Three New Hybrid Tomatoes

crosses between male-sterile and fertile varieties prove superior for quality and early yield of market tomatoes

Charles M. Rick, C. Grant Baughn, and Bernarr J. Hall

A high early yield of marketable fruit was the goal achieved in an experiment in the breeding of hybrid tomatoes that started in 1947.

The first F_1—first generation—hybrid of merit was H60, the result of crossing the Pearson variety with the Pennheart variety. H60 revealed the potentialities for increasing earliness and combining desired qualities of parental lines.

Because defects in hybrid H60 were revealed during the experiments, additional new crosses were produced and evaluated. Small preliminary plantings in several districts permitted the selection of the most promising hybrids, which were later grown in larger test plantings and in observational trials in many areas. On the basis of these evaluations, the three most promising hybrids were selected.

The three outstanding hybrids are designated by numbers which were applied to them during the period of testing. The hybrid numbers and their parentages are:

UC Hybrid 2—H2—is the progeny of a cross between male-sterile Pearson ms_2 and the variety LA211;

UC Hybrid 8—H8—is the progeny of male-sterile Ace ms_{17} crossed with LA211;

UC Hybrid 11—H11—is the result of crossing male-sterile Ace ms_{17} with the variety Earlypak.

The parent LA211 was obtained by selection in an accession—NDAC49, also the source of the variety Cavalier—from the North Dakota Experiment Station. The male-sterile parents were discovered here in earlier investigations as unfruitful mutants in fields of their respective varieties. Such sterile lines have been used in isolation plots as female parents for all of the crosses in this work because they greatly reduce the labor required for seed production by eliminating the need for emasculation. When fertile female parents are used, emasculation accounts for approximately half the time spent in the hand operations of cross-pollination. Hybrids obtained from fertile plants of the same variety would presumably perform as well as those reported here.

Yielding Ability

Replicated tests of the ability of the hybrids to yield early crops of marketable fruit were conducted at Meloland in the Imperial Valley—representing early-market conditions—and at Davis where—though not an early market district—conditions may permit evaluation of early yielding ability.

The tests were made during a three-year period at both stations, but only two of the series—those of Meloland, 1954, and Davis, 1955—provided satisfactory data; the other tests were impaired to such an extent by nematode, frost, and salt damage that they would not permit statistical analysis, even though they consistently revealed a trend of the hybrids to yield earlier than the standard varieties. The results of these two tests are summarized in the accompanying table and graph.

The same design was used in both plantings: four replications each of the three hybrids and two standard varieties; 20′ rows used as plots; fruit sorted into cull and marketable fractions; weight and number of fruits recorded.

The Meloland planting was managed according to the usual practice of the area: plants were brush covered during early growth and staked later. The Davis planting was neither covered nor staked. As standard varieties, First Early and Earlypak were selected to represent the best of the currently grown varieties of the area instead of the parental lines, most of which are inferior in respect to earliness or other traits.

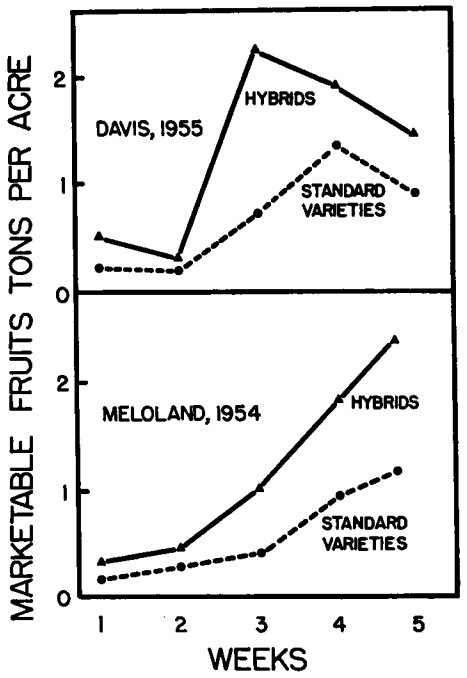
The recorded statistics bear out the frequently reported ability of F_1 hybrid tomatoes to set fruits under adverse environmental conditions. This ability is reflected in the early yield of the hybrids being about twice as high as that of the standard varieties, and—as a group—the hybrids were about 10 days earlier.

In respect to earliness, hybrids H2 and H8 behave similarly, bearing about two weeks, and H11 about one week in advance of the standard varieties used as controls. This time advantage has been observed under most conditions tested but appears to be greatest during the cool weather of the early season in the early districts.

Yield records of the Davis planting

Comparison of Yields of Hybrids and Standard Varieties in Replicated Yield Plots

	Meloland, 1954			Davis, 1955	
	First 5 weeks tons/acre	First 8 weeks tons/acre	Mean fruit weight pounds	First 5 weeks tons/acre	Mean fruit weight pounds
First Early	2.44	3.55	0.21	4.32	0.27
Earlypak	3.32	19.45	0.23	2.39	0.29
UC Hybrid 2	4.61	13.67	0.21	6.94	0.34
UC Hybrid 8	6.65	13.67	0.23	7.27	0.30
UC Hybrid 11	6.70	20.54	0.24	4.88	0.33
LSD (5%)	2.67			1.60	
LSD (1%)	3.66			2.20	



Comparison of the yields of F_1 hybrids with those standard varieties in the first five weeks of harvest. Harvest period at Davis was July 22 to August 19, 1955; at Meloland, April 22 to May 25, 1954.

UC Hybrid 2. Staked plants photographed near Santa Ana July 8, 1955. Many pink and red ripe fruits had been previously removed in two pickings. Total height of growth 20–24".

were discontinued after five weeks because the harvests of all lines dropped to very low levels for a long period thereafter.

Harvests were continued at Meloland for eight weeks until seasonal high temperatures greatly reduced quality and terminated commercial harvests in that area. During the last four weeks yields of Earlypak picked up rapidly, overtaking those of H2 and H8 and approaching those of H11. The later yields of First Early remained low.

A similar cycle of yields has been observed in other test plantings in addition to the occasional tendency of H2 and H8 to return to fruiting much later in the season. On the other hand, it has been characteristic of H11 to sustain its yield, even of large fruit sizes, over a very long harvest period—for example, from June to October in San Diego County.

In addition to the above tests of yielding ability, harvests were also recorded in two plantings made in San Diego County in 1955. The records for one of these—a replicated test at Rancho Santa Fe—reveal that H11 yielded 15.5 tons of marketable fruit per acre in the first four pickings, in contrast to 1.5, 2.1, and 4.1 tons for three strains of Pearson. Total yields for the entire season were not significantly different.

Plots in the other test near Chula Vista were not replicated, yet the differences are great. The mean harvest per plant from untreated plots—for the first month of harvest—was 5.9 pounds for H11, 0.7 pound for Pearson, and 2.9 pounds for Earlypak. Harvests from hormone-treated plants of all three varieties were remarkably similar, falling within the range of 8–10 pounds per plant.

The salient features of plants and fruits of the hybrids are compared in the table on this page. In plant type, H2 and H8 are similar, having rather small, compact, determinate vines, too short for conventional staking. Thus—even though they have consistently yielded the earliest in many tests—their dwarfness disqualifies them in most market tomato districts. On the contrary, they do meet the requirements of certain areas—notably the Niland district in Imperial Valley, which requires an extra early compact plant to be grown without staking and to be protected by brush and paper throughout the season.

On account of their extra early yield and good quality, H2 and H8 might also be suited to home gardens. The vine type of H11 is very similar to that of Pearson and Earlypak and is therefore well adapted to staking. In contrast to the adequate foliage cover of H11, that of H2 and H8 might not always be sufficient to prevent fruit scalding under mid-season conditions.

The fruit characteristics of the hybrids

A Comparison of the Hybrids in Respect to Plant and Fruit Characteristics

	Hybrid H2	Hybrid H8	Hybrid H11
Plant habit	Small determinate	Small determinate	Large determinate
Foliage cover	Moderate	Moderate	Dense
Season	Very early usually short	very early usually short	Early long
Fruit shape	Deep oblate smooth	Medium oblate few flat & irregular	Medium oblate smooth
Stylar scar	1–8 mm.	3–10 mm. some deformed	1–5 mm.
No. of locules	5–7	6–8	4–6
Color of unripe fruit	Dark shoulder	Uniform ripening	Dark shoulder
Color of ripe fruit	Normal red	Normal red	Normal red
Core	Small	Small	Small
Firmness	Average	Average	Very firm
Flavor	Subacid	Subacid	Mild Subacid

are generally satisfactory. All three hybrids produce fruit of acceptable size despite heavy loads. H11 is best in this respect; it has a tendency to maintain large fruit size throughout a long season. The three are likewise characterized by a well-rounded smooth fruit shape that is easily packed and is attractive to the consumer. They are not prone to cracking and are generally free from other defects except that fruits set under unusually cool conditions tend to be rough, particularly with H8 and to the least degree with H11.

H11 is outstanding for the high level of firmness of its fruits, lending it another advantage for shipping and handling. A possible defect of H11 that has been found in a few areas is a tendency for the stylar end of the fruit to be depressed and for occasional fruits to develop blossom-end rot. Otherwise it appears to be well adapted for producing high-quality fruits for both early and main-season markets. Color and flavor of the hybrids are comparable to those of the best available early varieties.

These observations were made in the main plantings at Davis and Meloland and also in the Niland area of Imperial County, at many different locations in San Diego, Riverside, Orange, Ventura, Yolo, Butte, Tulare, and Sacramento counties.

The essence of all of the evaluations is that H11 is the best hybrid of the group, being most widely adapted as an early and long-season market tomato. H2 and H8 are less generally adapted but seem to satisfy the need for tomatoes with compact growth and earliest yields to be grown continuously under shelters. Of the latter two hybrids, H2 is generally conceded to be superior.

This experience with hybrid tomatoes has revealed that, much to the advantage

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UC Hybrid 2. Unstaked plant photographed at Davis in second week of August, 1955. Most of the exposed fruits are ripe. This hybrid is best handled without staking for early concentrated yields.

REPLANT

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parative purposes, each seedling variety was grown in the original soil adjusted to 100 ppm inorganic nitrogen. The reduced growth effect of the previous cropping to citrus on the seedlings varied from 0% to 88%. The magnitude of growth reduction varied with the rootstock grown for both the final and the previous croppings.

Previous cropping to trifoliate orange seedlings exerted the least depressed growth effect, followed by Cleopatra mandarin, Troyer citrange, Rangpur lime, and sour orange in ascending order. Trifoliate orange also grew best—relative growth—as a replant. It was followed by Troyer citrange, sour orange, Rangpur lime, and Cleopatra mandarin. The third crop of trifoliate orange seedlings grew just as well in this soil as did the first crop. Except when following trifoliate orange, Cleopatra mandarin grew very poorly, especially following sour orange and Rangpur lime. At harvest time, the roots of Cleopatra mandarin showed considerable decay. The roots of other seedlings showed only slight to moderate root decay.

The second test was repeated using a walnut soil from Santa Paula. Trifoliate orange seedlings grew rather poorly in this soil and were therefore replaced by sweet orange seedlings. Previous cropping to Cleopatra mandarin exerted the least reduced growth effect on subsequent plantings of the other seedling varieties, but this rootstock made the poorest growth as a replant seedling. As in the previous soil, the roots of the Cleopatra mandarin showed considerable decay. The soil was examined for citrus root nematode and for *Phytophthora* spp. with negative results. Apparently other organisms caused the root rotting.

After the third cropping, the soil was mixed, repotted, and planted to a variety of crops. The original walnut soil was used as a check. All noncitrus crops grew just as well in the soil previously cropped to citrus seedlings as in the original walnut soil. Two crops—rye and brome grass—grew better in the old citrus soil. This indicates that the reduced growth factors were probably specific for citrus.

Leaf and feeder root analyses of the seedlings for nitrogen, calcium, magnesium, potassium, sodium, sulfur, chlorine, phosphorus and manganese showed no significant differences attributable to previous cropping history.

Observations

Trifoliate orange seedlings reduced growth of subsequent plantings of several seedling varieties less than did sour orange, Troyer citrange, Rangpur lime, or Cleopatra mandarin, and also grew better than these varieties as a replant. Troyer citrange grew relatively well as a replant but greatly reduced growth of the other seedlings planted following it. Cleopatra mandarin exerted less of a reduced growth effect on seedlings that followed than did sour orange, sweet orange, Troyer citrange, or Rangpur lime seedlings, but was itself the poorest replant seedling following all the seedling varieties tested.

These studies involved the use of rootstock seedlings only, but the nature and selection of the bud no doubt could exert marked effects on the performance of the rootstock.

J. P. Martin is Associate Chemist, University of California, Riverside.

W. P. Bitters is Associate Horticulturist, University of California, Riverside.

J. O. Ervin is Laboratory Technician, University of California, Riverside.

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TOMATOES

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of the plant breeder, many of the undesirable or defective traits of the tomato behave as if completely or nearly completely recessive. If one line with a defect is crossed with another line in which the desired alternative trait is present, the hybrid usually bears the desired trait. This pattern of inheritance has been found in the following undesired traits: *1*, poor fruit-setting ability; *2*, large core; *3*, rough or grooved fruits; *4*, nipple formation at stylar end of fruit; *5*, softness of fruit; and *6*, susceptibility to blossom-end rot. On the contrary, a few traits, such as compact determinate habit, were observed to behave in opposite fashion. Disease resistance is often inherited as a dominant condition, thereby suggesting a way for improving future tomato hybrids. The F_1 hybrid breeding technique therefore provides a unique opportunity for achieving in one generation improvements that would require much more time and would be more difficult with other breeding methods.

Charles M. Rick is Professor of Vegetable Crops, University of California, Davis.

C. Grant Baughn is Assistant Specialist in Vegetable Crops, University of California, Davis.

Bernarr J. Hall is Farm Advisor, University of California, San Diego County.

Professors H. Mattson and J. H. Schultz of the North Dakota Agricultural College provided seed of NDAC49 from which LA211 was derived.

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PACKING

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per season are increased. For example, in a plant of 40,000 pounds per hour capacity, costs with 100 hours of operation per season average about $10.80 per 1,000 pounds but drop to $6.50 per 1,000 pounds with 400 hours of operation per season. The decrease in average costs results from spreading the fixed costs of equipment over a larger annual volume as hours of operation per season are increased.

While substantial economies are indicated through increasing hours of operation per season, the possibilities of this kind of adjustment are limited in some respects. With no storage of field-run fruit—for later packing—the length of operating season is, for practical purposes, limited to the harvest period. Variation in season hours is then possible only through variation in hours of operation per day.

Extension of hours of operation beyond the customary eight hours per day is possible through operation on an overtime or double shift basis. If a 50% higher wage is paid for overtime work—as is required in many plants—costs will be higher than with straight-time operation unless the season is short—less than 25 days—and the season volume is less than five to seven million pounds. Double shift operation might be feasible in some areas. Even with the payment of a 10% higher wage for the second shift and allowance for increased storage costs for incoming fruit, potential savings for the industry with double shift operation would amount to approximately $160,000 per year.

While some of the potential savings could be achieved in the short run, most of them involve changes in durable facilities which would be economical only as existing facilities are worn out. As a practical matter, it is likely that only a part of the possible savings can be attained. However, a substantial cost reduction could be realized.

B. C. French was Co-operative Agent of the Agricultural Marketing Service, U. S. Department of Agriculture, and the California Agricultural Experiment Station, University of California, Berkeley, when the above-reported study was made.

L. L. Sammet is Co-operative Agent of the Agricultural Marketing Service, U. S. Department of Agriculture, and the California Agricultural Experiment Station, University of California, Berkeley.

R. G. Bressler is Director of the Giannini Foundation of Agricultural Economics, University of California, Berkeley.

The above brief article is based on a detailed report, "Economies of Scale in Pear Packing," Mimeographed Report No. 181, available without cost from the Giannini Foundation of Agricultural Economics, 207 Giannini Hall, University of California, Berkeley 4.