Herbicide treatments did not differ statistically with respect to percent brownout of broadleaf forbs. Percent brownout ranged from 83 to 100 %. All treatments differed from check plots which were rated at 7 and 0 % in MS and SC, respectively.

Herbicide treatments did not differ statistically with respect to overall percent brownout of hardwood species. Foliar brownout ranged from 70 to 95 %. All treatments differed from the check plots which were rated at 0 % at both locations. Herbicide treatments were particularly effective on sweetgum in SC. Brownout ranged from 95 to 100 %. Low levels of brownout occurred on water oak with a range of 23 to 42 %. Two treatments were effective on winged elm. Applications of Fosamine + imazapyr (Chopper) + metsulfuron and Fosamine + imazapyr (Chopper) + glyphosate resulted in 100 and 95 % brownout, respectively. Remaining treatments provided less than 50 % brownout.

The above three-way mixtures provided effective (90 % or more) control of all species on both sites. Low level control of water oak and winged elm in SC resulted from the Krenite plus Chopper treatment. Krenite mixed with either Chopper or Arsenal provided poor control of red maple and winged elm in MS.

INITIAL BROWNOUT RESPONSE TO MON78015, MON78229, MON 78128, AND OTHER GLYPHOSATE PRODUCTS AND TANK MIXTURES. A.W. Ezell, Department of Forestry, Mississippi State University, Mississippi State, MS 39762, L.R. Nelson, Clemson University, Clemson, SC 29634, and J.L. Yeiser, Stephen F. Austin State University, Nacogdoches, TX 75962.

ABSTRACT

A total of ten herbicide site preparation treatments were applied on recently cutover forest sites in South Carolina, Mississippi, and Texas. All treatments included glyphosate either alone, tank mixed with imazapyr, or in a premix formulation with imazapyr. Applications were completed in late July with a CO_2-powered backpack sprayer using 10 gpa total spray volume to simulate aerial application for site preparation. Each treatment was replicated three times at all locations. A pretreatment inventory of woody stems in plots was completed by species and height class, and an ocular estimate of brownout was completed at 8 WAT.

Overall, all treatments did an excellent job of brownout on grass and broadleaf species. The Texas site had little or no broadleaf coverage in the plots, but Mississippi and South Carolina exhibited greater than 90% brownout on herbaceous competition. Overall brownout of woody species in Mississippi ranged from 83 - 95% with no significant difference between any of the herbicide treatments. In Texas, brownout of woody species ranged from an average of 49% to 89% but the treatments did not vary significantly (statistically) in their performance. In South Carolina, two of the herbicide treatments were statistically significant in their brownout difference from the other 8 treatments on woody species. Average brownout ranged from 64-87% at this site. Considering all species at all study sites, the brownout response to these treatments is considered to be excellent.

HARDWOOD STEM REDUCTION WHEN PREPARING PINE SITES WITH A NEW FORMULATION OF HEXAZINONE. J.L. Yeiser, Stephen F. Austin State University, Nacogdoches, TX 75962 and A.W. Ezell, Mississippi State University, Mississippi State, MS 39762.

ABSTRACT

Site preparation rates of Velpar L and a new Velpar DF formulation were tested alone and in combination with Garlon 4 for unwanted woody stem reduction on pine sites in Texas and Mississippi. In Texas only, Velpar L+Accord and Krenite S+Arsenal AC were also tested. Herbicide treatments were applied in Texas on June 1, 1999 and in Mississippi on June 5, 1999. Both sites were evaluated 16 months following treatment. When the new Velpar DF formulation was compared with Velpar L, percent stem reduction of American beautyberry, sweetgum, yaupon, post oak, water oak, and overall species was similar. In Mississippi, the new Velpar DF alone and in mixture with Garlon 4 reduced red maple and post oak more than Velpar L. In contrast, Texas sweetgum was controlled more with new Velpar DF and Velpar L than with Velpar DF+Garlon, Velpar L+Garlon 4 or Velpar L+Accord mixtures suggesting antagonism. Although differences were detected for specific species, overall stem reduction was similar for the new and current formulations of Velpar both alone and mixed with Garlon 4, illustrating the trade-off in species control that can occur. Rootstocks were effectively controlled by herbicides. Ingrowth was similar for herbicide and check plots. Sixteen months after treatment, competitor levels on herbicide plots were significantly less than on check plots, but perhaps still too high for intensive pine culture. The new hexazinone formulation shows promise as part of an integrated pest management approach to preparing sites for planting.

INTRODUCTION

Herbicides used during the chemical preparationof pine sites include, but are not limited to, Arsenal AC, Accord, Garlon 4, Velpar L and Krenite S. DuPont has developed a new formulation of hexazinone, called Velpar DF, and its potential for woody plant control during the preparation of pine sites is unknown. The objective of this study was to compare woody stem reduction resulting from site preparation applications of Velpar L and Velpar DF, alone and in combination with Garlon 4 for the control of unwanted woody species occupying pine sites.

METHODS

A site in Texas and Mississippi were selected for testing. The Texas test site was in the Upper Coastal Plain near Diboll (Angelina County). The soil was a moderately well drained sandy loam with a top 6-in. pH of 4.5. This site supported a mixed pine hardwood stand prior to clearcutting in the fall of 1998. Yaupon (Ilex vomitoria Ait.), and sweetgum (Liquidambar styraciflua L.) were the dominant woody species occupying the site. Sweetgum and oak were very uniform in height and commonly 3-ft. tall. Yaupon was somewhat less uniform in height and varied from 1.5- to 4-ft. in height. Minor components of green ash (Fraxinus pennsylvanica Marsh.), post oak (Q. stellata Wangenh.), mockernut hickory (Carya tomentosa (Poir.) Nutt), honeylocust (Gleditsia triacanthos L.), mixed red oak (Quercus falcata Michx. and Q. nigra L.) and fringetree (Chionanthus virginicus L.) were present in too few plots or occurred too infrequently to justify an individual species assessment. These species were also commonly 3-ft. tall when herbicides were applied. At treatment time, light grass (Dichanthelium spp) and light broadleaf communities were present, perhaps due to the heavy litter layer. American beautyberry (Callicarpa americana L.) did occur in major proportions throughout test plots. Soil moisture was good on application day. Plots were geo-referenced to facilitate plot assessment over time. Loblolly pine (Pinus taeda L.) seedlings were planted in January 2000.

The Mississippi site was in the Upper Coastal Plain approximately 5 miles west of Ackerman, MS. The soil was a clay loam with a pH of 5.6. The site supported a mixed pine-hardwood stand prior to clearcutting in October 1998. The major undesired woody species occupying the site were sweetgum, mixed red oaks (Quercus phellos L., Q. nigra L., Q. falcata Michx. and Q. pagoda Raf.), and red maple (Acer rubrum L.). Lesser amounts of post oak (Q. stellata Wangenh.) and black cherry Prunus serotina Ehrh.) were scattered across plots. At the time of treatment, moderate grass (panicgrasses Dichanthelium spp, and sedges Carex spp) and broadleaf communities (ragweed (Ambrosia artemisiifolia L.), goldenrod (Solidago odora Ait.), dock (Rumex spp), dogfennel (Eupatorium capillifolium (Lam.) Small) and mares-tail (Conyza canadensis (L)) existed. Soil moisture on application day was moderate.

Test treatments were:

1. 6 qt of Velpar L (3 lb a.i.) + 2 qt of Garlon 4,
2. 4 lb of new Velpar DF (3 lb a.i.) + 2 qt of Garlon 4,
3. 6 qt of Velpar L,
4. 4 lb of new Velpar DF,
5. 6qt of Velpar L + 2 qt of Accord (in Texas only),
6. 4 qt of Krenite S + 16 oz of Arsenal AC in Texas only, and
7. Untreated Check

A backpack aerial simulator supporting a single, KLC9 flood nozzle approximately 12 ft above the ground was used to broadcast herbicides in a total carrier volume of 10 GPA in Texas on June 1, 1999 and in Mississippi on June 5, 1999. A single pass was used to spray treatment plots. The dimensions of treatment plots were 100 ft X 30 ft. Rootstocks within an internal measurement plot 80 ft X 10 ft were followed for treatment efficacy. All test treatments at both sties contained 2.5% Timberland 90 surfactant.

Prior to treatment, measurement plots received a 100% inventory of woody species. On October 2, 2000 in Mississippi (16 months after treatment), stems surviving treatment were tallied by species. In Texas, pretreatment rootstocks > 1-ft in height were flagged. In October 9, 2000, unflagged stems > 1-ft in height were tallied as ingrowth. Competitor stems 16 months after treatment was computed as the sum of treated but surviving stems plus ingrowth. Percent stem reduction was computed as the number of competitor stems divided by the initial stem count on each plot.

Seven treatments in Texas and five treatments in Mississippi were established in each of three blocks according to a randomized complete block design. In Texas, statistical parameters were percent control of treated hardwoods, ingrowth of hardwoods, and the total number of competing hardwood stems 16 months after treatment. In both Texas and Mississippi percent stem reduction was also a statistical parameter. Data were analyzed according to an analysis of variance using the GLM procedure of SAS (6). Means were separated using Duncan's New Multiple Range test. All tests were conducted at the P=0.05 level.

Drought was severe in Texas during both years of this study. Below average rainfall occurred from mid-June 1999 through late February 2000. Drought commenced again in July of 2000 and continued through data collection in October. A major drought occurred in Mississippi during 2000 as well.

RESULTS

Mississippi,

All herbicide treatments reduced rootstocks on sprayed plots while rootstock numbers commonly increased on check plots (Table 1). When stand-alone treatments of the new formulation of Velpar DF and Velpar L were compared, percent stem reduction of sweetgum, water oak, and overall species was similar. The new Velpar DF reduced red maple and post oak better than Velpar L. When the new DF and current liquid formulations of Velpar were mixed with Garlon 4 and compared, the new Velpar DF+Garlon 4 reduced more rootstocks of red maple and water oak. In contrast, Velpar L+Garlon 4 reduced more rootstocks of sweetgum and post oak. Both mixtures reduced all species similarly. In general, Velpar L+Garlon 4, new Velpar DF+Garlon 4, Velpar L, and Velpar DF were in the group of treatments best reducing competitors in 4, 3, 3, or 5, respectively, of the 5 species groups of competitors tested.

Texas

American beautyberry was controlled best by hexazinone mixtures and Krenite S+Arsenal AC (Table 2). Hexazinone alone did not control American beautyberry. Because ingrowth was similar across all plots, soil active herbicides did not impede plot reinvasion of American beautyberry. The number of competitors 16 months after treatment in plots treated with hexazinone alone or Velpar L+Garlon 4 was similar to the check and greater than for other herbicides. Conceptually, best treatments reduce existing and ingrowth of new rootstocks leaving few unwanted rootstocks to compete with newly planted pine seedlings. Treatments varied in the number of competitors present in test plots 16 months after treatment. For example, untreated check plots initially supported 13 rootstocks of American beautyberry. Plots receiving best treatments for American beautyberry reduction (new Velpar DF+Garlon 4, Velpar L+Accord) initially supported 13 rootstocks. On assessment day, best herbicide treatments and untreated plots had 6 and 19 rootstocks of American beautyberry, respectively. Therefore, best herbicide treatments reduced American beautyberry rootstocks 54% while it increased 46% in checks. This difference is significant.

Sweetgum control was best with Krenite S+Arsenal AC and differed among treatments of hexazinone alone and hexazinone mixed with Accord or Garlon (Table 2). Generally, hexazinone mixtures provided less control than hexazinone alone, suggesting antagonism. The number of ingrowth rootstocks of sweetgum was consistent across treatments and lower than observed for other species. When the number of rootstocks surviving treatment was summed with ingrowth, fewer competitor rootstocks resulted from treatments of hexazinone alone, Velpar DF+Garlon or Krenite S+Arsenal AC. If best treatments leave the fewest pine seedling competitors, then treatments exhibiting greatest sweetgum reduction are hexazinone alone, new Velpar DF+Garlon 4, Krenite S+Arsenal AC. These herbicide treatments and checks started with 12 and 13 rootstocks, respectively. Sixteen months following treatment, 3 and 11 sweetgum rootstocks occurred in plots of best treatments and checks, respectively. Rootstocks were reduced by 75% on treated and 15% on untreated plots and this difference is significant. The reduced rootstock number on check plots probably resulted from two consecutive years of major drought.

Rootstocks of yaupon were similarly controlled by all herbicide treatments (Table 2). Yaupon was probably the test species most difficult to control. Ingrowth was similar for all treated and untreated plots. Because control was generally low for yaupon, the number of ingrowth rootstocks equaled and commonly exceeded the number of rootstocks controlled. Consequently, competitor levels 16 months after treatment were commonly greater than when the study began. In fact, herbicide (excluding Velpar DF) and check plots started with 10 and 17 rootstocks, respectively. When assessed 16 months after treatment, herbicide and check plots supported 12 and 23 rootstocks, respectively. This represents a 20% and 65% increase on herbicide and untreated plots, respectively. This difference was significantly different. Velpar DF may have performed poorly on yaupon because, as a stand alone, it lacked the leaf conditioners present in Velpar L and Garlon 4 needed for enhanced waxy-leaf penetration.

When all species on the test site were considered, control of unwanted woody stems was greater for herbicide than check treatments (Table 2). Control was similar for all herbicide treatments and ingrowth was similar for all treatments. Numerically, herbicide plots started with an average of 184 and check plots 216, rootstocks. Sixteen months after treatment, 65 and 211 competitor rootstocks were growing on treated and untreated plots, respectively. This represented a significant reduction with 65% and 2% fewer rootstocks on treated than untreated plots, respectively.

When stand-alone treatments of the new formulation of Velpar DF and the current formulation of Velpar L were compared, percent stem reduction of American beautyberry, sweetgum, and overall species was similar (Table 2). Yaupon was the only species for which the new Velpar DF formulation did not reduce comparable rootstock numbers as did Velpar L. In mixtures with Garlon, both formulations similarly reduced stems of sweetgum, yaupon and overall species (Table 2). New Velpar DF+Garlon 4 reduced more rootstocks of American beautyberry than Velpar DF+Garlon 4. In general, Velpar L+Garlon 4, new Velpar DF+Garlon 4, Velpar L, Velpar DF, Velpar L+Accord, and Krenite S+Arsenal AC were in the group of treatments best reducing competitors in 2, 4, 3, 2, 3, or 3, respectively, of the 4 competitor groups tested. This indicates the new Velpar DF+Garlon was among those treatments providing best control in 4 of 4 competitor groups and shows promise as an herbicide mixture for site preparation.

In Texas, control varied by species and herbicide treatment (Table 2). Ingrowth was consistent within and across species. For American beautyberry and yaupon, the initial number of competitor rootstocks was similar to smaller than numbers 16 months after treatment. Only sweetgum experienced a consistent reduction in rootstock number. The number of rootstocks for all species 16 months after treatment indicated herbicides significantly reduced rootstocks. But the number of rootstocks at the end of the study, and therefore present during the first growing season, may still be too high for intensive pine culture. Managers committed to intensive pine culture on similar sites should consider integrated pest management with hexazinone or hexazinone mixtures providing a component of the needed weed control.

In conclusion, current and new formulations of hexazinone alone and in Garlon mixtures generally provided similar percent stem reduction of unwanted hardwoods occupying the two pine test sites. Use of the new formulation resulted in similar water oak and overall species reduction and more red maple reduction in Mississippi than currently achieved with Velpar L. Also, sweetgum reduction was less in Texas from hexazinone mixtures with Garlon and Accord than hexazinone alone. Results illustrate the benefits in control from some species and the loss of control for other species from tank mixtures. Antagonism for some species may exist for tank mixtures suggesting further refinement of the blends is needed. None of the test treatments reduced ingrowth below that of checks. Sixteen months after treatment, competitor levels on herbicide plots were significantly less than on check plots, but perhaps still too high for intensive pine culture. The new hexazinone formulation and its tank mixtures

show promise as part of an integrated pest management approach to unwanted woody plant control during the preparation of pine sites for planting.

Table 1. Test plots near Ackerman, MS were treated on June 5, 1999 and plots evaluated on October 2, 2000 for stem reduction (%).

HERBICIDES[1]	RATE (Prod/ac)	SWEETGUM	RED MAPLE	POST OAK	WATER OAK	ALL SPECIES
		(%)	(%)	(%)	(%)	(%)
Velpar L+Garlon 4	6 qt.+2 qt.	-91a	-75c	-100a	-98a	-81a
New Velpar DF+Garlon 4	4 lb.+2 qt.	-75b	-100a	-73b	-98a	-76a
Velpar L	6 qt.	-100a	-83b	-61b	-98a	-63a
New Velpar DF	4 lb.	-100a	-100a	-91a	-100a	-72a
Check	None	-16c	+31d	+157c	+24b	+26b

[1] Treatment means within a column sharing the same letter are not significantly different (Duncan's New Multiple Range Test, P=0.05).

Table 2. Site preparation plots near Diboll, TX were inventoried in May 1999 for initial rootstocks, herbicides were applied on June 1, 1999 and plots evaluated on October 9, 2000 for control (%), ingrowth (number of rootstocks), total competitors (number of rootstocks) and percent stem reduction.

HERBICIDES[1]	RATE (Prod/ac)	AMERICAN BEAUTYBERRY				
		Initial	Control	Ingrowth	Competitors	Reduction
Velpar L+Garlon 4	6 qt.+2 qt.	12	81a	10a	13ab	+8b
New Velpar DF+Garlon 4	4 lb.+2 qt.	12	90a	8a	6b	-50a
Velpar L	6 qt.	12	20b	8a	17a	+42c
New Velpar DF	4 lb.	11	30b	7a	14a	+27c
Velpar L+Accord	6 qt.+2 qt.	14	94a	7a	6b	-57a
Krenite S+Arsenal AC	4 qt.+16 oz.	11	83a	5a	8b	-27b
Check	None	13	15b	5a	19a	+46c
				SWEETGUM		
Velpar L+Garlon 4	6 qt.+2 qt.	14	68cd	2a	8ab	-43b
New Velpar DF+Garlon 4	4 lb.+2 qt.	12	63d	2a	5bc	-58ab
Velpar L	6 qt.	9	78bc	1a	4bc	-56ab
New Velpar DF	4 lb.	10	81b	1a	3c	-70ab
Velpar L+Accord	6 qt.+2 qt.	14	64d	3a	8ab	-43b
Krenite S+Arsenal AC	4 qt.+16 oz.	16	97a	1a	1c	-94a
Check	None	13	3e	2a	11a	-15c
				YAUPON		
Velpar L+Garlon 4	6 qt.+2 qt.	11	51a	9a	13b	+18a
New Velpar DF+Garlon 4	4 lb.+2 qt.	9	51a	6a	11b	+22a
Velpar L	6 qt.	13	45a	7a	17ab	+31a
New Velpar DF	4 lb.	6	35a	5a	10b	+67b
Velpar L+Accord	6 qt.+2 qt.	9	46a	3a	9b	0a
Krenite S+Arsenal AC	4 qt.+16 oz.	9	32a	3a	10b	+11a
Check	None	17	3b	6a	23a	+65b
				ALL SPECIES		
Velpar L+Garlon 4	6 qt.+2 qt.	183	80a	21a	58b	-68a
New Velpar DF+Garlon 4	4 lb.+2 qt.	160	81a	22a	52b	-67a
Velpar L	6 qt.	311	67a	23a	126b	-59a
New Velpar DF	4 lb.	165	75a	20a	61b	-63a
Velpar L+Accord	6 qt.+2 qt.	149	80a	19a	49b	-67a
Krenite S+Arsenal AC	4 qt.+16 oz.	138	80a	16a	44b	-68a
Check	None	216	11b	19a	211a	-2b

[1] Treatment means within a column sharing the same letter are not significantly different (Duncan's New Multiple Range Test, P=0.05).