HARVESTING: From manual to mechanical

Harvesting grapefruit with one-box plastic boxes that will be hand loaded into a truck.

Harvesting fruit with 10-box metal bins.

This first article in a series about mechanical harvesting takes a quick look at the past.

By S.H. Futch, J.D. Whitney, J.K. Burns and F.M. Roka

Mechanical harvesting and many other improvements in harvesting of Florida citrus have their origins in the mid-1950s. During the 1950s and 1960s, a consistent labor supply for hand harvesting was becoming increasingly difficult to obtain and acreage, along with yields of Florida citrus, was steadily increasing.

These concerns led to the development of a citrus mechanical harvesting program spearheaded by the Florida Department of Citrus, the United States Department of Agriculture and the University of Florida. The program sought to develop harvesting systems to remove or aid in the removal of fruit, thereby reducing the number of hand harvesters needed. Industry interest in mechanical harvesting decreased in the 1980s when the devastating freezes of 1983, 1985, and 1989 decreased acreage and volume of fruit to be harvested.

More recently, while sufficient labor has been available to hand harvest the citrus crop, the cost for hand harvesting operations has steadily increased without regard to the delivered-in price that growers received. In today's production system, it is easy to spend more for harvesting the crop than for all other production costs combined, including fertilizers, sprays, irrigation and weed control.

The cost squeeze (increasing harvesting costs and steady or decreasing price for fruit) results in small profit margins currently being experienced by growers and led the Florida Department of Citrus to resurrect the mechanical harvesting program. Galen Brown was hired as the program's administrator and the Citrus Harvesting Research Advisory Council was convened in 1995. The goal of this program is to develop harvesting systems that reduce harvesting costs.

Harvesting is the last major area where growers can achieve cost reductions via mechanization. Commercially available systems can help growers maintain profitability in a global marketplace. Interestingly, citrus is one of the last major tree crops which still relies on hand harvesting. Most of the other major tree crops, even some which are intended for the fresh market, have adopted mechanization, thereby reducing labor requirements as well as total harvesting costs.

THE 1950s

In the 1950s, initial mechanization programs resulted in the conversion of harvesting systems from the standard wooden 90-pound field box to larger containers which utilized a tractor mounted system and 10-box wire baskets. These baskets were transported to and dumped into high-lift trucks which could contain 60 to 100 boxes of fruit. Additional advancement led to the development of 'Lightning Loaders' which provided greater harvesting efficiencies. These trucks allowed loading of semitrailers which were located outside the grove, thus replacing the single-axle trucks which had been previously used. Converting from the 150-180 box single-axle trucks to utilization of semi-trailers significantly reduced transportation and unloading labor requirements at the processing plants.

It was not until the 1970s that the wire baskets were replaced by the currently used round polyethylene tubs. While this mechanization aided in the loading process, fruit was still harvested by hand from ladders by thousands of hand harvesters throughout the state.

RESEARCH AND SYSTEM DEVELOPMENT

During the last 40 years, significant efforts have been devoted to improve productivity and mechanize the harvesting of the Florida citrus crop. Initial work focused on ways to improve the hand harvesting operation by providing harvesting aids to improve worker productivity. Through these studies, it was determined that the hand harvesters spent at least 25 percent of their time in activities that were not directly related to fruit removal from the tree. Various aids were subsequently developed that provided marginal improvements in harvesting efficiencies, but these harvesting aids and systems have experienced limited long-term successes.

Beginning in the 1960s, efforts were directed at developing mechanical harvesting systems that provided mass removal of the fruit from the tree. These initial systems either shook the entire tree near its base (trunk shakers) or would attach to a single large limb (limb shakers) to remove fruit by shaking action. Systems were integrated with a catch system mounted to the shakers, which minimized dropping fruit on the ground and improved overall harvesting labor productivity.

When shake and catch systems are employed, you actually have a unit on each side of the tree, one with a trunk shaker and one with a system to collect the fruit, separate trash (leaves and stems) from the fruit and then convey the fruit into a truck to be transported to a semi-trailer at the edge of the grove. With a catch frame, trunk or limb shakers could improve hand harvest labor productivity from

8-10 boxes per hour to slightly more than 30 boxes per hour.

Other harvesting systems utilized air speed (wind) or pressurized water as the fruit removal force. Once the fruit was on the ground, rakes and windrow machines gathered and collected fruit, removed leaves and trash and transported the fruit from the field to roadside trailers. Once the fruit was loaded on semitrailers, it was then transported via conventional methods to the processing plant.

ABSCISSION

Researchers developing these early systems quickly realized that if products or materials were developed that loosen the fruit from the tree, improvements in harvesting rates could be achieved. These fruit loosening agents were termed abscission materials. Work has continued on the development of these abscission materials with significant effort in developing or securing compounds that can be registered for use in commercial citrus.

The removal of Valencia oranges has posed additional concerns to the development of systems or a combination of systems to aid in the removal of the mature fruit while not significantly removing the young, developing crop. With the development of appropriate abscission chemicals, selective fruit removal could be enhanced.

SYSTEMS OF THE 1990s AND PRESENT

From these early beginnings, modern mechanical harvesters have emerged. The units which are currently being utilized in the industry are of two basic types – the trunk or canopy shake systems. Various types of these harvesting systems will also operate with a catch frame system which is incorporated to catch the fruit and load it into a truck for transportation to a semitrailer at the edge of the grove. These systems will be discussed individually in future articles.

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What's new in citrus rootstock improvement?

Introducing 'mandelos' and 'tetrazygs'

By Jude W. Grosser

Developing new rootstocks is daunting and time-consuming. Historically, it has taken from 35-50 years to develop and release a new rootstock (i.e., Carrizo and Swingle).

The long list of traits necessary for improved rootstocks continues to grow. The incidence of citrus blight is increasing, Diaprepes root weevil and Phytophthora palmivora have emerged as new threats, and tree size control has become more important to reduce harvesting costs. We would of course love to have an acceptable replacement for sour orange that is resistant to CTV-induced quick decline disease.

The use of emerging biotechnologies offers new approaches that may allow for more efficient packaging of all the necessary attributes into improved rootstocks. New ideas being employed to evaluate new material also have potential to greatly shorten the time required to release an improved rootstock. This report will discuss some of the novel approaches being utilized at the CREC (University of Florida Citrus Research and Education Center at Lake Alfred) in efforts to develop and evaluate improved rootstocks for the Florida citrus industry. Continued cooperation with forward-thinking Florida growers will also play an important role in this process.

Somatic hybridization for rootstock improvement

Citrus is one of the few commodities where somatic hybridization (the fusion of individual cells from two parents performed in a petri dish) is reaching its predicted potential. Somatic hybridization differs from conventional hybridization (traditional breeding) in that the complete genetic information of each parent is added together (in conventional hybridization, each hybrid gets a segregated half of each parent's genes). Therefore, instead of the 'x' used to designate a sexual cross, we use a '+' to denote the additive nature of somatic fusion. Another difference is that you only get one hybrid from each parental combination, rather than an unlimited amount from a sexual cross; so, there is only one to evaluate. Citrus somatic hybrids are now possible from many desirable parental combinations.

Complementary hybridization:

For the past 19 years, the primary strategy of my program for rootstock improvement has been to combine complementary diploid rootstocks by cell fusion to generate tetraploid somatic hybrid rootstocks. For example, the fusion of sour orange with Carrizo citrange may combine the CTV-induced quick-decline resistance of Carrizo with the blight tolerance of sour orange. Successful somatic hybridization has been accomplished for numerous combinations, and more than 70 such hybrids have been propagated and entered into commercial field trials.

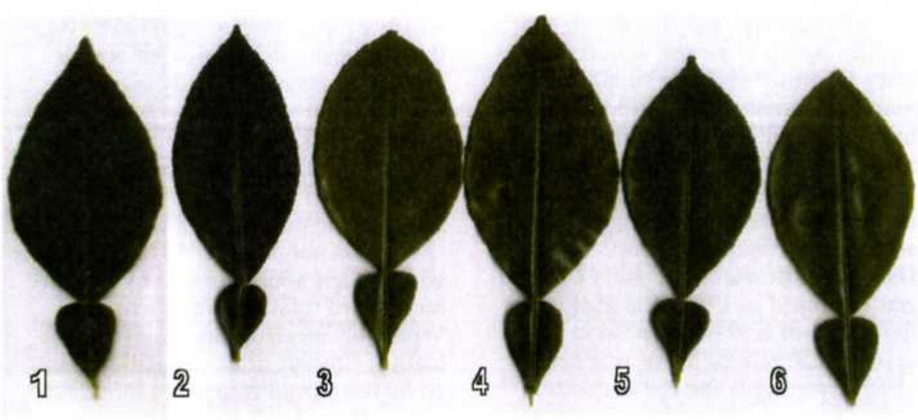

Figure.1. Leaf morphology of sour orange and some new somatic hybrids of mandarin + pummelo ('mandelos'). 1- Sour orange; 2 - Amblycarpa + C. grandis 'Chandler'; 3 - Amblycarpa + HBP (Hirado Buntan Pummelo); 4 - Amblycarpa + HBP sdl-JL-2B; 5 - Amblycarpa + HBP sdl-5-1-99-1B; 6 - Amblycarpa + 'LingPing Yau'-sdl-8-1-99-4A.