TENNESSEE STATE UNIVERSITY
College of Agriculture, Human & Natural Sciences
Cooperative Extension Program

An Outreach Education Program Serving Limited Resource Individuals, Families and Communities

Understanding, Selecting, and Applying Herbicides for Vegetation Management in Tennessee Forestry

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Herbicides for vegetation control in forestry has become well established. The development of more cost effective herbicides and application equipment has led to the increased use of this forest management tool. Economic studies show that significant growth and improved survival are possible when woody and herbaceous competition is controlled.

HERBICIDE USE

Herbicides are used in many ways: 1) release of newly established seedlings, 2) woody release of young trees, and 3) for site preparation to establish a new stand of trees.

Most cut-over areas or new sites require some type of site preparation and/or release for successful tree establishment. Vegetation control can also be of value when maintaining natural stands of pines or pine-hardwood mixtures. When pines are planted on old-field or new sites, herbaceous weeds can significantly retard growth and reduce pine survival.

In many situations, control of competing vegetation can best be done with herbicides where mechanical control is not possible.

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What Are Herbicides?

Herbicides are chemicals that suppress or kill certain plant growth. They affect plants by disrupting some internal growth or development function. Most herbicides do not affect humans and animals since our growth and development is different from that of plants. Thus, forest herbicides are considered safe, when specific label directions are followed.

Safety and Environmental Protection

Care must be taken when handling concentrated herbicides to protect eyes, internal tissue and skin. Many herbicides are formulated in common petroleum or alcohol type carriers that may cause severe irritation or tissue damage. At a minimum, wear a long-sleeve shirt, long pants, plastic or neoprene gloves and some type of eye protection. Follow specific label requirements for protective clothing and equipment that may be required. (Some production equipment may be difficult to use so always use common sense).

Herbicides registered for forestry uses by the United States Environmental Protection Agency (EPA) and Tennessee Department of Agriculture, Pesticide Division have been well tested. More than one herbicide and application method may be registered for use on the same site. Choose the herbicide or combination that will most effectively and economically control the targeted plants. *Applying a herbicides not registered, or for uses not indicated on the label, is illega*l, *and may cause adverse effects to non-targeted species or the environment. Always read the label before using any herbicide.* Copies of the label(s) and the "Material Safety Data Sheet(s)" (MSDS) must be read and understood before a herbicide application is made. These are available from suppliers and manufacturers. Also get information on endangered species, for there may be restrictions on the use of certain materials in your area. Then, read and carefully follow information on the label and the MSDS for a safe, effective herbicide application.

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The laws require that applicators be certified before they can purchase or apply "restricted use" pesticides, but it is suggested that applicators of any pesticide be certified. The certification process will add to your knowledge about herbicide safety and attest to your competency.

Applicators for hire must be certified before they use any pesticide, and they must have a pesticide contractors license and sufficient liability insurance. (Contact your Tennessee Department of Agriculture for further information)

Forest Weeds

Forest weeds are unwanted vegetation that compete or interfere with timber and other resource management objectives. The weeds can be obstacles to regeneration, crop development and growth as they compete for moisture, nutrients and light. They may be classified as weed trees, brush, vines and herbaceous weeds (broadleaf weeds and grasses). The following section attempts to address weed control as it relates to specific sites.

Site Evaluation

***Soil Type*:** Soil type influences the effective performance of a herbicide. If the soil is high in clay, a higher rate of an herbicide (within the recommended rate range) is more effective, because herbicides have a tendency to be readily adsorbed to or tied-up by clay particles, making the herbicide less available for weed kill. Herbicides applied to clay soils will not readily leach or volatilize. If the soil is high in sand, a lower rate of a herbicide (within the recommended rate range) is more effective. Because herbicides applied to sandy soils are not readily tied up, they will effectively kill the weeds. However, herbicides applied to sandy soils can be easily leached and volatilized, making long-term weed control more difficult.

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Weed Species: Since selectivity of plants to herbicides is an important factor in good weed control, the weed species must be properly identified to allow the selection and application of an effective herbicide. If the weed species is not on the herbicide label, the weeds will not be killed.

Pine Species: There are several pine species, so it is important that the herbicide you use is recommended for the pine species you have planted. Some pine species have good tolerance to an herbicide while others will not tolerate the herbicide toxicity.

Climatic Conditions: Climatic conditions such as rainfall and temperatures are critical to the performance of an herbicide. Under normal conditions, adequate moisture and warm temperatures will allow better herbicide uptake and foliar absorption, resulting in better weed kill. If temperatures are too cool (below 50˚F), herbicide uptake by roots and leaves will be greatly reduced. If soil moisture is limited (<40 to 50 percent of field capacity), plants are stressed, causing poor herbicide uptake and creating a condition for potential pine tree damage. Before and herbicide is applied it is important that soil moisture and temperature are adequate.

Herbicide Selection: A limited number of herbicides registered for use in newly planted pines. The selection of a herbicide must be based on the weeds present or expected. If the herbicide has only preemergence activity, it must be applied to the soil before weeds begin to emerge. If the herbicide has both preemergence and postemergence activity, it may be applied after weeds emerge but before they get too large (not over two to four inches tall). If the herbicide has only postemergence activity, it must be applied after the weeds emerge but before they get too large.

Herbicide Application: If the application and equipment calibration is not done correctly, maximum performance from the treatment will not be achieved. Therefore, it is important to use the correct volume and pressure and appropriate equipment. If a band treatment is used, the band

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width should correspond to the weed species. If the weed species present are of the low-growing type, such as grasses (except Bermuda), a three-to four-foot band is adequate. If weed species are of the tall-growing type, a five- to six-foot band is needed.

PINE RELEASE AND SITE PREPARATION

Woody vegetation control includes control of competing trees, shrubs and woody vines. This is for the release of two- to five-year old stands of pine trees from competition or for site preparation of cut-over areas to permit the establishment of a new stand. In pine production areas, this usually means control of the less desirable hardwood species. Not all hardwoods that interfere with the establishment or growth of more desirable trees grown for a specific purpose such as timber, wildlife food or scenic vistas.

Herbicide Application

Aerial application is generally used for site preparation before reforesting or planting seedling trees on an area. It is best used on large tracts, tracts with difficult access, or tracts on which the height of the remaining trees to be controlled precludes ground application. These areas can be treated in less time and often more economically by air.

Most forest herbicides are labeled for helicopter application only. Application with fixed-wing aircraft may not be as effective and is more subject to drift.

Ground application can be done with machines that are more versatile than aircraft. The machines can treat small or large areas and are not so limited by weather as aircraft. They are not as visible as aircraft, so they are not as apt to arouse public attention or concern. However, ground machine application is limited by of terrain and stand conditions.

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Crawler tractors, skidders, four-wheel drive farm tractors and the sturdier all-terrain-vehicles can be used for herbicide application. The selection depends on the job to be done and the site conditions.

Because of the expensive, specialized equipment necessary for aerial and mechanized ground application, consulting foresters and vendors are needed for this work. Much of the vegetation control can be done by hand application. Some areas can best be treated or can only be treated using hand equipment. Hand equipment is relatively inexpensive and the application techniques are not difficult. Individual landowners, or the labor they hire, can often do the job.

Hand application methods are most often used for individual stem treatments, but you can treat entire areas for site preparation or release with crews using hand application equipment. The spot-grid application is one way to treat areas. This is done with metered dosage spot-guns or other calibrated hand-delivery devices that apply chemicals very accurately. Carefully calibrated equipment is necessary because a soil-active herbicide is applied at very concentrated rates. The spots of concentrated herbicides are placed on the soil in a grid pattern throughout the area. This locates one or more spots so the herbicide comes in contact with the roots of the hardwoods to be controlled. Soil spots may also be placed around individual stems if there are not enough stems present for a larger area to be treated.

If hardwood stems are not numerous and are generally less than three inches in diameter, a modified basal spray is an effective area treatment. This is the streamline or thinline basal treatment, and is applied with a backpack sprayer using a solid stream nozzle tip. The applicator shoots a low volume of herbicide and penetrant mixture across the base of small hardwood stems and clumps. The mixture is applied as a solid stream in one or more narrow bands six to 12 inches above the ground line. A slashing motion back and forth across the small hardwoods

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or sprout clumps is used to apply the herbicide. Spray stems two to three inches in diameter on two or more sides. Larger trees or trees with thick, rough bark will not be killed unless they are completely wet on all sides. Areas with more than a few large trees should be treated with a different method.

Use backpack sprayers to apply foliar treatments to individual hardwoods. This technique is primarily for release of one- to three-year-old pine plantations or natural stands. Certain herbicides are labeled for this use and will not kill the pines if properly applied. However, do not spray the pines. With a backpack sprayer and wand, apply the diluted spray solution to the foliage of competing hardwoods between full leaf and early fall. For best results and efficiency of application, hardwoods should be less than six feet tall. On areas with more than 500 stems per acre, other types of broadcast application or control methods are more economical.

Various cut-surface treatments are effective and economical if the stems per acre are not numerous. These treatments control woody species that have passed the brush stage.

Application equipment may be a hatchet and squirt-bottle or a specialized tree injection tool. A tree injector wounds the tree bark and places herbicide in the wound. The injector may be a pipe with a chisel-like bit on the lower end, or a hatchet with a built-in calibrated pump.

Chisel types directed at the base of the tree are safer to use. Injections with these tools are usually spaced one to four inches apart, depending on species and chemical. Hatchet types are used at any convenient level, but care must be taken to prevent injury from glancing cuts. When using a hatchet and diluted herbicides, encircle the tree with overlapping cuts called frills. Chips should not be removed, but left to help retain the herbicide in the cuts. Use herbicides formulated from water-soluble salts for all cut-surface treatments. They can be used at full strength as packaged by the manufacturer, but are diluted when used in un-metered injectors or squirt-bottles.

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Hand-operated granular spreaders are used to apply soil-active herbicides. Some materials are selective and are labeled for herbaceous control over newly established pines or for woody release in older pines. Treatments are more effective when applied in the spring before full leaf out. It is often difficult to get even distribution with hand-operated spreaders because trees and brush interrupt the herbicide distribution. The vegetation also makes it difficult for the applicators to maintain uniformly spaced, parallel treatment swaths.

Appropriate application methods are specified on herbicide labels. Currently labeled herbicides and their recommended rates are updated each year see tables 1, 2, 3, 4, 5. Additional information is available at your county Extension office or Chemical Dealer.

This information should help you understand the requirements for an effective, economical and safe vegetation control operation.

There are various herbicides registered for use in planted pines, these herbicides or herbicide combinations will not give 100 percent control of all weed species, but if these treatments are properly applied and conditions are favorable, adequate control will be obtained. It is recommended that all herbicide treatments be made at the appropriate time. The following tables list herbicides and uses for weed control in pines.

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TABLE 1: **HERBICIDES FOR HERBACEOUS WEED CONTROL IN PINE PLANTATIONS**

HERBICIDE FORMULATION	RATE/ACRE (BROADCAST)	REMARKS & PRECAUTIONS
Atrazine (AAtrex Nine-0 & other trade names)* or (AAtrex 4L & other rade names)*	2.2 - 4.4 lbs. Nine-O or 4 - 8 pts. 4L	Atrazine provides both preemergence and postemergence activity. Apply in a minimum of 10 gallons of water per acre. Application may be made as a directed spray or over the top of pines, but before weeds exceed 1.5 inches. This treatment will control many annual grasses and broadleaf weeds. The addition of an oil concentrate containing 1 percent to 20 percent surfactant will improve the control of existing weeds. Use only on loblolly and slash pines.
Fluazifop-P-buytl 2.0 lb. a.i./gal. (Fusilade DX)	16-24 oz..	Apply in at least 25 gallons of water per acre. Application should be made over the top of pines and actively growing grasses. Always add 1.0 percent crop oil concentrate, or 0.25 percent of a non-ionic surfactant by volume. This treatment will give only post emergence control of grassy weeds. A split application may be necessary for perennial grasses. Fusilade will not control broadleaf weeds or sedges Fusilade may be used on all pine species.
Glyphosate (Accord) + Sulfometuron methyl (Oust) 75 DF	16 - 24 oz. Loblolly 12 - 16 oz. Slash + 2 - 4 oz.	Apply in at least 25 gallons of water per acre. Application should be made to actively growing broadleaf weeds and grasses. Non-ionic surfactant at 0.25 percent by volume should be added to help improve control. Do not apply this mixture during rapid candle expansion when over-the-top application is contemplated. This treatment will control many grasses, broadleaves, and sedges and give suppression of blackberries/brambles. Use only on loblolly and slash pines. Do not exceed 16 fl. oz. of accord on slash pines.
Imazapyr Arsenal – 4E (Applicators Concentrate)	4-10 oz.	Apply over-the-top or as a directed spray to pines. Apply in at least 25 gallons of water/A. The addition of 0.25% of a non-ionic surfactant by volume will help improve control. This treatment will provide good control of most grasses and broadleaf weeds and suppression of blackberries/brambles. This treatment is a good fit in areas where Johnsongrass and Bermuda grass are serious problems. Arsenal will provide both preemergence and postemergence weed control. Use 6.0-10 fl.oz. on loblolly pines. 4-8 fl. oz on slash pines and 4-6 fl oz on long leaf pines.
Metsulfuron methyl (Escort) 60 DF	0.5 - 1 1/2 oz.	Apply over-the-top or directed in at least 25 gallons of water/A for the control of many broadleaf weeds. This treatment is especially good where blackberries brambles are a problem. Do not use a surfactant when treating pine trees that are less than 1 year old. Use only on loblolly and slash pines.
Clethodim (Envoy) 0.94 lbs. a.i./gal.	13 to 17 ozs.	Apply over the top for control of annual and perennial grasses. Make application in enough water for good coverage (20-30 gallons per acre). The addition of a crop oil concentrate on a non-ionic surfactant will improve control. This treatment may be used on all pine species. Do not apply under drought conditions.
Sethoxydim (Vantage) 1.0 L	2 1/4 - 3 3/4 pts.	Apply in at least 25 gallons of water to actively growing grassy weeds. A split application may be necessary to help control perennial grasses. Do not add surfactant or crop oil to Vantage. This treatment will not control sedges or broadleaf weeds
Sulfometuron methyl (Oust)	2 - 8 oz.	Controls herbaceous weeds in Loblolly, slash, longleaf and Virginia pine. Do not use a surfactant. Use broadcast or band application before or just after weed emergence.
Sulfometuron methyl (Oust) + Hexazinone (Velpar L)	2 - 4 oz. + 2 - 3 pts.	Apply in at least 20 gallons of water/A for the control of many broadleaf weeds, vines and small woody plants. This treatment is especially good in areas where sprouts from roots of woody plants might become a serious problem.
Sulfometuron methyl + Hexazinone (Oustar) 75 DF	Rates vary by soil texture & seedling age and species *(See Label)*	Apply oustar to loblolly pines, slash pines, or long leaf pine seedling for the control of many grasses and broadleaf weeds. Make application of 12-16 oz./A to first year seedlings established for more than one year. Make application in 10-40 gallons per acre. Do not apply under drought stressed conditions.
Sulfometuron methyl (Oust) 75 DF + Metsulfuron methyl (Escort) 60 DF	2-3 oz. + 0.5 - 1.5 oz.	For control of blackberry and herbaceous weeds in Loblolly pine plantations. Apply from late winter through spring after soil has settled after planting. Do not use a surfactant.

TABLE 2: **FOREST HERBICIDES (continued)**

Site Preparation

HERBICIDE FORMULATION	RATE/ACRE (BROADCAST)	REMARKS & PRECAUTIONS
Picloram (Tordon K)* 2 lbs. a.i./gal.	2 qts.	Apply 5-25 gallons spray mix by air or 10 to 100 gallons mix by ground. Do not plant pines sooner than 6 months after treatment.
Triclopyr (Garlon 3A) 3 lb. a.i./gal.	2 - 3 gals.	Conifers planted sooner than 2 months after treatment may be injured.
Triclopyr (Garlon 4) 4 lb. a.i./gal.	4 - 8 qts.	Apply when target vegetation is actively growing. Apply to foliage with 5 - 25 gal. spray volume per acre by air or 10 - 100 gal. by ground.
Picloram + 2,4-D (Tordon 101M)* 2.5 lb. a.i./gal.	6 - 8 qts.	Delay planting of pines for at least 6 months following treatment to avoid pine seedling injury.
Imazapyr (Arsenal) 4 lbs. a.i./gal.	1 1/2 - 2 1/2 pts.	Use a minimum of 1/4% by volume of nonionic surfactant in the spray mix.
Imazapyr (Chopper) 2 lbs. a.i./gal.	40 - 80 oz.	Enhance brownup by appling Chopper in a 12-50% oil:water (volume:volume) emulsion carrier. Methylated or ethylated seed oils containing at least 50% esterfied seed oil by volume are recommended.
2, 4-D (Various trade names)	varies by a.i.	Check specific product labelsfor rates. Provides broadleaf weed control. Typically, apply recommended rate in 10 gal. of solution by air or 20 gal. by ground. Do not apply to established plantations as injury to planted pines will occur.
Hexazinone (Velpar ULW)	2 1/2 - 8 lbs.	Herbaceous weeds and plants. Soluble granular formulation. Apply using DuPont ULW Applicator aerial equipment in spring when weeds and brush are actively growing. Rainfall is needed for activation. Use lower rates on coarse texture soils and soil low in organic matter. Do not use on poorly drained or marshy sites. Maximum results will be seen in 12-24 months following treatment. Allow treated brush and trees to defoliate twice before burning.
Hexazinone (Velpar L)	1 - 3 gals.	Controls herbaceous weeds, brush and trees. Apply liquid mix in at least 5 gal./A by air or 25 gal./A by ground. Treat from bud break in late winter to early summer. Allow brush to defoliate twice before burning.
Metsulfuron methyl (Escort)	1/2 - 3 1/3 oz.	For control of blackberry and other broadleaf weeds use 1/2 - 1 1/2 ozs. Use 3 1/3 ozs. for control of cherry, locust, palmetto, and honeysuckle. Loblolly and slash pine only.
Sulfometuron methyl (Oust)	2 - 8 ozs.	Add 0.25% by volume surfactant for improved control. Use lower rates on coarse textured loamy sands, sandy loams soils and higher rates on fine textured sandy clay loam and silty clay loam soils. Apply just before or just after weed emergence and when rainfall will activate Oust in the soil.
Glyphosate (Accord) 4 lbs. a.i./gal.	2 - 5 qts. ***Directed/spot spray 3/4 - 2% by volume***	May increase Accord rate to 10 qts./A for hard to control trees, brush and weeds. A nonionic surfactant must be used with Accord. For surfactants with more than 50% a.i., mix 2 qts. surfactant per 100 gal. of spray solution. Surfactants less than 50% a.i. mix 4 qts. surfactant per 100 gal. spray solution. Apply to actively growing trees, brush, and weeds after full leaf expansion and before fall color and leaf drop. Aerial broadcast - apply 5-30 gal./A spray volume; ground broadcast - apply 10-60 gal./A spray volume; direct/spot spray - spray to wet foliage.
Glyphosate (Accord Site Prep) 4 lbs. a.i./gal.	2 - 10 qts. Directed/spot spray 3/4 - 2% by volume	This formulation contains a surfactant & no addition surfactant need be added. Do not use this formulation as an over-the-top pine release treatments as damage to desired conifers will occur. Apply to actively growing trees, brush, and weeds after full leaf expansion and before fall color and leaf drop. Aerial broadcast - apply 5-30 gal./A spray volume; ground broadcast - apply 10-60 gal./A spray volume; direct/spot spray - spray to wet foliage.

TABLE 3: **FOREST HERBICIDES (continued)**

HERBICIDE TANK MIXES FOR SITE PREPARATION

HERBICIDE FORMULATION	RATE/ACRE (BROADCAST)	REMARKS & PRECAUTIONS
Triclopyr (Garlon 4) + Imazapyr (Arsenal)	2 - 4 qts. + 16 - 24 ozs.	Conifers planted sooner than 1 month after treatment may be injured.
Picloram + 2, 4-D (Tordon 101M)* + Glyphosate (Accord)	6 - 10 qts. 3 - 5 qts.	Allow at least 6 months after treatment before planting pines.
Picloram + 2,4-D (Tordon 101M)* + Imazapyr (Arsenal)	6 - 10 qts. + 16 - 24 oz.	Allow at least 6 months after treatment before planting pines.
Triclopyr (Garlon 4) + Picloram + 2,4-D (Tordon 101M)*	2 - 4 qts. + 6 - 8 qts.	Allow at least 6 months after treatment before planting pines.
Triclopyr (Garlon 4) + Picloram (Tordon K)*	2 - 4 qts. + 2 - 2 1/2 qts.	Allow at least 6 months after treatment before planting pines.
Glyphosate (Accord) 4 lbs. a.i./gal. + Picloram (Tordon K)*	3 - 5 qts. + 2 qts./A	Wood brush, trees, and herbaceous weeds mix 2 or more qts. of a nonionic surfactant per 100 gal. of spray solutions. Apply tank mix solution at 10-50 gal./A with ground application, or 5-30 gal./A by aerial (helicopter only) application. Allow 6 months after treatment before planting pine seedlings.
Glyphosate (Accord) 4 lbs. a.i./gal. + Imazapyr (Arsenal)	3 - 6 qts. + 2 - 16 oz.	Use lower rates for herbaceous weed control. Higher rates for dense stands or hard to control brush and trees. Use a nonionic surfactant, mix 2 or more qts. nonionic surfactant per 100 gal. spray solution. Ground application - spray 10-60 gal. of tank mix per acre; aerial (helicopter) application - spray 5-30 gal. tank mix per acre. Apply after full leaf expansion until start of fall color.
Glyphosate (Accord) 4 lbs. a.i./gal. + Sulfometuron methyl (Oust)	2 - 5 qts. + 2 - 4 ozs.	Mix 2 or more qts. nonionic surfactant per 100 gal. of spray solution. Ground application - apply 10-60 gal./A tank mix; aerial (helicopter) application - apply 5-15 gal./A tank mix. Treat after full leaf expansion until start of fall color.
Glyphosate (Accord) 4 lbs. a.i./gal. + Triclopyr (Garlon 4)	3 - 5 qts. + 1 - 2 qts.	Mix 2 or more qts. of nonionic surfactant per 100 gal. of tank mix. Apply 10-60 gal. of tank mix per acre by ground application or 5-30 gal. per acre by helicopter. Treat in late spring through early summer.

TABLE 4:

HERBICIDES FOR INJECTION, DIRECTED & SPOT SPRAY TREATMENTS

HERBICIDE FORMULATION	APPLICATION	REMARKS & PRECAUTIONS
2,4-D (Various trade names)	Basal spray	Spray the lower 18-24 inches of plant stem with undiluted spray.
	Stump treatment	Spray the bark and root collar area of the stump thoroughly with undiluted spray.
Glyphosate (Various trade names)	Post directed spray 0.5 - 10% solution	May be applied as a shielded or directed spray to the base of the trees. DO NOT apply over-the-top of desirable seedlings. Severe injury to trees will occur if the spray contacts the foliage. Use a 0.5% solution for control of annual weeds less than 6" tall (add a nonionic surfactant). A1- 2% solution will control perennial weeds. Use 5% solution for annual & perennial weed control if spray coverage is not complete. Use a 5-10% solution for woody brush & trees. Refer to the label for rates and surfactant recommendations for specific perennial weeds.
Hexazinone (Velpar L)	Basal Soil Treatment 2-4 ml/inch DBH	Apply to root zone of undesirable hardwoods with a handgun application. Use 2-4 ml per inch of tree diameter at breast height on trees to be controlled. Place spots within 3 feet of root collar of trees to be controlled.
Hexazinone (Velpar L)	Injection	Inject 1 ml of undiluted Velpar L through bark of undesirable trees. Injections should be made at 4" intervals around stem. Treat in summer. Controls black cherry, oaks, red maple, sweetgum.
Imazapyr (Arsenal or Chopper)	Cut stump Treatment	Use a diluted solution of 4-6 oz. Arsenal or 8-16 oz. Chopper + one gal. water and spray or brush on to cambium area inside the bark of freshly cut stump.
	Injection	Apply 1 ml of diluted solution at 1 inch interval cuts through the bark around the tree. A concentrated solution of 2 qts. Arsenal + 2 qts. water can be used for injection at 1 ml for each 4 inches of tree diameter.
	Frill or girdle	Spray or brush a diluted Arsenal solution into cuts placed at 2 inch intervals around the tree. If the concentrated solution (20% Arsenal or 40% Chopper)is used make one cut into the stem for each 4 inches of tree diameter and spray or brush the concentrated Arsenal solution into each cut. For example a 4 inch diameter stem will receive 1 cut while an 8 inch diameter stem will receive 2 cuts.
Picloram + 2,4-D (Pathway, Tordon 101R)	Tree injection	Apply 1 ml of undiluted Pathway through the bark completely around stem at 2-3 inch intervals. Treatment can be made any season. Do not treat maple during spring sap flow. Dogwood and hickory may require application to continuous overlapping cuts around the stem.
	Stump treatment	Treat the cambium layer just inside of the bark of freshly cut stumps with undiluted Pathway.
Picloram + 2,4-D (Tordon 101M)*	Tree injection	Inject 1/2 ml of undiluted Tordon 101M or 1 ml of diluted (1:1 ratio in water) through the bark of undesirable trees at 3 inch intervals around the stem.
	Stump treatment	Spray the cambium area inside the bark of freshly cut stump with undiluted or diluted (1:1) Tordon 101M.
Triclopyr (Forestry Garlon 4) + Oil	Thinline or streamline	Tank mix 20 - 30% Garlon 4 + 70 - 80% oil. Apply with a small orifice solid-stream nozzle. Make two streaks across the lower stem of smooth bark hardwoods smaller than 3 inches in diameter. Application can be made in any season. Generally most effective 6 weeks prior to leaf expansion, until 2 months after.
Triclopyr (Garlon 3A)	Tree injection Hack & squirt	Inject or spray 1/2 ml of undiluted or 1 ml of diluted (1:1 in water) through bark at 3 - 4 inch intervals around the stem.
	Stump treatment	Spray the cambium area inside the bark of freshly cut stumps with undiluted Garlon 3A.

TABLE 5: HERBICIDES FOR PINE RELEASE FROM HARDWOODS

HERBICIDE FORMULATION	RATE/ACRE (BROADCAST)	REMARKS & PRECAUTIONS
Hexazinone (Velpar ULW)	1 - 4 lbs.	Soluble granular material. Applied using DuPont ULW applicator aerial equipment. Apply in spring when weeds and brush are actively growing. Do not apply to Loblolly pine less than 4 years old since transplanting on coarse textured soils, or less than 3 years from transplanting on fine textured soils. Some conifer mortality may occur if applied when saplings are under stress.
Triclopyr (Garlon 4)	*Directed spray only*	To release conifers from red maple, sweetgum, oaks and hickory, mix 1-5 gal. Garlon 4 in + water to make 100 gal. of mix. Direct spray to foliage of hardwoods using a back-pack sprayer with flat fan nozzle. Hardwoods less than 6 feet tall are most effectively treated. Treatment can occur any time after hardwoods reach full leaf and before onset of fall color. Direct spray away from desirable conifer foliage.
	2 - 4 qts/A	Broadcast application for mid-rotation understory brush control in flatwoods pine stands. For control of gallberry & wax myrtle apply 2 - 4 qts of Forestry Garlon 4 to to cover the foliage of understory competition, but DO NOT spray onto pines. Make applications from late summer (August) to fall (before leaf fall). Apply 30 gallons of water per acre. Forestry Garlon 4 may be tank mixed with Arsenal or Escort to increase control of palmetto, titi, fetterbush etc.
Hexazinone (Velpar L)	Spot Grid Treatment 2 - 8 qts.	Apply undiluted Velpar L on a grid pattern (3' x 3' to 6' x 7') to transplants 1 year old or 4 years and older. Injury may occur if pines are 2-3 years old. Use an application of 2 - 2.33 ml per spot depending on soil texture.
	2 - 8 qts.	Apply when Loblolly pine is between flushes or growth spurts and from early spring to early summer when hardwoods are in 1/2 leaf to point of full leaf growth. Do not use a surfactant. Some pine mortality may occur, and some pines may show discolored foliage. 1 - 2 inches of rain are needed for soil activation.
Metsulfuron methyl (Escort)	½ to 1- ½ oz.	Release of loblolly & slash pine from hardwoods and brush. Treat when pines are at least 3 years old on fine textured soils, 4 years and older on coarse textured soils. Apply from full leaf to just before leaf tissue hardens in the fall.
Metsulfuron methyl (Escort) + Imazapyr (Arsenal)	1/2 - 1 1/2 oz. + 1 pt.	In 2 year old Loblolly pine plantations controls blackberry, blackgum, elm, cherry and broadleaf weeds. Apply with 1 qt. surfactant in 100 gal. in late summer, early fall.
Metsulfuron methyl (Escort) + Sulfometuron methyl (Oust)	½ to 1- ½ oz. + 2 to 3 oz.	Release of loblolly pine from hardwoods and brush. Treat when pines are at least 3 years old on fine textured soils, 4 years and older on coarse textured soils. Apply from full leaf to just before leaf tissue hardens in the fall.
Metsulfuron methyl (Escort) + Hexazinone (Velpar L)	1/2 - 1 1/2 oz. + 1 1/2 - 6 qts.	Brush and herbaceous weed control in 1 year old Loblolly pine plantations. Do not use a surfactant.
Glyphosate (Accord) + Imazapyr (Arsenal)	1 1/2 - 2 qts. + 1 pt.	Apply after final resting buds have formed on conifers in the fall. Actively growing conifers will be damaged. Follow Accord label recommendation for surfactant use. Will control wood brush, trees, and herbaceous weeds.

HERBICIDES FOR PINE RELEASE FROM HARDWOODS (continued)

Glyphosate (Accord)	1.5 - 2.5 qts.	For release from herbaceous weeds and wood sprouts in Loblolly and slash pine plantations which have been established for more than one year. Mix up to 20 fluid oz. /A of Entry II or comparable nonionic surfactant. Apply in late summer to early fall after pines have hardened off.
Imazapyr (Arsenal)	1-2 pts.	Used as a broadcast to release Loblolly pine from competition. Apply to Loblolly plantations that have been established for 2 or more growing seasons in the field and after formation of final pine resting buds in the fall. Do not apply to pines under environmental stress.
	Directed spray 1/2 - 5% solution	Apply to foliage and buds of undesirable hardwoods competing with pines by a low-volume directed spray. Avoid application to foliage of desirable pines. Use a nonionic surfactant at 1/4% by volume.
	12 to 16 ozs.	For slash and longleaf pine, broadcast release treatments over the top of pines to control hardwoods must be made after August 15 and ONLY in stands 2 through 5 years old. DO NOT use a surfactant and use the lower rate on sandy soils.
Triclopyr (Garlon 3A)	***Directed spray***	Release conifers from red maple, sweetgum, oaks, ash and hickory, mix 1-5 gal. of Garlon 3A in 100 gal. water + a nonionic surfactant. Apply as a directed spray to the foliage of weed trees with a backpack sprayer. Treat after hardwoods have leafed out and before fall coloration. Hardwoods less than 6 feet tall are most economically and safely treated. Direct spray away from foliage of desired pines.
Triclopyr (Pathfinder II) 0.75 lbs. a.i./gal.	***Streamline Basal Bark Treatment***	Apply undiluted product in a directed straight-stream spray to one side of stems less than 3 inches in basal diamter to treat a 6 inch wide zone on the stem 1 to 2 feet above ground. On stems 3 to 4 inches in basal diameter, treat both sides of the stems. Apply in spring 6 weeks prior to hardwood leaf expansion until 2 months after leaf expansion is completed.

***Restricted use pesticide**

FOREST VEGETATION MANAGEMENT TERMINOLOGY

The elimination of the undesirable vegetation in pine plantations requires that the applicator be familiar with certain herbicide systems and terminology as related to forestry.

1. Band treatment -- Applied to a continuous restricted area such as on or along a crop row rather than over the entire field area.

2. Basal treatment -- Applied to encircle the stem of a plant at and above the ground level. It is usually applied with a backpack sprayer.

3. Brush control -- Control of woody plants such as sprout clumps, shrubs, small undesirable trees and vines.

4. Cambium -- Tissue lying just under the bark which produces new wood and bark in the tree.

5. Concentration -- The amount of active ingredient or herbicide equivalent in a quantity of carrier (such as water, oil, or dust) expressed as percent, lb./gal., ml/l, etc.

6. DBH (diameter-breast-height) -- Diameter of trees at a point 4.5 feet above ground level.

7. Directed application -- Precise application to a specific area of plant organ; such as to a row or bed, or to the lower leaves and stems of plants.

8. Dormant spray -- A chemical applied during the dormant season.

9. Foliar application -- Application of a herbicide to the leaves or foliage of plants.

10. Frill -- Series of overlapping cuts into the sapwood completely around the circumference of tree. Chips are not removed, but left to hold the herbicide in cuts. Herbicide can be applied with a brush squirt-bottle or sprayer.

11. Girdling -- Complete removal of a band of bark from around a woody stem.

12. Hardened off -- Term denoting stage of plant development when terminal buds have formed and stem and root tissues have ceased growth. Dormant stage of pine seedlings is often denoted by purplish or bronze-colored needles.

13. Herbaceous -- Plants with non-woody stems that normally die back to the ground in the winter.

Continued on back

CONVERSION TABLE FOR HERBICIDES ON SMALL AREAS

Rate per Acre	Rate per 1000 Sq. Ft.	Rate per 100 Sq. Ft.
	Liquid Materials	
1 pt.	3/4 Tbs.	1/4 tsp.
1 qt.	1 1/2 Tbs.	1/2 tsp.
1 ga.	6 Tbs.	2 tsp.
25 gal.	4 1/2 pts.	1 cup
50 gal.	4 1/2 qts.	1 pt.
75 gal.	6 1/2 qts.	1 1/2 pts.
100 gal.	9 qts.	1 qt.
	Dry Materials	
1 lb.	2 1/2 tsp.	1/4 tsp.
3 lbs.	2 1/4 Tbs.	3/4 tsp.
4 lbs.	3 Tbs.	1 tsp.
5 lbs.	4 Tbs.	1 1/4 tsp.
6 lbs.	4 1/2 Tbs.	1 1/2 tsp.
8 lbs.	2/5 cup	1 3/4 tsp.
10 lbs.	1/2 cup	2 tsp.
100 lbs.	2 1/4 lbs.	1/4 lb.

MEASURING TABLES FOR HERBICIDES

Herbicides are often bought in large packages or containers which do not have specific instructions for mixing smaller amounts to treat small areas. The following table compares various measurements that are needed to make smaller amounts of spray:

3 teaspoons (tsp.) = 1 tablespoon (Tbs.)
2 tablespoons = 6 teaspoons = 1 fluid ounce
4 tablespoons = 1/4 cup = 2 fluid ounces
1 cup = 16 tablespoons = 8 fluid ounces
2 cups = 1 pint = 16 fluid ounces
2 pints = 1 quart = 4 cups
4 quarts = 1 gallon = 16 cups
16 ounces = 1 pound

Precautionary Statement

In order to protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label. Persons who do not obey the law will be subject to penalties.

Disclaimer Statement

Pesticides recommended in this publication were registered for the prescribed uses when printed. Pesticides registrations are continuously reviewed. Should registration of a recommended pesticide be canceled, it would no longer be recommended by Tennessee State University. Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others which may be of similar suitable composition, nor does it guarantee or warrant the standard of the product.

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