Roadside Vegetation Management Research Project
Department of Plant Science College of Agricultural Sciences
https://plantscience.psu.edu/research/projects/vegetation-management

Factsheet
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Managing Tree-of-Heaven (Ailanthus altissima) on Roadsides

Background

Tree-of-heaven, commonly known as 'ailanthus' (*Ailanthus altissima*) is a fast growing, weak-wooded, root suckering tree, native to East Asia. The species was introduced to the U.S. in the late 1700's as a garden specimen and as a street tree in heavily polluted urban sites of the time. Ailanthus tolerates poor, dry soils and quickly colonizes disturbed sites, like roadsides and city lots. Ailanthus can grow greater than 60 feet tall and left unmanaged can grow rapidly into dense colonies with new shoots arising from its wide spreading root system. Because of the size, rate of spread, and weak wood it is an acute hazard along roadsides, utility rights-of-way, and poses an invasive threat to adjacent properties (Figure 1).

Figure 1: Disturbed and infertile soil along highways are ideal sites for ailanthus invasion. Its rapid growth, weak wooded character, and large colonies can create reduced site distance and collision or tree fall hazards.

Distinguishing Characteristics

Ailanthus has a large, compound leaf reaching up to 3 feet long, with as many as 30 leaflets compared to staghorn sumac (*Rhus typhina*) and black walnut (*Juglans nigra*) (Figure 2a). Crushed leaves of ailanthus smell like rancid peanut butter. Similarly, shoots of ailanthus can be easily distinguished from staghorn sumac and black walnut based on their lateral buds, leaf scars, and branch thickness and smoothness. Ailanthus stems are hairless, leaf scars are large and wrap around the lower portion of the lateral buds in an arrow shape (Figure 2b). The pith is solid, large, and peanut butter brown. Ailanthus seeds are winged and produced in abundance. Combining the heavy seed production with its freely suckering root system results in rapid infestation into neighboring areas including farmland, parks, and natural areas (Figure 3). After cutting or other disturbance, ailanthus resprouts aggressively from its stump and roots. Stump sprouts and root suckers can grow greater than 10 feet the first season.

Figure 2a & b.: a) The large, palm-like leaf of ailanthus (center) is similar in appearance to the leaves of the common roadside trees staghorn sumac (left) and black walnut (right). b) The bud, leaf scar characteristics, and shoot features differ between the three plants. Sumac (left) stems are fuzzy, axillary buds raised, and the leaf scar wrapping around the bud. Ailanthus stem (center) new growth is thicker with no hairs, and large arrow shaped leaf scars just below the lateral buds. Black walnut shoots are small with velvety new growth, and the leaf scars are small, three sided with three distinct vascular bundles in the scar.

Control Methods

The key to controlling ailanthus is controlling the root system. Control measures that do not address the regenerative capacity of the root system will fail (Figure 4).

Employing an *Integrated Vegetation Management* (IVM) approach means applying multiple control methods for effective control. A key principle of IVM is preservation of desirable competitive vegetation where practical while removing the undesirable vegetation. An optimal control program strikes a balance between productivity and selectivity.

An operation that eliminates ailanthus but also eliminates all the surrounding desirable vegetation creates a situation where the ailanthus can more easily re-infest the area.

What follows are several methods that can be used together in a pre-planned program for management of ailanthus while avoiding a less effective fire-fighting approach to control.

By Art Gover, Larry Kuhns, Jon Johnson, Jeff Jodon, Liz Egan and Jim Sellmer, 2022 (revised). This work was sponsored by the Pennsylvania Department of Transportation, Bureau of Operations and partially supported by the USDA National Institute of Food and Agriculture Federal Appropriations under accession #1017790. The contents of this work reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of either the Commonwealth of Pennsylvania or The Pennsylvania State University, at the time of publication. This work does not constitute a standard, specification, or regulation.

Well-established ailanthus is very difficult to control because of its height and density. Successful control will require a multiple step 'control phase', and an ongoing 'maintenance phase' in the following seasons to make sure ailanthus does not re-establish.

Mechanical Control

Young plants can be pulled out, dug up, or cut, but remaining stumps and small pieces of root will generate new shoots. This approach may only be appropriate in a small, isolated setting, such as a planting bed in a rest area. On the roadside, once existing ailanthus stems are cut, the area can be included in the regular mowing cycles each season to prevent re-establishment. Regrowth from an existing root system will be fast, but resprouts will be soft-wooded and can be mowed. Mowing may be more effective in the spring when stems are soft. Cutting and mowing alone are not effective control methods because it will take several years to completely deplete the root system, and one missed mowing cycle may allow the resprouts to get too big to mow. Mechanical treatments are effective at temporarily removing the top growth of ailanthus, but they are most effective when followed up with a chemical application.

Cultural Control

Encouraging or establishing and maintaining alternative groundcovers to compete with ailanthus will enhance the effects of other treatments. In most situations, eliminating the ailanthus will result in natural re-establishment of herbaceous groundcover. Ailanthus is less likely to re-establish on a site where there is an intact groundcover. Establishing a grass groundcover is the best approach. An established grass groundcover provides competition, flexibility of regular mowing where terrain permits, and an opportunity to use selective broadleaf herbicides to control ailanthus and other broadleaf weeds and brush while not injuring the grass.

Cool-season grasses including tall fescue or fine fescues can be used on moderately poor sites, where the soil pH is 5.5 or higher, not too dry, shallow, or coarse textured. Cool-season grasses establish relatively quickly when seeded during the early-to-mid spring or late summer-to-fall window of the growing season, which is the recommended best window for establishment.

Where site quality is poor either low soil pH and fertility, or very dry, perennial warm season grasses may be a better choice. Species such as big bluestem (pH 6-7.5), little bluestem (pH 5-8.4), and Indiangrass (pH 4.8-8) are slower to establish than fescues, and should not be fall seeded. However, they should provide a better permanent cover on poor sites. To hasten their establishment, nurse species such as annual ryegrass, spring oats, or perennial cool season grasses should be added to the mix. Seeding rates and specifications may be found in the PENNDOT Specifications Manual, Publication 408.

Figure 3: New ailanthus suckers developing from the root.

Figure 4: Vigorous sprouting occurs when ailanthus stems are killed but the root system remains intact. A basal bark treatment applied in April killed the treated stems above, but had little effect on the root system. Ailanthus should be treated between mid-June and prior to the onset of fall color to maximize root injury and minimize resprouting.

Chemical Control

There are several chemical application methods that can be used against ailanthus. Herbicides can be applied to plant foliage, intact stems, or cut surfaces (Table 1).

Foliar Applications

The most common approach is to spray the foliage. This is a very effective and productive approach. Foliar applications are most effective in the period between full canopy and prior to fall color approximately July through September in Pennsylvania. A foliar application is a broadcast or spot application. A broadcast application targets all of a designated area and is easiest to accomplish with a sprayer that applies a spray pattern of a fixed width. Most roadside treatments made with a spray truck are broadcast applications.

Spot applications are made to scattered targets and can be made using low- or high-volume techniques. A low-volume application delivers a minimal amount of concentrated spray solution onto the foliage. Low-volume applications are commonly made with a backpack sprayer providing simplicity and mobility. The target plant size is one limitation to using low-volume applications. Plants less than 10 feet tall found in low to moderate densities on site are ideal targets. The key to a successful low-volume application is being close enough to the foliage to apply the spray solution in a light, uniform manner.

Where ailanthus is tall or too dense for a backpack application, a high-volume treatment using a motorized sprayer and a handgun mounted on a length of hose is the preferred approach. With a high-volume application, a low-concentration spray solution is applied to the point where all the foliage is visibly wet. It is the preferred approach where target size or density requires a higher-pressure sprayer that allows you to send a spray stream higher and farther.

Basal Bark Application

The basal bark method is a way to selectively treat tall ailanthus. An herbicide-in-oil solution is applied to the base of each stem with a low-volume spray wand, virtually eliminating off-target application. Basal bark applications will kill the top growth of treated trees any time of year by chemically girdling the stem. To affect the root system, basal treatments must be made during the same application window as foliar treatments, from July through September. This allows the herbicides used in brush control to move into the roots with the sugars produced by the leaves during the growing season.

A drawback of basal bark treatment is that it is laborious, especially in high stem density situations such as colonies of ailanthus. For this reason, basal bark is better used as a follow-up treatment after a foliar application has been used to reduce stem density.

Hack and Squirt & Injection Treatments

Like basal bark treatments, hack and squirt & injection treatments are highly selective, and labor intensive. These treatments are best used for small infestations or as a follow-up after a foliar treatment has reduced stem density.

Hack-and-squirt and injection treatments call for applying small doses of concentrated herbicide solution to spaced cuts or injection points around the stem. Spaced cuts along the trunk are used rather than completely girdling the stem to assure that the plant's vascular system remains largely intact allowing the herbicide to move down into the root system. To maximize injury to the root system, these treatments should be applied during the 'foliar application window', from July through September.

Cut Stump Treatments

Cut stump treatments have been found to be less effective in controlling root suckers. This approach prevents more aggressive sprouts from developing on the stump, however, root suckers will develop rapidly and require further action. On root suckering species like ailanthus a more effective approach would be to apply a basal bark treatment and wait 30 plus days or until symptoms are visible. Then cut and remove the tree. Root suckers may still develop; however, the basal bark treatment may reduce the root suckering response.

Table 1. Herbicides on the current Pennsylvania State Herbicide Contract that can be used to treat ailanthus, listed by application technique.

Treatment	Products	Comments
Foliar	Glyphosate products (Aquaneat, Ranger Pro, RoundUp Pro), Garlon 3A, Vastlan	Common combinations include a glyphosate product (Aquaneat, RoundUp Pro, Ranger Pro) combined with Garlon 3A or Vastlan.
Basal Bark	Garlon 4 Ultra, Pathfinder II	Use as a follow-up or for small infestations. Garlon 4 Ultra must be diluted with an oil carrier. Pathfinder II is ready-to-use, with the same active ingredient as Garlon 4. A dye should be added to either product to aid with visibility of treatment. Root injury is increased when applied July through September (fall color). Applications outside of this window will kill the stems but will have less effect on the root system.
Hack-and-squirt	Glyphosate products listed under foliar, Garlon 3A, or Vastlan (products applied undiluted or in a 1:1 with water)	Use as a follow-up treatment to a foliar application. Root injury is increased when applied July through September (fall color). Applications outside of this window will kill the stems but will have less effect on the root system.
Cutting Stumps	Garlon 4 Ultra, Pathfinder II	Where tree removal is necessary for safety, cutting the tree close to the ground and treating the whole stump immediately with a dye included to assure treatment was made is the best approach. The treatment window is the same as for basal bark. Cut stump treatments will not prevent root suckers which will require further treatment.

Biological Control

Two promising but unregistered biological agents are being researched including a weevil *Eucryptorrhynchus brandti* and a natural occurring pathogen *Verticillium nonalfalfae*. Until they are registered the tools described are the most effective control options in an IVM program.

Implementing an Ailanthus Management Program

There will be areas where ailanthus exists that cannot be effectively treated by spray vehicles along roadways with larger rights-of-way (ROW). These areas need to be treated with a specific ailanthus program. This ailanthus program would include both 'control phase' and 'maintenance phase' applications.

Control phase treatments would be foliar applications using a handgun, followed three to four weeks later with an individual stem treatment such as basal bark or hack and squirt, to treat the misses and stems that were too tall to adequately cover with the foliar treatment (Figure 5 and 6). This two-step treatment is necessary to get as complete control as possible. If ailanthus is only partially controlled, it will regrow vigorously from its root system.

Maintenance phase treatments should be implemented the year after the control phase applications. After the initial maintenance application, future applications could be made every two or three years. Maintenance applications can be applied using basal bark or low volume foliar treatments. The advantage of basal bark is that any large stems that were previously missed can be effectively treated. Foliar applications provide more flexibility in what is treated such as other undesirable or noxious weeds at the site.

As the maintenance cycles progress, the elimination of ailanthus and other undesirable species and the establishment of a more desirable stable groundcover will allow for the implementation of standard maintenance practices.

Figure 5 & 6: Treatment of stands of ailanthus outside of the reach of truck-based applications is best accomplished with foliar applications applied with a handgun. Individual-stem treatments (basal bark or hack & squirt) should be used as a follow-up three to four weeks later to treat misses and stems that were too tall to effectively treat with the foliar application.

Summary

Well-timed and executed control measures can effectively eliminate the top growth and reduce the root system (Table 2). Initial control steps must be combined with timely effective follow-up treatments to prevent the re-establishment of ailanthus. However, the pressure from ailanthus to infest roadsides will only increase over time. Efforts to manage ailanthus and other exotic, invasive weeds are going to continue to be a routine part of roadside management.

Table 2. Ailanthus flowering, fruiting periods, and management calendar.

Lifecycle	Trtmt	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Flowering													
Fruit set													
	Foliar												
	Basal bark												
	Hack & squirt												
Cut 30 or more days after treatment													