PINE REGENERATION WITH SIMULTANEOUS CONTROL OF KUDZU[1/]. J. L. Michael, United States Department of Agriculture, Forest Service, Southern Forest Experiment Station, Auburn, AL 36849.

ABSTRACT

Kudzu (Pueraria lobata (Willd.)Ohwi) growing on clay, clay loam, and sandy loam soils in central and north Alabama was treated in a randomized design on each soil type with three replications using three application rates of Arsenal@ (imazapyr at 0.5, 1.0, and 2.0 lb ae/a), a single rate of Tordon® 101 [1.35 lb ae/a picloram plus 5 lb ae/a 2,4-dichlorophenoxy acetic acid (2,4-D), 2.5 gal/al, Lontrel® (3,6-dichloropicolinic acid at 2.0 lb ae/a), Lontrel plus 2,4-D (0.34 lb plus 1.66 lb 2,4-D ae/a), and Velpar L® (hexazinone at 3.0 lb ai/a). Sites were treated between mid-June and mid-July in 1983 and retreated at the same application rates in June 1984.

Tordon 101, Lontrel, and Lontrel plus 2,4-D gave the best results over all sites in each year of treatment. Hexazinone was effective in controlling kudzu only on the sandy loam soil, whereas the high rate of Arsenal was effective on the loamy soils but not on clay.

Survival of replanted pines was adversely affected by Tordon 101 and Velpar L treatment but not by Arsenal, Lontrel, or the Lontrel plus 2,4-D treatment. Pine height growth appeared to be inhibited most by Arsenal rates greater than 0.5 lb ae/a.

Kudzu control can be achieved simultaneously with pine regeneration on sandy loam sites using Lontrel, Lontrel plus 2,4-D, or Arsenal. None of these are fully registered for forestry, but Arsenal can be used under an Experimental Use Permit. On sites where kudzu infestation exists on heavy clay soil, simultaneous kudzu control and pine regeneration are more difficult.

INTRODUCTION

Kudzu, a perennial leguminous vine, was introduced into the United States from Japan in 1876. Since the 1930's when it was widely promoted for use in gully control and temporary pastures, it has escaped into hedgerows and captured many forest sites. Its rapid growth and habit of forming dense mats

---

[1/] Discussion of herbicides in this paper does not constitute recommendation of their use nor imply that uses discussed here are registered. If herbicides are handled, applied, or disposed of improperly, there is potential for hazards to the applicators, off-site plants, and environment. Herbicides should be used only when needed and should be handled safely. Follow the directions and heed all precautions on the container label.

Use of trade names is for the reader's information and convenience. Such use does not constitute official endorsement or approval by the U. S. Department of Agriculture to the exclusion of any other suitable product.

of vegetation permit it to smother even large pine trees and make regeneration almost impossible on infested lands. The forest managers' selection of site preparation techniques is limited to manual or mechanical grubbing of the plant, intensive grazing? or chemical treatment. Because kudzu reproduces via spread of stolons and rhizomes and often has a tap root 2 meters long, chemical methods are the most effective.

Chemical methods usually involve treatment for 2-3 years prior to plantation establishment. During the kudzu treatment period, most weeds are also controlled. Establishment of pine while bringing kudzu under control would be desirable because it would take advantage of vegetation management achievable with chemicals.

The objective of this study was to determine whether any of several new chemicals could both control kudzu and have sufficient pine tolerance to permit simultaneous pine regeneration.

METHODS

Study Sites

Three sites were selected for this study, which was installed in 1983. All three sites had been infested with kudzu for at least 5 years prior to the initial treatment. Three soil textures, sandy loam (Hamilton, AL), clay loam (Oak Bowery, AL), and clay (Dadeville, AL), were represented in the study. Plots were either 32 ft or 48 ft wide by 66 ft long. Each site was planted with 20 loblolly pine (*Pinus taeda* L.) seedlings prior to treatment in 1983, but due to the late planting, survival was very poor, and all plots were replanted by hand in February of 1984.

Study Design

Herbicide treatments were completely randomized on each soil type with three replications of each herbicide treatment and three untreated check plots. The clay soil site was not treated with Tordon 101.

Treatment

Herbicide treatments were applied with ground equipment in 20 gallons of spray volume per acre. Treatments included three rates of Arsenal (imazapyr at 0.5, 1.0, and 2.0 lb ae/a), and a single rate of Tordon 101 (6.35 lb ae/a, 2.5 gal/a), Lontrel (3,6-dichloropicolinic acid at 2.0 lb ae/a), Lontrel plus 2,4-D (0.34 lb plus 1.66 lb 2,4-D ae/a), and Velpar L (hexazinone at 3.0 lb ai/a).

The clay soil site was treated on June 21, 1983, the clay loam site on June 24, and the sandy loam site on June 30-July 14. Kudzu resprouted to varying degrees on all plots following the 1983 treatment. The clay soil site was retreated June 8-11, 1984, the clay loam site was retreated June 11-12, and the sandy loam site was retreated June 15, using the same rates applied in 1983.

Evaluation

Kudzu control was evaluated in November-December of 1983, October-November 1984, and June 1985. Pine survival was evaluated in December 1983, and in November 1984. During the post-treatment evaluations, percent control was estimated as the amount of visible bare ground. All plots were densely covered in kudzu prior to study initiation, and there was no bare ground at that time. Survival and control data were arcsin[sqrt(percent/100)] transformed and analyzed by two-way analysis of variance.

RESULTS AND DISCUSSION

Kudzu Control

Results of the evaluations and statistical analyses are presented in Tables 1-3. There were highly significant differences in control on all sites. In addition, there were significant interactions between site and treatment.

Control in 1985, averaged over all treatments except Tordon 101, differed significantly among the three sites investigated. Control was poorest on the clay site, was intermediate on the clay loam site, and was best on the sandy loam site for all periods of evaluation. Control differences on the three sites may be explained on the basis of soil texture. All the herbicides used in this study exhibit some degree of soil activity, and soil texture is known to be a factor influencing efficacy when soil-active herbicides are used. Usually the effectiveness of soil-active herbicides declines when the soil contains either a large amount of clay or a very large amount of organic matter. Soils on the test sites vary from mineral clay on the Dadeville site to clay loam on the Oak Bowery site and sandy loam on the Hamilton site. These differences in soils correlate with the increased herbicidal activity observed in comparing the poorest control at Dadeville to the best control at Hamilton.

The greatest and most uniform control averaged over all sites was achieved with Tordon 101 (99%), Lontrel (99%), and Lontrel plus 2,4-D (97%). Of these, only Tordon 101 is currently registered for forestry use. Control with Arsenal at 1 gallon/acre (2 lb imazapyr ae/a, 67%) was equivalent to that achieved with 1.5 gal/acre of Velpar L (3 lb hexazinone ai/a, 63%). Control with 0.5 gal/acre of Arsenal (22%) was significantly better than that achieved with 0.25 gal/acre of Arsenal (11%), which did not differ from the untreated check (0%). Interactions between location and treatment were highly significant (probability of greater F value was 0.0001). The herbicidal activity of the high rate of Arsenal was unacceptable at the clay site but among the best results achieved at the two remaining sites, averaging 94%. Velpar treatment resulted in a high degree of kudzu control at the sandy loam site (98%) but not at the other sites. The differences for both chemicals are probably attributable to soil characteristics.

Pine Survival

Pine survival in 1983 was erratic on all plots on all three installations (table 4). No correlations could be drawn between treatment and seedling survival. All sites were replanted in February 1984. At retreatment in

June 1964, survival was very good on the sandy loam (99%) and clay loam (97%) sites and poor on the clay site (61%). Deer browsing was extensive on the Oak Bowery site with 44% of the seedlings browsed between planting and May 2, 1984. Browsing, however, was not responsible for any seedling mortality on the Oak Bowery site.

Chemical treatment affected survival at all sites except the clay site where overall survival was very poor prior to treatment. The most obvious effects were with Tordon 101 and Velpar L treatments in which a very high degree of mortality was evident. Tordon 101 has long been known to be toxic to pines. Velpar L applied at rates exceeding 1 lb ai/acre is also known to be toxic to very young pines. Survival of pines in all the remaining treatments was significantly greater than on the untreated check. For Arsenal, survival is positively correlated with treatment rate, and probably reflects increased survival as a function of increased kudzu control (decreased plant competition). Survival of pines treated with the Lontrel and 2,4-D combination was higher than expected. Kudzu resprouting averaged approximately 10 percent on the clay site, 40 percent on the clay loam, and 50 percent on the sandy loam. Therefore, protection by cover from resprouted kudzu is inadequate to explain the high survival. These data suggest that a 1.66 lb/a rate of 2,4-D amine may be safe on young loblolly pine seedlings when applied in June.

Pine Growth

Growth of planted pines is presented in Table 5. ANOVA was not conducted for growth because of the complication of missing data in instances where survival was very low or a treatment not applied and where control variances obviously clouded the issue of competition vs chemical stunting. However, in the case of Arsenal, it appears that chemical stunting occurred at application rates greater than 0.5 lb ae/a. On the Hamilton and Oak Bowery sites where this chemical was effective in controlling kudzu, trees treated with 1 and 2 lbs ae/a appear shorter than those treated with 0.5 lbs ae/a.

CONCLUSIONS

Simultaneous control of kudzu and regeneration of loblolly pine are achievable on coarse-textured sites but not on clay sites. There are no treatments that can in a single application effect 100% long-term control (more than one growing season) of kudzu. Application of Arsenal at the 2.0 lb rate, Lontrel, or Lontrel plus 2,4-D effects adequate control and allows sufficient pine survival to effect regeneration. Pine growth during the first year following use of Arsenal, however, will be adversely affected. Currently, only Arsenal can be used, and it must be used under an Experimental Use Permit.

A modification of the concept of simultaneous regeneration and kudzu control that would probably work on most sites including clay soils involves initial treatment with 2 to 2.5 gallons of Tordon 101 per acre in June followed by planting of pine approximately 6-9 months later. A followup spot treatment with Arsenal would have to be applied as needed at 1 or more years after planting. Velpar L could be substituted for Arsenal as the followup treatment of choice on coarse-textured soils at age 2 or 3 years. Velpar L or Arsenal broadcast at age 2 or 3 years as a followup would have a major advantage over Tordon 101 spot treatment in the control of most herbaceous weeds.

Table 1.--Control of kudzu following herbicide treatment on a clay site. (The 1985 data represent residual control 1 year after the last treatment.)

Chemical	Rate	Percent control in[1/]		
		1983	1984	1985
	(lb ae/a)			
Arsenal	0.5	17 c	O b	o c
Arsenal	1.0	10 c	O b	o c
Arsenal	2.0	70 b	10 b	13 bc
Lontrel	2.0	100 a	97 a	100 a
Lontrel +	0.34			
2,4-D	1.66	97 ab	87 a	98 a
Velpar L	3.0 (ai)	13 c	18 b	27 b
Untreated	0	o c	O b	o c

[1/] Means in the same column followed by the same letter are not significantly different at the 0.05 probability level by ANOVA and Duncan's multiple-range test.

Table 2.--Control of kudzu following herbicide treatment on a clay loam site. (The 1983 data represent residual control 1 year after the last treatment.)

Chemical	Rate	Percent control in[1/]		
		1983	1984	1985
	(lb ae/a)			
Arsenal	0.5	10 bc	o c	o c
Arsenal			3 c	0 c
Arsenal	2.0	87 b	77 b	97 a
Lontrel	0.34	100 a	98 a	100 a
Lontrel +				
2,4-D	1.66	100 a	99 a	97 a
Tordon 101:				
picloram +	1.35			
2,4-D	5.0	100 a	100 a	100 a
Velpar L	3.0 (ai)	37 b	81 b	65 b
Untreated	0	o c	o c	o c

[1/] Means in the same column followed by the same letter are not significantly different at the 0.05 probability level by ANOVA and Duncan's multiple-range test.

Table 3.--Control of kudzu following herbicide treatment on a sandy loam site. (The 1985 data represent residual control 1 year after the last treatment.)

Chemical	Rate	Percent control in[1/]		
		1983	1984	1985
	(lb ae/a)			
Arsenal	0.5	20 b	40 b	33 c
Arsenal	1.0	80 a	95 a	65 b
Arsenal	2.0	73 a	98 a	90 ab
Lontrel	2.0	95 a	70 ab	98 a
Lontrel + 2,4-D	0.34 + 1.66	90 a	98 a	97 a
Tordon 101: picloram + 2,4-D	1.35 + 5.0	98 a	100 a	98 a
Velpar L	3.0 (ai)	99 a	98 a	98 a
Untreated	0	O b	o c	O d

[1/] Means in the same column followed by the same letter are not significantly different at the 0.05 probability level by ANOVA and Duncan's multiple-range test.

Table 4.--Survival of pines planted on three soil types in February, 1984 7 months after treatment in June, 1984.

Chemical	Rate	Percent survival on[1/]			
		Clay	Clay loam	Sandy loam	All
	(lb/ ae/a)				
Arsenal	0.5	41 a	79 a	86 a	69 a
Arsenal	1.0	38 a	74 a	92 a	68 a
Arsenal	2.0	76 a	94 a	93 a	88 a
Lontrel	2.0	76 a	82 a	100 a	86 a
Lontrel + 2,4-D	0.34 + 1.66	76 a	89 a	86 a	83 a
Tordon 101: picloram + 2,4-D	1.35 + 5.0	NA	8 b	2 b	5[2/]
Velpar L	3.0 (ai)	54 a	16 b	8 b	26 b
Untreated	0	27 a	22 b	24 b	24 b

[1/] Means in the same column followed by the same letter are not significantly different at the 0.05 probability level by ANOVA and Duncan's multiple-range test.

[2/] This treatment not included in the overall ANOVA because it was not applied at all sites.

Table 5.--Growth of replanted pines on three soil types 7 months after herbicide treatment in June, 1984.

Chemical	Rate	Clay			Clay loam			Sandy loam		
		N[1/]	Ht.	GLD	N[1/]	Ht.	GLD	N[1/]	Ht.	GLD
	(lb ae/ai)		(feet)	(inches)		(feet)	(inches)		(feet)	(inches)
Arsenal	0.5	2	1.1	0.2	3	0.9	0.2	3	11	03
Arsenal	2.0	3	1.2	0.2	3	0.7	0.2	3	0'9	0'3
Arsenal	2.0	3	1.1	0.3	3	0.7	0.2	3	0:9	0:2
Lontrel	-.-	3	1.2	0.2	3	1.1	0.2		1.5	0.3
Lontrel t	0.34									
2,4-D	1.66	3	1.2	0.2	3	0.9	0.2	3	1.2	0.3
Tordon 101:										
picloram t	1.35									
2,4-D	5.0	-	---	---	2	0.9	0.2	1	0.9	0.2
Velpar L	3.0a[2/]	3	1.1	0.2	3	0.8	0.2	2	1.2	0.3
Untreated	0	2	1.1	0.2	3	0.9	0.2	1	2.0	0.3

[1/] N equals the number of plots with surviving pines.

[2/] a = active ingredient (ai) instead of acid equivalent (ae).