

Nitric Acid and Benomyl Stimulate Rapid Height Growth of Longleaf Pine

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SUMMARY

Rapid height growth of longleaf pine seedlings, important to production of uniform, even-aged stands, can be promoted by controlling brown-spot needle blight and weed competition, and by increasing soil fertility. Root systems of container-grown longleaf pine seedlings were dip-treated in either benomyl/clay mix (10 percent a.i. benomyl) or clay control and planted in scalped rows that had been treated with various levels of nitric acid (0, 4, or 8 percent). After one growing season in the field, seedlings were evaluated for survival, brown spot infection, and vigor; plots were evaluated for weed competition. The benomyl root-dip treatment improved seedling survival, controlled brown spot infection, and promoted growth of outplanted seedlings in the first year. For the same period, treatment of soil with nitric acid improved seedling survival and vigor and significantly reduced the amount of competing vegetation. The combined use of benomyl and nitric acid resulted in the most rapid height growth.¹

Additional keywords: Brown-spot needle blight, *Scirrhia acicola* (Dearn.) Siggers, fertilizer, herbicide, disease control, *Pinus palustris*.

¹This publication reports research involving nitric acid as a pesticide. It does not imply that the use discussed has been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

Caution: Concentrated nitric acid is extremely caustic and will cause severe burns to skin or eyes. It also produces toxic fumes. Avoid prolonged inhalation and immediately rinse any spills on skin or clothing with copious amounts of water. Always add acid to water, not vice versa.

INTRODUCTION

Longleaf (*Pinus palustris* Mill.) pine seedlings possess a temporary dwarf habit of growth which has been a major obstacle in its regeneration. Partly as a consequence, longleaf has been supplanted by other pine species and now occupies only about 25 percent of the area it once dominated (Mann 1969). The initiation of rapid height growth of longleaf pine is normally delayed until the seedling has passed through a preliminary period of root and foliar development known as the grass stage (Wahlenberg 1946). This condition is an inherent seedling trait under genetic control, although the length of time seedlings remain in this grass stage is strongly influenced by such environmental influences as brown-spot needle blight, competition from other plants, and low soil fertility (Brown 1964). These may delay height growth up to 15 or 20 years (Bruce 1958, Dorman 1976). Cultural practices such as the control of brown-spot needle blight by chemicals or fire (Kais et al. 1981 a, 1981 b), the control of weed competition (Bruce 1958, Mann 1969, Pessin 1944), and fertilization (Hinesley and Maki 1980, Lewis 1977, Schmidting 1973, Smith and Schmidting 1970) have all resulted in earlier height growth.

Longleaf pine has excellent form, good wood qualities, and resistance to fusiform rust caused by *Cronartium quercuum* (Berk.) Miyabe ex Shirai f. sp. *fusiforme*. Yet, because of the problems associated with the grass stage during its early development, it is not planted extensively. Seedlings in a prolonged grass stage are frequently killed by brown-spot needle blight and weed competition. However, brown spot is primarily a disease of the grass stage, and a method of stimulating early height growth by controlling both brown spot and weeds would reduce losses, ensure a more uniform stand, and make longleaf pine more attractive for reforestation.

Brown spot has been effectively controlled by benomyl used as a root dip treatment before outplanting (Kais et al. 1981a, 1981 b). A 4 percent nitric acid solution has been used to control weed competition and to provide nutrition to pine seedlings in the form of available nitrogen (Hare 1984). A single nitric acid application helps overcome growth inhibition caused by low soil fertility and weed competition. It has pre-emergence activity when sprayed on bare soil and post-emergence activity when used as a directed spray on emerging weeds. Treated areas remain essentially weed-free during one growing season without any significant injury to pine seedlings.

The purpose of this study was to stimulate rapid height growth of containerized longleaf pine seedlings outplanted in the field. Three well-known growth inhibitors were studied: (1) brown-spot needle blight, (2) low soil fertility, and (3) weed competition. Benomyl root dip treatments were used to control the brown spot, while nitric acid soil application was used to provide nitrogen-nutrition and control weed competition. Previous tests had indicated that containerized longleaf pine seedlings planted by machine had excellent survival rates,

MATERIALS AND METHODS

Longleaf pine seeds were germinated in Leach Supercell² containers at Alexandria, Louisiana, in May 1981. These cells, 1 1/2 inches in diameter and 8 1/2 inches in length, each contained approximately 10 cubic inches of an equal mix of vermiculite and peat moss. Peters Water Soluble Plant Fertilizer (20-1 9-1 8 NPK) was applied at 150 ppm nitrogen weekly. Containers with seedlings were transferred to a greenhouse at Gulfport, Mississippi, in August 1981. They were next transferred to a lath-house at Saucier, Mississippi, on November 5, 1981, and held there until outplanting in January 1982. At planting time, compressed air was applied to the drain holes of the containers and seedlings were readily removed in one piece.

The field test was installed as a randomized complete block design consisting of 3 nitric acid levels x 2 root-dip treatments x 6 blocks x 30 seedlings for a total of 1,080 seedlings. Treatment row locations had been prepared by scalping 3-foot swaths in July 1981. The scalped rows were treated with 0, 4, or 8 percent nitric acid (HNO₃) in water on August 3, 1981. Solutions were prepared by adding 65 percent technical grade HNO₃ to water in a portable stainless steel tank. A long rubber hose with a

fan rose sprinkler and shut-off valve attached to the tank was used to moisten the soil surface and any emergent weeds on the scalped plots. Approximately 2.5 gallons of solution were applied to treatment areas of 30 x 2 feet (60 ft²).

Seedlings were machine planted with a Whitfield planter on January 27 - 28, 1982. The 180 seedlings per block were divided into two groups of 90 seedlings each. One group was dipped in plain kaolinite clay and the other into a kaolinite clay-benomyl mixture (10 percent a.i. benomyl). Thirty seedlings of each group were then planted at 3-foot intervals in one of the three different acid-soil treatment plots. Individual treatments and treatment rows were separated by a 10-foot spacing; blocks were separated by a 20-foot border. Naturally occurring longleaf pine seedlings in the area surrounding the planting were heavily infected with brown-spot needle blight.

In November 1982, seedlings were evaluated for survival, brown-spot infection, and vigor. All plot surfaces were rated for degree of weed competition at the same time. Brown-spot infection was determined for each seedling by a visual estimate of the percent of needle tissue area killed by the disease. Vigor was rated by using a vigor index: 1 = poor, 2 = fair, 3 = good, and 4 = excellent. Weed competition was evaluated with a competition index: 1 = none, 2 = slight, 3 = moderate, and 4 = severe. Data were evaluated by an analysis of variance. Treatment means were compared by means of Duncan's Multiple Range Test at the 0.05 level.

RESULTS

First-year field survival of seedlings varied from 66.3 to 88.0 percent (table 1). Significant survival differences of seedlings depended on the specific treatment combinations. There was an increase in survival with an increase in nitric acid dosage applied to the plots and a significantly greater survival rate for the seedlings treated with benomyl than those treated with plain clay dips. Survival of seedlings not treated with benomyl was significantly increased only at the higher level of nitric acid application.

Seedlings treated with benomyl had only 3.1 to 4.0 percent brown-spot infection, compared to the corresponding clay-treated seedlings that had from 28.3 to 39.6 percent. There were no infection differences on seedlings treated with benomyl and the three different acid-water treatments. However, clay-dipped seedlings had less infection following the 4 and 8 percent nitric acid treatments than did the seedlings in soil treated with water.

²The mention of a company or trade name does not imply endorsement by the USDA.

Table 1 .-Survival, infection, and vigor of containerized *longleaf* pine seedlings and weed control after 1 year in the field

Dip and acid treatments	Survival	Brown-spot infection	Vigor index ¹	Weed index ²
.....percent.....				
Benomyl/Clay				
0 nitric acid	79.7 abc ³	3.8 c	3.8 c	2.1 a
4% nitric acid	74.3 bcd	4.0 c	3.7 ab	1.3 b
6% nitric acid	88.0 a	3.1 c	3.9 a	1.2 b
Mean	80.7	3.6	3.6	1.5
Clay				
0 nitric acid	66.3 d	39.6 a	2.6 d	2.4 a
4% nitric acid	67.8 cd	28.3 b	3.3 bc	1.3 b
6% nitric acid	85.6 ab	29.6 ab	3.6 abc	1.1 b
Mean	73.2	32.5	3.2	1.6

¹Vigor index; 1 = poor, 2 = fair, 3 = good, and 4 = excellent,

²Weed competition index; 1 = none, 2 = slight, 3 = moderate, and 4 = severe.

³For each parameter, values in the same column followed by the same letter are not significantly different (P = 0.05). Each treatment value is the mean of 6 blocks of 30 seedlings each.



Figure 1 .--Effect of *benomyl* and nitric acid treatment on *longleaf* pine p/ants. Left: In control, scalping is evident but some weeds appear; p/ants are not large, as growth is limited by brown-spot needle blight infection, low soil nitrogen, and weed competition. Right: Treated plants are larger because brown-spot disease and weed competition are controlled and there is more soil nitrogen available.

Both the nitric acid-soil treatments and the benomyl root-dip treatments resulted in higher seedling vigor (table 1). Seedling vigor was greatest with the highest rate of HNO_3 (8 percent), and poorest with the water control. Seedlings dipped in benomyl at the time of outplanting were significantly more vigorous than seedlings treated with plain clay. Combinations of benomyl and HNO_3 generally had the highest survival and vigor with the least brown spot and weeds (table 1, fig. 1).

The weed competition index, including both grass and broadleaf weeds, was greatest where no nitric acid was applied to the soil (table 1). All nitric acid treatments significantly reduced the index below that of the control. The benomyl root treatment had no effect on weeds.

DISCUSSION

Longleaf pine survival, growth, and overall development was excellent in the 1 O-cubic-inch containers. Root dipping of the seedlings was a simple operation and the benomyl-clay mixture adhered tenaciously to the root cylinder. Furthermore, seedlings retained their root cylinder configuration and benomyl-clay coverage during the machine planting operation performed with the Whitfield tree planter. Survival, which was lower than expected, was probably reduced by unseasonably cold temperatures during the time seedlings were held in the lathhouse and later, after they were outplanted in the field.

The positive benomyl effect on survival and growth presumably resulted from effective disease control, permitting normal growth.

The nitric acid effect on both survival and growth of seedlings was twofold: direct, in that it provided readily usable nutrition to the seedlings, and indirect, in that it eliminated plants competing with the longleaf pine seedlings for available nutrients and moisture.

The greatest survival and vigor of longleaf pine seedlings occurred with the 8 percent HNO_3 treatment, with or without benomyl (table 1). However, the 4 percent and 8 percent HNO_3 sprays were equally effective for weed control. The 4 percent spray applied either just before planting or 2 weeks after would require less material, and this timing would provide more available nitrogen to the plants. These applications can be limited to a 1-foot radius around each seedling. Care must be taken to protect pine foliage from direct contact with diluted nitric acid if applied after planting.

Applied at a rate of 2.5 gallons/60 ft^2 , the cost per seedling of the nitric acid needed for a 4 percent spray applied in a 1-foot radius around each tree would be \$0.07. Cost of the acid material needed per acre of a longleaf planting with a 10- by 10-foot spacing would be approximately \$30 and of a 6- by 8-foot spacing about \$63 per acre. A 4 percent HNO_3 treatment of the 10- by 10-foot planting would provide approximately 1.8 kg of nitrogen per acre, while treatment of a 6- by 8-foot planting would provide 3.8 kg of nitrogen per acre. In both instances, 4.2 g of nitrogen are provided per seedling.

The combined use of benomyl and nitric acid could

overcome some of the persistent problems that are associated with the culture of longleaf pine. The growth stimulation following the simultaneous control of competing vegetation and brown-spot needle blight plus the addition of available nitrogen reduce the time required for root development, allowing seedlings to start height growth sooner. Longleaf pine seedlings receiving the treatments should be out of the grass stage within 2 to 3 years after outplanting. This in turn should produce the uniform stands that have been difficult to attain in the past and which are so crucial for longleaf pine regeneration in the future.

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