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# FOREST SERVICE INFORMATION

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Maryland Department of Natural Resources - Forest Service

## Tree-of-Heaven Control

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Tree-of-heaven (*Ailanthus altissima*), also known as ailanthus, shumac, stinking sumac, stink-tree, copal tree, or Chinese sumac is an introduced weed tree which is a common problem in many areas of the United States. It has long been established in some urban and agricultural areas, and increasingly invades our forests, displacing more desirable native trees.

### Description

#### Identification

Tree-of-heaven is a fast growing tree with smooth gray bark, which attains a height of 80 feet or more, and a diameter of more than 3 feet. It has long compound leaves, with leaflets that are smooth-edged except for 1-3 teeth near the base, each with a small gland on the lower surface. In the winter, the tree is distinguished by the gray stems with stout, blunt brownish twigs, and by the clusters of twisted papery seeds, which often hang on the trees over winter. It has a strong disagreeable odor; especially the male flowers and cut or bruised foliage.

Overall, tree-of-heaven is similar in appearance to walnut and to sumacs. Tree-of-heaven is not a sumac, nor is it closely related. Sumacs are desirable native shrubs that seldom reach more than 15 feet in height. Sumacs have leaflets with many small teeth on the edge, have clusters of red berry-like seeds, and turn dark red in autumn.

#### History

Tree-of-heaven is a native of central China, where it is known as "stinking chun". It was first introduced into the United States in Philadelphia in 1784, and later into Rhode Island and New York. It was initially valued as a horticultural specimen, and later as a street tree and shade tree. By the 1840's it was commonly grown by nurseries in the eastern United States. Its ease of establishment, rapid growth, absence of serious insect or disease problems, and tolerance of smoke and dust made it popular for urban planting. Chinese immigrants also introduced it into California in the 1850's. Its tendency to spread, both by seeds and root suckers was frequently commented on, but planting continued well into this century in places such as Baltimore and Washington. From these areas tree-of-heaven has gradually spread and become a serious weed in urban, agricultural, and forested areas.

#### Life Cycle

Tree-of-heaven seeds germinate beginning in May, and germination may continue to occur throughout the summer. It is not unusual for several successive "crops" of seedlings to arise on the same spot during the same year, given the right conditions. Tree-of-heaven is notorious for its ability to establish itself in barren and inhospitable environments, such as within cracks in a sidewalk. While able to grow in poor soils, it grows more vigorously in moist fertile sites. They are fairly intolerant of shade. Though they can sometimes germinate and grow in partial shade, they do much better in full sunlight. Seedlings quickly develop a strong taproot, and often grow 3 feet or more the first year.

While not an especially long-lived tree, once it is established it usually continues to dominate the site by re-sprouting and root suckering. It also produces a natural herbicide that is toxic to some other species of plants. Whenever the tree is cut it responds by re-sprouting from the stump or root collar. These sprouts can grow at tremendous rates; 10-15 feet per year are

common. Established tree-of-heaven is also constantly sending up root suckers, often quite far from the parent tree. When these suckers find a favorable spot they grow and establish new trees. These root suckers grow rapidly, up to 6 feet a year. Whenever a tree-of-heaven is disturbed, as by cutting or herbicide treatment it often responds by sending out masses of root suckers. Not all root suckers emerge at once, but occur over a one or two year period after disturbance. The ability to re-sprout and root sucker so well makes tree-of-heaven difficult to control.

Tree-of-heaven is one of the last trees to leaf out in the spring. This is true in its native China as well. Buds begin to swell around April 1st (in central Maryland), but leaves do not emerge until early May, and even then growth is relatively slow. By early June leaf and shoot growth is rapid, and continues through September. The tree often continues growing until freezing temperatures cause leaf drop. There is little or no leaf coloration other than a yellowing caused by frosts or drought.

Tree-of-heaven flowers are borne separately on male and female trees during the month of June. The male flowers have a particularly vile smell. Seeds form during the summer in clusters of green papery winged structures called samaras. An individual tree can produce as many as 300,000 seeds per year. These ripen in late summer and are dispersed by the wind during the fall, winter, and spring. Once they land they may lay dormant for several years until favorable conditions for germination occur.

## Control Options

### Manual and Mechanical Control

Very young seedlings are fairly easy to pull or dig out, depending on soil conditions. Care must be taken to get the entire root out, or at least as much as possible. Any root fragments left in the ground will try to grow. Pulling or digging would be difficult with older seedlings, or on root suckers - which appear much the same as seedlings. This would be an appropriate technique for around homes and other high use landscaped areas, and around new tree seedlings during the first year or two after planting.

Girdling, or cutting through the bark all around the trunk of the tree may kill the upper part of tree-of-heaven trees. For medium and large trees this is easier than cutting the tree off entirely. Sprouting and suckering will be the same as for a cut tree, with the same advice and limitations.

As many people have learned, tree-of-heaven is very difficult to control by cutting. Not only can the trees re-sprout with tremendous vigor, but massive root suckering can also occur. Usually, the end result is not only many more stems, but with stems covering a wider area. There are several circumstances or techniques that can help make this method more effective:

- **Take advantage of shade.** Where the tree is in a heavily shaded environment, sprouts and suckers will still emerge, but will gradually slow down and die unless they can reach through the tree canopy into the sunlight. Any large openings in the forest canopy, such as that created by cutting a large tree or a clump of trees will usually allow the tree-of-heaven to reach the canopy before it is shaded out.
- **Cutting in June and early July is probably best,** with late July, August, or late May next best. Cutting in the fall, winter, or early spring - at least the first time the tree is cut - would be less beneficial. Trees use food stored in the root system to grow. This reservoir of stored food is at its lowest point in early summer after it has grown a full set of leaves and made rapid height growth. If the tree is cut in early to mid summer, before the tree has had time to re-supply the roots, stored food for growth of sprouts and suckers is reduced, and they will be less vigorous.
- **Cut trees before they get large.** Young tree-of-heaven trees have not had as much time to develop the extensive root system that will promote vigorous sprouting and suckering. Sprouting and suckering will still occur, but will be easier to manage than if you allow the tree to get large before cutting.
- **Cut them repeatedly and frequently.** The more often you can cut them back to the ground the more you will damage them. The ideal situation would be where you can mow weekly during the growing season to keep new shoots and leaves from producing food for the root system. Depending on the degree of initial sprouting and suckering, and the amount of shade or root competition from other plants, cutting or mowing at least monthly during the growing season would probably eliminate it in 2-3 years. If there is no shade or root competition from other plants tree-of-heaven would be very hard to eliminate by cutting alone.

In many cases, relying on cutting alone to eliminate tree-of-heaven would be impractical, and even make the problem worse, though it may play a role in the overall control strategy.

## Prescribed Burning

Controlled burning of infested fields or forests (with appropriate permits) could have either positive or negative effects. By consuming or scorching the bark on tree-of-heaven, fire would act in much the same way as manual or mechanical cutting, and the advice and limitations above would apply. Burning during the summer, as for pine site preparation, would be more advantageous than at other times. Understory burning during the dormant season may kill the thin bark on tree-of-heaven, and could be effective if other undamaged trees created enough shade to retard sprouting and suckering.

Site preparation burning would remove most of the tree-of-heaven seeds in the leaf litter, but would create an ideal seedbed for any new seed from nearby sources.

## Grazing/Browsing

Cattle, sheep, goats, and deer will all eat tree-of-heaven under the right circumstances, though it does not seem to be a preferred food for any of them. It has been reported that goats will eat both the leaves and bark at certain times of year. Deer feed mostly on the leaves during summer. In forested areas of high deer population, where browsing pressure is heavy and there is some shade, deer reportedly eat most of the tree-of-heaven within their reach. Where livestock grazing pressure is heavy and if suckers and sprouts are not growing back at tremendous rates, control of new growth may be adequate.

## Biological Control

A variety of insects and diseases affect tree-of-heaven in a minor way. They seem to cause serious damage only when the tree is weakened by some serious stress such as old age, drought, or herbicide damage. Any new insect or disease that may be effective in controlling tree-of-heaven would most likely be found in central China. There are no known efforts under way to identify potential pathogens of tree-of-heaven for possible introduction.

## Herbicides

Herbicides are commonly used for tree-of-heaven control with varying degrees of success. The selection of herbicide and proper application, timing, and rate are important for good results. Table 1 at the rear of this publication provides recommendations for the use of different herbicides with different application techniques. Herbicide may be applied to tree-of-heaven in several ways:

- Sprayed onto the leaves and twigs. This is referred to as foliar spraying.
- Sprayed onto the bark around the base of small trees. This is referred to as basal bark spraying.
- Sprayed or brushed on a freshly cut stump.
- Sprayed or brushed in spaced or connected wounds through the bark around the trunk.

All of these methods have advantages in certain circumstances, and all can be an effective part of tree-of-heaven control. No one herbicide or method is going to be 100% effective in all circumstances all the time.

Many herbicides, properly applied, will kill the above ground portion of tree-of-heaven. The problem is that some of these do not do a good job of preventing sprouting from the stump or base of the tree, and many do not effectively prevent root suckering. Often, follow-up treatments are needed to achieve eradication, if that is the goal. Another consideration is that some herbicides have the potential to affect adjacent desirable trees, so care in selection and application is necessary. Even with these limitations, herbicides provide the most effective and practical tool for control of tree-of-heaven available.

For **foliar spraying** the herbicide is mixed with water and a small amount of non-ionic surfactant that helps the spray to cover and penetrate the leaves. All the leaves and green shoots should be thoroughly wet, especially at the top of the tree, but not to the point of runoff. Foliar spraying is the best method to use as long as the trees are within reach of the spray, and should be used for control of any sprouts or suckers that may arise after other treatments. Care must be used to avoid spray from contacting the foliage of nearby desirable trees.

**Basal bark spray** treatment is effective for treating trees up to 4 inches in diameter. Usually, the herbicide is mixed with fuel oil, kerosene, or mineral oil and sprayed onto the lower 12-18 inches of the trunk on all sides, but not to the point of runoff (low-volume basal). The thin bark of young tree-of-heaven is easily penetrated by the spray solution. This treatment can be made at any time of year, but appears to work better in the late winter and during the summer, with summer being the most effective time. There is less likelihood that spray will contact other plants, but heavy treatments in any one area may affect other trees through soil activity. Any sprouting or suckering which occurs after the top of the tree is killed should be foliar sprayed.

**Stump treatments** are usually made by spraying or brushing the outer part of the top of a freshly cut stump with a fairly concentrated herbicide solution. This should be done within 5 minutes of cutting. The herbicide is then absorbed into the roots and helps prevent re-sprouting and root suckering. While this does not usually prevent sprouting or suckering entirely, it shows an improvement over cutting alone. Summer appears to be the best time for treatment. In some cases the herbicide can affect nearby desirable trees through soil activity, especially if heavily applied in a given area. Yellow-poplar (tulip poplar) is especially sensitive. This is a slow and difficult method, but is good use for larger trees. Any subsequent sprouting or suckering should be treated by foliar spray.

**Injecting** herbicide through the bark at spaced intervals, or a connecting series of cuts is another way to deal with larger trees. A common way to inject trees is to make a series of downward angled cuts with a sharp hand-axe, leaving about 1 inch between them, around the trunk at any convenient height. About 1 milliliter of a fairly concentrated herbicide solution is then applied into each cut. It is then transported through the tree. This is referred to as the hack and squirt method. Properly done, this method nearly always kills the above ground portion of the tree, and usually inhibits sprouting and suckering. **Frill or girdle** treatment is similar, except that a continuous cut or series of overlapping cuts is made. As with stump treatment, summer appears to be the best time for treatment. Follow-up with foliar spray as needed.

The herbicides listed here have shown to be effective in tree-of-heaven control. Be sure to read and follow the label directions. The type of use should conform to those listed.

- Accord - (Monsanto), glyphosate 41.5%, Uses: forestry, and utility rights-of-way. Method: foliar spray.
- Ally - (DuPont), metsulfuron methyl 60%, Uses: weed control in pastures. Method: foliar spray.
- Arsenal - (BASF), imazapyr 53.1%, Uses: forestry site-prep and release for conifers, non-crop uses within forests. Methods: foliar spray, cut stump, injection.
- Banvel - (BASF), dicamba 48.2% Uses: certain crops, pasture, hay, and farmstead non-crop areas. Methods: foliar spray (usually in combination with 2,4-D amine), cut stump, frill or girdle.
- Crossbow - (Dow), triclopyr & 2,4-D esters, 16.5% & 34.4%, Uses: pastures, fencerows, roadsides, other non-crop areas and industrial sites. Methods: foliar spray.
- Escort - (DuPont), metsulfuron methyl 60%, Uses: non-crop weed and brush control, loblolly pine site prep and release. Method: foliar spray.
- Garlon 3A - (Dow), triclopyr amine 44.4%, Uses: rights-of-way, industrial sites, non-crop areas, and forests. Methods: foliar spray, cut stump, girdle, injection.
- Garlon 4 - (Dow), triclopyr ester 61.6% Uses: rights-of-way, industrial sites, non-cropland areas, and forests. Methods: foliar spray, basal bark.
- Pathfinder II - (Dow), triclopyr ester 13.6%, ready to use. Uses: forests, pastures, non-crop areas. Methods: basal bark, cut stump.
- Pathway - (Dow), picloram ester 5.4%, 2,4-D amine 20.9%, ready to use. Uses: forests, non-crop areas. Methods: cut surface (injection, frill/girdle, cut stump).
- Roundup - (Monsanto), glyphosate 41%, Uses: non-crop areas, ornamentals and Christmas trees, pastures, various crops. Method: foliar spray (must be very thorough).
- Stalker - (BASF), imazapyr 27.6%, Uses: forests, non-crop areas. Methods: basal bark, cut surface (injection, frill/girdle, cut stump).
- Vanquish - (Novartis), dicamba 56.8%, Uses: pasture, farmstead weed and brush control, non-cropland areas such as fence rows, roadways, rights-of-way, non-selective forest brush control including site-preparation, other non-crop areas. Methods: foliar spray (usually in combination with 2,4-D), cut surface (frill/girdle, cut stump).

### Post-Control Management

Once tree-of heaven is controlled there are several things you can do to help prevent the problem from re-occurring:

- Periodically re-check the area to see if new suckers or seedlings have appeared. Act quickly to cut or foliar spray them, since delay will make control more difficult.
- Establish a thick cover of competing vegetation. Trees are best, since they provide the most shade, although shrubs and perennial grasses can also be effective. Grass sod makes tree-of-heaven seedling establishment difficult, provides good root competition, and is compatible with maintenance by grazing, mowing, and some herbicides.
- Locate and control large seed-producing female trees anywhere in the area. These can provide seed to re-infest new areas.
- Several years prior to conducting any timber harvest or construction activities locate and eradicate tree-of-heaven of any size in and around the site. By taking advantage of existing shade you can eliminate them before the site is disturbed and exposed to sunlight.

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**Table 1. Chemical Recommendations for Different Application Techniques**

<b>Chemical and Product</b>	<b>Rate</b>	<b>Timing (in MD)</b>	<b>Potential Soil Activity</b>
<b>Foliar Spray (spray to wet)</b>			
Banvel + 2,4-D amine	1% each	June 1 - Sept. 15	Yes
Vanquish + 2,4,D amine	1%	June 1 - Sept. 15	Yes
Roundup <u>or</u> Accord	2%	July 1 - Sept. 30	No
Arsenal AC	0.5%	July 1 - Sept. 30	Yes
Ally or Escort	1 oz. (by weight) / 100 gallons	June 1 - Sept. 30	Yes
Garlon 3A	1.5 - 2 %	June 1 - Sept. 15	Slight
Garlon 4	1 - 1.5%	June 1 - Sept. 15	Slight
Crossbow	1.5 - 2%	June 1 - Sept. 15	Slight
<b>Basal Bark Spray</b>			
Chopper <u>or</u> Stalker	6 - 10% w/oil	<u>Summer</u> or late winter	Yes
Garlon 4	10 - 20% w/oil	<u>Summer</u> or late winter	Slight
Pathfinder II	100%	<u>Summer</u> or late winter	Slight
<b>Cut Surface Treatment (stump, frill or girdle, injection)</b>			
Banvel	50%	Year-round, best June-Oct.	Yes
Vanquish	50%	Year-round, best June-Oct.	Yes
Arsenal AC	4.5%	Summer	Yes
Chopper <u>or</u> Stalker	10%	June - Oct.	Yes
Tordon RTU <u>or</u> Pathway	100%	Year-round, summer best	<u>Yes</u>
Garlon 3A	100%	Year-round, summer best	Slight