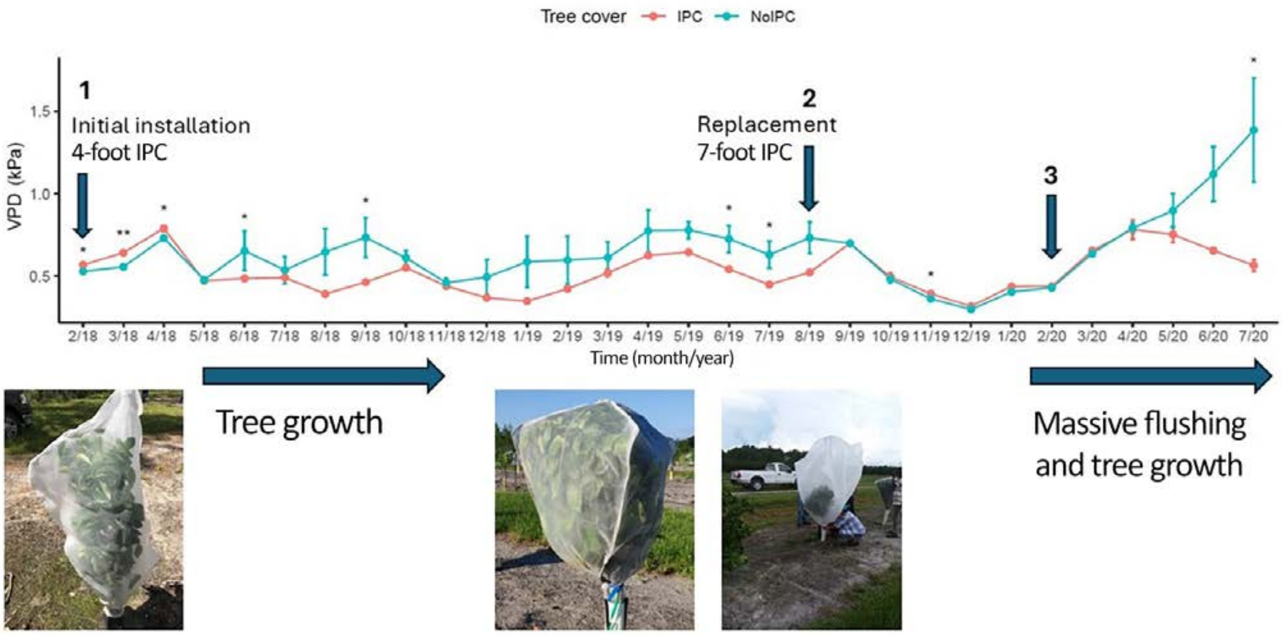

Figure 1. Evolution of vapor pressure deficit (VPD) in an individual protective cover (IPC) trial that lasted for 30 months, from initial planting and adoption of small 4-foot IPCs to substitution with 7-foot IPCs. The arrows mark initial planting and IPC installation (1), IPC replacement (2) and onset of spring flushing under large IPCs (3).

Water use under individual protective covers

BY FERNANDO ALFEREZ AND OSBALDO VASQUEZ

During the last seven years, the University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) Southwest Florida Research and Education Center (SWFREC) in Immokalee has been performing comprehensive studies on the use of individual protective covers (IPCs). This tool is now adopted by most growers planting new citrus trees in Florida both in solid sets and resets in mature declining groves.

In an initial trial that spanned for 30 months with Valencia scion grafted on Cleopatra rootstock (Gaire et al., 2021), trees were covered with small 4-foot IPCs for 18 months. Then, to allow more canopy growth, the covers were substituted for larger 7-foot IPCs that were maintained for 12 more months.

MEASURING VPD

Vapor pressure deficit (VPD) was monitored during these 30 months with dataloggers. VPD is a measure of how dry the air is, indicating the difference between the actual amount of water vapor in the air and the maximum amount it could hold at a given temperature. A higher VPD means the air is drier and more likely to draw moisture from plant leaves and soil, contributing to water stress conditions. A lower VPD, on the contrary, allows stomata to be open for a longer time, as conditions are not conducive to plant dehydration.

As shown in Figure 1, during the 30 months of the study, the VPD ranged from 0.32 kilopascals (kPa) to 0.79 kPa for trees with IPCs and from 0.30 kPa to 1.4 kPa for trees without IPCs. In other words, trees covered with IPCs had a significantly lower VPD compared to non-covered trees during most months between June 2018 and August 2019 and during May to July 2020.

In other studies, a reduction in VPD, air temperature, evapotranspiration and higher humidity was reported when using other plant covers. Under these conditions, higher photosynthetic rate, stomatal conductance, CO_2 assimilation and water-use efficiency were also reported. These conditions generally promote tree growth, which is what was observed in the study. Trees showed larger canopies and were taller than non-protected trees. However, this was observed only during the end of the experiment. Consistent with this, the largest differences in VPD were observed also during the last two months of the experiment. This fact caught the researchers' attention.

They hypothesized that when tree canopies are smaller and there is more free space inside the IPCs, VPD tends to be similar to that in the surrounding atmosphere. As the tree grows and occupies the space inside the IPC, VPD lowers as the air is more humid than in the surrounding atmosphere. This fact can be seen in Figure 1 (page 22). The arrows show the times of IPC installation and substitution, as well as when the tree started flushing and producing more biomass that fills the empty space inside the IPC.

In three instances, significant variation in VPD was seen:

1. At IPC installation. Interestingly, here VPD was higher in covered trees for a couple of months. This may be attributed to the planting and manipulation stress. After that period, VPD in covered trees was consistently and significantly lower than in non-covered trees.
2. At IPC replacement. Here, as there is new empty space still to be filled with tree biomass, internal VPD is equal to external VPD until spring flush starts.
3. Once spring flush ceases and a bigger canopy is established, VPD inside the IPCs again is significantly lower than in the outside surrounding atmosphere. Figure 1 shows that VPD is lower inside the IPCs. It is also more constant, showing less variations. All data were collected with dataloggers installed in bottom zip-tied IPCs.

ZIP-TIED VS. OPEN-BOTTOM IPCS

Many growers are not zip-tying the bags; they leave the bottoms open (Figure 2A). This has advantages as installation of the IPCs is less labor intense and faster, and a loose bottom

Figure 2A. Open individual protective covers (IPCs, top) and zip-tied IPCs (bottom) in commercial groves.

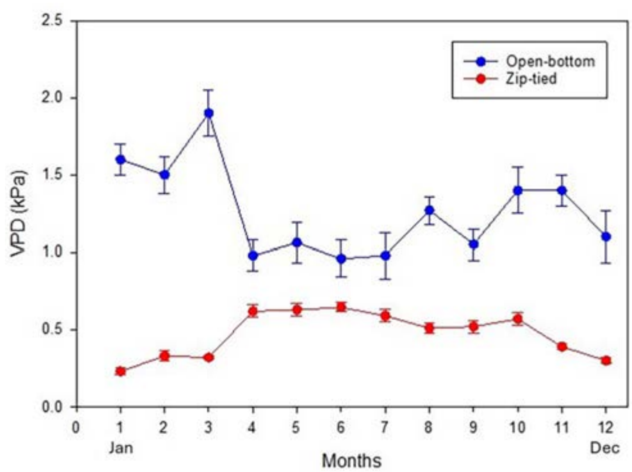

Figure 2B. Vapor pressure deficit (VPD) under open-bottom IPCs (blue) and zip-tied IPCs (red). Note the significantly higher and more variable VPD under open-bottom conditions.

may allow some beneficials to enter the canopy and reduce some secondary pests. However, the impact of this practice on the environmental conditions inside the bag and its effect on tree growth has not been studied in detail. Zip-tying or not may have some implications not only on tree growth but also on irrigation frequency and water-use efficiency.

To address these questions, UF/IFAS is conducting several trials. In the first trial on Valencia trees grafted on US-942, VPD was indeed significantly different when comparing zip-tied to open-bottom IPCs (Figure 2B). The fact that VPD in open-bottom IPCs is comparable to open-field conditions, more variable and higher than in zip-tied IPCs is of concern, as one of the advantages of IPC use may be lost at least in the first year or so.

Tree growth is currently being monitored in both IPC conditions to determine any effects on tree growth in the long run. Additionally, researchers are interested in knowing if water use will be different (i.e., if more frequent irrigation will be necessary in open-bottom IPC trees to achieve the same growth as in zip-tied IPC trees). This may have significant consequences on water regimes adopted in groves to achieve the best results on tree development and on tree water usage.

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