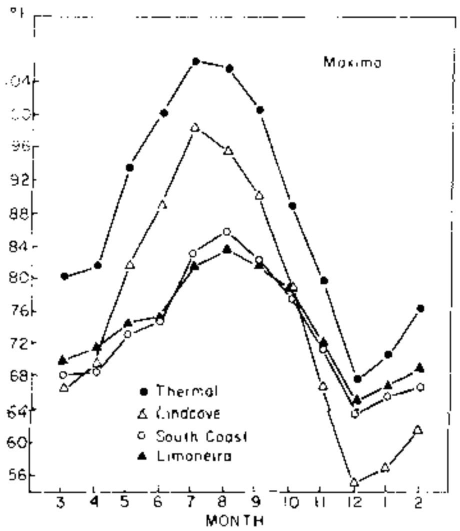
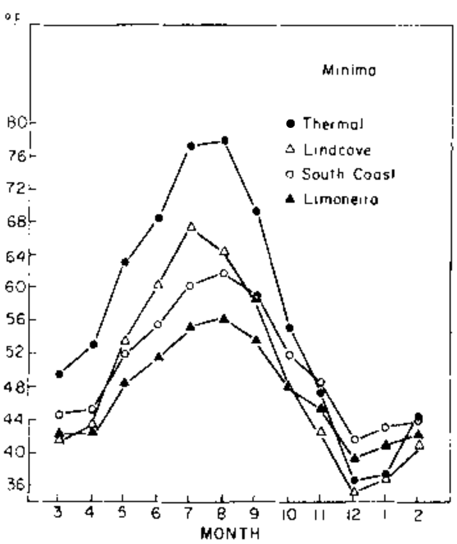
CLIMATE EFFECTS ON GRAPEFRUIT AND LEMONS



GRAPH 1. COMPARISON OF MONTHLY MEAN MAXIMUM TEMPERATURES (1967–72) FOR THE FOUR FRUIT SAMPLING LOCATIONS



GRAPH 2. COMPARISON OF MONTHLY MEAN MINIMUM TEMPERATURES (1967–72) FOR THE FOUR SAMPLING LOCATIONS. (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.)

Two previous articles in *California Agriculture* (November 1972 and April 1974) have reported some climate effects on oranges and mandarins. This third and final report covers data obtained on Frost Marsh nucellar and Redblush nucellar grapefruit harvested over a period of five crop seasons beginning with 1967–68. Eureka and Lisbon lemons were harvested over four seasons beginning with 1968–69.

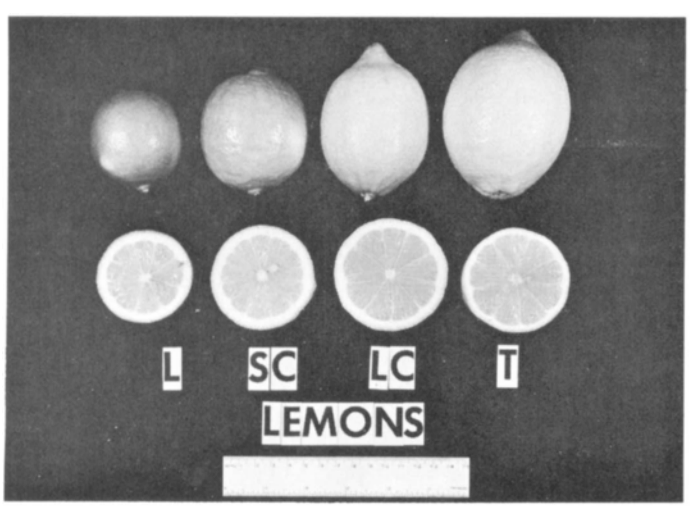
As in the previous reports, fruit sampling locations were the Limoneira Ranch near Santa Paula in Ventura County, South Coast Field Station near Irvine in Orange County, Lindcove Field Station in Tulare County, and a commercial citrus nursery near Thermal in the Coachella Valley of Riverside County. The Limoneira and South Coast locations represent relatively cool coastal valley climatic zones; Lindcove is in the hot Central Valley; and Thermal represents the very hot, interior low-elevation desert.

All grapefruit trees in this study were of the same scion budlines, on citrange rootstock and were similar in age. Lemon trees were of the same scion budlines; they were mostly on *C. macrophylla* rootstock but some trees on *C. taiwanica*, sour orange, and Cleopatra mandarin had to be used during some seasons when trees on *C. macrophylla* were not available or had set too small a crop. The four orchards involved in this study all received good maintenance. Since recent studies have indicated that climate is the most important single factor influencing variations in fruit maturity and quality within a variety, it is believed that the differences shown here are largely climatic effects, even though it was not possible to eliminate all other variables.

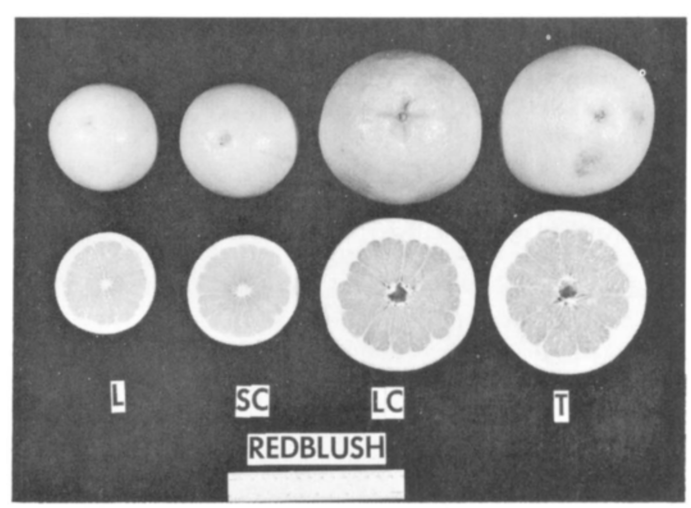
Graphs 1 and 2 compare temperature regimes for the five years of sampling from the nearest weather station with available records.

Fruit samples were collected at approximately six-week intervals each season on or about October 30, December 7, January 23, March 9, April 19, May 29 and July 30. Distances between orchards precluded picking all samples the same day. Lemons were harvested at three times, from late October to January; grapefruit were harvested on five dates, from January to mid-July.

Both grapefruit and lemons tend to bloom and set fruit over an extended period of time in cool climates. To in-



Eureka lemon fruit harvested in late October at Limoneira, South Coast, Lindcove, and Thermal, from left to right.



Redblush grapefruit harvested in late January at Limoneira, South Coast, Lindcove, and Thermal, from left to right.

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sure that all fruit in a sample originated in the same bloom, young fruit of the normal spring set were tagged just after the "June drop," and only these tagged fruit were sampled for analysis.

At each sampling, 48 fruit of each variety (24 per tree) at each location were analyzed. Fruit and extracted juice were weighed; length, width, and rind thickness were measured. Color of rind and flesh was visually rated by matching each fruit with color chart standards. Rind texture was rated by eye, comparing each fruit with a series of six photos of fruit ranging from smooth to coarse and pebbly. Flesh texture was rated as fine, medium, or coarse. Grapefruit juice was tasted and rated for palatability on a scale of 70 = acceptable, 80 = good, 90 = excellent. Concentrations of total soluble solids, citric acid, and ascorbic acid (vitamin C) were assayed.

The photographs illustrate typical differences in Redblush grapefruit picked in late January and Eureka lemons picked in late October. With both grapefruit and lemons, differences between major climatic zones were greater than differences between seasons for most of the measurements taken.

With the exception of rind and flesh color, results with Marsh and Redblush grapefruit were similar. Differences between Eureka and Lisbon lemons were much less than differences between major climatic zones. In general Eureka fruit was slightly larger than Lisbon fruit, and less elongate than Lisbon fruit except at Thermal. Eureka lemons, except at Thermal, yielded a slightly higher percentage of juice and had a slightly higher sugar-acid ratio than Lisbons at all locations. Other fruit quality criteria showed no differences between Eurekas and Lisbons.

Grapefruit size, shape, rind

Average fruit size is shown in graph 3. As with oranges and mandarins, grapefruit produced larger fruit in the warmer climatic zones. Grapefruit grown in the cool Limoneira location were smaller in July, 16 months after set, than were grapefruit grown at the warmer Thermal and Lindcove locations in January, about 10 months after set. This illustrates the size problem associated with growing grapefruit near the coast.

Fruit shape was also influenced by climate. Grapefruit produced at Thermal were longer (rounder) from button to stylar end compared to diameter, while grapefruit grown in the other locations were shorter (flatter).

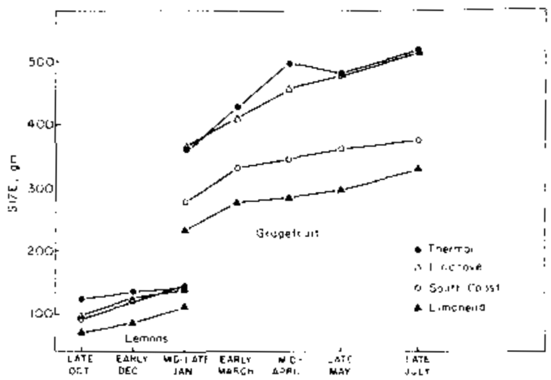
The climatic zones compared appeared to have little effect on rind color of Marsh grapefruit; greater differences were observed between individual fruits and opposite sides of the same fruit than were shown between locations, except that in January, fruit from Thermal showed the best color, and smaller fruit from Limoneira the least color. There was also little change in Marsh grapefruit rind color as the season progressed from January to July. Redblush rind color was best developed in the warmer interior locations. The greatest color change in Redblush occurred between late May and late July in fruit grown at Lindcove; during this period reddish rind color deepened considerably, so that in late July the rind of Lindcove fruit was a much deeper red than that from the other locations. Grapefruit grown at Lindcove exhibited considerable rind stipple on many fruit, particularly fruit growing on the outside of the tree. This type of rind blemish was very slight or lacking at the other locations.

Both grapefruit and lemons from all climatic zones were of acceptable rind texture for marketing. Grapefruit grown at Lindcove were the coarsest, while fruit grown at the two coastal locations were the smoothest. Thermal grapefruit were intermediate in texture.

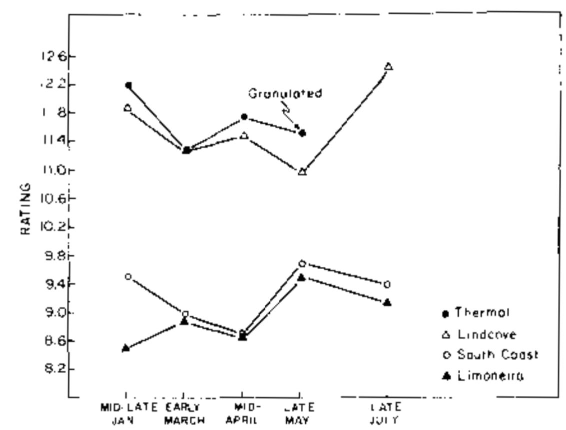
Rind thickness varied according to fruit size and between seasons, as well as between climatic zones. In general, both varieties of grapefruit produced fruit with the thickest rind at Lindcove, the thinnest rind at the two coastal locations, and intermediate rind thickness at Thermal. Average Marsh grapefruit rind thickness in mm for all samplings in all seasons was 7.5 at Limoneira, 7.3 at South Coast, 11.1 at Lindcove, and 9.1 at Thermal. Average Redblush rind thickness was 6.9 at Limoneira, 7.0 at South Coast, 9.3 at Lindcove, and 8.5 at Thermal.

Flesh characteristics

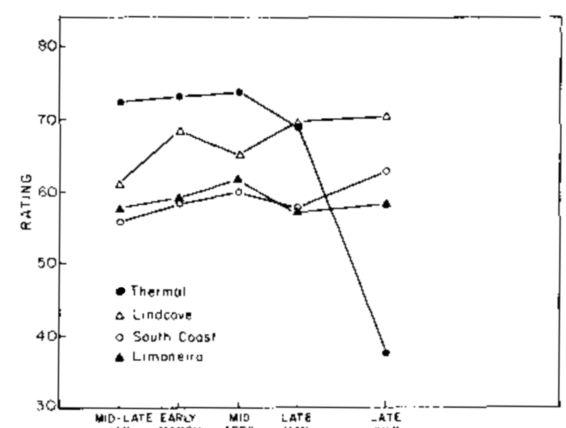
Marsh grapefruit grown at Thermal exhibited a slightly darker internal color than fruit from the other climatic zones through the May sampling; by July Thermal fruit were too granulated to



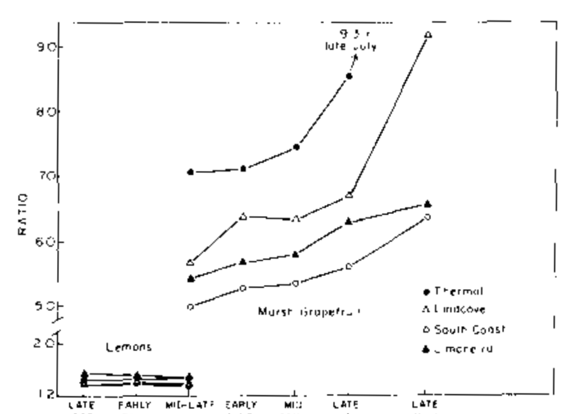
GRAPH 3. AVERAGE FRUIT SIZE OF LEMONS AND GRAPEFRUIT



GRAPH 4. FLESH COLOR RATINGS SHOWING RED PIGMENTATION DEVELOPMENT IN REDBLUSH GRAPEFRUIT



GRAPH 5. TRENDS IN GRAPEFRUIT TASTE RATINGS IN THE FOUR LOCATIONS



GRAPH 6. TRENDS IN TOTAL SOLUBLE SOLIDS TO ACID RATIO FOR LEMONS AND MARSH GRAPEFRUIT GROWN IN FOUR DIFFERENT CLIMATIC ZONES

judge internal color. Marsh grapefruit from Lindcove, South Coast, and Limoneira were very similar in flesh color through May, but by July fruit from Lindcove was darker than fruit from the coastal locations.

Redblush grapefruit from both interior locations was well colored throughout the season, while only very pale red coloration developed at the coastal locations (graph 4). Redblush developed the darkest red pigmentation of flesh at Lindcove in July. With grapefruit there were no apparent flesh texture effects of climate except for granulation by July at Thermal.

Grapefruit juice composition

Throughout most of the season, juice percentage of grapefruit varied only slightly between climatic zones: between 41 and 46% for Redblush, and between 39 and 47% for Marsh. Highest juice percentage was at Thermal with Redblush and at South Coast with Marsh; second highest was at South Coast with Redblush and at Thermal with Marsh. Lowest juice percentage with Marsh was at Lindcove; Redblush juice content was about the same at Lindcove and Limoneira. In July juice percentage of grapefruit at Thermal dropped to an average of 25% as the fruit became badly granulated.

There was little difference in taste ratings between Marsh and Redblush. Average taste ratings for both varieties combined are shown in graph 5. Results indicate that superior juice quality cannot be attained at the two cooler climatic zones. By July, grapefruit from Thermal was excessively overripe and granulated.

Solids-acid ratios for Marsh grapefruit are shown in graph 6. Solids-acid ratios for Redblush were almost identical to those for Marsh.

Ascorbic acid (vitamin C) content of grapefruit juice did not vary greatly between climatic zones. Coastal grown grapefruit contained slightly larger quantities of ascorbic acid.

The results of these studies show that, except for pigmentation, Marsh and Redblush grapefruit are commercially identical in physical and chemical characteristics.

Lemon size, shape, rind

Like the other varieties studied, lemons produced larger fruit in the warmer climatic zones, as shown in graph 3. Lemons also tended to be slightly more elongate when grown in the warmer interior climatic zones.

Lemons grown in the interior climatic zones were more yellow, while coastal-grown fruit was greener at each picking date. Color break from green to yellow was rapid and continuous from late October to mid-late January; lemons grown at Thermal changed color more rapidly from late October to early December than during the following six weeks.

Rind texture of lemons varied only slightly between climatic zones. As with grapefruit, lemons from Lindcove were coarsest, and those from the coastal climatic zones were smoothest.

Lemon rind thickness was strongly influenced by climate. Fruit grown at the two coastal locations had the thickest rind, with South Coast lemons having thicker rind than Limoneira fruit. Lemons from Thermal had the thinnest rind, while Lindcove lemons were intermediate between desert and coastal fruit in rind thickness. Average lemon rind thickness in mm for all samplings in all seasons was 4.9 at Limoneira, 5.5 at South Coast, 4.5 at Lindcove, and 3.7 at Thermal.

Flesh characteristics

Lemon flesh color varied only slightly between climatic zones. Lemons produced at the two coastal locations were lightest in flesh color; Thermal lemons were the darkest yellow color internally, while Lindcove fruit was intermediate in flesh color. There were no observed effects of climatic differences on flesh texture of lemons.

Lemon juice composition

Juice percentage of lemons increased from coast to interior. Average juice percentages for all harvests in all seasons were 31.2% for Limoneira, 33.2% for South Coast, 38.4% for Lindcove, and 43.2% for Thermal. This trend may be caused, at least in part, by the tendency of coastal fruit to have thicker rind than interior grown lemons.

Solids-acid ratios for lemons are shown in graph 6; figures for the two lemon varieties have been combined, since differences between these varieties were not significant. Lemon juice from coastal lemons contained more ascorbic acid (vitamin C) than interior grown lemons.

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BUD FAII

Noninfectious bud failure (BF) affects certain almond varieties and has become increasingly widespread in recent years.

Symptoms are produced by failure of vegetative buds (particularly on middle and terminal portions of shoots) to grow in the spring. This is followed by vigorous wide-angled growth from surviving buds. In some trees, particularly when other symptoms are severe, bands of roughened bark appear on some branches. As this pattern of bud failure develops, BF trees develop wild, disoriented growth patterns and hence the disorder is frequently called "crazytop."

Early work on the BF problem developed the concept of increased BF incidence with successive vegetatively propagated generations. At that time BF was attributed to a genetic disorder with unstable characteristics. Since then, observations suggest that environmental conditions affect the stability and expression of BF. Vegetative propagation is done on the premise that plants propagated from a common parent remain the same, but this premise is not fulfilled in the BF disorder. In other cases where variations have occurred after vegetative propagation, the problem has most often been attributable to environmental influences, virus infections or mutations. However, variability of noninfectious BF cannot, at present, be directly accounted for by any one of these factors. This series of articles adds further information on the nature of BF and discusses selection for freedom from BF within the Nonpareil variety. It documents the impact of environment on BF potential and expression and provides data on yield reduction due to BF. Finally, it outlines a system of management decisions for orchardists faced with almond trees affected with BF.