TEXAS DEPARTMENT OF AGRICULTURE
BULLETIN

Published by the Texas Department of Agriculture,
Austin, Texas

March-April, 1923 No. 75

THE CITRUS INDUSTRY
IN THE
LOWER RIO GRANDE VALLEY OF TEXAS

J. M. DELCURTO
E. W. HALSTEAD
H. 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 apprise 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, Florida, 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 commercial 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. Sharry 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; 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, 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 coöperation 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 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

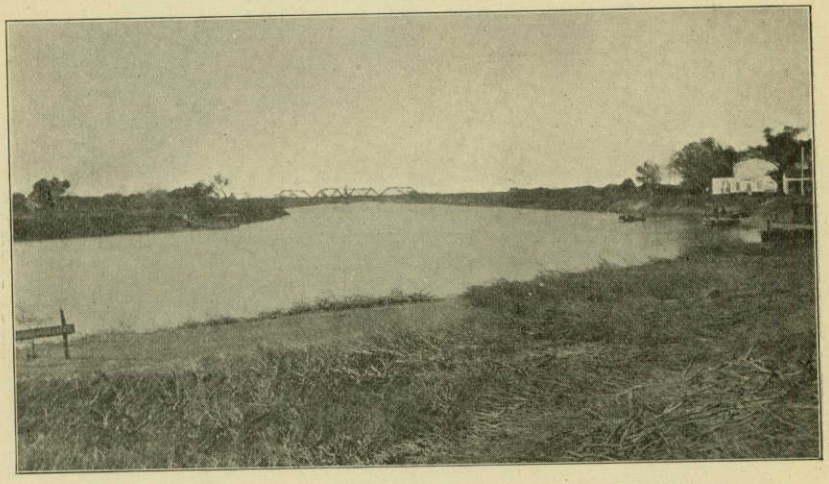


Fig. 1. The Rio Grande River at Brownsville, Texas.

irrigation is being cultivated at the present time. Of the four hundred thousand acres under canal, a large percentage is suitable for citrus planting. The other six hundred thousand 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. 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."

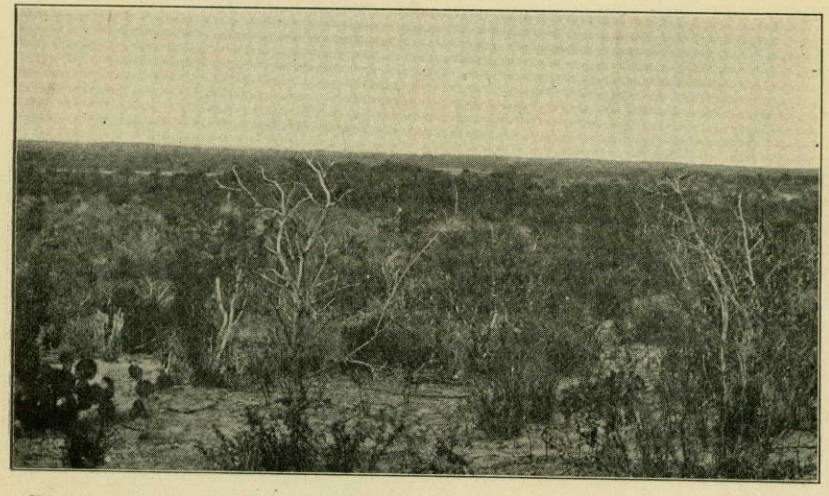


Fig. 2. A scene of land in the Lower Rio Grande Valley before it is cleared. (The mesquite in this figure, however, is much smaller than the average.)

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 semitropical 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 examinations, 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:

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

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

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%

"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 Silty Clay* is of alluvial origin and almost entirely composed of silty and clay, with a small percentage of sand.

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%

"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 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 Resaca 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. 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.

AVERAGE MECHANICAL ANALYSIS.

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

Fig. 4. A typical town in the Valley.

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 tablulation shows the approximate acreage of each type shown on the soil map and their general distribution 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."

TABULATION OF SOILS.

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	66,300		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

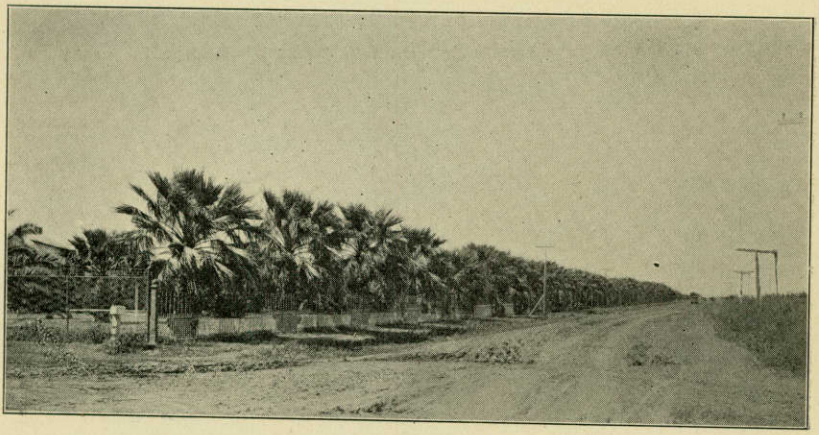


Fig. 5. A road scene.

ALKALI

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

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.

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.

CLIMATOLOGICAL 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	38	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	2	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	28.50	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	45	S.E.
Mission	Hidalgo	140	3		106	Aug. 20			4											
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 DATA 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.

*Record incomplete. †Also on subsequent dates.

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	73.9	102	Aug. 23	24	Feb. 2*	46	12.15	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	8.78	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																			
Raymondville	Cameron		5		107	July 18	16	Jan. 12	6	20.02	3.35	December	0.02	January	T.	63				S.E.

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																			
Raymondville	Cameron		5						7	32.85	8.20	September	0.10	August	0.0	85				S.E.

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.

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	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.

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

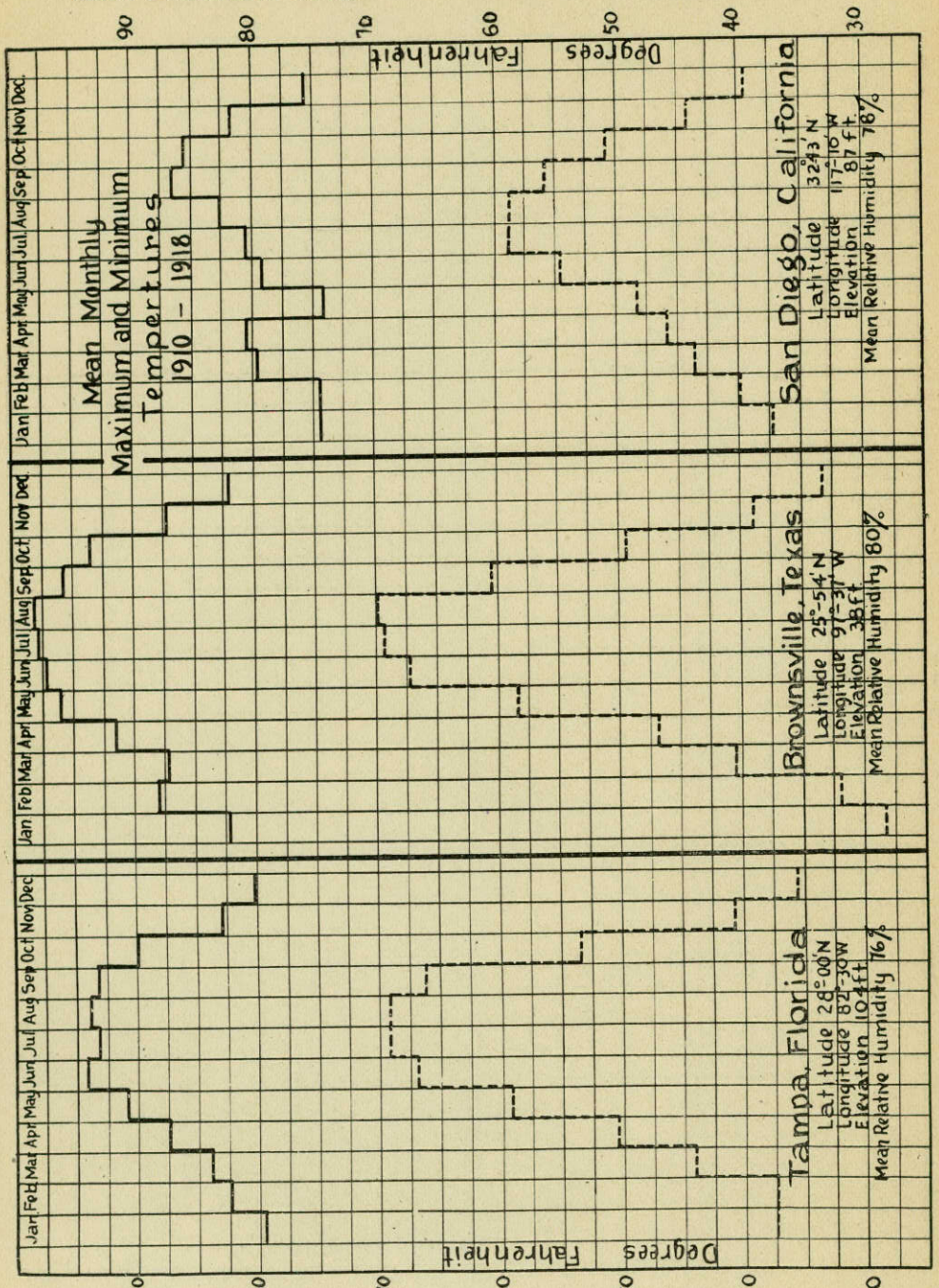
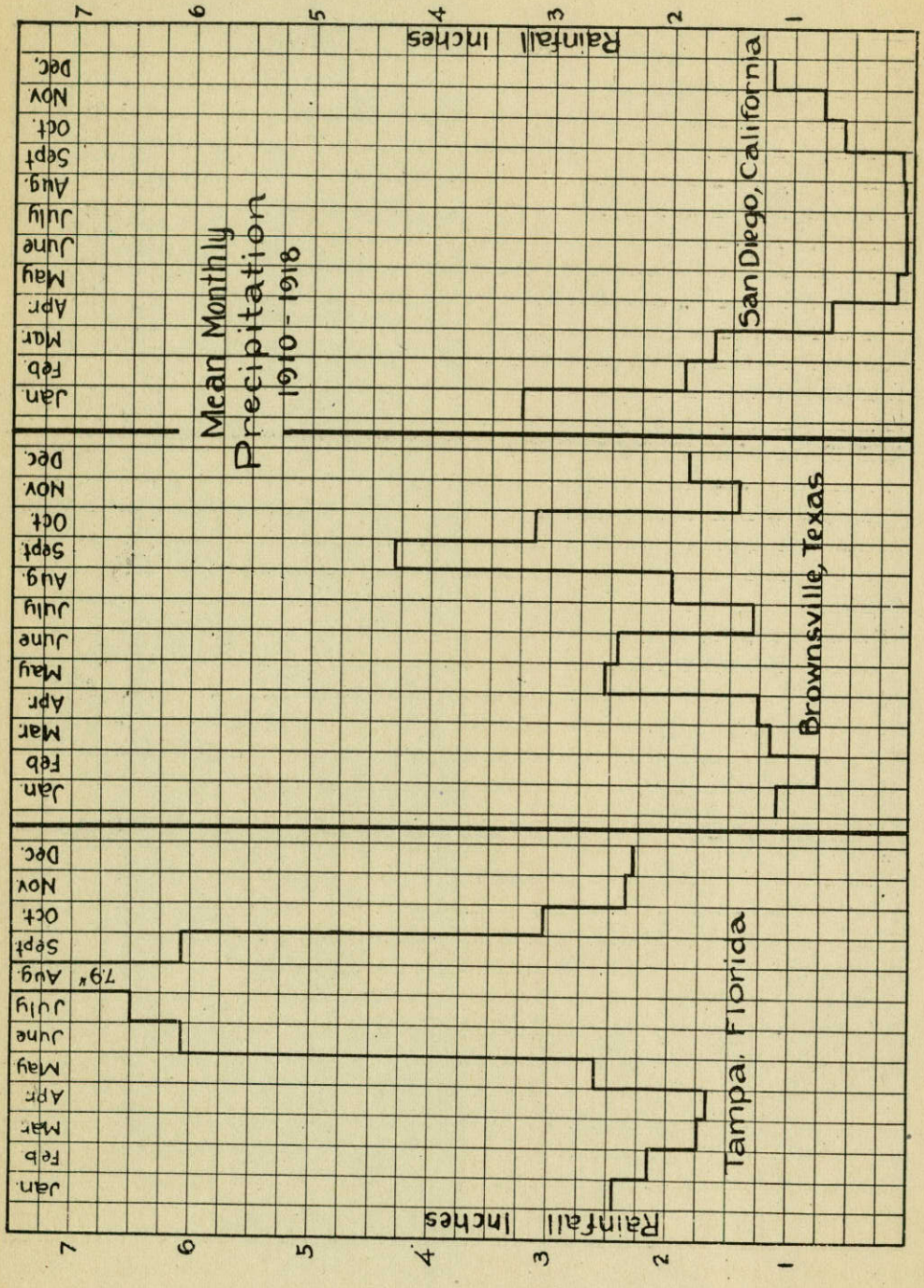


Chart No. 2.—Chart showing comparative precipitation of Brownsville, Texas, Miami, Florida, and San Diego, California. Courtesy of the United States Reclamation Service.



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

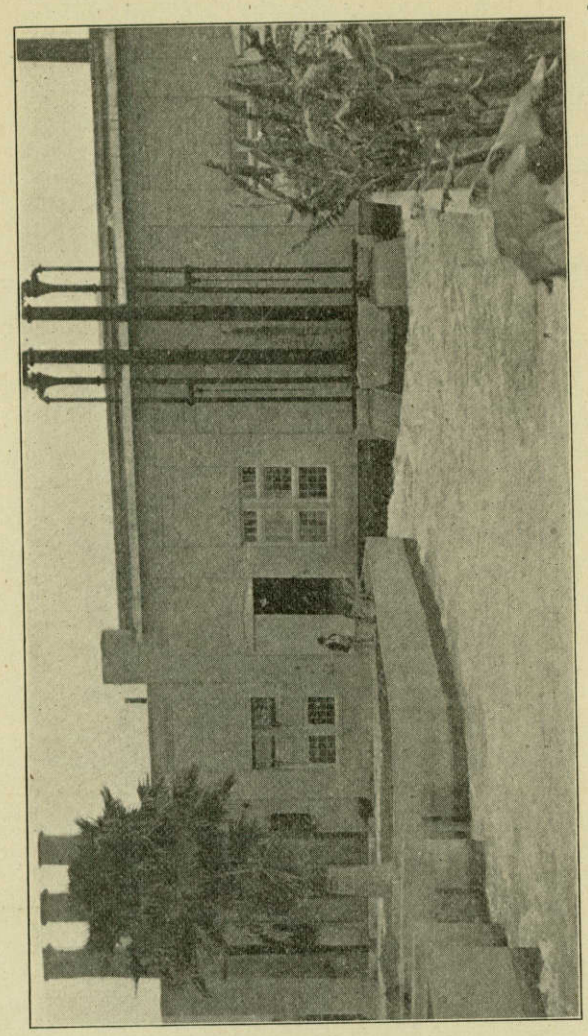


Fig. 6. Irrigation in the Valley. Mercedes Pumping Plant with two pumps, each of which has a capacity of 250,000 gallons per minute.

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 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 flate 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.

AREAS IN ACRES

Irrigation System	Total	Irrigable	Flat Rate	Service Rate
Mission, U. I. Company	30,000	28,000	$4.00	$3.00
Edinburg	3,000	2,700	4.00	2.50
Rio Bravo	4,000	3,500		
McAllen Mutual I. Co	7,000	6,500	3.00	2.00
Pharr-San Juan	6,500	58,000	2.00	1.00
Donna-Hidalgo Co., Irrigation Dist. No. 1	41,000	37,000	4.00	2.00
Llano Grande Plant Co	7,000	65,000		
Mercedes-Rio Grande Land & Irrigation Co	100,000	85,000	4.50	1.50
La Feria	30,000	26,000	2.50	1.00
Santa Maria Dist. No. 4	4,000	3,600	2.00	1.25
Harlingen-Cameron Co. District No. 1	40,300	3,800	2.00	1.25
San Benito-Cameron Co. W. District No. 2	69,250	63,000	3.00	1.50
Rio Grande	20,000	18,000		
West Brownsville	2,000	1,800		
Cameron Co. Dist. No. 5	20,000	17,000		
Totals	469,550	418,900	30 Main plants	

STATISTICS OF CITRUS PLANTING

The following data is compiled from the records of the last complete inspection, with the addition of the trees sold each year by the Valley nurseries and those shipped in from the Florida and California nurseries, beginning in 1918 with seven hundred thousand trees in orchard form. There were planted during the season of 1918 and 1919, one hundred fifty thousand trees. During the season of 1920 three hundred thousand trees were planted, of which thirty thousand were Valley grown. During 1920 and 1921 three hundred thousand trees were planted, of which fifty thousand were Valley grown. In 1921 and 1922 two hundred thousand were planted, of which seventy thousand were Valley grown, and at this writing the planting season of 1922 and 1923 has just started. Consequently, no exact figures can be given, but even this early, it is apparent that the

supply will be very much less than the demand. In fact, for the past three seasons the planting has been limited 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. Valley nurserymen are realizing this fact and are generally increasing their planting of sour stock so as to be able to supply this increasing demand. 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 fiscal year beginning September 1, 1922:

Grape Fruit	95,557
Round Oranges	41,910
Lemons	6,347
Limes	1,276
Sour Orange Seedlings	745,167

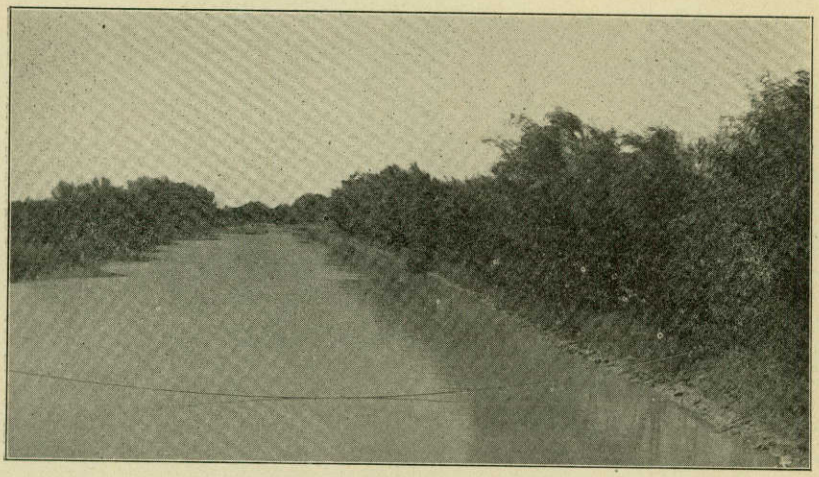


Fig. 7. Irrigation canal scene.

PERCENTAGE OF CLASSES

An analysis of the classes of trees in a large number of the groves running from three to twenty acres shows that the average citrus planting of commercial size in the Valley has 65 per cent grape fruit, 25 per cent oranges, and 10 per cent miscellaneous. The largest percentage of bearing trees is in the Mission-Sharyland district. A report of the Mission-Sharyland district up to February 14, 1923, shows that 41 car loads of citrus fruit have been shipped from Mission this season and it is estimated that there were 15 carloads of fruit still on the trees or in storage in this district. Data for the other districts was not available except that the packing house at Harlingen had handled 34 car loads of which Mission-Sharyland had furnished 15 cars. The only data available for previous years is that

of the season 1921-22 when 54 car loads were shipped out of the Valley, of which Mission-Sharyland district shipped 15.

"A total of 39,469 boxes of citrus fruits were shipped out of the lower Rio Grande Valley of Texas up to March 15 during the 1922-1923 season, according to the shipping records of the Gulf Coast Lines. Agents of the railroad in the Valley estimated there would be 3105 more boxes from March 15 to the end of the season, of which 1100 boxes are held in storage at Harlingen. This will make a grand total of 42,574 boxes to move during the season. This is equivalent to 142 cars.

During the 1921-1922 season a total of 25,247 boxes were shipped from the Valley. This gives an increase of 17,327 boxes for the 1922-1923 season over the 1921-1922 season, or approximately 68 2-3 per cent.

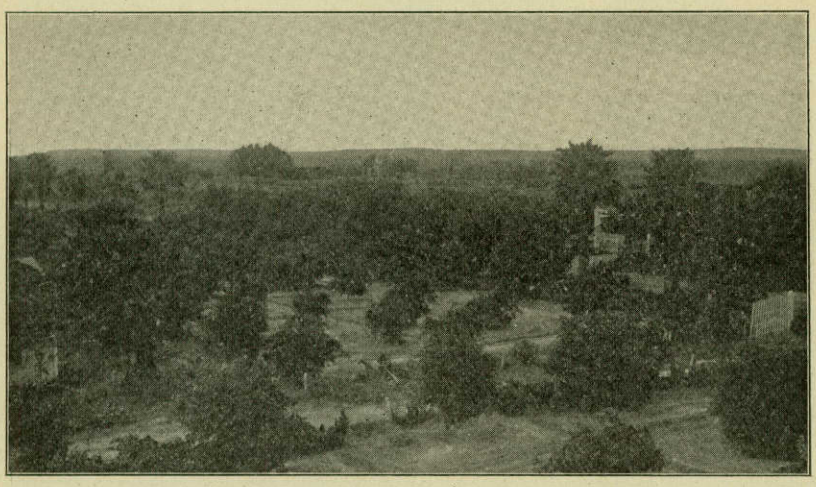


Fig. 8. Panoramic view of a Valley home and orchard. (Taken from Monty's Monthly.)

CLASSIFICATION OF FRUIT

Of the 39,469 boxes shipped up to March 15, the agents' reports show the following classifications:

Grapefruit 33,158, oranges (including tangerines and mandarins) 4501, lemons 1770½, limes 20 and mixed oranges and grapefruit 19½.

By including the estimates for the balance of the season the 42,574 boxes would classify as follows:

Grapefruit 36,128, oranges 4634, lemons 1772½, limes 20 and mixed oranges and grapefruit 19½.

The shipments by months, beginning with October 1, are recorded as follows.

October: 625½ grapefruit, 56 oranges, 230½ lemons. Total 912.

November: 3251 grapefruit, 607½ oranges, 686 lemons, 18 limes. Total 456½.

December: 9702 grapefruit, 456 lemons, 2294½ oranges, 2 limes, 19½ mixed oranges and grapefruit. Total 12,475.

January: 11,853½ grapefruit, 808 oranges, 306 lemons. Total 12,967½.

February: 5623 grapefruit, 456 oranges, 86 lemons. Total 6165.

March (to 15th): 2101 grapefruit, 280 oranges, 6 lemons. Total 2387.

Estimate balance of season: 2970 grapefruit, 133 oranges, 2 lemons. Total 3105.—(From the Houston Chronicle, Sunday, April 1, 1923.)

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 shade system or lathe house should

Fig. 9. Seed bed under half shade.

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 constantly 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. 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 the 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 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 a part of the foliage of the seedling is removed to force the

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

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 three feet long and 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. 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 down-ward 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 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 in-

ches 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

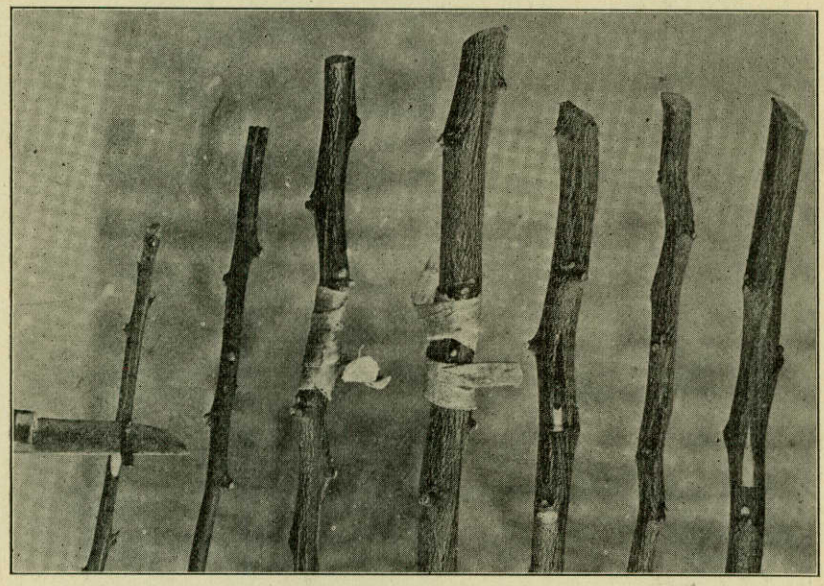


Fig. 11. Budding, showing all stages (reduced)

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 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.

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

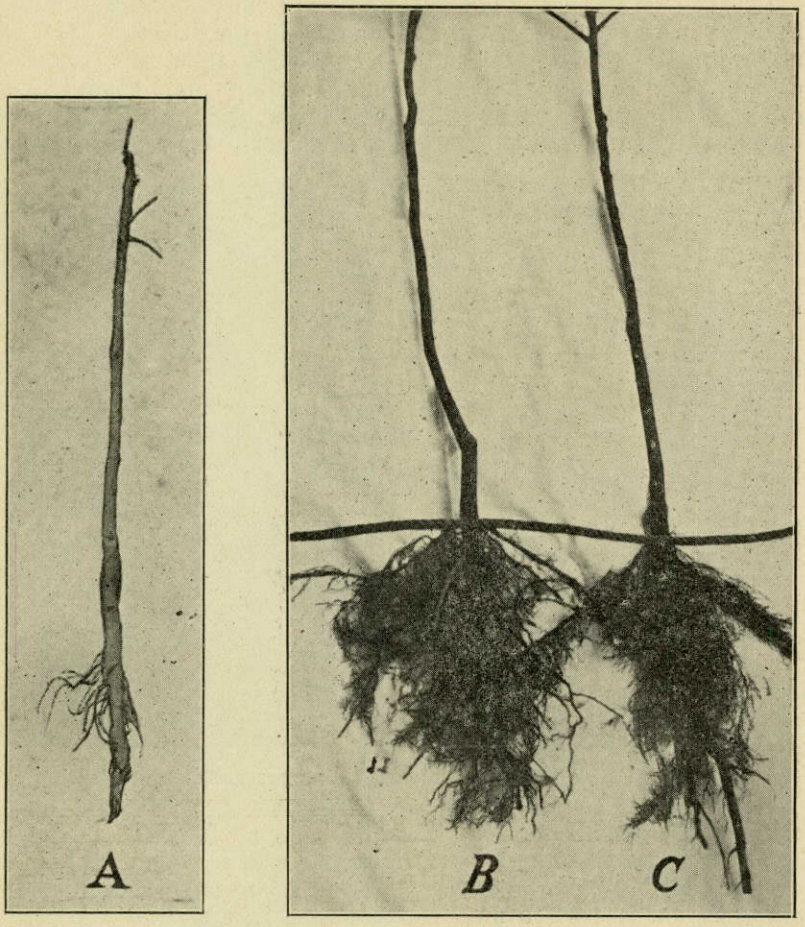


Fig. 12. (A) Poor nursery stock. (B) and (C) Gool root systems on nursery stock. Line of rope shows where the general level of the soil should be when trees are settled.

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 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 than placed in the hot wax until all parts of the cloth have been thoroughly penetrated by it.

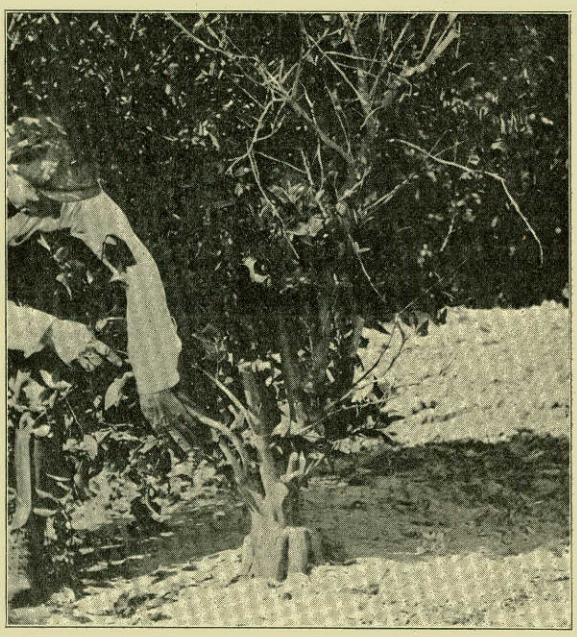


Fig. 13. Satsuma on Trifoliata root, showing enlargement of root stock growing under Valley conditions.

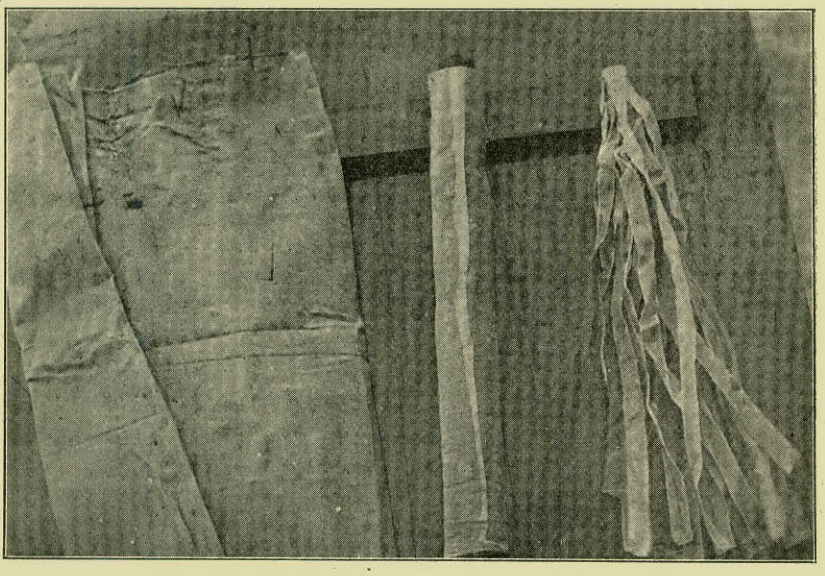


Fig. 14. Method for preparing budding cloth.

The roll is then taken out 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

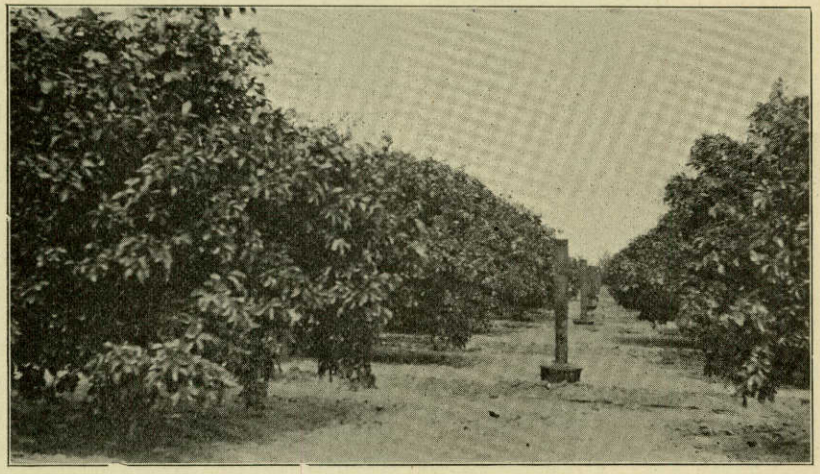


Fig. 15. Four-year-old Marsh seedless grape fruit grove planted 18x25 feet apart. Trees growing together the 18-foot way.

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 posible. 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 plant-

ing. 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.

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 beyong 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. 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. Plenty of room should be given between fences or canals and the first row of trees to allow for cultivation after the tree has attained large size.

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

After the ground has been staked out and when the trees are on hand ready to plant, the holes should be dug, usually about 18 inches in diameter and 18 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, the upper part of the burlap may be removed if desired, although this is not necessary. 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. Eeach 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. 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 root sys-

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

tem 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 come out on the southeast side of the

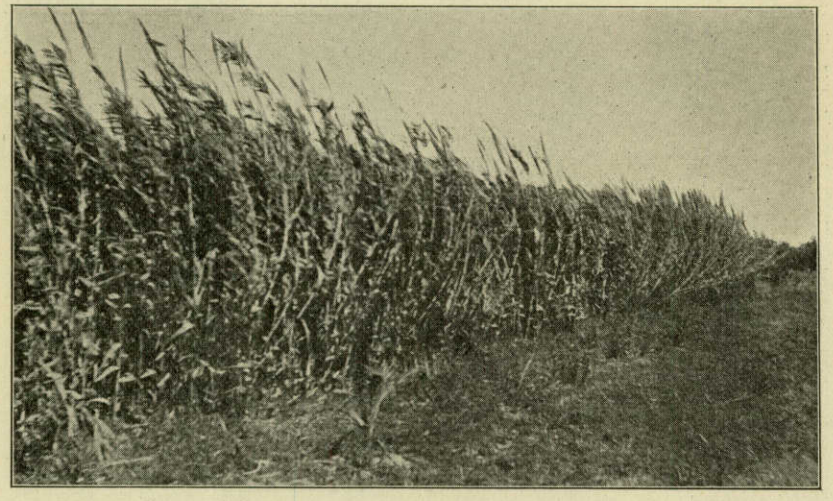


Fig. 19. A windbreak of bamboo.

tree, thus misshaping 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 popular with those who have them and 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 cut-

tings put out a year ago 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 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 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

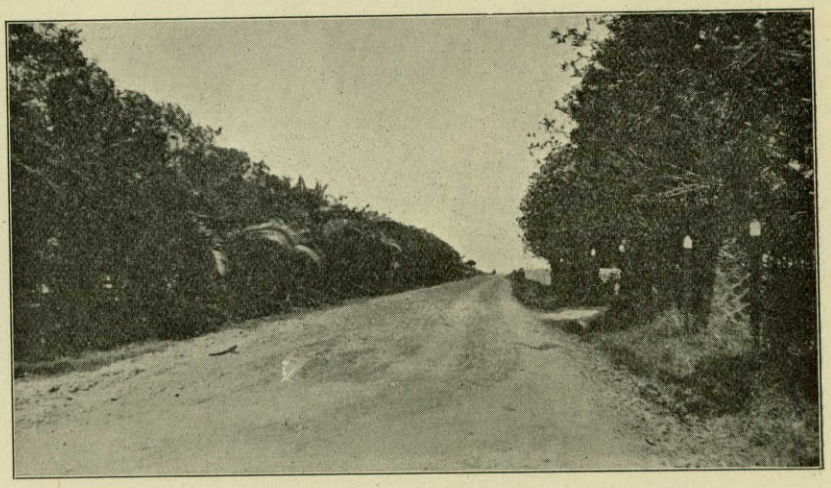


Fig. 20. Windbreak of alternating Oleander and Palm.

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.

CARE OF THE GROVE

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 once 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 during the flood stages of the river and increases as the flow of water decreases, being strongest when the river is at its

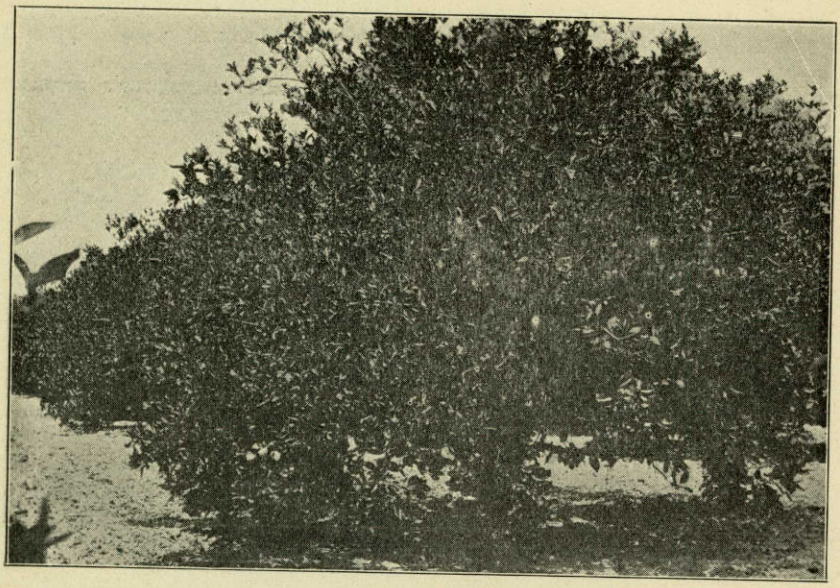


Fig. 21: Orchard scene.

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 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. 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 or five hundred pounds per acre for their large trees of a fertilizer having 12 per cent available phosphoric acid and 4 per cent potash, and using a top dressing of well rotted manure or cotton seed meal for their nitrogen. One of the best methods of applying the commercial fertilizer is to broadcast is 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 2 pounds

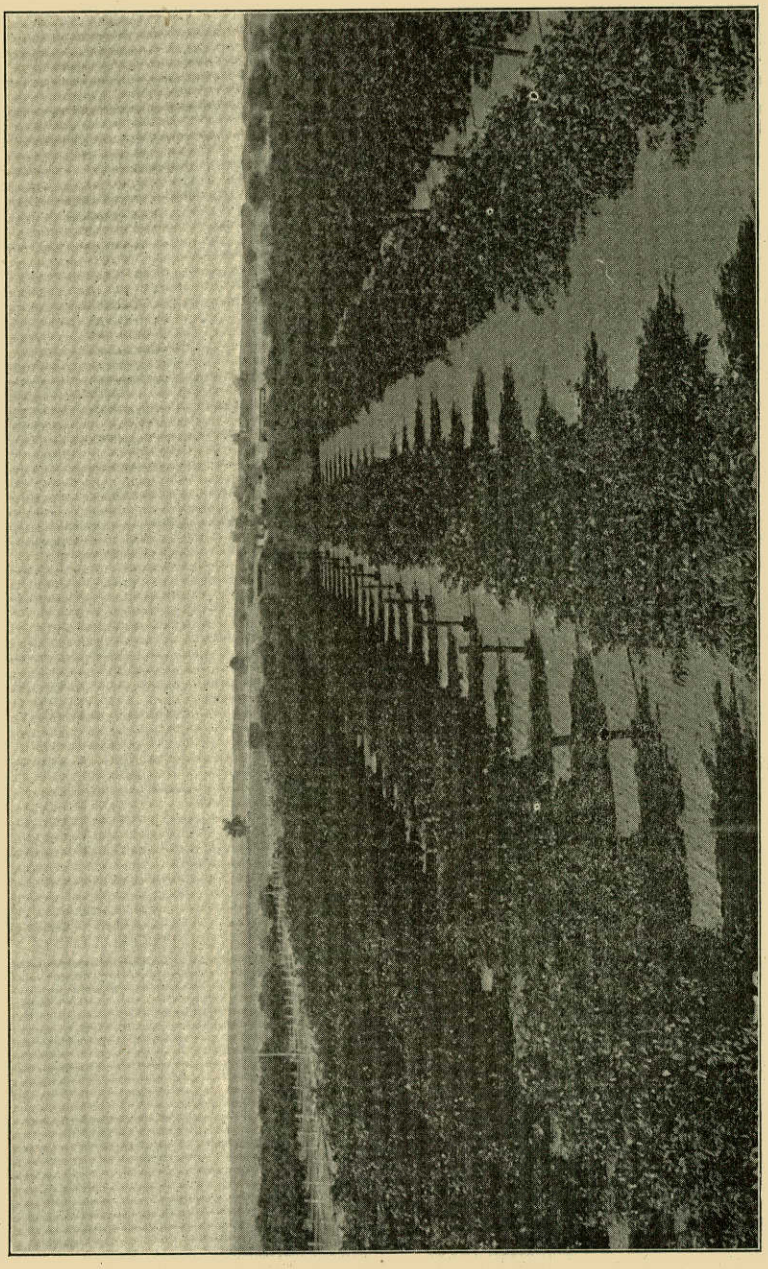


Fig. 22. Panoramic view of citrus grove. (From a supplement to Monty's Monthly.)

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 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.

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.

Sun light 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 10 or 12 inches long and forced to make a fork. The two branches should then each be forced to fork again in another 10 or 12 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 is in the early spring 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 completely 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 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

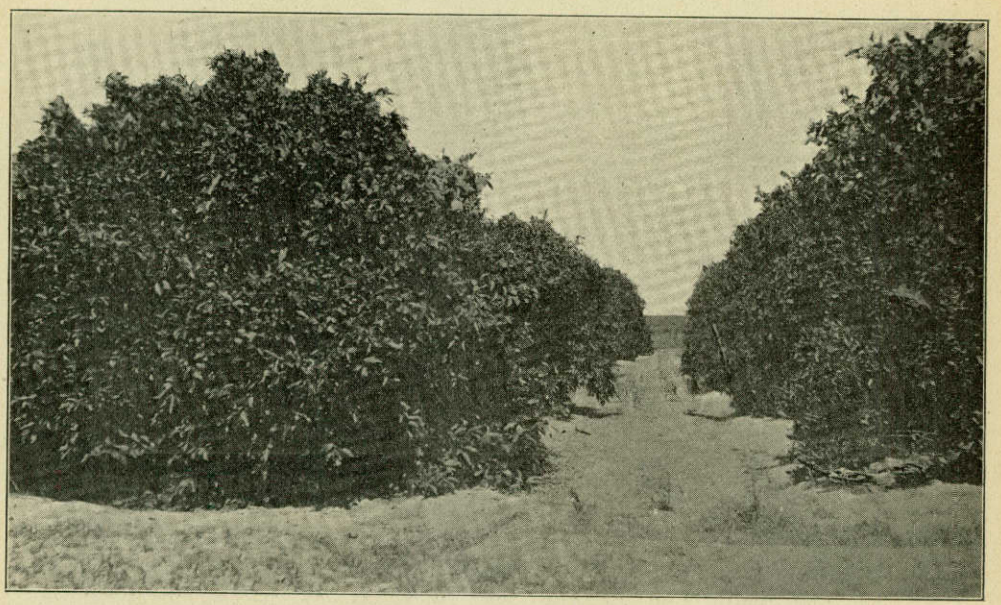


Fig. 23. Orchard scene.

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 either will much lessen the heating problem.

ARTIFICIAL METHODS 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, and detriment, and the comparative value of different trees, shrubs 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.

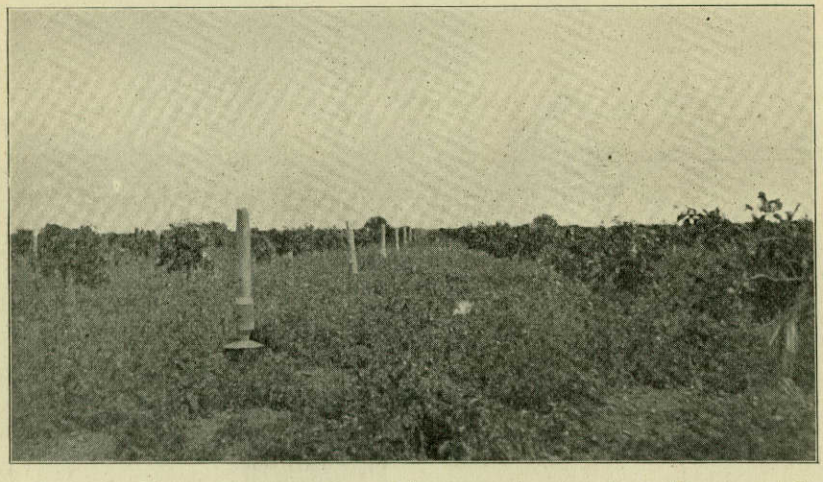


Fig. 24. Young grove protected by wrapping trunks with corn stalks and tule, and by oil heaters.

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 SPRAYING 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 of 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 that outside 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 twenty and even as low as twelve 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.

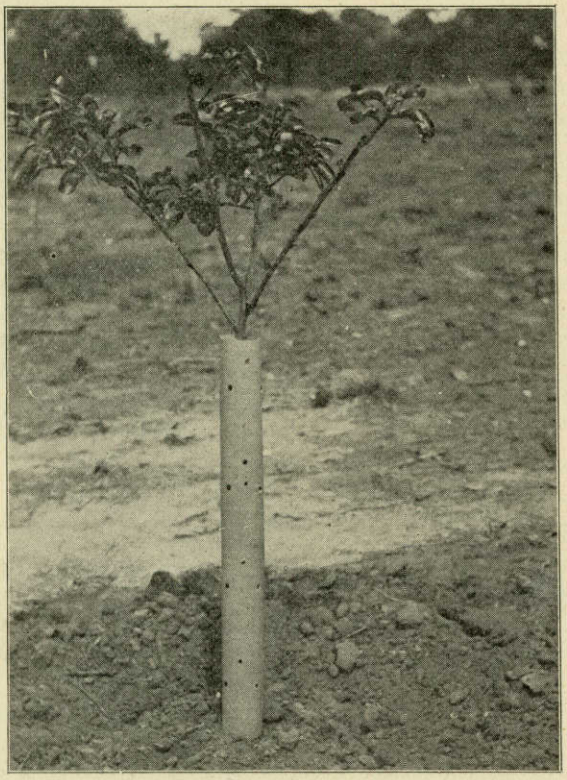


Fig. 25. Paper trunk protection for young trees.

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.

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 the 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.

TEMPERATURE 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 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. 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.

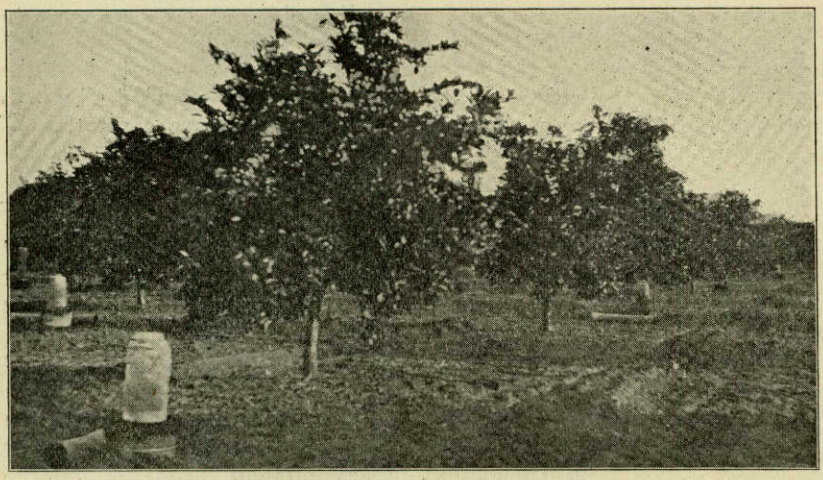


Fig. 26. Three-year-old Marsh seedless grove protected by heaters.

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.)

TIME OF PLANTING.

Young trees planted late in the fall and 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.

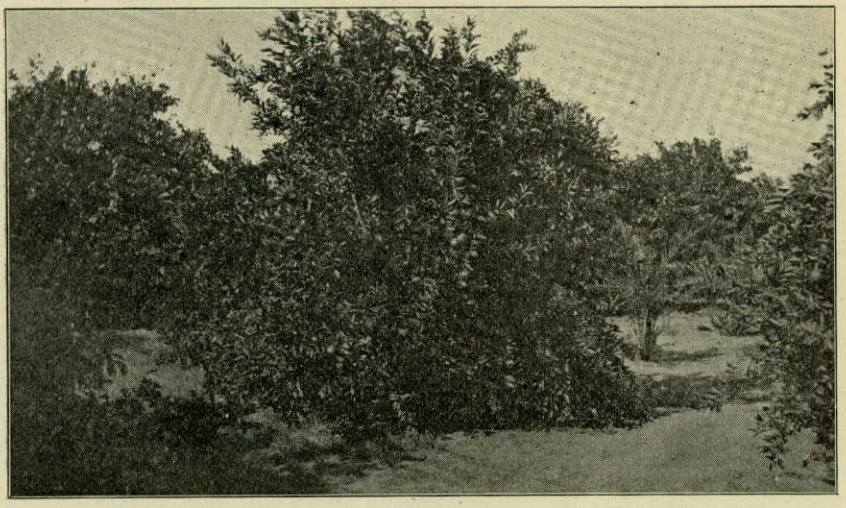


Fig. 27. Four-year-old Temple orange tree.

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 occurring 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 rejuve-

nation. 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 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 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.

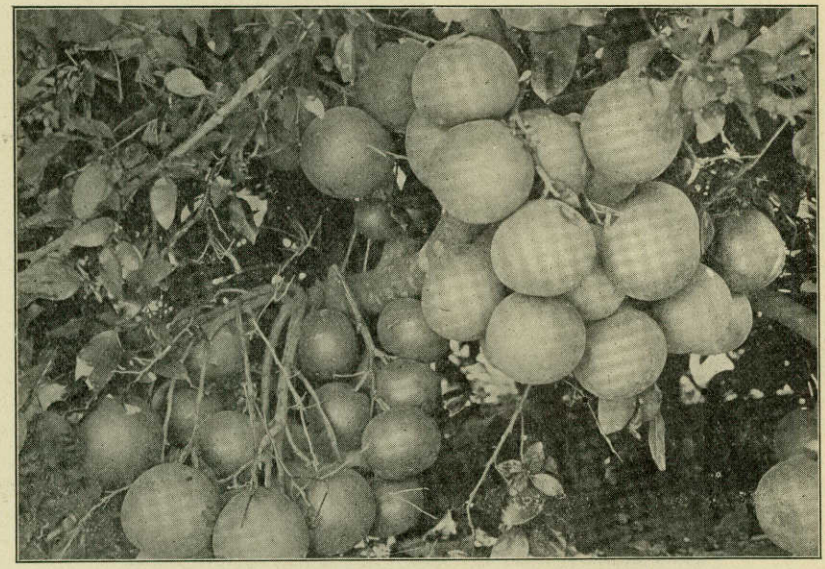


Fig. 28. Two bunches of grape fruit.

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 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 varieties. The practical grower of fruits, however, only looks to the largest returns for his labor and cares very little whether the

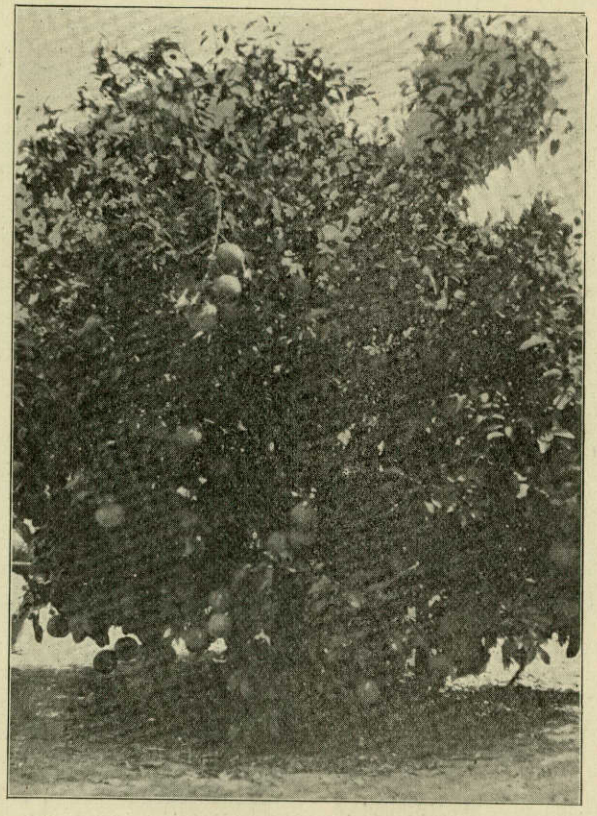


Fig. 28. Four-year-old Marsh seedless grape fruit with a heavy crop.

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
	Amara		Sour Bittersweet Seville
	Bergamia		Bergamot orange
2—Aurantium	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 pre-eminently useful for all portions of the world where it can be grown —for instance, 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 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 they 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 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

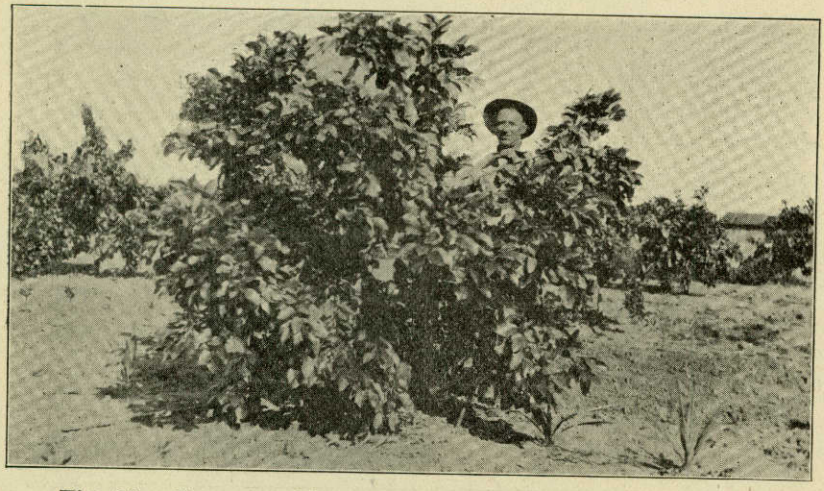


Fig. 30. Two-year-old grape fruit showing vigorous growth.

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 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 conditons 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 wth 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

Fig. 31. Orange tree in fruit.

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 or 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 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 crop before May 1st, the be-

ginning of their rainy season, as the fruit loses its flavor after the rains begin.

The Ruby, Rogan, St. Michael, and *Malto Blood,* all blood oranges, are all of fine flavor and appearance and have pulp of red or blood color. They might have commercial value in the Valley.

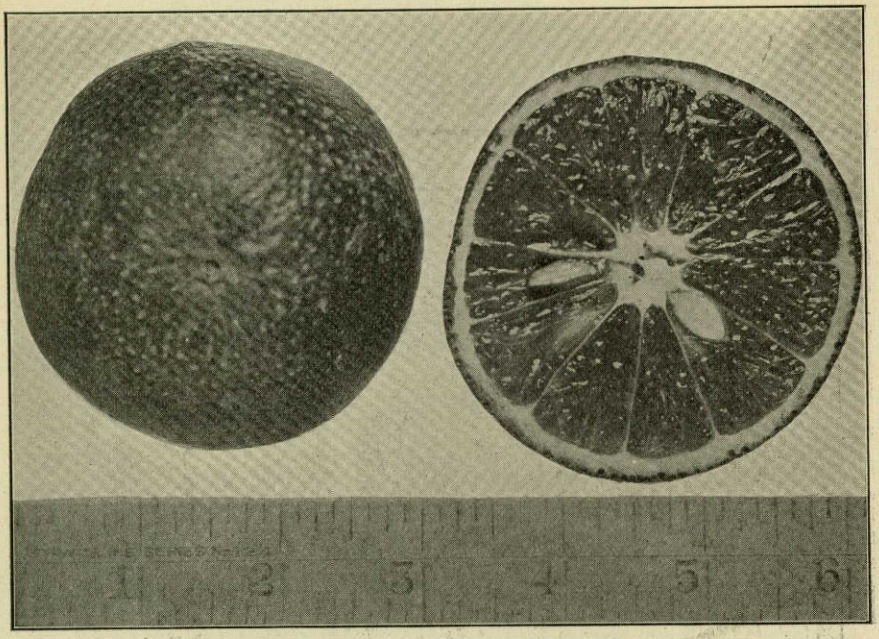


Fig. 32. Parson Brown orange, reduced.

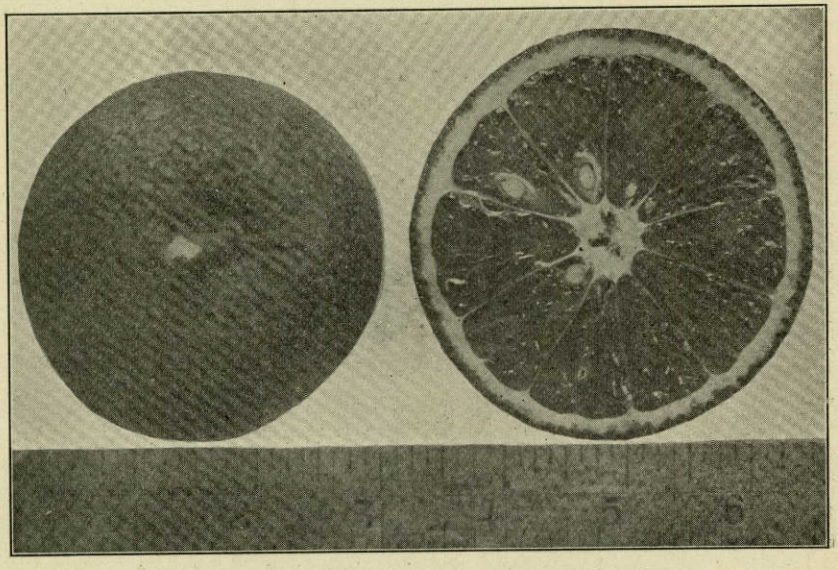


Fig. 33. Valentia late orange, reduced.

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

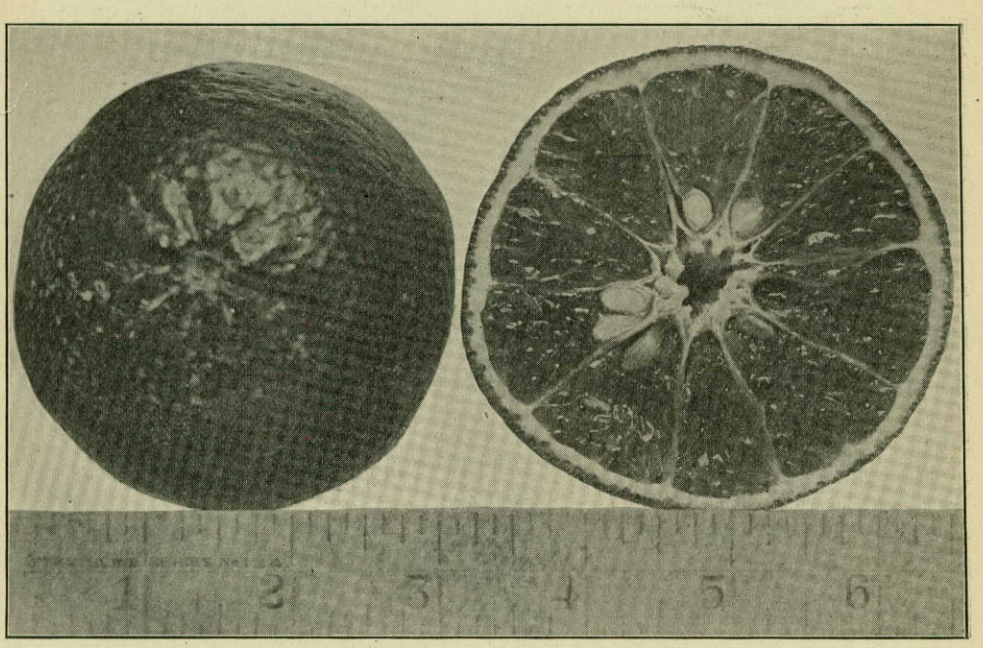


Fig. 34. Temple orange, reduced.

Satsuma cannot be grown in the Valley for the reason that it is not compatable with the sour orange root stock. *Trifoliata* 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 are very prolific and bring a fancy price even on the home market, are much more cold and resistant than any other 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 profilic 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. Has sold on the Chicago market at $18.00 per crate, making it rather an attractive proposition. There are several large 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

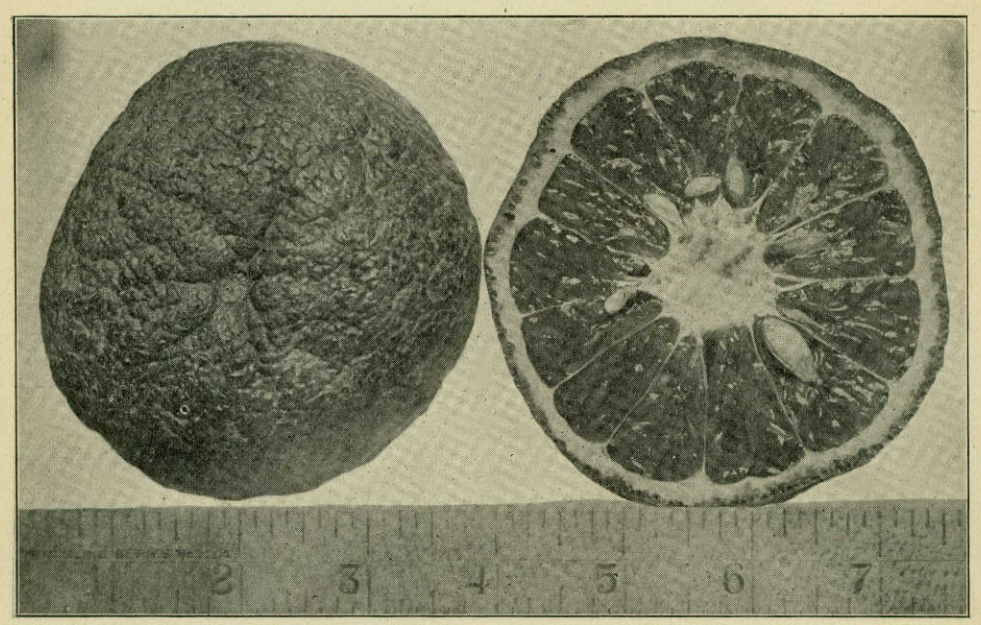


Fig. 35. King orange, reduced.

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.

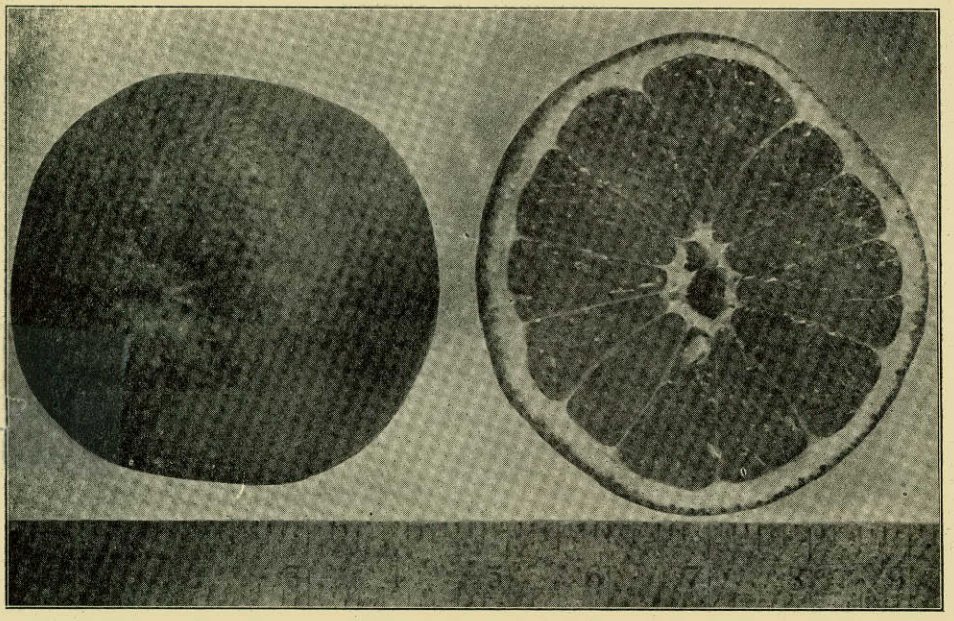


Fig. 36. Marsh seedless grape fruit, reduced.

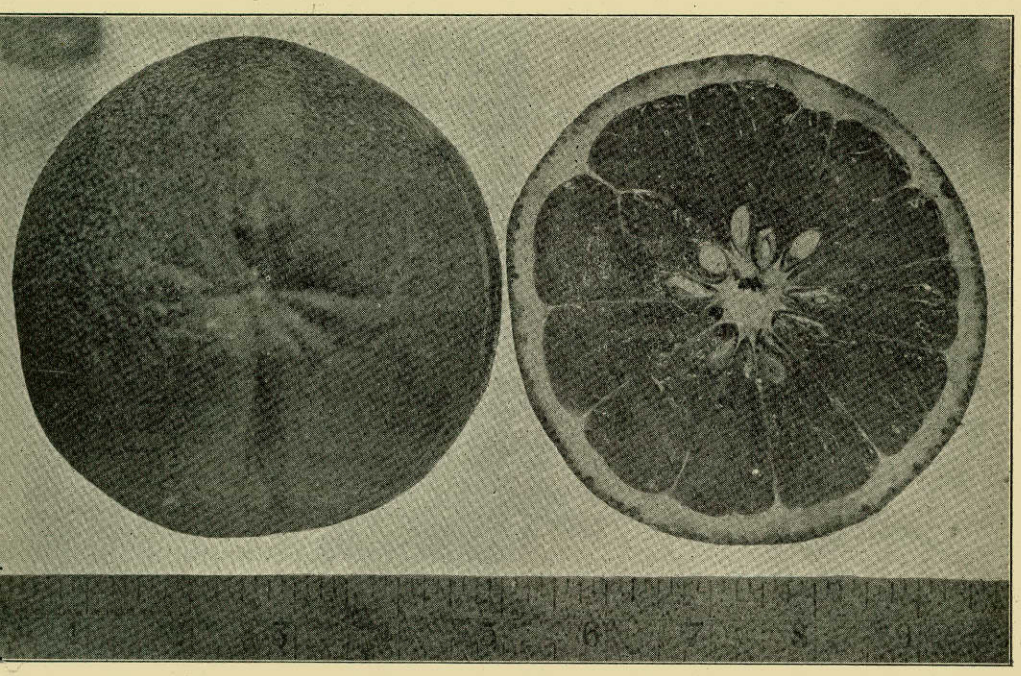


Fig. 37. Foster or pink grape fruit, reduced.

GRAPEFRUIT OR POMELO

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

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

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 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 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.

LEMON

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

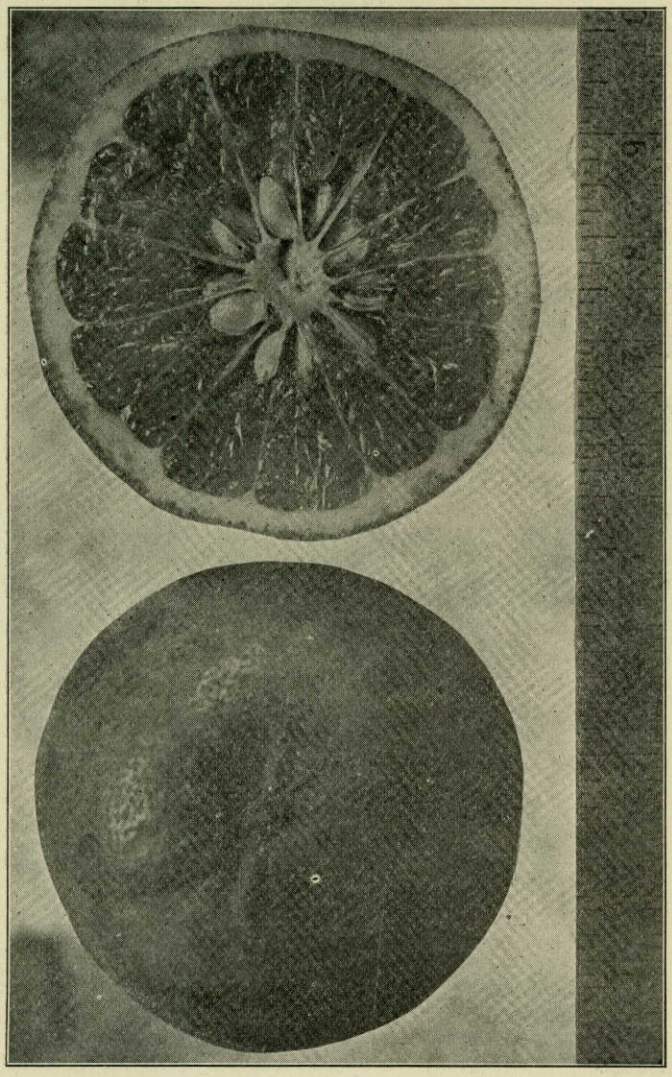


Fig. 39. Florida Standard grape fruit, reduced.

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.

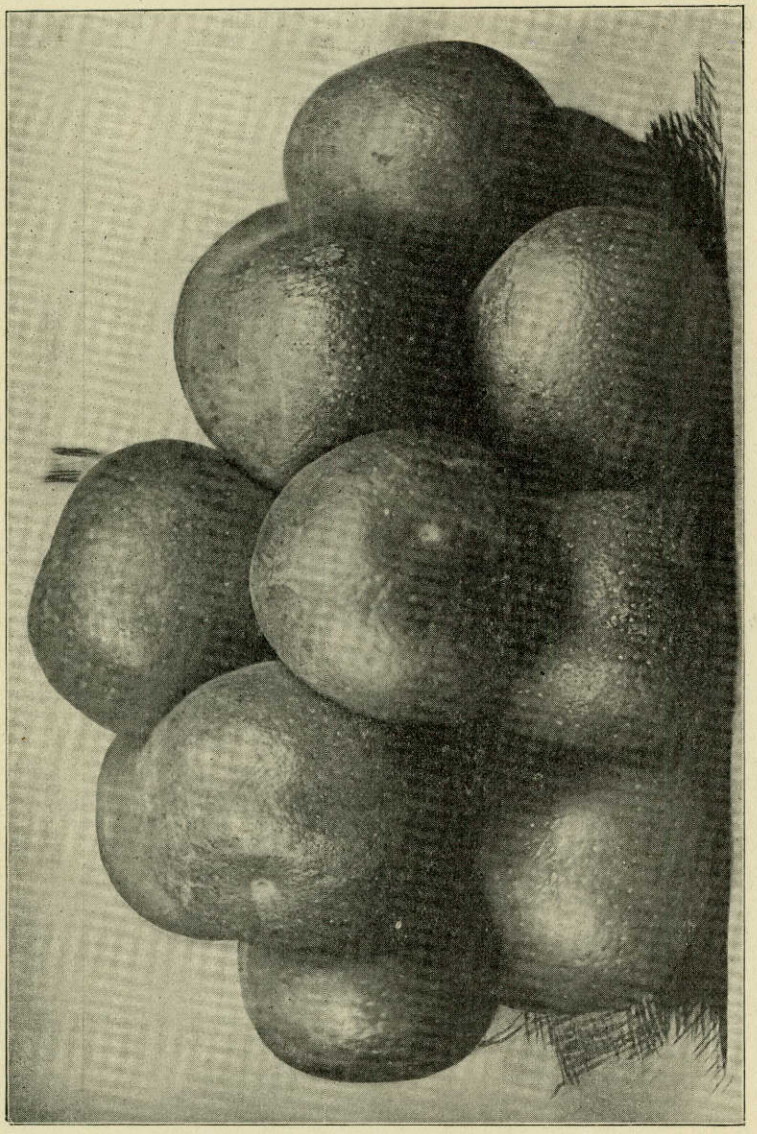


Fig. 40. An exceptional cluster of 18 Duncan grape fruit weighing 18 pounds, greatly reduced.

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.

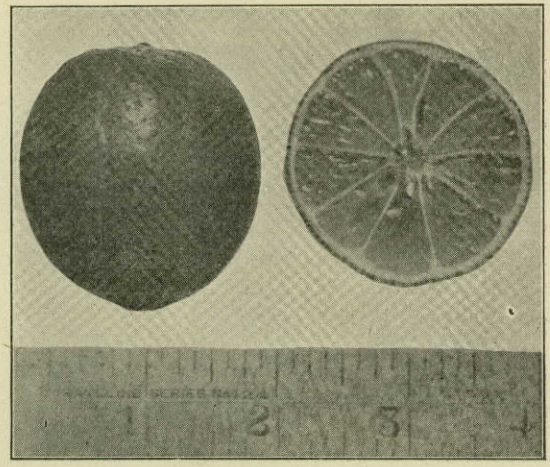


Fig. 41. Mexican lime, slightly reduced.

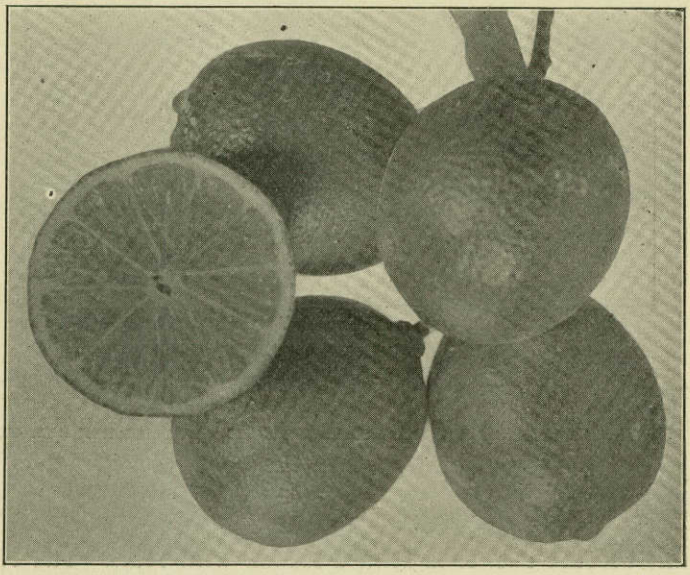


Fig. 42. Tahiti limes, slightly reduced.

The fruit is about the size of a large walnut, very thin skinned and full of very acid juice. Not as hardy as the orange.

The Tahiti, Persian and *Bear's 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. It is very juicy, with a fair acid content and with the flavor of a lime and orange. Not extensively planted.

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

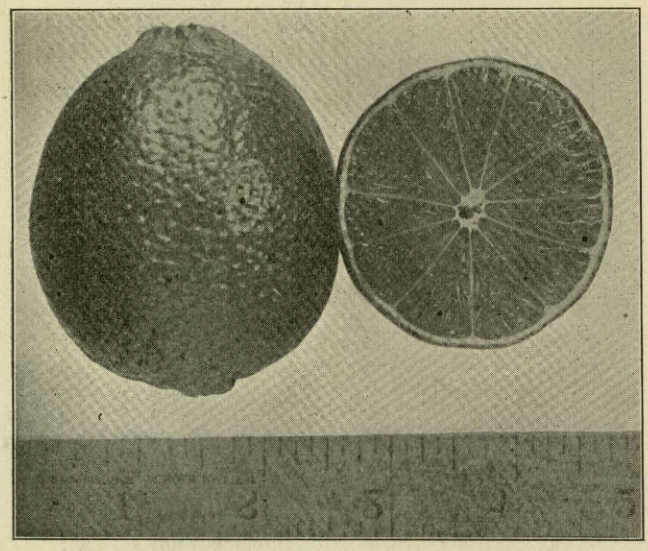


Figure 43. Persian limes, slightly reduced.

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, and it should be planted freely. Bears continually.

Calamondin: This is a hardy lime from the Phillipine 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, combined with a pleasing aroma. It makes a fine marmalade and drink, and is worthy of consideration.

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 trifoliata orange. The citrange is very cold resistant. If in a dormant condition it can withstand a temperature of 15° or even 10° Fahr. without injury. The Rusk is the most precocious of the cit-

ranges. This is being tried out in the Valley as a root stock for Satsumas and others.

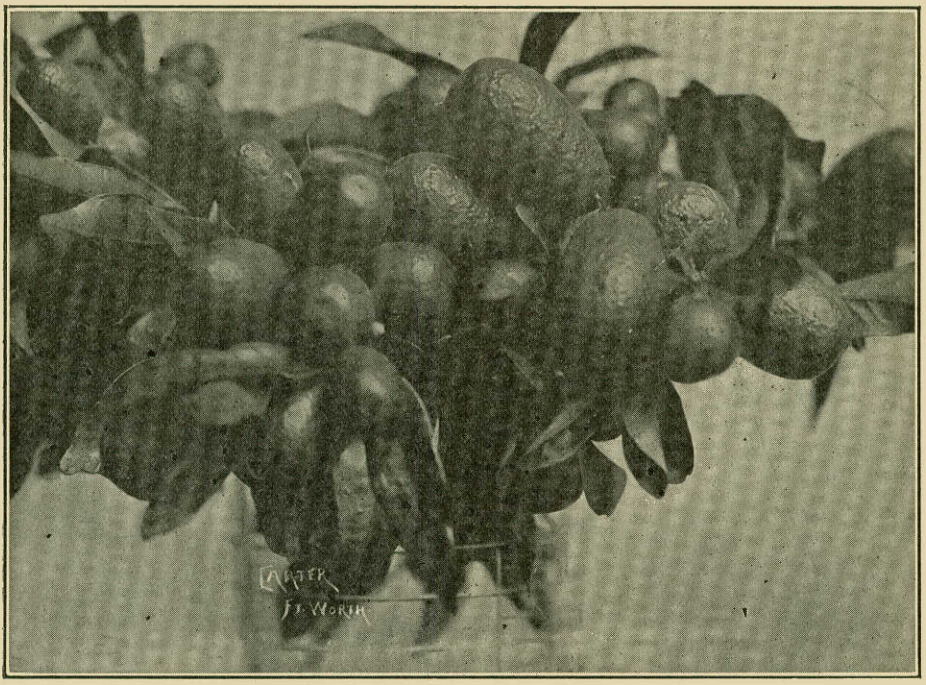


Fig. 44. Kumquats.

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

March 1, 1923.

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

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

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.

While special methods of curing lemons have been investigated in both Florida and California by several individuals of the Valley, sufficient information as yet has not been acquired to give absolute directions for procedure in this district.

Mr. Flindt, connected with the John H. Shary Curing House at Sharyland, Texas, and others who are working on this subject in the Valley, have given us the benefit of their observations.

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 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.

The Shary Curing House at Sharyland is 18x36 feet with a 9-foot elevation. It is built of brick and is capable of ample ventilation at the top. The procedure followed in this case is very similar to the California autumn method. The fruit is picked carefully while perfectly dry and placed in regular boxes and left standing under the tree from 12 to 24 hours. It is then hauled to the curing house and stored there, with plenty of space between the boxes. Great care is used in culling out any fruit that shows the slightest abrasion. Care is also maintained at all times to ferret out any decay that may develop in the curing house. The house is kept at a temperature of 80 degrees by the use of an oil stove when needed. The humidity is kept at 100 per cent and twice daily one-half pound of sulphur is burned in the house. Eight days is ordinarily sufficient to cure lemons by this method.

SPRAYING

One of the most essential things for the production of first class fruit in order to 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 with curved and rounded blades 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 accumulate 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 short 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.

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 12 x 12 x 24-7/8 inches inside, when the heads and fruit per box partitions are 7/8 inches thick. The California standard orange box is 11½ x 11½ x 26 inches and the California lemon box is 10½ x 10½ x 25-7/8 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.

FLORADA 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, 4-22
252	2 7-16	6	Layers 1, 3 and 5-21 fruits; layers 2, 4 and 6-21

FLORIDA POMELO PACKS.

No. and Size	Diameter of Fruit	No. of Layers	How packed
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 Diamter.
112	3¼
128	3⅛
150	3
176	2⅞
200	2¾
216	2⅝
250	2½
300	2⅜

MARKETING CITRUS FRUIT

BY J. H. HICKMAN, President,
Lower Rio Grande Valley Citrus Exchange.

The rapid growth of the citrus industry, in the Lower Rio Grande Valley, made necessary some form of concentrated action for the proper distribution and marketing of the fruit. From this necessity was born, in March, 1922, The Lower Rio Grande Citrus Exchange, a non-profit, co-operative organization, that has grown from the original nineteen members to a membership of nearly one hundred and fifty of the progressive citrus growers of the Valley, mar-

Fig. 45. Interior view of Citrus Packing Plant at Harlingen, Texas

keting during the first year of its existence about fifty per cent of the fruit produced.

By an arrangement with the Valley Packing Company our fruit was all standard packed, enabling us to put on the market a product superior in quality, and equal in pack, to that of other producing districts. The response from the jobbers, dealers and consumers was immediate, and at no time during the season just closed have we been able to supply the demand.

As our production the coming season will, probably, be five times greater than last season, it was definitely decided at a special meeting of the directors, held on March ninth, to install at least two, and perhaps three, new modern packing plants to care for the next season's crop. These plants will be owned by the exchange, and operated at actual cost for its members, safe-guarded by a fund for depreciation and repairs.

Our method of handling the fruit for our members is that it shall

be clipped from the trees and placed in field boxes, under the supervision of expert field men, thence transported by trucks, or otherwise, to the nearest packing plant, where it is carefully checked and records kept of each grower's fruit received. At the packing plant each owner's fruit is cleaned, processed and packed separately, according to sizes and grade, thus enabling us to keep our records accurately, and by a system of checking, each owner's fruit can be identified from the time it enters the packing plant until it is loaded in cars for shipment.

Our fruit is all sold F. O. B. packing plant, with draft attached to bill of lading, and the money is distributed as quickly as returns from the drafts come in, less the packing and the cost of selling, representing to the grower the net sum per box on the trees, realized by him; meanwhile relieving him of the investment for field boxes, crates, labels, wrappers and the cost of labor incidental to the packing.

Our exchange is unique, due to the fact that our members are all volunteers, we not requiring iron-clad contracts, believing that successful co-operation must come from within, by the honor, loyalty and support of its members, and that it must function for the profit of its members and the benefit of the industry. Failing in this, it has failed utterly, and cannot be kept alive by contracts nor process of law.

Our educational campaign, regarding cultural conditions and the suppression of pests, will be carried on under the direction of the very able experts, stationed among us by the Federal and State Governments.

We expect, as our production increases, to be able by carrying into effect our co-operative packing, buying of supplies and all costs incidental to production, to return to the growers a large per cent of money received, as our overhead expenses will decrease as our production increases.

Regarding varieties of grapefruit, our experience of the past season puts Marsh Seedless at the top of the list on a car lot basis, as well as for the express shipper, with considerable demand for Foster Pinks as something out of the ordinary, while the other varieties, to the trade, are just "grapefruit." We believe we will strengthen our marketing position by confining our future plantings to fewer good varieties, instead of "a little of everything."

Too few oranges have been planted. The Valley orange stands second to none, and our markets are demanding them. In fact, during the past season we could have sold more oranges than grapefruit.

Every effort will be made to strengthen our marketing organization, in order to return the maximum amount to our members for their fruit.

VALLEY PACKING COMPANY

H. RAYMOND MILLS, Pres.

The Valley Packing Copany, through its Packing House at Harlingen and others to be established as the industry warrants, is standardizing the packing of citrus fruits in the Lower Rio Grande Valley.

The Company's equipment is the most up-to-date obtainable and includes the Brogdex Method of treatment which is now being extensively used in California, Florida, Porto Rico and other fruit shipping sections.

The Packing Company, during the first season of operations charged one dollar per box for the service of cutting, concentrating, packing, treating and loading the fruit for shipment. Its intention is to reduce the charges per box as fast as the volume of fruit handled increases so as to warrant reductions and still maintain the high standard of packing, which is necessary to introduce the wonderful fruit of the Valley in the markets in competition with the older citrus producing sections."

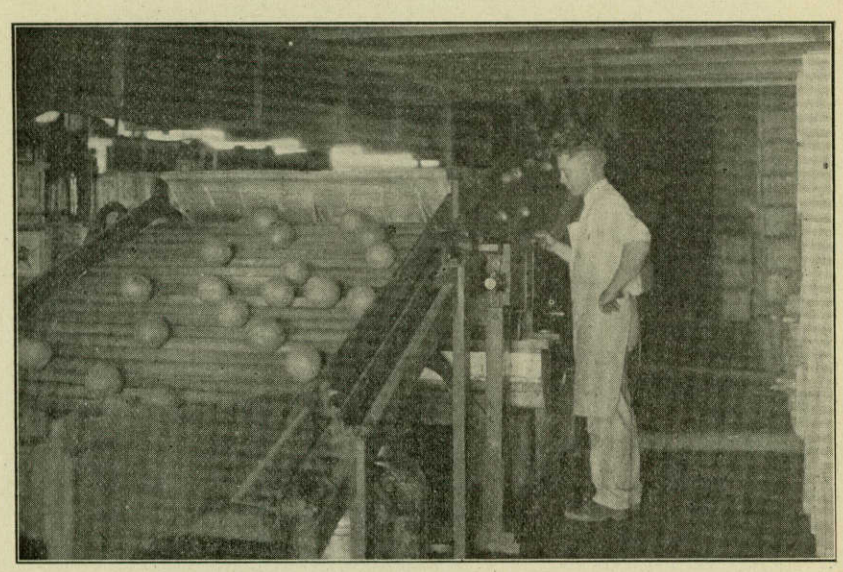


Fig. 46. A step in proper treatment and packing of citrus fruit in the Packing Plant at Harlingen, Texas.

CITRUS INSECTS

An esential 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

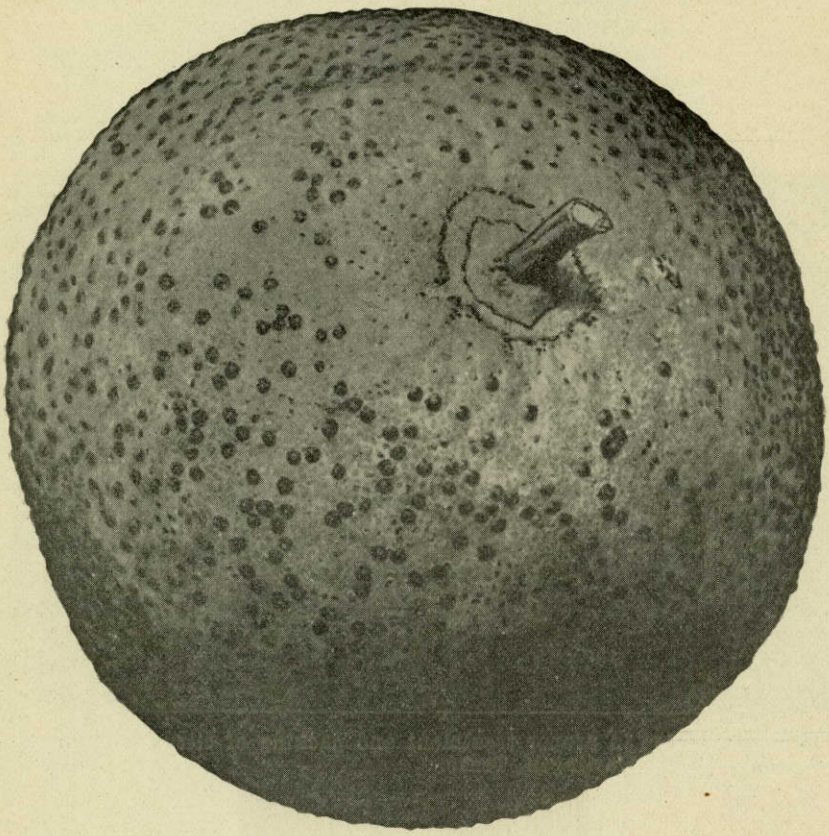


Fig. 47. Florida red scale on grape fruit.

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 to 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, protec-

tive 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, purple scale, California red 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, over-lap 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

Lepidosophes 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 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.

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 char-

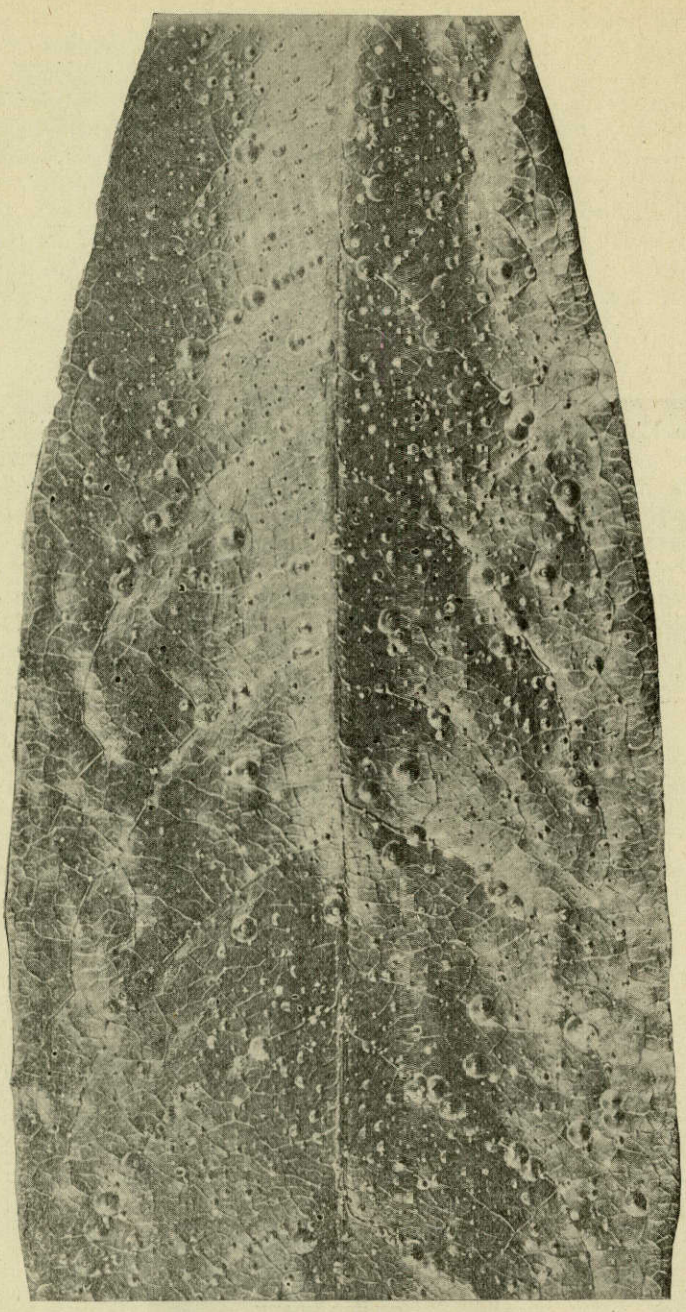


Fig. 48. Florida red scale on leaf ,enlarged twice. (Taken from Florida County Bulletin, Vol. 2, No. 1, 1917.)

acterized 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

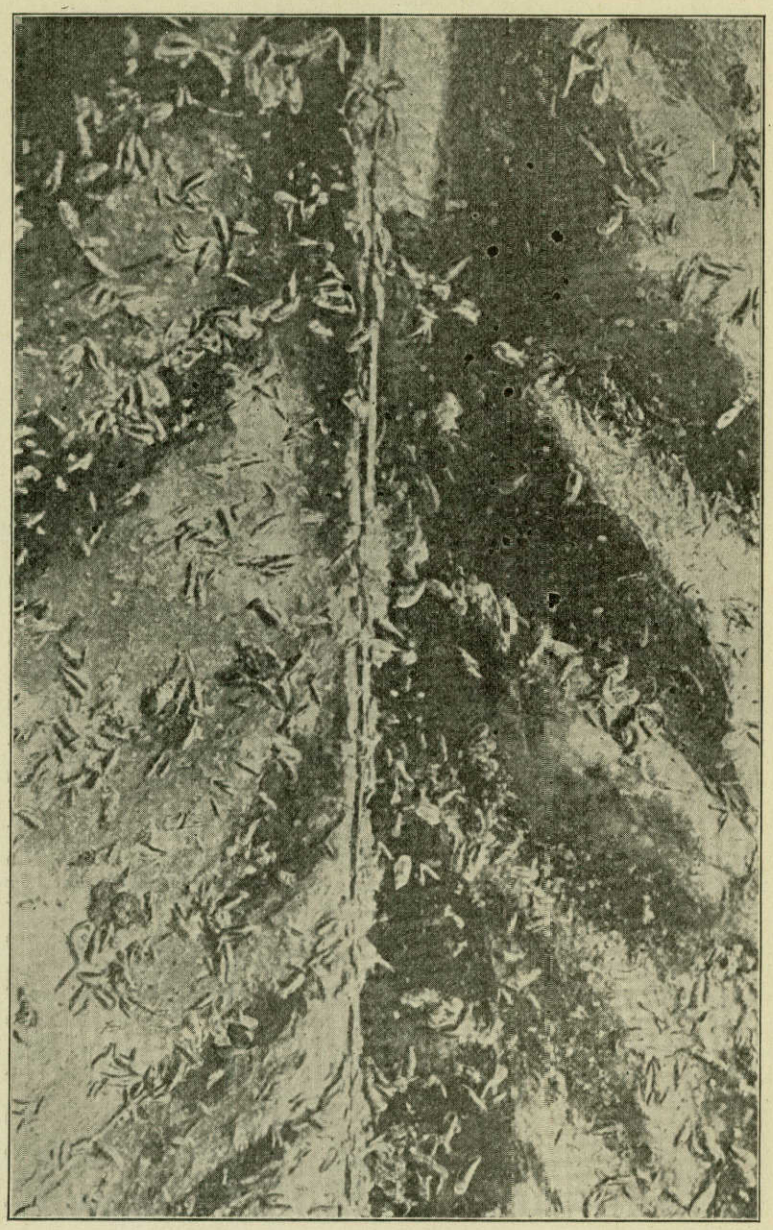


Fig. 49. Purple scale. (From California Bulletin No. 324, enlarged.)

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

COTTON CUSHIONY 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 con-

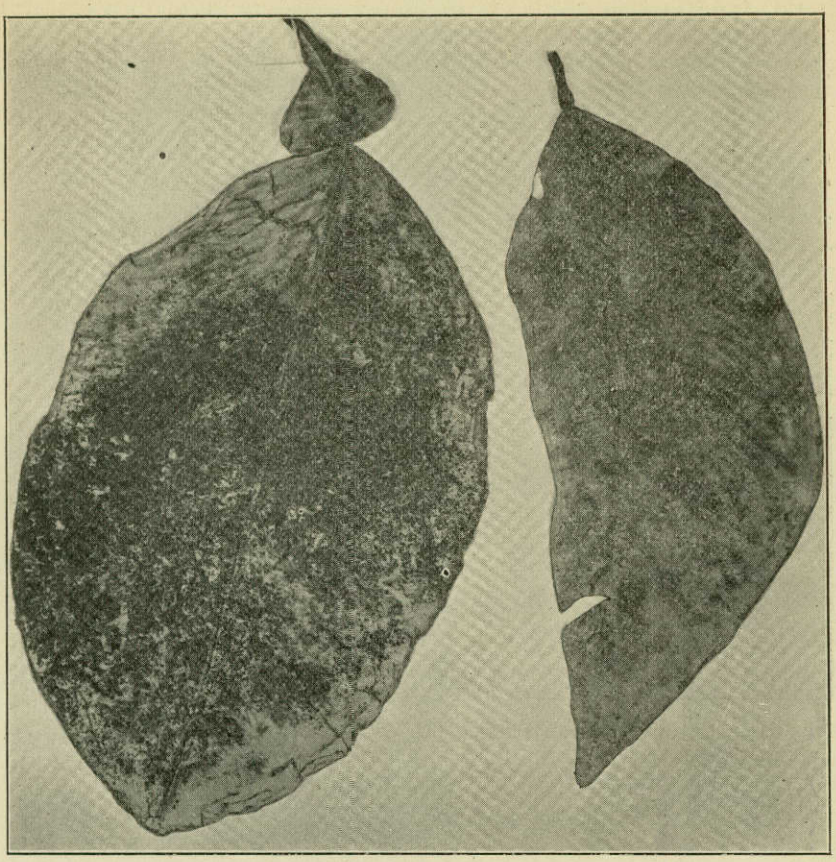


Fig. 50. Citrus leaf, showing soft brown scale with sooty mold and chaff scale.

trol 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 parafin oil emulsions as used in Florida with slight modifications have given best results in the Valley. The formulae for preparing them are given below. Both preparations have proven satisfactory.

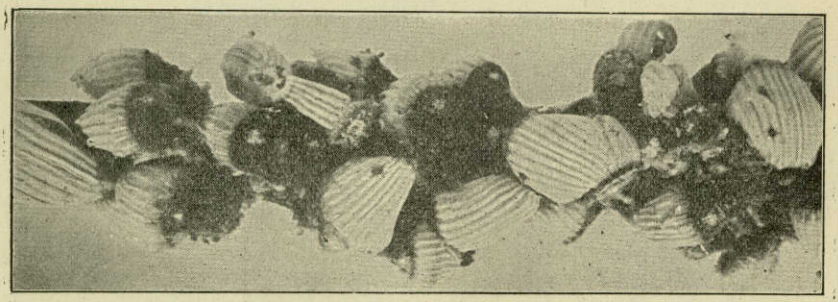


Fig. 51. Cottony cushion scale. (U. S. Manual of Dangerous Insects.)

Formula for Cold Stirred Emulsion Stock Solution

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

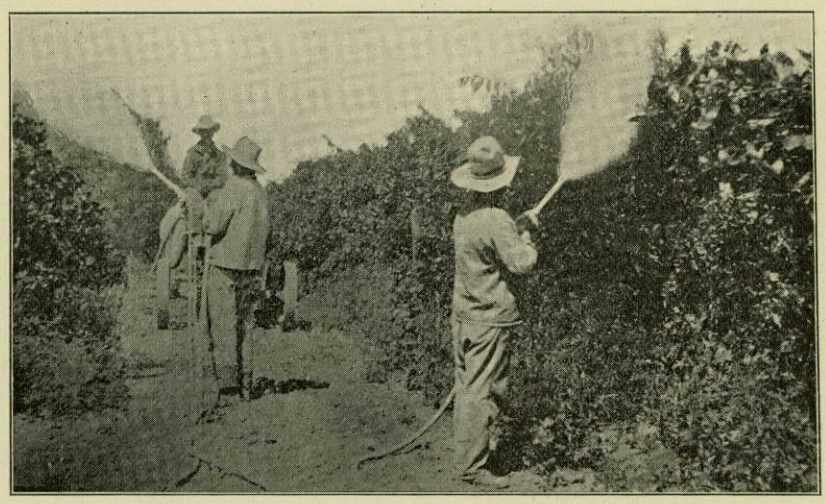


Fig. 52. Power spray in operation.

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 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 can not 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 aplications made at the correct times will control the pests. During some seasons and under adverse conditions supplementary sprays will be necessary. The success of this 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 occurrence 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 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.

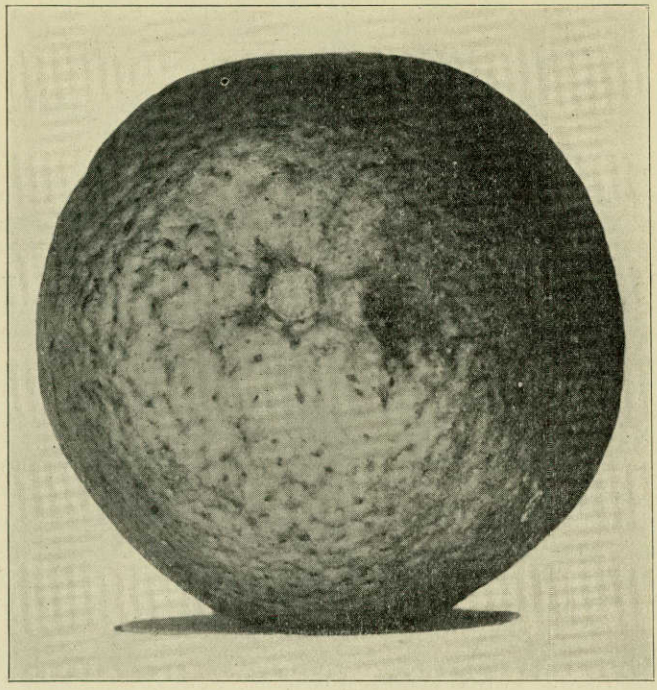


Fig 53. Rust mite injury on orange. (Note the dark discoloration on the area on the upper right hand surface.)

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 russet 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 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 very favorable for the development of

mites, for they multiplly 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 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. 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 hot dry 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 inhabit 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 prac-

tically 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 more susceptible to the various fruit rots.

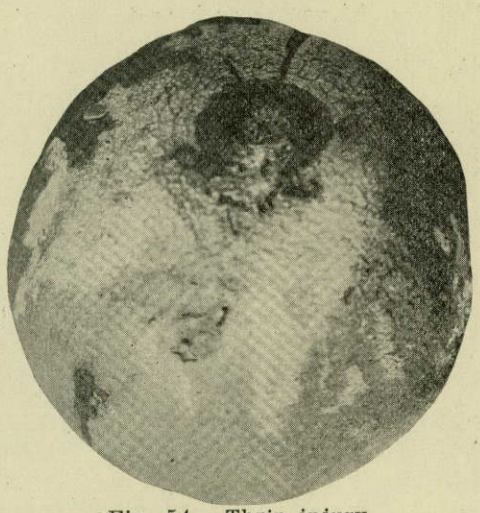


Fig. 54. Thrip injury.

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.....3½ 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 rust mite as ordinarily requirements from this time on will be similar. In such sprayings all parts of the plants should be drenched.

Rarely weather conditions are such as to prevent the multiplication of thrips, but in such cases spraying may be postponed until after the petals fall.

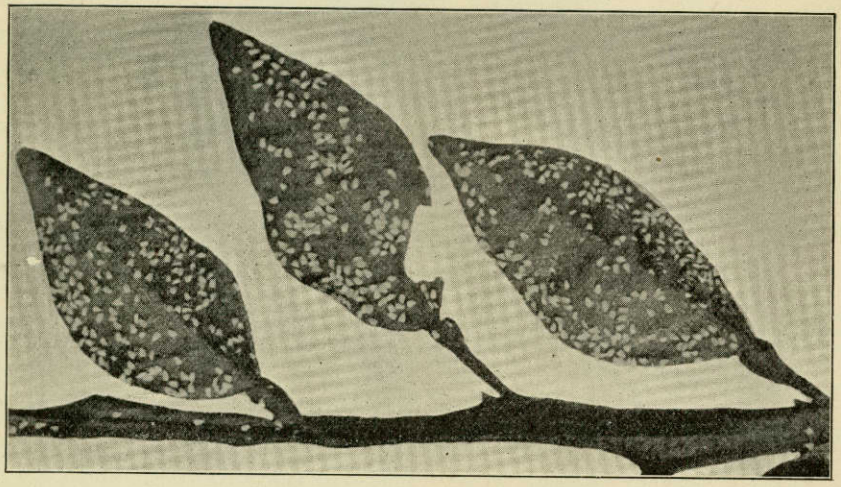


Fig. 55. Citrus White Fly. Adults of the Citrus White Fly crowd under the surface of the orange leaf. Adult appears slightly smaller than normal size. (Morris & Black.)

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 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.

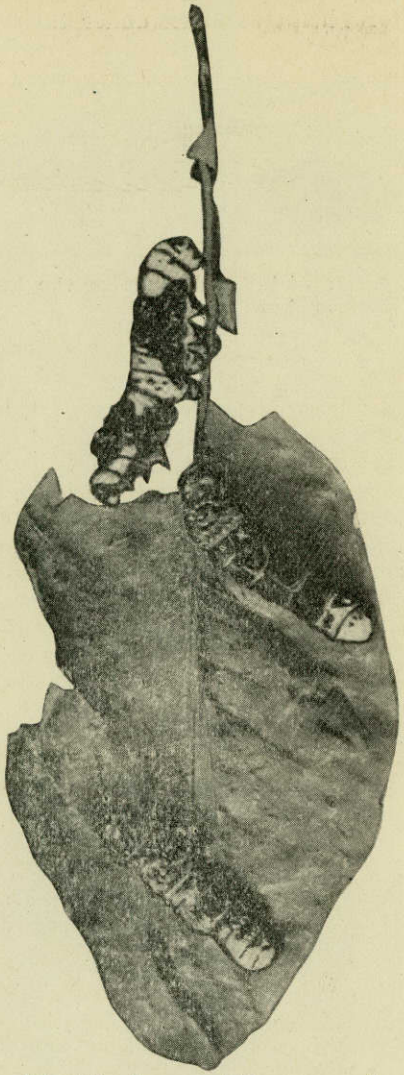


Fig. 56. Larvæ of the orange dog, a caterpillar which produces the beautiful yellow and black swallow-tail butterfly, commonly seen in the grove.

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 in the leaves, petals and twigs and secrete 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 controlled by either the oil emulsion spray or a spray for Thrips as given under the heading of Thrips. "Nico Dust" is also effective.

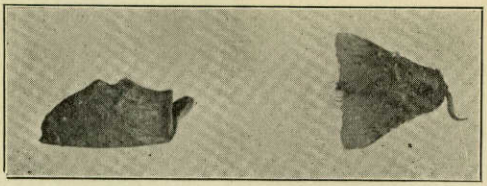


Fig. 57. Adult and pupa of the Flannel Moth or Asp.

CATERPILLARS.

Caterpillars of various kinds have been reported as attacking the foliage of citrus trees. The larvae 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 Arsenate of Lead, 2 lbs. to 50 gallons of water. Calsium 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.

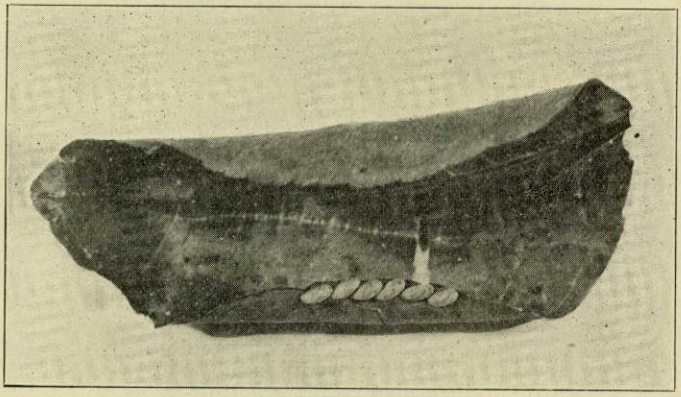


Fig. 58. Eggs of the Katydid on orange leaf.

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

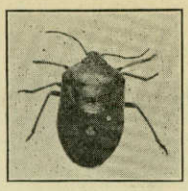


Fig. 59. Plant bug sometimes considered injurious by puncturing citrus fruit.

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 between the

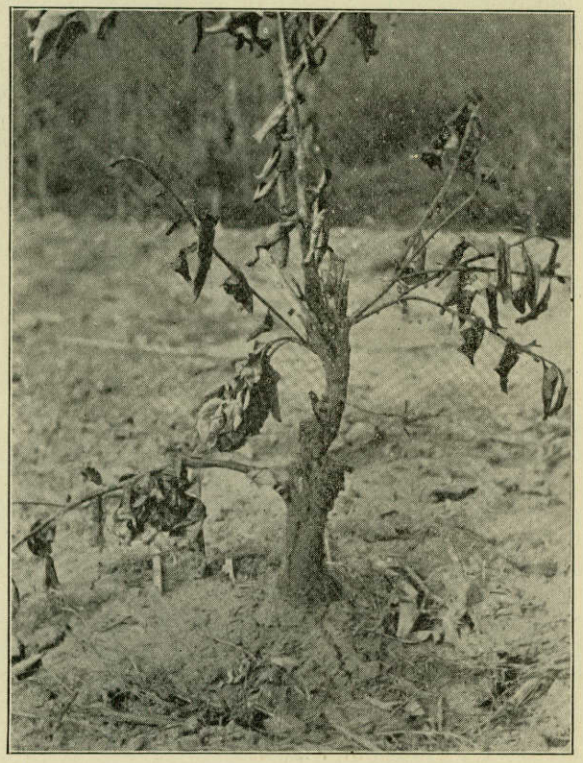


Fig. 60. A tree badly infested with ants.

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 a 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,

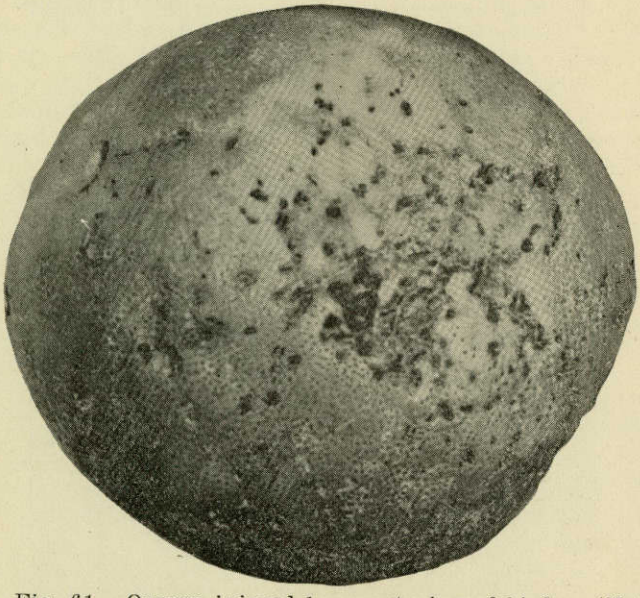


Fig. 61. Orange injured by puncturing of birds. (Note the holes made by the pecking of the birds).

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 portion 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 care should be taken in handling it.

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.

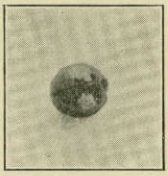


Fig. 62. Lady beetle, a friend of the citrus grower.

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.

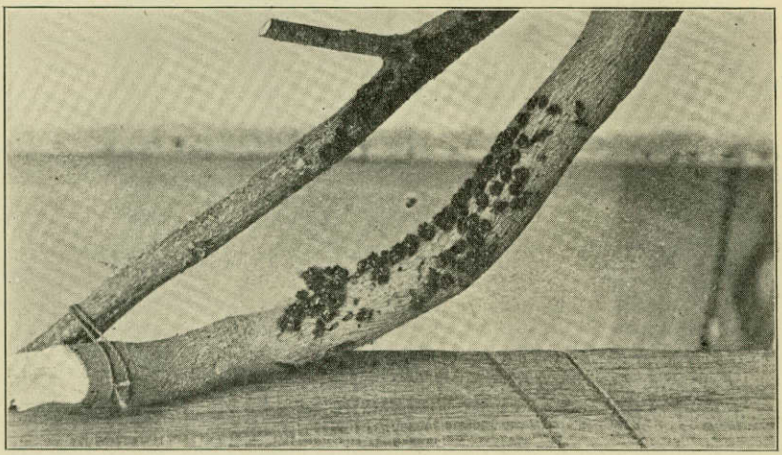


Fig. 63. Pupa cases of the Lady beetles from which the adults have emerged.

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 ac-

count 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 are 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 larva.

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.

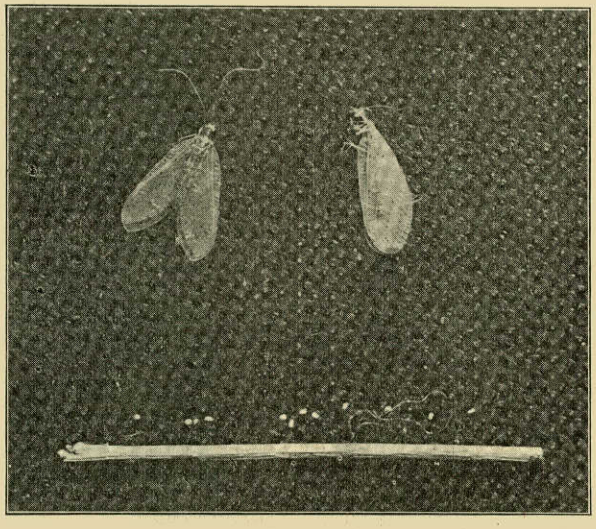


Fig. 64. Adults and eggs of the lace-wing fly, a friend of the citrus grower and farmer. Note that the eggs are set at the end of stalk-like formations. (See discussion.)

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

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-parasitic 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, a plant's environment has much to do with its behavior, growth and disease resistant 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 form 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.

Gumosis 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.*

Gumosis 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, 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 the primary

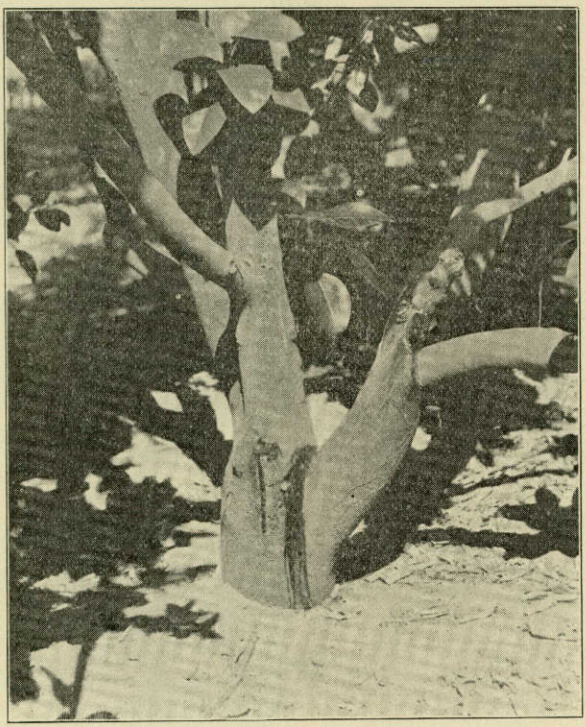


Fig. 65. Tree affected with Gummosis.

cause of this disease. In California and Florida several species of fungi were found capable of producing both foot rot and gumosis, under some conditions, but nevertheless both diseases are apparently the result of unfavorable conditions, which make possible the attack of many semi-parasitic 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 consider-

ation of the conditions 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 gumosis 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."

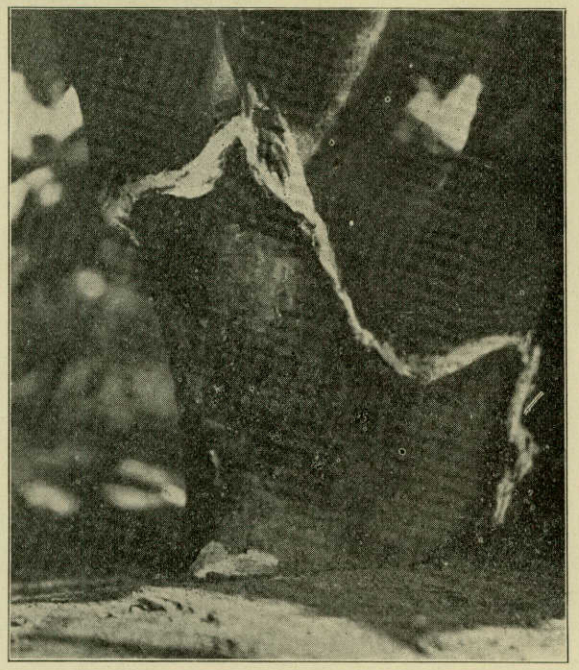


Fig. 66. Tree affected with foot rot or Mal-di-goma. (Note the affected area as outlined with chalk.)

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.

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 admit *thorough aeration.* Such wounds should be painted with a carbolineum solution or some other lasting disinfectant and left uncovered to *dry out thoroughly.* 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, disease areas on trunk and limbs should be cleaned well below line of discoloration 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

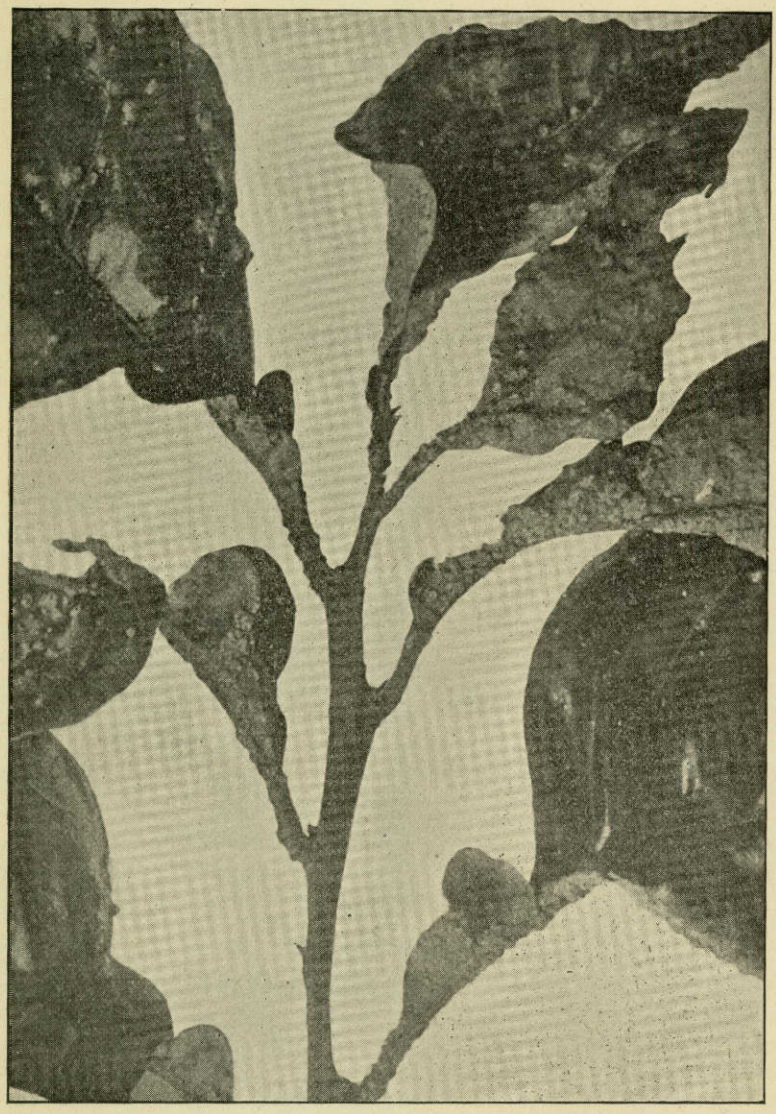


Fig. 67. Scab on orange leaves. (University of Florida Experiment Station Bulletin 124.)

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

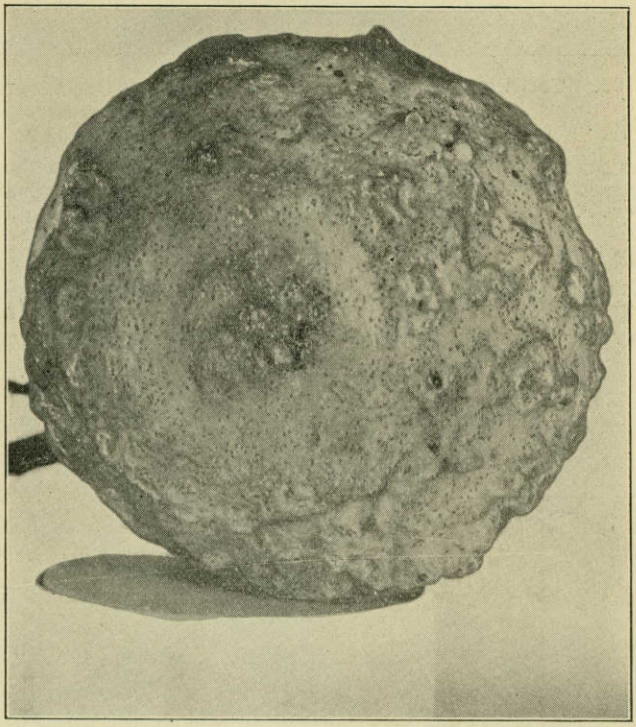


Fig. 68. Effects of scab on fruit.

profuse growth. Scab is especially troublesome on nursery stock where it attacks leaves and succulent twigs. The disease is not widespread 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.

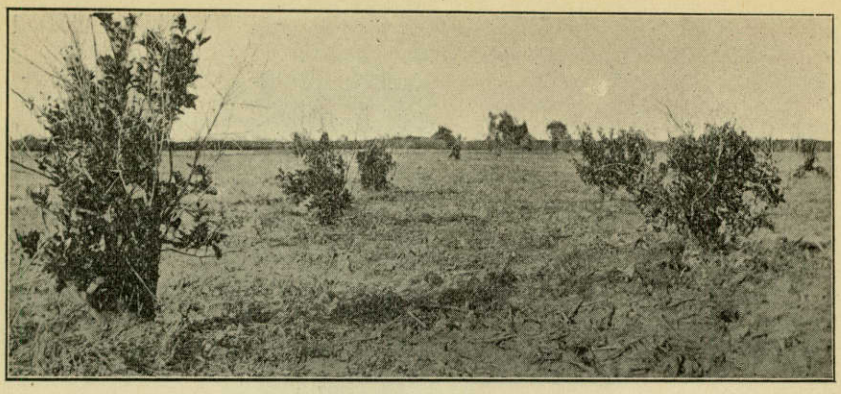


Fig. 69. Trees affected with weather tip in a neglected grove.

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.

Colletotrichum gloesporioides (Penz)

Wither tip is a fungus disease which affects the twigs, branches

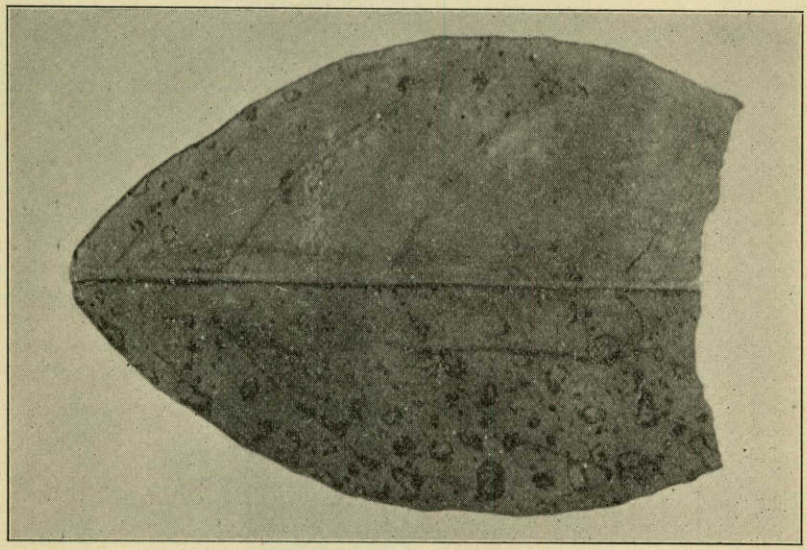


Fig. 70. Melanose on leaf, showing effect of distribution of spores by drops of dew or rain which has resulted in the markings along the edges where the water had accumulated or dripped.

and fruits of many varieties of citrus. It is reported as occurring both in California and Florida. Affected trees do not make normal growth and the fruit produced, even if it is not directly affected, is inferior. Ordinarily, however, healthy, vigorous 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 unfavorable weather 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 and from such locations spreads during favorable weather. Trees that are properly pruned and sprayed for scab will not show any injury from the disease.

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 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.

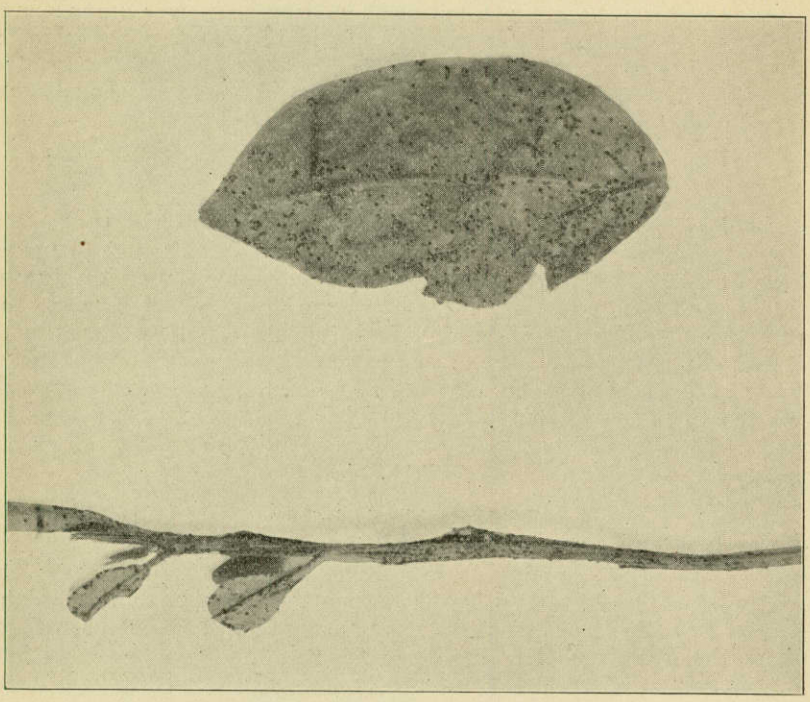


Fig. 71. A form of Melanose resembling scab.

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.

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 mix-

ture 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,

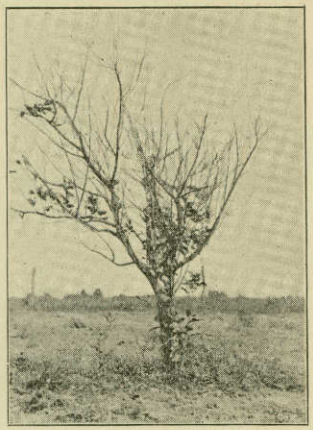


Fig. 72. Tree affected with root rot and Exanthema.

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 the 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 prevent-

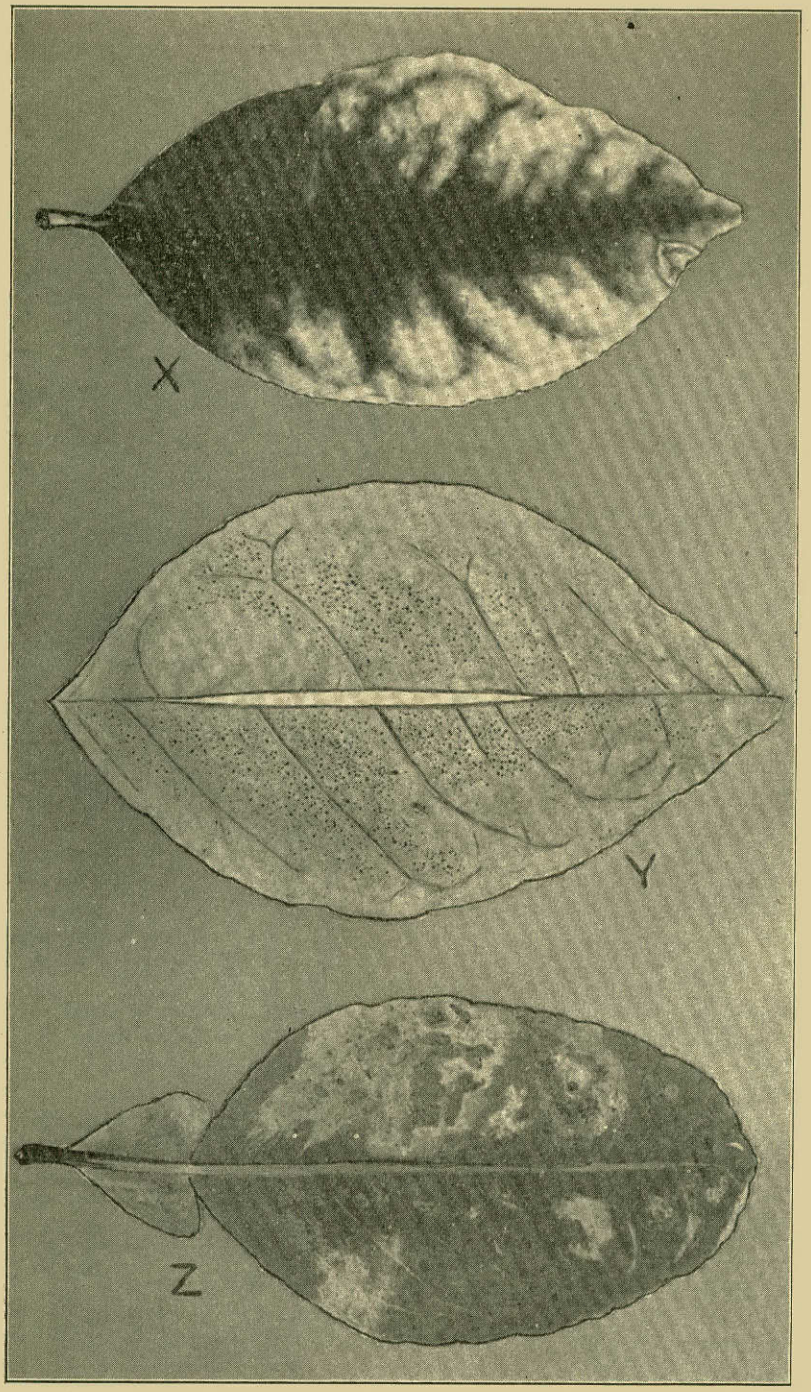


Fig. 72. "X" leaf showing "Frenching." "Y" Black Speck and Melanose. "Z" sun scorched.

ing the spread of the disease in case it is a parasitic 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.

SUN SCALD

The effects of sun scald 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. It is usually found on the under-surface of the leaf.

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

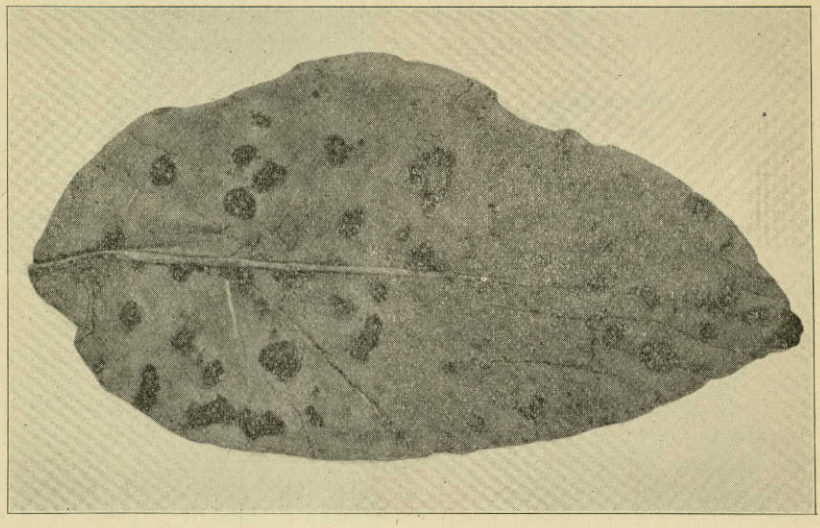


Fig. 74. Leaf spots found accompanying die back and scaly twig rupture.

importance to warrant remedial measures. Many 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 too heavy soils. None of them, however, do enough damage to warrant special control.

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.

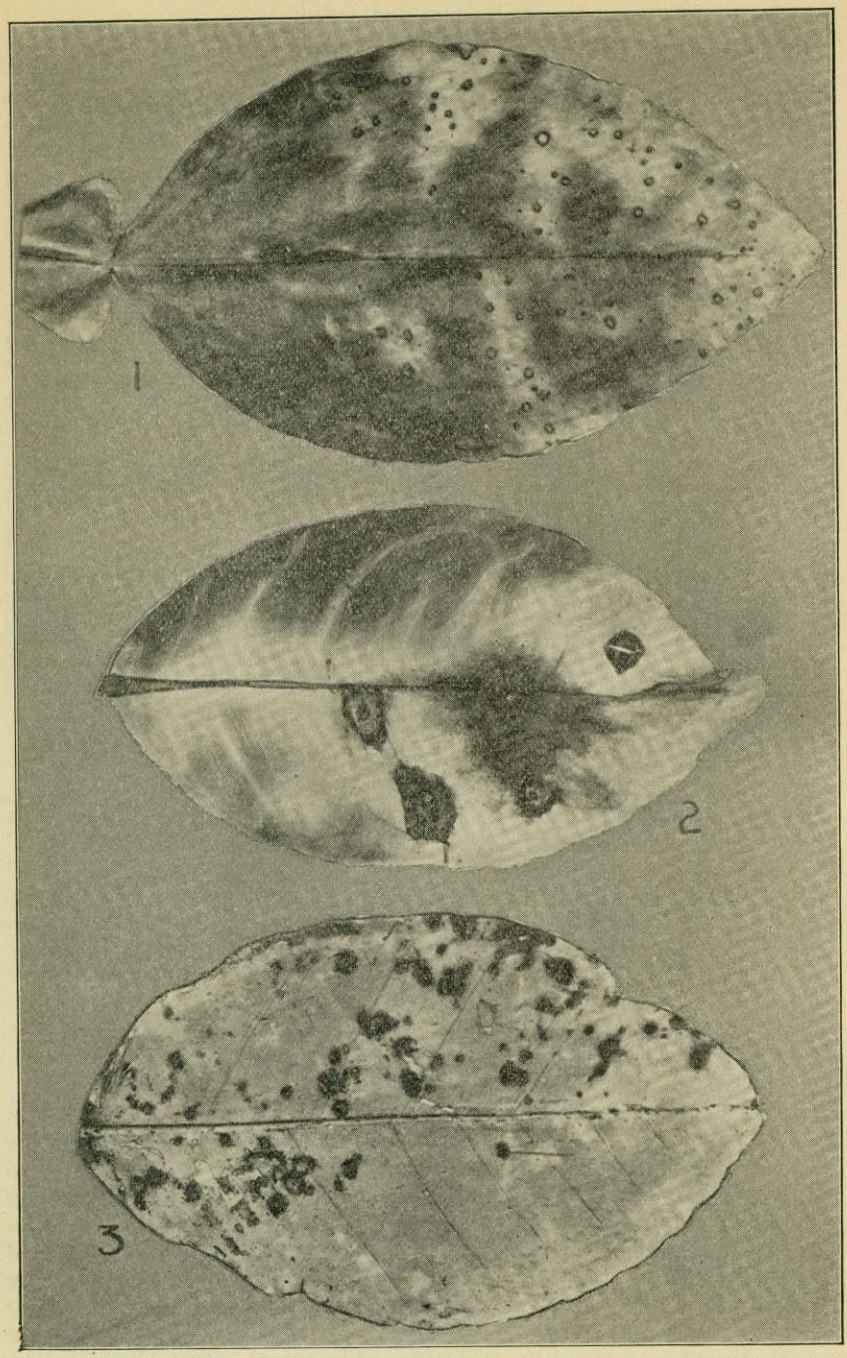


Fig. 75. (1) Glazy leaf spots. (2) Cercospora leaf spots. (3) Greasy leaf spots.

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 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 specific means of control can be given until the cause of the trouble is worked out.

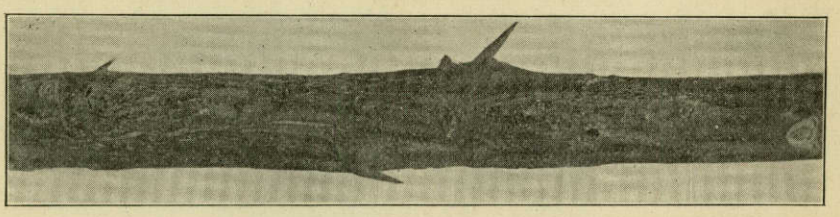


Fig. 76. Scaly twig rupture.

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. Florida state authorities are attempting to prevent its spread 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

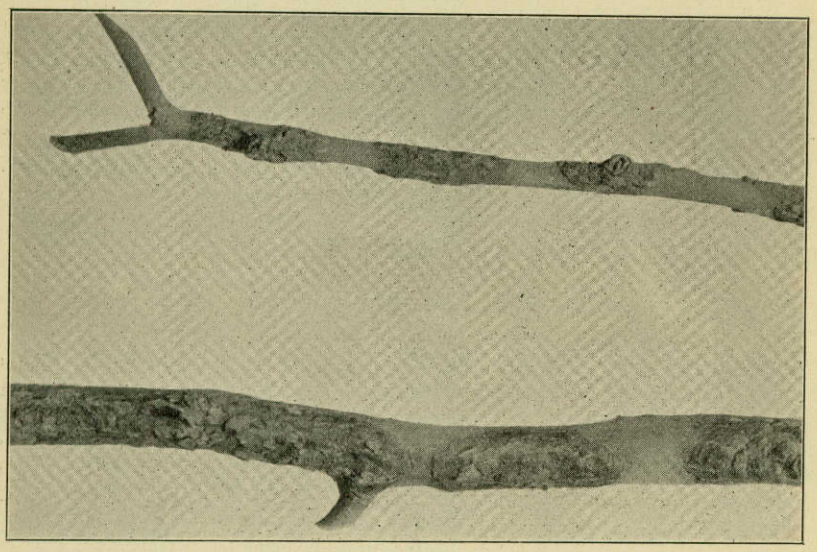


Fig. 77. Nail-head rust of Florida Scaly Bark, not occurring in Texas.

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

Pseudomonos 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 January 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 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 only exists 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

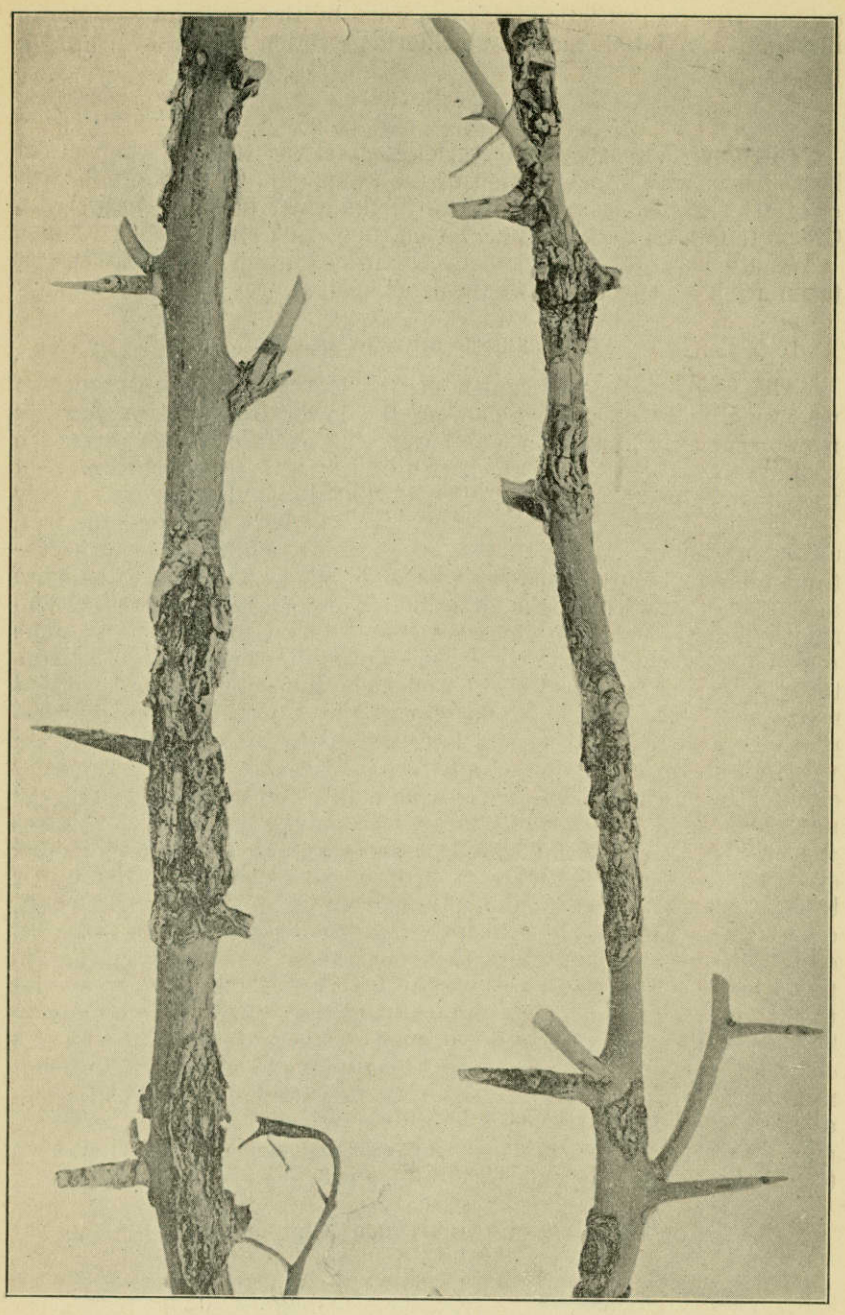


Fig. 78. Citrus canker on citrus trifoliata twig.

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, 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 trifolata 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 ½ to ¾ inch in diameter. The disease has been found on branches of grapefruit, trifoliata oranges, lemons, Sat-

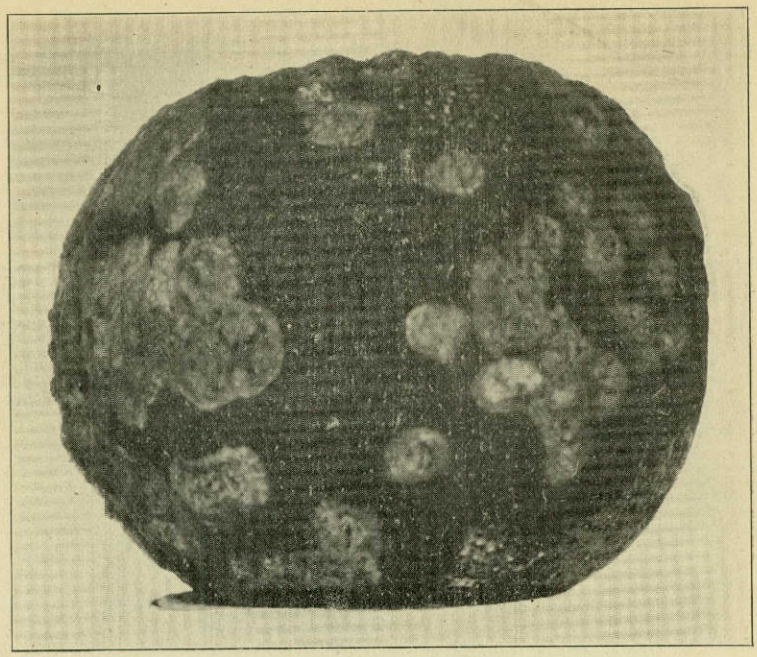


Fig. 79. Citrus canker on fruit.

sumas, 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 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 trifoliate 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

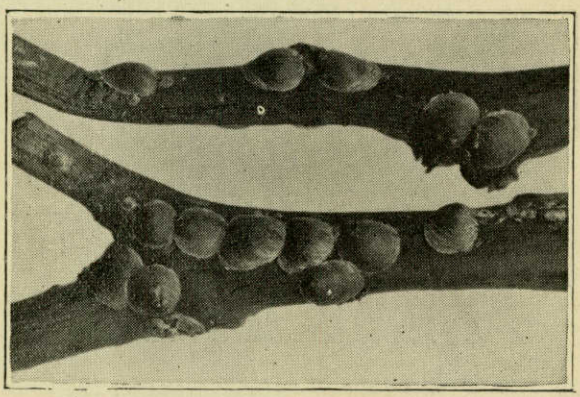


Fig. 80. Camphor scale. Kindness of Barber & Jones, Louisiana.

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.*

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.

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

CLASSICICATION 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	2.50
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 Nurseymen 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.

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