TEXAS DEPARTMENT OF AGRICULTURE
BULLETIN

Published by the Texas Department of Agriculture,
Austin, Texas

January and February, 1925—Second Edition No. 79

THE CITRUS INDUSTRY
IN THE
LOWER RIO GRANDE VALLEY
OF TEXAS

J. M. DELCURTO
E. W. HALSTEAD
HAL F. HALSTEAD

GEO. B. TERRELL,
Commissioner of Agriculture

Entered as second-class matter, May 8, 1909, at the postoffice at Austin, Texas, under Act of June 6, 1900

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PREFACE

This bulletin is presented for the primary purpose of aiding the citrus industry in the Lower Rio Grande Valley and by a statement of authentic facts to appraise the public of the magnitude and possibilities of this rapidly developing industry. This industry is comparatively young in the Valley, and very little has been published or is available on the subject of the proper care and treatment of the trees under the conditions in that locality.

Both soil and climatic conditions differ to some extent from those in either California, or the Gulf Coast, and the information available from these citrus belts is therefore not entirely applicable to this section. This makes the publication of this bulletin a necessity in order to give the growers the known facts that have been developed as the result of experience in the Valley.

The citrus industry in this section as stated is in its incipiency, and a great deal of experimental work must yet be done to determine many things necessary for its future development.

The Department of Agriculture desires to lend it a helping hand, and for this reason assisted in securing the passage of the law to establish a citrus experiment station either in Cameron or Hidalgo County, in order that greater efforts might be brought to bear in the development of citrus orchards, which are destined to be of great commericial value to the State.

In this bulletin we are giving the known facts in regard to best varieties to plant, the best methods of care and treatment of the trees, the prevention of plant diseases and insect depredations, and also a discussion of soil and climatic conditions as compared with other citrus sections.

The authors of this bulletin have studied this subject very carefully and spent much time in its preparation, and I feel that it contains the best thought that can be found on the subject until further developments are made in citrus growing in Texas.

This bulletin is published with the earnest hope that it will be beneficial to the growers, and that if it contains some errors that they will be overshadowed by the truths it contains, and we ask the readers to adopt the truths and disregard the errors.

GEORGE B. TERRELL,
Commissioner of Agriculture.

ACKNOWLEDGMENTS

The authors wish to express their appreciation for the assistance given by Dr. L. C. Corbett and T. Ralph Robinson, United States Department of Agriculture, Washington, D. C., in the making of fruit analyses, and to Messrs. Chas. Volz, John H. Shary and M. F. Armstrong of Mission and H. Hanson of Donna for samples of fruit used in illustrations of varieties; to Eltweed Pomeroy, Donna; S. J. Baker, San Benito; C. M. Greenlee, Donna; A. J. Whiteside, Donna; J. Hickman, Rio Hondo; E. E. Teeter, McAllen; W. M. Bell, Donna; H. S. Bonnycastle, Weslaco; A. H. Kalbfleisch, Mrs. F. M. Carter, W. F. Shaw, Mercedes; E. E. Evans, Mercedes; Mrs. J. C. Montgomery, Brownsville; T. C. Richardson, Lyford; and H. Raymond Mills, Harlingen, for many valuable suggestions on the various phases of the bulletin; to members of the Department of Agriculture for numerous favors and courtesies extended in the preparation of the bulletin, and to many other persons throughout the State whose co-operation has contributed in no small degree to the work at hand. Literature from both California and Florida has been freely consulted in working out many problems herein given. Where direct quotations are made, however, credit is given.

THE CITRUS INDUSTRY IN THE LOWER RIO GRANDE VALLEY OF TEXAS.

LOWER RIO GRANDE VALLEY

EXTENT.

That portion of the Lower Rio Grande Valley under consideration is contained in Hidalgo, Cameron and Willacy Counties and is bounded on the south by the Rio Grande River, the Gulf Coast on the east and the sand strip on the north, forming a triangle of about ninety miles along the river, sixty miles along the Coast and ninety miles on the north, containing in the aggregate approximately one million acres. Four hundred and sixty-six thousand acres of the territory is at present under canal, or will be when the present irrigation systems are fully developed. One-half of the area subject to irrigation is being cultivated at the present time. Of the 466,000 acres under canal, a large percentage is suitable for citrus planting. The other 534,000 acres which could be brought under irrigation by a gravity system, would make possible both irrigation and drainage, collecting the drainage waters of the upper portion for use along the coastal plain. This gravity irrigation project has been thoroughly studied and its feasibility proven by the survey made by the United States Reclamation Service.

HISTORY

Mexico exercised and claimed jurisdiction over this area from the time of her independence in 1821 to the treaty of Guadalupe Hidalgo in 1848, whereby she relinquished all rights to the territory north of the Rio Grande River. From 1521 to 1821, it was a part of the Spanish possessions in America.

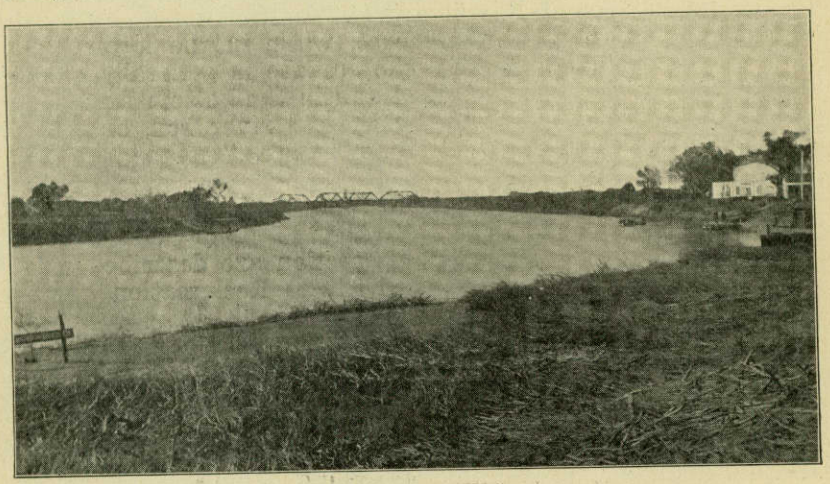


Fig. 1. The Rio Grande River at Brownsville, Texas.

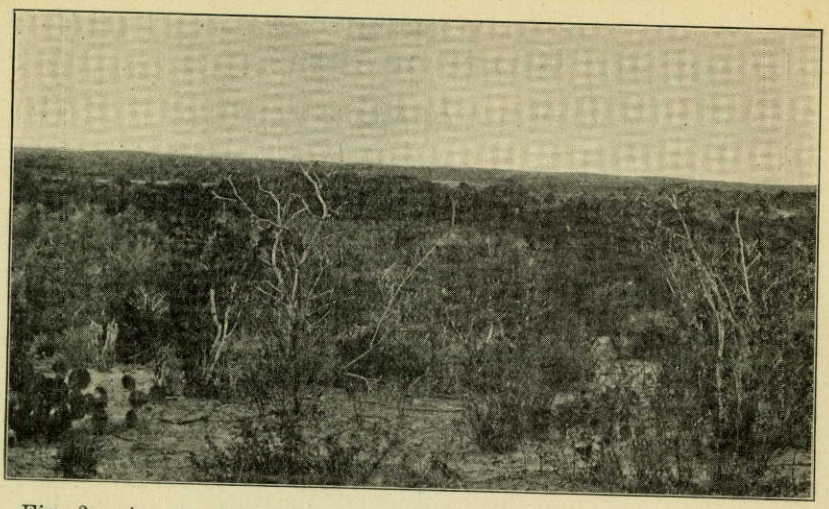


Fig. 2. A scene of land in the Lower Rio Grande Valley before it is cleared. (The mesquite in the picture, however, is much smaller than the average.

This area is now under private ownership, having been contained in Spanish and Mexican grants, which were confirmed by the Republic.

TOPOGRAPHY

Roughly this area is in three benches, the first, along the river is sometimes flooded by the rising of the river after heavy rains. From Weslaco to Mission, the second bench rises to thirty feet and farther west there is another thirty foot rise. The third lift is practically all in the Mission tract, while the second lift joins the coastal plain below Weslaco and extends to the north around Raymondville. In the upper Valley the drainage is to the south and east, while in the lower Valley it is to the east and north. The surface is generally smooth, except for the benches described and in the bottom lands along the river where it is cut up by the old river bed, or what is commonly known in that section as "resacas."

SOIL

The types of soil found in this section are described as follows in the report of the United States Reclamation Service:

VEGETATION AND SOIL

"32. Throughout the Valley native vegetation is luxuriant, often forming veritable jungles. The mesquite, which here reaches the dignity of a tree, sometimes being as much as two feet in diameter, predominates with guajillo, ebony, retama, tornillo, huisache, cactus and many other varieties of semi-

tropical trees and brush in abundance. Along the water courses cottonwood, willow and hackberry are found, while on the marsh and semi-marsh lands along the coast, sacahuiste, a coarse marsh grass, is common. Following the rains a great variety of grasses, shrubs, vines and weeds, many of them blossoming with beautiful flowers, spring up rapidly.

"33. No detail soil survey has ever been made of the lands within the project, but they are included in reconnaisance ex-

Fig. 3. Natural palm grove below Brownsville, Texas.

AVERAGE MECHANICAL ANALYSIS.

Description.	Fine Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very fine Sand.	Silt.	Clay.
Soil	0.1%	0.3%	0.6%	8.9%	32.8%	43.7%	13.9%
Subsoil	0.1%	0.2%	0.3%	8.0%	36.9%	39.1%	14.9%

aminations, made in 1907 and 1909 by the Bureau of Soils, United States Department of Agriculture.

"34. Of the soils included within the project area, the nine types considered as adapted to crop production, under favorable conditions of moisture and drainage, may be briefly described as follows:

"35. *Laredo Silty Loam* is composed almost entirely of very fine sand, silt and clay deposited by the Rio Grande.

"This type is found in the narrow valley above Closner and in the upper part of the delta, the most extensive area being located around Hidalgo, below which it is confined to the lands bordering the river and its former channels. This soil is well adapted to truck and a variety of other crops including sweet potatoes, sugar cane, corn and cotton.

"36. *Laredo Sitty Clay* is of alluvial origin and almost entirely composed of silt and clay, with a small percentage of sand.

"This type is confined to the delta where it occurs in irregular bodies, following the old river channels, and covering large areas in the southeastern part of Cameron County. It is one

AVERAGE MECHANICAL ANALYSIS.

Description.	Fine Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very fine Sand.	Silt.	Clay.
Soil	0.0%	0.5%	0.5%	4.2%	9.2%	62.5%	22.9%
Subsoil	T	0.2%	0.1%	2.2%	5.9%	65.5%	25.4%

of the most fertile soils found anywhere and, under favorable drainage conditions, is well adapted to almost every variety of vegetable as well as to the general farm crops suited to this section.

"37. *Laredo Clay* contains much lime and is stiff and tenacious when wet, but hard and baked when dry and uncultivated.

AVERAGE MECHANICAL ANALYSIS.

Description.	Fine Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very fine Sand.	Silt.	Clay.
Soil	0.0%	0.2%	0.4%	9.4%	4.1%	47.6%	38.2%
Subsoil	0.0%	0.3%	1.1%	2.2%	0.2%	34.6%	62.1%

"The principal development of this type is in the southern portion of the delta extending from Mission to San Benito, with small bodies located in other parts. This is a strong productive soil, but owing to its heavy texture, care must be taken to cultivate it when in proper moisture condition to prevent baking, and provision for artificial drainage should be made.

"38. *Cameron Clay* is a dark heavy soil, containing a large amount of humus which makes it more granular and easy to cultivate. It contains a large amount of lime and more alkali is present than in any other cultivated type in the delta.

AVERAGE MECHANICAL ANALYSIS.

Description.	Fine Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very fine Sand.	Silt.	Clay.
Soil	0.0%	0.4%	0.2%	1.5%	2.2%	45.8%	49.6%
Subsoil	0.1%	0.3%	0.1%	0.5%	1.1%	43.3%	54.7%

"The Cameron Clay occurs in the shallow basins between the old river channels and is widespread over the delta east of Mercedes, the most important tract being located near Brownsville, Olmita and east of Harlingen. This type requires more careful handling than any other soil in the delta, but when

properly drained and cultivated, is very productive and well suited to the heavier truck crops, corn, cotton and sugar cane.

"39. *Rio Grande Silty Clay* contains a large amount of both lime and organic matter and is confined to the lower overflow terraces of the larger bends of the river in the delta.

AVERAGE MECHANICAL ANALYSIS.

Description.	Fine Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very fine Sand.	Silt.	Clay.
Soil	0.1%	0.8%	3.4%	10.6%	2.4%	41.4%	42.2%
Subsoil	0.0%	0.2%	0.0%	25.0%	14.4%	42.1%	18.4%

"40. *Brennan Fine Sandy Loam* covers large areas in Starr and Hidalgo Counties, but is absent in Cameron County. Within the irrigable areas it prevails on the high land from Closner to McAllen and Edinburg, also north and east from Edinburg nearly to the Hidalgo-Cameron line. There is also a large body of this type north and east of Donna. This soil is generally high in lime content and low in organic matter. It is well adapted for early truck and fruits and is especially fine for grapes and melons.

"41. *Brennan Loam* is principally found to the east of McAllen and Edinburg extending nearly to Donna also around Bixby and into Cameron County as far as the railroad near Combes Siding. These two bodies are connected by narrow strips of the same type on the north and south. Another body, which extends nearly to Closner, lies south of McAllen and Mission. This soil has little organic matter, but is high in lime content. It bakes slightly but under irrigation breaks up into loose friable loam, which is easily cultivated, and with sufficient organic matter makes one of the very best soils for fruit, nuts and garden truck.

"42. *Victoria Fine Sandy Loam* is generally from ten to thirty inches in depth with a subsoil that, though friable and porous, is sufficiently heavy to give good foundation for holding moisture.

AVERAGE MECHANICAL ANALYSIS.

Description.	Fine Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very fine Sand.	Silt.	Clay.
Soil	T	0.4%	1.6%	52.9%	24.9%	14.2%	6.3%
Subsoil	0.2%	0.5%	1.4%	37.7%	13.6%	22.2%	23.9%

"This type is extensively developed to the east of Raymondville and Sebastian to the low lands bordering the Laguna Madre. Other areas are found north of La Feria and between the Arroyo Colorado and Rasaca de los Fresnos. A great variety of crops may be grown on this soil, but it is especially well adapted to early truck crops, tomatoes, lettuce and melons.

Fig. 4. A typical town in the Valley.

If climatic conditions prove sufficiently favorable, doubtless this soil will be found adapted to oranges as well as other semi-tropical fruits.

"43. *Victoria Loam* varies in color from a grayish brown to almost black, depending upon the amount of humus present. The surface soil is from eight to twenty inches in depth with a subsoil that is generally a compact clay loam, but this varies from a loam on the one side to a light clay on the other.

Description.	Fine Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very fine Sand.	Silt.	Clay.
Soil	0.7%	2.9%	1.9%	22.2%	19.0%	35.1%	13.4%
Subsoil	0.0%	0.4%	0.7%	29.3%	16.5%	25.3%	27.7%

"The largest body of this type extends from southwest of Sebastian to north and east of Raymondville. Smaller areas are located in the vicinity of Harlingen and La Feria, and small patches are found scattered through the Victoria fine sandy loam areas in Cameron County. This soil is very fertile and will produce large yields of truck, cotton, corn, sorghum and other crops when moisture conditions are favorable.

"44. *Lomalta and Point Isabel Series* comprise considerable areas of the low lands northeast of Brownsville and bordering the Laguna northward from a point opposite San Benito. These soils are either of Marine origin or formed by deposits of silt and clay in salty water. On account of poor drainage and the large amount of salt found in these soils, they have been considered as non-agricultural. However, a considerable area of Lomalta clay near Brownsville has been more or less effectually drained since 1909 and a part of this land is now in cultivation.

"45. The following tabulation shows the approximate acreage of each type shown on the soil map and their general dis-

tribution relative to first, second and third lift lands in the delta and the narrow valley bounded by the hills north of the Rio Grande above Closner. In the delta area, the first bench bordering the river and everything below about elevation 75 in the coastal plain has been classed as "first lift;" between elevations 75 and 145 as "second lift" and the areas included between elevations 145 and 175 as "third lift."

Classification.	Distribution.				
	Valley Acres.	First Lift Acres.	Second Lift Acres.	Third Lift Acres.	Total Acres.
Laredo silt loam	41,200	96,200			137,400
Laredo silty clay loam		164,600			164,600
Laredo clay		81,300			81,300
Cameron clay		77,500			77,500
Rio Grande silty clay		8,600			8,600
Brennan fine sandy loam		10,800	132,000	16,000	158,000
Brennan loam		56,000	66,309		122,300
Victoria fine sandy loam		172,400			172,400
Victoria loam		125,000			125,000
Lomalta loam		42,100			42,100
Lomalta fine sandy loam		21,300			21,300
Lamalta and Point Isabel clays		34,400			34,400
Gravelly soils	24,600				24,600
Nueces fine sand		11,800			11,800

ALKALI

"46. Only a small percentage of the soils is at present affected by alkali, although some lands under irrigation are being dam-

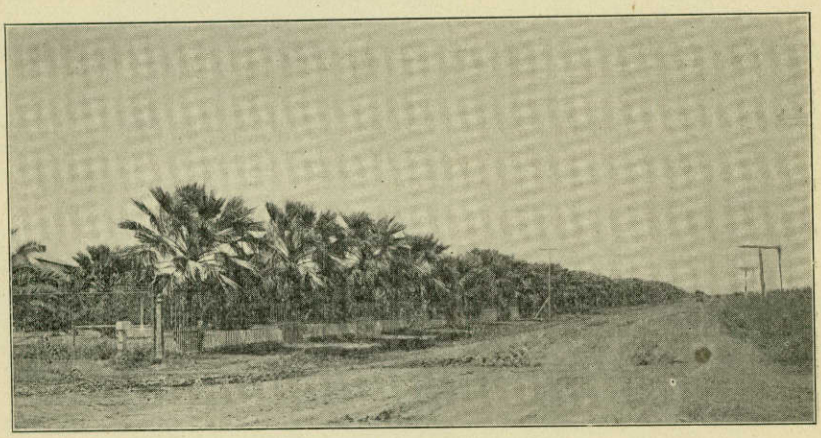


Fig. 5. A road scene.

aged as a result of seepage from the canals or from the use of large amounts of water without any provision for drainage. The principal alkali areas consist of the poorly drained semi-marsh lands along the coast, occupied chiefly by soils of the Lomalto and Point Isabel series. The lower depressions of the

Cameron Clay often contain considerable quantities of alkali, due to the water collecting here and remaining until removed by evaporation, thus leaving the salts behind. There are some small areas of Laredo silty clay loam and Brennan loam where seepage has resulted in such an accumulation of salts as to injure and sometimes prevent the growth of crops."

SOIL BULLETIN

A new soil survey of Cameron and Hidalgo Counties is now being made by the Bureau of Soils, U. S. Department of Agriculture. When the results of these surveys are published, copies may be obtained by writing the U. S. Department of Agriculture, Washington, D. C.

POPULATION

According to the census of 1920, the population of the three counties under consideration is as follows: Cameron County 36,662, Hidalgo County 38,110, Willacy County 1,003, and combined they have an area of 4,304 square miles. This population has been added to considerably since the above census was taken. At this writing the population is now probably over 100,000 in the two counties and rapidly increasing.

CLIMATE

The climate has been described as semi-tropical and semi-arid, and is such that crops can be grown every month in the year under irrigation.

RAINFALL

According to the Weather Bureau records, the precipitation is greatest along the coast, gradually diminishing towards the interior. The records at Brownsville from 1871 to 1919 show a range from 12.15 inches in 1917 to 60.06 in 1886, with the annual mean of 26.75 inches. The records of Raymondville from 1911 to 1919 show an annual mean of 25.93 inches. The records at Mercedes from 1914 to 1919 show 23.24 inches. The records at Mission from 1911 to 1919 (incomplete) show an annual mean of 20.48 inches. The records at Fort Ringgold for forty-two years show an annual mean of 17.49 inches. Rain falls on an average of forty-seven days during the year, and the mean relative humidity is said to be about 80%, and the sunshine an average of 60%.

IRRIGATION FACILITIES

Irrigation water is supplied on the various projects by fifteen different systems that range in size from that of the West Brownsville plant, which furnishes the water for two thousand

CLITMATOLOGICAL DATA: TEXAS SECTIONS AS TAKEN FROM THE U. S. BUREAU OF WEATHER REPORTS

CLIMATOLOGICAL DATA FOR THE YEAR 1912.

Stations.	Counties.	Elevation—Feet.	Temperature, in Degrees Fahrenheit.						Precipitation, in Inches.						Total Snowfall.	Sky.				
			Length of Record—Years.	Annual Mean.	Highest.	Date.	Lowest.	Date.	Length of Record—Years.	Total for Year.	Greatest Monthly.	Month.	Least. Monthly.	Month.		No. of Rainy Days.	No. Clear Days.	No. Partly Cloudy Days.	No. Cloudy Days.	Prevailing Direction of Wind.
Brownsville	Cameron	88	40	71.6	98	May 10	24	Jan. 13	41	38.82	13.53	October	0.12	August	0.0	86				S. E.
Harlingen	Cameron																			
Mission	Hidalgo	140	3	73.0	102	Sept. 25	22	Jan. 12	3	26.10	7.70	June	T.	August	0.0	42	140	174	52	S. E.
Raymondville	Cameron		0						2	27.32	7.80	June	T.	August	T.	78				S. E.

CLIMATOLOGICAL DATA FOR THE YEAR 1913.

Stations.	Counties.	Elevation—Feet.	Temperature, in Degrees Fahrenheit.						Precipitation, in Inches.						Total Snowfall.	Sky.				
			Length of Record—Years.	Annual Mean.	Highest.	Date.	Lowest.	Date.	Length of Record—Years.	Total for Year.	Greatest Monthly.	Month.	Least. Monthly.	Month.		No. of Rainy Days.	No. Clear Days.	No. Partly Cloudy Days.	No. Cloudy Days.	Prevailing Direction of Wind.
Brownsville	Cameron	38	41	71.4	98	Sept. 7	30	Jan. 7	42	30.64	14.38	September	0.28	July	0.0	94				S.
Harlingen	Cameron	37	1	72.3	103	July 22*	30	Jan. 8	42	25.91	8.43	September	0.18	November	0.0	86	193	108	64	S. E.
Mission	Hidalgo																			
Raymondville	Cameron		0	71.3	100	Aug. 4*	30	Mar. 17	3	34.69	6.52	June	1.24	March	0.0	101	130	167	68	S. E.

*Also on subsequent dates.

CLIMATOLOGICAL DATA FOR THE YEAR 1914.

Stations.	Counties.	Elevation—Feet.	Temperature, in Degrees Fahrenheit.						Precipitation, in Inches.						Total Snowfall.	Sky.				
			Length of Record—Years.	Annual Mean.	Highest.	Date.	Lowest.	Date.	Length of Record—Years.	Total for Year.	Greatest Monthly.	Month.	Least Monthly.	Month.		No. of Rainy Days.	No. Clear Days.	No. Partly Cloudy Days.	No. Cloudy Days.	Prevailing Direction of Wind.
Brownsville	Cameron	38	42	72.4	98	July 19	30	Jan. 31*	43	26.50	9.03	May	T.	July	0.0	87				S.
Harlingen	Cameron	37	2	71.7	100	July 8*	28	Feb. 25	3	30.01	9.63	May	T.	July	0.0	93	169	96	100	S. E.
Mission	Hidalgo																			
Raymondville	Cameron		1	72.1	104	Aug. 4	25	Jan. 31	4	34.73	11.80	May	0.05	July	0.0	86	133	147	85	S. E.

*Also on subsequent dates.

CLIMATOLOGICAL DATA FOR THE YEAR 1915.

Stations.	Counties.	Elevation—Feet.	Temperature, in Degrees Fahrenheit.						Precipitation, in Inches.						Total Snowfall.	Sky.				
			Length of Record—Years.	Annual Mean.	Highest.	Date.	Lowest.	Date.	Length of Record—Years.	Total for Year.	Greatest Monthly.	Month.	Least Monthly.	Month.		No. of Rainy Days.	No. Clear Days.	No. Partly Cloudy Days	No. Cloudy Days.	Prevailing Direction of Wind.
Brownsville	Cameron	38	43	73.4	104	Aug. 18	30	Jan. 25	44	17.45	4.30	December	T.	June	0.0	55				S.
Harlingen	Cameron	37	1	72.7	108	Aug. 18	28	Jan. 25	3	20.71	3.98	January	0.16	February	0.0	67	193	127	4[illegible]	S. E.
Mission	Hidalgo	140	3		106	Aug. 20														
Raymondville	Cameron		2	72.5	107	Aug. 18	28	Jan. 25	5	20.36	3.84	March	T.	February	0.0	65	149	162	54	S. E.

CLIMATOLOGICAL RATA FOR THE YEAR 1916.

Stations.	Counties.	Elevation—Feet.	Temperature, in Degrees Fahrenheit.						Precipitation, in Inches.						Total Snowfall.	Sky.				
			Length of Record—Years.	Annual Mean.	Highest.	Date.	Lowest.	Date.	Length of Record—Years.	Total for Year.	Greatest Monthly.	Month.	Least Monthly.	Month.		No. of Rainy Days.	No. Clear Days.	No. Partly Cloudy Days.	No. Cloudy Days.	Prevailing Direction of Wind.
Brownsville	Cameron	38	44	74.4	102	May 22	30	Jan. 17*	45	19.78	5.58	August	0.07	March	0.0	64				S. E.
Harlingen	Cameron	37	2		105	June 6			4											
Mission	Hidalgo																			
Raymondville	Cameron		3	74.3	109	June 6	24	Dec. 12	6	32.81	7.85	August	T.	March	0.0	72	148†	169†	39†	S. E.

*Also on subsequent dates. †Record incomplete.

CLIMATOLOGICAL DATA FOR THE YEAR 1917.

Stations.	Counties.	Elevation—Feet.	Temperature, in Degrees Fahrenheit.						Precipitation, in Inches.						Total Snowfall.	Sky.				
			Length of Record—Years.	Annual Mean.	Highest.	Date.	Lowest.	Date.	Length of Record—Years.	Total for Year.	Greatest Monthly.	Month.	Least Monthly.	Month.		No. of Rainy Days.	No. Clear Days.	No. Partly Cloudy Days.	No. Cloudy Days.	Prevailing Direction of Wind.
Brownsville	Cameron	38	45	73.0	102	Aug. 23	24	Feb. 2*	46	12.13	4.52	July	T.	October	0.0	39				S. E.
Harlingen	Cameron																			
Mission	Hidalgo																			
Raymondville	Cameron		4	72.9	105	Aug. 23	20	Dec. 30	6	8.73	3.48	July	0.03	November	0.0	53				S. E.

*Also on subsequent dates.

CLIMATOLOGICAL DATA FOR THE YEAR 1918.

Stations.	Counties.	Elevation—Feet.	Temperature, in Degrees Fahrenheit.						Precipitation, in Inches.						Total Snowfall.	Sky.				
			Length of Record—Years.	Annual Mean.	Highest.	Date.	Lowest.	Date.	Length of Record—Years.	Total for Year.	Greatest Monthly.	Month.	Least. Monthly.	Month.		No. of Rainy Days.	No. Clear Days.	No. Partly Cloudy Days.	No. Cloudy Days.	Prevailing Direction of Wind.
Brownsville	Cameron	38	46	74.3	103	June 19	25	Jan. 11	47	21.91	4.31	May	0.08	January	0.0	70				S. E.
Harlingen	Cameron																			
Mission	Hidalgo																			S. E.
Raymondville	Cameron		5		107	July 18	16	Jan. 12	6	20.02	3.35	December	0.02	January	T.	63				

CLIMATOLOGICAL DATA FOR THE YEAR 1919.

Stations.	Counties.	Elevation—Feet.	Temperature, in Degrees Fahrenheit.						Precipitation, in Inches.						Total Snowfall.	Sky.				
			Length of Record—Years.	Annual Mean.	Highest.	Date.	Lowest.	Date.	Length of Record—Years.	Total for Year.	Greatest Monthly.	Month.	Least. Monthly.	Month.		No. of Rainy Days.	No. Clear Days.	No. Partly Cloudy Days.	No. Cloudy Days.	Prevailing Direction of Wind.
Brownsville	Cameron	38	47	74.0	102	Aug. 31	24	Jan. 4	48	38.19	7.69	September	0.25	August	0.0	96				S. E.
Harlingen	Cameron																			
Mission	Hidalgo																			S. E.
Raymondville	Cameron		5						7	32.85	8.20	September	0.10	August	0.0	85				

CLIMATOLOGICAL DATA FOR THE YEAR 1920.

Stations.	Counties.	Elevation—Feet.	Temperature, in Degrees Fahrenheit.						Precipitation, in Inches.						Total Snowfall.	Sky.				
			Length of Record—Years.	Annual Mean.	Highest.	Date.	Lowest.	Date.	Length of Record—Years.	Total for Year.	Greatest Monthly.	Month.	Least Monthly.	Month.		No. of Rainy Days.	No. Clear Days.	No. Partly Cloudy Days.	No. Cloudy Days.	Prevailing Direction of Wind.
Brownsville	Cameron	38	48	74.0	100	April 16	32	Mar. 8*	49	20.79	6.70	June	0.0	April†	0.0	52				S. E.
Harlingen	Cameron	37	6	73.4	107	April 17	30	Dec. 28	6	12.12	3.09	June	0.0	July†	0.0	39	280	56	30	S. E.
Mission	Hidalgo																			
Raymondville	Cameron																			

*Also on subsequent dates. †Also on subsequent months.

CLIMATOLOGICAL DATA FOR THE YEAR 1921.

Stations.	Counties.	Elevation—Feet.	Temperature, in Degrees Fahrenheit.						Precipitation, in Inches.						Total Snowfall.	Sky.				
			Length of Record—Years.	Annual Mean.	Highest.	Date.	Lowest.	Date.	Length of Record—Years.	Total for Year.	Greatest Monthly.	Month.	Least Monthly.	Month.		No. of Rainy Days.	No. Clear Days.	No. Partly Cloudy Days.	No. Cloudy Days.	Prevailing Direction of Wind.
Brownsville	Cameron	38	49	75.4	99	April 21	34	Feb. 21	50	21.36	4.59	June	0.14	August	0.0	67				S. E.
Harlingen	Cameron	37	7	74.9	101	June 23	32	Feb. 21	7	21.56	4.53	September	0.07	December	0.0	42	286	55	24	S. E.
Mission	Hidalgo	140	7		105	June 22*	31	Feb. 19*	7	7.96	1.94	July	0.00	January†	0.0	29				
Raymondville	Cameron																			

*Also on subsequent dates. †Also on subsequent months.

CLIMATOLOGICAL DATA FOR THE YEAR 1922.

Stations.	Counties.	Elevation—Feet.	Temperature, in Degrees Fahrenheit.						Precipitation, in Inches.						Sky.				
			Length of Record—Years.	Annual Mean.	Highest.	Date.	Lowest.	Date.	Length of Record—Years.	Total for Year.	Greatest Monthly.	Month.	Least. Monthly.	Month.	Total Snowfall.	No. of Rainy Days.	No. Clear Days.	No. Partly Cloudy Days.	No. Cloudy Days.	Prevailing Direction of Wind.
Brownsville	Cameron	38	50	74.6	98	May 19*	31	Mar. 1*	51	38.69	12.61	September	5.38	December	0.0	95	------	------	------	S. E.
Harlingen	Cameron	37	8	73.8	101	April 10*	29	Mar. 3	8	35.49	13.18	September	0.12	December	0.0	73	248	51	66	S. E.
Mission	Hidalgo	140	8	75.0	105	Aug. 5	30	Mar. 1*	8	23 05	8.02	September	0.02	August	0.0	51	------	------	------	------
Raymondville	Cameron	------	9	73.4	103	April 10*	29	Jan. 14*	11	35.58	11.13	September	0.18	December	0.0	89	------	------	------	------

*Also on subsequent dates.

CLIMATOLOGICAL DATA FOR THE YEAR 1923.

Stations.	Counties.	Elevation—Feet.	Temperature, in Degrees Fahrenheit.						Precipitation, in Inches.						Sky.				
			Length of Record—Years.	Annual Mean.	Highest.	Date.	Lowest.	Date.	Length of Record—Years.	Total for Year.	Greatest Monthly.	Month.	Least. Monthly.	Month.	Total Snowfall.	No. of Rainy Days.	No. Clear Days.	No. Partly Cloudy Days.	No. Cloudy Days.	Prevailing Direction of Wind.
Brownsville	Cameron	38	51	73.7	95	May 26	31	Feb. 5	52	30.97	7.64	February	0.13	January	T.	111	122	142	101	S.
Harlingen	Cameron	37	9	72.6	100	July 21	29	Feb. 6	9	42.74	12.72	September	0.13	January	0.0	74	231	47	87	S. E.
Mission	Hidalgo	140	9	75.5	110	July 12	27	Feb. 6	9	22.89	5.83	February	0.04	January	0.0	68	------	------	------	------
*Raymondville	Cameron	------	10	73.7	101	Aug. 18	30	Jan. 4	12	23.73	5.39	February	0.14	May	T.	91	172	92	101	------

*Raymondville has become the county seat of the lately made Willacy County.

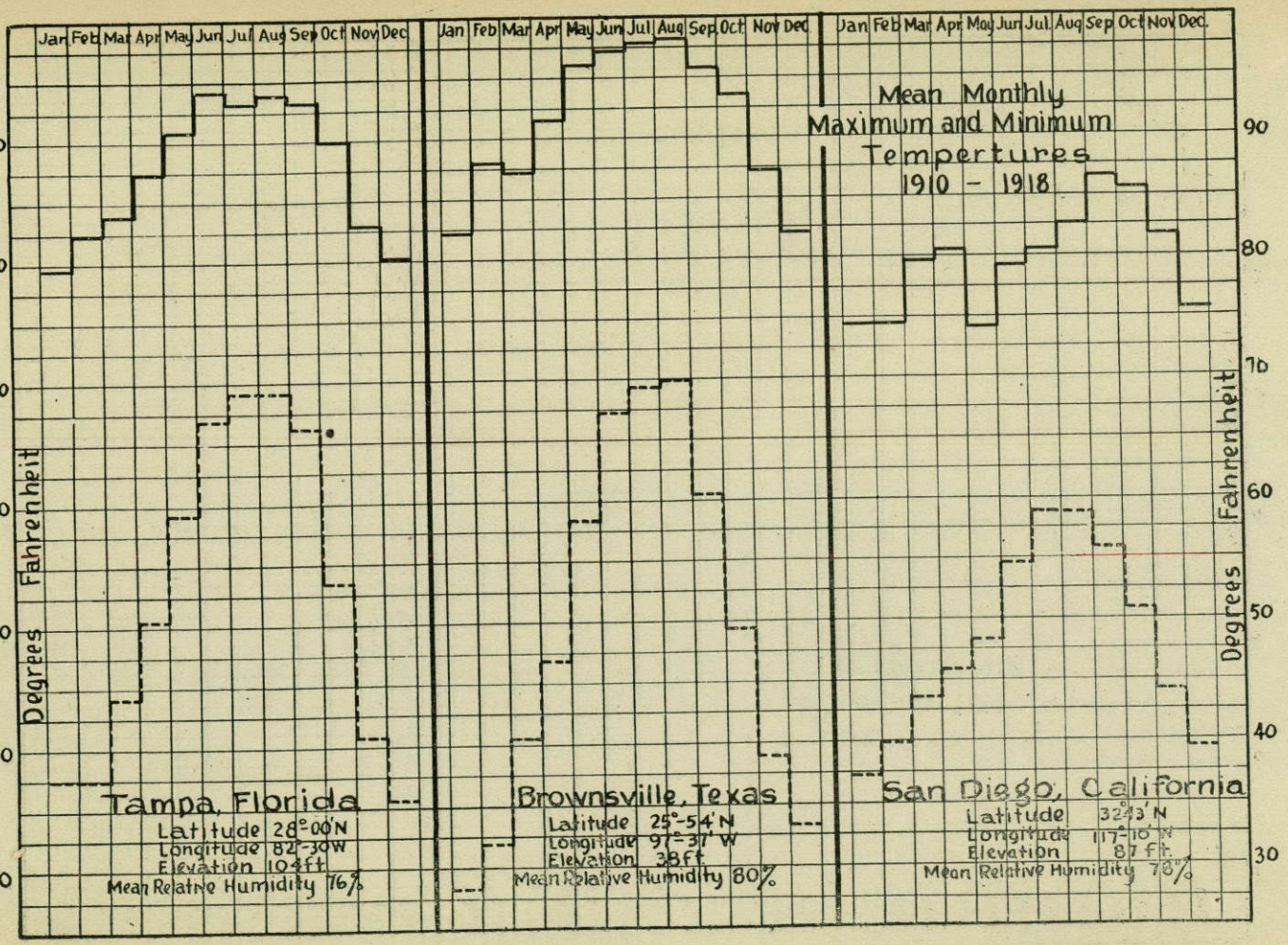
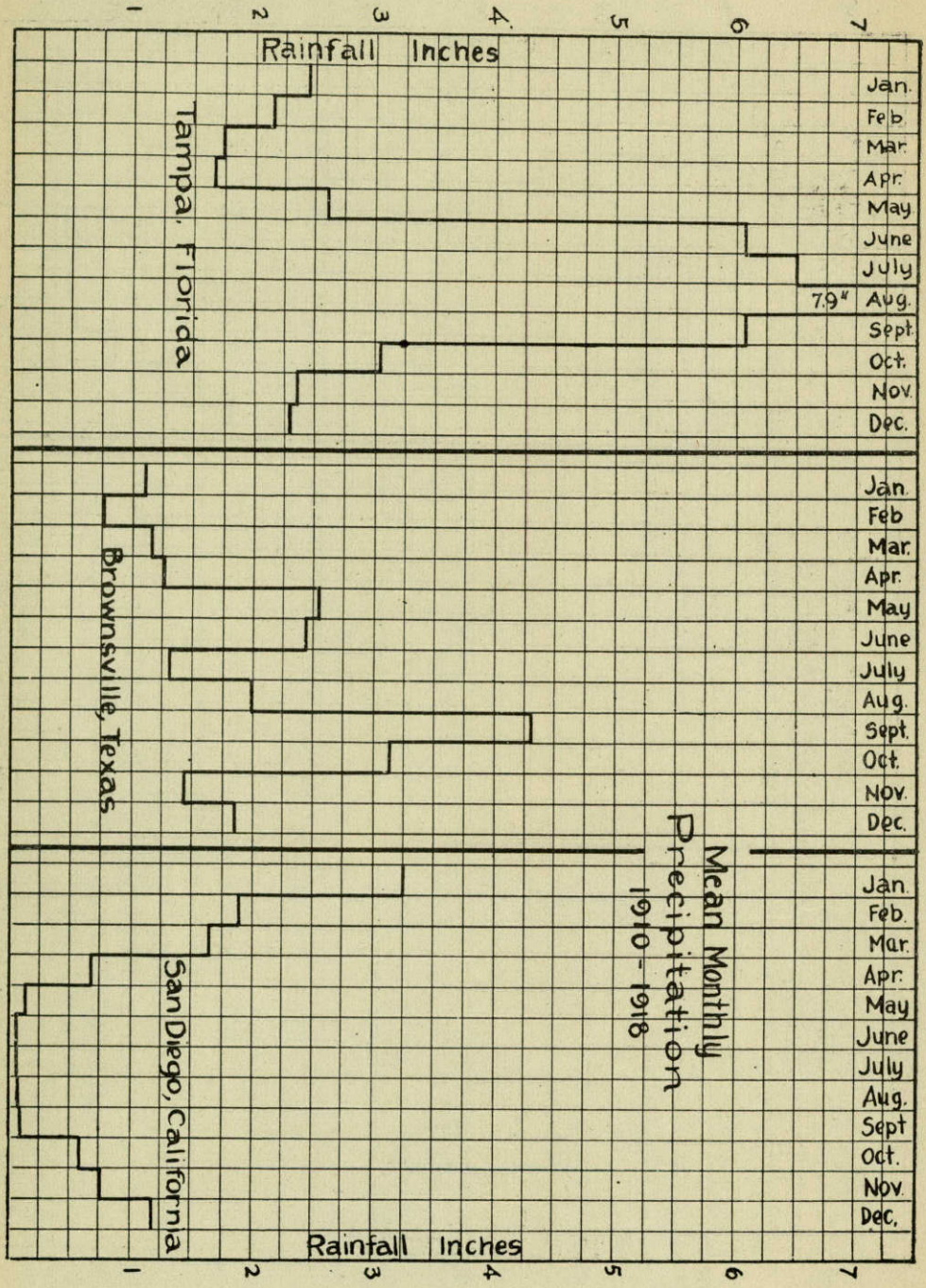


Chart No. 1.—Chart showing comparative temperatures of Brownsville, Texas, Miami, Florida, and San Diego, California. Courtesy of the United States Reclamation Service.

Chart No. 2.—Chart showing comparative precipitation of Brownsville, Texas, Miami, Florida, and San Diego, California. Courtesy of the United States Reclamation Service.



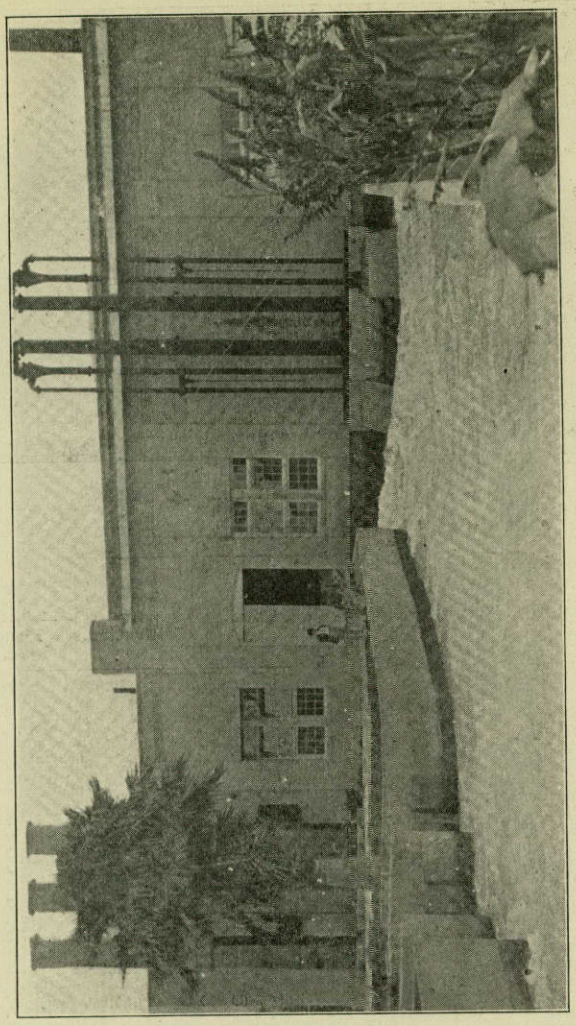


Fig. 6. Irrigation in the Valley. Mercedes Pumping Plant with two pumps, each of which has a capacity of 250,000 gallons per minute.

acres, up to the Mercedes plant, which waters an area of one hundred thousand acres. Below will be found a table giving the different systems, the total area of each, and the amount of this which is irrigable. Each system gets its water from a main pumping plant located on the banks of the Rio Grande River. Some of them in the Upper Valley have two and even three lifts, each lift being about thirty feet high. The annual irrigation charges are of two kinds; first, a flat rate per acre is charged against the entire acreage, second, a service rate which applies to each irrigation. These rates have not been standardized, and vary greatly under the different systems.

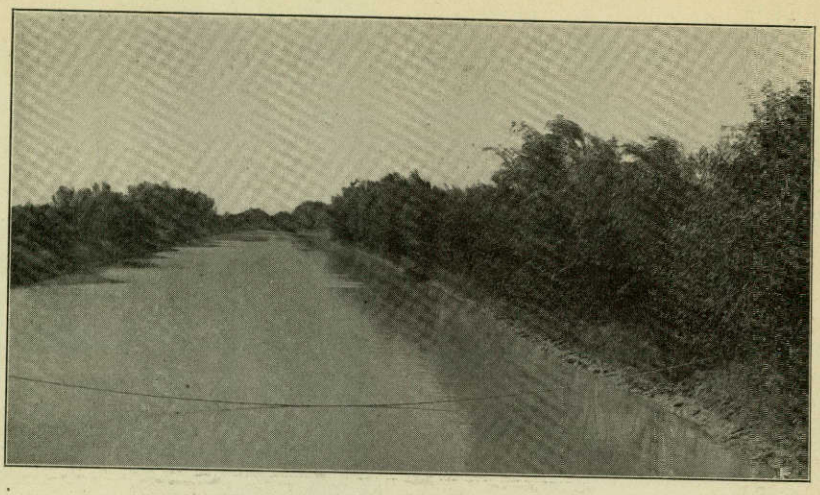


Fig. 7. Irrigation canal scene.

AREAS IN ACRES.

Irrigation System.	Total.	Irrigable or Under Cultivation.	Rates Revised to April 1, 1924.	
			Flat Rate.	Service Rate.
Mission, U. I. Co.	30,000	28,000	$4.00	$3.00 and $ 400
Edinburg, Hidalgo County, W. I. District No. 4	40,000	20,000	3.00	1.50
Rio Bravo	4,000	3,500		
McAllen, Hidalgo County, W. I. District No. 3	7,700	6,360	3.50	1.50
Pharr-San Juan, Hildalgo County, W. I. District No. 2	63,000	50,000	2.00	1.00
Donna, Hildalgo County, W. I. District No. 1	34,000	25,000	3.50	1.50
Mercedes-Rio Grande Land & Irrigation Co.	89,000	63,000	4.50	1.50
Santa Maria, Cameron County, W. I. District No. 4	4,000	1,500	3.00	1.25
La Feria, Cameron County, W. I. District No. 3	28,000	14,000	2.50	1.25
Harlingen, Cameron County, W. I. District No. 1	37,000	22,000	2.50	1.25
San Benito, Cameron County, W. I. District No. 2	68,000	36,000	2.75	1.50
Los Fresnos-Brownsville, Cameron County, W. I. District No. 6	18,000	9,300	3.00	1.00
Jardin-Brownsville, Cameron County, W. I. District No. 5	21,300	11,500	2.00	1.00
West Brownsville	2,000	1,800		
Rio Grande	20,000	18,000		
Totals	466,000	309,960	30 Main plants	

STATISTICS OF CITRUS PLANTING

Our reports from citrus canker inspection work, together with statistics obtained from destination and nursery inspections, show that there are approximately 2,000,000 trees planted in the Valley in orchard form at this date. Many of these trees are, of course, very young, and only a very small percentage are now in bearing. The more recent plantings are showing up much better than many of the first ones, as a result of more experience in the selection of locations, root stocks and varieties.

A count from every part of the Valley made in orchards of varying sizes, covering approximately a million trees, show that trees are planted in the proportion of 68% grapefruit, 28% orange, and 4% miscellaneous.

During 1920-21 three hundred thousand trees were planted, of which fifty thousand were Valley grown. In 1921-22 two hundred thousand were planted, of which seventy thousand were Valley grown. During the 1923-24 season, approximately four hundred and forty thousand trees were planted, as shown in the table given herewith:

TREES PLANTED IN 1923-24

Origin.	Grapefruit.	Oranges.	Lemons.	Tangerine.	Lime.	Miscellaneous.	Total.
Valley grown	185,088	101,607	40,290	5,704	5,249	336	338,274
Shipped in	44,481	53,470	995	1,111	191	29	102,277
Total	229,569	155,077	41,285	6,815	5,440	365	440,551

For the past four seasons the planting has been limited only by the supply of trees. The surplus of trees on sour stock from both Florida and California, together with the trees grown in the Valley have not been sufficient to meet the demand. During the 1923-24 season, the destination inspection reports show that 137,100 budded citrus trees, 726,625 sour orange seedlings and 21,506 scions were inspected and released from shipments made from Florida and California. Valley nurserymen are realizing these facts and are generally increasing their planting of sour stock so as to be able to supply their trade. The Valley should at no distant date grow all of the citrus trees that are planted there.

The following figures show the amounts of the principal classes of citrus nursery stock on hand in the nurseries of the Lower Rio Grande Valley District at the completion of inspection of such nurseries for the past two years:

TREES IN VALLEY NURSERIES

1922

Grapefruit	95,557
Round oranges	41,910
Lemons	6,347
Limes	1,276
Sour orange seedlings	745,167
Total	890,357

1923

Grapefruit	222,411
Round oranges	119,713
Lemons	21,551
Limes	5,535
Sour orange seedlings	1,591,430
Miscellaneous	11,772
Total	1,972,412

FRUIT SHIPMENTS FROM THE VALLEY

The first commercial shipments of any importance to be made from the Valley were during the season of 1921-22, when 54 carloads were shipped. In the following year 142 cars were shipped, consisting of the following classes of fruit, as shown in the table, giving the totals in boxes:

	Grapefruit.	Oranges.	Lemons.	Limes.	Total.
By freight and express	35,048	4,516	1,774	20	41,358

SHIPMENTS FOR THE SEASON 1923-24 IN STANDARD BOXES.

	Grapefruit.	Oranges.	Lemons.	Limes.	Total.
Express	25,489	5,893	862	4	32,248
Freight	38,205	548	447		39,200
Otherwise	1,427	25			1,452
Total	65,121	6,466	1,309	4	72,900

The figures show an increase over last year's shipments of 71%. The citrus exchange handled through its Harlingen and Sharyland packing houses 39.6% of the entire crop. While every town in the Valley shipped fruit this season, the principal shipping points were: Mission, which shipped 29.6% of the crop; Harlingen, which shipped 24.8%; San Benito, which shipped 16.1%; and Donna, which shipped 8.9% of the crop. Freight shipments amounted to approximately 60% of the total, and the express shipments account for the other 40%.

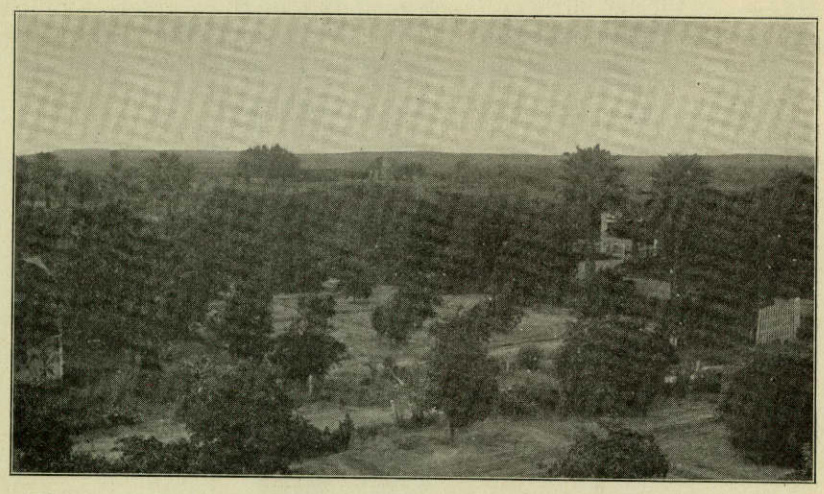


Fig. 8. Panoramic view of a Valley home and orchard. (Taken from Monty's Monthly.)

CITRUS CULTURE.

SEED BED

The foundation of a citrus grove is the root stock on which it is budded. Experience in the Valley has shown that sour orange stock is by far the best for Valley conditions. Many others have been tried only to be discarded. In planting a seed bed, care should be taken to plant only pure sour seed. There are a number of methods that have been successfully used in growing sour seedlings, but in all of them the seed beds should be carefully prepared. The seed should be soaked in water for several days before planting, changing the water twice daily to prevent souring. During extremely hot, dry weather, a half

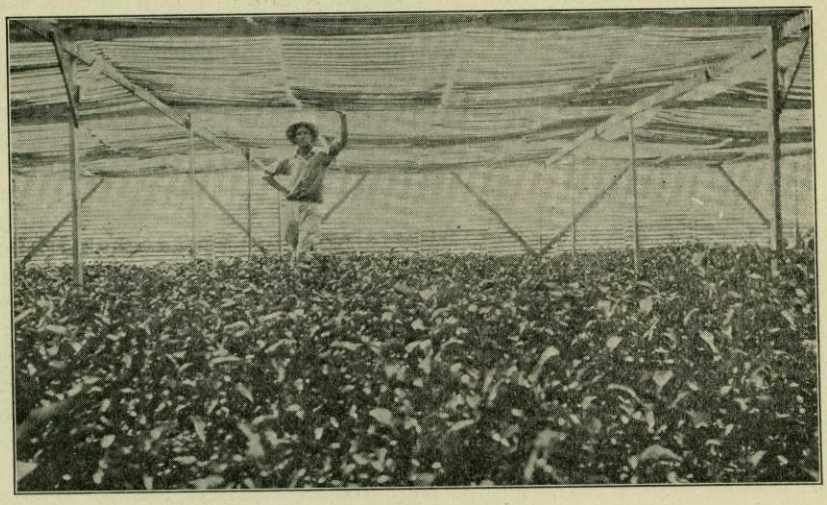


Fig. 9. Seed bed under half shade.

shade system or lathe house should be used to protect the young, tender plants. Too much shade, however, encourages "damping off." Where shade is used over the seed bed and space is limited, planting the seed in beds four feet wide, using a path one foot wide between the beds and spacing the seed one to the square inch, then covering with an inch of clean sand, has been very successfully used.

The use of sand to cover the seed aids the small plants when coming through the surface, as the sand does not crust as ordinary soil usually does. Sand also contains very little organic matter, and serves another useful purpose in assisting the prevention of "damping off." Another method is to make a flat bottom furrow four or five inches wide, spacing the seed, as above, in the bottom of the furrow and then covering with sand as given. These furrows are placed about two feet apart to give room for cultivation and irrigation. Good seed usually takes two to four weeks to germinate, and the beds should be kept con-

stantly moist from the time the seed are planted until they are up. After sprouting, they should be watched closely, and at the first sign of "damping off," the beds should be sprayed with a 3-3-50 Bordeaux mixture, covering the soil as well as the plants (see scab). The "damping off" can be recognized by the seedlings wilting down, and on examination the stems will be found to be discolored near the surface of the ground. Aeration of the soil by frequent shallow cultivation is one of the chief means of preventing and controlling this disease. The seedlings should be kept growing thriftily by frequent irrigation and cultivation. Care should be exercised in irrigation and only enough water used for the proper growth of the seedlings, as an over abundance of moisture is the principal cause of "damping off." One must use judgment in applying water to the seed beds, as soils and conditions vary and often a shallow cultivation will be better than an application of water.

The seedlings may be lined out in the nursery row from the seed bed, when the size of a lead pencil or larger, preferably in the winter or early spring months. Where the seedlings are all dug at once, the soil may be left a little dry, but if only the larger plants are taken, the ground should be soaked and the selected plants carefully pulled to avoid breaking the roots. When out of the ground, the roots should be trimmed to eight or nine inches long and the tops pruned back approximately one-third of their length, and complete defoliation is advised.

Extreme care should be taken not to unduly expose the roots to the sun and air. The nursery rows should be four feet apart and the plants should be placed sixteen inches apart in the rows. Between every four or five rows, an eight-foot row should be left to accommodate heaters for winter protection. This allows sufficient room for balling trees when taking them to set out in the orchard. When ready to plant the seedlings in the nursery rows (the ground being well prepared previously) furrows should be plowed eight to ten inches deep. The seedlings are placed by hand in their proper place, and the soft earth is carefully thrown up about the roots and the lateral roots placed the same depth and direction they were in the seed bed. The soil should be thoroughly firmed around the roots and the irrigation water should follow closely after planting. Irrigation and cultivation of the stock in the nursery row should continue. For the best results, stock should be allowed to get at least one-half inch in diameter before budding. They may be budded before this, but nothing is gained by so doing.

SELECTION OF BUD WOOD

Having decided on the varieties to be used, the next step is the selection of the bud wood and of the trees from which to obtain it. These trees should be known to be consistent bearers of large crops of good type fruit of their variety. The bud wood should be taken from the limbs showing blossoms or fruit. The bud stick should be matured wood from the next to the last

growth, and should be round and full, with strong, prominent dormant buds and more or less the size of a lead pencil.

BUDDING

Citrus budding can only be successfully done when the bark of the stock slips freely and by using dormant buds as described above. These conditions being present, a "T" cut is made in the bark of the seedlings four to six inches above the ground. The vertical cut is made about an inch long and the cross cut is usually made on the top of this (sometimes this operation is reversed) and the bud inserted from below.

The bud is then quickly cut and inserted, right side up, in the cut. The bud is pushed down until the upper end is at least a

Fig. 10. Citrus nursery stock protected by oil heaters.

quarter of an inch below the cross cut, and then firmly bound with a strip of waxed cloth by wrapping tightly around in such a manner as to exclude both air and moisture, and to hold the bud closely to the cambium layer of the stock. This wrapping is left on for fourteen days. If the cut has calloused well, it is entirely removed and part of the foliage of the seedling is removed to force the growth of the bud. A little foliage is left on at the top to serve foliage functions. As the bud grows, it should be tied up to help support the weight of the new growth and to keep the trunk of the new tree straight. At first the bud may be tied to the trunk of the seedling in which it is budded, but stakes should be used as the bud grows taller. These stakes should be about ½x1 inch and 32 inches to three feet long and should have one end sharpened. They should be placed in the ground close to the growing bud and in such a manner that the stalk of the seedling can later be cut off above the bud without interfering with the stalk. This may be done when the bud is about one-half inch in diameter. This cut should be started

close to the bud and sloped downward at an angle of about forty-five degrees. The wound should be covered with melted wax or paint. All suckers should be removed, forcing the entire growth of the plant into the bud. The head of the tree should be allowed to grow higher than desired so as to give a

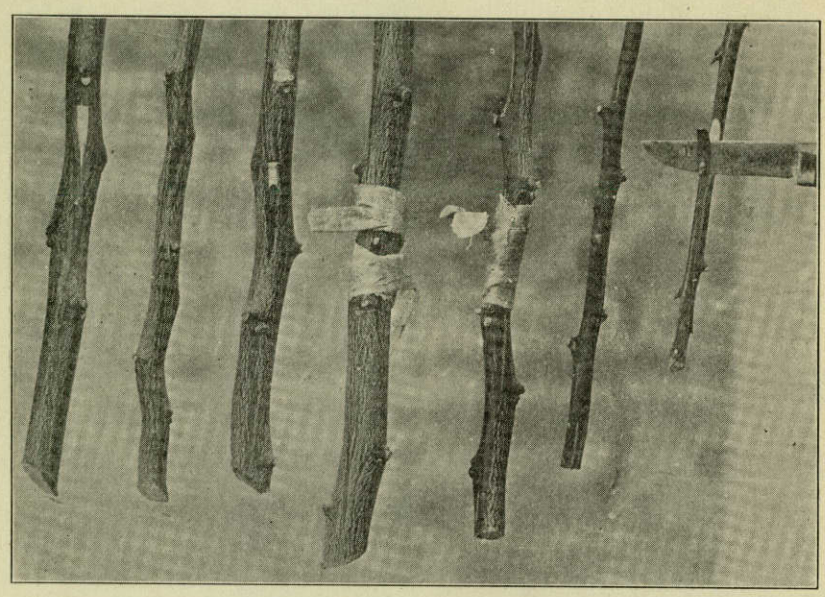


Fig. 11. Budding, showing all stages (reduced.)

good sturdy trunk. The head is usually made from 24 to 30 inches above the ground. When large enough the top may be cut off at 30 inches, and to force out the branches the leaves are removed about six inches from the top downward. This, of course, applies to the branching of the tree at any height that may be desired.

A good head has never less than three and never more than five main branches.

SELECTION OF SEEDLINGS

Mr. H. J. Webber of the California Experiment Station is carrying out some very interesting experiments in the selection of stocks in the seed bed. His experiments so far show the necessity of the careful culling out of all inferior and small stocks, both in seed bed and nursery. He shows that the proportionate difference between the large, medium and small seedlings from the same seed bed apparently continue on for the life of the tree. Good nursery men everywhere do considerable culling out of inferior plants. There is no question but that the culling should be carried much farther than it is and all undersized and inferior plants eliminated from the nursery, and only the most healthy and vigorous stocks should be budded. Careful attention to these points and the selection of bud wood from the best

strains of the various varieties would undoubtedly give much longer lived and more profitable citrus trees.

ROOT STOCKS

While sour orange stock best suits Valley conditions and assists in the prevention of gummosis and root rot of grapefruit, oranges and lemons, it is not compatible for kumquats and some

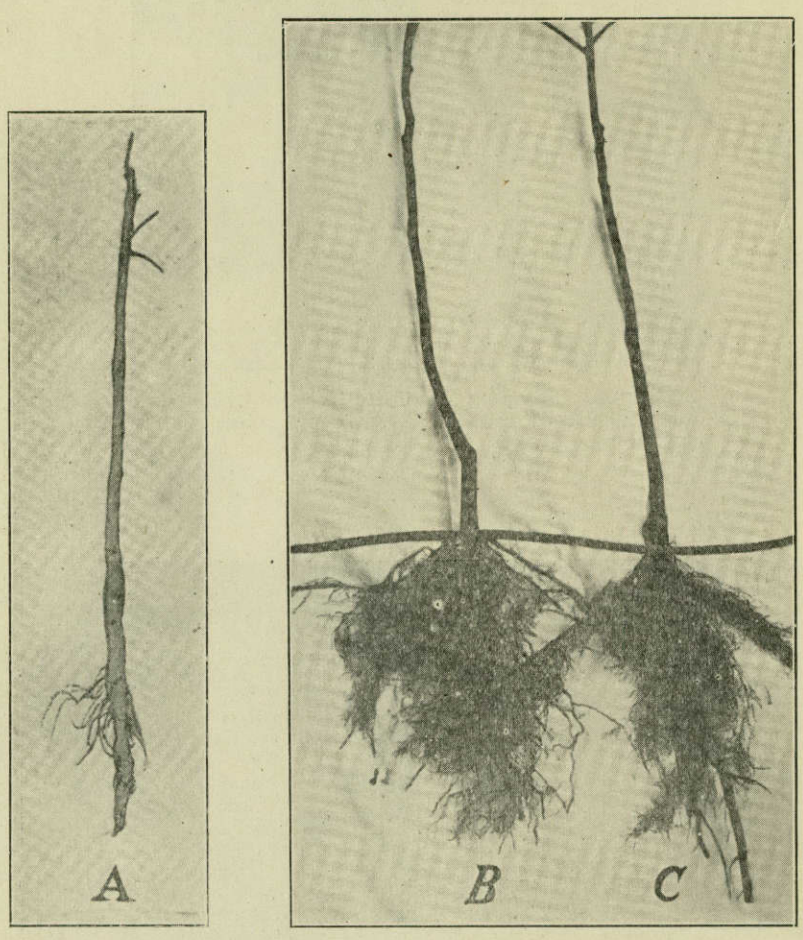


Fig. 12. (A) Poor nursery stock. (B) and (C) Good root systems on nursery stock. Line of rope shows where the general level of the soil should be when trees are settled.

of the limes. Other stocks are being tried out in the hope of finding a stock that will do well in the Valley and also be compatible with these classes and varieties.

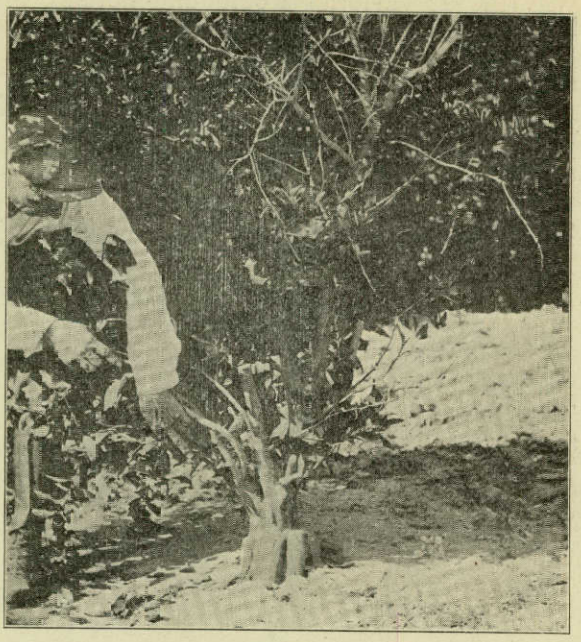


Fig. 13. Satsuma on Trifoliata root, showing enlargement of root stock growing under Valley conditions.

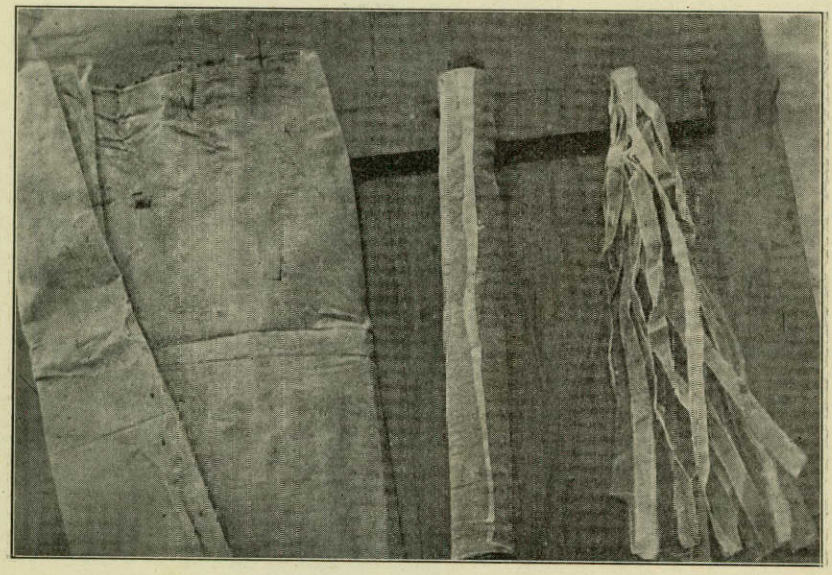


Fig. 14. Method for preparing budding cloth.

BUDDING CLOTH

For successful results in budding citrus it is necessary to use wax cloth for wrapping the bud. Get a cheap muslin or thin sheeting that will tear easily in narrow strips when waxed. Tear this in lengths as wide as the strips are to be long. This will vary with the size of the stock to be budded. Usually ten or twelve inches is sufficient. Take a round stick a little longer

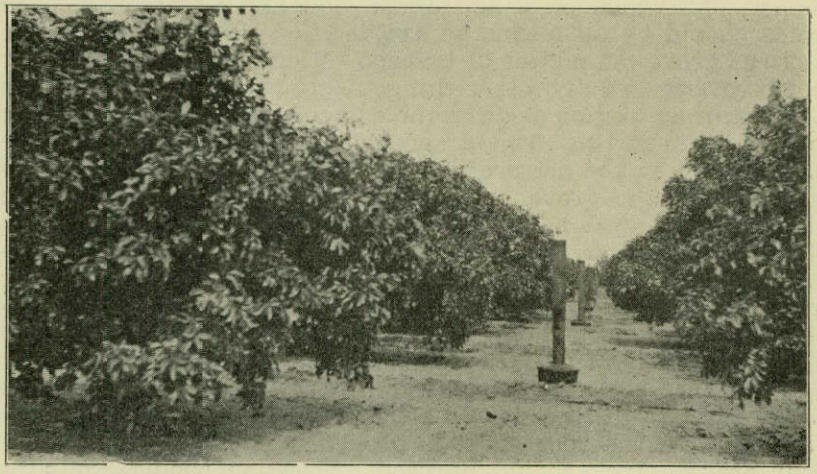


Fig. 15. Four-year-old Marsh seedless grape fruit grove planted 18x25 feet apart. Trees growing together the 18-foot way.

than the cloth is wide, and roll the cloth tightly around it until the roll is about two inches in diameter. It is then tied at the end so that it cannot unroll. The rolls so prepared are then placed in the hot wax until all parts of the cloth have been thoroughly penetrated by it.

The roll is then taken out unrolled and allowed to cool, after which it should be torn into strips about one-half inch wide, and is then ready for use. The wax used for making this cloth consists of two parts pure beeswax and one part of rosin, which is used to stiffen it. No oil, tallow or grease of any kind should be used, as it will make the wax so soft that in the hot sun, it will run and ruin the bud.

Sometimes instead of rolling the cloth on the stick as described above, the cloth is folded and dipped into the hot wax and the excess wax removed by drawing the cloth in between two small sticks held closely together. It is then folded while still hot and the narrow strips torn off when needed. Another method is to lay the cloth out flat and spread the hot wax thinly with a paint brush. In all these methods the idea is to get the cloth thoroughly permeated with the wax, but with the use of as little wax as possible.

LOCATION

The ideal location for a citrus grove is a high, well drained sandy loam. The location should have good air drainage as well as good water drainage. A site with good air drainage may be several degrees warmer than a lower point near by and this may mean the difference between a severe frost injury and none at all. Ideal conditions cannot be found on every farm, but one should approximate them as nearly as possible. Low heavy soils which bake and crack, and alkali soil or seepage lands should by all means be avoided. In selecting a site for a citrus grove the matter of transportation of the product must not be overlooked and other things being equal, a location close to a railroad station is preferable to one farther away. The cost of transporting fruit a considerable distance makes quite a difference in the net profits yielded by the grove. After the location for the grove has been selected, the land should be thoroughly plowed, harrowed and floated and put in first class shape for planting. If uneven, it should be leveled and all arrangements made for proper, permanent irrigation. A regular and sufficient supply of water for irrigation is absolutely essential for the permanent success of a citrus grove. After the situation has been decided upon, the *selection of the trees for planting, the varieties to plant* and *the distance apart they are to be planted* are the next matters of moment. In the selection of trees the root stock is of prime importance and only sour orange stock should be used. Selection should again be practiced as mentioned previously. The trees should be well grown, stake trained and properly headed, and one or two years old from the bud. Older trees may be planted, but one or two-year trees usually give the best results.

Fig. 16. Scene showing trees planted too close together, with limbs lapping at an early stage.

Fig. 17. Five-year-old grape fruit tree 23-foot spread.

TIME OF PLANTING

The best time to plant is after the danger of frost is past in early spring. Fall or winter planting is advocated by some, but the questionable advantage is more than offset by the possible damage from cold weather.

VARIETIES

The characteristics of the different varieties and their desirability for Valley conditions are fully discussed in another part of this bulletin.

DISTANCE FOR PLANTING

The common fault found in most of the early plantings in the Valley is that of planting the trees too close together for best results. In deciding upon the distance apart to plant, it should be remembered that the feeding roots of a citrus tree go some distance beyond the spread of the branches. There are many ten and fifteen-year-old trees in this section with a spread of twenty-five and thirty feet across and sufficient distance should be allowed between the trees when planting that when the trees have reached their full size they will not crowd one another. In view of this they should not be planted closer than twenty-five feet each way and even at this distance it would probably be best to make every fourth row one way still wider to allow access to all parts of the grove for spraying machines, wagons hauling the fruit, etc. The regular square planting seems to give the best results and allows easy access to all parts of the grove. Many are now planting 30 by 30 feet. The laying out of the orchard should be carefully done and the tree positions accurately marked so that when the trees are planted

they will line up in all directions. This may be easily done by the use of a wire with the planting distance marked upon it. The wire may be so marked with a drop or two of solder. At least twenty-five feet should be given between fences or canals and the first row of trees, to allow for cultivation after the tree has attained large size.

After the ground has been staked out and when the trees are on hand ready to plant, the holes should be dug, usually about eighteen inches in diameter and eighteen inches deep. If balled trees are used, the trees should be placed in position and the top of the ball left about two inches above the general level of the surrounding soil. The soft top soil should be filled in around the ball and packed firmly. After placing the tree and filling in part of the dirt, loosen the burlap on the upper part of the ball and press this burlap down, covering it with soil as the hole is filled. If the burlap is left on and exposed, it tends to dry out the ball of earth around the tree. The object of leaving the ball slightly above the surrounding level is to allow for the settling of the soil when water is applied. The irrigation water should follow closely behind the planting. If the trees are bare rooted, care should be taken not to expose the roots any more than it is possible to the sun and air. Any broken roots should be removed with a sharp knife. Many trees in the Valley have been placed too deep, therefore this factor should be given more attention. See Figs. 18 and 12, B. & C. The tree should be placed in position and the soft top soil put in around the roots, and packed firmly. Each root should be carefully placed by hand in the position in which it was when in the nursery, lateral roots angling somewhat downward in such position as would support the tree on all sides.

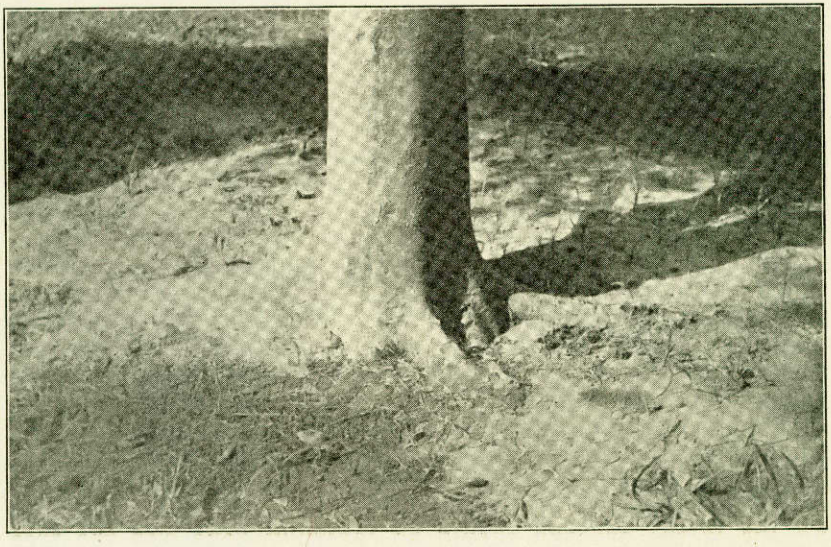


Fig. 18. A properly planted tree. (Note the roots at top of ground.)

With bare root trees as with balled trees, the top lateral roots should be at least two inches above the general level to allow for the settling of the soil, and the irrigation water should follow the planting even more quickly than with the balled tree.

IRRIGATION OF YOUNG TREES

It will be necessary during the first year after planting to irrigate the young trees quite often. They are forming a new

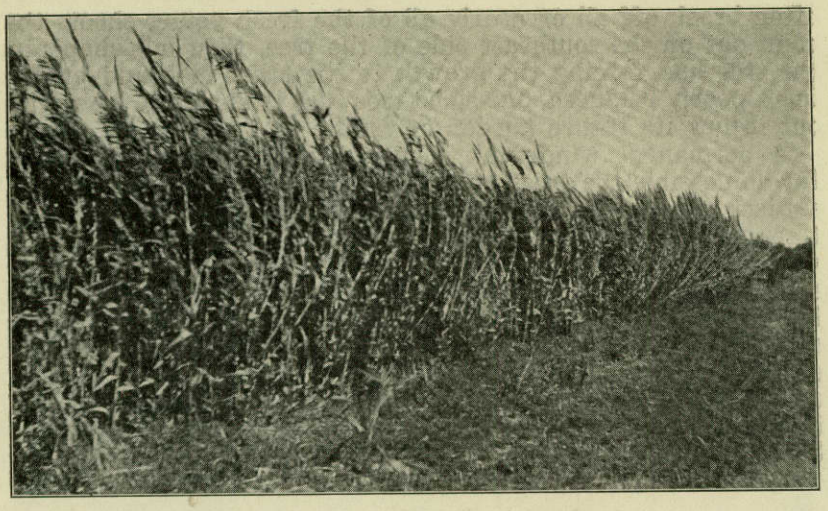


Fig. 19. A windbreak of bamboo.

root system and need more water to supply their needs than they will later when the new root system is fully developed. The ground should be cultivated as soon as possible after each irrigation and frequent shallow cultivations should be given between irrigations, conserving the water in the soil as much as possible. The same methods with possibly less frequent irrigations should be continued the following year. Irrigation should be lessened toward the fall to permit hardening of wood in order to better withstand low temperatures. If winter rains are insufficient, however, irrigation must be resorted to.

WINDBREAKS

The matter of a windbreak for the protection of the grove is a vital one, and where possible the windbreak should be planted even before the grove is. But this seldom being possible, a permanent windbreak should be planted soon after planting the grove. While this permanent windbreak is developing, the young trees should be protected for at least the first three years, while the framework of branches is being formed. This protection may be given by planting early in the spring several

rows of field corn between each row of trees, taking care never to put the corn closer than six feet to the tree row. This allows plenty of room to cultivate the trees on either side.

The corn should be drilled closely in the row so as to be thick enough to give protection from the strong southeast winds of springtime. It is to be understood that while one will probably get enough corn to pay for the labor, that it is not being planted for the crop but in order to protect the young grove and allow the young tree to develop a well balanced head. Without this protection the strong southeast wind will often break off all or nearly all of the fresh young shoots that comt out on the southeast side of the tree, thsu mis-shapening the tree and forcing the growth to the other side and producing a poorly balanced, one-sided tree that is unable to bear without injury its future burden of fruit.

A permanent windbreak should always be planned, and as far as possible the trees and plants should be used that are not subject to any of the insects and diseases that affect citrus trees. Trees that are land robbers should also be avoided, as well as plants that are too rampant growers and inclined to spread rapidly and so be difficult to keep under subjection and in their proper places. For quick protection around a grove, a vigorous growing plant that some have used with considerable satisfaction is "Bamboo grass." This grows to a height of ten and twelve feet in a few months' time and is easily kept in its place. The various kinds of palms, both the Washington and Phoenix, are poplar with those who have them and

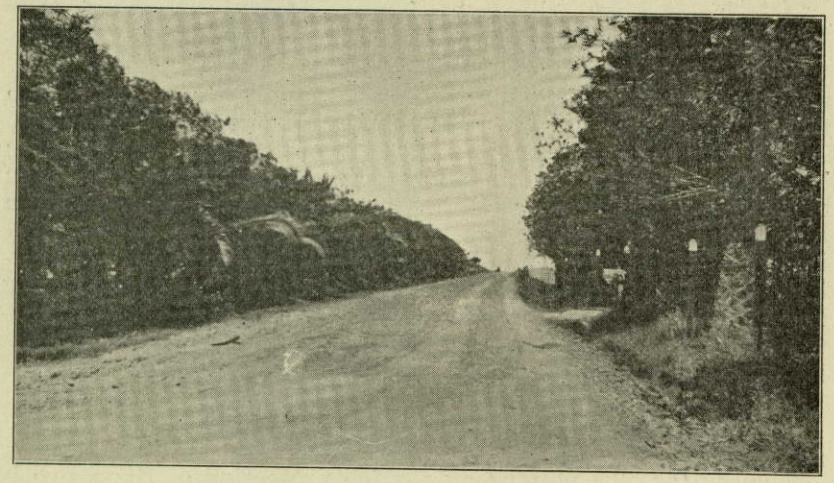


Fig. 20. Windbreak of alternating Oleander and Palm.

especially so where some close growing shrub is planted between them. There is a fast growing tree, *Tamarix-articulata* (Athel), that is said to have given wonderful results as a windbreak tree in Arizona and California. Small cuttings put out in the spring of 1922 at Laredo, had already made trees twelve

feet high and three inches in diameter at the base by November. Experiments are now under way with this and other shrubs and trees. Oleanders have been planted in hedges alone and alternately with palms, either of which plan gives good protection, but have the undesirable feature of being host plants to

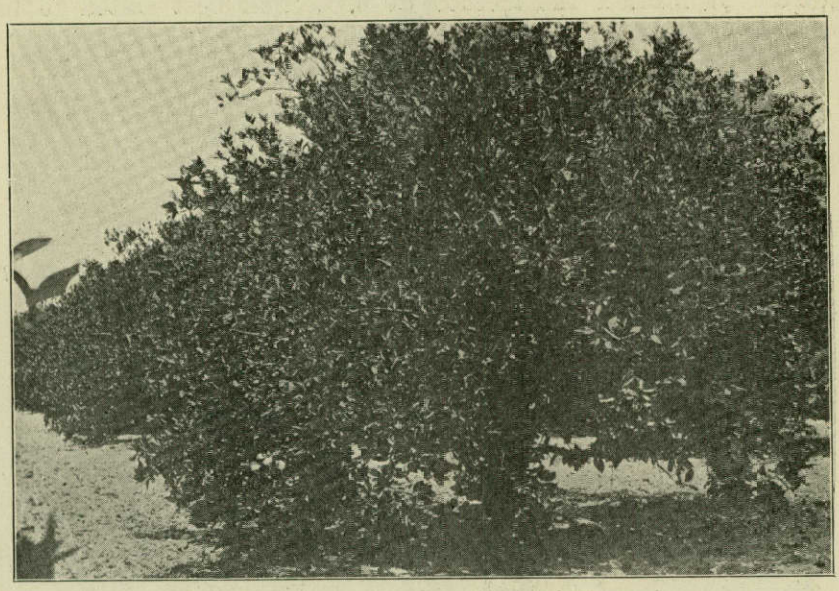


Fig. 21. Orchard scene.

some of the insect enemies of citrus trees. Eucalyptus trees have been used to some extent in the older citrus growing sections and they have the desirable quality of very rapid growth and freedom from citrus insects and diseases. On the other hand they are soil robbers and injure anything planted close to them. A properly planned windbreak, however, is a necessity to a citrus grove and is well worth the extra land that it uses. Leave twenty-five to thirty feet between the windbreak and the first row of citrus trees.

A windbreak does not necessarily mean a wind stop. Primarily a windbreak is to check the force of strong winds or to deflect their course, but should not check entirely the circulation of air through the grove, nor stop the atmospheric drainage. A tight windbreak may at times be a disadvantage by making the air too still within the protected area and so increase the danger from frost. A proper windbreak should check the strong prevailing southeast winds of spring and summer and so prevent mechanical injury to the trees, and also deflect the cold dry winds or the occasional norther. It is best to plant the windbreak far enough from the orchard trees that they will not suffer from its shade or lack food or moisture, caused by its proximity. There has been considerable discussion in the Valley as to where the windbreak should be placed

for the best protection of the grove, some advocating the north and west sides and others the east and south, but there is no question but that the best protected grove is the one with an effective windbreak on all four sides. Each grove owner should study the conditions surrounding his location and decide for himself the method of protection best suited to his particular needs.

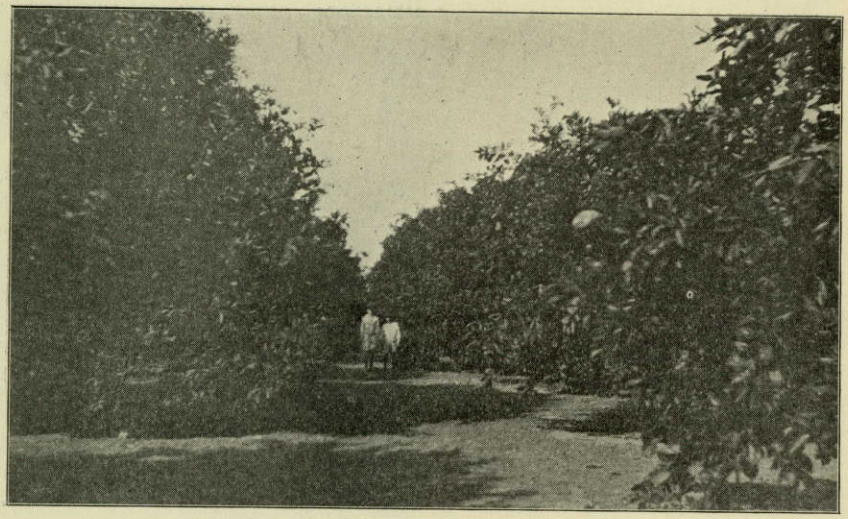


Fig. 21a. Orchard scene.

IRRIGATION

As previously indicated the young grove should never suffer for lack of moisture and should be irrigated as often as necessary, and this may possibly mean as often as one a month or six weeks during the summer. After each irrigation the moisture should be conserved in the soil by frequent shallow cultivations. The water of the Rio Grande carries considerable deleterious salt content at all times. There is less of this salt during the flood stages of the river and it increases as the flow of water decreases, being strongest when the river is at its lowest stage. Consequently, while the grove should be irrigated, the location, type of soil, drainage conditions and the frequency of cultivation will determine the length of time between irrigations, and such periods should be lengthened as much as possible by frequent shallow cultivations. Cultivation also helps to eliminate the salts deposited by the irrigation water. Winter truck crops are sometimes planted in the young grove, but this is not to be recommended as it forces a tender growth on the trees at a time when they should be dormant. The same close attention to the needs of the grove should be given all through its life time. Citrus fruits are composed largely of water, consequently, the condition of the soil in the bearing grove should be given constant attention so that the trees will not lack for sufficient moisture. No shock should be given the trees, however, from the time they are in bloom until fruit is well set. Consequently trees should not be irrigated during this period where they have been allowed to become so dry that the application of water will be a shock to them and possibly cause a loss of fruit. Even after fruit is well set, if trees are allowed to suffer for water and are suddenly irrigated heavily, a cracking of the fruit will result. Regular irrigation is important.

FERTILIZATION

Generally speaking the soils of the Valley are exceedingly rich and productive, but it is evident that some of the land types lack humus and others would be more correctly balanced in available plant food if properly fertilized. Many of the citrus orchards have been bearing good crops of fruit for a number of years without the addition of any fertilizer whatsoever, and would probably continue to do so in a less degree; but there is no doubt that the continued use of the land for the same crop will in time deplete the richest soil. This should not be allowed to happen as it is easier to keep the soil in good condition than it is to build it up after it has been depleted. The annual returns will be far better and the fruit will be of superior quality from the grove where the soil fertility is kept up than from one where it is allowed to deteriorate.

The method of correction of soils naturally varies with the soil in question. On the account of the high fertility of the Valley soil, very little effort has been directed toward this problem,

but as stated above, attention to this important subject is imperative.

Humus may be supplied by an application of well rotted barnyard manure. This may be applied as a top dressing and then plowed under. Another method—one that has been used successfully in Arizona—consists in plowing furrows with a double mold board plow or "middle buster," nine or ten inches deep just outside the spread of the branches and on both sides of the trees. The manure is applied in the bottom of the furrow and the dirt plowed back over it. These last furrows are then used for the next irrigation, after which the soil is again leveled. Probably the cheapest way to apply humus to the soil is by plowing under crops of legumes. Bur clover and Melilotus indica are also being used by some growers as a nitrogen supply and as a winter crop, with good results. Cow peas may be drilled in between the rows of "windbreak corn," or they may be either drilled or broadcasted among the trees after the corn has been cut. One of the best ways is to pass a disc-harrow over them and allow them to dry somewhat before being turned under.

Nitrogen, acid phosphate and potash are needed in varying quantities on the different soils. These plant foods generally function in producing plant tissues as follows: Nitrogen—foliage and twigs; acid phosphate—fruit; potash—matures fruit and wood. Commercial fertilizers have been used to advantage in supplying these needs. Many growers are using from one to seven pounds per tree, of five hundred pounds per acre for their large trees, of a fertilizer having twelve per cent available phosphoric acid and four per cent potash, and using a top dressing of well rotted manure or cotton seed meal for their nitrogen. Ordinarily it is a good rule to apply one pound of fertilizer for each year of the age of the tree, up to complete maturity, three times a year. The first application is to stimulate growth in the spring, the second to mature the fruit and the third to balance the wood growth. One of the best methods of applying the commercial fertilizer is to broadcast it over the ground in a ring, two or three feet wide just outside the spread of the branches. In the older groves it may be broadcasted over the entire surface of the soil not covered by the trees, as a large proportion of the feeding roots of the tree are beyond the spread of the branches. The fertilizer should be hoed or disked in as soon as possible after being applied. It is very quickly fixed in the soil if covered, but loses part of its strength if left exposed.

The addition of iron sulphate to the soil at the rate of two pounds to the medium tree will do much to correct excess lime in the soil and to add color to foliage and fruit.

Potash in varying proportions and as directed with the various brands of commercial forms, will do much for wood

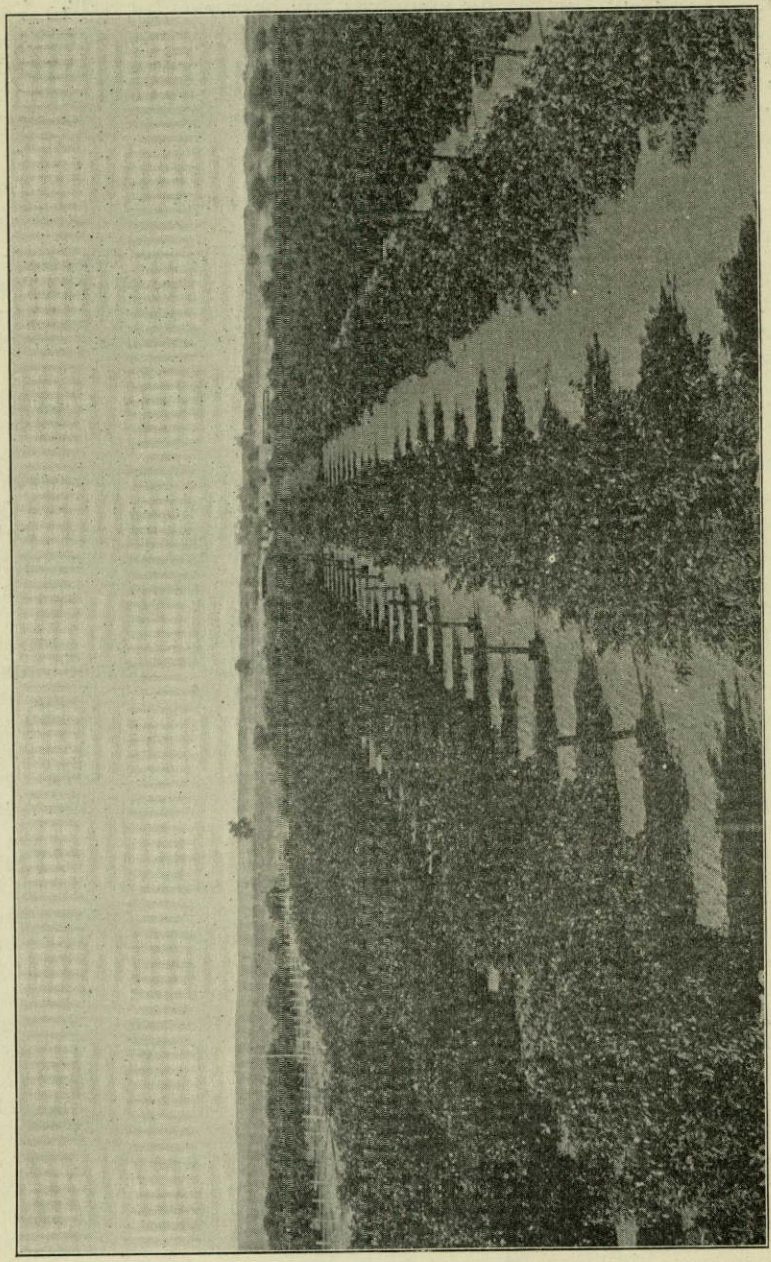


Fig. 22. Panoramic view of citrus grove. (From a supplement to Monty's Monthly.)

growth and will serve in the capacity of encouraging the tree to dormancy.

The study of the fertilization of citrus groves under Valley conditions is one upon which a great deal of work remains to be done, as each type of soil will probably require different combinations of fertilizing elements for best results. The Valley is to be congratulated since the Legislature, just adjourned, provided for the much needed experiment station in so generous a manner. It will have a wide and virgin field and the results of its work should be of inestimable value to the fruit growers and farmers of the Valley.

Fertilizer for Nursery Trees.

Citrus trees in the nursery may be pushed by the application of a balanced commercial fertilizer. One with 3 or 4 per cent nitrogen, 6 to 8 per cent phosphoric acid and 2 per cent potash, should give good results. Various modifications of this may be used as individual needs indicate.

PRUNING

Pruning is one of the activities of the nursery and grove which gives great latitude for individual judgment. Primarily, pruning is the shaping of the tree into a round sturdy, well balanced framework of the trunk, limbs and branches in order to make possible the production of a full crop of fruit and the carrying of this heavy burden without injury.

Sunlight is also essential to the welfare of the trees and to the production of fruit and the inner portions of the tree must receive such or it will remain barren. Too much sunlight on the other hand is disastrous. It must be understood also that plants depend to a great extent for their food upon the functioning of the foliage, and any serious interference with the comparative relationship between the root system and the foliage growth is injurious to the tree.

With these facts in mind and starting with small trees, they can be trained by pinching off the tip of the new growth when it has reached the desired length. The shorter the length of the joints between the forks of the limb, the stronger and sturdier will be the framework of the tree. In the training of the young tree the sprouts should be pinched off when ten or twelve inches long and forced to make a fork. The two branches should then each be forced to fork again in another ten or twelve inches. The process should be used on all of the branches until the tree has been perfectly shaped. When pinching off or cutting off the end of the branches, always take care that the last bud left on the branch points in the direction that you wish the new limb to grow.

The proper pruning of an old or neglected grove is a more difficult problem, and one that should, as a rule, be left to the experienced man who has had proper training. Such men are

exceedingly scarce in the Valley and it sometimes becomes necessary for the owner to do such trimming himself. In all pruning, *one of the first necessities is sharp tools suited for the work at hand.* These should consist of a pair of well shaped nine-inch pruning shears, a large pruning shears with handles about two feet long, a good pruning saw and possibly a chisel or two. The saw should have plenty of "set" for working in green wood. Be sure and *start* with *sharp tools* and *keep them sharp,* as good work cannot be done with dull and improper tools. Each individual tree is a problem in itself and should be studied as such, always keeping in mind the end you have in view, of the strong framework, sun protection, aeration, sunlight and a well shaped tree. Sometimes it is necessary to remove large branches that are close to or dragging on the ground, or large water sprouts which have been allowed to grow. When the tree of this kind has been properly pruned, the lower limbs should come down evenly to within a foot or fifteen inches of the ground and none should be below that. Each succeeding crop of fruit will pull down some of the limbs until they rest on the ground, consequently, the older trees will need some pruning each year. All dead or dying limbs should be removed. The citrus tree, before it begins to bear, can be safely pruned at almost any season of the year. However, it is best not to do any severe pruning late in the fall as this will start a new growth at a time when the tree should be dormant. Probably the best time for pruning bearing trees where severe pruning has to be done in the early spring is just before blossoming time. Bearing trees should not be pruned during blossoming time nor until the fruit is well set, say one inch in diameter, as any shock, good or bad, to the tree during the blooming period and while the fruit is small is likely to cause the tree to throw its fruit. This is also the reason why trees should not be irrigated during this same period, especially when they have been allowed to become so dry (which should never happen but does) that the application of water will be a shock to the tree and possibly cause the loss of fruit. In pruning the tree, all cuts should be made either close to the bud where new branches are to start, or where the limb or branch is taken off. The cut should be made parallel with the branch that is left and as close as possible to it. Never leave a stub. Where a stub is left it usually decays and gradually rots back into the main part of the tree. After the pruning has been done and all cuts made smooth and close to the part that is left, all wounds of any size, say half an inch or larger, should be covered with paint or hot wax. The wound should be allowed to dry, however, for several days before the paint is applied. The purpose of covering the wound is to protect it against the entry of the germs of decay until the bark has had time to grow completly over it. In pruning, it should always be kept in mind that leaf surface is very essential for the life of the tree, and a limb should not be removed without a purpose.

FROST PROTECTION

The disastrous freezes of 1894, 1895 and 1899 in Florida and those of 1912, 1913, 1919 and 1922 in California, and an examination of the weather reports of the Valley for past years are sufficient evidence to convince the broad-minded citrus

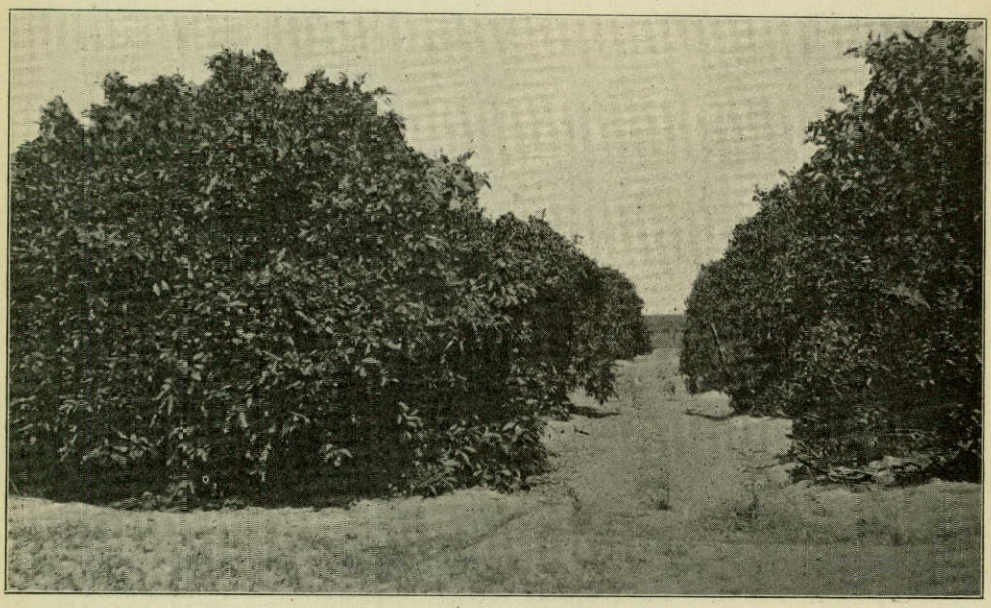


Fig. 23. Orchard scene.

grower of the necessity of having some means of protection against a sudden cold wave. Protection of a grove against freezing is just as important and just as much a part of the necessary equipment of a citrus grove as the cultivator or irrigation ditches. When you need protection you need it right now, and the next morning won't do. Therefore, a heating plant of some kind must be figured on in planning a citrus grove.

NATURAL FACTORS INFLUENCING THE TEMPERATURE

Elevation

Comparative elevation is a very important element in influencing temperature. Investigation shows that the lower portions of most districts are colder than the higher land of these districts. It must be understood that it is, in all cases, the relative elevation that is important, not the actual elevation above sea level. An adjoining lowland area, valley, or arroya that affords opportunity for the cold air to drain off is of a decided advantage. Air drainage is, therefore, as much of a factor as water drainage, and attention to both will much lessen the heating problem.

ARTIFICIAL METHOD OF PROTECTING GROVES

Along with the natural modifying agents of the temperature, as mentioned above, there are a number of artificial factors which regulate the temperature. *Windbreaks, running water, wrapping of the trees,* and *lath-coverings* must also be considered.

Windbreaks: The question of windbreaks, their benefit, detriment, and the comparative value of different trees, shrubs

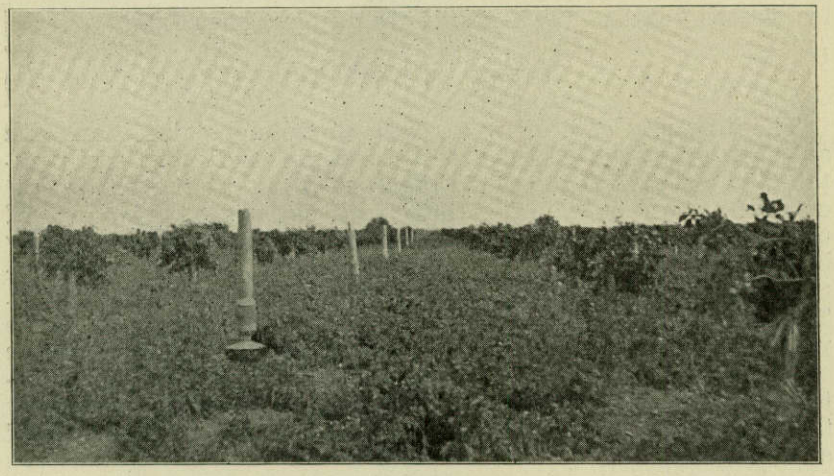


Fig. 24. Young grove protected by wrapping trunks with corn stalks and tule, and by oil heaters.

and grasses for such purposes, has been for many years a constant source of discussion. There are many good windbreaks which are enumerated under this head.

EFFECT OF RUNNING WATER OR IRRIGATION DURING FREEZE

In California one of the first methods of protection used was to run water through the grove. This is because water in being chilled gives up considerable heat. Experiments there have shown a well defined benefit from running water during a freeze. It is reported that after a freeze one small orchard of 500 one-year-old Valencia trees was found where one-half the trees had been irrigated. Ten per cent of the non-irrigated trees had been killed and the outer layer of growth on the remaining 90 per cent was badly injured, while the irrigated trees showed practically no frost injury.

Whereas the above would indicate that considerable protection might be obtained from running water, it should be understood that in very many instances little difference could be seen between the groves kept under water and those kept dry, and in but few cases did the trees show any greater vigor in putting out new growth.

Generally speaking, one should not rely on the use of running water to protect one's grove from freezing. No harm will result, however, from this practice, and if the temperature does not go too low, slight benefit may result.

EFFECT OF RUNNING WATER ON TREES

This method was also tried out in California and found impracticable, since a coat of ice soon formed on the trees so heavy as to break them down, and the injury from the heavy coating of ice was as great as the freezing would have been.

EFFECT OF WRAPPING

The difficulty of heating a young grove is greater than with an older grove where the trees are larger and more easily retain the hot air. The results obtained by wrapping the trunks of young trees or banking them with earth are, therefore, of much practical importance. When the trees are small they may be partly protected by banking with earth, which should extend up about one foot above the bud, or better, up to the limbs. The tree should, however, first be painted with a paste made with Bordeaux mixture, to each gallon of which one-half ounce of crude (Black) carbolic acid has been added. This should extend clear up to the limbs, and will to a certain extent keep your trees from being damaged by soil organisms. The carbolic acid also protects them from mice and insects. The trunk and tops may be protected with corn stalks, tule, or any such material. If this method is employed, enough material should be used so that when they are bound firmly in place, they will prevent the free movement of the air between them. The tops can not be well covered this way, but the trunk, when covered, will in most cases endure even a hard freeze.

When young trees are tightly wrapped as a protection against frost, it is important that the wrapping be removed before hot weather, as otherwise injury may result.

PROTECTION BY LATH HOUSES, BURLAP OR CLOTH COVERS

These coverings afford good protection to seed beds up to within a few degrees of frost. Lath-houses kept the temperature, in recent experiments, 4 degrees higher in the center of the house than the ouside of the house. It was found that the center of the house was about one degree warmer at the outer edge, near the sides.

PROTECTION BY ARTIFICIAL HEAT

The cold weather of 1913 demonstrated to the citrus growers of southern California that the only successful way thus far devised for counteracting severe freezes is by the use of orchard heaters. This cold spell lasted six days, with the thermometer

on three of these days going below 20, and even as low as 12 degrees. Reports show that in this particular instance success was not universal, but there were enough who succeeded to show that where the equipment and supplies were adequate, and the work done properly, heating was effective.

The same has been the experience of growers in the Valley. Where the heating equipment was adequate, and with sufficient fuel and wide-awake men in charge, large orchards in full bloom showed not the least effect of past cold spells.

EQUIPMENT AND MATERIAL

Most of the heating is done with oil burning pots. Many kinds of heaters have been tried in the Valley, some giving excellent results, some only fair, and others have been complete failures. Wood has been tried by some with fairly good results, while others have tried baled hay, but failed to secure any results whatever. Coke heaters are being tried out, and may be effective when perfected. The cold spells which occur in the Valley are of short duration, but occur very suddenly, and for this reason the type of heater must be one capable of heating quickly.

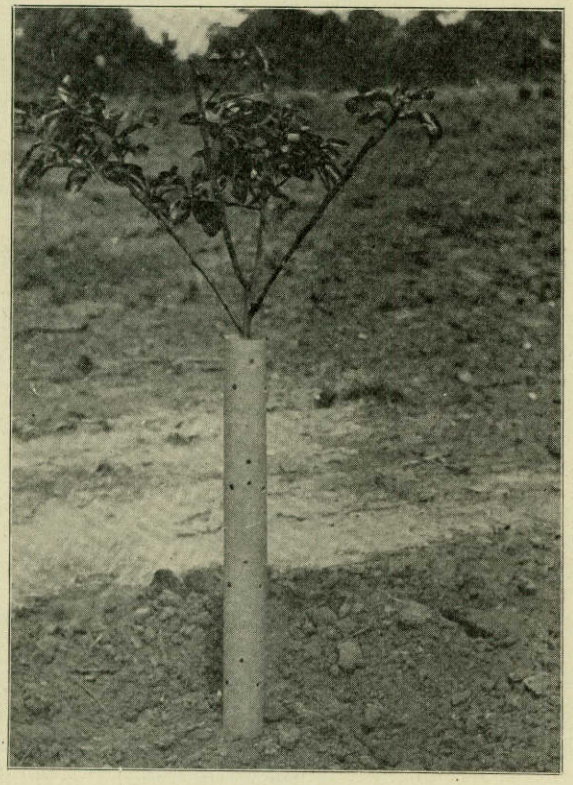


Fig. 25. Paper trunk protection for young trees

THE OIL POTS

The oil pots generally used vary in capacity from the two-gallon bucket to the large ten-gallon drum. Draft pots with stacks and gas combustion chambers are very efficient. The ten-gallon capacity tank is much more desirable, and it has been found that the larger pot with a ten-inch drum burned no more oil in a given length of time than a seven-gallon one with a much smaller drum, and the heat radiation was much greater. One conclusion very definitely reached by growers is that in the heating of an orchard, it is the actual radiated heat that is needed, rather than the smudge. The smoke given off by some oil heaters collects on the fruit and is hard to remove.

Coke Heaters, "Petroleum Coke," is being used quite considerably and with good results. Several good coke heaters are on the market. One of their numerous advantages is the fact that no storage facilities are required for the fuel. This can be piled up any old place without protection. Coke heaters are specially effective with nursery stock, as they heat closer to the ground.

METHODS

The groves in which the best results have been obtained have been equipped with one pot to the tree. Each pot will burn approximately one gallon an hour, when going full blast. This should raise the temperature of the grove from eight to twelve degrees higher than the outside temperature. Of course it is only during the coldest weather that it is necessary to have all the pots burning. One-fourth to one-half may be lighted for slight cold, and others lighted as it becomes necessary. It has been found difficult for many growers to get the right kind of help or to get it when needed. The use of the larger pots will reduce the amount of night labor needed, and the small ranch of ten acres ought to be handled successfully by two good men, if they are vigilant and their methods are correct.

TEMPERATURES AT WHICH TO FIRE

Past experience has shown that one of the most necessary precautions to take is to begin heating soon enough. There is a general agreement that it is easier to hold a temperature than to raise it after it has gone too low. For this reason, those who have had the most experience in heating, begin lighting up for the lemons at 31 degrees, but with oranges a degree or two lower may be risked before lighting up.

It has also proved of advantage to bank extra pots outside the grove along the windward side. Not only is this necessary in order to protect the outside rows, but it makes it much easier to hold the temperature within the orchard.

CAUSES OF FAILURE

The principal causes of failure in heating are briefly stated as follows:

1. The use of pots which are too small. They burn out quickly and are difficult to fill.
2. Insufficient number of pots per acre.
3. Shortage of fuel.
4. Use of fuel which does not give off enough heat.
5. Allowing the temperature to go too low before lighting.
6. Accumulation in pots of residue of asphaltum, which burns with difficulty. Be sure and get a crude oil with a parafin base.
7. Growers relying upon other people's reports of temperatures in other groves, rather than keeping track of the temperature in their own grove.
8. Discouragement after partial failure. This oftentimes proves disastrous.
9. Insufficient amount of heat.
10. Incapable help.
11. Inaccurate thermometers.

COST OF HEATING

The cost of heating in the Valley varies with the fuel used, oil being procurable at this writing as low as five cents up to ten cents. The best grade of oil with parafin base should be bought f.o.b. station at slightly under six cents. Coke (Petroleum) can be bought delivered at R. R. at about $11 to $12 the ton. The cost of heating will vary, of course, with amount of heating which is done. As before stated, a large heater burning full blast will burn about one gallon of oil per hour. So the actual cost per acre depends on the amount of heat used, and that depends on the degree of cold to be overcome.

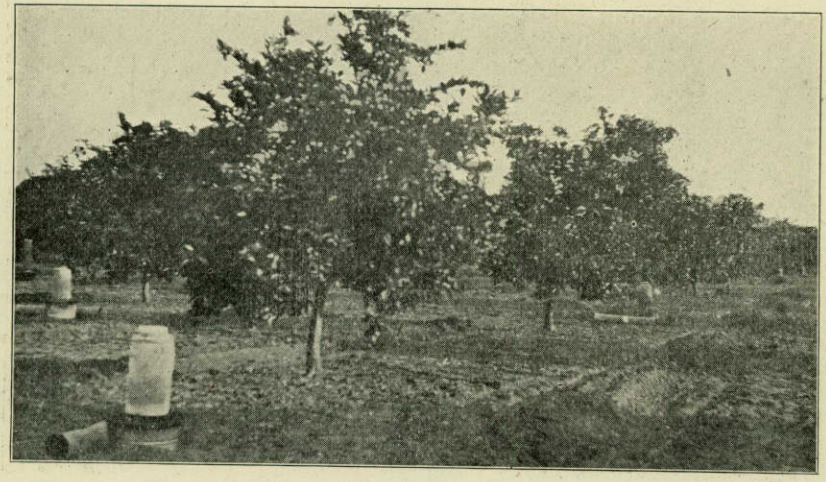


Fig. 26. Three-year-old Marsh seedless grove protected by heaters.

COST OF EQUIPMENT

Oil pots can be bought for various prices, according to the class desired. The majority range from three to five dollars. A large storage tank, best made of concrete, and placed underground is also essential. One or more tanks to use on a wagon or truck for filling pots in the orchard are very desirable. All of these cost according to capacity and quality.

FACTORS INFLUENCING RESISTANCE OF TREES TO COLD

There is a marked difference in the resistance that different citrus trees show toward cold. Trees side by side are often very differently affected. It is evident that this is not caused by difference in temperature, and search has been made to discover why certain trees stand cold better than others.

DORMANCY OF TREES

Trees that are dormant will stand much more cold than those in active growth. Cultivation, irrigation and pruning should, therefore, be omitted just before cold months. This applies more to young trees. Some of the things which influence the dormancy of citrus trees are dryness and time of irrigation, pruning and, in young trees, time of planting. Irrigation should be lessened towards fall to permit the hardening of wood. Small applications of forms of potash to the soil has a tendency to encourage dormancy. (See Fertilization).

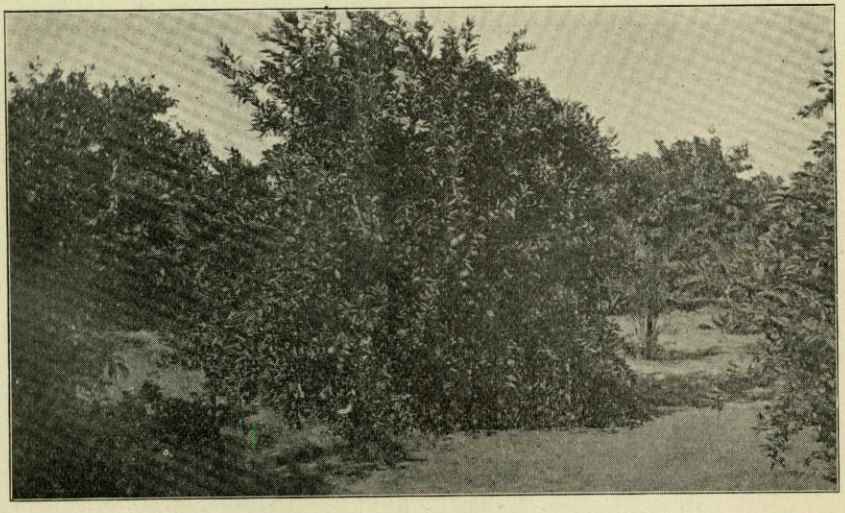


Fig. 27. Four-year-old Temple orange tree.

TIME OF PLANTING

Young trees planted late in the fall, not having started to grow at the time of a freeze, will be much hardier than trees planted earlier which are growing.

DRYNESS

It is very common to find trees which, on account of dryness, are less injured than those which have received more water. Therefore, one should not give a young tree too much water late in the fall.

INDIVIDUALITY OF TREES.

One of the most remarkable facts in frost protection is the greater resistance of some individual trees over others of the same age, kind, and under the same growing conditions. This is probably more noticeable in young orchards, though sometimes occuring in older orchards. Whether the escape of these trees from frost injury is due to accidental conditions, rendering them more dormant and thus more resistant, or whether due to inherent frost resistant qualities, has not yet been determined.

TREATMENT OF FROZEN TREES.

Soon after a freeze it becomes apparent that some citrus groves are seriously injured and something must be done for their rejuvenation. California literature describes their experiences with many valuable methods of treatment. The trees given these different treatments were watched, and it was possible to reach definite conclusions regarding the value of most of the practices followed.

BINDING THE BARK

In many places the loose bark resulting from frost injury was bound back to the tree again. The majority of such cases resulted in failures. Many growers, however, reported the bark reunited with the wood, and final recovery of the tree.

The best instances of recovery from wrapping were where cord-like binding twine or narrow strips of cloth were wrapped around the tree spirally, leaving the greater portion of the bark uncovered, and allowing the free access of the air, but holding the loose bark firmly against the wood. Such wrapping to have any effect must be done promptly after a freeze, while the injured surfaces of the bark and wood are fresh. Otherwise the wrapping naturally could have no beneficial effect. Where bark is split and loose, it is likely to bend outward as it dries and exert a force that will have a tendency to extend the injured area. Binding with the cord as indicated will prevent such extension of the injury and favor the healing of the bark.

Where trees are treated this way after a freeze they should be given no further treatment, unless the trunks are whitewashed to protect them from sunburn. No further treatment is necessary for several months, or until the new growth is well under way and until the bark that was killed has dried out and clearly shows the extent of the damage. As soon as this time arrives, the wrapping should be removed, the dead bark thoroughly cut away, and the injured patches thoroughly cleaned. After this cleaning, probably the best treatment is to first paint the injured area with Bordeaux paste and some weeks later with asphalt dissolved in benzine. The use of the Bordeaux paste seems to be very desirable, as it seems necessary to use some sterilizing agent to prevent the development of fungi. Following this with a coating of asphalt paint renders the wood impervious to water and gives the treatment a permanent finish.

WAXING AND PAINTING SPLIT BARK.

The covering of the splits with grafting wax was found of no avail, as was the use of white lead. No results were reported from either of the methods.

PRUNING INJURED TREES.

One of the most important operations after a freeze is pruning. It is maintained by some that prompt pruning is necessary in order to prevent a further dying back of frozen wood. This dying back is caused by a backward passage of sour sap. Difficulty is experienced, however, in ascertaining the extent of the

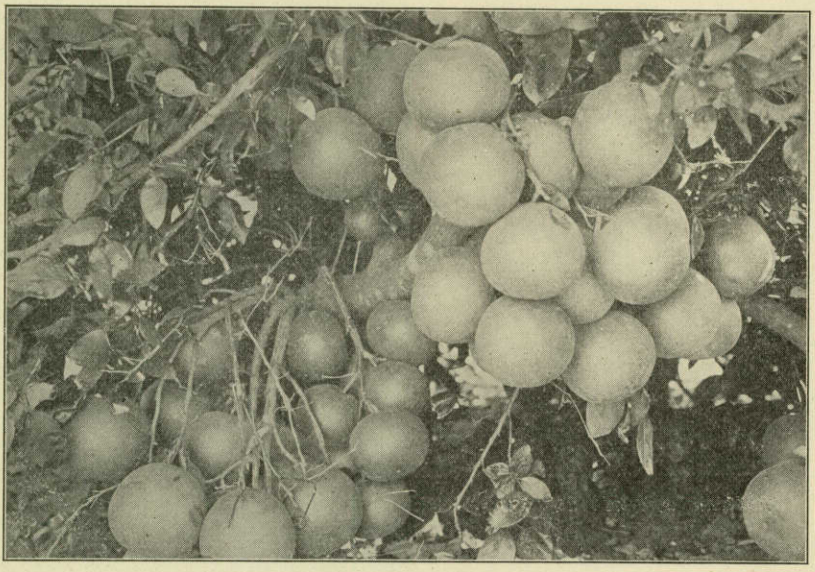


Fig. 28. Two bunches of grape fruit.

injury soon after a freeze, and many experienced growers find it better to delay pruning until the line of injury is clearly defined.

The effect of early and late pruning has been tested out by many California growers. The tests showed that nearly always the early-pruned trees had to be pruned again later.

The treatment of limbs on which large patches of bark were killed is very perplexing. No positive directions can be given regarding such cases. Judgment must be used in each individual case. Where a limb is more than half girdled, however, one might as well cut it off and allow a new strong branch to take its place. Many growers in California did not attempt to remove the small frozen twigs from slightly injured trees. This neglect was found to greatly increase the amount of spotted fruit and decay the next year.

OTHER FROST OBSERVATIONS AND RECOMMENDATIONS

Experience has shown that it is not necessary to remove frozen fruit from trees. It will, if allowed to remain, drop off of its own accord. There has been no evidence indicating that the succeeding crop would be appreciably injured by allowing it to remain.

Where young trees are entirely defoliated, they should be covered with a coat of whitewash to prevent sunburning. This should be applied before the new growth starts, or injury may result to the tender leaves.

Badly injured young trees should be removed and others planted in their place. Irrigation and fertilization of frozen trees has been tried out in hopes of assisting recovery. Little or no benefit was derived from such applications.

The planting of frosted nursery trees is not recommended, as the double shock of the freeze and the transplanting is more than they can stand.

As will be noted in the discussion of "Frost," valuable data has been taken from many bulletins of the California Agricultural Experiment Station, and credit is here given for same.

VARIETIES

The group of plants designated by the generic term "Citrus" is fairly well circumscribed, but there is quite a diversity of opinion among horticulturists as to the segregation of the different species and varities. The practical grower of fruits, however, only looks to the largest returns for his labor and cares very little whether the product belongs to one variety or another. Attempts to classify the plants under the general term "Citrus" vary exceedingly, and different opinions regarding their scientific relations are held by scientific investigators. There are, therefore, a number of different classifications.

In the table below, the writer has adopted the classification worked out by Dr. Herbert J. Webber in the Cyclopedia of American Horticulture.

Botanical Species.	Botanical Variety.	Horticultural Race.	Horticultural Variety.
1—Trifoliata			Trifoliatas
2—Aurantium	Amara		Sour Bittersweet Seville
	Bergamia		Bergamot orange
	Sinensis	The common orange	Bahia Valencia Pineapple Homosassa Many other varieties
3—Nobilis		The Mandarin group	Satsuma China (Mandarin) Dancy (Tangerine) Oneco King and others
4—Decumana		Pomelo or grapefruit	Royal Pernambuco Triumph and others
		Shaddock	Paradise Forbidden fruit and others
5—Japonica		Kumquat	Nagami Marumi Naiha and others
6—Medica	Genuina	Citron	Corsican Lyman Orange and others
	Lemon	Lemon	Lisbon Villa Franca Sicily Eureka and others
	Acida	Lime	Imperial Mexican Persian and others

Experience has taught us that no one variety of citrus is preeminently useful for all portions of the world where it can be grown. The Bahia or Washington Naval orange does splendidly in California and is of little value in Florida or the West Indies,

as it produces no crop of consequence there, while the Pomelo or grapefruit does well in Florida and is very little thought of in California. It becomes necessary, therefore, to test the particular variety in the section into which it is to be introduced. Some varieties are excellent in places far removed from their

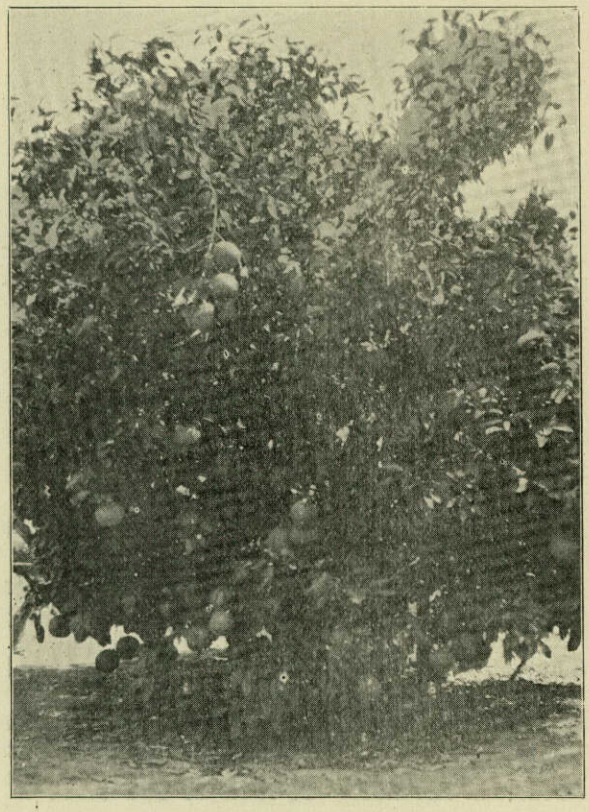


Fig. 29. Four-year-old Marsh seedless grape fruit with a heavy crop.

native habitat, as is illustrated by the Satsuma, an introduction from Japan, and the Bahia orange which was brought from Brazil by the United States Department of Agriculture and which has attained such excellence in California. The Bahia produces fair fruit in Florida but as stated is not prolific.

Frequently the most important varieties of citrus for any given locality are those which have originated as seedlings in that section or have arisen as bud varieties. As an illustration, the Surprise Naval originated in a grove at Federal Point, Fla., from buds received from California. Once in a great while seedlings come true, though as a rule vary exceedingly. Seedlings from the Mandarin group produce typical Mandarin fruit. Seedlings from the sweet orange produce typical sweet

oranges. Seedlings from the Pomelo produce pomelos of varying qualities.

The total number of varieties of citrus fruits that have been catalogued and described would run into the thousands. Out of

Fig. 30. Two-year-old grape fruit showing vigorous growth.

the many thousands, a few selected ones are of general value and can be planted over a considerable area.

Many of the varieties have been tried out in the Valley. As would be expected, some have proven better adapted than others. The following comments summarize general observations to date. In all cases the question of root stock is of vital importance to the success of all of the varieties. The sour orange root is the only one that reasonably stands against the soil conditions found here. There is not sand enough for the rough lemon, though we have to use it for Kumquats, Limequats, and some of the limes, as they do not do so well on the sour orange.

The Sour Orange (Bigaradia) or Seville Orange is grown all over the world. It is able to withstand more cold than most of the other citrus fruits and is rarely forced into new growth by warm weather occurring in winter. It is found in a thoroughly naturalized condition in many parts of Florida, where it was doubtless imported by the Spaniards.

The Sour Orange is well adapted to grow on a variety of soils and is especially well adapted to the soil conditions in the Valley and all our citrus should be budded on this stock, unless otherwise specified.

THE COMMON OR SWEET ORANGE

To this group belong the *Bahia* or *Washington Naval,* the *Valencia Late, Pineapple, Homasassa, Parson Brown, Lue Gim*

Gong, Ruby Blood, Mediterranean Sweet, Hart, Joppa, Paper Rind, Prato, Saul Blood, St. Michael, (blood) and many others.

Navals: Under this head there are dozens of named varieties—the *Bahia* or *Washington Naval, Thompson, Australian, Surprise, Double Imperial,* and many others. Of these, the *Washington Naval* is the one most planted in the Valley, but most of the older ones resemble more the Florida seeded, which are of little value, and from which they may have been budded. The more recent plantings, however, may prove up better, as most of them are direct from California and many others are budded with buds from there. They ripen early in the Valley—about November 1st—and are of fine flavor but have a large percentage of rag. This may be due, however, to the facts mentioned above. The true Washington Naval with a California parentage shows up comparatively well and has a promise of commercial success. The other navals have not been sufficiently tried out to give them any standing. The naval should not be permitted to remain on the tree long, as it will have a tendency to increase in rag texture.

The Parson Brown can be eaten in October, though not fully ripe till November. They are quite seedy but of fine flavor. They ripen in the Valley from two to three weeks sooner than they do in Florida; however, they begin to lose their fine flavor if left on the tree till January. Should be planted quite heavily.

The Pineapple is the mid-season orange in the Valley; of delightful flavor and full of juice, very few seeds. The longer

Fig. 31. Orange tree in fruit.

left on the tree, the better they get, becoming veritable balls of sugar. They ripen in December and can be left on the trees until March and even April.

Valencia Late is another of California's big croppers. As its name indicates, it is a late fruiter, ripening in January. It

may be left on the tree till well into the summer. It ripens in February in Florida and not until March in California. The latter state, owing to its lack of rainfall, markets them up until the following October. Florida, however, has to market its

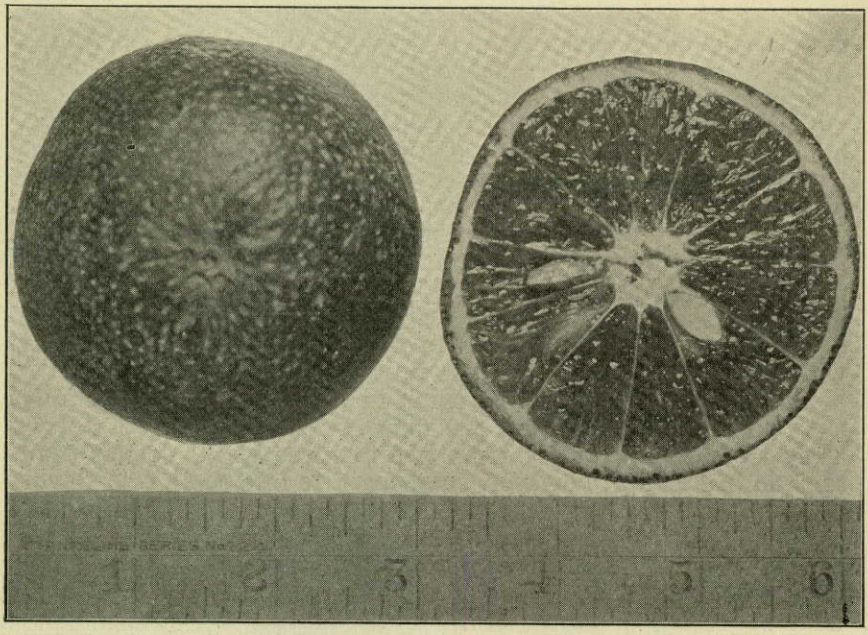


Fig. 32. Parson Brown orange, reduced.

crop before May 1st, the beginning of their rainy season, as the fruit loses its flavor after the rains begin.

The Ruby, Ragan, St. Michael and Maltese Blood, all blood oranges, are all of fine flavor and appearance and have a pulp more or less tinged with blood color. They might have commercial value in the Valley.

The Lue Gim Gong is another late variety and is being extensively planted in the Valley. It closely resembles *Valencia* and is said by some to be better. A diversity of opinion exists, however, on this point and it remains to be proven.

The Tardiff and *Harts Late* are other late oranges, but the *Valencia* and *Lue Gim Gong* should be given preference and especially the Valencia.

THE MANDARIN GROUP

This group is composed of what are sometimes called the "Kid Glove Oranges." They are loose skinned, and of a bright reddish orange color. The segments are loose and they are easily eaten. The *Satsuma* is being tried out on various root stocks and may finally be of value in the Valley. *Trifoliata*

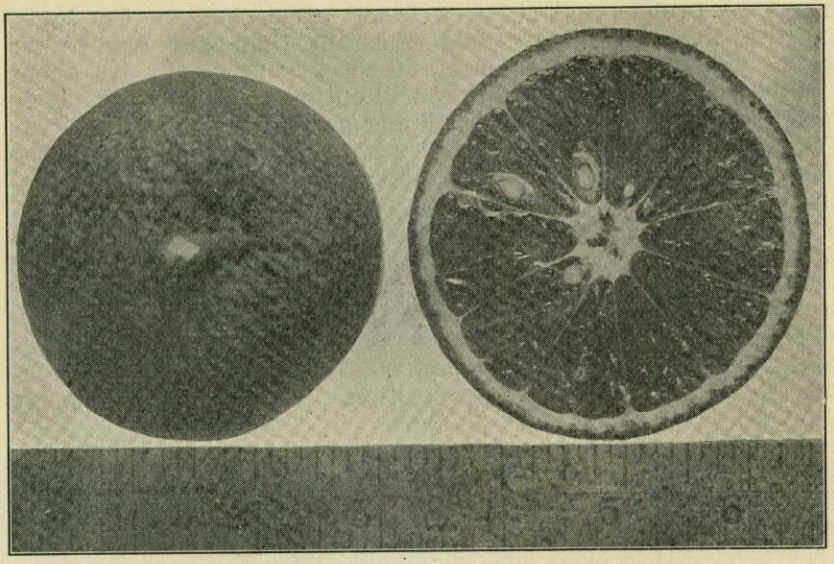


Fig. 33. Valentia late orange, reduced.

stock upon which it is grown successfully in certain sections, is not adapted to the Valley conditions.

The Tangerine (Dancy): This is another easily eaten orange, rather small, and if of a good strain is of excellent quality, full of juice and of a delightful flavor. They fruit early and

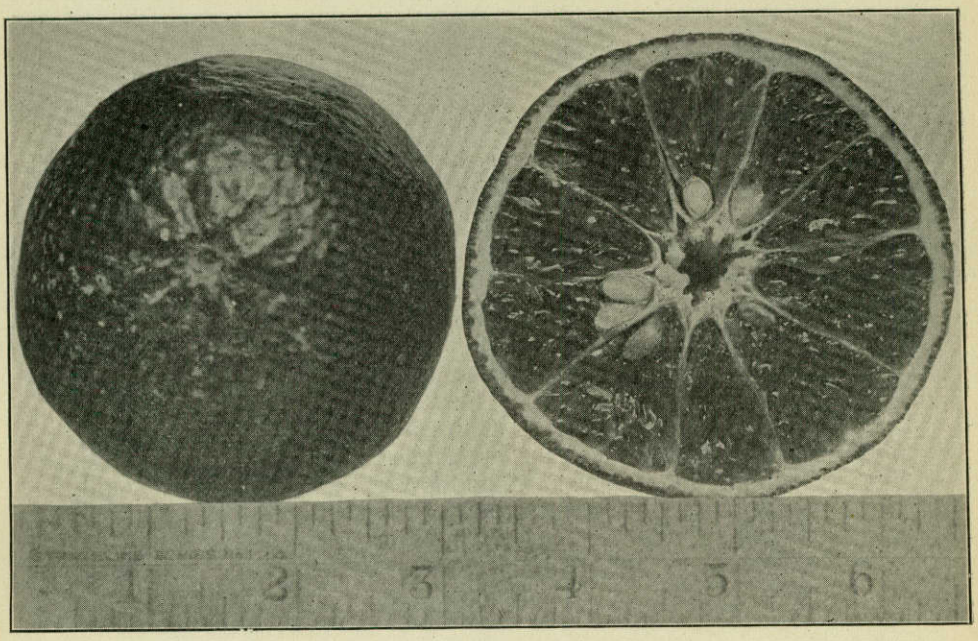


Fig. 34. Temple orange, reduced.

are very prolific and bring a fancy price even on the home market, are much more cold resistant than any orange we have. They are hard to bud and grow very slowly till about two years old, after which they will outgrow most others. They will produce more boxes of fruit per acre than any other citrus fruit and should be much heavier planted than they are. The fruit can not be left on the tree later than January, as it becomes puffy and poor.

The Temple: The Temple is a wonderfully prolific grower and early bearer, and the fruit is very delicious, full of juice and free from rag. It somewhat resembles the King Mandarin externally, but is of a distinctive flavor and much more juicy, It ripens its fruit in January, though it can be eaten in December. It has sold on the Chicago market at $18.00 per crate, making it rather an attractive proposition. There are several large

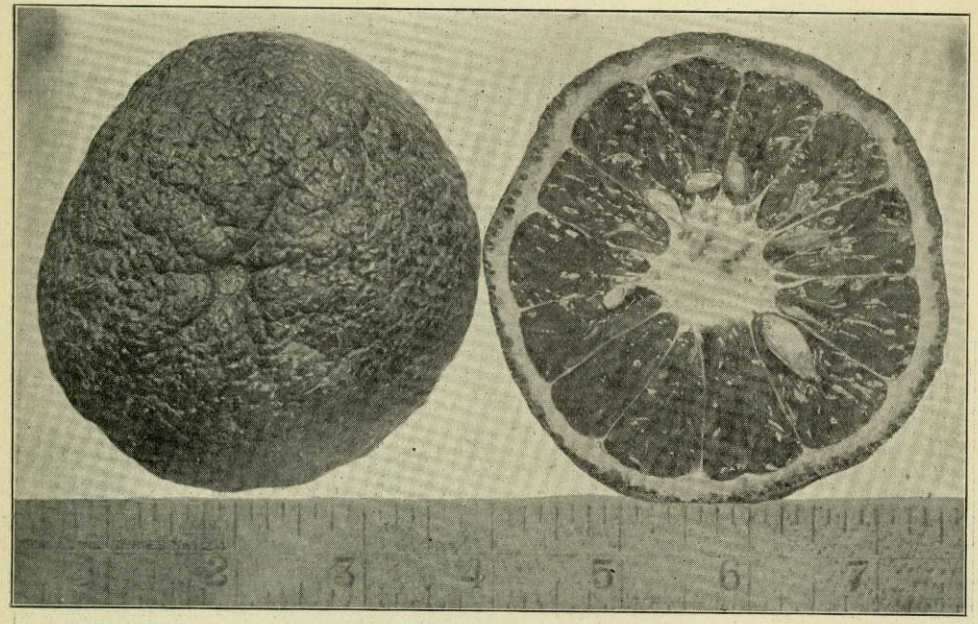


Fig. 35. King orange, reduced.

plantings of Temple in the Valley and more going in each season. It seems to be quite hardy and apparently very prolific.

The Mandarin Orange is of Chinese origin, as its name implies; small tree, with slender branches, willow-like leaves, and bright orange-yellow fruit. It has a very loose peel and small seed. There are many varieties, two of which have been planted and tried in the Valley.

The Willow-Leaf has a peculiar odor and agreeable flavor of its own.

The King has a wonderful flavor but is rough and unsightly in appearance. The branches are very brittle and do not hold

their fruit up well unless kept pruned severely. They are worthy of considerable heavy planting.

The Tangelo (Sampson) has been sparingly planted of late, but is worthy of consideration, especially for home use. As its name implies, it is a cross between the Tangerine and the Bowen Grapefruit. It is unlike either parent in quality, being more a sprightly flavored sweet orange and very full of juice when properly cared for. Its delicate skin and the fact that it dries out easily precludes its culture except for home use or special markets.

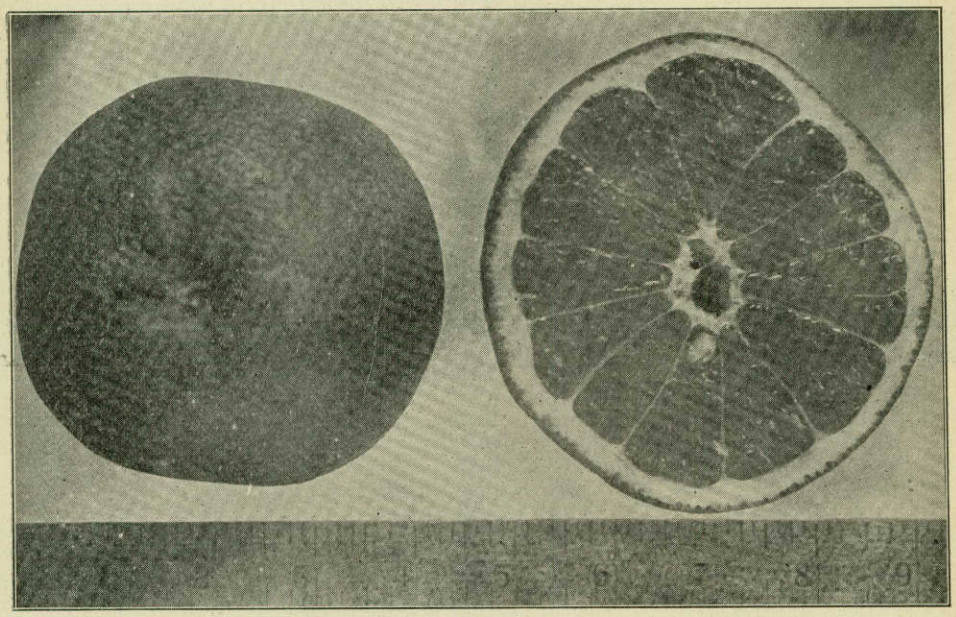


Fig. 36. Marsh seedless grape fruit, reduced.

GRAPEFRUITS OR POMELOS

Enough can not be said of the excellency of this fruit as produced in the Valley. Florida raises grapefruit of fine quality. California does not pay it much attention, as most of it raised there is of poor quality. Arizona raises some, but the Lower Rio Grande Valley raises it of a quality superior to that of any raised in Continental United States. Growers will have to learn, however, to spray their trees properly for the prevention of disease and insect blimishes on the surface of fruit for the production of perfect, bright fruit. Proper pruning, cultivation and fertilization are also essential for such results.

There are innumerable varieties of this excellent fruit, so only those that have been tried out and found to do well will be mentioned. Of these, the *Marsh seedless,* ripening in November and December, easily leads, especially as a market variety,

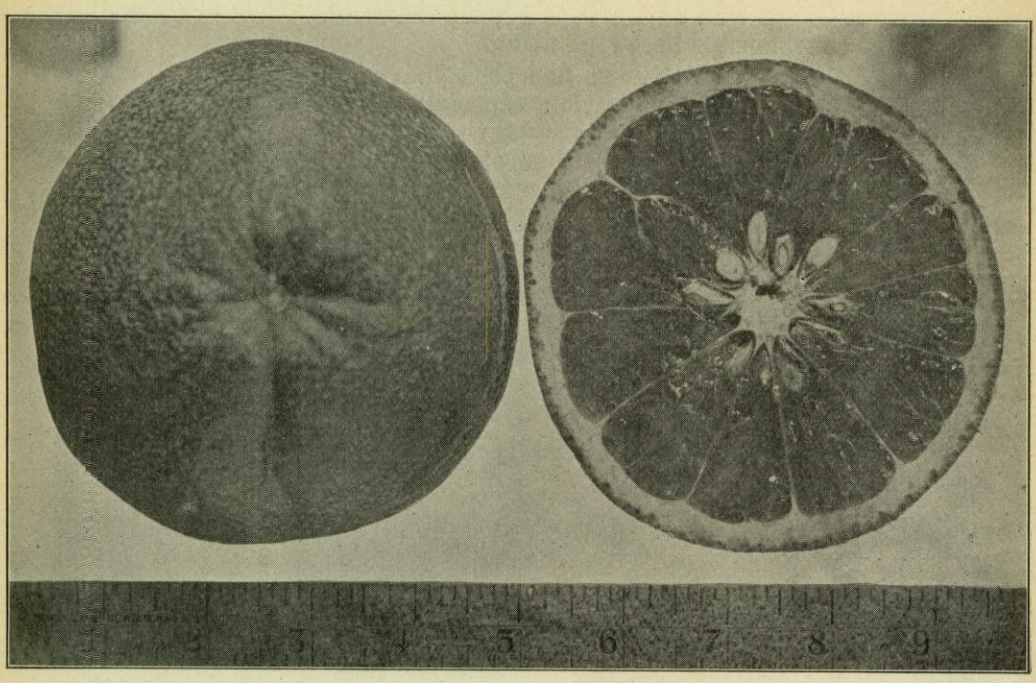


Fig. 37. Foster or pink grape fruit, reduced.

being smaller and of uniform size, thin skinned, almost entirely seedless, and a good shipper and keeper

Next from a commercial standpoint comes the *Walters*. It has more seeds but is of excellent flavor, keeps well and is not too large to find a ready market. This variety is worthy of

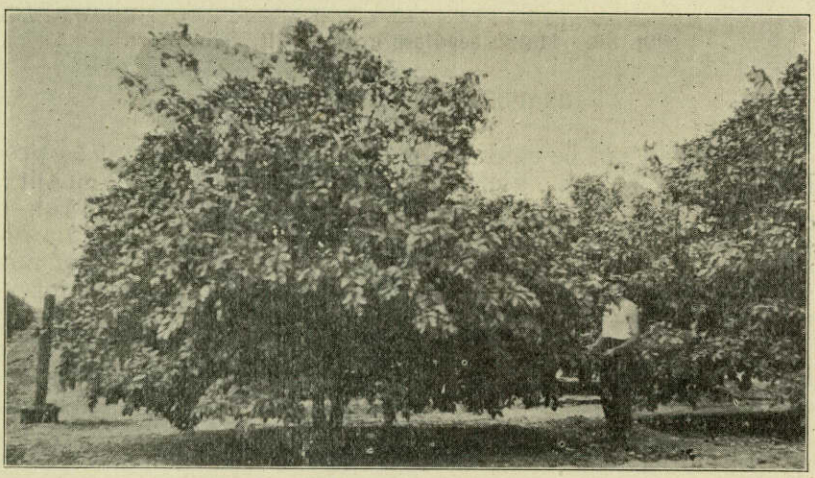


Fig. 38. Six-year-old Duncan grape fruit, four-year top, 18-foot spread of limbs with a yield of 8 boxes of fruit this season.

more extensive planting than heretofore. It ripens in October. Then comes a bud sport of the Walters, known as the Foster. It is pink fleshed and shows one or more pink cheeks which

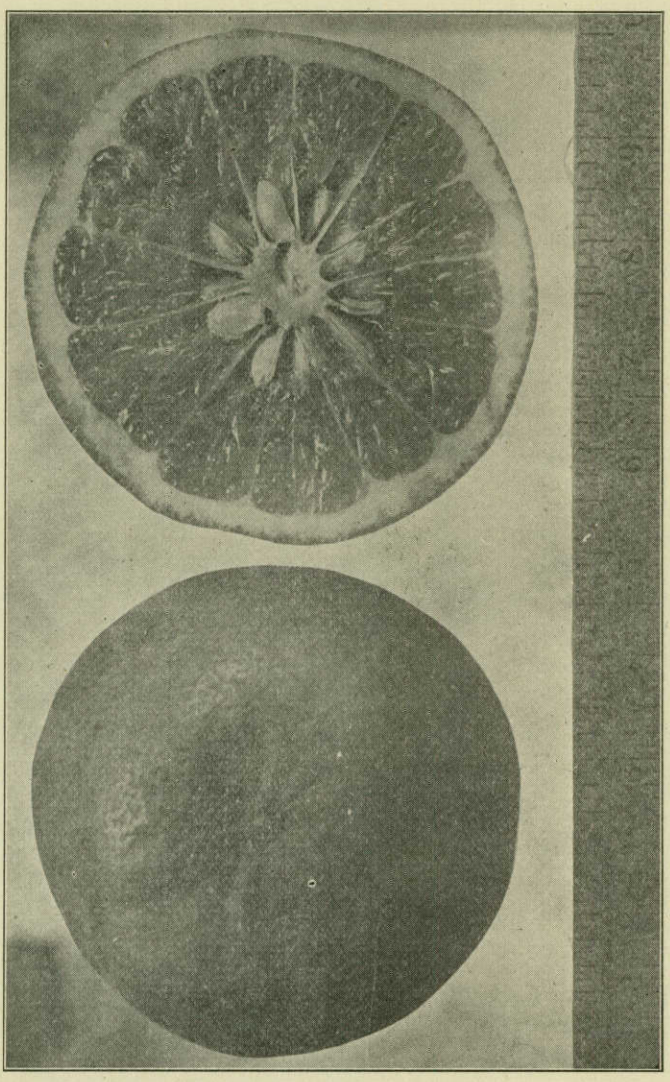


Fig. 39. Florida Standard grape fruit, reduced.

makes it very attractive. The flavor is distinctive. Its coloring makes it very popular in the market.

The *Duncan,* which is excelled by none as to delightfulness of flavor, is only kept from being a close rival of the others by its large size and multiplicity of seeds. For home use it is considered worthy of the greatest consideration. It ripens in November.

"Pink Marsh Seedless"—This is a new variety and is evidently a bud sport from the original Marsh Seedless, and is as its name implies pink fleshed.

There are several other varieties of grapefruit which may prove of value here. Among those fruiting in the Valley are: *McCarty, Inman Late, Excelsior, Gold Medal,* all of which are

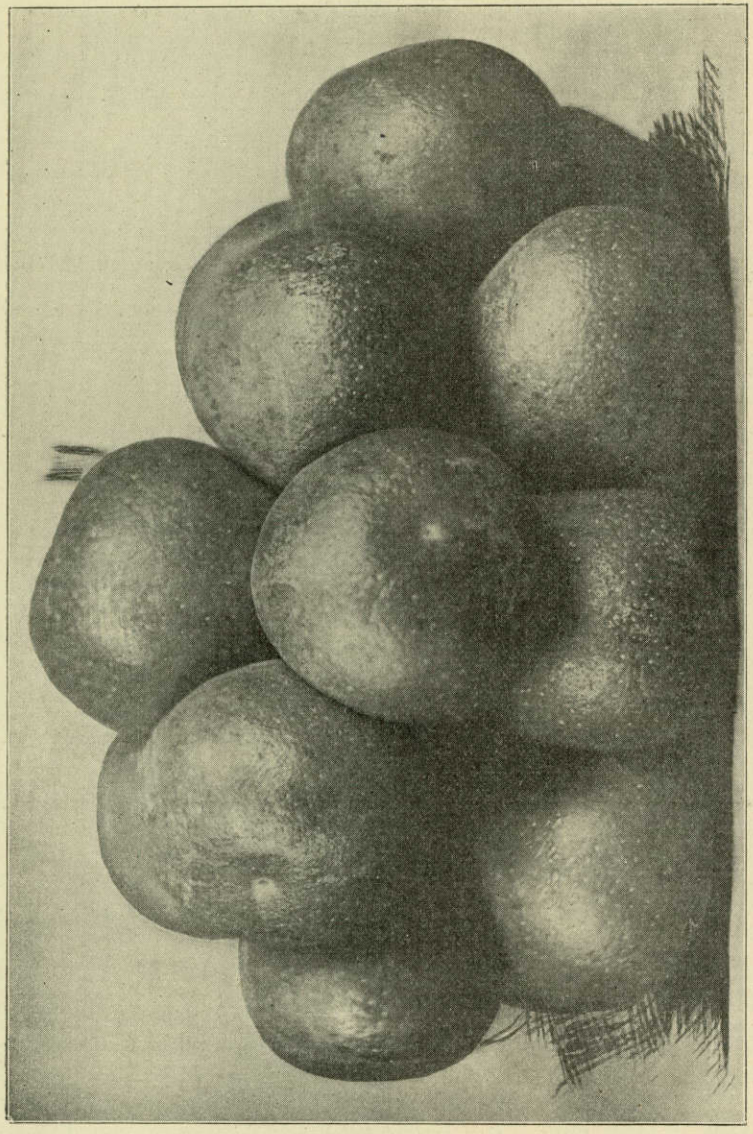


Fig. 40. An exceptional cluster of 18 Duncan grape fruit weighing 18 pounds, greatly reduced.

considered extremely late in Florida but ripen here along with the Duncan

LEMONS

There are four varieties of lemons planted in the Valley, three of which, the *Eureka, Lisbon,* and *Villa Franca,* are almost identical. The Kennedy seems to be a variety developed in the Valley; is very juicy and acid, but grows too large for commercial use. Any of the first three are all right for planting and some should be included in every ranch; but to successfully dispose of the lemon crop one must be equipped with a curing house, which necessitates special procedure. The lemon is not as hardy as the orange. (See Lemon. Page 68.)

The Ponderosa is of immense size, often weighing as much as four pounds. The juice and flavor is fine, but it is too large for commercial use. They might rightly be termed "hotel size" fruit. They are of interest as curiosities.

LIMES

These are the aristocrats of the Medica species and are fast taking the place of the lemon, as they bring a better price. It is said, however, that they do not keep as well as lemons. They are unexcelled for the making of drinks.

The Mexican, West Indian or *Key Lime* is the best known in the Valley, and where buds are taken from good bearing trees, is very prolific and has fruit of good size. One cannot go wrong planting this. The fruit is about the size of a large walnut,

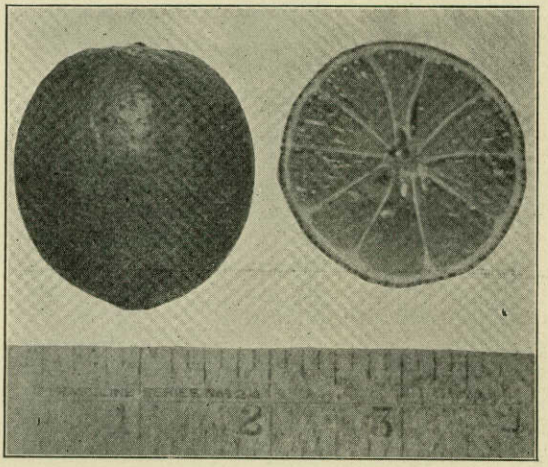


Fig. 41. Mexican lime, slightly reduced.

very thin skinned and full of very acid juice. Not as hardy as the orange.

Thornless Lime: This fruit resembles the Mexican lime in size and flavor, having that same characteristic taste and smell that makes the Mexican the standard. The tree is of upright growth and is thornless.

The Tahiti, Persian and *Bears' Seedless* resemble one another very closely. The flesh of the fruit is of a green color. They are as large as a lemon, of delicious flavor and very juicy. They have a good market value. Not as hardy as the Mexican lime.

The Rangpur is a red skinned, red fleshed lime and has loose skin and segments like a tangerine orange. Attains about the same size as a large tangerine, for which it is often mistaken.

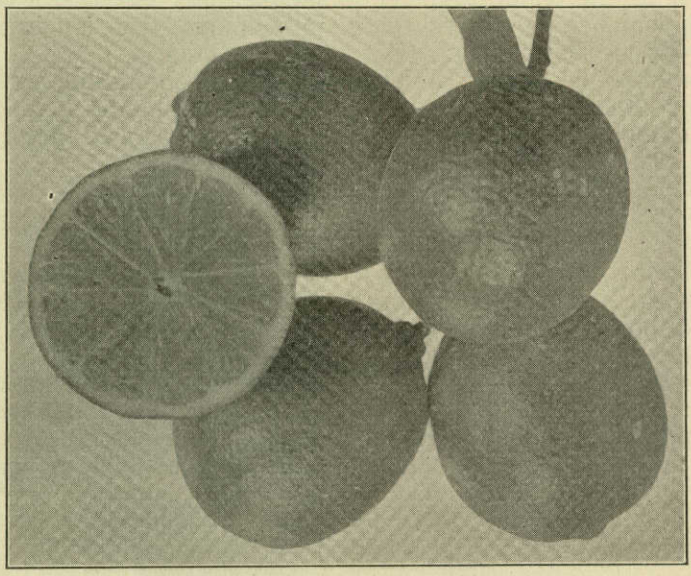


Fig. 42. Tahiti limes, slightly reduced.

It is very juicy, with a fair acid content and with the flavor of a lime and orange. Not extensively planted. It is very susceptible to rust mite injury.

MISCELLANEOUS

The Kumquat is of little commercial value as yet in the Valley, but is a wonderfully prolific bearer, especially the Nagami, which is said to make especially nice preserves. Its fruit is very small, oblong in shape. It will stand considerable cold.

The Limequat: The kumquat and the lime were crossed to get this excellent fruit which is known as the Eustis limequat. It has a delightfully acid flavor all its own, is as hardy as the kumquat and the fruit is larger than the Mexican lime. It should be planted freely. It bears continually.

Calamondin: This is a hardy orange from the Philippine Islands. The tree, with its load of fruit is wonderfully ornamental. After it attains bearing age, it is always loaded with fruit. The fruit is round, slightly flattened at the stem and of a rich orange-red color, with a distinctive acid flavor, com-

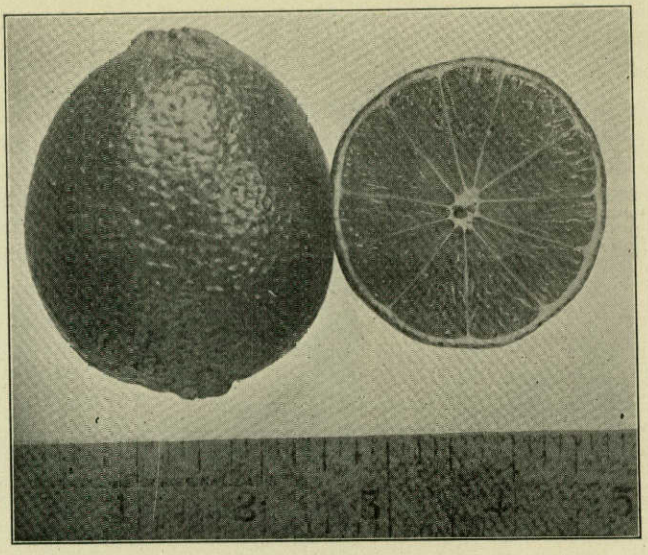


Figure 43. Persian limes, slightly reduced.

bined with a pleasing aroma. It makes a fine marmalade and drink, and is worthy of consideration.

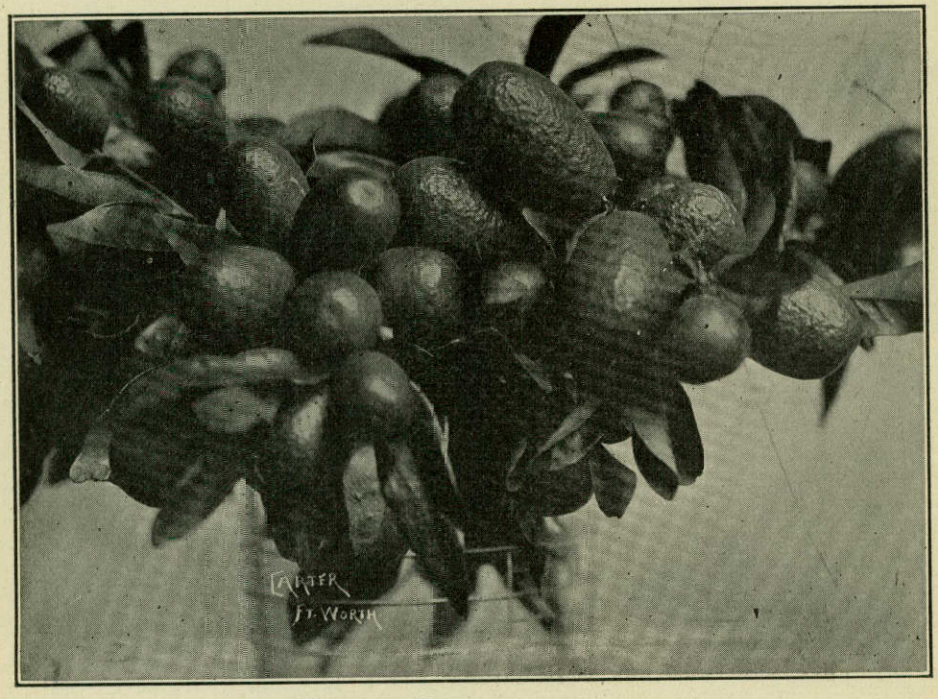
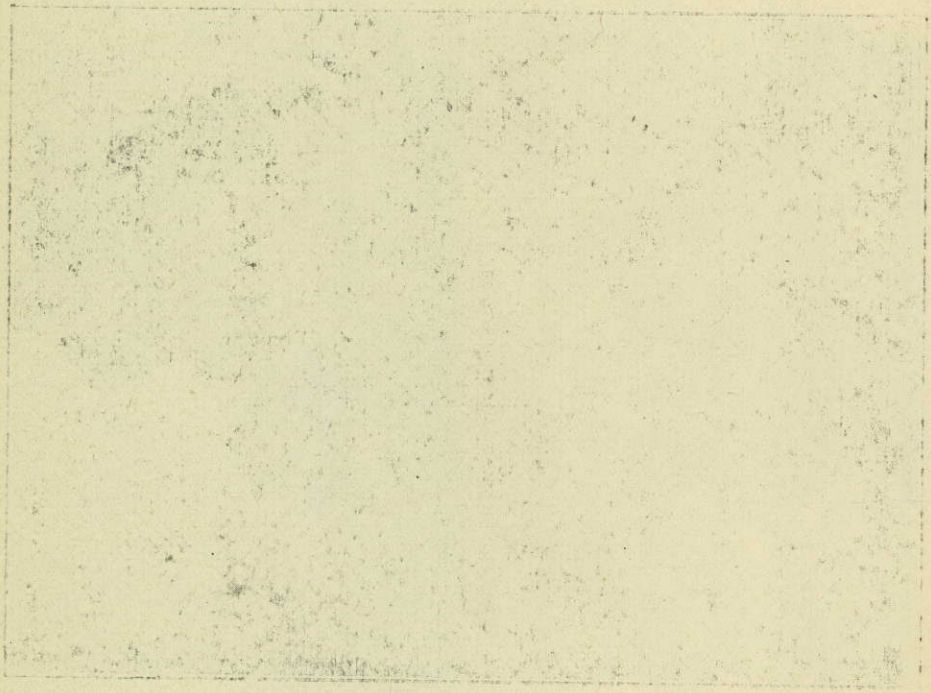


Fig. 44. Kumquats.

Citron: The fruit is large, thick skinned and unsightly. It is candied and used in cakes and preserves. The tree is not very hardy.

Citrange: A cross between the common orange and the hardy trifoliate orange. The citrange is very cold resistant. If in a dormant condition it can withstand a temperature of 15 degrees or even 10 degrees Fahr. without injury. The Rusk is the most precocious of the citranges. This is being tried out in the Valley as a root stock for Satsumas and others.



FRUIT ANALYSIS.

November, 25, 1922.

Analyses of citrus samples sent by E. W. Halstead, Mission, Texas, November 14, 1922.

Analyses made through the courtesy of Dr. L. C. Corbett of the Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

	Total Solids	% Acid Citric (Anhyd)	Acid Solids Ratio
Duncan grapefruit (Late Bloom old fruit)	9.03	1.11	8.1
Duncan grapefruit (regular)	10.03	1.43	7.0
Marsh seedless grapefruit	9.03	1.19	7.6
Foster grapefruit	9.03	1.29	7.0
Parson Brown Orange	10.03	0.45	22.3
Washington Naval Orange	10.08	0.43	23.4
King Mandarin	9.08	0.96	9.4
Dancy Tangerine	11.08	0.78	14.2
Eureka Lemon	9.08	8.87	1.4
Bear's Seedless Lime	9.03	6.37	1.4

Analyses of citrus fruit from Mercedes, Texas, sent by E. W. Halstead.

March, 1, 1923.

Foster grapefruit	11.15	1.12	9.92
Valencia Oranges	12.3	.93	13.3
Marsh Seedless grapefruit	9.4	1.22	7.7
Mediterranean Sweet Orange	11.5	.88	13.1
Temple Orange	12.48	.77	16.2

Analyses of Citrus Samples sent by E. W. Halstead, Mission, Texas, November, 1923.

December 3, 1923.

Variety-Condition	Total Solids	% Acid Citric	Solids-Acid Ratio
Orange:			
Lue Gim Gong (normal)	10	0.55	18.2
Pineapple (normal)	10	0.92	10.8
Valencia (skin dry, partly green)	9	1.69	5.3
Parson Brown (normal)	10	0.92	10.8
Washington Naval(normal, large size fruits)	10	0.55	18.2
Temple (normal)	10	1.16	8.6
King (normal)	8.5	0.94	9.0
Tangerine:			
Dancy (normal)	11	0.89	12.4
Lime:			
Sweet (skin dry, hard)	11	0.47	23.4
Grapefruit:			
Walters (normal)	10	1.41	7.1
Pernambuco (normal)	11.5	1.47	7.8
Foster (slightly withered)	9.6	1.58	6.1
Florida Standard (normal)	11.9	1.65	7.2
Duncan (skin somewhat dry)	11.4	1.67	6.8
Marsh (slightly withered)	8.9	1.17	7.6
Lemon:			
Eureka (skin dry and hard)	11	7.70	1.42
Villa Franca (normal	10.6	6.8	1.56
Mandarin:			
Willowby Leaf (decayed)			

LEMONS AND CURING

The commercial production of lemons involves special methods and differs in several particulars from that of other citrus fruits. In the first place lemons are much more susceptible to cold temperatures than are a majority of other citrus classes and consequently need greater protection from frost. They also have a tendency to grow rank and irregular, and for proper bearing they must receive constant attention relative to pruning. While there is a movement on hand to create a green lemon market, for commercial purposes the fruit must be properly cured.

Trees should be regularly pruned and pinched back and made to grow in the form of stalky branches. On account of their tendency of producing long bare branches without fruit twigs, they must be headed in to cause a development of fruiting spurs towards the center of the tree. This can be overdone, however, at the expense of foliage functions. A great many shoots will spring from the top and should be pruned to make a well-balanced tree. Some investigators claim that by tying these long shoots in a horizontal position that they will be converted into fruiting wood. The strong Valley winds, however, will probably cause the limbs to rub excessively if this method is used. The principles given under the heading of pruning also apply here.

For varieties, see discussion under that heading.

Lemons are picked about ten or twelve times during the year. Each picker is furnished with a pair of fruit clippers with rounded corners (no sharp points; the cutting edges equipped with a guard), a sizing ring (only lemons that will not pass through the ring are picked), a pair of soft cotton gloves and a picker's sack, also made of soft cotton. The sack fits over one shoulder and is made with the top closed and a slit only part way down the side to put the fruit in. Wooden trays that hold the fruit only one deep are also furnished. The first and most important part of the whole procedure is to get the fruit off the tree and into the curing house without the slightest bruise or scratch. While this applies particularly to lemons, it also is of importance in the production of every kind of citrus fruit. Lemons, however, if not handled with the greatest painstaking efforts will without question result in a complete failure.

In cutting the fruit from the tree, two cuts are made. The stem is first cut at least two inches from the fruit, to get it off the tree without injuring it. The stem is then cut again before placing in bag and after the fruit is where this can be done safely.

In California, for the process of spring storage, large houses are provided which afford a control of the ventilation. The storage floor is equipped with suspended tents. Immediately on bringing the fruit from the orchard, it is washed in a special

washing machine equipped with soft brushes, in a solution made of one pound of copper carbonate or permanganate of potash to 1000 gallons of water. When the washing solution is to be used throughout the day continuously, another eight ounces of the chemical is added in the afternoon. During moist, foggy weather, circulation of air is permitted by raising the tents, but during hot, dry weather they are kept closed to prevent rapid evaporation.

Lemons picked in the fall, however, after being properly washed, are removed to a special curing house in the picking boxes after being assorted into three colors—dark green, silver green and tree-colored or tree-ripened. The latter, however, are not put in the curing house.

HARVESTING AND MARKETING

SPRAYING

One of the most essential things for the production of first class fruit which will bring the highest price in the competition of the open market is the protection of the bearing grove from insect pests and diseases. This can be done by the use of the right spray or dust at the proper time. Efficient equipment capable of delivering the spray solution on the trees with sufficient force to reach all parts of the leaves, limbs and trunk, is absolutely essential in obtaining the best results from spraying. The grower who does not spray at all or who does not spray with the right spray at the proper time, consequently does not get effective results. He therefore penalizes himself from fifty cents to one dollar per box on every box of scaly, russet or thrip marked fruit that he sends to market. Formulas of the different sprays for the control of the insects and diseases and their time of application is gone into more fully in another part of this bulletin.

HARVESTING THE FRUIT

The harvesting of the citrus crop demands the utmost care during every operation, from the fruit on the tree to the properly packed box ready for the market. Preferably, the picking, handling and packing should be done by the trained help from the packing houses, but where the grower desires to do this work for himself, there are a number of things that he should take into consideration in the preparation of his fruit for the market and its delivery in good condition. Only such fruit should be picked for sale as he would like to purchase for use on his own table. Culls should not be shipped. The fruit should be cut from the tree with sharp fruit clippers having curved and rounded blades, thus allowing them to sever the stem close to the fruit. Pulling the fruit breaks the peel and allows the entry of the germs of decay, the same as any abrasion of the surface. The sound uninjured skin of the citrus fruit does not allow the entry of the germs of decay for considerable length of time after being taken from the tree, but a pulled fruit, or one that has the skin even slightly injured, is promptly attacked and ruined by some of the many kinds of decay germs which are everywhere prevalent and especially so where fruit has been allowed to decay. Injured or decaying fruits should never be allowed to accumlate where good fruit is being handled, but should be taken out and disposed of, preferably by burial. There are many unnoticed ways in which fruit can be injured, notably among these—the picker himself being careless with his clippers; not cutting the stems enough; by scratches from his finger nails; nails protruding in the field boxes; dirt left in boxes; dropping the fruit when picking; scratching with thorns; careless handling by ladders; the field boxes too full;

careless driving over rough roads; rough handling of the field boxes and by many other forms of carelessness.

It has developed that some growers, in order to profit by the early high prices, are picking their fruit before it is mature, and by so doing are defeating their own ends. The unripe fruit thrown on the early market lowers the price of the good fruit that is sent later. This practice should be most strongly discouraged.

PICKING EQUIPMENT

The best methods and equipment should be used in the handling of all citrus fruits. The pickers should wear soft cotton gloves, use the clippers as described above and the fruit should be placed in cloth picking bags, suspended from the shoulders, which open at the bottom, allowing the fruit to be emptied into the field boxes without bruising. One of the best ladders, where they are necessary, is one having a third leg on hinges, which can be put through the branches without injury to the tree and fruit. Climbing the tree should be avoided if possible, as this is liable to injure the bark. The fruit should be handled as little as possible and then only in the most careful manner.

PACKING

The home pack should be carefully and accurately graded, as to size and color, and put only in standard packs when it is to be sold on the open market, as an irregular pack has no standing and gets no consideration at the buyer's hand.

A thin, tough paper should be used for wrapping each fruit and the twist of the paper should be over the stem. The first two layers in the bottom of the box should have the twists up, the other layers should have it turned down. A table showing the size of the paper needed for the various sized fruits is given below.

Fruit per Box	Size of Paper
36-46	16x16 inches
54-64	14x14 inches
72-96	12x12 inches
112-150	11x11 inches
176-200	10x10 inches
216-226-252	9x 9 inches
270-360	8x 8 inches

BOXES

The Florida standard orange and grapefruit boxes are 12x12x24⅞ inches inside, when the heads and fruit per box partitions are ⅞ inches thick. The California standard orange box is 11½x11½x26 inches and the California lemon box is 10½x10½x25⅞ inches inside. Both the Florida and California

boxes have been used in the Valley. The Texas standards, however, are the same as those adopted in Florida. The grower should note what sized box he is using, in order to give him a full, well packed box with the number of fruit in it he desires. The following tables are taken from Hume's "Citrus Fruits":

PACKING DIAGRAMS

In order that the fruit may exactly fill the box it must not only be properly sized, but each fruit must be placed in position in the box according to a definite arrangement. These arrangements are commonly referred to as diagrams. Each layer contains a certain number of fruits placed in position. The fruit in the next layer above should never rest upon the individual fruits in the layer below, but should be placed so as to come between two or more fruits with a tendency to spread them. With the fruit placed so that the spaces or joints are broken, the contents of the box is solidly packed and yet retain a certain amount of elasticity.

The following tables give the size of the fruit, the number of layers, their arrangement and the number of fruits in each layer for the packing systems now commonly used in Florida and California.

FLORIDA SWEET ORANGE PACKS

No. and Size	Diameter of Fruit	No. of Layers	How Packed
96	3½	4	Layers 1 and 3-12 fruits; layers 2 and 4-12
112	3¼	4	Layers 1 and 3-14 fruits; layers 2 and 4-14
126	3⅛	5	Layers 1, 3 and 5-13 fruits; layers 2 and 4-12
150	3 1-16	5	Layers 3 and 5-15 fruits; layers 2 and 4-15
176	2 15-16	5	Layers 1, 3 and 5-18 fruits; layers 2 and 4-17
200	2 13-16	5	Layers 1, 3 and 5-20 fruits; layers 2, 4 and 4-20
216	2 11-16	6	Layers 1, 3 and 5-18 fruits; layers 2, 4 and 6-18
226	2 9-16	5	Layers 1, 3 and 5-23 fruits; layers 2 and 4-22
252	2 7-16	6	Layers 1, 3 and 5-21 fruits; layers 2, 4 and 6-21

FLORIDA POMELA PACKS

28	5¼	3	Layers 1 and 3-5 fruits; layer 2-4
36	5	3	Layers 1 and 3-6 fruits; layer 2-6
46	4¾	3	Layers 1 and 3-8 fruits; layer 2-7
54	4½	3	Layers 1 and 3-9 fruits; layer 2-8
64	4¼	4	Layers 1 and 3-8 fruits; 2 and 4-8
72	4⅛	4	Layers 1 and 3-9 fruits; layer 2 and 4-9
80	4	4	Layers 1 and 3-10 fruits; layer 2 and 4-10
96	3⅝	4	Layers 1 and 3-12 fruits; layer 2 and 4-12

FLORIDA SATSUMA MANDARIN PACKS

76	3¼	3	Layers 1 and 3-13 fruits; layer 2-12
90	3	3	Layers 1 and 3-15 fruits; layer 2-15
120	2¾	3	Layers 1 and 3-20 fruits; layer 2-20
168	2½	4	Layers 1 and 3-21 fruits; layer 2 and 4-21
216	2¼	4	Layers 1 and 3-27 fruits; layer 2 and 4-27

FLORIDA MANDARIN ORANGE PACKS

60	3½	3	Layers 1 and 3-10 fruits; layer 2-10
76	3¼	3	Layers 1 and 3-13 fruits; layer 2-12
90	3	3	Layers 1 and 3-13 fruits; layer 2-15
106	2¾	3	Layers 1 and 3-18 fruits; layer 2-17
120	2½	3	Layers 1 and 3-20 fruits; layer 2-20
136	2⅜	3	Layers 1 and 3-23 fruits; layer 2-22
144	2¼	4	Layers 1 and 3-18 fruits; layer 4-18

LEMONS AND LIMES

No. and Size	Diameter of Fruit	No. of Layers	How Packed
210	2¾	5	Each layer, 21 fruits.
250	2⅝	5	Each layer, 25 fruits.
270	2½	5	Each layer, 27 fruits.
300	2⅜	5	Each layer, 25 fruits.
360	2¼	6	Each layer, 30 fruits.
420	2-2⅛	6	Each layer, 35 fruits.

The time of ripening of the various citrus fruits in the Lower Rio Grande Valley are given under the description of the various varieties.

CALIFORNIA SIZES OF ORANGES

No. in Box	Inches in Diameter
112	3¼
128	3⅛
150	3
176	2⅞
200	2¾
216	2⅝
250	2½
300	2⅜

TEXAS CITRUS FRUIT GROWERS EXCHANGE

By John H. Shary

The Texas Citrus Fruit Growers' Exchange is composed of a stock company organized in accordance with the co-operative laws of Texas, with a capital of $100,000.00, paid in full to date. This amount will doubtless be increased as the Exchange grows. It is a strictly co-operative organization, but the financing and selling features are necessarily restricted in order to guard against mis-management and excessive expenditures which have caused the downfall of so many co-operatives.

Fig. 45. A Packing Plant.

Any citrus grower may take stock in the Exchange, but it is not obligatory in order to become a member. A local unit is being organized in each community of the Valley for the purpose of dealing with the Exchange and in general promoting the citrus interest of its members. Growers are eligible to membership in the units upon the signing of the uniform marketing-agreement of the Citrus Fruit Growers Exchange. It is through the local unit that the identity of the community will be retained. As soon as practical, each community will have its own brand or trade mark, which it is hoped will be established in the various markets.

There are three packing plants owned and operated by the Exchange at the following places, Sharyland, Mercedes and at Harlingen. These plants are equipped with the latest machinery, manufactured by Stebbler Parker Company, of California, and are conceded to be the most efficient for the handling of citrus fruit. The plants at Sharyland and Mercedes have a capacity of six cars per day each, and the plant at Harlingen two cars per day. The packing plants are all under one management in order to assure efficiency, economy and uniformity of grade and pack.

The organization gathers, grades, packs and ships the citrus fruit through its packing plants, strictly at cost. A fixed price is set at the beginning of the year, to be deducted from disbursements at the end of the year. The actual cost of operation is determined by a division of the number of crates going through the packing plant, into the cost of all materials and labor, plus depreciation and interest. If this is less than the fixed price, the difference is remitted pro rata to each member.

The Exchange intends to purchase all commodities connected with the growing and harvesting of fruit for its members, at a strictly cost basis, adding two per cent commission to defray expenses of that department. The selling department delivers all fruit and makes sales at the fixed charge of twenty-five (.25) cents per crate, out of which all commissions to brokers, salaries, and expenses incident to the sales are paid. The stockholders having absolute control, can eliminate excessive salaries and commissions. If profit is made, it goes to the stockholders as a dividend or as interest on their capital. If there is a loss, the Exchange bears it and not the growers.

The members sign a five year contract, but have the privilege to withdraw any year, between May 15th and June 1st. This insures fair and square treatment. The records and books are open to inspection by members at all times.

JOHN H. SHARY.
President Citrus Growers Exchange.

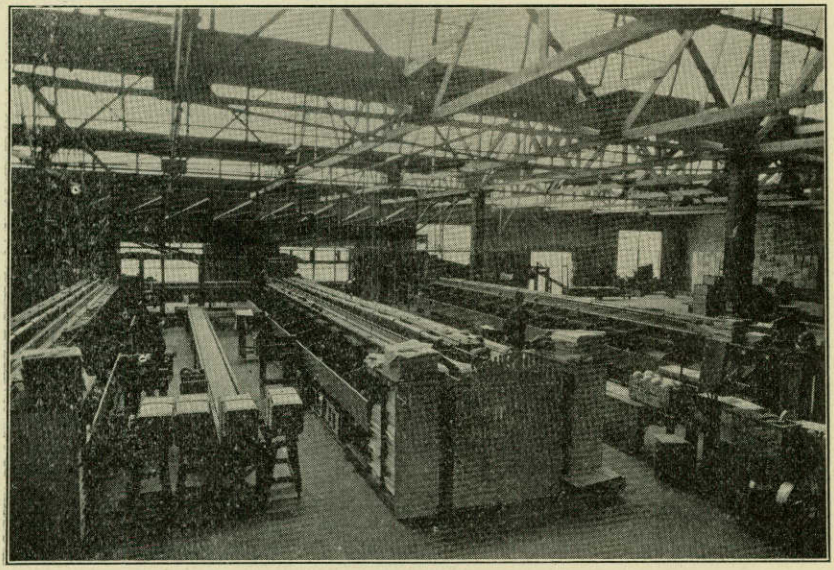


Fig. 46. A step in proper treatment and packing of citrus fruit in the Packing Plant at Harlingen, Texas.

METHOD OF HANDLING FRUIT FOR THE MARKET.

The method of handling fruit by the standard packing plants of the Valley does not vary greatly. All these plants lay a special stress on the careful handling of the fruit from the time it is picked until it is packed into the boxes; just as little handling as possible is practiced and all of the plants are equipped with conveyors where it is possible. The methods employed by the packing plants of the TEXAS CITRUS FRUIT GROWERS' EXCHANGE are probably typical of all the better plants of the Valley, and will be used in illustrating the Valley pack. Crews, in charge of a competent foreman, leave in trucks from the plants to the orchards equipped with ladders, clippers, bags and gloves. The pickers are furnished with gloves to keep from bruising the fruit, and as each fruit is cut, it is carefully placed in the picking bag which is slung from the shoulder of the picker. These bags hold from two to three dozen average size fruit, and as soon as the bag is filled the picker loosens the bottom of the bag, and the fruit is allowed to roll into the standard field box. These boxes hold about sixty-five to seventy per cent as much fruit as a standard packed box.

Twice a day or as often as necessary these filled field boxes are picked up by trucks or spring wagons, and the fruit is taken to the packing house. There it is received on a conveyor outside of the building and carried to the basement where these boxes are stacked four high and left to cool for two or three days.

After having remained in the basement a suitable time, which permits the fruit to cool and slightly shrink, the fruit is placed on a conveyor or elevator and taken to the washer. Here it is allowed to soak in water, to which is sometimes added Gold Dust, for ten to fifteen minutes and then conveyed to the cleaning brushes over which a spray of clean water is pouring. These brushes are constantly revolving, which causes the fruit to revolve, cleaning it from all sides. From the brushes it is elevated by the conveyors to the drier and air is circulated over it by a series of fans for a period of about twenty minutes. This thoroughly dries the fruit and prepares it for the sorting table where the grades are separated and conveyed to the various sizers.

These sizers consist of a series of rolls with various sized openings to which the fruit is conveyed by a belt. The fruit is carried on these belts until it reaches the proper sized opening when it drops into a bin which is carefully padded to prevent bruising. These sizers are mechanical in operation and exceedingly accurate, turning a uniform size fruit into each bin.

Packers take this fruit from the bins, wrap it in paper and pack it in standard size boxes. The sizes of the fruit run from twenty-eight to ninety-six to a box. The packing is done by contract, and the usual scale is six to eight cents for grape-

fruit and from eight to ten cents for oranges. The box leaves the packer on a conveyor and is taken to the press where the lid is pressed on, leaving the box with a center bulge of one and one-half to three inches. After nailing the lid, the center where the bulge is greatest is strapped with three-eighths inch galvanized strapping.

All boxes are printed on the side with the firm name, or the selling agency, and the particular brand is pasted on one end with a lithographed label. This makes an attractive package, and it is the aim of each house to put out the most attractive package. A common practice is to take the fruit immediately from the press and load it into the cars, ventilators or refrigerators, loading these two high and stacking on end in the car. Each row is held in place by narrow strips nailed to each box and the car is squeezed by high-powered jacks and the center is filled in. This makes a tight, solid load and will carry hundreds of miles without loosening and should arrive in the market, making a very attractive appearance when opened.

W. E. ALLEN,
Plant Manager.
TEXAS CITRUS FRUIT GROWERS EXCHANGE.

CITRUS INSECTS

An essential feature today of the successful growing of fruit of any kind is the control of plant diseases and insect pests. In none of these industries, however, is the matter of pest control of more importance than in the growing of citrus fruits. The mild warm climate that is necessary for the development of this industry is favorable to life and production of plant pests. As a result the factor of pest control must receive careful and persistent attention by the successful citrus grower.

The following pages are intended to give the grower such information as would make possible, the successful and practical control of these pests.

SCALE INSECTS.

In the Lower Rio Grande Valley, the most important class of citrus pests is scale insects. These minute insects establish themselves on the twigs, leaves and fruit, forming over their bodies protective scale-like formations. While the character of this scale or "house" is constant with the species, the various species develop different kinds of scale for their coverings. Under these coverings they suck and feed on the juice of the plant, greatly weakening the tree in general and when abundant cause death of the attacked portions. The tree, if it survives, is put in a weakened condition, and as a result it becomes susceptible to many semi-parasitic fungi. Aside from this injury, infested fruit is greatly lowered in market value.

In the Texas groves, Florida red scale, chaff scale, California red scale, purple scale, soft brown scale, are by far the most important of those established.

FLORIDA RED SCALE

Chrysomphalus aonidum, (Linneaus.)

The Florida red scale is the most injurious and most difficult to control of the scale insects occurring in the Valley. It is more common in the southern and eastern portions but occurs throughout the district. It was introduced in Florida more than forty years ago on sour orange trees from Cuba and from there it probably found its way to Texas.

It may be readily recognized from the illustration shown in Fig . 47. The scale is dark red in color, circular in form and further characterized by the regular outline and nipple-like exuviae, centrally located.

Four generations usually occur during a year under Texas conditions. These generations, however, overlap greatly and the climatic conditions of the specific year determine to a great extent the duration of the various stages of the insect.

The hard covering of this scale protects the mature insects and eggs from the general scale spray recommended. It is

therefore necessary to use stronger sprays for heavy infestations of this species, as given at the conclusion of "Control of Scale Insects," page 82.

PURPLE SCALE

Lepidosaphes beckii (Newm)

Although the work of controlling citrus insects in Florida is highly established, it is evident to the careful observer of fruit from that state that purple scale is by far the most generally

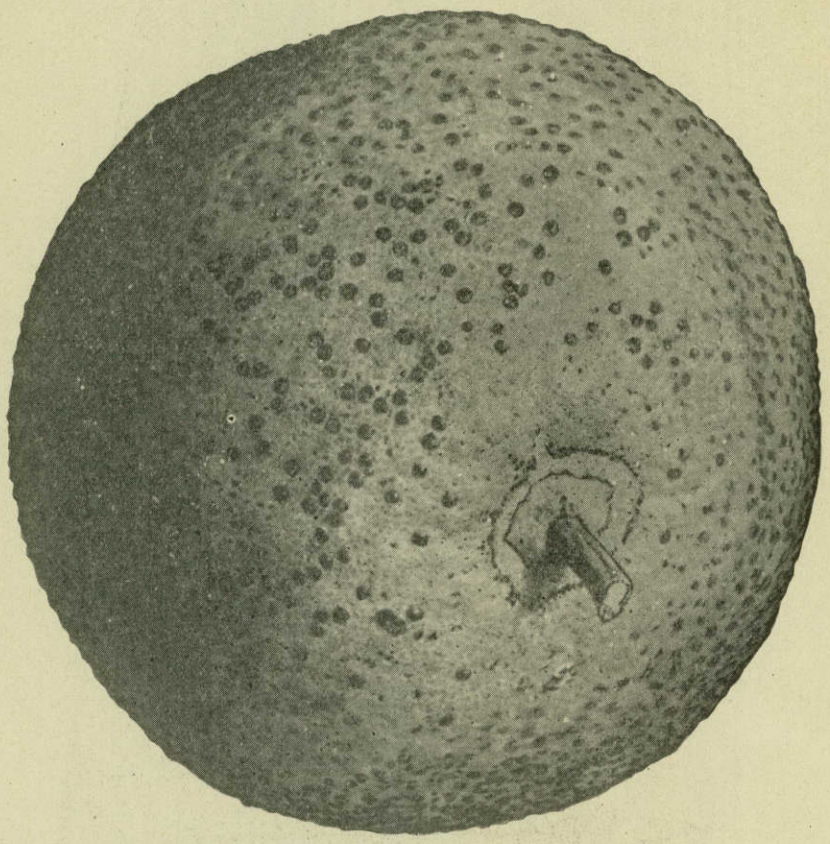


Fig. 47. Florida red scale on grape fruit.

distributed and important scale insect there. Its damage in Texas has already given it a place as one of the most injurious citrus pests in the State. It is widely distributed and its control will necessitate careful watch and application.

As the name implies, the scales are brownish purple in color, elongated oyster shaped and often slightly curved as shown in Fig. 49.

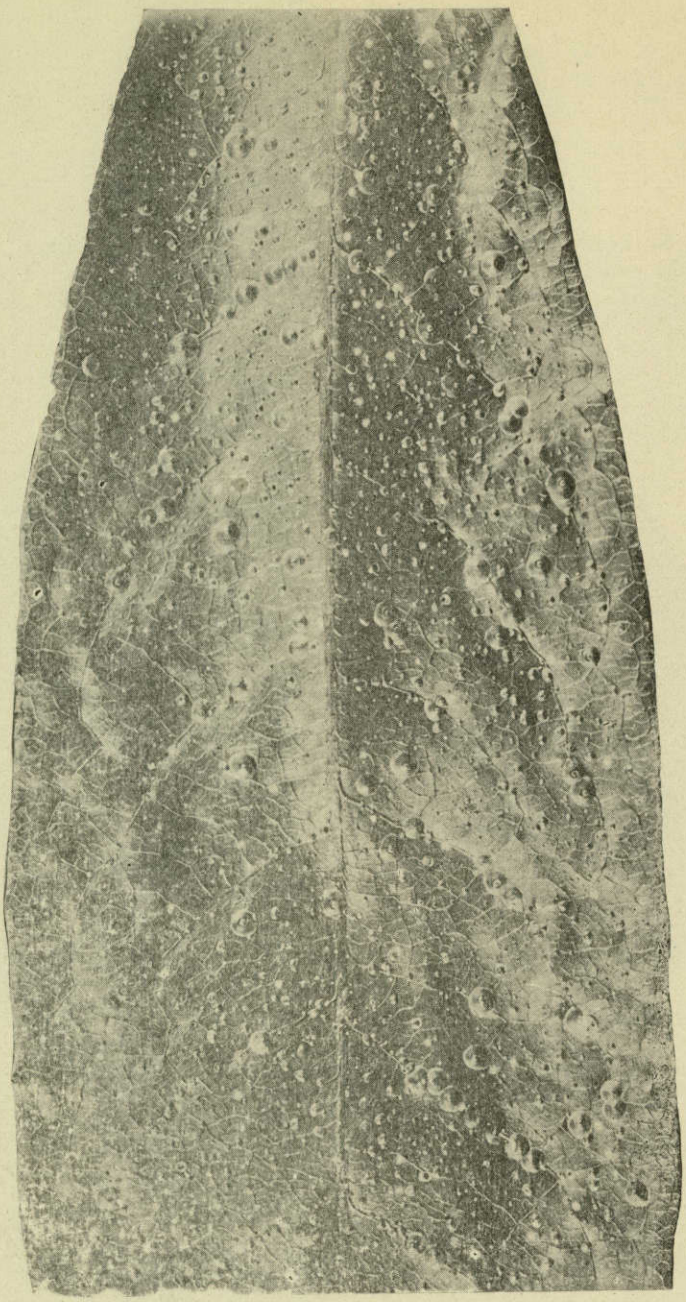


Fig. 48. Florida red scale on leaf, enlarged twice. (Taken from Florida County Bulletin, Vol. 2, No. 1, 1917.)

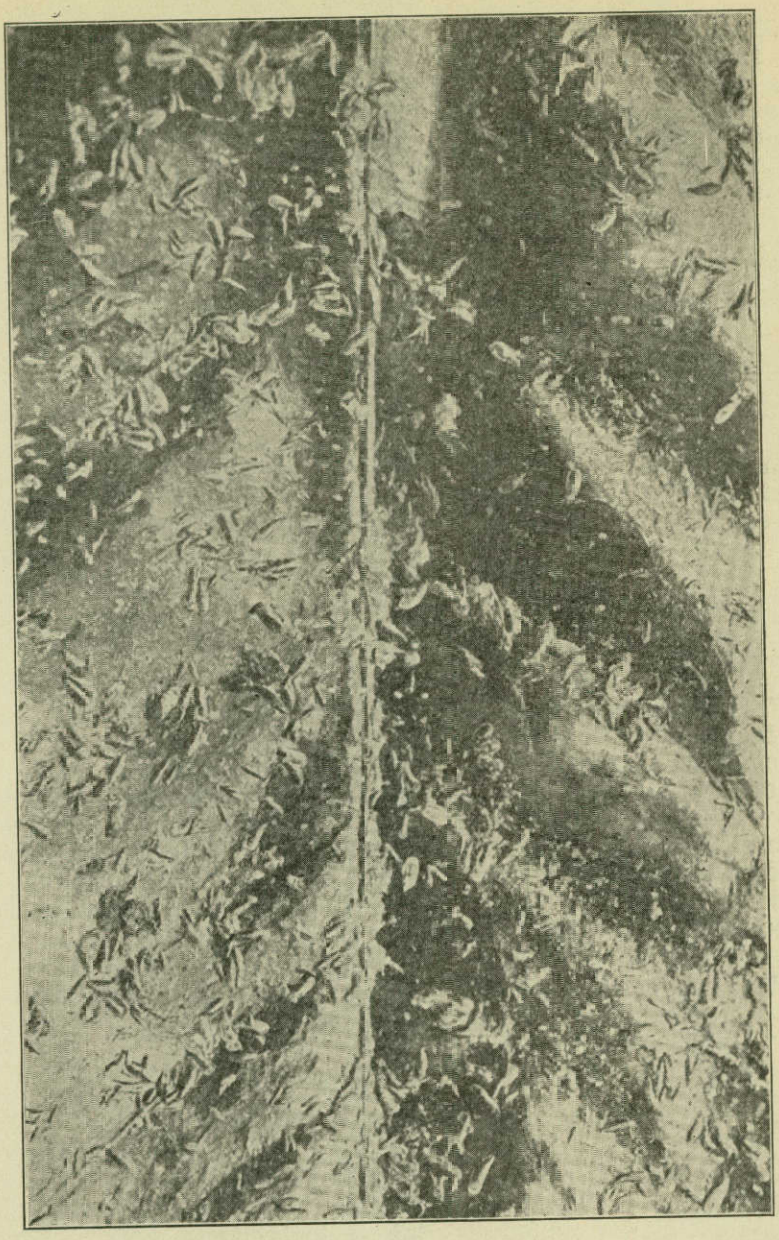


Fig. 49. Purple scale. (From California Bulletin No. 324, enlarged.)

CHAFF SCALE

Parlatoria pergandii, (Comstock)

This is a very prolific scale, which is probably the most common of scale insects in the western part of the Valley. The

scale is characterized by its habit of collecting in great masses on twigs, leaves and fruit, giving the tree the appearance of being covered with chaff. It greatly reduces the vitality of the tree and causes more or less defoliation. As stated, the scale is chaff-like in appearance, dusty gray in color, irregular in shape with the exuvia near one end. The male scale is longer than broad, with prominent lateral margins.

Fortunately, however, the scale is readily controlled by the oil emulsion sprays, given under the control of scale insects.

CALIFORNIA RED SCALE

Chrysomphalus aurantii, (Maskell)

The California red scale is not as yet well established throughout the Valley, but from its performance where it has been found, it bids fair to become one of the most serious of our pests. It is a closely related species to the Florida red scale but differs from it in being flatter, lighter in color and less regular in form.

BLACK SCALE

Saissetia oleae, (Bernard)

This scale is classed as one of the most serious citrus pests in southern California and is reported as being very injurious in many other citrus sections. In Florida, however, the scale is reported as of only minor importance. Its prevalence in Texas is very limited but on the account of its activity under similar climatic conditions in other sections where established, special precautions are being taken to prevent any further introduction and spread. Several infested shipments of nursery stock have been intercepted from California and a close watch is being kept for the scale from all sources.

The black scale may be recognized by its hemispherical shape and the prominent "H" shaped marking on the back.

SOFT BROWN SCALE

Coccus hesperidum, (Linnaeus)

Brown scale or soft scale as it is sometimes referred to is a very common pest in the Delta region. The large amount of black smut or sooty mold growing upon the honey dew secreted by this scale, as shown in Fig. 50 usually calls attention to its presence at once. The adult females are oval flat, soft, brown scales with a few indistinct markings. They congregate along the mid-rib and larger veins of the leaves and show quite a preference for young trees. The young are born alive in great numbers and establish themselves in groups on the tree, often becoming so thick as to overlap.

Soft brown scale does not confine itself to citrus alone, but occurs commonly on banana, fig, date, palm, rose, myrtle, willow and various other plants. The scale is readily controlled by the

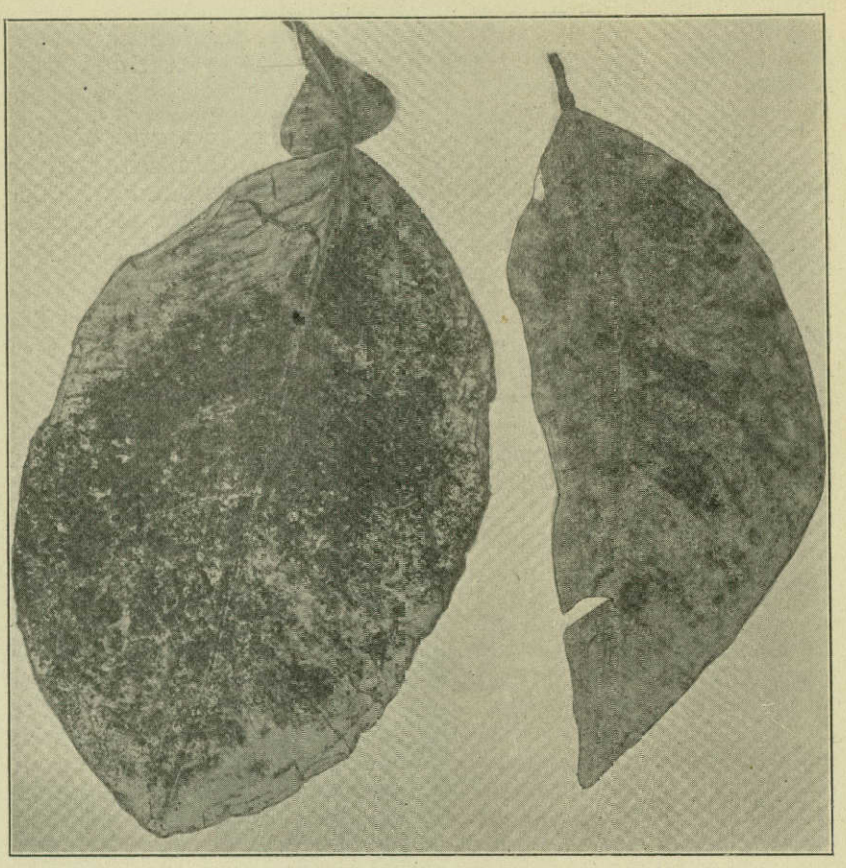


Fig. 50. Citrus leaf, showing soft brown scale with sooty mold and chaff scale.

use of oil emulsion sprays as recommended under control measures for scales.

COTTONY CUSHION SCALE.

Icerya purchasi, (Maskell)

The accidental introduction of this scale into California from Australia and its control by the imported "Vedalia" lady beetle, well illustrates the important role played by beneficial insects in the control of the injurious forms. The scale had not been in California very long when its spread and damage made it evident that the citrus industry of that state was being threatened. Investigation in Australia, its native habitat, resulted

in the importation of the Vedalia beetles which soon put the scale under control. The use of the beetles in other states has upheld their reputation as a means of control. The Vedalia never eradicates an infestation of scale but prevents the pests reaching injurious numbers. Unfortunately the beetles cannot survive when the scale becomes scarce and so at times it is necessary to restock them.

On account of the surface of the scale being to a great degree water proof, sprays are generally ineffective. In absence of the Vedalias, however, the oil emulsion sprays as recommended for Florida red scale when applied in a fine mist under high pressure and on small infestations, where tedious spraying is possible, have given some degree of success.

Several infestations have been found at times in the Rio Grande Delta, but through work of the State Department of Agriculture they have been practically eradicated. Any further outbreaks of the scale should be reported to the Department at Austin or its representative in the Valley, and proper action will be taken for the control and prevention of spread. The scales are well illustrated in Fig. 51.

CONTROL OF SCALE INSECTS

Many of the various species of scale insects described here are sufficiently alike in habits that they may be controlled by the same methods. Any special remedies recommended will be found discussed under the respective species. The paraffin oil emulsions as used in Florida with slight modifications have given best results in the Valley. A number of already prepared commercial emulsions and miscible oil sprays have also proven very successful. Some growers prefer to buy the stock solution in this form, even at a higher price, because it dispenses with the inconveniences of making the emulsion. Orchard owners, however, should use care in buying commercial emulsions or sprays on the market as some of them have not only been found practically worthless, but injurious to the trees. One should only purchase such preparations when he has seen the work they

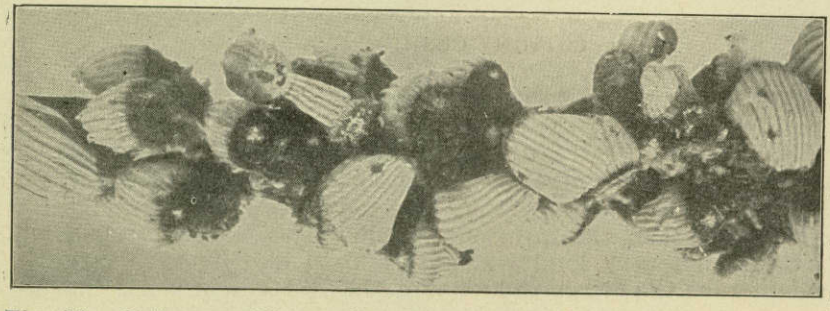


Fig. 51. Cottony cushion scale. (U. S. Manual of Dangerous Insects.)

accomplish or after consulting a government expert who keeps up with these questions.

Two formulae for preparing oil emulsions are given below: Both preparations have proven satisfactory.

Formula for Cold Stirred Emulsion Stock Solution

8 lbs. fish oil soap (preferably liquid.)
2 gals. parafin oil.
1 gal. of water.

The soap should be placed in a receptacle in which the emulsion is to be made. A pint of oil should be added and stirred vigorously until no free oil is visible. This should be continued until the required amount of oil is used and completely emulsified. The water should then be added slowly in the same manner. This stock solution should be diluted with 200 gallons of *soft* water or 1 gallon of this stock solution to 50 gallons of *soft water.*

A method of treating hard water is given in a following paragraph and must be used for the Valley water.

Formula for Boiled Emulsion Stock Solution

2 lbs. fish oil soap (1 gal. liquid.)
2 gals. parafin oil.
1 gal. of water.

Mix the ingredients together and heat to the boiling point. Then emulsify by pumping and repumping the mixture into itself. Merely stirring is not sufficient. A hand spray or barrel spray pump will serve the purpose. If the solution is too thick at the time it is to be used, bring it to a warm temperature but do not boil. This amount of stock solution should be diluted with 200 gallons of water.

To Soften Water

The importance of treating well water or the water of the Rio Grande River for spraying purposes is to be called to the attention in the making of both of these emulsion sprays. In fact, the spray cannot be made successfully with hard water. An easy method of softening the water is herewith given.

Add ½lb. of dissolved soap to 50 gallons of water and let stand for a few minutes. Then add either 4 ozs. of concentrated lye or caustic soda. Stir well and let stand a while before using.

To Render Emulsion More Stable

It has been found by members of the United States Department of Agriculture that the oil emulsion sprays can be rendered more stable by the addition of one pound of glue, flour or corn meal to the stock solution. Either should be made into a light paste and added to the boiled emulsion with the other materials, and to the "Cold Stirred Emulsion" after it has been emulsified but not diluted.

Method of Application of Sprays

It is very essential that the insecticide be applied with proper spray machinery. There are various types of suitable machinery on the market, the selection of which depends upon the particular needs of the individual grower.

The barrel spray pump is indispensable to any sized grove and will suffice entirely for the smaller plantings in the Valley. For

Fig. 52. Power spray in operation.

large groves or large trees a double lever pump or a power spray outfit is necessary. Either of the machines should be equipped with proper pressure hose, extension rods and suitable nozzles. Angled "mist" nozzles are preferable and the hole in the disk should be from one-twentieth to one-sixteenth of an inch in diameter. The opening should be smaller when used with pumps of low pressure capacity in order to better regulate the mist.

When using the barrel spray pump, a pressure of at least 100 pounds should be maintained. The larger sprayers should be operated with from 175-300 pounds of pressure. The pressure is an important factor in securing an even and satisfactory distribution of the emulsion. It must be understood that the oil emulsion sprays are contact insecticides and must strike the insects to be effective. Therefore, results can not be expected if the spray is not thoroughly administered. Every portion of the tree surface from both sides of the leaves to the trunk should be covered with the mist from the spray. The insecticide should be permitted to trickle into the soil for an inch or two around the tree trunk. It will ordinarily take one gallon of spray material to cover well trees from two to three years of age, while eight to ten gallons should be used on the very large trees. Many of the species of scale insects also attack other plants than citrus which should also receive attention from the grower.

We cannot be too emphatic in our appeal for thoroughness, for it is a lack of painstaking effort that explains many failures in scale control.

Time to Spray

Ordinarily two thorough applications made at the correct times will control the pests. During some seasons and under adverse conditions supplementary sprays will be necessary. The success of the spray also depends to a great extent upon timely applications. It has been found that sprays are most effective when the young scales are moving from under the mother scale to their new location. For a time after becoming established they are very tender and very susceptible to the effects of the spray, while many of the older scales and eggs escape without serious injury. (See Florida red scale, page 77). Consequently the strategical time to spray is when the "crawlers" are most abundant.

The first spraying, after blooming time, however, should not be made until the fruit is at least one inch in diameter. As the fruit approaches this size, a close watch should be kept for the development of "crawlers" and when found abundant, the first application should be made. Follow with a second spray in 30 to 50 days. This will allow time for all eggs to hatch but will not permit the new generation to mature and deposit more eggs.

If, however, for some reason results are unsatisfactory, watch for "crawlers" in July or August and repeat the operation. Promising results have also been obtained from an application just prior to the blooming period during a season favorable for the emergency of "crawlers" before the trees were in bloom. If a cold spell is anticipated, however, following the time for application, it had best be postponed, as such an occurence has been reported as causing severe defoliation.

Control of Florida Red Scale

On account of the unusually hard scale covering of the Florida red scale which adheres so closely to plant tissues, it is frequently necessary to apply the emulsion double strength to effect a control of heavy infestation of this scale. On nursery stock one application of three times regular strength will control the pest.

RUST MITES

Eriophes olerivorus (Ash).

The russeting of citrus fruit as shown in Fig. 53 is caused by small red wedge shaped mites, commonly known as "rust mites." These mites are microscopic in size and are only visible to the naked eye in masses. They cause injury, when they appear in great numbers, by piercing the oil cells of the rind, which in healing over darkens and develops into the common dark brown rus-

set frequently seen on citrus fruit. This russeting is thought by some to slightly improve the flavor of the fruit but in any event it reduces the size, renders it less attractive and consequently lowers its market value. During the past season a deduction of fifty cents per box was made on russet fruit. These

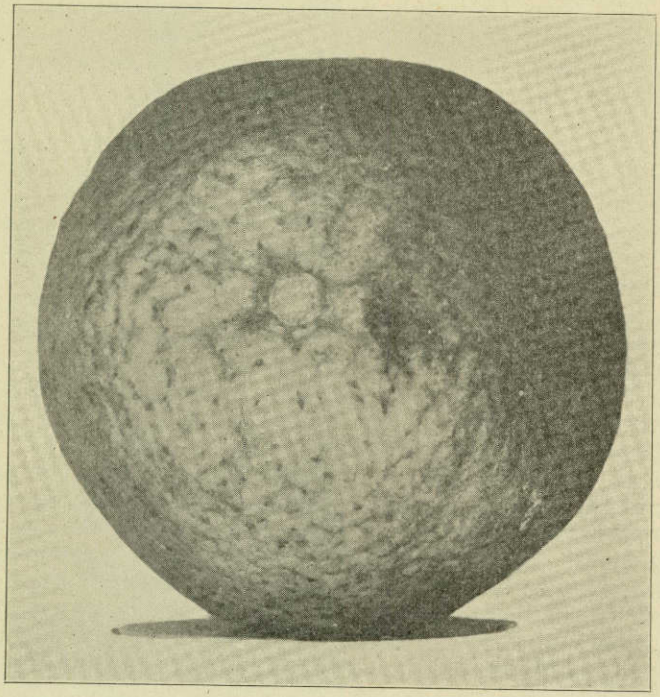


Fig. 53. Rust mite injury on orange. (Note the dark discoloration on the area on the upper right hand surface.)

mites also feed upon the leaves where the injury they do is often overlooked. When a heavy infestation occurs, however, the leaves lose their green color and curl at the edges.

Dry weather seems to be favorable for the development of mites, for they multiply very rapidly during such weather. Heavy rains wash many from the trees and retard their development. As a result, injury is more pronounced during hot dry weather. It is of interest to note that a number of authorities from foreign citrus sections state that less injury was found where the weeds or a mulch was permitted to remain on the soil under the trees. No explanation was offered for this coincidence and it is not to be recommended.

Mite Control

(Also see Control of Thrips)

The common remedy for mites is sulphur, which can be used in a number of ways. One of the best sprays, however, is the

soda-sulphur solution, the formula of which is herewith quoted from the U. S. Farmers' Bulletin, 933:

"The main value of the soda-sulphur solution consists in the properties which enable it to be used in combination with the oil emulsions. Owing to the superiority of lime-sulphur solution, the use of soda-sulphur solution alone is not advised. It has a distinct place, however, in forming a good combination spray for white flies, scale insects and mites. It is made as follows:

Stock Solution Formula

Flowers of sulphur	30 pounds
Caustic soda (98 per cent)	20 pounds
Water	20 gallons

To remove the lumps from the sulphur, place a wire screen over the barrel and rub the sulphur through with the hands, then slowly add about 3 gallons of water and stir so as to form a thin paste. The caustic soda should then be added and the entire mixture stirred vigorously. Some growers add the caustic soda gradually to prevent too vigorous boiling, and others add it all at once with water enough to prevent too vigorous boiling. It is also practicable to dissolve the caustic soda in about 4 gallons of water before it is added to the sulphur. The boiling will be quite violent and it may be necessary to add a gallon or more of water during the process, but whether or not this is necessary can be determined by the operator.

The main difficulty in making this formula is that too great heat is generated, which liquifies the sulphur before it can be acted on by the caustic. If sediment forms this has been the cause. To prevent this excessive heat add more water in the beginning and during the process. After boiling has ceased add about 16 gallons of water.

For spraying against red spiders and rust mites use one gallon of this stock solution to 40 gallons of water. *When used with the oil sprays* the strength should be a little weaker than if used alone. *When so used, dilute one gallon to 50 gallons of water. It it is to be used in combination with oil emulsion, it should be added to the tank or barrel of water before the oil emulsion.*"

To make the soda-sulphur solution combination as given in the spray schedule on page 100 add three quarts of the oil emulsion to 50 gallons of the diluted solution.

There are a number of commercial forms of lime sulphur combination on the market. The commercial liquid form with a hydrometer reading of 30 degrees Baume should be used by adding one pint of stock solution to seventy gallons of water. The commercial dry form should be used at the rate of three to five pounds of the mixture to fifty gallons of water.

The spray for thrips given under the discussion of "Thrips" is also very effective against the mite, and may be used to serve the double purpose.

Sulphur may also be applied to the trees in the form of a dust during dry hot weather where there is a possibility of burning the leaves with liquid spray. Commercial powdered sulphur (preferably flowers of sulphur) may be used alone. When the dust method is used, the insecticide should be applied to the trees with a dust gun in order to assure the material being finely distributed over the leaves. Best results will be obtained by applying the dust at night. All sulphur sprays are more effective during hot weather when rapid decomposition of sulphur takes place.

The time of application of the insecticide is a very important factor in the control of the mite. If the application is made after the fruit has been scarred, it will not remove the injury. Growers should equip themselves with a hand lens and learn to recognize the mites. As soon as they are noticed, the insecticide should be applied. *Ordinarily when only the control of the mite is sought, the first spraying should be made just before blooming time and another as soon as three-fourths of the petals have fallen, followed by a third application two weeks later.* Subsequent sprays should be made as the development of the mites warrants, keeping in mind that the injury can not be removed after it has been made.

During the early part of June the mites are generally very active and should be given attention.

THRIPS

The group of insects commonly known as thrips are minute fringed insects, closely resembling gnats. They frequently in-

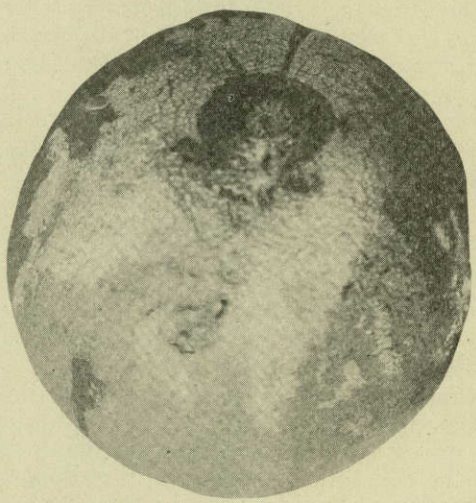


Fig. 54. Thrip injury.

habit flowers and may be readily observed by shaking almost any flower into the hand. Several species are known to attack citrus. In California *Euthrips citri* is the important species while in

Texas, *Euthrips tritici*, the common flower thrips, is responsible for the principal thrip injury.

The life histories of the species attacking citrus, however, are practically the same. The average life cycle in each case occurs in about twenty days. Injury is done to the blossoms in causing "bloom drop" and to the fruit by scarring. The insects rasp the tissues of the fruit, causing grayish sunken areas of more or less extent as shown in Fig. 54.

Much of the injury is done when the fruit is quite young, but may occur any time during the season. The injury not only lowers the market value of the fruit on account of appearance, but also makes the fruit susceptible to the various fruit rots.

Control

Thrips thrive during hot dry weather. They rarely reach injurious numbers for sometime after heavy rains. On account of their minuteness they are unable to escape washing rains and suffer a great mortality during such weather.

In California and Florida a lime sulphur and nicotine sulphate solution made as follows is used extensively in the control of thrips on citrus.

The spray has also given excellent results in Texas.

Thrips Spray

Commercial lime-sulphur solution 32 deg. Baume	2 1-3 qts.
Black leaf 40 "	3 1-2 ozs.
Water	50 gallons

Three to five pounds of dry lime sulphur may be used in place of the liquid solution.

Observations have shown that if dry weather preceeds and lapses into blooming period, it is very probable that the infestation of thrips will be heavy in the bloom. Regardless of weather conditions, however, if an examination of the early blooms indicates a heavy infestation, an application of the thrip spray should be made during the blooming period. The spray should be forced into the blooms. Some of the blooms will naturally fall, but these would have fallen regardless. The spray should be kept, however, in a fine mist by maintaining a pressure of 175-250 pounds. Especial attention must be given the question of pressure in this case, as a lower pressure than that recommended above will cause injury and give poor results.

Supplementary sprayings may be made in accordance with the control of the rust mite, as ordinarily requirements from this time on will be similar. In such sprayings all parts of the plants should be drenched.

Weather conditions are frequently such as to prevent the early multiplication of thrips, but in such cases spraying may be postponed until after two-thirds of the petals have fallen and the solution strengthened as per the spray schedule, see page_____.

WHITE FLIES

The class of insects known as "White Flies" are very closely related to the scale insects and in their early stages resemble them very much. The young crawl around for some time after

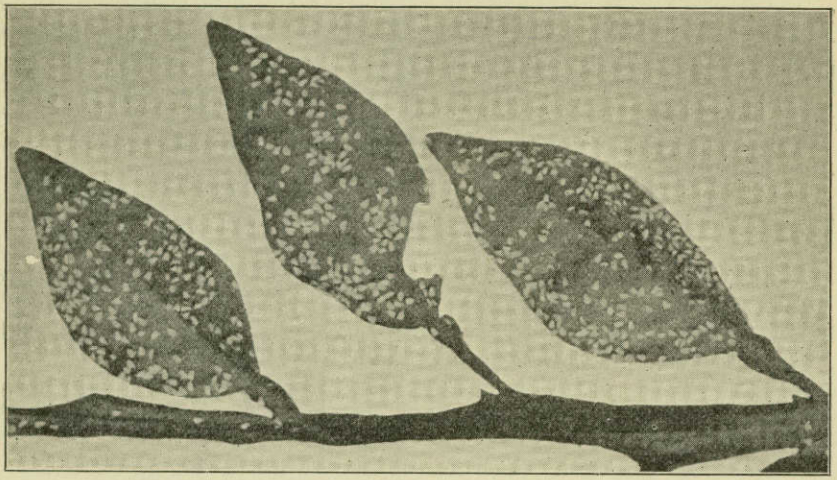


Fig. 55. Citrus White Fly. Adults of the Citrus White Fly crowd under the surface of the orange leaf. Adult appears slightly smaller than normal size. (Morris & Black.)

they have hatched from the egg, but later establish themselves permanently and secrete a scale-like covering as do the scale insects. The adults, however, are much more active than the adults of the scale insects and during a heavy infestation, they may be seen in great numbers as shown in Fig. 55. The injury done by white flies is by sucking the sap from the plant tissues and secreting quantities of honey dew upon which the sooty mold fungus grows.

The flies thrive under humid and moist conditions, but may reach injurious numbers under seemingly adverse conditions. The injury done by white flies in the Lower Rio Grande Valley is more severe in the southeastern part of the section, where they seem to find more ideal conditions. They may be controlled by the same oil emulsion spray as given under control for scale insects.

MEALY BUGS

Mealy Bugs belong to the group of insects which have sucking mouth parts, and the injury they do is very much of the character done by scale insects, white flies and plant lice. They are soft bodied creatures which congregate on the leaves, petals and twigs and secrete a cottony mass of material around themselves. They are not serious pests in the Valley and if they become numerous enough to warrant a remedy, they may be con-

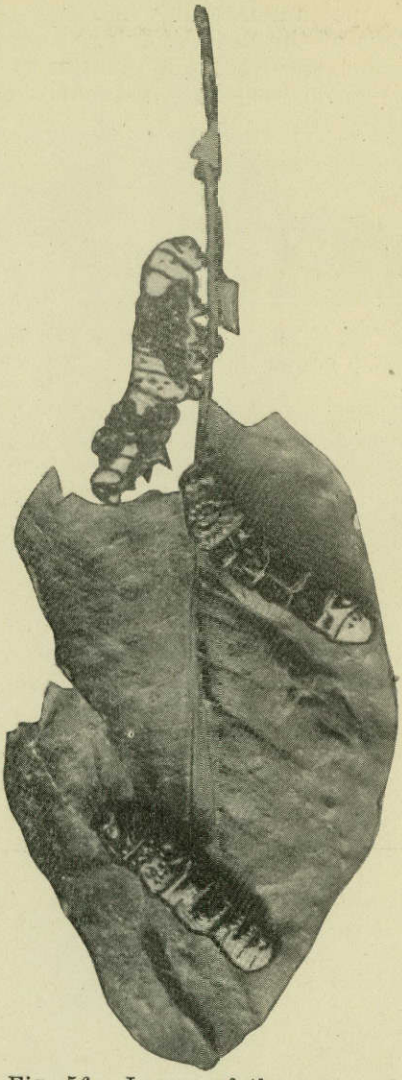


Fig. 56. Larvae of the orange dog, a caterpillar which produces the beautiful yellow and black swallow-tail butterfly, commonly seen in the grove.

trolled by either the oil emulsion spray or a spray for Thrips as given under the heading of Thrips. "Nico Dust" is also effective.

CATERPILLARS

Caterpillars of various kinds have been reported as attacking the foliage of citrus trees. The larva of the Flannel Moth is a hairy creature, resembling a small mouse. The hairs of these

larvae are slightly poisonous and when they come in contact with tender portions of the flesh, they are very painful. These caterpillars rarely become injurious enough to warrant control measures, but if they do, they may be controlled by a spray of

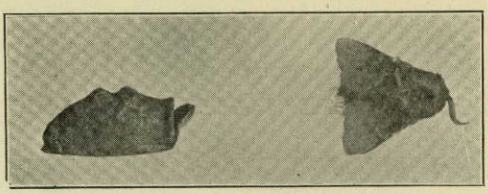


Fig. 57. Adult and pupa of the Flannel Moth or Asp.

Arsenate of Lead, 2lbs. to 50 gallons of water. Calcium Arsenate or Arsenate of Lead may also be applied as a dust effectively when mixed with lime. The orange dog caterpillar is shown in Fig. 56. This caterpillar is a very common pest in the citrus grove and may be controlled by hand picking or as given under Flannel Moth

KATYDIDS.

Katydids feed upon various plants and have caused noticeable damage to the fruits of the orange by gnawing and eating the rind in irregular patches. Due to the small amount of damage

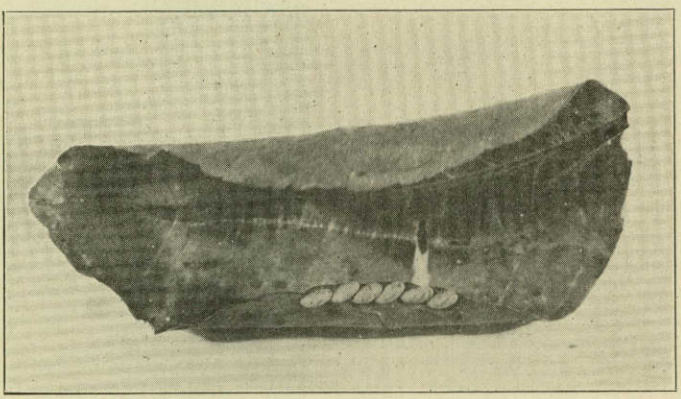


Fig. 58. Eggs of the Katydid on orange leaf.

done, control measures are not necessary from an economical viewpoint. Eggs of the katydids are shown in Fig. 58.

PLANT BUGS

The large class of insects known as plant bugs include various members, which occasionally puncture the leaves and fruit of citrus. The injury to the leaves often results in leaf spots, and

to the fruit by disfiguring it. The punctures in the fruit, leaves and twigs also furnish entrance to many secondary parasitic organisms. As the appearance of these bugs is usually spasmodic and of short duration, control measures are not likely to be warranted. Judicious handling of the cover crops will prevent much of the injury.

In Florida it is recommended that cover crops be cut in the middle of September. The portion of the crops around and be-

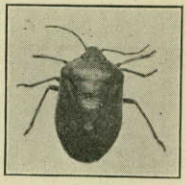


Fig. 59. Plant bug

tween the trees should be cut with a scythe first and thus permit the young nymphs of the bugs to congregate in the center where they will perish after the remainder of the crop has been cut.

It is also recommended, where the bugs are numerous, to collect them in a muslin net, attached to o wire loop and made with a wooden handle. The bugs may be jarred from the tree into the net, the bottom of which should be soaked with kerosene oil.

TERMITES AND ANTS

Rarely Termites or White Ants as they are sometimes termed, attack citrus trees, undermining them, especially where stumps or decayed wood are permitted to remain in the orchard. It has been observed that trees set too deep are also much more liable to be attacked by the pest than otherwise. It is also advisable to plant new cleared land to other crops for two years before planting the orchard, as the termites are frequently found in decaying timber on such land and are therefore numerous just after it is cleared. Beds of the ants may be eradicated by the use of "highlife" (Carbon Bisulphide) or a cyanide solution. True ants also attack diseased portions of trees and cause a secondary injury. Some species may also be found associated with scale insects. In either case a removal of the primary trouble will do much to eliminate the ants. Ant beds should be treated with a solution made of 4 ounces of potassium or sodium cyanide to one gallon of water. This chemical is very poisonous and injurious to trees and care should be taken in handling it.

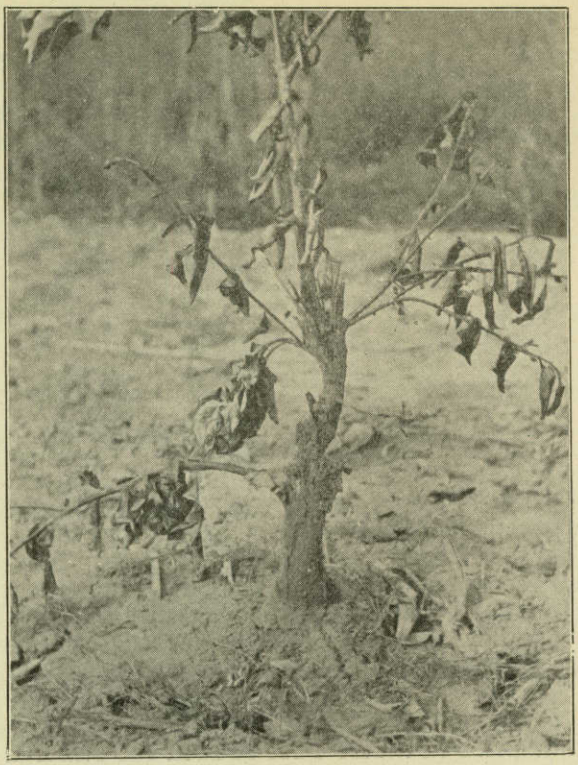


Fig. 60. A tree badly infested with ants.

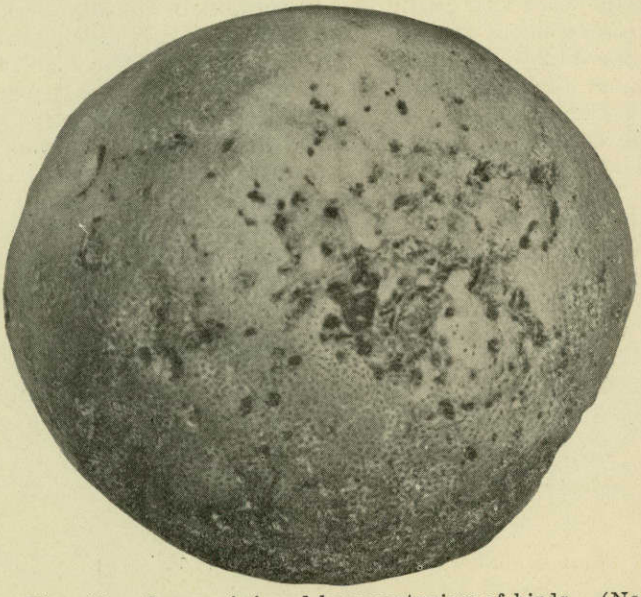


Fig. 61. Orange injured by puncturing of birds. (Note the holes made by the pecking of the birds.)

SPRAYING SCHEDULE FOR CITRUS FRUIT IN THE RIO GRANDE VALLEY.

The spraying schedule outlined below was formulated by representatives of the U. S. Department of Agriculture, Texas Experiment Station, Texas Department of Agriculture, and Extension Service of A. & M. College. It is intended to standardize spraying for the control of the more important citrus pests common in the Valley section. The purpose of any spraying schedule, however, is merely to outline the year's spraying work, taking into consideration practically all the pests with which the growers have to deal. For specific information about any particular insect or disease that may be giving trouble at the time, the grower will find valuable information and suggestions regarding it by consulting the reading matter given under the appropriate heading.

1. *Time*: When two-thirds of the petals have fallen.
   Enemy: Rust mites, thrips, and red spiders.
   Material: Lime sulphur solution, 3 qts. to 50 gals. water with 6½ oz. nicotine sulphate to 50 gals. water.

2. *Time*: 10 days or two weeks after No. 1.
   Enemy: Same as No. 1.
   Material: Same as No. 1,
   or,
   If Citrus Scab is present—
   Time: 10 days or two weeks after No. 1.
   Enemy: Thrips and Scab.
   Material: 3-3-50 Bordeaux Mixture and 6½ oz. nicotine sulphate to 50 gals. water.
   N. B.—Nicotine sulphate may be omitted if thrips are not abundant.

3. *Time*: When fruit is about 1 inch in diameter.
   Enemy: White flies, scale insects, rust mites, and red spiders.
   Material: Soda-sulphur-oil emulsion combination.
   If Scale is NOT abundant—
   (See rust mite control.)
   Material: Lime sulphur solution, 3 qts. to 50 gals. water.
   or,
   Dust with dry sulphur.

4. *Time*: Three to five weeks after No. 3.
   Enemy: Rust mites and red spiders.
   Material: Lime sulphur solution, 3 qts. to 50 gals. water.
   or,
   Dust with dry sulphur.

5 *Time*: In July, if rust mites are abundant.
Enemy: Same as No. 4.
Material: Same as No. 4.
or—If Scale is abundant—
Material: Same as No. 3.

6 *Time*: About September 1st.
Enemy: Scale insects, rust mites.
Material: Same as No. 3.

7 *Time*: Between December 1st and February 1st. When trees are nearest dormant. After most of the fruit is off and before much new growth is made.
Enemy: Scale insects. White fly.
Material: Oil emulsion, 1 gal. to 50 gals. water.
N. B.—This is essential only where scale or white fly is present. It is the most effective spray of all in cleaning up the orchard of these pests.

NATURAL CONTROL OF INSECTS

If it were not for the different natural controls of injurious insects that we have, plant life would probably soon become extinct. In fact, one authority states that it has been computed that the progeny of one plant louse in a single season, if allowed to multiply at the maximum rate and if none suffered accidental death, would make a mass of matter equal in weight to that of the earth.

Following is a brief outline of some of the natural enemies of injurious insects that attack citrus trees:

Of the predaceous insects, the lady beetles are probably the most important. (See Fig. 62.) Under this group are found the twice stabbed lady beetle (*Chilocorus bivulnerus*), Australian lady beetle (*Novius cardinalis*), Black-spotted red lady beetle (*Hippodemia convergens*), Blood Red Beetle (*Cyclomeda munda*), and others, most of which are common among the citrus groves, where they feed largely upon the crawlers and eggs of scales, tearing up the females to get them.

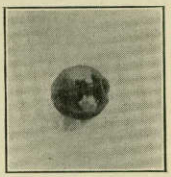


Fig. 62. Lady beetle, a friend of the citrus grower.

The larvae of lace-winged flies are flat and spindle-shaped, grayish in color, from one-fourth to one-third of an inch long, and are very voracious, attacking insects much larger than themselves. On account of the cannibalistic tastes of the larvae, the adults lay their eggs on stalks about a fourth of an inch high, thus placing them out of reach of each other. Adult and eggs shown in Fig. 64.

There are many different species of internal parasites that attack scale insects. Their presence may be noted by round holes in the top of dead scales, cut by the adult parasites when emerging. These parasites belong to several different sub-orders of Hymenoptera and Diptera and are generally classed as wasps or flies, although the majority are much smaller than the common forms. The females deposit their eggs either on or in the body of the insect, the resulting grub feeding upon the host until the insect thus parasitized dies from loss of body tissue, or from poisoning by the larvae.

Predaceous mites attack live scales to some extent, but their main supply of food is derived from the dry material of dead scales. The most common species is usually a pale flesh color, but others vary from white to yellow, some being dark red.

There are other predaceous insects that are more or less valuable, such as the devilhorse or mantis, assassin bug, the

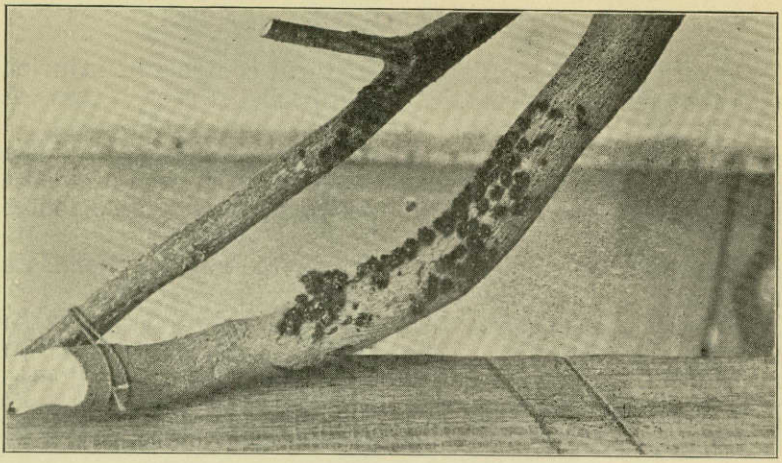


Fig. 63. Pupa cases of the Lady beetles from which the adults have emerged.

wheel bug, the thread-legged bug, the damsel bug, the ambush bug, the green soldier, or pumpkin bug, etc., which space does not permit mentioning to any extent.

The parasitic entomogenous fungi which attack insects, especially the various scales, and which are so generally resorted to in Florida as a means of control, are not important in the Valley on account of the hot, dry climate of that section, which does not permit rank growth of the fungi.

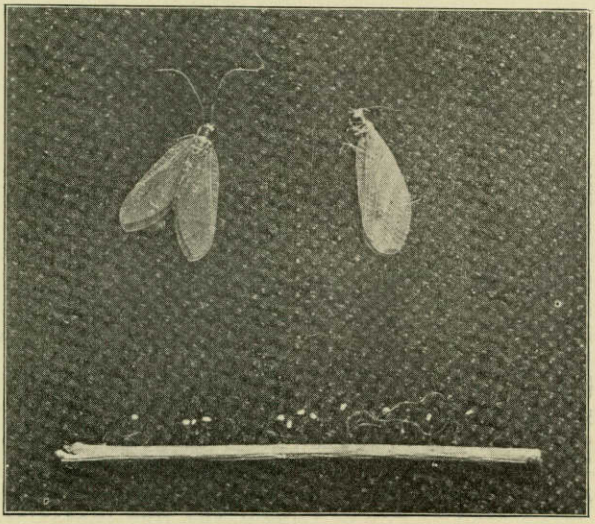


Fig. 64. Adults and eggs of the lace-wing fly, a friend of the citrus grower and farmer. Note that the eggs are set at the end of stalk-like formations. (See discussion.)

CITRUS DISEASES

The effect that environmental conditions, the general health status and peculiar physical properties of animals bear toward disease susceptibility has been universally recognized. These factors enter so vitally into the health of human beings that many times they are wholly responsible for such common maladies as headaches, indigestion, rashes, etc. As a result a simple and effective treatment not only of non-parastic troubles, but of parasitic diseases, is to subject the patient to better health conditions with reference to environment, climate and diet.

In this same way, plant's environment has much to do with its behavior, growth and disease powers. Plants act differently in different soils and climates, a phenomenon, which is generally governed by inherent requisites of a related group of plants. These peculiar likes and dislikes, however, extend into the varieties, and sometimes less conspicuously to the individual.

Successful plant disease prevention and control deserves a consideration of these realities. Regardless of the disease under consideration, a plant should be given an opportunity to help itself in resisting the trouble by the assistance of judicious root stock selection, varietal selection, planting, cultivation, fertilization and irrigation, in so far as conditions will permit.

This recommendation has a special significance with reference to citrus diseases, as the species belonging to the citrus group are exceedingly sensitive and responsive to their environment.

GUM DISEASES

Citrus trees are subject to more or less exudation of gum as the result of slight disturbances. Frequently leaves from gum spots and twigs and limbs exude gum as the result of "die back," mechanical injury or frost injury. Such exudations must not be confused with the two diseases described below.

GUMMOSIS

Gummosis is apparently a distinct trouble from mal-de-goma rot, while the probable cause of both diseases is the same. Although resembling parasitic diseases in nature, no organism has yet been found as primarily responsible. Conditions favoring the disease will be found under *Mal-de-goma.* h

Gummosis differs from foot rot in that the trunk, limbs and twigs are attacked rather than the tree base and crown roots. The trouble is characterized by more or less gumming in localized areas, accompanied by scabbing and peeling of the bark, forming gummy ulcerated sore spots. These spots enlarge and the entire tree becomes involved. When the affected areas girdle a limb of the tree, all portions above the girdle quickly die.

MAL-DI-GOMA OR FOOT ROT

As the name implies, this is a disease which is principally confined to the base of the tree.

The trouble is first noticed by a slight gumming and brownish discoloration on the trunk near the surface of the ground. The discoloration progresses up the trunk and downward along the roots, accompanied by a fetid odor. In the majority of cases, the rot works mainly on the crown roots, girdling the trunk. On affected parts the bark breaks away in patches,

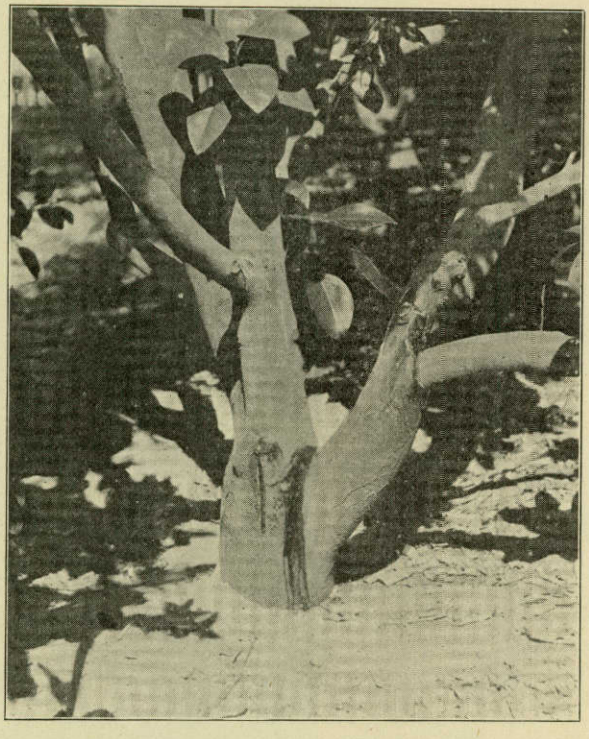


Fig. 65. Tree affected with Gummosis.

giving a gummy and scabby appearance. Affected trees are generally characterized by chlorosis or yellowing of the leaves.

As stated no specific organism has been found as primary cause of this disease. In California and Florida several species of fungi were found capable of producing both foot rot and gummosis, under some conditions, but nevertheless both diseases are apparently the result of unfavorable conditions, which make possible the attack of many semi-parastic soil organisms. The following conditions favor the development of the trouble *—improper root stock, poor drainage, excessive irrigation, too close planting, too deep planting and tight soils.*

CONTROL OF GUM DISEASES

The control of this class of plant diseases should especially be considered from two standpoints, namely—*prevention* and *treatment of affected trees.*

The prevention of such diseases necessitates a thorough consideration of the condition favoring the trouble. In the first place, poorly drained heavy soils should be avoided or corrected. Furthermore, there is a marked difference in the resistant powers of various root stocks. Sour orange root is by far the most resistant to the disease, and should be used. A prominent plant pathologist and citrus authority makes the following statement in regard to these diseases:

"Fortunately, foot rot as well as gummosis may largely be prevented by budding nursery trees to sour orange roots. This has been done for many years in Florida and has controlled the disease perfectly, even in cases in which the sour orange roots were used as resets in badly infected orchards."

Aside from these two principal means of preventions, trees should not be planted too closely (see "setting out orchard") and should receive careful cultivation and judicious, uniform irrigation.

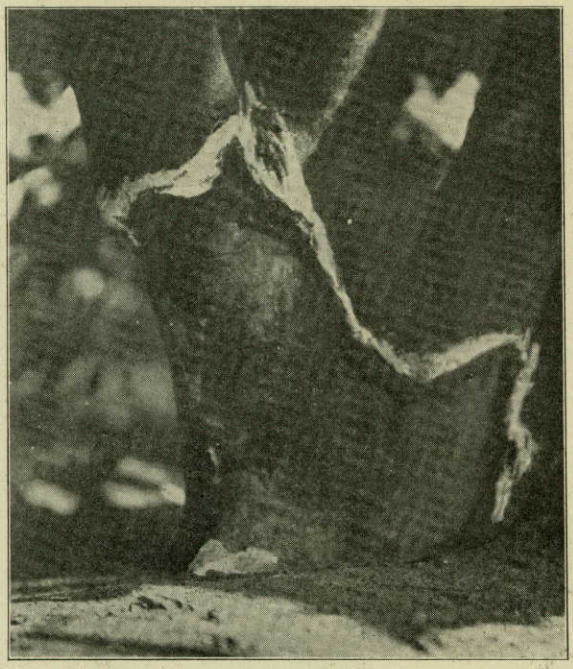


Fig. 66. Tree affected with foot rot or Mal-di-goma. (Note the affected area as outlined with chalk.)

TREATMENT OF AFFECTED TREES.

Many trees affected with foot rot in the Valley have been cured by digging away the soil from the affected roots and the cutting away of *all diseased parts* back to healthy tissues, in order to permit *thorough aeration.* Such wounds should be painted with a carbolineum solution or some other lasting disinfectant and left uncovered to *dry out thoroughly.* Carbolineum should be diluted with equal volume of soapy water, and pre-

Fig. 67. Scab on orange leaves. (University of Florida Experiment Station Bulletin 124.)

caution taken to use a non-injurious grade of chemical. Soil should not be replaced around crown roots until healing is well under way. In the case of gummosis, the same preventive measures should be employed. On affected trees, diseased areas on trunk and limbs should be cleaned well below line of discolor-

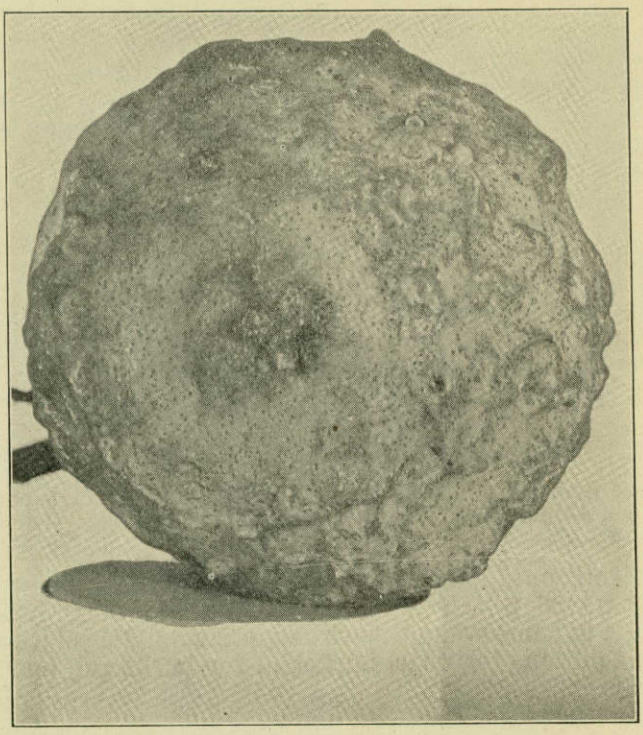


Fig. 68. Effects of scab on fruit.

ation and treated from time to time with a disinfectant as given above. Remaining limbs should be sprayed with a concentrated winter strength lime-sulphur solution. In fact, if the infection occurs in several places throughout the grove, the trunks and large limbs of all trees should be sprayed with the solution, using care not to apply this strong solution to the leaves.

Affected trees should be pruned so as to permit the entrance of an abundance of light and air. Badly affected trees should be removed and burned and the soil soaked and disinfected with formaldehyde solution, made of 5 pints of formaldehyde to 30 gallons of water.

SCAB

Cladosporium citri

Citrus scab is a trouble which may readily be recognized from the abnormal growth and warty distortions produced on leaves and fruit, as shown in Fig. 67. Early stages of the trouble

resemble a form of melanose but may be distinguished from it by the more profuse growth. Scab is especially troublesome on nursery stock where it attacks leaves and succulent twigs. The disease is not wide-spread in the Valley and only becomes of importance during rainy spring seasons.

CONTROL

During an ordinary season the early spraying for thrip or rust mite will control a light infection of scab. On nursery stock or where the disease is very persistent, several applications of Bordeaux mixture may be necessary. The first spraying should be made just before the buds begin to swell, followed by a second just after the petals have fallen. A caution is given to watch closely for scale insect increase after Bordeaux applications and promptly check them by proper insecticide applications. In Florida, where conditions are very favorable to white fly and scale insect increase, growers are compelled to use a Bordeaux oil emulsion mixture in the control of diseases. This mixture is made by the use of 1% oil emulsion added to the regular Bordeaux mixture solution.

FORMULA FOR BORDEAUX MIXTURE

Stone lime	5 pounds
Copper sulphate	3 pounds
Water	50 gallons

Dissolve copper sulphate in one-half barrel of water by suspending in burlap sack near the surface of the water. Slack lime and dilute to same volume as the copper sulphate solution. Pour the two solutions together, bucketful for bucketful, and use immediately.

WITHER TIP

Wither tip is a fungus disease which affects the twigs, branches and fruits of many varieties of citrus. It is reported as oc-

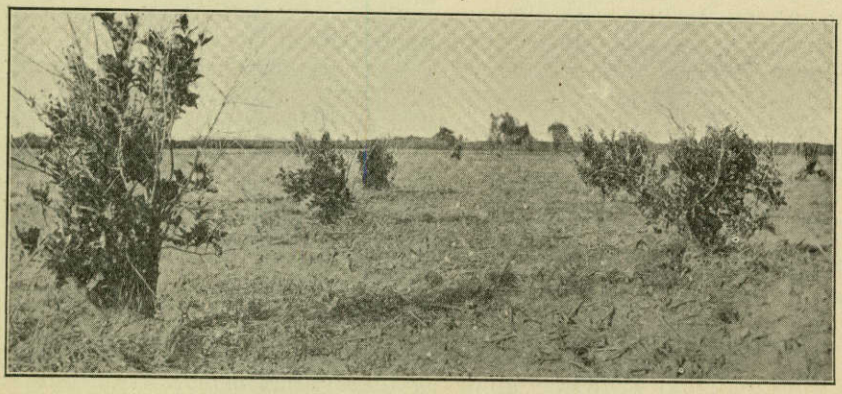


Fig. 69. Trees affected with wither tip in a neglected grove.

curring both in California and Florida. Affected trees do not make normal growth and the fruit produced, even if it is not directly infected, is inferior. Ordinarily, however, healthy, vig-

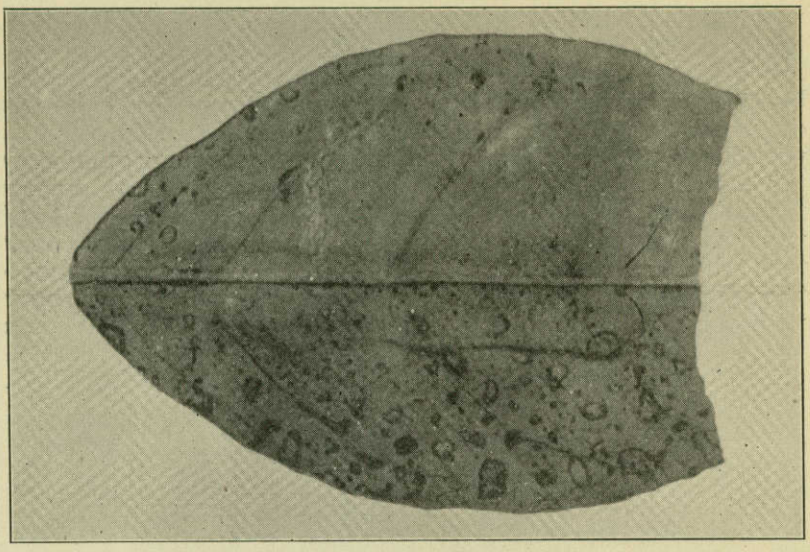


Fig. 70. Melanose on leaf, showing effect of distribution of spores by drops of dew or rain which has resulted in the markings along the edges where the water had accumulated or dripped.

orous trees are resistant to the disease. The trouble generally first manifests itself on the outer twigs in the form of a die back condition. The disease works back into the main body of the tree and frequently large limbs are killed by the effects of the casual organism. Badly affected trees are apt to drop many of their blossoms and much of their fruit. Dead twigs serve as a means of holding over the fungus spores during weather favorable for its spread. Upon the arrival of a heavy rain, spores are washed from these twigs and are distributed over other portions of the tree, resulting in "tear stain" and "stem end rot" of the fruit and the infection of other twigs.

CONTROL

The best means of control, therefore, is to keep the trees in a healthy, thrifty condition by proper cultural methods and to prune them properly in order that no dead or undesirable wood or stumps will be left. In removing diseased tissue from affected trees, the cut should be made considerably into the healthy tissue, making a smooth and even cut. All exposed surfaces should be disinfected or painted. The application of Bordeaux mixture as given for scab will also do much to control the trouble.

MELANOSE

Melanose is a superficial marking of the surface of twigs, leaves and fruit. The most conspicuous and important injury is that to the skin of the fruit, causing it to become discolored, rough and unsightly. On the twigs and leaves the markings may be either in the form of a large discolored area or as yellow to black specks. Until recently the Florida melanose disease caused by *Phomopsis citri* had not been reported from the Valley, but during the past year a number of infections have been found. A peculiar form of black speck melanose, which occurs widely over the section seems to be peculiar to Texas and is not reported from either California or Florida. The disease may affect the parts of the tree during any time from the first flush of growth to the harvesting of the fruit, but generally the greater part of the injury is done during the early spring. As in the case with wither tip, the fungus finds a harbor in dead or decaying wood

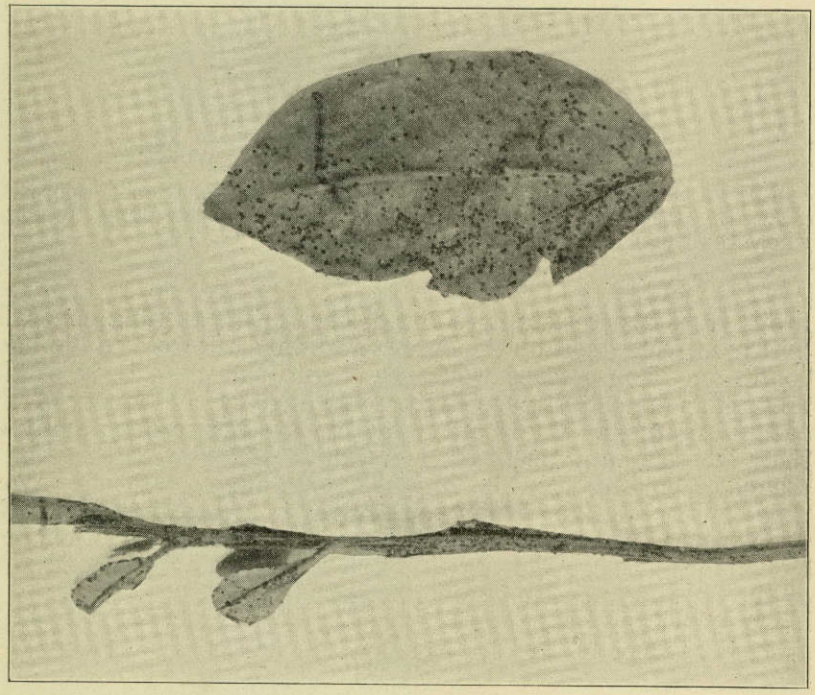


Fig. 71. A form of Melanose resembling scab.

and from such locations spreads during favorable weather. Trees that are properly pruned and sprayed for scab should not show any injury from the disease.

Under Florida conditions, best control of Melanose is accomplished by one or two Bordeaux applications about a month later than the application for scab. Infection depends on weather

conditions, and the time of spraying therefore must vary with the season.

DIE BACK OR EXANTHEMA

The disease is reported from Florida as occurring generally throughout the state and as causing considerable loss where action is not taken for its control. In the Valley the various forms of the disease are becoming quite common and as the industry develops, the trouble may become more general.

DESCRIPTION

"Die back" may be readily recognized by many characteristic symptoms representing various forms of the disease. The more

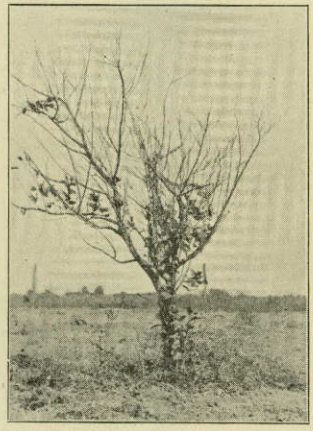


Fig. 72. Tree affected with root rot and exanthema.

conspicuous are, dark bark excresences, stained terminal branches, dark, irregular markings on the skin of the fruit, cracked fruit with brittle skin, gum pockets on twigs and ammoniated tissues. Either of these symptoms or a combination of them may occur on an infected tree.

CAUSE AND CONTROL

The cause of the trouble with its various manifestations is not thoroughly understood, although it is quite evident that the disease is the result of some form of malnutrition. Some of the principal causes of die back are: "hard pan" subsoil conditions, over-abundance of nitrogenous matter in the soil, poor drainage, excessive cultivation and irregular water supply. Considering such circumstances it is obvious that each case of the disease is more or less of an individual problem in itself.

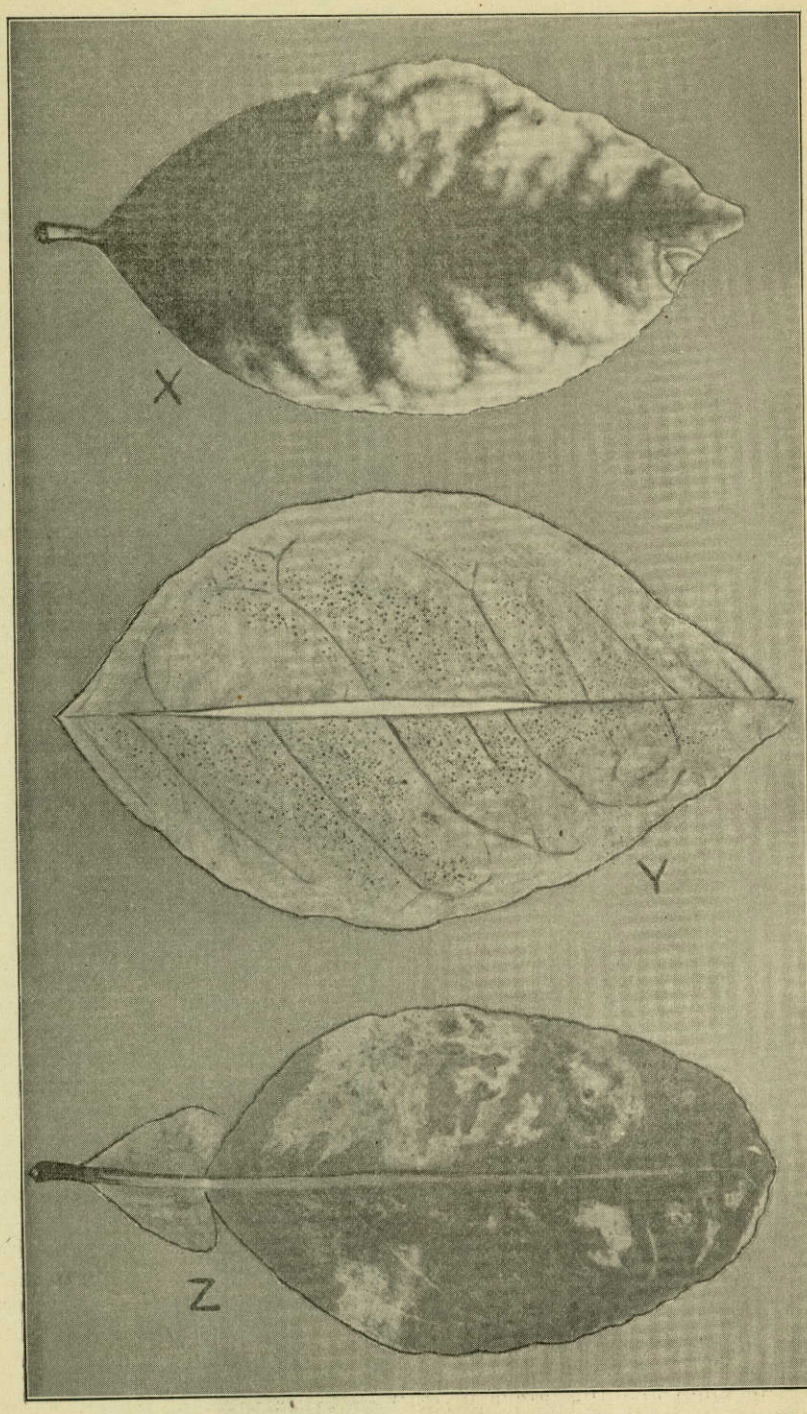


Fig. 73. "X" leaf showing "Frenching." "Y" Black Speck and Melanose. "Z" sun scorched.

Dynamiting through the hard pan and improving the drainage conditions when necessary has given good results. Cultivation around infected trees should be reduced to a minimum and a system of cover crops installed. The addition of iron sulphate or copper sulphate to the soil around the tree at the rate of 2 pounds per average-sized tree is to be recommended. Spraying with Bordeaux mixture both in California and Florida has many times been found beneficial in the control of the disease, probably on account of the stimulating effects of the spray. Formula for preparing Bordeaux mixture is given under "Scab."

ROOT ROT

Frequently when citrus trees are planted on poorly drained land or when they are set too deep, a form of root rot develops. Improper root stock and heavy stiff soils have also been assigned as primary causes of the disease. Such conditions prevent the tree from functioning properly and cause it to become susceptible to various semi-parasitic root fungi.

A parasitic form of root rot has also been observed. This trouble may or may not occur under unfavorable conditions for tree growth, but is greatly augmented in its attack by unthrifty trees. The external symptoms of the two forms of disease are very similar and the identification often necessitates a laboratory examination. (Diseased specimens will be examined by the Plant Pathologist upon their receipt.) In either case the trouble is usually first evidenced by poor growth, yellowing of the foliage, and later wilting. An examination of the roots reveals the decay of the rootlets and flaking of the outer tissues of the larger roots.

When once a tree is infected, it is rarely possible to save it, as the trouble is not externally evident until the disease has reached an advanced stage. It is therefore generally advisable to remove and destroy infected trees as soon as found, especially on the account of the possibilities of the disease being of a parasitic nature. Special care should be exercised in removing the stumps to get all the roots possible. All weeds should be eradicated and the soil disinfected, drained and aerated as well as possible. In the event that valuable trees are to be treated, extreme care should be taken toward preventing the spread of the disease in case it is a parastic form. A deep narrow trench round the trunk of the tree, made so as to confine the root system within, should be maintained. The application of sulphur, iron sulphate, or copper sulphate to the soil appears to retard the trouble.

Prevention of the disease lies in selection of root stock, correct planting and the avoidance of unfavorable land. Details pertaining to such cultural methods will be found under their respective headings.

FRUIT ROT

The various rots that attack citrus fruits are usually the result of secondary parasites which are able to attack the tissues of the plant only after the fruit has been injured mechanically or otherwise.

Blue and green mold are typical of this class of injury. Affected fruits show a soft moldy decay, which later is covered with a dusty mass of blue or green cottony mold. This trouble at one time threatened to prevent successful transportation of fruit from California, but investigations revealed the fact that careful picking, handling and transportation of fruit would eliminate the diseases. The results obtained during the succeeding years have without a doubt proven this conclusion.

Brown rot is principally a rot of lemons, both on the tree and in storage. It does, however, affect other citrus fruits. It is a very important trouble in California and occurs in Texas. It is caused by the fungus *Pythiacystis citrophthora* which is a soil fungus. Fruits therefore, near the surface of the ground are more likely to be attacked, but the disease has been found on fruit higher up in the tree. Affected specimens first reveal a slight purplish, discolored area, which later develops into a brown, rather dry decay of the rind. This disease may be readily distinguished from other citrus rots by its characteristic odor and rapid spread. The odor of brown rot is a penetrating rancid one, while that of blue mold and other common rots has more of a fermenting odor.

Brown rot unlike blue mold is able to attack perfectly healthy fruit and in transportation may spread throughout an otherwise healthy box of fruit, if an infected specimen is permitted to be packed in the box. The disease is not always apparent on the fruit when taken from the tree, and many times does not develop until the fruit is in the process of curing or in transit.

The control of this disease, therefore, lies in keeping the trees pruned up from the ground and the spraying of the soil and trees in the winter with a 4-4-50 Bordeaux mixture. (see scab) As the disease is spread in preparing the fruit for the market, disinfecting methods as given under "curing of lemons" must be resorted to.

Navel rot (Alternaria citri) This trouble of the navel orange has been found in several sections of the Valley, but has not been of very great economic importance. The trouble has also been noted from California and one of the authorities from that State discusses it as follows: "Affected oranges color prematurely in the fall and are affected with a dry black rot in the tissues below the navel end. This rot is not very virulent and remains confined to one section of the orange. Occasionally in seasons of considerable early rain, this trouble becomes quite abundant, but it is not usually a serious matter."

SUN SCALD

The effects of sun scald on the leaves are clearly shown in Fig. 73. Occasionally a comparatively few leaves on the tree will be found affected in this way, as the result of sudden changes in the weather. Only a few trees in an entire grove may show this injury on only a small portion of their foliage. This is accounted for by the fact that the affected leaves were in a certain stage of growth necessary for the scalding effect.

The fruit is also frequently sunburned under these conditions when not protected by the foliage. Sulphur applied for the control of rust mite was in several cases observed to increase the burn. These cases were found during exceedingly favorable days for sun scorching and ordinarily only beneficial effects result from the sulphur.

LEAF SPOTS

Various leaf spots are to be found on trees in the Valley, the most important of which are shown in Figs. 74 and 75, of which *black melanose or greasy spot* is the most important. The cause of this blemish is not known. Its injury, however, is not of sufficient importance to warrant remedial measures. Many of

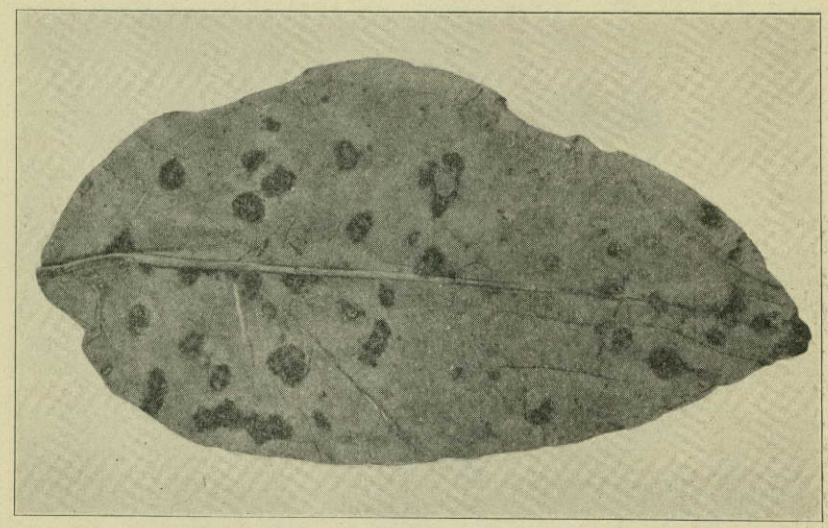


Fig. 74. Leaf spots found accompanying die back and scaly twig rupture.

of the leaf spots are the result of attacks of certain fungi, while others are the result of punctures of insects, especially plant bugs, and some have been attributed to physiological troubles, such as to heavy soils. None of them, however, do enough damage to warrant special control.

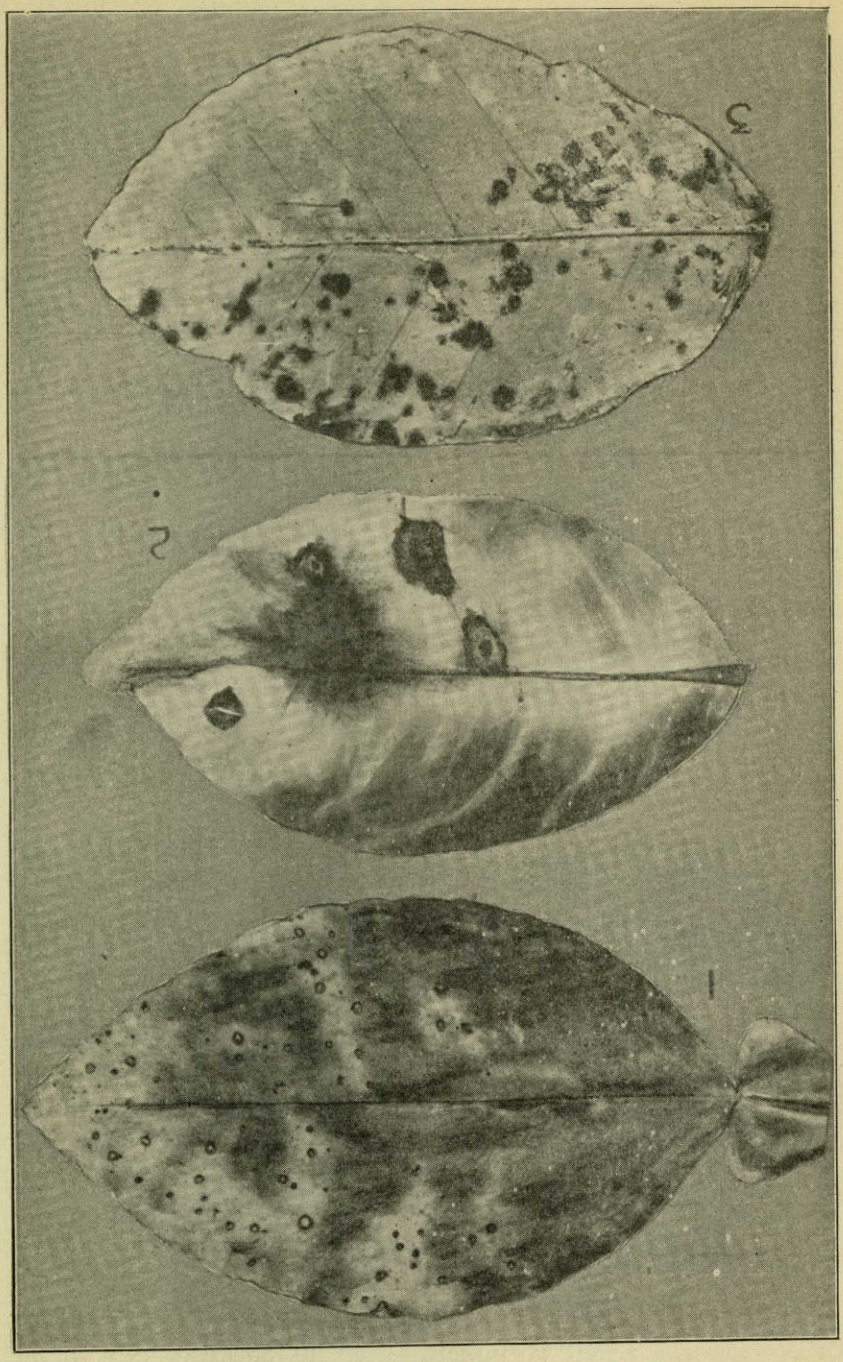


Fig. 75. (1) Glazy leaf spots. (2) Cercospora leaf spots. (3) Greasy leaf spots.

FRENCHING OF LEAVES OR MOTTLE LEAF

"Frenching," as the name implies, is a mottling of the leaves, showing as yellow areas on each side of the main rib and between the veins (Fig. 73.). Various factors have been assigned for the cause of this trouble, among them nematodes, or root knot, and unfavorable growing conditions. The nematodes have never been found on affected trees in the Valley and in the majority of cases the cause of mottle leaf could be traced to unsatisfactory soil conditions or too deep planting.

As various causes may be responsible for this trouble each case is an individual problem to itself. The control therefore lies in determining the soil deficiency and correcting it.

SCALY TWIG RUPTURE

This disease is a new trouble of unknown cause, which has lately been found in several locations in the Valley. Recent observations indicate that the trouble is one of physiological origin, but work is being carried on to determine definitely the cause. The trouble resembles *Florida Scaly Bark* more than any other disease reported from other states, but differs from it in several

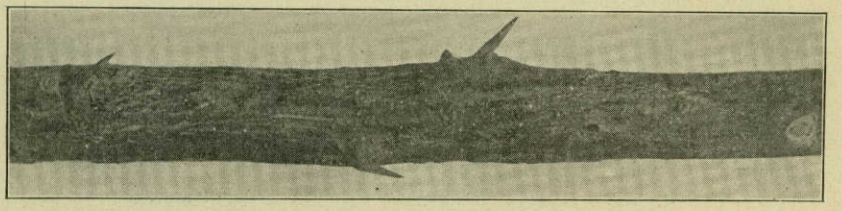


Fig. 76. Scaly twig rupture.

particulars. See Figs. 76 and 77. *Florida Scaly Bark* does not attack grapefruit readily, while *Scaly Twig Rupture* occurs more commonly on this class of citrus than any other.

The disease is first noticed by a brownish discoloration on the twigs, which enlarges and becomes raised. A comparatively distinct line of demarkation separates the healthy tissue from the discolored areas. Such areas differ from die back discolorations in being more distinct and pronounced. The raised brown spots later crack, forming cankerous lesions.

No spceific means of control can be given until the cause of the trouble is worked out.

A special circular will be issued regarding the disease at a later date when more is known of it. In the meantime badly affected trees should be removed. Trees to be treated should be freed of all scales and other insects and should be properly pruned so as to remove the greater part of the affected tissue. Spraying with Bordeaux mixture as given under "Scab" is to be recommended.

SCALY BARK

Cladosporium herbarium (Fawcett).

Scaly bark is a disease which does not to our knowledge exist in the State of Texas and is being mentioned here on the account of its existence in Florida and the possibility of its being introduced into this State. The disease has also been found in a number of orchards in Guadalajara, Mexico, by the writer. Florida state authorities are attempting to prevent its spread

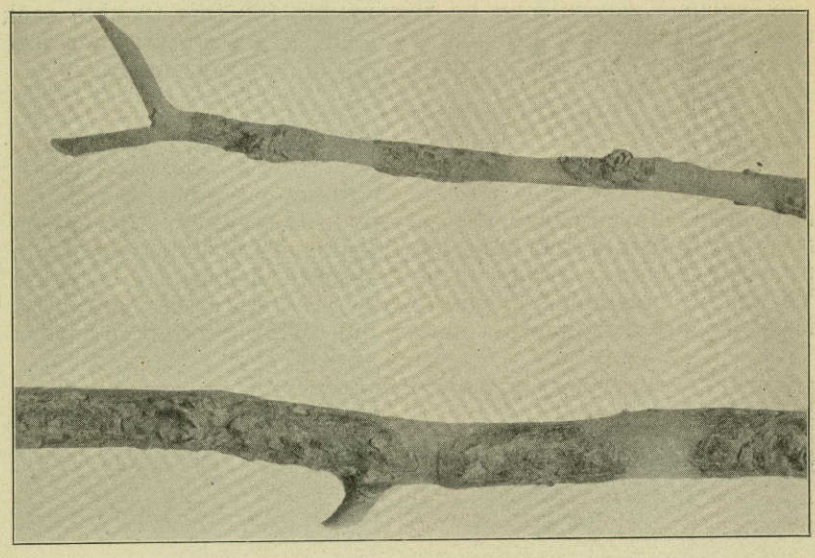


Fig. 77. Nail-head rust or Florida Scaly Bark.

in that state and have quarantined certain zones in which the disease has appeared. No nursery stock is permitted to be shipped from near these zones into the State of Texas. The disease bears some resemblance to a new trouble found in the Valley, which is discussed under the head of "Scaly Twig Rupture," but should not be confused with this trouble, as it is conspicuously different in many respects. We are herewith quoting from a Florida authority, (Bulletin No. 150) in regard to the symptoms of Scaly Bark.

APPEARANCE

"Scaly Bark is found on the trunks and branches of the tree. It is a bark disease and the early stages are quite distinct and characteristic. In more advanced stages it may sometimes be confused with gummosis, which it resembles in certain respects. A distinctive character of the disease is represented by the typical spots formed in the bark of the younger twigs and branches. These appear as round or oval shaped spots, one-fourth to one-half an inch or more in diameter, raised above the surface with

well marked edges, and rusty in color. (See Fig. 77.) In their beginning stages the young spots appear as greenish-yellow blotches on the surface of the green bark, somewhat watery or oily in appearance. As the spots grow older the surfaces become glazed, brittle, and usually break into cracks. A zonated effect is often noted in the more advanced stages. Eventually the surfaces break into small flakes. The spots may be isolated and distinct or in severe cases several may come together, forming large patches of rusty or reddish-brown scabby bark. On the larger limbs and trunks of trees where the disease is of long standing the surface of the bark will be rough and shaggy. (Fig. 77.) The spots in this case are not distinct and the entire surface of the affected part will be covered with thin flakes or scales. The stage of the disease resembles gummosis in many respects. Frequently an affected trunk or limb will be entirely girdled by rough, shaggy bark

Scaly Bark rarely appears on twigs less than six months old and the spots are more commonly observed in the bark of growth from nine to eighteen months old. Bark or wood much older than this is subject to attack, as is shown by the effect on the trunks and limbs of old bearing trees. The disease is slow to develop and the greatest number of infections seem to appear from about June first to December first.

Spots on the leaves are of rare occurrence and of little importance. They appear as brown blotches showing thru on both sides of the leaf. The edges are usually marked by a pale yellow color and sometimes a white area is observed at the center.

The effect on the fruit is quite typical and this phase of the injury is referred to as nail-head rust. The injury is usually confined to the rind, producing an unsightly and unsalable fruit. Affected fruits may show from a few to many brown sunken spots, some of which are apt to be in the form of sunken rings. These spots are at first yellowish to reddish-brown on the green fruits, but finally become dark and sunken. In the ringed spots the rings first become sunken with a raised portion at the center. Later the center may sink and the whole area inside the ring becomes dark. Spots on the fruit are usually round and vary in breadth from one-fifth to one-half inch. They begin to appear on the green fruit about July or August and may continue to appear until the fruit ripens. They are more apparent as the fruit begins to color."

CITRUS CANKER.

Pseudomonas citri (Hasse)

Citrus canker is a dangerous bacterial or germ disease of citrus trees, which was accidentally introduced into the United States from Japan about ten years ago in a shipment of Citrus trifoliata root stock. Soon after its occurrence in the Gulf States, its damage made apparent that it was by far the most infectious and destructive disease of citrus yet known. On Jan-

Fig. 78. Citrus canker on citrus trifoliata twig.

uary 1, 1915, the Federal Horticultural Board placed a quarantine on all countries, of citrus stock, including buds, scions, and

seeds in order to prevent further introduction of the disease in the United States. Fortunately the serious nature of the disease was early recognized and after exhaustive experiments had failed to reveal a method of control, the Federal Government together with every state involved began a campaign of eradication. The plan included a careful inspection of all citrus trees and the destruction of all infected ones together with a most scrupulous disinfection of everything involved in the process. So successful has the work been that there now exists only a very few isolated "danger zones" in the United States. Every precaution is being taken toward protecting the Texas citrus industry from possible introduction of the disease from such sources. While the disease does not to our knowledge exist in the Lower Rio Grande Valley district and the quarantine laws are probably sufficient to prevent introduction, nevertheless the rapid development being made by the industry in Texas makes it necessary that all concerned co-operate for the protection of their groves. Strangers should not be permitted to enter or roam promiscuously around a citrus premises without proper disinfection, as the disease may be carried in this way. Constant inspection is being maintained by the Federal and State Departments of Agriculture in an effort to complete the eradication. Special inspection suits are worn by the inspectors, as shown in Fig.81. A 1-1000 mercury bichloride solution is used in disinfecting.

DESCRIPTION

"Citrus canker attacks all varieties of citrus trees of commercial importance, with the exception of the kumquat. The different varieties are susceptible to the disease in the order named: grapefruit, citrus trifoliata, navel orange, lemon, tangerine and satsuma orange.

We are herewith quoting a detailed description of the disease as taken from a copy of the Journal of Agricultural Research:

OCCURRENCE ON THE LEAVES

"The first evidence of canker on the leaves is the appearance of very small oily or watery dots on the lower leaf surface. They may appear on either surface, but are more commonly found on the lower leaf surface. They are of a darker green color than the surrounding leaf tissue and may at this stage be mistaken for oil glands. The diseased areas are slightly convex, however, and within a few days will have extended the leaf, appearing on the upper surface as greenish-yellow spots. By continued development the convex surface of the spots comes to be more and more elevated until the epidermis is broken by the increased tension and the subjacent tissues are thus exposed to desiccation. The exposed tissues then become corky, darkening with age. The ruptured epidermis is turned back irregularly and persists as a lacerated membrane. The margin of the diseased area maintains an oily appearance even

after the spots have ceased to increase in size from very minute to a quarter of an inch in diameter and are typically circular in outline. They may occur singly, or when they are very numerous, fuse, thus forming large, irregular areas. Cankered areas are typically elevated on both leaf surfaces. In the case of canker on Satsumas, however, there is little or no elevation of the upper leaf surface. Neither is the oily margin so evident on this host, especially in case of old cankers, in which diseased tissues have become dark brown, simulating the appearance of melanose. The appearance of the disease on leaves of Citrus trifoliata is very similar to that on grapefruit. The uninvaded tissues surrounding the cankers are paler green than the normal tissue and gradually form a chlorotic or yellowish zone, which may invade all the tissues not actually occupied by the cankers. At this stage considerable defoliation, especially in the case of grapefruit and trifoliata oranges, may occur. Cankers on the leaf petioles cause defoliation even though the leaves are otherwise uninvaded.

OCCURRENCE ON THE TWIGS AND BRANCHES

"Limb canker appears more commonly on very young twigs because of the absence of any considerable suberization, but larger branches are subject to infection. Growing cankers have been observed on limbs $\frac{1}{2}$ to $\frac{3}{4}$ inch in diameter. The disease has been found on branches of grapefruit, trifoliata oranges, lemons,

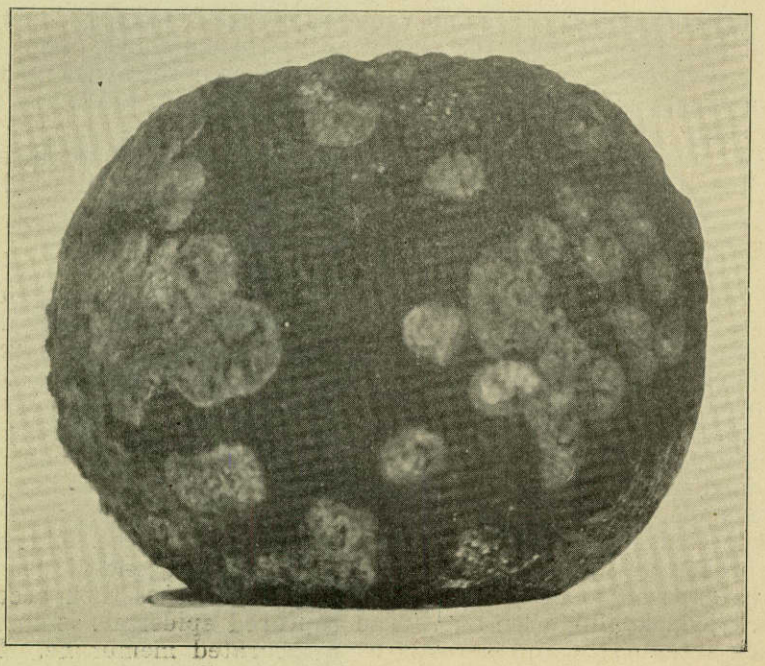


Fig. 79. Citrus canker on fruit.

Satsumas and certain varieties of round oranges. Cankers on twigs are first apparent as small, circular, watery spots. They rapidly enlarge, become blisterlike and the epidermis ruptures, exposing the cankerous tissue below. At this stage they project more or less prominently and are very similar in appearance to the spots on the foliage. Isolated cankers remain circular in outline. When the spots originate close together, however, large

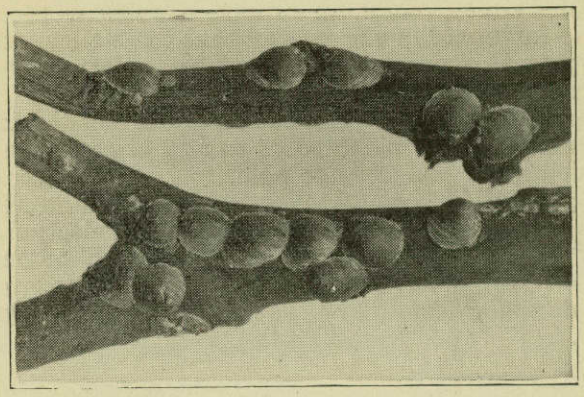


Fig. 80. Camphor scale. Kindness of Barber & Jones, Louisiana.

irregular, variously cracked or fissured cankers are developed, which may involve an area several inches in length. The epidermis persists as a grayish broken membrane at the margin of these cankers. Twigs and larger branches may be completely girdled, resulting in the death of the distal parts. Affected trees exhibit a stunted growth, and numerous branches may be developed below the dying tips.

"The disease is very severe upon stems of grapefruit and trifoliata oranges. On the latter host the thorns are abundantly cankered and the base of the thorns appears commonly to be the initial seat of infection. Limb cankers on trifoliata oranges oftentimes are zonate with different shades of brown, especially if the outer membranes have not yet been ruptured.

OCCURRENCE ON THE FRUIT

"The cankerous areas on the fruits are quite similar in appearance to the leaf cankers, differing mainly in the larger size of the former. They are scurfy elevations, for the most part circular in outline and surrounded by a zone of chlorotic rind tissues. The corky diseased tissues are quite superficial; and if the spots unite, large scaly areas are formed. In this case the fruits may crack open because of their increase in size owing to the growth of the fruits and may become prematurely yellow and drop. Fruits which are badly cankered and have burst open are, of course, subject to invasion by various organisms of decay.

Even if they remain on the tree, they are rendered very unsightly and are unsalable."

PROTECTION FROM INTRODUCTION OF FOREIGN PESTS.

As yet the Citrus industry in the Rio Grande Delta is young and many of the citrus pests of other localities are not yet established there. There are some, however, which occur only in small areas of the Valley, while others have a wider scope of distribution. It is fortunate in one respect that the Valley citrus section is developing at a time when it may be protected by proper inspection laws.

It is the purpose of such legislation to prevent the introduction of new and injurious plant pests and to prevent the spread of those which have gained a foothold.

Every precaution is being taken by the State and Federal Governments through the medium of nursery inspection laws, etc., to guard against the introduction and spread of such serious pests as *citrus canker, Mexican fruit fly, Mediterranean fruit fly, Florida scaly bark, black fly and hundreds of other dangerous pests.*

Fig. 81. Nursery stock being inspected by official inspectors. (Note the special suits and apparel which are disinfected after inspection of each premise.)

NURSERY INSPECTION LAW

Anyone selling nursery or floral stock in Texas is required to have his stock inspected by an official inspector, and if found apparently free of injurious insect pests and diseases, and upon the payment of the necessary fee, he is issued a certificate to do business in the State for the year. Subsequent inspections are made from time to time, throughout the year, in order to see that stock is kept free from pests. Every parcel of nursery stock shipped must bear a tag containing a copy of the State certificate, printed or written thereon. Transportation companies are required by law to refuse for shipment any form of nursery stock without proper tag.

CLASSIFICATION AND FEES

Classification.	Fees to be collected.
Wholesale and Retail Nursery and Floral	$13.50
Wholesale Nursery	10.00
Wholesale and Retail Nursery	10.00
Retail Nursery and Floral	7.50
Retail Nursery	5.00
One Class Nursery	3.50
Wholesale One Class	5.00
Wholesale Floral	7.50
Retail Floral	3.50
One Class Floral	2.50
Cape Jasmines	2.50
Dealers, Sale or Heel Yards	5.00

Forest or Shade Tree Dealers	5.00
Berry Plants	3.50
Orchard, Vineyards, Trees, Plants or Shrubs for Scions, Sprouts or Buds	2.50

Out-of-State Nurserymen desiring to do business in Texas must file, yearly, with the Commissioner of Agriculture, a copy of their State certificate, which certifies proper inspection, and also a fee of five dollars ($5.00). A Texas permit is then issued for the year, a copy of which, together with a copy of their State certificate must accompany each shipment into the State. These copies are commonly made in the form of tags.

Shipments of nursery stock from areas considered as danger zones, involving *citrus canker, Florida scaly bark, camphor scale* and other dangerous pests are prohibited.

Re-inspection of all incoming citrus stock into the lower Rio Grande Valley is made at point of destination before being released. This protection has already proven of inestimable value to all concerned. Many pests of other states, not yet established in Texas, and numerous injurious pests, not widely distributed, have been intercepted on such shipments and prevented from being disseminated throughout the district.

INDEX BY SUBJECTS.