



## ***Japanese knotweed (Polygonum cuspidatum)***

### **Description**

- Refer to the DCNR Invasive Exotic Plant Tutorial knotweed page ([http://www.dcnr.state.pa.us/forestry/invasivetutorial/japanese\\_knotweed.htm](http://www.dcnr.state.pa.us/forestry/invasivetutorial/japanese_knotweed.htm)), which describes Japanese knotweed and giant knotweed (*Polygonum sachalinense*).
- Herbaceous, rhizomatous, perennial dicot.
- Dioecious – male and female flowers on separate plants.
- Grows in tall (6 to 10-plus feet), dense stands that exclude almost all other vegetation.
- Native to East Asia, imported as an ornamental in the late-1800's.
- Grows almost anywhere, from acidic spoil in full sun to fertile, shaded alluvial soils along rivers and streams.

### **Management Keys**

Japanese knotweed is difficult to control, but as long as you are willing to invest the effort and follow a few key guidelines, it can be successfully suppressed.

#### **Target the Rhizomes**

To eliminate knotweed, you have to injure the rhizomes. This is most effectively done with systemic herbicides, when the plant canopy is exporting sugars to the rhizomes for growth and storage.

#### **Timing is Key**

Systemic herbicides are most effective when applied later in the growing season (Figure 1). This is when the foliage is sending sugars produced through photosynthesis to the roots and rhizomes. Systemic herbicides are moved in the same direction through the plant as the sugars.

Applications made too early in the season or too soon after cutting do not translocate to the rhizomes, and only injure the shoots.

#### **Cutting Helps**

Cutting alone is not an effective suppression approach. However, cutting prior to an herbicide application can be very helpful. If you wait until about June 1 to cut, and wait 8 weeks to treat, you will find that the knotweed regrowth is much shorter than when

it was cut. Typically, knotweed regrows 2 to 4 feet tall.

When knotweed is growing near water, cutting is useful because it is easier to treat the shorter regrowth without getting spray solution into the water.

If the knotweed is not near water, you have to decide if cutting the knotweed is a good use of your finite time and effort. Treating intact knotweed towering over your head is a lot like work, but cutting may be even more work.

#### **Be Patient**

Wait 8 weeks after cutting before applying herbicide. If you apply too soon after cutting, the herbicide will not be translocated to the rhizomes.

#### **Recommended Herbicides**

We recommend the herbicide *glyphosate*. *Glyphosate* is the active ingredient the many 'Roundup' products that are available for agricultural, professional, and homeowner use. As of this writing, the *glyphosate* products available on the PA statewide herbicide contract are 'Aquaneat' and 'Glyphomate 41'.

*Glyphosate* has several advantages:

- it's effective
- it has low toxicity to non-target organisms
- it is available in aquatic-labeled formulations
- it has no soil activity
- it's relatively inexpensive

The herbicide *imazapyr* ('Arsenal Powerline', 'Habitat') is effective against knotweed, but has considerable soil activity and can injure nearby trees through root absorption.

The herbicide *triclopyr* ('Garlon 3A') is recommended in some accounts, but our research has shown that rates up to 4 quarts/acre had no visible effect on the following year's growth.

#### **Be Persistent**

There are two phases of knotweed management – control and maintenance. The control phase takes two seasons, and includes at least two operations in year-one (e.g. cut and treat, or treat twice) and at least one application in year-two.

After your control efforts have nearly eliminated the knotweed, you need to periodically monitor the sites



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and treat any signs of new growth to prevent re-infestation.

### After the Knotweed

If you remove the knotweed early in its infestation, you probably will not need to establish replacement vegetation.

When a knotweed infestation is well established,

you may need to suppress the vegetation that follows as well, and establish desirable plants in that space. If you are planning on replanting the area, BE PATIENT. If you plant desirable vegetation before the knotweed is completely suppressed, it will be much harder to manage the remnant knotweed without injuring the desirable plants.

Figure 1. The management calendar for Japanese knotweed emphasizes late-season applications of the herbicide glyphosate to maximize injury to the rhizomes.

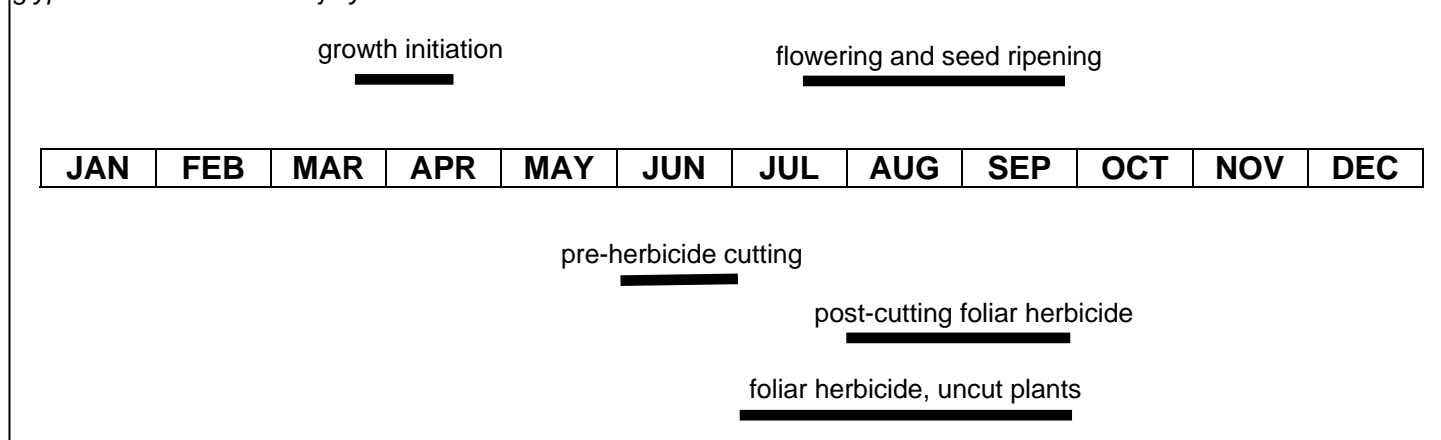


Table 1. Prescriptions for controlling Japanese and giant knotweed stress proper timing of operations to maximize injury to rhizomes. Improper timing (impatience) will result in treatments that provide 'topkill' (shoot injury) but little net effect.

timing	treatment	product rate	comments
June	cutting prior to foliar herbicide application	n/a	Cutting in June results in shortened regrowth and elimination of persistent stems from the previous season. This is a particular advantage in riparian settings, where knotweed will hang over the water. In this situation, it is impossible to treat without contacting the water with herbicide solution (therefore requiring a permit and an aquatic-certified applicator). Cutting will result in regrowth that is 2 to 4 ft. tall, which can be treated using a backpack sprayer (as opposed to a high volume application with a handgun), and without contacting the adjacent water.
anytime	cutting	n/a	Cutting does not eliminate knotweed, but it does slow its growth and lateral spread significantly. Where knotweed is adjacent to mowed areas, it should be included in mowing regimen. If you are going to treat the knotweed with a systemic herbicide, stop mowing 8 weeks prior to application.
At least 8 weeks after mowing	'Aquaneat' or 'Glyphomate 41'	4 qts/acre or 5.7 qts/acre	Use either of these <i>glyphosate</i> products to treat knotweed regrowth, waiting eight weeks after the June cutting to treat. The product rates differ because the glyphosate concentration differs. The application rates provide 4 lbs of <i>glyphosate</i> -acid per acre. Applications of 'Aquaneat' will require an additional surfactant (e.g. 'Timberland 90'). No additional surfactant is needed with 'Glyphomate 41'. Work at the early end of the operational windows so you can make a 'touch-up' application with the same treatment in September, before a killing frost.
July 1 to mid-September	'Aquaneat' or 'Glyphomate 41'	4 qts/acre or 5.7 qts/acre	Treatment to uncut knotweed should be delayed until after July 1. Unless the knotweed patches are small, this will need to be a high volume application. It is very difficult to get thorough coverage of dense vegetation that is over your head. Follow-up in September to treat misses and resprouts.

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## ***common reed (Phragmites australis)***

### **Description**

- Common reed is usually known simply as 'phragmites'.
- Refer to the DCNR Invasive Exotic Plant Tutorial phragmites page ([http://www.dcnr.state.pa.us/forestry/invasivetutorial/common\\_reed.htm](http://www.dcnr.state.pa.us/forestry/invasivetutorial/common_reed.htm))
- Herbaceous, rhizomatous, perennial, cool-season grass.
- Grows in tall (6 to 12-plus feet), dense stands that exclude almost all other vegetation.
- The invasive form of phragmites is an exotic genotype likely introduced via ship ballast. There is a native form that is less common.
- Grows in tidal and non-tidal marshes, other wet areas, and will persist in terrestrial settings when introduced via rhizome fragment.

### **Management Keys**

Due to its sheer size and persistence, phragmites is difficult to control, but as long as you are willing to invest the effort and follow a few guidelines, it can be successfully suppressed.

#### **Target the Rhizomes**

To eliminate phragmites, you have to injure the rhizomes. This is most effectively done with systemic herbicides.

#### **Timing is Key**

Systemic herbicides are most effective when applied later in the growing season. This is when the foliage is sending sugars produced through photosynthesis to the roots and rhizomes. Systemic herbicides are moved in the same direction through the plant as the sugars.

Applications made too early in the season or too soon after cutting do not translocate to the rhizomes, and only injure the shoots.

#### **Do Not Disturb**

After herbicide treatment, it is important that you do not disturb the rhizome system through any type of excavation or vehicle rutting.

### **Cutting Helps**

Cutting alone is not an effective suppression approach. However, cutting prior to an herbicide treatment will make the application easier. Cutting reduces the size and density of the regrowth, and eliminates the persistent stems from the previous season.

A point to consider is that it may be easier to simply spray the phragmites rather than cut it.

### **Be Patient**

Wait 8 weeks after cutting before applying herbicide. If you apply too soon after cutting, the herbicide will not be translocated to the rhizomes.

### **Recommended Herbicides**

*Imazapyr* ('Habitat' is an aquatic-labeled formulation) is regarded as the most effective herbicide against phragmites. However, *imazapyr* has considerable soil activity. Application near desirable trees and situations where you are relying on the seedbank for revegetation is not recommended.

*Glyphosate* is probably less effective than *imazapyr*, but has a greater 'comfort level'. *Glyphosate* is the active ingredient the many 'Roundup' products that are available for agricultural, professional, and homeowner use. As of this writing, the *glyphosate* products available on the PA statewide herbicide contract are 'Aquaneat' and 'Glyphomate 41'. Both of these products have aquatic labeling.

*Glyphosate* has several advantages:

- it *is* effective
- it has low toxicity to non-target organisms
- it has no soil activity
- it's relatively inexpensive

A new option still being evaluated is the herbicide *imazamox* ('Clearcast'). Operational results to date suggest it is very active against phragmites. It has less soil activity than *imazapyr*, and may be less injurious than *glyphosate* to many species that would be contacted during spray operations.



## Where's the Water?

If standing water is present, a spray application requires the presence of an applicator certified for aquatic application, and a permit from the PA Fish & Boat Commission. It's easier to wait for drier conditions so that a permit is not required.

## Be Persistent

There are two phases of phragmites management

– control and maintenance. The control phase takes two seasons, and includes at least two operations in year-one (e.g. cut and treat, or treat twice) and at least one operation in year-two.

After your control efforts have nearly eliminated phragmites, you need to periodically monitor the sites and treat any signs of new growth to prevent re-infestation.

Figure 1. The management calendar for phragmites emphasizes late-season applications of the herbicide glyphosate to maximize injury to the rhizomes.

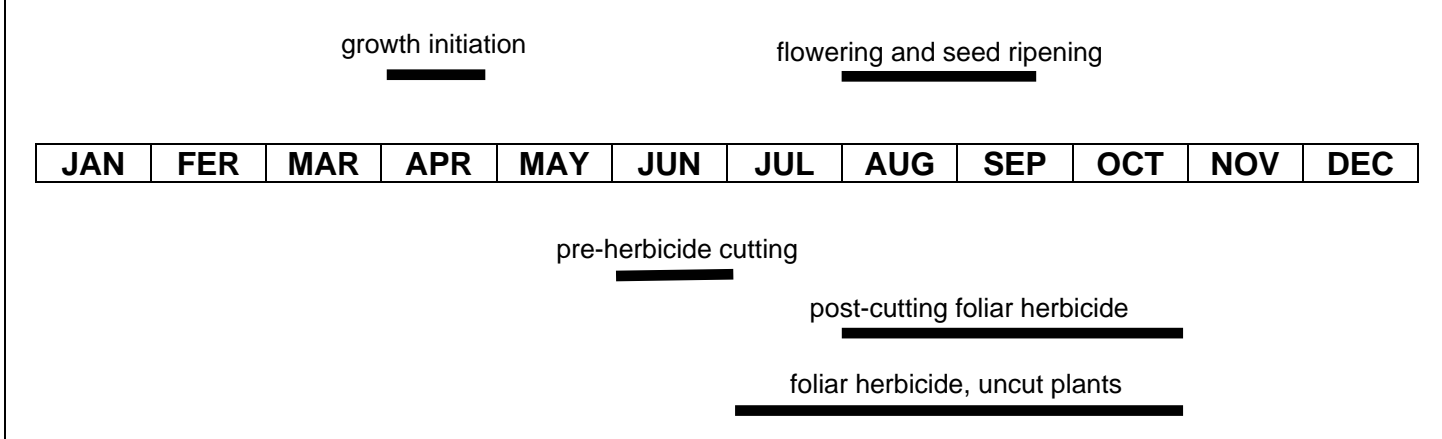


Table 1. Prescriptions for elimination of phragmites stress proper timing of operations to maximize injury to rhizomes. Improper timing (impatience) will result in treatments that provide 'topkill' (shoot injury) but no net effect.

timing	treatment	product rate	comments
June	cutting prior to foliar herbicide application	n/a	Cutting in June results in shorter, less dense regrowth. It also eliminates the persistent stems from previous seasons. This makes a subsequent herbicide application easier. However, cutting is very laborious – unless you have a small infestation or a mower that won't get stuck or leave damaging ruts, it may easier to spray twice rather than to manually cut and spray.
anytime	cutting	n/a	Repeated cutting does not eliminate phragmites, but it does slow its growth and lateral spread significantly. Where phragmites is adjacent to mowed areas, it should be included in the mowing regimen (conditions permitting). If you are going to treat phragmites with a systemic herbicide, stop mowing 8 weeks prior to application.
At least 8 weeks after mowing, or to uncut phragmites after July 1	'Aquaneat' or 'Habitat' or 'Clearcast'	7.5 pints/acre or 5 pints/acre or 4 pints/acre	Use any of these products to treat regrowth, waiting eight weeks after the cutting to treat, or treat uncut phragmites after July 1. Phragmites will usually remain green into late October, allowing time for a follow-up application as well. 'Habitat' ( <i>imazapyr</i> ) has significant soil activity and should not be used over the root system of desirable trees
fall follow-up, while foliage is still green	'Aquaneat'	7.5 pints/ac	Phragmites can be treated as late as early November in some locations. Use an aquatic-labeled <i>glyphosate</i> product for the follow-up treatment if 'Habitat' or 'Clearcast' were used for the initial treatment.
after herbicide treatment	STAY OUT	n/a	Do not disturb the rhizome system after herbicide application. Where rhizomes are severed due to mechanical injury, you will likely observe more resprouting.

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## Exotic Shrubs

### Description

- Refer to the DCNR Invasive Exotic Plant Tutorial (<http://www.dcnr.state.pa.us/forestry/invasivetutorial/List.htm>) pages for 19 invasive shrubs, including:
  - Japanese barberry (*Berberis thunbergii*)
  - autumn olive (*Elaeagnus umbellata*)
  - privets (*Ligustrum* spp.)
  - shrub honeysuckles (*Lonicera* spp.)
  - multiflora rose (*Rosa multiflora*)
- As a group, they are adapted to a wide range of habitats, and plague almost every plant community type worth protecting.
- The exotic shrubs tend to leaf out sooner and drop their leaves later than native shrubs.
- None of these shrubs sucker (produce new shoots from their roots).

### Management Keys

The exotic shrubs that plague Pennsylvania are not difficult to control. They are prolific, and there are usually too many of them. However, compared to other species, they are not hard to kill.

#### Target the 'Tops'

None of the problem shrubs are suckering (root sprouting) species. If you effectively treat the top of the plant, the roots will die.

#### Timing Flexibility

Because they leaf-out early and drop their foliage late compared to most native woody species, and do not sprout from their roots, you have a longer operational window to manage exotic shrubs compared to rhizomatous or root-creeping species. Foliar treatments are an option for most species from June into October. Stem treatments can be done all year, weather permitting.

#### Foliar Treatments

Typically, you will have several of the shrub species present on your site. These species vary in their response to different herbicides, so it is important to use a treatment that is effective against all of the species. Use a mixture of herbicides to provide a broad spectrum of control.

A mix we like for shrub treatments is a mixture of *glyphosate* and *triclopyr*. We mix these at a 4:1 ratio, targeting 3.0 lbs *glyphosate*-acid per acre and 0.75 lbs *triclopyr*-acid per acre. This mix is non-selective, but has practically no soil activity, and both herbicides are available as aquatic-labeled products. Case in point – *glyphosate* alone will provide effective control of Morrow's honeysuckle (*Lonicera morrowi*), but provides little control of autumn olive (*Elaeagnus umbellata*); and *triclopyr* is very active against autumn olive but ineffective against honeysuckle. The mixture of *glyphosate* and *triclopyr* is effective against both species.

#### Stem Treatments

Stem treatments are effective against the exotic shrubs, and you can implement them throughout the year, giving you scheduling flexibility. The two most useful options are basal stem treatment, and stump treatment.

Basal stem treatment uses a concentrated mixture of the herbicide *triclopyr* in oil that is applied to the entire circumference of the lower 8 to 18 inches of the stem, depending on its size. 'Pathfinder II' is a ready-to-use *triclopyr* product available on the Pennsylvania statewide herbicide contract.

If you want to remove the topgrowth of the shrubs, the preferred approach would be cutting the stems close to the soil line, and treating the stump. 'Pathfinder II' is effective for this treatment. You can also use *glyphosate*, in a 1:1 mixture with water. The oil-based 'Pathfinder II' can be applied anytime after cutting, while a *glyphosate* treatment needs to be applied as the stems are cut.

#### Mechanical Control

Small infestations of small plants - particularly the shrub honeysuckles, multiflora rose, and barberry - can be pulled by hand effectively. Autumn olive is comparatively well rooted and is difficult to pull.

Mowing effectively eliminates the shrub canopy, and eliminates the need to drag and chip or burn the stems after cutting.

Resprouting is often suppressed after mowing because the beating the stump receives during the



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mowing often kills the stem tissue. This will depend on shrub size and species. Larger shrubs will tend to suffer more damage this way, while smaller plants are more likely to be cut somewhat cleanly, and will therefore resprout more vigorously.

Mowing should be followed with an herbicide application to eliminate the resprouts. Foliar applications are easier than stump (stubble?) treatments because the targets are easier to find, and treating knee-to-waist high resprouts with a backpack sprayer is a relatively quick process.

Figure 1. The management calendar for exotic invasive shrubs is quite flexible because the foliage comes early and falls late. Stem treatments to intact or cut stems provide a year-round window of opportunity.

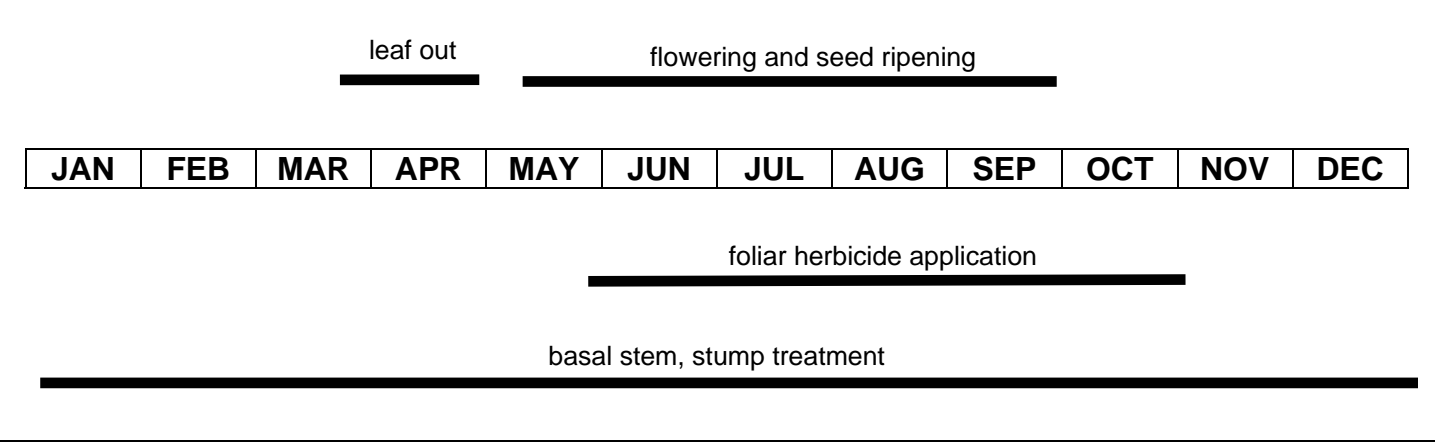


Table 1. The invasive shrub ‘complex’ that plagues Pennsylvania can be treated throughout the year. These shrubs leaf out early and drop their leaves late, providing a long foliar application window. Basal stem and stump treatments can be made anytime the weather permits.

timing	treatment	product rate	comments
June to onset of fall color	‘Aquaneat’ plus ‘Garlon 3A’ plus surfactant	3 qts/ac plus 1 qt/ac	This combination of <i>glyphosate</i> plus <i>triclopyr</i> is effective against a broad spectrum of woody species. Additionally, this mixture reduces risk to non-targets because it has practically no soil activity, and the herbicide products are aquatic-labeled.
year-round	‘Pathfinder II’	ready-to-use	‘Pathfinder II’ is a <i>triclopyr</i> -in-oil mixture for basal stem and stump treatment. Basal stem applications wet the entire circumference of the lower 8 to 18 inches of the stem, without running off. Stump treatments can be made anytime after cutting, and should cover the outer edge of the cut surface and the bark of the stump. An oil-soluble dye should be added to improve tracking and avoid skips and double-treating.
year-round	‘Aquaneat’	1:1 mix with water	‘Aquaneat’ is an aquatic-labeled <i>glyphosate</i> product that can be used for stump treatment. Unlike the oil-based ‘Pathfinder II’, this water-based treatment must be applied as soon as the stems are cut. A water-soluble colorant should be added to improve tracking and avoid skips and double-treating.





## *Japanese stiltgrass (Microstegium vimineum)*

### **Description**

- Refer to the DCNR Invasive Exotic Plant Tutorial stiltgrass page ([http://www.dcnr.state.pa.us/forestry/invasivetutorial/Japanese\\_stiltgrass.htm](http://www.dcnr.state.pa.us/forestry/invasivetutorial/Japanese_stiltgrass.htm)).
- Herbaceous, annual, warm-season grass.
- Tolerant of full sun to heavy shade.
- Has a sprawling growth habit, with a canopy height between 12 and 24 inches.
- Seedheads emerge late-August to early-September.
- Infestations commonly start along road or trail edges, then spread outward.

### **Management Keys**

As a plant, stiltgrass is not hard to suppress. However, treatment often begins after stiltgrass has spread extensively and established a persistent seedbank, making control difficult.

#### **Target the Seedbank**

To eliminate stiltgrass, you have to prevent seed production, and exhaust the seed lying in wait in the soil. You should plan on at least a five-year process.

#### **Prevention is Easier**

If stiltgrass is just getting onto your site, determine where it's coming from. Shale and gravel for roadwork are common sources. Roadwork where stiltgrass is already established spreads it even further.

#### **Mechanical Control**

Small infestations of stiltgrass are readily pulled. A trimmer can be effective later in the season (Figure 1), if you cut the stiltgrass off at ground level. A lawnmower cuts too high and will not work, as stiltgrass is a common weed in turf.

#### **Early Control**

It is common to first observe stiltgrass along roads or trails. The infestation tends spread along the road or trail, then spread away into the understory. It is relatively easy to treat stiltgrass while it occurs as a narrow, linear infestation.

#### **Recommended Herbicides**

Stiltgrass is susceptible to a number of herbicides, allowing you to tailor a program that fits your schedule

and the plant community you are trying to preserve.

Preemergence herbicides that are effective against stiltgrass include *pendimethalin* ('Pendulum'), *imazapic* ('Panoramic'), and *sulfometuron* ('Oust XP').

*Imazapic* and *sulfometuron* can also be applied postemergence for effective control of stiltgrass. *Pendimethalin* will have the least effect on non-target species of these three materials, but it is also the least flexible to use. *Pendimethalin* must already be in the soil where the seed is germinating – it has to be absorbed by the emerging root tip to be effective. *Pendimethalin* has no effect on already established vegetation.

*Imazapic* and *sulfometuron* provide more flexibility in terms of application timing, but they will cause more injury to non-target herbaceous plants than *pendimethalin*.

Three postemergence herbicides that are effective against stiltgrass include *glyphosate* ('Aquanat'), *glufosinate* ('Finale'), and *quizalofop* ('Assure II'). *Glyphosate* is non-selective and systemic, and will injure all treated vegetation. *Glufosinate* is also non-selective, but it is a 'contact' herbicide, so the damage to treated non-target plants will be limited to where the spray contacted the plant.

The herbicide *quizalofop* only injures grasses. Stiltgrass is affected by *quizalofop* at low rates, so you can control stiltgrass but leave native woodland grasses such as whitegrass (*Leersia virginica*), nimblewill (*Muhlenbergia schreberi*), and autumn bentgrass (*Agrostis perennans*) largely intact.

#### **Alternate Groundcover**

If conditions permit, you should try to establish a groundcover to compete with the stiltgrass. If there already is groundcover, try to encourage its growth. Turf that is mowed too short and too often is more prone to stiltgrass infestation than a properly maintained turf.

#### **Be Persistent**

Stiltgrass can only be effectively controlled with repeated, annual effort. If you back off one season, the seedbank will be replenished, and your progress to date will be set back.



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Figure 1. The objective of stiltgrass management is to prevent seed set. Stiltgrass is effectively controlled with preemergence or postemergence herbicide applications, and small infestations can be hand-pulled or cut at ground level.

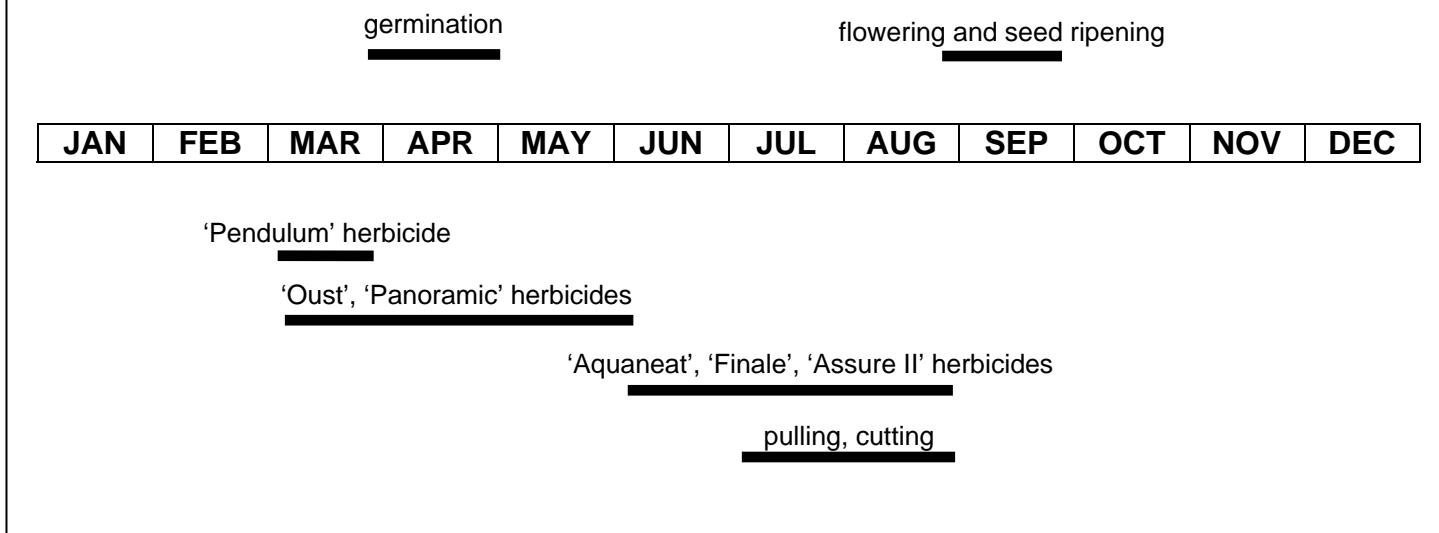


Table 1. Prescriptions for elimination of Japanese stiltgrass focus on preventing seed set. Stiltgrass is susceptible to a number of herbicides suitable for use in parks. Small infestations can be pulled or cut at ground level, which facilitates the use of volunteers.

timing	treatment	product rate	comments
early- to mid-March	'Pendulum Aquacap'	4.2 qts/acre	Preemergence applications of 'Pendulum' ( <i>pendimethalin</i> ) prevent stiltgrass establishment, and have little effect on plants that are already present. It is critical that <i>pendimethalin</i> be applied two to three weeks prior to germination to allow rainfall to move it into the soil profile. <i>Pendimethalin</i> is also effective against mile-a-minute.
early-March through May	'Panoramic' or 'Oust XP'	8 to 12 oz/acre or 1 to 3 oz/acre	'Panoramic' ( <i>imazapic</i> ) and 'Oust XP' ( <i>sulfometuron</i> ) have pre- and postemergence activity against stiltgrass. Preemergence applications will cause less damage to non-target species than postemergence applications. There comes a point in the season when you are better off using an herbicide that is not soil active (see below), to reduce the impact on non-target plants.
mid-May through August	'Aquaneat' or 'Finale' or 'Assure II'	24 oz/acre or 4 qts/acre or 4 oz/acre	'Aquaneat' ( <i>glyphosate</i> ) and 'Finale' ( <i>glufosinate</i> ) are non-selective herbicides with no soil activity. 'Finale' only injures the parts of the plant it contacts, while 'Aquaneat' is systemic, and will kill the entire plant. 'Assure II' ( <i>quizalofop</i> ) only affects grasses, but the rate used for stiltgrass is low enough that desirable grasses such as whitegrass ( <i>Leersia virginica</i> ), and nimbewill ( <i>Muhlenbergia schreberi</i> ) are only temporarily affected.
July through August	pulling or cutting	n/a	Small infestations of stiltgrass can be mechanically controlled. If you're cutting, use a trimmer that will cut the stiltgrass at the ground line to prevent resprouting from the lower nodes of the stem. The key to this treatment is to wait so that more stiltgrass will not germinate, but finish before the seedheads emerge.

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## ***Tree-of-heaven (Ailanthus altissima)***

### **Description**

- Tree-of-heaven is commonly known as 'ailanthus'.
- Refer to the DCNR Invasive Exotic Plant Tutorial [ailanthus page](http://www.dcnr.state.pa.us/forestry/invasivetutorial/tree_of_heaven.htm) ([http://www.dcnr.state.pa.us/forestry/invasivetutorial/tree\\_of\\_heaven.htm](http://www.dcnr.state.pa.us/forestry/invasivetutorial/tree_of_heaven.htm)).
- Fast growing, weak-wooded, clonal (root suckering) tree.
- Dioecious – male and female flowers on separate plants.
- Individual stems are relatively short-lived, but they can reach heights of 80 ft.
- Grows in dense clones where ailanthus stems occupy all layers, from understory to canopy.
- Native to East Asia, imported as an ornamental and urban street tree in the late-1700's.
- Grows almost anywhere, from sidewalk cracks or spoil in full sun to fertile, shaded alluvial soils along rivers and streams.

### **Management Keys**

Due to its size and vigor, and extensive spreading root system, ailanthus can be difficult to control. As long as you are willing to invest the up-front effort and follow a few key guidelines, it can be successfully suppressed.

#### **Target the Roots**

To control ailanthus, you have to injure the root system. This is most effectively done with systemic herbicides, when the plant canopy is exporting sugars to the roots for growth and storage.

#### **Timing is Key**

Systemic herbicides are most effective when applied later in the growing season (Figure 1). For ailanthus, we recommend waiting until July 1 to initiate treatment. This is when the foliage is sending sugars produced through photosynthesis to the roots. Systemic herbicides are moved in the same direction through the plant as the sugars.

Applications made too early in the season do not translocate to the roots, and only injure the aboveground growth.

### **Management Approach**

You need a program to manage ailanthus, not occasional bursts of activity. Ailanthus management falls into two phases – control and maintenance. The control phase will require two growing seasons, and the maintenance phase will be ongoing.

Anticipate three treatments during the control phase, and at least biennial treatments during the maintenance phase. If you are successful during the control phase, very little effort is required during the maintenance phase to prevent reinfestation.

#### **Mechanical Operations**

Cutting ailanthus is often necessary to remove potentially hazardous stems, but it is not usually useful as a control measure. You should only cut ailanthus if you are planning on treating the resulting resprouts. In situations where you want to remove ailanthus stems, it is better to cut *after* you have treated with herbicides.

#### **Herbicide Applications**

Ailanthus can be effectively treated with foliage or stem treatments. Tall, dense growth is best treated with a high volume ('spray to wet') application, while smaller stems can be treated with a low volume approach.

Effective stem treatment methods include basal bark and 'hack and squirt'. Basal bark treatments use a concentrated mixture of herbicide in oil, applied to the complete circumference of the lower 12 to 18 inches of the stem. The 'hack and squirt' method uses concentrated herbicide solution applied to spaced cuts around the perimeter of the stem. It is critical that the stem cuts are spaced so the applied herbicide can translocate to the roots. If you completely girdle the stem, the herbicide can only move up in the stem, and you will not injure the roots or the stem below the girdle.

Dense, or extensive infestations should be treated initially with a foliar application. The 'clean-up' application can be stem treatment, or foliar, depending on the size of the remaining stems. Large, tall stems are easier to treat with stem treatment, while smaller stems are easier to treat with a foliar application.



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## Recommended Herbicides

There are many herbicides available that are very effective against ailanthus, but we recommend using *glyphosate* and *triclopyr*. For foliar applications, we recommend a mixture of these herbicides (Table 1). Either herbicide can be used for hack-and-squirt treatments, and *triclopyr* is available in oil soluble formulations for basal bark applications.

## What about Stump Treatment?

If you need to cut down ailanthus for immediate safety reasons, by all means do so and treat the stump. However, cutting the stems and treating the

stumps does not provide effective control of the roots. When you remove the top, there is no more downward flow of sugars to the roots. Stump treatment of ailanthus will keep the stump free of sprouts, but it will not prevent root suckering.

If you want to cut ailanthus, treat it first, and then wait until the dormant season to cut it down. You should cut it before the next growing season because standing dead ailanthus decays quickly. If you leave it stand too long, you may be faced with considerable hazard while trying to remove the ailanthus.

Figure 1. The management calendar for ailanthus emphasizes late-season to maximize injury to the roots.

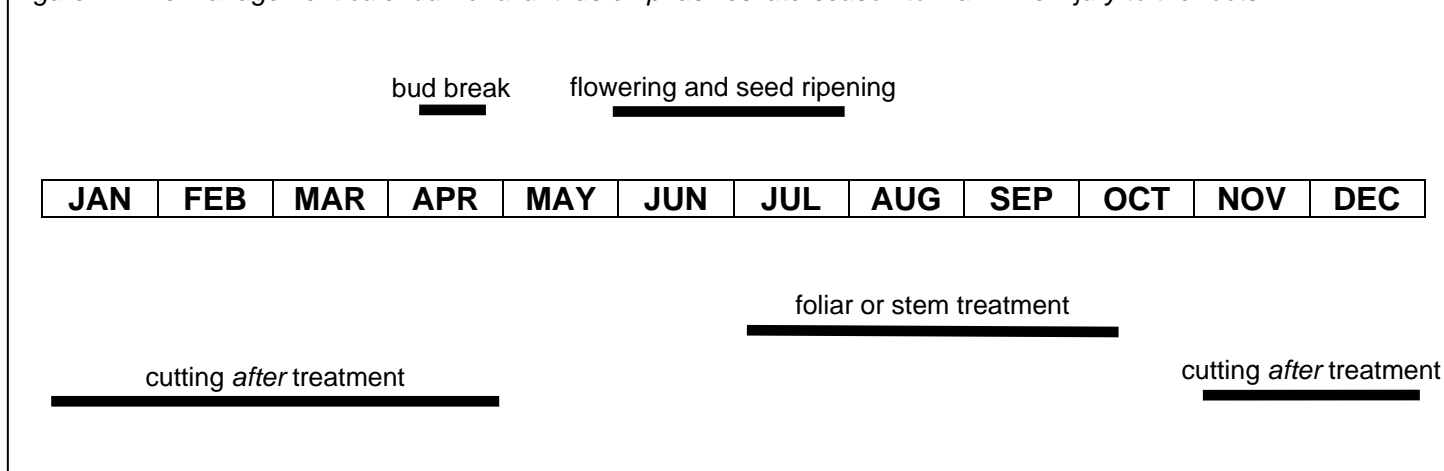


Table 1. Prescriptions for controlling ailanthus stress proper timing of operations to maximize injury to the roots. Improper timing will result in treatments that provide 'topkill' (shoot injury) but little net effect.

timing	treatment	product rate	comments
July 1 to fall color	foliar application of 'Aquaneat' plus 'Garlon 3A'	3 qts/acre  plus 1 qt/acre	The combination of <i>glyphosate</i> and <i>triclopyr</i> provides a broad-spectrum treatment that is effective against ailanthus and other woody species that should be targeted as well during the application. This is a non-selective mixture, but it has little soil activity, poses low risk to non-target organisms, and both products have aquatic labeling. A surfactant needs to be added. If the <i>glyphosate</i> product 'Glyphomate 41' is used instead (4.25 qts/acre), no additional surfactant is needed.
July 1 to fall color	basal bark application 'Pathfinder II'	ready-to-use	'Pathfinder II' is an oil-based formulation of <i>triclopyr</i> that can be used for basal stem applications. Treat the entire circumference of the lower 12 to 18 inches to wet the stem without runoff. This technique is laborious, and is best suited for treating small infestations or as a follow-up to a foliar application.
July 1 to fall color	hack-and-squirt 'Aquaneat' or 'Glyphomate 41' or 'Garlon 3A'	undiluted or 1:1 with water	These are water-based formulations useful for hack-and-squirt treatments. It is essential to space the cuts so there is intact bark between the cuts. If you completely girdle the stem, the herbicide cannot translocate to the roots. A simple guideline for number of cuts is 'inches in diameter plus one'. This is a laborious treatment best suited for low stem numbers, and stems at least 1-inch in diameter. Treat immediately after cutting, filling the cut with herbicide mixture.

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## *purple loosestrife (Lythrum salicaria)*

### **Description**

- Refer to the DCNR Invasive Exotic Plant Tutorial purple loosestrife page ([http://www.dcnr.state.pa.us/forestry/invasivetutorial/Purple\\_loosestrife.htm](http://www.dcnr.state.pa.us/forestry/invasivetutorial/Purple_loosestrife.htm)).
- Herbaceous, non-creeping, perennial forb.
- Reproduces only by seed – can produce over 500,000 seed per plant.
- Infestations can become near-monocultures, decreasing plant diversity and habitat value.
- Native to Eurasia, imported intentionally as an ornamental, and accidentally in ship's ballast.
- Infests wetlands, ditches, and riparian areas. Wetland Indicator status is 'OBL' (obligate - ≥99% chance that plant will occur in wetland)
- Noxious Weed in Pennsylvania – sale and propagation are prohibited.

### **Management Keys**

The difficult aspect of purple loosestrife control is where it grows, rather than *how* it grows. It's not that difficult to control an herbaceous perennial that reproduces only by seed. However, when it grows in a sensitive (wet) area amongst a diverse plant community, and produces so much seed that it will constantly be appearing, it becomes a challenge to manage.

The key to managing loosestrife is to intervene early so that you can be as selective as possible when treating.

#### **Prevent Seed Production**

To prevent an infestation from expanding, you must prevent further seed production. Flowering can begin as early as late June, and continue into September. You need to control loosestrife early in this window to limit seed production.

#### **Mechanical Operations**

Isolated loosestrife plants can be hand-pulled or dug. This technique is most effective when the soil is saturated. Purple loosestrife is well rooted, and any large root pieces you leave behind in the soil may resprout.

Cutting will reduce or prevent seed set. If seed has

formed, you can remove the flowers for disposal, then cut the rest of the plant to the ground.

#### **Biological Control**

Where infestations are extensive, biological control agents that feed solely on purple loosestrife can be released. The most common agent released is the *Galerucella* beetle, which feeds on the foliage. There have been releases within the State Park system with variable results. Releases are coordinated with the PA Department of Agriculture and USDA-APHIS.

#### **Herbicide Applications**

Herbicide applications against loosestrife will be postemergence applications. The two basic scenarios are spot treating scattered loosestrife growing among desirable plants, and near-monocultures where loosestrife is basically the only plant present.

Ideally, treatment needs to occur before seed set. Even though a site may be heavily infested with an established seedbank, adding more seed is never good. Also, removing loosestrife earlier in the season provides a window at the end of the growing season for the native seedbank to establish.

#### **Recommended Herbicides**

The two most useful herbicides to manage loosestrife are *glyphosate* and *triclopyr*. *Glyphosate* is non-selective, and has no soil activity. All contacted plants will be injured, but openings will be quickly colonized by the seedbank and uninjured propagules. *Triclopyr* is selective, with minimal soil activity and will leave grasses and other monocots (sedges, rushes) largely uninjured.

Both herbicides are available as aquatic-labeled products, and pose reduced risk to non-target organisms.

Your herbicide choice will be based on the density of the loosestrife and the desirable species that are present. In the worst-case scenario where you have a dense stand of loosestrife and other invasive species such as phragmites or narrowleaf cattail, you need to use *glyphosate* (or *glyphosate* plus *triclopyr* to cover all options if there are undesirable woody species present) and broadcast apply. If the loosestrife is sparse, you can choose herbicides based on the desirable species



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that are present. If the desirable species are mostly monocots, *triclopyr* will be a more selective option.

### Aquatic or Terrestrial Application?

The presence of widespread standing water or saturated soil render an application 'aquatic'. These conditions require the applicator to be certified for aquatic applications (Applicator Category 9) AND to get a permit from the PA Fish & Boat Commission to make the aquatic application. Time your applications for drier periods. Isolated standing water or saturated soil does not require a permit.

### Follow-up Treatments

Due to the vast amounts of seed that loosestrife drops, it will always reappear on a site once it has become established. Purple loosestrife is not a species that you control, declare victory, and walk away. Once you have eliminated the original infestation, you will need to spot-treat new plants as they arise, on an ongoing basis. However, by keeping purple loosestrife in check and encouraging a native plant community, you will be providing the best habitat possible under the circumstances.

Figure 1. The management calendar for purple loosestrife emphasizes treatment before seed set. When seed is present it should be removed and destroyed prior to herbicide treatment, cutting, or pulling/digging.

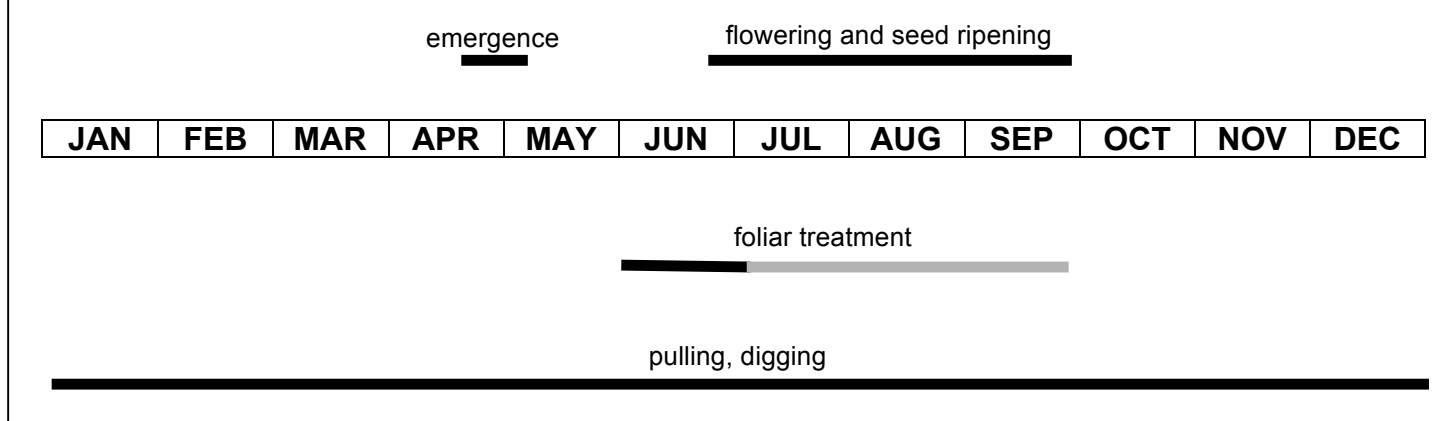


Table 1. Prescriptions for controlling *ailanthus* stress proper timing of operations to maximize injury to the roots. Improper timing will result in treatments that provide 'topkill' (shoot injury) but little net effect.

timing	treatment	product rate	comments
any time	pulling or digging	n/a	When plant numbers are small, purple loosestrife can be pulled or dug. Loosestrife does not have a creeping root system, but leaving large pieces of root may result in regrowth – similar to dandelion or other taprooted perennials. Purple loosestrife is well rooted, so this should be done in saturated conditions.
June - September	foliar treatment with 'Garlon 3A'	2 qts/ac	'Garlon 3A' is a water-soluble formulation of <i>triclopyr</i> that is active against dicot weeds, and safe to most monocots (grasses, sedges, rushes, etc). It has aquatic labeling, and little soil activity. Use an aquatic-labeled surfactant such as 'Timerland 90'. If plant numbers are small, remove inflorescences and destroy them after flowering begins to reduce addition to the seedbank. In larger, established infestations this is not practical.
June-September	foliar treatment with <i>glyphosate</i> 'Aquaneat' or 'Glyphomate 41'	3 qts/ac or 4 qts/ac	These <i>glyphosate</i> products are aquatic-labeled. 'Aquaneat' requires additional surfactant ('Timberland 90'), while 'Glyphomate 41' has surfactant pre-mixed. <i>Glyphosate</i> will injure all contacted plants. Sparse loosestrife should be spot-treated, while dense stands can be broadcast-treated. If plant numbers are small, remove inflorescences and destroy them after flowering begins to reduce addition to the seedbank. In larger, established infestations this is not practical.

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## *mile-a-minute (Polygonum perfoliatum)*

### **Description**

- Refer to the DCNR Invasive Exotic Plant Tutorial mile-a-minute page - ([http://www.dcnr.state.pa.us/forestry/invasivetutorial/mile\\_a\\_minute.htm](http://www.dcnr.state.pa.us/forestry/invasivetutorial/mile_a_minute.htm)).
- Annual vine reaching lengths of 20 ft., smothering desirable vegetation.
- Stem features stout, downward-pointing spines – often called ‘tearthumb’.
- Seed enclosed in fleshy blue ‘berry’ attractive to birds – which aid in dispersal.
- Distinctive triangular leaves.
- Native to East Asia, imported as seed in *Rhododendron* stock to a York County nursery in the 1930’s.
- Infests non-maintained areas, in full sun to partial shade.
- Noxious Weed in Pennsylvania.

### **Management Keys**

Mile-a-minute (MAM) is not a difficult plant to dispatch. It’s readily pulled and it is sensitive to moderate rates of several widely used herbicides. However, it can begin setting seed by mid-June; and it will grow onto and over desirable vegetation, making selective control with herbicides difficult.

#### **Prevent Seed Production**

To prevent an infestation from expanding, you must prevent further seed production. Flowering can begin in early June in southeast PA, and continue until killing frost. You need to control MAM early in the season limit seed production. MAM seed is viable in the soil for at least five years, so preventive MAM management is going to be an ongoing operation.

#### **Mechanical Operations**

Limited infestations of MAM can be pulled fairly easily – provided you have protective gloves.

Repeated cutting will reduce or prevent seed set. To be truly effective, cutting would have to be at ground level, using a string trimmer or similar device. Intact stems left after cutting will send up new branches. If seed has formed, remove the seed-bearing stems and destroy them.

### **Biological Control**

Where infestations are extensive, biological control agents that feed solely on MAM can be released. The MAM weevil (*Rhinoncomimes latipes*) became available in 2004 for release. Releases are coordinated with the PA Department of Agriculture and USDA-APHIS.

### **Herbicide Applications**

MAM is effectively controlled with pre- or postemergence herbicide applications. Significant infestations in high-priority areas should be treated with a preemergence application and follow-up postemergence applications to eliminate escapes and misses. Sparse populations are better treated with postemergence applications.

#### **Recommended Preemergence Herbicides**

For preemergence applications, three options for Park settings are ‘Pendulum Aquacap’ (*pendimethalin*), ‘Oust XP’ (*sulfometuron*), and ‘Plateau’ (*imazapic*). These herbicides are effective against MAM, are available on the state herbicide contract, and provide some selectivity – allowing you to preserve existing desirable vegetation. *Pendimethalin* is the most selective – it will not affect established herbaceous or woody vegetation. However, *pendimethalin* must be applied prior to germination to be effective. Plan on applying it by mid-March. *Imazapic* and *sulfometuron* have postemergence activity as well, so you can apply them even after the MAM has emerged. However, both of these herbicides will cause injury to some already established herbaceous species, even when applied preemergence. Delaying application until desirable vegetation is beginning active growth will increase the injury. If woody species have broken bud before *sulfometuron* application, they may be severely injured if you contact the emerging foliage.

#### **Recommended Postemergence Herbicides**

There are several widely used herbicides that are effective against MAM. However, we will limit recommendations to *triclopyr* (‘Garlon 3A’) or *glyphosate* (‘Glyphomate 41’). These products are on the state herbicide contract, they have little (*triclopyr*) to no (*glyphosate*) soil activity, and they both have aquatic labeling. These products are effective, available, and pose low risk to non-target plants and other organisms.



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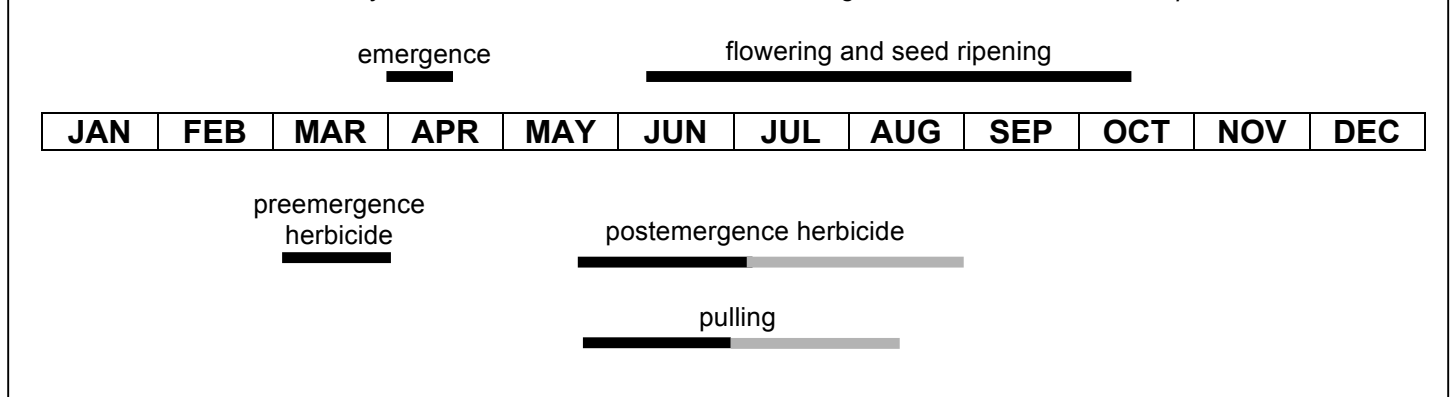
'Garlon 3A' only injures broadleaf plants, while 'Glyphomate 41' will injure all contacted plants. Choose your product based on the vegetation that the MAM is growing in and what vegetation you are trying to retain. If you are targeting a number of species while treating MAM, you can use a 4:1 mix of 'Glyphomate 41': 'Garlon 3A' (target 4 qts:1qt per acre). This will provide control of most any species you treat. This is a potent rate appropriate for brush, so apply it lightly to the MAM.

MAM has waxy leaves, so it is important to use a surfactant (e.g. 'Timberland 90', which is the current non-ionic surfactant on the state contract) with 'Garlon 3A'. 'Glyphomate 41' includes pre-mixed surfactant.

### Follow-up Treatments

In high-priority areas, spot treat escapes and misses later in the season. If plants bearing seed are present, pull and bag them, and destroy them.

**Figure 1.** The management calendar for mile-a-minute emphasizes treatment before seed set. When seed is present it should be removed and destroyed. Where bars are dimmed, this timing is less useful because of ripened seed.



**Table 1.** Prescriptions for controlling mile-a-minute (MAM) stress completing control operations before July 1 to prevent seed production. MAM is an indeterminate vine that flowers from mid-June until killing frost.

timing	treatment	product rate	comments
May to mid-June	pulling	n/a	As long as ripe or nearly-ripe seed (look for the blue fruit) are not present, the vines can be pulled (with protective gloves) and left to dry.
After mid-June	pulling and removing vines for destruction of seed	n/a	Once ripe seed is present, pulled vines should be bagged and destroyed, preferably by burning. The simplest approach would be to use sturdy paper bags and burn the bags.
May to killing frost	mowing, cutting	n/a	Cutting plants at the ground (i.e. string trimmer) will kill them. If you are mowing and leaving the lower stem intact, the vines will likely regrow. Repeated mowing will suppress seed set and prevent the vines from climbing desirable plants.
March	preemergence herbicide (choose one): 'Pendulum Aquacap' 'Plateau' 'Oust XP'	4.3 qts/ac 8 to 12 oz/ac 2 oz/ac	Use preemergence herbicides where infestations are dense, then follow-up in May with postemergence herbicide to treat misses. 'Pendulum' ( <i>pendimethalin</i> ) is the safest treatment to existing, desirable herbaceous plants. In forested settings, 'Plateau' ( <i>imazapic</i> ), or 'Oust XP' ( <i>sulfometuron</i> ) are safe to woody plants, but will cause injury to some herbaceous species. 'Plateau' and 'Oust XP' have significant postemergence activity, while 'Pendulum' has only preemergence activity and <i>must</i> be applied 2 to 3 weeks prior to germination get moved into the soil by rainfall.
May through June	postemergence herbicide (choose one): 'Garlon 3A' plus surfactant 'Glyphomate 41'	48 oz/ac 64 oz/ac	Use postemergence herbicides as the primary tool where infestations are not dense, and as a follow-up to preemergence applications. 'Garlon 3A' ( <i>triclopyr</i> ) will not injure grasses and other grass-like plants, while 'Glyphomate 41' ( <i>glyphosate</i> ) will injure all vegetation that is contacted. MAM is susceptible to a number postemergence herbicides, but <i>triclopyr</i> and <i>glyphosate</i> are on the state herbicide contract, have little-to-no soil activity, and have aquatic labeling.

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