



## Managing Japanese Knotweed and Giant Knotweed on Roadsides

### Untangling the Truth About Knotweed

Japanese knotweed (*Polygonum cuspidatum*, [known to some botanists as *Fallopia japonica*]), also known as 'bamboo', is a tall-growing, hollow-stemmed, perennial herbaceous plant capable of forming dense monocultures on a wide range of site conditions, from sterile road-cuts to stream banks (Figure 1). Knotweed is not a true bamboo (a woody, evergreen grass), but is a relative of plants such as buckwheat, smartweed, and the Noxious Weed mile-a-minute vine. Japanese knotweed and its close kin giant knotweed (*Polygonum sachalinense*) (Figure 2) are native to East Asia, and were introduced to the U.S. for use as ornamentals during the late 1800's. However, due to their imposing height (6 to 10 ft), dense growth habit, aggressive spread, and seeming indifference to control methods, the knotweeds have become a pervasive weed in a number of settings.

Knotweed stems emerge in late-March to mid-April, depending on soil temperatures, and begin a burst of rapid growth. Roadside knotweed can already be tall enough to cause sight distance problems before the end of April, and the plants are almost full height by the end of May. Flowering usually occurs in July, and the seeds mature in August and September.

Knotweed reduces sight distance and damages pavement along roads (Figures 1 and 3), overruns low-to-no maintenance areas, and crowds out existing plant communities.

As frightening as the aboveground growth of knotweed is, it is the rhizome system that is the root of the problem. A rhizome is an underground stem that gives rise to roots, aerial stems, and more rhizomes (Figure 4). Knotweed rhizomes spread vigorously, expanding the size of the knotweed stand. Rhizomes are also very durable. A very small piece of rhizome that is moved to another site will give rise to a new plant. Roadside maintenance such as ditch cleaning is one the primary ways that knotweed is spread.

### Control Methods

The key to controlling knotweed is controlling the rhizome system of the plant. Knotweed is one of those



Figure 1. Showy flowers of Japanese knotweed. The knotweeds were introduced to the U.S. in the late 1800's as ornamentals due their prominent late-season flower display and striking height. Due to its great size, knotweed reduces sight distance and encroaches on the travel lanes, particularly on secondary roads.



Figure 2. Japanese knotweed (left) and giant knotweed (right) occur throughout Pennsylvania. The leaves of Japanese knotweed are usually 4 to 6 inches long, while the leaves of giant knotweed can reach 12 inches in length and are distinctly heart-shaped. Though often confused with each other, there is little chance of confusing these imposing plants with any other species. The knotweeds have similar adaptations and growth habits, and can be regarded as equally problematic.

By Art Gover, Jon Johnson, and Larry Kuhns, 2005. 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.

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 rhizomes will not control this plant.

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

Control methods are categorized as mechanical, cultural, biological, or chemical. Your program should rely on as many methods as possible in a pre-planned approach.

Well-established knotweed is very difficult to control, and successful control will require a multiple-step 'control phase', and an ongoing 'maintenance phase' in the following seasons to make sure the knotweed does not re-establish. For example, the control phase could consist of a cutting followed by an herbicide application, or an early-summer herbicide application followed by a fall application.

### **Mechanical Control**

Cutting alone is not an effective tool for managing knotweed. However, cutting can be an integral part of managing this plant, particularly when combined with a follow-up herbicide application.

Knotweed is herbaceous (non-woody), so though it may be imposing, the stems cut quite easily. Where terrain permits, knotweed can be mowed (Figure 5). Where mowing is not feasible, motorized trimmers with metal blades, or hand tools such as a machete or stout sickle will suffice. A properly timed cutting will eliminate the tall canopy and make follow-up operations much easier. Our experience in Pennsylvania suggests targeting June 1 as a cutting date. The regrowth from this cutting date is vigorous, but limited in height. A June 1 cutting of 6 to 10 ft tall knotweed results in regrowth that is only 2 to 4 ft tall.

Cutting too early in the season can result in regrowth that reaches full height. This effect is often seen when knotweed growth is killed by a spring frost. Cutting later than June reduces your operational window to chemically treat knotweed, and waiting too late in the season can result in almost no regrowth. We have conducted late-August mowings and had almost no regrowth to treat.

### **Cultural Control**

Cultural methods can be described as indirect, or preventive weed control. One example of a cultural control method for knotweed is preventing the spread of rhizome pieces in soil and on excavation equipment.

Encouraging or establishing alternative groundcover provides competition to knotweed, and will enhance the effects of other treatments. However, Japanese knotweed appears to inhibit the growth of other plants. In trials



Figure 3. Knotweed shoots emerging through asphalt. Knotweed not only limits sight distance, it physically damages shoulders and road edges.



Figure 4. A Japanese knotweed rhizome fragment showing newly emerging shoots, roots, and rhizome branches.



Figure 5. Despite its imposing height, knotweed is non-woody and is readily cut. Where terrain permits, it can be mowed. Cutting around June 1 in Pennsylvania will eliminate the canopy and result in regrowth that is only 2 to 4 ft tall, making follow-up herbicide applications easier.

where Japanese knotweed growing in a monoculture has been controlled, only a few weed species seem to colonize the former knotweed area the next growing season. Giant knotweed appears to cause less inhibition, and we have been able to revegetate these areas with cool-season grasses (Figure 6). Revegetating treated knotweed areas with grasses allows you to use herbicides that will injure the knotweed regrowth but not harm the grasses.

### **Chemical Control**

Herbicides can be applied to the plant foliage or to the surrounding soil. Stem injection is advocated for some areas, but this is extremely laborious. Stem injection is only viable where spraying is prohibited, and the amount of knotweed is limited.

#### **Foliar Applications**

The most common herbicide application is to spray the foliage. This is a productive method, and more selective than soil applications to control knotweed. Three factors that will determine the success of a foliar application are application timing, spray equipment, and the herbicides selected.

#### *Application Timing*

Our current understanding of knotweed growth is that the first vigorous flush of growth is fueled by stored carbohydrates in the rhizomes. During this growth spurt, the net movement of carbohydrates is to the canopy - away from the rhizomes. The herbicides used for a foliar application move through the plant with the carbohydrates. To control the rhizomes, the application needs to be made later in the season, when net movement of carbohydrates is back to the rhizomes for growth and storage. By 'later in the season', we mean the window from July 1 to the first killing frost.

If the knotweed is going to be cut around June 1 as described above, a follow-up herbicide application should be delayed for at least six weeks. This allows the knotweed to resprout and develop its new (though smaller) canopy, and begin sending carbohydrates back to the rhizomes.

#### *Spray equipment*

The choice of equipment depends on accessibility, and size and density of the knotweed stand. In narrower rights-of-way (ROW), a fixed-pattern applied by a spray truck is certainly the easiest and quickest way to treat knotweed. On wider ROW where the knotweed is beyond the reach of a spray truck, uncut knotweed is best treated with a high-volume application using a handgun on a length of hose (Figure 7). If the uncut knotweed stand is large enough that you will be required to walk through it - as opposed to being able to treat it from the perimeter - you should count on spray volumes of 200 to 300 gallons per acre to achieve 'spray-to-wet' coverage.

When knotweed has been cut and the shorter



*Figure 6. Frost seeding a cool-season grass mix into a stand of giant knotweed. The grasses develop into a competitive groundcover after the giant knotweed canopy is removed with a selective herbicide application in the spring. This approach has not been successful with Japanese knotweed.*



*Figure 7. A high-volume foliar application is the best method to treat knotweed that has not been cut. This application should be made after July 1 and before a killing frost.*



*Figure 8. After cutting around June 1, a late-summer treatment to the waist-high knotweed regrowth is easily made with a backpack sprayer.*

regrowth is being treated, a backpack sprayer may be the tool of choice. The shorter canopy can be effectively treated with a low-volume spray (5 to 40 gallons per acre), and the backpack provides the applicator more mobility than dragging a hose and handgun. An additional benefit is that non-target vegetation is much easier to see and avoid during treatment (*Figure 8*).

#### Herbicide selection

Glyphosate is the herbicide of choice for controlling knotweed. It is effective, has no soil activity, can be used near water, it is readily available, and inexpensive (Table 1).

Arsenal (*imazapyr*) and Vanquish (*dicamba*) have demonstrated significant activity on knotweed, but have appreciable soil activity and should not be used near desirable trees. Garlon 3A (*triclopyr*) has not been effective against established knotweed - it injures the topgrowth but does not appear to injure the rhizomes. However, triclopyr is safe to grasses and has aquatic labeling in ROW settings. It may be useful as a follow-up treatment where desirable grasses, sedges, or rushes are present.

#### Granular Soil Applications

Spike 20 P (*tebuthiuron*) is a pelleted herbicide that is applied to the soil. This product is non-selective and soil active. The effects of a tebuthiuron application develop slowly. It may be well into the summer before you are convinced that a spring application was effective. Tebuthiuron remains active in the soil for more than a year and is readily taken up by the roots of all plants, including nearby trees. The treated site should begin to revegetate during the summer of the season after a spring application.

This product would have a fit only in a wide ROW where the treatment will not impact desirable trees, result in erosion, or pose a threat to water.

## Implementing a Knotweed Management Plan

Due to the difficulty of initially treating knotweed, and the persistence of its rhizomes, effective control requires a programmed approach that includes initial control operations and ongoing maintenance.

### Two Phase Program

Control of any persistent weed requires an effective control operation and ongoing maintenance to prevent the weed from re-establishing. The chances of totally eliminating a weed from an area are slim because there is usually more of it just on the other side of the ROW fence. To be effective, your program must target knotweed when it is most susceptible to control measures (*Figure 9*).

#### Control Phase

The effectiveness of the control phase will determine how much effort is required in the maintenance phase. Better control means less follow-up work. Therefore, effort and resources should be front-loaded into a multiple-operation control effort.

A common approach may be to treat uncut knotweed one time, late in the summer, with a high volume foliar application. This is an effective treatment, but thorough coverage of an extensive knotweed stand is difficult. There is a good chance there will be misses and some resprouts. You *should* schedule a follow-up treatment before the end of the season, and apply the initial high volume treatment before August 1 to allow time for resprouting to occur. If you are going to apply only once, delay the treatment to late-August/early-September window, after flowering, to maximize herbicide movement to the rhizomes.

Here are some other control phase treatment scenarios:

- *Late Cut/Treat*: Cut around June 1, followed by a glyphosate application between August 1 and the

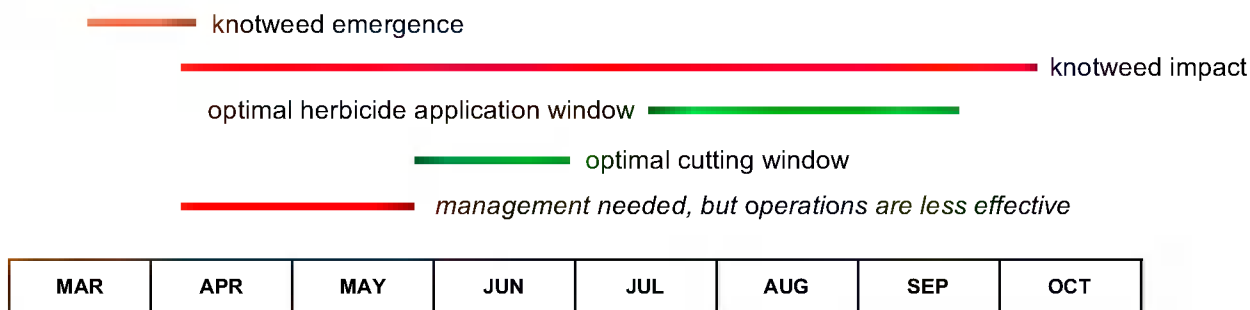


Figure 9. Our current view of the knotweed management calendar, based on its seasonal growth and response to control measures. In the roadside setting, the greatest concern is the period described as 'management needed, but operations are less effective', when knotweed is tall enough to impact sight distance, but mowing treatments will tend to result in tall regrowth and herbicide applications will only burn knotweed back, at best.

killing frost. The advantage of this late cut is that the knotweed regrowth is short. The drawback is that the knotweed was tall enough to negatively impact the roadside for at least a month.

- *Multiple Cut/Treat*: Cut twice in the spring to prevent the knotweed from hindering sight-distance followed by a glyphosate application between August 1 and a killing frost.
- *'Chemical mow'/Treat*: Target knotweed in late-April/May during the broadleaf weed control program with mixture such as Garlon 3A or Vanquish plus Escort XP (*metsulfuron*), or Garlon 3A plus Vanquish (Table 1). These mixtures will stunt and burn back the knotweed foliage. This will improve sight distance. Retreat with glyphosate in the late summer.

### Maintenance Phase

A follow-up application the first season after the control treatments is critical. The timing of maintenance herbicide applications follows the same calendar as the control applications - after July 1.

After this initial maintenance cycle, the visits can be scheduled on a two-year cycle if the treatments are successful. The maintenance applications can be applied using a backpack sprayer because targets will be limited. This allows the applicator to be selective in targeting, minimizing the damage to non-target plants.

If the non-target vegetation is mostly grasses, sedges, rushes, or other non-broadleaf species, you can enhance selectivity by using broadleaf herbicides such as Vanquish or Garlon 3A (Table 1).

### Revegetation

The maintenance of a knotweed management area will be easier if desirable vegetation colonizes the previously infested area. This desirable vegetation can either be installed, or allowed to develop from the species present in the seed bank. In many

Pennsylvania roadside settings, sites where knotweed is removed will revert to crownvetch after a few seasons. We have converted giant knotweed stands to grasses (Figure 6), but these sites also revert to crownvetch without annual maintenance to remove crownvetch from the grasses.

On sites where a specific plant community is desired after knotweed removal, such as riparian corridors, we offer a few suggestions.

- If you are establishing a seed mix, use species that allow you to use selective herbicides for maintenance applications.
- Use a short-lived, 'transitional' groundcover in areas where you are considering installing plants. This delay of a year or two will make it easier to eliminate the knotweed and to establish your plants
- Consider limiting planting to well-established trees or shrubs, which will already be tall enough to allow you to selectively treat the remnant knotweed.

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## SUMMARY

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Established knotweed stands are extremely tenacious. A well-executed control program will eliminate the existing stand along with the roadway hazards it presents for the short-term. Maintenance visits to the site to follow-up on resprouts are necessary to prevent re-establishment, and to allow an alternate groundcover to develop.

The routine maintenance program will only suppress knotweed, at best. Successful management of knotweed on the ROW requires special programming.

Table 1. Herbicides on the current (2005) Pennsylvania State Herbicide Contract that are effective for treating knotweed, listed by application technique.

Treatment	Products	Comments
Foliar	Glyphomate 41, GlyPro Plus ( <i>glyphosate</i> )	Best choice. Apply at 4 qt/ac. Due to aquatic labeling, Glyphomate 41 is preferred when applying near water.
	Arsenal ( <i>imazapyr</i> )	Significant soil activity. Do not use near desirable trees.
	Vanquish ( <i>dicamba</i> )	Soil activity. Safe to grasses, but nearby trees can be injured.
	Garlon 3A ( <i>triclopyr</i> )	Not effective for initial control - only seems to control topgrowth. Due to safety to grasses and aquatic labeling may be useful as a follow-up in sensitive settings.
	Escort XP ( <i>metsulfuron</i> )	Not effective by itself. However, Escort XP is a standard ingredient in treatments targeting broadleaf weeds and brush that could be used to 'chemically mow' knotweed early in the season.
Soil application	Spike 20 P	Suitable only where knotweed is not near desirable trees or adjacent to water. Effects are slow to occur, and long lasting. Treated areas may be devoid of any vegetation for almost two growing seasons.