

Close-up view of the picking assembly and trash throwing belt on an OXBO pickup machine.

Citrus fruit pickup machines

By Reza Ehsani

urrently in Florida, the most widely used type of citrus mechanical harvesting machine is the "continuous canopy shake and catch" system, which is used mainly by large growers. The size, cost of operation, and transportation of this large machine has limited the ability of small- to medium-size growers to make use of mechanical harvesting technology.

Small- to mid-size growers have limited options in choosing a mechanical harvesting system for their groves. Presently, small- to mid-size citrus growers can use a tractordrawn canopy shaker which shakes the fruit from the tree to the ground. With this option, hand labor is still needed to pick up the fruit. A "pickup machine" that lifts fruit from the ground could complement the tractor-drawn canopy shaker and aid in fully automating the harvesting process.

Pickup machines have been used for crops such as nuts for many years. Since 1970, different concepts for picking up citrus fruit have been developed and investigated; none have been commercially adopted. These systems were mostly tractor-driven, raked fruit into the row middle, and then picked up the fruit using a rotating paddle wheel. Most of the old design concepts for pickup machines are not suitable for today's groves with their smaller tree row width.

In general, a pickup machine consists of a raking system, pickup head, trash removal mechanism, and a series of conveyor belts. The raking or sweeping system is used to move the fruit from below the tree canopy into the middle of the row, where it can be picked up by the pickup head. The trash removal mechanism is an important component because it separates all unwanted objects from the fruit and can also remove soft and damaged fruit prior to loading onto a field truck.

A pickup machine must meet the expectations of growers and processors before it can be widely adopted. From the growers' point of view, a pickup machine needs to economically outperform the labor cost for hand-picked fruit to justify the purchase of these machines. That means, in addition to operation costs, other factors such as percent fruit recovery, percent fruit damage, average pickup rate, average ground speed, and ability to perform in different grove designs and soil conditions should be considered.

In addition, growers need to consider other costs such as skirting and repair costs due to damage to the irrigation line. On the other hand, the juice processing industry is more concerned about trash removal efficiency, percent sand in the fruit, percent damaged and split fruit, and overall fruit surface microbial load. Designing a machine that can meet all these requirements is a challenging task.

The OXBO International Corp. (OXBO) has recently introduced a new pickup machine prototype that can gather the fruit from the ground and transfer them to a truck that transports the fruit to the trailer. The OXBO pickup machine is a self propelled rake, pickup, and cleaning system with suitable size to operate in modern groves and uses a 7-feetwide, front-mounted innovative pickup head mechanism to pick detached fruit from the ground. The machine requires a single operator and needs a field truck to follow behind it to carry the fruit.

Two long arms on the front of the machine sweep oranges from under the tree canopy. A belt with iron rods is provided in front of the picking assembly to deflect trash such as bottles, cans or large branches. The pickup head assembly, using lollipop-type fingers, picks up the oranges from the ground. The oranges are transferred into an auger which moves them into a conveyor. Cleaning brushes push the sticks and leaves off to the side. Then, one set of pinch rolls removes stems from the oranges as well as small particles and debris. A second pair of pinch rolls removes split or rotten fruit which are collected on a rubber sheet before the fruit is conveyed to the field truck.

This pickup machine was evaluated by the Citrus Research and Education Center and preliminary results show that the average picking rate was 353 lb./min in the "ridge" area of Florida and 210 lb./min in the "flatwood" area. This flatwood area has a bed and swale type planting system and will be more challenging for the machine to operate. In order to be economically feasible, a picking rate of at least 540 lb./min is required. The picking efficiency was about 97 percent on the ridge area and about 80 percent in the flatwood area.

Only 0.53 percent of the fruit was damaged in the ridge, but approximately 9 percent of flatwood fruit was damaged due to difficulty in fruit pick up in the swale. The new OXBO pickup prototype, which is still under development, has good potential for commercialization if the pickup rate can be increased, particularly in flatwood groves.

THE TRASH CHALLENGE

For the pick up machines, trash seems to be one of the biggest challenges. Branches, glass or plastic bottles, empty cans, and irrigation pipes can cause damage to the pickup machine or can be picked up with the fruit, which is highly undesirable for delivery to processing plants.

Pickup machines, like any other equipment, are designed to perform the best under certain conditions. Grove condition can significantly affect the performance of these machines. For example, the presence of excessive trash and weeds, or unskirted trees, and an uneven surface of the row middle will reduce the machine performance. In addition, there may be certain environmental conditions such as wet soil or high temperature in which the use of these machines may not be advisable due to an increased potential for microbial load or sand content in the fruit.

The combination of a pull-behind,



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tractor-driven canopy shaker and a pickup machine could provide a new option for small- to medium- size growers. When a large quantity of fruit needs to be collected in a short time, such as massive fruit drop caused by a hurricane, large storm or labor shortage, a pickup machine would be a very valuable piece of equipment.

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