California Avocado Society 1986 Yearbook 70: 79-90

Avocado Breeding—Progress and Prospects

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Our last report to you was in the 1985 Yearbook. This will be an update on our patented selections, with some comments on possible future selections.

Esther

This continues to be the "orphan" of our three patents to date. Fruit flavor at the South Coast Field Station this past autumn was again acceptable. Not great, but acceptable. This is about the same as last year, and clearly better than its off-flavor in 1982 and 1983; but not as good as it was in earlier years.

Because the performance of all avocado varieties, including Hass, has been substandard at both UC Riverside and S.C.F.S. for several years, we have been hoping that this deteriorated Esther quality is a local peculiarity. However, we have not received a report of good Esther taste from any of you who have a tree of the variety. (Well, we haven't received any bad reports either — we don't recall hearing either way from anybody.)

Mr. Jose Gandia of Seville, Spain, has informed us that, for that country, he considered Esther the most promising of our patents and selections. Flavor there was reported as just fine. But Ing. Ramon Paz Vega of Uruapan, Mexico, reports unacceptably poor Esther flavor there.

Esther production in our major S.C.F.S. test has been excellent — in fact, the equal of Gwen. It also makes a fine tree; considerably smaller than Hass, with twice as much fruit per tree. On the other hand, it may russet severely by maturity. And it has a nearly round shape. And it has proven unusually susceptible to Greenhouse Thrips injury. And the last few years, it has failed to hang in good condition significantly beyond the end of the usual Hass season,

Conclusion. It is most like the Reed variety, with a better tree and even heavier production. But its flaws, especially taste, appear probably fatal at this point. Not recommended for commercial planting.

Whitsell

It continues to perform creditably. Plantings of it have not been heavy so far. However, at the Grace Orchards, west of Moorpark in Ventura County, about 10,000 trees were topworked to it in the spring of 1984 and another 3,000 a year later. Fruits from these trees should give a fair test of market performance this year (1987).

Production. Meaningful yield comparisons at UC Riverside have had to be abandoned because of tree injury from a combination of summer heat and unknown soil toxicity. The larger and better-replicated Field 23 S.F.C.S. experiment from topworking spring 1984 gives the results shown in Figure 1. The respective production totals are obtained by counting the number of fruits of each tree of each variety. There were 41 trees of Whitsell, 35 of Hass, 18 of the more uniform Gwens. For each of the two years of production (set springs 1985 and 1986), the average number of fruits per tree was multiplied by the average weight per fruit at maturity; for the 1986-87 crop year, fruit size of each variety had to be estimated at publication deadline time, late 1986.

The above calculation gives the average crop weight per tree of each variety. This is multiplied by the calculated number of trees per acre for each variety to give the computed mean production per acre.

The established distance between rows in this S.C.F.S. Field #23 is 20 feet. The Hass trees were grafted at ordinarily 20 feet apart in the row. Experience at UC Riverside indicated that the Whitsell and Gwen needed no more than half the ground spacing of Hass, so the trees of both were grafted at ordinarily 10 feet apart in the row. For our calculations, numbers of trees per acre were rounded off at 100 and 200, respectively.

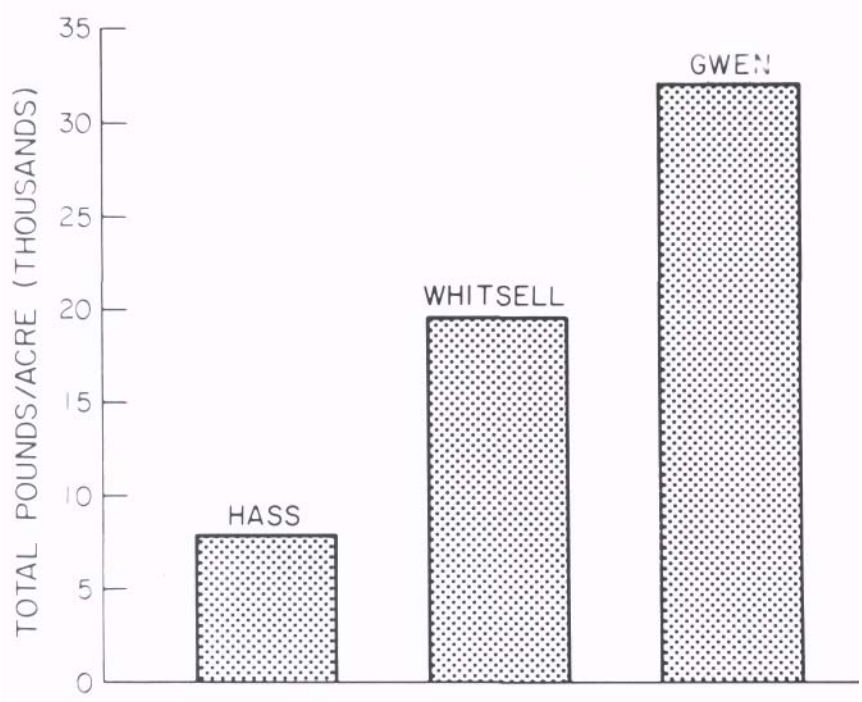

Figure 1. Calculated production from set the first two years after topworking.

As Figure 1 shows, the Whitsell trees have so far produced at an estimated rate of about 2½ times as much fruit/acre; the calculated figures are 7,700 Ibs. for Hass versus 19,600 Ibs. for Whitsell. Average fruit number per tree has been about the same (Table 1), but Whitsell tree spacing density is twice as great, and Whitsell fruit size is larger (Table 1).

Table 1. Mean varietal performance at S.C.F.S., 1984 grafts.

	Hass	Whitsell	Gwen
Fruit number —1986*	4	8	93
—1987	113	134	182
Fruit size (oz.) — 1986	8.0	11.2	10.2
estimated — 1987	9	11	9
Seed size — 1986	16%	13%	14%
Tree height (ft.)	13.7	10.5	12.6
Tree area (sq. ft.)	74.7	15.3	28.2
Tree volume (cu. ft.) (all fall, 1986)	1023	161	355

* Year of fruit maturity.

Fruit counts have not been made at Grace Orchards; the Whitsell trees there also have set heavily two years from topworking.

Tree size. Table 1 summarizes the data after two cropping seasons. The tree height average differences among the three varieties are small, with Whitsell shorter than the other two. In tree spread, there is much more difference: Whitsell averages about half of Gwen and 1/5 of the Hass square footage.

However, this could be misleading as an indication of desirable planting distance. The Hass tree is typically rather uniform in outline (circumference), whereas Whitsell is highly irregular. The Whitsell area calculations are more subjective judgments, assuming that its branches were fitted into a more or less uniform outline. Thus, its tree spacing should be somewhat greater than this calculated area would suggest. Ideally, there might be three times as many Whitsell as Hass topworks per acre; which would make the 2½ times fruit-bearing advantage of Whitsell to date an underestimate of Whitsell superiority. But, topwork situations rarely permit ideal spacing choices.

The Whitsells grafted at Grace Orchards are also large, with some of them very tall indeed. *Topworked* Whitsells are *not* "dwarf."

On the other hand, as ordinary nursery trees, Whitsell is more dwarfed relative to Hass. An example is another S.C.F.S. field, where a number of container trees of both varieties were planted out spring 1982: the tallest Whitsell is about half the height of the shortest Hass. We don't have enough experience to make a firm recommendation for Whitsell field spacing as nursery trees; roughly ¼ the Hass spacing seems reasonable so far.

Efficiency. The final line in Table 1 lists respective tree volumes, simply as the product of two preceding lines. This is of some interest as a rough gauge of relative efficiency of the three varieties. The average Whitsell tree volume is less than 1/6 that of Hass. Yet,

they have produced about the same fruit numbers, and the Whitsells are running about two ounces larger. Thus, the indicated tree efficiency of Whitsell appears so far to be over seven times as great as Hass efficiency.

Does this mean that you could produce a pound of Whitsell fruit for 1/7 the fertilizer and water that a pound of Hass requires? We think that would exaggerate Whitsell efficiency. The added nutrient drainage from the heaver Whitsell fruit cropping would be a partial counter-balance. And the smaller size and irregular contour of the Whitsell tree probably increases its relative water loss from evapotranspiration.

Nevertheless, that Whitsell is a significantly more efficient producer of avocados than Hass seems unquestionable. It presumably gets this greater efficiency from three advantages:

1) Smaller tree size of itself provides greater surface for photosynthetic sun exposure per given tree volume.

2) Irregular tree contour adds to this greater sun exposure.

3) There probably is also selection for greater inherent (genetic) efficiency.

Whitsell fruits are illustrated in Figure 2.

Uses. The possible usages of Whitsell that we suggested two years ago seem as valid as ever:

1) *Cross-pollination* of such "A" flower types as Hass, Gwen, Pinkerton, etc. The Grace Orchard Whitsells are intergrafted among Hass trees for this purpose. There is now good evidence that Hass fruit set is markedly benefited by cross-pollination.

2) *Topworking alternate rows when Hass groves crowd.* This will have the advantage of 1) above; plus, the slim Whitsell trees will mean long-delayed further crowding,

3) *Early Hass season.* Although it is certainly no earlier than Hass, its larger size can be a real marketing advantage during the Hass period of smaller than optimum fruit size.

4) *Eastern market window.* After the late Florida varieties are finished and before its new crop begins, Whitsell should fit well on the East Coast, about February or March through May. It is rough-skinned, but its green color and larger size should be advantageous. Its lack of the Gwen and Hass "nuttiness" of flavor may be a plus here. Reed is sometimes picked for this market, but that season is usually long before its eating prime, whereas Whitsell would be about at its best.

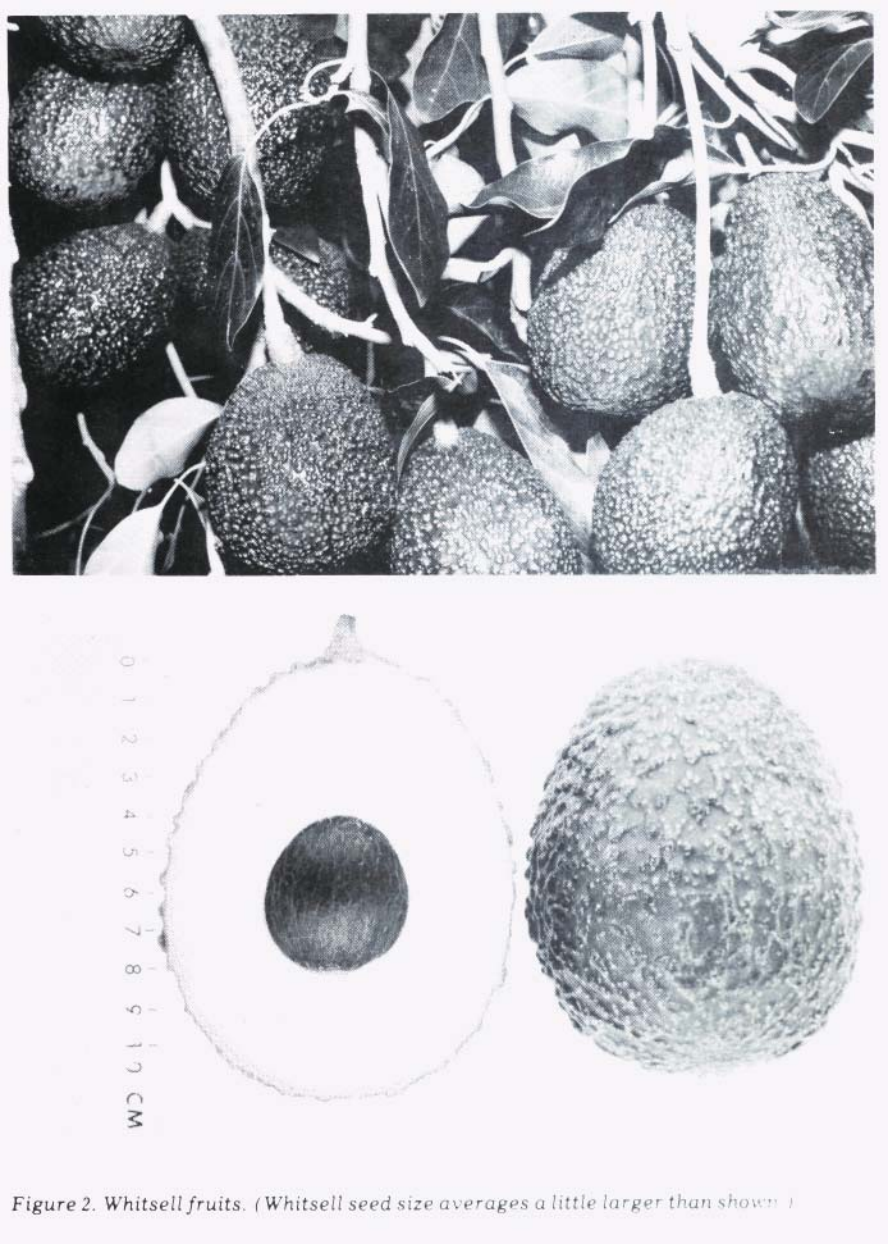

Figure 2. Whitsell fruits. (Whitsell seed size averages a little larger than shown.)

Gwen

It continues to be our patent in greatest demand; up until this year, its expansion has been limited by a shortage of budwood. A major test of its handling and storage ability is scheduled for the 1987 maturity season, headed by Drs. Mary Lu Arpaia and Irv Eaks of UC Riverside,

Production. Fruitfulness of the Gwen on private, commercial properties has been highly variable so far. In places, set has been even quicker and heavier than in UC groves: a commercial set considerably less than a year from topworking, and a very heavy set the next year.

However, in other places, fruit set had been delayed for unknown reasons. All trees are still so young that not much fruit would as yet to be expected from the established commercial varieties like Hass. But the Gwen has consistently been highly precocious under *all* UC treatments, involving differences in tree type (topworked versus nursery), climatic region, irrigation method, soil type, etc.

Why are some Gwen trees elsewhere so slow, comparatively, to begin real bearing?

One suggestion is that on certain properties, vegetative growth is being stimulated at the expense of fruit set by better nutrition, especially nitrogen. On this assumption, the Gwens are developing a larger and stronger tree base on which they will produce even more fruit than the UC "standard" in the years ahead. Maybe Gwen will prove to need less nitrogen than other varieties; we are beginning to test this possibility.

Another suggestion is that Gwen has more need for cross-pollination. Every avocado variety that has been tested has set significantly more fruit when cross-pollinated. Years of limited observation at UC Riverside (an isolated tree in a barley field) showed that Gwen could set heavily on its own. But early evidence elsewhere indicates that the Gwen also benefits from cross-pollination. This does seem to be a contributing factor to the delayed set in some groves.

Perhaps interactions are involved. For example, cross-pollination could partially compensate for setting delayed by great tree vigor. Unknown factors may be important, perhaps in complicated interactions. We do not know. But unless *all* **Gwen** groves set well, spring 1987, we have to begin a probing investigation.

The one major comparison of Gwen (and Whitsell) production with the Hass is in Field 23 at the South Coast Field Station (Figure 1 and Table 1). Calculations were made as described in the earlier Whitsell section to obtain the comparisons of Figure 1. That is, as compared with Hass, Gwen has set twice as many fruits per tree (Table 1), on trees twice as close together, and with fruits that averaged two ounces larger the first year, for an indicated per acre yield advantage of over four to one. The respective extrapolated averages were 7.700 Ibs. for Hass and 32.100 Ibs. for Gwen.

These were the first trees topworked, spring 1984. A number of grafts of all varieties failed and had to be repeated during spring 1985. This gives us a second set of first-year data. For 1984 grafts, set spring 1985 (maturing 1986), the average of Hass, Whitsell, and Gwen were (Table 1): 4,8, and 93 fruits, respectively. For 1985 grafts, set spring 1986, the averages were 2, 9, and 110, respectively.

Figure 3 shows Gwen on two trees, set a year after the spring 1985 topworking.

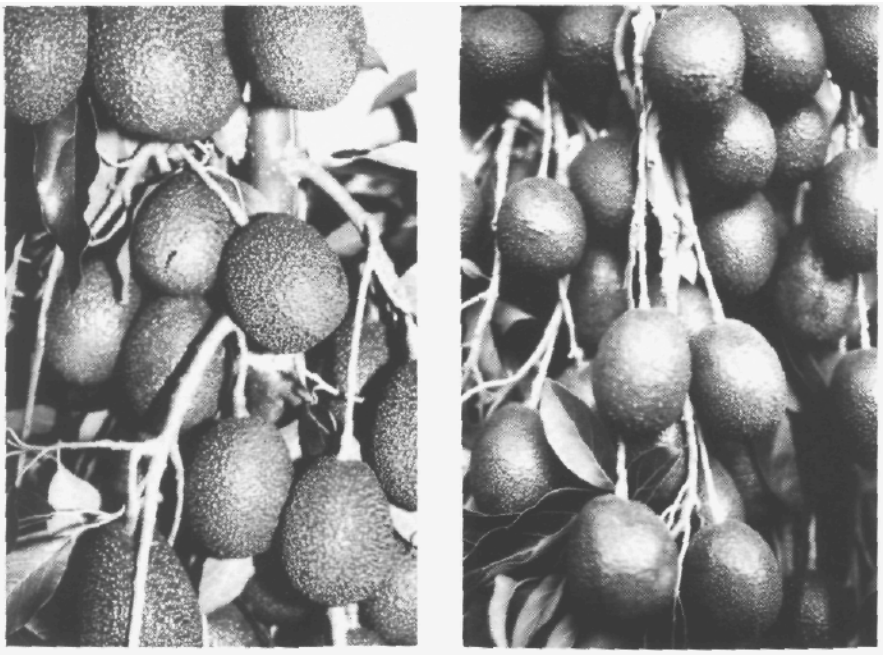

Figure 3. Gwen trees showing fruit 18 months from topworking.

The remarkable Gwen precocity can be a significant advantage for quick cash flow. And it can make a significant grove-life difference when trees may be lost to root-rot, housing development, or other factors. However, as noted above, not all Gwen plantings have shown this precocity.

Tree size. As Table 1 shows, Gwen tree height so far averages only about one foot shorter than Hass. For Gwen (as for Whitsell), we expect early and heavy fruit production to slow down upright growth and bend over the longer stems, so that height inferiority to Hass will increase in the years ahead.

In ground area occupied (Table 1), Gwen is nearly twice Whitsell and over 1/3 that of Hass. Gwen contour uniformity is much greater than Whitsell and similar to Hass. This may decrease as the concentrated Gwen fruit-set bends down some branches. Already, the upright-growing, usually tapered Gwen form means that here also the tree width values represent somewhat subjective estimates — much less so than Whitsell, but more than Hass. The average Hass tree square footage of 74.7 is 2.6 times that of Gwen. But, combining the greater Gwen tree taper and its likelihood of loaded branch bending, we think that a safer Gwen tree density is about twice that of Hass. This fits in with our experience elsewhere at S.C.F.S and also at UC Riverside, but may not fit the larger Gwens in some San Diego groves.

Our S.C.F.S ratio is 2:1, with Hass at 20 feet in the row, Gwen at 10, and all rows 20 feet apart. However, a 20 x 10 spacing, as for Gwen and also Whitsell, is not a very desirable one; there will be crowding in the row long before there is efficient use of the space between rows. Rather, a spacing of 15 feet by 12 to 14 would be better for that square footage per tree.

In topworking situations, one has to take the spacing that one finds. How efficient is a

spacing of, say, 15 feet by 20 for Gwen? For larger trees in San Diego County and perhaps elsewhere, this might be quite allowable. And even under conditions like those in our S.C.F.S grove, the wider spacing might be acceptable, for two reasons. First, our Gwen yields per tree so far are twice those of Hass; the Gwen advantage could be less than maximum and still be major.

Second, at such a wide spacing, Gwen might never need thinning. Tree thinning is a usually inescapable Hass hassle: often delayed until production — and trees — are hurt; the stumping sometimes practiced reduces production further and probably only delays the inevitable; the cost, including brush removal; some grower psychic pain(!) at taking the chain saw to one's "offspring." One plants close together because the later thinning is outweighed by earlier production increases; Gwen precocity with smaller tree size may strike some growers as a happy combination at wider than "optimum" spacing.

Table 1 shows that Gwen trees averaging just over 1/3 the volume of Hass, have produced twice as many fruits, and the fruits were larger the first year at least. This represents an indicated tree "efficiency" rating about six times as great for Gwen. A pound of Gwen fruit has cost much less water, fertilizer, etc., to produce than a pound of Hass. Plus, the much lower Gwen picking costs on small, loaded trees. Plus, the much lower fixed overhead costs (land, taxes, etc.) per pound with such heavy production. As with Whitsell, but probably to a lesser degree, ordinary container Gwen trees develop at a smaller fraction of their Hass counterparts than do topworked trees of the two varieties. All of our young Gwen container trees (like all our topworked trees outside of Field 23) have been heavily cut year after year for budwood. Their small size is therefore ambiguous. A single, older container tree had been cut very little; at the time of its removal last spring it was 16 years old. 15 feet tall with about 12 feet spread at its widest. One tree is not enough for much confidence. Gwen trees might be planted two to three times the recommended Hass density.

Fruit size. Table 1 gives the mean weight of 50 fruits of each of the three varieties, when they reached edible maturity in January 1986. Whitsell was, as expected, the largest, but Gwen, surprisingly, had fruits averaging 2.2 ounces larger than Hass. We believe that the Hass fruits were abnormally small because its trees were not really ready to set this first year and so what bloom there was came late. The Gwen size advantage, therefore, could be fleeting.

Such a conclusion seems confirmed by sizes this second year. Hass fruits this fall are larger than a year ago, in spite of having a commercial set for the first time; we predict that they will reach maturity at about nine ounces, up from eight. Conversely, fruits on the loaded, smaller Gwen trees were smaller than Hass fruits over summer; they have recently been growing faster, and we guess that the two varieties will mature at about the same size.

The Gwen fruits are more uniform in size. Hass tends to have somewhat more large fruits and considerably more small ones.

Mr. Norton W. Hatfield of Valley Center has kindly shared with us the size categories of 219 Gwen fruits from his couple of trees, delivered to Calavo on September 16, 1986. Over 1/3 of the total were size 36, and nearly all the remainder were size 32, 40, or 48; only 16 fruits fell into the next size classes.

Season. About the same as Hass. One analysis found its dry matter content to be less than that of Hass, at the same date. This suggests that Gwen may be palatable at a lower dry weight; our taste tests indicate that it has been edible at least as early as Hass. Which suggests, in turn, that eventually the Gwen may need a lower dry weight maturity standard. At present, it is given the same standard as Hass, in recognition of their genetic relationship — a standard that presumably will delay the Gwen picking seasons somewhat.

Still, from this past season's experience, it may be desirable to delay Gwen harvesting; early in the Hass season, most Gwen fruits had objectionable neck creasing when they ripened, We had not observed this as a problem in earlier years, from older trees. Perhaps it is partly a juvenile trait, possibly accentuated by an unusual season. But we think that it is at least partly inherent in the Gwen nature; first, the probably lower dry matter; second, the stiffer skin, so that as it ripens Gwen creases, whereas the more leathery Hass skin contracts uniformly and inconspicuously. Gwen skin creasing could probably be minimized by pre-ripening the early fruit.

At this time, we think it wise for Gwen to require the Hass dry matter standard, and so for its commercial picking to be delayed perhaps a month or so as compared with Hass.

At the other end of the picking season, the mid-September harvest by Norton Hatfield, noted above, is indicative of its tree storage time — in one of our earliest harvest zones. There is one report from the Corona area of Gwen hanging in good condition a month longer than Hass. We need more experience, from more regions, on this point.

Hass and Gwen are in the same general "nutty" class of avocado flavors, differing from the "spicy" Fuerte class in one direction and the "aromatic" Nabal class in another. Of course, for any variety there often are significant taste differences fruit to fruit, region to region, season to season. Some experienced tasters cannot ordinarily tell the two varieties apart; others find the Hass "richer" in flavor, the Gwen "nuttier"; still others may detect other differences. Considering that there may be unknown flesh differences affecting uses such as processing, plus the fact that Gwen remains mostly green when it ripens, it should *not* be mixed in with Hass for delivery to the handler.

The grove of Mr. Ted Herlihy, near the corner of Highways 15 and 76, has a large Gwen planting, with older Hass trees on either side. In autumn, 1986, he observed that while there were Greenhouse Thrips on fruits of the bordering Hass trees, the Gwen fruits on adjoining trees were nearly free from infestation. Possibly there is a tree age factor here. It merits observation wherever Thrips are a problem.

Uses.

1. *For new plantings.*

2. *Where trees of undesirable varieties are to be topworked.* At the present time that would be especially the fall greenskins, which have commonly been planted closer together, and so would go well with Gwen.

3. *Where Hass trees are crowding.* We have suggested that alternate rows be topworked to Whitsell (cross-pollination) or Gwen, instead of being removed. This would

require careful irrigation modification; and the new grafts would be subject to some shading from the old trees — the opinion has been expressed that such may inhibit Gwen set. However, we have obtained heavy set on Gwen topworked among older trees. It still seems to us that this may be the most profitable way to respond to Hass crowding, and we suggest its trial. Others may prefer to graft over all trees of any crowding variety, to Gwen, or to Whitsell, or to both for mutual cross- pollination.

4. *Healthy Hass trees with inferior production.*

During 1987, a thorough test for Gwen cold storage and handling is planned. Also, the California Avocado Commission plans a conclusive study of its eating quality, compared with the Hass standard. And we hope that there will be resolution of the puzzling delayed productivity in some San Diego orchards. In the meantime, it would be prudent to postpone large-scale commercial Gwen acreage.

Other Selections

Hx48 and *H287* are two older selections that have been of interest because both are a little earlier maturing than Hass and both set more fruit than Hass.

Hx48isa Hass "look-alike"; the experienced grower can tell them apart, but, especially when ripe, Hx48 would be considered an unusually attractive Hass by the ordinary consumer. And it is perhaps a month earlier, with considerably more fruit on smaller trees, a smaller seed, and at least as good peeling. Alas! Its fruit quality, with both purple flesh fibers and inferior flavor, have been unacceptable the last three or four years — about the time that Esther deterioration occurred, Unlike Esther, Hx48 has not made even a partial recovery recently. It formerly was of high quality, distinctly superior to Esther. We do not understand these developments. Possibly, Hx48 will be a good fruit some places, but we cannot endorse it at this time.

Selection H287, a Hass "child" whereas Hx48 is a Hass "grandchild", is another attractive, very small-seeded fruit, somewhat larger, and commercially earlier than Hass. It sets even more precociously and heavily than Hx48. And its flavor is invariably good. Mr. Oliver Atkins had kindly arranged a shipping and consumer-acceptance test, on which it did well. Alas! It commonly drops so many partly-grown fruits that the mature crop is mediocre. Possibly, it will hold fruit well some places; but, with the advent of Gwen and Whitsell, new selections must bear better than H287 to be approved.

We are thus left with no selection of Hass type, but significantly earlier, that we can now advocate commercially. Instead, we would recommend the *Pinkerton;* its large size, earlier maturity, heavier set, and other good qualities (Bergh 1984; Atkins 1986) make it a very attractive substitute for early-season Hass.

TX531. A Hass hybrid, selected years ago as a superior fall greenskin. It has large crops of large fruits of good quality and on a good tree. However, it has sometimes shown disconcerting variability of fruit size and maturity for us. And the fall green market catastrophe this year, sucking under even Fuerte, has presumably sounded the death knell of all such avocados.

New selections. In several fields at UC Riverside and in Field 46, South Coast Field

Station, we have several dozen more recent selections that are now beginning their second testing. Which of them, if any, will prove worthy of patenting for commercial use, is unknown at this time. Any that show real promise will be quickly grafted and topworked for large-scale third-testing.

Future selections. With some 45,000 seedlings out there (mostly on private properties), and a final planting of about 25,000 seedlings planned for spring, 1987 (if we can find cooperators), it may very well be that our best selections have not yet fruited. Or even have not yet been planted.

We are still breeding for the whole year-round spectrum. For the long period when "King Hass" now rules benevolently, our earlier selections tell us that we can significantly strengthen the California avocado enterprise by breeding new genetic combinations of equally high quality, but much more productive on much smaller trees.

Our recent breeding has emphasized the fall-early winter season when Hass is probably either over-mature or under-mature; the old crop tending toward rancidity, while the new crop is still bland. We are approaching this season from both ends: looking for early-maturing, cold hardy, largely Mexican types with black skins like Hass; and looking for very late-maturing Guatemalans with at least rough skin like Hass.

Avocado breeding is a bit like roulette gambling: equally chancy, equally exciting — but far more constructive!

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