



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

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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 improve availability of 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 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, and subsoiling/ripping),
- chemical (using soil, foliar, or soil and foliar active herbicides),
- prescribed fire,
- or combinations of these three 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.

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 species. 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 is a group 2 herbicide, or acetolactate synthase (ALS) inhibitor, according to the Weed Science Society of North America classification system. Symptoms following application may be visible within one or two weeks, but may take much longer depending on application method, species, etc. (two months or longer). Imazapyr has an acute lethal dose to 50% of a test (rat) population (LD_{50}) of > 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 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 acid equivalent (ae) imazapyr per gallon product (Table 1 and 2),
- planned planting month for pine seedlings (Table 1 and 2),
- surface (0-8") soil texture (percent sand, silt, or clay),
- percent soil organic matter,
- soil drainage class,
- precipitation quantity between herbicide application and planting.

2 VERSUS 4 LB PER GALLON FORMULATIONS:

Current 2 lb imazapyr per gallon products labeled for forestry use 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 (e.g. Chopper® Gen2, Polaris™ SP, Rotary™). Current 4 lb imazapyr per gallon forestry products do not contain surfactant because they are used for selective applications “over-the-top” of pines (e.g. Arsenal® herbicide Applicators Concentrate (AC), Polaris™ AC Complete, Imazapyr™ 4L). For use over pines, the amount of surfactant should be tailored to the specific pine species and age the herbicide will be sprayed over to ensure pine tolerance to the herbicide. Surfactants improve herbicide uptake by both weeds and pine crop trees.

IMAZAPYR TIMING AND DOSAGE STUDIES

Many site preparation timing studies have been reported during the last 20+ years. One application timing study by Lauer and Quicke (2006) using 48 fluid ounces per acre (oz/ac) Chopper (0.75 lb ae/acre) showed superior growth rates for loblolly and slash pine two 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 in the same study. 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 into early November) imazapyr site preparation treatments may be due to negative effects from residual soil active imazapyr.

Another study by Yeiser and Ezell (1999) found that Chopper at 64 oz/ac gave similar oak control as 48 oz/ac in July and 32 oz/ac in September (Figure 1). This Chopper (study conducted before the introduction of Chopper Gen2) dosage and timing study included 2 quarts per acre (qt/ac) of Accord and illustrates that as the growing season progresses there may be many cases where less Chopper Gen2 is needed.

Sulfometuron methyl (Oust XP®), metsulfuron methyl (Escort® XP or MSM®) or the commercial packaged combination of the two (Oust Extra®) is often tank mixed with imazapyr and glyphosate or imazapyr and triclopyr to provide some residual control of grasses and broadleaf weeds 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 methyl 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 methyl and/or metsulfuron methyl with the standard tank mix of imazapyr + glyphosate or triclopyr because of pine tolerance issues.

On sandy, well to excessively drained sites, planted pines sometimes show phytotoxic symptoms such as fasciculation (multiple buds) in the apical leader, yellowing, and stunting following late imazapyr applications using Chopper Gen2 at 48 oz/acre (0.75 lb ae/acre) or more (Photos 2 and 3). Photos 4 and 5 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) rate. Photos 6 and 8 illustrate cases of first year poor survival where loblolly pine seedlings

were planted within 3 months of a 48 oz/acre Chopper (2 lb ae/gallon) application (Photo 6 included 4 oz/ ac Oust Extra) on well to excessively drained sandy and loamy sand soils with low rainfall amounts between herbicide application and time of planting. Conversely, on the same sites where it appears that no herbicides were applied near roads or property boundaries, loblolly pine seedling survival was 80% or greater and seedlings showed good vigor (Photos 7 and 9).

RECOMMENDATIONS

Imazapyr is occasionally used alone for site preparation at a rate of 0.75 lb ae/acre or more. Usually, 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 site preparation burning. Labeled Arsenal AC rates for site preparation range from 0.75-1.25 lb ae/acre (24-40 oz/acre product) for loblolly pine, shortleaf pine and longleaf pine, and from 0.62-1.0 lb ae/acre (20-32 oz/acre product) for slash pine. The label specifies tank mixtures of 16 to 32 fl oz/ac Arsenal AC with labeled rates of glyphosate or triclopyr ester, irrespective of pine species.

The keys are to:

1. match the amount of imazapyr with the competing vegetation type (e.g. hardwoods, shrubs, etc.) or plant species (label instructions) to be controlled,
2. determine the herbicide rate needed for the amount/abundance and heights of the vegetation to be controlled,
3. what imazapyr application timing is most likely from May into October (refer to Figure 1), and
4. assess if other herbicide(s) should be added to the tank with imazapyr to broaden the spectrum of vegetation control.

In many cases, the 32 to 48 oz/ac application rates of Chopper Gen2 (16 to 24 oz/ac Arsenal) with the appropriate amount of glyphosate or triclopyr should give good competing vegetation control. Keep in mind the factors that determine imazapyr site preparation application rate per acre and timing referred to on page 2.

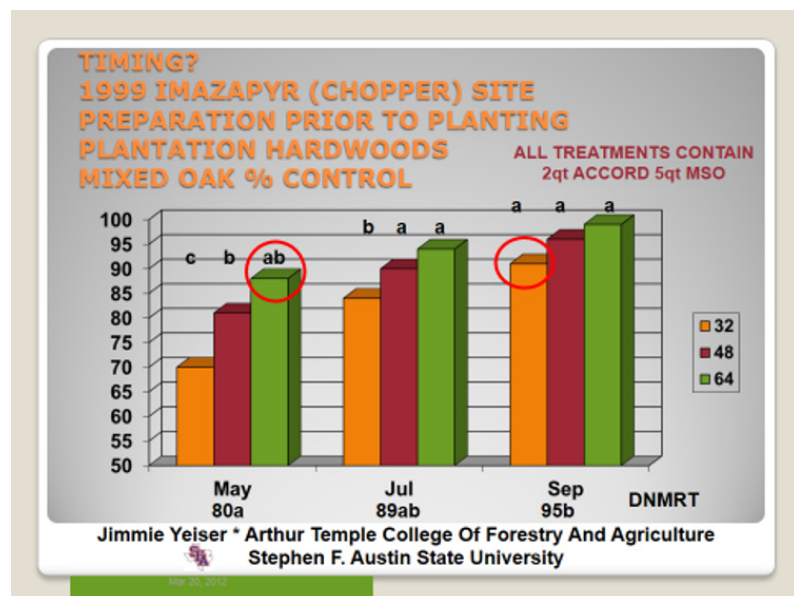


Figure 1: Chopper hardwood control study illustrating the effects of dosage and timing on percent hardwood control. Note that 32 oz/ac in September gave slightly better hardwood control than 64 oz/ac in May. Overall, control was better later in the year than earlier in the year (Sept > July > May) (Yeiser and Ezell 1999).

Tolerance to imazapyr is greatest for loblolly pine, whereas longleaf and slash pine have similar tolerance, and are more prone to imazapyr injury than loblolly. Since Chopper Gen2 contains half the concentration of imazapyr, the recommended product rates are doubled. Other generic products follow these same recommendations, but in all cases the labeled rates may be excessive. On many sites, lower imazapyr application rates than the labeled amount can be used with acceptable competition control results.

Based on the previously mentioned studies and field observations throughout the Southeast during the nearly four 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).

If a site has a sandy surface soil texture, is well, somewhat excessively to excessively drained, has organic matter content < 2%, and low rainfall totals occur between application date and planned planting date 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 rate applied by 2 oz for 4 lb ae/gal imazapyr products and by 4 oz for 2 lb ae/gal product formulations.

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. Imazapyr product rates less than 48 oz/ac should add an appropriate tank mix herbicide such as glyphosate, triclopyr or other compatible herbicides labeled for this use, following all herbicide product label directions.

Herbicide Site Preparation Treatment Date*					
	June	July	August	September	October
Herbicide Product Rates Per Acre (fluid ounces)**					
Planting Date	Loblolly Pine				
November	52	48	44	36	NO
Dec-Jan	56	52	48	44	32***-40
February	60	56	52	48	44
	Longleaf and Slash Pine				
November	48	44	40	32***	NO
Dec-Jan	52	48	44	40	32***-36***
February	56	52	48	44	40

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

**Do not plant within 90 days of a 48 oz/acre rate when using the 2 lbs ae/gallon imazapyr formulation (e.g. Chopper Gen2) herbicide application, especially when rainfall amounts for the area are lower than normal, soil moisture is not adequate for planting, the site is well to excessively drained with a sandy surface soil texture, and competing vegetation is less than 1 to 2 feet tall.

*** Do not plant within 60 days of a 32 -36 oz/ac imazapyr rates when using the 2 lbs ae/gallon imazapyr formulation, especially when rainfall amounts for the area are lower than normal, soil moisture is not adequate for planting, the site is well to excessively drained with a sandy surface soil texture, and competing vegetation is less than 1 to 2 feet tall.

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. Imazapyr product rates less than 24 oz/ac should add an appropriate tank mix herbicide such as glyphosate, triclopyr or other compatible herbicides labeled for this use, following all herbicide product label directions.

Herbicide Site Preparation Treatment Date*					
	June	July	August	September	October
Herbicide Product Rates Per Acre (fluid ounces)**					
Planting Date	Loblolly Pine				
November	26	24	22	18***	NO
Dec-Jan	28	26	24	22	16***-20
February	30	28	26	24	24
Planting Date	Longleaf and Slash Pine				
November	24	22	20	16***	NO
Dec-Jan	26	24	22	16***-20	16***-18***
February	28	26	24	22	20

*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 90 days of a 24 oz/acre when using the 4 lbs ae/gallon imazapyr formulation (e.g. Arsenal AC) herbicide application, especially when rainfall amounts for the area are lower than normal, soil moisture is not adequate for planting, the site is well to excessively well drained with a sandy surface soil texture, and competing vegetation is less than 1 to 2 feet tall.

*** Do not plant within 60 days of a 16- 18 oz/ac imazapyr rate when using the 4 lb ae/gallon imazapyr formulation, especially when rainfall amounts for the area are lower than normal, soil moisture is not adequate for planting, the site is well to excessively drained with a sandy surface soil texture, and competing vegetation is less than 1 to 2 feet tall.

LITERATURE CITED:

- Lauer, D.K.; Quicke, H.E. 2006. Timing of Chopper herbicide site preparation on bedded sites. So. Jour. Of App. Forestry. 30(2). pp. 92-101.
- Yieser, J.; A. Ezell. 1999. Chopper timing and dosage study on hardwood control. Presented at the Weed Science Society of America annual conference.

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Photo 1: *An aerial herbicide application over unwanted competition.*

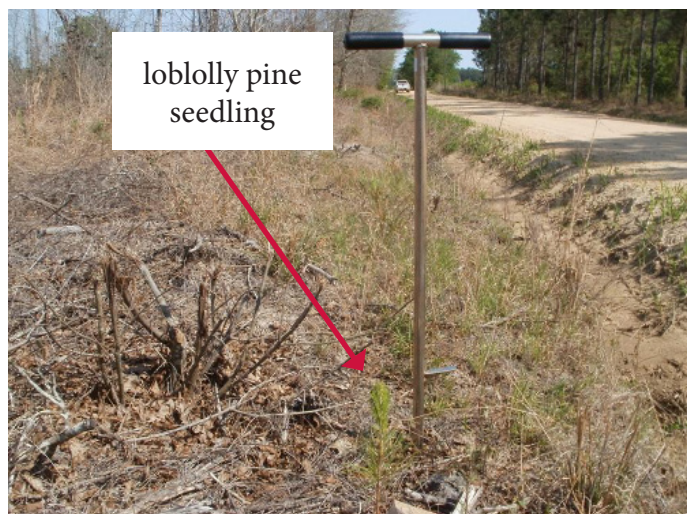


Photos 2 and 3: *Stunted loblolly pine growth following site preparation using 48 oz/acre Chopper (0.75 lb ael/acre imazapyr) plus surfactant, applied in late August of the previous year.*

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Photos 4 and 5: *Slash pine planted 22-23 December 2010 following site preparation using 48 oz/acre Polaris SP (imazapyr @ 0.75 lb ae/acre), 3 qt/acre Accord (glyphosate), and 3 oz/acre Spyder (sulfometuron methyl) in late August 2010, and burned early November 2010. Photos were taken summer (Photo 4) and at the end (Photo 5) of the first growing season. This stand had approximately 85% survival and good growth in a hot and dry (well below normal rainfall) first growing season.*



Photos 6 and 7: *At left, poor loblolly pine survival (<40%) following site preparation using 48 oz/acre Chopper (imazapyr) + 16 oz/acre Garlon 4 (triclopyr ester) + 4 oz/ac Oust Extra (sulfometuron methyl + metsulfuron methyl) applied during late September 2010. The seedlings were planted in early December 2010. At right, the same site as photo 6, but at the stand edge where little herbicide appears to have been sprayed, showing good survival (80%) and seedling appearance in the detected planted rows.*



Photo 8 and 9: *At left, poor loblolly pine survival (<50%) following site preparation using 48 oz Chopper/acre (imazapyr) applied late September 2010. Seedlings were planted early December 2010. At right, the same site as photo 8, but at the edge where little or no herbicide appears to be sprayed and good survival (80-95%) and seedling appearance were observed in detected rows.*

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