

A Guide to Using Imazapyr for Chemical Site Preparation in Southern Pine Plantation Establishment

By: David Dickens – Forest Productivity Professor, The University of Georgia Warnell School of Forestry and Natural Resources, Pat Minogue – Assistant Professor of Silviculture, University of Florida, School of Forest Resources and Conservation, and David Moorhead – Silviculture Professor, The University of Georgia Warnell School of Forestry and Natural Resources

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Introduction

Some form of site preparation is needed to establish southern pine plantations. This is the case whether the site was a harvested forest, a pasture site, or a former cropland site. Southern pines are shade intolerant, therefore requiring direct sunlight - a “free-to-grow” environment. Like all plants, they have three major requirements for growth: water, sunlight, and nutrients. Site preparation should optimize all three of these requirements. In most cases, competition control is the most important objective in preparing a site for planting southern pine seedlings. On soils that are somewhat poorly to very poorly drained (many Atlantic and Gulf Flatwoods soils), mechanical bedding is often needed to improve soil aeration, fostering adequate seedling survival and early growth. Some site preparation activities can also enhance the planting of a site by reducing or moving logging debris. Types of site preparation include: mechanical (chopping, shearing, piling, disking, bedding, 3-in-1 plowing, subsoiling, and ripping), chemical (using soil, foliar, or soil and foliar active herbicides) or combinations of mechanical and chemical treatments. The use of herbicides for forest site preparation has become common in the last 30 years. This paper addresses appropriate imazapyr site preparation rates for different application timings to optimize planted pine seedling growth and survival, while avoiding seedling injury caused by residual herbicide.

The active ingredient, imazapyr, is a foliar and soil active herbicide (absorbed by foliage, stems, and roots) with relatively broad spectrum control of many tree, shrub, vine, broadleaf, and grass weeds. Imazapyr is typically applied as a broadcast spray over unwanted vegetation prior to planting (Photo 1). Following absorption into plants, imazapyr moves within the xylem (upward), phloem (primarily downward), or from cell to cell throughout the plant very quickly, accumulating in regions of new growth. Imazapyr works to prevent the synthesis of three amino acids produced by plants, which are required for protein synthesis and plant sustenance. Imazapyr has an acute lethal dose to 50% of a test (rat) population (LD_{50}) > 5000 mg/kg, classed by the US Environmental Protection Agency as “practically nontoxic”. Imazapyr's low toxicity to humans is due in part to its mode of action. It works on amino acid synthesis pathways that are specific to plants and not found in humans or animals. Since the patent for imazapyr expired in 2002, other herbicide manufacturers have been able to produce and sell the herbicide, greatly reducing the price per gallon. Common imazapyr forestry herbicides contain either 2 or 4 pounds acid equivalent (ae) imazapyr per gallon. Because of the broad spectrum of vegetation controlled, low LD_{50} for humans, and the reduced prices for this product, imazapyr is widely used for forest site preparation.

Factors that determine imazapyr site preparation application rate per acre and timing include:

- whether using the 2 or 4 lb ae imazapyr per gallon product (Table 1 and 2),
- planned pine seedlings planting month (Table 1 and 2),
- surface (0-8") soil texture (% sand, silt, or clay),
- percent soil organic matter,
- soil drainage class,
- and site rainfall amount between herbicide application and planting.

2 versus 4 lb acid equivalent (ae) imazapyr per gallon formulations:

Current products labeled for forestry use containing 2 lb ae imazapyr/gallon are primarily used for site preparation and other non-selective treatments. These contain surfactants to improve leaf wetting and herbicide uptake by foliage and stems (Chopper® Gen2, Polaris™ SP, Rotary™). Current forestry products containing 4 lb ae imazapyr/gallon do not contain surfactant, because they are used for selective applications, "over-the-top" of pines (Arsenal® AC, Polaris™ AC Complete, Imazapyr™ 4 L). For selective herbicide use over pines, the amount of surfactant should be tailored to the specific pine species and age to ensure pine tolerance to the herbicide. Surfactants improve herbicide uptake by both weeds and pine crop trees.

At least two site preparation timing studies done in the last 20 years using 48 oz Chopper (0.75 lb ae/acre) have shown superior growth rates for loblolly pine two to four years post planting when the product was applied in June and seedlings were planted in mid-December to early January. Imazapyr applications made later in the year (September - October) and earlier (February-April) resulted in less loblolly pine growth. Reduced loblolly pine growth rates observed for early imazapyr treatments (pre-June) are thought to be due to less effective hardwood control, particularly for recent harvests where hardwood resprouts have not developed to an adequate size to absorb an effective dose from the foliage and roots. Another reason may be reduced herbaceous vegetation control in the first growing season after planting, as the residual herbicide degrades with time. Reduced growth rates observed for pines planted following the later (September - October) imazapyr site preparation treatments may be due to negative effects from residual soil active imazapyr. On sandy sites in particular, planted pines sometimes show phytotoxic symptoms such as fasciation (multiple buds) in the apical leader, yellowing, and stunting following late imazapyr applications using Chopper at 48 oz/acre (0.75 lb ae/acre) or more (Photos 1 and 2). Photos 3 and 4 show good slash pine survival and growth when imazapyr is applied four months prior to planting using Polaris SP at the 48 oz/acre (0.75 lb ae/acre). Photos 5 through 8 illustrate cases where loblolly pine seedlings were planted within 3 months of a 40 or 48 oz/acre Chopper (2 lb ae/gallon) application and first year survival is poor.

Recommendations

Imazapyr is sometimes used alone for site preparation at a rate of 0.75 lb ae/acre or more. Normally lesser amounts are used in combination with other herbicides, in particular glyphosate or triclopyr (as described on the Arsenal AC label). These herbicide combinations broaden the spectrum of weeds controlled and generally improve fuels to support broadcast site prep burning, which is typically done six weeks or more after herbicide treatment. Labeled Arsenal AC rates for site preparation range from 0.75-1.25 lb ae/acre (24-40 oz/acre product) for loblolly pine and longleaf pine, and from 0.62-1.0 lb ae/acre (20-32 oz/acre product) for slash pine. Tolerance to imazapyr is greatest for loblolly pine, whereas longleaf and slash have similar tolerance, and are more prone to imazapyr injury than loblolly. Since the Chopper Gen2 product contains half the concentration of imazapyr compared to Arsenal, the recommended product rates are doubled. Other generic products follow these same recommendations, but in all cases the labeled rates

may be excessive. Therefore in many cases, on many sites, a lesser imazapyr application rate than the labeled amount can be used with acceptable competition control results.

Based on the two previously mentioned studies and field observations throughout the southeast during the nearly three decades since imazapyr was introduced, the rate of imazapyr applied should be adjusted for the particular pine species to be planted and the time interval between herbicide application and planting (Tables 1 and 2).

Table 1. Suggested highest imazapyr product rate using formulations containing 2 lb acid equivalent imazapyr per gallon* to optimize growth and to minimize planted loblolly, longleaf, or slash pine seedling phytotoxicity. Rates less than 48 oz imazapyr product should contain appropriate tank mix combinations with glyphosate, triclopyr, sulfometuron methyl or other compatible herbicides labeled for this use, following all herbicide product label directions.

Planting Date	Herbicide Site Prep Treatment Date**			
	May - June	July - August	September	October
Herbicide product rates per acre*				
Loblolly Pine				
October	48 oz	40 oz	NO	NO
November	52 oz	44 oz	40 oz	36 oz (NO)***
Dec-Jan	56 oz	48 oz	44 oz	40 oz
Feb-Mar	64 oz	56 oz	52 oz	48 oz
Longleaf and Slash Pine				
October	44 oz	36 oz	NO	NO
November	48 oz	40 oz	36 oz	(32 oz) NO***
Dec-Jan	52 oz	44 oz	40 oz	36 oz
Feb-Mar	60 oz	52 oz	48 oz	44 oz

*Imazapyr product formulations containing 2 lb acid equivalent imazapyr per gallon such as: trade names (manufacturer): Chopper, Chopper Gen2 (BASF Specialty Products), Polaris SP (NuFarm), and Rotary 2SL (Alligare LLC).

**Do not plant within 60 days of a 48 oz/acre or greater (2 lbs ae/gallon) imazapyr herbicide application.

*** Do not plant within 45 days of a 32 or 36 oz/ac imazapyr rate when rainfall amounts for the area are lower than normal, soil moisture is not adequate for planting, and competing vegetation is less than 1 foot tall.

If the site has a sandy, loamy sand, or sandy loam surface soil texture, is moderately well, well to excessively well drained, and has an organic matter content < 2%, then the time interval between application and planting may be increased by one month (Tables 1 and 2). Another option is to reduce the herbicide product rate applied by 2 oz for 4 lb ae/gal imazapyr products and by 4 oz for 2 lb ae/gal product formulations.

Table 2. Suggested highest imazapyr product rate using formulations containing 4 lb acid equivalent imazapyr per gallon* to optimize growth and minimize planted loblolly, longleaf or slash pine seedling phytotoxicity. Rates less than 24 oz imazapyr product should contain appropriate tank mix combinations with glyphosate, triclopyr, sulfometuron methyl or other compatible herbicides labeled for this use, following all herbicide product label directions.

Planting Date	Herbicide Site Prep Treatment Date**			
	May - June	July- August	September	October
Herbicide product rates per acre*				
October	24 oz	20 oz	NO	NO
November	26 oz	22 oz	20 oz	18 oz (NO)***
Dec-Jan	28 oz	24 oz	22 oz	20 oz
Feb-Mar	32 oz	28 oz	26 oz	24 oz
Longleaf and Slash Pine				
October	22 oz	18 oz	NO	NO
November	24 oz	20 oz	18 oz	(16 oz) NO***
Dec-Jan	26 oz	22 oz	20 oz	18 oz
Feb-Mar	30 oz	26 oz	24 oz	22 oz

*Imazapyr product formulations containing 4 lb acid equivalent imazapyr per gallon: trade names (manufacturer): Arsenal AC (BASF Specialty Products), Polaris AC Complete (NuFarm), and Imazapyr 4SL (Alligare LLC).

**Do not plant within 60 days of a 24 oz/acre or greater (4 lbs ae/gallon) imazapyr herbicide application.

***Do not plant within 45 days of a 16 or 18 oz/ac imazapyr rate when rainfall amounts for the area are lower than normal, soil moisture is not adequate for planting, and competing vegetation is less than 1 foot tall.



Photo 1 and 2. Stunted loblolly pine growth following site preparation using 48 oz/acre Chopper (0.75 lb ae/acre imazapyr) + surfactant, applied in late August of the previous year.



Photo 3 and 4. Left and right photos: Slash pine planted 23-24 December 2010 following site preparation using 48 oz/acre Polaris SP (imazapyr @ 0.75 lb ae/acre) and 3 qts/acre Accord (glyphosate) in late August 2010, burned early November 2010, and 2 oz/acre Spyder (sulfometuron methyl) applied late April 2011 (left photo taken 30 August and right photo taken 17 November 2011). This stand had approximately 85% survival and good growth in a hot and dry (12" below normal rainfall) first growing season.



Photo 5 and 6. Left photo: poor loblolly pine survival (<40%) following site preparation using 48 oz/acre Chopper (imazapyr) + 16 oz/acre Garlon 4 (triclopyr) + 4 oz/ac Oust Extra (sulfometuron methyl + metsulfuron methyl) applied late August 2010. The seedlings were planted in early December 2010. Right photo: the same site as photo 5, but at the edge where little herbicide appears to be sprayed, showing good survival (80%) and seedling appearance.



Photo 7 and 8. Left photo: poor loblolly pine survival (<50%) following site preparation using 40 oz Chopper/acre (imazapyr) applied late August 2010. Seedlings were planted early December 2010. The right photo: the same site as photo 7, but at the edge where little or no herbicide appears to be sprayed and good survival (80-95%) and seedling appearance were observed.

Athens, Georgia 30602-2152
Phone: 706.542.6819 • fax: 706.542.5073
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