The Many Facets of the GEM Avocado

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The GEM avocado has been receiving tremendous attention from growers in California over the past few years, with the 2021-2022 crop likely to exceed 5 million pounds. The variety — named for former UC Riverside staff researcher Gray E. Martin — originated from a block of Gwen variety seedlings that were planted in Ventura County in 1985. After its selection by Gray, budwood of the variety was grafted onto trees at South Coast Research and Extension Center in Irvine in 1992. The variety was patented on March 14, 2002, and as of March 14, 2022, the patent is expired.

GEM trees are typically described as upright and compact. Compared to Hass trees, GEM trees have more dense foliage, are less alternate bearing, and the fruit tend to be larger. The GEM tree tends to hold its fruit more internally than Hass; thus, the GEM fruit are less susceptible to sunburn. Anecdotal data also suggest the variety is slightly more heat and cold tolerant than Hass. GEM trees also are precocious, flowering and fruiting sooner after planting than Hass trees, often producing a commercially harvestable crop in the second year after planting.

Despite these positive characteristics, growers have been slow to adopt the variety and it wasn't until the 2019-2020 crop year that the California GEM crop topped 1 million pounds. Thus, beginning in the 2020-2021 crop year, the California Avocado Commission began to track GEM statistics separately from other varieties as it does for Hass and Lamb Hass. This article will attempt to comprehensively review the GEM variety, including potential economic returns, using data compiled from a variety of sources in California.

Gray E. Martin with his namesake tree, the GEM avocado, in a grove in Temecula, California, June 2021.

Cultural Management

The GEM avocado is a much more compact tree than Hass and tends to grow more upright, almost columnar, rather than spreading like Hass. Many growers who have planted GEMs have found that side pruning is virtually unnecessary. Further, topping to maintain overall tree height doesn't need to begin until about year eight after planting and then tree height usually can be maintained by clipping a single branch in the top of the tree each year. The variety lends itself well to maintaining a tree height of about 10 to 12 feet, which eliminates the need for ladders in the grove.

Given the GEM's growth habit, it lends itself to high density planting. Some growers have planted GEM trees as close as five to six feet between trees and eight feet between rows. Despite the tree's upright habit, the author's opinion is that these spacings are too narrow. Plantings in the range of eight feet between trees and 12 to 14 feet between rows is probably close to ideal for this variety. This equates to a tree density of about 380 to 450 trees per acre. Between-tree spacings greater than 8 feet tend to result in plantings with excessive space remaining between trees for many years, space that could be producing fruit.

Despite the GEM's smaller stature, it is a hungry tree. Growers who have planted GEMs and fertilized them as if they were Hass have not been happy with their performance. No specific studies have been conducted to determine the optimal leaf nutrient levels for GEM, but based on their experience Brokaw Nursery believes the optimum leaf nitrogen level is likely close to 3%, compared to 2.2-2.5% for Hass (https://www.californiaavocadogrowers.com/articles/gem-observations-and-recommendations-brokaw-nursery).

In addition, GEM trees have more dense foliage than Hass, which, when coupled with the higher densities they are planted at, likely results in higher water needs in addition to more fertilizer. The growth habit of the trees, columnar with dense almost weeping branches, also makes using microsprinklers questionable. Because of their growth habit, it is not feasible to skirt prune GEM trees to allow microsprinklers to reach under the canopy without removing a significant amount of the canopy and, thus, fruiting potential. Therefore, drip irrigation may be more suitable for GEM trees — an irrigation system that most avocado growers are not familiar with. With their low hanging branches and fruit, growers using microsprinklers with GEM trees may experience a higher proportion of downgraded or even cull fruit due to the fruit being wet from irrigation.

Flowering and Fruiting

The GEM avocado is an "A" flower type — opening as female in the morning of the first day and male the afternoon of the second day. Thus, if growers are interested in planting a pollenizer variety a "B" flower type is needed. However, given GEM's unique shape and growth habit, most available "B" flower type trees do not pair well with it. The University of California variety "BL-516" (frequently called "Marvel") was originally selected by Gray Martin to be a pollenizer for GEM since it has a similar growth habit but has not yet been released by the University (see page 10 in this issue of *From the Grove*).

It is not uncommon for GEM trees to flower extremely heavily when young, which can cause defoliation. Growers should be aware of this trait and carefully watch their trees the first couple of years after planting and be prepared to whitewash the trees to prevent sunburn if they defoliate. If possible, it's best to not let the young trees carry too much fruit in the first year or two, which can hinder the trees' growth and establishment. Young trees also need to be securely staked to help them support the crop load and prevent tree damage or death from limb breakage in high winds.

GEM fruit tend to set in small clusters. As the fruit grow, their weight pulls the fruiting branch down and into the canopy so fruit are well protected from sunburn. It is not uncommon to walk up to a GEM tree and see absolutely no fruit, only to discover that when a branch is pulled aside the tree is loaded with fruit, all safely hidden inside the canopy. This habit is likely why, at least in part, growers have observed that GEM trees are more heat and cold tolerant than Hass.

GEM fruit are larger than Hass. In the patent for GEM, the average GEM fruit size was reported as 235 grams (8.28 ounces) compared with Hass at 204 grams (7.19 ounces). Overall, growers can expect to see the size curve shift one to two sizes larger for GEM fruit than they usually see for Hass fruit. It is common for young GEM trees to produce very large fruit, but this usually goes away by year three.

Wind Scarring

Many GEM growers have reported high levels of wind scar on the fruit in their young trees. There was some debate that the scarring being observed was the result of a greater susceptibility to avocado thrips, but this was put to rest with a CAC-funded study in 2020 (see "GEM Avocado Fruit Scarring: Causes and Preventive Measures" Spring 2021 *From the Grove*).

Because GEM fruit tend to set in small clusters, the very young fruit (pea to marble size) can rub against each other or against limbs and leaves in high wind areas and develop scars. As the fruit enlarge, these scars are stretched and become larger, sometimes covering a significant portion of the fruit's surface. This appears only to be an issue in young trees in areas with high spring winds and seems to diminish as the trees mature.

Fruit Production

Few replicated trials have been conducted doing a side-by-side comparison of GEM and Hass production. Figure 1 shows data from six trial sites comparing GEM yields to Hass yields. Five of these trials — Oxnard, Arroyo Grande, Santa Paula #1, De Luz and Irvine — were conducted by Dr. Mary Lu Arpaia. The trees in these five trials were all top worked to GEM following stumping of older trees on seedling, Duke 7 or Toro Canyon rootstocks, and were at relatively wide spacings (approximately 20' x 20'). Yield data was collected once the trees came back into production following top working. There were five to 16 trees from which data was collected across the five sites. The sixth trial, Santa Paula #2, was planted by Brokaw Nursery from new nursery trees. There were 51 GEM trees on Toro Canyon rootstock, and 196 Hass trees on a combination of Toro Canyon and Dusa rootstocks planted at approximately 6' x 14'.

The shortest of these six trials lasted four years (Oxnard) and the longest went for seven years (Irvine and Santa Paula #2). In all these trials, the GEM trees out produced the Hass trees, measured as pounds of fruit per tree, over the duration of each trial. Although within a given year — for example, 2009 Santa Paula #2, 2001 Irvine — the Hass trees sometimes outperformed the GEM trees. The greatest yield difference was found at Santa Paula #1, where over the five years of data collection the GEM trees produced 326 pounds more than the Hass trees. The smallest yield difference was at Arroyo Grande where the GEM trees produced only 47 pounds more than the Hass trees over five years. Averaged across all six locations and years, the GEM trees yielded 55% more fruit compared to the Hass trees.

Although there is anecdotal data suggesting the GEM variety is more cold and heat tolerant than Hass, it is notable that the two trial locations with the lowest yields —Arroyo Grande and De Luz — are also, on average, likely the coolest and hottest locations, respectively. That said, the Hass trees were similarly low yielding at both locations and GEM did outperform the Hass trees at both locations. This is by no means definitive data, but growers should be aware that GEM is still a new enough variety that a lot of questions remain unanswered.

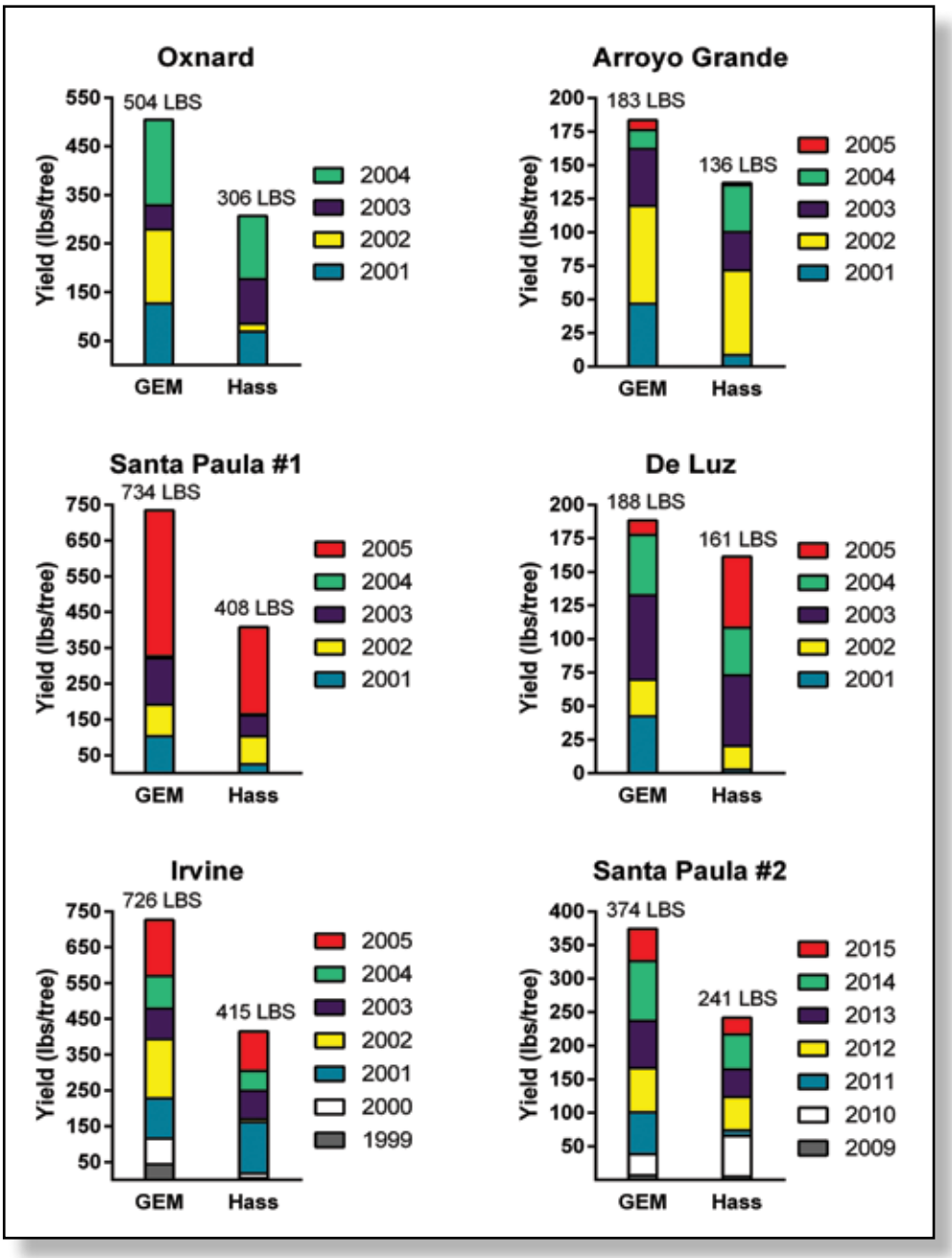

Figure 1. The yield data from six trial sites where GEM and Hass avocados were planted side-by-side. At all sites except Santa Paula #2, the GEM and Hass varieties were top worked onto stumped trees and were at relatively wide spacing. At Santa Paula #2, the trees were all planted from new nursery trees at a spacing of approximately 6' x 14'. Data courtesy of Dr. Mary Lu Arpaia, University of California Riverside, and Rob Brokaw, Brokaw Nursery.

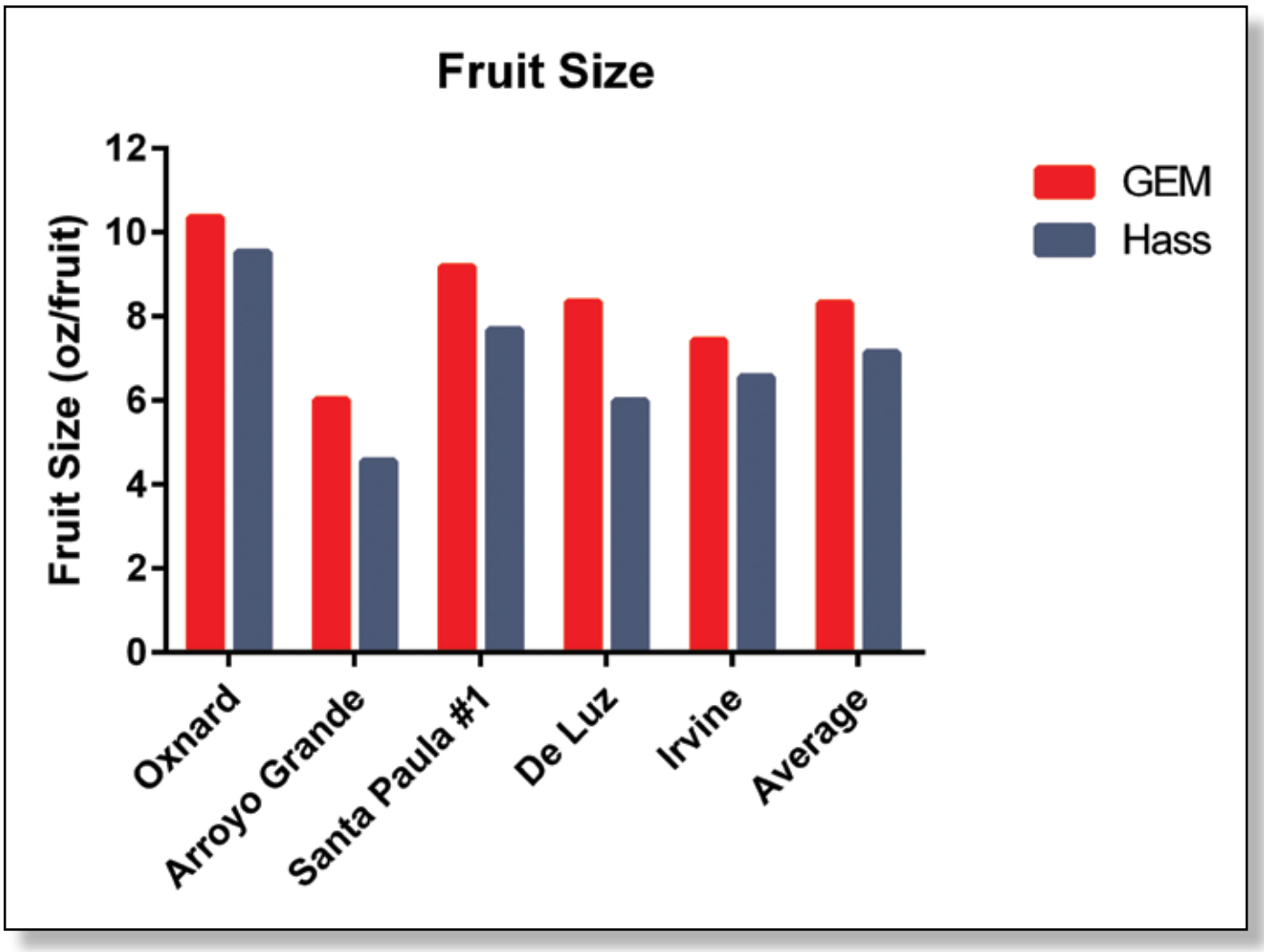

Figure 2. The average size (ounces per fruit) of fruit harvested from GEM and Hass trees at five of the six sites for which yield data are presented in Figure 1. Data courtesy of Dr. Mary Lu Arpaia, University of California Riverside.

At five of the six trial sites shown in Figure 1, additional data on individual fruit size and alternate bearing was collected. Figure 2 shows the average fruit size for GEM and Hass fruit across the duration of the trials (four to seven years) at each site, as well as the overall average across all sites and years. GEM fruit were consistently larger than Hass fruit, as claimed in the GEM patent. The largest fruit for both GEM and Hass came from the Oxnard trial site, while the smallest fruit were from the Arroyo Grande site. Overall, GEM fruit averaged 8.3 ounces (size 48) and Hass fruit averaged 7.1 ounces (size 60) across all sites and years.

Alternate bearing is measured as a ratio of yield in one season compared to yield the next season. An alternate bearing index of 1 equates to perfect alternate bearing — crop, no crop, crop, no crop — whereas an ABI of 0 indicates no alternate bearing (equal crop every year). Across all trial sites and years, GEM trees averaged an ABI of 0.55, whereas Hass trees had an average ABI of 0.77. The ABI of GEM trees ranged from 0.43 (Arroyo Grande) to 0.70 (Santa Paula #1). The ABI of Hass ranged from 0.65 (Oxnard) to 0.89 (De Luz). Overall, these data support the observation that GEM tends to be less alternate bearing than Hass, although under some conditions GEM can alternate bear at a similar level to Hass (e.g., Santa Paula #1).

GEM vs. Hass Prices

As stated earlier, CAC only began tracking GEM independently from other varieties in the 2020–21 crop year (Nov. 2020 – Oct. 2021). Thus, average returns data is limited. For the purposes of this article, several handlers anonymously shared their payout data for Hass and GEM fruit for the 2020–21 and 2021–22 seasons. Across these two seasons, GEM fruit ranged from $0.89 per pound to $2.08 per pound, whereas Hass fruit ranged from $0.94 per pound to $1.94 per pound. Overall, CAC data indicate an average GEM price of $1.20 per pound in the 2020–21 season and $1.70 per

pound for the 2021–22 season to date. Hass price data averaged $1.22 per pound for the 2020–21 season and $1.70 for the 2021–22 season to date. CAC-compiled data, which are based on reporting from all AMRIC handlers, can be found at https://www.californiaavocadogrowers.com/industry/pounds-and-dollars-variety. (AMRIC — Avocado Marketing and Research Information Center — handlers are defined as those handlers who handled a minimum of 1% of the previous years' total California avocado crop volume.)

Based on the available data, it is hard to argue that GEM or Hass fruit are generally more profitable simply from a price per pound perspective. There were certainly times across the two seasons for which data are available that GEM fruit were securing a higher price than Hass ($0.68 greatest difference). However, the opposite also is true and there were times when Hass fruit were securing a higher price than GEM fruit ($0.29 greatest difference). But again, based on AMRIC data, there is essentially no difference in the average price per pound for the two varieties ($1.20 vs $1.22 in 2020-21; $1.70 vs $1.70 in 2021-22).

GEM vs Hass Profitability

The fundamental question that many growers are asking is: "Is it profitable to plant GEMs?" This is a difficult question to answer given the rather limited data set available and how diverse the California avocado growing region is in terms of climate, water quality and water availability. The accompanying table attempts to summarize the costs and returns associated with GEM compared to Hass.

To create this table, several assumptions were made and those will be discussed here. A general underlying assumption is that we are comparing replanting the same piece of ground, just doing so with either Hass or GEM. That means we are not comparing GEM trees growing on flat ground in Ventura to Hass on a steep slope in Temecula, and we're not comparing well water to district water.

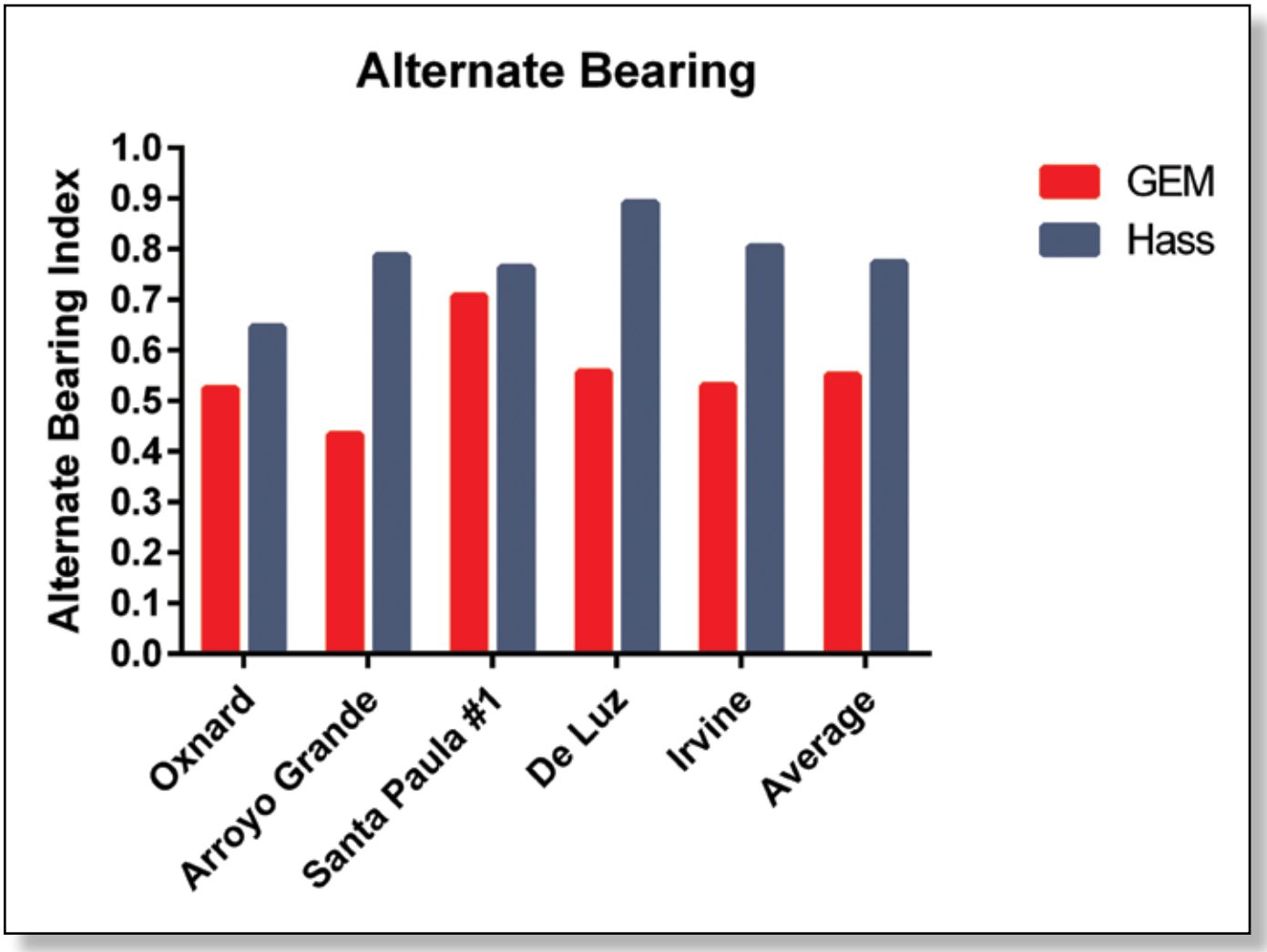

Figure 3. The alternate bearing index for GEM and Hass trees at five of the six sites for which yield data are presented in Figure 1. Data courtesy of Dr. Mary Lu Arpaia, University of California Riverside.

The relative costs and returns for GEM avocados compared with Hass avocados grown in California based on data presented in the accompanying article. For purposes of this comparison, a GEM planting spaced at 8' x 14' was assumed (450 trees per acre) and compared to a Hass planting spaced at 15' x 15' (190 trees per acre). See article text for details on assumptions that were made to compose this analysis.

Cost/Return	Years 1-5	Years >6
Tree Costs	240% ↑	N/A
Planting Costs	240% ↑	N/A
Water Costs	240% ↑	25% ↑
Fertilizer	20% ↑	20% ↑
Pruning	=	80% ↓
Pest Control	=	=
Harvesting	=	20% ↓
Yield	55% ↑	55% ↑
Downgrade/Cull fruit	5-10% ↑	=
Price per pound	=	=

Tree spacing is a major assumption that needs discussion. It is the author's opinion that for the most part the idea of planting Hass trees at high density (10' x 10' or closer) has been well established to be too time- and pruning-intensive for the average grower to manage effectively. Thus, for the purposes of this comparison a Hass planting at 15' x 15' was used as the "modern" standard planting density. Similarly, since there is not an industry-wide accepted planting density for GEM trees, the author's opinion of an ideal GEM spacing of 8' x 14' was used. These two spacings result in a density of approximately 190 trees per acre for Hass and 450 trees per acre for GEM, assuming a solid planted acre with no grove roads or other unplanted areas. This is a 2.4x (240%) increase in trees per acre for GEM vs Hass, thus the initial tree cost is 2.4x higher for GEM than Hass, assuming both varieties sell at the same price.

Another assumption made was that these trees were being planted in a replant situation, thus irrigation mains are already installed, and no major underground pipe work is needed. Therefore, the planting cost — planting the tree, staking the tree, above ground irrigation parts — were assumed to equal the tree cost. As a result, planting costs are 2.4x higher for GEM compared with Hass.

During the early years of grove establishment, most growers use drippers or some form of deflector on microsprinklers to focus water on each individual tree. Thus, early in the life of a grove the water cost is directly proportional to the number of trees per acre. In this case, this would be 2.4x greater for GEM than Hass. However, once trees begin to close canopy, their water use is more correlated with canopy volume per acre than the number of trees per acre. However, we know that GEM is a thirstier tree than Hass, although we do not have solid data to say exactly how much thirstier it is. Therefore, assuming the higher tree density results in somewhat greater canopy volume per acre, plus the greater thirst of GEM, the water use in year 6 and beyond is assumed to be 25% greater for GEM than Hass.

We know that GEMs have a higher fertilizer need than Hass as they do for water, but no data is available to determine exactly how much more is needed. For this discussion, the higher fertilizer demand of GEM was assumed to be a modest 20%.

Neither Hass nor GEM trees will require any pruning in the first years after planting, aside from maybe some sucker removal, thus the cost of pruning for both varieties is equal for years 1-5. Beginning in year 6, Hass planted at 15' x 15' will begin to touch and some pruning will start to be required on a routine basis. As mentioned earlier, the GEM trees will not require any pruning until they begin to need some topping for

height control. Thus, the pruning costs of GEM are assumed to be 80% less than for Hass in year 6 and beyond.

There are no known pest issues with GEM beyond what is normally dealt with in Hass — Persea mite and avocado thrips — nor are they known to be any more resistant to these pests than Hass. Thus, pest control costs are assumed to be equal.

Harvesting is a tricky area to discuss. For this article, the author spoke with several grove managers and labor contractors to better understand harvesting costs. Essentially, harvesting costs are on a per pound basis, period. The need for ladders to harvest will drive up harvesting costs. Steep slopes that slow harvesters down will drive up harvesting costs. Therefore, in the early years when trees are small and crop load is light harvesters can move quickly from tree to tree and harvesting costs are probably equivalent regardless of variety. Since we presumed a "modern" Hass spacing and management, the trees will likely be kept short enough to avoid ladder work so that will not affect harvesting costs as the trees mature. Likewise, we're assuming the same ground so any aspect or physical feature of the terrain that will affect harvesting costs will affect Hass and GEM similarly. That said, GEMs produce more fruit per tree and the trees are spaced more closely. This results in some efficiency of harvest due to less movement in the harvesting process, which should translate to faster picking and may result in a slight harvesting cost savings. Thus, in year 6 and beyond it is assumed harvesting costs will be 20% lower for GEM than Hass.

Based on the data presented, yield of GEM is assumed to be 55% higher than Hass. In the early years, the potential wind susceptibility of GEM may be a factor for growers in wind prone areas. Thus, in the early years of the grove 5-10% more downgraded or culled fruit are assumed for GEM, but this generally diminishes as the trees age and so there is no downgrade penalty in year 6 and beyond.

Lastly, as the currently available data show, the price per pound on average for GEM and Hass fruit is equivalent.

Recognizing that everyone is expecting to see a number at this point let's come up with one. We will assume a tree cost of $35 for both Hass and GEM and, thus, a planting cost of $35 per tree for a total of $70 per tree. It follows then that our 190 Hass trees will cost $13,300 to get in the ground and the 450 GEM trees will cost $31,500, a difference of $18,200. For the sake of discussion, let's assume everything else in our costs table balances out so we're just dealing with needing to recover the difference in planting costs. If we assume that we get the 2021-22 average price of $1.70 per pound for our fruit, the $18,200 difference in planting costs equates to 10,705 pounds of fruit. In the yield data presented earlier, the greatest yield difference was at Santa Paula #1 where the GEM trees produced 326 pounds more fruit per tree cumulative over five years, or an average of 65 pounds per tree per year. The lowest yield difference in the data presented was at Arroyo Grande where the yield difference was just 47 pounds per tree cumulative over five years, or just under 10 pounds per tree per year. For our example of 490 trees per acre, this is a range of 4,230 pounds to 29,340 pounds per acre more production from GEM than Hass. Of course, the trees will take some time to grow and come into production and achieve these yield levels, but it is feasible that once the trees are producing the higher planting costs associated with GEM could be recouped in just a couple of years — that is if most of the assumptions made here are true.

So, should you plant GEM or Hass? That's a question only you can answer for yourself. But I hope the information presented here helps you put some of the puzzle pieces together and answer that question.