



INVASIVE PLANT FACT SHEET

# Tree-of-Heaven

(*Ailanthus altissima*)

## Background

Tree-of-heaven (*Ailanthus altissima*), commonly referred to as ailanthus, is a rapidly growing deciduous tree native to both northeast and central China, as well as Taiwan. It was first introduced into the United States in the Philadelphia area in the late 1700s. Immigrants later introduced tree-of-heaven to the West Coast in the 1850s.

The tree was initially valued as a unique, fast-growing ornamental shade tree with the ability to grow on a wide range of site conditions, tolerating poor soils and air quality. It was widely planted from New York City to Washington, D.C. By the early 1900s the tree began losing popularity due to its “weedy” nature, prolific root sprouting, and foul odor. Tree-of-heaven has spread and become a common invasive plant in urban, agricultural, and forested areas.

## Description

**Size:** Tree-of-heaven has rapid growth and can grow into a large tree, reaching heights of 80 feet and up to 6 feet in diameter.

**Bark:** The bark of tree-of-heaven is smooth and brownish-green when young, eventually turning light brown to gray, resembling the skin of a cantaloupe.

**Leaves:** Tree-of-heaven leaves are pinnately compound, meaning they have a central stem in which leaflets are attached on each side. One leaf can range in length from 1 to 4 feet with anywhere from 10 to 40 leaflets. The leaflets are lance-shaped with smooth or “entire” margins. At the base of each leaflet are one to two protruding bumps called glandular teeth. When crushed, the leaves and all plant parts give off a strong, offensive odor.

**Twigs:** The twigs of tree-of-heaven are alternate on the tree, stout, greenish to brown in color, and lack a terminal bud. They have large V- or heart-shaped leaf scars. The twigs easily break to expose the large, spongy, brown center, or pith.

**Seeds:** Seeds on female trees are a 1-to-2-inch-long twisted samara, or wing. There is one seed per samara. The samaras are found in clusters, which often hang on the tree through winter.

## Look-Alikes

This species is easily confused with some of our native trees that have compound leaves and numerous leaflets, such as staghorn sumac, black walnut, and hickory. The leaflet edges





A



E



B



F



C



G



D

- A. Bark
- B. Compound leaf
- C. Smooth leaf margin showing glandular teeth
- D. Brown spongy pith
- E. Leaf scar on twig
- F. Winged seeds called samaras
- G. Clonal patches growing along highway

*Photos by Dave Jackson*

of these native trees all have teeth, called serrations, while those of tree-of-heaven are smooth. The foul odor produced by the crushed foliage and broken twigs is also unique to tree-of-heaven.

## Dispersal

Tree-of-heaven is dioecious, meaning a tree is either male or female, and typically grows in dense colonies, or “clones.” All trees in a single clone are the same sex. Female trees are prolific seeders with the potential to produce more than 300,000 seeds annually. The single-seeded samaras are wind dispersed.

## Management Calendar

The management calendar for tree-of-heaven emphasizes late season treatment to maximize control of the roots.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Bud Break												
Flowering and Seed Ripening												
Foliar or Stem Treatment												
Cutting after Treatment												

## Treatment and Timing

Prescriptions for controlling tree-of-heaven stress proper timing of operations to maximize injury to roots. Improper timing will result in treatments that provide “top kill” (shoot injury) but little control of the roots. Product names reflect the current Pennsylvania state herbicide contract; additional brands with the same active ingredients are available.

Treatment	Timing	Herbicide	Product Rate	Comments
<b>Foliar Application</b>	July 1 to onset of fall color	Rodeo (glyphosate)  plus Garlon 3A (triclopyr 3 lb/gal) or Vastlan (triclopyr 4 lb/gal)	3 quarts/acre  plus 2 quarts/acre or 1.5 quarts/acre	The combination of glyphosate and triclopyr provides a broad-spectrum treatment that is effective against tree-of-heaven and other woody species that should also be targeted during the operation. This is a nonselective mixture, but it has little soil activity and poses little risk to nontarget organisms through root uptake. Garlon 3A and Vastlan are both triclopyr formulations but have different active ingredient concentrations. A surfactant (e.g., Alligare 90) needs to be added. If using a different glyphosate product, be sure to check the product label to see if a surfactant is needed (some come premixed).
<b>Basal Bark</b>	July 1 to onset of fall color	Pathfinder II or Garlon 4 Ultra (triclopyr ester)	Ready-to-use or 20% by volume, 1:4 in basal oil	Pathfinder II is a ready-to-use oil-based formulation of triclopyr used for basal bark applications. Treat stems up to 6 inches in basal diameter by wetting the entire circumference of the lower 12 to 18 inches, without runoff; apply a shorter band to small-diameter stems. This technique is best suited for treating small infestations or as a follow-up to treat surviving stems after a foliar application. If stems are larger than 6 inches in basal diameter use hack-and-squirt.
<b>Hack and Squirt</b>	July 1 to onset of fall color	Rodeo (glyphosate) or Garlon 3A (triclopyr 3 lb/gal) or Vastlan (triclopyr 4 lb/gal)	Use either product undiluted or 1:1 with water	Glyphosate or triclopyr in water are effective for hack-and-squirt treatments. It is essential to space the cuts, leaving intact bark between them. If the stem is completely girdled, the herbicide cannot translocate to roots. A simple guideline for the number of hacks is one per inch of diameter, with a minimum of two. Spray herbicide solution into hacks immediately using a squirt bottle, filling the cuts. This treatment is best suited for low stem numbers and stems at least 1 inch in diameter.
<b>Cut Stump</b>	N/A			If cutting tree-of-heaven for immediate safety reasons, do so and treat the stump. However, cut stump herbicide applications are not recommended because they do not provide effective control of roots. Stump treatments will keep the stump free of sprouts, but they will not prevent root suckering. When tree removal is necessary, it is best to treat with one of the above-mentioned herbicide applications first, wait for symptoms to develop (generally 30 days), and then cut.

Established trees continually spread by sending up root suckers that may emerge as far as 50 feet from the parent tree. A cut or injured tree-of-heaven may send up dozens of stump and root sprouts. Sprouts as young as two years are capable of producing seed. Tree-of-heaven produces allelopathic chemicals in its leaves, roots, and bark that can limit or prevent the establishment of other plants.

## Site

Tree-of-heaven grows almost anywhere, from mine spoil in full sun to fertile, partly shaded, alluvial soils along rivers and streams. Besides urban areas, tree-of-heaven is now found growing along woodland edges, roadsides, railways, fencerows, and in forest openings. Tree-of-heaven is intolerant of shade and cannot compete under a closed forest canopy but will quickly colonize

disturbed areas, taking advantage of forests defoliated by insects or impacted by wind and other disturbances.

## Control

Due to its extensive root system and resprouting ability, tree-of-heaven is difficult to control. Treatment timing and following up the second year are critical to success. Mechanical methods, such as cutting or mowing, are ineffective, as the tree responds by producing large numbers of stump sprouts and root suckers. When cutting tree-of-heaven is necessary to remove potentially hazardous trees, it is best to treat with an herbicide first, wait for symptoms to develop (approximately 30 days), and then cut.

Hand pulling young seedlings is effective when the soil is moist and the entire root system is removed. Small root fragments are capable of generating new shoots. Seedlings can be easily confused with root suckers, which are nearly impossible to pull by hand.

To control tree-of-heaven, target the roots with systemic herbicides applied in mid- to late summer (July to onset of fall color) when the tree is moving carbohydrates to the roots. Herbicide applications made outside this late growing season window will only injure aboveground growth. Following treatment, repeated site monitoring for signs of regrowth is critical to prevent reinfestation.

Herbicides applied to foliage, bark, or cuts on the stem are effective at controlling tree-of-heaven. Cut stump herbicide applications do not prevent root suckering and should not be utilized. There are many effective herbicides available for use on tree-of-heaven, including dicamba, glyphosate, imazapyr, metsulfuron methyl, and triclopyr. For most treatments we recommend using herbicides containing the active ingredients glyphosate or triclopyr because they have practically no soil activity and pose little risk to nontarget plants through root uptake.

Foliar herbicide sprays are used where tree height and distribution allow effective coverage without unacceptable contact with nearby desirable plants. Treatments are applied in mid- to late growing season with equipment ranging from high-volume truck-mounted sprayers to low-volume backpack sprayers.

For dense or extensive infestations, treat initially with a foliar application to eliminate the small, low growth. Then follow up with a bark or hack-and-squirt application on the remaining larger stems. The initial foliar application will control most of the stems, while the follow-up stem treatment controls missed stems or those too tall for adequate coverage.

Basal bark applications provide a target-specific method for treating tree-of-heaven that are generally less than 6 inches in basal diameter. Using a low-volume backpack sprayer, a concentrated mixture of herbicide containing the ester

formulation of triclopyr in oil is applied from the ground line to a height of 12 to 18 inches, completely around the stem. To maximize translocation to the roots, apply herbicides from mid- to late summer.

Hack-and-squirt herbicide applications are highly selective with a concentrated herbicide solution applied to downward-angled cuts in the stem. For effective hack-and-squirt applications, apply the herbicide solution to cuts spaced evenly around the stem. Leaving uncut living tissue between the hacks allows the herbicide to move to the roots. Again, make applications in mid- to late summer.

Well-established tree-of-heaven stands are only eliminated through repeated efforts and monitoring. Initial treatments often only reduce the root systems, making follow-up measures necessary. Persistence is the key to success.

## Human Health Concerns

Tree-of-heaven can affect human health. The tree is a very high pollen producer and a moderate source of allergy in some people. In addition, a few cases of skin irritation or dermatitis have been reported from contact with plant parts (leaves, branches, seeds, and bark) and products. Symptoms often vary and depend on several factors, including the sensitivity of the individual, the extent of contact, and the condition of the plant or plant product. There are rare reports of myocarditis (inflammation of the heart muscle) from exposure to sap through broken skin, blisters, or cuts. People who have extensive contact with the tree should wear protective clothing and gloves and be careful to avoid contact with the sap.

Prepared by David R. Jackson, forest resources educator; Art Gover, research support associate, Wildland Weed Management Program; and Sarah Wurzbacher, forest resources educator.

## extension.psu.edu

Penn State College of Agricultural Sciences research and extension programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.

Where trade names appear, no discrimination is intended, and no endorsement by Penn State Extension is implied.

This publication is available in alternative media on request.

Penn State is an equal opportunity, affirmative action employer, and is committed to providing employment opportunities to all qualified applicants without regard to race, color, religion, age, sex, sexual orientation, gender identity, national origin, disability, or protected veteran status.

Produced by Ag Communications and Marketing

© The Pennsylvania State University 2020

Code EE0218 RevXX10/20mpc