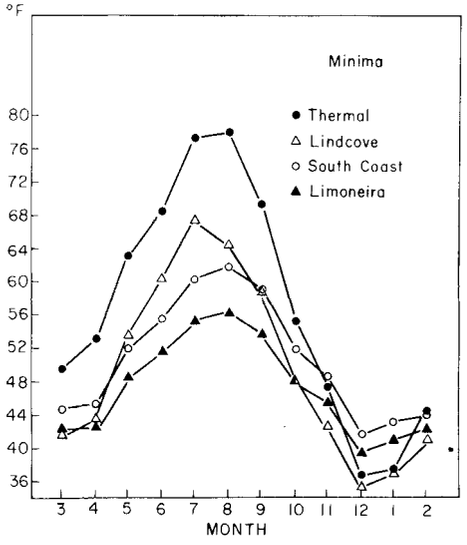
CLIMATE EFFECTS ON MANDARINS AND VALENCIA ORANGES

GRAPH 1. COMPARISON OF MONTHLY MEAN MAXIMUM TEMPERATURES (1967–1972) FOR THE FOUR FRUIT SAMPLING LOCATIONS.*



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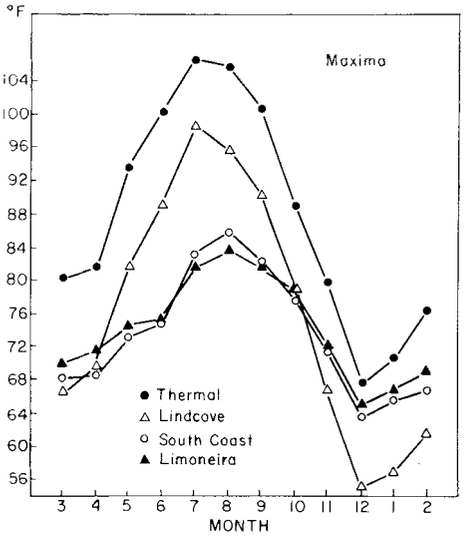


* Sources: Lindcove and South Coast Field Station weather records; Climatological Data, U. S. Department of Commerce, Thermal Airport for Thermal and Santa Paula for Limoneira.

E. M. NAUER · J. H. GOODALE

L. L. SUMMERS · W. REUTHER

Results reported here, along with the results of similar studies conducted both in the field and in environmentally controlled glasshouses, emphasize the importance of climate in the production of marketable citrus fruits. The most important market criteria such as size, rind color, and maturity are determined to a large degree by the climate in which the trees are grown. These data can be useful in determining the most suitable varieties for trial in new areas.

SOME EFFECTS OF CLIMATE on navel oranges were reported two years ago, together with a brief discussion of the background and implications of such data. Similar studies were also carried out with mandarins, Valencia oranges, grapefruit, and lemons. This report covers Satsuma mandarin fruit collected over a period of four crop seasons beginning with 1967–68, Dancy mandarin fruit collected over three seasons beginning with 1969–70, and Valencia oranges for five seasons beginning with 1967–68.

Locations compared were the Limoneira Ranch near Santa Paula in Ventura County, South Coast Field Station near Irvine in Orange County, Lindcove Field Station in Tulare County, and a commercial citrus nursery near Thermal in the Coachella Valley of Riverside County. The Limoneira and South Coast locations represent relatively cool coastal valley plant climatic zones; Lindcove is located in the hot Central Valley of California; and Thermal represents the very hot, interior low elevation desert. No Satsuma mandarin trees were available for this study at Thermal.

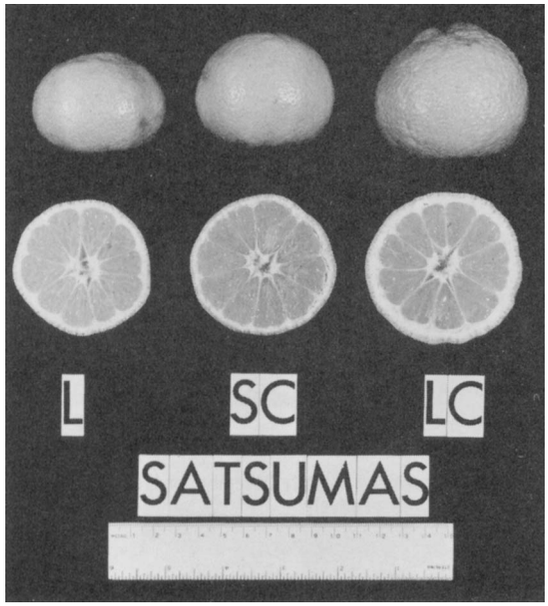
All trees within each cultivar were of the same budline and all were on Troyer citrange rootstock except the Dancy mandarin trees at Thermal which were on sour orange root. Trees within each variety were similar in age although not all were planted the same year. The four orchards in this study all received good maintenance. These similarities eliminated most non-climatic differences between orchards, so that variations in fruit quality could be attributed primarily to climate. Recent studies indicate that climate is the most important single factor influencing variations in fruit maturity and quality within a variety. Results of studies in controlled environment glasshouses also agree with the effects of climatic differences reported here.

As with navel oranges, there were several marked differences between Limoneira and South Coast fruit, indicating the importance of seemingly small differences within a broad climatic zone. Graphs 1 and 2 compare temperature regimes for the five years of sampling from the nearest available weather station. They show that the seasonal temperature regime at Limoneira differs less from South Coast than from the other locations.

Fruit samples were collected at approximate 6-week intervals each season on about October 30, December 7, January 23, March 9, April 19, May 29, and July 30. Because of the distances involved, it was not possible to collect all the fruit the same day, so actual picking dates vary by a few days from the dates given. Satsuma mandarins were harvested at

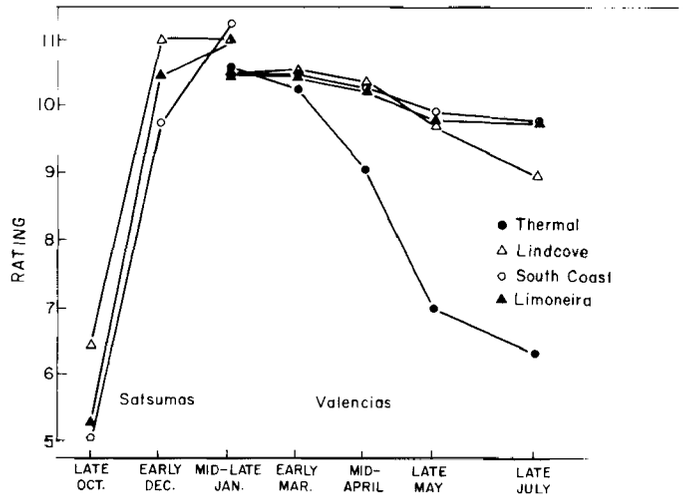
AVERAGE OF TOTAL SOLUBLE SOLIDS, PERCENT ACID, AND SOLIDS-ACID RATIO FOR SATSUMA MANDARINS, DANCY MANDARINS, AND VALENCIA ORANGES AS AFFECTED BY CLIMATIC DIFFERENCES AT FOUR LOCATIONS

	Total soluble solids (%)				Citric acid (%)				Solids-acid ratio			
	Limon.	So. Co.	Lind.	Therm.	Limon.	So. Co.	Lind.	Therm.	Limon.	So. Co.	Lind.	Therm.
Satsumas												
Late Oct.	10.0	7.9	10.1	..	1.44	1.23	1.15	..	6.9	6.4	8.8	..
Early Dec.	11.2	8.7	11.6	..	1.15	0.98	1.03	..	9.7	8.9	11.3	..
Mid–late Jan.	12.6	9.7	12.6	..	1.08	0.84	0.94	..	11.7	11.5	13.4	..
Dancy												
Early Dec.	11.9	10.7	11.3	11.7	2.31	1.66	1.60	1.35	5.2	6.4	7.1	8.7
Mid–late Jan.	13.5	12.4	12.7	14.9	1.50	1.10	1.11	1.34	9.0	11.3	11.4	11.1
Early Mar.	13.7	13.4	13.9	15.3	0.98	0.80	0.77	1.18	14.0	16.8	18.1	13.0
Valencias												
Mid–late Jan.	13.2	9.7	11.1	11.2	2.33	1.83	2.04	1.24	5.7	5.3	5.4	9.0
Early Mar.	13.2	10.0	11.3	11.0	2.09	1.39	1.60	1.01	6.3	7.2	7.1	10.9
Mid-April	12.2	10.3	11.6	11.4	1.73	1.17	1.39	0.95	7.1	8.8	8.3	12.0
Late May	11.8	10.9	12.2	10.6	1.32	1.08	1.18	0.82	8.9	10.1	10.3	12.9
Late July	11.9	10.4	11.6	9.4	1.19	0.86	0.85	0.34	10.0	12.1	13.6	27.6



Satsuma mandarin fruit harvested in early December at

GRAPH 3. RIND COLOR RATINGS FOR SATSUMAS AND VALENCIAS*



three times, from late October to January; Dancy mandarins, three times from January to March; and Valencias at five harvest dates from January to late July.

At each sampling date, 48 fruit of each variety at each location were taken to the laboratory for maturity and quality analyses. Fruit and extracted juice were weighed; length, width, and rind thickness were measured; and rind color, rind texture, flesh color, and flesh texture were rated visually against prepared standards. The juice was tasted and rated for palatability, and concentrations of total soluble solids, citric acid, and ascorbic acid (vitamin C) were assayed.

The photos illustrate typical differences in Satsuma and Dancy mandarin fruit harvested in early December, and Valencia fruit harvested in late January. As was true with navel oranges, differences among major climatic zones were greater than differences among seasons for most of the measurements taken.

Fruit size and shape

Satsuma mandarins produced the largest fruit at Lindcove and much smaller fruit at the two coastal locations; Satsumas produced at Limoneira were somewhat smaller on average than South Coast fruit. Dancy mandarins produced at Thermal and Lindcove were similar in size and larger than fruit from the coastal locations; again, South Coast fruit was larger than Limoneira fruit.

The largest Valencia oranges were produced at Thermal; Lindcove Valencias were next largest, then South Coast, and Limoneira fruit was smallest. All three varieties exhibited more seasonal size variation than navel oranges. This was probably due to the more pronounced tendency of mandarins and Valencia oranges toward alternate bearing in the seasons studied.

Fruit shape, as represented by length-width ratio, was also influenced by climatic zone. As with navels, mandarin and Valencia orange fruits grown in the warmer interior locations were longer from button to stylar end (rounder) compared with diameter (width) and those from the cooler coastal locations shorter (flatter). Average length-width ratios for Satsuma mandarin fruit were: Lindcove, 0.829; South Coast, 0.749; Limoneira, 0.746. Dancy length-width ratios were: Thermal, 0.819; Lindcove, 0.839; South Coast, 0.791; Limoneira, 0.783. Valencia orange ratios were: Thermal, 1.039; Lindcove, 1.028; South Coast, 0.986, Limoneira, 0.974.

Rind color, texture, thickness

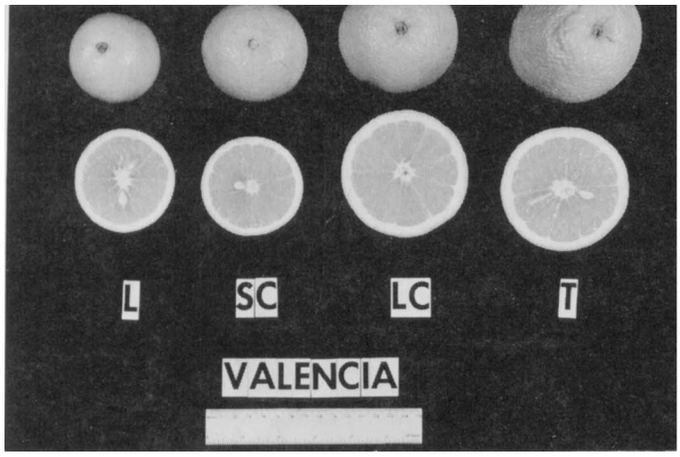
Rind color was rated by eye by comparing each fruit with a color chart ranging from dark green to reddish orange. The greatest color change in Satsumas occurred between late October and early December at all three locations sampled. There was relatively little further color change between the December and January samplings (graph 3). Dancy mandarins were well colored at Thermal and Lindcove at the first sampling in December, while fruit at South Coast and Limoneira were still quite green. By January, and into March, Dancy rind color was nearly the same at all four locations.

Valencia oranges exhibited maximum orange and minimum green rind color at the first sampling in January. Thereafter re-greening occurred, beginning with the March sampling at Thermal and in April at the other locations (graph 3).

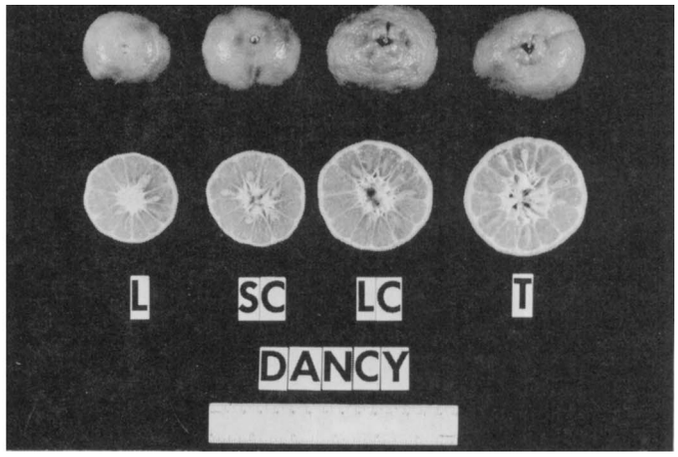
Rind texture was rated by eye by comparing each fruit with a series of photographs (8 photos for mandarins, 6 for oranges) of fruit ranging from very smooth to very coarse and pebbly. Mandarin rind texture increased in coarseness during the season from first to final sampling at all locations. Fruit produced at the inland locations was coarser than fruit produced near the coast; but all locations produced fruit that would be commercially acceptable from the standpoint of rind texture.

Valencia rind texture became smoother as the season progressed, except at Thermal where it became slightly coarser after March. The smoothest textured fruit was produced at South Coast; rind texture was similar at Limoneira and Lindcove and somewhat coarser, while Thermal grown fruit was coarsest.

Rind thickness varies according to fruit size. To minimize this effect, a rind thickness index was used for comparisons between climatic zones. This index was calculated by multiplying the average rind thickness by 2 and dividing by the average fruit diameter, times 100. On this basis, rind thickness varied considerably between seasons and fruit sampling dates. Generally, both mandarin varieties produced a thicker rind, as indicated by rind thickness index, at Limoneira and Lindcove, while mandarin fruit produced at South Coast had the thinnest rind. Valencia orange fruit exhibited a similar effect; relative rind thickness was greatest at Limoneira, in-



Valencia orange fruit harvested in January at Limoneira, South Coast, Lindcove, and Thermal, respectively.



Dancy mandarin fruit harvested in early December at Limoneira, South Coast, Lindcove, and Thermal, respectively.

termediate at Lindcove and Thermal, and thinnest at South Coast.

Internal quality

Flesh color trends were similar to rind color trends. Internal color development preceded rind color development, and good internal market color was obtained at the earliest sampling dates at all locations even though much of the fruit was far too sour to market. Valencia oranges grown at Thermal became lighter in flesh color as the season progressed from March to July.

Fruit was rated for flesh texture by eye as fine, average, or coarse-textured. Satsuma mandarin fruit was rated fine to average textured, at all 3 locations throughout the season, with fruit from Lindcove being rated slightly more coarse than fruit from the coastal locations. Dancy mandarin fruit ranged from fine-average at Limoneira to slightly coarser than average at Thermal. Valencia orange fruit grown at Limoneira was rated the finest textured; fruit grown at Lindcove was finer textured than South Coast fruit, while fruit at Thermal was coarsest in flesh texture. In general, rind texture was dependent on fruit size, with the larger fruit being coarser textured.

Percent juice by weight was lower at Thermal than at the other locations for both Dancy mandarins and Valencia oranges. Juice percentage decreased as the season progressed for both mandarin varieties at all locations except at Limoneira where juice percentage for Dancy remained constant. Valencia orange juice percentage held about steady or increased slightly throughout the season except at Thermal where it decreased rapidly from May to July.

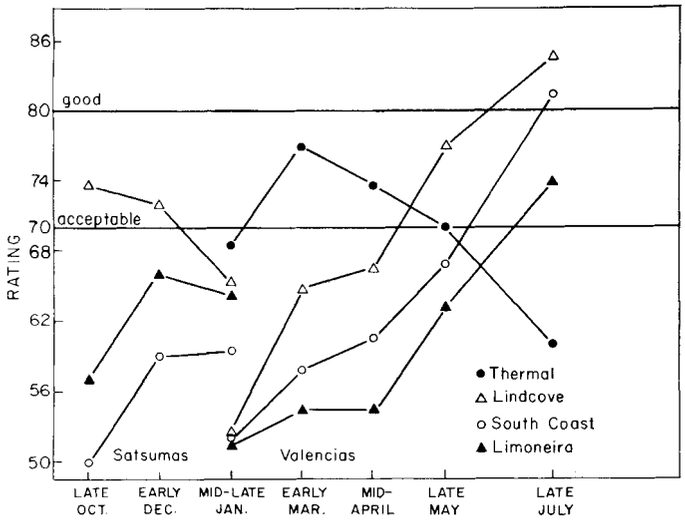
Juice was rated for flavor on a scale of 50 to 100, with 70 being acceptable; 80, good; 90, excellent. Graphs 4 and 5 compare average taste ratings for Satsuma mandarins and Valencia oranges with average sugar-acid ratios at each sampling date. Satsuma juice never reached acceptability in the coastal locations, and at Lindcove it was acceptable only in the October and December samples. Dancy mandarin juice reached acceptability at Lindcove in January and March, at Thermal and South Coast in March; and at Limoneira, not at all during these samplings.

Valencia orange juice from Thermal reached peak acceptability in March, then declined to become unacceptable by July; Valencia juice at Lindcove was acceptable by late May, but at the two coastal locations it was not acceptable until July.

Ascorbic acid (Vitamin C) content in juice was generally higher in fruit grown at the coastal locations except that Dancy mandarins grown at Thermal exhibited a high ascorbic acid content early in the season. Ascorbic acid content decreased in Dancy mandarins and Valencia oranges between the next-to final and final samplings.

E. M. Nauer is Specialist; J. H. Goodale is Senior Nurseryman; L. L. Summers is Staff Research Associate; and Walter Reuther is Professor of Horticulture and Horticulturist, Department of Plant Sciences, University of California, Riverside, California. *Assistance was also provided by R. L. Blue, D. C. Elfving, C. N. Roistacher, and R. L. Wagner.*

GRAPH 4. SATSUMA AND VALENCIA TASTE RATINGS



GRAPH 5. TOTAL SOLUBLE SOLIDS TO ACID RATIO FOR SATSUMAS AND VALENCIAS