Determination of

FRUIT BEARING ZONES

in California Citrus Trees

S. B. BOSWELL · R. M. BURNS

To facilitate counting, surveyor's flagging tape was placed around the tree 6 ft high. Each compass quadrant (northeast and northwest, southeast and southwest) was tagged. This picture and cover show a fruit count being made at a navel orange grove in Ojai in March 1971.

In almost every plot studied, most citrus fruit was produced on the south half of the tree. The exceptions were the navel and Valencia groves at Woodlake, where most fruit was produced on the east half of the tree. Of the fourteen plots counted, six showed that the southwest quadrant had significantly more fruit.

These results indicate that maximum production would be obtained from trees planted so that any crowding or shading does not affect the south canopy. In most areas, crowding of the southwest quarter of the trees should be avoided, if possible. To expose the section of the tree with the most fruit-bearing capabilities, trees should either be planted far enough apart so that there is no crowding and shading, or close-set rows should be planted in an east-west direction. Best plantings theoretically, would be in rows from northwest to southeast, with trees in each row offset from the adjoining row.

THIS STUDY was initiated primarily because most of the new citrus plantings have more trees per acre than the older plantings—leading to crowding of trees in the rows. This crowding causes shading, and problems in harvesting and irrigation. Pest and disease control are also often more difficult. Information is needed as to the direction of tree rows and density of planting for maximum production.

If it is known in a certain area that one side of a tree produces the most fruit, the tree rows may be planted in a direction that favors the productive side. As the trees begin to crowd and shade, hedging and pruning may be done to favor the productive side.

A long term spacing trial near Bakersfield showed that Frost Nuceller Washington Navel orange on Troyer citrange rootstock were crowded to a point of reduced production by the third harvest season, when planted 9×11 ft and 11×11 ft. In these large scale trials, rows were in a north and south direction.

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NITRATES IN THE UPPER SANTA ANA RIVER BASIN IN RELATION TO GROUND-WATER POLLUTION. Bul. 861. The results of a 3-month study of the nitrate problem in Santa Ana Basin by the Kearney Foundation of the University of California. Includes a review of available data in order to identify and quantify existing high-nitrate concentrations in groundwater; a review of the history of land and water use and waste disposal in the area; development of guidelines for rates of fertilization, water application, and animal waste disposal; identification of areas of potential pollution; and identification of problems needing further study.

FRUIT DISTRIBUTION ON ORANGE, GRAPEFRUIT AND LEMON TREES AT 14 CALIFORNIA LOCATIONS

Variety	County	Nearest city	Age	Height	Row direction	Spacing	Trees counted	Per cent of fruit in each compass quadrant NW	NE	SW	SE
1. Washington Navel orange	Riverside	Riverside	54	18′	EW	20′ × 24′	6	22y*	21y	24y	33z
2. Washington Navel orange	Ventura	Ojai	25	14′	EW	20′ × 20′	6	23y	21y	26yz	30z
3. Washington Navel orange	Ventura	Fillmore	20	14′	NS	21′ × 24′	6	22xy	16x	37z	25y
4. Washington Navel orange	Ventura	Piru	30	18′	EW	22′ × 24′	6	20y	23y	28z	29z
5. Washington Navel orange	Tulare	Woodlake	41	15′	EW	22′ × 24′	6	21y	31z	21y	27y
6. Valencia orange	Riverside	Riverside	54	18′	EW	20′ × 24′	6	19x	17x	26y	38z
7. Olinda Valencia orange	Riverside	Mecca	15	12′	EW	24′ × 24′†	6	22xy	19x	32z	27y
8. Valencia orange	Tulare	Woodlake	34	16′	EW	22′ × 24′	6	19y	29z	19y	33z
9. Olinda Valencia orange	Ventura	Fillmore	25	17′	EW	18′ × 24′	6	22x	20w	31z	27y
10. Marsh grapefruit	Riverside	Riverside	54	18′	EW	20′ × 24′	6	20y	22y	27z	31z
11. Marsh grapefruit	Riverside	Indio	15	19′	EW	27′ × 24′	6	25y	20x	30z	25y
12. Marsh grapefruit	Riverside	Indio	15	22′	EW	27′ × 24′	6	24y	19x	30z	27y
13. Marsh grapefruit	Ventura	Bardsdale	14	14′	EW	17′ × 23′	6	22y	21y	29z	28z
14. Olivelands 8A lemons	Ventura	Santa Paula	10	14′	NS	19′ × 24′	6	23y	16x	31z	30z

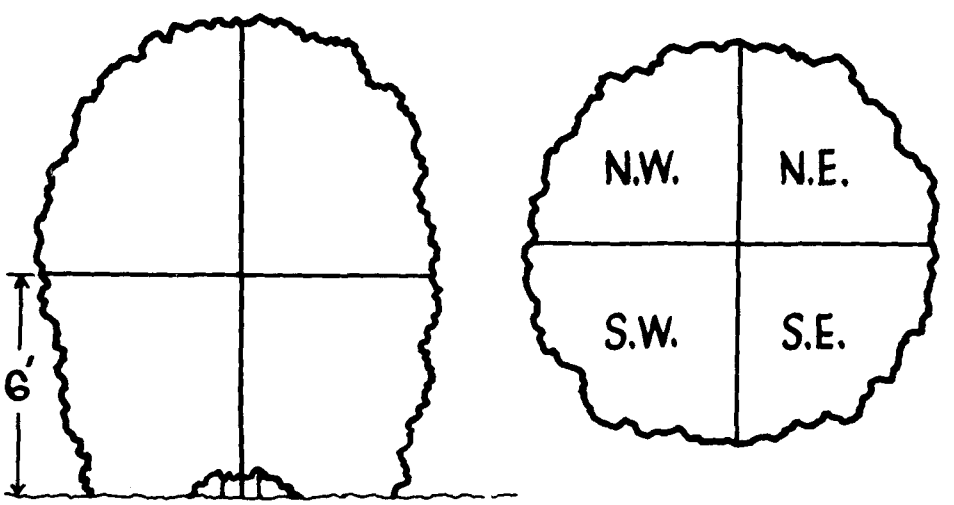
* All ranking is at the 1% level, means are significantly different if they do not have subscript letter in common. Duncan's multiple range was used for testing the significance of difference.
† A quincunx planting with a tree in the center.

Recent research also shows that fruit-bearing characteristics are usually consistent regardless of tree age or size. Maximum fruiting occurs at between 50% and 75% of tree height. With respect to production versus radius (trunk to outer canopy), the maximum production occurs at between 60% and 75% of maximum tree radius. In compass direction, production is greatest in the 1/8 tree section south of east.

Four quadrants

In the experiment reported here, fruit was counted in four quadrants on trees of citrus varieties in the major citrus growing areas in California. These counts were made in nine different citrus areas in three counties, and included five navel orange groves, four Valencia groves, four grapefruit groves and one lemon grove. Each quadrant was aligned in a north-south, east-west direction. The trees were also divided for fruit counts from the ground to 6 ft in height and from 6 ft high to the top of the trees. This meant that there were eight separate segments of each tree in which the fruit was counted. Navel and Valencia oranges and grapefruit were counted on the tree. Due to the continuous bearing habit of the lemon tree, four individual harvests were made and subsequently counted during the year. Fruit was counted on a total of 88 trees in the 14 grove locations. For statistical analysis, all the fruit from each quadrant were added together and compared with the other quadrants. To facilitate counting, surveyor's flagging tape was placed around all trees 6 ft high. Each compass quadrant (north, south, east and west) was also tagged (see photo).

TREE QUADRANTS USED IN FRUIT COUNTS



Navel oranges

Fruit on navel trees was counted at Riverside in Riverside County, at Ojai, Fillmore and Piru in Ventura County, and at Woodlake in Tulare County. In all counts except that at Woodlake there was more navel fruit on the south half of the tree. The percentage of fruit from each quadrant is shown in table 1. The counts on trees at Riverside showed that 33% of the fruit was located in the southeast quadrant—a significant difference with respect to the other quadrants. Ojai trees showed significantly more fruit in the southwest and southeast than in the northwest and northeast quadrant. Fillmore trees showed 37% of their fruit located in the southwest quadrant, again a significant difference. Piru trees showed significantly more fruit on the south half of the tree in comparison with the north half. In Woodlake, 58% of the navel fruit was located on the east side of the tree. The northeast quadrant had significantly more fruit than the northwest and southwest quadrants.

Valencia oranges

Fruit on valencia orange trees was counted at Riverside and Mecca in Riverside County, at Fillmore in Ventura County and at Woodlake in Tulare County. In all cases except Woodlake, there was more fruit on the south half of the trees. However, there were some differences between quadrants from different areas. In Riverside, 38% of the fruit was produced on the southeast quadrant, a significant difference from the other quadrants. However, 64% of the production was on the south half of the tree.

In Mecca the highest percentage of

fruit was produced in the southwest quadrant, which was significantly different from the north half, but not from the southeast quadrant of the tree. The Valencia trees in Mecca were spaced 24 × 24 ft, with a tree in the center.

In Fillmore, all quadrants were significantly different from each other, with 58% of the fruit found on the south half of the tree (table 1).

At Woodlake, 62% of the fruit was produced on the east half of the tree, which is significantly different from the west half. These figures are similar to those obtained at the navel orange grove at Woodlake.

Grapefruit

Fruit on grapefruit trees was counted at Riverside and Indio in Riverside County and at Bardsdale in Ventura County. Indio grapefruit is harvested in late winter and early spring, while Riverside and Ventura County fruit is not harvested until summer. In all cases there was more fruit produced on the south half of the trees. At Riverside, 58% of the fruit was produced on the south half of the tree—significantly different from production on the north half of the tree. In Bardsdale, 57% of the fruit was found on the south half of the tree. In most locations except Riverside, a 1% or higher fruit production was produced on the southwest quadrant; and one location at Indio showed a significant difference in favor of the southwest quadrant.

Lemons

In this study, the only lemon trees counted were located on the Limoneira Ranch near Santa Paula in Ventura County. The four harvests in 1972 are described in table 1. The data show that the southwest quadrant produced the most fruit. It was not, however, significantly different from the southeast quadrant, which was second. The northwest quadrant was third and the northeast produced the least fruit. The south half of the tree produced 61% of the tree's total production.

S. B. Boswell is Specialist, Department of Plant Sciences, University of California, Riverside. R. M. Burns is U. C. Agricultural Extension Farm Advisor (Citrus), Ventura County. C. B. Cree, Department of Plant Sciences, University of California, Riverside assisted with the statistical analysis.

TABLE 1. NUMBER OF BLOOMS* FOR EACH OF SEVEN CROPS OF FIRST-YEAR ROSES, CULTIVAR 'TOWN CRIER' HARVESTED FROM JULY THROUGH JUNE, SAN JOSE, 1971–72

Harvest period	Bed	Can†
July–August	4.86	5.81
September	4.67	6.00
October–November	5.33	5.57 ns
December–January	2.91	3.39
February–March	3.48	3.95
April	3.67	4.33
May–June	5.06	5.52

* Average per square foot of three replications of eight plants each.

† Container-grown production significantly greater for all crops except October–November (least significant difference is 0.34 blooms at p = .05).

T. G. BYRNE

Greenhouse roses in California are typically planted in ground beds, but they also produce exceptionally well in five-gallon containers (see table 1). This type of culture appears to offer advantages that may prove commercially useful, including good production on poor growing sites; centralized soil preparation and planting operations; seasonal variations in spacing and/or cultivars; and the containment and possible recycling of run-off water. The use of individual plant containers also permits part of the crop to be rotated between high-cost greenhouse production areas and low-maintenance outdoor "plant renewal" sites. Production from "renewed" plants is greater than from continuously cropped plants.

GREENHOUSE ROSE WINTER PRODUCTION INCREASED BY OUTDOOR ROTATION

TABLE 2. NUMBER OF BLOOMS* BY GRADE HARVESTED FROM CONTINUOUSLY CROPPED AND ROTATED ROSES CULTIVAR 'FOREVER YOURS' PER WEEK DURING TWO CROP CYCLES, 1973

	Blooms per square foot									
Week of harvest	10 – 13 in.		14 – 19 in.		20 – 25 in.		26 plus in.		All grades	
	Rot'd	Cont	Rot'd	Cont	Rot'd	Cont	Rot'd	Cont	Rot'd	Cont
Jan. 28				0.19						0.19
Feb. 4		0.06		0.38		0.45		0.19		1.08
Feb. 11	0.06		0.90	0.38	1.86	0.77	0.38	0.45	3.20	1.60
Feb. 18			3.07	1.09	1.47	0.96	0.13	0.19	4.67	2.24
Feb. 24				0.38		0.06		0.06		0.50
crop total	0.06	0.06	3.97	2.42	3.33	2.24	0.51	0.89	7.87	5.61
Mar. 25		0.06		0.13		0.58				0.77
Apr. 1		0.32		0.32	0.19	0.51		0.06	0.51	0.89
Apr. 8	0.38	0.06	2.50	0.58	2.11	1.22	0.19		5.18	1.86
Apr. 15			0.90	0.19	0.58	0.38	0.06	0.06	1.54	0.63
Apr. 22			0.06	0.51		0.26		0.06	0.06	0.83
Apr. 29				0.19		0.58		0.32		1.09
crop total	0.38	0.12	3.78	1.92	2.88	3.53	0.25	0.50	7.29	6.07

* Average per square foot of four row replications of three plants each.

THE USE OF individual plant containers rotated between the greenhouse and outdoors resulted in greater winter bloom production in an experiment at San Jose. Two groups of roses that had been growing in cans in the greenhouse for three years were pruned to 30 inches on August 14, after being allowed to bloom out for three weeks. One group was taken outdoors after pruning. It was fertilized and given minimal maintenance, but left unharvested until brought into the greenhouse again in early January. This was the "rotated" group. The other group was grown in the greenhouse, with a crop harvested in September and a pinch made for Christmas in late October. This was the "continuous" group. Flower production from these two groups of plants was recorded from January 28 through April 29—a period of two complete crop cycles.

A comparison of the production of the continuous group with that of the rotated group (see table 2) indicates that production per square foot of greenhouse would have been increased if the continuously cropped plants had been replaced by the outdoor, uncropped plants immediately after the Christmas harvest. In fact, the rotated group produced 30% more flowers of cultivar 'Forever Yours.' A similar increase was noted for cultivar 'Golden Wave' (data not presented here).

A direct conversion of number of flowers to the amount of money received for them is not possible, because of different prices for different grades. The flowers from these plots, however, were graded when harvested. This made possible a conversion of production to money, using prices of the San Francisco wholesale market as reported by the Federal-State Market News Service.

On this basis the return for the first post-Christmas crop was $1.62 per square foot for the rotated group, and $1.16 for the continuous group. The return on the second crop was $1.19 for the rotated group and $1.10 for the continuous group. The rotated plants, then, returned fifty-five cents (24%) more per square foot during the two-crop period.

T. G. Byrne is Specialist, Floriculture Research Facility, U.C. Deciduous Fruit Station, San Jose.