a lemon grove in Ventura County. Three of the treatments were antitranspirant-like, two were plastics, one was a growth inhibitor, and one a nonsprayed check (see table).

The growth inhibitor treatment Slo Gro (MH) was sprayed on the young grapefruit trees November 22, 1971. This was one week before planting and earlier than the other materials, since previous trials had shown it can take as long as three weeks before the growth inhibition effect of MH on citrus takes place.

The antitranspirant-like compounds (Chem Frost, Needle Fast, and Wilt Pruf) were sprayed November 24, 1971. The plastics, polyurethane foam (photo 1) and white polyester paint (photo 2), were applied November 27, 1971, by a commercial plastic fabrication company. The foam resulted in a rigid porous coating from 0.5 to 1.0 cm thick, primarily on the upper surface of most leaves and on portions of the branches. The polyester paint left a thin coat on the upper, and sometimes lower surface of most leaves, and on most of the branches.

Interplanted

All 70 treated trees, including the nonsprayed checks, were interplanted November 29, 1971, in a four-year-old lemon grove near Piru in Ventura County (photo 3). This grove had a history of yearly below-freezing winter temperatures.

The first tree evaluation was December 9, 1971—after the previous cold night with a minimum temperature of 28°F. The only measurable cold symptom was leaf drop (see table). This was not great enough to be damaging, but there was significantly less leaf drop on treatments 3 (Chem Frost) and 7 (Wilt Pruf). Treatments 4 (polyurethane foam) and 5 (white polyester paint) had significantly more leaf drop than any of the other treatments.

The next evaluation was on February 29, 1972, three months after planting. Since the initial cold night of December 8, 1971, there had been cold weather, but no recorded temperatures below freezing. However, there were many treatment trees showing cold symptoms of leaf tip burn and necrotic spots. The only significant difference between treatments was growth inhibition (see table). Treatment 2 (Slo Gro) showed significantly less new growth inhibition (see table) .Treatment

A final evaluation on June 29, 1972, seven months after treatments and planting, showed no significant differences in tree evaluations between any treatments.

Residue

It was interesting to note that more than one year after the application of the two plastic treatments (polyurethane foam and white polyester paint) there was still some residue on the branches and leaves. The only detrimental effect was the somewhat increased leaf drop immediately after the one cold night at the start of the trial. When the plastic foam and paint finally came off the leaves, they were healthy and green underneath, showing that photosynthetic activity was apparently not curtailed.

In summary, after a relatively warm winter with only one night below 32°F the only significant differences between the chemical frost protection spray treatments were in leaf drop and growth inhibition. None of these differences were considered commercially important. However, the testing of chemicals for the prevention of freeze damage to citrus is continuing.

R. M. Burns is University of California Agricultural Extension Farm Advisor (Citrus), Ventura County. Thurman Tate, Foreman of the Robinson and Lamy Company of Piru, California, sprayed the plastic materials on young grapefruit trees; Stan Wear, Vice President of Ventura Coastal Corporation, provided tree sites and care for the young grapefruit trees; and Farm Advisor Robert Brendler provided statistical assistance.

FROST PROTECTION SPRAY TREATMENTS AND EVALUATIONS OF GRAPEFRUIT NURSERY TREES PLANTED IN THE FIELD NOVEMBER 29, 1971, NEAR PIRU, IN VENTURA COUNTY

Treatment†	Date applied	Rate	Evaluations* 12–9–71	2–29–72
			Leaf drop	New Growth
1. Check (no spray)			2.2b	2.6bc
2. Slo Gro (maleic hydrazide)	11–22–71	2 oz/gal H_2O	1.8ab	1.0a
3. Chem Frost (antitranspirant-like)	11–24–71	1:100 parts H_2O	1.4a	2.2ab
4. Polyurethane foam (Polyisocyanate)	11–27–71	coverage	3.2c	2.6bc
5. White polyester paint (Titanium Dioxide)	11–27–71	coverage	3.4c	2.6bc
6. Needle Fast (antitranspirant)	11–24–71	1:4 parts H_2O	2.6b	3.6c
7. Wilt Pruf (antitranspirant)	11–24–71	1:4 parts H_2O	1.4a	2.6bc

* Evaluation Index (1 = least and 5 = most leaf drop or new growth. All ranking is at the 5% level, means are significantly different if they do not have a subscript letter in common. Duncan's multiple range was used for testing the significance of difference.
† Five single tree replicates per treatment.

SPACING

FOR MAXIMUM

F. J. HILLS

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Tests indicate that maximum sugar production requires spacing beets no closer than 5 inches, in rows spaced 30 inches apart, or no closer than 7 inches in rows 14–26 inches apart (14 inches between rows on the bed and 26 inches between rows of adjacent beds), and that rows spaced 10–20 inches produced no more sugar than the 14–26-inch rows.

Poor seedling emergence has in years past forced growers to plant sugar beet seeds close together. The resulting thick, irregular stand of seedlings was hand-thinned to leave about 12 inches between plants. Field emergence has been greatly improved in recent years, however, by the development of seed protectants, precision planters, improved methods and equipment for seedbed preparation, better irrigation, herbicides for weed control, and fast-emerging monogerm seeds. It is now possible for growers to plant to a preselected stand, or to plant at a greatly reduced rate and use synchronous electronic thinners to establish the final stand. Planting at a reduced seeding rate still has risks however, and the grower who plants to a stand usually plants seeds as close together as is consistent with his plan to establish a stand that will not require thinning. It is common to find stands with plants averaging 4 inches and closer. Crops in such stands may be commercially acceptable but are often lower in yield than they could be.

Davis experiment

The effects of close in-row spacings for the two most commonly used row spacings in California were tested in Davis in 1971. Seeds of the sugar beet variety US H9B were planted one inch apart on raised planting beds of two types: single-row beds spaced 30 inches apart, and double-row beds with 14 inches between rows on the bed and 26 inches between rows of adjacent beds (see diagram). Nine in-row spacings were established by

SUGAR BEETS PRODUCTION

hand-thinning to 1.5, 2, 3, 5, 7, 9, 11, 13, and 15 plants, spaced as evenly as possible, per 3 ft of row. This gave a range of in-row spacings from 24 to 2.4 inches.

Root yield

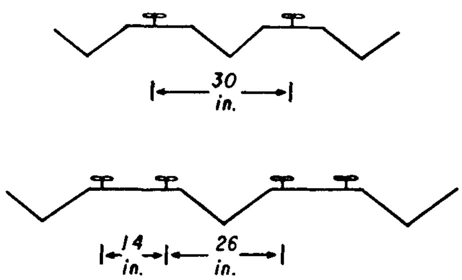
Plots were harvested at two different dates: when the yields of the most productive spacings were about 20 and 29 tons per acre. Harvest date had no differential effect on yields produced by the in-row spacings, so the results of both dates are averaged in the graph. Root and sucrose yields were near maximum, with spacings of 4 to 10 inches in 30-inch rows and 6 to 12 inches in 14–26-inch rows.

The roots were dug by hand, and yields were based on roots 2 inches in diameter or more. Commercial harvest methods would result in a loss of some roots 2 inches in diameter (through elimination by the cleaning devices on the harvester and the beet loading station). This would increase the rate of loss with thick stands, so spacings no closer than 5 inches for 30-inch rows and 7 inches for 14–26-inch rows might be preferable for commercial practice.

While root yields from close-spaced plantings decreased more rapidly in 14–26-inch rows than in 30-inch rows, at plant spacings greater than 12 inches, root yields declined more slowly on 14–26-inch row (see graph). Thus, this row spacing offers considerable safety from yield loss when poor emergence or thinning practices result in widely spaced plants.

Sucrose concentration

Closely spaced sugar beets usually tend to be higher in fresh-weight sucrose concentration, and table 1 indicates this was also true in this experiment (largely due to decreases in tissue water in beet roots as spacings decreased). Nonsucrose dry matter increased with decreased spacing, however, resulting in a decline in dry-matter sucrose concentration and further depressing total sugar production.



Row spacings on raised planting beds for sugar beet culture in California.

Photosynthate partitioning

Total dry-matter production (roots plus tops) increased for both row arrangements as in-row spacing decreased (see graph), but the percentage of total dry matter as roots, decreased (see table 1). Thus, as spacing decreased, an increasing proportion of photosynthate was partitioned to tops, and, as previously discussed, a greater percentage of the photosynthate going to roots was partitioned to nonsucrose dry matter rather than to sucrose, an undesirable situation from the standpoint of sugar production.

TABLE 1. EFFECT OF IN-ROW SPACING ON FRESH AND DRY WEIGHT SUCROSE CONCENTRATION IN SUGAR BEET ROOTS AND ON THE PARTITIONING OF DRY MATTER TO ROOTS

	In-row spacing (inches)			
Row spacing (inches)	2.4	4.0	12.0	18.0
	Sucrose, fresh wt. basis			
	%	%	%	%
30	15.3	15.2	14.7	14.2
14–26	15.4	15.2	14.8	14.7
	Sucrose, dry wt. basis*			
	%	%	%	%
30	65.8	67.0	68.2	69.1
14–26	64.3	65.9	67.6	67.7
	Total dry matter as roots**			
	%	%	%	%
30	68.6	72.7	77.0	77.6
14–26	67.8	69.7	75.1	77.4

* Estimated by: [(fresh wt % sucrose)/(% root dry matter)] 100

** Root dry matter, divided by dry matter in roots and tops, multiplied by 100.

TABLE 2. EFFECT OF ROW SPACING ON SUGAR BEET PRODUCTION (EACH VALUE IS AN AVERAGE OF TWO IN-ROW SPACINGS OF APPROXIMATELY 7.5 AND 12 INCHES)

	U.C. Davis		IVFS*
Row spacing	1967	1968	1968
	Tons per acre ROOTS		
Inches			
30	24.2	32.7	26.4
10–20	25.2	34.2	26.5
14–26	—	34.5	27.2
LSD, 5%	1.0	2.0	1.4
	SUCROSE		
	%	%	%
30	12.4	13.6	15.1
10–20	13.4	13.3	15.3
14–26	—	13.7	14.8
LSD, 5%	0.4	0.7	0.4
	SUCROSE 100 lbs. per acre		
30	59.8	88.0	79.8
10–20	67.1	90.6	81.3
14–26	—	93.7	80.3
LSD, 5%	2.2	4.0	4.3

* Imperial Valley Field Station.

Rows 10–20-inches

Three experiments tested planting two rows 10 inches apart on 30-inch beds, a 10–20-inch row spacing (34,848 feet of row per acre); single 30-inch rows (17,424 feet of row per acre); and 14–26-inch rows (26,136 feet of row per acre). Results (table 2) show that 10–20-inch rows produced somewhat more sugar than 30-inch rows but did not differ significantly in root or sugar production from 14–26-inch rows. Thus, with our present varieties, there appears to be little to gain by row spacings closer than 14–26 inches.

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EFFECTS OF IN-ROW SPACINGS ON THE YIELD OF ABLE ROOTS, SUCROSE AND TOTAL DRY MATTER SPACINGS OF 30 AND 14–26 INCHES.