in water with 0.25% v/v of non-ionic surfactant. Treatments were applied using a CO_2 powered backpack sprayer and an 8010E flat fan nozzle. Each plot was 6 by 70 feet in size with a 3-foot untreated buffer between each plot. Each treatment was applied at a total volume of 40 gallons per acre. The experiment was conducted in a completely randomized design with for replications for each spray date. Control was measured using the line-intercept method. The number of akebia intercepts was determined along a 25 foot line in the center of each spray plot. Native plant numbers and cover were also assessed.

Triclopyr was more effective than glyphosate for the control of akebia for January, February and May spray dates. October applications were not assessed to date. Two lbs ae/ac of triclopyr resulted in over 90% control when applied in January. Efficacy was higher for both herbicides when they were applied in January; May applications received rain only one hour after application and February applications were adversely affected by hard frosts that killed akebia leaves prior to applications. Native plants were not harmed by the dormant season applications and a diversity of native understory herbs was established where akebia was controlled.

REDUCING HARDWOOD STEMS ON PINE SITES WITH ACCORD SP, CHOPPER, AND KRENITE S COMBINATIONS. J.L. Yeiser, L.R. Nelson, and A.W. Ezell, Stephen F. Austin State University, Nacogdoches, TX 75962; Clemson University, Clemson, SC 29634-1003; and Mississippi State University, Mississippi State 39762.

ABSTRACT

Site preparation rates of Accord SP, Chopper, Krenite and selected Accord SP mixtures were contrasted for control of unwanted woody species occupying pine sites following harvest. One site in each of Texas, Mississippi, and South Carolina were tested. Herbicides were applied in August 1999 and plots evaluated for percent stem reduction in late summer of 2000. In South Carolina, treatments of Accord SP, Accord SP+Chopper and Accord SP+Garlon in addition to Krenite S+Chopper and Chopper significantly and similarly reduced unwanted stems of sweetgum, red maple, water oak and overall species. In Mississippi, Accord SP, and Accord SP+Chopper treatments provided woody stem reduction comparable to other test treatments. Only Krenite+Chopper provided significant reduction of more species than Accord SP. In Texas, Accord SP, Accord SP+Chopper and Accord SP+Garlon in addition to Krenite+Chopper and Chopper all provided excellent and comparable control of the unwanted woody species tested. Ingrowth occurred on all Texas treatment plots and was the primary origin of woody competitors during the first growing season. The number of hardwood rootstocks present at planting time may be too high for systems of intensive pine culture. Herbicide treatments did not influence the level of herbaceous competition the spring following application. The resultant herbaceous competitor community was dominated by broadleaf species. Accord SP, Krenite S, Chopper and selected mixtures have promise as part of an integrated approach to woody plant control when preparing pine sites for planting.

INTRODUCTION

Accord SP has replaced Accord for use as the major glyphosate formulation for site preparation. Accord SP controls unwanted pine and a wide range of hardwoods occupying pine sites. Krenite, manufactured by DuPont, also controls pine and numerous hardwood species. The objective of this screening study was to compare hardwood stem reduction resulting from treatments of Accord SP, Krenite S, Chopper and selected mixtures during the preparation of sites for planting with loblolly pine.

METHODS

One site in each of Texas, Mississippi, and South Carolina were selected for testing (Table 1). The post-harvest Texas site was dominated by oak (Quercus. stellata Wangenh., Q. marilandica Muenchh., Q. incana Bartr.), hickory (Carya tomentosa (Poir.) Nutt, C. cordiformis (Wangenh.) K. Koch), sassafras (Sassafras albidum (Nutt.) Nees, summer grape (Vitis aestivalis Michs.) and sumac (Rhus copallina L., R. glabra L., R. aromatica L.). Minor components of ash (Fraxinus spp, gum bumelia (Bumelia lanuginosa (Michx.)Pers., and farkleberry (Vaccinium arboreum Marsh.) occurred infrequently throughout plots. Prior to treatment, slash and harvesting debris were mechanically thrashed leaving a heavy mulch layer across the site, perhaps explaining the presence of light grass (Andropogon virginicus L., Dichanthelium spp) and broadleaf communities on application day. Soil moisture was good on application day. Loblolly pine (Pinus taeda L.) seedlings were planted in January 2000.

In Mississippi, the hardwood community following harvest was dominated by 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 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.

The harvest in South Carolina left sweetgum, water oak, and red maple dominant on the site (Table 1). Minor unwanted woody species included black cherry, winged elm winged sumac, black oak, southern red oak, white oak and blackgum. Soil was dry on application day.

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. A single pass was used to spray treatment plots. The dimensions of treatment plots were 100 ft X 30 ft. Rootstocks within an internal, 80 ft X 10 ft measurement plot were followed for treatment efficacy. The surfactant used was Timberland 90 (2.5%). Treatments are presented in Table 2.

Prior to treatment in summer 1999, measurement plots received a 100% inventory of woody species > 1-ft in height. Plots were again inventoried in the summer of 2000 for stems/rootstocks surviving treatment. Stems > 1-ft in height and absent at the initial inventory but present for the final inventory were tallied as ingrowth. Percent control=number of treated rootstocks dead/total number of rootstocks. An index of post-treatment woody competition is computed by summing the number of rootstocks surviving treatment and the new emerging rootstocks. Percent stem reduction=((the number of dead stems X (-1))+ingrowth)/total. Negative values indicate a decrease in competitors and a positive value denotes an increase in competitors. In Texas, percent herbaceous ground cover was visually assessed in May 25, 2000, approximately 10 months after treatment. Seedling survival was evaluated on October 9, 2000.

Ten treatments were tested. Treatments were assigned to plots in a randomized complete block design with three blocks. In Mississippi and South Carolina data were analyzed for percent stem reduction. In Texas, statistical parameters included percent control of treated hardwoods, ingrowth of hardwoods, the total number of competing hardwood stems 10 months after treatment, and percent stem reduction. Data were analyzed 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.

Soil moisture in Texas, Mississippi, and South Carolina was moderate at study onset. In Texas, severe drought occurred during fall and winter of 1999. All three sites experience extreme drought during the summer and fall of 2000.

RESULTS

South Carolina

Many treatments significantly and similarly reduced unwanted stems of sweetgum, red maple, water oak and overall species (Table 2). For example, 8 (94%), 7 (82%), 9 (86%), and 8 (86%) out of 9 possible herbicide treatments similarly reduced sweetgum, red maple, water oak, and all species, respectively. Accord SP (8qt) was among the treatments providing best reduction of each test species. Glyphosate plus proprietary surfactants (Accord SP (8qt)), and glyphosate with a proprietary penetrant as well as different tank partners and rates commonly resulted in similar reduction. Accord SP (8qt) alone, Accord+MON59120 (8qt+2.5%), Accord SP+Chopper (7qt+10oz, 5qt+24oz), and Krenite+Chopper (6qt+10oz, 4qt+24oz) reduced more red maple stems than Accord SP+Garlon 4 (6qt+48oz) and more sweetgum, red maple, and all species stems than Krenite S (6qt).

Mississippi,

Accord SP (8qt) and eight additional treatments (Accord+MON59120 (8qt+2.5%), Accord SP+Chopper (7qt+10oz, 5qt+24 oz), Accord SP+Garlon 4 (6qt+48oz), Krenite S+Chopper (6qt+10oz, 4qt+24oz) Chopper (64oz), Krenite S (6qt)) provided best stem reduction of sweetgum, water oak, winged elm and all species (Table 2). Accord SP (8qt) provided intermediate reduction of red maple stems. Changing surfactants (Accord+MON59120) failed to reduce more red maple stems and forfeited water oak and overall control. A mixture of Accord SP+Chopper (5qt+24oz) did reduce more red maple stems than Accord SP (8qt), but surrendered wing elm reduction. A mixture of Accord SP+Garlon 4 (6qt+48oz) failed to provide best reduction of red maple, water oak and winged elm, leaving more holes in the spectrum of control than Accord SP alone (8qt). Only Krenite S+Chopper (4qt+24oz) provided a broader spectrum of reduction than Accord SP (8qt). Chopper (64oz) and Krenite S+Chopper (6qt+10oz) reduced the red maple that Accord SP (8qt) did not, but both failed to reduce the winged elm that Accord (8qt) did reduce. Accord SP (8qt), Accord+MON59120 (8qt+2.5%), Accord SP+Chopper (7qt+10oz), Accord SP+Chopper (5qt+24oz), Accord SP+Garlon 4 (6qt+48oz), Krenite S+Chopper (6qt+10oz), Krenite S+Chopper (4qt+24oz), Chopper (64oz), and Krenite S (6qt) provided best reduction of 4, 2, 4, 4, 2, 4, 5, 4, and 1, respectively, of the five species groups tested. These data suggest Accord SP (8qt) alone and Accord SP+Chopper (7qt+10oz, 5qt+24oz) treatments provide woody stem reduction comparable to rival test treatments.

Texas

Plot assessments for individual species revealed similar control of rootstocks of hickory, oak, sassafras and summer grape (Table 3). Mortality on checks was probably due to drought and significantly less than for herbicide treatments. For all individual species, ingrowth was statistically similar across all treatments, including the check, although zero ingrowth was recorded for some species and treatment combinations. With excellent control and limited ingrowth, the number of established competitors 12 months after treatment to compete with planted pine seedlings was small and similar for all herbicide treatments and species. Percent stem reduction by species was similar for all herbicide treatments and significantly better than for untreated check plots.

When all species were considered as a group, control was excellent (Table 3). Ingrowth on plots treated with Accord SP+Chopper (7qt+10oz) and Accord SP+Garlon 4 (6qt+48oz) was similar to the untreated check. Otherwise, ingrowth was similar. For all treatments, ingrowth contributed significantly to the number of established competitors 12 months after treatment. Competitors on check plots were significantly greater than other treatments. Competitors present on herbicide treatments differed only for extreme values. For example, Krenite S+Chopper (6qt+10oz) and Chopper (64oz) had an average of 5.3 competitor rootstocks. This was significantly fewer than Accord SP+Garlon (6qt+48oz) with an average of 26.3 rootstocks. Competitor levels for all herbicide treatments may be too high for intensive pine management. Percent stem reduction was lowest for check plots. Percent stem

reduction for Accord SP (8qt), Accord SP+Chopper tank mixes, Krenite S+Chopper tank mixes, Chopper and Krenite S was best and similar. Data suggest Accord SP (8qt) and Accord SP+Chopper tank mixes, Krenite S+Chopper tank mixes, Chopper, and Krenite S provided similar woody stem control.

In spite of the high rates tested, herbaceous ground cover in May was similar for all treatments. Mean ground cover for herbicide treatments was 64% and the untreated check 60%. Herbaceous competition was largely from a tall broadleaf, cucumber-leaf sunflower, Helianthus debilis, with approximately one percent cover from grass, largely Andropogon spp.

Seedling survival after one growing season ranged from a high of 88% (Krenite S+Chopper (6qt+10oz) to a low of 63% (Accord SP+Chopper (7qt+10oz)) with the check in the middle with 71% survival. Survival on all treatment plots met the manager's projected goal of 400 seedlings per acre.

In conclusion, Accord SP, Chopper, Krenite S and selected mixtures provided comparable control of the unwanted woody species tested. Stem reduction was excellent for all three sites. Ingrowth occurred on all Texas treatment plots and was the primary origin of the woody pine-seedling competitors during the first growing season. The number of competing rootstocks at the Texas site suggests competition levels may still be too high for sites planned for intensive pine culture. Herbicide treatments did not influence the level of herbaceous competition the spring following application. The resultant herbaceous competitor community was dominated by broadleaf species, with the obvious absence of grasses. Accord SP, Krenite S, Chopper and selected mixtures have promise as part of an integrated approach to woody plant control when preparing pine sites for planting.

Table 1. Description of the three study sites including application and evaluation dates.

	Texas	Mississippi	South Carolina
Location	Mount Enterprise (Rusk)	Ackerman (Choctaw)	Antreville (Abbeville)
Physiography	Upper Coastal Plain	Upper Coastal Plain	Upper Coastal Plain
Soils	carizzo deep sand	sandy clay loam	sandy clay loam
Stand	mixed pine hardwood	mixed pine hardwood	mixed pine hardwood
Clearcut	Oct 1997	Nov 1998	Jan 1998
Site Preparation	mulched June 99	None	shear & pile 1998
Application Date	Aug 7, 1999	Aug 13, 1999	Aug 16, 1999
Stems Counted	Initial July 1999 Final Aug 2000	Initial Aug 1999 Final Oct 2000	Initial Aug 1999 Final Aug 2000

Table 2. Test plots near Ackerman, MS were treated on August 13, 1999 and evaluated on October 4, 2000 and test plots near Antreville, SC were treated on August 15, 1999 and evaluated August 11, 2000 for percent stem reduction of unwanted hardwoods on pine sites.

HERBICIDES[1]	RATE (Prod/ac)	SWEETGUM	RED MAPLE	WATER OAK	WINGED ELM	ALL SPECIES
		(%)	(%)	(%)	(%)	(%)
SOUTH CARLINA		(%)	(%)	(%)		(%)
Accord SP	8 qt	-93a	-83a	-77a		-89a
Accord+MON59120	8 qt+2.5 %	-92a	-55ab	-83a		-88a
Accord SP+Chopper	7 qt+10 oz	-93a	-100a	-100a		-94a
Accord SP+Chopper	5 qt+24 oz	-100a	-100a	-93a		-98a
Accord SP+Garlon 4	6 qt+48 oz	-92a	-17b	-62a		-82a
Krenite S+Chopper	6 qt+10 oz	-82a	-33ab	-98a		-72a
Krenite S+Chopper	4 qt+24 oz	-98a	-100a	-100a		-92a
Chopper	64 oz	-100a	-100a	-100a		-71a
Krenite S	6 qt	+10b	-17b	-60a		-27b
Check	None	+17b	-15b	+217b		+28c
MISSISSIPPI						
Accord SP	8 qt	-93a	-58b	-100a	-100a	-84ab
Accord+MON59120	8 qt+2.5 %	-97a	-54b	-83b	-100a	-73b
Accord SP+Chopper	7 qt+10 oz	-100a	-67b	-100a	-91a	-96a
Accord SP+Chopper	5 qt+24 oz	-93a	-100a	-100a	-60c	-95a
Accord SP+Garlon 4	6 qt+48 oz	-96a	-69b	-67c	-60c	-85ab
Krenite S+Chopper	6 qt+10 oz	-98a	-100a	-97a	-20d	-87a
Krenite S+Chopper	4 qt+24 oz	-100a	-100a	-100a	-100a	-98a
Chopper	64 oz	-100a	-100a	-100a	-75bc	-97a
Krenite S	6 qt	-90a	+33c	-69c	-33d	-59c
Check	None	-5b	+39c	-55c	+56e	+10d

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

Table 3. Site preparation plots near Mt. Enterprise, TX were inventoried in August 1999 for initial number of rootstocks, herbicides were applied on August 7, 1999 and plots evaluated on August 1, 2000 for control of treated rootstocks, ingrowth of new rootstocks, total competitors 12 months after treatment, and percent stem reduction.

Herbicides[1]	Rate (Prod/ac)	Initial Rootstocks per plot	Control (%)	Ingrowth Rootstocks per plot	Competitors Rootstocks per plot	Reduction (%)
				HICKORY		
Accord SP	8 qt	9	-100a	1.3a	1.3b	-86a
Accord+MON59120	8 qt+2.5 %	9	-100a	1.5a	1.5b	-90a
Accord SP+Chopper	7 qt+10 oz	6	-100a	0.8a	0.8b	-78a
Accord SP+Chopper	5 qt+24 oz	10	-100a	2.3a	2.3b	-51a
Accord SP+Garlon 4	6 qt+48 oz	5	-100a	1.5a	1.5b	-69a
Krenite S+Chopper	6 qt+10 oz	13	-100a	0.5a	0.5b	-93a
Krenite S+Chopper	4 qt+24 oz	10	-100a	0.8a	0.8b	-87a
Chopper	64 oz	8	-100a	0.7a	0.7b	-92a
Krenite S	6 qt	10	-100a	2.0a	2.0b	-79a
Check	None	8	-23b	1.7a	6.7a	-8b
				OAK		
Accord SP	8 qt	24	-100a	1.5a	1.5b	-88bc
Accord+MON59120	8 qt+2.5 %	11	-100a	0.5a	0.5b	-96c
Accord SP+Chopper	7 qt+10 oz	5	-97a	0.4a	0.5b	-89bc
Accord SP+Chopper	5 qt+24 oz	10	-100a	0.6a	0.6b	-86bc
Accord SP+Garlon 4	6 qt+48 oz	16	-97a	1.5a	1.8b	-91bc
Krenite S+Chopper	6 qt+10 oz	11	-100a	1.3a	1.3b	-56b
Krenite S+Chopper	4 qt+24 oz	9	-100a	0.6a	0.6b	-93bc
Chopper	64 oz	13	-100a	0.3a	0.3b	-89bc
Krenite S	6 qt	14	-89a	1.3a	1.5b	-81bc
Check	None	10	+8b	0.6a	10.7a	+16a
				SASSAFRAS		
Accord SP	8 qt	40	-97a	4.0a	4.7b	-81b
Accord+MON59120	8 qt+2.5 %	33	-100a	2.0a	2.0b	-92b
Accord SP+Chopper	7 qt+10 oz	32	-100a	11.7a	11.7b	-69ab
Accord SP+Chopper	5 qt+24 oz	46	-100a	3.0a	3.0b	-94b
Accord SP+Garlon 4	6 qt+48 oz	65	-100a	7.3a	7.3b	-86b
Krenite S+Chopper	6 qt+10 oz	32	-100a	0.7a	0.7b	-99b
Krenite S+Chopper	4 qt+24 oz	52	-100a	1.7a	2.0b	-96b
Chopper	64 oz	42	-100a	4.7a	4.7b	-80b
Krenite S	6 qt	25	-100a	4.0a	4.0b	-83b
Check	None	44	-58b	12.0a	32.3a	-40a
				SUMMER GRAPE		
Accord SP	8 qt	8	-100a	0.3a	0.3b	-97bc
Accord+MON59120	8 qt+2.5 %	5	-100a	3.0a	3.0b	-6ab
Accord SP+Chopper	5 qt+24 oz	9	-100a	2.3a	2.3b	-68abc
Krenite S+Chopper	4 qt+24 oz	6	-100a	2.3a	2.3b	-57abd
Accord SP+Chopper	7 qt+10 oz	5	-100a	2.0a	2.0b	-63abc
Krenite S+Chopper	6 qt+10 oz	10	-100a	0.7a	0.7b	-89bc
Accord SP+Garlon 4	6 qt+48 oz	4	-100a	2.7a	2.7b	-40abc
Chopper	64 oz	9	-100a	0.0a	0.0b	-100c
Krenite S	6 qt	9	-100a	0.7a	0.7b	-93bc
Check	None	6	-34b	2.7a	7.3a	+8a
				ALL SPECIES		
Accord SP	8 qt	119	-100a	9.3b	9.3bc	-86c
Accord+MON59120	8 qt+2.5 %	99	-100a	8.7b	8.7bc	-91c
Accord SP+Chopper	5 qt+24 oz	108	-100a	10.3b	10.3bc	-90c
Krenite S+Chopper	4 qt+24 oz	106	-100a	7.7b	7.7bc	-93c
Accord SP+Chopper	7 qt+10 oz	70	-99a	16.0ab	16.3bc	-76bc
Krenite S+Chopper	6 qt+10 oz	95	-100a	4.7b	4.7c	-94c
Accord SP+Garlon 4	6 qt+48 oz	81	-100a	26.3a	26.3b	-46b
Chopper	64 oz	86	-100a	6.0b	6.0c	-94c
Krenite S	6 qt	94	-100a	8.8b	8.8bc	-91c
Check	None	105	-26b	18.3ab	96.0a	-9a

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