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The Gateway to the Yuma Mesa

THE YUMA MESA

By A. E. Vinson, F. J. Crider and G. E. Thompson

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ILLUSTRATIONS

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Three-year-old Washington Navel orange at Mulford Winsor's residence on the Yuma Mesa

THE YUMA MESA

By A E Vinson, F J Crider, and G E Thompson

GENERAL INFORMATION

For many years the irrigation of the Yuma Mesa with the water of the Colorado River has been discussed Various attempts by individuals and companies to accomplish this end have been undertaken with more or less success, and investigations made by engineers of the U. S. Reclamation Service have shown the reclamation of large tracts on the Mesa to be possible at reasonable cost. It has been realized, however, that the determining factor in the establishment of a permanent project of this nature has been whether or not the agricultural possibilities are such as to warrant the necessary investment. As early as 1891 Mr C. B Collingwood, at the request of Mr H W Blaisdell, investigated the character of the soil of this Mesa and made a special study of the amount and composition of the silt carried by the Colorado River These results were published as Bulletin No. 6 of the Arizona Agricultural Experiment Station Aside from the general soil survey of the Yuma district by J Garnet Holmes, of the U. S. Department of Agriculture, Bureau of Soils, in 1903, and minor observations made in reports of the Reclamation Service engineers, nothing further bearing on this phase of the project has been attempted. At the request of the Reclamation Service, this commission was appointed by Dr. R. B. von KleinSmid, President of the University of Arizona, to make such investigation and report upon the agricultural possibilities of the Yuma Mesa with special reference to the production of citrus and other commercial fruit crops. This commission was composed of the agricultural chemist, the horticulturist, and the agronomist of the University of Arizona, College of Agriculture, who were already more or less conversant with conditions on the Mesa, having made previous observations there in connection with their regular work.

After thoro consideration of all available information the commission visited the tract again early in November, 1918, to make further investigations In this work they were generously assisted by Mr. W. W. Schlecht, Project Manager of the Yuma Reclamation Project; Mr. J. W. Longstreth, Agricultural Agent of Yuma County; Mr Geo. M. Hill, a citrus grower, and other persons having knowledge of conditions on the Mesa. Careful studies were made of the citrus plantings and of other crops and vegetation now growing there, and inquiries were made concerning the past history of these crops, particularly the old citrus grove known as the Blaisdell Orchard. Units A and B of the project, as surveyed by the Reclamation Service, were inspected by several automobile and foot trips. Soil samples representative of the different soil phases were taken for chemical and mechanical analysis, and for physical tests and pot cultures. Fruit samples were obtained for physical and chemical analysis, and for comparison with similar fruits from Florida and California.

TOPOGRAPHY OF THE YUMA MESA

The Yuma Mesa rises abruptly about 100 feet above the valley of the Colorado River and stretches to the mountains on the east, sloping gently southward into Mexico. Depressions, commonly spoken of as pot holes, are found at a few places. The entire region, probably, was once the floor of the upper end of the Gulf of Cali-

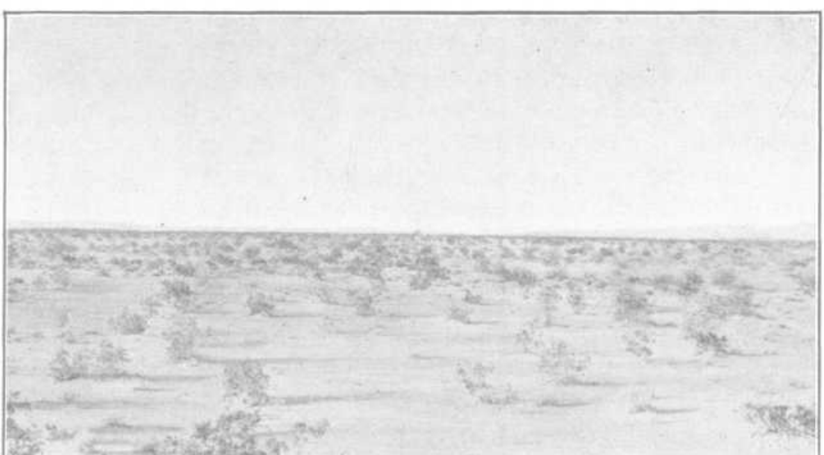

Fig. 2.—General view on the Yuma Mesa

fornia, which accounts for the prevalence of sands. Frequent draws lead from the mesa to the valley below making the margin quite rough. The great body of the Mesa, however, is level and may be brought under cultivation with little expense for grading creosote bushes. A few dunes, too large for leveling, occur, but other than the leveling of small sand dunes, collected about the these are not extensive and, judging from the old shrubbery on their tops, show little evidence of shifting While much of the tract is not easily accessible on account of sands, good road building material is easily available. The northern point of the Mesa extends well into the city of Yuma and is the site of many well-kept suburban homes, which have afforded additional evidence of the capacity of the soil to support a good growth when water is applied.

The city of Yuma, situated at the northern end of the project, is on the main line of the Southern Pacific Railroad, insuring prompt shipment, quick delivery, and lessened expense in marketing crops produced. When it is considered that many commercial fruit districts are located on branch roads, this advantage becomes apparent

CLIMATE OF THE YUMA MESA

Climate more than anything else has been the determining factor in the location and development of the citrus districts of the world. The physical nature of the soil may be modified, plant food supplied, and water problems solved, but unless a region has the natural and fundamental requisites of climate, it cannot become a commercial citrus producing center. In this particular the Yuma Mesa qualifies preeminently Its climate is unique among the citrus districts of the country in that no other area in North America has occuring together the smallest rainfall, lowest relative humidity, and greatest percentage of sunshine—a combination which makes possible the production of fruit of the finest quality, the highest color, and with the earliest ripening period A product with this distinctive excellence wins favor, extra high prices, and a permanent place in the market. Furthermore, the fruit can be allowed to remain on the trees until it attains maturity without fear of competition. The history of plantings on the Mesa shows that the Navel crop can be placed on the market in November and December, and at this time is of such perfect quality as to command a price far in excess of oranges from any other district. Grapefruit at this time also has extremely superior quality over that found on the market from other citrus districts, which insures the highest selling price.

Another climatic feature of paramount importance found on the Yuma Mesa is immunity from injurious frost. The tract is composed for the most part of a broad table land with a gentle slope towards the edge of the Mesa, which breaks up into numerous wide draws, affording excellent air drainage to the valley below. Coupled with this ideal topography there is an almost constant circulation of air. Observations on the Mesa covering a period of twenty-six years (the age of the oldest citrus planting in this district) with accurate weather records covering the greater portion of this time, show no serious injury from cold. In the disastrous freeze of 1913 when the temperature in the Southwest was lower than had been known for a period of sixty years, lemon trees on the Mesa were only slightly affected, the thermometer registering from three to eight degrees higher than in the citrus districts of California. It can, therefore, be stated most positively that the frost hazard, a matter which should receive first consideration in the selection of a location for citrus growing, is a negligible factor

Fig. 3.—Windbreak of evergreen tamarisk on the Yuma Mesa, 18 months from planting

in this district, and should give the prospective citrus grower no concern. In view of the great expense involved in the use of smudge pots, as practiced in some of our older citrus regions, immunity from frost injury is an item of extreme economic importance.

Weather records kept at the Blaisdell Orchard from October, 1893, to June, 1987, are given in Bulletin 58 of the Arizona Agricultural Experiment Station and are reproduced here in Table I.

TABLE I—WEEKLY MAXIMUM AND MINIMUM TEMPERATURES TAKEN AT THE BLAISDELL ORCHARD

1893	Max.	Min.
Oct. 30	80	50
Nov. 6	91	48
Nov. 13	85	45
Nov. 20	79	40
Nov. 27	73	34
Dec. 4	79	41
Dec. 11	83	44
Dec. 18	81	44
Dec. 25	76	42
1894		
Jan. 1	74	38
Jan. 8	69	32
Jan. 15	65	30
Jan. 22	71	33
Jan. 29	73	30
Feb. 5	74	37
Feb. 12	71	32
Feb. 19	72	29
Feb. 26	76	31
Mar. 5	82	33
Mar. 12	78	36
Mar. 19	95	46
Mar. 26	84	34
Apr. 2	96	49
Apr. 9	95	50
Apr. 16	95	54
Apr. 23	96	45
Apr. 30	101	55
May 7	95	45
May 14	105	57
May 21	100	52
May 28	100	57
June 4	100	59
June 11	96	53
June 17	101	60
June 25	102	61
July 2	105	61
July 9	115	67
July 16	112	78
July 23	107	71
July 30	115	76
Aug. 6	111	77
Aug. 13	101	70
Aug. 20	107	68
Aug. 27	109	75
Sept. 3	106	69
Sept. 10	98	64
Sept. 17	103	60
Sept. 24	108	68
Oct. 1	110	68
Oct. 8	101	58
Oct. 15	99	62
Oct. 22	99	58
Oct. 28	91	50
Nov. 5	91	53
Nov. 12	91	46
Nov. 19	84	42
Nov. 27	85	47
Dec. 3	82	36
Dec. 10	72	37
Dec. 17	65	37
Dec. 24	71	41
Dec. 31	66	46
1895		
Jan. 6	72	31
Jan. 13	81	38
Jan. 21	73	41
Jan. 28	65	33
Feb. 4	71	35
Feb. 11	77	39
Feb. 18	76	36
Feb. 25	84	44
Mar. 4	86	44
Mar. 11	85	45
Mar. 18	79	38
Mar. 25	90	41
Apr. 1	97	42
Apr. 8	90	41
Apr. 15	101	47
Apr. 22	96	50
Apr. 29	94	51
May 6	100	50
May 13	108	62
May 20	102	58
May 27	98	55
June 3	95	49
June 10	104	60
June 17	105	60
June 24	109	60
July 1	110	65
July 8	107	65
July 15	107	67
July 22	111	67
July 29	108	70
Aug. 5	113	68
Aug. 12	112	71
Aug. 19	110	73
Aug. 26	106	73
Sept. 2	103	60
Sept. 9	105	59
Sept. 16	106	64
Sept. 23	104	54
Sept. 30	104	58
Oct. 7	96	54
Oct. 14	97	56
Oct. 21	93	52
Oct. 28	86	49
Nov. 4	93	48
Nov. 11	79	40
Nov. 18	87	40
Nov. 23	87	32
Dec. 2	77	37

TABLE I—WEEKLY MAXIMUM AND MINIMUM TEMPERATURES TAKEN AT THE BLAISDELL ORCHARD—*Continued*

1895	Max.	Min.
Dec. 9	76	39
Dec. 16	82	43
Dec. 23	65	33
Dec. 30	65	26
1896		
. . . .	. . .	. . .
. . . .	. . .	. . .
Feb. 10	68	38
Feb. 17	72	37
Feb. 24	85	42
Mar. 2	83	44
Mar. 9	92	45
Mar. 16	80	35
Mar. 23	88	48
Mar. 30	93	50
Apr. 6	101	47
Apr. 13	87	47
Apr. 20	90	40
Apr. 27	87	42
May 4	87	47
May 11	91	46
May 18	92	50
May 25	97	58
June 8	105	57
June 14	100	61
June 22	115	67
June 29	116	63
July 6	105	64
July 13	104	53
July 20	108	80
July 27	103	73
Aug. 4	102	69
Aug. 11	102	67
Aug. 17	105	69
Aug. 24	111	72
Aug. 31	101	71
Sept. 7	107	69
Sept. 14	104	70
Sept. 21	99	68
Sept. 28	105	58

1896	Max.	Min.
Oct. 5	100	52
Oct. 12	98	54
Oct. 19	99	59
Oct. 26	90	57
Nov. 2	88	54
Nov. 9	80	45
Nov. 16	76	38
Nov. 23	82	52
Nov. 30	84	45
Dec. 7	70	36
Dec. 14	77	38
Dec. 21	75	40
Dec. 28	71	40
1897		
Jan. 4	74	41
Jan. 11	61	38
Jan. 18	70	40
Jan. 25	60	38
Feb. 1	72	40
Feb. 8	70	42
Feb. 15	72	42
Feb. 22	69	37
May 1	73	36
May 8	80	35
May 13	72	35
May 20	72	37
May 27	82	43
Apr. 3	97	47
Apr. 10	94	56
Apr. 17	82	44
Apr 24	92	47
May 1	97	50
May 8	97	49
May 15	94	54
May 22	101	58
May 29	99	53
June 5	109	62
June 11	106	60
June 18	105	56

From May, 1916, to the present time detailed weather records have been kept on the Mesa by Mrs. Geo. M. Hill. A summary of these records is given in Table II.

The effects of summer heat and strong winds are items that should receive consideration in establishing a citrus planting; but they are not matters that would prove detrimental to citrus growing in this particular locality. While the heat is quite intense during portions of the summer, proper methods of pruning obviate any serious difficulty from this quarter. Injury from winds has been observed to occur only on the outer edges of the orchards on

TABLE II—MAXIMUM, MINIMUM AND AVERAGE MONTHLY TEMPERATURE AT THE GEO. M. HILL ORCHARD

Month	5 A. M. Max.	5 A. M. Min.	Noon Max.	Noon Min.	3 P. M. Max.	3 P. M. Min.	6 P. M. Max.	6 P. M. Min.	5 A.M. Avg.	Noon Avg.	3 P.M. Avg.	6 P.M. Avg.
1916—May	92	55	98	70	102	74	98	70	67	90	93	89
June	82	65	108	88	116	92	112	84	71	100	104	95
July	88	72	106	93	112	82	106	84	81	102	104	99
Aug.	88	70	107	94	108	98	103	90	80	100	103	97
Sept.	84	62	106	88	108	88	102	82	73	96	99	90
Oct.	66	50	94	72	94	74	84	70	57	80	83	72
Nov.	56	38	86	53	90	55	79	48	49	70	76	65
Dec.	52	28	73	50	76	52	68	43	39	62	65	54
Year	76	55	97	67	101	77	94	71	65	88	91	83
1917—Jan.	53	32	76	44	78	44	59	44	40	61	62	51
Feb.	58	36	84	60	86	62	67	52	47	74	75	61
Mar.	76	36	92	60	102	63	76	52	45	74	74	62
Apr.	70	40	95	53	93	70	90	58	53	81	88	72
May	68	52	95	70	98	74	90	68	60	84	90	79
June	84	62	110	91	120	96	110	88	76	103	107	103
July	90	80	110	82	113	90	108	84	85	101	104	98
Aug.	88	68	106	94	110	100	104	94	81	102	105	98
Sept.	86	62	104	88	108	88	100	80	78	99	101	92
Oct.	76	54	103	80	108	80	94	76	66	92	94	86
Nov.	60	40	86	74	92	76	75	60	52	80	82	68
Dec.	58	36	84	64	84	68	68	52	44	75	76	69
Year	72	50	95	65	99	76	87	67	61	87	88	78
1918—Jan.	50	33	82	60	84	56	62	50	41	71	70	59
Feb.	58	32	82	62	92	62	66	52	44	71	74	60
Mar.	62	42	90	66	93	66	84	60	53	80	80	73
Apr.	68	44	100	74	108	78	93	70	54	90	99	79
May	72	49	101	74	105	78	82	70	57	93	96	78
June	86	60	110	100	122	102	100	84	75	105	102	94
July	86	70	110	94	112	98	100	90	81	103	106	95
Aug.	86	66	113	88	118	86	104	76	77	98	101	88
Sept.	83	60	103	88	106	95	96	78	73	97	100	87
Oct.	78	46	97	80	100	78	88	60	62	88	90	72
Nov.	55	44			82	56	64	52	45		72	63
Dec.	66	38	75	68	78	68	52	50	46	71	73	51
Year	71	49	97	78	100	70	81	66	59	88	90	75

Fig. 4.—Windbreak of Eucalyptus on the Blaisdell citrus orchard, 26 years from planting

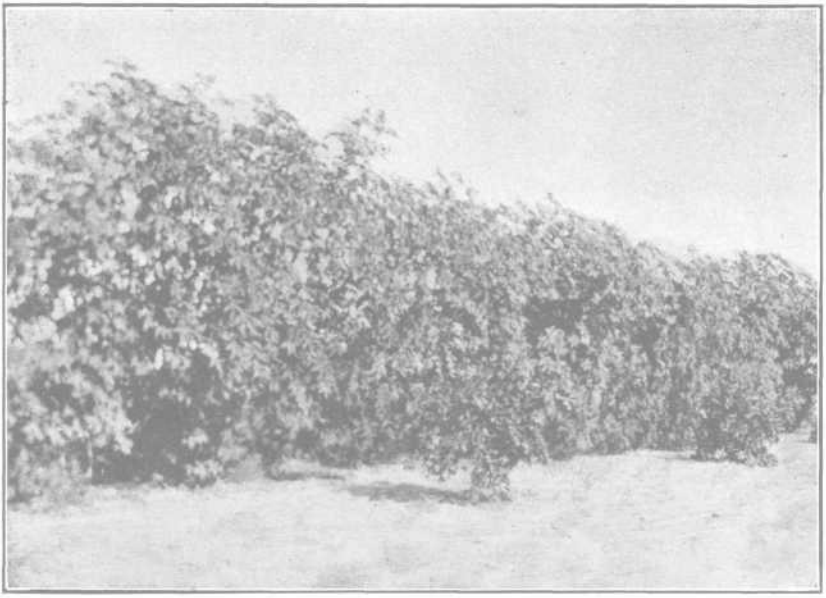

Fig. 5.—Castor beans used as a temporary windbreak in a young citrus orchard on the Yuma Mesa

the north and west sides, and is easily remedied by planting windbreaks Two plants that have been found particularly well adapted to this section for the purpose of windbreaks are eucalyptus *(Eucalyptus rudis)* and the evergreen species of tamarisk *(Tamarisk articulata)* The latter is very ornamental and if generally used would form a most attractive landscape feature of the district Furthermore, it is easily propagated from cuttings, and on the Yuma Mesa has made a growth of 25 feet in 18 months, becoming sufficiently large to serve as a windbreak in less than two years from the time of planting See Figure 3

SOIL OF THE YUMA MESA

The soil of the Yuma Mesa has been classified by the U. S. Department of Agriculture Bureau of Soils as Yuma Sand. It is probably of marine origin and consequently is quite uniform over a large area. In common with marine soils it does not contain a large total amount of plant food elements. The abrupt edges of the Mesa left by the erosion of the river valley show some stratification. Bands of shale-like clay of varying thickness may be seen where vertical sections are exposed. It is not definitely established to what extent these clay bands reach out under the Mesa. At several points clay strata reach the surface, but dip off rapidly again beyond the reach of an ordinary spade. Drilled wells have encountered clay in several locations. The clay strata are often strongly alkiline. With the exception of these bands, the sands are deep and well drained.

The most striking character of the Yuma Sand is its highly calcareous nature; even the drifting sands and dune sands effervesce strongly with acid. The lime does not exist as grains of calcium carbonate, excepting to a small extent in the silt and clay separates, but as a more or less uniform incrustation on all the soil particles. This incrustation remains on the particles thru the process of separation in mechanical analysis, and all separates from the finest to the coarsest effervesce with acids. The incrusted particles give the soil a characteristic appearance, which at once suggests the name "tarnished sand." The lime content varies in the vertical section, and usually a band of cemented soil a foot or more in thickness is found at or near the surface. The surface appearance of the Yuma Mesa is that of gravelly and sandy streaks and patches alternating. By following the gravelly areas a light automobile can be driven over the Mesa. Investigation shows that the gravelly areas in a general way mark the places where the lime cemented strata come near the surface. A vertical section thru one of these lime cemented strata shows a mottled or marble-like appearance, due to the cutting of limy concretions varying in size from a wheat grain to a walnut. In places the lime becomes so dominant as to form semi-chalky layers. These are hard when dry, but soft as clay when wet. An explanation of the surprising fertility of these seemingly barren sands may be found in the distribution of the calcareous incrustation over the surface of the soil grains. This probably averages 8 or 10 percent of the total weight of the soil. Associated with the calcareous incrustation occurs a considerable part of the phosphorus and potassium found in the soil, which would account for the ready availability of the mineral plant foods present.

CHEMICAL COMPOSITION OF THE YUMA SAND

In Bulletin No. 6 of the Arizona Agricultural Experiment Station, Collingwood reports the analysis of a sample of this soil taken from Blaisdell Heights and compares it with an analysis of a sample from the Fruitdale Tract, Fresno, California, made by Dr. Hilgard. The analyses are comparable, having been made from the same portion of the soil by the same methods of analysis. In each case the "fine earth" passing 0.5 m. m. sieve was used, and solution was effected by the same strength (1.115-sp. gr.) hydrochloric acid. Analyses are given in Table III.

TABLE III—ANALYSIS OF FRESNO AND YUMA HEIGHTS SOIL

	Fruitvale Tract Fresno, Cal.	Blaisdell Heights Yuma, Ariz.
	%	%
Insoluble matter	78.91	84.30
Potash	0.82	0.64
Soda	0.29	0.32
Lime	1.14	4.57
Magnesia	1.58	0.51
Oxide of iron	7.51	1.07
Alumina	6.30	3.28
Phosphoric acid	0.07	0.07
Sulphuric acid	0.01	0.01
Carbonic acid		3.73
Water and organic matter	3.28	1.50

The Fruitdale soil showed more acid soluble constituents, due, however, to large amounts of iron and alumina; whereas the Yuma Mesa soil showed very much more calcium carbonate. In the Yuma soil the sum of the lime and carbonic acid corresponds almost exactly to the theoretical amount of calcium carbonate corresponding to the carbonic acid. This indicates that practically all the lime found in the acid soluble portion of the soil existed as calcium carbonate. The acid soluble phosphoric acid content of the two soils was identical, and the potash content corresponded quite closely. The inference would be that the Yuma soil was the equal if not the superior of the Fresno soil due to the association of its plant food elements with well distributed calcium carbonate rather than with iron and alumina.

For the investigation which forms the basis of this report two series of samples were taken: one set of ten for chemical analysis and another of eight large samples for pot cultures and physical tests A few other samples for special determinations were also taken. The chemical analysis was restricted to the determination of acid insoluble material, of total potassium and phosphorus, and 1 115 sp. gr. hydrochloric acid and 2 percent citric acid soluble potassium and phosphorus. The results are reported in Table IV

6915. Small area of shale-like clay soil adjoining Hill's nursery; possibly the same as the clay strata seen on the edge of the mesa

6917. Surface foot of sandy soil from center of Sec 9; this layer did not show lime concretions.

6917a. Second foot in same hole containing abundant lime concretions.

6918 Average of first three feet avoiding surface six inches of wind blown sand; soil homogeneous to bottom of hole; south side of N. W. corner of Sec. 15 near the edge of a pot hole; Project A.

6919 Tarnished sand from south of center of east of S. W. ¼ of Sec. 4 at depth of three feet. Surface was calcareous cemented sand; typical of the tarnished sands that make up the greater part of the Mesa soil.

6920 Surface cemented sand from same hole as 6919. Fifty feet away this same cemented sand occurred at depth of two feet; sometimes spoken of as hardpan, but disintegrates immediately when moistened.

6922 First foot from a little N. W. of the S. E. corner of the proposed experiment station tract. A small amount of lime was seen near bottom of the hole at about three feet depth

6923 Third foot from south of middle of Sec 7, Project B. The sand at this depth appeared slightly less tarnished than the first foot, which was the typical tarnished sand of the Mesa.

6924 Second foot from same hole, containing some lime concretions

6925 First foot same hole; typical of a large tract which shows less variation than the north end of the Mesa in Project A

The material represented in 6915 is not important, since it was noted at or near the surface in very small areas It is a highly calcareous alkaline clay which accounts for the low content of insoluble matter It is probably the most abundantly supplied with mineral plant food of any soil on the Mesa, and when sufficient water is available can be leached free from injurious amounts of alkali. It is omitted in averaging the composition of the Mesa soils.

TABLE IV—COMPOSITION OF YUMA MESA SOIL—ANALYSIS BY C. N. CATLIN

Sample	Acid insoluble	Total K_2O	1 115 sp gr HCl soluble K_2O		Citric acid soluble K_2O	Total P_2O_5	1 115 HCl soluble P_2O_5		Citric acid soluble P_2O_5
	%	%	%	Lb K in 2,000,000	%	%	%	Lb P in 2,000,000	%
6915	57 105	1 68	589	9780	0155	185	115	1004	051
6917	84 31	1 78	166	2760	0096	062	049	419	018
6917a	86 16	1 82	178	2960	0054	108	086	751	022
6918	98 98	1 66	168	2870	0093	108	086	751	026
6919	81 08	1 28	213	3540	0051	170	104	908	024
6920	79 12	1 71	266	4420	0101	170	088	768	017
6922	92 46	1 63	135	2240	0103	092	07	611	023
6923	91 16	1 65	282	4680	0074	092	07	611	029
6924	88 63	1 55	116	1920	0076	108	07	699	030
6925	90 70	1 44	119	1918	0107	185	07	611	031

The remaining samples, which are all tarnished sands varying chiefly in their content of calcium carbonate, compare favorably with the medium and less fertile soils of the United States with regard to phosphorus, but are very deficient in potash—a matter that need give little concern since the Colorado water, as will be shown, carries large amounts of water soluble potash. The average acid soluble phosphorus in 2,000,000 pounds of the Mesa tarnished sand as shown by nine analyses is 681 pounds, as compared with 875 pounds shown by 262 samples of surface soils of California according to Hilgard (Hopkins' Soil Fertility, p. 102). The average of the Yuma Mesa set is lowered much by a single sample (6917) which contains only 419 pounds. The richest sand from the Mesa contained 908 pounds. While the acid soluble phosphorus content is not high, the citric acid soluble phosphorus shows a large part of it readily available. An average of nearly one-third of the strong hydrochloric acid soluble phosphorus is also soluble in 2 percent citric acid, whereas it has been estimated roughly that in humid regions usually only one percent annually of the total phosphorus could be rendered available by practical cultural means. In a few cases only about one-half of the total phosphorus dissolved in 1.115 sp. gr. hydrochloric acid. The high apparent availability of the phosphorus agrees with the rapid growth made by vegetation when sufficient water is supplied. This condition would be expected in an almost rainless region where slow weathering has gone on for ages with no leaching.

For comparison the average composition of the very sandy orange soils of Florida is given in Table V.

TABLE V.—AVERAGE COMPOSITION OF FLORIDA SANDY ORANGE SOILS

	Percent	Percent of the element	Elements in 2,000,000 lb. soil
			Pounds
Silica	93 82		
Phosphoric acid	.085	.037	740
Potash	.039	.032	640
Soda	.107		
Lime	.295		
Magnesia	.129		
Iron and Alumina	760		
Nitrogen	.054		
Humus	.64		
Loss on ignition	3 11		

While the Yuma Mesa sand is quite similar to the Florida sand with regard to phosphorus, it probably has a decided advantage with regard to easy availability of the phosphorus, since the Florida soil occurs in a region of abundant rainfall, and the easily available phosphorus would be leached out. The potash content of the Yuma sand is several times that of the Florida sand.

FERTILITY OF THE YUMA SAND

The average plant food content of citrus fruits is nitrogen .118 percent, phosphoric acid .054 percent, and potash .293 percent. If we take 400 boxes of about 70 pounds each as a large yield per acre, there will be required for the annual crop 33 pounds of nitrogen, 6.7 pounds of phosphorus and 68.1 pounds of potassium. A report by G. Harold Powell, Secretary of the Citrus Protective League of California, based on the practice of 271 ranches containing 8095.9 acres, showed the expenditure of $44.20 per acre annually for chemical fertilizers and barnyard manure. Florida growers also find heavy fertilization profitable. The waters of the Colorado will in large part furnish the fertilizers which prove so expensive in other citrus districts.

Table VI, showing the plant food carried in the waters of the Colorado during 1900, has been compiled from Bulletin 44 of the Arizona Agricultural Experiment Station, The River-Irrigating Water of Arizona, by R. H. Forbes.

TABLE VI—COMPOSITION OF THE WATER OF THE COLORADO RIVER

	Parts per 100,000	Pounds per acre-foot
Nitrogen in silt and water	Average .274	7.45
Nitrogen as nitrates	Average .079	2.15
Potassium soluble	Average 1.51	41.07
Phosphorus in sediment		5.56

Since not less than 2½ acre-feet of water would be applied annually, the minimum amount of plant food added from this source would be: Total nitrogen 18.6 pounds, of which 5.4 pounds would be nitrate nitrogen; potassium 102.7 pounds, phosphorus 12.9 pounds. A comparison of the crop composition with the plant food content of the irrigating water shows the potassium requirement to be supplied in excess. The nitrogen requirement is about one-half covered, but it should be mentioned in this connection that much nitrogen would be supplied by leguminous cover crops which should be grown to raise the humus content of the soil and improve its physical condition. The phosphorus requirement appears to be more than covered by that carried in the silt but this figure is somewhat uncertain for these reasons. The analysis

Fig. 6.—Alfalfa used as a cover crop in the Blaisdell citrus orchard

Fig. 7.—Cover crop of cow peas planted in rows in Hill's citrus orchard on Yuma Mesa. The land between the trees had received no water or cultivation up to the time the trees were planted

shows the silt in the river water itself and not the residue delivered to the land; this amount is extremely variable thru the year and the average found might vary widely from that actually delivered. The phosphorus content of the sediment would probably be very slowly available. Based on these considerations, fertilizer needs on the Mesa would probably be found covered best by light applications of acid phosphate, stable manure and leguminous cover crops—a relatively inexpensive practice when compared with that in use in other citrus districts. See Figure 6 and 7 for cover crop.

ALKALI

Small areas of alkali occur in the Yuma Mesa, but are neither so extensive nor will they be so difficult to handle as in the valley. These areas are not readily detected due to the shifting surface sands, but it is said they may be traced immediately after a rain. Where alkali does occur it is probably related to the heavier soil phases, such as the clay bands. Collingwood found the following amounts of alkali in the clay seams exposed in the railroad cut at Yuma:

TABLE VII—ALKALI IN CLAY SEAMS UNDER YUMA MESA

Sample	Soluble solids	Sodium chloride	Sodium sulphate	Sodium carbonate
	%	%	%	%
4 ft. beneath surface...........	0 25	0.15	0.10	trace
8 ft. beneath surface...........	0 75	0 60	0.15	trace

The analyses given in Table VIII show the nature and amount of alkali in a few spots that show surface indications of alkali.

TABLE VIII—ALKALI IN ALKALI SPOTS ON YUMA MESA

Sample	Water soluble solids	Sodium chloride	Calcium sulphate or equivalent	Sodium carbonate
	%	%	%	%
No. 1	0.232	.004		.119
No. 2	0.952	.032	.370	
No. 3	2.452	.400	.631	
6915	1.412	.840	.087	
6926	1.784	.572	.762	
6927	5.600	4.200	22.241	

Sample 6915 was the alkaline calcareous clay described elsewhere; 6926 and 6927 were taken from strong alkali spots that had developed after irrigation on the same tract from which Nos. 1, 2 and 3 were taken before irrigation. Further analysis showed 6927 to contain much calcium chloride.

Altho alkali spots do occur, the tarnished sands which make up the greater portion of the Mesa soil are free from injurious amounts of water soluble salts as shown by the analyses in Table IX.

TABLE IX—ALKALI IN TARNISHED SANDS ON YUMA MESA

	Water soluble solids	Sodium chloride	Calcium sulphate or equivalent	Sodium carbonate
	%	%	%	
6917	0.120	0.020	0.054	
6917a	0.200	0.052	0.087	
6918	0.092	0.008	0.004	
6919	0.664	0.276	0.087	
6920	0.196	0.052	0.044	
6922	0.124	0.016	0.044	
6923	0.148	0.020	0.065	
6924	0.140	0.016	0.087	
6925	0.128	0.016	0.065	

The results indicate the absence of injurious amounts of soluble salts and the entire absence of sodium carbonate or black alkali in the sands. Some apprehension has been expressed that black alkali would develop from the action of irrigating water on the calcium carbonate which occurs so abundantly on all parts of the Mesa. The fact that almost without exception the soils tested had the capacity to neutralize considerable black alkali, and that the Colorado River water has a high permanent hardness thruout the year, should remove any danger from this source. Sodium chloride is also much in excess of sodium sulphate in the river water and this has been shown to inhibit largely the reverse reaction between sodium sulphate and calcium carbonate which gives rise to black alkali. Some white alkali may rise from frequent shallow irrigation, but can be leached back easily into the deeper subsoil. Analyses show the alkali found in the valley to carry 1 part of potassium to 4.3 parts of sodium and the year's average of the river flow to be 1 part of potassium to 9 parts of sodium, with a much higher ratio of potassium during flood periods. White alkali then becomes an important source of readily available potash in these soils.

PHYSICAL CHARACTERS OF THE YUMA MESA SAND

The soil of the Yuma Mesa when dry is for the most part loose easily shifted sand, but when wet it resembles a sandy loam. The dry appearance and the mechanical analysis are both somewhat misleading, due to the calcareous incrustations on the soil grains. This incrustation and the fine silt and clay particles which are often cemented are not broken down entirely by shaking with ammonia. Under the microscope the sand grains have a roughened appearance and as mentioned elsewhere, even the coarsest separates effervesce strongly with acid. The roughened surface of the sand grains probably accounts for the relatively high water holding capacity of this sand. The mechanical analysis of a few typical samples of the tarnished sand are given in Table X.

TABLE X—MECHANICAL ANALYSIS OF YUMA MESA SOIL

Sample	Gravel over 2.0 m. m. in diam.	Fine soil						
		Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	%	%	%	%	%	%	%	%
6942...	3.8	2.3	3.5	7.7	13.7	30.3	29.5	12.9
6943...	13.3	8.3	15.7	24.7	25.3	11.2	8.4	5.1
6944...	4.4	7.1	19.6	33.0	29.2	6.9	3.3	0.2
6945...	none	2.2	3.8	4.5	26.2	42.5	13.9	6.7
6947...	12.9	2.3	4.7	10.0	34.9	31.4	9.7	6.4
6949...	none	1.6	5.5	24.5	47.7	17.2	1.9	1.4
6922...	....	3.7	14.6	20.8	36.3	19.3	3.1	1.9
6923...	....	1.6	13.7	22.3	50.7	7.9	2.5	0.9
6924...	....	1.6	9.1	18.8	45.8	17.6	5.8	1.3
6925...	....	2.8	12.1	16.0	41.5	21.4	4.0	1.8

Nos. 6922, 6923, 6924 and 6925 are the same soils described under chemical composition.

No. 6942. Top foot of silt from the Colorado River water mixed with sand as it occurs on the old Blaisdell Orchard. Cover crops had been plowed under, but no recent manure had been applied. Orange roots were abundant in this layer half way between the tree rows.

No. 6943. So-called hardpan of gravelly sand with some lime concretions; about one foot thick, occuring as sub-soil beneath 6942.

No. 6944. Clean tarnished sand beneath 6943; containing few orange roots probably due to insufficient irrigation to penetrate the third foot.

No. 6945. Virgin tarnished sand between the old Blaisdell Orchard and Hill's Orchard. A little lime was noticeable.

No. 6946. Indurated sand with much lime from just outside S. W. corner of Hill's Orchard.

No. 6947. Surface from gravelly area between the Hill and Hibbard places; immediately overlying the excessively limy sample 6948.

No. 6948. Very limy material beneath 6947.

No. 6949. Blown sand from beneath creosote bushes; found on the surface on all parts of the Mesa and appears less tarnished than the bedded sands.

The moisture equivalent and wilting percentage as determined by C. A. Jensen of the Bureau of Plant Industry and given in the engineer's report on the Yuma Mesa Project are repeated in Table XI. The following quotation is from Mr. Jensen's report to the project manager:

"The moisture equivalent represents approximately the amount of moisture the soil will hold 24 hours after irrigation, and is probably about the optimum. Some of these soils have the lowest wilting percentage of any that I have ever seen. The difference between the moisture equivalent and wilting percentage represents approximately the amount of available moisture, that is, about the percentage that a plant can get after an irrigation less the amount lost by evaporation."

TABLE XI—MOISTURE EQUIVALENT AND WILTING POINT YUMA MESA SOILS—BY C. A. JENSEN

Sample	Depth below surface	Moisture equivalent	Wilting percentage
		%	%
1........	4 in.	23.9	13.0
2..........	18 in.	7.0	3.8
3..........	3 ft	8.3	4.5
4..........	4 ft.	8.4	4.6
11..........	Surface	9.8	5.3
12..........	12 in.	4.2	2.3
13..........	2 ft.	2 5	1.35
14..........	3 ft.	1.54	0.85
15..........	4 ft.	1.75	0.95

No. 1. 2, 3, 4 are from the old Blaisdell Orchard in N. E. ¼, N. W. ¼ S. 33, T. 8 S., R. 23 W.

No. 11, 12, 13, 14 and 15 are from 300 feet S. W. of N. E. corner N. W. ¼ N. E. ¼ S. 4, T. 9 S., R. 23 W. Of 6 samples taken at different points of the Mesa, this sample was found to be, by mechanical analysis, the coarsest; i. e. it contained the lowest amount of fine material.

Table XII gives the moisture holding capacity of the same series of soil as was used for the mechanical analysis reported in Table X. Only the soil passing a 2.0 m. m. sieve was used, and the determinations were made with the soil packed in brass tubes on the iron compactor in the usual way. From 2 or 3 to 24 hours were required for water to rise thru the soil when the tubes were placed under a water head equal to their height, about 10 inches.

Very little water drained off the tubes under the force of gravity during the first 24 hours, and after that time almost none. If the depth of water equivalent to that retained after 24 hours be computed, it is seen that approximately 4 inches of water is retained per foot of soil. The silty surface soil in the old orchard shows a much higher water holding capacity. It would thus appear that under ordinary irrigation, especially with a scant supply, the soil would not be wet very deeply, even though it appears to be sandy. The relatively high water holding capacity of these sands must be attributed to the roughness of the soil particles, which in turn is caused by the calcareous incrustation.

TABLE XII—PHYSICAL PROPERTIES OF YUMA MESA SOILS

Sample	Apparent sp gr of fine soil	Wt per acre ft.	Water when saturated	Water retained after 24 hours	Water retained per acre ft. soil	Depth of water retained in one acre ft. soil
		Pounds	%	%	*Pounds*	*Inches*
6942...	1.380	3,758,050	28 2	37.5	1,033,363	4.6
6943...	1.497	4,075,582	23.1	22.7	924,157	4.1
6944...	1.540	4,192,650	22.7	22.3	934,960	4.1
6945...	1.405	3,825,112	28.1	27.1	1,036,505	4.6
6946...	1.412	3,844,170	20.2	19.9	764,989	3.4
6947...	1.398	3,806,055	25.1	24.4	928,677	4.1
6948...	1.351	3,678,097	26.7	26.2	963,661	4.2
6949...	1.582	4,306,995	20.5	20.3	874,318	3.9

The belief has been expressed that great difficulty would be experienced in getting water to penetrate the silt that would be deposited on the surface from the Colorado water, and, when once through the surface blanket, water would sink very rapidly beyond the reach of crops. In the light of data recorded in Table XII, and the incrusted nature of the said, these fears seem without foundation. The soil, which in its virgin state shows good water holding capacity, will be improved by the Colorado silt. Silt will probably be deposited at the rate of about .034 inches a year, or 1 inch in 30 years. For many years this silt can be broken and incorporated with the sand by ordinary tillage implements, and for many additional years there will be the possibility of bringing sand to the surface with power subsoiling tools.

FRUIT CROPS ON THE YUMA MESA

FIRST CITRUS PLANTINGS

Too much credit can not be given the pioneer citrus grower of the Yuma Mesa, Mr. H. W. Blaisdell, who had the foresight to realize something of the possibilities of this district for citrus production and established here in 1892 an orchard of twenty acres, and eight years later another orchard of forty acres. Considered in the light of actual returns, it can not be said that the orchards have proven a financial success, but the plantings are of extreme value and importance in that they have furnished sufficient evidence to show that orchards operated under more favorable circumstances would be profitable.

Fig. 8.—View in ten-acre block of Valencia oranges in Blaisdell orchard on the Yuma Mesa

A review of the methods employed in the handling of these orchards shows that crops requiring clean cultivation were grown between the rows while the trees were young. In later years the practice generally followed was to allow sour clover, together with a natural growth of weeds and grass, to cover the entire area during summer. This was turned under in the fall or winter. The present appearance of the orchard would indicate that Bermuda grass and sand burrs have been allowed to encroach severely upon the trees, in some instances entirely choking them out. When the orchards were set about a pound of bone phosphate was applied in each tree hole. This was supplemented by liberal applications of stable manure to crops planted between the rows of trees. Furrow irrigation was practiced, but very frequently the trees suffered from a lack of water. During several summers they were injured to such an extent as to cause their leaves to drop.

From a careful study of the orchards, and from information secured from past as well as present owners and managers, it appears that the failure of these plantings to yield profitable returns was largely due to the following causes:

1. High cost of water, with consequent lack of sufficient irrigation.
2. The absence of methods of culture tending to improve the soil, particularly the growing of leguminous cover crops between the rows of trees.
3. Absentee control, with frequent changes of managers.
4. Orchard trees being planted wider apart than necessary with numerous vacancies being allowed to exist.
5. The use of too large a number of varieties rather than a few standards.
6. General neglect, particularly during later years, in matters of cultivation, pruning, and irrigation.

RECENT CITRUS PLANTINGS

In addition to the old citrus grove of sixty acres there are at the present time on the Mesa eighty-eight acres of young orchards, set in the spring of 1916 As evidenced by Figures, 11, 12 and 13, the trees have made a very substantial growth. By actual measurement the growth per season has averaged from two to four feet, which compares very favorably with the growth made by young trees in older citrus regions. The methods employed in the handling of these orchards are extremely simple and such as would make practical the development of large areas. The trees have been fertilized in some cases with stable manure, but no soil-building crops have been grown, owing to the added expense of supplying them with water. If water is furnished in abundance at reasonable cost such crops can be planted between the rows of trees, in which case a better growth of tree will result and the matter of handling the orchards will be still further stimulated.

In order to determine the possibility of growing cover crops on the Yuma Mesa, Mr. George M. Hill planted a small area of his

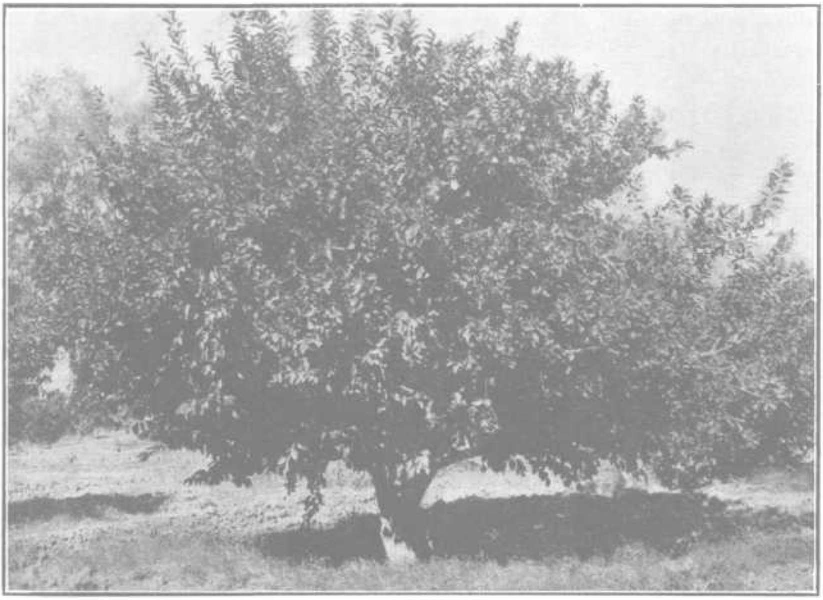

Fig. 9.—Individual lemon tree on the Yuma Mesa

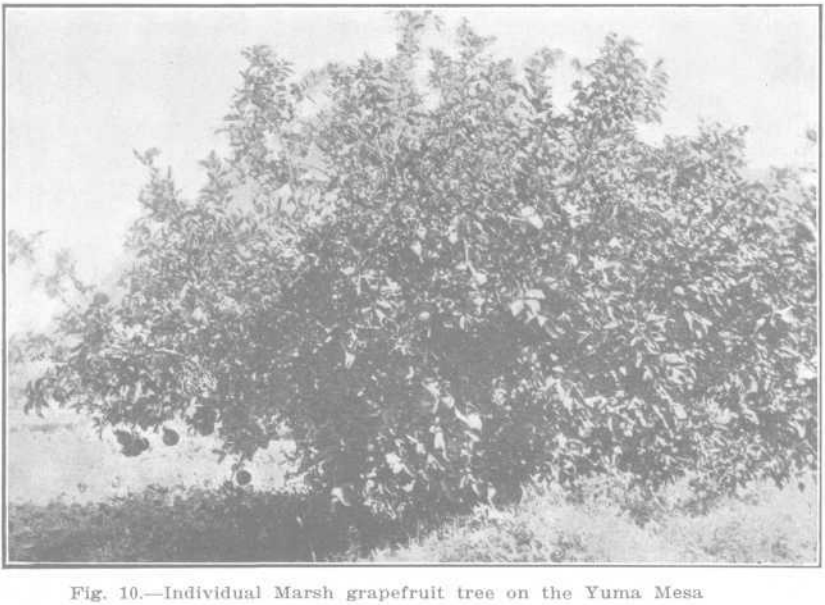

Fig. 10.—Individual Marsh grapefruit tree on the Yuma Mesa

orchard to cowpeas, tepary beans, and peanuts, all of which made a very substantial growth, see Figure 7.

INSECT AND PLANT DISEASE PROBLEMS ON THE MESA

A feature of the Mesa as a citrus district not to be overlooked is its freedom from injurious insect and plant diseases. In the large citrus regions of both California and Florida, the cost to the growers in the control of these pests is a heavy expense—materially cutting down profits—which serves to emphasize the very great economic advantage of a district where these control measures are unnecessary. It cannot be hoped that the Yuma Mesa will always be entirely free from such infestation, but with the rigid quarantine against foreign importations that is now being maintained in the State of Arizona, it should be a long time before any serious difficulty of this sort arises.

CHARACTERISTICS OF FRUIT GROWN ON YUMA MESA

While it is commonly known that citrus fruits attain the very highest quality in an arid soil and climate, special effort has been made to determine if this in reality applies to the fruit produced on the Yuma Mesa, and if so in what way and to what extent. Repre-

Fig. 11.—Citrus orchard of George M. Hill on the Yuma Mesa, 8 months from planting

Fig. 12.—The same orchard as shown in Figure 11, one year later

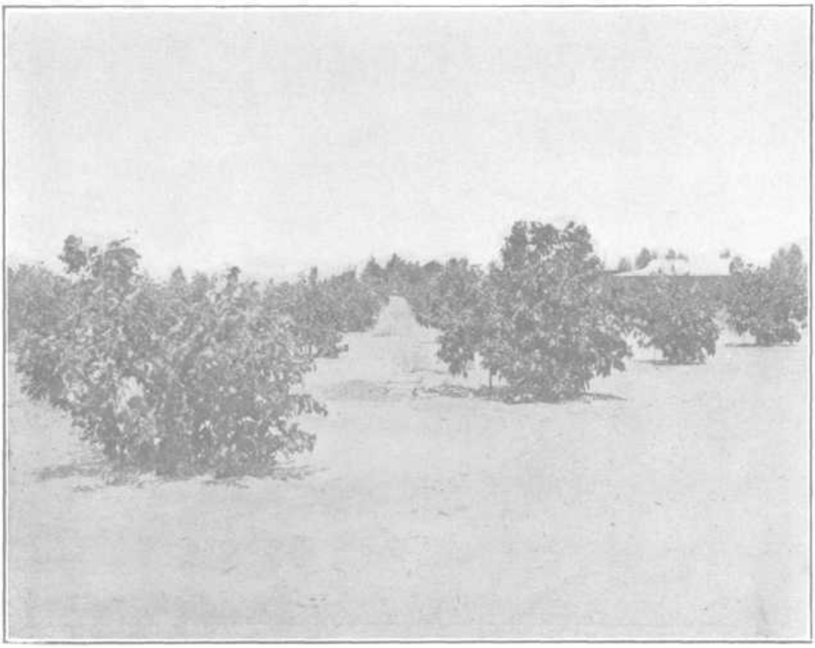

Fig. 13.—The same orchard as shown in Figure 11, two years later

TABLE XIII—PHYSICAL ANALYSES OF YUMA CITRUS FRUITS

Variety	Date of harvest	Total weight	Color of rind	Thickness of rind	Rind	Pulp	Juice
		Grams		M M	%	%	%
Washington Navel orange	Nov 15	331.9	Rich yellow	4.6	21.9	26.4	51.7
Valencia orange	Nov 15	188.4	Greenish yellow	5.3	18.4	25.2	56.4
Mediterranean Sweet orange	Nov 15	147.4	Greenish yellow	4.6	24.9	26.1	49.0
Marsh grapefruit	Nov 15	323.4	Light yellow	6.0	26.6	24.2	49.2
Eureka lemon	Nov 15	134.8	Yellow	1.8	19.3	23.3	57.4
Lisbon lemon	Nov 15	137.2	Yellow	2.0	17.7	26.5	55.8

TABLE XIV—PHYSICAL ANALYSIS OF CALIFORNIA WASHINGTON NAVEL ORANGES

Place of production	Total weight	Rind	Pulp pressed	Juice
	Grams	%	%	%
Northern Calif District	255	27.3	23.1	49.6
San Joaquin	231	27.6	24.2	47.2
Southern Calif District	176	29.4	23.3	47.3
Total average for the three districts	221	28.1	23.5	48.0

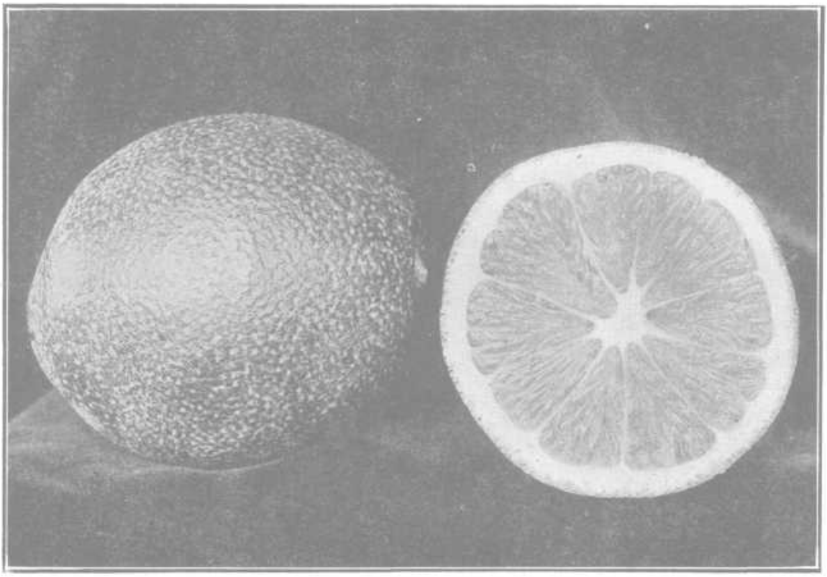

Fig. 14.—Washington Navel orange produced on the Yuma Mesa. (Thickness of rind due to pulling before fully ripe.)

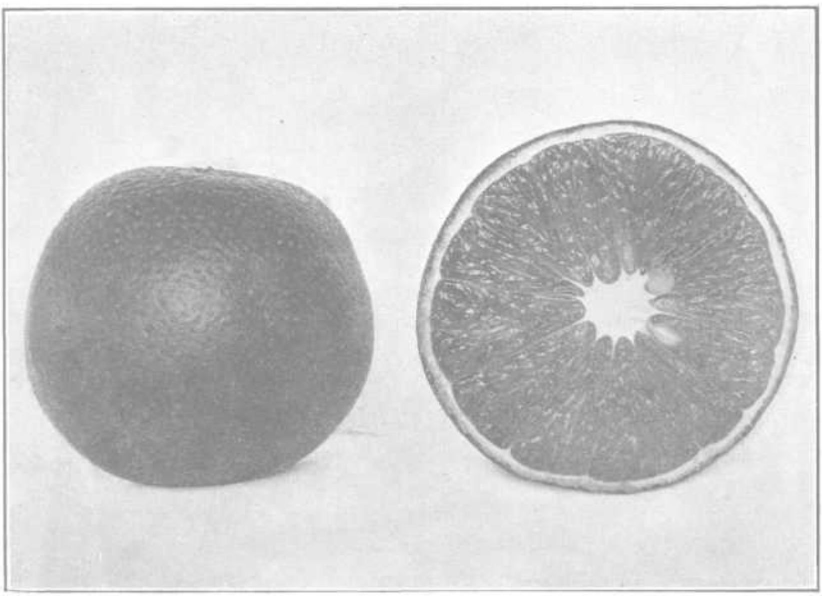

Fig. 15.—Valencia orange produced on the Yuma Mesa

sentative samples of the leading varieties now growing in this district were closely studied and compared with similar varieties of other commercial citrus growing regions—particularly California and Florida. Table XIII is a summary of the physical analyses of Yuma fruits.

For comparison with the fruit of the older citrus regions the physical analysis of the California Washington Navel, as given in the California Experiment Station report of 1902, is given in Table XIV. The figures represent the average of a number of samples collected from the leading citrus districts of California. They were taken during the latter part of November—one or two weeks later than the Yuma Mesa samples.

It will be observed that in percentages of rind and juice content, the Yuma Navels are superior at this season to the California Navels.

Table XV gives the composition of the fruit on the Yuma Mesa as relates to sugar and acid content. This analysis represents the average of two determinations; samples taken November 15.

TABLE XV—CHEMICAL COMPOSITION OF YUMA MESA CITRUS FRUITS

Variety	Total weight	Apparent sugar	Citric acid	Cane sugar	Invert sugar	Total sugars
	Gram	*Degrees Brix*	%	%	%	%
Washington Navel orange	337.2	12.22	.57	5.99	4.16	10.15
Valencia orange	187.1	11.88	1.12	4.22	4.38	8.60
Mediterranean Sweet orange	143.6	12.02	1.88	3.75	3.66	7.41
Marsh Seedless grapefruit	323.4	11.34	2.00	3.68	4.18	7.86
Eureka lemon	147.3	10.17	7.04			
Lisbon lemon	143.8	10.19	7.05			

This analysis shows that the Washington Navel variety of orange has attained by the middle of November a degree of ripeness or of total sugar content of 10.15 percent, which, according to Wickson, is .16 percent in excess of a fully ripe Southern California Navel and exceeds by 2.70 percent the Navel as produced in Florida. The percentage of citric acid in fully ripe Southern California Navels, as given by Wickson, is 1.45 percent and that of Florida Navels .95 percent, whereas, the samples from the Yuma Mesa orchard show only .57 percent. This low acid content, together with the high sugar content, establishes a record for sweetness in the Navel variety of orange that is unsurpassed. The Valencia, Mediterranean Sweet, and Marsh Seedless are not expected to approach this variety in sweetness during fall; however, they show a remarkably high percentage of sugar for the season. The acidity and juice content of the Eureka and Lisbon varieties of lemon are both high—as much so as could be desired in this fruit.

In summing up the results of both the physical and chemical analyses of the fruits in question it can be said that the excellent flavor, abundant juice, fine texture of flesh, thinness of rind, high color, earliness of maturity and freedom from blemishes combine to give it a distinctive and unparalleled quality, presenting most clearly a unique and enviable advantage which the Yuma Mesa possesses as a commercial citrus district

GENERAL ADAPTATION OF VARIETIES OF CITRUS TO THE YUMA MESA

While there is much room for experimentation in the matter of varieties of citrus best suited to the Yuma Mesa, several of the standard varieties have been grown for a number of years and have already demonstrated their adaptability to the conditions found in this district. Outstanding facts regarding these varieties are as follows:

ORANGES

The Washington Navel, Valencia, and Mediterranean varieties have all produced satisfactory crops on the Mesa and could be relied upon under proper methods of culture and irrigation to give good returns; but of the three the Washington Navel appears to offer the greatest promise to the commercial grower. Its early shipping season, beginning in the first part of November, allows this variety to be placed on the market in advance of fruit from other citrus districts The bulk of the crop could be marketed just previous to the holiday season when citrus fruits are in greatest demand. These facts, together with the high quality and general popularity of the Navel, furnish the grower the very best advantages of market, and consequently insure for him the very highest prices. This variety has been known to produce an average of from five to nine boxes per tree in the old orchard, and during the present season there are a number of individual trees that are giving equally good yields. Another advantage of the Navel is its early bearing habit, as much as 16 finely formed fruit having been produced on two-year-old trees on the Mesa. See Frontispiece The Valencia variety in the old orchard is carrying a crop this year that will average from 6 to 8 boxes per tree tor a ten-acre block. Although excellent in quality and a good yielder, this variety does not appear to lend itself quite so well to commercial planting from the fact that it comes in later in the season when the California crop is being placed on the market in great quantity. The Mediterranean Sweet has given good results in the old orchard, and its season being only a little later than the Navel should make it a very satisfactory variety.

GRAPEFRUIT

The Marsh Seedless grapefruit, universally considered the leading commercial variety, has given a good account of itself on the Mesa, and promises to become a very profitable crop for this district. It is highly enough colored and sufficiently sweet to be placed on the market in November, but as there is no special advantage in seeking out an early market for this fruit, it might be allowed to remain on the tree until in absolutely prime condition, (climate offering no obstacles), at which time it is of most superior quality and commands a fancy price. The latter fact is illustrated by the Los Angeles market report as printed in a February issue ot the Los Angeles Times in 1912 as follows:

Marsh Seedless grapefruit, local or Southern California, $1.75 to $2.25 per box.

Marsh Seedless grapefruit, Northern California, $2.25 to $2.75 per box.

Marsh Seedless grapefruit, Yuma Mesa, $5 00 to $5 50 per box.

LEMONS

Both the Eureka and Lisbon varieties of lemon have given splendid yields on the Mesa, and the fruit has all the requisites of a good commercial product, being particularly high in juice content and having a very thin rind. An outstanding feature of this fruit as grown on the Mesa, is its freedom from discoloration, which makes washing unnecessary. It has been noted that the lemon as grown in this locality tends to produce the greater portion of its crop in the fall—a time when the market demand is rather low. However, there should be no difficulty in holding the crop in storage thru the winter, as is practiced in many of the older lemon districts, until early summer when it could be marketed to advantage

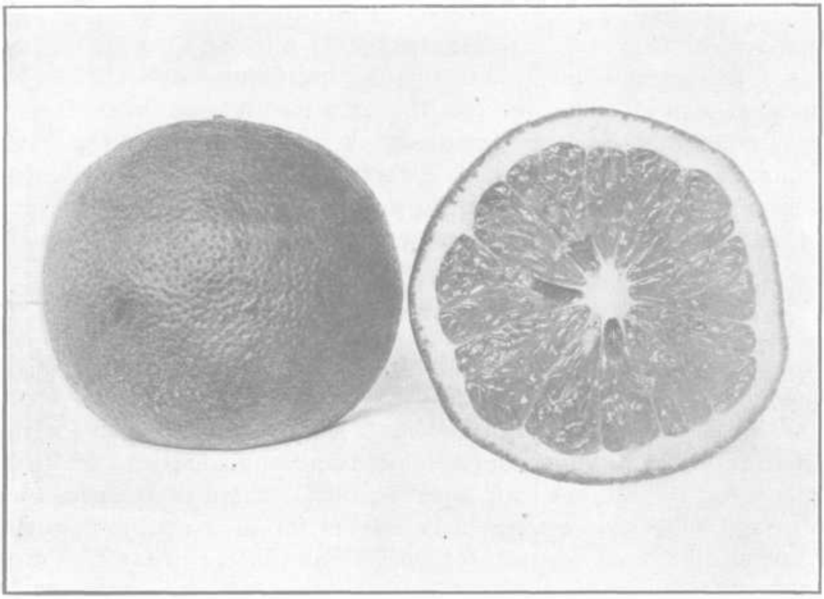

Fig. 16.—Grapefruit produced on the Yuma Mesa

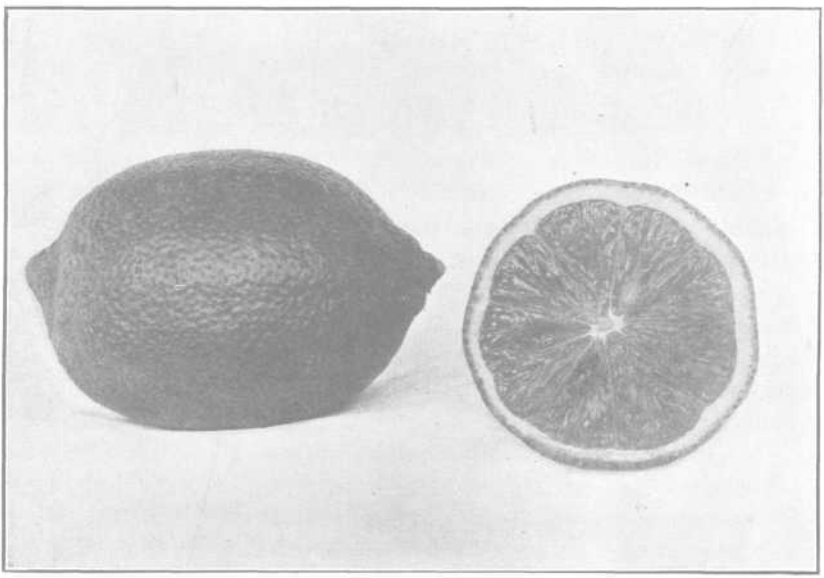

Fig. 17.—Lisbon lemon produced on the Yuma Mesa

In general, the varieties in the old orchard have given a good account of themselves, when the adverse circumstances under which they have been handled are considered They give genuine evidence of profitable yields that could be increased and made constant with proper methods of culture and irrigation In speaking of this orchard the present manager, Mr. R. M. Moore, states: 'We own two orange groves in California and earnestly believe that the Yuma Mesa is the best location for an orange, lemon, or grapefruit grove of any place in the United States, as samples of fruit have shown us that there is none better grown."

OTHER FRUITS ADAPTED TO THE MESA

In addition to or in combination with citrus fruits the Yuma Mesa offers most ideal conditions for the commercial production of a number of other fruits, among the most important of which are dates, olives, grapes, and figs. Also there are a number of truck crops that could be produced with profit.

DATES

While the lower altitudes of the greater portion of southern Arizona are well adapted to date culture, the Yuma Mesa presents special advantages in the growing of this fruit, particularly such varieties as the Deglet Noor that matures late in the season. With practical immunity from frost, together with relatively low humidity during harvest (under which conditions the date palm ripens its fruit to best advantage), afforded by this district, the Deglet Noor and kindred varieties could be allowed to remain on the trees until fully mature, becoming enriched to the highest degree in flavor and sugar content. The knowledge that this world-famous variety can be profitably produced only in specially favored regions lends interest to the fact that the Yuma Mesa appears to possess the proper requisites for its successful culture. While the Deglet Noor variety is emphasized, this does not preclude the fact that many other varieties would succeed admirably well here. As proof sufficient that the date would thrive on the Mesa there are at present a number of old, neglected seedling trees along the roadside on the Blaisdell Orchard that bear heavy crops. At the low estimate of ten cents per pound (fresh dates are now selling at from twenty-five cents to one dollar per pound) it is easily possible for the grower to make enormous net profits per acre.

OLIVES

The olive, like the date, is peculiarly adapted to arid conditions such as are found in the Southwest, and should receive favorable consideration as an adjunct planting on the Mesa. Its value for both pickles and oil has become so fully established that the demand for these products is permanently assured. With proper handling this fruit should yield very profitable returns.

GRAPES

It is believed that the grape would give quicker returns on the Yuma Mesa than any of the fruits, paying crops being produced the second year from planting. Furthermore, the grape can be

Fig. 18.—Two-year-old grape vines on the Yuma Mesa

relied upon to bear every year. Both the soil and climate are conducive to the production of the highest quality European grapes, unequaled in point of earliness by any other section of the United States. By planting early maturing varieties, such as the Thompson Seedless, table grapes could be grown and placed on the market in advance of the bulk of the grape crop from the older commercial grape growing centers, and as a consequence command the best prices. It is not only true that table grapes could be profitably grown here to advantage, but very excellent raisins could also be produced, as the absence of rain during the harvest season affords excellent opportunity for curing the raisin crop. Grapes have already been grown in a small way in this district, sufficiently to demonstrate beyond question that the Mesa land will produce a vigorous growth of vine and heavy yields. See Figure 18. The grape could be interplanted between rows of citrus with good results, but it is believed that it is of sufficient importance to warrant the making of special plantings.

FIGS

The Mesa is particularly adapted to the production of the Smyrna or dried fig of commerce. To produce this fig of the

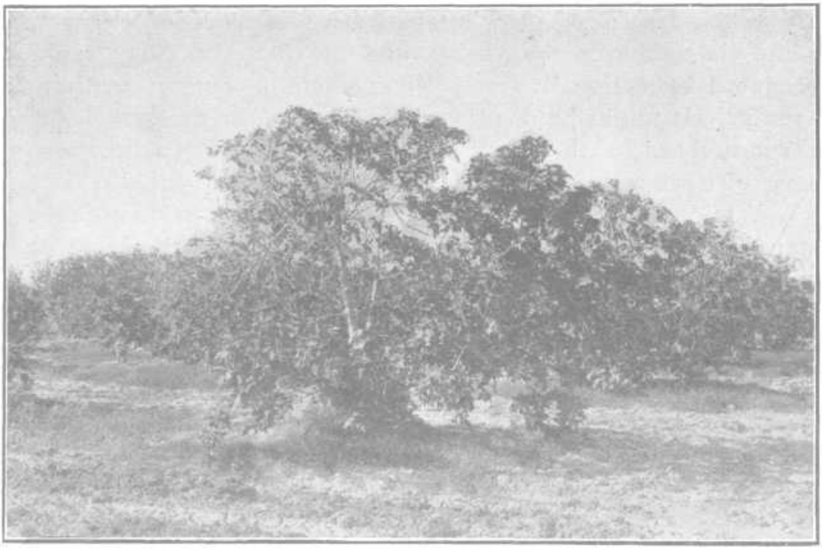

Fig. 19.—Three-acre fig orchard on the Yuma Mesa

finest quality, thinnest skin, and richest sugar content requires a warm, dry climate, such as is afforded by this region. Moreover, the climate is such that the little wasp *(Blastophaga grossorum)* necessary for the pollination of this type of fig could be colonized permanently. Like the grape, the fig can be depended upon absolutely to produce a crop every year, and the fact that our importations of Smyrnas are constantly increasing, the annual amount averaging not far from 13,000 tons, is in itself sufficient indication of the possibilities of a great industry under the favorable conditions presented by this section. To successfully produce the dried fig it is not only necessary that a warm, practically frost free climate be had, but there must be an absence of rain during harvest in order that the crop may be dried successfully, which condition is found here.

Evidence of the thrifty growth of figs on the Mesa is shown by the condition of the three-acre orchard of Adriatic figs now growing on the old Blaisdell ranch. Figure 19 shows a picture of this orchard as it now stands.

TRUCK CROPS

The mild climate of the Yuma Mesa affords an opportunity for the successful production of a number of the truck crops, particularly cantaloupes, tomatoes, and sweet potatoes. These crops are well adapted to growing between the rows of citrus trees while the orchards are young, and the fact that they could be produced exceptionally early gives them a distinct market advantage. It might be mentioned that in the early years of the old citrus orchard on the Mesa cantaloupes were grown between the rows of trees and were found quite profitable.

While the crops mentioned above appear to have an outstanding value as regards profitable production on the Mesa, there are doubtless others that individual growers would find equally satisfactory.

FIELD CROPS ON THE YUMA MESA

Field crops growing under virgin soil conditions were compared with crops growing on land that has been under cultivation for upwards of twenty years. All improved farms of the Mesa were visited, and their condition noted. The native vegetation of the Yuma Mesa also was observed and examined as an indication of the natural productiveness of the soil. Much information regarding the results secured in the growing of field crops upon the Mesa was secured from old residents of the vicinity.

The chemical and mechanical analysis of the Mesa soils are reported upon in another section of this report, and will not be discussed here. It is sufficient to say that the total amount of plant food is relatively low, but the available amount relatively high, consequently when water is supplied in sufficient quantities, crops adapted to the climate of the Yuma Mesa may be expected to grow and produce in a satisfactory manner. The soil is deficient in organic matter, and also in nitrogen As stated elsewhere in this report, the irrigation water from the Colorado River carries considerable nitrogen and a very heavy deposit of silt. For this reason irrigation will build up these soils and the longer they are held under cultivation and irrigated with water from the Colorado River, the more productive they should become, provided green manure crops are sufficiently utilized and a well regulated cropping system followed.

On the Mesa lands near the Blaisdell Orchard in 1918 there was a field of cotton of approximately 10 acres, on land said to be, and appearing to be, virgin soil. This field was not uniform in growth, but taken on the average it was a very creditable field and was estimated by competent parties to yield approximately one-half bale of short staple cotton per acre. Examination of the field showed that it had not been supplied with sufficient water, as the portions of the field along the irrigation ditches, and the portions toward the lower side of the field, showed a more rank growth of cotton stalk and a greater quantity of lint See Figure 20.

In another field near this same orchard, milo was grown in 1918 on soil that had previously grown one other crop. This field likewise suffered from lack of water, and the stand was very thick, but even with these handicaps, the milo made a creditable forage growth. The yield of grain was light.

Reliable parties report that in previous times barley, oats, and wheat have been grown with more or less success, but, mainly due to the high irrigating costs, they were seldom profitable. It is reasonable to suppose from the character of the soil that a considerable number of truck crops could be profitably handled, and probably peanuts and certain of the vetches could be made to yield moderate crops.

There is no question but that Sudan grass sufficiently irrigated would return large yields of hay, or would supply a considerable amount of pasture. Many of the common varieties of sorghum can also be grown to advantage.

An engineer's report on this Mesa project, issued some months ago, indicates that it probably would cost in the neighborhood of $7.00 per acre foot to deliver irrigating water to this land. Considering the fact that this land is comparatively porous and open, and the climate dry and hot, it will doubtless require large amounts of irrigation to give relatively satisfactory results with common

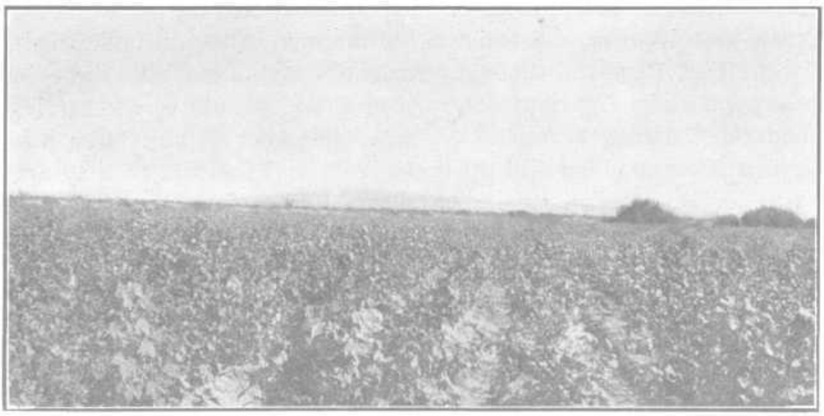

Fig. 20.—Cotton on Yuma Mesa on land under second year's cultivation.

field crops. It is very questionable whether any of the field crops previously mentioned can be made profitable from the market standpoint. They can, however, be grown by the farmer who is living upon his land and developing a citrus orchard. Properly handled they will be sufficiently productive to enable him to live upon his own farm without being forced to buy expensive feeds through the local markets, and by the use of these crops and the use of alfalfa and various beans and pea crops, the farmer will be able gradually to improve the fertility and the texture of the Mesa soils.

In proof of the above statement, examination of the older portion of the Blaisdell Orchard shows that the sandy Mesa soil has been so thoroly changed by irrigation, deposits of silt, and the decay of crops grown that the surface 18 inches to 2 feet now appears to be, and is often called, a heavy adobe soil. Alfalfa planted as a cover crop in this old orchard has done very well indeed, as is shown by one of the pictures accompanying this report. Likewise cow peas have made an excellent growth. Sesbania, a rank growing legume, has been used on the Mesa for green manuring purposes and it promises to be very satisfactory.

SUMMARY

The climate of the Yuma Mesa combines the smallest rainfall, the lowest relative humidity, and the greatest percentage of sunshine of any citrus region in North America. This combination and its freedom from injurious frost make the Mesa a most promising region for citrus culture.

The fruit grown on the Yuma Mesa is unexcelled in color, quality, early maturity and freedom from blemishes.

The Mesa is now and probably can be kept free from injurious citrus pests.

The Mesa is particularly well adapted to growing such other crops as dates, olives, grapes, figs and early truck.

The Yuma Mesa, joining the main line of the Southern Pacific at Yuma, is insured efficient shipping facilities.

While ordinary field crops probably cannot compete with similar crops grown in the valley, they can be produced in quantities sufficient for home needs.

The total plant food in the soil of the Mesa is relatively low, but its availability is high. Chemical analyses show it to compare favorably with soils from the citrus districts of California and Florida

The irrigating waters of the Colorado River will in large part supply the fertilizing elements which prove so expensive in many citrus sections.

Cover crops which have been found desirable in the handling of all orchards can be grown successfully on the Mesa.

In view of the findings set forth in this report this commission hereby recommends that the Yuma Mesa be brought under irrigation according to the plans proposed by the engineers of the Reclamation Service, and developed by the growing of citrus and other sub-tropical fruits.