

Longleaf Note: 1

Applications to Restoration Ecology

As longleaf pine has been extirpated from much of its natural range, considerable effort is underway to reestablish longleaf and its associated forest community. Because longleaf seedlings have a grass stage, they do not compete well with other plants for light, water, and nutrients. Thus, seedling survival can be poor and emergence from the grass stage may take several years. This note provides important information on herbaceous vegetation control that can be applied to longleaf pine seedlings. We encourage spot treatments over each seedling because this method causes the least impact on the plant community, results in the retention of most of the ground cover for use by wildlife, and minimizes potential erosion.

Herbaceous Vegetation Control

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Herbaceous weeds compete with pines for water, nutrients, and light. These weeds can decrease survival of planted pines during the first growing season and continue to limit growth of young pines. The impact of herbaceous vegetation diminishes as stands reach crown closure. The goal of herbaceous weed control is to increase survival and growth by control of herbaceous vegetation, usually in the first year following planting. Applications are usually made over the top of newly planted pine seedlings. Any mortality or stunting due to herbicide use will reduce the profitability of these treatments. Proper calibration of spray equipment, timing of application, and selection of the proper herbicide and rate are crucial to the success of these treatments.

There are many herbicides available for herbaceous weed control (HWC)(Table 1). We rely on the **selectivity** of herbicides to obtain crop safety and weed control by using herbicides with a specific mode of action, treating weeds in an early stage of development (so it is possible to use lower rates of herbicides that may not be selective at higher rates), and limiting uptake by the crop species at time of application. For these reasons, most herbicides used for HWC are applied as **pre-emergent** or **early post-emergent** applications and selectivity is achieved by using a herbicide that only works on germinating weeds, or using a low rate of herbicide that works well on immature weeds but poorly on established mature weeds. Surfactants should be used only when specifically recommended because they increase uptake by the crop species and do not increase uptake by emerging weed seeds.



Table 1. Herbicides currently registered for first year herbaceous weed control¹.

Product	Active ingredient	Crop species (pines)	Rate per treated acre
Aatrex 4L ²	Atrazine	Loblolly, slash	4-8 pints/acre
Accord	Glyphosate	None unless as directed sprays	1-2% solution + surfactant
Arsenal AC	Imazapyr	Loblolly, loblolly x pitch hybrid, Virginia	6-10 fluid oz/acre
		Longleaf	4-6 fluid oz/acre
		Slash	4-8 fluid oz/acre
Escort	Metsulfuron	Loblolly	0.5-1.5 oz/acre + surfactant
Fusilade II	Fluazifop	Conifers	16-24 oz/acre + crop oil or non-ionic surfactant
Oust	Sulfometuron	Loblolly, longleaf, slash, Virginia	2-8 oz/acre
Pronone 10MG	Hexazinone	Loblolly	5-12.5 lbs/acre with rate dependent on soil texture
Vantage	Sethoxydim	Loblolly, slash, longleaf, Virginia	2.25-3.75 pints/acre
Velpar L	Hexazinone	Loblolly, longleaf, slash	2-6 pints/acre with rate dependent on soil texture
Escort+Arsenal AC	See products above	Loblolly	Escort at 0.75-1.5 oz/acre + Arsenal AC at 4-6 oz/acre
Escort+Velpar L	See products above	Loblolly	Escort at 0.5-1.5 oz/acre + Velpar L at 1.5-3 pints/acre
Oust + Accord	See products above	Loblolly	Oust at 2-4 oz/acre + Accord at 16-24 oz/acre + Entry II surfactant
		Slash	Oust at 2-4 oz/acre + Accord at 12-16 oz/acre + Entry II surfactant
Oust + AAtrex 4L	See products above	Loblolly	Oust at 2-4 oz/acre + AAtrex 4L at 4-8 pints/acre
Oust + Arsenal AC	See products above	Loblolly	Oust at 1-2 oz/acre + Arsenal AC at 4-6 oz/acre
Oust + Velpar L	See products above	Loblolly, slash, longleaf	Oust at 2-4 oz/acre + Velpar L at 2-3 pints/acre

¹This list is intended as a guide only. Read and follow directions on individual product labels.

² AAtrex 4L is a restricted use herbicide due to ground and surface water concerns. Best management practices should be followed. Do not apply within 50 ft of wells, within 66 ft of open streams, or within 200 ft of lakes.

Herbicides vary in which weeds they control and how they actually disrupt the physiological processes of weeds. These differences affect the timing and method of application and the weed species controlled. Accord, Fusilade II, and Vantage must be applied post-emergence since they rely on foliar uptake. Fusilade II and Vantage work only on grasses and must be applied during the correct stage of grass development. Accord, Arsenal AC, and Velpar L will control many grasses and broadleaf species. These herbicides are selective only because they are used at low rates. For this reason, they must be applied accurately and with proper calibration of spray equipment to avoid excessive damage to the crop species. Velpar L rates are dependent on soil textures. Low rates must be used on sandy soils and rates can be increased for finer textured soils or soils high in organic matter. Oust, Escort, and AAtrex 4L must be applied pre-emergent or early post-emergent. Oust is one of the best herbicides available for HWC since pine safety is achieved over a wide range of rates. While 2 oz/acre is the lowest rate recommended for Oust, little improvement in weed control is seen from higher rates, except for hard to control species. Higher rates are usually used when Oust is used by itself or to improve the duration of weed control. Arsenal AC and Velpar L have moderate persistence in soil so they are often added to Oust to improve the duration of weed control as well as broaden the spectrum of weed control. AAtrex 4L is the only restricted use herbicide in this list due to ground and surface water concerns. It must be applied by a certified applicator following best management practices. Proper use of this product will ensure its continued registration, while misuse may result in its unavailability in the future.

All these herbicides are mixed with clean water for a total spray volume of 15-30 gallons per treated acre for most ground applications. All mixtures should be thoroughly agitated before application. Research has shown that large batch tanks can require 30 minutes of agitation before total mixing occurs. Extended storage of mixed solutions can be problematic. Oust and Escort will start to break down in water and should not be stored more than 24 hours. Mixtures with Velpar L should not be stored overnight, especially cold nights, since Velpar L will crystallize at low temperatures and clog equipment.

Proper planning is important. In many instances this planning should start the year prior to planting, as treatment selection will depend on:

1. Crop species
2. Weed species and stage of weed development
3. Application method (spot, band, broadcast, aerial)
4. Soils

These factors are all inter-related, so a change in one may affect the others. Decisions concerning treatments often occur only weeks or days before application when it is too late to change many of these factors. A lack of planning can compromise treatment efficacy and crop performance.

Crop species

Selection of crop species can be important to success. The crop species can determine the timing of methods and the selection of herbicides. While all of these herbicides can be used with loblolly pine, some of these herbicides cannot be used with other species or must be used at lower rates than with loblolly. Herbicides and herbicide rates safe for use in longleaf pine, for instance, make weed control feasible in areas where there are few established weeds following proper site preparation, but make weed control very difficult in a Bermuda grass pasture. Here the options are to either apply an August pre-plant application to control the Bermuda grass or plant loblolly pine so that spring treatments can be made with the proper herbicides at higher rates.

Pine safety requires adherence to labeled rates. Rates are often reduced when herbicides are used in combinations. Use of Arsenal AC for HWC provides a good example of these concepts. Slash and longleaf pines are not as tolerant to Arsenal AC as is loblolly pine. Lower rates must be used to avoid excessive damage. A surfactant is not recommended since the addition of a surfactant would increase pine uptake and possibly increase damage. Note that the Oust-Arsenal AC combination is recommended for loblolly pine only. Pine tolerance to Arsenal AC is reduced when used with Oust because these herbicides have a similar mode of action.

Weed species and stage of weed development

Weed control in forestry is very challenging. Forested sites are anything but uniform. Changes in soils, topography, and drainage across a given stand can be quite large compared to an agricultural field. These factors, along with a minimum amount of cultivation, can result in a large number of weed species on any given site. Past experience is often the only insight we have about what weeds to expect since most forestry applications are made before weeds have emerged. Timing an application to degree of weed growth is usually not possible due to the large number of acres involved and the extensive type of management. These factors require that herbicides in forestry have a broad spectrum of control. Fortunately for us, this is the case. Tank mixes are very common because they improve the spectrum of control. Mixes of Oust with more persistent soil active herbicides such as Velpar L, Arsenal AC, and AATrex 4L improve both the spectrum and duration of control.

There are several difficult to control weed species. Control of these species may not be complete and may depend on developmental stage of the weed species. A description of the problem species and general technique for control follows.

Bermuda grass was a difficult to control species before Arsenal AC was registered for forestry. Bermuda grass is a running grass that can invade a treated band or spot very quickly. Spot or banded applications made the year before planting can be recolonized quickly during the first growing season. Current recommendation is to use a pre-plant broadcast application or a post-plant spot, banded, or broadcast application. Accord at 4-5 qts/acre or Arsenal at 16 oz/acre can be applied as a broadcast pre-plant application in August before planting. Application should be made before the end of August because

activity declines as this grass approaches dormancy. Post-plant applications can be made with Arsenal AC or Arsenal AC + Oust at the highest labeled rates in early spring just as the grass starts to green. Bands or spots should be as large as possible. Bands or spots are possible with Arsenal AC because its residual activity will keep grass from immediately recolonizing treated areas. Bermuda grass is tolerant to Oust but can be added to improve control of other weed species that may be present and should be used only when the crop species is loblolly pine.

Broomsedge can be difficult to control. Control of this species is dependent on site-preparation and tank mixes. Mechanical tillage or chemical site-preparation treatments can be used to reduce the levels of established broomsedge before planting. Broomsedge coming from seed the first year can be controlled with tank mixes of Oust with Arsenal AC or Velpar L. This species is tolerant to Oust. Established broomsedge is difficult to control and the best operational treatment is the Oust + Accord combination applied in June when broomsedge greens up.

Morningglory, sicklepod, and cocklebur are tolerant to many of our herbicides. The Oust + AAtrex 4L combination is currently the only cost effective treatment for these species. Treatment should be applied before emergence.

Johnsongrass is difficult to control. The grass herbicides Vantage and Fusilade II have some activity but must be applied at the correct stage of development and often need a second application. This makes them an expensive option. The best operational treatments are Oust at more than 4 oz/acre or the Oust + Arsenal AC combination applied as a pre-emergent or early post-emergent. Directed applications of Accord will also work where feasible.

Panic grasses can be difficult to control. Herbicide combinations of Oust + Velpar L and Oust + Arsenal AC will control most panic grasses if they are originating from seed. Arsenal AC or Oust + Arsenal AC will control established panic grasses.

Blue vervain is tolerant to Arsenal AC but can be controlled with Oust + Velpar L.

Blackberry is tolerant to Arsenal AC. Combinations with Escort are often used to improve control of this species.

Crotons, nutsedge, and trumpet creeper are tolerant to our current herbicide treatments.

Application method

Herbicides can be applied in **spots** around crop trees, in **bands** over tree rows, or **broadcast** over the entire area. Spot applications are usually done by hand on sites where there are no clearly defined rows (such as handplanted sites), or on sites where access for mechanical equipment is limited. Herbicide costs are low for this method since herbicide is only applied to a spot. However, control over application rates can be poor and labor costs can be high. Banded

application is usually done by tractor mounted sprayers three rows at a time but can also be done one row at a time with backpack sprayers. Banded applications have lower herbicide costs than broadcast applications since only about half of the planted acre is treated. Trees must be planted in well defined rows. Cost effective tractor applications usually require well spaced rows so three rows can be treated in a single pass. Broadcast applications are more expensive than banded or spot applications since the entire area is being treated. Broadcast applications have the advantage in that they can be made on handplanted or machine planted sites with ground equipment or helicopters.

Tractor and helicopter applications with proper nozzle configuration and calibration allow excellent rate control. Backpack applications will not be as accurate. Banded applications are safer than broadcast because there is little possibility of overlapping adjacent spray swaths. Oust provides a wide margin of safety and can be used with any application method. Arsenal AC, Velpar L, and Accord have narrow margins of safety and must be applied accurately. Using these herbicides in backpack applications or broadcast applications with overlap can result in pine damage.

The choice of application method usually considers cost. Banded and spot applications provide the same growth response and survival as broadcast applications as long as the area treated is larger than 35 square feet around each crop tree. Survival can probably be improved by treating a smaller area, although growth response will be reduced.

Soils

Soils determine future productivity, herbicide performance, and herbicide containment. Soil conditions can determine the application method chosen, which herbicide and herbicide rate will be used, post-treatment erosion, and off-site movement of herbicides.

Broadcast HWC applications should not be made on sites with steep slopes or slopes with highly erodible soil. Any short term gain due to weed control could be lost in long term crop productivity due to erosion. Banded or spot applications should be considered in these situations.

Soil texture and soil acidity can affect herbicide performance. Herbicide formulations containing hexazinone are strongly affected by soil texture and percent organic matter. Lower rates are needed for weed control on sandy soils than on clay soils or soils high in organic matter. Similarly, crop tolerance is lower on sandy soils. Careful matching of rate with soil texture is required. Although most of our forest soils are acidic, there may be some instances such as a limed agricultural field being converted to forest where soils are much less acidic. Oust and Escort are both sensitive to soil acidity. Recommended rates are for normal forest soils. Less acidic soils require much lower rates for the same level of crop tolerance and weed control.

Applications should not be made on coarse sandy or gravelly soils and adequate buffers should be left around streams and bodies of water. This is especially true for Arsenal AC, Velpar L, and AAtrex 4L. These products are somewhat persistent and can move off-site under extreme

conditions. It is important that the forestry community use these products wisely as detection of these products in groundwater or streams at high levels will result in further restrictions of their use in forestry. Please use them properly.

Other considerations

There are other considerations in the prescription process. These include timing of planting, type of site-preparation, decisions about tank mixes, and herbicide selection based on pine response. These considerations are important in forestry because any treatment made at planting is a long-term investment. There is often no clear choice of which specific herbicide treatment provides the best return since herbicide treatments vary in cost and since duration of control often increases with rate. It is clear that HWC will not be profitable where herbaceous weeds are not a problem, where weeds are not controlled by the selected treatment, or where treatments cause excessive damage to the crop.

The impact of herbaceous weeds on pine growth and survival should not be underestimated. Long term studies estimate that increased early pine growth due to HWC advances stand development by 1 to 3 years. Stand development can be advanced up to 5 years if HWC also improves survival. Of course, proper site-preparation, planting, seedling handling, and seedling quality can also improve survival and growth.

The knowledge that HWC improves early pine growth can be utilized in the selection of site-preparation treatments. Reduced herbaceous vegetation the first year will result in faster pine growth regardless of how it is obtained. Some degree of first-year HWC can be obtained through the use of proper site-preparation. Mechanical treatments and chemical site-preparation treatments that contain imazapyr, glyphosate, or hexazinone will often result in reduced herbaceous vegetation levels during the first spring. These treatments will also reduce the established weeds and make post-plant HWC treatments more effective.

Long-term studies indicate that crop growth increases with duration of weed control. Tank mixes are often the way to improve the spectrum and duration of control. However, costs often increase as herbicides are added. Tank mixes should be considered when knowledge of expected weed species is limited or the species present cannot be controlled by one herbicide alone. A common question is whether to use Arsenal AC or Velpar L in a tank mix with Oust. Generally, the Oust + Velpar L combination will provide a larger growth response for the same level of weed control. Arsenal AC can cause short term suppression of height growth. This suppression is not serious at low rates, and probably not as serious in the deep South where pines with weed control continue to respond late in the season. Arsenal AC should definitely be considered for control of established panic grasses and Bermuda grass since Oust + Velpar L will not control these species. There is often no clear answer as to which combination will provide the best return on investment.

Prescription guide

A prescription guide is provided in Table 2. This is intended only as a guide and does not replace the label. Follow all label instructions and restrictions. The guide provides prescriptions based on soils, condition of vegetation, timing, and crop species for two broad geographical regions and old field or pasture sites. This guide does not replace local knowledge and experience and there is no doubt that these general prescriptions can be improved by this experience.

Table 2. Herbaceous Weed Control Prescriptions.

Soils	Conditions	Treatment (per acre rates) ¹	Timing ²	Crop Species
Lower Coastal Plain				
Spodosols	bare soil	Oust @ (2-3 oz) + Velpar L @ 32 oz	March-April	loblolly, slash, longleaf
Spodosols	bare soil	Arsenal @ 6 oz	March-April	slash
Spodosols	bare soil	Arsenal @ (6-8 oz)	March-April	loblolly
Spodosols	bare soil	Oust @ (2-3 oz) + Arsenal @ (4- 6 oz)	March-April	loblolly
Spodosols	established grasses	Arsenal @ 8-10 oz/ac	March-April	loblolly
Spodosols	established grasses	Arsenal @ 6-8 oz/ac	March-April	slash
Spodosols	established grasses	Oust @ 2 oz + Arsenal @ 6 oz	March-April	loblolly
Spodosols	shrubs + herbs	Delayed double bed	Pre-plant	all species
Spodosols	shrubs + herbs	Early bed + Arsenal @ (8-12 oz) + Accord 2 qt	Pre-plant	all pines
Spodosols	shrubs + herbs	Early bed + Arsenal @ (8-12 oz) + Garlon 4 @ (2- 3 qts)	Pre-plant	all pines
non-spodosols - sands		(use same prescriptions as spodosols)		
non-spodosols - clays	bare soil	Oust @ 2 oz + Velpar L @ 48 oz.	March-April	loblolly, slash, longleaf
		Arsenal @ 6 oz	March-April	slash
		Arsenal @ 6-8 oz	March-April	loblolly
		Oust @ (1.5-2 oz) + Arsenal @ (4-6 oz)	March-April	loblolly
Upper Coastal Plain - Piedmont				
sandy	bare soil	Oust @ (2-3 oz) + Velpar L @ 24-32 oz	March-April	loblolly, slash, longleaf
		Oust @ (3-4 oz)	March-April	Virginia, loblolly, slash
		Arsenal @ (4-6 oz)	March-April	longleaf
		Arsenal @ 6-8 oz	March-April	loblolly, slash
clay	bare soil	Oust @ 2 oz + Velpar L @ 32-48 oz	March-April	loblolly, slash, longleaf
		Velpar L @ 48-64 ³ oz	March-April	shortleaf, loblolly, Virginia
		Arsenal @ 8 oz	March-April	loblolly, slash
		Oust @ (1.5-2 oz) + Arsenal @ (4-6 oz)	March-April	loblolly
clay or sands	established herbs	Arsenal @ (8-10 oz)	March-April	loblolly
		Oust @ (1.5-2 oz) + Arsenal @ (4-8 oz)	March-April	loblolly
	(Fescue + forbs)	Oust @ 2 oz + Velpar L @ 32-48 oz	March-April	longleaf
		Oust @ 2 oz + Accord @ 16 oz	June	loblolly, slash

Soils	Conditions	Treatment (per acres rates)	Timing	Crop Species
Old fields - Pastures				
Previous cropland	sicklepods, cocklebur	Oust @ 2 oz + atrazine @ 2-4 lbs	March-April	loblolly, slash, longleaf
Previous cropland	morningglory			
Previous cropland	Johnsongrass	Arsenal (4-6 oz) + Oust (2-3 oz)	March-April	loblolly
		Oust @ 5 oz	March-April	loblolly, longleaf, slash, Virginia
Pasture	non-Bermuda grass	Oust @ 2 oz + Velpar L @ 32 oz	March-April	loblolly, slash, longleaf
		Oust @ 2 oz + Arsenal @ (4-6 oz)	March-April	loblolly
Pasture	Bermuda grass	Arsenal @ (7-8 oz)	March	loblolly, slash
		Arsenal @ (4-6 oz) + Oust (2-3 oz)	March	loblolly
Pasture	Bermuda grass	Accord @ 5 qts/ac + surf.	August pre-plant	All species
		Arsenal @ (12-16 oz) + surf.	August pre-plant	loblolly, slash, longleaf

These are recommendations based on labeled rates, studies reported in the literature, and experience with current operational forestry practices. Other combinations may be available. These rates will usually work under the specified conditions and research has shown them to provide increases in growth and/or survival under many but not all conditions. Rate recommendations do not supersede label restrictions - read and follow label instructions before application.

1. Highest range rate provides best weed control. The best weed control for mixtures is usually achieved by using the highest rate for one with the lowest rate for the other.
2. Best range is given. This can usually be extended by 2 weeks (earlier or later) with satisfactory results.
3. Up to 10% loblolly mortality could occur at high rate of this range.
4. Higher rate recommendations for established vegetation may cause some pine damage in order to control herbs.

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