

DRAFT Citrus Producers Guide to Preparing for and Recovering from Hurricanes in the Southeast U.S.

This is a draft of guidance being developed by the USDA SE Climate Hub to help citrus producers prepare for and recover from hurricane damage.

This section will focus on:

- Long- and short-term recommendations for building resilience to hurricanes in citrus groves, nurseries and citrus under protective screens (CUPS).
- Damage evaluation to assist with recovery.
- Horticultural recovery efforts to put the trees back into production.

I. Pre-Hurricane Planning – Long-term Preparedness

Measures taken to protect managed land from hurricanes expected to come in months or years (i.e., the coming hurricane season and future hurricane seasons)

Initial Site Planning

- Consider water table and soil drainage. Total water management is a must and should be planned ahead. Irrigation and drainage systems must be in place.
 - Automated drip or microsprinkler irrigation systems must be installed and well maintained. This will allow to fine-tune irrigation after flooding.
 - Surface and subsoil drainage must be adopted. A system of canals, ditches, beds and/or drain tiles must be included.
 - Water retention areas are recommended.

Site Establishment

- Carefully consider windbreaks. Past experience on two of the most popular species in Florida (eucalyptus and red cedar) showed that red cedar resist strong winds much better than eucalyptus.
- When planting trees under protective screens, make sure that screens can be removed and put back in place easily and quickly.
- Ditches between beds (especially in south Florida) must have enough capacity to accommodate and channel excess water.

Seasonal Considerations Outside of Hurricane Season

- Ditches should be kept clean through a good maintenance program including chemical weed control. Tree recovery from temporary flooding is more effective under good drainage structure maintenance conditions.
- Trees should be pruned regularly to reduce broken limbs and minimize toppled or uprooted trees.

Monthly Considerations During Hurricane Season

- Monitor water table regularly. In south Florida, flatwoods soils have a restrictive (argillic or spodic) layer within 30 to 48 inches of the soil surface that can perch the water table and significantly affect tree water relations. To optimize production and tree health, water table level should be monitored and maintained within an optimal zone.
- A general rule of thumb is that 1 inch of rain will cause the water table to rise about 10 inches in fine textured soils, 6 inches in most of the flatwoods sandy soils, and 4 inches in coarse sands. It may take 4 to 6 days for the water table to return to its desired levels following rains of 1 inch or more.

Annual Considerations

- Maintain windbreaks in good shape with regular pruning, especially if they are close to aerial power or telephone lines.
 - Train personnel, especially in the safe operation of unfamiliar equipment that they may have to use.
 - Consider getting a UAV pilot license and to purchase a UAV. This will help with damage assessment when access to the grove is impossible or not safe.
-

II. Pre-hurricane Planning – Short-term Preparedness

Measures taken to prepare for an existing hurricane that is forecast to make landfall in the next week or less

When a Hurricane Is Forecast to Impact Your Area (1 to 7 days before)

- Personnel assignments must be ready
 - All managers must know their responsibilities and establish action teams for preparation before the hurricane and recovery after the hurricane.
 - Make a list of all tasks.
- All emergency equipment must be ready (generators, chain saws, compressors, heavy machinery).
- Communication equipment must be ready.
- Have a list of phone numbers, emails and addresses of all employees.
- Have a list of updated phone numbers for police, fire dept., medical facilities and electric companies.
- Pump down all water from ditches.

One Day Before a Hurricane is Forecast to Impact Your Area

- Move machinery, pesticides, herbicides and fertilizers to a secure place (or high ground if possible).
- Disconnect electrical power to all buildings that may get flooded.

- Remove greenhouse plastic, shade cloth and screen from screenhouses. If trees are potted, lay them on the ground to avoid wind damage.
 - Shut down gas pumps.
 - Tanks containing fuel, fertilizer, and other materials should be kept full so they do not move by the wind and rain, and to ensure that sufficient fuel is available for machinery which will be used in recovery efforts after the storm.
-

III. Post-hurricane Recovery

Measures taken to assess and repair damage after a hurricane

Immediately After the Hurricane has Passed

- As soon as it is safe, call in the employees needed for inspection and clearing debris from roads. Understand that any employee may have also emergencies and domestic issues.
- Clear road access to have a clear path for workers and speed up recovery.
- Visually inspect the grove and do an initial damage assessment. This has to be done safely, easily and quickly by using UAVs (drones)
- Start pumping excess water out of the grove.
- As soon as possible, reinstall plastic covers in greenhouses and screens in the CUPS structures. This should be done in less than one week to avoid psyllids and other pests getting in contact with the trees.
- Reset potted trees to an upright position.

Within a Week Following Hurricane Impacts

- Remove water from the grove, ideally in the first 72 hours to avoid root damage from flooding.
- Upright toppled trees as soon as possible. Sometimes this cannot be done within one week. Experience shows that tree recovery is good even for trees that were toppled after 3 weeks.
- Prune back toppled trees and remove any broken limbs.
- Paint exposed trunks and branches with white paint to prevent sunburn.
- If flooding occurred, assess root damage
 - Short-term estimates of flooding stress can be obtained by digging into the soil and smelling soil and root samples. Sour odors indicate an oxygen deficient environment. The presence of hydrogen sulfide (a disagreeable rotten egg odor) and sloughing roots indicate that feeder roots are dying.
 - Symptoms of flooding injury may occur within a few days or weeks, but usually show up after the water table has dropped and the roots become stranded in dry soils. Leaf wilting, leaf drop, chlorosis, and dieback may develop and tree death may occur.
 - With acute water damage, foliage wilts suddenly followed by heavy leaf drop. Trees may totally defoliate and actually die, but more frequently partial defoliation is followed by some recovery.

Within a Month Following Hurricane Impacts

- The shoot to root ratio may need to be reestablished by canopy pruning
- Reschedule irrigation to minimize flooding and water damage. Once the grove has recovered from flooding, normal irrigation scheduling may be resumed.
 - Evaluate soil and root conditions after flooding subsided.
 - Determine potential for fungal invasion through soil sampling and propagule counts.
 - If there is a Phytophthora problem, fungicides may be used. Use of fungicides should be based on rootstock susceptibility and history of Phytophthora disease problems in the grove.
 - Reduce irrigation amounts but increase frequencies. This will adequately provide water to the depleted, shallow root systems, allowing them to regenerate.
 - Maintain subsurface moisture to promote development and growth of feeder roots.
 - In heavily damaged root systems, frequent irrigation at reduced amounts may be necessary for more than one month, well into the winter months to allow enough time for roots to resume new growth.
- Fertilization must be adapted to the new situation
 - Fertilization rates and schedules must be adjusted for flood-damaged trees.
 - Severe leaf loss must be replaced to maintain fruit production. This may be achieved by using balanced nutrition.
 - More frequent than normal foliar or light ground applied fertilizers will allow roots to regenerate. Periodic visual inspection of the trees will allow to assess the recovery and adjust the fertilizer program.

This draft guidance was developed by subject matter experts from the University of Florida



Fig 1. Flooding caused by a hurricane. Credit: Dr. Mongi Zekri



Fig 2. Flooding raising the water table and causing leaf wilting and root damage to a citrus tree. Credit: Dr Mongi Zekri.



Fig 3. Root rot caused by flooding. Credit: Dr Mongi Zekri.



Fig 4. Toppled trees with broken trunks that have to be uprooted and replaced. Credit: Dr. Mongi Zekri



Fig 5. Toppled trees which can be saved by quickly resetting them to an upright position. Credit: Dr. Mongi Zekri



Fig 6. - Resetting of toppled trees to an upright position after pruning.