Chemical Site Preparation for Conservation Land-Use Development

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The potential for biological resource production in the upper Coastal Plain and Piedmont regions of the humid southeastern United States continues to deteriorate due to accelerated soil loss in response to mechanical methods used for land-use conversion. The purpose of this research was to develop chemical methods of site preparation for a safe, effective, and efficient conversion of land-use from woodland to grazing land. Aerial application of 3.6 kg/ha tebuthiuron pellets killed approximately 90% of the woodland-tree species. A good stand of tall fescue ('Ky 31') resulted from an aerial seeding following a fall burn of the treated site. Herbicide residue remaining in the soil resulted in significant damage to loblolly pine seedlings planted one year after herbicide application. Fescue seedlings and established plants were tolerant of the herbicide residue.

INTRODUCTION

The continued decrease in profitability of row-crop farming in the Piedmont and Upper Coastal Plains regions has promoted increased harvests of the economical timber from the privately owned forest acres. The remaining hardwood species dominate the harvested sites resulting in a land-use of little economical value to the landowner. Revegetation to economical species by natural succession is extremely slow due to competition from remaining species following the selective harvests. In 1978, periodic surveys of permanent sample plots in the Piedmont region indicated a significant change in forest types, particularly the loss of southern pine land to hardwood-woodland. It was determined that 58% of the loblolly and slash pine acreage harvested between 1961 and 1972 were occupied by hardwood species in 1978.

There is an increasing interest by landowners in the development of economical land-use systems for these woodland acres by: 1) conversion to grazing land following harvest of the valuable timber; **2)** preparation of the sites for natural and/or artificial reforestation; or **3)** preparation of land for use as agroforestry. The rolling topography, and high average annual rainfall, which commonly occurs as intense rainstorms, result in optimum conditions for high rates of soil erosion from unprotected land. Conservation of the soil, on the sloping land, is probably best achieved through reforestation or conversion to perennial forage species for grazing.

During land-use conversion, intensive site preparation not only affects the ecosystem more than any other management practice, it also can determine the success or failure of vegetation

establishment. Once used only on flat terrain and on sites with high growth potential, intensive site preparation is now being used on sloping, previously eroded sites in the Piedmont and upper Coastal Plain regions as a means of converting commercially unproductive stands to productive forest types. Intensive site preparation for planting to forage and forestry species has included the mechanical methods of: 1) brush chopping - a bulldozer towing a straight-blade rolling chopper that fa11s the residual vegetation before breaking it into small pieces; 2) shearing and windrowing - standing vegetation is sheared to ground level with a V. blade and the debris is windrowed and burned; 3) bedding on the contour - following shearing and windrowing the vegetation, terrraces are developed on the contours. These methods are very expensive for the owner of small tracts of land who has to hire the site preparation. Additionally, intensive site preparation by mechanical methods results in substantial sediment losses from sloping sites.

There is a need for the development of systems for converting the vegetation on the woodland acres to species that are economically important while conserving the soil and preserving the nutrients in the ecosystem. Chemical site-preparation could a1low for safe, effective, and efficient systems for land-use conversion.

METHODS AND MATERIALS

The research site was a 36 hectare tract of land located 3 miles west of Williamson, Georgia. The merchantable timber was harvested from the site during the summer of 1982. The remaining woodland species were predominantly sweetgum, oak, and some pine (Table 1). The herbicide, tebuthiuron, was aerially applied to the site on March 7, 1983 using a Meterate attachment on a fixed-wing aircraft. Tebuthiuron was applied to the site at a rate of 3.6 kg/ha as 40% pellets. The major soil type on the 36-hectare research site is a sandy clay loam of the Cecil series.

Research on this site was directed toward converting the land to pasture by seeding to forage species. Approximately 31 hectares of the treated site were burned on several occasions during the first 2 weeks in October. Approximately 60% of the site had a good cover of leaf ash. 'Regal' Ladino white clover and 'Kentucky 31' tall fescue were aerially seeded into the ash on October 29, 1983 at rates of 7.2 kg/ha and 18 kg/ha, respectively. The tall fescue seed-lot was 1-yr old and tested to be 90% free of the endophyte fungus.

During the first of March of 1984 and 1985, approximately 500 improved Loblolly pine seedlings were planted across the treated site to determine the influence of residual tebuthiuron on pine seedling establishment.

Vegetation surveys, forage samples, and soil samples were periodically obtained from the treated site and chemically analyzed for forage quality and nutrient content.

RESULTS AND DISCUSSION

Mechanical-site preparation for land-use conversion to reforestation or conversion to grazing land is expensive for the private landowner and generally the use of bulldozers promotes soil erosion from the hillsides. This research program was established to develop a method for chemical-site preparation that would result in a safe, effective, and efficient system for land-use conversion. It was determined that the standing-dead woodland species should help protect the soil during the establishment *of* the introduced crop.

Tebuthiuron was found to be an effective herbicide for this use when applied as a pellet formulation and is presently registered for this use by the Environmental Protection Agency. The pellet formulation and the properties of tebuthiuron preclude drift during aerial application and minimize the risk of off-site damage. The pellets were evenly and precisely distributed through a Meterate method of aerial application by fixed-wing aircraft. The pellets deposited on the soil surface are disintegrated by the first significant rainfall and the herbicide is moved into the soil. Subsequent rainfall moves the herbicide into the root zone to be absorbed by the roots of woody species. Following translocation in susceptible species, **it** inhibits photosynthesis. The chemical properties of this herbicide result in its persistance in the ecosystem allowing for a long-term control of brush species.

Data from this research has indicated that oak, pine, elm, maple, and poplar tree-species are relatively susceptible to tebuthiuron applications and red cedar and sweetgum are considered to be fairly tolerant to the herbicide treatments. Data from our research also indicate similar results (Table 1). The mode of action for tebuthiuron in killing the trees was for a sequential series *of* defoliations before the tree finally dies. Some species of trees and especially trees of larger size were defoliated by August following the March application and would refoliate the next spring indicating viable trees. However, many of these trees were determined to be dead by September 9, 1984.

Table 1. Influence of 3.6 kg/ha tebuthiuron on tree defoliation, rated August 1983, and trees killed, rated September 9, 1984, resulting from aerial treatment with 40% pellets.

Tree species	Stand composition (%)	Average tree height (M)	Desiccation rating (%)	Trees killed *(%)*
Pine (loblolly and shortleaf)	33	15	98	95
Sweetgum	37	16	60	75
Oak (water, Southern red, white, and post)	19	12	100	100
Yellow Poplar	4	8	0	65
Persimmon	1	6	10	30
Black Gum	3	8	80	95
Red Maple	1	11	50	85
Hawthorn	1	5	100	100
Red Cedar	1	8	0	0

Because of high humidity during the fall of 1983, the treated site would not carry a hot fire. However, approximtely 70% of the area was covered with ash at the time the seed were aerially applied by a fixed-wing airplane. The fescue established into a good stand during the spring of 1984 (Table 2). Due to cold weather much of the white clover stand was lost over the winter and the forage was predominantly tall fescue at the June, 1984 harvest. The site had 2300 kglha green forage available in June, 1984 and 1800 kglha green forage in October, 1984.

Table 2. Forage establishment following aerial seeding into leaf ash on October 29, 1983.

Rating date	Seedling Count		Ground cover		Green forage production
	clover	fescue	clover	fescue	
	----No./M2-------		-------%-------		-----kg/ha------
Dec. 19, 1983	112	162	5	8	----
June 18, 1984	20	96	10	45	2300
Oct. 31, 1984	-	-	0	72	1800

Pine seedling survival decreased from June, 1984 to February, 1985 indicating the presence of herbicide in the ecosystem over this period of time. Only 52% of the pine seedlings survived one year after planting and two years after herbicide application (Table 3).

Table 3. Pine seedling survival following 1984 planting date.

Rating date	Survival	Average seedling height	Vigor rating
-	%	cm	
June 18, 1984	87	14	8*
Aug. 13, 1984	64	16	7
Dec. 17, 1984	61	22	9
Feb. 4, 1985	52	23	8

*Rating scale from 1 - 10 where 1 equals no branching and/or greater than 70% needle discoloration and 10 equals healthy seedling.

Results of this research and research conducted on other sites indicate that tebuthiuron can be effectively used for killing woodland species in a system of conversion to grazing land using tall fescue as the forage species. The persistence of the herbicide in the ecosystem for up to 24 months provided good control of all brush on vine weed species. The site remained free of all broadleaf weed species throughout the 18 months of fescue establishment. However, this herbicide persistence resulted in approximately 50% loss in pine seedlings planted one year after herbicide application. Therefore, pine plantings will have to be delayed for up to two years after herbicide treatment on sites being converted to reforestation or another herbicide will have to be used.

There was no additional gully soil erosion during the conversion period and only minimal sheet erosion occurred during this period. Chemical site preparation will be about one-fourth the cost necessary for mechanical site preparation.