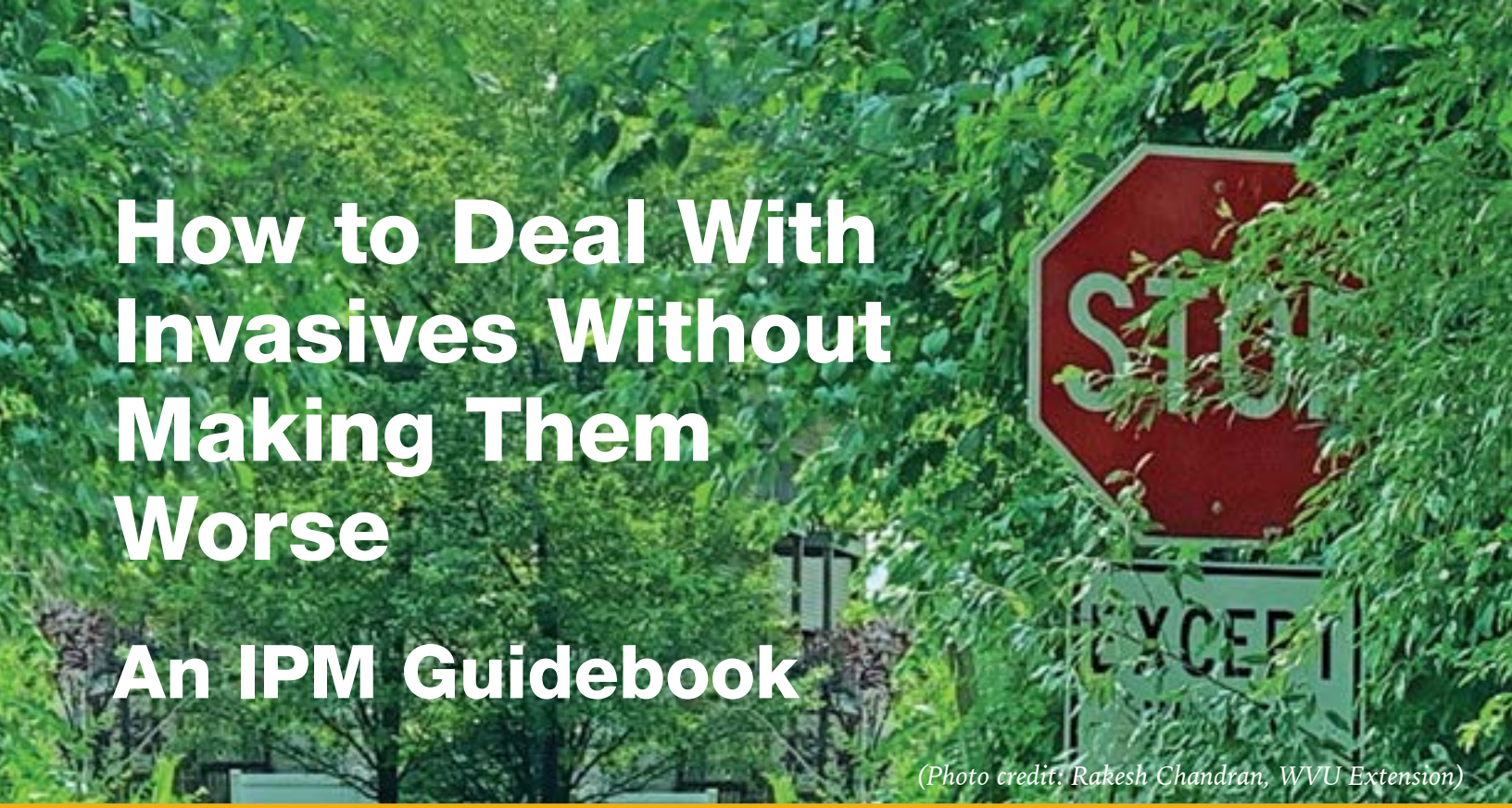
How to Deal With Invasives Without Making Them Worse

An IPM Guidebook



(Photo credit: Rakesh Chandran, WVU Extension)

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WV EXTENSION

Itap West Virginia
WV Local Technical Assistance Program

How to Deal With Invasives Without Making Them Worse

An IPM Guidebook

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This publication is not a replacement for the label. Always read the label on any herbicide before use. Formulations and concentrations change regularly. Inclusion of any name brands in this publication is for ease of reference and does not constitute an endorsement of that product.

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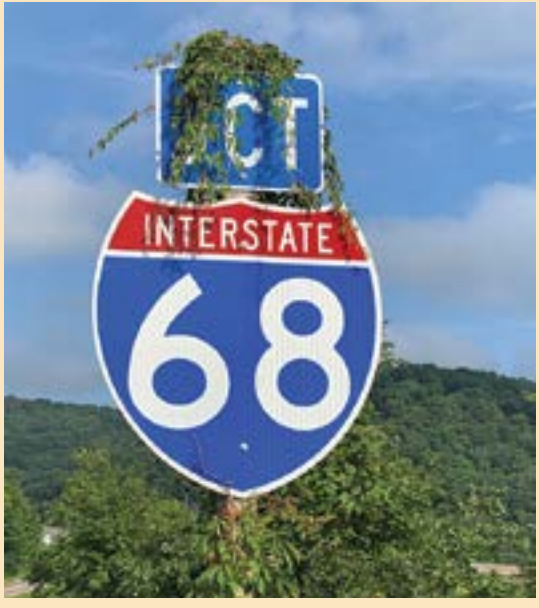
Introduction

Rapid growth of invasive species can lead to obstructed sight lines, soil movement and increased workloads for roadway maintainers. Rights-of-way managers have been fighting them for a long time. Yet, mowing or cutting alone can make invasives such as Japanese knotweed and tree-of-heaven worse. They are easily spread by seed, root suckers and even plant parts. Not only is using the right chemical important, but timing is also critical to control these nuisance plants. This guide will discuss how to correctly identify and properly treat several invasive species, including preventive techniques to reduce the spread and maintain less problematic species in the landscape.

Species that will be addressed include tree-of-heaven (TOH), autumn olive, multiflora rose, kudzu, roundleaf bittersweet, Japanese knotweed, poison hemlock and Japanese stiltgrass.



Vine growing over I-68. (Photo credit: Rakesh Chandran, WVU Extension)

General Overview

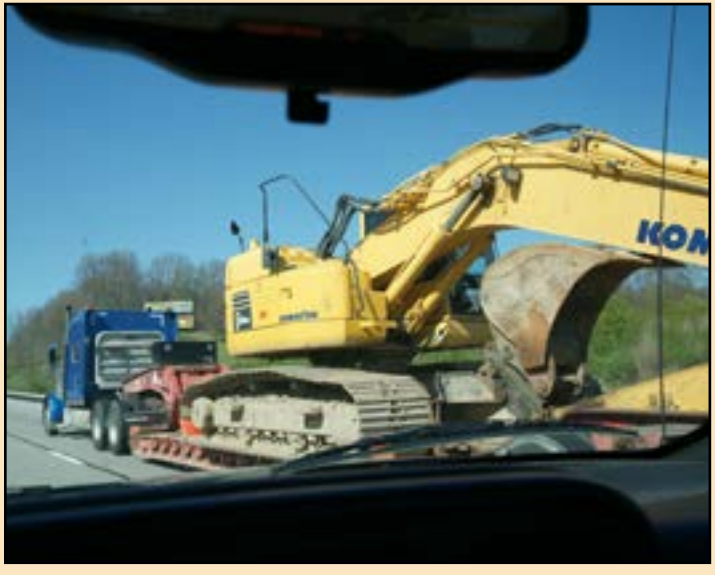
Prevention

Disturbed Areas

Invasives are most common in disturbed areas because there are openings for them to thrive. Weeds are like nature's band-aids, covering any bare spots. Reduce activities during wet periods and do not mow shorter than two inches. Clean equipment between sites to reduce soil movement. Learn which plants are okay to leave behind and which will cause problems.

Slow the Spread

Knowing how plants spread is important. If plants sprout prolifically from roots or stumps, cutting alone can increase the problem. Clean equipment between sites to avoid transporting plant parts and seeds. Use clean or sterilized fill soil.



(Photo credit: Rakesh Chandran, WVU Extension)

Effective Controls

Mechanical

Understanding the physiology of plants is important for appropriately timing a control method. The goal is to kill the root system since it can sprout new growth if left viable. The roots expend energy during spring months when the plant works to reestablish its canopy. During this time, the predominant flow of stored sugars (the plant's energy reserves) is in the upward direction, into new shoots and leaves. Being aware of this process and waiting until plants are fully leafed out can make mechanical control methods, such as prescribed burns, bush-hogging and cutting, more successful.

Chemical

Trade names for products are provided for example purposes only, and other products with the same active ingredient(s) may be available. Trade names mentioned in this publication are not a recommendation for one product over another. Individual product labels should always be examined for specific information and appropriate use.

Types of Herbicides

The herbicides effective for woody plants are systemic, which means they circulate throughout the plant. Like with mechanical controls, optimal herbicide effectiveness is achieved when well-timed applications take advantage of the seasonal changes in the plant's physiology. When systemic herbicides are applied later in the season and the flow of sugars is downward toward the roots, better movement of chemicals to

the root system may be facilitated. Choosing the proper herbicide, timing, method and rate of application will determine the success of the treatment. Repeated applications during successive growing seasons may be required in some instances.

Systemic herbicides that are pulled into the root system are more effective in managing perennial weeds and woody species. They are best applied in late summer to fall when the plant is actively growing and storing sugars for the winter.

Contact herbicides will kill only the plant parts that they directly contact and are effective in managing annuals and sometimes biennials. Thorough spray coverage is essential for effective control.

Pre-emergent herbicides will kill newly germinating plants and are usually used to control annuals. Germination periods vary widely, and you must know the specific plant's germination period to be effective. For example, winter annuals germinate in fall while summer annuals germinate in the spring. Herbicide application prior to seed germination is critical for successful control.

Selective herbicides typically kill only one general type of plant (e.g., 2,4-D is selective towards broadleaved plants). Non-selective herbicides can cause injury to, and potentially kill, any plant they contact (glyphosate and paraquat are non-selective).

Things to Know

Calibration and Nozzle Selection

The proper nozzle selection and tank pressure can determine the success of an herbicide application. Systemic herbicides typically need a finer mist for good coverage. However, this increases drift potential which can impact non-target plants. To reduce drift, avoid spraying on windy days. While using contact herbicides, use a coarse spray to obtain good coverage; adding the appropriate surfactant can enhance herbicide uptake. Air-mix nozzles can be used for both systemic and contact herbicides. Metal nozzles should be used while using oil as a carrier, whereas plastic or metal nozzles can be used while using water as the carrier to apply herbicides. Check the label for appropriate nozzle selection. Proper calibration is important to obtain good coverage and to apply the herbicide at the label rate. Calibration should be done at least once a year, depending on how frequently spraying is conducted.

DBH Calculation

Diameter at Breast Height (DBH) is measured at 4.5 feet above the uppermost soil line. This measurement will help determine if basal bark or hack and squirt would be more effective. Quick method: hold a pen (approximately six inches) horizontally at shoulder height against the stem. If the stem is smaller, use basal bark treatment. If the stem is larger, use the hack and squirt method as described on the following page.

Foliar and Ground applications

Herbicides can be applied to foliage or soil using a boom/broadcast sprayer or backpack sprayer. Broadcast application is typically done using a boom with multiple nozzles. Refer to the tables that follow to find the rate of application to control specific weeds. Backpack sprays are typically used for spot or directed application of herbicides to obtain selective control or in areas where booms are unwieldy. For optimal coverage and less waste, the spray should be applied until just before it drips off the leaf.

A cluster of 2-3-inch diameter TOH receiving basal bark treatments of triclopyr ester herbicide. (Photo Credit: Steven K. Rettke, Rutgers Coop. Ext.)

Basal Bark Treatment

For plants with a woody stem less than six inches DBH, use an oil-based herbicide with a penetrant as the carrier. Examples of penetrants are mineral oil, kerosene and no. 2 diesel oil. Make sure the penetrant chosen is compatible with the herbicide (see label). Spray to thoroughly cover the lower 12-20 inches of the stem on all sides. Thoroughly wet the bark but not to the point of runoff. This can be done when the plants are dormant, except when there is snow on the ground. Treat surviving stems the following year. Do not cut down plants until they are dead, which will take time. Use a knife to peel back the bark; if the tissue beneath the bark is completely brown, it usually means the plant is dead.

Hack and Squirt

For plants with a woody stem greater than six inches DBH, use a hatchet at a 45-degree angle to make small cuts or frills around the circumference of the tree. Make one cut for every inch of diameter while leaving space between each cut to avoid girdling the tree. Continued flow of the circulatory system is important to obtain thorough uptake of the herbicide through the root system. Use a spray bottle to apply a water-based herbicide into the wound. Treat surviving stems and sprouts the following year. Leave trees standing until they are dead.

Stump Treatment

Stump treatment involves the use of a sponge, brush, or sprayer to apply an herbicide solution to a freshly cut stump. If the stem is less than six inches DBH, spray or paint herbicide over entire stump. If it is greater than six inches DBH, spray or paint a one-inch-thick circle around the outer edge of the stump. This technique is most effective in later summer through fall and when spray is applied within one hour of cutting. This technique is not recommended for tree-of-heaven. Adding dye can be helpful to track treatment.

Hack and squirt: Leave spaces between the cuts so you don't girdle the stem. Use a squirt bottle to spray the herbicide into the cuts. (Photo Credit: Steven K. Rettke, Rutgers Coop. Ext.)

Root Crown Method (Mostly Used for Kudzu)
This method involves applying an herbicide solution to the main root crown of a plant. Carefully follow the rhizome of a young or resprouting stem back to the main plant. Dig and cut into the root crown using a Pulaski or similar tool. Apply herbicide solution to the main root crown and any below-ground runners.

Timing: Weather, Season and Patience

Weather

Rainfall can wash off your chemicals. Read the label to learn how long the chemical needs to dry before rainfall.

High air temperatures and low humidity can make certain formulations more volatile. Ester formulations of tricloyr and 2,4-D should not be applied in hot temperatures (check label).

Season

Know which season is best to treat the specific weed for greatest impact. Treating in the wrong season is not only a waste of chemicals but also a waste of time and effort.

Patience

When using systemic chemicals, wait 7-10 days for the full treatment impact before cutting. This will help avoid wasting time and effort. Larger trees may require a longer treatment length; read the product label to verify wait time.

Tree-of-Heaven (*Ailanthus altissima*)

Coupled with its size and structural weakness, the rapid rate of spread and growth of tree-of-heaven means that the species should be a key part of roadside inspection programs.

Tree-of-heaven roots can damage sewer lines and other underground utilities.

Identification: Tree-of-Heaven

Bark: In young plants, it's smooth and light brown. Once mature, it's rough patterned pale grey.

Leaves: Pinnately compound (frond), 2-7 inches long with many leaflets. The leaflet edge is smooth, but there are one or two "teeth" at the base of each.

Tree-of-heaven road view. (Photo credit: Chuck Bargeron, University of Georgia, Bugwood.org)

Young tree-of-heaven. (Photo credit: Richard Webb, Bugwood.org) Seeds. (Photo credit: Chuck Bargeron, University of Georgia, Bugwood.org)

Tree-of-heaven leaf. (Photo credit: Rakesh Chandran, WVU Extension) Leaflet closeup. (Photo credit: Richard Webb, Bugwood.org)

Growth and Dispersal: Tree-of-Heaven

It grows best in full sun or on sun/shade borders. Young sprouts can grow 10-15 feet per year. It spreads by seed and extensive root sprouts up to 50 feet from parent tree. Average mature height is around 60-80 feet. The average mature crown spread is 80 feet.

Control: Tree-of-Heaven

Mechanical

Cutting alone is not advised.

Wait 30 days after treatment before removal. Treat surviving stems the following year.

Chemical Control: Tree-of-Heaven

Application Method	Active Ingredient	Brand Name Example	Application Rate	Most effective Time of Year
Foliar (low canopy)	Glyphosate			When actively growing before fall color
	Imazapyr	Arsenal®, Roundup® or Habitat®	2% with water	
Basal Bark (<6" DBH)	Triclopyr ester		1:2 with oil	Mid-July through Mid-October
	Imazapyr	Arsenal®, Pathfinder® II, Garlon® 4 ultra or Habitat®	1:4 with water	
Hack and Squirt (>6" DBH)	Glyphosate			Mid-July through Mid-October
Hack and Squirt (>6" DBH)	Triclopyr amine	Roundup®, Garlon® 3A	1:1 with water	Mid-July through Mid-October
	Imazapyr	Arsenal® or Habitat®	1:4 water	
Cut Stump	Not recommended			
Girdling	Not recommended			

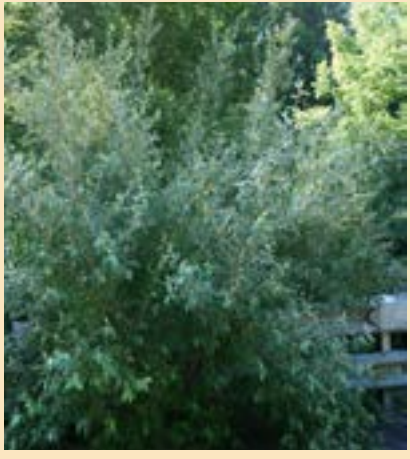
Autumn Olive (*Elaegnus umbellata*)

Dense thickets of autumn olive can block line-of-sight and may serve as a source of undesirable weed seeds to nearby pastures and farms. These shrubs disrupt nutrient cycles and hydrology can create fire hazards.

Identification: Autumn Olive

Bark: Grey, shedding, fibrous

Leaves: Smooth edged ovals, alternately arranged, upper side green, underside silvery



Autumn olive road view.
(Photo credit: Rakesh Chandran, WVU Extension)

Autumn olive leaf closeup.
(Photo credit: Rakesh Chandran, WVU Extension)

Autumn olive flowers.
(Photo credit: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org)

Growth and Dispersal: Autumn Olive

It grows best in open woods, forest edges, roadsides and heavily disturbed areas.

At mature height, it is between six and 20 feet, typically with multiple stems or in thickets.
It spreads primarily from seed and readily sprouts from stumps and roots.

Control: Autumn Olive

While new infestations of younger autumn olive plants may be controlled within a growing season, a persistent approach spanning 3-5 years may be required to control well-established stands. A combination of mechanical and chemical methods is recommended whenever feasible.

Mechanical Controls

Young shrubs may be grubbed out when the soil is moist and loose in spring. Wait until leaves are fully formed and remove the entire root system. Any sprouts appearing after mechanical removal should be treated with herbicides to achieve proper kill.

Chemical Control: Autumn Olive

Application Method	Active Ingredient	Brand Name Example	Application Rate	Most Effective Time of Year
Foliar (low canopy)	Glyphosate	Roundup®	2-4% with water	July-September if adequate soil moisture. Late spring is suitable.
	Triclopyr	Renedy® Ultra, Crossbow®	2-4% with water	
	Fluroxypyr	PastureGard® HL	2-4% with water	
	Picloram	Grazon® P+D	1-2% with water	
Basal Bark (<6" DBH)	Triclopyr	Remedy® Ultra, Crossbow®	12.5% mixed with high-grade mineral oil or No.2 diesel oil	OK year-round, except when snow or rain prevents the spray from being applied all the way to the ground. Best impact will be after fall frost and before leaf-out in spring.
Cut Stump	Glyphosate		20-25% with water	Late summer-fall
	Triclopyr	Pathfinder® RTU	Full strength	
	Picloram and 2,4-D	Tordon® RTU	Full strength	

Soil Residual Treatment: Autumn Olive

A pelleted formulation containing Tebuthiuron (Spike® 20P) may be broadcast directly over soil in the vicinity of autumn olive stems.

NOTE: There is a high potential for groundwater contamination and nearby tree death. Read label fully and be aware of required application rates, setback requirements and residual effects. Best in areas desired for bare ground.

Multiflora Rose (Rosa multiflora)

An aggressive spreader, one plant can produce 500,000 to 1,000,000 seeds that can germinate for 20 years. This rose can be found in a wide variety of locations. As they spread, they form impenetrable thickets that climb over and smother native vegetation.

Identification: Multiflora Rose

Long arching stems form dense shrubs or climbing vines. Stout woody thorns with a slight curve

Leaves: Alternately arranged, pinnately compound with 7-9 finely serrated leaflets and shaggy stipules where they connect to the stem.

Multiflora rose road view. (Photo credit: Randy Westbrooks, Invasive Plant Control, Inc., Bugwood.org)

Multiflora rose bush. (Photo credit: Ohio State Weed Lab, The Ohio State University, Bugwood.org)

Multiflora rose closeup. (Photo credit: Chris Evans, University of Illinois, Bugwood.org)

Growth and Dispersal: Multiflora Rose

Can grow one foot per year.

Mature height: up to 15 feet

Mature width: up to 10 feet (thickets can be 30 feet in diameter).

Spreads via red fruit eaten by birds and mammals, suckers, or via tips of canes as they bend and touch the ground.

Found on roadsides, open woodlands, forest edges, pastures, etc. Prefers moist, well-drained soils and can grow in full sun to shaded sites.

Control: Multiflora Rose

Expect ongoing effort to control and manage existing stands. Reestablishment from cut stems, roots and seed germination will occur.

Mechanical

Small infestations can be controlled by repeated mowing several times throughout spring and summer for 3-4 years. Large infestations may require heavy equipment to pull out or otherwise remove stems.

Chemical Control: Multiflora Rose

Application Method	Active Ingredient	Brand Name Example	Application Rate	Most Effective Time of Year
Foliar (low canopy)	Glyphosate	Accord® XRT	4% in water and surfactant	July-October if adequate soil moisture.
	Triclopyr	Garlon® 3A	2% in water and 0.5% non-ionic surfactant	
	Aminopyralid	Milestone®	7 oz/ac	Fully expanded leaves; generally near flowering period; pre-emergence with seedlings
	Triclopyr+ 2,4-D	Crossbow®	1-2% with water	
	Metsulfuron	Escort®	1-3 oz/ac or 1-2 oz/100gal	Fully expanded leaves until killing frost
	Imazapyr	Arsenal® AC	1% in water and surfactant	August-October

Chemical Control: Multiflora Rose continued

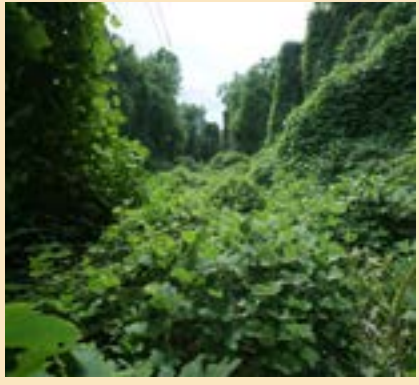
Application Method	Active Ingredient	Brand Name Example	Application Rate	Most Effective Time of Year
Basal Bark	Triclopyr	Garlon® 4	20-25% mixed with high-grade mineral oil or No. 2 diesel oil	January-February; May-October
	Triclopyr	Pathfinder® II	Undiluted	
Cut Stump/ Stem	Glyphosate	Accord® XRT	20% in water and surfactant	April-October
	Triclopyr	Brush-B-Gone® Brush Killer® Vine X®	Undiluted	Year-round
	Triclopyr	Pathfinder® II	Undiluted	January-February; May-October

Kudzu (*Pueraria montana*)

This aggressive perennial vine can weigh up to 400 lbs. and quickly blanket trees, homes, road signs and anything else in its path. It will shade out existing plants, encircle tree trunks, uproot trees and tear down powerlines. It has also contributed to train derailments.

Identification: Kudzu

Leaves: Made up of three large, ovate (egg-shaped) leaflets resembling soybean plants. They are alternately arranged with hairs on the underside. Leaflets can be lobed. Flowers are purple and hang in long clusters.



Kudzu road view. (Photo credit: Rakesh Chandran, WVU Extension)

Kudzu stems. (Photo credit: Leslie J. Mehrhoff, University of Conn., Bugwood.org)

Closeups: Kudzu flowers and seed pods. (Photo credit: Leslie J. Mehrhoff, University of Conn.)

Young kudzu leaf. (Photo credit Rakesh Chandran, WVU Extension)

Growth and Dispersal: Kudzu

Trailing or climbing vine. Can reach 100 feet in length and can grow one foot per day or 60 feet per season. Prefers forest edges, roadsides and disturbed areas with full sun. It can spread through seed but primarily spreads through runners, rhizomes and vines. It will also root through nodes that contact the soil. They have extensive root systems which can comprise 50% of the plant's biomass.

Control: Kudzu

Well-established stands can take up to 10 years to fully control. Regrowth from surviving root crowns may often be delayed until two years after herbicide treatment, with no signs of survival during the first growing season. Check and retreat annually as needed.

Mechanical

Grubbing: Using a Pulaski or similar digging tool, remove the entire plant, including the taproot. Removed vegetation should be destroyed by burning or bagging. Because many roots exceed six feet, eradication by this method is very difficult and should be considered primarily for small initial incursions.

Cutting Kudzu:
Vines and runners should be chopped just above the ground level and the pieces destroyed. Early in the season, cutting is repeated at two-week intervals to weaken the crown and prevent resumption of photosynthesis. Later in the season, the interval between cuttings can be extended. Cutting does not typically kill roots and should only be used to control the spread of kudzu.

Chemical: Kudzu

Application Method	Active Ingredient	Brand Name Example	Application Rate	Most Effective Time of Year
Foliar (low canopy)	Glyphosate Triclopyr Picloram	Roundup® Garlon® Grazon® P+D	2% with water and 0.5% non-ionic surfactant	June-October, above 65 F Best when plants are preparing for winter.
Basal Bark/ Stem	Triclopyr	Garlon® ester	20% with water	Not effective in dormant season but effective in spring prior to appearance of new growth and when plants are actively growing.
Root Crown	Glyphosate Triclopyr	Roundup® Garlon®	50% with water 50% with water	Follow resprouting stem to main root, dig and cut into the root crown, apply herbicide to main crown and runners.
Cut Stump/ Cut Stem (cut to 2")	Glyphosate	Roundup®	50% with water	Effective above 40 F; Cut stem 2 inches above ground level and immediately apply herbicide to cross section of stem.
	Triclopyr	Garlon®	25% with water	Effective if ground is not frozen; Cut stem 2 inches above ground level and immediately apply herbicide to cross section of stem.

Roundleaf Bittersweet (*Celastrus orbiculatus*)

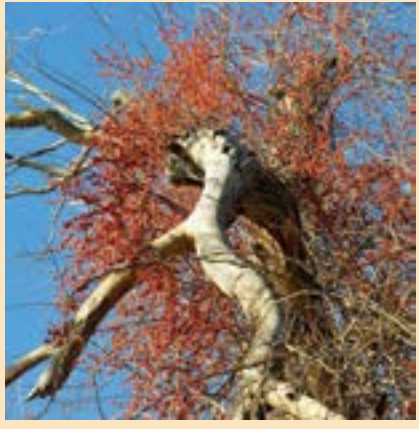
Also known as the oriental bittersweet. This plant will quickly take over any trees in the area. Its fast growth will cover the canopy and lead to dieback of upper branches. Advanced infestations will also strangle trees and kill them.

Identification: Roundleaf Bittersweet

Bark: Smooth or grey with dimples when young and fissured when older.

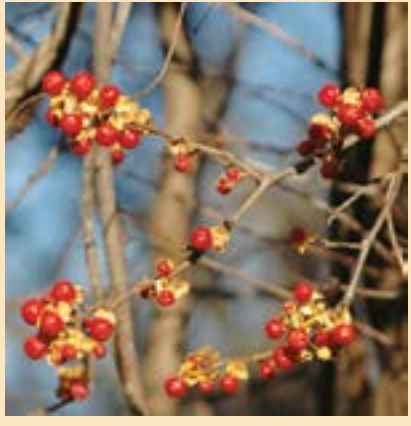
Leaves: Rounded with glossy appearance and green is darker on top.

Berries: Bright orange and occur in multiple locations along the vine.



Roundleaf bittersweet road view. (Photo credit: Richard Rowley/ Glastonbury Partners in Planting/ Bugwood.org)

Roundleaf bittersweet stems. (Photo credit: Karen Cox, WVU Extension)



Closeup: Roundleaf bittersweet berries. (Photo credit: Chris Evans, University of Illinois, Bugwood.org)

Growth and Dispersal: Roundleaf Bittersweet

Twining vines can reach 60 feet in length with diameters over 10 inches. Fruit is attractive to birds. This vine spreads extensively by root suckers and rhizomes.

Control: Roundleaf Bittersweet

Mechanical

Not recommended without chemical treatment unless very early in the infestation.
Repeated cutting of hanging vines must be done every growing season to deplete root resources.

Chemical: Roundleaf Bittersweet

Application Method	Active Ingredient	Brand Name Example	Application Rate	Most Effective Time of Year
Foliar (low canopy)*	Glyphosate and Triclopyr	Shore-Klear® and Garlon® 3A	3 qt/ac	July through onset of fall color
	Triclopyr	Vastlan®	1.5 qt/ac	
Basal Bark (<6" DBH)	Triclopyr ester	Pathfinder® II or Garlon® 4 ultra	RTU or 20%, 1:4 in basal oil	Year-round
Hack and Squirt (>6" DBH)	Glyphosate	Aquaneat®	50% 1:1 mix with water	Year-round
	Triclopyr	Garlon® 3A or Vastlan®	50% 1:1 mix with water	
Cut Stump	Triclopyr ester	Pathfinder® II or Garlon® 4Ultra	RTU or 20% 1:4 in basal oil	Year-round
	Glyphosate or Triclopyr	Aquaneat® or Garlon® 3A or Vastlan®	50% 1:1 mix with water	

**If vine is on a tree, take care to not allow herbicide to contact bark of the tree. Unwrap and remove remaining vine.*

Japanese Knotweed (*Fallopia spp.*)

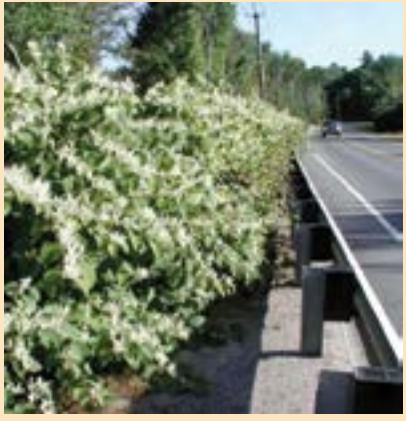
Japanese knotweed is a fast growing weed that colonizes disturbed and riparian areas. It has been found to decrease soil stability and quickly blocks line of sight. There are three species of knotweeds in West Virginia – giant knotweed (Fallopia sachalinensis), which has large, heart-shaped leaves; Japanese knotweed (Fallopia japonica), which features smaller spade-shaped leaves; and the hybrid Bohemian knotweed (Fallopia X bohemica), which has characteristics that fall in between the two and is considered to be the most prevalent in West Virginia. All species of knotweed will be referred to simply as knotweed for the rest of this publication.

Identification: Knotweed

Leaves: Heart or spade shaped.

Stems: Tall, hollow forming clusters and thickets.

Flowers: White clusters in fall.



Flowering knotweed road view. (Photo credit: Leslie J. Mehrhoff, Univ. of Conn., Bugwood.org)

Cut knotweed stems. (Photo credit: Karen Cox, WVU Extension)

Giant knotweed leaf. (Photo credit: Rakesh Chandran, WVU Extension)

Young knotweed leaf. (Photo credit: Rakesh Chandran, WVU Extension)

Knotweed seeds. (Photo credit: Leslie J. Mehrhoff, Univ. of Conn., Bugwood.org)

Growth and Dispersal: Knotweed

Spreads through seeds, rhizomes and fragments. Can reproduce through a thumbnail-sized piece of root or a single node.

Control: Knotweed

Mechanical

Digging and grubbing can be effective only if all underground parts are completely removed. Recommended only for new infestations.

Regular mowing can control knotweed in a turf environment but is not recommended as a removal practice. Cutting without chemical application will lead to shoots emerging along remaining roots up to 60 feet from the parent plant.

Integrated Approach

An integrated approach where knotweeds are cut back after development of full foliage in spring (early June), followed by regrowth and herbicide application in late summer or early fall is most effective.

Knotweed rhizome. (Photo credit: Jennifer Andreas, Washington State Univeristy, Bugwood.org)

Chemical: Knotweed

Repeated applications will be required for at least 3 years for established stands.

Application Method	Active Ingredient	Brand Name Example	Application Rate	Most Effective Time of Year
Foliar (low canopy)	Glyphosate	Roundup® (terrestrial) Shore-Klear® (aquatic)	5 lb ae/gal (49%) 3% with 1.25 oz/gal surfactant	July-October*
	Imazapyr	Arsenal® (terrestrial only)	4 lb/gal 2% with 1.25 oz/gal surfactant	
	Imazapyr	Habitat® (aquatic approved)	4 lb/gal 2% with 1.25 oz/gal surfactant	
	Glyphosate+Imazapyr	Roundup®+Arsenal®	3% and 1% with 1.25 oz/gal surfactant	

This plant is a favorite for bees; avoid broadcast sprays while in flower.
Spray to wet more than 80% of the foliage without creating droplets.
Do not apply herbicide under drought-like soil conditions.
Revegetate with suitable native species to prevent future infestations. Areas treated with glyphosate may be reseeded two weeks after treatment, but areas treated with imazapyr should not be reseeded until the following year due to residual activity of this herbicide.

Poison Hemlock (*Conium maculatum*)

This fast-growing weed can be fatally poisonous if ingested. It is toxic to humans and livestock and can kill livestock in fresh or dried state.

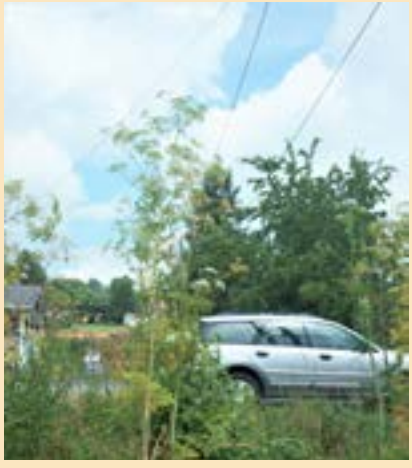
Identification: Poison Hemlock

Can be a winter annual or biennial plant. Typically has a rosette and flowering stage.

Stems: Thick, hollow, ribbed, with purple spots and no hairs.

Leaves: Compound, triangular, lacey and fernlike, rank odor when crushed.

Flowers: Umbrella-like clusters (June-August)



Poison hemlock road view. (Photo credit: Rakesh Chandran, WVU Extension)

Poison hemlock seeds. (Photo credit: Jan Samanek, Phytosanitary Administration, Bugwood.org) Poison hemlock stem.(Photo credit: Rakesh Chandran, WVU Extension)

Poison hemlock flowers. (Photo credit: Rakesh Chandran, WVU Extension)

Growth and Dispersal: Poison Hemlock

Spreads only by seed. One plant may produce over 30,000 seeds that remain viable for 3-6 years. Seeds spread by adhering to vehicles, clothing and animals and may germinate from September through February when temperatures are between 60 F and 85 F.

Prefers moist, shaded, disturbed areas but will spread to dry upland areas.

Control: Poison Hemlock

Due to dense seed banks, one should expect 3-6 years to control an infestation and manage small populations as they are brought in.

Mechanical

Hand remove or cut small sites before flowers develop. Removal of root is not needed but watch for regrowth and cut as needed to prevent flowering. Inspect clothing, animals and tools for seed.

Mow close multiple times during growing season. Clean machinery before moving out of infested area.

Tilling or cultivation is not recommended as the entire root system may not be removed, and it creates a risk of inhaling toxic vapors.

Chemical Control: Poison Hemlock

The following applications are all for broadcast or backpack sprayers.

Common Chemical Name (active ingredient)	Product Example	Broadcast Rate per Acre	Backpack Sprayer Treatment	Time of Application	Remarks
2,4-D ester or amine formulations	Range Star® or Alligare®	1-2 pounds ai per acre	3%	Seedling to rosette stage, early March-April or October-November	2,4-D is selective for many broadleaf species but will not harm most grasses. 2,4-D strengths depend on the manufacturer. Read and follow label mixing directions.
Aminopyralid+ metsulfuronmethyl	Opensight®, Chaparral®	2.5-3.3 ounces per acre	NA		A selective granule herbicide for use on noncropland, rights-of-way, non-irrigation ditch banks, natural areas and grazed areas in and around these sites.

Chemical Control: Poison Hemlock continued

Common Chemical Name (active ingredient)	Product Example	Broadcast Rate per Acre	Backpack Sprayer Treatment	Time of Application	Remarks
Dicamba	Weed Stop®, Banvel®, Vanquish®	2-4 quarts	1-3%	November or March-April	Selective; affects many broadleaf species but will not harm most grasses.
Dicamba+2,4-D	Weedmaster®, Brash®, Range Star®	2-4 pints	0.7%+05% non-ionic surfactant	Seedling to rosette stage	Selective with a broad spectrum; may affect some sensitive pasture grasses and legumes. Don't use near water.
Metsulfuron-methyl	Escort®	1-2 ounce per acre+ 0.25% non-ionic surfactant	1 gram per gallon+ 0.25% non-ionic surfactant	Early spring or late fall (at bud/ bloom or rosette stages)	Selective; not for use on irrigation ditches or near waterways. Best used during warm, moist conditions – activity in cold, dry conditions can be delayed.

Chemical Control: Poison Hemlock continued

Common Chemical Name (active ingredient)	Product Example	Broadcast Rate per Acre	Backpack Sprayer Treatment	Time of Application	Remarks
Glyphosate	RoundUp® (terrestrial formulation), Shore-Klear® (aquatic formulation)	RoundUp®: 1.3-2.7 quarts Shore-Klear® 1.5-2.5 pints plus 2 quarts non-ionic surfactant per acre	RoundUp®: 1-1.5% Shore-Klear® 5-8%	At rosette stage	Non-selective; not soil active. Shore-Klear is registered for aquatic use. For hollow-stem injections, inject 5 ml of a 5% solution into hollow stem for individual plant treatment; see label for details.

Chemical Control: Poison Hemlock continued

Common Chemical Name (active ingredient)	Product Example	Broadcast Rate per Acre	Backpack Sprayer Treatment	Time of Application	Remarks
Imazapyr	Habitat®, Arsenal®	Habitat®: 2 pints+ adjuvant Arsenal®: 2-3 pints+ adjuvant	0.75-1.5%	Pre-emergence to rosette stage	Non-selective; slightly persistent; amino acid synthesis inhibitor. Habitat is registered for aquatic use. See label for adjuvant options. In addition to overspray, death or injury of nontarget plants may occur from root transfer of Imazapyr between intertwined root systems.

Notes for Chemical Control of Poison Hemlock continued

Herbicide/water ratio – For example, a gallon of spray water with a 3% mixture is made by adding a sufficient volume of water to four ounces of liquid herbicide until a volume of one gallon is reached (4oz/gal 128 oz/gal=0.03 or 3%).

Chemical control is practical to manage larger populations of poison hemlock. However, not all herbicides are labeled for pasture or hayfields, and some have residual effects that must be managed. If you are spraying near pastures, please contact the landowner and consult with the local Extension agent.

If using a weed wiper, higher concentrations (10% to 20% depending on growth stage) may be required to obtain good control. Herbicides are most effective when applied during the vegetative (rosette) stage before the plants bolt; fall or spring treatments are effective. If temperatures remain above 60 F for a few hours after treatment, it should be effective.

For small spot treatments, apply glyphosate as directed by spray or using a hand-held weed wiper.

Japanese Stiltgrass (*Microstegium vimineum*)

Japanese stiltgrass is a shallow-rooted, warm-season, annual grass that typically thrives in moist and shaded environments.

Identification: Japanese Stiltgrass

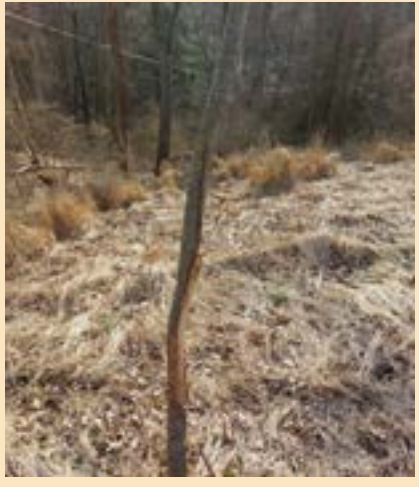
Leaves: Lance-shaped and asymmetrical with a reflective midrib. The ligule, a structure at the base of the inner side of the leaf, is short and membranous.

Stems: Slender, wiry, typically grows to about knee-height, but can grow up to three feet tall under ideal conditions. It resembles dried hay during the winter.

Growth and Dispersal: Japanese Stiltgrass

Stems can produce new roots from lower nodes that contact the soil. Seeds are borne on spikes and are usually dispersed by animals or moving surface water, but they also can be moved with heavy equipment or hay. Japanese stiltgrass comes to bloom by late summer. The seeds can remain viable in the soil for three to five years. Seeds start to germinate in early spring, from late March to mid-April in West Virginia.

Japanese stiltgrass road view. (Photo credit: Rakesh Chandran, WVU Extension)



Dead Japanese stiltgrass. (Photo credit: Karen Cox, WVU Extension)

Closeup of Japanese stiltgrass leaves. (Photo credit: Rakesh Chandran, WVU Extension)

Magnified Japanese stiltgrass seedlings. (Photo credit: Rakesh Chandran, WVU Extension)

Control: Japanese Stiltgrass

Mechanical

Best in newly infested areas with small populations. In landscapes, applying a suitable mulch, such as wood chips or landscape fabric, prior to seed germination can be effective. The shallow root system makes hand removal an effective method to manage small populations. Bare soil must be kept covered because early removal may cause germination of remaining seeds in the exposed soil, which may complete another life cycle during the growing season. Mechanical methods, such as mowing, should be conducted just before they come to bloom in late summer. In lawns or landscapes, however, where they are constantly mowed, the plants may adapt by blooming at low heights.

Reseed the area with desirable native plants and remove any residual stiltgrass before it comes to bloom. Monitor site for the three to five years after treatment to deplete the seed-bank and prevent re-infestation.

Chemical Control: Japanese Stiltgrass

Application Method	Active Ingredient	Brand Name Example	Application Rate	Most Effective Time of Year
Pre-emergent	Pendimethalin	Prowl H2O® or Pendulum®	4 qt/ac	Early to mid-March
Foliar	Fenoxaprop	Acclaim Extra®	1 qt/ac	Apply when actively growing prior to bloom Selective: will not affect broadleaved plants
	Sethoxydim	Poast® or Vantage®	1.5% solution and water plus a 1% nonphytotoxic vegetable-based oil – requires 1 hour to set before rainfall	
	Glyphosate	Accord®, Shore-Klear® or Roundup®	2% and water plus 0.5% non-ionic surfactant – requires 2 hours to set before rainfall	Apply when actively growing prior to bloom Non-selective: will affect all plants contacted
	Glufosinate	Finale®, Liberty®, or Rely®	4-6 quarts/ac	Apply when temperatures are above 65 F

Application rates vary by age and size; these application rates are based on the time of year noted.

Glossary

Foliar: Affecting the leaves; foliar sprays are applied to the leaves.

Root-sprouters: Plants that sprout from the roots.

Rhizome: A type of root that can create a new plant in a new location. (see images)

Surfactant: Additive that improves contact area of spray droplets on the leaves. Check the label to determine the appropriate surfactant to be used. (non-ionic surfactant, crop oil, methylated seed oil, etc.)

Rhizomes of roundleaf bittersweet. (Photo credit: Leslie J. Mehrhoff, University of Connecticut, Bugwood. org)

Rhizomes of knotweed. (Photo credit: John Cardina, The Ohio State University, Bugwood.org)

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