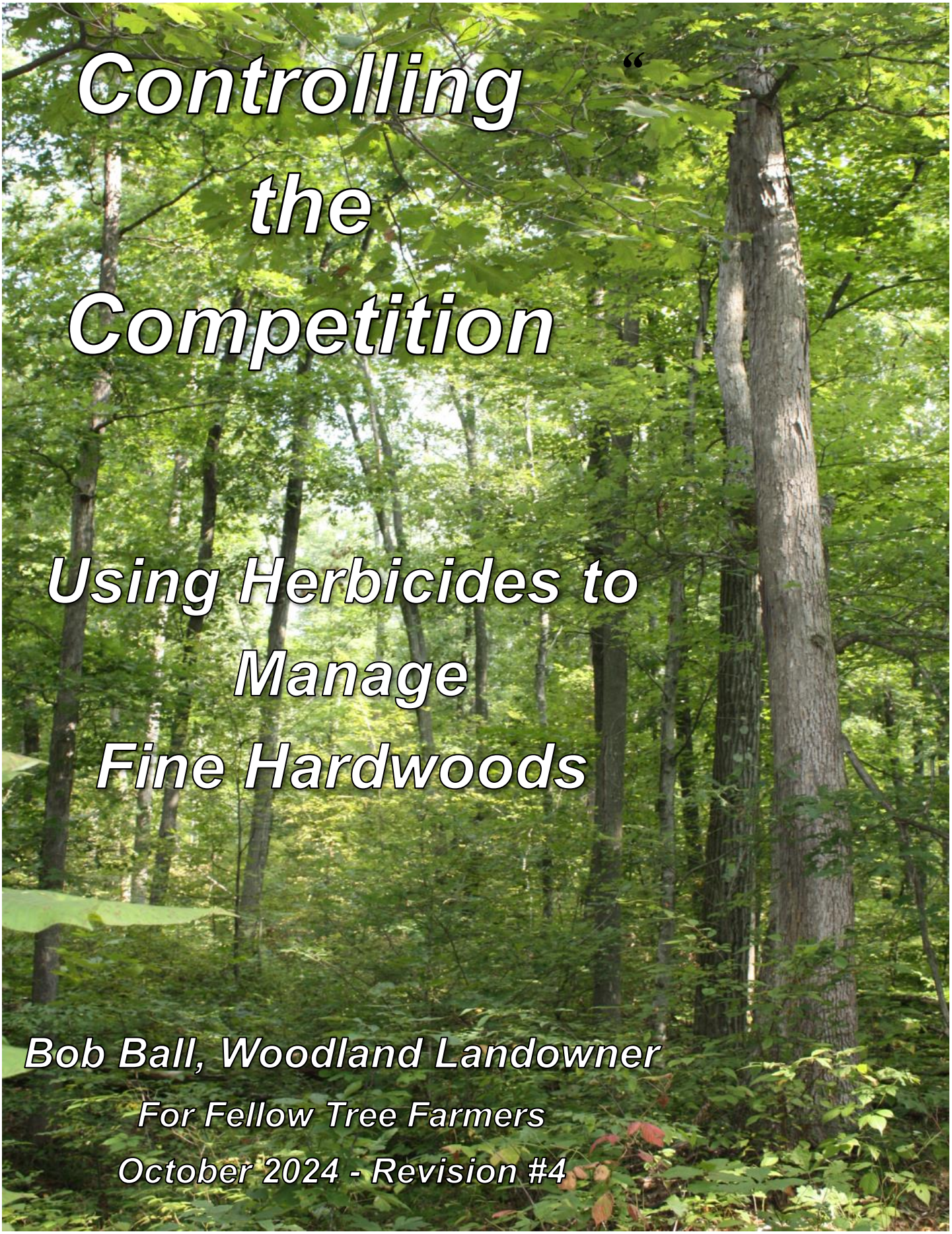

Controlling the Competition

Using Herbicides to Manage Fine Hardwoods

Bob Ball, Woodland Landowner

For Fellow Tree Farmers

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Growing Hardwood Trees Depends on Managing Competition

Photo Captions

Top: USFS Foresters evaluating impacts of using verticillium wilt to kill ailanthus.

Top Left: *Pathway* herbicide applied to cut stump of sugar maple.

Left: Mowing and canopy shading will not control competing grasses. Broadcasting approved grass herbicides would provide far better control of toxic fescue.

Growing fine hardwood timber depends largely on using herbicides to control trees, shrubs, vines, grasses and invasive plants competing with our crop trees. This guide offers the basics needed when using herbicides. Written by a woodland landowner for fellow tree farmers, it reflects methods and procedures learned from others applied in my woodland. The guide relies heavily on online websites managed by foresters, university foresters, and private industry to provide specific herbicide recommendations and practice details.

Tree farmers enjoy sharing how we manage our trees. This conveys what I have learned from discussions during forestry field days and wherever we described success stories, our failures, and concerns about controlling grasses, weeds, vines, shrubs, trees and invasive species. This Guide is a combination of weed science merged with the knowledge and experiences from active woodland managers. Watch for frequent ***"hyperlinks"*** throughout that will take you to specific and timely information on that topic.

Introduction:

This Guide was written to help fellow woodland landowners in managing their hardwood timber. It is a reference only. This is not a substitute for recommendations from foresters, herbicide product labels, professional publications or technical articles released by chemical companies or universities describing the proper use of herbicides to control your weed species. **Always read and follow the product label - it's the law!**

This relies heavily on many online references providing specific controls. Target weeds are limited to common invasives and other species found in increasing numbers in our woodlands. The focus is on the treatment of these (and more) unwanted shrubs, trees, and competing grasses:

- Autumn Olive
- Ailanthus (Tree-of-Heaven)
- Multiflora Rose
- Bush Honeysuckle (Amur)
- Japanese Honeysuckle
- Osage Orange
- Honey Locust
- Gray Dogwood
- Eastern Redcedar
- Hardwood trees competing with crop trees –
    * Hard Maple, Red Maple & Boxelder
    * Ironwood (Hop Hornbeam)
    * Black Locust & Hackberry
    * Callery (Bradford) Pear
- Grasses, legumes and forbs that compete with tree seedlings –
    * Tall Fescue and Smooth Brome
    * Sericea Lespedeza
    * Garlic Mustard
    * Japanese Stiltgrass

Updates to this Guide will be provided upon request. You are encouraged to print your favorite online herbicide recommendations and keep the information in a sealed plastic bag where herbicides are mixed for use in your woods. Suggestions and recommendations to correct or improve this informal publication are welcome.

Multilfora Rose is pretty during the flowering stage, and it attracts pollinators. But it is a nasty, invasive species to eliminate from your woodland and pastures! The wildlife and pollinator values of this plant can be replaced by other, non-invasive species.

Overview of Treatment Options:

There are physical, biological and chemical means of either removing or killing unwanted species. This guide only addresses the ***chemical means of control***, however, we are not discounting the value of otherwise removing unwanted species either physically or through biological controls. You may need to use all options for more challenging species.

There are six methods of applying herbicides to control undesirable trees, shrubs, vines, shrubs and grasses:

- Broadcast Spraying (applying herbicide to areas or strips of grasses and non-woody plants),
- Basal Bark Spraying,
- Hack-n-Squirt (stem injection),
- Cut-stump treatments, Girdling, and
- Foliar Spraying (applying herbicide to foliage of woody plants).

Methods of Herbicide Application:

Broadcast Spraying - This option consists of spraying areas in preparation for tree planting as well as spraying around and possibly over established seedlings before foliage emerges. Small treatment areas can be sprayed with a backpack sprayer, but larger areas may need power equipment. Typically, the herbicides of choice are either: *Selective, post emergence (ex. Clethodim or Fusilade for grasses or 2,4-D for broadleaf plants); Non-Selective, post emergence (broad spectrum) capable of killing most vegetation (ex.* Glyphosate or Roundup; *or Pre-Emergent, non-selective* herbicides (Simazine/Princep); or *Pre and Post-emergent* products like (Oust) to prevent resprouting while providing some burndown. Understanding mode of action for products will determine which herbicides to use.

Label rates for power equipment refer to volume of herbicide per acre **where you calculate volumes of spray to apply per acre.** Label rates for hand operated sprayers provide volumes of herbicide and surfactant in relation to a volume of water or other recommended carriers like diesel, kerosene and crop oil. *With power sprayers there are several variables that must be considered and controlled to apply herbicides according to label rates. When doing this properly, the volume per acre approach makes sense. To use a % concentration formula is unacceptable for power spraying.*

Broadcasting using power equipment also requires more effort to prepare for a successful spraying. Will you be using existing power equipment or purchasing or renting a sprayer? Will your unit be mounted in the bed of a utility vehicle, pulled behind a tractor or utility vehicle or mounted on the 3-point hitch of a tractor? The **photo - right** shows a backpack sprayer that you manually pump and typical of those used when applying herbicides to small areas on our tree farms.

Broadcast spraying requires skill and practice. Calibrate the sprayer with a tank of water only so you are confident the hardware components of your system are working properly. Check for system leaks, that the nozzles are positioned at the correct height and direction, and all nozzle sprays create an overlapping pattern.

The pH, hardness or sediment content in your spray water can reduce the effectiveness of some herbicides. Read the labels or ask your herbicide dealer to define the water quality recommended for mixing their product. Specimen labels do not always define water, and it may be the key ingredient. If you believe hardness or pH may be an issue with your unsoftened tap water, use rain water or filtered pond water with no or minimal sediment. It may be necessary to add ammonium sulfate (AMS) to the spray tank to adjust pH. Some herbicides are less effective if the mix water does not meet label recommendations.

The target vegetation usually focuses on tall fescue and smooth brome, plus common broadleaf weeds like ragweed, water hemp, and mares tail. These plants (especially fescue and brome) are vigorous competitors with seedlings for nutrients as well as being allelopathic and must be controlled to have a successful tree planting. Broadcast spraying is generally the most expensive option because it uses the greatest volume of herbicide, but it is a critical step in planting and maintaining trees in succeeding years.

There are several excellent references online to help you decide what equipment will work best for your situation. Factors to consider when using power sprayers are:

- spray tank volumes in relation to the area to be sprayed and travel time to a supply of spray water;
- the vertical height of the overall unit and whether or not that poses a problem spraying on steep slopes;
- the power supply for your pump: battery driven, gasoline powered or PTO?
- Is your unit a *boom sprayer* or *boomless*? Consider travel routes to reach your spray sites and the slopes in your fields. Areas with restricted widths due to narrow gates, rows of planted trees, brush, uneven ground or steep slopes are more suitable to boomless units.
- Can you adjust the height of your booms or nozzles, nozzle spacings, directions and flow patterns?
- If renting or borrowing a sprayer, check the condition of the pump, tank and hoses. Leaks?

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Study label rates of your herbicides when planning to broadcast spray. One excellent single source for reading *specimen labels* is: the CDMS product database at: http://www.cdms.net/. Enter the product brand name in the *"Product Search"* block to begin searching.

It is important to understand there is a difference between the word ***"herbicide"*** and the ***"active ingredient"*** that comprises that herbicide. For example, on pages 17-18 the active ingredient is listed in the left column while the middle column labeled ***"brand name"*** is more commonly known as the herbicide. This becomes important when reading labels that specify a rate of active ingredient versus a percentage or volume of the herbicide which may include multiple products. For example, the active ingredient, Simazine, can be purchased in either *Sim-Trol* at 42.1% Simazine or *Princep 4L* with 41.9% Simazine.

Read the labels carefully. *Roundup*, for instance, is prescribed in volume of product (pints/quarts)/acre) for broadcasting and the volume varies according to the target weeds and sizes of those weeds. *Oust*, a dry flowable product, is prescribed in ounces or grams per acre, so you may need measuring devices (often provided) for both liquids and granular products. Estimate the volumes of spray you will need for the area treated and consider the travel distances and time between the spray site and your source of water.

A chapter member offers the following guidance...% concentration is a ratio of the amount of herbicide to the amount of water. Herbicides typically used in ***backpack sprayers*** have a broad range of effectiveness once you gain experience in how much spray to apply. Wet the foliage but not to the point of runoff. For spot spraying this is often good enough, but it may be more or less than the optimum amount. If you think of the variables involved in spot-spraying: how much spray gets on each section of the plant, and in the case of pump sprayers, the variability of the pressure unless you constantly re-pump to keep the pressure fairly constant, we can see why volume control is questionable. The broad range of effectiveness of most herbicides allows for these inconsistencies. Typically, spot-spraying uses more herbicide than needed to do the job.

Spraying with power equipment allows the operator to more accurately apply the recommended amount of herbicide. This is done by calibrating a sprayer using a set speed of the vehicle. Sprayer manuals typically include instructions in how to correctly calibrate. The next consideration is the nozzle design. Nozzles are rated by gallons per acre at various speeds and pressures. The last variable is the sprayer pressure. The pressure is set with most ATV sprayers while PTO sprayers have adjustable pressure valves. With those facts the operator should then calibrate the sprayer to determine the amount of volume of water spread over a measured distance and area to determine the gallons applied per acre. If you determine with your vehicle running say at 4 miles an hour, with the usual nozzles and pressure, your sprayer delivers 15 gallons of water per acre. If your spray tank holds 60 gallons, each tank of spray will cover 4 acres. If the herbicide label rate is one quart per acre add 4 quarts in the tank to deliver the one quart rate specified. If you will be using a "tank mix of herbicides, agitate the tank mix for at least 15 minutes to ensure the volume is thoroughly mixed.

Which spray method (manual or power) to use depends some on the mount of spraying you do and the jobs to be done. For some, broadcast spraying is almost entirely with power equipment and the volume of herbicide used is large enough that accuracy is important. Instead, if you typically do a limited amount of spraying or the areas to be sprayed are small then backpack or hand pump sprayers are fine. In that case the broad effectiveness of the herbicide and environmental safety issues are likely adequately handled. In larger spray applications accuracy and environmental safety are more relevant and require power sprayers as a control mechanism.

If you need spraying done, but prefer to not do this work yourself, consider using custom applicators. Often consulting foresters do spraying or they know who can do it for you.

To view an industry perspective on herbicide applications methods, go to:***"Corteva AgroSciences -Application Methods"***

Photo Above - Tree planting strips sprayed using power equipment.

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Once you have completed spraying your target weeds let the spray do its job! It may take a few hours, days or a few weeks for the chemical to be totally effective. Herbicide dealers may suggest you not mow or bushhog sprayed fields for several months to allow the product to fully translocate into the plant's root system. This wait time varies based on many factors, but when in doubt give the herbicide more time to fully do its job. The foliage may look dead, but are the roots dead?

The care and maintenance of broadcast spray equipment is important. Follow the manual with your sprayer for maintenance requirements together with guidance on the herbicide label for cleaning herbicides out of spray tanks, feed lines, nozzles and pumps. Collect rinse water and dispose of it properly. Using the triple rinse technique with a mild detergent may work very well for most herbicides, but some products require more effort. Drain everything completely then add 1-2 gallons of RV nontoxic antifreeze into the tank and circulate it through the system to prevent freezing for sprayers stored outside. Remember to lubricate PTO pumps!

Basal Bark – (*photo - left)* This method involves using a low-pressure backpack, garden, or handheld sprayer (**backpack unit *shown on page 4***) to apply herbicide to the stems of woody vegetation usually less than 6" in DBH (diameter at breast height) and fewer than 1000 stems per acre. Select herbicides recommended to be mixed with an oil carrier (diesel fuel, kerosene, or crop oil) and wet the lower 12 - 15 inches completely around the stem including the root collar. Do not spray to the point of runoff. ***Basal Bark Spraying*** can be done any time of the year when the stems are dry. Add a coloring agent to the mix to avoid retreating stems if your oil and herbicide residue does not leave a visible stain on the bark. Treating even larger diameter stems can be effective, however, the product label may not recommend basal bark spraying stems larger than 6" in diameter. Treating larger stems uses a lot of herbicide product, and it may be considered an ***"off-label"*** use of those herbicides. Other treatment methods may be more cost-effective in killing larger trees and apply less herbicide per acre.

Hack-n-Squirt (***photo - right)*** Use a sharp hatchet or machete to make frills in the stem cutting at a downward angle and proper spacing following label recommendations. The number of chops ranges from 1 per inch to 1 per three inches of stem diameter. Find a ratio that works best on your species. Some species need overlapping chops while others need gaps of clear bark. Cuts must penetrate the bark into living tissue or sapwood (the outer area of lighter -colored wood in the stem cross-section), and produce a cupping effect to hold the herbicide. Spray a volume (1/2 to 1 milliliter) of herbicide into each cut. Either spray into the chop (using a plastic spray bottle) or spray onto the blade tilted slightly outward while it is still in the cut. It is faster. Do not allow herbicide to flow out of the cut. One-half to one trigger pull on many spray bottles will provide the needed volume of herbicide per hack.

Professionals who rely on Hack-n-Squirt often use a "hypo-axe"; a backpack sprayer with an injection hatchet replacing the spray nozzle. Each chop applies a measured volume off herbicide into the tree. This approach works extremely well, but these units can be costly for landowners.

This method, as well as cut stump and girdling, are not recommended for use during periods of heavy sap flow. Depending on the weather, sugar maple and elm are early species to turn around sap flow in the fall or early spring to where injection treatments are no longer effective. Typically the fall transition is associated with the first freeze of the year. If the chemical was immediately absorbed into the hack wound, you should be good. But, if it pools and remains, the treatment may not be effective. Once the sap has turned around, you will see large wet areas on the bark after an hour or so where sap is seeping out of the wound. Delay the cutting and hacking treatments or focus on species with a later starting dormant period.

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Keep the blade of the hatchet or machete sharp by filing frequently. Select a hatchet with a blade width of 2" yet with sufficient weight to easily, yet safely, make the needed hacks. Begin using this technique slowly until your hands, wrist, arms and shoulders are conditioned for repeated chopping. Some species like American Beech or ironwood are hard to chop which can cause the hatchet to glance away. This can be a quick way to kill many target species with a minimal amount of chemical and equipment, ***but be careful!***

Cut-stump – ***(photo - right)*** This method is ***s***praying or painting approved herbicides on **freshly cut surfaces** of stumps. Focus on the cambium layer next to the bark of the cut surface. For water-soluble herbicide mixtures, spray or paint the living tissue or sapwood (the outer area of lighter-colored wood in the stem cross-section) of stumps immediately after cutting. For oil-soluble mixtures, treatments can be delayed following cutting, but sooner is better! If you delay treatment, spray the sides of the stump to the root collar and the sapwood around the entire circumference of the cut surface until thoroughly wet, but not to the point of runoff. *Avoid periods of high sap flow!*

Girdling - (*photo - below*) Many of us feel we are not getting anything done in the woods unless we fire-up a chainsaw. It has become a right-of- passage into the woods to grab your chainsaw, bar oil and 50:1 fuel mix and go kill some unwanted trees or invasives. Girdling is similar to ***Hack-n-Squirt*** in the sense we are applying herbicide into the cambium layer to kill the target species. This technique is most effective in **"ring porous trees"** where you can observe growth rings. Using a small to medium size powered saw with a 14" or 16" bar, hold the saw in a horizontal position waist high walking around the tree cutting into the cambium layer completing a circle around the entire stem diameter. Adjust the depth of cut per species and diameter of tree, but 3/4" to 1" is typical. If you cut too deeply on small stems it may be more practical doing the cut stump method.

You may prefer walking forward around the tree with the saw at waist height while others like walking backward. The forward approach allows you to see and avoid obstacles while walking. It is not necessary to bend down and make this cut closer to the ground. The plant tissues will translocate the herbicide into the roots saving your back!

"Spiral cuts" are becoming more common. This approach results in a spiral chainsaw cut that begins waist high and curls around the trunk to the root collar exposing many more inches of the cambium to treatment. It takes time to master the technique, but it is very effective for hard-to kill species. This approach can replace the "double girdle" approach designed to achieve the same goal of getting more herbicide into the cambium layer or not using any herbicide at all. **In my opinion, do not waste time cutting the girdle(s) then not using herbicide.** The tree may survive sending out dozens of sprouts at the wound.

(photo - left) *Scott Brundage spraying into the girdle. Blue dye avoids retreating wasting time and herbicide.*

Follow label recommendations for wearing "Personal Protective Equipment (PPE) when applying herbicides.

Foliar sprays – *(photo - left)* Spraying the herbicide solution onto the foliage when the plant is actively growing. Some herbicides specify treating during the flowering stage of the plant. Typically, all of the foliage must be touched, but not sprayed to the point of runoff from the leaves. Read the product label for requirements in using adjuvants like nonionic surfactants.

Low volume backpack sprayers can be effective, but high pressure spray units are much easier and faster especially when the plants are several feet tall or some distance away. The key is being able to get completely around the target tree or shrub so you can wet all of the foliage. Keep in mind wind direction to avoid spray mist coming back into your face, AND to reduce the risk of drift to non-target species and crop trees. Using a high volume sprayer mounted in the bed of an ATV or UTV or a PTO unit with several feet of spray hose and a quality hand-gun is faster and less physically demanding, plus you are farther away from the spray.

Know the **"time of concentration"** or **"rain fast"** time for foliar applied sprays and do not spray when rainfall is eminent. This waiting period can range from 30 minutes to 24 hours with some products!

Before You Begin - Planning:

My recommendations assume you have decided to use pesticides (herbicides) to solve your woodland management weed problems. However, this approach is not for everyone. For many good reasons, it may be in your best interests to focus instead on either the physical or biological methods and NOT get into using herbicides. For example, using the ***double girdle*** approach with no herbicide. You are encouraged to consider the following before deciding how you will proceed in addressing your weed problems:

(**Note:** "weeds" = invasive species, competing grasses and some forbs, and other undesirable competing woody species to include the need to deaden trees, vines and other weeds to release desirable crop trees.)

- What is the nature and extent of your weed problems?
- How much time and money do you want to devote to controlling your weeds?
- What equipment, tools and herbicides do you have readily available that you are comfortable using?
- Do you have health and safety concerns about using herbicides and having these products stored on your property?
- Do you have access to herbicide dealers you can rely on to sell products at a fair price and also provide you with technical advice about using their products?
- Are there commercial applicators you can contract with to get this work done?

This guide takes the approach your weed pressures are so excessive the use of herbicides to take back control of your woodland is essential, AND you are comfortable in using these products. However, on your land you may be able to solve your problems in other ways that do not require using herbicides. You have options. Plus, you can always hire a contractor to carryout work you are not comfortable doing yourself.

Too often woodland landowners begin buying tools, equipment and even herbicides before planning. The decision to manage weed problems requires thought to avoid building an inventory of hardware and expensive chemicals you may rarely, if ever, use.

You are encouraged to read Chapter 16 ***"Pesticide Use"*** of the ***"Missouri Forest Management Guidelines"*** developed by the Division of Forestry, Missouri Department of Conservation. I suggest reading pages 159 – 166 before buying any herbicides. The list of ***"References"*** on page 20 includes often used sources of information. The science of weed management is constantly refining as new herbicide products become available together with improved techniques to apply them.

Considerations When Buying Herbicides:

Study which herbicides you need to solve your weed problems versus buying what is on sale at your local farm supply store or buying what other landowners use. There is a wealth of safety and application information on the specimen label. Thoroughly read the ***Material Safety Data Sheets*** (MSDS) for the herbicides you are considering watching for any alerts that may impact your safety. Specimen labels and the MSDS (or SDS) sheets can be found in the ***"Product Databases"*** at: http://www.cdms.net/. Labels can be found elsewhere online using a search engine like ***Google*** or with companies selling herbicides.

Seek advice from Walnut Council members, foresters, university specialists, representatives of chemical companies and your local farm supply store salesman before buying. One purpose of this guide is to help you make the right selections to avoid problems and to help ensure the products work as you envision.

Where you decide to purchase is important. Work with your local agribusiness dealer where possible. They have the professional expertise you may need when you need it. The Missouri Chapter of Walnut Council, as a benefit to their members, purchases *Pathway*, *Glyphosate Pro* 4 and *Remedy Ultra*. Members attending field days pay only the chapter's costs. The savings in price helps offset your Walnut Council dues. There are chemical supply businesses that ship herbicides often cheaper than you can buy locally. A few online herbicide sources I have used include:

- **"ePestSolutions.com"-** https://www.solutionsstores.com/catalogsearch/result/?q=herbicides
- **"Keystone Pest Solutions, LLC -** https://www.keystonepestsolutions.com/herbicides-28/forestry-32/?zenid=9c0397de8f68df16157a34d528b193f9
- **"Chemical Warehouse"-** https://chemicalwarehouse.com/
- **"Forestry Suppliers" -** https://www.forestry-suppliers.com/index1.php

My personal preference is **"Chemical Warehouse".** They provide a broad selection, plus fair pricing with free shipping. ***"Forestry Suppliers"*** sells herbicides, plus they offer products we typically use in woodland management. Consider these sources as good references for what may be available to control your target weeds. Another source is "***Amazon.com"***. The product descriptions at these sites include product ratings and buyer comments providing useful information to help you make decisions. Herbicide prices vary greatly! Do not overlook shipping costs or your time and expense to pick up these products.

For purposes of carrying out activities described in this guide, it will NOT be necessary to purchase *restricted use pesticides* which require one of three levels of certification before they can be legally used in accordance with the ***Missouri Pesticide Use Act***. Professionals with the correct certifications must apply those products.

If you will be mixing relatively **small tank volumes of spray**, calculating the amount of herbicide to add to your sprayer tank is much easier when the specimen label includes the ***percent of product concentration*** needed to kill listed weeds. The information under **Broadcast Spraying** describes the method for mixing herbicides for **power sprayers**. Regardless of which type of sprayer or herbicides you are using and the label rates, make detailed notes on the rates you mix and include where you sprayed, the date and time you sprayed and include weather conditions and field operations. For example, did it rain shortly after you applied a foliar spray to autumn olive? Did you do a broadcast spray of fescue then forget and bushhog the field shortly after spraying? What concentration did you use or how many ounces of herbicide did you add to the spray tank? Did you include a surfactant? Monitor your results and consider what changes may be needed before using that product or that rate again. If you have the time, try alternate herbicides and application techniques. Learn what works best for you in controlling your target weed species then stick with those procedures. You should be keeping accurate records of your spraying activities anyway and there are forms to record that data.

Label rate tables often refer to *"low volume"* and *"high volume"* spraying. However, this is different from the term *"low volume herbicide"* that refers to applying very *low amounts* of concentrated herbicide such as when aerial spraying. Unless the label says otherwise, consider a backpack or hand pump sprayer as a low volume sprayer. Motor or PTO driven pump sprayers are considered high volume units. The rates for these sprayer volumes vary greatly, so learn which tables to follow!

When mixing herbicides, refer to the table ***"Commonly Used Measures"*** on page 19. Usually ***add surfactants last*** to avoid excessive foaming in the mixing tank then mix thoroughly. ***Ammonium sulfate*** is effective at treating hard water making herbicides more available to plant absorption, plus you are foliar feeding plants nitrogen for more vigorous growth.

TIPS in Using Herbicides Effectively:

This section conveys more keys to success when relying on herbicides to kill target weed species. It reflects the lessons learned from several of our members who have been managing their woodlands for many years. We all share a common angst: the battle with invasive species is becoming an increasingly complex and expensive challenge that needs all of our attention if we are to be successful.

Follow Herbicide Specimen Labels –
Follow the label – It's the Law! Specimen labels and the MSDS or Safety Data Sheets (SDS) pages can be found in the ***"Label Database"*** at: http://www.cdms.net/. Become familiar with the standard format of these labels to save time when searching for specific items about each product. If you still have questions after reading the label call the company. Tell them the product you are using and ask to speak to their forester or someone who may otherwise be able to respond to your technical questions. The company may refer you to a regional representative or local dealer. These specialists are very knowledgeable in using their products.

Use Accepted Safety Procedures –
The Safety Data Sheets provide guidance that can protect you and those working with you from harm. Additional information can be found in Chapter 16 *"Pesticide Use"* of the ***"Missouri Forest Management Guidelines"*** (pages 159 – 166) developed by the Division of Forestry, Missouri Department of Conservation.

Photo Above - Crossbow, a popular and effective herbicide has restrictions to include use on woody plants.

Timing of Treatments – (*from Matt Kraushar, Purdue University Forestry*). "Weather needs to be taken into account when utilizing herbicides as a control technique. Periods of extreme heat (greater than 85 degrees) or cold (below freezing), drought, excessive rainfall, humidity, etc. all play an integral role in the efficacy of herbicides on a plant. Conditions affect how the plants react to the herbicide, as well as what happens to the herbicide.

A general rule of thumb: when foliar or broadcast spraying we want plants growing vigorously. Lots of green foliage. A plant in flower is under some stress due to the energy required to produce flowers (and subsequently seeds). This type of stress, unlike drought and heat stress, is an acceptable time for herbicide application, but plant stress decreases effectiveness of herbicides.

All species have a characteristic that favors treatment. There are windows in time that make for very selective control measures based on these characteristics. For example: Japanese honeysuckle is an evergreen plant that can be treated with a foliar herbicide (such as glyphosate) during the dead of winter when temperatures are above freezing (two-three days with 40+ degree days) which allows for targeted control with no off-target damage. Another example is Amur honeysuckle. It is one of the first plants to leaf out and one of the last to go dormant. This characteristic provides great windows to use a non-selective foliar product, selectively!"

Storing Herbicides - Herbicides should NOT be stored where they can be exposed to low temperatures. The definition of "low" varies greatly by product. Refer to the *"Storage and Disposal"* section of your herbicide label for "Pesticide Storage" requirements. For example, many products state "Store above 28 degrees F or agitate before use." *"Glyphosate Pro 4",* a generic glyphosate product, says "store above 10 degrees F to keep from crystallizing". The active ingredients can precipitate out or even crystalize in very cold temperatures and must then be thoroughly warmed at 68 degrees F and agitated before using. Also, it's interesting to note the effectiveness of *Roundup* and *glyphosate* decreases with temperatures below 50-60 degrees! Follow label storage and use requirements to ensure the herbicides are effective when needed. Thoroughly agitate the containers before mixing and then properly dispose of or recycle clean, empty containers.

Additional Considerations - The following additional considerations may factor into your selection process. Do your research before focusing on products you know little about to learn later those herbicide have drawbacks or restrictions. Herbicide labels may touch on:

- **Slow vs. Fast Acting –** Herbicides that feature a quick kill do not always provide the best long-term results. Speed pertains to how quickly herbicides affect the plant; the time needed for the chemical to translocate through the plant tissue. Ideally, you want a chemical that translocates into the root system over a reasonable period of time to thoroughly kill all tissue. Contact herbicides, such as glyphosate, begin killing green tissue on contact. Herbicides that are hotter than others tend to burn the foliage when applied giving the plant an appearance it is dead only to return vigorously months later. The saying *"fast is slow and slow is fast"* applies to herbicides. Allow the herbicide time to translocate. Too often people spray a contact herbicide only to mow or remove the sprayed foliage before the herbicide has had sufficient time to work. Mixing adjuvants with the herbicide stronger than as instructed in the label can make that product too hot burning the foliage too quickly. Leaving out the adjuvant can work in reverse too where the herbicide is not as effective.
- **Solubility and Persistence** - Be careful using herbicides that are highly water soluble and mobile in the soil profile. They tend to go where you do not want them and can enter tree roots of your favorite crop tree several feet away from where they are applied. Or they enter surface or ground water systems and move great distances. Likewise, some chemicals are very persistent in the soil with a long half-life that you forget about and then wonder why tree seedlings do not survive at certain locations.
- **Sprayers and Spraying –** Diesel fuel mixed with herbicides makes a very effective Basal Bark, but working parts in some older sprayers quickly soften and break down. Be certain the sprayer you are using or purchasing has *"Viton"* seals and the spray tank is UV stabilized polyethylene. If you frequently use dry flowable herbicides, ask how well your pump will hold up over time. You may need to replace the spray nozzles more often which is an easy repair, but replacing the pump gets costly. Foliar and broadcast spraying techniques use more volume, so also consider the size of the spray tank needed for your applications. Broadcast spraying large areas will require a boom or "boom-less" spray unit mounted onto a UTV, ATV or tractor with a spray tank holding larger volumes. Spraying sapling size trees will mean using a mounted spray system with nozzles turned out towards the row or using a hand sprayer or backpack sprayer that have tank volumes of 1-4 gallons.
- **Spray Nozzles** - A common spray nozzle for backpack and either ATV or UTV mounted sprayers is the *TeeJet Conejet Adjustable Spray Tip (part #5500-X2 or X3)* available in brass or plastic. Include a 5 lb. check valve and screen in the spray wand to limit herbicide waste from drips at the nozzle. To reduce atomization when applying a foliar herbicide, ask your dealer about nozzles that minimize small droplets or add a *"drift control agent"* to your mix.
- **Sprayer Calibration** - Learn how to properly calibrate your spray unit when broadcast spraying. Calibration is a critical step. Calibrate based on the volume of liquid being delivered through your nozzles per sprayed acre at your planed rate of travel. Adjust either the mix or spraying variables (pump capacity, pressure, nozzle discharge rates) to deliver the desired herbicide volume. There are numerous reference sites online and through handouts that step you through the process of calibrating your sprayer. One excellent site to calibrate a backpack sprayer is: https://extension.psu.edu/calibration-how-tos-how-to-calibrate-a-backpack-sprayer. A site by Corteva AgriScience describes calibrating backpack, boom and boomless sprayers: https://www.corteva.us/products-and-solutions/land-management/getting-maximum-return-on-herbicide-applications.html Test your sprayer and calibration using water only and treat a gravel or concrete driveway. Watch for even drying of the applied water to spot defective nozzles and the amount of spray overlap from your pattern.
- **Cleaning and Storage of Equipment –** A key factor in deciding which type of sprayer to purchase is simply the issue of where will you store it? Pumps and hoses should be drained and properly cleaned before winter storage. Unless you have a building to protect the sprayer during the winter, your spray program may be limited to backpack units. Remember to triple rinse the spray tank and use a cleaning product usually recommended in the sprayer manual. Most farm supply stores carry concentrated cleaning products for spray tanks. Be sure to collect the outflow from cleaning your tank and dispose of the liquid safely. Filling or cleaning spray tanks on a concrete floor with a floor drain can cause a chemical burn downstream. ***Be wise and protect our environment***.

Herbicide Rates to Control Common Weed Species

As of September 2024

The following five tables display options for controlling several weed species. These herbicide recommendations were derived from three general sources: 1) personal experiences which are situational; 2) experiences and opinions of technical experts, and 3) publications based on scientific research and manufacturer labels.

THE RECOMMENDATIONS BELOW MAY VARY SOMEWHAT WITH MANUFACTURER LABELS, BUT THEY ARE CONSISTENT WITH LABEL RATES. STUDY PRODUCT INFORMATION, RATES, TIMING AND SAFETY PRECAUTIONS BEFORE MAKING HERBICIDE DECISIONS.

Ailanthus (Tree of Heaven)

Basal Bark	Cut Stump	Hack-n-Squirt	Girdling	Foliar Spray
Remedy Ultra, Element 4, Garlon 4 or Relegate (20% in oil)	Remedy Ultra, Element 4, Garlon 4 or Relegate (20% in oil)	Garlon 3A /Vastlan (1 milliliter/hack) 1 hack/inch to 1 hack/3 inches DBH	Girdling is Not Recommended for Ailanthus. Use systemic herbicides.	Remedy Ultra, Relegate or Garlon 4 (1.5% + 1/2% NIS in water)
Pathfinder II RTU in oil.	Pathway or Tordon RTU Full Strength	Rodeo (1/2 milliliter/hack) 1 hack/inch to 1 hack/3 inches DBH		Escort XP or Patriot (0.5 grams/gal. HV) or (2 grams + 1/2 oz NIS/ Gal. LV in water)
15% Remedy Ultra, Element 4 or Garlon 4 + 5% Stalker in oil	Stalker, Chopper (8-12 oz/gal. in oil)	Pathway or Tordon 1 milliliter/hack 1 hack/inch to 1 hack/3 inches DBH		Glyphosate 4 Plus (41% concentration) (2% in water + surfactant) Razor Pro - no NIS
Adding 10% CideKick helps penetrate bark.	Glyphosate 4 Plus , Razor (60% in water)	Critical: Leave 1-2" of bark between hacks.		Rodeo + Garlon 3A or Vastlan + NIS in water. Use label rates.
Feb. 15 - April 15 or June 1 - Sept. 15 (most ideal)	Treat outer 1/3 stump within 5-15 minutes of the cut during growing season.	June 1 to November 1; do not apply during sap flow.		June 15 - September 15 Also, July 1 - Fall Color (most ideal)

Autumn Olive

Basal Bark	Cut Stump	Hack-n-Squirt	Girdling	Foliar Spray
Remedy Ultra, Relegate or Garlon 4 (20-25% in oil)	Pathway or Tordon RTU; Full Strength ——— Garlon 3A / Vastlan Full Strength	Pathway or Tordon RTU ; Full Strength (See Ailanthus)	Pathway or Tordon RTU Full Strength	Garlon 3A /Vastlan or Tahoe 3A (2% + 1/2% NIS in water)
Chopper or Stalker (8-12 oz/gal.+ oil	Glyphosate 4 Plus (20% In water) Treat outer 1/3 stump	Garlon 3A /Vastlan (See Ailanthus)	Glyphosate 4 Plus (20% In water)	Remedy Ultra, Relegate or Garlon 4 (1-2% + ½% NIS in water)
Pathfinder II + Milestone at 1-2% Agitation Needed	Remedy Ultra, Relegate or Garlon 4 Ultra (20% in oil)	Remedy Ultra, Relegate or Garlon 4 Ultra (20% in oil)	Remedy Ultra, Relegate or Garlon 4 Ultra (20% in oil)	Glyphosate 4 Plus (2% in water + ½% NIS)

Notes: **Garlan 3A can cause cornea damage!** ***Read and Follow Product Labels***

Suggested herbicide rates are a general guideline. Not all listed herbicides are labeled for all targeted woody species. You may need less or even more herbicide depending on your target species and conditions. These tables do NOT factor in cost-effectiveness.

- CAUTIONS! Do NOT use Pathway near Tulip Poplar nor on trees possibly root grafted to crop trees!
- Avoid high temperature days – 85 degrees F + with Basal Barks to reduce volatilization
- NIS = Nonionic Surfactants; COC = Petroleum Crop Oil Concentrate; MSO = Modified Seed Oil
- Percents are based on actual volumes; ounces of granules are based on 100 gallons with the exception of Patriot which is based on 75 gallons; FS = Full Strength
- Apply foliar treatments when foliage is actively growing; v/v = volume of product to volume of solution
- Low Volume (LV) is typically a backpack, hand pump sprayer; High Volume (HV) is pump driven
- Oil = diesel, kerosene, bark oil, MSO, COC; follow label rates for all adjuvants.

Multiflora Rose

Basal Bark	Cut Stump	Girdling	Foliar Spray
Remedy Ultra, Garlon 4 or Relegate (25%; in oil)	Pathway, Tordon RTU Full Strength		Remedy Ultra, Garlon 4 or Relegate (2% in water)
Chopper or Stalker (6 - 9% in oil)	Remedy Ultra, Garlon 4 or Relegate (20-25% in oil)		Escort XP or Patriot (0.5 grams/gal. HV) or (1 gram + 1/2 oz NIS/Gal. LV in water)
Pathfinder II in oil	Glyphosate 4 Plus (10 - 20%)	Girdling is not recommended nor practical. Use systemic herbicides.	Glyphosate 4 Plus (1-1.5%) in water; increase percent towards end of growing season.
	Chopper or Stalker (6-12 % in oil)		Garlon 3A /Vastlan or Tahoe 3A (2% + 1/2% NIS in water)
	Pathfinder II RTU in oil. ——— Garlon 3A / Vastlan Full Strength		

Notes: Garlan 3A can cause cornea damage! **Read & Follow Label Directions**

Bush Honeysuckle

Basal Bark	Cut Stump	Girdling	Foliar Spray
Remedy Ultra, Garlon 4 or Relegate (20-25%; in oil)	Glyphosate 4 Plus or Razer (20% in water)		Escort XP or Patriot (0.5 grams/gal. HV) or (1 gram + 1/2 oz NIS/Gal. LV in water)
Garlon 4 and Stalker (15% Garlon 4 + 3% Stalker in oil)	Garlon 4 and Stalker (15% Garlon 4 + 3% Stalk-er in oil)		Garlon 3A or Tahoe 3A (3 -5 % + 1/4% NIS in water)
	Pathway or Tordon RTU; Full Strength ——— Garlon 3A / Vastlan Full Strength	Girdling is not recommended nor practical. Use systemic herbicides.	Glyphosate 4 Plus or Razor (2% Solution) (June - early November)
Adding 10% CideKick helps penetrate bark.	Garlon 4 or Remedy Ultra (20% + 10% Cide-Kick II in oil)		Rodeo + Garlon 3 (FS - 2:1 mix)
	Pathfinder II in oil		Razor XRT II (2% HV or 4% LV - water)

Notes: Garlan 3A can cause cornea damage! **Read & Follow Label Directions**

Suggested herbicide rates are a general guideline. Not all listed herbicides are labeled for all targeted woody species. You may need less or even more herbicide depending on your target species and conditions. This table does NOT factor in cost-effectiveness.

- CAUTIONS! Do NOT use Pathway near Tulip Poplar nor on trees possibly root grafted to crop trees!
- Avoid high temperature days – 85 degrees F + with Basal Barks to reduce volatilization
- NIS = Nonionic Surfactants; COC = Petroleum Crop Oil Concentrate; MSO = Modified Seed Oil
- Percents are based on actual volumes; ounces of granules are based on 100 gallons with the exception of Patriot which is based on 75 gallons; FS = Full Strength
- Apply foliar treatments when foliage is actively growing
- v/v = volume of product to volume of solution
- Low Volume (LV) is typically a backpack, hand pump sprayer; High Volume (HV) is pump driven
- Oil = diesel, kerosene, bark oil, MSO, COC; follow label rates for all adjuvants.

Woodland Brush Control *(Black Locust, Dogwood, Elm, Greenbriar, Honeylocust, Hophornbeam, Hawthorne, Osage Orange, and Japanese Barberry)*

Basal Bark	Cut Stump	Hack-n-Squirt	Girdling	Foliar Spray
Garlon 4, Relegate or Remedy Ultra (25% in oil)	Pathway or Tordon RTU; Full Strength	Garlon 3A /Vastlan (1 mL/hack) 1 hack/inch of DBH	Pathway or Tordon RTU; Full Strength	Remedy Ultra, Garlon 4 or Relegate (1-2% in water + ½% NIS)
Chopper or Stalker (8-12 ounces/ gal. in oil)	Garlon 4, Relegate or Remedy Ultra (10-20% in oil)	Chopper or Stalker (8-12 ounces/gal. in oil)	Milestone VM (10% in water + 1/2% NIS)	Milestone VM (2-8 mL/gal. water)
	Garlon 3A /Vastlan (Full Strength)			Escort XP or Patriot plus NIS (2 grams + 1/2 oz NIS/ gal. in water)
Adding 10% CideKick helps penetrate bark.	Glyphosate 4 Plus or Razor (20- 50% in water)			Glyphosate 4 Plus or Razor (5% Solution) (June - October)

Notes: Garlan 3A can cause cornea damage! ***Read and Follow Label Directions***

Suggested herbicide rates are a general guideline. Not all listed herbicides are labeled for all targeted woody species. You may need less or even more herbicide depending on your target species and conditions. This table does NOT factor in cost-effectiveness.

- CAUTIONS! Do NOT use Pathway near Tulip Poplar nor on trees possibly root grafted to crop trees!
- Avoid high temperature days – 85 degrees F + with Basal Barks to reduce volatilization
- NIS = Nonionic Surfactants; COC = Petroleum Crop Oil Concentrate; MSO = Modified Seed Oil
- Percents are based on actual volumes; ounces of granules are based on 100 gallons with the exception of Patriot which is based on 75 gallons; FS = Full Strength
- Apply foliar treatments when foliage is actively growing
- v/v = volume of product to volume of solution
- Low Volume (LV) is typically a backpack, hand pump sprayer; High Volume (HV) is pump driven
- Oil = diesel, kerosene, bark oil, MSO, COC; follow label rates for all adjuvants.

photo - left: The Fiskars X7 is my preferred hatchet for Hack-n-Squirt. It comes with a plastic sheath for your belt.

photo - right: These large ailanthus trees were single girdled a few years ago then basal sprayed later with 20% *Relegate* in diesel. Hack-n-Squirt is an option also, but the kill is much slower. Basal bark is not labeled for trees this large, but it can be effective with the right herbicide mixture, plus it takes a greater volume of herbicide and diesel.

Controlling Target Species of Weeds Using Approved Herbicides

Click on the hyperlinks below to view a description of the plant and/or control methods including herbicide recommendations for the target species. If you do not see what you are looking for, move around within that site searching for recommendations that suite your situation. Try hyperlinks for other species as well. Two common sources for this information are the ***"Invasive Plants Control Database"*** from within the **Midwest Invasive Plant Network,** plus various Land Grant Universities in the Midwest.

Target Species

Autumn Olive

- Autumn Olive
- Autumn Olive
- Ailanthus (Tree-of-Heaven)
- Ailanthus (Tree of-Heaven)
- Bush Honeysuckle (Amur)
- Bush Honeysuckle (Amur)
- Bush Honeysuckle (Amur)
- Eastern Redcedar
- Gray Dogwood
- Honey Locust
- Honey Locust

Bush Honeysuckle

Japanese Honeysuckle

- Japanese Honeysuckle
- Japanese Barberry
- Japanese Barberry
-
- Multiflora Rose
- Multiflora Rose
- Oriental Bittersweet
- Oriental Bittersweet
- Osage Orange
- Osage Orange
- Rough Leaf Dogwood
- Wild Plum
- Winged Burning Bush

Controlling Target Species of Weeds Using Approved Herbicides

(Continued)

Hardwood trees competing with crop trees –

* Boxelder
* Boxelder
* Black Locust
* Callery/Bradford Pear
* Hackberry
* Hackberry
* Hard Maple
* Hard Maple
* Ironwood
* Red Maple

Sericea lespedeza

Grasses, legumes and forbs that compete with tree seedlings –

* Garlic Mustard
* Garlic Mustard
* Garlic Mustard
* Japanese Stiltgrass
* Sericea Lespedeza
* Smooth Brome
* Tall Fescue

Garlic Mustard

Japanese Stiltgrass

Disclaimer: The herbicide rates on pages 12-14 are products I have used personally, my contractors have used them on my tree farm, or they are in common use by fellow tree farmers either by them or by their contractors. In all cases, ***READ PRODUCT LABELS,*** product Fact Sheets, refer to the included hyper-link references or consult trusted experts before applying any herbicide products.

Common Forestry Herbicides

Active Ingredient	Brand Name - % Active	Manufacturer
2,4-D	DMA 4 IVM - 46.3%	Corteva AgroSciences
Clopyralid	Transline - 40.9%	Corteva AgroSciences
Clethodim	Clethodim 2 EC - 26.4%	Willowood
	Volunteer - 26.4%	Tenkoz, Inc.
Dicamba	Vanquish - 58.1%	Nufarm Americas, Inc
Glyphosate	Roundup Pro Conc. - 50.2%	Bayer CropScience
	Razor Pro - 41% + Surfactant	Nufarm Americas, Inc.
	Refuge - 52.3%	Nufarm Americas, Inc.
	Rodeo - 53.8%	Nufarm Americas, Inc.
	Razor - 41%	Syngenta
	Foresters' - 53.8%	Corteva AgroSciences
	Accord XRT II - 50.2%	Corteva AgroSciences
	Accord Concentrate - 53.8%	Corteva AgroSciences
	Glyphosate 4 Plus - 41%	Alligare
	Buccaneer Plus - 41%	Tenkoz, Inc.
Hexazinone	Velpar DF VU - 75%	Bayer CropScience
	Velpar L VU - 25%	Bayer CropScience
	Velossa - 25%	Helena Agri-Enterprises, LLC
Imazapyr	Arsenal - 27.8%	BASF
	Chopper - 27.6%	BASF
	Stalker - 27.7%	BASF
	Polaris - 27.7%	Nufarm Americas, Inc.
	Polaris SP - 27.6%	Nufarm Americas, Inc.
	Habitat - 28.7%	BASF
Metsulfuron Methyl	Escort XP - 60%	Bayer CropScience
	Patriot - 60%	Nufarm Americas, Inc.

Common Forestry Herbicides - Continued

Active Ingredient	Brand Name - % Active	Manufacturer
Picloram	Tordon K - 24.4%	Corteva AgroSciences
	Trooper 22K - 24.4%	Nufarm Americas, Inc.
Picloram and 2,4-D	Pathway - 5.4% / 20.9%%	Corteva AgroSciences
	Tordon RTU - 5.4% / 20.9%	Corteva AgroSciences
	Tordon 101 Mixture - 10.2% / 39.6%	Corteva AgroSciences
Simazine	Sim-Trol 4L - 42.1%	Sipcam Agro Solutions
	Princep 4L - 41.9%	Syngenta Crop Protection, Inc.
Sulfometuron Methyl	Oust XP - 75%	Corteva AgroSciences
	Spyder - 75%	Nufarm Americas, Inc.
Sulfometuron Methyl and Metsulfuron Methyl	Oust Extra - 56.25% / 15%	Bayer CropScience
Triclopyr	Element 3A - 44.4%	Corteva AgroSciences
	Element 4 - 61.6%	Corteva AgroSciences
	Garlon 3A - 44.4%	Corteva AgroSciences
	Garlon 4 Ultra - 60.45%	Corteva AgroSciences
	Remedy Ultra - 60.45%	Corteva AgroSciences
	Pathfinder II - 13.6%	Corteva AgroSciences
	Relegate - 61.6%	Nufarm Americas, Inc.
	Tahoe 3A - 44.4%	Nufarm Americas, Inc.
	Tahoe 4E - 61.6%	Nufarm Americas, Inc.
	Vastlan - 54.72%	Corteva AgroSciences
Triclopyr and Fluroxypyr	PastureGard HL - 45.07% / 15.56%	Corteva AgroSciences
Tricloppyr and Aminopyralid	Milestone VM Plus - 2.22% / 16.22%	Corteva AgroSciences
Fluazifop-P-Butyl	Fusilade DX - 24.5%	Syngenta Crop Protection, Inc.

Commonly Used Measures

Primary Unit	Second Unit	Third Unit	Fourth Unit	Fifth Unit
English				
Tablespoon (tbsp)	3 teaspoons (tsps.)	15 ml		
Ounce	2 tbsp	6 tsp	30 ml	
Cup	½ Pint	16 tbsp	8 Ounces	237 ml
Pint	2 Cups	16 Ounces		
Quart	2 Pints	4 Cups	32 Ounces	946 ml
Gallon	4 Quarts	8 Pints	16 Cups	128 Ounces
1 Pound	16 Ounces			
Cubic Yard	27 Cubic Feet	202.5 Gallons		
Acre	43,560 sq. ft.			
Acre Foot	43,560 cu. Ft.			
Mile	5,280 feet			
1 Square Mile	640 ac.			
Weight of Water	8.34 lbs./gal.			
Metric				
Gram	0.035274 Ounces			
Liter	0.264 Gallons	33.8 fl. oz.		
28 Grams	1 Ounce			
Meter	3 feet 3.37 inches			
Hectare	2.471 ac.			

Google: "Conversion Using Online Volume Converter"

Percent Solutions Simplified - Per 3 Gallons of Solution (Rounded)

(Formula = 128 oz/gal. x # gals. x % solution = Volume of Herbicide in Ounces)

Percent Solution	Volume		Percent Solution	Volume
.25%	1 ounce		15%	58 ounces
1%	4 ounces		20%	2.4 quarts
3%	12 ounces		30%	3.6 quarts
5%	19 ounces		50%	6 quarts

Area Formulas

Circumference of a Circle = Pi x Diameter **or** 2 x Pi x Radius

Area of a Circle = Pi x Radius Squared **Where Pi** = 3.14159

Managing Woody Vegetation in Woodland
-- References --

1) ***"CDMS Specimen Label Database";*** http://www.cdms.net/

2) ***"Midwest Invasive Plant Network"***; http://www.mipn.org/

3) ***"Manual Herbicide Application Methods for Managing Vegetation in Appalachian Hardwood Forests"***; USDA-Forest Service; General Technical Report NRS-96.

4) ***"Herbicides and Forest Vegetation Management Controlling Unwanted Trees, Brush, and Other Competing Forest Vegetation"***; Pennsylvania State University Extension; https://extension.psu.edu/herbicides-and-forest-vegetation-management

5) *"Weed and Brush Control for Forages, Pastures and Non-Cropland"*; College of Agriculture, Food and Natural Resources, University of Missouri Extension; IPM 1031.

6) ***"Invasive Plants",*** University of Kentucky, College of Agriculture, Food & Environment, Department of Forestry and Natural Resources, http://forestry.ca.uky.edu/invasive_plants

7) ***"Using Basal Bark Herbicide Applications to Control Understory Tree Species"***; Forest Science Fact Sheet Series; Pennsylvania State University Extension; https://extension.psu.edu/using-basal-bark-herbicide-applications-to-control-understory-tree-species

8) ***"Relative Effectiveness of Herbicides Commonly Used to Control Woody Vegetation in Forest Stands"***; Extension Fact Sheet F-51-06; The Ohio State University Extension; https://woodlandstewards.osu.edu/sites/woodlands/files/imce/0051%20herbicide%20relative%20effectivenes.pdf

9) ***"Forest Vegetation Management"***; Penn State Extension; https://extension.psu.edu/herbicides-and-forest-vegetation-management

10) ***"Chemical Control of Unwanted Shrub & Tree Vegetation",*** Iowa State University Extension Forestry, http://www.extension.iastate.edu/forestry/publications/PDF_files/F-341.pdf

11) ***"Forestry Landowner Assistance",*** Iowa Department of Natural Resources, Forestry Bureau, http://www.iowadnr.gov/Conservation/Forestry/Forestry-Landowner-Assistance

12) ***"Invasive Plants", Missouri Department of Conservation, Division of Forestry,*** https://mdc.mo.gov/trees-plants/problem-plant-control

13) **"*Missouri Forest Management Guidelines",*** Missouri Department of Conservation, Division of Forestry, https://mdc.mo.gov/trees-plants/forest-care/missouri-forest-management-guidelines

14) ***"Management of Invasive Plants and Pests of Illinois",*** University of Illinois Extension and Southern Illinois University, https://uofi.box.com/v/ManagementGuide

15) ***"A Management Guide for Invasive Plants in Southern Forests",*** U.S. Department of Agriculture Forest Service, Southern Research Station, https://www.srs.fs.usda.gov/pubs/36915

* * *


Not managing invasives species
could be *THE END*.