California Cling Peach Advisory Board
2009 Annual Report

Project Titles: Processing Peach Selections for Mechanization

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Synopsis. UC Davis, as California's Land Grant University, has had extensive field facilities for plant research and by fully utilizing these resources the Processing Peach Breeding Program was able to become probably the largest processing peach genetic improvement program in the world and one of the largest public peach variety development programs in the United States -yet at a fraction of the cost typically associated with programs of this size. Although the initial breeding program plan projected a maximum breeding population size to be reached in 2004-2005, a recent surge in breeding activity occurred in response to industry requests for new peach varietal types amenable to mechanical harvest (Fig. 1). In the last 2 years, massive cuts in University support have doubled breeding costs (Fig. 2). This 1to 2 year project was developed to maintain current breeding program momentum while simultaneously implementing drastic reductions in operating costs through the mechanization of many of our field practices. Initial results document dramatic reductions in field costs since the start of this program in April, 2009 (Fig. 3). In some ways the magnitude of the breeding programs indebtedness had a positive effect, in that it allowed us to radically change less efficient, yet entrenched University practices in 4 areas which previously required high cost hand labor: a) planting and weeding; b) pruning, c) thinning, and d) field rouging of inferior seedlings and propagations of promising selections. A more detailed description of each area of improvement follows in the following report sections.

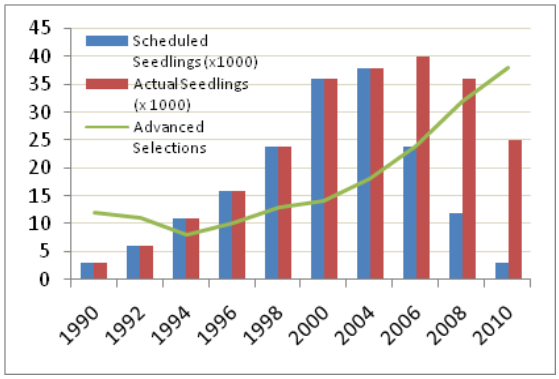

Fig. 1. Initial breeding projections vs. actual.

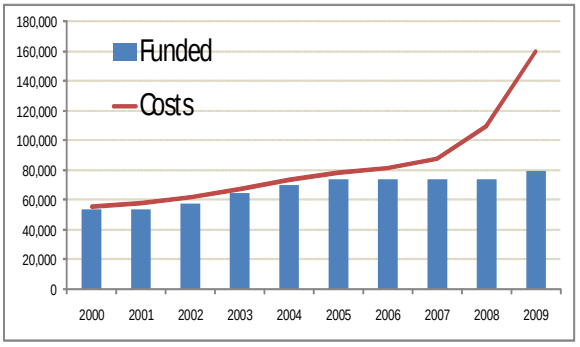

Fig. 2. Breeding program costs vs. funding by year.

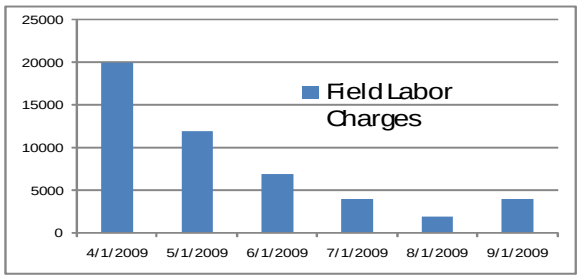

Fig. 3. Reductions in field cost since start of project.

A. **Planting and weeding**.

Previously, all planting was done by hand, using either a small shovel, or, more recently, a specialized planting peg. While allowing a high degree of control over the planting process, this approach was expensive, and because the shovel or planting peg sometimes compacted the surrounding soil, could result in poor seedling root development. We are presently modifying a Holland Model 1500 transplanter (Figure 4) to handle both bare root and rooted seedlings. Previously, I have used a similarly modified transplanter on seedlings with shoot length of approximately 12 inches, achieving planting rates of over 50 plants per minute. Initial tests for mechanized peach seedling transplanting are scheduled for March, 2010. Successful incorporation of this equipment to breeding program practices will only increase field efficiency, but should lead to straighter roll patterns (facilitating irrigation line layout), improved root-soil interface conditions and so seedling take, and reduced greenhouse costs since seedlings can be transplanted to an earlier growth stage.

Fig. 4. Modified seedling transplanter.

Following spring standard field transplanting, the seedling pots were typically hand we did several times over the first two years of growth resulting in high labor expenses. In 2009 we controlled weeds in half of our seedling blocks to a combination of hint-hoeing at three months old in the application contact herbicide. In their remaining seedling blocks, we control was entirely through the use of different herbicide applications. Field evaluations as the beginning of the 2010 growing season (Figure 5) showed effective weed control in both treatments with slightly smaller trees in herbicide-only blocks. Slightly better tree survival was observed in herbicide-only blocks too, apparently, to the lower number of trees accidentally rogued out during hoeing. (Hire tree mortalities with hand hoeing were particularly evident in planting of our compact tree breeding lines, since early seedling trees are very small and easily missed during hoeing see Figure 5). Most serious problem with the herbicide-only control was a late season proliferation of grassy weeds. Consultations with Dr. Tom Lanini, however, identified herbicide combinations effective for this late-season weed control (don't be late in 2009 season for maximum control)

Fig. 5. Weed control in double-row 2009 Seedling Blocks. Cultivation (incl. Hand hoeing) followed by herbicide application (left). In-row herbicide application only (right). [Standard-sized seedlings shown at left with shorter stature, compact seedling progeny shown at right center]. All new plantings will be converted to single rows starting in 2010. Photos taken just prior to 2010herbicide strip spray for both trials.

B. Pruning.

Standard commercial pruning practices continue to be employed in our Advanced Selection Blocks (Figure 6a) to ensure uniform evaluations of breeding selections. To reduced field costs in Advanced Selection Blocks, we are expanding the use of mechanical top-hedging. In contrast, minimal pruning is being utilized in Seedling Selection Blocks (Figure 6b) starting in 2009 in addition to bulldozing 90% of all trees over 4 years old. Tree growth conditions particularly tree density, and fertilizer and water applications) are being manipulated to limit vegetative growth in seedling trees while encouraging earlier flower and fruit development (Figure 6b). The goal is to promote a limited expansion of current year shoots involving, the preformed bud nodes within the over-wintering meristems. An example of an exposed plant meristem is shown in Figure 7a (where the growing point is artificially colored blue & green). The numbers represent developing leaves in increasing order of age with approximately 14 to 18 leaf primordia typically present within overwintering peach meristems. The space between concurrent leaf axis is referred to as the node and most shoot growth during the spring/early summer is the result of extension of these internode regions rather than new growing-point development. A logitudinal section of a similar plant meristem is shown in Figure 7b showing the internode spaces as well as the axillary buds (i.e. in the leaf axis) which can result in current season lateral shoot growth (as in Figure 8). By limiting summer growth stimulations (water, nitrogen, pruning cuts, etc.) our goal is to limit seasonal growth mainly to these preformed bud node expansion. By discouraging later neoform (newly formed that season) meristem growth as well as watersprout growth (from hard-pruning cuts) the final tree form is more manageable (both within and

Fig. 6. Standard pruning in Advanced Selection blocks (left). Minimal pruned trees in Seedling evaluation Block at 3rd year of growth (right)

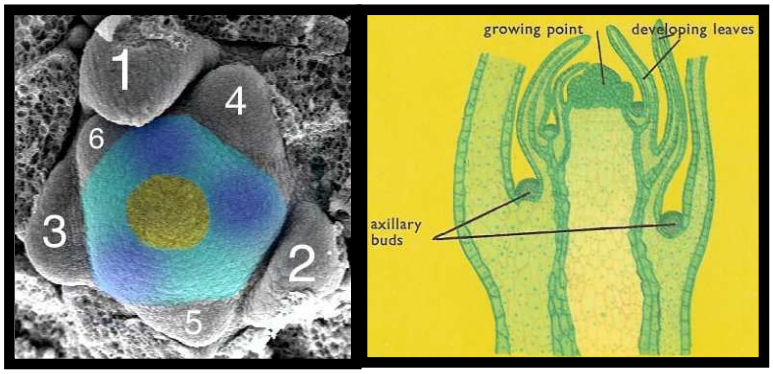

Fig. 7. Top-down view of an exposed plant shoot tip showing (green-blue highlighted) growing-point and early developing shoot leaves (left). Longitudinal section shown at right showing internodal distribution (for the nodes in that section) as well as axillary buds located in axils of developing leaves. [Both images from the web].

among growing seasons), retains a more accurate representation of genetic differences within and between breeding populations, and (based on our earlier field observations) will result in a higher bloom density and fecundity at flowering (though total flower count will be reduced since fewer branches will be present). While this management approach is not commercial viable since the tree growth will soon become unmanageable, our goal in the seedling blocks is to manage the trees until the first crop in year 3 (at which time promising selections will be propagated and the entire block then bulldozed (see section D). This minimal pruning approach does have commercial significance, however, as it allows us to identify/characterize tree architectures which have reduced pruning requirements, as well as architectures amenable to developing the type of 'fruiting wall' necessary for some of the equipment being developed for mechanical harvesting. For example, in Figure 8, the limited current season growth (preform bud extension with multiple lateral shoots, also of limited growth) of our advanced selection Compact#2 under standard cultural conditions is shown, demonstrating a potentially more manageable, minimal pruning yet productive and high quality processing peach compatible with Central Valley growing conditions (more information on Compact selections now in Regional trials presented in *Regional Testing of Cling Peach Selections* and *Development of Cling Peach Varieties* 2009-10 Annual Reports).

Fig. 8. Limited (and more readily manageable) growth of pruned shoot typical of preformed bud expansion.

C. Thinning.

In early 2009, the breeding program had over 40,000 trees of various ages at evaluation blocks in Davis and Winters, CA, resulting in the very high pruning and thinning costs (most of April and May expenditures in Fig. 3). As part of this project, over 90% of trees older than 3 years have been eliminated in by early summer, 2009. Over 25,000 trees remain (Fig. 1) mostly seedling trees from 2006 to 2009 plantings. The majority of trees are trained to a perpendicular-V, and are young and flexible enough (Fig. 6b representative of a 2007 planting) to allow rapid thinning using the Darwin mechanical thinner (Fig. 9; in collaboration with R. Duncan). Trees would be over-thinned to facilitate evaluation of fruit size/shape potential (since yield evaluation of seedling, own-rooted trees is problematic). For longer term use, a more basic prototype line thinner is being developed which would be driven by the tractor rear PTO, be reduced in size (approx. 8 ft.) and have a mid-placed bar to support the brush spindle and act as a pushbar/spacer to press young scaffolds upwards for a uniform and complete coverage of interior hangers by the (standard weed-eater type) lines (see Fig. 9).

Fig. 9. Mechanical thinner. Prototype for seedling trees would have scaffold push/spacing bar (highlighted in yellow) and brush length reduction to 8 ft.).

D. Field rouging of inferior seedlings and propagations of promising selections.
Previous rouging-out of peach tree breeding populations was largely through the hand-sawing of trees (due to UCD worker safety regulations). In 2009, trees to be rouged-out following growing season evaluation, where first killed with a Roundup injection (using the EZ-Ject herbicide injection system developed for forest tree thinning), and subsequently cut-out with a modified Tree-Squirrel pruner, greatly increasing efficiency and reducing costs. Examples of saved and rouged-out trunks can be seen in Fig. 6b). In 2010, 2nd year trees will be herbicide injected immediately following their rejection by our fruit evaluation standards, removing them from any future competition with remaining trees. Dead wood will not be removed at the end of year 2, but upon completion of the 3rd year of evaluation the entire block will be removed the following Spring. Trees selected for further evaluation will be dormant bud propagated by Duarte Nursery in February for planting that May. Any selections not successfully propagated by dormant-bud propagation will be t-budded at this time and the orchard removed (bulldozed). The current status of UCD breeding plots is summarized in Fig. 10.

On a larger scale, we are targeting a fuller complementation of the incorporation these largely mechanized augmentations to all stages of the breeding program, in that it promises not only sizable reductions in program costs, but should greatly facilitate the evaluation of advanced selections for their potential for mechanization under more commercial Central Valley orchard conditions.

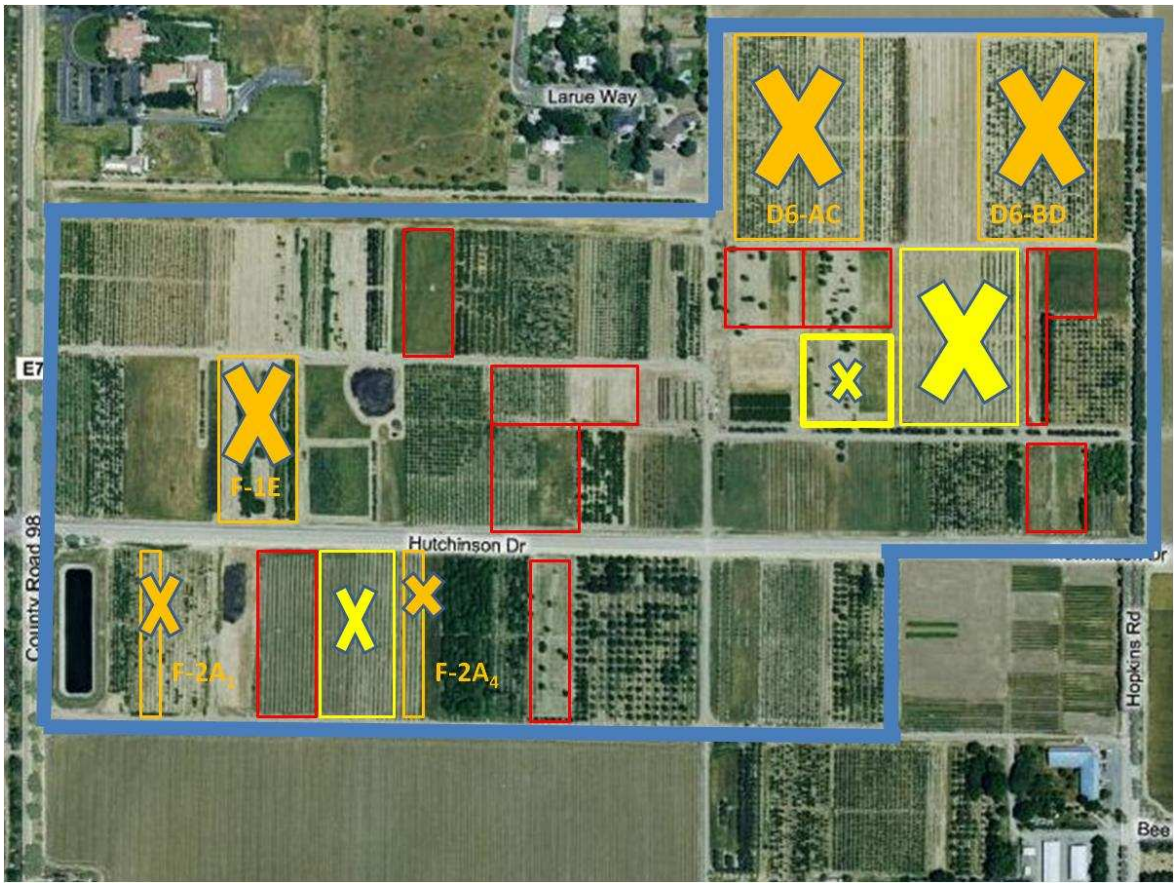

Fig. 10. Status of UCD Davis Processing Peach Breeding plots. (Orange –removed spring, 2009; Yellow –to be removed spring, 2010; Red –Remaining seedling plots, all under 4 years of age and so compatible with mechanized management.