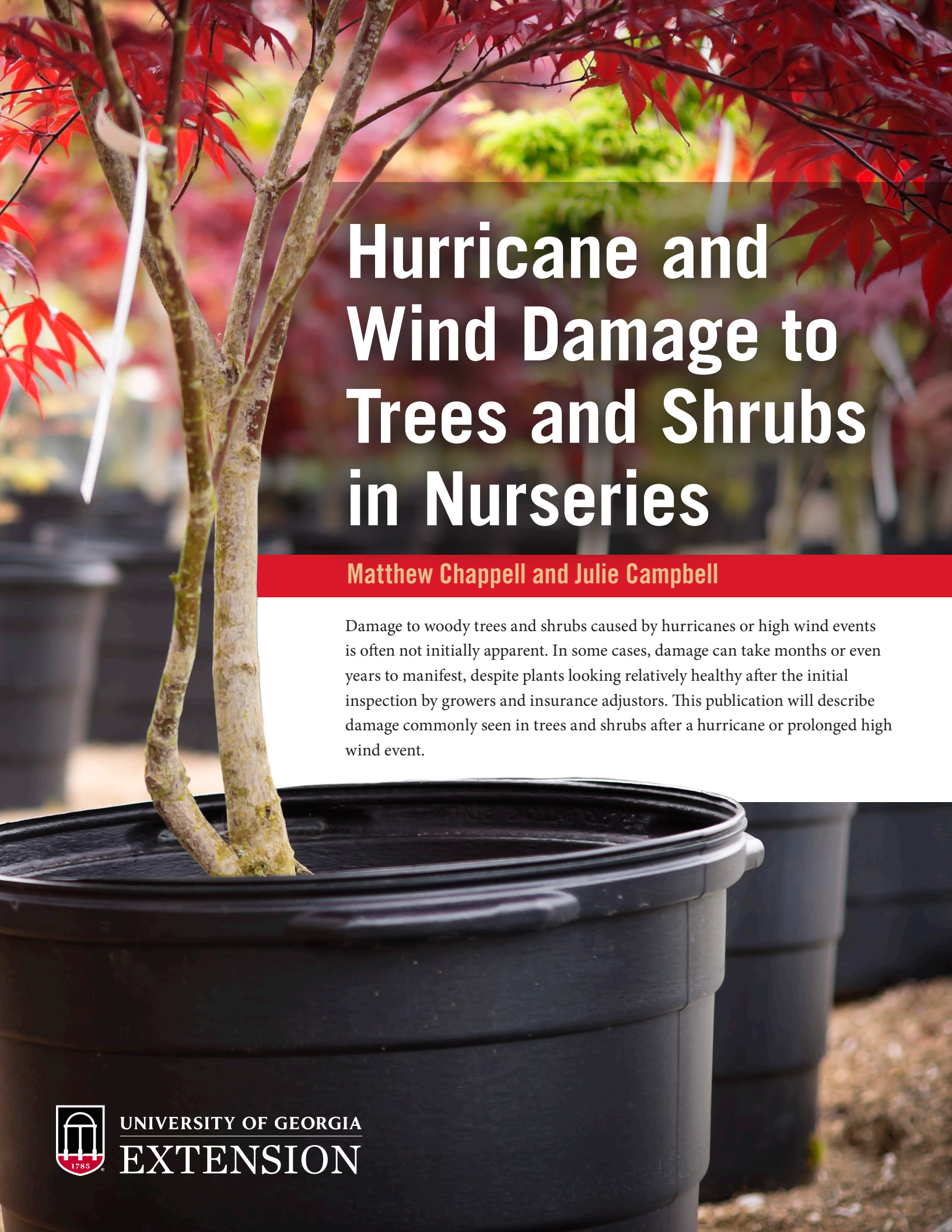

# Hurricane and Wind Damage to Trees and Shrubs in Nurseries

Matthew Chappell and Julie Campbell

Damage to woody trees and shrubs caused by hurricanes or high wind events is often not initially apparent. In some cases, damage can take months or even years to manifest, despite plants looking relatively healthy after the initial inspection by growers and insurance adjustors. This publication will describe damage commonly seen in trees and shrubs after a hurricane or prolonged high wind event.

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# Phases of plant damage

Damage to container-grown trees and shrubs presents differently than damage to annual agronomic crops such as cotton or peanuts. However, like agronomic crop damage, significant reductions in quality can cause a decrease in value and a negative net profit, despite a lack of substantial plant mortality. Woody ornamental crops are perennial—meaning that they don't have to be replanted every year—so damage is frequently observed throughout the subsequent growing season or beyond. There are three distinct phases of damage development after a hurricane or wind event:

## 1. Initial damage:

Immediate damage typically manifests as plant death and can be seen within a week after the event. Plants can be drastically misshapen due to the canopy being pushed toward the leeward wind side of the container, and stem or branch breakage can cause an irregular canopy shape. Prolonged flooding can result in significant root damage due to a lack of air exchange in the root zone, which can lead to immediate or lagging susceptibility to pathogens and/or insects.

## 2. One week to several months:

Secondary damage includes damage to the crown of the plant, which is the stem just below the soil line. This occurs when there is incomplete fracturing and/or damage to the stem/trunk from the buffeting of high winds. The result can be separation of the cambium (vascular tissue) from the pith (inner wood). Primary roots can also be damaged as plants violently shift in the container or field. Secondary pathogen infection is common when primary roots fail. Damaged roots serve as entry points for pathogens and also release sugars (carbohydrates) that serve as a food source for soilborne pathogens. Finally, some plants that are defoliated due to high winds will try to push new growth. When this growth is initiated late in the growing season, the result can be significant cold damage during the first freeze event.

## 3. Several months to one year:

Trees will be substantially more prone to secondary fungal, bacterial, and insect damage when weakened by a storm event. Pests either enter through damaged tissue or are drawn to the plants by chemicals, especially ethylene, released by damaged and decaying tissue. In cases where major damage occurs across a nursery, it is difficult and costly to apply preventative chemical treatments to control these issues.

# Types of plant damage

## Trunk damage:

Trunk damage (Figure 1) may be obvious (e.g., broken or cracked trunks) or subtle. Significant bark or cambium injury renders the plant a complete loss whether the tree or shrub is a single trunk or trained to multiple stems. Rub damage is often initially overlooked within a few days of the event, as plants show little to no visible signs of stress.

**Figure 1.** Catastrophic trunk damage to trees and large shrubs.

Left: Close up of bark and cambium damage resulting from support system movement.
Right: Near complete defoliation and canopy death as a result of the damage.

## Misshapen plants:

Hurricanes and wind from strong storms can push tree and shrub canopies toward the leeward side. It is difficult to straighten tree trunks and canopies without causing notable root damage or breaking the trunk. Generally, the only remedy to misshapen plants (Figure 2) is to prune them considerably and allow regrowth. The extra time and labor expended on the plant typically results in crop being delayed to market and sold at a net loss.

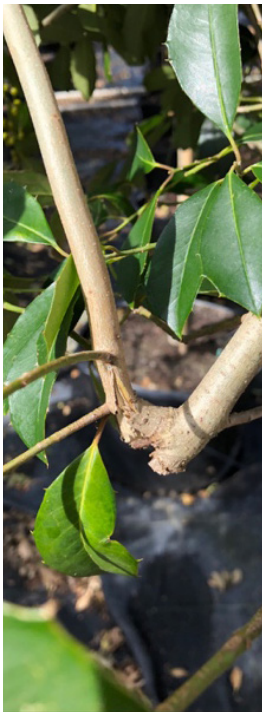
**Figure 2.** Misshapen loropetalum due to high winds from the left, causing the plant to lean considerably to the right.

## Stem breakage:

Stem breakage (Figure 3) to secondary branches (stems originating from the trunk) or stem tips (outermost growth) can occur on the windward side due to wind force, or the leeward side of the tree due to physical damage after a fall. Generally, the only remedy to stem breakage is to prune plants significantly and allow plants to regrow, which can add an entire season or more to the production cycle. This additional time and labor typically results in plants being sold at a net loss.
***Note: In cases of mid- to late-fall damage, plants should not be pruned until dormancy to avoid cold damage as a result of new growth.***

**Figure 3.** Stem breakage such as this secondary ilex stem (right) result in misshapen canopies (left) that require major pruning to rehabilitate.

The red highlighted area represents the void in the canopy that resulted from a secondary stem failure.



# Crown damage:

Crown damage (Figure 4) can occur at or below the soil line and, as a result, can be very difficult to pinpoint. In seed-grown plants, damage is typically isolated to the root flare. In vegetatively propagated plants, damage typically occurs just above the first lateral roots. Incomplete fracture of primary stems or the trunk is difficult to diagnose until water stress is imposed on the affected plants, at which time the foliage will suddenly wilt and die. Crown damage is common on those plants that appear misshapen with a wind-blown appearance. This is exacerbated when growers try to remedy misshapen plants by forcing the stems back to an upright position.

**Figure 4.** Crown damage at or below soil line.

The plant on the left has died due to the stem breaking below the soil line, whereas the plant on the right still appears healthy, although it is misshapen due to wind. With time, the plant on the right may also decline for the same reason.

# Incomplete (initial) trunk damage:

Most trees produced are supported ("trained") with the aid of stakes. In some cases, a more permanent support system using wires prevents blow-over. Both stakes and wire support systems can cause what appears to be minor damage to the cambium in the immediate days or weeks after a hurricane event. However, the damage becomes progressively worse over the proceeding winter as freeze-thaw cycles result in the cambium completely detaching from the pith (wood) of the tree. The resulting damage is apparent as plants initiate growth the following season (Figure 5).. Foliage will emerge notably smaller and less dense, and cankers (swollen areas on the trunk) will form at or just below the damage point. These trees should be considered a total loss. Additionally, they represent a liability if sold, as they can fail in the landscape (typically within 10 years after planting) and cause substantial property or personal damage.

**Figure 5.** Incomplete (initial) trunk damage due to a strap/wire support system (top) and bamboo staking (bottom).

In both of these cases, there is no noticeable effect currently (two weeks after the event) but damage will likely become apparent in the following growing season.

# Secondary pathogen infections or insect damage due to root and stem damage:

As the plants are buffeted by high winds, the root system shifts violently, causing significant breakage of primary and secondary roots. Similar breaks occur in the canopy of the tree. These roots and shoots exude sap, which has a high carbohydrate content. Root pathogens use these carbohydrates and eventually reach population levels that cannot be managed by natural plant defenses or fungicide applications, and the result is plant infection (Figure 6). Similarly, foliage that is shredded or stems that are jaggedly broken do not heal quickly. Damaged tissues produce ethylene that attracts a variety of insects (particularly wood-boring insects) and can cause entry points for canopy infections. These plants are often considered a total loss even though symptoms of infection or infestation may not become evident until the following growing season.

**Figure 6.** Secondary pathogen infection and insect infections due to root and stem damage.

In this case, a plant -volatile chemical (ethylene) is produced by the plant when it receives damage to stems and/or foliage. Granulate ambrosia beetle is attracted to ethylene and burrows into the stem of the tree, causing primary structural damage and transmitting vascular pathogens that cause disease and can ultimately cause plant mortality. This photo was taken in spring 2018 on nursery stock damaged by Hurricane Irma.

# Winter injury to new growth:

Many tree and shrub species will push new growth after a defoliation event, such as a hurricane. When defoliation events occur within six to eight weeks of the first freeze event, the plant does not have adequate time to harden off. As a result, significant winter injury can occur (Figure 7). Winter injury can both affect new growth and cause vertical fractures in the trunk. This is due to the plant's attempt to support the fresh tissue by transporting water to it. The results are seen the following spring as "oozing" wounds in bark. These wounds make great entry points for fungal/bacterial infections and/or wood-boring insects. These plants should be considered a complete loss, as cambium damage will not heal properly and will thus reduce the structural integrity of the plant.

**Figure 7.** Winter injury following new growth (caused by defoliation during a late season hurricane) is not relegated to the tender new growth.

Often, fluids in the trunk flash-freeze, causing the vascular tissues to swell and burst as ice forms. The result is major damage to the trunk, which is not seen for six to 12 months after the injury occurs. In the case of this photo, the damage occurred in the fall following Hurricane Sandy and became apparent the following June.

# The economics of plant damage

Proceeding a major wind event, plants may not initially be considered a total loss, yet there can still be a meaningful impact on revenues. Growers should immediately assess plant damage after a hurricane or wind event and document and photograph damage over subsequent months, and in some cases, over multiple growing seasons. Damaged plants can attract and harbor insects and diseases that can lead to damage of later crops by providing a source of pests/pathogens. It is not always economically viable to continue production of plants if they are found to have lasting damage. As mentioned above, damaged plants often require additional time and labor to rehabilitate them to the point of salability, reducing net income. The additional production cost should be taken into consideration and discussed with insurance personnel when assessing crop damage.

Growers should also keep in mind that, while this publication covers damage to plants themselves, high wind events can cause economic losses due to infrastructure and input losses. Examples include damage caused by a lack of irrigation due to system damage, a lack of power to run pumps, or a lack of labor to stand up containerized plants so that irrigation is effectively applied. The failure of storage buildings can leave pesticides and fertilizers exposed and sometimes ruined. Losses can also be due to production inputs being lost. For example, topdressed fertilizer is often dumped out of containers when they fall, which will need to be reapplied to maintain adequate plant nutrition. Soil can also be lost when the pots fall, which can also cause a loss of preemergence herbicide protection and quick reapplication to avoid manual weeding.

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