

Pre-plant Chemical Site Preparation Options to Establish Loblolly, Longleaf, and Slash Pine Plantations in South Georgia and North-Central Florida

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E. David Dickens – Forest Productivity Professor UGA WSFNR, Pat Minogue Silviculture Associate Professor UFL SFR&C, and David J. Moorhead – Silviculture Professor; UGA WSF&NR

Some form of site preparation is needed to establish a southern pine (loblolly, longleaf, slash, Virginia, shortleaf) plantation. This is the case whether the site was just harvested, a pasture site, or formerly cropland. Southern pines are shade intolerant, therefore requiring a “free to grow” environment. Southern pines, like all plants, have three major requirements: water, sunlight, and nutrients. Site preparation activities should optimize all three of these requirements. In most cases, competition control is the most important objective in preparing a site for planting seedlings of any southern pine species. On soils that are somewhat poorly to very poorly drained (many Atlantic and Gulf Flatwoods soils), mechanical bedding is often needed to ensure adequate seedling survival and early growth. Some site preparation activities can also enhance the plantability of the site by reducing or moving logging debris. This paper will discuss the chemical site preparation treatment options for establishing loblolly, longleaf, and slash pine in South Georgia and North Central Florida.

Figure 1 is a summary of results from 18 long-term plots published by Glover and Zutter (1993) following hardwood stem counts at age 3-years and loblolly pine basal area (the sum of stem areas at 4.5 feet height, in square feet per acre, a measure of stocking) at age 27-years (for non-thinned stands). The figure illustrates that when hardwood stem count (stems one-inch diameter and larger) at age 3-years is less than 150 stems/acre (ten study areas) then loblolly pine basal area at age 27-years is from 110 to 210 square feet/acre and pine survival and growth is good to excellent. When hardwood stems at age 3-years is in the range of 200 to 350 per acre (three study areas) then pine basal area is 50 to 65 square feet by age 27-years. When hardwood stem count at age 3-years is 450 per acre, loblolly pine basal area is approximately 25 square feet/acre (Figure 1). In fact, as hardwood stems per acre at age 3-years are in the range of 700 to 1150, pine basal area decreases to almost zero. This figure shows the importance of controlling hardwoods at planting to have good pine survival and growth. Even a relatively low level of hardwood competition greatly reduces final pine harvest volume.

Generally, during the first three years in the life of a pine stand competition primarily comes from grasses and broadleaf weeds (Lauer and others 1993). Later hardwoods, volunteer pines, and woody shrubs become the main competitors in the pine plantation on cut-over sites, reducing sunlight,

water, and nutrients supporting pine growth. The key to successful reforestation is to control perennial grasses, volunteer pines, woody shrubs, and hardwoods prior to planting pines using relatively high rates of broad spectrum herbicides and then control grasses and broadleaf weeds with selective herbicides applied over newly planted pines in the early spring. At site preparation we have more herbicide and rate options, but once the seedlings have been planted we may use only selective herbicides and rates, to which various pine species are tolerant.

Recently harvested forest sites should be sprayed with site preparation herbicides only after the hardwood spouts have developed to about waist height. In cases when the former stand had abundant hardwoods this timing is even more important. The objective is to dose the persistent hardwood root mat with translocating herbicides, through herbicide uptake from the foliage of hardwood spouts or from root uptake from the soil. Glyphosate is taken into the plant only by the foliage and triclopyr is largely absorbed by the foliage or stems. Imazapyr, sulfometuron, and metsulfuron are absorbed by the foliage and the roots, and imazapyr and metsulfuron have long persistence in the soil.

Following herbicide spraying, reforestation sites are commonly burned to reduced logging slash and post-harvest growth of vegetation. The improved access provided by prescribed fire fosters a better planting job in many cases, particularly where the prior stand had high hardwood density. Broadcast site preparation burning should be planned for six or more weeks after spraying to allow time for the herbicides move to the hardwood roots, thus reducing re-spouting. The fuels on the ground, which will carry the fire, may be manipulated to produce a better burn. For example, combinations of imazapyr and glyphosate are common when upland sites support grass cover; whereas, on lower Coastal Plain sites combinations of imazapyr and triclopyr are chosen to improve the effectiveness of burning where fuels consist of shrubs and broadleaves. Many other combinations are prescribed to improve the spectrum of vegetation of control; taking into consideration those species not controlled by a particular herbicide used alone.

With the common use of genetically improved pine seedlings, it is desirable to control natural pine seedlings at site preparation, particularly where natural pine seedlings are dense. Natural pines are controlled by prescribed site preparation burning, by directed foliar herbicide treatments to pines, and in some cases by herbicide tank mixtures in broadcast treatment, the later usually in combination with prescribed fire (Table 4). It is best and easiest to control volunteer pines when they are less than 2 to 3 feet tall. Pines are most susceptible to herbicides during active growth in the spring and summer. The use of high application water carrier volumes (15-20 gal/ac aerial, 30-40 gal/ac ground spraying) and the addition surfactants will improve herbicide uptake through the pine foliage.

The common herbicides used to establish loblolly, longleaf, and slash pine plantations are: imazapyr (Arsenal[®], Chopper[®], etc.) and glyphosate (Accord[®], Glypro[®], etc.). These are often tank mixed to control upland species in the middle to upper Coastal Plain; whereas, imazapyr and triclopyr (Garlon[®], Remedy[®], etc.) are tank mixed in the lower Coastal Plain flatwoods to control waxy leaf shrubs and trees. On excessively well drained, deep sands of the Sand Hills, hexazinone (Velpar L[®], Velpar DF[®]), a soil active herbicide is often used as it's rate is soil texture dependent and effective at lower rates.

Sulfometuron (Oust XP[®]), metsulfuron (Escort[®], MSM[®]) or the commercial packaged combination of sulfometuron and metsulfuron (Oust Extra[®]) is often tank mixed with imazapyr and glyphosate or imazapyr and triclopyr to provide some residual control of grasses and broadleaves in the spring following winter planting (controlling weeds in the year following site preparation spraying). To ensure residual weed control with these herbicides application should occur after August. Metsulfuron or triclopyr are often tank mixed with imazapyr to control blackberry, which is not controlled by imazapyr alone. Currently we do not recommend the late summer or fall tank mix of sulfometuron and/or metsulfuron with the standard tank mix of imazapyr + glyphosate or triclopyr because of pine tolerance issues.

At least 50-60% bare ground around the seedlings into early July can be very important for survival and growth, particularly in droughty springs following planting. Even in growing seasons with abundant rainfall pine growth is increased dramatically with good herbaceous weed control (HWC). The site preparation tank mixes with sulfometuron and metsulfuron described above may provide some residual weed control following planting, but to achieve optimum pine growth responses post-plant HWC should be planned (Dickens et al. 2015, Dickens et al. 2016, Minogue et al. 2016, Moorhead et al. 2016).

Chopper[®] (imazapyr) is one of the most common forest herbicides used for site prep in the SE US. Lauer and Quicke (2006) found when imazapyr was applied in June, a relatively early timing, gave 26% (loblolly) and 46% (slash) greater 2-year pine growth than later treatments using the same 48 oz/ac rate (Figure 2,. Another study by Yeiser (2013) found that 32 oz/ac Chopper applied in September gave slightly better hardwood control than 64 oz/ac Chopper applied in May (Figure 3). Based on these studies and others, hardwood control improves when imazapyr is applied late in the growing season, but pine growth is reduced, suggesting problems with pine tolerance due to residual herbicide soil activity. On Coastal Plain sites we recommend early (June) application and reduced herbicide rates later in the summer and early fall (see Dickens et al. 2012).

HERBICIDES FOR PRE-PLANT SITE PREPARATION Herbicides are typically applied in 10 to 20 gallons/acre (GPA) water by air or in 20-30 GPA with ground equipment; with a non-ionic surfactant, crop oil or methylated seed oil to improve leaf penetration for foliar active herbicides.

ARSENAL[®] AC (BASF; 53% imazapyr; 4 lb acid equivalent (ae) per gallon) OR 27% imazapyr; **CHOPPER[®] or CHOPPER GEN 2[®]** (BASF; 27% imazapyr; 2 lbs ae per gallon) or generic imazapyr products (Polaris AC, Polaris SP, Rotary 2SL, Imazapyr 4SL)

- ◆ Absorbed by roots and foliage; a soil and foliar active herbicide
- ◆ Effective control of 48 species of annual and perennial grasses, 73

broadleaves, including difficult to control species like Bermudagrass and seedling Johnsongrass as well as, but not limited to: bahiagrass, barnyardgrass, bluegrass (annual, Kentucky), crabgrass, fescue, foxtail, Italian ryegrass, lovegrass, panicums, sandbur, wild oats, witchgrass, camphorweed, carpetweed, chickweed, clovers, cocklebur, dandelion, dogfennel, horseweed, goldenrod, knotweed, lambsquarters, milkweed, ragweed (common, giant), pepperweed, pigweed, plantain, pokeweed, purslane, pusley (Florida), shepard's purse, sowthistle, stinging nettle, annual spurge, sunflower, tansymustard, wild carrot, wild parsnip, and wild turnip, several vine species, and 65 woody trees and brush species (see Arsenal or Chopper label for complete list)

- ◆ Weak on broadleaf weeds in the composite group (see Oust® XP®), blackberry, and most legumes
- ◆ Optimum timing: May into early October (refer to http://www.bugwood.org/Imazapyr_Site_Prep_6-2012.pdf for application and planting interval timing)
- ◆ Site prep rates: Typically 16 to 24 oz/ac for the 4 lb ae/gallon product (Arsenal AC) and 32 to 48 oz/ac for the 2 lb ae/gallon product (Chopper, Chopper Gen2). Rates can change depending on tank mix combinations, application timing, pine species, and planned planting date.
- ◆ Notes: Imazapyr is a widely used forest herbicide due to its relatively broad spectrum of control, residual soil activity/control, and is often tanked mixed with other products to enhance the spectrum of control.

VELPAR L® (Bayer; 25% hexazinone, 2 lb active ingredient per gallon) and **VELPAR DF®** (75% hexazinone) or generic hexazinone products

- ◆ Use rate is dependent on soil texture. Refer to Tables 1 and 2.
- ◆ A soil active herbicide
- ◆ Broad spectrum weed control of broadleaf weeds and most grasses, weak on Bermudagrass, some panicums, and broomsedge. Grass & broadleaf control including, but not limited to: chickweed, crabgrass, dogfennel, fescue, fireweed (willowweed), goldenrod, horseweed, Kentucky bluegrass, nutsedge (yellow), panicum (broadleaf), pokeweed, ragweed, shepherd's purse, white snakeroot, yellow sweetclover, annual bluegrass, barnyardgrass, foxtail barley, foxtail fescue, Italian ryegrass, jointed goatgrass, bromes (red, ripgut), reed canarygrass, signalgrass, yellow foxtail, mustard, pepperweed, pigweed, sunflower, vetch, wild carrot, wild oats, asters, bracken fern, and fleabane

- ◆ Woody plants and vines controlled: ash, aspens, birch, blackgum, black cherry, deerbrush, flowering dogwood, elm, hawthorn, hickory, honeysuckle, red maple, oaks, sourwood, sweetgum, and willows (listed but not limited to; see DuPont Velpar L or DF labels for all species controlled).
- ◆ Optimum timing: late March into early June. Apply when hardwood competition to be controlled is in the half to full leaf expansion phase for best control. Rainfall required for activation.
- ◆ Site prep rates: Typically 1 to 2.5 gallons/acre for Velpar L. Rate will depend on soil texture (course soils = 1 – 1.5 gallons/acre, medium textured soils = 1.5 to 2 gallons/acre and fine textured soils = 2 to 2.5 gallons/acre) and use higher rates with increasing % organic matter. For Velpar DF 2.67 to 6.67 lbs/acre (course soils = 2.67 to 4 lbs/ac, medium textured soils = 4 to 5.33 lbs/ac, and fine soils = 5.33 to 6.67 lbs/acre).
- ◆ Notes: hexazinone works well on sandy, sandy loams, and loamy sand soils and is considered the best product to control most oak species.

ACCORD XRT® (DOW; 53.5% glyphosate, 5 lb glyphosate a.e. per gallon) or generic glyphosate products labeled for forestry site prep use

- ◆ Uptake by foliage, a foliar active herbicide only; no soil activity or residual
- ◆ Effective control of a broad spectrum of grasses, broadleaf weeds, vines, most hardwoods, and small (less than 2 feet tall) volunteer loblolly and slash pines (when applied in June to early August)
- ◆ Rates of 3 to 6 qts/ac from mid-July to early October @ 15 to 25 GPA

FORESTRY GARLON XRT® (DOW; 83.9% triclopyr, 6.3 lb triclopyr a.e. per gallon) or generic triclopyr products labeled for forestry site prep use

- ◆ Uptake by foliage, a foliar active herbicide only; negligible soil activity or any significant residual
- ◆ Best herbicide for control of waxy leaf flatwoods species such as gallberry, titi, wax myrtle, and saw palmetto (with Escort on saw palmetto) as well as good control of most hardwoods, broadleaf weeds, vines and small (less than 2 feet tall) volunteer loblolly and slash pines (when applied in June to early August)
- ◆ A grass friendly herbicide – will not kill most native (and non-native) grasses

- ◆ Rates of 1 to 3 qts/ac from mid-July to early October @ 10 to 15 GPA aerial application or 15 to 25 GPA ground application (caution – a volatile herbicide, vapors prone to movement during warm periods, particularly with ester formulations)

TANK MIXES:

- ◆ Flatwoods sites: 32 to 48 oz/ac Chopper + 1 – 2 qt/ac Garlon with 1 qt/ac methylated seed oil (MSO) @ 15 to 25 GPA applied from mid-July to early October will control most waxy leaf shrubs
- ◆ Middle to Upper Coastal Plain sites: 32 to 48 oz/ac Chopper + 3 to 4 qts/ac Accord @ 10 to 15 GPA aerial application or 15 to 25 GPA ground application from June to early October will control most Coastal Plain woody plants

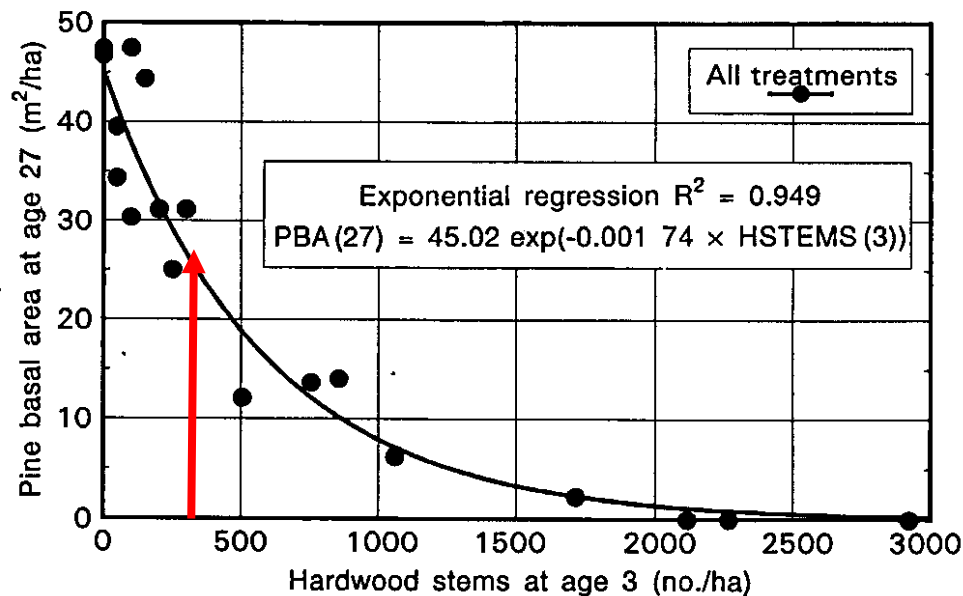


Figure 1. Relationship between pine basal area per hectare at age 27-years and number of hardwood stems greater than 2.5 cm at age 3-years (Glover and Zutter 1993).

Conversion factors: 2.5cm=1 inch, 2.47 acres=1 hectare, 4.36 ft²/acre=1m²/hectare

Table 1. Velpar L rate per acre based on soil texture

Pre-plant Chemical Site Prep	
<ul style="list-style-type: none"> • Early season (late March –late May) = hexazinone (soil active): • Velpar L (liquid), *rate based on soil texture, % OM • Great oak control, weak on sassafras, yellow-poplar 	
Soil texture	Velpar L rate (qts/ac)
Coarse –sand , loamy sand, sandy loam	4 – 6
Medium – loam, silt loam, sandy clay loam	6 – 8
Fine – silty clay loam, clay loam, sandy clay, silt, silty clay, clay	8 - 10

Table 2. Foliar spray Velpar DF rate per acre based on soil texture

Pre-plant Chemical Site Prep	
<ul style="list-style-type: none"> • Early season (late March – late May) = hexazinone (soil active herbicide) • Velpar DF (dry flowable), *rate based on soil texture, % OM • Great oak control, weak on sassafras, yellow-poplar 	
Soil texture	Velpar DF rate (lbs/ac)
Coarse –sand , loamy sand, sandy loam	2.67 – 4.0
Medium – loam, silt loam, sandy clay loam	4.0 – 5.33
Fine – silty clay loam, clay loam, sandy clay, silt, silty clay, clay	5.33 – 6.67

Table 3. Chopper (imazapyr) and Chopper + Garlon (triclopyr) for the lower Coastal Plain/Flatwoods or Chopper+Accord (glyphosate) rate per acre for the middle & upper Coastal Plain and Sand Hills based on timing

<h2>Pre-plant Chemical Site Prep</h2>			
<ul style="list-style-type: none"> • Mid-late season (June – early October) = imazapyr (soil and foliar active): • Chopper @ 40 to 48 oz/ac → can go to 64 oz/ac (not recommended) but need longer wait period to plant pine seedlings > 4-5 months) • Arsenal is Chopper @ 2x strength without a surfactant • Great sweetgum control, weak on blackberry, legumes 			
Physiographic Region	Chopper rate (oz/ac)	Glyphosate rate (41% ae; qts/ac)	Garlon 4 rate (61.6% ai, oz/ac)
Flatwoods (waxy leaf species present)	48; before 1 August		32 - 64
	40; 1 August – 15 September		
Middle to upper Coastal Plain and Sand Hills	32; > 15 September	3 - 5	

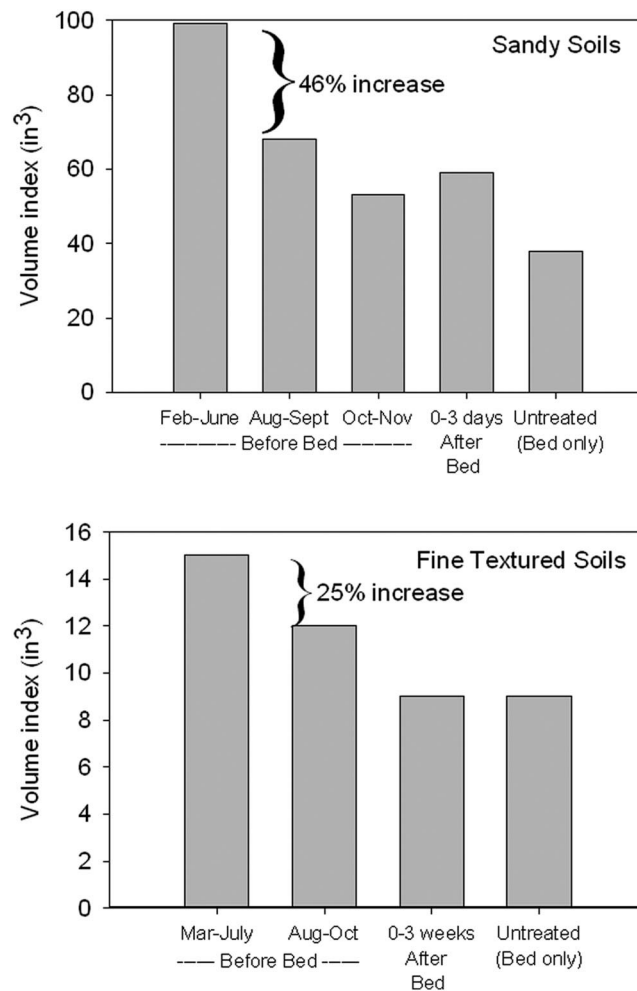


Figure 2. Chopper @ 48 oz/ac site prep studies (Lauer and Quicke 2006) illustrating timing and 2-year volume index for slash (upper graph) and loblolly pine (lower graph). Note the 46% greater 2-yr volume index for slash pine when Chopper was applied prior to August and 26% greater 2-yr volume index for loblolly pine when Chopper was applied prior to August.

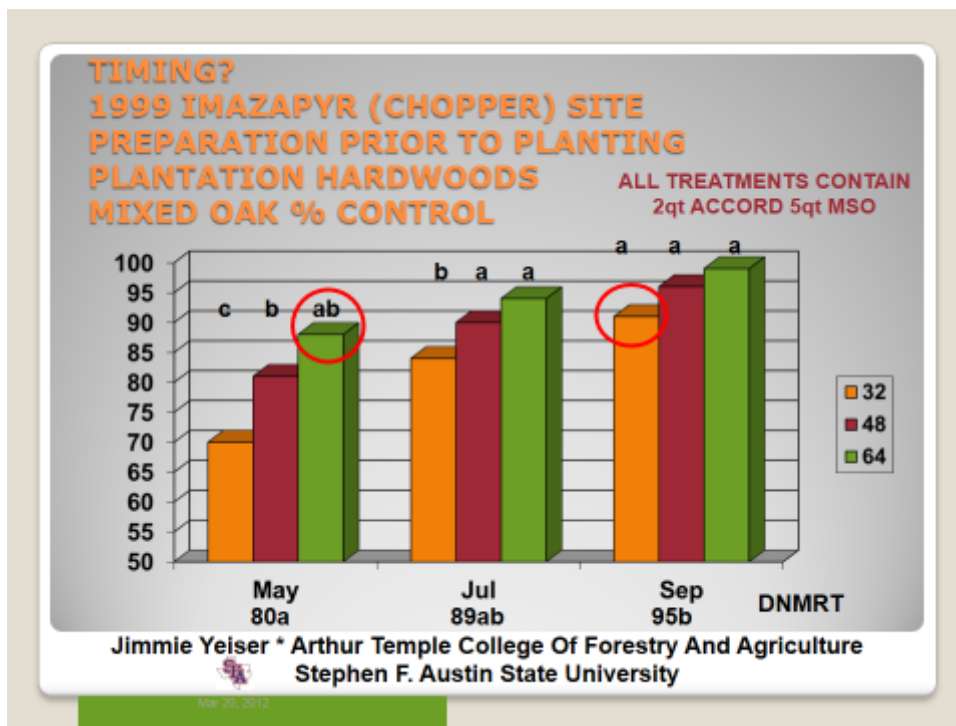


Figure 3. Chopper timing and dosage study illustrating the effects on hardwood (oak sp.) control. Note that 32 oz/ac in September gave slightly better hardwood control than 64 oz/ac in May. Overall control was better later in the year than earlier in the year (Sept > July > May). Ezell and Yeiser 1999.

Table 4. Herbicides to add to the tank to control volunteer pines.

Controlling Volunteer Pines Preplant when using Imazapyr - Add one of the following herbicides:
3 to 10 qts/ac glyphosate + surfactant (July-Aug)
7 oz/ac Milestone (aminopyralid) + 21-32 oz/ac Garlon (triclopyr) XRT (Aug-mid Oct)
2-4 qts/ac Krenite S (fosamine) with a burn or 4-6 qts/ac without a burn (July-Oct)
6 oz/ac Detail (saflufenacil) 1% v/v methylated seed oil (MSO) during active growing season + glyphosate

Shorter volunteer pines (< 2 to 3 feet) are easier to control. A prescribed fire 2 months after the herbicide(s) have been applied can reduce volunteer pine numbers.

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Athens, Georgia 30602-2152

Phone: 706.542.6819 • fax: 706.542.5073

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