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FACT SHEET

EXCESS WATER PROBLEMS ON WOODY ORNAMENTALS

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Flooding, excess water, and poorly drained soils can be serious problems for many woody ornamentals. These may result in plant decline and death as well as uprooting of trees. Roots in flooded or waterlogged soils are damaged and die from oxygen deficiency, which inhibits normal respiration in the roots. This leads to sharp increases in the levels of carbon dioxide, methane, hydrogen, and nitrogen gas around the roots, causing them to suffocate and die. Additionally, toxic compounds, such as ethanol, hydrogen sulfide, and other harmful compounds often build up in saturated soils.

In addition to direct damage to the root system, flooding can incite a cascade of physiological changes in woody plants that influence growth and many other biological processes. For example, photosynthesis may be inhibited and growth may slow or stop. Flooding can also initiate changes in levels of growth regulators in a plant—increasing concentrations of auxin, ethylene, and abscisic acid, and decreasing concentrations of gibberellic acids and cytokinins. Even when standing water is not present, poorly drained soils can reduce plant growth and long–term survival in the landscape due to chronic low oxygen levels in the soil.

Tolerance to flooding depends on many factors, including plant species and general vigor, site and soil conditions, time of year, and extent or duration of flooding and water quality (Figure 1). Some plants may recover from flooding injury in one season, whereas others do not recover at all. Many popular landscape woody ornamentals are among the most sensitive species to flooding. These include Norway and sugar maple, beech, northern red and white oak, yellowwood,

Figure 1. Mature trees in standing water after a storm.

cherry, plum, eastern redbud, crabapple, lilac, rhododendron, privet, cotoneaster, euonymus, weigela, and evergreen species such as pine, Norway and Colorado blue spruce, hemlock, eastern red-cedar, and yew (Figure 2).

Figure 2. Dead yews growing in low area prone to recurring flooding after heavy rain events.

Woody plants have two basic types of roots—woody and non-woody. Woody roots are generally more tolerant to flooding than non-woody roots. Non-woody roots, also called feeder roots, comprise the majority of plant roots. These roots are responsible for uptake of water and dissolved nutrients in the soil. They are sensitive and are frequently the first ones damaged by waterlogging. When non-woody roots are damaged, they are unable to provide water to the top of the plant and a water deficit develops. Non-woody roots are fairly short-lived and last a few weeks to a year. As a result, they are continually being produced by the plant—although under waterlogged conditions, this process is disrupted so the plant has insufficient absorptive roots to meet its needs.

Damage to non-woody roots can be sudden or gradual, depending upon the plant species and the flooding conditions. This can occur on plants in obviously wet sites and those in marginal sites or soils with more subtle water problems, such as along city streets or in areas where high clay content and compaction in the soil impede drainage. Most trees and woody shrubs cannot grow in waterlogged soils for very long and can die if flooded for only a few days during the growing season. Visible symptoms are *often* not evident until considerably after the damage has occurred, especially when the root damage is gradual.

SYMPTOMS:

Symptoms of excess water depend upon the plant species and are highly variable. These include epinasty or downward rolling of leaves, stem swelling, chlorosis or yellowing of the foliage, reduced and stunted growth, twig dieback, leaf drop, early fall color, root death, and in some cases, plant death. Oedema can also develop on leaves of some species (Figure 3).

Figure 3. Oedema visible on upper (top photo) and lower (bottom photo) surfaces of rhododendron leaves after growing in waterlogged soils.

Seedlings and new transplants are more sensitive to excess water problems than established plants. This can be attributed to the lack of an established root system and to damage to the non-woody roots during the transplant process. Needled evergreens are

generally considered more sensitive to waterlogged soils than broadleaved, deciduous plants (Figure 4).

Figure 4. Fraser fir transplants with off-colored needles after growing in poorly drained soil for two years.

Symptoms of waterlogging may not develop in a woody ornamental until water demands on the root system increase, typically during the hot summer months when the canopy is actively losing water through transpiration. This is sometimes exhibited as a sudden collapse of the tree or shrub. Other trees appear to lose vigor and slowly decline over a period of years. This can occur on trees that have been otherwise "healthy" for 10-15 years, but are growing in poor sites or heavy soils. Dormant plants generally appear to tolerate flooding longer than those in active growth.

Trees with substantial root damage from flooding or saturated soils can begin to lean and are prone to uprooting or "windthrow" (Figure 5). These should be monitored and removed once they become hazardous.

In addition to direct root damage, woody ornamentals stressed by waterlogging become much more susceptible to some soil-borne pathogens. In particular, root and crown rots associated with *Phytophthora*, *Fusarium,* and *Rhizoctonia* species can occur with greater frequency on plants routinely exposed to excess water (Figure 6).

Figure 5. Tree uprooted after period of standing water and saturated soil.

Figure 6. Fraser fir with Phytophthora root rot exhibiting diagnostic discoloration of the cambium at the root/crown area.

MANAGEMENT AND REMEDIATION STRATEGIES:

Although the weather cannot be manipulated and there are no "cures" for plants permanently affected by excess water once the damage is done, there are strategies that can help to minimize the occurrence of this issue.

- Select a well-drained site and avoid planting in chronically flooded areas. Rework or modify the site by planting on raised beds or berms, or by installing drain tiles to direct water away from the root zone.
- Use sound planting and cultural practices to maintain overall plant vigor. Avoid fertilizing for at least a year following a flood because of root injury.
- Select appropriate species for soil and site conditions: water-tolerant (e.g., red maple, larch, green ash) *vs*. water-intolerant (e.g., crabapple, spruce, hemlock, yew, white pine).
- Aerate the soil around the tree or shrub to reduce compaction associated with wet or waterlogged soil. Apply organic mulch (such as shredded bark) to help remediate or improve soil structure.
- Prune and remove any dead twigs or branches, since they can serve as sites for secondary invaders or opportunistic pests.
- Monitor plants for symptoms of decline over the next few years.

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