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About the Institute
The Hunt Institute for Botanical Documentation, a research division of Carnegie Mellon University, specializes in the history of botany and all aspects of plant science and serves the international scientific community through research and documentation. To this end, the Institute acquires and maintains authoritative collections of books, plant images, manuscripts, portraits and data files, and provides publications and other modes of information service. The Institute meets the reference needs of botanists, biologists, historians, conservationists, librarians, bibliographers and the public at large, especially those concerned with any aspect of the North American flora.

Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.

CITRICOS

ORIGEN

Se puede decir que las especies más comunes de cítricos cultivados comercialmente no tienen exactamente determinado su lugar de origen. En general, los cítricos tienen su origen en las pendientes relativamente calientes del sur de los Himalayas, en el noreste de la India y la adyacente Birmania; (2; 1) se incluyen también algunas otras partes del noreste de Asia.

Las diferentes especies tienen diversos orígenes, dentro de los límites establecidos en el párrafo anterior. Debido a su constitución, los cítricos no podrían haber sobrevivido en un bosque tropical con grandes lluvias, en la jungla (1;85), esto incluye casi toda Malasia, el sureste de la India y las tierras bajas de Birmania, Siam e Indochina.

De acuerdo a su resistencia al frío, también se puede hacer una distribución geográfica de los orígenes de distintas especies del género citrus. Algunas especies toleran más el efecto de bajas temperaturas que otras.

Considero necesario mencionar que la mayoría de las especies de cítricos tienen compatibilidad genética en mayor o menor grado y que por lo tanto cabe la posibilidad que haya habido casos de hibridización que originen nuevas formas. De acuerdo a Chandler, cabe la posibilidad de que el limonero, el toronjo y el naranjo dulce, sean híbridos entre dos de las otras especies. Según el mismo autor, el cidro, la lima, el pomelo, el mandarino, el kunquats y el naranjo trifoliado no son híbridos entre otras especies.

La naranja dulce debe haber desarrollado sus presentes características en el noreste de la China. Como la toronja, no se conoce en ningún lugar en un estado silvestre y posiblemente se originó de otra especie cítrica en cultivo, (2; 1). La primera referencia escrita data del siglo sexto BC en un libro chino, "Shu-Ching" el cual a su vez parece haber tomado la información de una escritura anterior.

El limón, la cidra y algunas especies de mandarinas han desarrollado su forma actual en la India. La lima se conoce en su forma silvestre en la península de Málaca.

El primer cítrico conocido en Europa fué la cidra, muy apreciada por su fragante cáscara.

Se sabe que Cristóbal Colón, en su segundo viaje (1493), llevó semillas de naranja, limón y cidra de las Islas Canarias a la Española. No se sabe si las naranjas eran dulces o agrias.

La introducción de los cítricos a la Florida, E. U., coincide con el establecimiento de la Colonia de San Agustín en 1565. De los cítricos plantados por los españoles en esta zona, se inició la expansión del cultivo por medio de los indios, quienes llevaban los frutos y tiraban las semillas en el campo. Por 1579 los naranjos eran comunes en dicho estado.

IMPORTANCIA ECONOMICA DE LOS CITRICOS

Los cítricos junto con el banano y la piña constituyen los frutos tropicales más cultivados para el consumo de fruta fresca. Sin contar el número de hectáreas cultivadas, se puede decir que el cultivo de los cítricos es más conocido mundialmente que los otros dos arriba mencionados. Se pueden encontrar siembras de cítricos en los países asiáticos tanto del cercano como del lejano Oriente, en Africa, zonas de Europa aledaños al mar Mediterráneo, Norte, Centro y Sur América, Australia, Nueva Zelandia y en algunas islas del Pacífico (4; 272).

En cuanto al consumo, los productos del género están entre los más populares productos frutales tanto en los trópicos como en las zonas templadas. Los naranjos y las toronjas son algunos de los pocos frutos tropicales disponibles en gran escala en las zonas templadas. Los productos cítricos se consumen como fruta fresca, en jugos, mermeladas y también en forma enlatada como parte de ensaladas de frutas tropicales. Algunos sub-productos de la industria citrícola son utilizados en:

a - Alimentación de ganado
b - Producción de melaza
c - Aceites para usos culinarios
d - Producción de alcohol
e - Producción de vinos y otras cosas más

De acuerdo a datos estadísticos de la FAO*, la producción de cítricos tiene un positivo incremento hasta la presente fecha. Logicamente, a través de los años se han visto alti-bajos en dicha producción debido a efectos climatológicos, enfermedades, plagas y también por el incremento en tamaño de las áreas urbanas que algunas veces roban espacio de las plantaciones citrícolas, como ha ocurrido en varios lugares de California.

Los cítricos tienen su origen netamente tropical; sinembargo, la mayor producción de ellos se encuentra en climas sub-tropicales. Las partes sureñas de los Estados Unidos, especialmente Florida y California, producen la mayor cantidad de frutos cítricos en el mundo. Algunos datos estadísticos sobre producción y extensión del cultivo de los cítricos nos ayudarán a comprender mejor su importancia.

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* (4): FAO-1966.

PRODUCCION MUNDIAL DE CITRICOS

AÑOS 1948 - 1964*

CUADRO 1

NARANJAS Y MANDARINAS:

Continente y País	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Totales Regiones																	
Europa P	1431	1273	1724	1798	2212	1934	2191	2122	1388	2271	2342	2708	2707	3237	2590	3373	3135
Norte América P	4028	4176	4694	4774	4829	5144	5301	5360	5330	4375	5185	5069	4784	5651	4159	3710	4881
América Latina P	3135	3224	3379	3363	3402	3418	3588	3613	3755	3947	4029	4197	4362	4560	5003	5073	5100
Cercano Oriente P	629	575	599	760	865	864	982	997	991	1072	1092	1169	1239	1128	1301	1627	1628
Lejano Oriente P	625	612	843	789	975	918	1212	1175	1542	1602	1746	1711	1916	2050	2226	2345	2675
Africa P	542	658	717	783	755	850	928	975	1052	1151	1133	1290	1428	1393	1452	1506	1630
Oceanía P	134	120	145	114	113	141	133	155	151	144	138	174	147	190	217	204	192
Total Mundo P	10724	10838	12301	12581	13357	13524	14664	14681	14525	14884	16077	16775	17040	18709	17448	18338	19741

*P - Producción: 1000 Toneladas Métricas

4: 270 - 280

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Como se puede deducir de los datos suministrados por las tablas anteriores, la producción de cítricos es una labor agrícola de gran envergadura y con un buen futuro tanto para consumo interno de nuestros países como para la exportación. Sinembargo, debe mantenerse en cuenta que las labores de cultivo y los métodos de producción en general, deben ser bastante mejorados en la mayoría de nuestros países para obtener los resultados deseables en los mercados de exportación, suministrando la cantidad y, sobre todo, la calidad requerida por los países importadores.

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BOTANICA DE LOS CITRICOS

Es bien claro el hecho de que hay confusión en la clasificación botánica de los cítricos. El número de especies y géneros varía con la opinión de diversos autores. En este breve estudio haremos mención únicamente de los géneros y especies más comunmente aceptados, sin entrar en discusión de detalles y teorías sobre cuál es el mejor método de clasificación para los frutales en mención.

Las especies del género citrus pertenecen a la subfamilia Aurantioides de la familia de las Rutáceas, que contiene unos 150 géneros y aproximadamente 1600 especies, consistiendo principalmente en árboles y arbustos siempre verdes, aromáticos y localizados principalmente en los trópicos.

El género citrus en sí, consiste de 16 especies. Sinembargo, algunos autores los agrupan en tres géneros: Citrus, Poncirus y Fortunella. Esta última clasificación será utilizada a lo largo de este trabajo. La diferenciación entre estos tres géneros se hace de la siguiente manera:

Hojas con tres folíolos, decíduas . . . . . Poncirus

Hojas generalmente con un folíolo (aparentemente simple), persistentes:

Ovario 3-5 o 6 carpelos . . . . . Fortunella

Ovario 8 carpelos o más . . . . . Citrus

Como se dijo antes, todas las especies de cítricos son árboles o arbustos siempreverdes, con madera dura y a menudo con espinas, que salen en las axilas de las hojas, junto a las yemas. Las hojas son aparentemente simples, pero se han derivado de una hoja original pinnada, por reducción a una simple hojuela. La hoja es entonces unifoliar en estructura y tiene una sola lámina entera y brillante, que está unida a un pecíolo por medio de una articulación; a su vez, el pecíolo se une al tallo por medio de una articulación.

Los árboles son aromáticos y las hojas tienen glándulas oleaginosas. Las largas raíces fibrosas generalmente no producen "pelos", asociaciones de la micorriza con las raíces más finas son comunes en las especies de cítricos. Las flores son solitarias o en grupos, y tienen un olor dulce; los pétalos son blancos, generalmente cinco, envueltos abrazados por cinco sépalos de color verde. El número de segmentos del periantio tiende a variar en las diferentes especies, los estambres son más o menos numerosos, siempre siendo más de cuatro veces el número de pétalos y reunidos en cinco grupos, estando los filamentos de cada grupo parcialmente unidos en la base. Hay un ovario superior, compuesto de ocho a dieciséis carpelos, teniendo cada lóculo varios óvulos arreglados en dos líneas, con placentación axial. El ovario está coronado por un estilo corto, en el que hay tantos parajes como haya lóculos, el estilo es decíduo.

La fruta típica de los frutos cítricos es una forma especial de baya, en la que el exocarpio y el mesocarpio son coríaceos en textura; recibe el nombre de "hesperidio". La epidermis de la fruta está cubierta con una cutícula gruesa y estomas, en diferentes números, encontrándose en la capa celular de la epidermis, mientras que el exocarpo es una masa más gruesa compuesta de células parenquimotosas irregulares, ricas en cloroplastos actuando fotosintéticamente en la maduración de la fruta.

Incluídos en este tejido se encuentran numerosas glándulas oleaginosas, con un aceite escencial y rodeadas por células aplanadas del exocarpio. El mesocarpio es una masa más gruesa, esponjosa y de color blanco, rodeando la parte carnosa y jugosa de la fruta; varía en grueso de acuerdo a la especie.

Las células del parénquina que constituyen esta capa son muy irregulares en forma y tamaño y extensos espacios intercelulares ocurren en todo el tejido.

Este tejido es rico en vitamina C, azúcares y celulosa y contiene apreciables cantidades de pectinas. El centro de la fruta está ocupado por los carpelos del ovario, dispuestos alrededor de el axis medular de la fruta, en forma de segmentos o "gajos". Cada segmento se desarrolla a partir de un simple carpelo y está rodeado de una membrana transparente derivada del endocarpio. Los segmentos están llenos con una masa de filamentos multicelulares que se desarrollan desde la pared del carpelo y en las que el jugo es producido conforme la fruta se madura. Las semillas se encuentran con placentación axilar y se encuentran localizadas dentro de los sacos de jugo, en cada lóculo, cerca del axis central.

TIPOS DE CITRICOS Y VARIEDADES DE LOS MISMOS

Teniendo la sub-familia Aurantioides una compatibilidad bastante grande entre los géneros y muchas de sus especies, es digno de esperarse que una clasificación basada en tipo y características comerciales, es mucho más complicada que para muchos otros frutos tropicales, debido a que hay una innumerable cantidad de cruces que han originado nuevas formas. Además, los frutos cítricos, tanto en su reproducción sexual como en la asexual, son susceptibles a sufrir cambios en su estructura genética la que origina una fuente más de posibles individuos con características diferentes a las de sus progenitores.

En las páginas a seguir, no se espera hacer un estudio extensivo de las variedades existentes ni sobre las características individuales de cada variedad mencionada; se desea dar al estudiante una idea clara de los tipos de cítricos y de algunas de las características utilizadas para hacer las arbitrarias divisiones hortícolas denominadas "variedades".

En general, el estudio necesario para determinar la variedad de un fruto cítrico está fuera del alcance de este curso.

Si hay algún interés por parte del lector en estas clasificaciones, recomiendo se consulte el tomo I, págs. 481-83 de Webber (8)*.

Siguiendo el orden utilizado por Camp (7) dividiremos las variedades a estudiar en: a) naranjos, b) toronjas, c) mandarinas, d) limas y limones, e) híbridos y variedades misceláneas.

La nomenclatura botánica para estas especies y, otras no mencionadas en este trabajo, pero que son cultivadas por el hombre es la siguiente:

Citrus paradisi	Toronja
Citrus sinensis	Naranja dulce
Citrus limon	Limon
Citrus aurantifolia	Lima
Citrus aurantium	Naranja agria
Citrus reticulata	Mandarina
Citrus grandis	Pomelo

De acuerdo a las condiciones climáticas existentes en Florida, Camp clasifica las variedades de árboles cítricos en la siguiente forma:

a) Tempranas: variedades que maduran en la última parte de octubre y durante el mes de noviembre.

b) Estación intermedia: maduran durante los meses de diciembre, enero y febrero.

c) Tardías: lista para su embarque desde marzo hasta principios de verano (junio).

Para facilitar el entendimiento de las descripciones a seguir y debido a la poca información existente sobre este respecto en nuestro medio, haremos uso de la clasificación antes mencionada.

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* 8) Webber, H. J. The citrus industry, vol. I. University of Calif. Press, Berkeley and Los Angeles, 1943.

Como se dijo antes, se darán descripciones de unas pocas variedades y especificamente, se tratarán las variedades existentes en los huertos de la E. A. P.

NARANJAS DE MADURACION TEMPRANA

PARSON BROWN

Origen: Webster, Florida. Variedad vieja

Fruta: Tamaño relativamente grande, 10-19 semillas y con su pulpa más o menos fibrosa, jugo amarillo oscuro, cáscara ligeramente rugosa y tiende a quedarse verde en vez de cambiar a amarillo en el otoño; sinembargo, lo hace con facilidad en el cuarto de almacenamiento.

Arbol: bastante vigoroso, crecimiento erecto, facilmente cultivado y resistente al frío. Bastante cultivado.

HAMLIN

Origen: Glenwood, Florida. Variedad relativamente nueva (en cultivo).

Fruta: tamaño relativamente pequeña, ligeramente oval, cáscara bastante lisa y delicada, generalmente sin semillas, aunque pueden tener 1 a 5 semillas; madura muy temprano en el otoño.

Arbol: bastante vigoroso, buena producción; un poco más susceptible al frío que la Parson Brown.

Desventaja: fruto con tamaño relativamente pequeño, cáscara delicada.

VARIEDADES DE ESTACION INTERMEDIA

PINEAPPLE

Origen: Florida

Fruta: redonda u oblonga 12-20 semillas, cáscara de color anaranjado oscuro, jugo bastante dulce.

Arbol: tiene la tendencia a mostrar muerte regresiva de las ramas cuando no está siendo bien cultivado. Cosechas son alternadas si no se controla lo anterior.

JAFFA

Origen: Palestina

Fruta: redonda o ligeramente oblonga, tamaño grande, color rojo anaranjado, jugo anaranjado oscuro, semillas 6-9.

Arbol: bastante vigoroso con hábito peculiar de crecimiento erecto en el que las ramas tienden a estar erectas en vez de lateral o casi lateralmente como en las otras variedades. Las hojas tienden a estar más cercanas entre sí en las ramas jóvenes, con una forma peculiar de traslape que las distingue de las otras variedades. Resistente al frío.

VARIEDADES TARDIAS

VALENCIA

Origen: no muy claro, llevadas a Florida desde dos diferentes lugares: Inglaterra y California.

Fruto: ligeramente ovalado, mediano o grande en tamaño, cáscara anaranjada oscuro. Semillas pocas; raramente 6, jugo de excelente calidad.

Arbol: vigoroso, resistente al frío.

VARIEDADES MISCELANEAS

NARANJAS DE SANGRE

Es un grupo de variedades en los cuales se desarrolla un color rojizo sanguíneo en la pulpa, algunas veces como marcas muy finas en las paredes de los segmentos y algunas veces como manchas rojas en los segmentos. La cantidad de color rojo está relacionada con las condiciones climáticas, siendo más acentuadas por las bajas temperaturas.

A temperaturas cálidas puede que no se vean manchas rojizas del todo. Algunas variedades incluídas en este grupo son: Ruby Blood, Maltese, Saul' s Blood y St. Michael' s Blood.

NARANJAS CON OMBLIGO

Esta es una serie de variedades que se caracterizan por la presencia de un ombligo o protuberancia en la parte distal del fruto. Todas las variedades de este grupo se caracterizan por tener un crecimiento vigoroso y erecto; sinembargo, son bajos productores de frutos con cáscara gruesa y rugosa. Entre este grupo se encuentran las variedades Carter, Golden Nugget, Texas y otras más, siendo la más importante Washington Navel o Bahía. Esta es una variedad que tiene muy pocas o ninguna semilla, excelente sabor y aroma, además de buen tamaño y apariencia de la fruta. Su principal objeción es la gruesa cáscara con que cuenta. La naranja Washington es originaria de Bahía, Brasil.

TORONJA

La toronja, citrus paradisi Macfadyen, es derivada de la hibridación del pomelo, citrus grandis Osbeck, con otra fruta cítrica no identificada hasta la presente fecha. El tamaño del fruto es mayor que el de los naranjos, mandarinas y limones, pero es de un tamaño inferior al pomelo. Los frutos se desarrollan formando pequeños racimos en las ramas del árbol, de allí su nombre en inglés: "Grapefruit" (grape-uva, fruit-fruta). Los frutos de las variedades con semillas tienen de 30 a 60, sinembargo, existen nuevas variedades carentes de ellas. La pulpa tiene un sabor dulce-amargo, dependiendo el grado de amargura en la variedad a consumir. A continuación se hace una descripción breve de algunas variedades:

Foster

Originada como una mutación de la variedad Walter' s, en Florida,

U. S. A. El color de la pulpa es rosado. Semillas 55-60. La cáscara tiene un color rosado. Desventaja: su gran número de semillas.

Marsh ó Marsh sin semillas:

Originaria de Lakeland, Florida, U. S. A. Casi sin semillas, generalmente 2 a 8, fruta oblonga y achatada en los polos. La médula central del fruto ligeramente abierta. Arboles vigorosos y bastantes productivos. El color de la pulpa del fruto es amarillo claro.

Thompson o Marsh Rosada

Variación genética de la variedad Marsh. Exactamente las mismas características de la toronja Marsh, con la excepción de que su pulpa es de color rosado. La apariencia externa de la fruta es también igual a la de la toronja Marsh.

TORONJAS DE PULPA ROJA

Principalmente encontradas y desarrolladas en Texas y Florida. Constituyen variaciones genéticas de la variedad Thompson. El fruto es de color rosado oscuro a rojo, que se muestra a través de la cáscara, especialmente cuando las frutas se tocan unas a otras, o cuando están en contacto con las hojas. La variedad más conocida es la Ruby; sinembargo, otras variedades como Webb's Red Blush (Texas) y Glen Red (Florida) son también ampliamente cultivadas. Estas variedades se parecen a la Marsh sin semillas y a la Marsh rodada (Thompson) en tamaño y textura, pero tienen la ventaja de una pulpa roja o rosada oscura y además muestran su color a través de la cáscara, lo que facilita su mercadeo. Desventajas: relativamente pequeña y más susceptible al ataque de los ácaros.

MANDARINAS

El nombre de mandarina o naranja mandarina es dado a una serie de frutas cítricas que tienen como características comunes, dis-

tinguiéndolas de las naranjas, una cáscara bastante libre de la pulpa, cotiledones verdes generalmente en las semillas y flores solitarias o en grupos que nunca forman una inflorescencia ramificada. Son frutos para el consumo de fruta fresca y tienen el problema de ser difíciles de transportar por lo delicado de su cáscara.

De acuerdo a Siegler, tres especies se agrupan bajo el nombre de mandarinas: Satsumas, King y Kunembo y las mandarinas propiamente.

Satsuma	(Citrus unshiv Marc.)	(C. reticulata de Swingle)
King	(Citrus nobilis Lour)	(C. reticulata x C. sinensis de Swingle)
Mandarinas	(Citrus reticulata Blanco)	

A continuación se nombran algunas de las variedades más importantes comercialmente, sin hacer uso discriminatorio de la clasificación botánica arriba mencionada. En caso de mayor interés por parte del lector recomiendo leer las páginas 39-46 en el libro de Ziegler, "Citrus growing in Florida".

MANDARINA DANCY

Origen: variación genética de la variedad Moragne

Fruta: oblonga en forma, generalmente 23/4 a 3 pulgadas en diámetro lateral; color anaranjado oscuro a rojo. Base del fruto tiene ombligo, 11 a 14 secciones y generalmente cerca de 14 semillas, aunque el número varía mucho. La cáscara es fina y libre de la pulpa. La pulpa es suave y el sabor es rico con un aroma peculiar.

Arbol: redondo en su forma de crecimiento, con ramas colgantes y generalmente bastante productivo.

Desventaja: sus ramas colgantes tienden a rajar las horquetas cuando el árbol tiene producciones fuertes o pesadas. Tendencia a producir muchas frutas de tamaño pequeño.

Hay una gran cantidad de otras mandarinas, incluyendo la Oneco, Warnuro, Clementine y Cleopatra, la última siendo usada más que nada como patrón o portainjerto de otras especies de cítricos.

SATSUMA

Grupo de variedades de origen japonés, bastante parecidas a la mandarina Dancy en forma y apariencia, aunque no tienen el color oscuro de dicha variedad. La cáscara es también más gruesa y más ronchosa. La pulpa no tiene el mismo delicado sabor ni el mismo aroma típico de la Dancy, madura más temprano y es más resistente a las bajas temperaturas.

Fruta: 3 pulgadas en diámetro amarilla o anaranjada amarillenta en color. El exocarpio más o menos grueso seis semillas o 4 semillas.

Arbol: enano, ramas colgantes y bastante resistente al frío, la variedad más común Owari.

KING

La naranja King tiene figura oblonga y parece una mandarina grande. El diámetro lateral es de $3\frac{1}{2}$ a 4". El color de la fruta es anaranjado oscuro, la base cerca del calix es algo rugosa y con pliegues. La cáscara es gruesa y granulada pero se despega facilmente de la pulpa. Sabor es bueno, más a naranja que a mandarina y tiene cerca de 20 semillas.

Arbol: crecimiento peculiar erecto. Cuando las frutas están presentes las ramas terminales se doblan dando la apariencia de tener ramas colgantes como característica de crecimiento.

LIMONES

Origen: noroeste de la India. Materiales traídos a América parecen tener su centro de distribución desde las costas del Mediterráneo (Italia, España, Portugal). Basicamente hay solo dos tipos de limones

de tipo comercial, y estos fueron seleccionados en Sicilia y en Portugal. Las diferentes variedades son selecciones entre estos dos tipos, representados típicamente por las variedades "Eureka" y "Lisbon" (2).

EUREKA

Origen: seleccionado de plantas propagadas por semilla, traídos a California desde Sicilia.

Pocas espinas, bastante ácido y pocas semillas. Las frutas se desarrollan principalmente en las puntas de las ramas. No es muy resistente a bajas temperaturas. Susceptible a enfermedades virosas atacando la base del tallo.

LISBON

Origen: Australia, de plantas propagadas por semillas lllevadas de Portugal.

Espinas son bastante frecuentes; sinembargo el árbol es más vigoroso y productivo que el Eureka, acidez es alta. Más semillas que el Eureka. Las frutas tienden a ser producidas en la parte interna del follaje.

HARVEY

Origen: desconocido. Características muy similares a las del tipo Eureka.

MEYER

Origen: China

Definitivamente no es un limón puro. Se supone sea un híbrido pero no se sabe cuál es el otro progenitor además de limón; posiblemente naranja o mandarina.

La fruta madura semeja mucho a una naranja grande tanto externa como internamente, aunque puede poseer un pequeño ombligo en ca-

da polo; es bastante jugoso con un exocarpio suave y delicado, semillas cerca de 10. Contenido de ácido es menor que el resto de los limones y no tiene el olor característico de los limones.

Arbol: pequeño, arbustivo; casi sin espinas y mucho más resistente al frío que el resto de los limones.

LIMAS

Aunque los frutos son muy similares en tamaño, forma, contenido de ácido y otras características a los limones, las limas constituyen una especie distinta del género citrus.

Hay, como en todos los casos de las frutas cítricas, cierto número de variedades que caen dentro del grupo de las limas, sinembargo haremos mención unicamente de la variedad Tahiti o limón Persa. Esta variedad no es una lima verdadera, es un híbrido triploide cuyos progenitores son desconocidos. Es una lima grande y ovalada, generalmente tiene 3 pulgadas de largo. Forma es bastante similar a la de un limón. Cáscara bastante lisa, pulpa de color verde y casi siempre sin semillas; el jugo es bastante ácido.

Arbol: enanos 12-15 pies de altura y con ramas colgantes. Son bastante susceptibles a la enfermedad llamada gomosis causada por uno de dos hongos: Diplodia o Phomopsis.

HIBRIDOS Y VARIEDADES MISCELANEAS

TANGELOS

Es el nombre dado a híbridos entre mandarinas y toronjas, aunque creces entre mandarinas y naranjas, y mandarinas con satsumas están frecuentemente incluídas en el grupo. La mayoría de estas variedades son atractivas por su agradable color y su cáscara suave.

En la E. A. P. la variedad cultivada es "Orlando", que se caracteriza por su alto contenido de jugo, su cáscara lisa, tamaño relativamente grande y el color anaranjado amarillento cuando maduro. El olor

de sus aceites recuerda mucho el olor de mandarina.

KUNQUATS

El kunquats no pertenece al género Citrus, sino al género Fortunella. Hay diversas variedades, sinembargo, la mayoría tienen su valor como plantas ornamentales. Variedades principales:

Marumi: tamaño pequeño, uso ornamental.

Nagami: más grande y usado como ornamental o para hacer mermeladas.

Otra fruta parecida al kunquat, pero que probablemente sea un híbrido de kunquat con otro porgenitor desconocido, es el Calamondin. Es una fruta pequeña, de forma similar a la mandarina, pero con pulpa bastante ácida. El árbol es alto, con follaje denso y produce una fuerte cosecha de frutos amarillo-anaranjados. Su uso es más que nada ornamental.

Hay muchas otras variedades de frutos cítricos que no están incluídos en este breve trabajo. Si el estudiante tiene deseos de ampliar sus conocimientos en este respecto, recomiendo el estudio del capítulo V de Webber y Batchelor, The citrus industry, tomo I.

EL MEDIO PARA LOS CITRICOS

INTRODUCCION

Una combinación de varios aspectos relacionados con el clima y con el suelo constituyen lo que se puede llamar el ambiente de los cítricos. En mayor o menor grado, estos aspectos tienen influencias sobre la calidad de los frutos a producir. Podemos decir que basicamente, estos constituyentes son: temperatura, humedad, luz, vientos prevalentes y por supuesto, tipo de suelo. A continuación se harán breves comentarios sobre cada uno de ellos.

TEMPERATURA

Puede decirse que los cítricos, como la mayoría de las plantas, tienen sus límites óptimo, máximo y mínimo con respecto a las tem-

peraturas del medio ambiente en que se desarrollen. Muy generalizadamente, diremos que temperaturas de 6.6°C son letales para los cítricos y que temperaturas de 57°C, o mayores, causan severas quemaduras en las hojas y frutos de algunas especies. La temperatura óptima varía con la especie a tratar y con algunas condiciones del ambiente rodeando a la plantación.

La temperatura influye notablemente en el desarrollo de los frutos en los árboles cítricos. El tiempo que transcurre entre la floración y maduración del fruto, en la toronja Marsh y la naranja Valencia, puede ser de nueve a diez meses o menos, en los trópicos, y de quince a dieciséis meses en las zonas costeras del sur de California. (Temperaturas más bajas) (1; 104-5).

La temperatura influye también en la desaparición del color verde. Bajas temperaturas son las causantes de la desaparición de este color. El grado de acidez también se ve aumentado por la presencia de bajas temperaturas. Climas calurosos tropicales cuentan con frutos que tienen una acidez relativamente baja.

El tiempo frío retarda el crecimiento de las plantas pertenecientes al género Citrus y de especies cercanas, con excepción, talvez, de los limoneros, más que en los árboles de otras especies de clima caliente, como el aguacate, y crecen muy lentamente si la temperatura está permanentemente entre 12.7° y 14.3°C. (1; 105).

En regiones subtropicales, los descensos de la temperatura ambiental durante ciertas épocas del año, causan muchas veces severos daños y algunas veces la muerte de los árboles cítricos. Cuando es destruído un tejido muy tierno de un árbol cítrico, como el de las flores o los frutos jóvenes, se debe probablemente a la formación de hielo a través del protoplasto. Esto parece conducir siempre a la muerte.

Cuando una madera bien endurecida e inactiva es destruída por un descenso lento de la temperatura, no se sabe exactamente cuál es

la causa de la muerte.

En zonas afectadas por la presencia de bajas temperaturas se utiliza la generación artificial de calor en los huertos. Esto se pude hacer por el uso de calentadores específicamente diseñados para dicho propósito. Puesto que la mayoría de nuestros países no cuentan con esta clase de problema en las zonas citrícolas, no se hará más mención sobre el tópico de bajas temperaturas y sus efectos en las plantaciones de frutas cítricas.

AGUA

Los cítricos son plantas muy susceptibles a las variaciones de la humedad existente en el suelo y en el medio ambiente. La floración, la formación y retención de los frutos por parte de las plantas, asimismo como el crecimiento en general, son seriamente afectados por la escasez de agua. También, una excesiva humedad en el suelo fomenta la presencia de varias enfermedades.

La floración es inducida por una relativa escasez de agua en el suelo y una reducción del crecimiento vegetativo en forma activa por parte de la planta.

El tamaño de los frutos y su contenido de jugo es bastante afectado por la humedad del suelo. Experimentos realizados con limoneros han sugerido que si un productor cree que no está regando con suficiente frecuencia o que es un gasto inncesario regar demasiado frecuentemente, puede estudiar un sistema midiendo frutos por la mañana temprano, cuando están más turgentes, posiblemente de nuevo a primera hora o en la tarde y desde luego a última hora ón la tarde, iniciando estas mediciones diarias unos cuantos días, antes de un riego y continuándolos algunos días después del riego. Los frutos mostrarán cierta contracción durante el día, pero si las mediciones muestran un notable aumento en las dimensiones del fruto, inmediatamente después de un riego, éste había dejado de adquirir turgencia plena, durante las

noches, antes del riego, y el productor puede deducir que sus riegos no habían sido suficientemente frecuentes. O si la contracción de los frutos durante los días soleados antes del riego, era mucho mayor que en los días soleados posteriores al riego, el hecho será una indicación de que gran parte del suelo de la zona ocupada por las raíces carecía de agua utilizable entes del riego y de que si se puede disponer de agua, será conveniente regar con más frecuencia (1; 12-13).

La cantidad de agua requerida por un cítrico, así como la mayoría de las plantas, depende de varios factores, entre los que podemos incluir los vientos prevalentes (secos o húmedos), el tipo de suelo y el tamaño de la planta.

Los vientos húmedos son favorables, pero los vientos secos tienen la capacidad de acelerar la transpiración de las plantas, aumentando así sus requerimientos de agua. Los suelos arenosos retienen menos la humedad que los suelos arcillosos; el tamaño de la planta afecta básicamente en dos formas: plantas más grandes necesitan más agua por riego, pero no necesariamente más riegos o riegos con tanta frecuencia como lo requieren las plantas jóvenes. Estos últimos requieren más frecuencia en los riegos por tener un sistema radicular más pequeño, menos profundo , y también por la inmadurez de sus tejidos.

La zona radicular de los cítricos tiene la mayor necesidad de agua en las primeras pulgadas de suelo, cercanas a la superficie del mismo. En un huerto de naranja Valencia de Arizona, con árboles de 17 a 19 años de edad, y suelo profundo, el 33 por ciento del agua utilizada fué extraída de los 30 cm. superiores del espesor del suelo, 23 por ciento, de la capa comprendida entre los 30 a los 60 cms. , 16 por ciento en la comprendida entre los 60 y 90 cms., 13 por ciento entre los 90 y 120 cms., 8 por ciento entre los 120 y 150 cms., y 7 por ciento entre los 150 y 180 cms. Desde luego, una cantidad desconocida de agua perdida en los primeros 30 cms. del espesor del suelo no fué extraída

por los árboles, sino pérdida por evaporación en la superficie del suelo.

Se sugiere que una vez humedecido hasta una profundidad de 180-210 cms., el riego siguiente puede ser lo suficientemente ligero para humedecer la capa de los 60 a 90 cms. superiores del suelo.

VIENTO

En la Escuela Agrícola Panamericana no parece haber problema con los vientos existentes en la zona dedicada a la siembra de frutos cítricos. Sinembargo, cabe mencionar que en algunas otras partes citrícolas del mundo el tipo de vientos prevalentes tiene un gran efecto en lo que se refiere al cultivo de los frutales en mención.

Básicamente, hay tres formas en las que el viento puede dañar a los árboles. Una de ellas es por ser demasiado secos y calientes incrementando así la pérdida de agua por parte de la planta, como se dijo antes. En segundo lugar tenemos los vientos fuertes, huracanados, que causan la quebradura de las ramas, daños a los frutos, y algunas veces hasta la caída de los árboles. Por último tenemos los vientos fríos, que como también se mencionó antes, causan la cristalización de las partículas en la parte interna de los frutos y tejidos jóvenes dañando seriamente las plantaciones.

Al respecto, lo que se recomienda es hacer una buena escogencia del lugar donde se sembrará el huerto y también el establecimiento de barreras rompe-vientos, como se verá más adelante bajo el título de "Cultivo".

LUZ

Las zonas tropicales no tienen mayor problema con los requisitos de luz para el cultivo de los cítricos. La energía necesaria para la formación de azúcares por medio de fotosíntesis está siempre presente. La temperatura es variable en diferentes zonas, pero en general, se puede deducir que escogiendo bien el lugar, no se presentarán proble-

mas por culpa de ella.

El tipo de luz, la longitud de onda específicamente, si es deficiente en algunas zonas tropicales para brindar una coloración adecuada del fruto. Por ejemplo, en Florida, los rayos ultra violeta son absorbidos por la atmósfera en una forma mucho mayor que en zonas más áridas, resultando en un desarrollo de color menos brillante de las naranjas y las mandarinas (; 95) (Ziegler-Wolfe).

SUELOS [1]

Tanto los cítricos, como muchos otros árboles frutales, no todo el tiempo prosperarán bien en terrenos que cuentan con buenas cosechas de plantas tipo anual. Esto se debe, generalmente, a la relación: sistema radicular - tipo de suelo. Los sistemas radiculares de plantas anuales y perennes tienen diferencias morfológicas que requieren también diferentes tipos de suelos, con diferentes características físicas y químicas.

Las raíces de los cítricos tienen grandes requerimientos de oxígeno para efectuar las funciones metabólicas y también para la obsorción de agua y nutrientes. El oxígeno disponible también favorece la presencia de una flora beneficiosa en el suelo. De esta manera, condiciones físicas que brinden una adecuada aereación del suelo en la zona de las raíces, son esenciales.

Las características físicas de un suelo son de mayor importancia para el desarrollo de los árboles cítricos, que las características químicas del mismo. A continuación haremos un breve análisis de cada una de estas características, comenzando con las de tipo físico, para estudiar luego las de tipo químico.

Características físicas de los suelos:

Se han hecho varios estudios relacionados con la importancia de

(1) La mayor parte de esta sección está basada en lo expuesto por Batchelor y Webber (Ref. no. 9), en páginas 233 a 240.

la naturaleza física del suelo y sus efectos en la aereación y profundidad del sistema radicular de las plantas. Las características físicas están determinadas por el tamaño de las partículas del suelo, (textura), la relación o disposición de esas partículas con respecto de una a otras (extructura) en los varios estratos del suelo, y por último, las relaciones entre los diversos estratos (perfil).

Estos factores determinan el espacio poroso total y el tamaño de los poros a través de los cuales deben moverse el aire y el agua en el suelo. En otras palabras, estos espacios regulan el drenaje del agua a través de la masa del suelo.

Drenaje y profundidad del suelo:

Ninguna característica de un suelo bueno para cítricos es más importante que el drenaje. Si no hay un drenaje adecuado, la acumulación de agua en la zona de las raíces causa una falta de aereación y daño a las raíces, siguiéndola una reducción en la actividad radicular y posiblemente toxicidad.

Falta de drenaje causa cambios químicos indeseables en el suelo y también un aumento en la actividad de organismos patógenos. Logicamente, esto trae como consecuencia una pérdida en el vigor del árbol y algunas veces, la muerte. Suelos poco profundos que por cualquier motivo impidan un buen drenaje deben ser descartados para el cultivo de los cítricos.

Tipos de suelo:

Suelos que poseen un perfil relativamente uniforme a través de la extensión de la zona radicular, son preferidos puesto que no hay una interrupción del movimiento del agua a través de sus capas. El desarrollo de las raíces es más uniforme en ellos.

Suelos de una textura muy arenosa se desprecian algunas veces; estos suelos son bajos en materia orgánica y por supuesto, bajos en

nutrientes. Además, suelos arenosos se lixibian rápidamente y requieren un mejor control en los programas de fertilización. Su poca capacidad de retención del agua es también un tanto indeseable, especialmente en zonas con lluvias esporádicas o donde la irrigación no es muy frecuentada.

En el otro extremo, o sea en el caso de los suelos arcillosos, también hay sus objeciones. La aereación de ellos es pobre, debido al pequeño tamaño de los poros en su interior. La distribución de las raíces en estos suelos es restringida y los árboles en algunos casos no desarrollan todo su tamaño potencial. Problemas pueden desarrollarse debido a la alta capacidad de retención del agua de dichos suelos. Los suelos muy arcillosos producen solamente cosechas pequeñas de cítricos, pudiendo ser utilizados más económicamente con otros cultivos.

Características químicas de los suelos:

Fertilidad: la fertilidad de los suelos para cítricos parece ser dentro de ciertos límites, menos importante que las características físicas ya mencionadas. Por supuesto, si a unas características físicas buenas se le añade una fertilidad natural también buena, las cosechas y el desarrollo de los árboles serán mejores. Se recomienda siempre hacer análisis del suelo para establecer los programas de fertilización y determinar la presencia o ausencia de sales tóxicos a los árboles frutales.

PH: la reacción alkalina o ácida de los suelos para los cítricos no es un problema muy grande para el establecimiento de la plantación. Se encuentran árboles cítricos desarrollándose bien en un pH cerca 5 (muy ácido) y también en pH: de 8.5 (muy alcalino). Sinembargo se considera ideal un pH que fluctúe entre 5.5 y 6, o sea relativamente ácido.

La sección correspondiente a los nutrientes y su relación con el

cultivo de los cítricos será cubierta bajo el título de "Fertilización".

PROPAGACION DE LOS CITRICOS

La propagación de los cítricos es comercialmente hecha por medio de injertos de yema, en la mayoría de los casos. Se ha comprobado la ventaja de este medio de propagación sobre otros usados comercial y experimentalmente. Se usó en un tiempo la propagación por semillas y también se ha hecho uso de propagación por medio de estacas, injertos de púa y el acodado.

Los cítricos tienen la ventaja de producir, algunas veces, embriones apomícticos fieles al tipo de la planta madre; sinembargo, siempre hay variaciones en huertos constituidos por plantas originadas de semilla. Además, las plantas derivadas de semilla tienen, generalmente, más espinas y requieren un tiempo más largo para empezar a producir frutos.

Cualquier método de propagación vegetativa puede dar las ventajas uniformidad, producción temprana, pocas espinas (o su ausencia completa) y una estación de producción uniforme, pero solamente por medio de la injertación se puede obtener un sistema radicular mejor adaptado a las condiciones de suelo y una mayor resistencia a ciertas enfermedades viróticas o fungosas.

De acuerdo a lo visto en el curso de Propagación de Plantas, la injertación consiste en unir dos individuos, o partes de individuos, para que lleguen a funcionar como una sola planta. Estas dos partes son el patrón (supliendo sistema radicular) y el injerto (supliendo la parte área). Los patrones, en el caso de los cítricos, son plantas propagadas por semilla y que debido a caracteristicas propias, pueden suplir sistemas radiculares fuertes, bién adaptados a la región. Logicamente, estos patrones deben ser compatibles con la variedad a ser injertada.

No hay, hasta el momento, un patrón que sea completamente supe-

rior a los demás.

Todos tienen características deseables y, desgraciadamente, todos tienen también algunas características indeseables. A continuación se incluye una lista de los patrones más usados, haciendo un breve exposición de las características de cada uno:

MANDARINA CLEOPATRA (Citrus reticulata, Blanco)

Es un patrón adaptado a diversos tipos de suelos. Resiste bastante bién los suelos pesados y húmedos, pero no crece muy bien en suelos livianos y arenosos; sinembargo, buenos resultados se obtienen con un buen programa de fertilización. El árbol tiene un crecimiento vigoroso y tiene más resistencia a la pudrición del pie del tallo, que la naranja dulce o el limón rugoso. Los árboles injertados en este patrón tienden a entrar en producción más lentamente que los injertados en otros patrones, con excepción de la naranja dulce. La calidad de la fruta es satisfactoria, pero de un tamaño inferior.

NARANJA AGRIA (Citrus aurantium, Linn)

Patrón bastante bien adaptado a suelos pesados; talvez el mejor patrón para este tipo de suelos. Resiste muy bien a la gomosis. Los árboles injertados en él tienen la capacidad de producir la cosecha en una forma temprana y con frutos de muy buena calidad. Tiene bastante resistencia al efecto de bajas temperaturas y puede pasar, en cierto grado, esta característica a la variedad en él injertada. La desventaja de la naranja agria es su susceptibilidad a la "tristeza"; enfermedad virótica que ataca el sistema radicular, matando la planta en un corto tiempo; por esta razón, en algunos países de América Latina (Argentina, Uruguay, Paraguay, Perú y Brasil) está descartado como patrón.

NARANJA DULCE (Citrus sinensis, Osbeck)

No se adapta bién a suelos muy pesados, con mal drenaje. Es susceptible a la pudrición causada por Phytophtora sp. Es resistente a la

tristeza. La fruta de los árboles injertados en él, son de excente calidad, sinembargo, la producción es tardía. Además, es poco resistente a los períodos de sequía. En general, se puede decir que no es un patrón muy recomendable, con la excepción de aquellos casos en los que se quiere muy alta calidad del fruto.

LIMON RUGOSO (Citrus limon)

Es el patrón más adaptado a suelos arenosos y livianos. No se adapta bién a suelos pesados y cuando hay mal drenaje tiene bastante susceptibilidad a la pudrición de la base del tallo. Es también susceptible al daño causado por bajas temperaturas. El fruto producido por los árboles injertados en limón rugoso tiende a tener cáscara gruesa, poco jugo, y es inferior en calidad a aquellos frutos de árboles injertados en naranja agria. Características deseables de este patrón son, entre otras, el tener un crecimiento vigoroso y rendir una buena producción en tiempo bastante corto. El limón rugosos es también resistente a la tristeza y a la sequía.

Además de los patrones mencionados, hay varios otros usados comercialmente con buenos resultados; entre ellos podemos citar la naranja trifoliada (Poncirus trifoliata) y la toronja (Citrus paradisi).

Debido a lo breve del curso y a que en la E. A. P. usamos básicamente mandarina Cleopatra y naranja agria como patrones, dejaremos al interesado la recomendación de revisar estos materiales en Citrus growing in Florida, Citrus industry of Florida y Citrus fruits, libros incluídos en la bibliografía de este trabajo.

PREPARACION DE LA SEMILLA PARA PATRON O PORTAINJERTO

La obtención y preparación de la semilla que se siembra para producción de patrones es un proceso sencillo, pero que requiere sumo cuidado y atención. Una vez decidido el patrón a usar, se obtienen los frutos de árboles sanos, robustos, y con fruta de buena calidad. Los frutos tendrán que haber desarrollado completamente y estar maduros o en un estado de madurez avanzado. En la E. A. P. este estado de desarrollo se encuentra, en la mandarina Cleopatra, aproximadamente por los meses marzo-mayo. Las frutas son cosechadas y llevadas en cajas a un lugar donde puedan dejarse en agua por un período de dos a tres días, después de las cuales las frutas están un poco fermentadas y la pulpa suelta las semillas con mucho más facilidad. Se procede entonces a cortar la fruta, haciéndolo unicamente en los polos, pués de otra manera las semillas situadas en el centro de la fruta serían también cortadas. Hecho los cortes, la semilla se extrae exprimiendo los frutos sobre una zaranda que continuamente recibe agua para lavar los materiales indeseables o residuos de la pulpa. Las semillas así obtenidas se secan a la sombra y después son tratadas con substancias protectoras fungicidas e insecticidas. Concluído ese trabajo las semillas se guardan en frascos debidamente etiquetados.

La siembra de los semilleros debe hacerse lo más pronto posible, puesto que la semilla de los cítricos pierde su viabilidad relativamente rápido si no se guarda en condiciones de almacenamiento controladas.

Con respecto a la calidad y la cantidad de semillas a sembrar, se recomienda seleccionar las semillas, eliminando las que tengan daños mecánicos y las fuera de tipo. Una manera rápida y fácil de separar las semillas buenas de las malas es el ponerlas en un recipiente con agua. Las de buen tamaño, y generalmente viables, se irán al fondo,

mientras que las malas y livianas, o indeseables, se quedarán flotando.

La cantidad recomendada es aproximadamente dos veces la cantidad de plantitas deseadas. Esto es debido a que hay que esperar un pequeño porcentaje de pérdida durante la vida del semillero, además de que se puede hacer una mucha mejor selección de las plantas a sembrar.

SEMILLEROS

Las semillas deben ser plantadas en semilleros que reúnan las siguientes condiciones: suelo fértil, de buen drenaje y libre de malezas, insectos y enfermedades. Tener facilidad para riego y accesibilidad para equipo y materiales de trabajo. Además, se recomienda tener en mente que si la intensidad de la luz solar es muy fuerte, las plántulas pueden requerir la protección de un sombreadero, temporal o permanentemente.

La siembra se puede hacer al voleo o en hileras, que es el método usado en la E. A. P. La semilla se siembra a 2-3 cms. entre semillas y aproximadamente 10-15 cms. entre hileras. Nuestros semilleros son canteros de madera tratada, 2 x ". El largo de los canteros es de mts. y el ancho de mts. lo que permite trabajos de deshierba, raleo y mantenimiento con bastante facilidad. Sinembargo, los semilleros pueden hacerse en el puro suelo o en cajas pequeñas, de acuerdo a la cantidad de semillas necesitadas. Debe recordarse que la altura de la caja no debe ser inferior a los 6", pués si fuera más baja afectaría el desarrollo de las raíces. La profundidad de siembra puede variar desde 3/4 a 1" de profundidad.

La germinación de la semilla ocurrirá entre 15-25 días después de la siembra, dependiendo en el tipo de semilla y algunos otros factores, como la temperatura del suelo.

Hecha la siembra y germinada la semilla, los trabajos son estrictamente de mantenimiento hasta que las plantitas alcancen tamaño para

trasplante al vivero. Debe mantenerse el semillero libre de malezas y se debe chequear con frecuencia para eliminar posibilidades de ataques de plagas o enfermedades. La enfermedad más común en los semilleros suele ser "domping-off" o mal del talluelo, causada por Rhizoctonia u otros hongos. Estos ataques se pueden preveer haciendo los riegos moderados y solamente cuando se consideren necesarios. Para estimular un mejor crecimiento, se recomienda algunas veces la fertilización de las plantas con fertilizantes nitrogenados, en forma líquida si es posible.

Las plantitas se dejan en el semillero hasta que tienen un diámetro, en la base del tallo, de aproximadamente 3/6 a 1/4". En nuestras condiciones, esto lleva aproximadamente 6 a 8 meses. No se recomienda un trasplante más temprano pués las plantitas son cuidadas más intensivamente en los semilleros que en los viveros, ahorrando además, trabajo y dinero.

Cuando las plantas están aptas para el trasplante al vivero, se sacan y se efectúa la siembra lo más rápido posible, puesto que los cítricos son fácilmente dañados cuando hay un secamiento de las raíces. El semillero se riega bien el día anterior o en la mañana, si es que el trasplante ha de hacerse en la tarde. Las plantitas se sacan utilizando un palín o cualquier otra herramienta que no maltrate las raíces, si estas son muy largas se cortan a unas 6 a 8" del cuello de la planta. Conforme se sacan las plantitas, se ponen en una cubeta con agua o bien se ponen en un recipiente forrado con sacos húmedos y limpios. No deben exponerse las raíces a la luz directa del sol ni deben permanecer al descubierto si es que hay vientos más o menos rápidos. Sacadas las plantitas se llevan a un lugar sombreado y sin vientos donde se hará una selección del material a sembrar en el vivero. Todas las plantas pequeñas, enfermas o imperfectas se deben eliminar.

Hecha la selección, las plantitas son podadas, dejando las raíces de un tamaño uniforme (6 a 8") y cortando aproximadamente una tercera parte del asta principal. Con este paso las plantas quedan listas para ser llevadas al vivero.

EL VIVERO

Las plantitas provenientes de semillero son trasplantadas a un vivero donde se desarrollarán lo suficiente para ser injertadas y posteriormente trasladadas al campo.

La selección del lugar para el vivero debe hacerse considerando el tipo de suelo y las facilidades para el mantenimiento. Se prefieren suelos profundos y libres de rocas. Si las plantas se van a sacar en pilón se preferirá un suelo con una razonable cantidad de arcilla pués facilitaría la sacada de las plantas; si las plantas se sacaran en "escoba" se puede utilizar un suelo liviano. Si el suelo no es muy rico, se puede mejorar por el uso de cosechas de cobertura y el uso de fertilizantes comerciales antes de la siembra. Se debe arar profundo, desmenuzar los terrenos y nivelar después el terreno.

La siembra de las plantitas se hace en líneas rectas, en bloques de terreno que faciliten el paso de implementos de trabajo y las labores en general. La distancia entre surcos es de $3\frac{1}{2}$ a 4 pies y entre plantas debe haber de 12 a 15 pulgadas. Cuando se siembran las plantitas a 4 pies entre surcos y 1 pie entre plantas, caben aproximadamente 10,890 plantitas en un acre. Sinembargo, se debe considerar que hay que dejar unas cuantas calles, las que se hacen dejando un surco sin sembrar; de esta manera caben aproximadamente 10,000 plantitas /acre.

En el momento de sembrar, el terreno debe estar húmedo para facilitar el trabajo; se marca con las distancias establecidas y la siembra se hace usando palines grandes, en la siguiente manera:

1 - Se inserta el palín en el suelo

2 - Se mueve haciendo presión hacia un lado.

3 - En el espacio que queda se inserta la planta (sin maltratar raíz principal)

4 - Se saca el palín, se endereza la planta y se cubre haciendo presión con el pie

La colocación de la raíz principal es muy importante; debe quedar en su posición natural, sin doblarse o maltratarse mecánicamente. También es muy importante el hacer suficiente presión con el pie para cubrir bien las raíces y eliminar el peligro de dejar las raíces en una "bolsa de aire" sin contacto con el suelo.

Efectuada la siembra debe irrigarse, si no hay la posibilidad de tener lluvias en unas pocas horas.

Los cuidados del vivero son básicamente: riego, control de malezas, control de insectos y enfermedades, si es que se presentan, y fertilización para tener un crecimiento vigoroso. En algunos casos se recomienda la poda para establecer una sola asta, en la que se hará la injertación. La fertilización se hace con fertilizantes que contengan una dósis alta de nitrógeno, lo que estimulará el crecimiento. El vivero debe mantenerse libre de malezas, ya que estos roban nutrientes y algunas vecee on hospederas de insectos y enfermedades. La frecuencia de los riegos, en las zonas que sean necesarios, varía con el tipo de suelo. Suelos normales necesitarán riegos aproximadamente cada 10 a 15 días; suelos arcillosos pueden extender más el número de días para cada riego.

Si el vivero ha tenido un desarrollo normal, las plantitas estarán listas para ser injertadas después de unos 6-9 meses. El diámetro de los tallos deberá ser aproximadamente 3/8 a $\frac{1}{2}$ pulgada. Los injertos estarán listos para ser trasladados al campo definitivo después de 18 a 24 meses de hecha la injertación.

INJERTACION DE LOS CITRICOS

Como se dijo con anterioridad, la propagación comercial de los cítricos, se hace en la actualidad por medio de injertos de yema. Es-

pecíficamente, se utiliza el injerto de "T" o escudete, el que se hace en su forma normal, o en T invertida.

Como en otros frutales, se pueden utilizar en los cítricos los injertos de púa y otras modificaciones de los injertos de yema, pero la experiencia y el ahorro de material vegetativo dan preferencia al injerto arriba mencionado. Las técnicas y el material necesario para este tipo de injerto han sido discutidas en el curso de propagación de plantas. Consecuentemente, no redundaremos en ese tópico, pero si haremos mención de la manera de preparar y seleccionar el material vegetativo a ser injertado.

La injertación de los cítricos se puede hacer en nuestro medio durante cualquier época del año con buenas posibilidades de "pegue". Sinembargo, no se recomienda mucho durante los meses secos del año (enero - abril) ni tampoco durante los meses bastante lluviosos de agosto - octubre, lo que nos deja un marge de aproximadamente tres meses para hacer nuestros injertos con un mayor margen de seguridad. Durante los meses secos, los patrones no "abren" con tanta facilidad además de que las altas temperaturas pueden tener un efecto perjudicial en los tejidos tiernos de la yema injertada. En la época fuertemente lluviosa encontramos el peligro de tener una mayor incidencia de hongos que ataquen el punto de unión entre patrón y yema, lo que causaría una baja en el porcentaje de pegamiento.

SELECCION DEL MATERIAL A INJERTAR

Yemas utilizadas en la injertación de cítricos deben ser provenientes de árboles cuidadosamente seleccionados y de la variedad deseada. Es necesario tener una rígida selección del material por dos razones: a) en cítricos cabe la posibilidad de tener variación aún dentro de una misma variedad y b) la transmisión de enfermedades es posible por medio de material vegetativo enfermo.

Se ha mencionado ya que los cítricos son susceptibles de tener variaciones genéticas con relativa frecuencia, por lo tanto los árboles madres deben seleccionarse tomando en cuenta la fidelidad al tipo y por supuesto sus hábitos de crecimiento y producción.

La transmisión de diversas enfermedades tales como psorosis, gomosis y otras más está científicamente comprobada, por lo que material proveniente de árboles enfermos debe ser descartado para propagación vegetativa.

Las yemas a ser injertadas deben venir de madera más o menos madura que haya desarrollado durante el transcurso de ese año. Los cítricos tienen la característica de contar con un crecimiento en forma angular en los brotes nuevos; ese material es indeseable para la injertación y siempre se debe evitar su uso pués dificulta más el trabajo, además de ser relativamente tierno. La parte basal de las ramas jóvenes que son casi redondas, suplen las mejores yemas. Este material generalmente corresponde al penúltimo crecimiento.

Material con espinas debe evitarse, pués logicamente transmitirá esa característica en la copa del futuro árbol.

El estado de desarrollo de las yemas es muy importante. En la E. A. P. se cortan varetas con yemas ni muy desarrolladas ni muy pequeñas. Dichosamente no contamos con heladas, así que no se recomienda usar yemas que vayan a estar latentes por mucho tiempo después de hecho el injerto.

Las varetas se cortan de un tamaño adecuado para su manejo, se quitan las hojas y se ponen en bolsas de plástico que contienen musgo o paja húmeda para ser llevadas al campo. Cada bolsa debe ir claramente identificada. Si las varetas se van a almacenar por varios días, se hace el mismo proceso, solo que la humedad de la paja o el musgo es menor y las bolsas se guardan en el cuarto frío a aproximadamente ^{o}F.

MANEJO DE LOS INJERTOS JOVENES

Una vez hecho el injerto y comprobada la formación del callo (pegue) entre patrón y yema, se procede a estimular el brote o desarrollo de la yema recién injertada.

Se observa que algunas veces las yemas a pesar de estar pegadas, quedan por varios días o semanas en un estado de latencia. Para estimular un rápido crecimiento se recomiendan dos prácticas: a) la poda de media savia y b) el decapitamiento del patrón.

En el primer caso, el proceso consiste en cortar el asta del patrón aproximadamente a unos 6-8" del injerto, pero teniendo cuidado de no trozar completamente el patrón sino lo suficiente como para poder doblar hacia abajo la parte superior formando un ángulo de más o menos 45° con el resto del patrón. La decapitación, como su nombre lo indica, consiste en trozar completamente el patrón a una altura de 3-5" arriba del injerto.

Los dos procesos anteriores aumentan la cantidad de nutrientes y productos hormonales que llegan a la yema injertada, promoviendo así su más rápida brotación y desarrollo posterior.

Una vez forzadas las yemas, ellas crecen rápidamente y el punto de unión con el patrón es bastante débil. Para protegerlas y para darles una buena forma de crecimiento, son amarradas a estacas de aproximadamente 1 x 1" y de $3\frac{1}{2}$ a 4 pies de alto. Las estacas se clavan cuando los injertos tienen unas 5" de altura y se ponen a una distancia de 1 a 2" del lado en que está el nuevo brote. Si se ponen en el lado opuesto, se forma un arco indeseable en el futuro árbol. El amarre se hace cada 6 pulgadas y se utiliza rafia, alambre de cobre cubierto con papel, tela, o cualquier material que no dañe los tejidos blandos de la planta. En el amarre se debe dejar suficiente espacio para el crecimiento lateral posterior, pués de otra manera se estrangularía la planta en crecimiento. Conforme se desarrolla el injerto hay

que hacer continuos chequeos para eliminar cualquier nuevo brote del patrón.

El trozo de patrón que se había dejado después de forzar la yema es eliminado cuando el injerto tiene aproximadamente 1 pie de altura; esto se hace cortando lo más cerca posible de la parte superior del injerto y procurando hacer un corte inclinado (bizel) y liso. Se utiliza una tijera de podar o una sierra para poda, afinando el corte con navaja bién afilada. Hecho esto se cubre el corte con cera para injertar.

La formación de una horqueta a aproximadamente 25-36" es estimulada cuando el patrón tiene 40 a 45" de altura. Esta horqueta eventualmente constituirá la cabeza o corona del árbol de donde saldrán las ramas productoras de frutos. La inducción de la formación de la horqueta es hecha simplemente por una poda regresiva hasta la altura deseada. La remoción de la yema terminal estimulará el desarrollo de las yemas laterales.

Desde el paso anterior hasta la sacada de las plantas, los trabajos necesarios serán los de eliminación de brotes nuevos o chupones en lugares indeseables, generalmente la parte inferior de la horqueta recién formada.

SACANDO PLANTAS DEL VIVERO PARA SIEMBRA EN CAMPO DEFINITIVO

Las plantas lista para su trasplante al campo definitivo son seleccionadas en el vivero y se sacan de acuerdo al siguiente procedimiento:

1 - Se poda el arbolito con tijeras de podar (pericas), reduciendo el tamaño de las ramas más gruesas.

2 - Se cortan las ramas tiernas y se elimina el follaje por completo, utilizando una tijera de podar pequeña.

3 - Se identifica el árbol a sacar poniendo una etiqueta que identifique el nombre de la variedad, teniendo en cuenta el no escribir con tinta corriente, pués se borra cuando la etiqueta es mojada.

4 - Se escarba alrededor del árbol, o solamente en dos lados dando una forma de "V" al corte. Dependiendo del tamaño de la planta, se profundiza lo más posible en el suelo siguiendo la raíz pivotante o principal, la que es cortada con un solo golpe de la pala o palín.

5 - Con la ayuda de la pala se mueve la planta para aflojar las demás raíces y después se hala hacia arriba para obtener la planta con raíces en escoba.

6 - Se pone la planta en un lugar sombreado y después se lleva, junto con las demás, al lugar donde serán podadas las raíces y alistadas para la siembra o el empaque.

También se acostumbra a veces sacar las plantas en "pilón", o sea con tierra alrededor de las raíces, pero puesto que el arriba mencionado es el método más usado en cítricos, no se hará discusión del segundo.

Como en la sacada de las plantas se lesionan algunas raíces, y para facilitar el empacado, se acostumbra podar las raíces, eliminando partes rajadas o golpeadas y también las raíces laterales muy gran-

des. Además, se podan un poco las raíces secundarias finas.

Podadas las raíces, los arbolitos están listos para la siembra directa en el campo o para el empacado. Este último se hace en la E. A. P. poniendo las plantas en grupos de 3-6 y hasta 12 plantas en sacos de gangoche (bramantes); acomodándolas entre sí con una capa de heno húmedo para evitar el roce y maltrato de las mismas. Los sacos son amarrados y cada grupo lleva su identificación individual. El heno es humedecido para evitar la deshidratación excesiva de las raíces. Las plantas así empacadas pueden resistir desde varios días a varias semanas antes de la siembra, pero por supuesto, se recomienda efectuar ésta lo más rápido posible para tener un mayor éxito en el transplante.

ESTABLECIMIENTO DEL HUERTO

Habiendo hecho de antemano la selección del lugar donde se sembrará la plantación, se procede a la siembra de arbolitos. La siembra se puede efectuar de varias maneras, pero aquí enumeraremos las más comunes y tomando como base el material expuesto en "cítricas", del Servicio Shell para el Agricultor*.

Métodos de siembra

Antes de decidirse a plantar sus matas cítricas, el agricultor debe pensar en el sistema de riego que mejor conviene a su huerto. Como sea que estos frutales son cultivos permanentes, cualquier mejora que requiera el terreno deberá efectuarse con anterioridad a la siembra de los mismos. Por lo tanto, desde entonces procederá a nivelar el campo, para que al regar no se formen charcos. Convendría efectuar dichas tareas con bastante anticipación a la siembra de los frutales, pués los rellenos suelen bajar a causa de las lluvias y del riego y, de ocurrir estos, precisaría efectuar una renivelación.

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* Fundación Shell, cítricos, 1966. 2a. edición. Serie A, no. 27.

THE CITRUS FRUITS

The cultivated citrus fruits had their origin in southern Asia, but they have long been established in tropical and subtropical regions all over the world. In the American tropics they are the most popular of dessert fruits, preferred by people of all classes. And as everyone knows, they are of tremendous commercial importance, especially in subtropical parts of the United States, in Brazil, and in Argentina.

Commercial plantings of sweet oranges have been increasing rapidly in the strictly tropical zone. This development involves not only large operators, but also many small growers as has been the case in the older commercial areas. Increased efficiency of production in tropical America will be attained mainly through experimentation and experience, though much can be learned by drawing upon the knowledge which has been acquired in other regions. Because Florida and California are close to the tropics and have developed an advanced citrus technology, they are valuable sources of information. When practices developed in those States are applied elsewhere, however, it must be borne in mind that the climate of California is colder and drier than many parts of tropical America, and the soils of Florida are quite different.

Climate and Soil

Citrus fruits thrive in warm, moist climates. Where irrigation is available, dry climates are often very satisfactory. Grapefruit and tangerines endure hot, dry climates better than oranges. Where summer temperatures are kept moderate by cloud and fog, oranges and lemons are likely to have good quality

while grapefruit quality is poor. Cool weather as the fruits mature improves quality and color; oranges usually do not develop yellow color if night temperatures remain above 55 degrees F. In European and North American markets grapefruit from hot, dry regions is considered to have best quality, but this is not the case in Latin America. Here the ideal is a sweet fruit of very low acidity, and a warm, moist climate produces this. Grapefruit grown on the Atlantic coast of Central America attains large size, is very juicy, and is mildly acid. At 5000 feet elevation it is so acid, and sometimes so bitter, that it could not be sold readily in temperate zone markets. Oranges, on the other hand, attain highest color and quality in Central America at 3500 to 4500 feet, and at 6000 to 7000 feet near the equator. In fact, it has been said that "oranges produce their best fruit when pushed right up against the frost line." Many regions which are so cool in winter that trees are occasionally damaged by frost are famous for the quality of their oranges.

There is, of course, another side to the picture: the production of juice for canning and for concentrates. Here, dessert quality is not the main consideration. Navel oranges grown under irrigation in a cool, dry climate are more delicious, but they do not produce as much juice as Valencias grown in a warm, moist one.

Soils for citrus trees should be well drained to a depth of at least 2½ feet; greater depth will give increased tree size and yield. With a water table kept constantly at 2½ to 3 feet below the surface, growth and production may be very satisfactory, but it is rarely that a constant depth of water table occurs. When the water table fluctuates widely during the year, the highest

level usually determines depth of rooting, and trees suffer as the water level drops. Conversely, when normally there is root development to 3 feet or more, poor drainage may permit temporarily a high water table, with death of feeding roots if it lasts more than a week or two. On sandy land, soil acidity is most favorable in the range pH 5.5 to 6.5, but on loam and clay soils which are well drained, growth may be good from pH 5 to 9. Alkaline soils are not satisfactory, nor is high salinity.

THE SWEET ORANGE

To distinguish it from the sour or Seville orange, still an important fruit is some parts of the world, it is customary to call oranges which are eaten out of hand, or squeezed for juice, sweet oranges. This is fair enough, for they belong to a different species (Citrus sinensis) from the sour orange, C. aurantium. Both species originated in the Assam-Burma region, but in prehistoric times passed into southern China where their present characteristics were formed. Later they were carried beyond Burma to India (perhaps 3000 years ago) and thence to the eastern Mediterranean, about the first century A.D. The Arabs took sour oranges to Spain at an early date, but it is not certain that sweet ones were grown in that country much more than a century before the time of Columbus. On his second voyage (1493) the Admiral called at the Canary Islands, where he picked up seeds of oranges and other useful plants. By 1526, Gonzalo Fernandez de Oviedo assures us, both sweet and sour oranges were fruiting on Santo Domingo, whence they had already spread to Tierra Firme (the South American mainland). Bernal Diz del Castillo,

who took part in the Conquest of Mexico, mentions with justifiable pride that he planted orange seeds on the Isthmus of Tehuantepec.

Varieties

Washington Navel or Bahia Navel. Wherever grown in tropical America this commands a higher price in local markets than any other orange - often more than double the price of good local seedlings.

The fruits are round, large in size (usually more than 3 in. in diameter), and characterized by seedlessness and the presence of the "navel", which is a small secondary ovary developed just inside the apex. Sometimes the navel is large, or even so protruding that it detracts from the appearance of the fruit; sometimes it is so small as scarcely to be noticeable. The skin is thicker than that of many other oranges; this depends to a certain degree on environmental conditions, as does the color and flavor of the fruit. In short, Washington Navel is not nearly so adaptable to a wide range of climates as numerous other ~~varieties~~ oranges. Grown at low elevations in the tropics, it lacks the brilliant orange color which it attains at higher ones, and quality is poor. Furthermore, at low elevations crops are small. At higher ones they are ~~fair~~, better; sometimes there are two crops per year. In Central America, it can be said that the best zone for Washington Navel lies between 3000 and 4000 feet.

Numerous bud mutations have been propagated by nurserymen. Several of these are claimed to be superior to the type in some particular respect. Not much experience with these has been accumulated in tropical America, where commercial plantations have been based

on what has been considered the typical or standard Washington Navel. The Robertson Navel of California, Summerfield Navel and Dream Navel of Florida, and Araras Bahianinha of Brazil are worth testing widely.

It is highly important to choose budwood carefully when propagating navel oranges. This practice was established in California by A.D. Shamel and his associates; it consists in selecting budwood from branchlets which produce ideal fruits, with special attention to reducing the percentage of navels which are objectionably large.

Valencia. This is the most important orange variety in the world - the standard late orange everywhere. It tends to be considerably smaller than Washington Navel, but it is juicy and of excellent flavor. Typically there are only 3 to 6 seeds in a fruit, sometimes none. The tree is very productive and is completely successful at all elevations from sea level to 5000 feet in Central America, 6000 or even higher near the Equator. It is noteworthy that most of the older producing regions - for oranges of this type - are not at sea level, but at 3000 to 4000 feet in Guatemala, 5000 to 6500 feet in Colombia. Highest quality is developed in regions with cool nights.

Pineapple. This is a mid-season orange of fine quality and good yield. The fruits are round or slightly flattened, medium in size, deep orange in color if temperatures are favorable, sweet and somewhat distinctive in flavor. Pineapple has proved very popular in Central America, in spite of the fact that it has more seeds (10-20) than any other important commercial orange.

Hamlin. The standard early orange in Florida, this has done well in Central America. It is almost seedless (0-5) and yields good crops of fruit quite similar to Valencia in quality. Jaffa is another good variety which has done well in tropical America. Hamlin, Pineapple, and Jaffa lengthen the orange season - they all mature earlier than Valencia.

Temple. Commonly sold as an orange, although it is undoubtedly a tangor (orange-tangerine hybrid), this variety is of unusually high quality; in fact, it is considered a fancy fruit. It is roundish-oblate, medium in size, deep orange in color when grown in a cool climate. It has not yet been tested extensively in tropical America. Like oranges, at low elevations the skin color at maturity may still be green.

MANDARINS

The term "mandarin" comprises several different kinds of citrus fruits characterized by sweet pulp and a rind easily separated from the flesh. Some of them are marketed as oranges, but they are quite easily distinguished from the latter. Some had their origin in India, some in Japan, others in China, and still others in Malaysia. Seedling mandarins of good size and quality are found in several regions of tropical America. Some of these might well be selected for propagation.

King mandarin (C. nobilis or C. reticulata) is a fruit of large size, with very thick rind, which is grown in tropical America because of its high quality, although nowhere is it cultivated on a large scale. It had its origin in Indo-China. Maturity is late in the season.

Several mandarins are called tangerines, of which the best known is the Dancy. Sometimes the tangerine, or even all mandarins, are grouped into one polymorphic species, C. reticulata, but this is not a very realistic treatment. The name C. reticulata was originally applied to the tangerine called Ponkan in Taiwan and Suntara in India, a very different fruit from the Dancy of China, sometimes distinguished as C. tangerina. Dancy has slender branches and small, bright reddish orange fruits which are juicy and well flavored. They mature in mid-season. Cleopatra tangerine (C. reshni) is mostly used as a root stock, but it is worthy of culture for its ornamental value. Ponkan is a larger tangerine than Dancy, less colorful but equally good in quality. It matures early.

The Satsuma (C. unshiu or C. reticulata) originated in Japan, where it is grown on a larger scale than anywhere else. Trees usually are not large but bear heavy crops of small, flattened fruits with no seeds. Adapted best to cool winter climates, they have not yet been planted extensively in the American tropics. Owari is the best-known variety.

Mandarins have been hybridized with other citrus fruits, especially grapefruit and orange. The mandarin-grapefruit hybrids are called "tangelos" and some of them are commercially important. Orlando tangelo is early maturing, with yellow rind, while Minneola is late maturing, with reddish-orange rind, and excellent flavor. These tangelos are the size of oranges but more juicy. They resulted from crosses made in Florida in 1911 by W. T. Swingle. One notable characteristic is their inability to pollinate themselves. Nearly all other citrus fruits can be planted alone,

but these tangelos must be interplanted in order to produce good crops, as must also Robinson "tangerine", Page "orange" (tangor), and Clementine tangerine. Dancy and Temple are good pollinators. Temple has already been mentioned under oranges, as a natural hybrid of mandarin and sweet orange.

GRAPEFRUIT

Grapefruit (C. paradisi) had its origin in the West Indies, probably by mutation from the Asiatic shaddock (C. grandis). Although known in Barbados as early as 1750, it attracted little attention until late in the 19th century, when Florida began large scale production. Fruit size is much larger than that of oranges and rind color is yellow, not orange, but the most important difference is in taste. Because of lower ratios of sugar to acid, grapefruits are usually less sweet than oranges, and the abundant juice is of characteristic flavor. Canned, sweetened grapefruit is an excellent product while canned orange juice (single strength, "hot pack") is not.

White-fleshed varieties are seedy Duncan and seedless Marsh, the latter having somewhat less flavor but commercially preferred for its lack of seeds. Triumph is not extensively grown but is worthy of cultivation for its sweetness, in spite of being seedy and rather small in size. Thompson is pink-fleshed and Ruby is red-fleshed. Both are seedless; ~~but~~ the latter shows red color even through the yellow rind. Flesh color has no correlation with flavor.

THE LIME

The ~~common~~ true lime (C. surantifolia) has small, seedy, very acid fruits borne on small, thorny trees with slender twigs and small leaves. It is very commonly grown all through tropical America, being next to sweet orange in volume of production. It is usually grown from seed. It had its origin in Malaysia, but is abundant now in all tropical lowlands. Much less common is the large, seedless lime, called Persian (or Tahiti) in Florida and Bearss in California. The lemon-sized fruit is acid, less aromatic than that of the true lime. The trees are larger and thornless, with stout twigs and leaves as large as those of the orange. This lime, perhaps a hybrid, is sometimes called C. latifolia. It originated in California about 1870 from seed of a lime from Tahiti. Commonly it is budded, the preferred stocks being Rough lemon or Rangpur lime, but propagation by air-layering (marcottage) has also been successful. Careful selection of scion sources is important, since propagation from plants showing lime-bark disease (resulting from genetic causes) will predispose the resulting trees to this serious malady. Common limes are free from this but are very subject to attack by a fungus causing anthracnose lesions on fruit and "die-back" of young shoots. Copper sprays on each new flush give control. Both types of lime produce flowers on new flushes usually made several times a year.

Very similar to the lime is the calamondin (C. madurensis or C. mitis), native to the Philippines and Indonesia. The fruit is small, seedy, very acid, with reddish-orange rind. It has little commercial value, but it is highly ornamental for home planting and is fairly free of pests.

THE LEMON

The true lemon (C. limon), grown on a large commercial scale in Italy and California, is not cultivated commercially in tropical America, because it does not seem to produce fruit of best quality. The lime takes its place as an acid fruit. The fact that the latter is called "limón" in Spanish often results in horticultural confusion. The true lemon is usually distinguished in Spanish-speaking countries as limón real. ~~while~~ The rough lemon (C. jambhiri), so widely used as a root-stock and occasionally grown in tropical America as a culinary fruit, does not have a very definite name in Spanish; sometimes it is called "limón rugoso" or "limón áspero."

THE CITRON

Apparently this was the first citrus fruit to be introduced in the Mediterranean region (some 2000 years ago) where it was not considered a culinary delicacy by any means, but enjoyed certain ceremonial privileges. Botanically it is Citrus medica. In Sicily, and to a small extent in several other parts of the world, it is cultivated commercially for the preparation of candied citron peel which is used in the preparation of various delicacies. It is occasionally seen in tropical American gardens but is of no commercial importance. The tree is easily propagated by cuttings.

THE SOUR ORANGE

Perhaps after the citron, the sour or Seville orange (Citrus aurantium) was the first of the citrus fruits to be brought to

the Mediterranean region; certainly it was one of the first (if not the first of all) to be planted in tropical America. The Arabs took it into Spain, where it became popular; it resisted the cold winters of Andalucia, and for its handsome foliage and fragrant flowers it was planted in patios, including the great one at the mosque in Córdoba. The fruit was much used before sweet oranges were introduced. In modern times it is still important as the basis of the famous orange marmalades prepared in Scotland and elsewhere.

The tree is such a robust one that it escaped from cultivation and became naturalized in tropical America and Florida shortly after it was planted by the first Spanish colonists. While today it is not a commercial crop of importance, it is one of the first citrus trees likely to be seen in many an old garden from Mexico to Chile. Horticulturally, its major importance lies in its usefulness as a rootstock for many of the most important citrus fruits, especially the sweet oranges.

THE KUMQUAT

Kumquats are not in the genus Citrus but in the closely related Fortunella. The fruit is small, with little juice and thick, fleshy rind. It is not very popular as a fresh fruit, but is much enjoyed as marmalade, or candied. Kumquats are rarely seen in tropical America, but the small, shrubby trees are very ornamental, especially when laden with orange-colored fruits. Large oval Nagami, small round Marumi, and large round Meiwa are the common varieties. Kumquats originated in China and Japan; the trees can tolerate more cold than any of the oranges.

Nucellar Seedlings

There is a characteristic of the orange and other citrus fruits (with exception of the pummelo or shaddock, rarely grown in tropical America) which is of great horticultural importance. This is the production of what are technically known as nucellar seedlings. It is due to this phenomenon that seedling orange trees may be much alike, not only in growth and productivity, but also in fruit characters. Oranges harvested from a hundred - or a thousand- trees in any particular region may be just about as uniform in character as those from an equal number of grafted Valencias.

Nucellar embryos arise in the following manner; after the flower has been pollinated and fertilization has taken place in the ovule, buds develop from the tissues surrounding the embryo sac - the nucellus. Since these are not the result of fertilization, but are in reality parts of the mother plant, they reproduce the characteristics of the latter just as is the case when buds or scions are used in grafting. Several of these nucellar buds may develop in a single seed. They commonly crowd out the embryo which has resulted from fertilization - the embryo which would develop into a tree not exactly like its parent. Seedling variation is familiar to those who have planted avocado seeds, or those of many other fruits which have been improved through selection or mutation.

Of course, an occasional fertilized embryo does develop into a tree, and of course trees from nucellar seedlings may give rise to new horticultural varieties through mutation.

In modern times grafting has superseded the use of seedling trees in those regions where there is extensive commercial cultivation on an orchard basis. Though seedlings ultimately attain a larger size than grafted trees, the latter assure reproduction of the desired variety, begin production at an earlier age, and can be placed on root stocks which give resistance to unfavorable soil conditions and certain diseases. Nucellar seedlings are of great value in connection with nursery work, assuring a high degree of uniformity among seedling root stocks; they have also been useful in connection with the development of virus-free strains of fruits, since viruses are not usually transmitted through seeds.

Rootstocks

Choice of the rootstock for budding (or other type of grafting) is one of the most important decisions that the orange grower is called on to make. Stocks differ in their adaptation to soil conditions--drainage, salinity, texture, pH value--and to various pests--fungi, insects, and viruses. No one stock is best under all conditions, and under the same conditions a stock which is best for one kind of citrus fruit may not be best for another. The stocks most commonly used for oranges are: Rough lemon, sour orange, Cleopatra mandarin, sweet orange, Rangpur lime, trifoliate-orange, and citranges. All of these produce high percentages of seedlings which are quite uniform in character.

Rough lemon (*C. jambhiri* or *C. limon*) is best adapted to deep, well-drained, sandy soils on which it produces larger trees in a given time than other stocks. However, fruit is inferior in quality to that of the other common stocks. This is not

usually of great significance except with some orange hybrids and satsumas. In Florida and South Africa Rough lemon is the leading stock.

Sour orange (C. aurantium) is usually the preferred stock for low, poorly drained soils, on which it produces fruit of high quality on long-lived trees. Most budded trees in tropical America (except Brazil) are on this stock. This is true also in Spain, Italy, and California. Unfortunately, many orange trees are symptomless carriers of the tristeza virus, and when scions of such trees are budded on sour orange, they may die rather quickly. This happened in Brazil on a disastrous scale. If scions free of virus are available and no virus-infected trees are in the vicinity from which tristeza can be transmitted by aphids, sour orange stocks are still recommended.

Cleopatra mandarin (C. reshni or C. reticulata) has been much used (ever since tristeza virus became a problem) for stocks on soils where sour orange was formerly employed. It has most of the good qualities of that stock except that growth and production of the trees in early years is lower, and it is resistant to tristeza. On deep sandy soils, Cleopatra is preferred to Rough lemon for certain hybrids, such as Temple and tangelos.

Sweet orange (C. sinensis) stock produces trees of good size with fruit of good quality on soils where foot rot (gummosis) is not a problem. Foot rot is the most serious citrus disease in many parts of tropical America.

Rangpur lime (C. limonia) has been used extensively in Brazil to replace sour orange stocks killed by tristeza. This stock, resistant to gumming diseases on low, moist soils, dwarfs trees budded upon it if they carry the exocortis virus.

Trifoliate-orange (Poncirus trifoliata) seedlings are highly resistant to gumming, tristeza, and xyloporosis, but very susceptible to exocortis virus, which causes severe dwarfing. On heavy soils, if the scions used do not carry exocortis, it has advantages. Fruit quality is good on this stock; however, it is not suited to strictly tropical climates.

Citranges are hybrids between trifoliate-orange and sweet orange. They have trifoliate leaves like the Poncirus parent. Several have been tested as stocks in California and Florida, and one of them--Troyer or Carrizo-- is being used to a certain extent; it is outstanding in resistance to footrot and cold, and in production of vigorous, high-yielding trees if the scions are free from exocortis virus. It merits testing widely in tropical America, although its cold-hardiness is of value only in the subtropics.

Propagation

In commercial nurseries, citrus trees are almost always propagated by budding (bud-grafting), the common shield-bud generally being used. Grafting (scion-grafting) is successful but much slower and more troublesome to perform. It is used only in topworking old trees. Even in such cases, it is usually best to cut back large limbs and bud the sprouts, rather than to graft directly into the cut limbs.

Budsticks should be of well-rounded, well-matured wood, of the next to the last flush of growth. It is highly important that the budwood be free of virus infection.

Seedling stocks are usually grown in two stages. First, fresh, plump seeds are sown thickly in a seedbed where they can be watered as needed and protected from ants. When the seedlings are about ½ inch in diameter at the base, they are transplanted into the nursery where they are spaced 1 ft. apart in rows 3 ft. apart. Most of the seedlings will be similar in size; those markedly larger or smaller should be discarded. In both seedbed and nursery row, the seedlings should be kept growing vigorously by light applications of well-balanced fertilizer and by irrigation where necessary. When the seedlings are about ½ inch in diameter they should be budded.

As soon as it is certain that the buds have united well with the stocks, the latter should be "lopped" that is, cut nearly through a few inches above the buds, and the tops bent over to the ground. Tops from adjacent rows should be laid in the common middle. Lopping will stimulate the buds to start growth. When they have grown to 6 in., the stock is pruned off cleanly by a slanting cut just above the bud. After the bud has attained a diameter above the union of 5/8 inch or more, the young trees are ready to be set out in the orchard.

Orange trees should have low heads, with not over 20 inches of trunk below the main branches. Heading too high is a common mistake in citrus orchards of tropical America. High heads increase the cost and effort of spraying, pruning, and harvesting, with no compensating benefits. Only in areas of high rainfall, where having a trunk clear of limbs for 3 feet may decrease gummosis problems by providing better air circulation, is a high head advantageous. Single-trunked trees are greatly to be

preferred, and no trunk sprouts should be allowed to develop below a height of 16 inches from the ground. Good nursery trees are usually branched already when transplanted to the orchard. They should be topped at 2 feet from the ground to assure formation of scaffold branches below this height, if they are not already branched. On branched trees, the laterals should be headed back to a length of 6 inches, and any branches below a height of 16 inches pruned cleanly away.

Preparation of Site

The site chosen for the orchard should be well drained. It should be cleared of trees and brush, and made smooth of surface well before planting time. It is desirable to ascertain the soil reaction and, if practicable, to adjust it to about pH 6 if the soil is more acid than this. If the slope of the ground is so great that erosion is likely to be troublesome, contours should be laid out and trees planted either along contour lines on the slope, or in case of steeper slopes, on terrace beds.

There are several planting systems available, but the rectangular system, and especially the square, is most often used because it is the simplest and most convenient. If regular pruning to control size is planned, however, it is desirable to space trees closely in rows and provide wider spaces between rows, so that machinery can pass. In humid regions, a spacing for orange trees of 25 by 25 feet is very satisfactory for usual methods of culture, giving 70 trees per acre; in arid regions closer spacing to give 100 trees per acre is often practical.

~~The area should be carefully staked~~ Tree locations should be marked by stakes before planting begins.

Transplanting

Transplanting to the field should be done when the young budded trees are not in an active flush of growth. Since much of the root system is necessarily lost in digging, the top is pruned back, as above suggested, to balance the roots. Of utmost importance in transplanting is preventing the roots from drying, and it is very helpful to protect the tops to decrease loss of moisture from the remaining leaves.

In transplanting, the trees should be set so that they are at the same depth as they were in the nursery row, or slightly higher if the ground is nearly level and water drains away slowly. The roots of the nursery tree should be spread out naturally, and the backfilled soil washed in among them so that no air pockets are left. A ring of soil about 3 feet in diameter around the planted tree helps to prevent applied water from running off. About 10 gallons of water per tree is considered an average requirement at planting time. During the first year after planting, the scanty root system makes it necessary to provide water whenever there is a period of 2 or 3 weeks without rainfall.

Fertilizing

It is highly desirable that a grower learn as quickly as he can what fertilizer is needed for his soil, for otherwise he may either waste money on elements not needed or deprive his trees unintentionally of needed elements. The following discussion is necessarily rather generalized, since soils vary greatly in their nutrient needs, but it will at least provide a basis on which to build a fertilizer program for a particular orchard.

Fertilizer applications during the first few years in the

orchard--the non-bearing years--are customarily small and frequent because of the limited extent in width and depth of the root systems. In humid regions, a mixed fertilizer is commonly used, with applications every 2 months. In general, fertilizers should be higher in nitrogen than in potash or phosphate. In arid regions, usually nitrogen only is applied, starting with 1 oz. per tree of sulphate of ammonia and increasing this by increments of 1 oz. at each of 3 applications a year during 4 years. It must be remembered that unless fertilizer is carried down to the roots by rain or irrigation water, it will not be available to the trees.

Where rain can be depended on, fertilizer should be spread evenly around trees, starting with an area equal to the diameter of the root system at planting and increasing the area steadily so that the amount of fertilizer per square foot remains about constant. When irrigation is the usual source of water, the fertilizer is best sprinkled in the furrow bottoms or spread evenly in the basin about each tree.

Bearing trees in humid regions should usually be fertilized 2 or 3 times a year, preferably at the beginning of each growth flush. A well balanced fertilizer containing nitrogen, phosphorus, potassium, and magnesium should be used initially, but as trees increase in age the phosphorus content may well decrease until trees over 10 years old receive none. The amount of fertilizer per tree will be increased, of course, as the trees grow larger and bear larger crops. When trees attain maturity, no further increase in fertilizer amount is indicated. Applications should be spread as evenly as possible from near the trunk out somewhat beyond the canopy drip line. With trees over 10 years old,

fertilizer may conveniently be spread by a mechanical distributor from one trunk to the other down the middle.

In arid regions, a single application is usual, made just beforethe principal flush or so as to be available at this time. Since nitrogen is usually the only nutrient needed under these conditions, any nitrogen source may be used, remembering that inorganic forms will be rapidly available while organic forms will need some months to become available. It is suggested that trees 5 years old be given ½ lb. actual nitrogen (for example, 2½ lbs. sulphate of ammonia), and the amount increased 1 oz. annually until 1 lb. actual N is provided. If animal manure is also being applied in the amount of several tons per acre, the nitrogen application can be somewhat less. If facilities are available for leaf analysis, a content of 2.5% N on a dry-weight basis indicates that adequate nitrogen is being supplied. Too much nitrogen is undesirable because of its effect in reducing fruit quality.

On sandy soils the grower must be sure the soil reaction (pH) is such as to assure availability of applied nutrients. For citrus trees, this means maintaining a reaction close to pH 6.0 in acid soils. Application of sulfur sprays or dusts for pest control, or of sulfate of ammonia as a source of nitrogen, are the practices most likely to make soils more acid, necessitating applications of lime to bring the soil up to pH 6 again. Without additions of sulfur, orchard soils tend only slowly to increase in acidity. When sulfur is being used, soil reaction should be checked annually; otherwise, once in 5 years should suffice.

Symptoms of deficiencies of nitrogen, potassium, phosphorus,

and magnesium should not occur in citrus trees which are properly fertilized. Deficiency of nitrogen results in decreased length of shoots and loss of green color in the leaves, the older ones becoming chlorotic before the new ones. There is no reliable symptom of phosphorus deficiency, and it has rarely been shown to exist except on certain muck soils, where very acid fruit with very thick rind was produced. Potassium deficiency also rarely causes distinctive leaf symptoms, the lack of this element being shown chiefly in decreased fruit size, very thin rind, and early fruit drop. Magnesium deficiency produces a characteristic chlorosis of leaves, which become progressively yellowed from the base upward on either side of the midrib until the whole leaf is golden-yellow. Grapefruit is more sensitive than orange to magnesium deficiency, and seedy varieties more than seedless. In severe cases, defoliation occurs. On soils where this deficiency is common, magnesium is always included in the fertilizer mixture. Dolomitic lime is often used instead of calcic lime to correct the reaction of acid soils, in order to supply magnesium also. Prompt correction of deficiency can be obtained by soil application of Epsom salt (magnesium sulfate) in a single application in quantities of 1 lb. Epsom salt for each 1 lb. of sulfate of ammonia.

Such heavy metal elements as iron, zinc, copper, and manganese are needed by orange trees in addition to the large amounts of more common nutrients. These micronutrient elements are supplied only when deficiency symptoms in leaves show their need.

Leaves of citrus trees deficient in iron show a fine network of green veins on a yellowish-green or yellow background, the symptoms appearing first in young leaves. The deficiency is most common on calcareous soils, especially marls, but may appear on acid soils high in copper. On most soils iron is readily available when applied as chelates, while application of iron in sprays does not usually correct the deficiency. On the marl soils only certain special chelates are effective.

Zinc deficiency is shown by irregular patches of yellow or white between broad, irregular areas of green along the main veins. This condition is called "mottle-leaf" or "frenching." Leaf size diminishes as the deficiency persists, and shoot length decreases, so that in severe cases of zinc deficiency the new flushes consist of clusters of small, nearly white leaves with green veining. This deficiency may occur on any soil type and is often difficult to correct by ~~soil~~ applications to the soil. ~~cations~~. Zinc is readily absorbed, however, from foliage sprays. When deficiency symptoms are evident, a spray of 3 lbs. zinc sulfate and 1 lb. hydrated lime in 100 gal. of water or an equivalent amount of zinc in a neutral form should be applied just before the bloom flush is made. Half of this concentration as an annual spray will prevent symptoms from appearing; or if zineb is used for rust mites, it will supply enough zinc so that maintenance sprays of zinc are not needed.

Manganese deficiency symptoms are somewhat intermediate between those for iron and zinc. The green bands along the veins are somewhat wider than the veins themselves, but are more

uniform in width than for zinc, and leaf size is not affected as it is with zinc deficiency. Usually the chlorotic interveinal areas are only light or yellowish green, and only in severe cases is fruitfulness affected. When manganese deficiency symptoms persist throughout the year, and do not disappear as leaves mature, correction can be made with a spray containing 3 lbs. manganese sulfate and 1½ oz. hydrated lime in 100 gal. of water. Manganese is more often deficient on calcareous than on acid soils; on the latter, soil applications are often effective, using 1 lb. of manganese sulfate for each 1 lb. of nitrogen in the annual program. However, manganese accumulates in the soil and may interfere with iron intake, so that regular addition of manganese to the fertilizer is not desirable. On calcareous soils, sprays are more effective than soil applications.

Copper deficiency, unlike that of the above three, does not show up as leaf chlorosis. The first symptom is development of vigorous, succulent, new shoots which become S-shaped. These soon die back from the tips, and lateral shoots which are thereby stimulated to develop also dieback, so that the tree has much dead brush. Both twigs and fruits characteristically develop gum pockets. Young trees on acid soils often show this deficiency, but it is rarely seen in bearing trees because the copper sprays commonly used for disease control supply adquate copper for growth. If symptoms appear, control is easily obtained by applying copper sulfate to the soil, adding to the fertilizer one-tenth as much copper sulfate as the nitrogen content. Copper accumulates in soils with unfavorable.

effects on iron availability, hence the use of copper in fertilizers should not be continued after need for it is no longer evident, and should never accompany spraying with copper.

Boron deficiency is not nearly so common as boron excess. The symptoms of deficiency are loss of green color in the veins of young leaves, which are often enlarged and split lengthwise, and small fruits with pockets of brown gum in the rind. Applications to the soil readily correct boron deficiency, but great care is needed because it is so easy to create a harmful excess. Borax may safely be applied once a year in the fertilizer program, using one-twentieth as much borax as the nitrogen content, but should never be applied unless need is shown. Damage from excess boron is common in arid regions. Leaves first become yellowed at the tip and sides, gradually becoming yellowed all over; in severe cases the new leaves are nearly white. A characteristic symptom is development on the lower leaf surface of rough, brownish, resinous eruptions. Correction of boron excess depends on leaching out the toxic salt, if possible, and disking into the soil 500 to 1000 lbs. per acre of hydrated lime to counteract the boron toxicity. Irrigation water must have less than 1 ppm of boron in order not to cause injury.

Pest control

Pests of citrus trees are many, and while some can be controlled by pesticide sprays, others cannot. Thus insects and mites are subject to spray control, fungus diseases sometimes are, but virus infections are rarely controlled by spraying and then only through control of insect vectors.

Fungus Diseases

Foot rot, or brown-rot gummosis, caused by one or more species of Phytophthora, is perhaps the commonest malady of cultivated citrus species in tropical America. It is a disease of the lower trunk and crown roots, occurring under conditions of constant high soil moisture, especially in low, heavy soils. The first symptom is dark, water-soaked bark near the soil line, followed by decay which eventually progresses from the bark into the wood. The bark dries out with age, shrinking so that there is a sharp line marking the boundary between diseased and healthy tissue. Formation of abundant gum is a common symptom, but foot rot is not the only disease characterized by gummosis. Badly diseased trees begin to die back as though girdled, especially if foot rot has extended more than half way around the tree. Prevention is the only satisfactory control, and is achieved by using resistant stocks. In areas of high rainfall, budding may need to be done 12 to 15 inches above the soil to prevent infection of the scion trunk by splashing raindrops. Some degree of control can be attained by removing the soil around the crown roots to leave a basin 1 ft. deep and 3 ft. across, and treating diseased roots by cutting away dead bark and applying Bordeaux paste. Drainage of low areas is helpful.

Melanose is a disease caused by Diaporthe citri, which seriously lowers the grade of oranges and grapefruit, as well as causing some dying of twigs, dropping of leaves, and stem-end rot of harvested fruit. Marketability is affected by unsightly lesions on the fruit, which are small, round, and sunken at first but eventually are raised postules, dark brown in

color, with the feel of sandpaper. They may be streaked down the sides of the fruit ("tear-stain"), crowded into areas so that scar tissues forms and cracks ("mud-cake"), or simply scattered over more or less of the fruit surface. Control is by spraying with neutral copper compounds at a dosage of 0.75 lb. metallic copper per 100 gal. of water. Timing is very important, the critical period for spraying being 2 to 3 weeks after petals have fallen.

Scab, caused by Elsinoë fawcetti, is a disease which lowers fruit grade. It also seriously distorts leaves at times, thus impairing their functioning. Grade is lowered by raised or warty areas on the surface of lemons, some mandarins, and Temples; while these protuberances sometimes occur on grapefruit, more often the lesions are only slightly raised scabs. The same copper sprays are effective as for melanose, but 2 applications are usually needed: the first, just before the bloom flush pushes out; the second, when most of the petals have fallen. If scab attacks are very light, only the first application may be required; if the disease was severe the previous season, the first application should be of double strength, 1½ lb. metallic copper per 100 gal. of water. Sweet orange is not attacked by common scab, but grapefruit, lemon, Temple, and satsuma are very susceptible.

Insects and Mites

Scales are the most damaging insects to citrus in most parts of tropical America, extracting sap from leaves, twigs, and fruits, and often defoliating trees when infestation is heavy. Purple scale (Lepidosaphes beckii) is commonly the most serious

of these pests; it is characterized by slender, club-shaped scales. It often causes death of twigs, and its infestations on fruit lower the grade. Florida red scale (Chrysomphalus aonidum), with circular, shield-like armor, is as damaging to leaves and fruit as purple scale, but does not kill twigs. Rufous or West Indian red scale (Selenaspidus articulatus) is serious in some countries, usually not in the same regions as Florida red. The scale coverings of these two are similar except that rufous scale is pale brown, while Florida red is reddish-purple. Snow scale (Unaspis citri) attacks only the trunk and limbs, not the leaves, and is a serious pest in northern South America and a minor pest in some other areas. The massed scales on the bark look like a coating of snow or white-wash. Cottony-cushion scale (Icerya purchasi) is only serious in western South America, and is distinguished by the large cottony abdomen full of eggs.

Good control can be obtained for all scales except cottony-cushion by spraying with oil emulsions containing 1.3% of actual oil, but oil sprays must not be used within 3 weeks of sulfur sprays, nor should they be applied when leaves are near wilting from high temperature. Malathion at 3 to 5 lbs. of 25% wettable powder in 100 gal. of water is effective for control of all scales. Introduction of the Vedalia ladybeetle has usually reduced damage by cottony-cushion scale to very minor proportions, and certain parasitic wasps of the genus Aphytis have done the same for purple and Florida red scales in Florida and California.

Whiteflies affect tree vigor by sucking sap from leaves, thus decreasing yields. The black sooty-mold fungus on leaves

and fruit is usually the result of whitefly infestation. Sprays for scales also control whiteflies. Blackfly is a very destructive form of whitefly, but less common.

Aphids feed chiefly on very young shoots and often stunt them severly. Young trees may be retarded in growth. Because aphids multiply rapidly, control measures must be taken promptly. Nicotine sulphate is a good control, using 1 pint of 40% solution plus ½ cup of any detergent in 100 gal. of water. Dusting with 1% lindane is also effective.

Rust mites decrease tree vigor and lower fruit grade by making the rind brown or "russeted." Heavily infested trees may drop most of their leaves. Since rust mites are difficult to see with the naked eye, the grower should inspect leaves frequently with a hand lens. Zineb affords good control when the spray contains 1 lb. per 100 gal. of water. Chlorobenzilate at ½ lb. of the 25% wettable powder per 100 gal. water is even more effective and may be combined with a copper spray, as zineb cannot be. Sulfur dust or wettable sulfur spray at 5 lbs. per 100 gal. are also effective, but sulfur changes soil reaction undesirably and reduces natural control more than most insecticides do.

Leaf-cutting ants are serious pests of citrus trees in many parts of the tropics. For control, a handful of 5-10% chlordane or aldrin should be dropped into the mouth of each active tunnel. A single treatment is rarely enough.

Fruitflies are also serious pests of citrus in many tropical countries. They do not injure trees, but the eggs laid in the fruits hatch into maggots which displease consumers. All kinds of citrus fruits are infested except acid limes and lemons. The

most promising control is by using poison-bait sprays, but this is effective only when carried out cooperatively over a large area. If a single orchard is sprayed while neighboring ones are not, very little benefit will result. A commonly used spray contains 1 lb. hydrolyzed yeast protein and 3 lbs. of 25% wettable powder malathion in 100 gal. of water. Spraying should be repeated every 2 weeks as long as fruitflies, as shown by traps, are present.

Viruses

Several virus infections are frequently present in citrus trees, most of them causing visible injury only when a particular root stock is employed. Tristeza virus of a virulent strain causes rapid decline in growth, and death within a few years, of sweet orange trees on sour orange stock. Scions from infected trees budded into Rough lemon, Cleopatra mandarin, or trifoliata produce healthy trees. Exocortis virus causes severe dwarfing, with excessive scaling of bark below the bud union, when infected scions are budded on trifoliata or Rangpur, but not on other common stocks. Xyloporosis virus adversely affects any trees budded on sweet lime, and Orlando tangelo budded on any stock. Psorosis virus is unique in being unrelated to root-stock, gradually causing decline and scaling of trunk bark in the top in every case. All of these viruses are chiefly transmitted by buds taken from infected trees, although if the proper insect (an aphid) for transmission is present, tristeza is spread by it from one tree to another. Rapidity of spread varies with the species of aphid. Selections of virus-free budwood must be made by technicians because it is difficult for growers to detect infection.

Nematodes

These microscopic worms are common in tropical soils, and some of them are serious pests of citrus trees. They feed on fine rootlets, greatly decreasing the ability of roots to take in water and nutrients. The citrus nematode (*Tylenchulus semipenetrans*) is found all over the world in regions where citrus trees have been grown for a long time, although it is not a serious problem everywhere. It is an important pest in California but a minor one in Florida. Trifoliata and citrange stocks are quite resistant to this nematode. Since it spreads very slowly, an important element in control is to prevent its introduction to new areas by assuring that nursery beds are free from infestation; nurseries should either be on new land or well-fumigated soil.

The burrowing nematode (*Radopholus similis*) has become a major pest in Florida but has not attacked citrus trees elsewhere although infesting a wide variety of other crops in many tropical countries. Research in Florida has discovered stocks resistant to this nematode; none of the commonly used ones is resistant.

Other Cultural Practices

In addition to fertilizing and spraying trees for pest control, the grower must devote much attention to soil management, irrigation, and pruning.

The soil on which an orchard is planted is an important part of the capital investment of a grower. How well he manages this capital has much to do with orchard profits. If the soil is initially well drained and fertile, he wishes to keep it

thus and must avoid practices which impair these qualities. If drainage is unsatisfactory at the outset, he must endeavor to improve it; drainage may be excessive or insufficient. He can do little to change soil depth, except as lowering the water table may increase this quantity.

Sandy soils are usually excessively well drained, if they possess desirable depth. The means of decreasing porosity and too rapid movement of water through the soil (which leaches mineral nutrients rapidly) is to incorporate large amounts of organic matter. This is usually done most economically by growing green-manure plants in the middles during the rainy season, or during part of the year when harvesting is not being done. Usually leguminous plants are preferred because they supply considerable amounts of nitrogen in the organic matter which results from their decomposition in the soil. Widely used examples include crotalarias, cowpeas, velvet beans, and lab-lab. These should be disked under before the stems have become woody.

Heavy soils are more of a problem. Green manures may improve soil structure so that clay soils drain more freely, but ~~the~~ plowing or disking operations may affect adversely the initially good drainage by making soil structure more compact. ~~tpolous, puddl~~

The same considerations apply to weed control, which is always an important item in orchard management because weeds compete seriously with trees for water and nutrients at certain times of year. Cultivation controls weeds satisfactorily on sandy soils, which have no structure to lose, but on clay soils cultivation may adversely affect structure. In California, weed control on heavy soils is largely effected through the use of herbicides which do not damage soil structure. Monuron has proved to be a much cheaper herbicide than diesel oil sprays which formerly were used.

Irrigation

Some regions where citrus fruits are grown have abundant, well-distributed rainfall, but most do not. Often there is a rainy season of 4 to6 months, followed by a dry season during which irrigation is essential. Some areas never have adequate rainfall at any season, so that irrigation is needed throughout the year. The real problem, providing water is available, is to know when to irrigate and how much water to apply. The soil should not become so dry that roots are unable to absorb water, causing permanent wilting of leaves; and yet, on the other hand, keeping soil too moist hinders root growth by excluding oxygen, and soil fungi which attack root and crown bark are favored.

On deep, sandy soils there is little danger of causing injury by over-watering, except as this makes necessary more fertilizer applications because of the high rate of leaching. At the first indications of temporary wilting, the orchard should be irrigated and the soil brought to a saturated condition. On heavy, slowly draining soils, there is the danger of using too much water. Such soils should never be saturated; only enough water should be applied to bring the soil moisture to an optimum at about 60% of saturation. Especially on shallow soils must irrigations be light and frequent.

Citrus trees do not need to be kept growing constantly, although limes can thus be treated. Most species need to have a period of slow growth to enable the food storage which will result in a heavy bloom. In subtropical areas this slowing of growth is brought about by low winter temperatures. In the tropics proper, withholding water is a means of doing this. When trees are making a new flush of growth, they need a steady

supply of water, but where the bloom flush normally comes at the beginning of the rainy season, it is well to allow trees to become a little thirsty in the preceding months. This does not mean, however, letting trees wilt permanently and drop their leaves.

Pruning

The annual renewal pruning customary with most deciduous fruits is not needed to promote heavy crops for citrus fruits. However, when trees crowd so that the branches on the sides shade each other, production falls off. If trees have clear space between them, pruning (except to remove watersprouts) is needed mainly for sanitary reasons. When vigorous sprouts arise on the trunk and push rapidly up through the canopy, they are a detriment to the tree. Eventually they will emerge above the canopy, slow down in growth rate, and begin to bear fruit, but only at the expense of previously bearing branches below them which are now shaded out. If there is an unfilled area in the canopy, due to removal of a large branch because of disease or wind, one or more watersprouts can be trained to fill this vacancy; otherwise, these should be removed as soon as their presence is noted.

Pruning of diseased or dead limbs is always desirable, to keep disease from spreading or the dead limbs from decaying back into the trunks. Ideally, even twigs and small branches killed by scales should be pruned out, as they quickly become infected by the melanose fungus and are a steady source of spores for fruit infection. This requires a great deal of hand labor,

and growers usually find it more economical to control melanose by spraying. In pruning a branch, it should always be cut flush with the trunk or larger branch from which it arises, so that no projecting stub is left. Large branches which are too heavy to be held in one hand should be cut one-third through on the lower side before cutting down from the upper side, to avoid tearing a strip of bark and wood from the supporting limb or trunk.

Branches in the lower part of the canopy may be pulled down by weight of fruit until fruit and twigs touch the ground. Such fruits are especially liable to attack by scales and they are almost impossible to spray. Furthermore, such low-hanging branches prevent free circulation of air around the lower trunk of the tree, thus promoting infection by foot rot. They should be pruned so that there is a foot of clear space (not three or four feet) between branches and ground.

When trees become so large that they crowd each other, pruning the sides to admit light will increase production. An aisle of clear space 4 or 5 feet across should be established, and the pruning repeated every few years so that the space is never closed. There is some temporary loss of fruit when pruning is done, but the next crop is usually larger. The best time for pruning is just after the bloom flush, but if it is delayed until later, it should be before another growth flush, to minimize the dieback which follows puuning. The sides should be pruned to be slightly narrower at the top than at the bottom. At the same time that the sides are being pruned, the top may be lowered. As the tree grows taller the difficulty and cost of spraying and harvesting become greater; furthermore, total

production is little more on a tree 30 feet high than on one of 20 feet.

Citrus orchards are being planted much more closely than formerly by many growers in Florida and California. Tree size is controlled by regular " hedging" of sides and top. The interior of large trees bears comparatively little fruit, since the periphery of the canopy receives most light and bears most of the crop. Hedged trees have a much higher proportion of their total volume on the periphery than trees usually do, and so the larger number of smaller trees produces larger crops with better color than in the usual type of culture. With large acreages, the cost of the mechanical hedging machines is very low on a per-tree basis.

Harvesting

Oranges should not be picked until they are properly mature, but in the tropics this condition is not easily determined by external appearance. Taste is the best criterion of maturity. Oranges decrease in acidity and increase in sugar content as they mature. When the sweetness and acidity are agreeably blended, the fruit is ready to be taken from the tree. In countries with large commercial production it has been necessary for government agencies to establish standards of maturity because growers could not be depended on to harvest only mature fruit. These standards are based on measurements of acid and soluble solids (nearly all sugar), with minimum ratio and minimum solids specified. Thus,in Florida sweet oranges must have 9.2% solids and a 9.4 ratio of solids to acid.

Harvesting of oranges requires care, even though the fruits seem to have a leathery rind which can stand rough treatment. Actually the rind is easily injured and the breaks give opportunity for decay organisms to enter. Care must also be taken not to "plug" oranges in picking, that is, not to let some of the rind around the stem be left on the tree with the stem, so that there is a hole through the rind at the stem end. Sometimes oranges can be pulled off the tree without "plugging" if the fruit is turned so that the pull is at right anles to the stem; if this is not successful, the orange should be carefully cut from the stem close to the fruit.

Harvested fruit should be washed to free it of dust and scales, and for commercial sales, graded as to size and blemishes. It will pay the grower to establish a reputation for marketing only fruit of dependable quality, internal and external.

THE CITRUS FRUITS

The cultivated citrus fruits had their origin in southern Asia, but they have long been established in subtropical and subtropical regions all over the world. In the American tropics they are the most popular of dessert fruits, preferred by people of all classes. And as everyone knows, they are of tremendous commercial importance, especially in subtropical parts of the United States, in Brazil, and in Argentina.

Commercial plantings of sweet oranges have been increasing rapidly in the strictly tropical zone. This development promises to involve not only large operators, but also many small growers as has been the case in the older commercial areas. Increased efficiency of production in tropical America will be attained mainly through experimentation and experience, but in addition, much can be learned by drawing upon the knowledge which has been acquired in other regions. Because Florida and California are close to the tropics and have developed an advanced citrus technology, they are valuable sources of information. When practices developed in those States are applied elsewhere, however, it must be borne in mind that the climate of California is colder and dryer than many parts of tropical America, and the soils of Florida are quite different.

Citrus fruits thrive in warm, moist climates. Where irrigation is available, dry climates are oftentimes excellent, especially for oranges. Cool weather improves color and quality of fruit. Grapefruit, however, is best when grown in regions where the weather is warm and moist throughout the year. This statement brings up a point which requires explanation: the matter of taste. Most Latin Americans prefer <u>sweet</u> fruits. The situation is not quite the same in world markets. Grapefruit grown on the Atlantic coast of Central America

reaches large size; it is very juicy; and mildly acid. At 4000 or 5000 feet it is so acid, and often so bitter, that it could not readily be sold in temperate zone markets. Oranges, on the other hand, attain highest color and quality at 3000 to 4000 feet in Central America, 5000 or 6000 near the Equator. It has been said, in fact, that "oranges produce their best fruit when pushed right up against the frost line." Many regions which are so cool in winter that trees are occasionally damaged by frost are famous for their oranges.

There is, of course, another side to the picture: the production of juice for canning and for concentrates. Here, dessert quality is not the only consideration. Navel oranges grown under irrigation in a cool dry climate are more delicious, but they do not produce as much juice as Valencias grown in a warm moist one.

THE SWEET ORANGE

To distinguish it from the sour or Seville orange, still an important fruit in some parts of the world, it is customary to call oranges which are eaten out of hand, or in processed form, sweet oranges. This is fair enough, for they belong to a different species (Citrus sinensis) from the sour orange, C. aurantium. Both species originated in the Assam-Burma region, but in prehistoric times passed into southern China where their present characteristics were formed. Later they were carried back beyond Burma to India (perhaps 3000 years ago) and thence to the eastern Mediterranean, about the first century A.D. The Arabs took sour oranges to Spain at an early date, but it appears that sweet ones were not grown in that country much more than a century before the time of Columbus. On his second voyage (1493) the Admiral called at the Canary Islands, where he picked up seeds of oranges and other useful plants. By 1526, Gonzalo Fernandez

de Oviedo assures us oranges, both sweet and sour, were fruiting on Santo Domingo, whence they had already spread to Tierra Firme (the South American mainland). Bernal Diaz de Castillo, who took part in the Conquest of Mexico, mentions with justifiable pride that he planted orange seeds on the Isthmus of Tehuantepec.

Varieties

Modern pomologists tend to classify sweet oranges in three groups: common oranges (such as Valencia and many varieties which resemble it closely); navel oranges (Washington or Bahia Navel and its strains or sub-varieties); and blood oranges (Ruby and a few others).

When grown in climates with cool winters (as in southern Spain) the blood oranges are characterized by red pigment in the flesh, which may even show through the skin in the form of a reddish blush. In tropical America deep red color, if it occurs at all, is very rarely seen. Blood oranges closely resemble Valencias in most respects, and even if they do not show any red color are fine fruits - considered by some authorities superior to Valencia in flavor.

Most seedling oranges in tropical America may be classified as belonging to the Valencia group. Often it takes an expert to tell whether a fruit he is asked to examine is from a grafted Valencia tree or a local seedling. There are minor differences, of course, but they are not always striking: size and form of fruit, flavor, and especially the number of seeds, usually there are quite a few more in a seedling fruit than in a grafted Valencia.

Navel oranges were described and figured as early as the seventeenth century. Apparently they were looked upon as freaks. The varieties which are cultivated today are of relatively recent origin. In the vicinity of Rio de Janeiro, Brazil, an orange is grown commercially which is known as Selecta. It is reputed to have been brought

long ago from the Portuguese island of São Tomé, off the West coast of Africa. Trees of this variety produce rather large fruits, somewhat oblate in form, and normal so far as concerns the production of seeds. But occasionally among these normal fruits will be found a seedless one with a more or less pronounced navel. It is not rare to find a number of such fruits on a single tree.

According to tradition, a horticulturist at Bahia (Sao Salvador) about the year 1820 took branchlets which produced these seedless fruits with navels and grafted them on young seedling trees - perhaps those of the sour orange, which has long been a favorite rootstock for citrus. Thus was established an interesting mutation, which when grown under favorable environmental conditions produces what is generally considered the most delicious dessert orange in the world. Presumably it was its seedlessness, however, rather than its quality, which first attracted attention.

It must not be assumed that all navel oranges grown today had their originaat the same time and the same place. There are many forms, often called strains, which have originated in modern times, due to the well-marked tendency of the Bahia navel orange to produce what are termed bud-mutations or bud-sports. Few other important horticultural fruits surpass it in this respect.

Washington Navel or Bahia Navel. Toward the end of the last century a small shipment of grafted trees of this variety was received by the U. S. Department of Agriculture at Washington. These trees came from Bahia, but when the variety came into bearing at Riverside, California it was given the name Washington, which has clung to it in the United States and most parts of tropical America. In Brazil it is known as laranja de ombigo (navel orange) but is associated with the place of origin. Wherever grown in tropical America it commends a higher price in local markets than any other orange - often more

than double the price of good local seedlings.

The fruits are round, large in size (usually more than 3 ins. in diameter), and characterized by seedlessness and the presence of the "navel" which is a small secondary ovary developed just inside the apex. Sometimes the navel is large, sometimes so protuding, that it detracts from the appearance of the fruit; sometimes it is so small as scarcely to be noticeable. The skin is thicker than that of many other oranges; this depends to a certain degree on environmental conditions, as does the color and flavor of the fruit. In short, Washington Navel is not nearly so adaptable to a wide range of climates as numerous other varieties. Grown at low elevations in the tropics, it lacks the brilliant orange color which it attains at higher ones, and quality is poor. Furthermore, at low elevations crops are small. At higher ones they are fair, but not as heavy as those produced by varieties of the Valencia group. In Central America, it can be said that the best zone for Washington Navel lies between 3000 and 4000 feet.

Numerous bud mutations have been propagated by nurserymen, several of which are claimed to be superior to the type in some particular respect. Not much experience with these has been accumulated in tropical America, where commercial plantations have been based on what has been considered the typical or standard Washington Navel. The Robertson Navel of California, Summerfield Navel and Dream Navel of Florida, and Araras Bahianinha of Brazil are worth testing widely in tropical America.

It is highly important to choose budwood carefully when propagating navel oranges. This practice was established in California by A.D. Shamel and his associates; it consists in selecting budwood from branchlets which produce ideal fruits, with special attention to

reducing the percentage of navels which are objectionably large.

Valencia. This is the most important orange variety in the world - the standard late orange everywhere. It tends to be considerably smaller than Washington Navel, but it is juicy and of excellent flavor. Typically there are only three to six seeds in a fruit. The tree is very productive; it is completely successful at all elevations from sea level to 5000 feet in Central America, 6000 or even higher near the Equator. It is noteworthy that most of the major producing regions - for oranges of this type - are not at sea level, but at 3000 to 4000 feet in Guatemala, 5000 to 6000 feet in Colombia. Highest quality is developed in regions with cool nights.

Pineapple. This is a mid-season orange of fine quality and good yield. The fruits are round or slightly flattened, medium in size, deep orange in color if temperatures are favorable, sweet and somewhat distinctive in flavor - whence the name pineapple, perhaps, though the resemblance is slight. This variety has proved very popular in Central America, in spite of the fact that it has more seeds (10-20) than any other important commercial orange.

Hamlin , the standard early orange in Florida, has done well in Central America. It is almost seedless (2-5) and yields good crops of fruit quite similar to Valencia in quality. Jaffa is another good variety which has done well in tropical America. Hamlin, Pineapple and Jaffa lengthen the orange season - they all mature earlier than Valencia.

Temple. Although it is commonly sold as an orange, (it is really a tangor, orange-tangerine hybrid) this variety is of unusually high quality, in fact it is considered a fancy fruit. It is roundish-oblate, medium in size, deep orange in color when grown in a cool climate. It has not yet been tested extensively in tropical America.

Nucellar Seedlings

There is a characteristic of the orange and other citrus fruits (with exception of the pummelo or shaddock, rarely grown in Tropical America) which is of great horticultural importance. This is the production of what are technically known as nucellar seedlings. It is due to this phenomenon that seedling orange trees may be so much alike, not only in growth and productivity, but also in fruit characters. Oranges harvested from a hundred - or a thousand - trees in any particular region will be just about as uniform in character as those from an equal number of grafted Valencias.

Nucellar embryos arise in the following manner: after the flower has been pollinated and the ovule has been fertilized, buds develop in the tissues surrounding the embryo - the nucellus. Since these are not the result of fertilization of the ovule, but are in reality parts of the mother plant, they reproduce the characteristics of the latter just as is the case when buds or scions are used in grafting. Several of these nucellar buds may develop in a single seed. They commonly crowd out the embryo which has resulted from the fertilized ovule - the embryo which would develop into a tree not exactly like its parent. This variation is familiar to those who have planted avocado seeds - or seeds of many other fruits which have been improved by man through selection or mutation.

Of course an occasional fertilized ovule does develop into a tree, and of course trees from nucellar seedlings may give rise to new horticultural varieties through mutation. In modern times grafting has superseded the use of seedling trees in those regions where there is extensive commercial cultivation on an orchard basis. Though seedlings ultimately attain a larger size than grafted trees, the advantages of grafting are several: production at an early age,

and the use of rootstocks which give resistance to unfavorable soil conditions and certain diseases. Nucellar seedlings are of great value in connection with nursery work, assuring a high degree of uniformity among seedling rootstocks; they have also been useful in connection with the development of virus-free strains of fruits, since viruses are not usually transmitted through seeds.

Rootstocks

Choice of the rootstock for budding (or bud-grafting) is one of the most important decisions that the orange grower is called on to make. Stocks differ in their adaptation to soil conditions--drainage, texture, pH. value--and to various pests--fungi, insects, and viruses. No one stock is best under all conditions, and under the same conditions, a stock which is best for one kind of citrus fruit may not be best for another. The stocks most commonly used for oranges are: Rough lemon, sour orange, Cleopatra mandarin, sweet orange, Rangpur lime, trifoliate-orange, and citranges. All of these produce high percentages of seedlings which are very uniform.

Rough lemon (C. jambhiri or C. limon) is best adapted to deep, well-drained, sandy soils, on which it produces larger trees in a given time than other stocks. However, it produces fruit inferior in quality to that of the other common stocks. This is not usually of great significance except with some orange hybrids. In Florida and South Africa it is the leading stock.

Sour orange (C. aurantium) was until recently the preferred stock for low, poorly drained soils, under these conditions it produces fruit of high quality on long-lived trees. Probably most budded trees in tropical America (except Brazil) are on this stock. This is true also in Spain, Italy, and California. Unfortunately, many orange trees are symptomless carriers of the tristeza virus, and when scions

of such trees are budded on sour orange, the trees may die rather quickly. This happened in Brazil on a disastrous scale. If scions free of virus are available and no virus-infected trees are in the vicinity from which tristeza can be transmitted by aphids, sour orange stocks are still recommended.

Cleopatra mandarin (C. reshni or C. reticulata) has been much used, ever since tristeza virus became a problem, for stocks on soils where sour orange was formerly employed. It has all of the good qualities of that stock except that growth of the trees in early years is sometimes slower, but it is resistant to tristeza. On deep sandy soils, Cleopatra is preferred to Rough Lemon for certain orange hybrids.

Sweet orange (C. sinensis) stock produces trees of good size with fruit of good quality on soils where foot rot (gummosis) is not a problem. Foot rot is the most serious citrus disease in many parts of tropical America.

Rangpur lime (C. limonia) has been used extensively in Brazil to replace sour orange stocks killed by tristeza. This stock, resistant to gumming diseases on low, moist soils, dwarfs trees budded upon it if they carry the exocortis virus.

Trifoliate-orange (Poncirus trifoliata) seedlings are highly resistant to gumming, tristeza, and xyloporosis, but very susceptible to exocortis virus, which causes severe dwarfing. On heavy soils, if the scions used do not carry exocortis, it has advantages. Fruit quality is good on this stock, however, it is not suited to strictly tropical climates.

Citranges are hybrids between trifoliate-orange and sweet orange. They have trifoliate leaves like the Poncirus parent. Several have been tested as stocks in California and Florida, and one of them--

Troyer-- is being used to a certain extent. It is outstanding in resistance to footrot and cold, and in production of vigorous, high-yielding trees if the scions are free from exocortis virus. It merits testing widely in tropical America, although its cold-hardiness is of value only in the subtropics.

Propagation

In commerical nurseries, citrus trees are almost always propagated by budding(bud-grafting), the common shield- or T-bud, generally being used. Grafting (scion-grafting) is successful but much slower and more troublesome to perform and is used only in topworking old trees. Even in such cases, it is usually best to cut back large limbs and bud the sprouts, rather than to graft directly into the cut limbs.

Budsticks should be of well-rounded, well-matured wood, of next to the last flush of growth. It is highly important that the budwood be free of virus infection.

Seedling stocks are usually grown in two stages. First, fresh, plump seeds are sown thickly in a seedbed where they can be watered as needed and protected from ants. When the seedlings are about ¼ inch in diameter at the base, they are transplanted into the nursery where they are spaced 1 ft. apart in rows 3 ft. apart. Most of the seedlings will be similar in size; those markedly larger or smaller should be discarded. In both seedbed and nursery row, the seedlings should be kept growing vigorously by light applications of well-balanced fertilizer and by irrigation where necessary. When the seedlings are about ⅜ inch in diameter, they should be budded.

As soon as it is certain that the buds have united well with the stocks, the latter should be "lopped" that is, cut nearly through a few inches above the buds, and the tops bent over to the ground.

Tops from adjacent rows should be laid in the common middle. Lopping will stimulate the buds to start growth. When they have grown to 6 or 8 in., the stock is pruned off cleanly by a slanting cut just above the bud. After the bud has attained a diameter above the union of 5/8 inch or more, the young trees are ready to be set out in the orchard.

Orange trees should have low heads, with not over 20 inches of trunk below the main branches. Heading too high is a common mistake in citrus orchards of tropical America. High heads increase the cost and effort of spraying, pruning, and harvesting, with no compensating benefits. Only in areas of high rainfall, where having a trunk clear of limbs for 3 feet may decrease gummosis problems by providing better air circulation, is a high head advantageous. Single-trunked trees are greatly to be preferred, and no trunk sprouts should be allowed to develop below a height of 16 inches from the ground. Good nursery trees are usually unbranched when transplanted to the orchard and are topped at 2 feet from the ground to assure formation of scaffold branches below this height. If trees are already branched, the trees are topped as above, the laterals headed back to a length of 6 inches, and any branches below a height of 16 inches pruned cleanly away.

Transplanting

Transplanting to the field should be done when the young budded trees are not in an active flush of growth. Since much of the root system is necessarily lost in digging, the top is pruned back, as above suggested, to balance the roots. Of utmost importance in transplanting is preventing the roots from drying, and it is very helpful to protect the tops to decrease loss of moisture from the remaining leaves.

The site chosen for the orchard should be well drained. It should

be cleared of trees and brush, and made smooth of sufrace well before planting time. It is desirable to ascertain the soil reaction and, if practicable, to adjust it to about pH 6 if the soil is more acid than this. If the slope of the ground is so great that erosion is likely to be troublesome, contours should be laid out and trees planted either along contour lines on the slope, or in case of steeper slopes, on terrace beds.

There are several planting systems available, but the rectangular system, and especially the square, is most often used because it is the simplest and most convenient. If regular pruning to control size is planned, however, it is desirable to space trees closely in rows and provide wider spaces between rows, so that machinery can pass. In humid regions, a spacing for orange trees of 25 by 25 feet is very satisfactory for usual methods of culture, giving 70 trees per acre; in arid regions closer spacing to give 100 trees per acre is often practical. The area should be carefully staked before planting begins.

In transplanting, the trees should be set so that they are at the same depth as they were in the nursery row, or slightly higher if the ground is nearly levelaand water drains away slowly. The roots of the nursery tree should be spread out naturally, and the backfilled soil washed in among them so that no air pockets are left. A ring of soil about 3 feet in diameter around the planted tree helps to prevent applied water from running off. About 10 gallons of water per tree is considered an average requirement at planting time. During the first year after planting, the scanty root system makes it necessary to provide irrigation whenever there is a period of 2 or 3 weeks without rainfall.

Fertilizing

It is highly desirable that a grower learn as quickly as he can what fertilizer is needed for his soil, for otherwise he may either waste money on elements not needed or deprive his trees unintentionally of needed elements. The following discussion is necessarily rather generalized, since soils vary greatly in their nutrient needs, but it will at least provide a basis on which to build a fertilizer program for a particular orchard.

Fertilizer applications during the first few years in the orchard--the non-bearing years--areccustomarily small and frequent because of the limited extent in width and depth of the root systems of the young trees. In humid regions, a mixed fertilizer is commonly used, with applications every 2 months. In general, fertilizers should be higher in nitrogen than in potash or phosphate. In arid regions, usually nitrogen only is applied, starting with 1 oz. per tree of sulphate of ammonia and increasing this by 1 oz. at each of 3 applications a year for 4 years. It must be remembered that unless fertilizer is carried down to the roots by rain or irrigation water, it will not be available to the trees.

Where rain can be depended on, fertilizer should be spread evenly around trees, starting with an area equal to the diameter of the root system at planting and increasing the area steadily so that the amount of fertilizer per square foot remains about constant. When irrigation is the usual source of water, the nitrogen is best sprinkled in the furrow bottoms or spread evenly in the basin about each tree.

Bearing trees in humid regions should usually be fertilized 2 or 3 times a year, preferably at the beginning of each growth flush. A well balanced fertilizer should be used initially, but as trees increase in age the phosphorus content may well decrease until trees over 20

years old receive none. The amount of fertilizer per tree will be increased, of course, as the trees grow larger and bear larger crops. When trees attain maturity, no further increase in fertilizer amount is indicated. Applications should be spread as evenly as possible from near the trunk out somewhat beyond the canopy drip line. With trees over 10 years old, fertilizer may conveniently be spread by a mechanical distributor from one trunk to the other down the middles.

In arid regions, a single application is usual, made just before the principal flush or so as to be available at this time. Since nitrogen is usually the only nutrient needed under these conditions, any nitrogen source may be used, remembering that inorganic forms will be rapidly available while organic forms will need some months to become available. It is suggested that trees 5 years old be given ½ lb. actual nitrogen(for example, 2½ lbs. sulphate of ammonia), and the amount increased 1 oz. annually until 1 lb. actual N is provided. If manure is also being applied in the amount of several tons per acre, the nitrogen application can be somewhat less. If facilities are available for leaf analysis, a content of 2.5% N on a dry-weight basis indicates that adequate nitrogen is being supplied. Too much nitrogen is undesirable because of its effect in reducing fruit quality.

On sandy soils the grower must be sure the soil reaction (pH) is such as to assure availability of applied nutrients. For citrus trees, this means maintaining a reaction close to pH 6.0 in acid soils. Application of sulfur sprays or dusts for pest control, or of sulfate of ammonia as a source of nitrogen, are the practices most likely to make soils more acid, necessitating applications of lime to bring the soil up to pH 6 again. Without additions of sulfur, orchard soils tend only slowly to increase in acidity. When sulfur

is being used, soil reaction should be checked annually; otherwise, once in 5 years should suffice.

Symptoms of deficiencies of nitrogen, potassium, phosphorus, and magnesium should not occur in citrus trees which are properly fertilized. Deficiency of nitrogen results in decreased length of shoots and loss of green color in the leaves, the older ones becoming chlorotic before the new ones. There is no reliable symptom of phosphorus deficiency, and it has rarely been shown to exist except on certain muck soils, where very acid fruit with very thick rind was produced. Potassium deficiency also rarely causes distinctive leaf symptoms, the lack of this element being shown chiefly in decreased fruit size, very thin rind, and early fruit drop. Magnesium deficiency produces a characteristic chlorosis of leaves, which become progressively yellowed from the base upward on either side of the midrib until the whole leaf is golden-yellow. Grapefruit is more sensitive than orange to magnesium deficiency, and seedy varieties more than seedless. In severe cases, defoliation occurs. On soils where this deficiency is common, magnesium is always included in the fertilizer mixture. Dolomitic lime is often used unstead of calcic lime to correct the reaction of acid soils in order to supply magnesium. Prompt correction of deficiency can be obtained by soil application of Epsom salt (magnesium sulfate) in a single application in quanities of 1 lb. Epsom salt for each 1 lb. of sulfate of ammonia.

Such heavy metal elements as iron, zinc copper, and manganese are needed by orange trees in addition to the large amounts of more common nutrients. These micronutrient elements are supplied only when deficiency symptoms in leaves show their need.

Leaves of citrus trees deficient in iron show a fine network of green veins on a yellowish-green or yellow background, the symptoms

appearing first in young leaves. The deficiency is most common on calcareous soils, especially marls, but may appear on acid soils high in copper. On most soils iron is readily available when applied as chelates, while application of iron as sprays does not usually correct the deficiency. On marl soils only certain special chelates are effective.

Zinc deficiency is shown by irregular patches of yellow or white between broad, irregular areas of green along the main veins. This condition is called "mottle-leaf" or "frenching." Leaf size diminishes as the deficiency persists, and shoot length decreases, so that in severe cases of zinc deficiency the new flushes consist of clusters of small, nearly white leaves with green veining. This deficiency may occur on any soil type and is often difficult to correct by surface applications. Zinc is readily absorbed, however, from foliage sprays. When deficiency symptoms are evident, a spray of 3 lbs. zinc sulfate and 1 lb. hydrated lime in 100 gal. of water should be applied just before the bloom flush is made. Half of this concentration as an annual spray will prevent symptoms from appearing; or if zineb is used for rust mites, it will supply enough zinc so that maintenance sprays of zinc are not needed.

Manganese deficiency symptoms are somewhat intermediate between those for iron and zinc. The green bands along the veins are somewhat wider than the veins themselves, but are more uniform in width than for zinc, and leaf size is not affected as it is with zinc deficiency. Usually the chlorotic interveinal areas are only light or yellowish green, and only in severe cases is fruitfulness affected. When manganese deficiency symptoms persist throughout the year, and do not disappear as leaves mature, correction can be made with a spray containing 3 lbs. manganese sulfate and 1½ oz. hydrated lime in 100 gal.

of water. Manganese is more often deficient on calcareous than on acid soils; on the latter, soil applications are often effective, using 1 lb. of manganese sulfate for each 1 lb. of nitrogen in the annual program. However, manganese accumulates in the soil and may interfere with iron intake, so that regular addition of manganese to the fertilizer is not desirable.

Copper deficiency, unlike that of the above three, does not show up as a leaf chlorosis. The first symptom is development of vigorous, succulent, new shoots which become S-shaped. These soon die back from the tips, and lateral shoots which are thereby stimulated to develop also die back, so that the tree has much dead brush. Both twigs and fruits characteristically develop gum pockets. Young trees on acid soils often show this deficiency, but it is rarely seen in bearing trees because the copper sprays commonly used for disease control supply adequate copper for growth. If symptoms appear, control is easily obtained by applying copper sulfate to the soil, adding to the fertilizer one-tenth as much copper sulfate as the nitrogen content. Copper accumulates in soils with unfavorable effects on iron availability, hence the use of copper in fertilizers should not be continued more than a few years.

Boron deficiency is not nearly so common as boron excess. The symptoms of deficiency are loss of green color in the veins of young leaves, which are often enlarged and split lengthwise, and small fruits with pockets of brown gum in the rind. Applications to the soil readily correct boron deficiency, but great care is needed because it is so easy to create a harmful excess. Borax may safely be applied once a year in the fertilizer program, using one-twentieth as much borax as the nitrogen content, but should never be applied unless need is shown. Damage from excess boron is common in arid regions. Leaves first become yellowed at the tip and sides, gradually

becoming yellowed all over; in severe cases the new leaves are nearly white. A characteristic symptom is development on the lower leaf surface of rough, brownish, resinous eruptions. Correction of boron excess depends on leaching out the toxic salt, if possible, and disking into the soil 500 to 1000 lbs. per acre of hydrated lime to counteract the boron toxicity. Irrigation water must have less than 1 ppm of boron in order not to cause injury.

Pest control

Pests of citrus trees are many, and while some can be controlled by pesticide sprays, others cannot. Thus insects and mites are subject to spray control, ffungus diseases sometimes are, but virus infections are rarely controlled by spraying.

Fungus Diseases

Foot rot, or brown-rot gummosis, caused by one or more species of Phytophthora, is perhaps the commonest malady of cultivated citrus species in tropical America. It is a disease of the lower trunk and crown roots, occurring under conditions of constant high soil moisture, especially in low, heavy soils. The first symptom is dark, water-soaked bark near the soil line, followed by decay which eventually progresses from the bark into the wood. The bark dries out with age, shrinking so that there is a sharp line marking the boundary between diseased and healthy tissue. Formation of abundant gum is a common symptom, but foot rot is not the only disease characterized by gummosis. Badly diseased trees begin to die back as though girdled, especially if foot rot has extended more than half way around the tree. Prevention is the only satisfactory control, and is achieved by using resistant stocks. In areas of high rainfall, budding may need to be done 12 to 15 inches above the soil to prevent infection of the scion trunk by splashing raindrops. Some degree of control can be attained

by removing the soil around the crown roots to leave a basin 1 ft. deep and 3 ft. across, and treating diseased roots by cutting away dead bark and applying Bordeau to paste. Drainage of low areas is helpful.

Melanose is a disease caused by Diaporthe citri, which seriously lowers the grade of oranges and grapefruit, as well as causing some dying of twigs, dropping of leaves, and stem-end rot of harvested fruit. Marketability is affected by unsightly lesions on the fruit, which are small, round, and sunken at first but eventually are raised pustules, dark brown in color, with the feel of sandpaper. They may be streaked down the sides of the fruit ("tear-stain"), crowded into areas so that scar tissue forms and cracks ("mud-cake"), or simply scattered over more or less of the fruit surface. Control is by spraying with neutral copper compounds at a dosage of 0.75 lb. metallic copper per 100 gal. of water. Timing is very important, the critical period for spraying being 2 to 3 weeks after petals have fallen.

Scab, caused by Elsinoe fawcetti, is a disease which lowers fruit grade. It also seriously distorts leaves at times, thus impairing their functioning. Grade is lowered by raised or warty areas on the surface of lemons, some mandarins, and Temples; while these protuberances sometimes occur on grapefruit, more often the lesions areconly slightly raised scabs. The same copper sprays are effedtive as for melanose, but 2 applications should be made. The first, just before the bloom flush pushes out, should be of double the strength (1.4 lb. metallic copper) of the melanose spray. The second, made when most of the petals have fallen, should be of single strength. Sweet orange is not attacked by common scab, but grapefruit, lemon, Temple, and Satsuma are very susceptible.

Insects and Mites

Scales are the most damaging insects to citrus in most parts of tropical America, extracting sap from leaves, twigs, and fruits, often defoliating trees when infestation is heavy. Purple scale (Lepidosaphes beckii) is usually the most serious of these pests; it is characterized by slender, club-shaped scales. It often causes death of twigs, and its infestations on fruit lower the grade. Florida red scale (Chrysomphalus aonidum), with circular, shield-like armor, is as damaging to leaves and fruit as purple scale, but does not kill twigs. Rufous or West Indian red scale (Selenaspidus articulatus) is serious in some countries, usually not in the same regions as Florida red. The scale coverings of these two are similar except that rufous scale is pale brown, while Florida red is reddish-purple. Snow scale (Unaspis citri) attacks only the trunk and limbs, not the leaves, and is a serious pest in northern South America and a minor pest in some other areas. The massed scales on the bark look like a coating of snow or white-wash. Cottony-cushion scale (Icerya purchasi) is only serious in western South America, and is distinguished by the large cottony abdomen full of eggs.

Good control can be obtained for all scales except cottony-cushion by spraying with oil emulsions containing 1.3% of actual oil, but oil sprays must not be used within 3 weeks of sulfur sprays, nor should they be applied when leaves are near wilting from high temperature. Malathion at 3 to 5 lbs. of 25% wettable powder in 100 gal. of water is effective for control of scales. Introduction of the Vedalia ladybeetle has usually reduced damage by cottony-cushion scale to very minor proportions, and certain parasitic wasps of the genus Aphytis have done the same for purple and Florida red scales in Florida and California.

Whiteflies lower tree vigor by sucking sap from leaves, thus decreasing yields. The black sooty-mold fungus on leaves and fruit is usually the result of whitefly infestation. Sprays for scales also control whiteflies. Blackfly is a similar insect but less common.

Aphids feed chiefly on very young shoots and often stunt them severely. Young trees may be retarded in growth. Because aphids multiply rapidly, control measures must be taken promptly. Nicotine sulphate is a good control, using 1 pint of 40% solution plus ½ cup of any detergent in 100 gal. of water. Dusting with 1% lindane is also effective.

Rust mites decrease tree vigor and lower fruit grade by making the rind brown or "russeted." Heavily infested trees may drop most of their leaves. Since rust mites are difficult to see with the naked eye, the grower should inspect leaves frequently with a hand lens. Zineb affords good control when the spray contains 1 lb. per 100 gal. of water. Sulfur dust or wettable sulfur spray at 5 lbs. per 100 gal. are also effective, but sulfur changes soil reaction undesirably.

Leaf-cutting ants are serious pest of citrus trees in many parts of the tropics. For control, a handful of 5-10% chlordane or aldrin should be dropped into the mouth of each active tunnel. A single treatment is rarely enough.

Fruitflies are also serious pest of citrus in many tropical countries. They do not injure trees, but the eggs laid in the fruits hatch into maggots which displease consumers. All kinds of citrus fruits are infested except acid limes and lemons. The most promising control is by using poison-bait sprays, but this is effective only when carried out cooperatively over a large area. If a single orchard is sprayed while neighboring ones are not, very little benefit will result. A commonly used spray contains 1 lb. hydrolyzed yeast protein and 3 lbs. of 25% wettable powder malathion in 100 gal. of water.

Spraying should be repeated every 2 weeks as long as fruitflies, as shown by traps, are present.

Viruses

Several virus infections are frequently present in citrus trees, most of them causing visible injury only when a particular stock is employed. Tristeza virus of a virulent strain causes rapid decline in growth, and death within a few years, of sweet orange trees on sour orange stock. Scions from infected trees budded into rough lemon, Cleopatra mandarin, or trifoliata produce healthy trees. Exocortis virus causes severe dwarfing, with excessive scaling of bark below the bud union, when infected scions are budded on trifoliata or Rangpur, but not on other common stocks. Xyloporosis virus adversely affects any trees budded on sweet lime, and Orlando tangelo budded on any stock. Psorosis virus is unique in being unrelated to rootstock, gradually causing decline and scaling of trunk bark in the top in every case. All of these viruses are chiefly transmitted by buds taken from infected trees, although if the proper insect (an aphid) for transmission is present, tristeza is spread by it from one tree to another. Selections of virus-free budwood must be made by technicians because it is difficult for growers to detect infection.

Nematodes

These microscopic worms are common in tropical soils, and some of them are serious pests of citrus trees. They feed on fine rootlets, greatly decreasing the ability of roots to take in water and nutrients. The citrus nematode (Tylenchulus semipenetrans) is found all over the world in regions where citrus trees have been grown for a long time, although it is not a serious problem everywhere. It is an important pest in California but a minor one in Florida. Trifoliata and citrange stocks are quite resistant to this nematode. Since it spreads very slowly, an important element in control is to

prevent its introduction to new areas by assuring that nursery beds are free from infestation; nurseries should either be on new land or well-fumigated soil.

The burrowing nematode (Radopholus similis) has become a major pest in Florida but has not attacked citrus trees elsewhere although infesting a wide variety of other crops in many tropical countries. Research in Florida has discovered stocks resistant to this nematode; none of the commonly used ones is resistant.

Other Cultural Practices

In addition to fertilizing and spraying trees for pest control, the grower must devote much attention to soil management, irrigation, and pruning.

The soil on which an orchard is planted is an important part of the capital investment of a grower. How well he manages this capital has much to do with orchard profits. If the soil is initially well drained and fertile, he wishes to keep it thus and must avoid practices which impair these qualities. If drainage is unsatisfactory at the outset, he must endeavor to improve it; drainage may be excessive or insufficient. He can do little to change soil depth, except as lowering the water table may increase this quantity.

Sandy soils are usually excessively well drained, if they possess desirable depth. The means of decreasing porosity and too rapid movement of water through the soil (which leaches mineral nutrients rapidly) is to incorporate large amounts of organic matter. This is usually done most economically by growing green-manure plants in the middles during the rainy season, or during part of the year when harvesting is not being done. Usually leguminous plants are preferred because they supply considerable amounts of nitrogen in the organic matter which results from their decomposition in the soil. Widely used

examples include crotalarias, cowpeas, velvet beans, and lab-lab. These should be disked under before the stems have become woody.

Heavy soils are more of a problem. Green manures may improve soil structure so that clay soils drain more freely, but the plowing or disking operations may affect adversely the initially good drainage by making soil structure more compact. The same considerations apply to weed control, which is always an important item in orchard management because weeds compete seriously with trees for water and nutrients at certain times of year. Cultivation controls weeds satisfactorily on sandy soils which have no structure to lose, but on clay soils cultivation may adversely affect structure. In California, weed control in citrus groves on heavy soils is largely done by use of herbicides which have no effect on the soil. Monuron has proved a much cheaper herbicide than diesel oil sprays which formerly were used.

Irrigation

Some regions where citrus fruits are grown have abundant, well-distributed rainfall, but most do not. Often there is a rainy season of 4 to 6 months, followed by a dry season during which irrigation is essential. Some areas never have adequate rainfall at any season, so that irrigation is needed throughout the year. The real problem, providing water is available, is to know when to irrigate and how much water to apply. The soil should not become so dry that roots are unable to absorb water, causing permanent wilting of leaves; and yet, on the other hand, keeping soil too moist hinders root growth by excluding oxygen, and soil fungi which attack root and crown bark are favored.

On deep, sandy soils there is little danger of causing injury by over-watering, except as this makes necessary more fertilizer

applications because of the high rate of leaching. At the first indications of temporary wilting, the orchard should be irrigated and the soil brought to a saturated condition. On heavy, slowly draining soils, there is the danger of using too much water. Preferably, such soils should never be saturated; only enough water should be applied to bring the soil moisture to an optimum at about 75% of saturation. Especially on shallow soils must irrigations be light and frequent.

Citrus trees do not need to be kept growing constantly, although limes can thus be treated. Most species need to have a period of slow growth to enable the food storage which will result in a heavy bloom. In subtropical areas this slowing of growth is brought about by low winter temperatures. In the tropics proper, withholding water is a means of doing this. When trees are making a new flush of growth, they need a steady supply of water, but where the bloom flush normally comes at the beginning of the rainy season, it is well to allow trees to become a little thirsty in the preceding months. This does not mean, however, letting trees wilt permanently and drop their leaves.

Pruning

The annual renewal pruning customary with most deciduous fruits is not needed to promote heavy crops for citrus fruits. However, when trees crowd so that the branches on the sides shade each other, production falls off. If trees have clear space between them, pruning (except to remove watersprouts) is needed mainly for sanitary reasons. When vigorous sprouts arise on the trunk and push rapidly up through the canopy, they are a detriment to the tree. Eventually they will emerge above the canopy, slow down in growth rate, and begin to bear fruit, but only at the expense of previously bearing branches below

them which are now shaded out. If there is an unfilled area in the canopy, due to removal of a large branch because of disease or wind, one or more watersprouts can be trained to fill this vacancy; otherwise, these should be removed as soon as their presence is noted.

Pruning of diseased or dead limbs is always desirable, to keep disease from spreading or the dead limbs from decaying back into the trunks. Ideally, even twigs and small branches killed by scales should be pruned out, as they quickly become infected by the melanose fungus and are a steady source of spores for fruit infection. This requires a great deal of hand labor, and growers usually find it more economical to control melanose by spraying. In pruning a branch, it should always be cut flush with the trunk or larger branch from which it arises, so that no projecting stub is left. Large branches which are too heavy to be held in one hand should be cut one-third through on the lower side before cutting down from the upper side, to avoid tearing a strip of bark and wood from the supporting limb or trunk.

Branches in the lower part of the canopy may be pulled down by weight until fruit and twigs touch the ground. Such fruits are especially liable to attack by scales and they are almost impossible to spray. Furthermore, such low-hanging branches prevent free circulation of air around the lower trunk of the tree, thus promoting infection by footrot. They should be pruned so that there is a foot of clear space (not three or four feet) between branches and ground.

When trees become so large that they crowd each other, pruning the sides to admit light will increase production. An aisle of clear space 4 or 5 feet across should be established, and the pruning repeated every few years so that the space is never closed. There is some temporary loss of fruit when pruning is done immediately after the current crop is harvested. At the same time that the sides are

being pruned, the top may well be lowered. As the tree grows taller the difficulty and cost of spraying and harvesting become greater; furthermore, total production is little more on a tree 30 feet high than on one of 20 feet.

By many growers in Florida and California, citrus orchards are being planted much more closely than formerly. Tree size is controlled by regular "hedging" of sides and top. The interior of large trees bear comparatively little fruit, since the periphery of the canopy receives most light and bears most of the crop. Hedged trees have a much higher proportion of their total area on the periphery than trees usually do, hence the larger number of smaller trees produces larger crops with better color than in the usual type of culture. With large acreages, the cost of the mechanical hedging machines is very low on a per-tree basis.

Harvesting

Oranges should not be picked until they are properly mature, but in the tropics this condition is not easily determined by external appearance. Taste is the the best criterion of maturity. Oranges decrease in acidity and increase in sugar content as they ripen. When the sweetness and acidity are agreeably blended, the fruit is ready to be taken from the tree. In countries with large commercial production it has been necessary for government agencies to establish standards of maturity because growers could not be depended on to harvest only mature fruit. These standards are based on measurements of acid and soluble solids (nearly all sugar), with minimum ratio and minimum solids specified. Thus, in Florida sweet oranges must have 9.2% solids and a 9.4 ratio of solids to acid.

Harvesting of oranges requires care, even though they seem to have a leathery rind which can stand rough treatment. Actually this

rind is easily injured and the breaks give opportunity for decay organisms to enter. Care must also be taken not to "plug" oranges in picking, that is, not to let some of the rind around the stem be left on the tree with the stem, so that there is a hole through the rind at the stem end. Sometimes oranges can be pulled off the tree without "plugging" if the fruit is turned so that the pull is at right angles to the stem; if this is not successful, the orange should be carefully cut from the stem close to the fruit.

Harvested fruit should be washed to free it of dust and scales, and for commercial sales, graded as to size and blemishes. It will pay the grower to establish a reputation for marketing only fruit of dependable quality, internal and external.

MANDARINS

The term "mandarin" comprises several different kinds of citrus fruits characterized by sweet pulp and a rind easily separated from the flesh. Some of them are marketed as oranges, but they are quite easily distinguished from sweet oranges. Some had their origin in India, some in Japan, others in China, and still others in Malaysia. Seedling mandarins of good size and quality are found in several regions of tropical America, and these may well be selected for propagation locally.

King mandarin (C. nobilis or C. reticulata) is a fruit of large size, with very thick rind, which is grown in tropical America because of its high quality, although nowhere is it cultivated on a large scale. It had its origin in Indo-China. Maturity is late in the season.

Several mandarins are called tangerines, of which the best known is the Dancy. Sometimes the tangerine, or even all mandarins, are grouped into one polymorphic species, C. reticulata, but this is not

a very realistic treatment. The name C. reticulata was originally applied to the tangerine called Ponkan in Taiwan and Suntara in India, a very different fruit from the Dancy of China, sometimes distinguished as C. tangerina. Dancy has slender branches and small, deep orange-colored fruits which are juicy and well flavored. They mature in mid-season. Cleopatra tangerine (C. reshni) is mostly used as a root-stock, but is worthy of culture for its ornamental value. Ponkan is a larger tangerine than Dancy, less colorful but equally good in quality. It matures early.

The Satsuma (C. unshiu or C. reticulata) originated in Japan, where it is grown on a larger scale than anywhere else. Trees are usually not large but bear heavy crops of small, flattened fruits with no seeds. Adapted best to cool winter climates, they have not yet been found planted extensively in the American tropics. Owari is the best known variety.

Mandarins have been hybridized with other fruits, especially grapefruit and orange. The mandarin-grapefruit hybrids are called "tangelos" and some of them are commercially important. Orlando tangelo is early maturing, with yellow rind, while Minneola is late maturing, with reddish-orange rind, and excellent flavor. These tangelos are the size of oranges but more juicy. They resulted from crosses made in Florida in 1911 by W. T. Swingle. One notable characteristic is their inability to pollinate themselves. Nearly all other citrus fruits can be planted alone, but these tangelos must be interplanted in order to produce good crops. Dancy and Temple are good pollinators. Temple has already been mentioned under oranges, as a natural hybrid of mandarin and sweet orange.

GRAPEFRUIT

Grapefruit (C. paradisi) had its origin in the West Indies, probably by mutation from the Asiatic shaddock (C. grandis). Although

known in Barbados as early as 1750, it attracted little attention late in the 19th century, when Florida began large scale production. Fruit size is much larger than that of oranges and rind color is yellow, not orange, but the most important difference is in taste. Because of lower ratios of sugar to acid, grapefruits are usually less sweet-tasting than oranges, and the abundant juice contains a characteristic flavor not pleasing to everyone. On the other hand, canned, sweetened grapefruit is an excellent product while canned oranged juice (single strength, "hot pack") is not. In tropical America, at elevations of less than 1500 ft., quality is good, but above 3000 ft. fruit is quite acid.

Both white-fleshed varieties are seedy Duncan and seedless Marsh, the latter having rather inferior flavor but commercially preferred for its lack of seeds. Triumph is not extensively grown but is worthy of cultivation for its sweetness, in spite of being seedy and rather small in size. Thompson is pink-fleshed and Ruby is red-fleshed. Both are seedless but the latter shows red color even through the yellow rind. Flesh color has no correlation with flavor.

THE LIME

The common lime (C. aurantifolia) has small, seedy, very acid fruits borne on small, thorny trees with slender twigs and small leaves. It is very commonly grown all through tropical America, being next to sweet orange in production, and is always grown from seed. It had its origin in Malaysia, but is abundant now in all tropical lowlands. Much less common is the large, seedless lime, called Persian (or Tahiti) in Florida and Bearss in California. The lemon-size fruit is equally acid, but the trees are larger and thornless, with stout twigs and leaves as large as those of the orange. This lime, perhaps a hybrid, is sometimes called C. latifolia. It

originated in California about 1870 from seed of a common lime from Tahiti. Commonly it is budded, the preferred stocks being usually Rough lemon or Rangpur lime, but propagation by air-layering (marcottage) has also been successful. Careful selection of scion sources is important, as propagation from plants showing lime-bark disease (resulting from genetic causes) will predispose the resulting trees to this serious malady. Common limes are free from this but are very subject to attack by a fungus causing anthracnose lesions on fruit and "die-back" of young shoots. Copper sprays on each new flush give control. Both types of lime produce flowers on new flushes made several times a year.

Very similar to the common lime is the calamondin (C. madurensis or C. Mitis), native to the Philippines and Indonesia. The fruit is small, seedy, very acid, but with reddish-orange rind. It has little commercial value, but it is highly ornamental for home planting and is fairly free of pests.

THE LEMON

The true lemon (C. limon), grown on a large commercial scale in Italy and California, is not cultivated commercially in tropical America, because it does not seem to produce fruit of best quality. The lime takes its place as an acid fruit. The fact that the latter is called "limón" in Spanish often results in horticultural confusion. The true lemon is usually distinguished in Spanish-speaking countries as limón real, while the rough lemon (C. jamghiri), so widely used as a rootstock and occasionally in tropical America, as a culinary fruit does not have a very definite name in Spanish; sometimes it is called "limón rugoso" or "limón áspero."

THE CITRON

Apparently this was the first citrus fruit to be introduced in the Mediterranean region (some 2000 years ago) where it was not considered a culinary delicacy by any means, but enjoyed certain ceremonial privileges. Botanically it is Citrus medida. In Sicily, and to a small extent in several other parts of the world, it is cultivated today commercially for the preparation of candied citron peel which is used in the preparation of various delicacies. It is occasionally seen in tropical American gardens but is of no commercial importance. The tree is easily propagated by cuttings.

THE SOUR ORANGE

Perhaps after the citron, the sour or Seville orange (Citrus aurantium) was the first of the citrus fruits to brought to the Mediterranean region; certainly it was one of the first (if not the first of all) to be planted in tropical America. The Arabs took it into Spain, where it became popular; it resisted cold winters of Andalucia, and for its handsome foliage and fragrant flowers it was planted in patios, including the great one at the mosque in Cordoba. The fruit was much used before sweet oranges were introduced. In modern times it is still important as the basis of the famous orange marmalades prepared in Scotland and elsewhere.

The tree is such a robust one that it escaped from cultivation and became naturalized in tropical America and Florida shortly after it was planted by the first Spanish colonists. While today it is not a commercial crop of importance, it is one of the first citrus trees likely to be seen in many an old garden from Mexico to Chile. Horticulturally, its major importance lies in its usefulness as a rootstock for many of the more important citrus fruits, especially the sweet oranges.

THE KUMQUAT

Kumquats are not in the genus Citrus but in the closely related Fortunella. The fruit is small, with little juice and thick, fleshy rind, and is always eaten whole. It is not very popular as a fresh fruit, but is much enjoyed as marmalade, or candied. There is little culture of kumquats in tropical America, but the small, shrubby trees are very ornamental, especially when laden with orange-colored fruits. Large oval Nagami, small round Marumi, and large round Meiwa are the common varieties. Kumquats originated in Asia; the trees can tolerate more cold than any of the oranges.

The Meyer lemon (C. meyeri) is not a variety of true lemon and does not even look like one, but it tastes like a lemon and bears much more regularly than true lemons do in tropical America usually, It was found in northern China by U.S.D.A. explorer Frank Meyer and introduced to the United States in 1908. The mature fruit looks like a large orange, in both external and internal appearance, with thin, smooth rind, abundant juice, and about 10 seeds. The juice is a little lower in acidity than that of true lemons, but it is of good quality if care is taken to avoid getting any of the peel oil into it. Even a small amount of oil from the rind gives a very undesirable flavor to the juice. The tree is dwarf in habit, nearly thornless, and as resistant to cold as an orange. Besides being readily budded on the usual citrus stocks, the Meyer lemon is easily propagated by cuttings. Probably it arose as a hybrid, but its origin is quite uncertain.

BETTER FRUIT PROGRAM 1966

Spray and Dust Schedule for Citrus

IMPORTANT NOTICE

Save a life; it might be yours! Instruct workers periodically as to hazards in using insecticides. Never let workers take insecticides home, where families may be poisoned.

Do not use this schedule until you have carefully read the General Instructions.

BEFORE USING ANY PESTICIDE

STOP

READ THE PRECAUTIONS

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THIS PROGRAM, compiled by the Advisory Committee of the Florida Citrus Commission, is based on information furnished by University of Florida Agricultural Experiment Stations and Agricultural Extension Service; Florida Department of Agriculture Division of Plant Industry; Florida State Horticultural Society; U. S. Department of Agriculture Agricultural Research Service, Horticultural Crops Research Branch and Entomology Research Division; professional consultants; and commercial firms. Where local conditions appear to make necessary some modification in the schedule, consult your County Agent, Packinghouse Manager, Salesman, Field Man, Consultant; or write the Agricultural Experiment Station or Extension Service at Gainesville; the U. S. Department of Agriculture, 2120 Camden Road, Orlando; the Indian River Field Laboratory, Ft. Pierce; or the Florida Citrus Experiment Station, Lake Alfred.

With Picked Trees in the Background, a Truck Takes the Fruit to the Packinghouses