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TAKING THE CALIFORNIA AVOCADO BREEDING PROGRAM INTO THE NEXT CENTURY

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Abstract

In recent years much attention has been directed toward propagating new avocado selections in a central test plot to compare their performance (as replicated trees) with standard varieties. Vital data such as precocity, production, fruit quality, maturity season, relative fruit size, flower type, and tree form is emerging. Early data from recent selections indicate some interesting prospects for commercialization. Among the selections showing valuable commercial traits are: 'BL122', 'Sir Prize', 'BL 667', 'Gem' ('3-29-5'), 'Harvest, 'OA 184', '5-552', 'BL 343', and 'Regal'. These will be briefly described in order of priority. Others like 'RT5176' and 'BLI058' are serious contenders as pollinizers. Isolated plots are currently being established to determine how effective these are in comparison with such standard pollinizers as Bacon, Fuerte, and Zutano.

The priorities for the breeding program going into the next century will be discussed including: 1. The continued evaluation of scion material from crosses made in California and of any promising materials obtained from other international industries. 2. Emphasis on 'Hass-like' material that may extend the 'Hass' season and 'B'-flower 'Hass'-like selections that provide pollination benefit. The examination of outcrossing of 'Hass' and new 'B'- flower types, and the study of bee preferences, flower visitation, and the role of bees in outcrossing. 3. Evaluation of salt tolerance of rootstock materials both from the rootstock breeding program and international sources. Examining the link between *Phytophthora* tolerance and salt tolerance. 4. Examine the potential of dwarfing rootstocks and interstocks on avocado phenology and production. 5. In the course of conducting routine field work in the breeding program we will continue to examine innovative horticultural techniques in the areas of grafting, tree training, and pruning.

1. Introduction

For the first 20 years, the cultivar improvement program begun by Dr. Bergh emphasized inbreeding to identify better parents, while concomitantly developing better breeding lines, discarding inferior alleles, concentrating superior ones, and getting rid of excess tree vigor (Bergh, 1987). Since then, the proportion of progeny seedlings worth selecting for commercial testing has increased markedly. The result is that the proportions of selection-worthy seedlings have continued to increase (Bergh, 1987). By 1984, the project's first three patents were released: cultivars 'Gwen', 'Whitsell', and 'Esther'. Further large-scale seedling evaluation for better commercial selections is currently being carried out in the field with the assistance of Gray Martin. More than a hundred selections are under observation, of which over a dozen have been grafted in replicate plots for further testing. We are constantly re-evaluating our total

program, and will continue to publish these re- evaluations (Bergh, 1992a; Martin, 1993a; Bergh and Lahav, 1993).

2. Significant new selections

2.1 Lamb/Hass

The mother tree 'Lamb/Hass', loosely referred to as 'Lamb', previously described as 'BL122', was planted May 1985 at Mr. Bob Lamb's property, Camarillo, California. The 'Lamb' mother tree is one of many thousand seedling avocados with 'Gwen' avocado as the maternal parent. The 'Gwen' has previously been described as a "grandchild" of 'Hass'. Therefore, the 'Lamb' genealogy is defined as a "great grandchild" of 'Hass'.

The 'Lamb/Hass' avocado has several distinguishing characteristics that make it commercially valuable: 1. The appearance of 'Lamb' is uniquely similar to 'Hass'; most consumers will commonly identify 'Lamb' as a 'Hass'-type. 2. Production performance exceeds 'Hass' in all preliminary trials. 3. The season of maturity is later in the year than 'Hass', and mature fruit remains on the tree without significant drop. Therefore, growers will have the option of extending 'Hass'-type production throughout the year. Additionally, there are many affiliated benefits with the extension of the production season. 4. Early indications are that the variety has resistance to California’s newest avocado pest; persea mite.

The fruit shape is pear with a distinctive flattop or flat "shoulder." The ripe fruit color is black, and unripe fruit is green, mostly indistinguishable from 'Hass'. The fruit size varies with crop size, but is typically larger than 'Hass' relative to yield (280-320 grains). The roughness of the skin is finely-pebbled, typically less rough than 'Hass'. Russeting is almost non-existent. The skin is thicker than 'Hass' and slightly less pliable, often breaking when peeled back from the flesh, although peel separation from the flesh is clean. The flesh color is identical to 'Hass', but flesh fibers are both more common particularly in small sized fruit. The seed size and adherence to flesh is similar to 'Hass'. Overall flesh quality is "good". In the 'Hass' "late" season, the quality relative to 'Hass' is "very good". Two seasons of preliminary postharvest fruit storage data suggests 'Lamb/Hass' compares favorably with the 'Hass' standard.

Individual differences in tree form and leaf foliage are frequently subtle and generally non-descript. The 'Lamb' is said to exhibit upright tendencies, at least more so than 'Hass', but pruning can substantially influence this. The leaf color of 'Lamb' is distinctly darker than 'Hass', resembling varieties like 'Bacon' and 'Reed', the third and fourth leading commercial cultivars. No differences are apparent with respect to cold injury, with both varieties classified as "tender". Anise fragrance has not been detected in the stems or leaves. The flower type is W, the same as 'Hass', and bloom is similarly timed in spring. Fruit set frequently occurs in clusters and is evenly distributed throughout the tree.

2.2 Sir Prize

The original 'Sir Prize' mother tree was planted April 1986 at Mr. Bob Lamb's orchards, Camarillo, California. The tree was first tested in the spring of 1991 and currently has been expanded for testing in commercial growing areas throughout the California industry. 'Sir Prize' originated from an open-pollinated breeding cross with 'HX48' avocado as the maternal parent. The 'HX48' was itself a 'Hass' seedling, thus the 'Sir Prize' can be described as a "grandchild" of 'Hass'.

The 'Sir Prize' avocado has several distinguishing characteristics that make it commercially valuable: 1. The appearance of 'Sir Prize', although significantly different from 'Hass', is more 'Hass'-like than any previous commercial avocado of its type. When ripe, both the black color of the skin and the pear shape of the fruit will lead most consumers to recognize it as 'Hass', or at least a "Hass"-type. 2. The season of maturity averages 6-8 weeks earlier than 'Hass' in any one location. 3. The overall fruit size is larger than 'Hass', and size increase occurs earlier in the season, making early-season maturity even more important. Currently large-sized, early-season, 'Hass'-type avocados like 'Sir Prize' command premium returns to growers. 4. 'Sir Prize' is primarily classified as a Mexican-race avocado. Mexican race avocados are typically more cold resistant and are, therefore selected for inland valleys and other regions unsuitable for 'Hass'. Cold tolerance is currently being tested. 5. Early production data indicate a heavy yield potential. 6. The flower type is '13% the compliment of 'A' ('Hass'). Commonly avocados of the W-type are used for enhancing pollination of 'Hass'.

The fruit is pear shaped with a distinctive ridge along one side. The extent of the ridge is slight to moderate and becomes almost unrecognizable as the fruit loses moisture during the ripening process. Fruit size is significantly larger than 'Hass', averaging greater than 350 grams on juvenile trees. This large size is recognized as favorable in the early- season market period. The skin texture is a medium-minus, and not truly pebbled like 'Hass'. Although the skin is flecked with numerous tiny islands of varying yellow shades, giving the illusion of 'Hass'-like pebbles. The skin thickness is fine-plus, similar to the commercial variety 'Fuerte'. This skin thickness is commonly referred to as "thin" as compared with the "thick" 'Hass'. The skin is pliable and separates easily from the flesh. The flesh color is similar and indistinguishable from 'Hass'. Flesh fibers are few and insignificant. The seed size is described as "small", with an average seed to fruit ratio of 10-12%; comparable 'Hass' ratios average 15% or higher. The flesh quality is considered excellent, equivalent with 'Hass'; exceeding 'Hass' during the early-season period. Preliminary postharvest handling features appear promising and should be "more than acceptable."

'Sir Prize' is upright in tree form, although this character can be influenced by pruning. The leaf type and shape is more typical of the Mexican race avocados than 'Hass'. Young leaf anthocyanin pigment is present varying from light to moderate. No anise fragrance has been detected in the stems or leaves. Peak bloom period is earlier than 'Hass' by several weeks, the flower type is 'B'.

2.3 Other selections

Other selections include: 'BL 667', heavy producing 'B'-flower 'Hass'-type; 'Gem' ('3- 29-5'), heavy producing 'Hass'-type; 'Harvest', 'Hass'-like with very good production on mother tree, currently evaluating trees in replicate plots; 'OA 184', 'B'-flower 'Hass'-type, quality slightly inferior to 'Hass'; '5-552', excellent quality green-skin, better than 'Ardith', slightly susceptible to greenhouse thrips; 'BL 343', very preliminary data, but appears to be 2 months ahead of 'Hass' maturity with comparable quality; slightly less pear-shaped than 'Hass' (slim ovate); 'Regal', many good qualities make 'Regal' an excellent candidate for further breeding work; off-flavor has been described by some who have sampled this variety. Others like 'RT5176' and 'BL1058' are serious contenders as pollinizers. Isolated plots are currently being established to determine how effective these are in comparison with such standard pollinizers as Bacon, Fuerte, and Zutano.

3. Future priorities

Breeding involves flowering, and the avocado has a unique system for promoting cross-pollination (Bergh, 1986b). This has led to the possible commercial need for a good pollen source for 'Hass' (Martin, 1993b) and a better understanding of insect pollinators. Avocado flower dichogamy is of general botanical significance and will be the subject of further study in this program. Avocado evolution and taxonomy are also of considerable botanical interest and concern to the breeder (Bergh and Ellstrand, 1986; Fournier et al., 1990; Scora and Bergh, 1992; Bergh, 1992a; Bergh, 1993). Biotechnology research associated with the breeding program is likely to play a much larger future role in elucidating a number of taxonomic questions in the *Persea* genus (Clegg and Bergh, 1991; Pliego-Alfaro and Bergh, 1992; Bergh, 1992a).

Testing selections as grafted trees involves considerable skill in topworking. Gray Martin has developed several improved techniques, of direct value to the breeding program, of commercial value, and of interest to plant propagation theory (Martin, 1991a; Martin and Bergh, 1992). Gray is examining new techniques of tree training and structuring, in sharp contrast with the conventional wisdom of basically just letting the tree grow (Martin, 1991b; Bergh, 1992a; Martin, 1993c and d). The program will also study the effect of dwarfing rootstocks and interstocks on avocado growth and performance. This research is now well underway, and promises to have value in breeding, commercial orchards, and our understanding of phenology (Thorp and Sedgley, 1993).

Each year seeds produced by selfing and cross-pollination in isolated plots of lines with resistance to *Phytophthora* root rot are turned over to Dr. John Menge (Plant Pathology at the University of California Riverside) for testing. Some selections are now under commercial field testing. The best *Phytophthora* resistant selections are continuously topworked into the isolate plots for further improvement of progeny. Selections found to *have Phytophthora* tolerance will be further screened for salinity tolerance. Salinity tolerance testing will be done based on previous work by Kadman and Ben Ya'acov (1976) and Oster *et al.* (1985).

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