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LONG TERM RESPONSE OF LOBLOLLY

PINE TO COLLOIDAL PHOSPHATE ^{1/}

M. Victor Bilan and Marcey A. Gillespie ^{2/}

Abstract.--Three or six ounces of colloidal phosphate were applied either in planting hole or on soil surface while planting loblolly pine in East Texas. Combination of phosphate in the planting hole with NK on soil surface increased diameter growth for four years and the height growth for 18 years after planting.

INTRODUCTION

This study was initiated in 1960, during the period of intensified interest in commercial forest fertilization stimulated by rapidly increasing demand for forest products and by shrinking forestry land base. Calphos ^{3/} fertilizer was donated by the cooperator to test its effect on growth of loblolly pine seedlings in East Texas. Calphos, which is a brand of naturally occurring colloidal phosphate, contains at least about 8% of phosphorus, 17% of calcium and lesser amounts of 18 other elements. Beneficial effect of colloidal phosphate on growth of slash pine in Florida was reported by Pritchett and Swinford in 1961.

EXPERIMENTAL PROCEDURES

The study was established on a Woden sandy loam soil of old field in Nacogdoches County, Texas. The site was burned and cleared of brush just prior to establishment of the study in February, 1961.

The sandy loam surface soil was classified as very low on nitrogen and phosphorus and low on potassium and calcium.

The study consists of four blocks each 160 feet by 100 feet, in a four-replicate split plot design. Ten furrows spaced eight feet apart were plowed parallel to the short side of each block, thus subdividing each block in two plots and the entire experimental field into eight plots each 100 feet by 80 feet. Ten rows of 25 one-year-old loblolly pines were hand planted on each plot with eight-foot intervals between rows and four-foot intervals between pines in the same row. One of the following treatments was applied at random to one pair of rows of seedlings in each plot:

1. 3 oz. of Calphos placed in the planting hole of each seedling.
2. 6 oz. of Calphos placed in the planting hole of each seedling.
3. 3 oz. of Calphos spread on soil surface in 12-inch radius around each seedling.
4. 6 oz. of Calphos spread on soil surface in 12-inch radius around each seedling.
5. Control.

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^{3/} Thompson Sales Company, Inc., P. O. Box 246, Montgomery, Alabama 36101.

One week after planting 1 oz. of 60% muriate of potash and 1.5 oz. of 40% ammonium sulfate were spread on soil surface in 12-inch radius around each pine in one of the two rows given similar Calphos treatments.

Height and survival of all trees were recorded annually from the first through the fourth year after treatments, while the diameter at breast height was recorded during the third,

fourth and eleventh year after treatments. Data obtained 18 years after the treatments are based on the diameter of all surviving trees and on the height of five dominant trees per row. Factorial analysis of variance was used for the final measurements, while all data obtained previously were subjected to a split-split plot statistical analyses.

RESULTS AND DISCUSSIONS

Height Growth

Combination of placing Calphos in the planting hole and spreading potassium and nitrogen on soil surface increased height growth of loblolly pine seedlings during the first four years after treatment (Table 1). Either 3 oz. or 6 oz. of Calphos were equally effective on the furrowed and on the unfurrowed plots. Spreading of Calphos on the soil surface did not prove to be effective either with or without nitrogen and potassium regardless of furrowing. Furrowing alone did not seem to affect height growth of planted seedlings during their first four years of growth.

Eighteen years after treatment, trees that received 3 oz. or 6 oz. of Calphos in the planting hole were still significantly taller than the control trees (Table 2). At this time, Calphos proved to be effective with or without addition of nitrogen and potassium. According to an equation developed by Lenhart (1972), site index at base age 25 was improved from 61 feet for control trees to 63 feet for trees that received Calphos in the planting hole.

Brendemuehl (1970), Bengston (1970), and Pritchett (1961) have demonstrated the importance of placing fertilizer material, especially phosphorus, in contact with the rooting zone of the soil for the best response. Pritchett and Swinford (1961) reported that broadcasting and disking of colloidal phosphate at the rate of 1/2 ton per acre just before planting increased significantly height growth of slash pine in Florida, and that superior height growth was evident 15 years after the treatment.

Diameter and Basal Area

Application of either 3 oz. or 6 oz. of Calphos in the planting hole and of nitrogen and

potassium on the soil surface increased significantly diameter growth of the planted loblolly pines during the third and the fourth growing season on both, the furrowed and unfurrowed plots (Table 3). However, no significant differences were evident among the average diameter growth of any treatments 11 or 18 years after planting.

Close (4 feet by 8 feet) original spacing 74% average survival 18 years after treatment resulted in an average of 1,007 trees per acre and a basal area of 224 square feet (Table 4). The excessive stand density inhibited diameter growth and probably resulted in the absence of statistical differences among the treatments for the diameter growth and basal area per acre. When expressed as percentage of control, Calphos application at the rate of 6 oz. on surface and 3 oz. or 6 oz. in planting hole produced between 10% and 16% more basal area.

Volume

Volume in cunits was determined by the equation:

$$\text{cunits} = 0.008 + 0.0002 D^2H$$

Statistical analysis did not detect any significant differences among average volume per acre produced by individual Calphos treatments 18 years after fertilization. However, like diameter and basal area, volume produced by 6 oz. and 3 oz. of Calphos in the planting hole was 10% and 19% greater than the volume produced by control trees.

Merchantable volume in cords was determined by the equation:

$$\text{cords} = 0.75 (\text{cunits/tree}) \frac{\text{dbh}-3.5}{\text{dbh}} \text{ assuming uniform taper}$$

and a top diameter limit of 3.5 inches. Although differences among treatment means were statistically not significant, 6 oz. of Calphos on soil surface produces 21% more cord volume than the control. Trees treated with 3 oz. in the planting hole produced 10% more cord volume than the control trees. Pritchett and Swinford (1961) also reported increase in cord wood volume of slash pine in Florida 15 years after application of 0.5 to 1.0 ton of colloidal phosphate per acre disked into fine sand before planting.

Table 1.--Average height of loblolly pine plantation by treatments during the first four years after planting.

Age of Trees	TREATMENTS				
	0 control	3oz. surface	Calphos 6oz. surface	3oz. hole	6oz. hole
years	-----feet-----				
	No Furrowing no NK				
2	1.4 a ¹	1.3 a	1.5 a	1.4 a	1.4 a
3	3.6 a	3.6 a	3.5 a	3.6 a	3.7 a
4	7.0 a	6.7 a	6.9 a	7.0 a	7.3 a
5	10.8 a	10.4 a	10.6 a	11.0 a	11.3 a
	Furrowing no NK				
2	1.5 a	1.5 a	1.5 a	1.5 a	1.5 a
3	3.9 a	3.9 a	3.7 a	3.9 a	3.8 a
4	7.4 a	7.4 a	7.2 a	7.4 a	7.3 a
5	11.2 a	11.1 a	11.0 a	11.0 a	11.1 a
	No Furrowing + NK				
2	1.3 a	1.3 a	1.4 a	1.5 b	1.6 b
3	3.4 a	3.3 a	3.4 a	3.8 b	3.9 b
4	6.9 a	6.7 a	6.6 a	7.4 b	7.6 b
5	10.7 a	10.4 a	10.3 a	11.3 b	11.6 b
	Furrowing + NK				
2	1.4 a	1.5 a	1.4 a	1.8 b	1.7 b
3	3.7 a	3.8 a	3.7 a	3.6 ab	4.2 b
4	7.1 a	7.2 a	7.2 a	7.3 ab	7.8 b
5	10.8 a	10.9 a	10.8 a	11.9 b	11.6 b

^{1/} Treatment means followed by a common letter do not differ significantly according to Duncan's multiple range test.

Table 3.--Average diameter of loblolly pine plantation by treatments and age.

Age of Trees years	TREATMENTS				
	0 control	3oz. surface	Calphos 6oz. surface	3oz. hole	6oz. hole
	-----inches-----				
	No Furrowing no NK				
4	0.68 a ^{1/}	0.58 a	0.62 a	0.69 a	0.73 a
5	1.58 a	1.50 a	1.52 a	1.56 a	1.62 a
12	5.10 a	4.98 a	5.38 a	5.27 a	5.13 a
19	5.91 a	6.12 a	5.94 a	5.96 a	6.28 a
	Furrowing no NK				
4	0.72 a	0.71 a	0.72 a	0.73 a	0.70 a
5	1.62 a	1.57 a	1.55 a	1.48 a	1.57 a
12	4.82 a	4.80 a	5.33 a	4.63 a	4.85 a
19	5.88 a	5.81 a	6.26 a	5.77 a	6.00 a
	No Furrowing + NK				
4	0.62 a	0.58 a	0.59 a	0.80 b	0.79 b
5	1.53 a	1.44 a	1.47 a	1.73 b	1.72 b
12	5.09 a	4.99 a	5.26 a	5.53 a	5.14 a
19	5.92 a	6.09 a	6.14 a	6.73 a	6.02 a
	Furrowing + NK				
4	0.64 a	0.74 a	0.64 a	0.85 b	0.79 b
5	1.52 a	1.49 a	1.53 a	1.73 b	1.69 b
12	5.12 a	4.78 a	4.79 a	4.86 a	5.20 a
19	6.10 a	6.21 a	5.78 a	5.93 a	6.03 a

^{1/} Treatment means followed by a common letter do not differ significantly according to Duncan's multiple range test.

Table 2.--Average height of loblolly pine trees after fertilizing for all furrowing and nitrogen-potassium treatments combined.

Calphos Treatments				
0 contro <u>1</u>	3oz. surface	6oz. surface	3oz. hole	6oz. hole
-----feet-----				
53.2 c <u>1/</u>	53.8 abc	53.4 bc	54.6 a	54.5 a

^{1/} Treatment means followed by a common letter do not differ significantly according to Duncan's multiple range test.

Table 4.--Average parameters of loblolly pine trees 18 years after treatment for all furrowing and NK treatments combined.

Treatment	Height	Diameter	Basal Area	Volume
Calphos	feet	inches	sq. feet/ acre	cords/ acre
control	53.2 c <u>1/</u>	6.0 a	211 a	16.6 a
3oz. surface	53.8 bc	6.1 a	198 a	15.3 a
6oz. surface	53.4 bc	6.0 a	237 a	20.2 a
3oz. hole	54.6 a	6.1 a	244 a	18.3 a
6oz. hole	54.5 a	6.1 a	232 a	17.2 a

^{1/} Treatment means followed by a common letter do not differ significantly according to Duncan's multiple range test.

CONCLUSIONS

Height and diameter growth of loblolly pine were significantly increased during the first four years after planting when Calphos was applied in the planting hole and nitrogen and potassium were applied to soil surface. Beneficial effect of Calphos was also evident in the height growth 18 years after treatment with or without nitrogen and potassium application.

Average tree survival was 95% four years after fertilizing and 74% eighteen years later, and none of the applied treatments affected the stand density. Due to close spacing and a very low mortality, original significant effect of Calphos applied in the planting hole was not as consistent 11 and 18 years after treatment as it was during the initial four years. Yet, application of 6 oz. of Calphos to soil surface and 3 oz. or 6 oz. of Calphos in the planting hole produced 10% - 20% increase in basal area, total volume and merchantable cordwood volume 18 years after treatment.

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