



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

Not-so-Heavenly Tree

Tree-of-heaven, or ailanthus, is a fast growing, weak-wooded tree, native to China that can grow 60 ft tall under roadside conditions. *Ailanthus* grows in colonies that spread quickly as new shoots arise from the root system. Because of its size and rate of spread, it is an acute hazard along roadsides, and poses a threat to adjacent properties as well (Figure 1).

Ailanthus has a large, compound leaf that is up to 3 feet long, with as many as 30 leaflets (Figure 2). This accounts for nicknames such as 'Brooklyn palm' (Figure 3). *Ailanthus* tolerates poor soils, and can quickly colonize disturbed areas and low maintenance landscapes. The winged seeds are produced in abundance, and vastly improve the plant's ability to infest adjacent areas. *Ailanthus* suckers freely from its root system (Figure 4), and after cutting or other disturbance, *ailanthus* resprouts ferociously from the stump and its roots. Stump sprouts and suckers can grow 10 feet or more in the first season. Due to its rapid growth and structural weakness, it is highly undesirable along roadways and utility rights-of-way, as well as in parks and wildlands.

Ailanthus was introduced to America in the late 1700's for use as an urban tree. It is highly tolerant of poor air quality and poor soils, and has become a feature of most cities, growing almost anywhere, from vacant lots to sidewalk cracks. *Ailanthus* has truly exploded into the landscape in the last few decades as the Interstate highway system has provided a convenient pathway to move this plant from the cities into the countryside. *Ailanthus* is troublesome enough that it should be removed from the right-of-way (ROW) wherever it occurs, even on large ROW where it might be a safe distance from the roadway. Unmanaged *ailanthus* serves as a source for further infestation on the ROW and adjacent properties.

Control Methods

The key to controlling *ailanthus* is controlling the root system. *Ailanthus* is one of those plants best thought of as being like an iceberg - what you can see is only the tip of the problem. Control measures that fail to address the regenerative capacity of the root system will fail (Figure 5).



Figure 1. Due to its rapid growth, tree-of-heaven, or *ailanthus*, can quickly become established on the right-of-way. Unless aggressively managed, it will quickly grow tall enough to impede sight distance, become a collision target or tree-fall hazard.



Figure 2: 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).

By Art Gover, Larry Kuhns, and Jon Johnson, 2004 (revised). This work was sponsored by the Pennsylvania Department of Transportation. 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.

The best approach is to use as many methods as possible in a manner where each operation adds to the effect of previous operations. This is a simplified way of describing *Integrated Vegetation Management (IVM)*. Listed below are the different approaches that can be used - ideally used together in a pre-planned program, rather than repeated instances of 'fire-fighting'.

The key principle to an IVM program is to preserve as much desirable vegetation as practical while removing the undesirable vegetation. A control program needs to strike the 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.

Well-established ailanthus is very difficult to control because of its height and density, and successful control will require a multiple-step 'control phase', and an ongoing 'maintenance phase' in the following seasons to make sure the 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 type of approach would 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 to prevent re-establishment. Regrowth from an existing root system will be fast and furious, but these resprouts will be soft-wooded and can be mowed. 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 alternative groundcover, and going to the effort to maintain it provides competition to ailanthus, and 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. On Pennsylvania roadsides, this often means the area is re-colonized by crownvetch. On sites with no history of crownvetch, establishing a grass ground cover may be the best approach to achieve a low maintenance groundcover. Establishing grass mixtures not only provides a competitive groundcover, but also provides the flexibility of regular mowing (where terrain permits) as well as the use of selective herbicides that injure broadleaf weeds and brush, but not grass.



Figure 3. The characteristic 'palm frond' appearance of ailanthus.



Figure 4: A new ailanthus sucker developing from the root.



Figure 5: 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 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.

Foliar Applications

The most common approach is to spray the foliage. This is a very effective approach, and is usually the most productive. Foliar applications are most effective in the window between full canopy development and fall color. In Pennsylvania, this is approximately mid-June through mid-September. Foliar treatments can be described by how they are applied, and by how much solution is applied to each plant. 'How' a foliar application is made is described as 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. 'Low-volume' describes an application that deposits a minimal amount of concentrated spray solution on the foliage. Low-volume applications can be made with a backpack sprayer, and provide simplicity and mobility. The limitation to using low-volume applications is plant size - this technique is best used on plants less than 10 feet tall, occurring in low to moderate densities. 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 the 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 provides a means to treat tall ailanthus very selectively. The 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 mid-June to mid-September. It is only after the canopy has fully leafed out that translocation of plant sugars produced in the leaves to the roots occurs. Since the herbicides used for brush control move with these sugars in the plant's conductive tissue, the herbicides can only get to the roots if the plant sugars are going there.

A drawback of basal bark treatment is that it is fairly 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.

Cut Surface Treatments

'Cut surface' is a general term that encompasses stump treatment, hack-and-squirt, girdling, and injection treatments. Like basal bark treatments, cut surface treatments are highly selective, and labor intensive. Therefore these treatments are best used for small

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	Arsenal, Escort XP, Garlon 3A, Garlon 4, Glyphomate 41, GlyPro, GlyPro Plus, Krenite S, Vanquish	Common combinations include a glyphosate product (Glyphomate 41, GlyPro, GlyPro Plus) alone, or combined with Arsenal or Escort XP; Krenite S plus Arsenal, Garlon plus Escort XP; or Garlon plus Vanquish.
Basal Bark	Garlon 4, Pathfinder II	Use as a follow-up or for small infestations. Garlon 4 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. Root injury is increased when applied mid-June to mid-September (fall color). Applications outside of this window will kill the stems, but will have less effect on the root system.
Stump Treatment	All products listed for Foliar and Basal Bark except Escort XP	Suckering from the roots is inevitable after cutting, but preventing the more vigorous stump sprouts will make follow-up treatments easier to accomplish.
Hack-and-squirt	Arsenal, Garlon 3A, Glyphomate 41, GlyPro, GlyPro Plus, Vanquish	Use as a follow-up treatment to a foliar application. Root injury is increased when applied mid-June to mid-September (fall color). Applications outside of this window will kill the stems, but will have less effect on the root system.

infestations or as a follow-up treatment after a foliar treatment has reduced stem density.

Stump treatment is simply applying a concentrated herbicide solution to the cut surface and remaining stump after cutting down a tree. This prevents sprouts from developing on the stump. In the case of ailanthus, root suckers *will* develop, but preventing stump sprouts is helpful because they are larger and more vigorous than root suckers.

Cut stump applications can be water-based or oil-based. Regardless of the mixture you use, it is best to treat as you cut. If you are using a water-based stump treatment, you need to treat immediately after cutting. If you are using an oil-based herbicide, the penetrating qualities of the oil do allow you to treat most any time after cutting. However, it is still better to treat as you cut because it is often difficult to find stumps after cutting.

Hack-and-squirt and injection treatments call for applying small doses of concentrated herbicide solution to spaced cuts or injection points around the stem. Using spaced cuts is preferable to completely girdling the stem because this leaves the plant's conductive system largely intact, and allows herbicide to circulate to the root system. To maximize injury to the root system, these treatments should be applied during the 'foliar application window', from mid-June to mid-September.

Implementing an Ailanthus Management Program

On roadways with larger ROW, there will be areas where ailanthus exists that cannot be effectively treated by the spray vehicles used during the course of the regular Weed & Brush and Side Trim programs. 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, to treat the misses and the stems that were too tall to adequately cover with the foliar treatment (Figure 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, and your effort will be largely wasted. Ailanthus is a weed where a half-effort provides much less than half-control.

Maintenance Phase treatments should be implemented the year after the Control Phase applications. After the initial maintenance application, the maintenance applications could be done 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. The foliar application gives you more flexibility in what you can treat. After ailanthus has been removed from a location,



Figure 6: Treatment of stands of ailanthus outside of the reach of truck-based applications is best accomplished with foliar applications applied with a handgun. An individual-stem treatment such as basal bark 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.

there may be other undesirable or Noxious weeds that appear, and a foliar application will allow you to treat both weeds and woody vegetation.

Over time, the Ailanthus Program transitions to being more maintenance applications than control applications because the area you *have* controlled increases, and the area *left* to control decreases. As the maintenance cycles progress, the ailanthus and other undesirable species are eliminated from the roadside, and a stable groundcover made up of desirable (or tolerable) species develops. As the composition of the vegetation changes, the amount of effort per acre decreases, which allows the acreage under the Maintenance Phase to continue to expand while dedicating the same effort to the program.

Summary

It is important to understand that well-established ailanthus will only be effectively managed on the ROW through ongoing, repeated effort. Well-timed and executed control measures can effectively eliminate the top growth and reduce the root system, and effective follow-up will prevent the re-establishment of the treated ailanthus. However, the pressure from ailanthus to infest roadsides is only going to increase over time. Efforts to manage ailanthus and other exotic, invasive weeds are going to increasingly become a routine part of roadside management.