THE EFFECT OF SOIL FUMIGATION ON THE GROWTH AND YIELD OF LOBLOLLY PINE SEEDLINGS IN THE NURSERY

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The production of pine seedlings is expensive and exacting. The gross cost of nursery stock may be several thousand dollars per acre; few, if any, crops are more soil depleting or require more careful soil management practices. These factors, together with increased demands for more and better seedlings, are of much concern to those charged with the responsibility of seedling production and nursery management. In general, a unit of nursery soil tends to produce a constant weight of seedling tissue in the form of either many small seedlings or fewer large ones; therefore, any practice that will insure a maximum production of plantable seedlings is of considerable importance.

The purpose of this study was to test the general hypothesis that more plantable loblolly pine seedlings of better quality could be grown on a given unit of nursery soil through soil fumigation for the control of plant parasitic nematodes. Nematodes are microscopic eelworms, many of which feed on the roots of plants. They may be the underlying cause of puzzling ailments in certain nurseries.

Nematologists have established the fact that parasitic nematodes are associated with the roots of all the major southern pines. They have found seven different genera of parasitic nematodes that can attack the roots of loblolly (Pinus taeda), slash (P. elliottii), longleaf (P. palustris), and shortleaf (P. echinata) pine seedlings. A recent survey showed that among several species of parasitic nematodes Xiphinema americanum and Helicotylenchus spp. occurred most commonly in a number of forest soils in Louisiana. Available information indicates that X. americanum may be of considerable economic importance in southeastern United States, probably as a parasite of trees and shrubs. A species of Helicotylenchus has been established as a parasite of boxwood.

Materials and Methods

To ascertain the effects of soil fumigation for the control of nematodes and the effects of nematodes on the growth and development of loblolly pine seedlings, an experiment was established at the North Louisiana Hill Farm Experiment Station, Homer, La., during 1956.

The site selected for the nursery was a portion of an abandoned old field containing scattered pole-sized loblolly and shortleal pine. The soil type was Lakeland fine sand. An analysis of the soil indicated that nematodes (primarily Xiphinema americanum and Helicotylenchus app.) were present in high numbers.

The experiment included various types of nematocide treatments, with a split-plot design for seedling density superimposed upon each treatment. Seedlings were grown at two densities, 30 and 60 per square foot, on plots treated 2 weeks prior to planting with the following soil fumigants- [2] "D-D"[3] at 25 gallons per acre; "Nemagon" [4] at 7.5 gallons per acre; "Dowfume W-85"[5] at 7.5 gallons per acre; "Dowfume MC-2"[6] at 2 pounds per 100 square feet; and check (no fumigants). The treatments were established on plots 4 feet square in a 5 by 5 latin-square design.

The initial application of fertilizer was made on March 8, 1956, at the rate of 600 pounds per acre of 8-8-8 broadcast and mixed into the soil. An additional application of 300 pounds per acre of 8-8-8 was made on the surface between rows on June 25, 1956.

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2 Mention of any chemical company or product does not imply endorsement by the U.S. Department of Agriculture.

3 1,3-dichloropropene-1,2-dichloropropane (50-50) mixture supplied by Shell Chemical Corp.

4 1,2-dibro-3-chloropropane (97 percent) supplied by Shell Chemical Corp.

5 1,2-dibromoethane (83 percent) supplied by Dow Chemical Co.

6 Methyl bromide (98 percent), chloropicrin (2 percent) supplied by Dow Chemical Co.

Soil samples were collected in April, June, July, and September and processed for extraction of nematodes by standard laboratory methods. The nematodes present were recorded as to identity and number in each treatment on each sampling date.

The seedlings were lifted from a depth of 12 inches and graded according to Wakeley's [7] morphological grades during the week of February 3, 1957. The data collected from each treatment-density class were analyzed statistically.

Results

The increased vigor and growth of seedlings (fig. 1) in the fumigated plots were correlated directly with reduced populations of parasitic nematodes. The first sampling for parasitic nematodes 2 weeks after fumigation showed that they were virtually eliminated from the treated plots. All fumigants were highly effective, and there were no differences in initial nematode control. Numbers of the ectoparasitic nematodes Xiphinema americanum and Helicotylenchus spp. were suppressed in all fumigated plots throughout most of the growing season. The results suggested that parasitic nematodes were the cause of severe growth reduction of loblolly pine seedlings in the untreated plots.

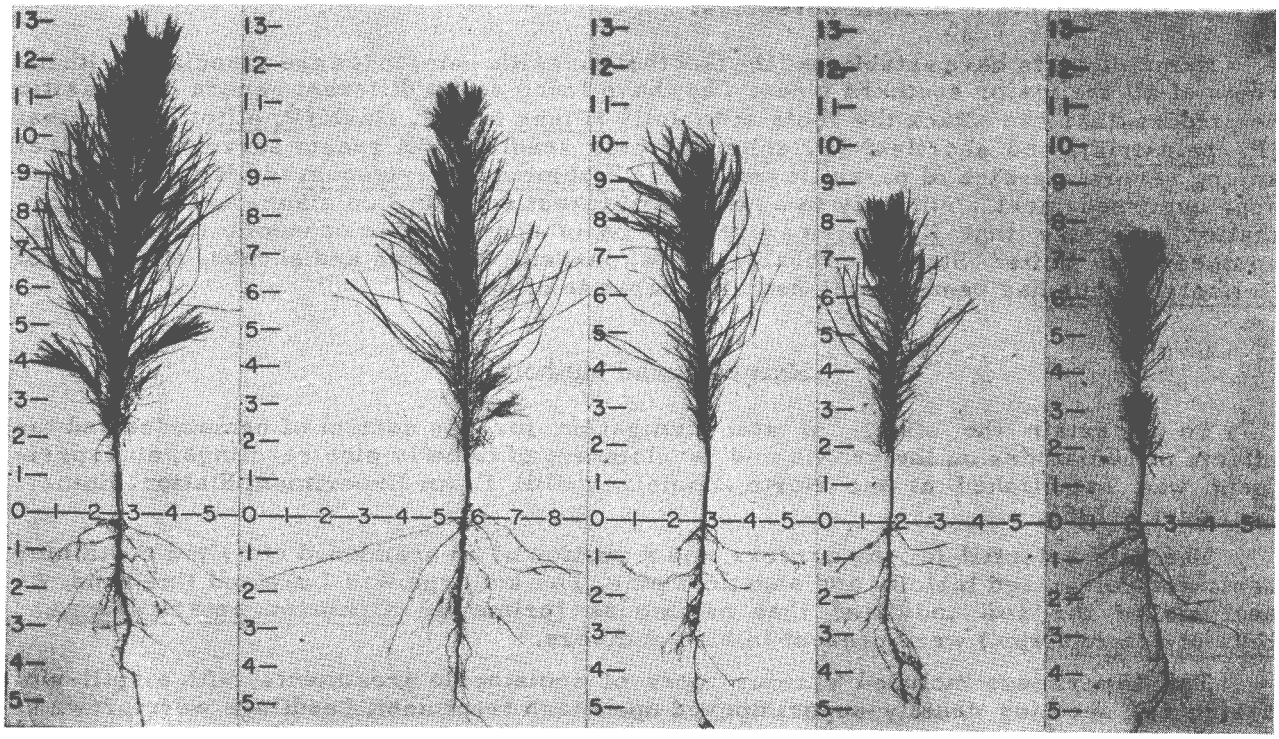

Figure 1.--Representative samples of loblolly pine seedlings 130 days old grown in plots treated with various nematocides. (Background numbers represent inches.)

Table 1 shows the effect of soil fumigation on the production and quality of loblolly pine seedlings grown at the different densities. "Plantable" seedlings include Grades 1 and 2; Grade 3 seedlings are considered "cull."

Soil fumigation increased the yield of plantable seedlings at both densities. At the lower density, the increase was from 24 to 28 seedlings per square foot, an increase of 17 percent over the nonfumigated yield. At the higher density, the increase was from 31 to 43 seedlings per square foot, an increase of 39 percent over the nonfumigated yield. This increase in plantable seedlings due to fumigation was statistically highly significant.

[7] Wakeley, Philip C. Planting the southern pines. U.S. Dept. Agr., Agr. Monog. 18. 233 pp.. illus. 1954.

Table 1.--Effect of soil fumigation on production and quality of loblolly pine seedlings grown at two densities

Density and treatment	Grade 1 seedlings per sq. ft.		Grade 2 seedlings per sq. ft.		Grade 3 seedlings per sq. ft.		Plantable seedlings per sq. ft.	
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*
Density--30 per sq. ft.:								
MC-2	18	57	11	35	2	8	29	92
D-D	17	54	12	38	2	8	29	92
Nemagon	16	51	12	39	3	10	28	90
W-85	14	44	14	43	4	13	28	87
Check	9	31	15	46	7	23	24	77
Density--60 per sq. ft.:								
MC-2	15	25	32	53	13	22	47	78
D-D	11	19	33	55	16	26	44	74
Nemagon	8	13	33	55	19	32	41	68
W-85	8	13	33	55	19	32	41	68
Check	2	4	29	48	29	48	31	52

Table 2.--Effect of soil fumigation on the size of loblolly pine seedlings

Seedbed density and treatment	Grade 1		Grade 2		Grade 3	
	Stem height	Stem diameter at root collar	Stem height	Stem diameter at root collar	Stem height	Stem diameter at root collar
Density--30 per sq. ft.:	*Inches*	*32 ds of an inch*	*Inches*	*32 ds of an inch*	*Inches*	*32 ds of an inch*
MC-2	17.4	8.0	13.7	5.0	10.6	3.0
D-D	16.9	7.6	12.9	5.0	10.7	3.0
Nemagon	15.9	7.8	12.3	5.0	9.9	3.0
W-85	14.3	6.8	11.4	4.8	9.6	3.0
Check	12.4	6.6	9.8	4.2	7.9	3.0
Density--60 per sq. ft.:						
MC-2	18.4	7.8	14.0	5.0	11.3	3.0
D-D	16.1	7.0	13.3	5.0	10.7	3.0
Nemagon	16.2	7.2	12.8	4.6	10.2	3.0
W-85	15.3	6.8	12.6	5.0	10.1	3.0
Check	13.2	6.6	10.6	4.0	8.8	3.0

The maximum production of plantable seedlings was attained by fumigating and increasing seedbed density to 60 per square foot. This combination almost doubled the production per square foot of nursery space. Although the cull percentage was increased even with fumigation, as a result of increased density, the loss resulting from wasted seed was minor compared with all the other economic factors involved in nursery management.

Table 2 summarizes the effect of soil fumigation on height and diameter growth of all seedling grades. Since the seedlings were lifted-at the same depth and some of the roots of the larger plants were destroyed, analyses of growth data were restricted to stem height and stem diameter.

Soil fumigation resulted in significantly greater height and diameter growth of Grade 1 and 2 seedlings. Increased density had no detrimental effects on the height and diameter growth of the seedlings within these grades.

Information obtained as to lateral root development (table 3) further shows the response of loblolly pine seedlings to fumigation. The data show that the lateral root development of seedlings grown on the fumigated soil was much more extensive. Within each grade, more lateral roots with greater total lengths were obtained at both densities.

Table 3.--Effect of soil fumigation on the lateral root development [1] of loblolly pine seedlings

Seedbed density and treatment	Grade 1		Grade 2		Grade 3	
	Lateral roots per seedling	Total length	Lateral roots per seedling	Total length	Lateral roots per seedling	Total length
Density--30 per sq. ft.:	*Number*	*Inches*	*Number*	*Inches*	*Number*	*Inches*
MC-2.....	25	89	18	46	13	20
D-D.....	21	82	16	41	12	21
Nemagon.....	17	79	15	49	9	23
W-85.....	16	74	14	57	12	29
Check.....	17	67	12	35	11	22
Density--60 per sq. ft.:						
MC-2.....	24	79	20	50	14	26
D-D.....	23	77	20	45	12	26
Nemagon.....	17	55	17	51	12	27
W-85.....	23	81	17	50	14	26
Check.....	16	61	14	42	9	18

[1] Ninety-nine percent of the lateral roots measured originated within 8 inches of the root collar.

Summary

The results of this study indicate that the practice of soil fumigation for nematode control offers considerable promise for increasing the production and improving the quality of loblolly pine seedlings in nurseries infested with certain parasitic nematodes.

This experiment, designed to measure the effects of soil fumigation on the growth and development of loblolly pine seedlings, showed the following:

1. The production of plantable seedlings was almost doubled by fumigating the soil and increasing seedbed density from 30 to 60 per square foot.

2. Fumigation of the soil resulted in the production of seedlings with better morphological characteristics within each grade, irrespective of the density.

3. Increased density had no detrimental effects on the morphological characteristics of the plantable seedlings produced.

4. The yield of plantable seedlings was greater on fumigated soil, regardless of density.

5. Soil fumigation was highly effective in reducing populations of parasitic nematodes during the period of active pine seedling growth.