 10 to 1 ratio. Many juice processing plants will have even higher minimum maturity standards.

Once a orchard block is determined ready for harvest, a crew of harvesters is sent to pick the entire block of fruit by hand, using wooden ladders and canvas pick sacks. In Florida, almost 96% of all oranges are still harvested by hand. Since 1999, the industry has been harvesting a portion of the processed orange crop with mechanical harvesters. The three types of machines being used commercial are the continuous canopy shake and catch system, the trunk shake and catch system, and the tractor-drawn continuous canopy shaker. During this time, over 90,000 acres have been mechanically harvested, all at a savings versus hand harvesting. In the 2004 – 2005 season only 15,000 A or about 2.5% were mechanically harvested. The pickers dump the fruit into plastic tubs that hold approximately 900 pounds of oranges. A special truck, called a "goat", will then come through the grove and, using a hydraulic boom, pick up the tub and dump it into the back of the goat into a special body. Most mechanically harvested fruit is harvested directly into a goat. The goat then goes outside the block of trees and the body rises up and dumps its load of oranges into a large open tractor-trailer that holds about 45,000 pounds of oranges. A truck-tractor then hauls the trailer to the processing plant.

Hand harvesting oranges

Dumping full bag into a tub

Full tub of oranges

Mechanical Tree Shaker

A fruit loader or "goat"

Dumping tub into the goat

Goat dumping oranges into a waiting trailer

Harvest

The largest period of time that agricultural workers come in contact with mature citrus trees is during harvest, which is usually done by hand. All oranges except Valencia have the potential to be machine-harvested. Currently, over 95 percent is hand-harvested versus machine-picked. The pickers use 20-foot ladders which are propped up on the tree limbs as the fruit is picked. The fruit is placed in a long bag that is eventually emptied into either a bulk trailer (processed citrus) or bins/boxes (fresh fruit). The fruit is then transported to either the processing plant or the packinghouse. The workers will dress in long-sleeved shirts and pants due to the abrasive nature of the citrus foliage. However, citrus is picked with a bare hand. Pickers never contact mechanically-harvested citrus since it is bound for the processing plant. Off grade fruit color fruits go to juice processing plants. On average, one picker can pick ten 90-pound boxes per hour. Production averages 300 to 400 boxes per acre depending on variety. Fresh fruit pickers work a 30 hour week during the harvest season and process pickers work a 40- hour week (fruit picked for the fresh market must be dry of dew/rain prior to harvest). For fresh fruit, standard packing line operations are used in this order: dumping, culling, washing, brushing, waxing, drying, grading by humans, sizing, and boxing. Oranges, grapefruit, and tangerines/hybrids mature and are ready for picking in all months but September and August (see Tables 33 and 34). Lime and lemon are harvested from June through September. Consequently, citrus harvest can occur during the entire year.

From Brown (2005). Hand picking of fruit by snapping each fruit from its stem is the traditional method of harvesting Florida oranges and grapefruit. Mechanical use in Florida is increasing about 17,000 of the 586,859 A of oranges were mechanically harvested during 2002-2004. As orchards are replaced they can be replanted more conducive to mechanical harvesting. In Florida 95% of the oranges are processed. A

field box is 90 lb and average harvest by hand is 10 FB/hr or 900 lb/hr. Crews are usually 20 hand harvesters and harvest 1500 FB/8 hr day or 67.5 lb. Future tree plantings are recommended at densities of 346 – 445 trees/ha (140-180 trees/A). (Rouse) Future plantings should be in row spacing 10 – 15 ft and 22 – 24 ft between rows. Tree heights need to be limited to 16 ft. Some of the mechanical methods harvested 500 trees/hr, or 800 FB/hr. There are eight different mechanical harvesting systems being tested. Potential to go from 8 – 10 boxes/hr to 30 boxes/hr with a trunk shaker and catch frame. Majority of mechanical harvesters are of a shake a catch system. Sanders Orange harvesting systems – A mechanical harvester has the potential to replace 20 – 50 manual pickers. Max worker rate is 0.5 t/h; shaking harvester is 10t/h and canopy harvester is 25t/h.

Postharvest

For processing citrus, fruit coming into the processing plant is hand-graded by workers on either side of a conveyor belt. Workers remove any broken or decayed fruit prior to the wash process. The number of workers depends on the number of "lines" operated by the plant. Usually six to eight workers per line work a 40-hour week during the harvest season. No protective gloves are worn during this process

For fresh market citrus, workers conduct the same initial hand-grading, which is followed by a wash, waxing, and fungicide application. Then, a second hand-grading is performed. There are usually about half of the number of graders for the second grading in comparison to the initial grading.

Since Florida lacks uniform rainfall throughout the year, irrigation must be set to water the plants during bloom and early fruit set. Irrigation is also used for freeze protection for young trees (up to five years in age). Micro-sprinkler systems (95 percent of the acreage) are used for under-canopy irrigation. Older groves that still have high-rise irrigation (five % of the acreage) may use this system to form a layer of ice on the young trees when conditions are freezing. The state water management districts require that retention ponds be constructed to receive runoff from citrus groves. These must have the capacity to hold rainwater from a one-day storm with a 10-year frequency or a three-day storm with a 25-year frequency. The first inch of runoff must be held for five days with no more than a one-half-inch discharge in any one day. This allows for pesticide degradation to occur.

Unlike other fruit, citrus must mature on the tree. It must be sampled to determine the amount of sugar (soluble solids) prior to harvest, as well as the acid to sugar ratio. Of the oranges grown in Florida, approximately 95 percent end up being

processed (either from-concentrate or not-from-concentrate) with the remainder destined for fresh market consumption. All of the grapefruit are destined for fresh market as well. Rind color and quality are crucial only to the fresh fruit market. Such fruit, destined for packinghouses after harvest, must have cosmetic appeal to the consumer. Rejected fresh fruit is processed, which still results in approximately half of the grapefruit being processed.

Since citrus fruit ripen throughout the year based on species or variety, harvest occurs throughout the year. Harvesters climb on ladders and pick fruit by hand, which is placed in a bag and taken to the bulk trailer. A small amount of processed oranges (15,000 acres or about 2.5 percent) were mechanically harvested in the 2004-05 season (4). Processed fruit heads to the processor, where it is washed and squeezed. Once fresh market fruit reaches the packinghouse, trash is eliminated, as well as split and rotten fruit. This is followed by a water spray, wash, and rinse, at which time the fruit is hand-graded. Off-grade fruit goes to processing, while fresh market fruit are treated with wax and fungicide(s), as mandated by Florida law, to inhibit postharvest decay. There is generally one more minor hand-grading that occurs after the waxing.

Processing of the Citrus Fruit Crops for Their Juice
(Adapted from Townsend, 2007, University of Florida http://www.ultimatecitrus.com/Story/oj_story.html) and FMC technologies, http://www.fmctechnologies.com/FoodTech/BeveragesJuice , and Milk/CitrusProcessing/CitrusJuiceExtractor.aspx, and Braddock, 1999, Handbook of Citrus Byproducts and Processing Technology):

At the processing plant, the trailer load of oranges is weighed on scales in order to determine the weight of fruit received, which will be used to base the payment to the grower. The trailer of oranges is then unloaded onto a conveyor belt. From this belt, the Florida Department of Agriculture and Consumer Services (FDACS) takes a representative sample to test it for juice content and maturity, and to certify the pounds solids per box (the unit that growers' payment is based upon). The fruit is then diverted to storage bins labeled according to the juice specification as determined by FDACS. Oranges are then selected from the bins to enable blending of optimal quality. The fruit is conveyed by belt through a washing process. Then it enters into the processing plant where it is graded for bad or damaged fruit. The fruit is then separated by size and sent to the juice extractors. Inside the extractors, before juicing, the peel is pricked to extract the oils found in the peel, and then the juice is extracted.

Full orange trailers on processing plant's yard

Unloading orange trailers

Orange storage bins

The oranges are washed

Then graded

Then juiced in the extractors

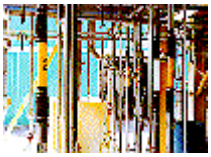
The pulpy juice next goes through a finisher screen where the pulp and seeds are removed, which, along with the peel, is diverted to be used for byproducts, such as cattle feed. From this point, the juice may either go directly into a pasteurizer in the case of Not From Concentrate (NFC), or it goes on to the evaporators where most of the water is taken out of the juice by vacuum and heat, then chilled, to yield frozen concentrated orange juice (FCOJ). This process also strips out certain essences and oils. The concentrated juice, about 65° brix, is then piped to the tank farm where concentrate is stored at about +10° F, separated by variety and ratio (brix to acid) range.

The finishers or screens

The peel/pulp dryer for cattle feed

The Waste Heat Evaporator

The evaporators; removes water from the juice



Juice is being concentrated

100,000 gal. stainless tanks of FCOJ

When ready to ship frozen orange concentrate to a customer, such as a juice packager, the concentrate is blended from the various tanks to meet the specifications of the customer and meet USDA requirements. Essences and oils (recovered in the processing process) are also added back to enhance the flavor. This blending process is how juice made from concentrate, FCOJ, has a more consistent quality year round than fresh juice or NFC. The NFC is the oldest processing technique for orange juice. The FCOJ (at about 65° brix) is either put into 55-gallon drums and shipped in a refrigerated truck, or is loaded onto a special food-grade insulated tanker truck and delivered to a packaging plant. Some Florida processing plants also have packaging plants at the same site. Many dairies around the country also package orange juice using the same equipment used to package milk. To make cans of frozen concentrate, filtered water is added back to bring the brix level down to 42° (about 3 times more concentrated than fresh juice). For chilled reconstituted (recon) ready-to-serve (RTS) orange juice, filtered water is added to bring the brix down to about 11.8°, the average of fresh squeezed juice. It is then put up into cardboard cartons, glass, or plastic jugs to be sold at the retail store. All FCOJ, Recon, and NFC forms of orange juice are always pasteurized before it reaches the consumer to protect from contaminates.

Oil separators/recovery

Insulated food grade tanker

FMC FoodTech's, Lakeland, FL citrus juice extraction systems process 75% of the world's juice production in 50 different countries. The Extractor separates the juice from those constituents which, if allowed to remain in contact with the juice for any period of time, will have an adverse effect on the end product. The fruit is penetrated by a porous tube and then crushed by interlocking fingers. The juice flows through the tube and the shredded peels are collected for further processing. A premium juice extractor (PJE) which uses components specifically designed to reduce oil levels and bitterness in juice. The PJE is ideal for both not-from-concentrate and for fresh juice. The other extraction technique is to utilize the Brown Reamer made by the Brown International, Covina, CA in which the fruit is cut in half and each half is pressed by a rotating burr or reamer to extract the juice and the peels are collected separately and further processed for oil.

For the Oil Recovery:

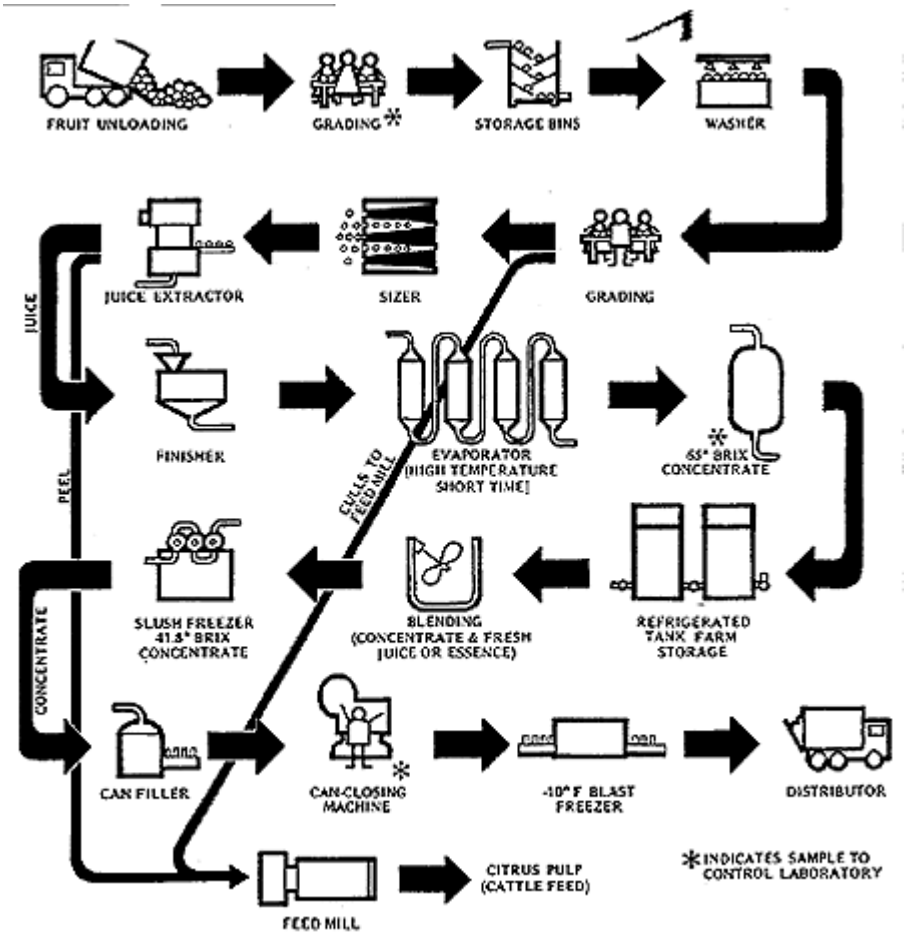
The FMC FoodTech Citrus Juice Extractor is unique in that it is a machine in which oil recovery is performed in the same piece of equipment as juice extraction. This method not only minimizes the space and energy required to recover oil, but also delivers high yields. Water usage and waste disposal are minimized through the use of water recycle systems. The quality of the oil recovered allows processors to market their product as cold pressed oil.

Pulp Recovery:

The FMC FoodTech Citrus Juice Extractor offers various methods of pulp recovery. The juice cell sac sizes can be custom tailored to the needs of the processor and its customers. In one configuration the FMC Citrus Juice Extractor can produce pure juice sacs of nominal size for use in concentrated juices and other products. It can also be configured to produce high quality premium pulp cells as part of the Pulp Recovery System. Juice sacs from this system are primarily used in the manufacture of not-from-concentrate juices. The juice cell sacs produced by this system range in size from 4 mm to 10 mm, are virtually free of peel and seed particles and embryonic seeds and up to 90% of the juice sacs retain their floating character. Each FMC FoodTech Citrus Extractor is capable of handling 325 - 500 fruits/minute or 2 - 7 tons of citrus per hour. The Brown Model 400 can handle 350 - 400 fruits/minute.

For processed fruit, growers are paid for "lbs-solids" or sugar content, based on juice analysis. Harvested fruits are culled for rot, and remaining fruit is washed prior to juicing. Juice is extracted by inserting a cylindrical strainer in the center of the fruit and compressing the fruit hydraulically. Extracted juice contains some pulp and oils, which are separated from the juice by centrifugation and screening. Juice is pooled into lots of various colors and sugar levels; some mixing is done to produce uniform product. Sales of frozen concentrate have been outpaced by single-strength juice products in recent years, due to the superior flavor of the latter.

Figure 4. Flow Chart Process for Preparing Frozen Concentrated Orange Juice from Florida Oranges.



Source: Frozen Concentrated Orange Juice from Florida Oranges, Richard F. Matthews, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, April 1994.

Comparison of the Raw Agricultural Commodities (RAC) and Processed Commodities for the Citrus Fruits (see Table15).

Table 15. Citrus Fruit Portion Analyzed for the Raw Agricultural Commodity (RAC) and the Processed Commodity (40 CFR Vol. 58, No. 187, 9/29, 1993, pp. 50888 – 50893. Portion of Food Commodities Analyzed Pesticide Residues: Proposed Rule), and Table 1 Raw Agricultural and Processed Commodities Derived from Crops (EPA Residue Chemistry Guidelines OPPTS 860.1000).

Commodity	Portion Analyzed (RAC), Use as a Feedstuff (F)	Processed Commodity and Use as a Feedstuff (F)
Citrus	Analyze the whole fruit.	Refined oil Dried pulp (F) Juice

Juice and oil are the only processed food items required for the Citrus fruit group 10 and the dried pulp is a significant livestock feed item.

Other uses for the specific citrus fruit commodities are discussed under the preparation, cooking methods, uses, and marketing standards for members of the citrus and cooking methods for members for members of the citrus fruit crop group:

LIVESTOCK FEED ITEMS:

Dried citrus pulp is the one significant animal feed items associated with the Citrus crop group 10. It is the ground peel, residue of the inside portions and occasional fruits of the citrus family which have been dried and produces a coarse flaky product. Most of the dried citrus pulp is from oranges and grapefruit but may contain some residues of lemon, lime and tangerines. It may contain dried citrus meal or pellets and whole citrus seeds and has an above average palatability. It is also defined as the dried residue of peel, pulp and seeds of orange, grapefruit and other citrus fruit. Approximately 5 million tons of citrus peel is processed in Florida. It is dried to a moisture percent of 10%. It can be fed to beef and dairy cattle only at 20% maximum. Citrus dried pulp is roughage generated mainly in Florida and smaller amounts in California. Over 70% of the U.S. production is exported to Europe on a yearly basis with the remainder used as a maximum amount of 10% in premixed rations. Dried citrus pulp can contain from 1.8 to 8.3% seeds with an average seed content of 4.75% (Chapman et al.). Wet citrus pulp is also nutritious but is limited in use due to its high moisture content and cost of transporting the material. Citrus molasses is manufactured from the bound juice released from the limes cured and pressed orange and grapefruit peel residues. Approximately 3,125 lb of citrus molasses from press liquor from the peel and pulp residue can be

produced from 85,000 lb of fresh grapefruit. Newer processors that dry the citrus peel residue are greatly limiting any citrus molasses production.

Over the past 5 years, a significant increase in the amount of citrus pulp being used on Florida ranches. This increase in use is a response to a decrease in demand for dried Florida citrus pulp in the world market.

A combination of the decline in export market opportunities and the high energy-costs associated with citrus pulp drying have resulted in Florida citrus juice plants offering wet pulp to area cattlemen. This product is typically shipped directly from the citrus processing facility, placed in piles in the pasture and offered free-choice to cattle. The surface of these wet citrus pulp piles will quickly harden while the interior of the pile begins to undergo fermentation. Within a few days cattle will begin to rapidly consume the fermented product. Under this management situation, a large amount of waste is expected. The amount of product dry matter delivered along with wastage should be considered when comparing the value of dry and wet citrus pulp. Even though a considerable amount of waste is expected, the feeding of free-choice, wet citrus pulp requires less investment in feeding equipment and storage space compared to dry pulp, which will require some on-ranch investment in dry storage capability. Citrus pulp is classified as an energy concentrate byproduct feed, containing low crude protein and a moderate amount of digestible energy.

Book values typically provide a citrus pulp total digestible nutrients (TDN) content ranging from 80 to 84% on a dry matter (DM) basis. These values were likely obtained as much 30 years ago and have not been updated due to the regional use of citrus pulp and the lack of domestic interest over the past couple decades. With the current wide-spread use of both wet and dry citrus pulp in Florida, we have begun testing the current energy content. Current TDN values for Florida citrus pulp now appear to be significantly less compared to historic values reported in the literature. Protein has always been low in citrus pulp and ranges from 5 to 9% crude protein (DM basis). This value is insufficient to provide adequate supplemental protein to the diet of cows during the winter months. In Florida there is a need supplemental protein for forage-fed cattle provided citrus pulp supplements. Cattle provided citrus pulp with no additional protein voluntarily consumed 23% less forage compared to cattle provided a source of supplemental protein along with the citrus pulp

The most commonly adverse reported condition associated with citrus pulp feeding is ruminal parakeratosis, a digestive disorder associated with the feeding of high concentrate diets. This condition is described as the hardening and enlargement of the rumen papillae, and has been widely reported in ruminant feeding systems that utilize low roughage rations. Citrus pulp at more than 60% of the concentrate mixture for cattle full-fed in feedlot can result in rumen parakeratosis. When supplementing citrus pulp to grazing cattle, make certain there is sufficient pasture forage available to prevent ruminal parakeratosis. It is unlikely that rumen parakeratosis would be a problem in grazing cattle unless the supplemental citrus pulp is their only feed option.

POTENTIAL FUTURE USE OF CITRUS PEELS:

In the future orange peels from Florida juice production may be diverted from being used for livestock feeds to ethanol production. Excepts from an article by Sara Parker (See Parker 2007) on converting orange peels into cellulosic ethanol is discussed below:

"Approximately 5 million tons of citrus peel waste annually, the Florida orange juice industry has the potential to provide up to 60 million gallons of cellulosic ethanol for Florida residents, according to Bill Widmer, a research chemist with the USDA-ARS Citrus and Subtropical Products Laboratory in Winter Haven.

"After stripping the alcohol we still end up with a residue that we need to get rid of -- about one-third of the solid is still there and the short term solution right now is to dry that, and produce cattle feed from it," said Widmer. "We haven't demonstrated everything from a raw peel to two-hundred proof alcohol -- and stripping that ethanol out of the beer stream -- I don't think it's a major hurdle, I think it's a minor one. But it's one that we do have to demonstrate."

"I think what you're going to see over the next fifteen years is wood plants in Georgia and Alabama; citrus plants in Florida; and corn plants in the Midwest," said Tom Endres, senior vice-president of operations at Xethanol Corporation. Xethanol, which formed a joint venture with Renewable Spirits last year to create Southeast Biofuels, plans to build a pilot plant this year with the potential to produce up to 50,000 gallons of ethanol from the citrus waste.

But with more research, material from the residue left after limonene removal and ethanol production could be turned into other profitable industrial products, such as building-material additives for concrete, said Widmer".

Citrus Industry Byproducts

One harvested box of orange weighs 90 lb (40.8 kg) and over half of the yield is juice (50 lb), while the remainder (40 lb) is waste products (Braddock, 2003). The peel has essential oils that are recovered during juice extraction such as D-limonene. Essential

oils are used for food and beverage flavors, in the perfume industry, for personal care and consumer products. Cold press citrus oils are used as a flavoring for orange juice. Table 16 shows the yields of oil/ton of citrus fruits. Table 17 gives the amounts of citrus byproducts for each ton of oranges and Table 18 gives the ranges of the peel, pulp, and juice content of the representative commodities of the Citrus fruit group as orange, tangerine, lemon and grapefruit. Citrus dried pulp is used for cattle food and is dried to a moisture level of 10 - 12%. The press liquor is concentrated with evaporators to about 72% sugar and is called citrus molasses and is added back to the citrus dried pulp or sold separately for ethanol production. Flavonoids and limonoids are used for potential medicinal or pharmaceutical uses.

Table 16. Yields of Oil from Various Citrus Fruits (kg oil/ton fruit, FAO Statistics, 2005).

Citrus Fruit/Variety	Range of Oil (kg/ton)	Average Oil Content (kg/ton)
Orange		
Hamlin	3.5 – 4.2	3.9
Pineapple	3.7 – 4.8	4.8
Valencia	5.2 – 8.1	6.7
Temple	3.4 – 4.5	3.9
Grapefruit		
Duncan	2.4 – 3.4	2.8
Marsh	2.7 – 3.6	3.1
Ruby Red	2.5 – 3.9	3.2
Tangerine		
Dancy	6.7 – 8.7	7.7
Orlando	4.8 – 6.2	5.6

Table 17. Typical Amounts of Citrus Byproducts from Orange Processing (Goodrich and Braddock, 2006):

Byproduct	Kg/box oranges*
Dry pellets (90% DM)	4.0
Molasses	1.4
Essential oil and d-limonene	0.3
Pulp wash soluble solids	0.3
Pectin	1.3

Frozen pulp	2.0
Flavonoids	0.2

* Oranges – 40.8 kg/box, juice yields 55%

Table 18. Peel, Pulp, and Juice content of the Representative Commodities for the Citrus Fruit Group 10 which are the Orange, Tangerine, Lemon, and Grapefruit.

Citrus Portion	Orange	Tangerine	Lemon	Grapefruit
Peel %	21.5 - 38.1	25.6-33.0	32.0-46.6	33.6-36.4
Pulp %	61.9-78.6	67.6-73.6	53.4-67.9	63.6-67.3
Juice %	23.8-51.0	32.5-38.6	21.6-27.0	30.0-33.6

CROP ROTATIONS FOR THE CITRUS:

The members of the Citrus fruit group are not rotated because of their long productive life spans at the same location most citrus orchards are kept at the same location for ≤ 40 years, and will be replanted at the same locations they age and lose production. Trees can range from 25 to 40 ft in height and take 10 to 15 years to develop before they bear fruit. In Florida, yields for navel, Valencia orange, white and pink grapefruit at different ages from 3 to > 24 years may be are shown in Table 19. Yields increased greatly as trees mature.

Table 19. Florida Citrus Tree Ages 3 to > 24 years and Yields in Estimated Boxes Fruit/Tree (2001-2006).

Commodity	3 -5 year old tree	6-8 years	9 – 13 years	14 – 23 years	> 24 years	Average boxes
Early Navel orange	1.38 boxes	1.8	2.74	3.51	4.36	3.08
Late Valencia Orange	1.11	1.66	2.10	2.42	3.82	2.25
White grapefruit	1.63	2.83	3.10	3.29	5.00	3.75
Pint/red grapefruit	1.48	2.20	3.27	3.59	4.40	3.46

Navel orange – 90 lb/box; Valencia – 90 lb/box; Grapefruit -85 lb/box.

PEST PROBLEMS FOR THE CITRUS CROPS: (Developed from USDA Crop Profiles from AZ, CA, LA, and TX, Extension Bulletins, and Research Literature).

There are several common pest problems among the citrus fruits. The most important pest problems associated with this group of commodities are plant diseases including postharvest diseases, as well as some insects and mites. The following are the list of important insects, mite, and diseases of the citrus fruits (USDA Crop profiles 2006, Ruther, 1978):

1. Insects and mites: Caribbean and Mediterranean fruit flies, citrus bud mite, citrus leafminer, citrus root weevil, black fly, citrus rust mite, California red scale, cutworm, Asian citrus psyllid, scales, black flies, psyllid, glassy winged sharpshooter, Argentina and fire ants, katydid, grasshopper, aphids, mealybug, thrips, citrus leafminer, spider mites, whitefly.
2. Diseases: citrus scab, branch knot, Septoria leaf spot, algal leaf spot, tar spot, oil spotting, lime blotch, California red scale, anthracnose, brown rot, black spot, greasy spot, gummosis, heart rot, damping-off, seedling blight, Diplodia dieback, Fusarium oxysporum, Phytophtora root rot, charcoal root rot, xyloporosis, melanose, citrus blast, citrus blight, greasy spot, sooty mold, green mold, blue mold, citrus canker, citrus greening, and several viruses including crinkly leaf virus, psorosis, tristeza virus, and powdery mildew.
3. Nematodes: Citrus nematode, burrowing nematode, sting nematode, sting nematode, lesion nematode, and sheath nematode.
4. Weeds: Over 100 weeds found in citrus orchards as a combination of annual and perennial grasses and broadleaf weeds, such as milkweed, morningglory, saltbush, goatweed, Virginia creeper, guineagrass, and lantana.
5. Vertebrate pests: meadow voles, rat, rabbit, armadillo, deer, pocket gopher, coyote, and squirrels.

Proposed citrus fruit commodities that are being added to the crop group share many of the same pest problems because of their similar cultural practices and their highly desirable fruits to many pests.

The members of the Citrus Fruit Crop Group share many of the same pest problems since they are all members of the same botanical family the Rutaceae. Because of the similarity in the botany, cultivars and cultural practices among these crops, they have similar pest problem. Availability of a similar set of pest control options for the Citrus fruit group would be useful in promoting integrated pest management (IPM) strategies. Some of the pests affect the external appearance of the fruit some from damage by feeding on the leaves or buds, and some by reducing postharvest keeping qualities.

Asiatic citrus canker caused by a bacterium (*Xanthomonas axonopodis* pv. *citri*) and citrus greening or Huanglongbing (*Candidatus liberibacter*) have become much more important severe plant diseases that must be quarantined to help control the diseases in Florida and prevent spread to other citrus producing States. Grapefruit and Persian limes are highly susceptible to citrus canker. 'Navel', 'Pineapple', and 'Hamlin' sweet oranges are moderately susceptible, while 'Valencia' orange, tangors, tangelos, and other mandarin hybrids are susceptible and mandarins' are moderately susceptible. The wind is a major dispersal agent of the disease, and the best control is eradication of the infected trees. Citrus greening or Huanglongbing (HLB) is a serious disease of citrus because it affects all citrus cultivars and causes rapid decline of trees. HLB has seriously affected citrus production in a number of countries in Asia, Africa, the Indian subcontinent and the Arabian Peninsula, and was recently discovered in Brazil (2004) and Florida (2005). Huanglongbing is vectored by the Asian citrus psyllid. When psyllid is abundant and environmental conditions are favorable, HLB can rapidly destroy existing groves and prevent commercial production of oranges and other citrus cultivars. Mature trees if infected may decline and become non-productive and young trees that become infected never come into fruit production. HLB is difficult to manage and continued production of citrus has proven difficult and expensive in areas where it is widespread. HLB is one of a few citrus diseases that can be considered a truly limiting factor for citrus production. There are no HLB tolerant mandarin, orange or grapefruit cultivars to replace declining trees. The general control strategy has been to eradicate all existing sources of HLB within an area, then replant with HLB-free trees grown from clean budwood. Psyllid populations must also be reduced as much as possible.

Citrus fruit orchards have many weed control problems that must be controlled to ensure adequate yields and harvesting efficiencies. This citrus group shares a multiplude of insect, disease, viral, and nematodes. Weeds include grassy and broadleaf such as annual, biennial, and perennial weeds such as milkweed, morningglory, and saltbush. Animal pest problems include meadow voles, squirrels, deer, armadillos, and rabbits.

COMPARISON OF POTENTIAL RESIDUE LEVELS IN THE CITRUS:

Magness, Markle, and Compton in 1971 classified food and feed crops based on predicting the potential for pesticide residues based on exposure of the edible parts to applied pesticides, which led to the development of the crop groups. The majority of the citrus fruits were classified in the Fruit Crops Category I. Category I include the citrus fruit crops with fruits mostly medium to large, peel nearly always discarded when consumed or processed. Peels may be dried and used as livestock feed particularly the orange and grapefruit. Category I fruit crops will have minimum exposure of the edible portions to direct contact to pesticide. The lime is placed in Fruit Crops Category II since it has somewhat greater exposure of edible parts to pesticides than in Category I, because of greater surface in proportion to weight. The fruits are medium to small with the peels generally discarded before being consumed. The Calamondin, citron, and kumquat are placed in Fruit Crops Category IV with increased exposure of edible parts to pesticide residues because the peel is commonly consumed. The fruits are medium to small.

One would expect pesticide residues to be similar in most of the members of the Citrus fruit crop group, and distinct citrus fruit crop subgroups may be based on potential of residue to be deposited on the fruit.

We expect that all proposed members of the citrus fruit crop group will have similar residue levels based on similarities of the raw agricultural commodities (RAC's), cultural practices, and pest problems. A comparison of established tolerances on citrus fruit commodities also supports that residue levels will be similar between members of the crop group and subgroups (See Tables 20, 21, 22, and 23). The proposed representative commodities cover over 99% of the total citrus fruit production in the U.S., and they also tend to be an equal or more conservative estimate of tolerances and potential residues. Based on existing tolerances in 40 CFR and the USDA FAS mrldatabase, a comparison of these tolerances for the representative commodities is listed in Table 20 for the U.S., Codex MRL's, and the European Union (EU). In several cases the U.S. tolerances are higher than those established in the EU. Tables 21 contain tolerances established in the U.S. on the proposed representative commodities (orange, tangerine, lemon, lime, and grapefruit) and are remarkably similar. Table 22 for the Orange subgroup and Table 23 for the proposed lemon/lime subgroup also show consistent tolerance levels between representative commodities. Grapefruit is listed in Table 21 and tolerance levels are also very similar to the other representative commodities.

Table 20. Tolerances established on Citrus Fruits Group[3]
(FASONLINE; Duggan 2006a)

Compound	CFR Citation	US	Codex	EU
2,4-D	180.142	5	1	0.05
Abamectin	180.449	0.02	0.01	0.01

[3] Only include tolerances established on citrus fruit group, not individual commodities.

Compound	CFR Citation	US	Codex	EU
Acephate	180.108	–	–	0.02
Acequinocyl	180.599	0.2	–	–
Acetamiprid	180.578	0.5	–	–
Aldicarb	180.269	0.3	0.2	0.2
Amitraz	180.287	–	–	0.05
Atrazine	180.220	–	–	0.1
Azinphos-methyl	180.154	2.0	2.0	1
Azoxystrobin	180.507	10	–	1
Benomyl	180.294	10	–	5
Bentazon	180.355	–	–	0.1
Bifenthrin	180.511	0.05	–	0.1
Bromacil	180.210	0.1	–	–
Bromoxynil	180.324	–	–	0.05
Buprofezin	180.511	2.5	–	–
Captafol	-	–	–	0.02
Captan	180.103	–	–	0.1
Carbaryl	180.169	10	1	1
Carbofuran	180.254	–	–	0.3
Carfentrazone-Ethyl	180.515	0.1	–	0.01
Chlorfenapyr	180.513	–	–	0.05
Chlorothalonil	-	–	–	0.01
Chlorpropham	-	–	–	0.05
Chlorpyrifos	180.342	1.0	1	0.3
Clethodim	180.458	1	–	–
Clofentezine	180.448	–	0.5	0.5
Cryolite	-	7	–	–
Cyfluthrin	180.436	0.2	–	0.02
Cypermethrin	180.418	–	2	2
Cyromazine	180.414	–	–	0.05
Deltamethrin	180.435		0.02	0.05
Diazinon	180.153	0.7		0.02
Dichlorvos	180.235	–	–	0.1
Dicofol	180.163	Pending	5	2
Diflubenzuron	180.377	0.5	0.5	
Dimethoate	180.204	2.0	2	0.02
Diphenylamine	-	–	–	0.05
Diquat Dibromide	180.226	0.02	–	0.05
Disulfoton	-	–	–	0.02
Diuron	180.106	1.0	–	–
Dodine	-	–	–	0.2
Endosulfan	-	–	–	0.5
EPTC	180.117	0.1	–	–
Esfenvalerate	-	–	–	0.02
Ethion	180.173	5.0	–	2

Compound	CFR Citation	US	Codex	EU
Ethofumesate	-	–	–	0.05
Ethylene Oxide	-	–	–	0.1
Fenamiphos	-	–	–	0.02
Fenarimol	-	–	–	0.02
Fenbutatin-Oxide	180.362	20	5	5
Fenpyroximate	180.566	0.6	-	-
Fenpropathrin	180.466	2	–	–
Fentin Hydroxide	-	–	–	0.05
Fenvalerate	-		2	0.02
Ferbam	180.114	7	–	–
Fludioxonil	180.516	10	–	–
Fluridone	180.420	0.1	–	–
Folpet	-	–	–	0.1
Fosetyl-Al	180.415	5	–	–
Fosthiazate	-	–	–	0.02
Glufosinate-Ammonium	-		0.1	
Glyphosate	180.364	0.5		0.1
Hexythiazox	-	–	0.5	
Hydrogen Cyanide	180.130	50	–	–
Imazalil	180.413	10	5	5
Imidacloprid	180.472	0.7	1	
Inorganic bromide resulting from fumigation	-	–	30	0.05
Inorganic bromide resulting from soil treatment	-	–	–	0.05
Iprodione	-	–	–	0.05
Kresoxim-Methyl	-	–	–	0.05
Lambda Cyhalothrin	-	–	–	0.02
Malathion	-		4	2
Maleic Hydrazide	-	–	–	0.2
Mancozeb	-	–	–	5
Maneb	-	–	–	5
Mesotrione	-	–	–	0.05
Metalaxyl	180.408	1	5	0.5
Methamidophos	-	–	–	0.2
Methanearsonic acid	180.289	0.35	–	–
Methidathion	180.298	2	–	2
Methomyl	-	–	1	0.05
Metiram	-	–	–	5
Metsulfuron-Methyl	-	–	–	0.05
Mevinphos	-	–	–	0.2
Myclobutanil	-	–	–	3
Napropamide	180.328	0.1	–	–
Norflurazon	180.356	0.2	–	–

Compound	CFR Citation	US	Codex	EU
O-phenylphenol	180.129	10	10	–
Oryzalin	180.304	0.05	–	–
Oxamyl	180.303	3	5	–
Oxydemeton-Methyl	-	–	–	0.02
Paraquat Dichloride	180.205	0.05	–	0.05
Pendimethalin	180.361	0.1	-	-
Permethrin	-		0.5	0.05
Phorate	-	–	–	0.05
Phosalone	-	–	–	1
Phosmet	180.261	5	5	–
Piperonyl Butoxide	-	–	5	–
Procymidone	-	–	–	0.02
Prohexadione Calcium	-	–	–	0.05
Propargite	-	–	3	
Propiconazole	-	–	–	0.05
Propyzamide	-	–	–	0.02
Pymetrozine	-	–	–	0.3
Pyraclostrobin	180.582	2		1
Pyrethrins	-		0.05	1
Pyridaben	180.494	0.5	–	–
Pyridate	-	–	–	0.05
Pyrimethanil	180.518	10	–	–
Pyriproxyfen	180.510	0.3	0.5	
Quinoxyfen	-	–	–	0.02
Sethoxydim	180.412	0.5	–	–
Spinosad	180.420	0.3	0.3	
Spirodiclofen	180.608	0.5	–	–
Sulfosate	180.489	0.05	–	–
Tebufenozide	180.482	0.8	2	
Thiabendazole	180.207	10	10	5
Thiophanate-Methyl		–	–	5
Thiram	-	–	–	3
Triadimefon	-	–	–	0.1
Triallate	-	–	–	0.1
Tridemorph	-	–	–	0.05
Trifloxystrobin	180.555	0.3	–	0.3
Trifloxysulfuron	180.591	0.03	–	–
Trifluralin	180.207	0.05	–	–
Zeta-Cypermethrin	-	–	2	
Zoxamide	-	–	–	0.02

Table 21. Tolerances Established in U.S. on Representative Citrus Fruit Crops

Compound	CFR Citation	Orange	Tangerine	Lemon	Lime	Grapefruit
Aldicarb	180.269	0.3	-	0.3	0.3	0.3
Dicofol	180.163	10	10	10	10	10
Dimethoate	180.204	2.0	2.0	2.0	2.0	2.0
Fenamiphos	180.349	0.6	0.6	0.6	0.6	0.6
Formetanate hydrochloride	180.276	4.0	-	4.0	4.0	4.0
Malathion	180.111	8.0	8.0	8.0	8.0	8.0
Methomyl	180.253	2.0	2.0	2.0	-	2.0
Naled	180.215	3.0	3.0	3.0	-	3.0
O-phenylphenol	180.129	10	10	10	10	10
Oxydemeton-methyl	180.330	1.0	-	1.0	-	1.0
Parathion	180.123	30	30	30	30	30
Phosphine	180.225	0.01	0.01	0.01	0.01	0.01
Propargite	180.259	5.0	-	5.0	-	5.0-
Simazine	180.213	0.25	-	0.25	-	0.25
Thiazopyr	180.496	0.05	-	-	-	0.05

Table 22. Tolerance Comparison Between Members of the Orange Subgroup 10A. (Based on 40 CFR Part 180, and EPA OPPIN 6/4/2007).

Compound	CFR Citation	Orange	Tangerine
Dicofol	180.163	10	10
Dimethoate	180.204	2.0	2.0
Fenamiphos	180.349	0.6	0.6
Malathion	180.111	8.0	8.0
Methomyl	180.253	2.0	2.0
Naled	180.215	3.0	3.0
O-phenylphenol	180.129	10	10
Parathion	180.123	30	30
Phosphine	180.225	0.01	0.01

Table 23. Tolerance Comparison Between the Representative Commodities of the Lemon/lime Subgroup 20B. (Based on 40 CFR Part 180, and EPA OPPIN 6/4/2007).

Compound	CFR Citation	Lemon	Lime
Aldicarb	180.269	0.3	0.3
Dicofol	180.163	10	10
Dimethoate	180.204	2.0	2.0
Fenamiphos	180.349	0.6	0.6
Formetanate hydrochloride	180.276	4.0	4.0
Malathion	180.111	8.0	8.0

Compound	CFR Citation	Lemon	Lime
O-phenylphenol	180.129	10	10
Parathion	180.123	30	30
Phosphine	180.225	0.01	0.01

REQUIRED NUMBER OF CROP FIELD TRIALS FOR CROP GROUP 10 AND COMPARISON OF EPA CROP PRODUCTION REGIONS WITH THE NAFTA CROP PRODUCTION REGIONS:

The Florida Department of Citrus (Brown, M., 2005) is estimating losses due to citrus canker of orange and grapefruit from 212.3 to 218 million boxes and 27.6 to 33.5 million boxes, respectively over the next ten years. Hurricanes that hit Florida in 2004-2005 also caused high citrus tree loss and spead several diseases such as citrus canker and citrus greening. Lime acres have not been reported since 2002 because of the devastating storms and disease.

A reevaluation of crop production data fro the 2002 USDA Agricultural Census shows that the amended Citrus fruit crop group 10 will not require additional field trials because the acreage for orange, tangerine, lemon, lime, and grapefruit have not significantly changed from the 1991 data used in the current field trial guidelines (EPA OPPTS 860.1500). The proposed number of crop field trials for Crop group 10 Citrus fruit, as well as the required number of crop field trials for Crop subgroups 10A, 10B, and 10C is listed in Tables 24, 25, and 26, respectively as well as suggested regional distribution of the citrus crops is in Table 27. The citrus fruit crops in this group are adapted best to the subtropical areas of the U.S. found in a zone from Florida, Texas, Arizona, and New Mexico, and California. These include EPA Residue Field Trial Regions 3, 5, 6, 10, and 13 (Table 26 and 27).

Table 24. Draft Required Number of Field Trials for Citrus Fruit Commodities to Establish a Citrus Fruit Crop Group 10. (40 CFR 180.41) [OPPTS 860.1500, Table 2).

Representative	Number of Field Trials for	Number of Field Trials for

Commodity	Commodities if Not Part of the Crop Group	Commodities as Part of the Crop Group Based on 2002 AGCensus
Orange	16 in current guidelines	12 field trials can combine orange and tangerine. Recommend not more than four tangerine trials.
Tangerine	5 in current guidelines	Combined with orange.
Lemon	5 in current guidelines	5 field trials can combine lemon and lime
Lime	3 in current guidelines	Combined with lemon.
Grapefruit	8 in current guidelines	6
Total	29*	23

* Attachment 7. Methodology for Determining Number of Field Trials, in Appendix A of the EPA OPPTS 860.1500 Crop Field Trials. Current guidelines have orange, lemon, and grapefruit as the representative commodities.

Table 25. Required Number of Field Trials for Crop Subgroup 10A, 10B, and 10C. (40 CFR 180.41) [OPPTS 860.1500, Table 3).

Crop Subgroup	Representative Commodity	Production Acres 2002	Number of Field Trials
10A	Orange or Tangerine	994,871 – orange or 31,419 – tangerine	12 in current guidelines.*
10B	Lemon or Lime	81,021 – lemon or 1,491 - lime	5 in current guidelines.
10C	Grapefruit	157,358	8

* Attachment 7. Methodology for Determining Number of Field Trials, in Appendix A of the EPA OPPTS 860.1500 Crop Field Trials.

Table 26. EPA Crop Production Regions for the Citrus Fruit Crops. [Representative Commodities (*) for the Crop Group].

Commodity**	1	2	3	4	5	6	7	8	9	10	11	12	13
Calamondin										X			
Citrus citron													X
Citrus hybrids			X							X			
Grapefruit*			X			X				X			
Kumquat			X							X			
Lemon*					X					X			X
Lime*										X			X
Lime, sweet										X			X
Orange, sour			X			X				X			X
Orange, sweet*			X			X				X			X

Commodity**	1	2	3	4	5	6	7	8	9	10	11	12	13
Pummelo			X			X				X			
Satsuma mandarin			X							X			
Tachibana orange			X							X			
Tahiti lime										X			X
Tangelo			X							X			
Tangerine*			X							X			
Tangor			X							X			
Trifoliate orange			X							X			
Uniq fruit										X			X

** Commodities that are not representative commodities have field trial regions generally based on the USDA Plants Database, 2006.

Table 27. EPA Crop Production Regions Suggested Distribution of the Citrus Fruit Crop Field Trials ≥ 3 for the Representative Commodities for the Crop Group based on 2002 AGCensus Data.

Commodity	# Field Trials	1	3	5	6	7	10	13
Orange	16		12		4			
Tangerine	5		3	3		3	2	
Grapefruit	8		6		1		1	
Lemon	5						7	1
Lime	3						1	2

The citrus crops are not yet adapted to Canada and when full NAFTA regions are developed Table 28 will be updated. Efforts to update the NAFTA regions will begin in late 2007. Any future conflict in testing between regions can generally be resolved by having the ChemSAC review the test protocol regions before residue trials are initiated and any differences can also be resolved by input from the International Crop Grouping Consulting Committee (ICGCC).

Table 28. NAFTA Field Production Regions for the Citrus Fruit Crop Group 10.

Commodity	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Orange*			X							X			X	
Tangerine			X							X				
Lemon										X			X	
Lime										X			X	
Grapefruit*			X			X				X			X	

* Representative Commodities for the Crop Group.

CODEX CLASSIFICATION OF PROPOSED COMMODITIES AND EPA FOOD AND FEED COMMODITY VOCABULARY: See Table 29. Comparison of Citrus Fruit Crop Groups: Codex (001) and EPA (10). (Data prepared by Dr's. Yuen-Shaung NG, Hong Chen, and Dr. Bernard A. Schneider, US EPA and USDA IR-4, 2004, 2007).

EPA is proposing 28 commodities for the Citrus Fruit Crop Group, and CODEX has a current Citrus Fruits, Except Kumquat Group 001, which has 38 commodity terms. Kumquats are listed in the Codex Crop group 005 for "Assorted tropical and sub-tropical fruits – edible peel". Sixteen Codex commodity terms already match those in the proposed EPA Food and Feed Commodity Vocabulary (See Table 38). CODEX has nine commodities in their group that will be considered by EPA as members of other crop groups such as the tropical /subtropical fruit groups. Kumquats are also classified in their group 005 which is for assorted tropical and subtropical fruits with inedible peel. We have placed kumquats in the Citrus fruit group since it has always been a member of the U.S. Crop group 10 and plant taxonomists often classify kumquats in the citrus family. In addition the proposed EPA Citrus Fruit Crop Group has eleven commodities not in the Codex Citrus Fruit Group (Table 28). In the next proposed revision to the CODEX Classification of Foods and Animal Feeds we would expect these changes to be considered as additions to their Citrus group in the harmonization effort that Dr. Hong Chen, USDA IR - 4 is coordinating with the Codex delegation. Therefore, this proposal will not only increase harmonization with the Canadian and NAFTA crop grouping system, but it is compatible with the international system of CODEX. The Food Quality Protection Act of 1996 placed increased emphasis on using CODEX MRLs in setting tolerances for pesticides in the U.S.

Table 29. EPA/Codex Citrus Fruit Group Comparison
(Based on Ng and Schneider, 2007).

Codex Group #	Codex Commodity Name	EPA Group #	EPA Commodity Name
001	CALAMONDIN, SEE ALSO SUBGROUP 0003 MANDARINS	10	CALAMONDIN
001	CITRON, SEE ALSO SUBGROUP 0002, LEMONS AND LIMES	10	CITRON, CITRUS
001	TANGORS, SEE SUBGROUP 0003 MANDARINS	10	TANGOR
001	ORANGES, SWEET, SOUR (INCLUDING ORANGE-LIKE HYBRIDS)	10	CITRUS HYBRIDS
001	TANGELOLO, SEE SUBGROUP 0005 SHADDOCKS OR POMELOS	10	CITRUS HYBRIDS
001	CHIRONJA, SEE SUBGROUP ORANGES, SWEET, SOUR	10	CITRUS HYBRIDS
071	CITRUS PULP, DRY	10	CITRUS, DRIED PULP
070	CITRUS JUICE	10	CITRUS, JUICE
069	CITRUS MOLASSES	10	CITRUS, MOLASSES

Codex Group #	Codex Commodity Name	EPA Group #	EPA Commodity Name
001	CITRUS FRUIT	10	FRUIT, CITRUS
001	GRAPEFRUIT, SEE ALSO SUBGROUP 0005 SHADDOCKS OR POMELOS	10	GRAPEFRUIT
070	GRAPEFRUIT JUICE	10	GRAPEFRUIT, JUICE
001	NATSUDAIDAI, SEE SUBGROUP 0005 SHADDOCKS OR POMELOS	10	JAPANESE SUMMER GRAPEFRUIT
005	KUMQUATS	10	KUMQUAT
005	KUMQUAT, MARUMI, SEE KUMQUATS	10	KUMQUAT
005	KUMQUAT, NAGAMI, SEE KUMQUATS	10	KUMQUAT
001	LEMON, SEE ALSO SUBGROUP 0002 LEMONS AND LIMES	10	LEMON
001	LIME, SEE ALSO SUBGROUP 0002 LEMONS AND LIMES	10	LIME
001	SATSUMA OR SATSUMA MANDARIN, SEE SUBGROUP 0003 MANDARINS	10	MANDARIN, SATSUMA
001	MEDITERRANEAN MANDARIN, SEE SUBGROUP 0003 MANDARINS	10	MEDITERRANEAN MANDARIN
070	ORANGE JUICE	10	ORANGE, JUICE
001	MYRTLE-LEAF ORANGE, SEE CHINOTTO	10	ORANGE, SOUR
001	ORANGE, SOUR, SEE ALSO SUBGROUP 0004 ORANGES, SWEET, SOUR	10	ORANGE, SOUR
001	CHINOTTO, SEE ORANGE, SOUR	10	ORANGE, SOUR
001	BIGARADE, SEE ORANGE, SOUR	10	ORANGE, SOUR
001	ORANGE, BITTER, SEE ORANGE, SOUR	10	ORANGE, SOUR
001	SEVILLE ORANGE, SEE ORANGE, SOUR	10	ORANGE, SOUR
001	BLOOD ORANGE, SEE ORANGE, SWEET	10	ORANGE, SWEET
001	MALTA ORANGE, SEE BLOOD ORANGE	10	ORANGE, SWEET
001	ORANGE, SWEET, SEE ALSO SUBGROUP 0004 ORANGES, SWEET, SOUR	10	ORANGE, SWEET
001	SHADDOCK, SEE ALSO SUBGROUP 0005 SHADDOCKS OR POMELOS	10	PUMMELO
001	POMELO, SEE SHADDOCKS OR POMELOS	10	PUMMELO
001	UGLI, SEE SUBGROUP 0005 SHADDOCKS OR POMELOS	10	PUMMELO
001	SHADDOCKS OR POMELOS (INCLUDING SHADDOCK-LIKE HYBRIDS)	10	PUMMELO
001	NATSUDAIDAI, SEE SUBGROUP 0005 SHADDOCKS OR POMELOS	10	PUMMELO
001	TANGELO, LARGE-SIZED CULTIVARS, SEE SUBGROUP 0005	10	TANGELO
001	TANGELO, SMALL AND MEDIUM SIZED CULTIVARS, SEE SUBGROUP 0003	10	TANGELO
001	MANDARIN, SEE ALSO SUBGROUP 0003 MANDARINS	10	TANGERINE
001	MANDARINS (INCLUDING MANDARIN-LIKE HYBRIDS)	10	TANGERINE
001	CLEMENTINE, SEE MANDARIN	10	TANGERINE
001	CLEOPATRA MANDARIN, SEE SUBGROUP 0003 MANDARINS	10	TANGERINE
001	DANCY OR DANCY MANDARIN, SEE SUBGROUP 0003 MANDARINS	10	TANGERINE
001	MEDITERRANEAN MANDARIN, SEE SUBGROUP 0003 MANDARINS	10	TANGERINE
001	TANGERINE, SEE SUBGROUP 0003 MANDARINS	10	TANGERINE
001	TANKAN MANDARIN, SEE SUBGROUP 0003 MANDARINS	10	TANGERINE
001	WILLOWLEAF MANDARIN, SEE MEDITERRANEAN MANDARIN	10	TANGERINE
001	KING MANDARIN, SEE SUBGROUP 0003 MANDARINS	10	TANGERINE

Codex Group #	Codex Commodity Name	EPA Group #	EPA Commodity Name
NA	NA	10	AUSTRALIAN DESERT LIME
NA	NA	10	AUSTRALIAN FINGER LIME
NA	NA	10	AUSTRALIAN ROUND LIME
NA	NA	10	BROWN RIVER FINGER LIME
NA	NA	10	LIME, SWEET
NA	NA	10	MOUNT WHITE LIME
NA	NA	10	NEW GUINEA WILD LIME
NA	NA	10	RUSSELL RIVER LIME
NA	NA	10	TABACHIBAN ORANGE
NA	NA	10	TAHITI LIME
NA	NA	10	TRIFOLIATE ORANGE
NA	NA	NA	UNIQ Fruit

PREPARATION, FOOD FORMS, COOKING METHODS, FOOD FORMS, SPECIFIC USES, MEDICINAL USES, FRUIT YIELDS, AND MARKETING STANDARDS FOR MEMBERS OF THE CITRUS FRUIT CROP GROUP:

Preparation and Cooking Methods for Citrus Fruits:

The 28 commodities in the proposed amended citrus fruit crop group are all perennial angiosperms (flowering plants) that are herbaceous small trees that produce an edible fleshy berry-like fruit called a hesperidium. Most small fruits and berries are eaten as fresh fruit, as a hesperidium. The cooking methods and food forms used to prepare citrus is shown in Table 37. Citrus fruits have many food and nonfood uses. They are used fresh, drinks, flavoring, marmalade, juice or confection. Zest (zeste) is a piece of the peel or of the thin oily, outer skin of normally an orange or lemon used for flavoring foods similar to spices. Marmalade is a condiment derived from cooking orange and lemon. Citrus fruits have also been used for more medicinal purposes than most other fruit crops. Citrus peel is used for cattle feed and extracted oils used as insecticides, perfumes, and furniture cleaning agents. They also have ornamental landscape uses, plant extracts for medicinal uses, and uses as dyestuffs. Specific uses for some of the citrus fruits will be discussed below.

General fruit preparation for citrus fruits: Navel oranges, tangerines, tangelos, temple oranges and clementines are peeled easily by simply pulling off the skin. Other citrus fruits can be peeled by cutting as close to the flesh as possible with a sharp paring

knife. Grapefruit may be cut into segments by cutting in half horizontally, scoop out seeds with the point of a knife and use a small knife, preferably a curved grapefruit knife, to cut around each segment and free it from the surrounding membrane. Lightly roll whole lemons or limes on a countertop or warm them slightly before cutting to release more juice. Squeeze through a piece of cheesecloth to avoid pits in juice.

Specific Uses of Citrus:

Calamondin:

Calamondin made into juice or marmalades. Fruits are halved, depulped, immersed in salt water to ferment for about 40 days. After partial de-salting and boiling to soften the peel, it is candied in a strong sucrose/glucose solution. The candied peel is sun-dried or put up in jars for future use.

Citron:

Fruits are halved, depulped, immersed in salt water to ferment for about 40 days. After partial de-salting and boiling to soften the peel, it is candied in a strong sucrose/glucose solution. The candied peel is sun-dried or put up in jars for future use, and its use is for Peel candied, used in confections and culinary. Candying is done mainly in England, France and the United States. The candied peel is widely employed in the food industry, especially as an ingredient in fruit cake, plum pudding, buns, sweet rolls and candy. The fruit of the wild 'Chhangura' is pickled in India. In Indonesia, citron peel is eaten raw with rice. The entire fruit of the 'Fingered citron' is eaten. If there is sufficient juice in the better cultivars, it is utilized for beverages and to make desserts. In Guatemala, it is used as flavoring for carbonated soft drinks. In Malaya, citron juice is used as a substitute for the juice of imported, expensive lemons. A product called "citron water" is made in Barbados and shipped to France for flavoring wine and vermouth. In Spain, a syrup made from the peel is used to flavor unpalatable medical preparations.

In China and Japan the dried fruits are put with in stored clothing to repel moths. In southern China, the juice is used to wash fine linen. Formerly, the essential oil was distilled from the peel for use in perfumery. In some of the South Pacific islands, "Cedrat Petitgrain Oil" is distilled from the leaves and twigs of citron trees for the French perfume industry. The flowers have been distilled for essential oil which has limited use in scent manufacturing. Branches of the citron tree are used as walking-sticks in India. The wood is white, rather hard and heavy, and of fine grain. In India, it is used for agricultural implements. Mainly thick peel or rind; the entire Etrog fruit can be eaten.

Grapefruit:

Grapefruit is used as a fresh fruit and is canned as juice and segments, and marmalade. About equal amounts fresh and processed. Grapefruit is customarily a breakfast fruit. The juice is marketed as a beverage fresh, canned, or dehydrated as powder, or concentrated and frozen. It can be made into excellent vinegar or carefully fermented as wine. An average of 15 lb is needed per canner load of 7 quarts, an average of 13 lb is needed per canner load of 9 pints and an average of about 2 lb yields 1 quart (Simmone, 2003). Grapefruit peel is candied and is an important source of pectin for the preservation of other fruits. The peel oil, expressed or distilled, is commonly employed in soft-drink flavoring, after the removal of 50 % of the monoterpenes. The waste from grapefruit packing plants has long been converted into molasses for cattle. After oil extraction, the hulls can be used for soil conditioning, or, combined with the dried pulp, as cattle feed. A detoxification process must precede the feeding of this product to pigs or poultry.

Kumquat:

The kumquat is mainly decorative, but whole fruits is edible and may be eaten out of hand, or made into marmalade, and it is generally eaten fresh with its rind, or transformed into marmalades, jellies, and fresh kumquats, especially the 'Meiwa', can be eaten raw, whole. For preserving, they should be left until they lose some of their moisture and acquire richer flavor. The fruits are easily preserved whole in sugar syrup. Canned kumquats are exported from Taiwan and often served as dessert in Chinese restaurants. For candying, the fruits are soaked in hot water with baking soda, next day cut open and cooked briefly each day for 3 days in heavy syrup, then dried and sugared. Kumquats are excellent for making marmalade, either alone or half-and-half with calamondin. The fruit may be pickled by merely packing in jars of water, vinegar, and salt, partially sealing for 4 to 5 days, changing the brine, sealing and letting stand for 6 to 8 weeks. To make sweet pickles, halved fruits are boiled until tender, drained, boiled again in a mixture of corn syrup, vinegar, water and sugar, with added cloves and cinnamon, and then baked until the product is thick and transparent. Kumquat sauce is made by cooking chopped, seeded fruits with honey, orange juice, salt and butter.

Lemon:

In Colombia, lemon soup is made by adding slices of lemon to dry bread roll that has been sautéed in shortening until soft and then sieved. Sugar and a cup of wine are added and the mixture brought to a boil, and then served. Lemon peel can be candied at home and is preserved in brine and supplied to manufacturers of confectionery and baked goods Fresh fruit, canned juice, add to drinks, culinary source of pectin. Mainly fresh, some processed. Lemon oil is used for flavoring purposes in soft drinks and baked foods. Slices of lemon are served as a garnish on fish or meat or with iced or hot tea, to be

squeezed for the flavorful juice. Lemon peel oil is much used in furniture polishes, detergents, soaps and shampoos. It is important in perfume blending and especially in colognes. Petitgrain oil (up to 50% citral), is distilled from the leaves, twigs and immature fruits of the lemon tree in West Africa, North Africa and Italy. With terpenes removed, it is greatly prized in colognes and floral perfumes. The lemon parts consumed include the interior juice vesicles with the rind is candied or used in marmalade. Dried rind from processing plants livestock feed.

Lime

Besides being used for juice the lime can be pickled by first making 4 incisions in the apex, covering the fruits with salt, and later preserving them in vinegar. Before serving, the pickled fruits may be fried in coconut oil and sugar and then they are eaten as appetizers. Pickling is done in India by quartering the fruits, layering the pieces with salt in glass or glazed clay jars, and placing in the sun for 3 to 4 days. The contents are stirred once a day. Green chili peppers, turmeric, ginger or other spices may be included at the outset. Coconut or other edible oil may be added last to enhance the keeping quality. Another method of pickling involves scraping the fruits, steeping them in lime juice, then salting and exposing to the sun. The oil derived from the Mexican lime is obtained by three different methods in the West Indies: 1) by hand-pressing in a copper bowl studded with spikes; 2) by machine pressing, cold expression, of the oil from the spent half-shells after juice extraction, or simultaneously but with no contact with the juice; or 3) by distillation from the oily pulp that rises to the top of tanks in which the washed, crushed fruits have been left to settle for 2 weeks to a month. Limes are used in limeade drinks, culinary as for marinating meats, flavoring, and in ice cream, confections and as agarnish for desserts. Mainly fresh, some processed. They are available fresh or frozen. Lime juice is made into syrup and sauce and pies similar to lemon pie. "Key Lime Pie" is a famous dish of the Florida Keys and southern Florida, but today is largely made from the frozen concentrate of the 'Tahiti' lime. Tahiti limes are used fresh for canned lime juice, frozen lime juice, frozen lime juice concentrate, frozen limeade and powdered lime juice. Lime juice is used to cover sliced fruits to prevent darkened and to keep cauliflower white while cooking. Mexican limes are often made into jam, jelly and marmalade. In Malaya, they are preserved in syrup. The minced leaves are consumed in certain Javanese dishes. In the Philippines, the chopped peel is made into a sweetmeat with milk and coconut. Dried limes are used in Persian cooking. The dehydrated peel is fed to cattle. In India, the powdered dried peel and the sludge remaining after clarifying lime juice are employed for cleaning metal. The hand-pressed peel oil is mainly utilized in the perfume industry.

Mediterranean mandarin:.

The Mediterranean mandarin is used as a beverage base and fresh fruit.

Pummelo:

The pummelo is mainly eaten as fresh fruit and it is sweeter than the grapefruit. It is used to make jams, jellies, marmalades and syrups.

Sour orange:

Sour orange is used for marmalade, flavoring and in drinks. The normal types of sour orange are usually too sour to be enjoyed out-of-hand. In Mexico, however, sour oranges are cut in half, salted, coated with a paste of hot chili peppers, and eaten. The greatest use of sour oranges as food is in the form of marmalade and for this purpose they have no equal. The juice is valued for ade and as a flavoring on fish and, in Spain, on meat during cooking. It is used like vinegar in the Yucatan. In Egypt and elsewhere, it has been fermented to make wine. "Bitter orange oil", expressed from the peel, is in demand for flavoring candy, ice cream, baked goods, gelatins and puddings, chewing gum, soft drinks, liqueurs and pharmaceutical products.

Sweet orange:

Sweet oranges are used fresh, canned and frozen juice, canned segments, and marmalade. In addition to its food uses, orange peel oil is a prized scent in perfume and soaps. Oil derived from orange and other citrus seeds is employed as cooking oil and in soap and plastics. The high-protein seed residue is suitable for human food and as an ingredient in cattle feed and the hulls enter into fertilizer mixtures. The essential oils distilled from orange flowers and foliage is important in perfume manufacturing. Some Petitgrain oil is distilled from the leaves, flowers, twigs, and small, whole, unripe fruits

Satsuma mandarin

In the UK, mikan are commonly eaten at Christmas. In Canada, they are a popular snack at any time of the year, and fruit grown in Morocco are commonly sold in supermarkets.

Tangerine

Tangerines are easily peeled by hand into separate segments. They can be eaten fresh or canned and used in fruit salads, as snacks, desserts, puddings, and custards or as a flavoring for meat marinades. The skin can be used as a zeste or garnish for food and sweets.

Medicinal Uses of Citrus Fruits:

There are several medicinal uses of citrus fruits. Citron juice with wine was considered an effective purgative to rid the body of poison. In India, the peel is a remedy for dysentery and is eaten to overcome halitosis. The candied peel is sold in China as a stomachic, stimulant, expectorant and tonic. In West Tropical Africa, the citron is used only as a medicine, particularly against rheumatism. The flowers are used medicinally by the Chinese. In Malaya, a decoction of the fruit is taken to drive off evil spirits. A decoction of the shoots of wild plants is administered to improve appetite, relieve stomach ache and expel intestinal worms. A leaf infusion is given as an antispasmodic. In Southeast Asia, citron seeds are given as a vennifuge. In Panama, they are ground up and combined with other ingredients and given as an antidote for poison. The essential oil of the peel is regarded as an antibiotic.

Lemon juice is widely known as a diuretic, antiscorbutic, astringent, and febrifuge. In Italy, the sweetened juice is given to relieve gingivitis, stomatitis, and inflammation of the tongue. Lemon juice in hot water has been widely advocated as a daily laxative and preventive of the common cold, but daily doses have been found to erode the enamel of the teeth. Prolonged use will reduce the teeth to the level of the gums. Lemon juice and honey, or lemon juice with salt or ginger, is taken when needed as a cold remedy. It was the juice of the Mediterranean sweet lemon, not the lime that was carried aboard British sailing ships of the 18th Century to prevent scurvy, though the sailors became known as "limeys". Oil expressed from lemon seeds is employed medicinally. The root decoction is taken as a treatment for fever in Cuba and for gonorrhea in West Africa. An infusion of the bark or of the peel of the fruit is given to relieve colic.

Lime juice dispels the irritation and swelling of mosquito bites. In Malaya, the juice is taken as a tonic and to relieve stomach ailments. The pickled fruit, with other substances, is poulticed on the head to allay neuralgia. In India, the pickled fruit is eaten to relieve indigestion. The juice of the Mexican lime is regarded as an antiseptic, tonic, an antiscorbutic, an astringent, and as a diuretic in liver ailments, a digestive stimulant, a remedy for intestinal hemorrhage and hemorrhoids, heart palpitations, headache, convulsive cough, rheumatism, arthritis, falling hair, bad breath, and as a disinfectant for all kinds of ulcers when applied in a poultice. The leaves are poulticed on skin diseases and on the abdomen of a new mother after childbirth. The leaves or an infusion of the crushed leaves may be applied to relieve headache. The leaf decoction is used as eye drops and to bathe a feverish patient; also as a mouth wash and gargle in cases of sore throat and thrush. The Tahiti lime juice, given quickly, is an effective antidote for the painful oral irritation and inflammation that result from biting into aroids such as *Dieffenbachia* spp., *Xanthosoma* spp., *Philodendron* spp., and their allies. Lime juice has also been applied to relieve the effects of stinging corals.

Sour orange juice is antiseptic and hemostatic. Africans apply the cut-open orange on ulcers and yaws and areas of the body afflicted with rheumatism. In Italy, Mexico and Latin America generally, decoctions of the leaves are given for their antispasmodic, stimulant, tonic and stomachic action. The flowers, prepared as a syrup, act as a sedative

in nervous disorders and induce sleep. An infusion of the bitter bark is taken as a tonic, stimulant, febrifuge and vermifuge.

Sweet orange is eaten to allay fever and catarrh. The roasted pulp is prepared as a poultice for skin diseases. The fresh peel is rubbed on acne. In the mid-1950s, the health benefits of eating peeled, whole oranges were much publicized because of its protopectin, bioflavonoids and inositol (related to vitamin B). The orange contains a significant amount of the vitamin-like glucoside, hesperidin, and 75 - 80% of it in the albedo, rag and pulp. This principle, also rutin and other bioflavonoids were for awhile much advocated for treating capillary fragility, hemorrhages and other physiological problems, but they are no longer approved for such use in the United States. An infusion of the immature fruit is taken to relieve stomach and intestinal complaints. The flowers are employed medicinally by the Chinese people living in Malaya. Orange flower water, made in Italy and France as cologne, is bitter and considered antispasmodic and sedative. A decoction of the dried leaves and flowers is given in Italy as an antispasmodic, cardiac sedative, antiemetic, digestive and remedy for flatulence. The inner bark, macerated and infused in wine, is taken as a tonic and carminative. A vinous decoction of husked orange seeds is prescribed for urinary ailments in China and the juice of fresh orange leaves or a decoction of the dried leaves may be taken as a carminative or applied on sores and ulcers. An orange seed extract is given as a treatment for malaria in Ecuador but it is known to cause respiratory depression and a strong contraction of the spleen.

Pummelo in the Philippines and Southeast Asia, have decoctions of the leaves, flowers, and rind are given for their sedative effect in cases of epilepsy, chorea and convulsive coughing. The hot leaf decoction is applied on swellings and ulcers. The fruit juice is taken as a febrifuge. The seeds are employed against coughs, dyspepsia and lumbago. Gum that exudes from declining trees is collected and taken as a cough remedy in Brazil.

Citrus Fruit Yields:

Table 30 shows the juice equivalents for an individual citrus fruit as well as the peel equivalent. For example one medium orange (154 g) yields ¼ cup juice and 4 teaspoons of grated peel.

Table 30. The Juice Yields of the Citrus Fruits and Other Portions Such as the Peel Used for Food.

Citrus Commodity	Juice Equivalents	Peel Equivalents
Citrus specialties	One medium tangerine = 109 g. = about ¼ cup juice.	Similar to orange.
Grapefruit	One medium grapefruit (308 g)	One medium grapefruit = 3 - 4

Citrus Commodity	Juice Equivalents	Peel Equivalents
	= 2/3 cup juice. Five – six medium lemons = 1 cup juice.	teaspoons grated peel.
Lemon	One medium lemon (58 g) = 3 tablespoons juice. Five – six medium lemons = 1 cup juice.	One medium lemon yields 3 tablespoons of grated peel.
Lime	One medium lime (67 g) or 2 inch diameter = ¼ cup juice or 2 tablespoons of juice.	
Orange	One medium orange (154 g) yields ¼ cup juice.	One medium orange = 4 teaspoons grated peel.

USDA Marketing Standards for Citrus Fruits:

The USDA Agricultural Marketing Service (USDA AMS) has established standards for marketing many of the citrus fruits. For citrus the standards are based on size (diameter), color, skin texture, injury, shape, juice content, and lack of diseases or insect damage. Oranges can vary in diameter from 2 6/16 to 5 1/16 inches, grapefruit from 3 5/16 to 5 9/16 inch. There are also eight grades of orange juice that includes: pasteurized orange juice, canned orange juice, orange juice from concentrate, frozen concentrated orange juice, reduced acid frozen concentrated orange juice, canned concentrated orange juice, concentrated orange juice for manufacturing, and dehydrated orange juice. The orange juice standards include items on flavor, defects like seeds, color and Brix. There are also standards for grades of orange marmalade that include sweet orange, bitter orange, and combination of sweet and bitter oranges and are based on color, absence of defects, uniformity of the gel, and flavor.

AVAILABILITY AND STORAGE LIFE OF THE CITRUS FRUIT CROP GROUP MEMBERS IN THE MARKETPLACE:

Citrus fruits are widely available in the marketplace both from domestic production and imports. The available and peak production periods for oranges, lemon, and grapefruit in the marketplace are shown in Tables 31, 32, and 33, respectively. The citrus varieties and harvesting times for California (Table 34) and Florida (Table 35) varieties are also discussed below as well as a description of the citrus varieties. Most citrus may be stored for periods of up to one to two months and variation in the storage times for the citrus are in Table 36. Specific food uses for citrus fruits are discussed under the Comparison of harvesting, raw agricultural commodity (RAC), edible portions, and processed food item section of this report. In most cases based on U.S. production and imports citrus is now available all year around.

Table 31. Availability of Oranges in the U.S. Marketplace (A = Available, P = Peak).

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
California	P	P	P	P	P	P	A	A	A	P	P	P
Florida	A	A	A	A	A	A				A	A	A
Texas	P	P	A	A	A				A	A		
Australia							A	A				

Table 32. Availability of Lemons in the U.S. Marketplace (A = Available, P = Peak).

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arizona	A	A	A	A	A	A				A	A	A
California	P	P	P	P	P	P	P	P	P	P	P	P
Chile						A	A					
Spain					A	A	P	A				

Table 33. Availability of Grapefruit in the U.S. Marketplace (A = Available, P = Peak).

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
California	A	A	A	A	A	P	P	P	P	P	A	A
Florida	P	P	P	P	P	A			A	P	P	P
Texas	P	P	P	A	A				A	P	P	P
Bahamas										A	A	A

Specific Citrus Variety Availability:

In Florida, most oranges bloom in March-April and there is three main production seasons. Early varieties, such as 'Hamlin' and 'Parson Brown', reach maturity in October through January. The midseason varieties such as the 'Pineapple Orange' reach maturity in December-February. Late season varieties such as the 'Valencia' mature from February-June. For harvesting citrus in California and Florida see Tables 34 and 35, respectively.

TABLE 34:

Sunkist California Varietals Chart
(http://www.sunkist.com/products/varietal_chart.asp

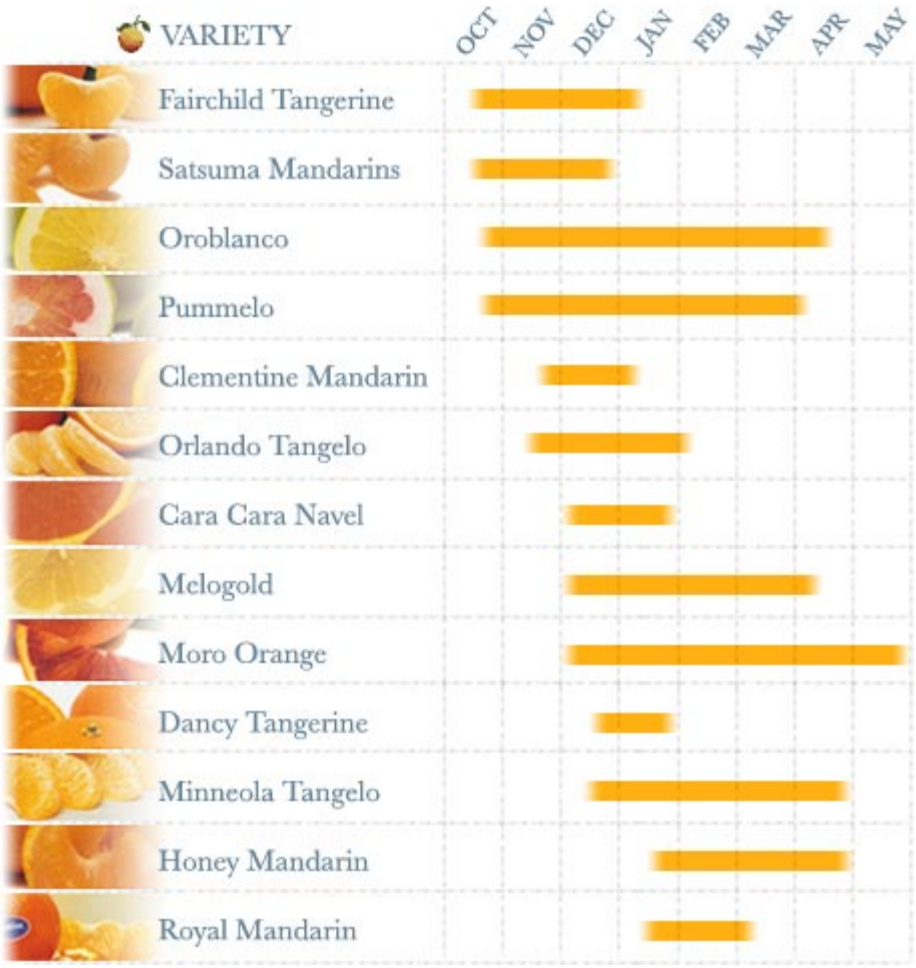


Table 35. Florida Citrus Harvesting Periods. (Adapted from Ferguson, J.J. 2002. Your Florida Dooryard Citrus Guide - Appendices, Definitions and Glossary. Univ FL. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Document HS 891. (http://edis.ifas.ufl.ed).

Citrus Variety	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.
Navel	X	X	X	X								
Ambersweet	X	X	X	X								
Hamlin	X	X	X	X								
Parson Brown	X	X	X	X								
Pineapple			X	X	X							
Sunstar			X	X	X	X						
Midsweet				X	X	X						
Gardner				X	X	X						
Valencia						X	X	X	X			
Duncan			X	X	X	X	X	X				
Marsh		X	X	X	X	X	X	X				
Redblush (Ruby)		X	X	X	X	X	X	X				
Star Ruby			X	X	X	X	X	X				
Minneola tangelo			X	X	X							
Orlando tangelo		X	X	X								
Nova tangelo		X	X									
Robinson tangerine	X	X	X									
Sunburst tangerine		X	X									
Dancy tangerine			X	X								
Murcott (Honey tangerine)				X	X	X						
Temple orange				X	X	X						
Osceola	X	X										
Fallglow	X	X										
Page mandarin	X	X	X	X	X							
Owari (satsuma)	X	X										
Ponkan mandarin			X	X								
Tahiti (Persian) lime									X	X	X	X
Key Lime (Mexican)	X	X	X	X	X	X	X	X	X	X	X	X
Meyer lemon		X	X	X	X	X						
Bearss lemon	X	X	X							X	X	X
Calamondin		X	X	X	X	X	X					

Nagami kumquat		X	X	X	X	X	X					
Melwa kumquat		X	X	X	X	X	X					
Limequat		X	X	X	X	X						
Midsweet				X	X	X						
Sunstar			X	X	X	X						

Specific Information on Florida Citrus Fruit Varieties – Followup to Table 35 (Adapted from J.J. Ferguson, 2002, Walleim, 1996 and Tucker, 1995).

Sweet Oranges (Representative for Crop Subgroup 10A):

The sweet oranges grown in Florida can be divided into three broad seasonal categories: 'Hamlin', 'Parson Brown', 'Ambersweet', and navels are considered early-season cultivars; 'Pineapple orange' is a mid-season cultivar; and 'Valencia' is a late-season cultivar.

Early-Season Oranges are harvested October to January.

The 'Hamlin' orange has a high degree of cold tolerance especially with early harvest before winter freezes. Fruit yield is high and juice has a light color. The fruit stores well on the tree but is susceptible to splitting and creasing and there are 0 – 6 seeds per fruit.

The 'Parson Brown' orange is an early season orange that can be harvested slightly earlier than 'Hamlin'. Its seediness and lower fruit yields make it less desirable than 'Hamlin' for fresh fruit. There are 0 - 30 seeds per fruit.

The 'Ambersweet' orange is moderately cold hardy. The fruit can usually be harvested prior to damaging freezes. Fruit resembles navel orange, peels easily, has good fruit and juice color at maturity, but varies greatly in seediness. This is a newer cultivar; so many questions remain about fruit production and fruit quality. This one is a very good early-season orange cultivar for either fresh fruit and/or juice. There are 0 - 30 seeds per fruit.

The 'Navel' orange is considered an early season orange and is harvested October to January. Navels differ from other oranges by having a rudimentary secondary fruit embedded at the blossom end of the fruit. Premature yellowing and rot of this secondary fruit often results in premature fruit drop. The fruit peels relatively easily and sections well. If juiced, drink within several hours before a bitter flavor develops. It tends to require more precise irrigation and nutrition management. Two periods of fruit drop,

early- and late-summer, account for 15 - 20 percent of the crop in some years. 'Cara Cara navel' is used for salads because of its near-crimson flesh. There are 0 - 6 seeds per fruit.

Mid-Season Oranges are generally harvested December – March.

The 'Pineapple orange' is harvested December to February. This leading mid-season cultivar has good external color and internal quality but is the least cold hardy of orange varieties. It is subject to alternate bearing, pre-harvest fruit drop during heavy crop years, creasing and pitting. There are 15 – 25 seeds per fruit.

The 'Sunstar' orange is harvested December to March. This variety has slightly darker juice color than 'Hamlin 'and about as much fruit. It is more cold hardy and subject to less pre-harvest fruit drop than 'Pineapple' orange. It ripens about the same time as 'Pineapple'.

The 'Midsweet' orange is harvested January to March. 'Midsweet' ripens later that 'Pineapple' and holds well on the tree. Fruit yield and quality are about the same as 'Hamlin' but juice color is deeper.

The 'Gardner' orange is harvested January to March. This midseason orange ripens around February 1, about the same time as 'Midsweet'. 'Gardner' is about as cold hardy as 'Sunstar' and 'Midsweet'.

Late-Season Oranges:

The 'Valencia' orange is the main late season orange and is harvested March to June. This cultivar carries two crops on the tree after bloom, the current season's crop and the previous season's crop that takes about 15 months to mature. With its excellent internal fruit quality and juice color, the 'Valencia' is the most important sweet orange variety. The tree tends towards alternate bearing. Fruit stores well on the tree and may regreen late in the season. 'Valencia' orange has superior peel and flesh color. There are 0 – 6 seeds per fruit.

Grapefruit (Representative for Crop Subgroup 10C):

Two basic types of grapefruit are grown in Florida, the white-fleshed ('Marsh' and 'Duncan') and the pink-fleshed or colored grapefruit ('Redblush', 'Thompson', 'Flame').

The 'Duncan' grapefruit is harvested from December to May. It produces seedy, high quality fresh fruit with pale, yellow flesh. This grapefruit is popular for using the sectioning in deserts. There are 30 - 70 seeds per fruit.

The 'Marsh' grapefruit is harvested from November to May. This seedless fruit with pale yellow flesh and large, has a open cavity in center, and is used commercially for juice. There are 0 - 6 seeds per fruit.

The 'Redblush' grapefruit is also harvested from November to May. It is a widely grown ruby red grapefruit used for juice and cocktail products. The peel is a pink blush and the flesh pink to pale red. There are 0 - 6 seeds per fruit.

The 'Star Ruby' grapefruit is harvested from December to May. Peel has a dark-pink blush; flesh is deep red with a smooth peel. These trees are less cold hardy than other grapefruit cultivars and more susceptible to foot rot.

Other grapefruit cultivars include 'Thompson', 'Ray Ruby', 'Flame', and 'Rio Red'. Seeds: and they contain 0 - 6 seeds per fruit.

Tangerine or Mandarin and Mandarin Type Fruits (Representative for Crop Subgroup 10A):

Tangerines or mandarins include fruit of small to medium-size; loose rind and fruit sections; with a distinctive flavor, color and aroma; and excellent eating out-of-hand qualities. Trees are usually very cold tolerant. The peel on some mandarins tears easily, so harvesting is done by cutting the stem with pruning shears. Seed numbers generally vary with the degree of cross-pollination.

'Minneola' tangelo is harvested from December to February. This fruit has a characteristic flavor that often exhibits a prominent neck at the stem end. Fruit production is enhanced by cross-pollination. Trees are extremely cold hardy, but highly susceptible to Alternaria brown spot. There are 7 - 12 seeds per fruit.

'Orlando' tangelo is harvested from November to January. This early-season cultivar produces a large, cold-hardy tree with cup-shaped leaves. Trees must be fertilized more heavily and frequently than most other cultivars, especially with nitrogen,

as foliage tends to turn yellow in the fall and late winter. It bears fruit within 3 - 4 years as a seedling tree, and is moderately susceptible to Alternaria brown spot. There are 0 - 35 seeds per fruit.

The 'Robinson' tangerine is harvested from October to December. Cross-pollination required for this early tangerine of excellent eating quality. Fruit tends to dry-out early on vigorous rootstocks, is thin-skinned, and susceptible to splitting. It is one of the more cold-hardy cultivars, but susceptible to twig and limb dieback. There are 1 - 20 seeds per fruit.

'Sunburst' tangerine is harvested from November to December. Cross-pollination required. Foliage and twigs are highly susceptible to environmental stress and rust mite damage. This thin-skinned fruit is also susceptible to splitting. There are 1 - 20 seeds per fruit.

'Murcott' or 'Honey' tangerine is harvested from January to March. It has excellent eating-quality but heavy alternate bearing sometimes results in limb breakage and tree collapse. Trees are normally cold hardy, but highly susceptible to cold damage when heavily laden with fruit, which is also susceptible to scab. The fruit is borne on the outside canopy, resulting in susceptibility to wind scaring and sunburn. There are 10 - 20 seeds per fruit.

The 'Dancy' tangerine is harvested from December to January. It produces large crops of small fruit, though highly susceptible to Alternaria brown spot. Limb breakage may also occur with heavy crops. The fruit is excellent in quality and peels so easily it must be hand clipped to harvest. There are 6 – 20 seeds per fruit.

The 'Temple' orange is harvested from January to March. It is an excellent eating-quality fruit with a pebbly rind that is easily peeled. Mature fresh fruit and juice are of superior flavor and color. The trees are very sensitive to citrus scab, cold temperatures and aphids. There are 15 - 20 seeds per fruit.

The 'Osceola' is a citrus hybrid that is harvested from October to November. Cross-pollination is required to produce this small, highly colored but seedy fruit. The tree is relatively cold hardy, but susceptible to scab. Fruit is also clipped to harvest. There are 15 - 25 seeds per fruit.

'Fallglow' is a citrus hybrid that is harvested from October to November. The fruit is juicy, may have a tart taste, and are usually larger than other citrus hybrids. The tree is not as cold hardy as most citrus hybrids and is highly susceptible to aphids. There are 20 - 25 seeds per fruit.

'Page' mandarin is harvested from October to February. It bears many small fruit of excellent eating quality. The tree is relatively cold hardy, but susceptible to scab. There are 0 - 25 seeds per fruit.

The 'Owari' mandarin is harvested from September to November. The trees have a characteristic, open-growth habit with less foliage than other cultivars, and perform well on trifoliate orange rootstock. It produces its best-quality fruit in northern areas of Florida. Fruit achieves excellent eating quality before good external color appears, but does not store well on the tree. It is also clipped at harvest. There are 0 - 6 seeds per fruit.

The Acid Citrus Fruit Types (Representative for Crop Subgroup 10B):

This acid citrus fruit includes lemons, limes and citrons. They usually bloom more frequently than other cultivars and are highly cold-sensitive.

The 'Tahiti' or 'Persian' lime is harvested from June to September. These thorny trees are highly susceptible to cold injury, limiting their culture to southern Florida. Fruit is large, acid, and harvested while green. Maturity is based on size and juice content since fruit is pale yellow when fully mature. There are 0 – 1 seeds per fruit.

The 'Key' or 'Mexican' lime is harvested year around. The small fruit are prized for the lime flavor they give pies. Juice is also used as condiment. They are susceptible to the cold, so these trees can be grown outdoors only in south Florida, and should be container-grown and moved inside during cold weather in other areas. Key lime will produce flowers repeatedly, so fruit in various stages of development are found on the tree at the same time. There are 3 - 8 seeds per fruit.

The 'Meyer' lemon is harvested from November to March. This variety's cold-hardiness makes it a popular selection for dooryard plantings. It has a low-spreading growth habit with few thorns. The fruit are relatively large with high juice content, a smooth skin, and lower acid levels than other lemon varieties. There are 0 - 10 seeds per fruit.

The 'Bearss' lemon is harvested from July to December. Trees are very vigorous, thorny, and sensitive to cold. Continuous growth makes it difficult to control tree size. There are 1 – 6 seeds per fruit.

Other Citrus Fruits:

The Calamondin is harvested from November to April. This acid fruit flavors drinks, marmalades and jellies. Popular in landscapes and ornamental containers, rooted cuttings of this cultivar are also widely marketed as "miniature oranges" for use as a winter houseplant. While rooted cuttings grow like shrubs, budded trees can reach 15 - 20 feet and are cold-hardy. There are 3 - 5 seeds per fruit.

The 'Nagami' kumquat is harvested from November to April. This oblong or egg-shaped fruit has an acid taste and bright-orange color. There are 0 - 3 seeds per fruit.

The 'Meiwa' kumquat is harvested from November to April. The peel and pulp of these large, round fruit have a pleasant spicy-sweet taste, and are used for preserves and candied fruit. The tree is compact and foliage is dark green. Trees are used in home and commercial landscaping and are quite cold-hardy. There are 1 - 6 seeds per fruit

The Limequat is harvested from November to March. The hybrids of limequat are 'Eustis', 'Lakeland', and 'Tavares', hybrids of kumquats and the 'West Indian' or key lime, all resemble the key lime in size, form and composition and are commonly substituted for key lime. 'Eustis' and 'Lakeland' kumquats are similar in color to the key lime where as the 'Tavares' limequat has more orange color. 'Eustis' and 'Lakeland' are sister hybrids of the 'West Indian' or key lime and the round or 'Meiwa' kumquat. 'Tavares' is a hybrid of key lime with the oval or 'Nagami' kumquat. All limequats are more cold resistant than key limes but less cold resistant than kumquats. There are few to many seeds in a limequat.

Storage Life of Citrus Fruits:

Most citrus may be stored for periods of up to one to two months at temperatures ranging from 32 - 40° F. Chilling injury is common in grapefruit, lemons, and limes when stored below 50°F, but rare in oranges and tangerines. A unique aspect of citrus is the ability to store fruit on the tree. Fruit may reach minimum maturity standards in early winter, but since they are nonclimacteric, they ripen slowly and will not soften or abscise for periods up to several months.

In general citrus fruits have a relatively long storage time for the fresh marketplace (See Table 36). The lemon has the longest storage life at 4 – 4 weeks and the tangerine the shortest at 2 – 4 weeks.

Table 36. Approximate Storage Life of Citrus Fruits in Commercial Storage (Adapted Hardenburg, et al., 1986).

Commodity	Approximate Storage Life With Proper Storage Temperatures
Blood orange	3 – 8 weeks
Calamondin	2 weeks
Grapefruit	6 – 8 weeks
Jaffa orange	8 – 12 weeks
Kumquat	2 – 4 weeks
Lemon	4 - 24 weeks
Lime	2 – 8 weeks
Orange – CA and AZ	3 – 8 weeks
Orange – FL and TX	8 – 12 weeks
Tangerine	2 – 4 weeks
Uniq fruit	2 – 3 weeks

CHANGES TO EPA DATABASES NEEDED FROM REVISIONS TO THE CITRUS FRUIT CROP GROUP:

The revisions to the amended Citrus Fruit Crop Group 10 will affect the need to update many Risk Assessment Models, Residue Chemistry Guidelines, OPP databases, and/or HED Standard Operating Procedures (SOP).

The affected EPA databases may include the following:

(1) **Risk Assessment Models** - The terminology in the Food Exposure Modules of our current Risk assessment Models from DEEM-FCID, Lifeline, and Cares will need to be updated to reflect new terminology and the new Crop Group terminology.

(2) **EPA Residue Chemistry Test Guidelines (OPPTS 860.1000, Background)**, Table 1 Raw Agricultural and Processed Commodities and Feedstuffs Derived from Crops and EPA Residue Chemistry Test Guidelines (OPPTS 860.1000, Background), EPA Residue Chemistry Test Guidelines (OPPTS 860.1500, Crop Field Trials), Table 5 Suggested Distribution of Field Trials by Region for Crops Requiring > 3 trials and Table 6 Regional Distribution of Crop Production.

Any differences between the EPA and NAFTA Crop Production Regions after the NAFTA Regions are updated will be addressed by the ICCGR Workgroup or by the EPA HED ChemSAC. The EPA Residue Chemistry Test Guidelines (OPPTS 860.1500, Crop Field Trials) Table 5 Suggested Distribution of Field Trials by Region for Crops Requiring >3 trials and Table 6 Regional Distribution of Crop Production will be updated to reflect more recent crop production information. There is no conflict with Canada.

(3) **Health Effects Division Standard Operating Procedures: HED SOP 99.3 -– "Translation of Monitoring Data" issued March 26, 1999.** This policy provides guidance on translating pesticide monitoring data from one commodity to other similar commodities. Most of the monitoring data is from the USDA Pesticide Data Program (PDP) or the Food and Drug Administration (FDA). The policy is based on the crop groupings in the 40 CFR 180.41.

There is an entry for oranges in which the residue data can be translated to all the members of the Citrus Fruit Group 10. USDA PDP peels the oranges before they analyze them for pesticide residues. The policy does not have to be updated at this time, since it will be applicable to the whole crop group.

(4) **HED SOP 99.6 - "Classification of Food Forms with Respect to Level of Blending" issued August 20, 1999.** This SOP provides rationale and guidance to HED on revised criteria for inputting residue values and pesticide usage information into acute dietary exposure and risk assessments based on commodities. These revisions permit the Agency to more fully utilize data generated by the USDA Pesticide Data Program.

Some of the Citrus Fruit Crop Group members are included in the HED SOP 99.6. See Table 36 below. Other members not in the original SOP will need to be added to the HED SOP 99.6. All of the oils are considered refined and blended, while the seeds can be uncooked, cooked, baked, or boiled.

TABLE 37. Classification of Food Forms with Respect to Level of Blending for the Citrus Fruit Crop Group. (HED SOP 99.6, April 20, 1999).

COMMODITY	FOOD FORM	CLASSIFICATION
Citron citrus	13-- Baked	PB - Partially blended
Citron citrus	14 – Boiled	PB - Partially blended
Grapefruit - peel	11 - Uncooked	PB - Partially blended
Grapefruit - juice	11 - Uncooked	PB - Partially blended
Grapefruit - juice	31 – Canned: NFS	PB - Partially blended
Grapefruit – juice - concentrate	41 – Frozen: NFS	PB - Partially blended
Grapefruit – peeled fruit	11 - Uncooked	NB – Not blended
Grapefruit – peeled fruit	12 – Cooked: NFS	NB – Not blended
Grapefruit – peeled fruit	31 – Canned: NFS	PB - Partially blended
Lemon-juice	11 - Uncooked	PB - Partially blended
Lemon-juice	12 – Cooked: NFS	PB - Partially blended
Lemon-juice	13 - Baked	PB - Partially blended
Lemon-juice	14 – Boiled	PB - Partially blended
Lemon-juice	15 - Fried	PB - Partially blended
Lemon-juice	31 – Canned: NFS	PB - Partially blended
Lemon-juice	32 – Canned: Cooked:NFS	PB - Partially blended
Lemon-juice	34 – Canned: Boiled	PB - Partially blended
Lemon-juice	41 – Frozen: NFS	PB - Partially blended
Lemon-juice	41 – Frozen: Cooked	PB - Partially blended
Lemon juice - concentrate	12 – Cooked: NFS	PB - Partially blended
Lemon juice - concentrate	13-- Baked	PB - Partially blended
Lemon juice - concentrate	14 – Boiled	PB - Partially blended
Lemon juice - concentrate	31 – Canned: NFS	PB - Partially blended

COMMODITY	FOOD FORM	CLASSIFICATION
Lemon juice - concentrate	34 – Canned: Boiled	PB - Partially blended
Lemon juice - concentrate	41 – Frozen: NFS	PB - Partially blended
Lemon - peel	11 - Uncooked	PB - Partially blended
Lemon - peel	13-- Baked	PB - Partially blended
Lemon - peel	14 – Boiled	PB - Partially blended
Lemon - peel	31 – Canned: NFS	PB - Partially blended
Lemon - peel	34 – Canned: Boiled	PB - Partially blended
Lemon - peel	41 – Frozen: NFS	PB - Partially blended
Lemon – peeled fruit	11 - Uncooked	NB – Not blended
Lemon – peeled fruit	12 – Cooked: NFS	NB – Not blended
Lemon – peeled fruit	31 – Canned: NFS	NB – Not blended
Lime - juice	11 - Uncooked	PB - Partially blended
Lime - juice	31 – Canned: NFS	PB - Partially blended
Lime - juice	32 – Canned: Cooked:NFS	PB - Partially blended
Lime - juice	34 – Canned: Boiled	PB - Partially blended
Lime - juice	41 – Frozen: NFS	PB - Partially blended
Lime - juice	12 – Cooked: NFS	PB - Partially blended
Lime - juice	41 – Frozen: NFS	PB - Partially blended
Lime – juice - concentrate	12 – Cooked: NFS	PB - Partially blended
Lime – juice - concentrate	41 – Frozen: NFS	PB - Partially blended
Lime - peel	13-- Baked	PB - Partially blended
Lime - peel	14 – Boiled	PB - Partially blended
Lime peeled fruit	11 - Uncooked	PB - Partially blended
Orange -juice	11 - Uncooked	PB - Partially blended
Orange -juice	12 – Cooked: NFS	PB - Partially blended
Orange -juice	31 – Canned: NFS	PB - Partially blended
Orange -juice	41 – Frozen: NFS	PB - Partially blended
Orange – juice - concentrate	11 - Uncooked	PB - Partially blended
Orange – juice - concentrate	12 – Cooked: NFS	PB - Partially blended
Orange – juice - concentrate	13-- Baked	PB - Partially blended
Orange – juice - concentrate	14 – Boiled	PB - Partially blended
Orange – juice - concentrate	31 – Canned: NFS	PB - Partially blended
Orange – juice - concentrate	41 – Frozen: NFS	PB - Partially blended
Orange – juice - concentrate	42 – Frozen: Cooked	PB - Partially blended
Orange - peel	11 - Uncooked	PB - Partially blended
Orange - peel	12 – Cooked: NFS	PB - Partially blended
Orange - peel	31 – Canned: NFS	PB - Partially blended
Orange - peel	41 – Frozen: NFS	PB - Partially blended
Orange – peeled fruit	11 - Uncooked	NB – Not blended
Orange – peeled fruit	12 – Cooked: NFS	NB – Not blended
Orange – peeled fruit	31 – Canned: NFS	PB - Partially blended
Tangelo	11 - Uncooked	NB – Not blended
Tangerine	11 - Uncooked	NB – Not blended
Tangerine	31 – Canned: NFS	PB - Partially blended
Tangerine	41 – Frozen: NFS	PB - Partially blended
Tangerine - juice	11 - Uncooked	PB - Partially blended
Tangerine - juice	31 – Canned: NFS	PB - Partially blended
Tangerine - juice	41 – Frozen: NFS	PB - Partially blended
Tangerine – juice - concentrate	Tangerine – juice - concentrate	PB - Partially blended

(5) **HED SOP 2000.1 – "Guidance for Translation of Field Trial Data from Representative Commodities in the Crop Group Regulation to Other Commodities in Each Crop Group/Subgroup" issued September 12, 2000.**

There is no guidance in the SOP for the new Citrus Fruit Crop Subgroups, so the following guidance for translation of the representative commodities to other members of the group/subgroups will be provided below:

Current Crop Group 10: Citrus Fruits

Representative Commodities: Sweet orange, lemon, and grapefruit

CROP GROUP COMMODITY	REPRESENTATIVE COMMODITY
Calamondin	Sweet orange
Citrus citron	Sweet orange
Citrus hybrids	Sweet orange
Grapefruit	Grapefruit
Kumquat	Sweet orange
Lemon	Lemon
Lime	Lemon
Orange, sour	Sweet orange
Orange, sweet	Sweet orange
Pummelo	Grapefruit
Satsuma mandarin	Sweet orange
Tangerine	Sweet orange

Proposed Crop Group 10-07: Citrus Fruits

Representative Commodities: Orange or tangerine*, lemon or lime, and grapefruit

CROP GROUP COMMODITY	REPRESENTATIVE COMMODITY
Australian desert lime	Lemon or lime
Australian finger lime	Lemon or lime
Australian round lime	Lemon or lime
Brown River finger lime	Lemon or lime
Calamondin	Orange
Citron	Orange
Citrus hybrids	Orange
Grapefruit	Grapefruit
Japanese summer grapefruit	Grapefruit
Kumquat	Lemon or lime

Lemon	Lemon
Lime	Lime or Lemon
Mediterranean mandarin	Tangerine
Mount white lime	Lemon or lime
New Guinea wild lime	Lemon or lime
Orange, sour	Orange
Orange, sweet	Orange
Pummelo	Grapefruit
Russell River lime	Lemon or lime
Satsuma mandarin	Tangerine or orange
Sweet lime	Lime or Lemon
Tachibana orange	Orange
Tahiti lime	Lime or lemon
Tangelo	Orange or tangerine or grapefruit
Tangerine	Tangerine
Tangor	Orange or tangerine
Trifoliate orange	Orange
Uniq fruit	Grapefruit

The proposed new translations of field trials from the representative commodities to other commodities in the Orange subgroup 10-07-A would be as follows:

Proposed Crop Subgroup 10-07A: Orange subgroup

Representative Commodity: Orange or tangerine/mandarin

CROP SUBGROUP COMMODITY	REPRESENTATIVE COMMODITY
Calamondin	Orange
Citrron	Orange
Citrus hybrids	Orange
Mediterranean mandarin	Tangerine
Orange, sour	Orange
Orange, sweet	Orange
Satsuma mandarin	Tangerine
Tachibana orange	Orange
Tangelo	Orange or tangerine
Tangerine	Tangerine
Tangor	Orange or tangerine
Trifoliate orange	Orange

The proposed new translations of field trials from the representative commodities to other commodities in the Lemon/lime subgroup 10-07-B would be as follows:

Proposed Crop Subgroup 10-07B: Lemon/Lime subgroup

Representative Commodity: Lemon or Lime

CROP SUBGROUP COMMODITY	REPRESENTATIVE COMMODITY
Australian desert lime	Lemon or lime
Australian finger lime	Lemon or lime
Australian round lime	Lemon or lime
Brown River finger lime	Lemon or lime
Kumquat	Lemon or lime
Lemon	Lemon
Lime	Lime
Lime, sweet	Lemon or lime
Mount white lime	Lemon or lime
New Guinea wild lime	Lemon or lime
Russell River lime	Lemon or lime
Tahiti lime	Lime or lemon

The proposed new translations of field trials from the representative commodities to other commodities in the Grapefruit subgroup 10-07C would be as follows:

Proposed Crop Subgroup 10-07C: Grapefruit subgroup

Representative Commodity: Grapefruit

CROP SUBGROUP COMMODITY	REPRESENTATIVE COMMODITY
Grapefruit	Grapefruit
Japanese summer grapefruit	Grapefruit
Pummelo	Grapefruit
Tangelo	Grapefruit
Uniq fruit	Grapefruit

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(6) **HED Dry Matter Database will be updated to add the Table below**:

Table 38. Health Effects Division Dry Matter and Seeding Rate Database. Citrus Fruit Crop Group. Prepared by Dr's. NG and B. A. Schneider. June 2007.

Commodity	% Dry Matter
Calamondin	10.2
Citrus, dried pulp	87.0, 91.0
Citrus, juice	12.0
Citrus, molasses	67.0
Citrus, oil	0.0
Grapefruit, white	19.5
Grapefruit, pink	19.1
Grapefruit, juice	10.0, 11.8
Lemon	7.9, 11.0, 13.6, 13.7
Lemon, juice	9.0, 19.0
Lemon, peel	18.3, 18.4
Lime	10.3, 10.7, 11.8, 12.0
Lime, juice	9.7, 10.0
Orange	13.0, 13.9, 17.7
Orange, juice	11.7, 12.0
Orange, naval	13.0
Orange, peel	27.5, 28.0
Orange, Valencia	13.8
Pummelo	10.9, 11.0
Tangerine	12.0, 12.4, 13.0
Tangerine, juice	11.1, 13.0

Commodity Definitions:

COMMODITY DEFINITIONS [(40 CFR § 180.1(h)]:

There are currently two commodity definitions for Citrus fruits and tangerines and four other proposed for grapefruit, lemon, lime, and orange that need to be discussed.

Current 40 CFR § 180.1(g):

Tolerances and exemptions established for pesticide chemicals in or on the general category of raw agricultural commodities listed in column A apply to the corresponding specific raw agricultural commodities listed in column B. However, a tolerance or exemption for a specific commodity in column B does not apply to the general category in column A.

A B ----------

Current Citrus fruits Commodity Definition:

Citrus fruits.....Grapefruit, lemons, limes, oranges, tangelos, tangerines, citrus citron, kumquats and hybrids of these.

Current Tangerines Commodity Definition:

Tangerines.....Tangerines (mandarins or mandarin oranges), tangelos, tangors, and other hybrids of tangerines with other fruits.

Proposed Tangerine Commodity Definition:

Tangerine.....Tangerine (mandarin or mandarin orange), clementine, Mediterranean mandarin, Satsuma mandarin, tangelo, tangor, and cultivars, varieties, or hybrids of tangerines with other fruits.

Proposed Commodity Definitions for Grapefruit, Lemon, Lime and Orange.

Grapefruit.....Grapefruit, pummelo, shaddock, tangelo, Uniq fruit, and cultivars, varieties, or hybrids of grapefruit with other fruits.

Proposed Commodity Definitions for Lemon:

Lemon.....Lemon, Australian finger lime, Australian round lime, Brown River finger lime, calamondin, kumquats, lime, Mount white lime, New Guinea wild lime, Russell River lime, sweet lime, Tahiti lime, and varieties and/or hybrids of these lemons with other fruits.

Proposed Commodity Definitions for Lime:

Lime.....Lime, Australian desert lime, Australian finger lime, Australian round lime, Brown River finger lime, calamondin, kumquats, lemon, Mount White-lime, New Guinea wild lime, Russell River lime, sweet lime, Tahiti lime, and varieties and/or hybrids of these limes with other fruits.

Proposed Commodity Definitions for Orange:

Orange.....Orange, Calamondin, Citrus citron, Mediterranean mandarin, Satsuma mandarin, Sour oranges, Sweet oranges, Tachibana orange, Tangerine (Mandarin), Tangor, Trifoliate orange, and varieties and/or hybrids of these.

HED Recommendations on Commodity Definitions:

I recommend ChemSAC **reject** the established and proposed updated commodity definition for citrus fruits. It is essentially a repeat of the commodities in the Citrus fruit group 10, and while it may be useful for labeling citrus fruits is no longer a tolerance term, because we have an expanded citrus fruit group and several other commodity definitions such as tangerine are more specific to certain citrus.

I recommend updating the tangerine commodity definition as follows:

Tangerine.....Tangerine (mandarin or mandarin orange), clementine, Mediterranean mandarin, Satsuma mandarin, tangelo, tangor, and cultivars, varieties, and/or hybrids of tangerines with other fruits.

This will help in clarifying what other citrus fruits a tangerine will cover.

Grapefruit.....Grapefruit, Japanese summer grapefruit, pummelo, shaddock, tangelo, Uniq fruit, and cultivars, varieties, and/or hybrids of grapefruit with other fruits.

This will also clarify what commodities are covered by grapefruit tolerances and follows the EPA Commodity Reviewer's Guide approved by ChemSAC, 2006. The inclusion of cultivars, varieties and hybrids will leave no doubt which specific related varieties are covered.

I recommend establishing a new commodity definition for lemon as follows:

Lemon.....Lemon, lime, and cultivars, varieties, and/or hybrids of lemon with other fruits.

This commodity definition is mainly to show lemons also can cover limes. The list of many of the limes is not necessary for lemon and they will be included in the lime commodity definition.

I recommend establishing a new commodity definition for lime as follows:

Lime.....Lime, Australian desert lime, Australian finger lime, Australian round lime, Brown River finger lime, lemon, Mount White lime, New Guinea wild lime, Russell River lime, Sweet lime, Tahiti lime, and cultivars, varieties and/or hybrids of these limes with other fruits.

I recommend establishing a new commodity definition for orange as follows:

Orange.....Orange, sweet orange, sour orange, calamondin, tachibana orange, tangelo, trifoliate orange, and cultivars, varieties and/or hybrids of these oranges with other fruits.

I recommend establishing a new commodity definition for grapefruit as follows:

TOLERANCE EXPRESSION GUIDANCE:

Until the Federal Register Notice is issued revising the Crop Group Regulation to establish the amended Citrus Fruit Crop Group 10 with three Crop subgroups the commodities approved for the crop group and subgroups will have to be listed as separate commodities at the same tolerance level. This also applied to the new Crop subgroups, the individual commodities will have to be listed separately with each at the same tolerance level. When ChemSAC approves the Citrus fruit crop group 10, the Risk Integration, Minor Use, and Emergency Response Branch (RIMUERB) of the Registration Division can immediately implement the new Crop Group and Crop Subgroups with new tolerance expressions located in the Section F submissions. The seven tolerance expression examples will provide an expedited way to establish tolerances in or on citrus fruit crops, especially for new reduced risk pesticides, without requiring additional residue data for all the crops noted. This will create a practice in the United States which is already formalized in Canada and promote international harmonization. Several tolerance expression examples for guidance purposes for use by RIMUERB and HED reviewers will be listed below:

Example 1. What is the tolerance expression for the amended Citrus Fruit Crop Group 10?

Answer to Example 1:

The tolerance expression for the amended Citrus Fruit Crop Group 10 will be "Fruit, citrus, group 10."

Example 2. What is the correct Section F tolerance expression for the three new Citrus Fruit Subgroups?

Answer to Example 2:

The tolerance expression for the three New Citrus Fruit Crop Subgroups is as follows:

Name of Crop Subgroup	Tolerance Expression for the Crop Subgroup
Orange subgroup 10A	Orange subgroup 10–07A
Lemon/Lime subgroup 10B	Lemon/Lime subgroup 10–07B
Grapefruit subgroup 10C	Grapefruit subgroup 10–07C

Example 3: How will the Crop group and subgroups appear in the Federal Register for the proposed crop group regulation [40CFR 180.41(c)]? This example is for the Field and External Affairs Division (FEAD) use in preparing the new Federal Register Regulation. The example follows the same format as the current Crop Grouping Regulation Federal Register Notice (FR 60, No.95, 5/17/95, 26626-26643) and the Proposed Expansion of the Crop Groups (FR 72, No. 99, 5/23/07, 28920-228930).

Answer to Example 3:

"Crop Group 10-07: Citrus Fruit Crop Group".

Representative commodities. Orange or tangerine, lemon or lime, and Grapefruit

Commodities	Related crop subgroups
Australian desert lime, *Eremocitrus glauca* (Lindl.) Swingle	10-07B
Australian finger lime, *Microcitrus australasica* (F. Muell.) Swingle	10-07B

Australian round lime, *Microcitrus australis* (A. Cunn. ex Mudie) Swingle	10-07B
Brown River finger lime, *Microcitrus papuana* Winters	10-07B
Calamondin, *Citrus madurensis* Lour.	10-07A
Citron, *Citrus medica* L	10-07A
Citrus hybrids, *Citrus* spp. and *Fortunella* spp.	10-07A
Grapefruit, *Citrus x paradisi* Macfad.	10-07C
Japanese summer grapefruit, *Citrus natsudaidai* Hayata	10-07C
Kumquat, *Fortunella* spp.	10-07B
Lemon, *Citrus limon* (L.) Burm. f.	10-07B
Lime, *Citrus aurantiifolia* (Christm.) Swingle	10-07B
Mediterranean Mandarin, *Citrus nobilis* Loureiro var. deliciosa Swingle	10-07A
Mount White lime, *Microcitrus garrowayae* (F. M. Bailey) Swingle	10-07B
New Guinea wild lime, *Microcitrus warburgiana* (F. M. Bailey) Tanaka	10-07B
Orange, sour, *Citrus aurantium* L.	10-07A
Orange, sweet, *Citrus sinensis* (L.) Osbeck	10-07A
Pummelo, *Citrus maxima* (Burm.) Merr.	10-07C
Russell River lime, *Microcitrus inodora* (F. M. Bailey) Swingle	10-07B
Satsuma mandarin, *Citrus unshiu* Marcow.	10-07A
Sweet lime, *Citrus limetta* Risso	10-07B
Tachibana orange, *Citrus tachibana* (Makino) Tanaka	10-07A
Tahiti Lime, *Citrus latifolia* Tan.	10-07B
Tangelo, *Citrus x tangelo* J.W. Ingram & H.E. Moore	10-07A, 10-07C
Tangerine (Mandarin), *Citrus reticulata* Blanco	10-07A
Tangor, *Citrus reticulata* × *Citrus sinensis*	10-07A
Trifoliate orange, *Poncirus trifoliata* (L.) Raf.	10-07A
Uniq fruit *Citrus aurantium* Tangelo group	10-07C
Varieties, cultivars and/or hybrids of these	

(i) Table. The following Table 2 identifies the crop subgroups for Crop Group 10, specifies the representative commodities for each subgroup and lists all the commodities included in each subgroup.

TABLE 2 -Crop Group 10: Subgroup Listing

Representative commodities	Commodities
Subgroup 10-07A: Orange subgroup. Orange or tangerine/mandarin.	Calamondin; Citron; Citrus hybrids; Mediterranean Mandarin; Orange, sour; Orange, sweet; Satsuma mandarin; Tachibana orange; Tangerine (Mandarin); Tangelo, Tangor; Trifoliate orange; varieties, cultivars and/or hybrids of these.
Subgroup 10-07B. Lemon/lime subgroup. Lemon or lime.	Australian desert lime; Australian finger-lime; Australian round lime; Brown River finger lime; Kumquat; Lemon; Lime; Mount White. Lime; New Guinea wild lime; Russell River Lime; Sweet lime, Tahiti Lime; varieties, cultivars and/or hybrids of these.
Subgroup 10-07C: Grapefruit subgroup. Grapefruit	Grapefruit; Japanese summer grapefruit; Pummelo; Tangelo; Uniq fruit; varieties, cultivars and/or hybrids of these.

Example 4: How will I express the tolerances on an interim basis until the Federal Register Notice is final for the Citrus fruit group 10-07, for example at a tolerance level of 1.5 ppm? This example will be useful for the Registration Division (RD) and Health Effects Division (HED) to prepare tolerance tables. All the new proposed commodities will have to be listed separately from the crop group tolerance and at the same level as the crop group.

Answer to Example 4:

Commodity	Parts per million (ppm)
Calamondin	1.5
Citron	1.5
Citrus hybrids	1.5
Grapefruit	1.5
Grapefruit, Japanese summer	1.5
Kumquat	1.5
Lemon	1.5

Commodity	Parts per million (ppm)
Lime	1.5
Lime, Australian desert	1.5
Lime, Australian finger	1.5
Lime, Australian round	1.5
Lime, Brown River finger	1.5
Lime, Mount white	1.5
Lime, New Guinea wild	1.5
Lime, Russell River	1.5
Lime, Sweet	1.5
Lime, Tahiti	1.5
Mandarin, Mediterranean	1.5
Mandarin, Satsuma	1.5
Orange, sour	1.5
Orange, sweet	1.5
Orange, tachibana	1.5
Orange, trifoliate	1.5
Pummelo	1.5
Tangelo	1.5
Tangerine	1.5
Tangor	1.5
Uniq fruit	1.5

Cultivars, varieties and/or hybrids of those above commodities

Example 5: How will I express the tolerances on an interim basis until the Federal Register Notice is final for the Orange subgroup 10-07A for example at a tolerance level of 1.5 ppm? This example will be useful for the Registration Division (RD) and Health Effects Division (HED) to prepare tolerance tables.

Answer to Example 5 for the Orange subgroup 10-07A:

Commodity	Parts per million (ppm)
Calamondin	1.5
Citron	1.5
Citrus hybrids	1.5
Mandarin, Mediterranean	1.5
Mandarin, Satsuma	1.5
Orange, sour	1.5
Orange, sweet	1.5
Orange, tachibana	1.5
Orange, trifoliate	1.5
Tangelo	1.5
Tangerine	1.5
Tangor,	1.5

Cultivars, varieties, and/or hybrids of those above commodities

Example 6: How will I express the tolerances on an interim basis until the Federal Register Notice is final for the Lemon/lime subgroup 10-07-B, for example at a tolerance level of 1.5 ppm? This example will be useful for the Registration Division (RD) and Health Effects Division (HED) to prepare tolerance tables.

Answer to Example 6 for the Lemon/lime subgroup 10-07B:

Commodity	Parts per million (ppm)
Kumquat	1.5
Lemon	1.5
Lime	1.5
Lime, Australian desert	1.5
Lime, Australian finger	1.5
Lime, Australian round	1.5
Lime, Brown River finger	1.5
Lime, Mount White	1.5
Lime, New Guinea wild	1.5
Lime, Russell River	1.5
Lime, Sweet	1.5
Lime, Tahiti	1.5

Cultivars, varieties, and/or hybrids of those above commodities

Example 7: How will I express the tolerances on an interim basis until the Federal Register Notice is final for the Grapefruit subgroup 10-07C, for example at a tolerance level of 1.5 ppm? This example will be useful for the Registration Division (RD) and Health Effects Division (HED) to prepare tolerance tables.

Answer to Example 7 for the Grapefruit subgroup 10-07C:

Commodity	Parts per million (ppm)
Grapefruit	1.5
Grapefruit, Japanese summer	1.5
Pummelo	1.5
Tangelo	1.5
Uniq fruit	1.5

Cultivars, varieties, and/or hybrids of those above commodities

EPA FOOD AND FEED COMMODITY VOCABULARY FOR THE CITRUS FRUIT CROP GROUP:

The following terms for the oilseed commodities will be incorporated to the EPA Food and Feed Commodity Database (http://www.epa.govopp/foodfeed). The Table 39 below is identical to the current Food and Feed Commodity Vocabulary format. A search of the lookup terms will link to the EPA preferred tolerance/commodity term, and the Base crop/Animal term is the specific crop animal terms associated with the preferred term. Until the Federal Register Notice for the Crop Group is final, the Crop Group designation on each term will be listed as no crop group or crop subgroup and given the crop group 99 for the present.

Table 39. EPA FOOD AND FEED COMMODITY VOCABULARY

SEARCH OR LOOKUP TERM FOR CITRUS FRUIT COMMODITIES	PREFERRED TOLERANCE TERM	BASE CROP/ANIMAL TERM
Australian desert lime; Desert lime; australische Wüstenlimette; Lime, Australian desert	Lime, Australian desert lime	Australian desert lime
Australian finger lime; Australische limette; Lime, Australian finger	Lime, Australian finger	Australian finger lime
Australian round lime; Australian lime; Dooja; Australische Limette	Lime, Australian round	Australian round lime
Brown river finger lime; Lime, brown river finger	Lime, brown river finger	Brown river finger lime
Calamondin; Golden lime; Lime, golden; Scarlet lime; Lime, scarlet; Panama orange; Orange, panama; Chinese orange; Orange, Chinese; Calamansi; Kalamansi; Kalamondin; Philippine lime	Calamondin	Calamondin
Citron, citrus; Citrus citron; Citron; Citron melon; Corsican citron; Diamante citron; Esrog; Ethrog; Etrog; Leghorn citron; Preserving melon; Stock melon; Cidra; Limon cidra; Etrog; Esrik; Citron citrus; Budda hand	Citron	Citron
Tangor, Citrange, Citrangequat, Citrangedin, Limequat, Uniq fruit, Tangelolo, Tangelo, Chironja, Ugli fruit, Oro Blanco, Orangelo, King orange, Orange, king; Temple orange, Lemandarin, Rangpur lime, Mandarin lime, Otaheite orange	Citrus hybrids	Citrus hybrids
Grapefruit; Toronja; Pomelo; Toronjo	Grapefruit	Grapefruit
Japanese summer grapefruit; Japanese summer orange; Dai dai mikan; Natsudaidai; Pomelo japonés de verano	Grapefruit, Japanese summer	Japanese summer grapefruit

Kumquat; cumquat; comquot; kin kan; kin kit; too kin kan; kin; kin kuit; kuit xu; chu tsu; chantu kumquat; kumquat; laranja de ouro; dos orientalis; Kunquat; Comquot; Changshaw; Hongkong kumquat; Kumquat, dwarf; Round kumquat; Meiwa; Marumi kumquat; Cumquat; Oval kumquat; Nagami; Nagami kumquat; Cumquat tree; Nagami; Meiwa kumquat; Kumquat, Meiwa Sweet kumquat; Maylayan kumquat; Jiangsu kumquat; Swingles kumquat	Kumquat	Kumquat
Lemon; Limon; Limon Amarillo; Lemon, Rough; Jambhiri orange; rough lemon	Lemon	Lemon
Lime; key lime; lime, key; bartender lime; Mexican lime; West Indian lime; need more names	Lime	Lime
Mediterranean mandarin; Mandarin, Mediterranean; Willowleaf mandarin	Mandarin, Mediterranean	Mandarin, Mediterranean
Mount white lime; Lime, mount white	Lime, Mount white	Lime, Mount white
New Guinea wild lime; Lime, New Guinea	Lime, New Guinea wild	Lime, New Guinea wild
Orange, sour; Sour, orange; Orange, bergamot; Bergamot orange; Orange, bigarade; Birarade orange; Orange, bitter; Bitter orange; Orange, myrtleleaf; Myrtleleaf orange; Orange, Seville; Orange, servile; Orange, soap; Neroli; Petitgrain; Chinotto	Orange, sour	Orange
Orange, sweet; Sweet, orange; ; Naranja; Orange, blood; Blood orange; Orange, China sweet; Orange, Chinese navel; Malta orange; Orange, malta; Orange, pigmented; Orange, sanguine; Orange, Valencia; Valencia orange; Valencia	Orange, sweet	Orange
Pummelo; pummelo; Shaddock; Pommelo; Chinese grapefruit; Grapefruit, Chinese; Ugli; Unique fruit	Pummelo	Pummelo
Russell River lime; North Queensland lime; Lime, north Queensland	Lime, Russell river	Russell river lime
Satsuma mandarin; Mandarin, Satsuma; Satsuma tangerine; Tangerine, tangerine	Mandarin, Satsuma	Mandarin, Satsuma
Tachibana orange	Orange, tachibana	Tachibana orange
Tahiti lime; Lime, Tahiti; Persian lime; Lime, Persian	Lime, Tahiti	Tahiti lime
Tangelo; citrus k early; k early citrus	Tangelo	Tangelo
Tangerine; Mandarin orange; Orange, mandarin; Cleopatra mandarin; Tankan mandarin;	Tangerine	Tangerine
Tangor; temple tangor; tangor, temple	Tangor	Tangor
Trifoliate orange; Orange trifoliate	Orange, trifoliate	Trifoliate orange

Uniq fruit; Unique fruit; Ugly fruit; Uglifruit; Ugli®	Uniq fruit	Uniq fruit

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APPENDIX I: Dietary Value of the Citrus Fruits:

Table A. Dietary Value of the Citrus Fruits, per 100 gram edible portion:

	Sweet orange	Grapefruit	Tangerine	Lemon	Lime
Water (%)	88	90	87	90	88
Calories	44	40	44	27	37
Protein (%)	0.75	0.45	0.8	1.1	0.1
Fat (%)	0.2	0.1	0.3	0.3	0.3
Carbohydrates (%)	10.3	9.5	10.9	8.2	12.3
Crude Fiber (%)	0.6	0.3	1.0	0.4	0.9
	% of US RDA*				
Vitamin A	4.0	0.2 (white) 8.8 (pink)	1.9	<1.0	<1.0
Thiamin, B1	6.4	2.8	5.6	2.9	3.1
Riboflavin, B2	1.9	1.2	1.7	1.2	1.1
Niacin	2.2	1.1	1.6	0.5	1.1
Vitamin C	109	84	76	118	88
Calcium	1.2	1.1	4.5	3.2	2.4
Phosphorus	2.1	1.9	2.2	2.0	1.9
Iron	2.5	2.0	4.0	6.0	2.6
Sodium	---	---	---	---	---
Potassium	4.2	3.4	2.3	2.9	2.1

* Percent of recommended daily allowance set

TABLE B. Nutritional aspects: Per 100 g of Edible Portion of the Orange Contains:

	Fruit (fresh)	Juice (fresh)*	Juice (canned, unsweetened, undiluted)	Frozen concentrate (unsweetened, undiluted)	Juice (dehydrated)	Orange Peel (raw)
Calories	47-51	40-48	223	158	380	
Moisture	86.0 g	87.2-89.6 g	42.0 g	58.2 g	1.0 g	72.5%
Protein	0.7-1.3 g	0.5-1.0 g	4.1 g	2.3 g	5.0 g	1.5 g
Fat	0.1-0.3 g	0.1-0.3 g	1.3 g	0.2 g	1.7 g	0.2 g
Carbohydrates	12.0-12.7 g	9.3-11.3 g	50.7 g	38.0 g	88.9 g	25.0 g
Fiber	0.5 g	0.1 g	0.5 g	0.2 g	0.8 g	
Ash	0.5-0.7 g	0.4 g	1.9 g	1.3 g	3.4 g	0.8 mg
Calcium	40-43 mg	10-11 mg	51 mg	33 mg	84 mg	161 mg
Phosphorus	17-22 mg	15-19 mg	86 mg	55 mg	134 mg	21 mg
Iron	0.2-0.8 mg	0.2-0.3 mg	1.3 mg	0.4 mg	1.7 mg	0.8 mg
Sodium	1.0 mg	1.0 mg	5 mg	2 mg	8.0 mg	3.0 mg
Potassium	190-200 mg	190-208 mg	942 mg	657 mg	1,728 mg	212 mg
Vitamin A	200 I.U.	200 I.U.	960 I.U.	710 I.U.	1,680 I.U.	420 I.U.
Thiamine	0.10 mg	0.09 mg	0.39 mg	0.30 mg	0.67 mg	0.12 mg
Riboflavin	0.04 mg	0.03 mg	0.12 mg	0.05 mg	0.21 mg	0.09 mg
Niacin	0.4 mg	0.4 mg	1.7 mg	1.2 mg	2.9 mg	0.9 mg
Ascorbic Acid	45-61 mg	37-61 mg	229 mg	158 mg	359 mg	136 mg

TABLE C. Nutritional aspects: Food Value Per 100 g of Lemon Edible Portion*

	Fruit (fresh, peeled)	Juice (fresh)	Juice (canned, unsweetened)	Juice (frozen, unsweetened)	Lemonade (concentrate, frozen)	Peel (raw)
Calories	27	25	23	22	195	
Moisture	90.1 g	91.0 g	91.6 g	92.0 g	48.5 g	81.6 g
Protein	1.1 g	0.5 g	0.4 g	0.4 g	0.2 g	1.5 g
Fat	0.3 g	0.2 g	0.1 g	0.2 g	0.1 g	0.3 g
Carbohydrates	8.2 g	8.0 g	7.6 g	7.2 g	51.1 g	16.0 g
Fiber	0.4 g	trace	trace	trace	0.1 g	

	Fruit (fresh, peeled)	Juice (fresh)	Juice (canned, unsweetened)	Juice (frozen, unsweetened)	Lemonade (concentrate, frozen)	Peel (raw)
Ash	0.3 g	0.3 g	0.3 g	0.2 g	0.1 g	0.6 g
Calcium	26 mg	7 mg	7 mg	7 mg	4 mg	134 mg
Phosphorus	16 mg	10 mg	10 mg	9 mg	6 mg	12 mg
Iron	0.6 mg	0.2 mg	0.2 mg	0.3 mg	0.2 mg	0.8 mg
Sodium	2 mg	1 mg	I mg	I mg	0.2 mg	6 mg
Potassium	138 mg	141 mg	141 mg	141 mg	70 mg	160 mg
Vitamin A	20 I.U.	20 I.U.	20 I.U.	20 I.U.	20 I.U.	50 I.U.
Thiamine	0.04 mg	0.03 mg	0.03 mg	0.03 mg	0.02 mg	0.06 mg
Riboflavin	0.02 mg	0.01 mg	0.01 mg	0.01 mg	0.03 mg	0.08 mg
Niacin	0.1 mg	0.1 mg	0.1 mg	0.1 mg	0.3 mg	0.4 mg
Ascorbic Acid	53 mg	46 mg	42 mg	44 mg	30 mg	129 mg

TABLE D. Nutritional aspects: Per 100 g of edible Grapefruit portions.

	Pulp (raw)	Juice (raw)	Peel (candied)**
Calories	34.4-46.4	37-42	316
Moisture	87.5-91.3 g	89.2-90.4 g	17.4 g
Protein	0.5-1.0 g	0.4-0.5 g	0.4 g
Fat	0.06-0.20 g	0.1 g	0.3 g
Carbohydrates	8.07-11.5 g	8.8-10.2 g	80.6 g
Fiber	0.14-0.77 g	trace	2.3 g
Ash	0.29-0.52 g	0.2-0.3 g	1.3 g
Calcium	9.2-32.0 mg	9.0 mg	
Phosphorus	15-47.9 mg	15.0 mg	
Iron	0.24-0.70 mg	0.2 mg	
Sodium	1.0 mg	1.0 mg	
Potassium	135 mg	162 mg	

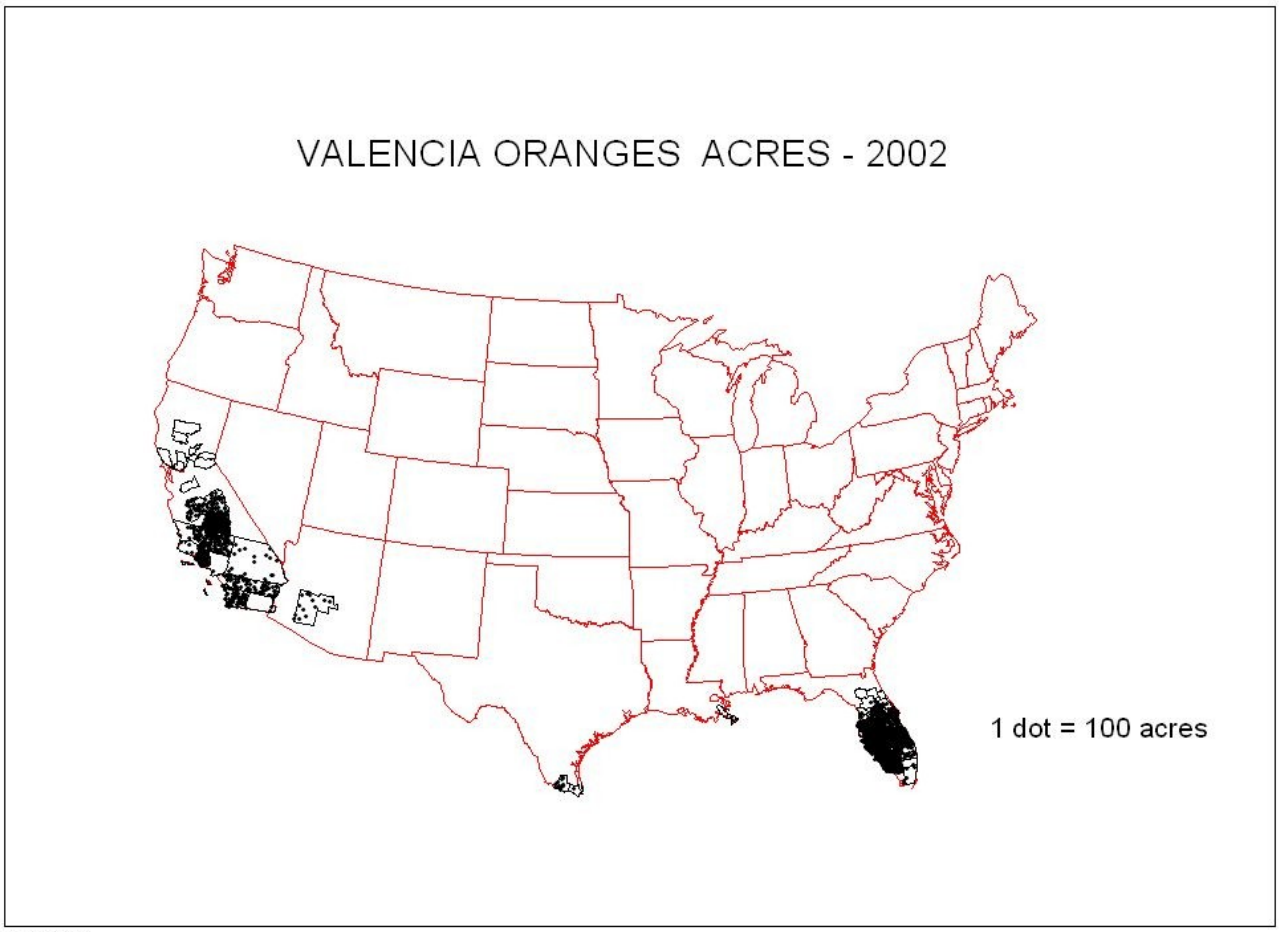
	Pulp (raw)	Juice (raw)	Peel (candied)**
Vitamin A			
(white)	10 I.U.	10. I.U.	
(pink/red)	440 I.U.	440 I.U.	
Thiamine	0.04-0.057 mg	0.04 mg	
Riboflavin	0.01-0.02 mg	0.02 mg	
Niacin	0.157-0.29 mg	0.2 mg	
Ascorbic Acid	36-49.8 mg	36-40 mg	
Tryptophan	2 mg		
Methionine	0-1 mg		
Lysine	12-14 mg		

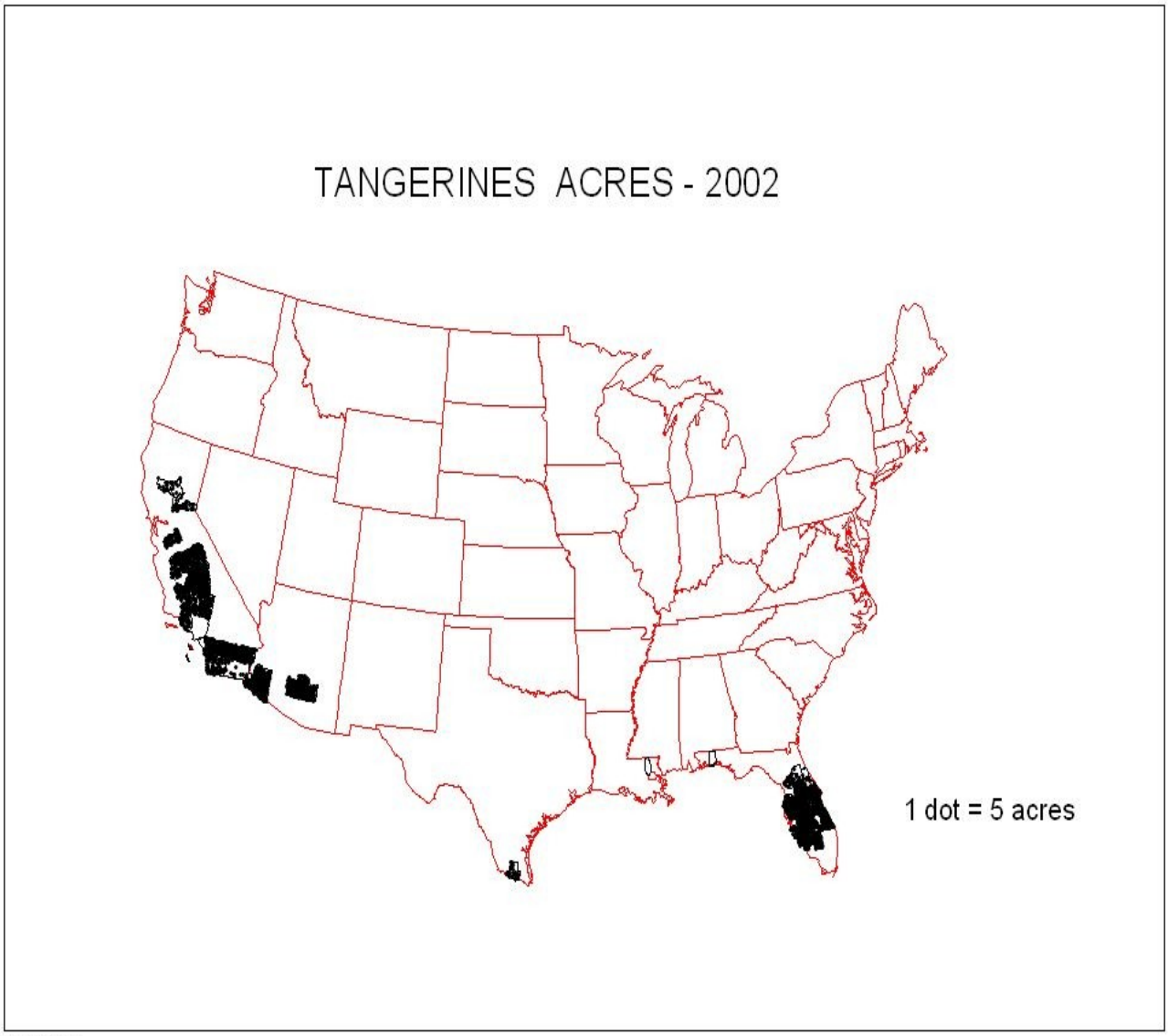
Table E. Dietary Value of the Kumquat, Calamondin, and Pummelo, per 100 gram edible portion:

	Kumquat	Calamondin	Pummelo
Water (%)	80.9	85.2	89.1
Calories	71	53	38
Protein	1.88 g	0.81 g	0.76 g
Fat	0.86 g	0.31 g	0.04 g
Carbohydrates	15.9 g	13.3 g	9.62 g
Crude Fiber	6.5 g	1.8 g	1.0 g
Vitamin A	290 I.U.	34 mcg	0
Thiamin, B1	0.037 mg	0.058 g	0.034 mg
Riboflavin, B2	0.09 mg	0.036 g	0.027 mg
Niacin	0.42 g	0.376 mg	0.222 mg
Vitamin C	43.9 mg	26.7 mg	61 mg
Calcium	62 mg	37 mg	4 mg
Phosphorus	19 mg	1.9	17 mg
Iron	0.86 mg	0.15 mg	0.11 mg
Sodium	10 mg	2 mg	1 mg
Potassium	186 mg	20 mg	216 mg

* Percent of recommended daily allowance set

APPENDIX II: Maps of the Total Acres for Valencia Orange, Tangerine, Lemon, Lime, and Grapefruit - 2002.





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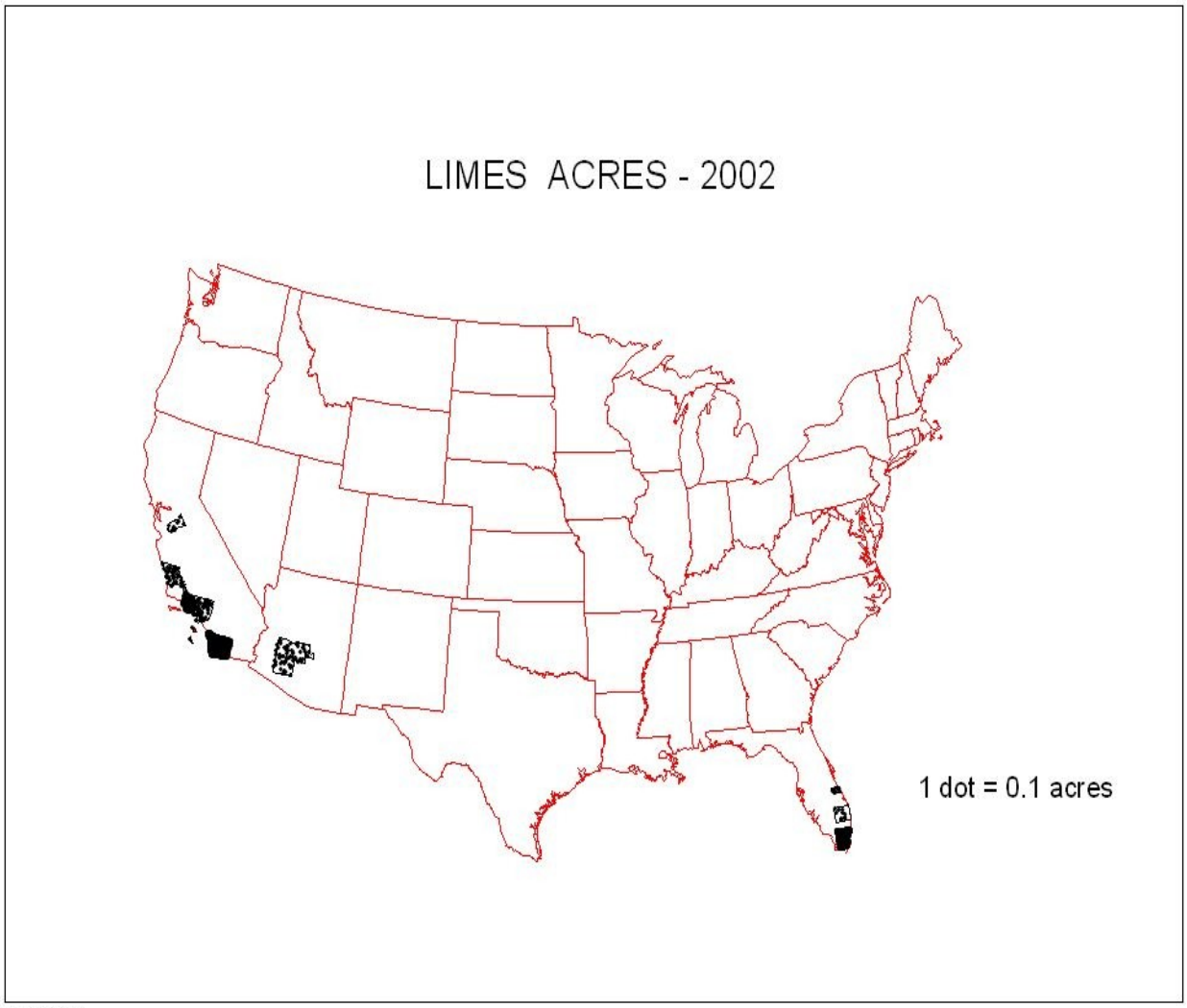

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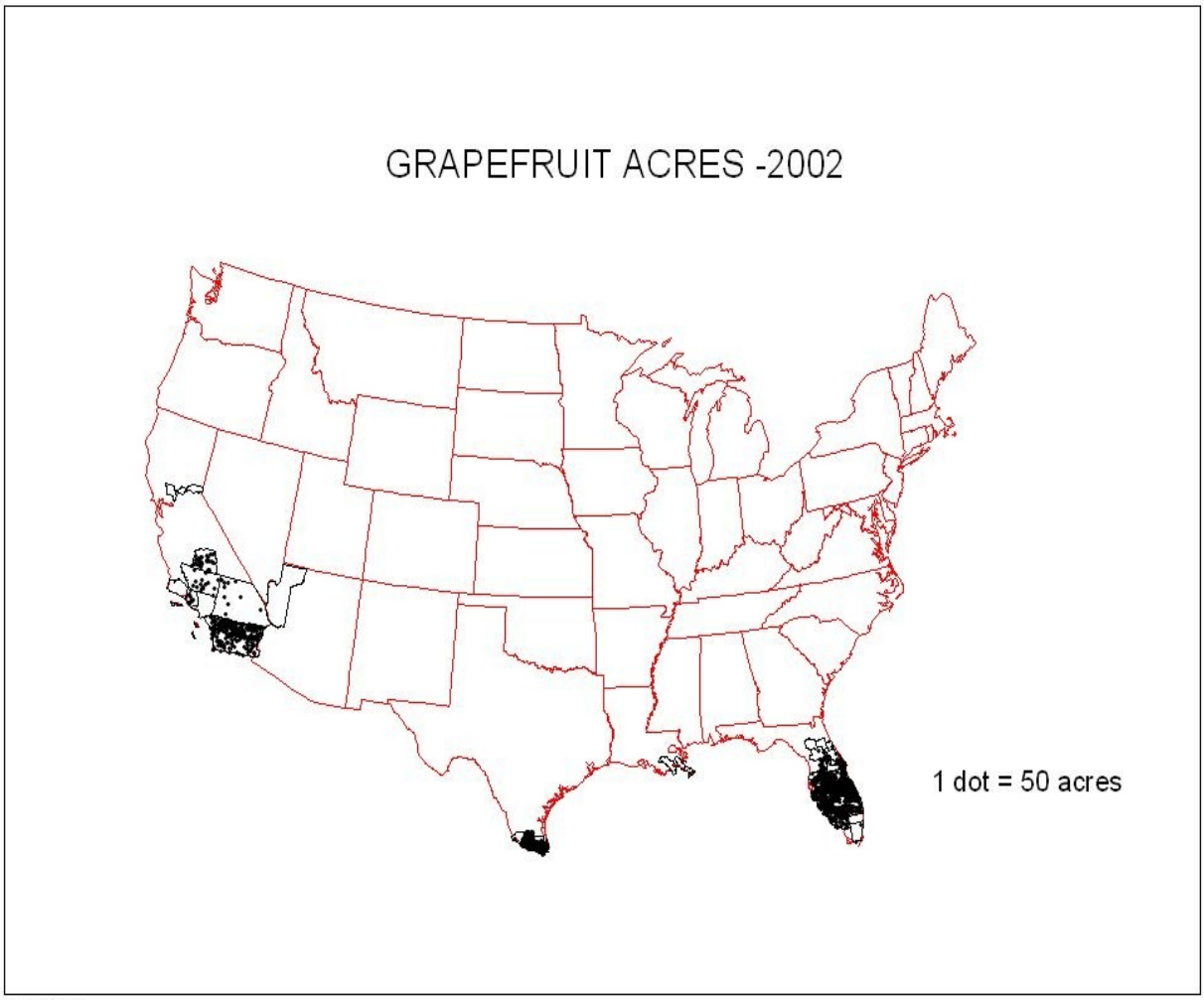

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