California Cling Peach Advisory Board
2010 Final Report

Project Titles:	Processing Peach Selections for Mechanization
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Introduction

University of California (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 peach variety development programs in the United States -yet at a fraction of the cost typically associated with programs of this size. Although initially projected to reach its maximum (Figs. 1). Combined with anticipated, though unexpectedly massive (and continuing) cuts in University support, breeding costs (primarily field and labor costs) doubled in 2008-09 (Fig. 2). This 2 year project was developed to maintain current breeding program momentum while drastically reducing costs through the modification and mechanization of many of our field practices. Initial results document dramatic reductions in field costs since the initiation of this program in April, 2009 (Fig. 3). [The slightly increased expenditures in September, 2009 result from one-time removal costs for large sections of our breeding blocks (Fig. 4).] In some ways the magnitude of the breeding programs indebtedness had a positive effect in that it allowed us to drastically change inefficient, yet entrenched University practices. For example, 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 where first killed with a Roundup injection following growing season evaluation and subsequently cut with a modified Tree-Squirrel pruner, greatly increasing efficiency and reducing costs. Weed control, which was primarily done

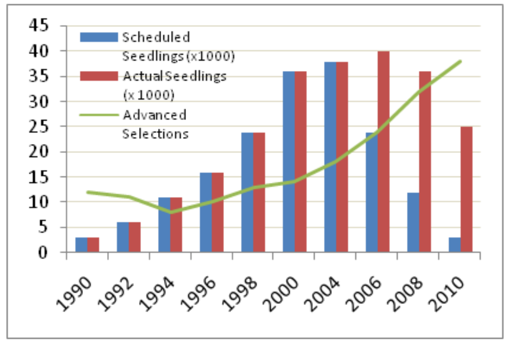

Figure 1. Initial breeding population size projections showing the recent surge in breeding activity in response to industry requests for new peach varietal types amenable to mechanical harvest

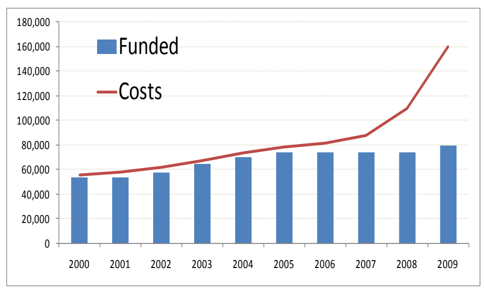

Figure 2. Processing Peach Breeding funded projects versus actual costs.

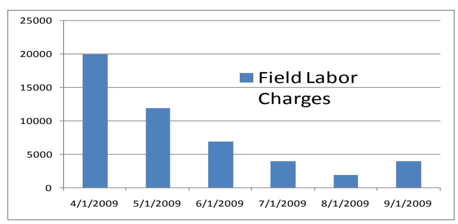

Figure 3. Reduction in labor charges resulting from increased mechanization.

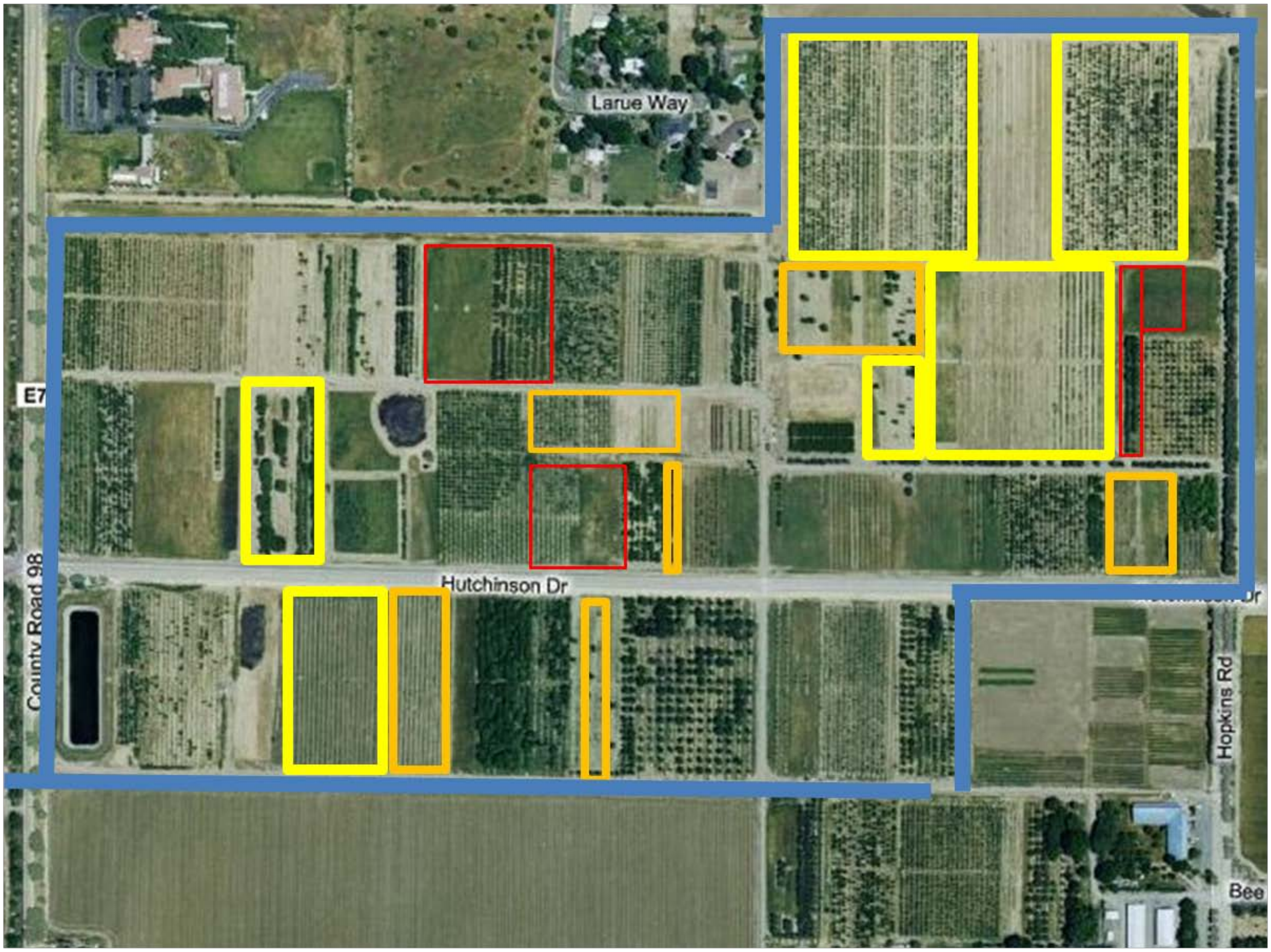

Figure 4. Breeding plots removed in 2009-10 (yellow) planned for 2011. Plots in red represent 2009 plantings.

by hand hoeing was achieved by selective cultivation and herbicide applications (in cooperation with Tom Lanini). We are continuing to work with Ted DeJong and Louise Ferguson to develop efficient procedures for tree size control and mechanical thinning using recent improvements in both our technology and understanding of tree growth patterns. Incorporating these largely mechanized augmentations to all stages of the breeding program not only achieves sizable reductions in program costs, but should greatly facilitate the evaluation of advanced selections for their potential for mechanization under commercial orchard conditions. In addition, ongoing research by Drs. Ted DeJong and Bruce Lampinen at UCD have shown that tree yields are directly dependent on their ability to capture sunlight energy in leaves adjacent to the developing fruit. Associated physiological and modeling studies continue to increase our understanding of the best tree architectures for optimal light capture efficiency. This research is usually based on traditional open-vase or perpendicular-V plantings which require sizable management inputs in training, pruning and thinning. For example the standard processing peach tree architecture while facilitating traditional orchard management, limits its value as a mechanically-harvestable peach since the traditional architectures are difficult to integrate with mechanization. Before the 2008 season, 95% of our variety development efforts targeted traditional perpendicular-V/open-vase tree types with only minor modifications (for example advanced selection Late#2 combines standard tree structure with a greater ability to fruit on older wood). A significant emphasis towards tree architectures more amenable to mechanical orchard management (training, pruning, thinning, harvest) began in the 2008 season and has progressed to the point that approximately 30% of 2010 crosses have targeted mechanical-amenable tree architectures to accelerate these options in the UCD cultivar development pipeline. The ideal mechanical-amenable tree architecture would be a uniform fruiting-wall requiring low cultural (prune, thin, harvest) inputs and be genetically controlled by major genes which would allow a rapid transfer to the range of processing peach maturity periods. Mechanization has also figured prominently in reducing costs in the three major seedling orchard operations: planting, weeding, pruning, thinning and tree removal.

Figure 5. Standard double-row tree plantings following hand-hoeing for weed control (left) and herbicide only (right).

Planting.

The standard procedure involved hand transplanting of up to 10,000 or more ~ 8 month old peach seedling trees per year in double rows (row spacing: 1 foot; the spacing within row: 2 feet) using a crew of a dozen or more individuals over a period of 2 to 3 days.

Solution.

An old vegetable transplanting sled was modified to allow required deep root transplanting of seedling peach trees following a specialized cultivation of planting rows to allow rapid yet uniform soil coverage to the proper root depth. Plantings can now be completed by our breeding crew in one day with very good tree survival. Planting row-pattern was modified to single row planting with trees 1 foot apart (figure 6). The single row solution allowed similar tree densities per acre which greatly facilitated mowing and weeding. In addition the higher root densities resulted in more compact trees. Higher tree densities also tended to recruit more upright growth (see Figure 9) resulting in a more convenient hedge type row for evaluation and fruit harvest. The greater stress on the trees from the higher densities also were folded in earlier flowering in fruiting and the ability for earlier evaluation and removal.

Weeding.
Standard procedure involved multiple hand weeding using specialized orchard hoes requiring large number of individuals over a large number of days throughout the growing season.

<u>Solution</u>.
Through largely trial and error, weed control in seedling trees has been achieved through a combination of specialized cultivation and herbicide application (in consultation with Tom Lanini) often using specialized spray nozzles and arrangements. Roundup has proven effective but can injure or kill trees if spray falls on the peach leads. The herbicides *Poast* and Shark work well on a combination of grass and broadleaf weeds but was somewhat less effective on *Fluvellin* and field bindweed. Very good results were achieved using the herbicide Rely combined with specialized spray nozzles for more precise application [herbicide rely is known to cause filming on almond shoots on rapidly growing trees is so neat to be used with caution]. On larger trees, a higher density planting is utilized to shade out weeds within the row with precision mowing used to control weeds up to tree trunks edges. Using this approach, costs have been dramatically reduced while tree performance has actually improved owing to earlier and timelier weed management and reduced tree injury/death from hand cultivation damage.

Figure 6. Peach seedling role approximately 2 months after transplanting (left) and following application of the herbicide Rely (right).

Figure 7. Effective weed control through selective RoundUp herbicide application and close-mowing on compact trees((left) and standard sized- seedling trees (right).

Pruning.
Standard procedure involved hand pruning of all trees to a 2-scaffold perpendicular-V shape requiring a large number of individuals working over a large period of time.
Solution.
By managing planting density as well as water and fertilizer application according to predictions from the DeJong Peach Growth Model and our previous experience, tree vigor/growth is controlled to produce a more compact tree capable of producing adequate fruit for evaluation. The reduced growth of the seedling tree results in fewer scaffolds and reduced shoot extension on scaffolds present (Figure 8). This cultural management to limit seasonal tree growth actually results in earlier flowering and fruit production, allowing evaluation of trees/fruit to be completed by the fourth year after planting –vs. 5 to 6 years in the old system. In addition, this approach allows a more accurate assessment of individual tree structure and crop bearing-habit (such as the potential for spur bearing) than was possible with pruning.

Figure 8. Unpruned seedling tree showing desirable compact growth and reductions in number of scaffolds and shoot extension.

Thinning.
Standard procedure involved hand thinning of each individual flower requiring a large number of individuals working over a large period of time.
Solution.
An experimental weed eater-type mechanical flower thinner (Darwin Fruit Thinner-Figure 9) being tested by Scott Johnson was modified to work on young, high density seedling progeny trees. The machine resulted in inevitable differences in the thinning of interior (inaccessible) and exterior (accessible) scaffolds and so give us the opportunity to assess fruit set/sizing potential under both high crop and low crop conditions. However, these differences also required more precise manipulation of orchard equipment such as flail-mowers within these higher density fruiting orchards. In addition to mechanical flower- thinners, we are also experimenting with dormant-season sprays reduce overall flower and so final fruit densities as well as using modifications

Figure 9. Darwin fruit thinner.

of the development to reduce thinning needs. For example, unpruned trees in their second season of food production will often show significantly lower flower densities because of aggressive new shoot growth resulting from pruning back occur. Also suppressed was the renewal of lower fruit-anger wood (Figure 10) which, while desirable in our seedling evaluations, would be undesirable a commercial operation because of the dramatic reduction in crop potential.

Orchard removal.

Standard procedure involved hand sawing of up to 10,000 individual 5-7 year old trees (owing to the high risk of injury of unskilled laborers using chainsaws) followed by bulldozing. Hand sawing required a small of experienced workers working over a large period of time as so was very costly.

Solution.

Forestry- type hand herbicide applicators (EZ-Ject) are used to rogue-out trees during the first two years of growth. A hydraulic powered mobile tree-pruner (Tree Squirrel) was also modified to allow rapid rouging-out of older seedling trees within rows within the evaluation season (Figure 8). After 4 years the remaining trees were cut back with chainsaws by prior to being bulldozed. More recently, we are experimenting with leaving all seedling trees until bulldozing at year 4 since it is cheaper to leave even undesirable trees in the orchard until its removal. To reduce the high-density growth suppression undesirable trees during their final 2 evaluation years, nearby undesirable trees are killed using the Roundup injection (Roundup does not move to kill adjacent trees through root grafting as can occur with walnut). The dead trees, however, remain in place as they tend to help support and train targeted evaluation trees.

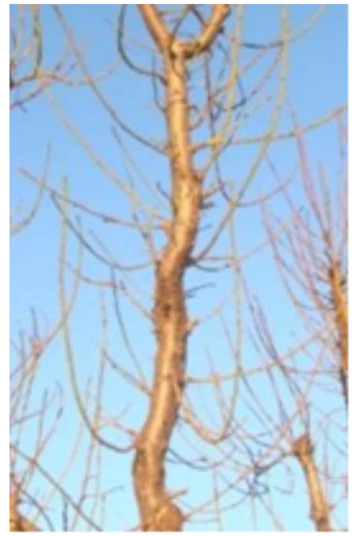

Figure 10. Fruit-hanger wood induced by toping (pruning) shoot terminals though much less induced on lower branches were pruning is absent.

Figure 11. EZ-Ject herbicide applicator injecting a 22 shell filled with glyphosate into the base of the tree to be killed (left). Close-up of the glyphosate filled 22-shell showing its position in the outer tree bark where the glyphosate will be slowly released. The slow release of systemic herbicide also kills even the finer root strands and so dramatically reduces orchard replant problems from root knot nematode etc.