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HERBACEOUS WEED CONTROL TRIALS WITH A PLANTING MACHINE SPRAYER AND A CRAWLER-TRACTOR SPRAYER--FOURTH YEAR PINE RESPONSE.

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ABSTRACT

Operational trials of herbaceous weed control treatments by machine application were studied at two southern Alabama locations for establishing loblolly pine (Pinus taeda). The first study tested the feasibility of a spray attachment for planting machines to apply banded treatments while planting in February and March. Two rates of sulfometuron (Oust), 2 oz and 4 oz ai/a, and two band widths, 3 ft and 5 ft, were evaluated. Fourth-year pine growth was significantly increased with all banded treatments when compared to the untreated check. The best treatment, 2 oz sulfometuron and 5 ft bands, resulted in twice the pine volume of no treatment, although trees growing within adjacent windrows had almost 10 times the volume of the best treatment. The second study compared unsprayed plots with broadcast applications of sulfometuron plus hexazinone (2 oz Oust + 1½ qt Velpar L/a) by a crawler-tractor sprayer over newly planted loblolly pines. Broadcast applications with the tractor sprayer increased pine volume by 2.4 times over the untreated check. Both application systems hold promise for operational applications in the late planting season.

INTRODUCTION

Herbaceous weed control significantly increases early growth of southern pines and many hardwood species (1,3,4,5,6,7,8,13,15,16,20, 21,23,28). Some research shows that early growth gains with southern pines are maintained for 10 to 20 years (12,22,24). Survival of newly planted pines can also be significantly increased with weed control, especially with plantings of loblolly pine in eastern Texas (14). Another benefit that weed control affords in vulnerable young plantations is fire protection (9). These benefits are only possible if cost-effective applications of registered products can be made without injury to the crop trees.

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Banded application of herbaceous herbicides centered over tree rows is one of the most cost-effective methods of ground application. Such treatments often yield the same early growth benefits as broadcast applications after one year of treatment (5,19). Unfortunately, because of the imprecise layout of planting rows on most reforestation sites, banded applications by tractor sprayers are very difficult to impossible. As a solution to this problem, a spraying system was designed that could be mounted on most tree planting machines, thus enabling herbicide application during planting. Performance characteristics of this system was previously reported, along with a system mounted on a crawler-tractor designed for broadcast applications (17).

Other planter sprayers have been designed and operationally used or tested over the past 30 years (10,11,25). However, these were used before the advent of the newer herbicides labeled for weed control on forestry sites, especially Oust by DuPont.

Oust is the herbicide most often applied for herbaceous weed control in the southern pine region (19) and also shows promise for hardwood plantation establishment (26,27). Oust is usually applied in the early spring, a period starting just before weed emergence in late-February to late-March and running through April. The normal tree planting season begins in late-November and often goes through March. Thus, the only overlap with Oust application timing and tree planting is late-February through March. This was the period used for the initial testing of a simultaneous planting and spraying operation, as well as for broadcast application trials. Additional research will be required to test efficacy at timings throughout the planting season and with varying rates.

METHODS

Study locations were in the Southern Loam Hills Region of the Middle Coastal Plain Province in southeastern Alabama. Soils at the first study location were the Orangeburg series (fine-loamy, siliceous, thermic Typic Paleudults) characterized by scattered remnants of sandy loam surface soil and the exposed sandy clay loam B-horizon. The clay fraction ranged from 7-18% and organic matter was less than 2%. The second study location was on the upper terraces of hilly terrain with a Saffell series (loamy-skeletal, siliceous, thermic Typic Hapludults). The Saffell series has very gravelly sandy-loam surface and subsurface horizons, with 5-20% clay and 1-2% organic matter. Fully-stocked loblolly pine stands had occupied both sites prior to harvesting. Site preparation on both sites was by shearing, windrowing, and windrow burning during the summer of 1983. Loblolly pines were planted on both study locations.

Study 1. Oust was tested at two rates: 2 and 4 oz active ingredient (ai) per acre. These rates were considered to be 1X and 2X rates for these soils. Band widths of 3 and 5 ft were compared. The spray system was mounted on a Reynolds Tree Planter pulled by a skidder. Ground speed was maintained by gear and throttle settings at 2.1 mph—a normal tree planting speed.

The proto-type of the planting-machine sprayer tested in this study used a single Floodjet nozzle (Spraying Systems Co.) for spraying the band. To achieve the specified rates, while using the same herbicide concentration and two swath widths, four different Floodjet nozzles were used: TK 2, 2.5, 3, and 5. The nozzles were mounted parallel to the ground which resulted in a broad bell-shaped pattern of spray distribution. Thus, soil within the interior 1/3 of the swath, where the seedling occurred, received a 30% higher rate, with the outside 2/3 of the swath receiving 30% less.

The sprayer had a 50-gallon tank mounted on the top of the wildland tree planter. This tank size permitted the planting operation to proceed without refills except in the morning and at noon. A 3 gpm, 12-volt electric pump supplied spraying pressure and agitation to the tank. An electric solenoid valve with a switch inside the compartment permitted the planter to turn the spray off during turns, while maintaining agitation. Another switch permitted the planter to stop and start the pump.

A randomized complete block design was used with four blocks that were superimposed on an operationally treated unit of 280 acres. Two blocks were positioned along broad upper slopes and were planted/treated on February 23 and 24, 1984. Two blocks were positioned along mid-slopes and were treated March 12 and 13, 1984. Seedlings were planted 9 ft between rows and 6 ft between seedlings--807 trees/a. Plots consisted of four planting rows about 300 ft long. Within the interior two rows, 50 seedlings were tagged. Seedling height and groundline diameter (GLD) were measured after planting and after four growing seasons. Seedlings planted in windrows adjacent to each block--50 each--were tagged after the first growing season and annually measured as a comparison to the treated trees, but not included in the analyses.

Competition was assessed on August 27 and June 4--late in the first growing season and early in the second growing season--to evaluate the degree and duration of control. Four 0.001-acre competition plots per treatment plot, measuring 5 ft wide and 8.7 ft long, were systematically centered lengthwise over the rows and between measurement seedlings. Cover was estimated by an experienced observer for grasses, forbs, woody and semi-woody vegetation, vines, and total cover.

Study 2. This study was a semi-operational comparison of treated and untreated plots that were about 2 acres each. Treated plots received a mixture of Oust 2 oz product + Velpar L 1½ qt per acre. There were three replications of paired plots. Broadcast treatments were made using the crawler tractor sprayer previously described (17) that was equipped with the Boomjet 5880 cluster-nozzle (Spraying Systems Company). The tractor sprayer was equipped with a spray control system that maintained rate with varying ground speeds. Spray volume was about 30 GPA. Treated plots were planted in February and applications were made on March 12, 1984 (the same time period as Study 1). Fifty seedlings in each plot's interior were tagged and measured annually for height and groundline diameter (GLD) after each of the first four growing seasons.

Analysis of variance was used with both studies to test for treatment differences. A pine volume index was calculated by summing the surviving pine's GLD^2 X Ht, thus integrating growth in groundline diameter and height with survival. For Study 1, orthogonal contrasts were selected before the study to compare competition components and pine response on treated and untreated plots, band width, and herbicide rate. Percent values were transformed using arcsin square-root to help normalize their distribution.

RESULTS AND DISCUSSION

Study 1. Grass and total competition cover were significantly (ã<0.01) decreased on treated plots only in the first year (Table 1). When forbs and grass cover were combined for the first year, a significant decrease was also found with this most Oust-vulnerable grouping. For the first and second year, woody cover averaged 14 and 20% and vine cover averaged 13 and 20% and were not significantly affected by treatments. The least amount of grass and total vegetative cover was found with Oust 4 oz and 5 ft bands in the first year.

Grasses, comprised mainly of broomsedge (*Andropogon virginicus*) and panic grasses (*Panicum* spp.), were the principle competition in both years. Recent research has shown grasses to be the most competitive vegetative component with newly planted loblolly pine seedlings (18). The dominant forbs were ragweed (*Ambrosia artemisiifolia*) and poorjoe (*Diodia teres*). The prevalence of poorjoe is indicative of an intensively impacted site from the mechanical scarification. Dominant semi-woody species were blackberry (*Rubus* spp.) and sumac (*Rhus* spp.). Woody species were mostly blackgum (*Nyssa sylvatica*), pignut hickory (*Carya glabra*), and persimmon (*Diospyros virginiana*).

The response in pine volume growth for the four years after treatment is shown in Figure 1. Pine volume after four years, along with average height, GLD, and survival are summarized in Table 2, including those pines growing in the windrows. Much of the site's growth potential was evidently in the windrow, which would have decreased the overall response from herbicide control. Contrasts indicate that herbicide treatments significantly (ã< 0.05) increased height and diameters, but not survival, on all treatments. The lack of significance with the contrasts comparing band width and rate is partially due to the interactions shown in Figure 2. Increasing the rate with the 5-ft band decreased diameter growth and survival, while increasing the rate with 3-ft bands resulted in increased height, GLD, and survival.

Treatments with 2 oz Oust in 5-ft bands resulted in the greatest growth and the most efficient use of the herbicide investment (Table 3). The decrease in growth with the 4 oz rate in the 5 ft band would suggest pine phytotoxicity by the herbicide because weed suppression was greatest with this treatment. Root growth potential of loblolly pines has been shown to decrease with increasing rates of Oust within the range tested (2). An improved version of the spray system now uses two 65^{o} flat-fan nozzles that have an even distribution in order to minimize the potential for phytotoxic levels around the seedling and to maintain effective control up to the edge of the swath.

Block differences were significant at the 0.01-level in the analysis of variance, with the lower slope blocks treated in March having significantly better survival and growth.

Study 2. Pine volume growth on the second site after four years was 2.4 times greater with herbaceous weed control—1,995 cu. ft per acre compared to 841 cu. ft per acre (Figure 3). This response was 17.5 times greater than the best treatment in Study 1, which could be partially attributable to the better soil condition, as well as broadcast applications. This would support the axiom that herbaceous control treatments should be used on the more productive soils to gain the most return in tree growth.

CONCLUSIONS

The following conclusions can be made from these results:

a. A planting machine sprayer can successfully apply banded herbicides simultaneous with tree planting in late-February and March for significantly increasing early loblolly pine growth.

b. Over-the-top spraying with Oust and Oust + Velpar in late-February through March in the southern Coastal Plain can measurably increase early loblolly pine growth if correct application and rates are used.

c. Windrowing treatments can result in large disparities in the early growth of pines planted within the windrow and those growing in the intervening area. Such treatments may lessen the growth response from herbaceous control treatments applied at establishment.

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Table 1. Competition cover by component in the first and second growing seasons and contrasts of components and years that had significant treatment differences at the 0.05-level when analyzed by ANOV.

Treatment	Grass		Forbs		G + F		Total	
years:	1	2	1	2	1	2	1	2
	-(percent)-							
Check	67	52	29	5	96	57	88	66
4 oz 5 ft	21	42	17	4	37	46	58	62
2 oz 5 ft	41	55	14	5	55	61	71	63
4 oz 3 ft	40	44	22	5	62	49	74	63
2 oz 3 ft	41	40	21	3	61	43	70	62
Contrasts:	Probability of a greater F							
3 ft vs 5 ft	0.15	—	—	—	0.25	—	0.26	—
2 oz vs 4 oz	0.18	—	—	—	0.25	—	0.06	—
check vs treat	0.001	—	—	—	0.0003	—	0.0002	—

Table 2. Height, groundline diameters, survival, and volume indices of loblolly pines after four years that were untreated (check), treated with Oust at two rates and two band widths, and planted in windrows.

Treatment	Height	GLD	Survival	Volume Index
	(feet)	(in.)	(percent)	(cu.ft/a)
Check	6.3	1.4	75	55
4 oz 5 ft	7.5	1.7	75	102
2 oz 5 ft	7.5	1.7	85	114
4 oz 3 ft	7.1	1.5	85	82
2 oz 3 ft	6.3	1.4	78	67
Within windrow	14.4	3.7	100	1117
Contrasts:	Probability of a greater F			
3 ft vs 5 ft	0.17	0.77	0.76	0.91
2 oz vs 4 oz	0.17	0.42	0.15	0.37
check vs treat	0.04	0.02	0.39	0.04

Table 3. Herbicide costs and efficiency of treatments in yielding increased pine volume after 4 years, assuming Oust costs $7.50 per ounce product.

Treatment	Herbicide cost	Volume	Volume increase	Cost of each additional cubic foot
	(dollars/a)	--- (cu. ft/a) ---		(dollars)
Check	0.00	55	0	—
4 oz 5 ft	22.20	102	47	0.47
2 oz 5 ft	11.09	114	59	0.19
4 oz 3 ft	13.32	82	27	0.49
2 oz 3 ft	6.65	67	12	0.55

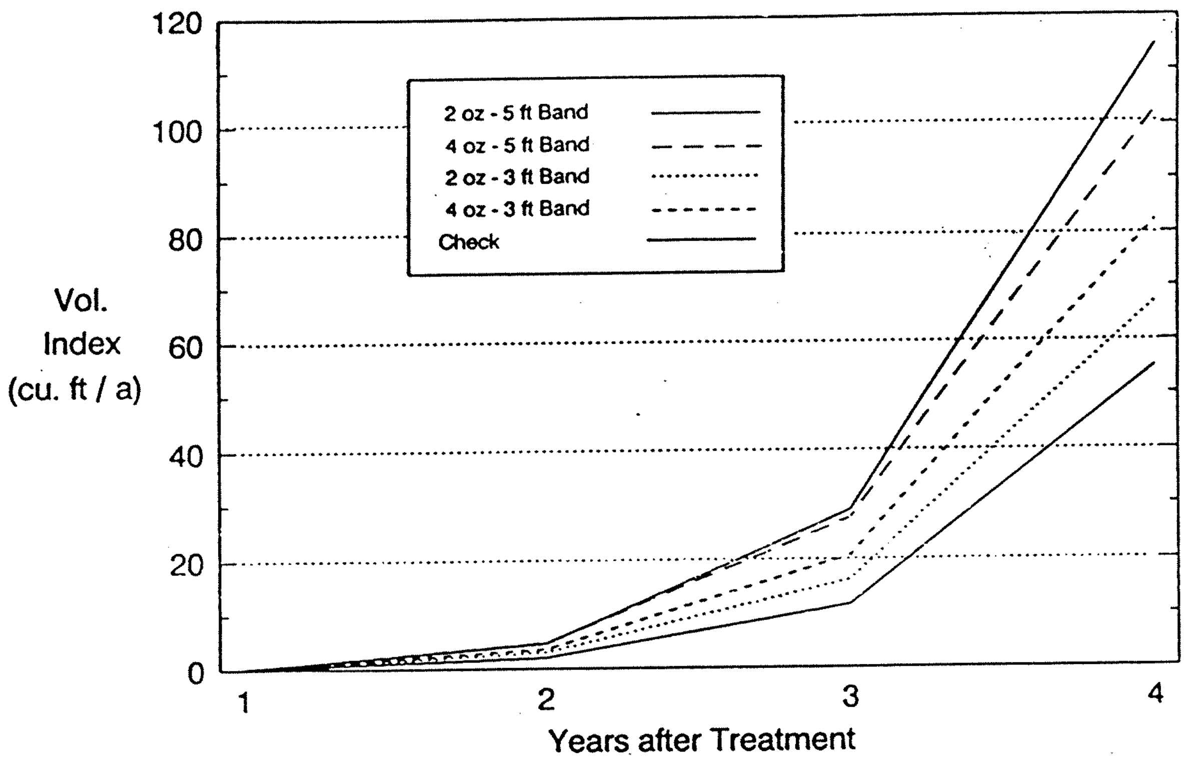

Figure 1. Loblolly pine volume index for four years after treatment with four banded treatments applied at time of planting compared to a check treatment.

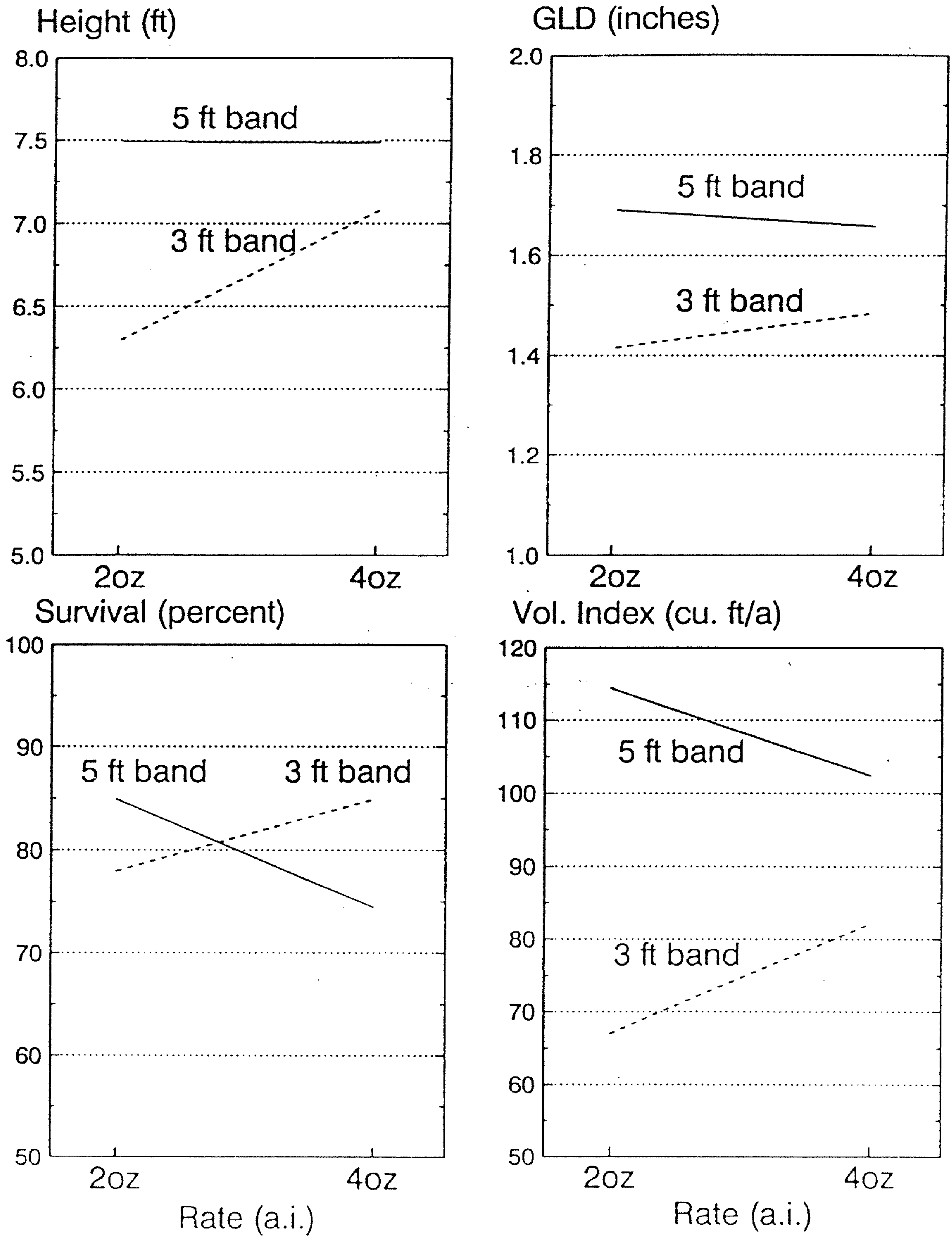

Figure 2. The treatment interactions in average height, groundline diameter, survival and volume index of loblolly pines treated with 2 or 4 oz ai Oust and 3 or 5 ft band widths at the time of planting.

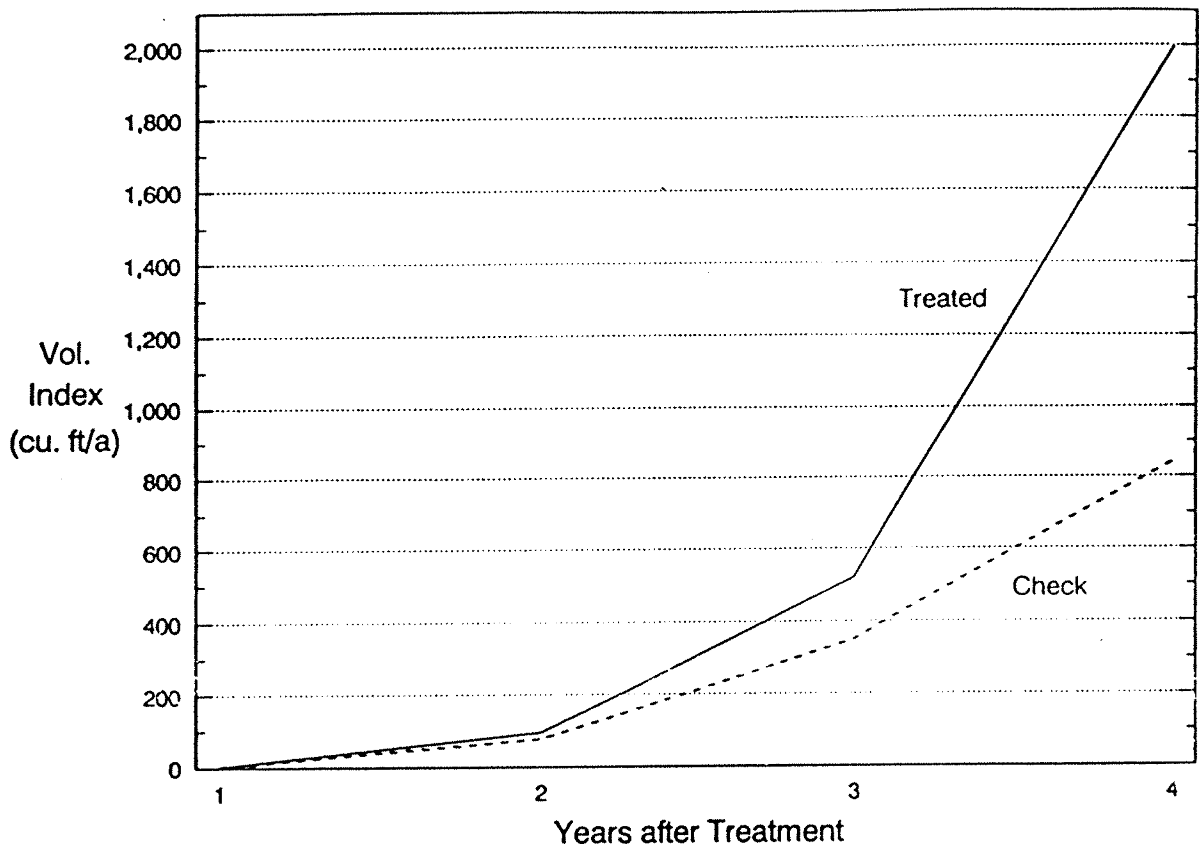

Figure 3. Loblolly pine volume index for four years after treatment with Oust 2 oz + Velpar L 1 1/2 qt after planting compared to untreated checks.