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FORESTRY HERBICIDE PRESCRIPTIONS

Western Gulf Region

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This publication provides general suggestions for herbicides used to control unwanted vegetation for "typical" forest management situations in the Western Gulf region of the U.S. including southern Arkansas, Louisiana, southeast Oklahoma, and eastern Texas. The information is presented in good faith. However, no warranty is expressed, implied, or given for any of the content presented in the manual. Vegetation control varies tremendously when treatments are applied under less than optimum conditions and/or with inexperienced applicators. The provided information discusses key elements to successful application; however, users should always refer to the respective herbicide labels prior to making any application.

This publication accompanies a web-based herbicide Decision Support Tool (DST) for forest silvicultural prescriptions that can be found online at http://texasforestinfo.tamu.edu and can be accessed free of charge. All prescriptions and treatments included in this publication are also included in the web-based herbicide DST. Both provide insight to the cost and efficacy of various treatment options.

An advisory committee consisted of representatives from the following groups: BASF Professional and Specialty Solutions | Bayer CropScience LP | DOW AgroSciences LLC | Louisiana State University Agricultural Center | Mississippi State University—College of Forest Resources | Nutrien Solutions | Red River Specialties, Inc. | Texas A&M Forest Service | University of Arkansas at Monticello—College of Forestry, Agriculture & Natural Resources | University of Arkansas Division of Agriculture. Thank you all for your effort.

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Send suggestions and/or comments to Eric Taylor (etaylor@tfs.tamu.edu) or Kyle Cunningham (kcunningham@uada.edu).

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Silvicultural prescriptions are located on the page numbers indicated. More than one control option is provided for most situations. Each is ranked according to performance and cost. Carefully check out each option before making a final selection.

Texas A&M Forest Service | U of A Division of Agriculture Research & Extension, University of Arkansas System | Arkansas Forestry Commission | Louisiana Tech University | LSU AgCenter

Introduction

Competing vegetation or competition is always a concern in forest management. Controlling competition to crop trees (e.g., pine or oak seedlings) in forest management is an essential management operation that assists in meeting management objectives such as timber production, wildlife, recreation, health and resilience, and ecosystem restoration. Forest research shows that competition control provides the greatest benefit to the survival and growth of planted seedlings relative to any other silvicultural (forest management) method available. Specific benefits of competition control include:

- Increased nutrient availability to crop trees
- Increased water availability
- Increased sunlight availability
- Increased seedling survival
- Increased growth rates
- Reduced risk of catastrophic crop loss
- Shorter rotation lengths
- Increased revenues
- Improved forest inventory accuracy

What You Should Know Before Applying Herbicides

Crop Species

Knowing whether your crop species is pine or hardwood is simply not enough to determine appropriate herbicide prescription. Determining the exact species is crucial. The four pine species important to forest management in the Western Gulf Region. These include loblolly (*Pinus taeda*), longleaf (*Pinus palustris*), shortleaf (*Pinus enchinata*), and slash (*Pinus elliottii*) pines. Understanding that differences exist between pine species regarding establishment methods, response to competition and variation in sensitivity to herbicides is essential to selecting a proper prescription.

Different hardwood species respond differently to herbicides. The oak (*Quercus spp*.) group alone contains more than a dozen species. Other hardwood species, such as black walnut (*Juglans nigra*) and persimmon (*Diospyros virginiana*), may further differ in their resistance or susceptibility to a particular herbicide. Selecting a hardwood species that will grow well on a given site and fit into the required operations (such as chemical competition control) for establishment is critical to a successful planting. Currently, this manual addresses only oak species for chemical competition control. If a planting includes non-oak species, additional considerations should be made.

Primary Competitors

Competing species to crop trees fall into four primary groups or categories (with example species provided for each category):

- Common grasses – bermudagrass, bahiagrass, johnsongrass, fescue, broomsedge
- Woody species – persimmon, blackgum, sweetgum, ash, hickory, sumac
- Broadleaf weeds – fireweed, goldenrod, curly dock, horsetail, ragweed, smartweed, pigweed
- Vines – trumpet creeper, poison ivy, Virginia creeper, crossvine

Additionally, brambles (such as *Rubus* species) can be a goal of control. Often, woody plants, vines and brambles are referred to as the “brush” group for control. This manual separates these groups to better define silvicultural scenarios and more specific control considerations.

Site Conditions

Landowners and managers should consider several site factors prior to making an herbicide application. In some instances, site conditions may alter the rate requirements for herbicides or preclude their use altogether. Site conditions may impact total spray volumes required and equipment needs. A detailed analysis of the following site characteristics is essential to making a successful application and avoiding potential pitfalls.

Size of the treatment area

- Affects method of application, need for a contractor, and cost.
- Proper mapping is essential to ensure accurate acreage to best facilitate application process (e.g., mixing the proper amount of chemical for a site).

Topography

- Steep terrain can create difficulty in ground applications.
- Lowlands may create sensitive, wet areas that require additional considerations and planning.

Structure of vegetation present

- Affects application type (e.g. aerial versus ground).
- Affects equipment used in application.
- Affects total solution volume necessary.

Species of dominant competing vegetation present

- Affects herbicide formulations and mixtures necessary

Soil type

- Soil texture and drainage can impact herbicide efficacy (may increase or decrease) and rate.
- Soil pH can impact prescription levels or may exclude certain prescriptions.

Wildlife habitat

- Forest herbicides typically exhibit low toxicity to animals.
- Habitat alterations are most important, and they could be positive or negative to wildlife.

Sensitive areas

- Endangered species, water sources, crops, and other sensitive areas should be identified and protected from herbicide applications.

Environment

Environmental conditions (e.g., wet, dry, hot or cold periods) can be a major consideration when planning an herbicide application. Understanding the nuances between herbicides and how they respond to specific environmental conditions can increase the efficacy of an application. More importantly, understanding environmental conditions and how they impact (or not) herbicides can greatly reduce the risk of non-target impacts and harmful effects on nearby sensitive zones. Some environmental factors include:

Weather conditions – Applications made during extreme conditions, drought, heat wave, excessive rainfall or high winds, can result in an improper application and subsequent movement of herbicides off site. For example:

- High temperatures are an important factor to consider, as they can result in herbicides volatilizing, off-site movement and severe off-site impacts.
- Some herbicides require rainfall to be active, while too much rainfall can wash away others.

- Applications made in high winds can result in off-site impacts.
- Applications made when wind is calm (usually early morning), and conditions induce photosynthetic activity result in the highest efficacy ratings.

Season – Soil-active herbicides are typically applied early in the year, while foliar-active herbicides may be more effective from mid to late growing season.

Rates and Application Guidelines

The herbicide rate prescriptions and application guidelines listed in this publication are for "typical" site conditions listed in the Site Conditions description. If specific site conditions differ from those listed, adjustments to prescription rates and application guidelines may be necessary. In every case, refer to the selected herbicide label(s) prior to application to ensure proper rates and application methods are being used. When using a tank mix, always follow the most restrictive label recommendations.

Adjuvants

The adjuvant (e.g. surfactant) recommendations are based on season, specific labels, and are specific to the protocol listed. Scenarios may occur where the type and volume of adjuvant should be adjusted. In every case, refer to the herbicide label(s) and adjuvant label prior to application.

Silvicultural Method

Prescriptions are based on specific silvicultural methods. Each herbicide prescription will include the referenced silviculture method intended such as a summer site preparation and fall planting method for containerized loblolly pine establishment.

Application Timing

Because prescriptions are linked to a specific silvicultural method, timing of applications should not vary greatly from those listed (if at all).

Prescription Rankings and Relative Costs

Each prescription provides relative costs of the chemistries that includes the herbicide and adjuvants (if required). The relative costs do not include the cost of application. A description of the cost scale and representative symbols is provided in Table 1. Each prescription also lists an overall performance rank and performance ranks for individual control factors. Definitions of each performance ranking term are listed in Table 2.

Table 1. Description of prescription cost scale and representative symbols.

Prescription Cost Per Acre Scale						
¢ < $15/acre	¢¢ = $16–$30/acre	$ = $31–$45/acre	$$ = $46–$60/acre	$$$ = $61–$75/acre	$$$$ = $76–$90/acre	$$$$$ > $90/acre

Table 2. Description of performance ranking terms and parameters.

Ranking Term	Definition	Specific Criteria
Cost per Acre:	Cost of chemical(s) including adjuvants only. Does NOT include cost of application.	See cost table above.
Overall Performance:	This is the general overall rating for comparative purposes.	Calculated average of the 11 individual ranking criteria to the rounded nearest half star.
Grass Control: **Broadleaf Control:** **Woody Control:** **Vine Control:**	Ability of prescription to provide general control of the listed planted type.	N/A = Not applicable None = No control ★ = Limited control of a few species ★★ = Significant control of some species ★★★ = Significant control of many species ★★★★ = Significant control of most species
Effective Speed:	Time required following application to observe significant application impact.	N/A = Not applicable None = No control ★★ = Signs may or may not appear within 6 weeks, but may be months before significant impact is observed or requires rainfall for activation. ★★★ = Signs appear within 3 – 6 weeks ★★★★ = Signs appear within ~ 2 weeks
Control Duration:	Length of time herbicide impacts will be evident.	★ = Very brief control period. Foliar-active only herbicides ★★ = Lower rates of soil-active herbicides ★★★ = High rate of a single soil-active herbicide. Could be a tank mix of a foliar plus a soil-active herbicide. Control usually around 120 days or longer. ★★★★ = Herbicides with control durations lasting greater than 3 months and potentially into the following growing season. Tank mixes of more than one soil-active herbicide or herbicides with extended half-life.
Hard to Control:	Plants with characteristics that make them difficult to control (i.e., waxy leaf plants).	Rating begins at 2 stars and represents Low, Medium and High.
Crop Tolerance:	General susceptibility of crop species. For site preparation prescription, this value represents the length of time until you can plant. For HWC, represents impact on seedling vigor.	None = Requires directed spray for HWC ★ = Greater than 6 months before you could plant ★★ = Greater than 3 months before you could plant ★★★ = Greater than 45 days before you could plant. Or, spray over top with limited impact on seedling vigor ★★★★ = Plant seedlings soon after application or spray over top with no impact
Resistant Species:	Species listed to have exhibited resistance.	★★ = Multiple common species listed ★★★ = One or two common species listed ★★★★ = Controls most species
Natural Pine Control:	Level of control on natural pine present on site.	None = Does not have impact on pines ★ = May cause some suppression symptoms ★★ = Suppresses but does not control pine ★★★ = Provides adequate control of pine ★★★★ = Provides good control of pine with more than a single effective herbicide in mix
Restrictions:	Factors that limit the use of a particular herbicide (i.e., soil pH).	Could be due to a restricted use product or an environmental factor that impacts efficacy, movement of chemical off site or potential damage to seedlings.

Table 3a. List of commonly-used silvicultural herbicides and associated brands.

Herbicide	Target Plants	Resistant Plants	Brands (Products)	Soil Activity
aminopyralid	Many annual, biennial, and perennial broadleaf weeds including thistle, ragweed, marestail, mimosa, redbud, and locust, kudzu, wisteria, and stiltgrass.	Many woody plants. Highest efficacy as a tank mix partner.	[2]Milestone	Moderate
clethodim	Many annual and perennial grasses.	Little or no harm to broad-leaved plants.	[1]Arrow 2EC, [1]Cleanse 2EC, [1]Envoy, [1]Intensity One, [1]Select Max, [1]Select 2EC, [1]Vaquero	Low
clopyralid	Many annual and perennial broadleaf weeds including knapweeds, thistles; the sunflower, legume, morning-glory and knotweed families. Works well on kudzu.	Little effect on grasses, mustard family and several other groups of broad-leaved plants.	Transline, Stinger, Clopyralid 3, Clean Slate	Low
dicamba	Many annual and perennial broadleaf weeds, and some woody plants (including pines) and vines.	Many woody plant species are resistant.	Vanquish, Sterling Blue	Moderate
fluazifop-p-butyl	Annual and perennial grasses only.	Little or no harm to broad-leaved plants.	[2]Fusilade II	Low
fosamine	Most woody plants.	Non-woody plants are resistant.	Krenite S	Low
glyphosate	Non-selective, systemic herbicide that can control most annual, biennial, perennial plants. Some woody plants including conifers.	Hickory, greenbrier, Virginia creeper, trumpet vine.	Accord XRT II, Rodeo, Foresters, Roundup Pro, Razor, Glyphosate 5.4, Glypro, many others	None
hexazinone	Controls some grasses, many annual and perennial broadleafs, and some woody species especially oak and hickory.	Sassafras, blackgum, tulip poplar, red maple. Most conifer species show resistance.	Velpar L, Velpar DF, Pronone, Velossa	High
imazapyr	Non-selective herbicide for grasses, broadleaves, vines, shrubs and trees, riparian and emerged aquatics.	Elms, woody legumes, wax myrtle, croton, blackberry, buckeye, eastern baccharis, pine.	Arsenal AC, Chopper Gen2, Polaris AC Complete, Polaris SP, Imazapyr 4SL, Rotary 2SL	High
metsulfuron methyl	Many annual and perennial weeds and woody plants especially kudzu and multiflora rose.	Grasses show high tolerance.	Escort XP, MSM 60, Patriot	High
oxyfluorfen	Pre- and post-emergent control of broadleaf weeds and certain grasses.	Certain conifers and deciduous species.	[2]Goal 2XL	Moderate
picloram	Annual, biennial, and perennial broadleaf plants and woody plants especially conifers.	Most grasses are resistant.	Tordon 22K, Picloram 22K, Trooper 22K	High
saflufenacil	Control of natural/wilding pines during site preparation.	A variety of species.	Detail	Low
sethoxydim	Annual and perennial grasses such as bahiagrass, crabgrass, annual ryegrass, wild oats.	Little or no impact on broadleaf herbs or woody plants.	[3]Poast, [3]Rezult, [3]Segment	None
sulfometuron methyl	Annual and perennial grasses and broadleaf weeds.	Many conifers and hardwood species are resistant.	Oust XP, Spyder, SFM 75	Low
triclopyr	Controls broad spectrum of woody plants, broadleaf weeds and vines.	Black cherry, persimmon, sumac, hickory. Little or no impact on most grasses.	Vastlan, Garlon XRT, Boulder 6.3, Relegate, Tahoe 4E, Triclopyr 4E, Pathfinder II	None

1Labeled for use in Christmas tree farms, conifer nurseries and conifer plantations (but not in forests). [2]Refer to supplemental labels by State for use in forestry or related sites. [3]No apparent forestry use on label.
Modified from Colby Lambert, Mark Megalos, James Jeuck. (2016). 2016 Quick Guide to Forestry Herbicides Used for Softwood and Hardwood Site Preparation and Release.

Table 3b. List of less common silvicultural herbicides and associated brands.

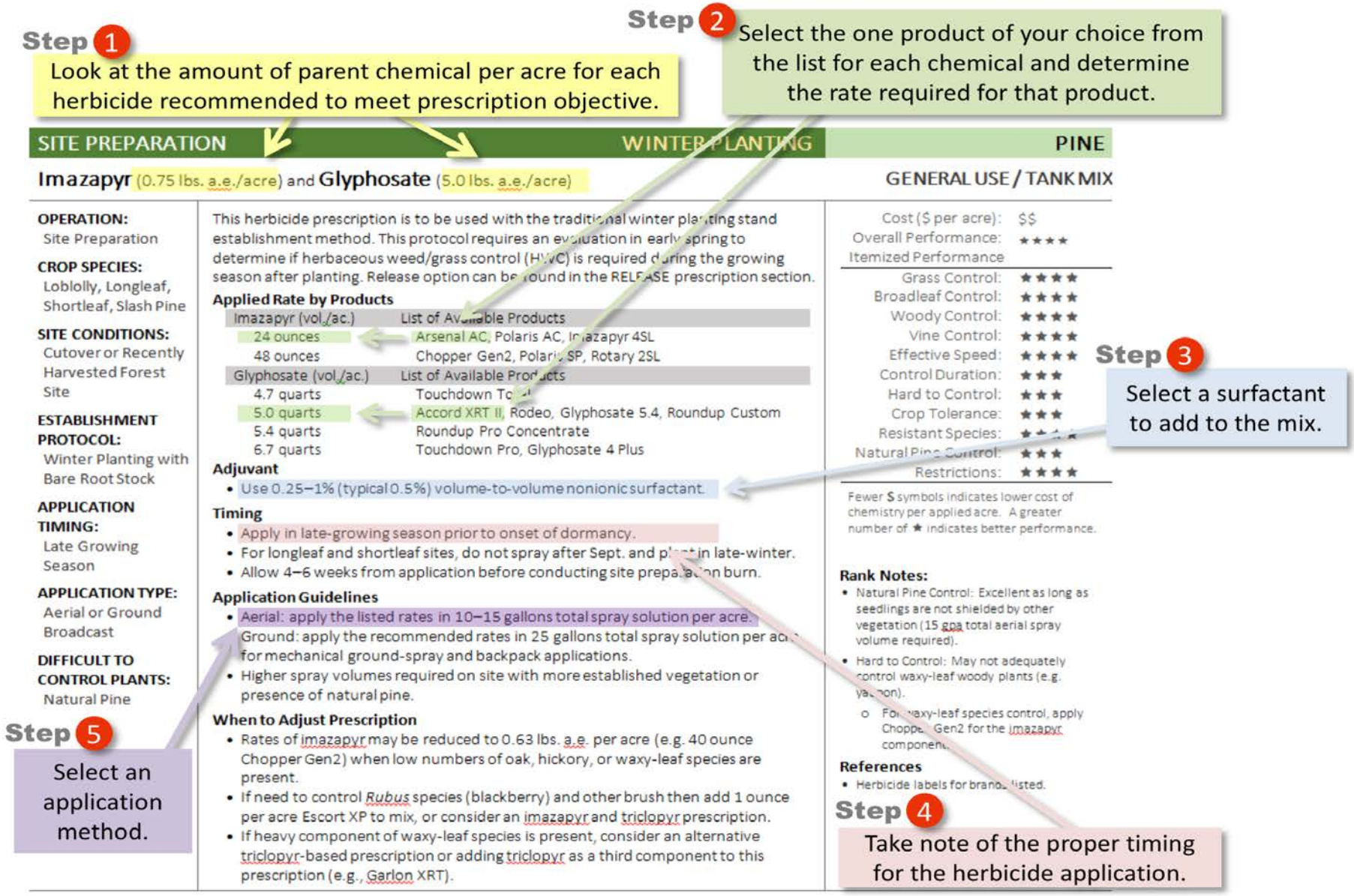
Herbicide	Target Plants	Resistant Plants	Brands (Products)	Soil Activity
2,4-D	Many annual and perennial broadleaf weeds, vines, and some woody plants when actively growing.	Red maple, ash, elm, persimmon, some oaks/hickories. No impact to grasses. Can be applied over conifers once hardened off.	Freelexx, Weedone	None
atrazine	Broad-spectrum broadleaf and grass control. Used as a preemergent or early post-emergent.	Minimally effective on established weeds.	Atrazine 4L, Atrazine 90DF	Moderate
idaziflam	Annual grasses such as crabgrass, goosegrass, foxtails, barnyardgrass, and annual bluegrass; annual broadleaf weeds including bittercress, doveweed, oxalis, pigweed, spurge; and annual sedges from seed.	Emerged weeds are not controlled. Poor control of Japanese stiltgrass and marsh parsley. Weeds sprouting from vegetative organs like rhizomes, tubers and bulbs are not controlled. Does not control nutsedge.	Esplanade F, Marengo	Moderate
imazamox	Chinese tallowtree, grass and broadleaf weeds		Clearcast L, Clearcast 2.7G	Moderate
fluroxypyr	Broadleaf annual and perennial weeds, and certain woody plants and vines		Vista XRT	Moderate

Table 4. Limited list of pre-mixed silvicultural herbicides and associated brands.

Herbicide 1	Herbicide 2	Herbicide 3	Products
aminopyralid	metsulfuron methyl		Chaparral, Opensight
aminopyralid	triclopyr		Capstone, Milestone VM Plus
dicamba	2,4-d		Veteran 720, WeedMaster, Spitfire, Brush-Rhap
imazapyr	glyphosate		Prep-It
imazapyr	metsulfuron methyl		Lineage Clearstand
imazapyr	sulfometuron methyl	metsulfuron methyl	Lineage Prep
hexazinone	sulfometuron methyl		Oustar, Westar
oxyfluorfen	penoxsulam		Cleantraxx
picloram	2,4-D		Graslan L, Tordon 101 Mixture, Pathway, Trooper P+D
sulfometuron methyl	metsulfuron methyl		Oust Extra, Spyder Extra, SFM Extra
triclopyr	2,4-D		Crossbow

Modified from Colby Lambert, Mark Megalos, James Jeuck. (2016). 2016 Quick Guide to Forestry Herbicides Used for Softwood and Hardwood Site Preparation and Release.

BASIC STEPS INTERPRETING HERBICIDE PRESCRIPTION



ALWAYS REFER TO HERBICIDE LABEL(s) BEFORE FINALIZING PRESCRIPTION

Activity: Site Preparation
Crop Species: Pine

Site Preparation

Herbicide applications made at the time of site preparation are the most important chemical control applications that can be made to establish tree seedlings on a variety of site conditions. Typically, site preparation with herbicides is designed to control most or all of the four primary competition groups, including grasses, broadleaf plants, woody plants, and vines. Because crop trees are not yet planted, landowners have a greater number of options in the type of herbicide used and their applied volume, which together can result in significantly better competition control. Once crop trees have been planted, controlling competing vegetation becomes much more difficult and, in some cases, not feasible.

Chemical site preparation discussed here is designed around planting scenarios, initial site conditions, crop species, and primary competitors. Planting scenarios include either traditional winter planting of bare root seedlings or fall planting with containerized stock. Initial site conditions are either recent clearcut, cutover, or old-field conditions. Crop species include four pines: loblolly, longleaf, slash, and shortleaf. Site preparation for oak species is described in its own section.

Some prescriptions may be appropriate for all pines or only one or two species, which are identified in each prescription. Primary competitors may include the four primary groups mentioned above, brambles, or hard-to-control species (such as yaupon or other waxy leaf species). Competitors could also include natural (or wilding) pine that may compete with selected pine crop tree planting stock.

Selecting the proper chemical site preparation prescription often involves an analysis of balance between efficacy and cost. Many site preparation prescriptions are described. Users should carefully determine which scenarios and conditions will adequately describe the respective planting operation being planned. Prescriptions should be identified and ranked to best facilitate the establishment operation in question. In some instances, simply selecting the least-expensive option may not provide maximum benefit.

Table 5. Commonly-used herbicides for pine site preparation.

Herbicide	Products	Time of Year	Target	Resistant (at typical rates)
imazapyr	Arsenal AC, Polaris AC, Chopper Gen2, Polaris SP	Growing season following full leaf expansion.	Most hardwoods, annual and perennial grasses and forbs, Bermuda, fescue, crabgrass, dog fennel, pigweed, greenbrier.	Elms, woody legumes, wax myrtle, croton, blackberry, buckeye, baccharis, pine
glyphosate	Accord XRT II, Rodeo, Roundup Pro	Prior to planting, active growth following full leaf expansion.	Most hardwood and conifer species, grasses and broadleaf weeds, blackberry.	Blackgum, hickory, greenbrier, Virginia creeper, trumpet vine
glyphosate and imazapyr	Prep-It	During periods of active growth.	Control most annual and perennial grasses, broadleaf weeds, vines, and woody plants.	
metsulfuron methyl	Escort XP, Patriot	During periods of active growth following full leaf expansion	Wide range of annual and perennial broadleaf weeds, elm, kudzu, multiflora rose	Some grasses, yellow poplar, loblolly pine
sulfometuron methyl	Oust XP, Spyder, SFM 75	Early spring, before herbaceous weeds emerge or shortly thereafter.	Annual grasses and forbs and certain perennial herbs.	Bermuda, broomsedge, croton, trumpet creeper, panicums, pines, hardwoods
sulfometuron and metsulfuron methyl	Oust Extra, Spyder Extra, SFM Extra	After full leaf expansion in spring. Herbaceous weeds: apply pre-emergent or shortly thereafter.	Various woody plants, vines and herbaceous weeds.	Loblolly pine
triclopyr	Vastlan, Garlon XRT II, Tahoe 4E, Triclopyr 4E	During periods of active growth.	Most hardwoods, southern pine, waxy species such as bay, gallberry, wax myrtle, and yaupon, forbs, dog fennel, pigweed, greenbrier, morning glory, blackberry	Grasses
aminopyralid	Milestone	Anytime during the growing season when weeds are small and active.	Blackberry, morning glory; horseweed, pigweed, thistle, sicklepod, ragweed, wilding pines, locust, redbud, mimosa, kudzu, Japanese stiltgrass	Grasses and longleaf pine
clopyralid	Transline, Clean Slate, Clopyralid 3, Stinger	Anytime during the growing season. Preferred when weeds are small and actively growing.	Certain broadleaf weeds including thistle, kudzu, sicklepod, morning glory, ragweed, coffee weed most legume species.	Most established grasses and woody plants
dicamba	Vanquish	During periods of active growth.	Many annual and perennial broadleaf weeds, woody brush (including oaks and pines), multiflora rose.	
fosamine	Krenite S	Apply during the growing season.	Postharvest control of pine and hardwood species for pine site preparation.	Non-woody plants (usually) and waxy leafed species.
hexazinone	Velpar DF, Velossa, Velpar L	Early spring–early summer after bud break and before hardening off.	Most hardwoods, blackberry, crabgrass, fescue, lespedeza, horseweed, dog fennel, annual and perennial rye grass.	Yellow-poplar, eastern redcedar, sassafras, blackgum, hollies, beauty-berry, bermudagrass, broomsedge, johnsongrass, trumpet creeper
picloram	Tordon 22K, Trooper 22K, Picloram 22K	During periods of active growth.	Annual, biennial, and perennial broadleaf weeds, woody plants especially legumes, southern pine and vines.	Most grasses are resistant
picloram + 2,4-D	Graslan L, Tordon 101 Mixture	During periods of active growth.	Most annual and perennial broadleaf weeds, woody plants, and vines.	Most grasses are resistant
saflufenacil	Detail	During active pine growth in late spring to early fall.	Control wilding pines in site preparation.	A variety of species. Designed to be a tank mix component.

Modified from Colby Lambert, Mark Megalos, James Jeuck. (2016). 2016 Quick Guide to Forestry Herbicides Used for Softwood and Hardwood Site Preparation and Release.

Imazapyr (0.75 pounds a.e./acre) and Glyphosate (5.0 pounds a.e./acre)

GENERAL USE / TANK MIX

OPERATION:
Site Preparation

CROP SPECIES:
Loblolly, Longleaf, Shortleaf, Slash Pine

SITE CONDITIONS:
Cutover or Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Winter Planting with Bare Root Stock

APPLICATION TIMING:
Late Growing Season

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
Natural Pine

This herbicide prescription is to be used with the traditional winter planting stand establishment method. This protocol requires an evaluation in early spring to determine if herbaceous weed/grass control (HWC) is required during the growing season after planting. Release option can be found in the RELEASE prescription section.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
24 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
48 ounces	Chopper Gen2, Polaris SP, Rotary 2SL
Glyphosate (vol./ac.)	**List of Available Products**
4.7 quarts	Touchdown Total
5.0 quarts	Accord XRT II, Rodeo, Glyphosate 5.4, Roundup Custom
5.4 quarts	Roundup Pro Concentrate
6.7 quarts	Touchdown Pro, Glyphosate 4 Plus

Adjuvant

- Use 0.25–1% (typical 0.5%) volume-to-volume nonionic surfactant.

Timing

- Apply in late-growing season prior to onset of dormancy.
- For longleaf and shortleaf sites, do not spray after Sept. and plant in late-winter.
- Allow 4–6 weeks from application before conducting site preparation burn.

Application Guidelines

- Aerial: Apply the listed rates in 10–15 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 25 gallons total spray solution per acre for mechanical ground-spray and backpack applications.
- Higher spray volumes required on site with more established vegetation or presence of natural pine.

When to Adjust Prescription

- Rates of imazapyr may be reduced to 0.63 pounds a.e. per acre (e.g., 40 ounce Chopper Gen2) when low numbers of oak, hickory, or waxy-leaf species are present.
- If need to control *Rubus* species (blackberry) and other brush then add 1 ounce per acre Escort XP to mix, or consider an imazapyr and triclopyr prescription.
- If heavy component of waxy-leaf species is present, consider an alternative triclopyr-based prescription or adding triclopyr as a third component to this prescription (e.g., Garlon XRT).

Cost ($ per acre):	$$
Overall Performance:	★★★★
Itemized Performance	
Grass Control:	★★★★
Broadleaf Control:	★★★★
Woody Control:	★★★★
Vine Control:	★★★★
Effective Speed:	★★★★
Control Duration:	★★★
Hard to Control:	★★★
Crop Tolerance:	★★★
Resistant Species:	★★★★
Natural Pine Control:	★★★
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Natural Pine Control: Excellent as long as seedlings are not shielded by other vegetation (15 gpa total aerial spray volume required).
- Hard to Control: May not adequately control waxy-leaf woody plants (e.g. yaupon).
  - For waxy-leaf species control, apply Chopper Gen2 for the imazapyr component.

References

- Herbicide labels for brands listed.

Texas A&M Forest Service | U of A Division of Agriculture Research & Extension, University of Arkansas System | Arkansas Forestry Commission | Louisiana Tech University | LSU AgCenter

Imazapyr (0.75 pounds a.e./acre) and Triclopyr (2.0 pounds a.e./acre–ester)

GENERAL USE / TANK MIX

OPERATION:
Site Preparation

CROP SPECIES:
Loblolly, Longleaf, Shortleaf, Slash Pine

SITE CONDITIONS:
Cutover or Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Winter Planting with Bare Root Stock

APPLICATION TIMING:
Late Growing Season

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
Waxy-leaf Species

This herbicide prescription is to be used with the traditional winter planting stand establishment method. This protocol is designed to provide effective control of waxy-leaf species but requires an evaluation in early spring to determine if herbaceous weed/grass control (HWC) is required during the growing season after planting. Release option can be found in the RELEASE prescription section.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
24 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
48 ounces	Chopper Gen2, Polaris SP, Rotary 2SL
Triclopyr (vol./ac.)	**List of Available Products**
1.3 quarts	Garlon XRT, Boulder 6.3,
2.0 quarts	Garlon 4 Ultra , Element 4, Relegate, Triclopyr 4, Tahoe 4E

⚠ Do not mix imazapyr with an *amine* formulation of triclopyr.

Adjuvant

- Use 1–2% volume to volume methylated seed oil (MSO). or
- Use 0.25–1% (typical 0.5%) volume to volume nonionic surfactant.

Timing

- Apply in late-growing season prior to onset of dormancy.
- For longleaf and shortleaf sites, do not spray after Sept. and plant in late-winter.
- Allow 4–6 weeks from application before conducting site preparation burn.

Application Guidelines

- Aerial: Apply the recommended rates in 10–15 gallons total solution per acre.
- Ground: Apply the recommended rates in 25 gallons total spray solution per acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established vegetation.

When to Adjust Prescription

- Rates of imazapyr may be reduced to 0.63 pounds a.e. per acre (e.g., 40 ounces Chopper Gen2) when low numbers of oak, hickory, or waxy-leaf species are present.
- For waxy-leaf species, Chopper Gen 2 and Garlon XRT are most appropriate products for application.

Cost per acre:	$$
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★★
Woody Control:	★★★★
Vine Control:	★★★★
Effective Speed:	★★★
Control Duration:	★★★
Hard to Control:	★★★★
Crop Tolerance:	★★★
Resistant Species:	★★★
Natural Pine Control:	★★★
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Grass Control: Triclopyr does not provide grass control.
- Effective Speed: May be slow to respond, following treatment application.

References

- Herbicide labels for brands listed.

Glyphosate (5.0 pounds a.e./acre), and Triclopyr (3.15 pounds a.e./acre–ester)

GENERAL USE / TANK MIX

OPERATION:
Site Preparation

CROP SPECIES:
Loblolly, Longleaf, Shortleaf, Slash Pine

SITE CONDITIONS:
Cutover or Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Winter Planting

APPLICATION TIMING:
Late Growing Season

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
Waxy-leaf Species, Vines, Natural Pine

This prescription is used with the traditional winter planting stand establishment method in which competition from natural pine IS an issue. Foliar coverage is essential to prescription effectiveness. Requires a follow-up release application for adequate herbaceous weed control in the first growing season. Release option can be found in the RELEASE prescription section.

Applied Rate by Products

Glyphosate (vol./ac.)	List of Available Products
4.7 quarts	Touchdown Total
5.0 quarts	Accord XRT II, Rodeo, Glyphosate 5.4, Roundup Custom
5.4 quarts	Roundup Pro Concentrate
6.7 quarts	Touchdown Pro, Glyphosate 4 Plus

Triclopyr (vol./ac.)	List of Available Products
2.0 quarts	Garlon XRT, Boulder 6.3,
3.2 quarts	Garlon 4 Ultra, Element 4, Relegate Triclopyr 4, Tahoe 4E

Adjuvant

- Use 1–2% volume-to-volume methylated seed oil (MSO).
  or
- Use 0.25–1% (typical 0.5%) volume-to-volume nonionic surfactant.

Timing

- Apply in late growing season prior to onset of dormancy.
- Allow 4–6 weeks from application before conducting site preparation burn.

Application Guidelines

- Make sure that triclopyr is mixed before adding glyphosate (see label.)
- Aerial: Apply the recommended rates in 15 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 25 gallons total spray solution per acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established, denser/taller vegetation.

When to Adjust Prescription

- Sulfometuron methyl plus metsulfuron methyl (Oust Extra) may be added at 4 ounces per acre to increase control duration of herbaceous plants into the following growing season.

Cost per acre:	$$$
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★★
Woody Control:	★★½
Vine Control:	★★★★
Effective Speed:	★★★★
Control Duration:	★
Hard to Control:	★★★★
Crop Tolerance:	★★★★
Resistant Species:	★★
Natural Pine Control:	★★★★
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Natural Pine Control: Excellent as long as seedlings are not shielded by other vegetation (15 gpa total aerial spray volume required).
- Control Duration: Soil activity is limited and residual efficacy will be low.
- Resistant Species: Black cherry and some hickories will exhibit some resistance to this treatment.

References

- Herbicide labels for brands listed.

Imazapyr (0.75 pounds a.e./acre)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Site Preparation

CROP SPECIES:
Loblolly, Longleaf, Shortleaf, Slash Pine

SITE CONDITIONS:
Cutover or Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
January-February Planting

APPLICATION TIMING:
Mid to Late Growing Season

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
None

This herbicide prescription is to be used with the traditional winter planting stand establishment method for pine. This prescription is an option for multiple-objective management where herbaceous legumes are beneficial for non-timber objectives.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
24 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
48 ounces	Chopper Gen2, Polaris SP, Rotary 2SL

Adjuvant

- Use 1% by volume methylated seed oil (MSO).

  or
- Use 0.25–1% (typical 0.5%) volume to volume nonionic surfactant.

Timing

- Mid to late growing season application is recommended.
- Do not spray after September.

Application Guidelines

- Aerial: Apply the listed rates in 10–15 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 25 gallons total spray solution per acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established, denser/taller vegetation.

When to Adjust Prescription

- Sulfometuron methyl may be added at 3 ounces per acre to increase control duration of herbaceous plants into the following growing season. Will control legumes also.
- Add Milestone at 7 ounces per acre for control of honeylocust, black locust or *Rubus*.

Prescription Weakness

- Slow effective speed.
- Does not provide complete control of elm, brambles, or natural pine

Cost per acre:	¢¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★
Woody Control:	★★★
Vine Control:	★★★
Effective Speed:	★★
Control Duration:	★★★
Hard to Control:	★★★
Crop Tolerance:	★★★
Resistant Species:	★★½
Natural Pine Control:	★
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Overall Performance: Because this prescription uses only a single product, the overall effectiveness is reduced.

References

- Ezell AW. Herbicide Use for Management of Shortleaf Pine. The Shortleaf Pine Initiative.
- Herbicide labels for brands listed.

Hexazinone (3.0 pounds a.e./acre)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Site Preparation

CROP SPECIES:
Loblolly, Longleaf, Shortleaf, and Slash Pine

SITE CONDITIONS:
Cutover or Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Late Winter Planting

APPLICATION TIMING:
Early Growing Season

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
Brambles, High Density of Oak and Hickory Species

This prescription is used with the winter planting stand establishment method, where adequate time is available between site preparation application and planting date. It is to be used as an early-growing season application. Pine seedlings should not be planted before January of the season following treatment.

Applied Rate by Products

Hexazinone (vol./ac.)	List of Available Products
6.0 quarts	Velpar L, Velossa

⚠ Hexazinone is highly sensitive to soil texture. Carefully follow label.

Adjuvant

- Use 0.25–1% (typical 0.5%) volume-to-volume nonionic surfactant.

Timing

- Apply in early growing season (e.g., April–May)
- Allow 4–6 weeks from application before conducting site preparation burn.

Application Guidelines

- Aerial: Apply the recommended rates in 10 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 25 gallons total spray solution per acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established, denser/taller vegetation.

When to Adjust Prescription

- Increase hexazinone rate on clay soils, decrease rate on sandy soils. See label.

Prescription Weakness

- Crop tolerance is low, sufficient time must pass prior to planting.
- Relative cost is much higher than other available treatments.

Cost per acre:	$$$$$
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★
Broadleaf Control:	★★½
Woody Control:	★★★
Vine Control:	★★★
Effective Speed:	★★
Control Duration:	★★★★
Hard to Control:	★★★
Crop Tolerance:	★
Resistant Species:	★★★
Natural Pine Control:	★★
Restrictions:	★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Vegetative Control: Several species of each plant type are resistant to this treatment.
- Cost: This treatment is cost prohibitive, unless specific reason for applying.

References

- Ezell AW. Herbicide Use for Management of Shortleaf Pine. The Shortleaf Pine Initiative.
- Herbicide labels for brands listed.

Texas A&M Forest Service | UofA Division of Agriculture Research & Extension, University of Arkansas System | Arkansas Forestry Commission | Louisiana Tech University | LSU AgCenter

Imazapyr (0.75 pounds a.e./acre), Glyphosate (5.0 pounds a.e./acre), and Sulfometuron Methyl (0.08 pounds a.e./acre)

GENERAL USE
TANK MIX

OPERATION:
Site Preparation

CROP SPECIES:
Loblolly Pine

SITE CONDITIONS:
Cutover or Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Winter Planting with Bare Root Stock

APPLICATION TIMING:
Late Growing Season

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
Natural Pine

This herbicide prescription is to be used with the traditional winter planting stand establishment method. This protocol is designed to provide herbaceous weed/grass control (HWC) for the following growing season and remove the need for a follow-up herbaceous weed control application.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
24 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
48 ounces	Chopper Gen 2, Polaris SP, Rotary 2SL

Glyphosate (vol./ac.)	List of Available Products
4.7 quarts	Touchdown Total
5.0 quarts	Accord XRT II, Rodeo, Glyphosate 5.4
5.4 quarts	Roundup Pro Concentrate
6.7 quarts	Touchdown Pro, Glyphosate 4 Plus

Sulfometuron (vol./ac.)	List of Available Products
3 ounces	Oust XP, Spyder, SFM 75

Adjuvant:

- Use 1% volume-to-volume methylated seed oil (MSO). If controlling natural pine increase MSO to 2.5%.
- Or use 0.25–1% (typical 0.5%) volume-to-volume nonionic surfactant.

Timing

- Apply in late-growing season prior to onset of dormancy.

Application Guidelines

- Aerial: Apply the recommended rates in 10–15 gallons total spray solution per acre. 15 GPA minimum for natural pine.
- Ground: Apply the recommended rates in 25 gallons total spray solution per acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with established, denser/ taller vegetation.

When to Adjust Prescription

- If need to control *Rubus* species (blackberry) and other brush then add 1 ounce per acre Escort XP to mix.
- Rates of imazapyr may be reduced to 0.63 pounds a.e./acre (e.g., 40 ounce Chopper Gen2) when low numbers of oak, hickory, or waxy-leaf species are present.

Cost per acre:	$$
Overall Performance:	★★★★
Itemized Performance	
Grass Control:	★★★★
Broadleaf Control:	★★★★
Woody Control:	★★★★
Vine Control:	★★★★
Effective Speed:	★★★★
Control Duration:	★★★★
Hard to Control:	★★★
Crop Tolerance:	★★★
Resistant Species:	★★★★
Natural Pine Control:	★★★
Restrictions:	★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Natural Pine Control: Excellent as long as seedlings are not shielded by other vegetation (15 gpa total aerial spray volume required).
- Restrictions: Soils with pH above 6.3 do not apply Oust Extra. See label
- Hard to Control: May not adequately control waxy-leaf woody plants (e.g., yaupon). Consider the Imazapyr and Triclopyr prescription as an alternative

References

- Herbicide labels for brands listed.

Imazapyr (0.75 pounds a.e./acre), Glyphosate (5.0 pounds a.e./acre), and Sulfometuron Methyl plus Metsulfuron Methyl (premix at 0.13 pounds a.e./acre)

GENERAL USE
PREMIX / TANK MIX

OPERATION:
Site Preparation

CROP SPECIES:
Loblolly Pine

SITE CONDITIONS:
Cutover or Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Winter Planting with Bare Root Stock

APPLICATION TIMING:
Late Growing Season

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
Brambles

This herbicide prescription is to be used with the traditional winter planting stand establishment method. This protocol is designed to provide herbaceous weed/grass control (HWC) for the following growing season and remove the need for a follow-up herbaceous weed control application.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
24 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
48 ounces	Chopper Gen2, Polaris SP, Rotary 2SL

Glyphosate (vol./ac.)	List of Available Products
4.7 quarts	Touchdown Total
5.0 quarts	Accord XRT II, Rodeo, Glyphosate 5.4
5.4 quarts	Roundup Pro Concentrate
6.7 quarts	Touchdown Pro, Glyphosate 4 Plus

Sulfometuron + Metsulfuron (vol./ac.)	List of Available Products
4 ounces	Oust Extra, Spyder Extra, SFM Extra

Adjuvant

- Use 1% volume-to-volume methylated seed oil (MSO).
- Or use 0.25–1% (typical 0.5%) volume-to-volume nonionic surfactant.
- Do not use surfactant containing acetic acid. See label.

Timing

- Apply in late-growing season prior to onset of dormancy.
- Allow 4–6 weeks from application before conducting site preparation burn.

Application Guidelines

- Aerial: Apply the recommended rates in 10 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 25 gallons total spray solution per acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established vegetation.

When to Adjust Prescription

- Rates of imazapyr may be reduced to 0.63 pounds a.e. per acre (e.g., 40 ounce Chopper Gen2) when low numbers of oak, hickory, or waxy-leaf species are present.

Cost per acre:	$$
Overall Performance:	★★★★
Itemized Performance	
Grass Control:	★★★★
Broadleaf Control:	★★★★
Woody Control:	★★★★
Vine Control:	★★★★
Effective Speed:	★★★★
Control Duration:	★★★★
Hard to Control:	★★★★
Crop Tolerance:	★★★
Resistant Species:	★★★★
Natural Pine Control:	★★★
Restrictions:	★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Hard to control: Polaris SP is the recommended imazapyr product to use on waxy-leaf species, increase to 48 oz.
- Restrictions: Soils with pH above 6.3 do not apply Oust Extra. See label.

References

- Herbicide labels for brands listed.

Texas A&M Forest Service | University of Arkansas Division of Agriculture Research & Extension | Arkansas Forestry Commission | Louisiana Tech University | LSU AgCenter

Imazapyr (0.75 pounds a.e./acre), Glyphosate (4.0 pounds a.e./acre) and Saflufenacil (0.05 pounds a.e./acre)

GENERAL USE
TANK MIX

OPERATION:
Site Preparation

CROP SPECIES:
Loblolly Pine

SITE CONDITIONS:
Cutover or Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Traditional Winter Planting

APPLICATION TIMING:
Late Growing Season

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
Natural pine

This site preparation prescription is used with the traditional winter planting stand establishment method in which competition from natural pine IS a primary goal for control. This prescription is a late-growing season application. It may require a follow-up release application for adequate herbaceous weed control in the first growing season. Release option can be found in the RELEASE prescription section.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
24 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
48 ounces	Chopper Gen2, Polaris SP, Rotary 2SL

Glyphosate (vol./ac.)	List of Available Products
3.6 quarts	Roundup Pro Max, Touchdown Total
4.0 quarts	Accord XRT II, Rodeo, Glyphosate 5.4, Roundup Custom
4.3 quarts	Roundup Pro Concentrate
5.3 quarts	Touchdown Pro, Glyphosate 4Plus

Saflufenacil (vol./ac.)	List of Available Products
2 ounces	Detail X

Adjuvant:
- Use 2.5% volume-to-volume methylated seed oil (MSO).

Timing
- Apply in late-growing season prior to onset of dormancy.
- Allow 4–6 weeks from application before conducting site preparation burn.

Application Guidelines
- Aerial: Apply the recommended rates in 15 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 25 gallons total spray solution per acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established, denser/taller vegetation.

When to Adjust Prescription
- Rates of imazapyr may be reduced to 0.63 pounds a.e. per acre (e.g., 40 ounce Chopper Gen2) when low numbers of oak, hickory, or waxy-leaf species are present.

Cost per acre:	$$
Overall Performance:	★★★★
Itemized Performance	
Grass Control:	★★★★
Broadleaf Control:	★★★★
Woody Control:	★★★★
Vine Control:	★★★★
Effective Speed:	★★★★
Control Duration:	★★★★
Hard to Control:	★★★
Crop Tolerance:	★★★
Resistant Species:	★★★★
Natural Pine Control:	★★★★
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:
- Natural Pine Control: Excellent as long as seedlings are not shielded by other vegetation (15 gpa total aerial spray volume required).
- Effective Speed: Will provide rapid burn-down of vegetation.
- Hard to Control: Chopper Gen 2 is the recommended imazapyr product to use on waxy-leaf species.

References

- Herbicide labels for brands listed.

Hexazinone (3.0 pounds a.e./acre) and Sulfometuron Methyl plus Metsulfuron Methyl (premix at 0.13 pounds a.e./acre)

PREMIX / TANK MIX

OPERATION:
Site Preparation

CROP SPECIES:
Loblolly Pine

SITE CONDITIONS:
Cutover or Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Traditional Winter Planting

APPLICATION TIMING:
Early Growing Season

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
High Density of Oak and Hickory

This prescription is not commonly used for pine site preparation, but is available for the winter planting stand establishment method, where adequate time is available between site preparation application and planting date. It is to be used as an April–May application, where there is a high density of oak and hickory species present.

Applied Rate by Products

Hexazinone (vol./ac.)	List of Available Products
1.25 gallons	Velossa
1.5 gallons	Velpar L
Sulfometuron + Metsulfuron Premix (vol./ac.)	**List of Available Products**
4 ounces	Oust Extra, Spyder Extra, SFM Extra

⚠ Hexazinone is highly sensitive to soil texture. Carefully follow label.

Adjuvant
- Use 0.25–1% (typical 0.5%) volume-to-volume nonionic surfactant.

Timing
- Apply in early growing season.
- Allow two full growth flushes after application before conducting site preparation burn.

Application Guidelines
- Aerial: Apply the recommended rates in at least 5 gallons total spray solution per acre.
- Ground: Apply the recommended rates in at least 25 gallons total spray solution per acre for mechanical ground spray.
- Higher spray volumes required on site with more established, denser, and taller vegetation.

When to Adjust Prescription
- Increase hexazinone rate on clay soils, decrease rate on sandy soils. See label.

Prescription Weakness
- Requires rainfall after application.
- Relative cost is high.

Cost per acre:	$$$$$
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★½
Woody Control:	★★½
Vine Control:	★★★
Effective Speed:	★★
Control Duration:	★★★★
Hard to Control:	★★★★
Crop Tolerance:	★★★
Resistant Species:	★★★
Natural Pine Control:	★
Restrictions:	★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:
- Broadleaf Control: provides excellent broadleaf control.
- Relative cost is prohibitive, unless specific reason for making application.

References
- Herbicide labels for brands listed.

Texas A&M Forest Service | University of Arkansas Division of Agriculture Research & Extension | Louisiana Tech University | LSU AgCenter

Glyphosate (5.0 pounds a.e./acre) and Triclopyr (3.15 pounds a.e./acre – ester)

GENERAL USE / TANK MIX

OPERATION:
Site Preparation

CROP SPECIES:
Loblolly, Longleaf, Shortleaf, Slash Pine

SITE CONDITIONS:
Cutover or Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Fall Planting with Containerized Stock

APPLICATION TIMING:
Late Growing Season

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
Waxy-leaf Species, Natural Pine

This prescription is used with the fall planting stand establishment method in which competition from natural pine IS an issue. This foliar applied prescription is a mid to late growing season application where soil-active herbicides cannot be applied due to proximity to planting concerns and potential crop-tree damage. Foliar coverage is essential to prescription effectiveness. This prescription may require a follow-up release application for adequate herbaceous weed control in the first growing season. Release option can be found in the RELEASE prescription section.

Applied Rate by Products

Glyphosate (vol./ac.)	List of Available Products
4.7 quarts	Touchdown Total
5.0 quarts	Accord XRT II, Rodeo, Gyphosate 5.4, Roundup Custom
5.4 quarts	Roundup Pro Concentrate
6.7 quarts	Touchdown Pro, Glyphosate 4 Plus

Triclopyr (vol./ac.)	List of Available Products
2.0 quarts	Garlon XRT, Boulder 6.3
3.2 quarts	Garlon 4 Ultra, Element 4, Relegate, Triclopyr 4, Tahoe 4E

Adjuvant

- Use 1–2% volume-to-volume methylated seed oil (MSO).

Timing

- Apply late growing season and allow 30 days before planting.
- Allow 4–6 weeks from application before conducting site preparation burn.

Application Guidelines

- Aerial: Apply the recommended rates in 15 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 25 gallons total spray solution per acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established, denser/ taller vegetation.

When to Adjust Prescription

- If site contains dense woody species, postponing planting one year may be desired to allow time for a better suited site preparation application the following spring.

Cost per acre:	$$$
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★★
Woody Control:	★★½
Vine Control:	★★★★
Effective Speed:	★★★★
Control Duration:	★
Hard to Control:	★★★★
Crop Tolerance:	★★★★
Resistant Species:	★★
Natural Pine Control:	★★★★
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Control Duration: Soil activity is limited and residual efficacy will be low.
- Resistant Species: Black cherry and some hickories will exhibit some resistance to this treatment.

References

- Herbicide labels for brands listed.

Imazapyr (0.75 pounds a.e./acre) and Glyphosate (5.0 pounds a.e./acre)

GENERAL USE / TANK MIX

OPERATION:
Site Preparation

CROP SPECIES:
Loblolly Pine

SITE CONDITIONS:
Cutover or Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Fall Planting with Containerized Stock

APPLICATION TIMING:
Early to Mid Growing Season

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
Natural Pine

This site preparation prescription is used with the fall planting stand establishment method. This prescription is an early to mid growing season application with minimum required woody plant heights of 2–3 feet. This establishment method may require a follow-up release application for adequate herbaceous weed control in the first growing season after planting. Release options can be found in the RELEASE prescription section.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
24 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
48 ounces	Chopper Gen2, Polaris SP, Rotary 2SL

Glyphosate (vol./ac.)	List of Available Products
4.7 quarts	Touchdown Total
5.0 quarts	Accord XRT II, Rodeo, Glyphosate 5.4, Roundup Custom
5.4 quarts	Roundup Pro Concentrate
6.7 quarts	Touchdown Pro, Glyphosate 4 Plus

Adjuvant

- Use 0.25–1% (typical 0.5%) volume-to-volume nonionic surfactant.

Timing

- Early mid growing season for fall planting is strongly recommended for this prescription.
- For optimal seedling growth, wait a minimum 60 days before planting following a 0.75 pounds a.e per acre imazapyr application…increased significance under dry conditions.
- Allow 4–6 weeks from application before conducting site preparation burn.

Application Guidelines

- Aerial: Apply the recommended rates in 10–15 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 25 gallons total spray solution per acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established vegetation and when targeting natural pine.

When to Adjust Prescription

- If need to control *Rubus* species (blackberry) and other brush then add 1 ounce per acre Escort XP to mix. Or, consider imazapyr plus triclopyr prescription.

Cost ($ per acre):	$$
Overall Performance:	★★★★
Itemized Performance	
Grass Control:	★★★★
Broadleaf Control:	★★★★
Woody Control:	★★★★
Vine Control:	★★★★
Effective Speed:	★★★★
Control Duration:	★★★
Hard to Control:	★★★
Crop Tolerance:	★★★
Resistant Species:	★★★★
Natural Pine Control:	★★★
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Natural Pine Control: Excellent as long as seedlings are not shielded by other vegetation (15 gpa total aerial spray volume required).
- Hard to Control: Chopper Gen2 is the recommended imazapyr product to use on waxy-leaf species.

References

- Herbicide labels for brands listed.

Imazapyr (0.75 pounds a.e./acre) and Triclopyr (2.0 pounds a.e./acre – ester)

GENERAL USE / TANK MIX

OPERATION:
Site Preparation

CROP SPECIES:
Loblolly Pine

SITE CONDITIONS:
Cutover or Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Fall Planting with Containerized Stock

APPLICATION TIMING:
Early to Mid Growing Season

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
Waxy-leaf, Brambles

This site preparation prescription is used with the fall planting stand establishment method in which competition from waxy-leaf species are a concern. This prescription is an early- to mid-growing season application with minimum required woody plant heights of 2–3 feet. This prescription may require a follow-up release application for adequate herbaceous weed control in the first growing season after planting. Release option can be found in the RELEASE prescription section.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
24 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
48 ounces	Polaris SP, Chopper Gen2, Rotary 2SL

Triclopyr (vol./ac.)	List of Available Products
1.3 quarts	Garlon XRT, Boulder 6.3,
2.0 quarts	Garlon 4 Ultra, Element 4, Relegate, Triclopyr 4, Tahoe 4E

⚠ Do not mix imazapyr with an amine formulation of triclopyr

Adjuvant

- Use 1–2% volume-to-volume methylated seed oil (MSO)
- Or use 0.25–1% (typical 0.5%) volume-to-volume nonionic surfactant.

Timing

- Early mid growing season for fall planting is strongly recommended for this prescription. Mid growing season treatment (e.g., late July) provides best results on waxy-leaf species.
- Allow 4–6 weeks from application before conducting site preparation burn.

Application Guidelines

- Aerial: Apply the recommended rates in 10–15 gallons total spray solution/acre.
- Ground: Apply the recommended rates in 25 gallons total spray solution per acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established vegetation.
- Triclopyr at higher application rates may reduce imazapyr efficacy.

Prescription Weakness

- This prescription may be slow to respond on some species, following treatment application.

Cost per acre:	$$
Overall Performance:	★★★½
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★★
Woody Control:	★★★★
Vine Control:	★★★★
Effective Speed:	★★★
Control Duration:	★★★
Hard to Control:	★★★★
Crop Tolerance:	★★★
Resistant Species:	★★★
Natural Pine Control:	★
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Grass Control: Triclopyr does not provide grass control.
- Brambles: Triclopyr will provide bramble (*Rubus*) control.
- Hard to Control: Chopper Gen2 is the recommended imazapyr product to use on waxy-leaf species.

References

- Herbicide labels for brands listed.

Imazapyr (0.75 pounds a.e./acre), Glyphosate (4.0 pounds a.e./acre) and Saflufenacil (0.05 pounds a.e./acre)

GENERAL USE
TANK MIX

OPERATION:
Site Preparation

CROP SPECIES:
Loblolly Pine

SITE CONDITIONS:
Cutover or Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Fall Planting with Containerized Stock

APPLICATION TIMING:
Early to Mid Growing Season

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
Natural Pine

This site preparation prescription is used with the fall planting stand establishment method in which competition from natural pine IS a primary goal for control. This prescription is an early- to mid-growing season application with minimum required woody plant heights of 2–3 feet. It may require a follow-up release application for adequate herbaceous weed control in the first growing season. Release option can be found in the RELEASE prescription section.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
24 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
48 ounces	Chopper Gen2, Polaris SP, Rotary 2SL

Glyphosate (vol./ac.)	List of Available Products
3.6 quarts	Roundup Pro Mac, Touchdown Total
4.0 quarts	Accord XRT II, Rodeo, Glyphosate 5.4, Roundup Custom
4.3 quarts	Roundup Pro Concentrate
5.3 quarts	Touchdown Pro, Glyphosate 4 Plus

Saflufenacil (vol./ac.)	List of Available Products
2 ounces	Detail

Adjuvant:

- Use 2.5% volume-to-volume methylated seed oil (MSO).

Timing

- Early to mid growing season for fall planting is strongly recommended for this prescription.
- For optimal growth, wait a minimum 60 days before planting following a 0.75 pounds a.e per acre imazapyr application especially under dry conditions.
- Allow 4–6 weeks from application before conducting site preparation burn.

Application Guidelines

- Aerial: Apply the recommended rates in 15 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 25 gallons total spray solution per acre for mechanical ground spray and backpack applications.

When to Adjust Prescription

- If need to control R*ubus* species (blackberry) and other brush then add 1 ounce per acre Escort XP to mix.

Cost per acre:	$$
Overall Performance:	★★★★
Itemized Performance	
Grass Control:	★★★★
Broadleaf Control:	★★★★
Woody Control:	★★★★
Vine Control:	★★★★
Effective Speed:	★★★★
Control Duration:	★★★
Hard to Control:	★★★
Crop Tolerance:	★★★
Resistant Species:	★★★★
Natural Pine Control:	★★★★
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Natural pine: Provides good control of natural pine.
- Effective Speed: Provides rapid burn-down of vegetation.
- Hard to Control: Chopper Gen2 is the recommended imazapyr product to use on waxy-leaf species.

References

- Herbicide labels for brands listed.

Texas A&M Forest Service | UofA Division of Agriculture Research & Extension University of Arkansas System | Arkansas Forestry Commission | Louisiana Tech University | LSU AgCenter

Glyphosate (6.0 pounds a.e./acre) and Sulfometuron Methyl plus Metsulfuron Methyl (premix at 0.13 pounds a.e./acre)

GENERAL USE
TANK MIX

OPERATION:
Site Preparation

CROP SPECIES:
Loblolly Pine

SITE CONDITIONS:
Cutover or Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Fall Planting with Containerized Stock

APPLICATION TIMING:
Late Growing Season

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
Vines,
Natural Pine

This prescription is used with the fall planting stand establishment method. This prescription is a late-growing season application where other soil-active herbicides cannot be applied due to proximity to planting concerns and potential impact on crop tree growth. This prescription may not completely control woody competition.

Applied Rate by Products

Glyphosate (vol./ac.)	List of Available Products
5.3 quarts	Roundup Promax
5.7 quarts	Touchdown Total
6.0 quarts	Accord XRT II, Rodeo, Glyphosate 5.4, Roundup Custom
6.5 quarts	Roundup Pro Concentrate
8.0 quarts	Touchdown Pro, Glyphosate 4 Plus

Metsulfuron (vol./ac.)	List of Available Products
4 ounces	Oust Extra, Spyder Extra, SFM Extra

⚠ If site contains dense woody species, postponing planting one year may be desired to allow time for a better suited site preparation application the following spring.

Adjuvant
- Use 1–2% volume-to-volume methylated seed oil (MSO).
- Do not use surfactant containing acetic acid. See label.

Timing
- Apply late growing season.
- Allow 4–6 weeks from application before conducting site preparation burn.

Application Guidelines
- Aerial: Apply the recommended rates in 15 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 25 gallons total spray solution per acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established, denser/taller vegetation.

Prescription Weakness
- Does not provide long-term grass control.

Cost per acre:	$
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★★
Woody Control:	★★½
Vine Control:	★★★★
Effective Speed:	★★★
Control Duration:	★★★
Hard to Control:	★★★
Crop Tolerance:	★★★★
Resistant Species:	★★½
Natural Pine Control:	★★★
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:
- Resistant Species: suppresses hickory species, but not complete control.

References
- Herbicide labels for brands listed.

Imazapyr (0.75 pounds a.e./acre) and Metsulfuron Methyl (0.12 pounds a.e./acre)

GENERAL USE / TANK MIX

OPERATION:
Site Preparation

CROP SPECIES:
Loblolly Pine

SITE CONDITIONS:
Cutover or Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Fall Planting with Containerized Stock

APPLICATION TIMING:
Early to Mid Growing Season

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
None

This prescription is used with the fall planting stand establishment method in which competition from natural pine IS NOT an issue. This prescription is an early to mid growing season application with desired woody plant heights of 2-3 feet. This establishment method may require a follow-up release application for adequate herbaceous weed control in the first growing season after planting. Release options can be found in the RELEASE prescription section.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
24 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
48 ounces	Chopper Gen2, Polaris SP, Rotary 2SL

Metsulfuron (vol./ac.)	List of Available Products
2 ounces	Escort XP, MSM 60, Patriot

Adjuvant

- Use 0.25–1% (typical 0.5%) volume-to-volume nonionic surfactant.
- Do not use surfactant containing acetic acid. See label.

Timing

- Early to mid growing season for fall planting is strongly recommended for this prescription.
- For optimal growth, wait a minimum 60 days before planting following a 0.75 pounds a.e. per acre imazapyr application especially under dry conditions.
- Allow 4–6 weeks from application before conducting site preparation burn.

Application Guidelines

- Aerial: Apply the recommended rates in 10 gallon total spray solution per acre.
- Ground: Apply the recommended rates in 25 gallons total spray solution per acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established, denser/taller vegetation.

When to Adjust Prescription

- If waxy-leaf species are present, use Chopper Gen2 or use an Rx with triclopyr.

Prescription Weakness

- Effective speed will be slow.

Cost per acre:	$
Overall Performance:	★★★½
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★★
Woody Control:	★★★
Vine Control:	★★★★
Effective Speed:	★★
Control Duration:	★★★★
Hard to Control:	★★★
Crop Tolerance:	★★★
Resistant Species:	★★★★
Natural Pine Control:	★
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

References

- Herbicide labels for brands listed.

Activity: Site Preparation
Crop Species: Oak

Site Preparation for Oak Species

Controlling competing vegetation during site preparation is an important operation to successfully establish oak seedlings. However, not all sites and scenarios will require chemical site preparation to successfully establish oak seedlings. Managers should conduct an evaluation of site conditions before choosing to perform chemical site preparation to establish oaks. Often, only a presence of substantial levels of woody species and/or vines will warrant chemical site preparation in the oak establishment scenario. Most grasses and broadleaf competition will be better controlled through herbaceous weed control applications conducted after crop trees have been planted. The exception to this rule would the presence of a difficult-to-control species (such as bermudagrass), which would be better controlled during site preparation.

Chemical site preparation applications for oak establishment are very different from chemical site preparation designed for pine establishment. The activity of the herbicide must be considered. For example, foliar-active-only herbicides (e.g. glyphosate) may be applied late into the fall prior to planting. However, soil-active herbicides (e.g., imazapyr) that will exhibit high length of control ratings require caution and planning for proper timing. Most soil-active site preparation herbicides should be avoided altogether, as their purpose is to control hardwood species. This manual only presents glyphosate, imazapyr or a tank mix of the two for oak establishment site preparation. Imazapyr can only be included when OAKS are the only crop species to be planted. Furthermore, timing requirements from the proper imazapyr labels must be followed specifically to avoid oak crop injury. Finally, if only a foliar-active herbicide is employed for site preparation, herbaceous weed control will be a necessary application for the following growing season.

Table 6. Commonly-used herbicides for hardwood plantation site preparation.

Herbicide	Products	Time of Year	Target	Resistant (at typical rates)
clopyralid	Transline, Clean Slate	Anytime during the growing season. Preferred when weeds are small and actively growing.	Certain broadleaf weeds including thistle, kudzu, sicklepod, morning glory, ragweed, coffee weed and most legume species including redbud and mimosa.	Most established grasses and woody plants
Imazapyr*	Chopper Gen2, Polaris SP	August	Most hardwoods, annual and perennial grasses and forbs, Bermuda, fescue, crabgrass, dog fennel, pigweed, greenbrier.	Elms, woody legumes, wax myrtle, croton, blackberry, buckeye, baccharis, hickory, pine
glyphosate	Accord XRT II, Rodeo, Roundup Pro Concentrate	Prior to planting, active growth following full leaf expansion.	Most hardwoods (black locust, persimmon, sassafras, sumac, sweetgum, yellow-poplar), southern pine, most annual and perennial grasses and forbs.	Red maple, blackgum, hickory, dogwood, greenbrier, Virginia creeper, trumpet creeper
metsulfuron methyl	Escort XP, Patriot	During periods of active growth following full leaf expansion.	Wide range of annual and perennial broadleaf weeds and woody plants, kudzu, multiflora rose.	Most grasses, yellow poplar
sulfometuron methyl	Oust XP, Spyder	Early spring, before herbaceous weeds emerge or shortly thereafter. Can also be applied in fall prior to planting.	Annual grasses and forbs and certain perennial herbs.	Bermuda, broomsedge, croton, trumpet creeper, panicums

*imazapyr is a soil active herbicide. Therefor timing of application is critical to avoid crop tree injury.

Imazapyr (0.5 pounds a.e./acre), and Glyphosate (3.0 pounds a.e./acre)

GENERAL USE / TANK MIX

OPERATION:
Site Preparation

CROP SPECIES:
Oaks Only!

SITE CONDITIONS:
Old Field or Cutover Sites

ESTABLISHMENT PROTOCOL:
February Planting with 1-0 Bare Root Seedlings

APPLICATION TIMING:
August

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
Broomsedge, Vines, Woody, Competition

This herbicide prescription is to be used in recent clearcuts or old-field settings. Only use when target competition control is in the vines and/or woody vegetation groups and is significant. This site preparation prescription is to be used strictly as an August application and requires a site preparation addition or follow-up release application for extended herbaceous weed control through the first growing season.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
32 ounces	Chopper Gen2, Polaris SP, Rotary 2SL

Glyphosate (vol./ac.)	List of Available Products
3.0 quarts	Accord XRT II, Rodeo, Touchdown Total, Glyphosate 5.4
4.0 quarts	Roundup Pro, Touchdown, Glyphosate 4 Plus

Adjuvant

- Use 0.25–1% (typical 0.5%) volume-to-volume nonionic surfactant.

Timing

- Strictly adhere to July–August application.
- Plant 1–0 bareroot seedlings in February

Application Guidelines

- Aerial: Apply the recommended rates in 10 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 20 gallons total spray solution per acre for mechanical ground spray and backpack applications.
- Apply sufficient volume to ensure thorough and uniform coverage.

When to Adjust Prescription

- If natural pine competition is present, increase glyphosate rate to 5 quarts/acre.
- If site does not flood and stay wet, Oust XP (or equivalent) at 3 ounces per acre can be added.

Prescription Weakness

- This application will control most competition types present at the time of application; however, the existing seed bank (concern in old fields) will re-establish herbaceous plants sometime in the following growing season, if no additional HWC incorporated.

Cost per acre:	$
Overall Performance:	★★★½
Itemized Performance	
Grass Control:	★★★★
Broadleaf Control:	★★★★
Woody Control:	★★★★
Vine Control:	★★★★
Effective Speed:	★★★★
Control Duration:	★★★
Hard to Control:	★★★
Crop Tolerance:	★
Resistant Species:	★★★
Natural Pine Control:	★★
Restrictions:	★★★★

Fewer **$** symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Crop tolerance is low, but fine to plant oak seedlings in February.
- Woody Control: If woody vegetation abundance is light, skip this application and focus on herbaceous weed control at planting.
- Vine Control: Site Preparation will be the only time to control most vines if oaks will be planted.

References

- Herbicide labels for brands listed.

Glyphosate (4.0 pounds a.e./acre)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Site Preparation

CROP SPECIES:
Oaks

SITE CONDITIONS:
Old Field or Cutover Sites

ESTABLISHMENT PROTOCOL:
Dormant Season Planting with 1-0 Bare Root Seedlings

APPLICATION TIMING:
Late Growing Season

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
Broomsedge, Vines and/or Woody Competition

This herbicide prescription is to be used in recent clearcuts or old field settings. Only use when competition control from vines and/or woody vegetation groups exists and is significant. This site preparation prescription is designed to allow a longer application period in the fall prior to planting and REQUIRES a site prep addition or follow-up release application for herbaceous weed control during the first growing season.

Applied Rate by Products

Glyphosate (vol./ac.)	List of Available Products
3.0 quarts	Accord XRT II, Rodeo, Touchdown Total, Glyphosate 5.4
4.0 quarts	Roundup Pro, Touchdown, Glyphosate 4 Plus

Adjuvant

- Use 0.25–1% (typical 0.5%) volume-to-volume nonionic surfactant.

Timing

- Apply August–October.
- Plant 1–0 bare root seedlings in dormant season.

Application Guidelines

- Aerial: Apply the recommended rates in 10 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 20 gallons total spray solution per acre for mechanical ground spray and backpack applications.
- Apply sufficient volume to ensure thorough and uniform coverage.

When to Adjust Prescription

- If cut-over site or natural pine competition is present, increase glyphosate rate to 5.0 quarts per acre.
- If site does not flood and stay wet, Oust XP (or equivalent) at 3 ounces per acre can be added.

Prescription Weakness

- Herbaceous competition will be intense in the growing season after planting.
- Seedling mortality potential will be high, if no additional HWC incorporated.

Cost per acre:	$
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★
Woody Control:	★★★
Vine Control:	★★★
Effective Speed:	★★★★
Control Duration:	★
Hard to Control:	★★★
Crop Tolerance:	★★★★
Resistant Species:	★★★
Natural Pine Control:	★★
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Crop Tolerance: high after treatment application is completed.
- Grass and Broadleaf Control: high immediately following application, but will return aggressively in next growing season.

References

- Herbicide labels for brands listed.

Imazapyr (0.5 pounds a.e./acre)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Site Preparation

CROP SPECIES:
Oaks Only!

SITE CONDITIONS:
Cutover or Old Field

ESTABLISHMENT PROTOCOL:
February Planting with 1-0 Bare Root Seedlings

APPLICATION TIMING:
August

APPLICATION TYPE:
Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
Vines and Woody Species

This herbicide prescription is to be used in clearcuts or old field settings, where oak species are scheduled to be planted. Only use when competition is significant in the vines and/or woody vegetation groups. This site preparation prescription is to be used strictly as an August application and requires a follow-up release application for adequate herbaceous weed control in the first growing season.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
32 ounces	Chopper Gen2, Polaris SP, Rotary 2SL

Adjuvant

- Use 0.25–1% (typical 0.5%) volume-to-volume nonionic surfactant.

Timing

- Strictly adhere to July–August application.
- Plant 1–0 bareroot seedlings in February.

Application Guidelines

- Aerial: Apply the recommended rates in 10 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 20 gallons total spray solution per acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established, denser/ taller vegetation.
- Apply sufficient volume to ensure thorough and uniform coverage.

When to Adjust Prescription

- none

Prescription Weakness

- Will control competition present at the time of application; however, the existing seed bank (concern in old fields) will re-establish herbaceous plants sometime in the following growing season, if no additional HWC incorporated.

Cost per acre:	¢¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★
Woody Control:	★★★
Vine Control:	★★★
Effective Speed:	★★★
Control Duration:	★★★
Hard to Control:	★★★
Crop Tolerance:	★
Resistant Species:	★★★
Natural Pine Control:	none
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Overall Performance: This protocol provides good control with a single chemical, but would be enhanced with a tank mix partner herbicide.

References

- Herbicide labels for brands listed.

Activity: Release – Herbaceous Weed Control
Crop Species: Pine

Herbaceous Weed Control

Herbaceous weed control (HWC) often is an essential step that may determine the difference between a successful or an unsuccessful planting. HWC is designed to control grasses and broadleaf plants into the growing season following planting. HWC will often be necessary even if adequate site preparation has been conducted. An evaluation of competition that will exist in the first growing season is beneficial in determining the need or type of treatment needed.

HWC can be either a single-product or tank-mix application. However, the available herbicides and application rates are often greatly reduced compared to possible site preparation rates. Subsequently, users will notice a reduction in many of the rating values for HWC treatments.

HWC weed control may be applied at three key timings during stand establishment:

1. Fall site preparation addition: Fall site prep additions are typically soil active herbicides added to a site prep tank mix in the late growing season prior to planting. Generally, these will include sulfometuron methyl and/or metsulfuron methyl.
2. Pre-emergent: Pre-emergent applications will be made near the planting date and prior to any green-up. Pre-emergent applications are conducted with soil-active herbicides.
3. Post-emergent: Post emergent HWC is feasible; however, rates are usually reduced and timing of application can increase in significance. An evaluation of existing competition and crop species will always benefit a HWC application.

Table 7. Commonly-used herbicides for early conifer release.

Active Ingredient	Products	Time of Year	Target	Resistant
imazapyr	Arsenal AC, Polaris AC	Late in second growing season following planting. Broadcast foliar application or directed foliar.	Many hardwoods, annual and perennial grasses and forbs, Bermuda, fescue, crabgrass, dog fennel, pigweed, greenbriar, morning glory.	Elms, woody legumes, wax myrtle, croton, blackberry, buckeye, baccharis, hickory, pine
glyphosate	Accord XRT, Rodeo, Roundup Pro Concentrate	Later summer or early fall, after formation of final conifer resting bud. Broadcast foliar application.	Many hardwoods (black locust, persimmon, sassafras, sumac, sweetgum, yellow-poplar), most annual and perennial grasses and forbs.	Red maple, blackgum, hickory, dogwood, greenbrier, Virginia creeper, trumpet creeper
metsulfuron methyl	Escort XP, Patriot	Active growth following full leaf expansion. Herbaceous weeds: apply pre-emergence or shortly thereafter. Broadcast foliar application.	Wide range of annual and perennial broadleaf weeds and woody plants, kudzu, multiflora rose.	Some grasses, yellow poplar
sulfometuron methyl	Oust XP, Spyder, SFM 75	Dormant season prior to conifer bud break. Broadcast foliar spray for herbaceous weed control.	Annual grasses and forbs and certain perennial herbs.	Bermuda, broomsedge, croton, trumper creeper, Johnsongrass, panicums
sulfometuron methyl + metsulfuron methyl	Oust Extra, Spyder Extra, SFM Extra	Active growth following full leaf expansion. Herbaceous weeds: apply pre-emergence or shortly thereafter. Broadcast foliar spray, loblolly pine only.	Various woody plants, vines and herbaceous weeds including blackberry. Suppression of bermudagrass and Johnsongrass	Conifers somewhat
triclopyr	Vastlan, Element 3A, Tahoe 3A, Element 4, Garlon 4 Ultra, Tahoe 4E, Garlon XRT	During periods of active growth. Directed spray application only.	Many hardwoods, vines, and broadleaf weeds such as dog fennel, pigweed, greenbrier, morning glory, sericea lespedeza.	Persimmon, black cherry, sumac, some oaks and hickories
aminopyralid	Milestone	Spring to late summer: broadcast foliar overtop only on longleaf. Do not use over the top of loblolly or slash pine.	Broadleaf weeds such as blackberry, morning glory; vetch, horseweed, pigweed, sicklepod, ragweed, and wilding pine suppression.	Young longleaf pine
clopyralid	Transline, Clean Slate, Clopyralid 3	Mid to late summer, after conifers have hardened off. Broadcast foliar application made over the top of tolerant tree species or directed spray for broadleaf weed control.	Certain broadleaf weeds including thistle, sicklepod, morning glory, ragweed, coffeeweed, wisteria, kudzu and many legume species	Grasses and many woody plants
hexazinone	Velpar DF, Velossa, Velpar L	Spring after bud break and before full leaf expansion. Broadcast foliar application.	Many hardwoods, blackberry, crabgrass, fescue, lespedeza, horseweed, dog fennel, annual and perennial rye grass	Grasses, yellow-poplar, eastern redcedar, sassafras, blackgum, hollies, American beautyberry, Bermudagrass, white snakeroot, broomsedge, Johnsongrass, sicklepod, trumpet vine

Modified from Colby Lambert, Mark Megalos, James Jeuck. (2016). 2016 Quick Guide to Forestry Herbicides Used for Softwood and Hardwood Site Preparation and Release.

Imazapyr (0.13 pounds a.e./acre) and Sulfometuron Methyl (0.06 pounds a.e./acre)

GENERAL USE / TANK MIX

OPERATION:
Release – Herbaceous Weed Control

CROP SPECIES:
Loblolly, Longleaf, Slash Pine

SITE CONDITIONS:
Old field, Cutover, Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Fall or Winter Planted

APPLICATION TIMING:
Early Growing Season

APPLICATION TYPE:
Band, Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
None

This prescription is recommended for loblolly, longleaf, and slash pine seedlings that were planted in fall or winter establishment method. This prescription is designed for sites that did not receive a pre-emergent HWC application and are experiencing significant competition from herbaceous plants.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
4 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
8 ounces	Rotary 2SL

Sulfometuron (vol./ac.)	List of Available Products
2 ounces	Oust XP, Spyder, SFM 75

⚠ DO NOT apply imazapyr products formulated for site preparation application (e.g., Chopper Gen2) over the top of pines.

Adjuvant
- None

Timing
- Adhere to an early growing season (e.g., March–April) application.

Application Guidelines
- Aerial/Ground: Apply the recommended rates in 5–10 gallons total spray solution per applied acre.

When to Adjust Prescription
- Once seedlings have hardened off during July, imazapyr rate may be increased to 6–8 ounces per applied acre for loblolly pine.
- Do not include sulfometuron methyl in a July treatment.

Prescription Weakness
- Seedlings may experience some brief impact on growth, but will recover quickly.

Cost per acre:	¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★★
Woody Control:	n/a
Vine Control:	n/a
Effective Speed:	★★★
Control Duration:	★★★★
Hard to Control:	★★★
Crop Tolerance:	★★★
Resistant Species:	★★★
Natural Pine Control:	n/a
Restrictions:	★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:
- Hard to Control: Does not control *Rubus* and broomsedge.
- Restrictions: Caution must be taken in areas with high soil pH.

References
- Herbicide labels for brands listed.

Texas A&M Forest Service | UofA Division of Agriculture Research & Extension University of Arkansas System | Arkansas Forestry Commission | Louisiana Tech University | LSU AgCenter

Sulfometuron Methyl (0.09 pounds a.e./acre) and Hexazinone (0.81 pounds a.e./acre)

GENERAL USE / TANK MIX

OPERATION:
Release – Herbaceous Weed Control

CROP SPECIES:
Loblolly, Longleaf, Slash Pine

SITE CONDITIONS:
Old Field, Cutover, Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Fall or Winter Planted

APPLICATION TIMING:
Pre-emergent or Early Growing Season

APPLICATION TYPE:
Band, Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
None

This prescription can be applied to loblolly, longleaf, or slash pine stand establishment sites that did not receive an herbaceous weed control (HWC) tank mix addition during a fall site preparation herbicide application. This herbaceous release is most effective when performed as a pre-emergent application.

Applied Rate by Products

Sulfometuron (vol./ac.)	List of Available Products
3 ounces	Oust XP, Spyder, SFM 75

Hexazinone (vol./ac.)	List of Available Products
40 ounces	Velpar L, Velossa
13 ounces	Velpar DF

⚠ Hexazinone may cause longleaf pine seedling mortality on sandy sites and on sites with low organic matter such as old field sites.
⚠ Do not use Oust when soil pH > 6.2.
⚠ Do not apply if crop pines are under stress.

Adjuvant
- None

Timing
- Apply as a pre-emergent or early-post emergent (e.g., March).

Application Guidelines
- Aerial/Ground: Apply the recommended rates in 5–10 gallon total spray solution per applied acre.
- Apply only during seasons when rainfall is sufficient to activate the herbicide in the soil.

When to Adjust Prescription
- Use 1 fewer ounce of sulfometuron methyl and 8 fewer ounces of hexazinone than listed above for coarse-textured soils and on soils with low organic matter content.
- Refer to the product labels for more information on soil texture and pH.

Cost per acre:	$
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★
Broadleaf Control:	★★★★
Woody Control:	n/a
Vine Control:	n/a
Effective Speed:	★★★
Control Duration:	★★★★
Hard to Control:	★★★
Crop Tolerance:	★★★
Resistant Species:	★★★★
Natural Pine Control:	n/a
Restrictions:	★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:
- Hard to Control: Does not control bermudagrass, broomsedge, some turf grasses, *Rubus* or vines.
- Restrictions: Caution must be taken in areas with high pH.

References

- Minogue P., D.J. Moorhead, E.D. Dickens, revised 2014. Herbaceous weed control recommendations for planted longleaf sites. 7p.
- Moorhead, D.J. 2018. Forest Herbicides in Georgia Pest Management Handbook – 2018. UGA Extension Special Bulletin 28.
- Herbicide labels for brands listed.

Sulfometuron Methyl plus Hexazinone (premix at 0.36 pounds a.e./acre)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Release – Herbaceous Weed Control

CROP SPECIES:
Loblolly, Longleaf, Slash Pine

SITE CONDITIONS:
Old Field, Cutover, Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Fall or Winter Planted

APPLICATION TIMING:
Pre-emergent or Early Growing Season

APPLICATION TYPE:
Band, Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
None

This prescription can be applied to loblolly, longleaf, or slash pine stand establishment sites that did not receive an herbaceous weed control (HWC) tank mix addition during a fall site preparation herbicide application. This herbaceous release is most effective when performed as a pre-emergent application.

Applied Rate by Products

Sulfometuron + Hexazinone (vol./ac.)	List of Available Products
12 ounces	Oustar

⚠ Hexazinone may cause longleaf pine seedling mortality on sandy sites and on sites with low organic matter such as old field sites.

⚠ As a premix, the a.i. of both chemicals is set. Note that hexazinone rate will tend to be too high on sandy and low soil organic matter sites before sulfometuron methyl is effective.

⚠ Do not use Oust when soil pH > 6.2.

Adjuvant

- None

Timing

- Apply as a pre-emergent or early-post emergent (e.g., March).

Application Guidelines

- Aerial/Ground: Apply the recommended rates in 5–10 gallon total spray solution per applied acre.
- Apply only during seasons when rainfall is sufficient to activate the herbicide in the soil.

When to Adjust Prescription

- Rate can be increased based soil texture and vegetation density. Suggested Year 1 weed control application product rates per acre is:
  - 10–12 oz Course textured soils (sand, loamy sand, sandy loam)
  - 12–16 oz Medium textured soils (loam, sandy clay loam, silt loam)
  - 16–19 oz Fine textured soils (clay loam, sandy clay, silty clay loam, silty clay)
- Refer to the label for more information.

Cost per acre:	¢¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★
Broadleaf Control:	★★★★
Woody Control:	n/a
Vine Control:	n/a
Effective Speed:	★★★
Control Duration:	★★★★
Hard to Control:	★★★
Crop Tolerance:	★★★
Resistant Species:	★★★★
Natural Pine Control:	n/a
Restrictions:	★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Hard to Control: Does not control bermudagrass, broomsedge, some turf grasses, *rubus* or vines.
- Restrictions: Caution must be taken in areas with high pH.

References

- Minogue P., D.J. Moorhead, E.D. Dickens, revised 2014. Herbaceous weed control recommendations for planted longleaf sites. 7p.
- Herbicide labels for brands listed.

Imazapyr (0.125 pounds a.e./acre), and Sulfometuron Methyl plus Metsulfuron Methyl (premix at 0.13 pounds a.e./acre)

GENERAL USE
PREMIX/TANK MIX

OPERATION:
Release – Herbaceous Weed Control

CROP SPECIES:
Loblolly Pine

SITE CONDITIONS:
Cutover, Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Fall or Winter Planting

APPLICATION TIMING:
Early Growing Season

APPLICATION TYPE:
Band, Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
None

This prescription can be applied to loblolly pine stand establishment sites that did not receive an herbaceous weed control (HWC) tank mix addition during a fall site preparation herbicide application. This herbaceous release is most effective when performed as a pre-emergent application.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
4 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
8 ounces	Rotary 2SL

Sulfometuron + Metsulfuron (vol./ac.)	List of Available Products
4 ounces	Oust Extra, Spyder Extra, SFM Extra

Adjuvant
none

Timing
- Strictly adhere to an early-growing season application.
- See site preparation section for combining herbaceous weed control with select site preparation applications.

Application Guidelines
- Apply the recommended rates in 5–10 gallon total spray solution per sprayed acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established, denser/taller vegetation such as a recently harvested forest site.

When to Adjust Prescription
- Use higher label rates when applying to clay loam or silty clay loam soils.

Prescription Weakness
- This prescription does not control bermudagrass, and some other turf grasses.

Cost per acre:	¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★★
Woody Control:	n/a
Vine Control:	n/a
Effective Speed:	★★★
Control Duration:	★★★
Hard to Control:	★★
Crop Tolerance:	★★★★
Resistant Species:	★★★
Natural Pine Control:	n/a
Restrictions:	★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:
- Hard to Control: Does not control Broomsedge or turf grasses.
- Restrictions: Caution must be taken in areas with high pH.

References
- Herbicide labels for brands listed.

Imazapyr (0.13 pounds a.e./acre)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Herbaceous Weed Control

CROP SPECIES:
Longleaf Pine

SITE CONDITIONS:
Old Field, Cutover, Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Fall or Winter Planting

APPLICATION TIMING:
Early Growing Season

APPLICATION TYPE:
Band, Aerial or Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
None

This prescription, applied during the spring following planting longleaf is critical to growth and survival in droughty years. HWC in general can increase the percentage of seedlings that move out of the grass stage by the second year. Application in a four-foot-wide band is often adequately effective and provides cost saving over broadcast treatment. Longleaf stand should be placed on a prescribed fire regiment for best results. Rx options including sulfometuron methyl will provide best results.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
4 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
7 ounces	Rotary 2SL

Adjuvant

- None

Timing

- Band spray imazapyr in early growing season (e.g., late March–April).
- Wait at least 2 months after planting before spraying herbicides over the top of longleaf pine during growing season. Seedlings should develop 2 inches of new roots and at least 3 more lateral roots during this time.

Application Guidelines

- Apply the recommended rates in 5–10 gallon total spray solution per sprayed acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established, denser/taller vegetation such as a recently harvested forest site.

When to Adjust Prescription

- If broadleaf weeds are present in significant quantity, then consider alternative prescription using sulfometuron methyl or other.

Prescription Weakness

- Weak on broadleaf weeds in the composite group and legumes.

Cost per acre:	¢
Overall Performance:	★★
Itemized Performance	
Grass Control:	★★½
Broadleaf Control:	★★
Woody Control:	n/a
Vine Control:	n/a
Effective Speed:	★★
Control Duration:	★★
Hard to Control:	★★
Crop Tolerance:	★★
Resistant Species:	★★
Natural Pine Control:	none
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Overall Performance: While an option, a higher efficacy level would be achieved by including sulfometuron methyl (see Rx).
- Grass Control: At this low rate, may see suppression but complete control of perennial grasses including bahiagrass, bermudagrass, Johnsongrass, crabgrass, fescue, and panicums.
- Broadleaf Control: Weak on composite group broadleaf weeds and legumes.

References

- Minogue, P. D.J. Moorhead, and E.D. Dickens. 2012 (Revised). Herbaceous weed control for planted longleaf sites. www.forestproductivity.net 7 p.
- Herbicide labels for brands listed.

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Imazapyr (0.13 pounds a.e./acre) and Aminopyralid (0.11 pounds a.e./acre)

GENERAL USE/TANK MIX

OPERATION:
Release – Herbaceous Weed Control

CROP SPECIES:
Longleaf Pine

SITE CONDITIONS:
Cutover, Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Fall or Winter Planting

APPLICATION TIMING:
Early Growing Season

APPLICATION TYPE:
Broadcast, Band

DIFFICULT TO CONTROL PLANTS:
None

This prescription can be applied to longleaf pine stands in the first to third year to control a broad range of grasses, broadleaf weeds and *Rubus*. May cause some transient needle curling, twisting or droop. Use caution, longleaf seedlings with exposed or elongated terminal buds may by injured.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
4 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
8 ounces	Rotary 2SL

Aminopyralid (vol./ac.)	List of Available Products
7 ounces	Milestone

⚠ Do not use over the top of loblolly, shortleaf, or slash pine

Adjuvant
- Do not add.

Timing
- Application should be made when target weeds are actively growing.

Application Guidelines
- Apply the recommended rates in 5–10 gallon total spray solution per sprayed acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established, denser/taller vegetation such as a recently harvested forest site.

When to Adjust Prescription
- Use higher label rates when applying to clay loam or silty clay loam soils.

Prescription Weakness
- May cause some transient needle curling, twisting or droop.
- Use caution. Longleaf seedlings with exposed or elongated terminal buds may by injured.

Cost per acre:	¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★
Woody Control:	n/a
Vine Control:	n/a
Effective Speed:	★★★
Control Duration:	★★★
Hard to Control:	★★
Crop Tolerance:	★★★★
Resistant Species:	★★★
Natural Pine Control:	n/a
Restrictions:	★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:
- Crop Tolerance: Some needle twisting. Damage to crop when elongated buds are exposed.

References

- Minogue P. D.J. Moorhead, E.D. Dickens, revised 2014. Herbaceous weed control recommendations for planted longleaf sites. 7p.
- Herbicide labels for brands listed.

Step 1: Sulfometuron Methyl (0.1 pounds a.e./acre)
Step 2: Imazapyr (0.19 pounds a.e./acre)

GENERAL USE
MULTIPLE TREATMENTS

OPERATION:
Release – Herbaceous Weed Control

CROP SPECIES:
Longleaf Pine

SITE CONDITIONS:
Pasture, Old-field with Large Grass Component. Fertile soil

ESTABLISHMENT PROTOCOL:
Winter Planting with Bare Root Stock

APPLICATION TIMING:
Early through Mid Growing Season

APPLICATION TYPE:
Aerial Broadcast, Band

DIFFICULT TO CONTROL PLANTS:
Grass

This is a multi-treatment prescription for fertile loamy old pastures and/or old fields with a large component of grasses. First, excavate a few seedlings before applying any "over-the-top" treatments. If there is less than 4 inches of new root growth since planting, do not attempt this treatment. Treatment cost could be high because of two-step process.

Applied Rate by Products

Step 1: Sulfometuron (vol./ac.)	List of Available Products
3 ounces	Oust XP, Spyder, SFM 75

Step 2: Imazapyr (vol./ac.)	List of Available Products
6 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
12 ounces	Rotary 2SL

⚠ DO NOT apply imazapyr products formulated for site preparation application (e.g., Chopper) over the top of pines.
⚠ If soil pH > 6.0, decrease sulfometuron to 2 ounces per acre.
⚠ If soil pH > 6.5, do not apply more than 1 ounce of sulfometuron to the acre.

Adjuvant: None

Timing

- Treatment 1: Broadcast apply sulfometuron between mid March and early April
- Treatment 2: Band-spray imazapyr as a post-emergent after mid May.
- Mow between rows if possible.

Application Guidelines

- Aerial: Apply the recommended rates in 10 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 20 gallons total spray solution per acre.

When to Adjust Prescription

- Two post-planting release treatments will be necessary if the site is a fertile old field and bermudagrass is present, if bahiagrass is not killed during the initial herbaceous release, or if crabgrass germinates after the initial treatment.
- If young crabgrass germinants are present, it is imperative that a post-emergent (second) herbicide be applied.

Cost per acre:	¢¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★★
Woody Control:	★★
Vine Control:	★★
Effective Speed:	★★
Control Duration:	★★★
Hard to Control:	★★
Crop Tolerance:	★★★
Resistant Species:	★★★
Natural Pine Control:	none
Restrictions:	★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

Crop Tolerance: Longleaf can be sensitive to higher rates of Imazapyr, use with caution.

References

- The Longleaf Alliance. 2018, Herbaceous Release on Agricultural Lands. http://www.longleafalliance.org
- Herbicide labels for brands listed.

Step 1: Sulfometuron Methyl (0.12 pounds a.e./acre) and Hexazinone (7.0 pounds a.e./acre)
Step 2: Imazapyr (0.16 pounds a.e./acre)

GENERAL USE
MULTIPLE TREATMENTS

OPERATION:
Release – Herbaceous Weed Control

CROP SPECIES:
Longleaf Pine

SITE CONDITIONS:
Pasture, Old-field with Large Grass Component. Sandy, Infertile soil

ESTABLISHMENT PROTOCOL:
Winter Planting

APPLICATION TIMING:
Post-emergent (May–June)

APPLICATION TYPE:
Aerial Broadcast, Band

DIFFICULT TO CONTROL PLANTS:
None

SOIL:
Limited pH < 6.5

This is a multi-treatment prescription for old pastures and/or old fields with a large component of grasses on sandy, infertile soils. First, excavate a few seedlings before applying any "over-the-top" treatments. If there is less than 4 inches of new root growth since planting, do not attempt this treatment.

Applied Rate by Products

Step 1:

Sulfometuron (vol./ac.)	List of Available Products
4 ounces	Oust XP, SFM 75, Spyder
Hexazinone (vol./ac.)	
28 ounces	Velpar L
30 ounces	Velossa

Step 2:

Imazapyr (vol./ac.)	List of Available Products
5 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
10 ounces	Rotary 2 SL, Stalker 2SL, Imazapyr 2SL

⚠ DO NOT apply imazapyr products formulated for site preparation application (e.g., Chopper) over the top of pines.
⚠ If soil pH > 6.0, decrease sulfometuron to 2 ounces per acre.
⚠ If soil pH > 6.5, do not apply more than 1 ounce of sulfometuron to the acre.

Timing

- Treatment 1: Broadcast apply a tank mix of sulfometuron methyl and hexazinone between mid March and early April.
- Treatment 2: Band-spray imazapyr as release after mid-May.

Application Guidelines

- Aerial: Apply the recommended rates in 10 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 20 gallons total spray solution per acre.

When to Adjust Prescription

- Two post-planting release treatments will be necessary if the site is a fertile old field and bermudagrass is present, bahiagrass is not killed during the initial herbaceous release, or if crab-grass germinates after the initial treatment.
- If young crabgrass germinants are present, it is imperative that a post-emergent (second) herbicide be applied.

Cost per acre:	$
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★★
Woody Control:	★★
Vine Control:	★★
Effective Speed:	★★★
Control Duration:	★★★★
Hard to Control:	★★
Crop Tolerance:	★★★
Resistant Species:	★★★
Natural Pine Control:	none
Restrictions:	★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Crop Tolerance: Hexazinone may cause pine seedling mortality on sandy sites and on sites with low organic matter (old-field sites), ensure proper calibration and follow label directions regarding appropriate rates for various soil types.

References

- The Longleaf Alliance. 2018, Herbaceous Release on Agricultural Lands. http://www.longleafalliance.org
- Minogue, Pat and David Moorhead. 2012. Herbaceous Weed Control Recommendations for Planted Longleaf Sites.
- Herbicide labels for brands listed.

Activity: Release – Herbaceous Weed Control
Crop Species: Oak

Herbaceous Weed Control for Oak Species

Just as with pine crop species, herbaceous weed control (HWC) in oak establishment often is a step that is the difference between a successful or unsuccessful planting. HWC is designed to control grasses and broadleaf plants into the growing season following planting. Often, HWC will be necessary even if adequate site preparation has been conducted. An evaluation of competition that will exist in the first growing season is beneficial in determining the need or type of treatment needed.

When planning for herbaceous weed control in oak establishment, considerations regarding proper herbicides and timing of applications are critical to not injuring oak seedlings. Herbicide protocols are available for both pre- and post-emergent applications, as well as site preparation additions in fall. Identifying target competition and selecting a proper prescription can positively impact oak seedling survival.

Table 8. Commonly-used herbicides for early hardwood release.

Ingredient	Products	Time of Year	Target	Resistant
clopyralid	Clean Slate, Transline	Anytime during the growing season. Preferred when weeds are small and actively growing.	Many broadleaf weeds such as sicklepod, morning glory, ragweed, coffeeweed, thistle, wisteria, and kudzu.	Grasses and most hardwood species
glyphosate	Rodeo, Refuge	Summer, during active growth, after full leaf expansion and before fall color. Spot treatments only avoiding contact with desirable species or broadcast during dormant period when hardwood crop trees are dormant.	Many hardwoods (black locust, persimmon, sassafras, sumac, sweetgum, yellow-poplar) most annual and perennial grasses and forbs.	Red maple, blackgum, greenbrier, Virginia creeper, trumpet vine.
hexazinone (yellow poplar only)	Velossa, Velpar L	Early spring, after soil has settled around planting slit and before bud break. Broadcast foliar application over top of planted seedlings.	Many hardwoods, blackberry, crabgrass, fescue, lespedeza, horseweed, dog fennel, annual and perennial rye grass.	Grasses, yellow-poplar, eastern redcedar, sassafras, blackgum, hollies, beautyberry, bermudagrass, snakeroot, broomsedge, Johnsongrass, sicklepod, trumpet vine
metsulfuron methyl	Escort XP, Patriot	Early spring, after soil has settled around root system and prior to bud break. Herbaceous weeds: apply pre-emergence or shortly thereafter.	Wide range of annual and perennial broadleaf weeds and woody plants, kudzu, multiflora rose.	Grasses, yellow poplar
oxyfluorfen	Goal 2XL	For maximum crop tree safety applications should occur prior to bud swell in the spring or after trees have initiated dormancy in the fall. Apply only as a directed spray to the soil beneath the trees.	Pre and early post emergent control of certain grasses and broadleaf weeds.	Apply to established deciduous trees or after transplanting. Oaks, poplar, sweetgum, eucalyptus, cottonwood and many others.
sulfometuron methyl	Oust XP, Spyder, SFM 75	Early spring, after soil has settled around planting slit and before bud swell stage.	Annual grasses and forbs and certain perennial herbs.	Bermuda, broomsedge, croton, trumpet vine, Johnsongrass, panicums
fluazifop-P-butyl	Fusilade DX	When grasses are in an early growth stage. Two or more applications may be needed for some grasses.	Annual and perennial grasses	All broadleaf weeds
clethodim	Select 2EC, Intensity, Dakota	When grasses are in an early growth stage. Two or more applications may be needed for some grasses.	Annual and perennial grasses	All broadleaf weeds

Modified from Colby Lambert, Mark Megalos, James Jeuck. (2016). 2016 Quick Guide to Forestry Herbicides Used for Softwood and Hardwood Site Preparation and Release.

Clethodim (0.12 pounds a.e./acre)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Release – Grass Control Only

CROP SPECIES:
All Pine and Oak Species

SITE CONDITIONS:
Old Field or Pasture

ESTABLISHMENT PROTOCOL:
Fall or Winter Planting

APPLICATION TIMING:
Apply Early-Growing Season

APPLICATION TYPE:
Band, Broadcast

DIFFICULT TO CONTROL PLANTS:
Grasses

This prescription can be applied to fall or winter-planting stand establishment sites that are experiencing competition from controllable grasses. Some difficult-to-control grass species may not be fully controlled by this prescription (e.g., broomsedge). This HWC prescription is to be used strictly as a post-emergent early-growing season application for the selected establishment method.

Applied Rate by Products

Clethodim (vol./ac.)	List of Available Products
16 ounces	Select Max, Intensity One
8 ounces	Select 2EC, Intensity, Clethodim 2E, Dakota

Adjuvant

- 0.25% non-ionic surfactant volume-to-volume (1 quart per 100 gallons).

Timing

- Apply early growing season.
- See application timing notes on label for rates and timing based on grass size (height or runner length).

Application Guidelines

- Apply the recommended rates in 5–10 gallon total spray solution per sprayed acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established, denser/taller vegetation.
- Read herbicide label section on tank mixing prior to tank mixing with any additional herbicides for HWC.

When to Adjust Prescription

- Application may be more effective when split into two applications.

Prescription Weakness

- Only controls grasses.

Cost per acre:	¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	n/a
Woody Control:	n/a
Vine Control:	n/a
Effective Speed:	★★★★
Control Duration:	★★
Hard to Control:	★★★
Crop Tolerance:	★★★★
Resistant Species:	★★★
Natural Pine Control:	n/a
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Grass Control: Good control of many grass species. May see partial control of bermudagrass and tall fescue. Must be applied at specific timing paired with growth stage.

References

- Herbicide labels for brands listed.

Fluazifop-P-butyl (0.13 pounds a.e. /acre)

GENERAL USE/SINGLE PRODUCT/MULTIPLE TREATMENTS

OPERATION:
Release – Grass Control Only

CROP SPECIES:
All Pine and Oak Species

SITE CONDITIONS:
Old Field or Pasture

ESTABLISHMENT PROTOCOL:
Fall or Winter Planting

APPLICATION TIMING:
Early Growing Season

APPLICATION TYPE:
Aerial Broadcast, Band

DIFFICULT TO CONTROL PLANTS:
Bermudagrass

This prescription can be applied to fall or winter-planting stand establishment sites that are experiencing competition from controllable grasses. Some difficult-to-control grass species may not be fully controlled by this prescription (e.g., broomsedge). However, it can be a good option for bermudagrass control, but requires split application and early timing. This HWC prescription is to be used strictly as a post-emergent, early season, application for the selected establishment method.

Applied Rate by Products

Fluazifop (vol./ac.)	List of Available Products
8 ounces	Fusilade DX

Adjuvant

- 0.25% non-ionic surfactant volume-to-volume (1 quart per 100 gallons)
  or
- 1% crop oil concentrate (1 quart per 25 gallons).

Timing

- Two applications recommended at 8 ounces per applied acre per application.
- Make applications 30 days apart.
- Apply early growing season.
- See application timing notes on label for rates and timing based on grass size (height or runner length).

Application Guidelines

- Apply the recommended rates in 5–10 gallon total spray solution per sprayed acre for aerial, mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established, denser/ taller vegetation.
- Read herbicide label section on tank mixing prior to tank mixing with any additional herbicides for HWC.

When to Adjust Prescription

- If making only one application, use the maximum rate recommended at 24 ounces per sprayed acre.

Cost per acre:	¢¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	n/a
Woody Control:	n/a
Vine Control:	n/a
Effective Speed:	★★★★
Control Duration:	★★
Hard to Control:	★★★
Crop Tolerance:	★★★★
Resistant Species:	★★★
Natural Pine Control:	n/a
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Grass Control: Performs well on many grasses. Does not control broomsedge or tall fescue.
- Hard to Control: Can be a good option for bermudagrass control, but requires split application and early timing.

References

- Herbicide labels for brands listed.

Sulfometuron Methyl (Site Prep = 0.09 pounds a.e./acre; Release = 0.06 pounds a.e./acre)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Release – Herbaceous Weed Control

CROP SPECIES:
Oak

SITE CONDITIONS:
Old Field, Cutover, Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Fall or Winter Planted

APPLICATION TIMING:
Pre-emergent (before bud swell in February through early-March)

APPLICATION TYPE:
Band, Broadcast

DIFFICULT TO CONTROL PLANTS:
None

This prescription can be applied on oak establishment sites that did not receive an herbaceous weed control (HWC) tank mix addition during a fall site preparation herbicide application. This product must be applied as a pre-emergent application using the following recommended rates. Once bud swell has begun on oak seedlings, do not use this prescription.

Applied Rate by Products

Fall Site Prep Application (added to a site preparation tank mix)	
(vol./ac.)	List of Available Products
3 ounces	Oust XP, Spyder, SFM 75

Pre-emergent Application	
(vol./ac.)	List of Available Products
2 ounces	Oust XP, Spyder, SFM 75

Adjuvant

- None

Timing

- During site prep in fall (low flood potential sites only). OR
- As a pre-emergent (February–March, prior to seedling bud swell).
- Do not apply after bud swell begins.

Application Guidelines

- Pre-emergent: 5–7.5 gallons mixture per sprayed acre.

When to Adjust Prescription

- If soil pH is above 6.2, damage could occur to planted seedlings. It is not recommended to spray sulfometuron methyl on soils with pH near or above 7.0.
- It is recommended to reduce rate by ½ list rate when pH is between 6.2–6.5.
- Use higher label rates when applying to clay loam or silty clay loam soils. Rate could be reduced on coarse-textured soils.

Prescription Weakness

- This prescription does not control bermudagrass, bahiagrass or some other turf grasses.

Cost per acre:	¢
Overall Performance:	★★★½
Itemized Performance	
Grass Control:	★★
Broadleaf Control:	★★★
Woody Control:	n/a
Vine Control:	n/a
Effective Speed:	★★★
Control Duration:	★★★★
Hard to Control:	★★★
Crop Tolerance:	★★★★
Resistant Species:	★★★★
Natural Pine Control:	n/a
Restrictions:	★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Grass Control: Provides good control of fescue.
- Hard to Control: Does not control Broomsedge, some turf grasses, R*ubus* or vines.
- Restrictions: Caution must be taken in areas with high soil pH.

References

- Herbicide labels for brands listed.

Clopyralid (0.5 pounds a.e./acre)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Release – Herbaceous Weed Control

CROP SPECIES:
Oak

SITE CONDITIONS:
Old Field, Cutover, or Recently Harvested Forest Site

ESTABLISHMENT PROTOCOL:
Fall- or Winter-Planted Oak Seedlings

APPLICATION TIMING:
Mid- to Late-Growing Season

APPLICATION TYPE:
Band, Broadcast

DIFFICULT TO CONTROL PLANTS:
Legumes, Kudzu and Wisteria

This prescription can be applied on oak establishment sites that did not receive a pre-emergent herbaceous weed control (HWC) treatment. The product can be safely applied over the top of oak seedlings during growing season. However, applications made early growing season, during active seedling growth, may result in some short-term leaf injury symptoms (such as curling).

Applied Rate by Products

Clopyralid (vol./ac.)	List of Available Products
21 ounces	Transline, Clopyralid 3

Adjuvant

- Use 0.25% non-ionic surfactant.

Timing

- Mid to late growing season, when plants are actively growing.

Application Guidelines

- Aerial: Apply in 5–10 gallons total mixture per acre.
- Ground: Apply in 10–20 gallons (or higher) per sprayed acre based on vegetation type, density and size.
- Do not apply during periods of excessive drought when plants are stressed.
- Apply prior to onset of leaf senescence of woody plants.

When to Adjust Prescription

- Application may be split into two applications (cut rate for each application, do not apply more than 0.5 pounds a.e. per acre annually).
- Weed height can greatly impact spray rate needed, refer to label prior to application.

Cost per acre:	¢¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★
Broadleaf Control:	★★★
Woody Control:	★★
Vine Control:	★★★
Effective Speed:	★★★
Control Duration:	★★★
Hard to Control:	★★★
Crop Tolerance:	★★★★
Resistant Species:	★★★
Natural Pine Control:	n/a
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Vine Control: Controls kudzu and wisteria.
- Woody Control: Controls redbud, locust, and mimosa.

References

- Herbicide labels for brands listed.

Step 1: **Clethodim** (0.12 pounds a.e./gallon)

Step 2: **Clopyralid** (0.38 pounds a.e./gallon)

GENERAL USE

MULTIPLE TREATMENTS

OPERATION:
Release – Herbaceous Weed Control

CROP SPECIES:
Oak

SITE CONDITIONS:
Old Field

ESTABLISHMENT PROTOCOL:
Winter Planted

APPLICATION TIMING:
Early and Mid Growing Season

APPLICATION TYPE:
Band, Broadcast

DIFFICULT TO CONTROL PLANTS:
Legume Species, Some Invasive Plants

This HWC application for oak species is designed for sites where hardwood seedlings have been planted and pre-emergent application was not made. The prescription provides control of a broad range of grasses and herbaceous weeds. The two-step process is designed for sites with both grasses and broadleaf competition problems.

Applied Rate by Products

Step 1

Clethodim (vol./ac.)	List of Available Products
16 ounces	Select Max, Intensity One, Envoy Plus
8 ounces	Select 2EC, Intensity

Step 2

Clopyralid (vol./ac.)	List of Available Products
16 ounces	Transline, Clopyralid 3

Adjuvant

- Use 0.25% non-ionic surfactant volume-to-volume.

Timing

- Step 1: Apply recommended rate of clethodim in April–May to control grasses (see label for grass size recommendations).
- Step 2: Apply recommended rate of clopyralid in May–July to control broadleaf weeds.

Application Guidelines

- Aerial: Apply the recommended rates in 10 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 20 gallons total spray solution per acre for mechanical ground spray and backpack applications.

When to Adjust Prescription

- If grass control alone achieves desired conditions, step 2 may be avoided.
- If broadleaf plants are dense in coverage or more mature consider increasing clopyralid rate up to 21 ounces.

Prescription Weakness

- Requires two applications.

Cost per acre:	¢¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★★
Broadleaf Control:	★★★
Woody Control:	n/a
Vine Control:	★★
Effective Speed:	★★★★
Control Duration:	★★
Hard to Control:	★★★
Crop Tolerance:	★★★★
Resistant Species:	★★★
Natural Pine Control:	n/a
Restrictions:	★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Restrictions: Do not apply clopyralid on sandy soils with a shallow water table. Use caution when applying in flood prone areas.
- Hard to Control: Will control kudzu, wisteria, mimosa, and locust

References

- Herbicide labels for brands listed.

Activity: Early Rotation Release – Woody Plants
Crop Species: Pine

Early Rotation Release from Woody Plants

Early rotation woody release is an application made in young, pre-commercial stands. Early rotation woody release involves growing season applications of both foliar- and soil-active herbicides. Because crop trees have already been established, the recommended rates in the respective prescriptions are typically lower than site preparation rates. Also, some herbicides must be avoided completely. The specific crop species also impacts these decisions. Because of the constraints, woody completion control is most effective when conducted at the time of chemical site preparation prior to planting seedlings. However, the following prescriptions provide alternatives for forest managers to use in specific scenarios where woody competition is a concern.

Imazapyr (0.5 pounds a.e./acre)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Early-Rotation Woody Release

CROP SPECIES:
Loblolly Pine

SITE CONDITIONS:
Young, Pre-commercial Stand

ESTABLISHMENT PROTOCOL:
Any

APPLICATION TIMING:
Mid to Late Growing Season

APPLICATION TYPE:
Band, Broadcast

DIFFICULT TO CONTROL PLANTS:
None

This woody release treatment is for use in young loblolly pine stands, after July 15 of the first growing season or after, where woody competition is not adequately addressed during chemical site preparation.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
16 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
32 ounces	Rotary 2SL

Adjuvant

- Add 0.25% crop oil concentrate.
  or
- Add 0.25% non-ionic surfactant.

Timing

- This application is designed for mid to late growing season timing, after saplings have hardened off for the current growing season.

Application Guidelines

- Aerial: Apply the recommended rates in 10 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 20 gallons total spray solution per acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established, denser/taller vegetation.

When to Adjust Prescription

- If significant presence of oak and/or hickory, raise rates to 20 and 40 ounces per acre, respectively.
- If significant present of elm or brambles refer to imazapyr and metsulfuron methyl early-rotation release prescription.

Prescription Weakness

- Elm and a few other species may not be fully controlled.

Cost per acre:	¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★
Woody Control:	★★★
Vine Control:	★★★
Effective Speed:	★★
Control Duration:	★★★
Hard to Control:	★★★
Crop Tolerance:	★★★
Resistant Species:	★★★
Natural Pine Control:	none
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Effective Speed: With late season application, may be following spring before full effect is observed.

References

- Herbicide labels for brands listed.

Imazapyr (0.5 pounds a.e./acre) and Metsulfuron Methyl (0.06 pounds a.e./acre)

GENERAL USE / TANK MIX

OPERATION:
Early-Rotation Woody Release

CROP SPECIES:
Loblolly Pine

SITE CONDITIONS:
Young, Precommercial Stand

ESTABLISHMENT PROTOCOL:
Any

APPLICATION TIMING:
Mid to Late Growing Season

APPLICATION TYPE:
Band, Broadcast

DIFFICULT TO CONTROL PLANTS:
Rubus

This woody release treatment is for use in young loblolly pine stands, after July 15 of the first growing season or after, where woody competition is not adequately addressed during chemical site preparation.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
16 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
32 ounces	Rotary 2SL

Metsulfuron (vol./ac.)	List of Available Products
1 ounce	Escort XP, MSM 60, Patriot

Adjuvant

- Add 0.25% crop oil concentrate
  or
- Add 0.25% non-ionic surfactant.

Timing

- This application is designed for mid- to late-growing season timing, after saplings have hardened off for the current growing season.

Application Guidelines

- Aerial: Apply the recommended rates in 10 gallons total spray solution per acre.
- Ground: Apply the recommended rates in 20 gallons total spray solution per acre for mechanical ground spray and backpack applications.
- Higher spray volumes required on site with more established, denser/taller vegetation.

When to Adjust Prescription

- If woody competition is intense, imazapyr component can be increased up to 16 ounces per acre. Increase Imazapyr rate to better control elm, dogwood, red maple and hickories also.

Cost per acre:	¢¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★★
Woody Control:	★★★½
Vine Control:	★★★
Effective Speed:	★★
Control Duration:	★★★★
Hard to Control:	★★
Crop Tolerance:	★★★
Resistant Species:	★★★
Natural Pine Control:	n/a
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Woody Control: Control of many species will be good.

References

- Herbicide labels for brands listed.

Hexazinone (1.15 pounds a.e./acre)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Early-Rotation Woody Release

CROP SPECIES:
Loblolly, Longleaf, Shortleaf, Slash Pine

SITE CONDITIONS:
Young, Precommercial Stand

ESTABLISHMENT PROTOCOL:
Any

APPLICATION TIMING:
Early-growing season

APPLICATION TYPE:
Band, Broadcast

DIFFICULT TO CONTROL PLANTS:
Rubus

This woody release treatment is for use in young loblolly pine stands, after the first growing season, where woody competition is not adequately addressed during chemical site preparation. This application should be performed early in the growing season prior to the onset of warm temperatures. At this rate, the application will provide suppression, but not control of many woody species.

Applied Rate by Products

Hexazinone (vol./ac.)	List of Available Products
1.5 pounds	Velpar DF (VU), Tide Hexazinone 75 WDG, Pronone Power Pellets

⚠ This rate is for medium textured soils only (loam, sandy clay loam, silt and silt loam).

Adjuvant
- None

Timing
- Apply in the early growing season after hardwoods break bud, but before temperatures rise above 80° Fahrenheit.

Application Guidelines
- See label – depends on method.

When to Adjust Prescription
- On course-textured soils (loamy sand, sandy loam) use 1.3 pounds per acre.
- On fine-textured soils (sandy clay, silty clay loam, clay) use 1.75 pounds per acre.
- If dense woody vegetation is present, an alternative prescription may be desirable.

Prescription Weakness
- May not control several woody species.

Cost per acre:	$
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★
Broadleaf Control:	★★★★
Woody Control:	★★½
Vine Control:	★★★
Effective Speed:	★★
Control Duration:	★★★★
Hard to Control:	★★★
Crop Tolerance:	★★★
Resistant Species:	★★★
Natural Pine Control:	none
Restrictions:	★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:
- Effective Speed: Will depend on rainfall occurrence after application.
- Woody Control: Will not provide complete control of several hardwood species.

References

- Minogue, Pat, and David Moorhead. 2012. Herbaceous Weed Control Recommendations for Planted Longleaf Sites.
- Herbicide labels for brands listed.

Glyphosate (5 percent by volume)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Early-Rotation Woody Release

CROP SPECIES:
Pine

SITE CONDITIONS:
Young Pre-Commercial Stands

ESTABLISHMENT PROTOCOL:
Any

APPLICATION TIMING:
Mid to Late Growing Season

APPLICATION METHOD:
Low Volume Directed Spray

DIFFICULT TO CONTROL PLANTS:
Broomsedge, Vines, Woody plants

This directed spray, woody release treatment is for use in young pine stands, after the first growing season, where woody competition is not adequately addressed during chemical site preparation. Caution must be taken to avoid contact with foliage of crop pines, which can be a challenge.

Available Products

Glyphosate (%/vol.)	List of Available Products
5%	Accord XRT II, Rodeo, Roundup Pro Concentrate, Touchdown Pro, Glyphosate 4 Plus, Touchdown Total, Glyphosate 5.4, and many other products

⚠ Many glyphosate products are available for use on forestry sites. If using a different glyphosate product, make sure to read the respective label prior to application.

⚠ Caution must be taken to avoid contact with foliage of crop pines.

Recommended Mixture
- Mix 5% glyphosate volume-to-volume with water (see application notes).

Adjuvant
- None

Timing
- Any time after full leaf expansion, but prior to leaf color change.

Application Guidelines
- Low-volume directed spray.
- Application must be made with no wind present and no matter how careful application is, crop trees are likely to see some injury.

When to Adjust Prescription
- If using a "spray-to-wet" technique with a handheld sprayer, reduce mix to 1.5% volume-to-volume with water.

Prescription Weakness
- No crop tolerance; no matter how careful application is performed, some injury to crop species will likely occur.

Cost per acre*:	¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★
Woody Control:	★★★½
Vine Control:	★★★
Effective Speed:	★★★★
Control Duration:	★★
Hard to Control:	★★★
Crop Tolerance:	none
Resistant Species:	★★★
Natural Pine Control:	★★★★
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.
*assuming that 10 gallons per acre applied.

Rank Notes:
- Cost per acre: Chemical cost is low, but application costs may be significant.
- Control Duration: Length of control is better for woody plants than for other vegetation types.

References
- Herbicide labels for brands listed.

Triclopyr–*choline* (2-3 percent by volume)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Early-Rotation Woody Release

CROP SPECIES:
Pine

SITE CONDITIONS:
Young, Pre-Commercial Stand

ESTABLISHMENT PROTOCOL:
Any

APPLICATION TIMING:
Mid to Late Growing Season

APPLICATION TYPE:
Low Volume Directed Spray

DIFFICULT TO CONTROL PLANTS:
Waxy Leaf Species, Legumes

This directed spray, woody release treatment is for use in young pine stands, after the first growing season, where woody competition is not adequately addressed during chemical site preparation. Caution must be taken to avoid contact with foliage of crop pines.

Available Products

Triclopyr (%/vol.)	List of Available Products
2-3%	Vastlan

⚠ Caution must be taken to avoid contact with foliage of crop pines.

Recommended Mixture
- Mix 2-3% triclopyr volume-to-volume with water.

Adjuvant
- Add 0.5% volume-to-volume non-ionic surfactant.

Timing
- Any time after full-leaf expansion, but prior to leaf color change.

Application Guidelines
- Directed Spray

When to Adjust Prescription
- Mix can range from 3–5 quarts per 100 gallons.

Prescription Weakness
- A few woody species may not be fully controlled.

Cost per acre*:	¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	none
Broadleaf Control:	★★★
Woody Control:	★★★
Vine Control:	★★
Effective Speed:	★★★★
Control Duration:	★★
Hard to Control:	★★★
Crop Tolerance:	none
Resistant Species:	★★★
Natural Pine Control:	★★★
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.
*assuming that 10 gallons per acre applied.

Rank Notes:
- Control Duration: Rank represent length for woody control. Duration will be shorter for broadleaf plants.

References
- Herbicide labels for brands listed.

Activity: Mid-Rotation Release
Crop Species: Pine

Mid-Rotation Release from Woody Plants

Mid-rotation release (or mid-rotation brush control) is a different operation than early-rotation woody release in both objective and application method. Mid-rotation release from woody plants can be a beneficial application to impact tree growth, facilitate fertilization treatments, or reduce site preparation intensity following final harvest. The operation is usually a broadcast application that may be applied from the ground or aerially. Factors such as tree height, density, and crop species present will impact the herbicide, application method and maybe timing of application.

Ground applications will allow for higher rates with higher efficacy ratings to be used. However, effective aerial applications are also presented. Many of the concerns associated with site preparation, such as hard-to-control species, can also be addressed during mid-rotation woody release. Caution must be taken with regard to pine crop species present, as they can differ in crop tolerance ratings to respective herbicides.

Imazapyr (0.75 pounds a.e./acre) and Triclopyr (1.2 pounds a.e./acre)

GENERAL USE / TANK MIX

OPERATION:
Mid-Rotation Brush Control

CROP SPECIES:
Pine

SITE CONDITIONS:
Mid to Late Rotation

ESTABLISHMENT PROTOCOL:
Any

APPLICATION TIMING:
Growing Season

APPLICATION TYPE:
Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
Yaupon

This herbicide prescription is applied beneath crop pine trees in stands with heavy yaupon competition and for which a primary goal is to optimize pine growth. This prescription should be applied within the first 9–12 month following a thinning operation or mechanical competition control operation to allow access from the ground. This prescription is okay to use if native grass restoration is not a primary concern. It is most beneficial in stands that are scheduled for fertilization treatments.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
24 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
48 ounces	Chopper Gen2, Polaris SP, Rotary 2SL

Triclopyr (vol./ac)	List of Available Products
24 ounces	Garlon XRT, Boulder 6.3
38 ounces	Triclopyr 4, Tahoe 4E, Relegate, Garlon 4 Ultra, Element 4

Adjuvant

- Add 0.5–1% premixed product containing methylated seed oil (MSO) and organosilicone surfactant (e.g., Elite Supreme).

Timing

- This application during the growing season after the time yaupon leaves are fully mature. Avoid applications during time of drought or when plants may not be active. Applications made while pines are actively growing or under stress may cause crop tree injury.

Application Guidelines

- Ground: Apply the recommended rates in 25–30 gallons spray solution per acre.

When to Adjust Prescription

- Mix can range from 10 to 60 ounces per acre of Garlon XRT or equivalent depending upon density and condition of yaupon.

Cost per acre:	$$
Overall Performance:	★★★½
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★★
Woody Control:	★★★★
Vine Control:	★★★★
Effective Speed:	★★★
Control Duration:	★★★
Hard to Control:	★★★★
Crop Tolerance:	★★★
Resistant Species:	★★★
Natural Pine Control:	★★★
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Overall control: This prescription will provide excellent vegetative control and may impact the need for site prep at final harvest.
- Crop Tolerance: Crop tolerance is high as long as product is applied properly.

References

- Herbicide labels for brands listed.
- Common recommendations from herbicide distributors and applicators.

Imazapyr (0.63 pounds a.e./acre), Glyphosate (2.78 pounds a.e./acre), Saflufenacil (0.045 pounds a.e./acre)

GENERAL USE / TANK MIX

OPERATION:
Mid Rotation Brush Control

CROP SPECIES:
Pine

SITE CONDITIONS:
Mid to Late Rotation

ESTABLISHMENT PROTOCOL:
Any

APPLICATION TIMING:
Growing Season

APPLICATION TYPE:
Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
Yaupon

This herbicide prescription is applied by skidder beneath crop pine trees in stands with heavy yaupon competition and for which a primary goal is to optimize pine growth. This prescription should be applied within the first 9–12 months following a thinning operation or mechanical competition control operation to allow access from the ground. Do not use this prescription if native grass restoration is a primary concern. It is most beneficial in stands that are scheduled for fertilization treatments.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
20 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
40 ounces	Chopper, Chopper Gen2, Polaris SP, Rotary 2SL
Glyphosate (vol./ac.)	**List of Available Products**
2.5 quarts	Roundup ProMax, Touchdown Total
2.7 quarts	Accord XRT II, Rodeo, Glyphosate 5.4, Roundup Custom
3.0 quarts	Roundup Pro Concentrate
Saflufenacil (vol./ac.)	**List of Available Products**
2 ounces	Detail X

⚠ DO NOT make this application over the top of pines.

Adjuvant

- Use 0.5% volume-to-volume product containing methylated seed oil (MSO) and organosilicone surfactant (e.g., Elite Supreme).

Timing

- Apply during the growing season after the time yaupon leaves are fully mature.
- Avoid applications during time of drought or when plants may not be active.
- Applications made while pines are actively growing or under stress may cause crop tree injury.

Application Guidelines

- Apply the recommended rates in 25–30 gallons spray solution per acre.

Cost per acre:	$$
Overall Performance:	★★★★
Itemized Performance	
Grass Control:	★★★★
Broadleaf Control:	★★★★
Woody Control:	★★★★
Vine Control:	★★★★
Effective Speed:	★★★★
Control Duration:	★★★★
Hard to Control:	★★★
Crop Tolerance:	none
Resistant Species:	★★★½
Natural Pine Control:	★★★½
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Crop Tolerance: High crop tolerance as long as proper ground application is made.

References

- The herbicide labels for brands listed.
- Non-published findings from select herbicide distributors and manufactures.

Texas A&M Forest Service | University of Arkansas Division of Agriculture Research & Extension | Arkansas Forestry Commission | Louisiana Tech University | LSU AgCenter

Imazapyr (0.63 pounds a.e./acre)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Mid-Rotation Brush Control

CROP SPECIES:
Loblolly Pine

SITE CONDITIONS:
Mid-Rotation

ESTABLISHMENT PROTOCOL:
Any

APPLICATION TIMING:
Mid to Late Growing Season

APPLICATION TYPE:
Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
None

This herbicide prescription is to be used at mid-rotation (12–18 years) and is intended for stands where primary goal is to optimize pine growth but the existing hardwood basal area is greater than 5 percent of total. MRBC is most beneficial in stands that are scheduled for fertilization treatments. This is the recommended prescription for ground application of imazapyr.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
20 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
40 ounces	Chopper Gen2, Polaris SP, Rotary 2SL

⚠ Do not apply imazapyr products formulated for site preparation application (e.g., Chopper and most other 2 lb. formulations) over the top of crop pines.

Adjuvant

- Use 1% volume-to-volume methylated seed oil (MSO).
  or
- Use 0.25–1% (typical 0.5%) volume-to-volume nonionic surfactant.

Timing

- Mid to late growing season.

Application Guidelines

- Ground: Apply the recommended rates in 25 gallons total spray solution per acre.
- Higher spray volumes required on site with more established, denser/ taller vegetation.

When to Adjust Prescription

- If completion is heavy, increase rate to 36 ounces (possibly up to 40 ounces) per acre.

Prescription Weakness

- May not adequately control elm species.

Cost per acre:	¢¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★
Woody Control:	★★★
Vine Control:	★★★
Effective Speed:	★★
Control Duration:	★★★
Hard to Control:	★★★
Crop Tolerance:	★★★
Resistant Species:	★★★
Natural Pine Control:	n/a
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Wood Control: Woody control is primary criteria of concern in this Rx.

References

- Herbicide labels for brands listed.

MID-ROTATION BRUSH CONTROL

SHORTLEAF, LONGLEAF PINE

Imazapyr (0.5 pounds a.e./acre)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Mid-Rotation Brush Control

CROP SPECIES:
Longleaf, Shortleaf Pine

SITE CONDITIONS:
Mid-Rotation, Commercial Stand

ESTABLISHMENT PROTOCOL:
Any

APPLICATION TIMING:
Mid to Late Growing Season

APPLICATION TYPE:
Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
None

This herbicide prescription is to be used at mid-rotation (12–18 years) and is intended for stands where primary goal is to optimize pine growth but the existing hardwood basal area is greater than 5 percent of total. MRBC is most beneficial in stands that are scheduled for fertilization treatments. This is the recommended prescription for ground application of imazapyr.

Applied Rate by Products

Imazapyr (vol./ac.)	List of Available Products
16 ounces	Arsenal AC, Polaris AC, Imazapyr 4SL
32 ounces	Chopper Gen2, Polaris SP, Rotary 2SL

⚠ Do not apply imazapyr products formulated for site preparation application (e.g., Chopper and most other 2 lb. formulations) over the top of crop pines.

Adjuvant

- Use 1% volume-to-volume methylated seed oil (MSO).

or

- Use 0.25–1% (typical 0.5%) volume-to-volume nonionic surfactant.

Timing

- Mid to late growing season

Application Guidelines

- Ground: Apply the recommended rates in 25 gallons total spray solution per acre.
- Higher spray volumes required on site with more established, denser/ taller vegetation.

When to Adjust Prescription

- If completion is heavy, increase rate to 36 ounces (possibly up to 40 ounces) per acre.

Prescription Weakness

- May not adequately control elm species.

Cost per acre:	¢¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★
Woody Control:	★★★
Vine Control:	★★★
Effective Speed:	★★
Control Duration:	★★★
Hard to Control:	★★★
Crop Tolerance:	★★★
Resistant Species:	★★★
Natural Pine Control:	n/a
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Wood Control: Woody control is primary criteria of concern in this Rx.

References

- Herbicide labels for brands listed.

Texas A&M Forest Service | U of A Division of Agriculture Research & Extension, University of Arkansas System | Arkansas Forestry Commission | Louisiana Tech University | LSU AgCenter

Glyphosate (4.0 pounds a.e./acre)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Mid-Rotation Brush Control

CROP SPECIES:
Pine

SITE CONDITIONS:
Mid-Rotation, Commercial Stand

ESTABLISHMENT PROTOCOL:
Any

APPLICATION TIMING:
Mid to Late Growing Season

APPLICATION TYPE:
Ground Broadcast

DIFFICULT TO CONTROL PLANTS:
None

This herbicide prescription is to be used at mid-rotation (12–18 years) and is intended for stands where primary goal is to optimize pine growth but the existing hardwood basal area is greater than 5 percent of total. MRBC is most beneficial in stands that are scheduled for fertilization treatments. This MRBC treatment is designated for application using a ground application method only.

Available Products

Glyphosate (vol./ac.)	List of Available Products
4.0 quarts	Accord XRT II, Rodeo, Glyphosate 5.4, Roundup Custom
4.3 quarts	Roundup Pro Concentrate
5.3 quarts	Touchdown Pro, Glyphosate 4 Plus

Adjuvant

- Use 1% volume-to-volume methylated seed oil (MSO).
  or
- Use 0.25–1% (typical 0.5%) volume-to-volume nonionic surfactant.

Timing

- This application is suitable for any point during the growing season, after full leaf expansion has occurred. Late summer/early fall applications will be most effective.

Application Guidelines

- Broadcast from the ground the recommended rates in 25 gallons total spray solution per acre.
- Higher spray volumes required on site with more established, denser/taller vegetation.
- Apply sufficient volume to ensure thorough and uniform coverage.

When to Adjust Prescription

- If late summer drought is a concern, June–July applications may provide higher efficacy rates.
- If significant levels of black cherry, red maple, hickory and dogwood are present refer to an alternative prescription.

Prescription Weakness

- May not provide complete control of black cherry, red maple, hickory, and dogwood.

Cost per acre:	¢¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	★★★
Broadleaf Control:	★★★
Woody Control:	★★★
Vine Control:	★★★
Effective Speed:	★★★★
Control Duration:	★
Hard to Control:	★★
Crop Tolerance:	none
Resistant Species:	★★★
Natural Pine Control:	★★★
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Crop tolerance: There is no crop tolerance to this application. Make sure herbicide does not drift and apply below the upper canopy only.
- Woody Control: Does not provide complete control of some hardwood species.

References

- Herbicide labels for brands listed.

Activity: Individual Plant Treatments
Crop Species: Pine and Oak

Individual Plant Treatment

Individual plant treatments can be extremely useful applications for everyone from small-scale woodlot owners to professional managers. These applications can achieve objectives for timber stand improvement operations, invasive species control, site preparation for oak natural regeneration and others. Timber stand improvement generally includes single-stem removal of unacceptable tree species for management objectives. Invasive species control may involve single-stem removal of sapling to small-size stems. Finally, individual plant treatment can be extremely useful in preparing a natural hardwood stand for regeneration. The individual plant treatment would facilitate mid-story control and subsequent increases in sunlight to promote shade-intolerant oaks (e.g., red oak group).

Individual plant treatments described here include two possible treatments: herbicide injection and basal bark sprays. These methods are typically employed to non-merchantable trees of unacceptable species for management with DBH one to six inches. Herbicide injection is a method where a specific herbicide(s) is applied to the cambium (which is located just under the bark) of unacceptable trees. This method may be referred to as hack-n-squirt, where a small hack (or incision) is made to the trunk of the tree and followed by injection of a small amount of herbicide solution. Basal bark sprays involve applying a specific herbicide, usually mixed with a penetrating oil, to the lower portion of main stems of unacceptable trees.

Individual plant treatments are typically most effective during the growing season and into fall. Always avoid applications during the “green-up” period in early to late spring when sap is flowing upward in stems. The application method, cost and resulting efficacy can differ drastically. Always be sure to compare available options and make the selection that minimizes cost and provides a level of efficacy to achieve objectives.

Table 9. Commonly-used herbicides for cut surface treatments.

Active Ingredient	Products	Time of Year	Target	Resistant
aminopyralid and triclopyr	Capstone	Any season except during spring sap flow. Injection or hatchet frill girdle and spray bottle.	Most woody species	Black cherry
imazapyr	Arsenal AC, Polaris AC	Any season, except during heavy sap flow in spring. Injection or hatchet frill girdle and spray bottle. Non-target injury could result through root grafting.	Most woody species	Elms, woody legumes,
glyphosate	Accord XRT II, Rodeo, Roundup Pro Concentrate	During active growth after full leaf expansion. Injection or hatchet frill girdle and spray bottle.	Most woody species including oak, poplar, sweetgum, sycamore; pine	Red maple, dogwood, black gum
triclopyr	Vastlan, Element 3A, Garlon 3A, Tahoe 3A, Pathfinder II	Any season, except during heavy sap flow in spring. Injection or hatchet frill girdle and spray bottle. Non-target injury could result through root grafting.	Most woody species	Black cherry
clopyralid	Clean Slate, Transline, Clopyralid 3	Periods of active growth. Injection or axe frill girdle and spray bottle. Non-target injury could result through root grafting.	Woody legumes	Most hardwoods, pine
dicamba	Vanquish	Any season, except during heavy sap flow in spring. Injection or hatchet frill girdle and spray bottle.	Many hardwoods and pines	Sweetgum, oak, maple
hexazinone	Velossa, Velpar L	Summer. Injector or Hypo-Hatchet. Non-target injury could result through root grafting.	Most hardwoods	Yellow-poplar, eastern redcedar, sassafras, blackgum, hollies, pines, sourwood, dogwood, maple
picloram and 2,4-D	Pathway	Any season, except during heavy sap flow in spring or during periods of drought. Injector or hatchet frill girdle and spray bottle. Non-target injury could result through root grafting.	Most woody plants, and vines	

Modified from Colby Lambert, Mark Megalos, James Jeuck. (2016). 2016 Quick Guide to Forestry Herbicides Used for Softwood and Hardwood Site Preparation and Release.

Imazapyr (20–40 percent by volume)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Individual Plant Treatment

APPLICATION TIMING:
June–January

APPLICATION TYPE:
Hack-N-Squirt

Target Plant:
Many woody species

This recommendation is for "wide spacing injection" treatments of individual stems. The prescription is to be used for silvicultural scenarios where individual tree control is needed. This could be for natural regeneration site preparation, forest stand improvement, or invasive species control. The recommendation is typically for non-merchantable stems between 1 and 6 inches in diameter.

Applied Rate by Products

Imazapyr (% by Vol.)	List of Available Products
20%	Arsenal AC, Polaris AC, Imazapyr 4SL
40%	Chopper Gen2, Polaris SP, Rotary 2SL, Stalker, Imazapyr 2SL

Recommended Mixture

- Prepare a mix with the quantity of imazapyr listed above in water.

Adjuvant

- None
- May add blue dye to mark injected trees.

Timing

- Apply year round, except during green-up period (spring). This treatment is most effective when applied from September–December.
- Once sap begins rising in species such as red maple, applications will be less effective until after green-up.

Application Guidelines

- Using a hatchet and squirt bottle, make one frill for every 3 inches of tree diameter and squirt 1 ml of solution into each frill.
- Make sure chemical is applied directly into frill and does not spill onto ground repeatedly. Misapplications can cause non-target injury of hardwood trees. Goal is to get chemical under the bark and into the cambium layer.

Prescription Weakness:

- Soil activity, requires experienced injection crew.

Prescription Strength

- Provides good efficacy across many woody species.
- Cost effective control, makes large scale injection more feasible.

Cost per 500 stems[1]:	¢
Overall Performance:	★★★
Itemized Performance	
Effective Speed:	★★
Woody Species:	★★★★
Control Duration:	n/a
Hard to Control:	★★★★
Crop Tolerance:	★
Resistant Species:	★★★★
Natural Pine Control:	★★★
Restrictions:	★★★★

Fewer ¢ or $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

[1]Average DBH of treated trees = 3 inches

Rank Notes:

- Effective Speed: May take up to 12 months to see full effect. Depending on application timing.
- Crop Tolerance: Non-target hardwood species can be damaged if misapplication occurs.
- Woody Species: Will suppress or control eastern redcedar, American holly, and pine.

References

- Clatterbuck and Armel. 2010. Site preparation for natural regeneration of hardwoods. Publication PB1799.
- Herbicide labels for brands listed.

Glyphosate (50 percent by volume)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Individual Plant Treatment

APPLICATION TIMING:
Summer to Fall

APPLICATION TYPE:
Hack-N-Squirt

TARGET PLANTS:
Many hardwood species

This prescription is to be used for silvicultural scenarios where individual tree control is needed. This could be for natural regeneration site prep, forest stand improvement, or invasive species control. The recommendation is typically for non-merchantable stems between 1 and 6 inches in diameter.

Available Products

Glyphosate (% by vol.)	List of Available Products
50%	Accord XRT II, Rodeo, RoundUp Custom, Glyphosate 5.4

Recommended Mixture

- Prepare a mix with the quantity of glyphosate listed above in water.

Adjuvant

- None

Timing

- Apply from summer to fall.

Application Guidelines

- Make one frill for every 2 inches of tree diameter and squirt 1 ml of solution into each frill.

Prescription Weakness:

- Requires slightly higher labor and time compared to the previous IPT prescription.
- Some hardwood species may not be completely controlled.

Prescription Strength:

- Control natural pine.
- Little concern for potential damage to crop trees. Major factor for inexperienced injection crews.

Cost per 500 stems[1]:	¢
Overall Performance:	★★★
Itemized Performance	
Effective Speed:	★★★
Woody Species:	★★★
Control Duration:	n/a
Hard to Control:	★★★
Crop Tolerance:	★★★★
Resistant Species:	★★★
Natural Pine Control:	★★★
Restrictions:	★★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

[1]Average DBH of treated trees = 3 inches

Rank Notes:

- Crop Tolerance: There is little concern for damage to crop trees.

References

- Clatterbuck, W.K.; Armel, G.R. 2010. Site preparation for natural regeneration of hardwoods. Professional Hardwood Notes. Publication PB1799. Knoxville, TN: University of Tennessee Extension, Institute of Agriculture. 12 p.
- Herbicide labels for brands listed.

Triclopyr (*amine* = 50 percent by volume : *choline* = 40 percent by volume)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Individual Plant Treatment

APPLICATION TIMING:
May–January

APPLICATION TYPE:
Hack-N-Squirt

TARGET PLANTS:
Chinese Tallowtree, Locust

This prescription is to be used for silvicultural scenarios where individual tree control is needed. This could be for natural regeneration site prep, forest stand improvement, or invasive species control. The recommendation is typically for non-merchantable stems between 1 and 6 inches in diameter.

Applied Rate by Products

Triclopyr (% by vol.)	List of Available Products
50%	Garlon 3A
40%	Vastlan

Recommended Mixture

- Mix the indicated percent triclopyr volume to volume with water.

Adjuvant

- None

Timing

- Apply from May–January. Do not apply during spring green-up period.

Application Guidelines

- Make overlapping hacks (frills) around stem and inject 1 ml solution per inch for each stem.

Prescription Weakness:

- Cost of application is high.
- Eye irritant, a concern with injection applications.

Prescription Strength

- Lower concern for damage to crop tree hardwoods.
- May be good option for locust species.

Cost per 500 stems[1]:	¢
Overall Performance:	★★★
Itemized Performance	
Effective Speed:	★★★
Woody Control:	★★★
Control Duration:	n/a
Hard to Control:	★★★★
Crop Tolerance:	★★★★
Natural Pine Control:	★★★
Resistant Species:	★★★
Restrictions:	★★★★

Fewer ¢ or $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

[1]Average DBH of treated trees = 3 inches

Rank Notes:

- Woody Control: Some woody species may not be fully controlled.

References

- Clatterbuck and Armel. 2010. Site preparation for natural regeneration of hardwoods. Publication PB1799.
- Herbicide labels for brands listed.

Hexazinone (100 percent - *undiluted*)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Individual Plant Treatment

APPLICATION TIMING:
Summer

APPLICATION TYPE:
Hack-N-Squirt

TARGET PLANTS:
Locust, Hickories, Other Hardwoods, Eastern Redcedar

This recommendation is an alternative to wide spacing injection method, and can be useful for specific problem species including eastern redcedar.

Applied Rate by Products

Hexazinone (%/vol.)	List of Available Products
100%	Velpar L, Velossa

⚠ DANGER – Labeled as an eye irritant, wear protective equipment during application and avoid contact with eyes.

Recommended Mixture
- Use undiluted

Adjuvant
- None

Timing
- Apply anytime in summer if plants are actively growing.

Application Guidelines
- Apply 1 ml of hexazinone per frill that are spaced 2 inches apart.

Prescription Weakness:
- Does not control yellow poplar, hornbeam, sassafras.
- Moves in the soil.
- Relative cost, both chemical and application.

Prescription Strength
- Effective on hard-to-control species including: hickories, honeylocust and eastern redcedar.

Cost per 500 stems[1]:	¢¢
Overall Performance:	★★½
Itemized Performance	
Effective Speed:	★★
Woody Control:	★★★
Control Duration:	n/a
Hard to Control:	★★★★
Crop Tolerance:	★
Resistant Species:	★★★
Restrictions:	★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

[1]Average DBH of treated trees = 3 inches

Rank Notes:
- Restrictions: This product has a DANGER rating as an eye irritant. Extreme caution must be taken if using this product in tree injection.

References

- Clatterbuck, W.K.; Armel, G.R. 2010. Site preparation for natural regeneration of hardwoods. Professional Hardwood Notes. Publication PB1799. Knoxville, TN: University of Tennessee Extension, Institute of Agriculture. 12 p
- Herbicide labels for brands listed.

Triclopyr – *ester* (5–20 percent by volume)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Individual Plant Treatment

APPLICATION TIMING:
Dormant Season thru Early Summer

APPLICATION TYPE:
Basal Bark Spray

TARGET PLANTS:
Woody Plants
Chinese Tallowtree, Maple, Sweetgum, Kudzu, Greenbrier, Chinese Privet, Japanese Privet

This prescription is recommended for areas containing small stems that cannot be treated though other application types (i.e., hack-n-squirt). The treatment is most applicable to sites containing numerous small stems. Due to cost, best suited for sites with no more than 500 stems per acre to treat.

Available Products

Triclopyr (%/vol.)	List of Available Products
5–20%	Garlon XRT, Boulder 6.3
20%	Garlon 4 Ultra, Triclopyr 4, Tahoe 4E, Relegate, Element 4

Recommended Mixture

- Application rate is 15% for Garlon XRT and 20% Garlon 4 Ultra (or equivalent) volume-to-volume for a low volume basal application (typical).
- Rates may vary by percent solution based on stem size and species susceptibility (see label).

Adjuvant

- Mixing oil (see label)

Timing

- Most effective from dormant season through early summer. May be applied year round, except when bark is wet.

Application Guidelines

- Apply with a backpack or knapsack sprayer and basal wand. Apply 12–15 inches on the stem from the groundline up.
- Use on stems up to 4 inches diameter with rough bark, and stems up to 6 inches diameter with smooth bark.
- Treat all sides of stem.

Prescription Strength

- Controls small pine.

Prescription Weakness

- Relative cost is high.

Cost per 100 stems[1]:	$$$$
Overall Performance:	★★★
Itemized Performance	
Effective Speed:	★★★
Woody Control:	★★★
Control Duration:	n/a
Hard to Control:	★★★
Crop Tolerance:	★★★
Resistant Species:	★★★
Restrictions:	★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

[1]Average DBH of treated trees = 3 inches

Rank Notes:

- Relative Cost: Basal bark applications can be expensive, but may be best option (compared to injection) for sites containing numerous stems less than 2 inches diameter.

References

- Herbicide labels for brands listed.

Activity: Forest Roads and Fire Lanes
Crop Species: Pine and Oak

Forest Roads, Fire Lanes, and Wildlife Openings

Applications to forest roadsides, fire lanes and wildlife openings can provide significant ecological benefits, reduced fuel loads, reduced levels of mechanical operations and more efficient management of forest areas. However, there are many considerations to account for prior to application. Selecting the proper herbicide to be both effective for the desired outcome and avoid harm to nearby forests and waterways are the primary considerations of these applications. Other application considerations will include: nearby forest species mix, soil type, road conditions, barriers to effective application (such as dust-covered foliage), need for aquatic label, and need for grass control or release are all import factors that must be properly evaluated. Finally, precautions must be followed to protect any workers or other human traffic that could occur during or shortly after this type of application is made.

The number one factor in achieving a desired outcome will include determining what type of vegetative cover is desired after the application. Often, grass establishment is a primary desired outcome in each of these site scenarios. An objective to release and maintain grasses will limit the number of available herbicides for application. Other vegetative considerations will include: species to control, vegetation height, and vegetation density to be controlled.

Another consideration will include the forest species mix in neighboring forest stands. The nearby stand consideration can be complex as conditions may change along the length of a roadside, fire lane or wildlife opening. If pines are present, are they a single species such as loblolly, or does the area also contain shortleaf, slash or longleaf pine? In other scenarios, one may encounter pines on one side of the road and hardwoods on the other.

Other listed factors such as road conditions, stream crossings, soil type changes and barriers to application must also be considered for an effective application that does not result in non-target impact. Road conditions can impact the applicators ability to maintain speed for uniform application. Stream crossings or nearby water courses can create the need for the herbicide to have an aquatic label. Because these applications can cover long distances, soil types and textures are likely to vary at different locations, which could significantly impact the effectiveness of the herbicide being used. Finally, conditions such as dust-covered foliage could impact the efficacy of foliar active herbicides (such as glyphosate) due to an inability to reach the leaf surface. For the reasons stated, roadside applications can be a challenge to perform effectively. Take time to properly evaluate and plan the operation prior to application.

Triclopyr (3.15 pounds a.e./acre – ester)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Forest Roads and Fire Lanes

CROP SPECIES:
Grasses

SITE CONDITIONS:
Roadside, Fire Lane, Wildlife Opening

APPLICATION TIMING:
Growing Season after Full Leaf Out

APPLICATION TYPE:
Ground Broadcast

TARGET PLANT:
Woody Plants, Vines, Broadleaf Plants

This herbicide prescription is to be used to help establish and maintain grasses and control woody plants and annual and perennial broadleaf weeds on forest roads, firelanes and wildlife openings. It is applied as a ground-applied foliar treatment. A High Volume Foliar Treatment (HVFT) is typically used as a reclamation tool used when undesirable brush densities and height are high. Once an HVFT or a mechanical mower has reclaimed the rights-of-way, the brush can be targeted with a Low Volume Foliar Treatment (LVFT) which is best suited for lower densities of brush with an average height between three to six feet when treated with a backpack sprayer and UTV mounted low volume sprayers.

Available Products

Triclopyr (vol./ac.)	List of Available Products
2.0 quarts	Garlon XRT, Boulder 6.3
3.2 quarts	Garlon 4 Ultra, Element 4, Triclopyr 4, Tahoe 4E, Relegate

⚠ Do not apply this product during extreme hot and dry conditions, or when leaves are covered with dust.

Adjuvant

- Use a minimum of ½% (typically 1%) by volume nonionic surfactant.

Timing

- Growing season after full leaf out.

Application Guidelines

- (HVFT): Apply the recommended rates in at least 50 gallons total spray solution per acre for mechanical broadcast ground spray.
- (LVFT): Apply the recommended rates in 40 gallons total spray solution per acre for broadcast or directed spray.

When to Adjust Prescription

- When hard to control species are prevalent or during applications made in late summer when the plants are mature and temperatures are high, consider an alternative application.

Cost per acre:	$
Overall Performance:	★★★
Itemized Performance	
Grass Control:	none
Broadleaf Control:	★★★
Woody Control:	★★★
Vine Control:	★★★
Effective Speed:	★★★★
Control Duration:	★★
Hard to Control:	★★★
Crop Tolerance:	★★★★
Resistant Species:	★★★
Natural Pine Control:	none
Restrictions:	★★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Restrictions: Avoid applications in hot and dry conditions to reduce risk of volatilized drift.
- Crop Tolerance: Nearby forest crop tolerance is high as long as spray does not reach nearby crop tree foliage.
- Grass Control: This application will help to promote native grasses which is desired on forest roads and fire lanes.

References

- Herbicide labels for brands listed.

Aminopyralid (0.11 pounds a.e./acre)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Forest Roads and Fire Lanes

CROP SPECIES:
Grasses

SITE CONDITIONS:
Roadside, Fire Lane, Wildlife Opening

APPLICATION TIMING:
Early Growing Season

APPLICATION TYPE:
Ground Broadcast

Target Plant:
Broadleaf Plants

This herbicide prescription is useful to help establish and maintain grasses and control annual, biennial and perennial broadleaf weeds on forest roads, fire lanes and wildlife openings. This protocol is for ground-based foliar treatment where plant selectivity is desired.

Available Products

Aminopyralid (vol./ac.)	List of Available Products
7 ounces	Milestone

Adjuvant

- Non-ionic surfactant should be used in spray mixtures at 1–2 quarts per 100 gallons of spray mixture.

Timing

- Anytime when plants are actively growing.

Application Guidelines

- Apply the recommended rates in a minimum of 10 gallons or more total spray solution per acre for ground broadcast treatments.

When to Adjust Prescription

- Rates may be increased for better control of woody species or some other target plants using label recommended methods. See label for details.

Prescription Weakness

- Does not provide good woody control without a tank mix partner.

Cost per acre:	¢¢
Overall Performance:	★★★
Itemized Performance	
Grass Control:	none
Broadleaf Control:	★★★★
Woody Control:	★
Vine Control:	★★★
Effective Speed:	★★★★
Control Duration:	★★★
Hard to Control:	★★★
Crop Tolerance:	★★★
Resistant Species:	★★★
Natural Pine Control:	★
Restrictions:	★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Restrictions: Do not apply near water. Restrictions exist for areas to be hayed or foraged.

References

- Herbicide labels for brands listed.

Aminopyralid plus Triclopyr (premixed at 1.1 pounds a.e./acre)

GENERAL USE / SINGLE PRODUCT

OPERATION:
Forest Roads

CROP SPECIES:
Grasses

SITE CONDITIONS:
Any

APPLICATION TIMING:
Anytime When Plants are Actively Growing

APPLICATION TYPE:
Ground Broadcast

Target Plant:
Broadleaf Plants, Woody, Shrubs, Vines, Trees

This herbicide prescription is useful to help establish and maintain grasses and control selected woody plants, annual, biennial and perennial broadleaf weeds on forest roads, fire lanes and wildlife openings.

Available Products

Aminopyralid (vol./ac.)	List of Available Products
9 pints	Capstone

Adjuvant

- Non-ionic surfactant should be used in spray mixtures at 1 to 2 quarts per 100 gallons of spray mixture.

Timing

- Apply anytime when plants are actively growing.

Application Guidelines

- Apply the recommended rates in 20 gallons or more total spray solution per acre for broadcast treatments.

When to Adjust Prescription

- If dense, non-legume woody species are to be controlled consider an alternative application.

Prescription Weakness

- May provide only partial control for many woody species.

Cost per acre:	$$
Overall Performance:	★★★
Itemized Performance	
Grass Control:	none
Broadleaf Control:	★★★★
Woody Control:	★★
Vine Control:	★★★
Effective Speed:	★★★★
Control Duration:	★★★
Hard to Control:	★★★
Crop Tolerance:	★★★
Resistant Species:	★★★
Natural Pine Control:	★
Restrictions:	★★

Fewer $ symbols indicates lower cost of chemistry per applied acre. A greater number of ★ indicates better performance.

Rank Notes:

- Woody Control: Will control woody legumes, poplar, poison ivy, wisteria, sumac, kudzu and rose.
- Restrictions: Do not allow direct application to enter water. Restrictions exist for areas to be hayed or foraged.

References

- Herbicide labels for brands listed.

Reference Tables
Crop Species: Pine and Oak

Table 10. Herbicide toxicity categories.

Toxicity Category	Description	Signal word	Oral LD_{50} (mg/kg)	Dermal LD_{50} (mg/kg)	Inhalation LD_{50} (mg/kg)	Eye effects	Skin effects	Amount needed (orally) to kill an average sized person
I	Highly Toxic and Severely Irritating	Danger	<50	<200	<0.2	Corrosive; corneal opacity not reversible within 7 days	Corrosive	A taste (<7 drops) to a teaspoonful
II	Moderately Toxic and Moderately Irritating	Warning	50-500	200-2,000	0.2-2.0	Corneal opacity reversible within 7 days; irritation persisting for 7 days	Severe irritation at 72 hours	A teaspoonful to an ounce
III	Slightly Toxic and Slightly Irritating	Caution	500-5,000	2,000-20,000	2.0-20	No corneal opacity; irritation reversible within 7 days	Moderate irritation at 72 hours	An ounce to a pint
IV	Practically Non-toxic and Not an Irritant	Caution	>5,000	>20,000	>20	No irritation at 72 hours	Mild or slight irritation	Greater than a pint

Table 11. Approximate oral LD_{50} for common silvicultural herbicides.

Common Name	Approximate LD_{50} (mg/kg)	Oral Toxicity Rating	Signal Word
aminopyralid (Milestone)			Danger
clopyralid (Transline)	> 5,000		Caution
dicamba (Vanquish)	757 -1707	III	Caution
fosamine (Krenite S)	> 5,000	IV	Caution
glyphosate (Accord XRT II, Roundup)	> 5,000	IV	Caution
hexazinone (Velpar)	> 5,000	IV	Danger
imazapyr (Arsenal)	> 5,000	IV	Caution
metsulfuron methyl (Escort)	> 5,000		Caution
picloram (Tordon 22K)	> 5,000	III	Caution
saflufenacil (Detail)	>2000	III or IV	Caution
sulfometuron-methyl (Oust)	> 5,000	IV	Caution
triclopyr-ester (Garlon XRT)	2,460	III	Caution
triclopyr-amine (Garlon 3A)	2,830	III	Danger
triclopyr-choline (Vastlan)			Warning
2,4-D-choline (Freelexx)			Danger

Table 12. Formulations abbreviations.

Abbreviation	Term	Abbreviation	Term
A	Aerosol	M or ME	Microencapsulated
AF	Aqueous flowable	MTF	Multiple temperature formulation
AS	Aqueous solution or aqueous suspension	P or PS	Pellets
B	Bait	RTU	Ready to use
C	Concentrate	S	Solution
CM	Concentrate mixture	SD	Soluble dust
CG	Concentrate granules	SG	Soluble granule
D	Dust	SP	Soluble powder or soluble packet
DF	Dry flowable	TC	Termiticide concentrate
DS	Soluble dust	ULV	Ultra low volume
E, EC, or EW	Emulsifiable concentrate	W or WP	Wettable powder
F	Flowable (liquid)	WDG	Water-dispersible granules
G	Granules	WS	Water soluble
GL	Gel	WSG	Water-soluble granules
L	Liquid (flowable)	WSL	Water-soluble liquid
LC	Liquid concentrate or low concentrate	WSB or WSP	Water-soluble bag, powder, or packet

Table 13. Units of Measure.

Abbreviation	Term	Abbreviation	Term
fl. oz.	fluid ounce	pt.	pint(s) (1 .04 lb. of water)
ac	acre	pt./100	pint(s) per 100 gallons
c.	cupful	qt.	quart(s) (2.09 pounds of water)
ft.	feet	sq. ft.	square feet
gal.	gallon(s) (8.35 pounds of water)	sq. in.	square inch
in.	inch	tbsp	tablespoonful
lb.	pound	tsp.	teaspoonful
mi.	mile	yd.	yard
oz.	ounce		

Table 14. Fluid ounces of herbicide needed for desired solutions.

Gallons of Mix	Fluid ounces of herbicide needed for desired solution (%)											
	0.25%	0.5%	0.75%	1.0%	1.25%	1.5%	2.0%	2.5%	3.0%	5.0%	10.0%	15.0%
1	0.3	0.6	1.0	1.3	1.6	1.9	2.6	3.2	3.8	6.4	12.8	19.2
2	0.6	1.3	1.9	2.6	3.2	3.8	5.1	6.4	7.7	12.8	25.6	38.4
3	1.0	1.9	2.9	3.8	4.8	5.8	7.7	9.6	11.5	19.2	38.4	57.6
4	1.3	2.6	3.8	5.1	6.4	7.7	10.2	12.8	15.4	25.6	51.2	76.8
5	1.6	3.2	4.8	6.4	8.0	9.6	12.8	16.0	19.2	32.0	64.0	96.0
10	3.2	6.4	9.6	12.8	16.0	19.2	25.6	32.0	38.4	64.0	128	192
15	4.8	9.6	14.4	19.2	24.0	28.8	38.4	48.0	57.6	96.0	192	288
30	9.6	19.2	28.8	38.4	48.0	57.6	76.8	96.0	115.2	192	384	576
100	32.0	64.0	96.0	128	160	192	256	320	384	640	1280	1920

Example: To prepare 3 gallons of a spray mixture (herbicide, water, and surfactant) containing 1% herbicide, add 4 ounces of herbicide.

Glossary of Terms – As defined by the Weed Science Society of America (http://wssa.net/wssa/wssa-glossary)

Active ingredient (AI)	The chemical herbicide formulation primarily responsible for its phytotoxicity and which is identified as the active ingredient on the product label.
Acid equivalent (AE)	The theoretical yield of parent acid from a pesticide active ingredient which has been formulated as a derivative.
Adjuvant	Any substance in an herbicide formulation or added to the spray tank to modify herbicidal activity or application characteristics.
Band treatment	Applied to a linear restricted strip on or along crop rows rather than continuous over the field area.
Basal treatment	Applied to encircle the stem of a plant just above the soil surface such that foliage contact is minimal. A term used mostly to describe treatment of woody plant.
Broadcast rate equivalent	For band treatments, it is the amount of herbicide applied per unit area when only the band area is considered. All rates for band treatment should be expressed as the broadcast rate equivalent. Broadcast treatment – Applied as a continuous sheet over the entire field.
Brush control	Control of woody plants such as brambles, sprout, clumps, shrubs, trees, and vines.
Chemical name	The systematic name of a chemical compound according to the rules of nomenclature of the international union of pure and applied chemistry (IUPAC), chemical abstracts service, or other organization. Chemical names presented in this handbook are those of the chemical abstracts' service.
Coarse-textured soil	The texture exhibited by sands, loamy sands, and sandy loams except very-fine sandy loam.
Common name	A generic name for a chemical compound.
Fined-textured soil	Consisting of or containing large quantities of the fine fractions, particularly of silt and clay. Includes clay loam, sandy clay loam, silty clay loam, sandy clay, silty clay, and clay textural classes. Sometimes subdivided into clayey texture and moderately fine texture.
Formulation	(1) A pesticide preparation supplied by manufacturer for practical use. (2) the process, carried out by manufacturers, of preparing pesticides for practical use.
Herbaceous plant	A vascular plant that does not develop persistent woody tissue above ground.
Herbicide	A chemical substance or cultured biological organism used to kill or suppress the growth of plants.
Herbicide resistance	The trait or quality of a population of plants within a species or plant cells in tissue culture of having a tolerance for a particular herbicide that is substantially greater than the average for the species and that has developed because of selection for naturally occurring tolerance by exposure to the herbicide through several reproductive cycles.
Label	The directions for using a pesticide approved as a result of the registration process.
Medium-textured soil	Intermediate between a fine- and coarse-textured soil. Includes very fine sandy loam, loam, silt loam, and silt textural classes.

Non-selective herbicide	A herbicide that is generally toxic to all plants treated. Some selective herbicides may become non-selective if used at very high rates.
Non-target species	A species not intentionally affected by a pesticide.
Over-the-Top	(Overtop Application) A broadcast or banded application applied over the canopy of crops such as by airplane or a raised spray boom of ground equipment.
Postemergence (POST)	(1) Applied after emergence of the specified weed or crop. (2) Ability to control established weeds.
Preemergence (PRE)	(1) Applied to the soil before emergence of the specified weed or crop. (2) Ability to control weeds before or soon after they emerge.
Rate	For herbicides, a quantity of active ingredient or parent compound equivalent expressed as moles or mass per unit area of treated surface or per unit volume of the treated environment (for aquatic or vapor applications). Rates expressed as formulated product should not be used in scientific publications.
Residual herbicide	A herbicide that persists in the soil and injures or kills germinating weed seedlings for a relatively short period of time after application. See persistent herbicide.
Resistance	Ability to withstand exposure to a potentially harmful agent without being injured (there is no general agreement as the distinction between herbicide tolerance and herbicide resistance in plants).
Soil pH	The negative logarithm of the hydrogen-ion concentration of a soil. The degree of acidity or (alkalinity) of a soil as determined by means of a glass, quinhydrone, or other suitable electrode or indicator at a specified moisture content or soil-water ratio, and expressed in terms of the pH scale.
Soil texture	The relative proportions of the various soil separates in a soil as described by the classes of soil texture: sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, and clay. Textural classes may be modified by the addition of suitable adjectives when coarse fragments are present in substantial amounts; for example, “stony silt loam”, or “silt loam, stony phase.” The sand, loamy sand, and sandy loam are further subdivided on the basis of the proportions of the various sand separates present.
Solution	A homogeneous or single phase mixture of two or more substances.
Spot treatment	A herbicide applied to restricted area(s) of a whole unit; i.e., treatment of spots or patches of weeds within a larger field.
Spray drift	Movement of airborne spray from the intended area of application.
Surfactant	A material that improves the emulsifying, dispersing, spreading, wetting or other properties of a liquid by modifying its surface characteristics.
Susceptibility	The sensitivity to or degree to which a plant is injured by a herbicide treatment.
Tank-mix combination	Mixing of two or more pesticides or agricultural chemicals in the spray tank at the time of application.

Tolerance	(1) Ability to continue normal growth or function when exposed to a potentially harmful agent (there is no general agreement as to the distinction, between herbicide tolerance and herbicide resistance in plants). (2) The concentration of a pesticide residue that is allowed in or on raw agriculture commodities as established by the environmental protection agency.
Toxicity	The quality or potential of a substance to cause injury, illness, or other undesirable effects.
Trade name	A trademark or other designation by which a commercial product is identified.
Weed	Any plant that is objectionable or interferes with the activities or welfare of man.
Weed control	The process of reducing weed growth and/or infestation to an acceptable level.

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