Long-Term impact of Aerial Application of 2,4,5-T to Longleaf Pine (*Pinus palustris*)[1]

J. L. MICHAEL[2]

Abstract. Twenty years after aerial application of 2.24 kg ae/ha of the butoxy ethanol ester of 2,4,5-T [(2,4,5-trichlorophenoxy)acetic acid] to release grass stage longleaf pine (*Pinus palustris* Mill.) seedlings, stocking was the same for each of three treated and control 4-ha plots. Treated plots, however, had significantly greater tree diameter (10%), taller trees (17%), and more merchantable tree volume/ha (40%). Merchantable tree volume differences 20 yr after treatment represent an 8 yr growth advantage for treated plots.

Additional index words. Benefit, pine release, herbicide, competition.

INTRODUCTION

In rhe south, 2,4,5-T has been the chemical most used for pine site preparation and release from competition. It is selective, causing only slight damage to pines, and versatile. It can be aerially sprayed, mist blown by ground crews, injected, or used as a basal stem spray (7).

A few short term studies report responses of stands released from competition with 2,4,5-T. Seven years after spraying with 1.68 kg ae/ha, diameter at breast height (dbh, 1.37m) of treated shortleaf pine (*Pinus echinata Mill.) was* 150% greater than that of untreated (2). Ten years after aerial spraying with 1.68 kg ae/ha height increase of treated white pine (*Pinus strobus* L.) was 65% greater than that of controls (5).

How 2,4,5-T affects tree growth should be most apparent at harvest time, but such long term data are lacking. Such a lack of information is nor surprising, however, because aerial spray trials in forestry began in the mid-1950's. A crop rotation (period from establishment to harvest) in forestry varies from 20 yr upward deprnding on crop species and site productivity so few studies have gone through a complete rotation since their first aerial application of 2,4,5-T. This paper is the first report of the long term impact of a single aerial application of 2,4,5-T on subsequent pine growth.

METHODS

The observations reported here result from an evaluation of a United States Forest Service, Southern Forest Experiment Station study begun in 1959 (3). The study compared the effectiveness of the acid and amine formulations of 2,4,5-T with the butoxy ethanol ester of 2,4,5-T in scrub hardwood control. The study area, located on the Escambia Experimental Forest[3] near Brewton, Alabama, was being regenerated to longleaf pine by the seed tree method. Several years before the study began (9 for compartment 136 and 8 for compartments 116 and 118), the stand had been reduced to 20 to 25 seed trees per ha, a basal area of about 1.6 m^2/ha. Hardwood competition, though nor measured when the study was installed, was described as a medium to dense stand of scrub hardwoods, primarily oaks [*Quercus incana* Bartr., Q. *stellata* var. *margaretta* (Ashe) Sarg., Q. *laevis Walt.*, *Q. marilandica* Muenchh. and *Q. falcata* Michx.], with an average dbh of 7.6 cm (Figure 1).

In July 1959, plots were sprayed by helicopter with 2.24 kg ae/ha in 47 L/ha carrier. The ester was carried in a diesel oil, wafer mixture (1:8 v/v). The study was replicated in a randomized design with plots 4 ha in area. Seed trees were removed from all plots in January 1961 and the study was closed. Since then study areas have been managed for timber production and a derailed record of silvicultural activities has been maintained. Parts of the original study that have not been destroyed include an ester treatment plot and a control plot in each of three compartments (116, 118 and 136).

[1] Received for publication September 10, 1979.

[2] Plant Physiol., George W. Andrews For. Sci. Lab., Devall St., Auburn Univ., Auburn, AL 36830, maintained by the South. For. Exp. Stn., For. Serv. U.S. Dep. Agric., in cooperation with Auburn Univ.

[3] Maintained by South. For. Exp. Stn., For. Serv., U.S. Dep. Agric. in cooperation with the T.R. Miller Mill Co.

Figure 1. Hardwood competition in an unsprayed area in the vicinity of the study. Note the presence of the seed trees and a few saplings but the apparent absence of seedlings. Although the area is well stocked with mostly 3 to 4 yr old seedlings they are suppressed by the competition and remain in the grass stage.

In each of the 3 ester and 3 control plots a random numbers table was used to designate five 0.04 ha subplots. For each pine tree in each subplot, dbh was recorded to the nearest 0.25 cm. For every third three in each diameter class (2.5 cm) height was recorded to the nearest 0.3 m. Heights of all dominant and codominant trees on each subplot were measured directly.

Data from trees for which both diameter and height were recorded were used to generate height/diameter curves for each subplot. From these curves, which typically had regression R^2 values of 0.94 to 0.97, I estimated the heights of each tree within each subplot. Using these estimated heights, measured diameters and a volume formula based on regional data for longleaf pine (4), I calculated plot volume, total volume of merchantable trees (inside of bark), and mean tree height for each subplot. For the purpose of this paper, "merchantable" applies to trees greater than 9 cm dbh, which is about the minimum marketable size. All data were submitted to a one way analysis of variance.

RESULTS AND DISCUSSION

Aerial spraying of 2,4,5-T did not affect stocking or number of merchantable trees per ha, but sprayed plots had significantly greater tree diameter, tree height, and merchantable tree volume (Table 1). Total and merchantable tree volume per ha on treated plots exceeded those on control plots by 32% and 40%, respectively.

Longleaf pine goes through a grass stage, rhe period of seedling growth between emergence and the beginning of height growth. This period may last from 2 to many years. Several factors influence its duration, but release from competing vegetation including hardwoods and seed trees is important (1,8). Time of release can help predict when height growth will begin. In the study area all plots were well stocked with seedlings mainly from the 1958 seed crop, some from 1957, and a few from earlier seed crops. The aerial spraying partially released the seedlings in 1959 and removal of the seed trees completed release in 1961.

Table 1. Effects of 2,4,5-T ester aerial spraying on stocking and productivity of longleaf pine 20 yr after treatment.

Variable	Treatment means	
	Control	Sprayed[a]
Trees/ha	2471	2473
Merchantable trees/ha	815	1012
Mean height of all trees (m)	8.33	9.78*
Mean height dominant and codominant trees (m)	12.25	13.39*
Mean dbh (cm)	7.79	8.60*
Total volume all trees (m^3/ha)	63.24	83.51
Total merchantable tree volume (m^3/ha)	49.65	69.39*

[a]Treated means followed by an asterisk differ significantly from the control at the 0.05 level.

The release from competition on sprayed plots apparently accelerated initiation of seedling height growth and caused the height advantage treated plots still have 20 yr later. For 1-yr-old seedlings 1 yr after spray, 20% of the sprayed seedlings and 12.5% of the unsprayed seedlings had died (3). Older seedlings suffered 2% mortality. The greater mortality in the sprayed areas was later offset by subsequent losses caused by competition in the unsprayed plots. Twenty years after treatment average stocking for all treated and control plots was the same (Table 1).

Mean annual volume increment (MAI) accrues over the life of a stand. Since 1959, when 2,4,5-T was applied and the seedlings were 6 to 8 months old, MAI is 3.16 m^3/ha for untreated plots and 4.18 m^3/ha for treated plots. Dividing the difference in cubic volume growth between treated and control by MAI for the control, the impact of treatment can he expressed as an additional 6 yr of growth. When similarly compared, there is an 8-yr growth advantage in total merchantable tree volume.

Langdon and Trousdell (6), working with loblolly pine (*Pinus taeda* L.) in the Coastal Plain and using a combination of competition control methods including individual stem spraying and injection, reported a 110% increase over controls in MAI (2.94 vs 6.16 m^3/ha) over 20 yr. When pine density was also controlled, MAI increased 205% over controls. Compared to these results the 32% increase in total tree volume and the 40% increase in total merchantable tree volume reported here is modest. But competition is usually much greater on loblolly pine sites especially those in the upper Coastal Plain and Piedmont than on lower Coastal Plain longleaf pine sites.

An additional factor to be considered in comparing results of this study with others is that since the original study war

Table 2. Cultural history of the three management compartments which contain the control and 2,4,5-T treated plots in Escambia Experimental Forest.

Year	Compartment 116	118	136
	Cultural treatment[a]		
1950			STC
1951	STC	STC	
1953		PB	PB
1956	PC	PC	PC
1957			FS[b]
1958			HI[b]
1959	AS[c]	AS[c]	AS[c]
1961	HC,PB	HC,PB	HC,PB
1962	MB	MB	
1964	HI		HI
1973		PB	
1974			PB[c]
1975		PB	
1977	PB	PB	
1978			PB[b]

[a]These treatments were applied to both the sprayed and control plots in each compartment unless specified otherwise: STC, seed tree cut; PB, prescribed burn; PC, cut in which merchantable posts were removed; FS, furrow direct seeding to 1/2 of the control area; HI, hardwood control by injection; AS, aerial spraying with 2.24 kg of 2,4,5-T ester ae/ha; HC, harvest cut.

[b]Applied only to the control area of this compartment.

[c]Applied only to the sprayed area of this compartment.

closed in 1961, plots in this study have been managed as timber production units (Table 2). Periodic prescribed burning has been used on each comparment for control of competing vegetation without regard to the study plot boundaries. In addition, compartments 116 and 118 received 9 and 11 gallons respectively of 2,4,5-T by mist blower in 1962. While the records do not indicate where in these compartments the mist blowing was conducted, the amount used would be sufficient to treat about 10 acres and was probably applied to the 10 acre control plots. Hardwoods were killed by injection in what was to become the control plot in compartment 136 the year before the study started and in compartments 116 and 136 in 1964 on an as needed basis. So the control plots probably received most timber stand improvement work, which reduced subsequent differences between treated and control plots. Therefore, the 32% increase in total volume and 40% increase in total merchantable tree volume is a conservative estimate of the gains from the 2,4,5-T spray treatments.

LITERATURE CITED

1. Boyer, W. D. 1975. Timing overstory removal in longleaf pine. J. For. 73:578–580.
2. Elwell, H. M. 1967. Herbicides for release of shortleaf pine and native grasses. Weeds 15:104–107.
3. Farrar, R. M. 1961. Aerial application of four silvicides in south Alabama. Proc. South. Weed Conf. 14:198–201.
4. Farrar, R. M. 1978. Silvicultural implications of the growth response of naturally regenerated even-aged stands of longleaf pine (*Pinus palustris* Mill.) to varying stand age, site quality, and density and certain stand structure measures. Ph.D. Thesis. Univ. Georgia. (Libr. Congr. Card No. Mic. 78–14941) 132 pp. Univ. Microfilms. Ann Arbor, MI (Diss. Abstr. 39:1066B).
5. Jaciw, P. 1972. How silvicides gave 10-year assist to conifer regeneration. Can. For. Ind. 92:30–36.
6. Langdon, O. G. and K. B. Trousdell. 1974. Increasing growth and yield of natural loblolly pine by young stand management. Pages 288–296 *in* Proc. Symp. on management of young pines. U.S. Dep. Agric., For. Ser.
7. Peevy, F. A. 1960. Controlling southern weed trees with herbicides. J. For. 58:709–710.
8. Smith, L. F. 1955. Development of longleaf pine seedlings near large trees. J. For. 53:289–290.