

Benomyl Root Dip and Scalping Improve Early Performance of Longleaf Pine on Pest-Infested Agricultural Croplands

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A kaolin clay-benomyl root dip and scalping independently improved first-year survival of longleaf pine seedlings on pest-infested agricultural croplands in northern Florida. The root dip treatment, however, appeared to have little or no impact on seedling growth after 2 years in the field, whereas scalping provided significant improvements in seedling emergence from the grass stage and height growth over the same time period. Tree Planters' Notes 46(3):93-96; 1995.

Longleaf pine (*Pinus palustris* Mill.) has been considered a difficult species to regenerate (Barnett and others 1990, Mann 1969). Its reputation for poor survival and delayed or slow early growth has limited its use in reforestation. Occasionally, however, researchers have reported good results when planting longleaf pine, especially when care is taken in handling and planting and when weed competition is adequately controlled (Barnett and others 1990, Mann 1969, Shipman 1958). Specific procedures showing promise with respect to improving survival and growth of planted longleaf pines include scalping (Shoulders 1958, Cordell and Marx 1995), and kaolin clay-benomyl root dips (Kais and others 1986a, 1986b; Kais and others 1981); the latter designed primarily for control of brown spot needle blight caused by *Mycosphaerella dearnessii* Barr [= *Scirrhia acicola* (Dearn.) Siggers]. As part of a larger study involving slash pine (*Pinus elliotii* Engelm. var. *elliotii*) seedlings on pest-infested agricultural croplands (Barnard and others 1995b), we evaluated the performance of longleaf pine seedlings planted on scalped soils and longleaf pine seedlings planted after being root-dipped in a benomyl-amended kaolin clay slurry. This paper summarizes our results.

Materials and Methods

Individual study sites were selected in Okaloosa, Madison, and Holmes Counties in northern Florida (Barnard and others 1995). Each site was uniformly cleared of herbaceous weed growth and agricultural stubble by mowing in the fall (October–November) of

1989 before the study plantings were established. In January 1990, longleaf pine seedlings representing each of three treatments were machine-planted at a spacing of about 1 by 3 m (4 by 10 ft) in parallel 75-tree row plots in each of 5 replicate blocks on each of the three study sites (that is, 375 seedlings/treatment/site). The following treatments were used:

SCALP—seedlings were planted on soils mechanically scalped 4 to 6 weeks prior to planting; that is, sod/stubble and soil removed with a tractor-drawn plow blade leaving a “furrow” about 0.75 m (30 in) wide and 7.5 to 10 cm (3 to 4 in) deep.

DIP—seedling roots were dipped in a 2.5% ai benomyl (Benlate® 50WP)/kaolin clay slurry (380 g clay + 20 g benomyl/liter of H₂O according to the method of Barnett (personal communication) and planted with no site preparation except the fall mowing.

CHECK—seedlings received no special treatment and were planted with no site preparation except the fall mowing.

Study sites were visited at approximately monthly intervals from April through December 1990. On each visit, all dead and dying seedlings were carefully dug, placed in plastic bags, and carried to the laboratory where they were individually examined for evidence of insect or pathogen activity. Seedling roots were examined visually for evidence of insect feeding typical of whitefringed beetles (*Graphognathus* spp.) (Barnard and others 1995, Dixon 1988, Filer and others 1977, Price 1988) and the presence of internal resin-soaking (resinosis) indicative of possible fungal pathogenesis (Barnard and others 1993, Barnard and others 1995b, Barnard and Blakeslee 1980). Roots were also examined with a 10x hand lens or stereomicroscope as needed for microsclerotia of *Macrophomina phaseolina* (Tassi) Goid., the charcoal root rot fungus (Barnard and others 1995b).

During January–February of 1992, after two complete growing seasons in the field, survival and growth of seedlings in the scalped and check treatments were assessed. The height of seedlings greater than or equal to 10 cm (4 in) tall was measured to the nearest centimeter (3/8 in). Seedlings less than 10 cm (4 in) in height were simply recorded as “grass stage.” Seedlings treated with the benomyl root dip were not measured because, upon cursory inspection, their growth appeared no different than that of the check seedlings.

First-year plot survival data was subjected to standard analysis of variance (ANOVA) and differences among treatment means across all three study sites were evaluated for significance at $P \leq 0.05$ using Duncan's new multiple range test. Treatment means (scalped versus check only) for second-year survival, grass stage, and height data were evaluated for significant differences within each study site using a simple t test at $P \leq 0.05$ and $P \leq 0.01$.

Results

At the end of the first growing season (December 1990), survival varied appreciably among sites and among treatments within two of the sites (figure 1). Survival of seedlings on the Holmes Co. site was outstanding (>94%) across all three treatments and did not differ significantly among treatments ($P \leq 0.05$). On the Okaloosa Co. and Madison Co. sites, significant differences among treatments were clear ($P \leq 0.05$). On both of these sites, survival was best in scalped rows (plots), worst in check rows, and intermediate in rows with root-dipped seedlings.

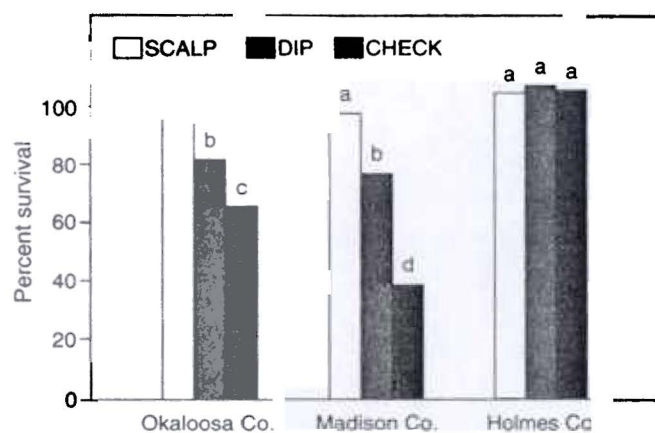


Figure 1—First-year survival of longleaf pine seedlings on pest-infested agricultural croplands in northern Florida for check (CHECK), root-dipped (DIP), and scalped (SCALP) treatments. Survivals depicted by bars with same-letter superscripts did not differ significantly at $P \leq 0.05$.

Evidence of insect feeding damage and potential fungal pathogen activity (that is, resin-soaked roots and/or the presence of microsclerotia of *M. phaseolina*) was detected on dead and dying seedlings from all three sites (figure 2). Insect feeding damage, predominantly that attributable to whitefringed beetles, was clearly most prevalent on seedlings from the Okaloosa Co. site, whereas *M. phaseolina* was most prevalent on seedlings from the Madison Co. site. Resin-soaked roots, although detected in seedlings from all sites, were generally not a frequent feature on seedlings from any site.

On each of the three outplanting sites, root-dipped seedlings exhibited less root resinosis than their respective checks. Respectively, 50% (9 of 18), 12% (19 of 152), and 2.5% (6 of 236) of the check seedlings at the Holmes, Okaloosa, and Madison County sites exhibited root resinosis. None (0 of 12) of the root-dipped seedlings at the Holmes Co. site and only 6% (6 of 100) and 1.7% (2 of 114) of the root-dipped seedlings on the Okaloosa and Madison Co. sites exhibited this symptom.

The occurrence of microsclerotia of *M. phaseolina* on root-dipped seedlings was similarly less than that on the check seedlings on both the Okaloosa and Madison Co. sites. Microsclerotia were detected on 12% (18 of 152) of the check seedlings and on only 7% (7 of 100) of the root-dipped seedlings removed from the Okaloosa Co. site. On the Madison Co. site, only 22% (26 of 114)

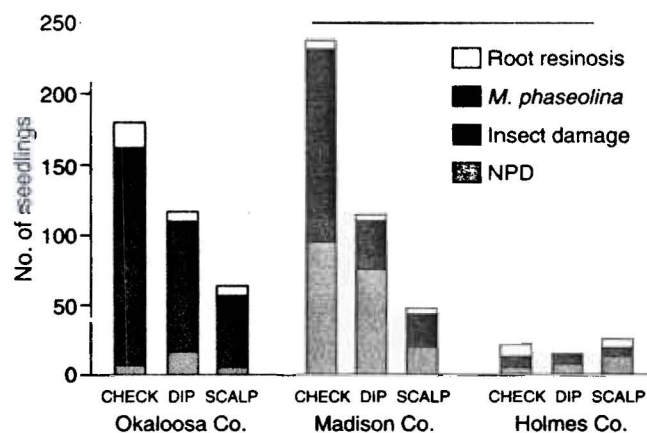


Figure 2—Relative incidence of first-year mortality of longleaf pine seedlings on pest-infested agricultural croplands in northern Florida and associated occurrence of root resinosis, microsclerotia of *Macrophomina phaseolina*, and insect feeding damage. Vertical scale indicates total number of dead and dying seedlings removed and assessed by treatment (CHECK = check, DIP = root-dipped, SCALP = scalped) through the first year following outplanting; total bar heights sometimes slightly higher than actual number of dead and dying trees since more than one pest indicator occurred on some trees. NPD = no pests or pest indicators detected.

of the root-dipped seedlings displayed microsclerotia, whereas these fungal structures were detected on 51% (121 of 236) of the check seedlings. In Holmes Co., where the numbers of seedlings examined was notably low, 11% (2 of 12) of the root-dipped seedlings exhibited microsclerotia of *M. phaseolina*, while 5% (1 of 18) of the check seedlings were counted as microsclerotia-positive.

No patterns or trends between the scalping treatment and the occurrence of root resinosis or microsclerotia of *M. phaseolina* on dead and dying seedlings were evident. Similarly, there were no apparent relationships between any of the treatments and the occurrence of the insect feeding damage detected on the dead and dying seedlings.

After two growing seasons, differences in survival, numbers of seedlings out of the grass stage [that is, seedlings ≥ 10 cm (4 in) in height], and height growth were clearly evident between seedlings planted in scalped and check rows (figure 3). Treatment differences were more pronounced on the Okaloosa and Madison County sites where pest pressures were high and performance of the check trees was relatively poor. However, performance of seedlings in scalped rows was consistently superior to that of the checks on all three sites.

Discussion

Results of this study clearly demonstrate the utility of scalping as a silvicultural practice when planting longleaf pines on similar pest-infested agricultural croplands. The marked improvements in survival and growth recorded for longleaf pine in this study closely parallel those recorded for slash pine in a larger and related study (Barnard and others 1995b). Results of the

current study also parallel results reported by Shoulders (1958). He reported that scalping improved survival of longleaf, slash, and loblolly (*P. taeda* L.) pines on grass roughs in central Louisiana. We believe that the improved seedling performance recorded in our study is the combined result of reduced weed competition, improved moisture relations, reduced pressure from certain pathogens (for example, *M. phaseolina*), reduced insect feeding damage, and probably improved planting efficacy (for example, facilitated operation of seedling planters on soil surfaces cleared of residual stubble and organic debris) (Barnard and others 1995b).

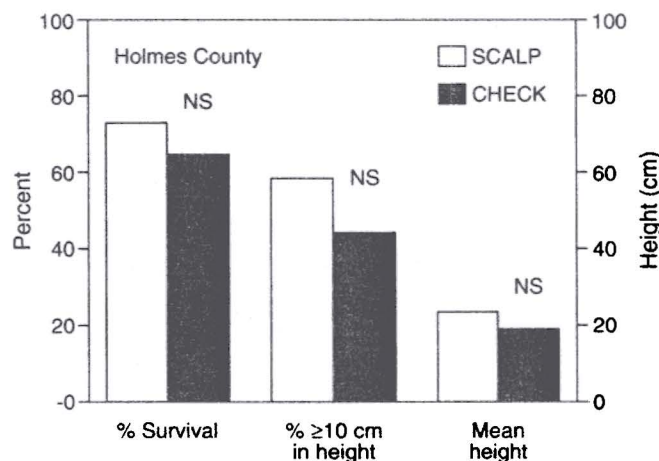
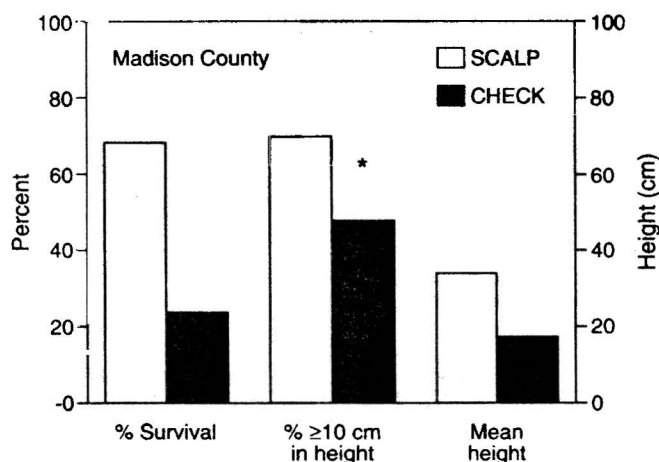
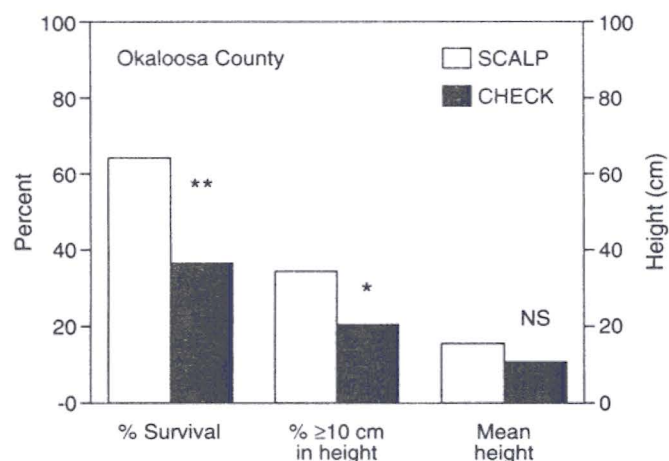


Figure 3—Comparative status of longleaf pine seedlings in check and scalped planting rows after 2 years on pest-infested agricultural croplands in northern Florida. Seedlings were considered out of the grass stage if their height was equal to or greater than 10 cm (4 in). Mean heights (3rd column pair) reflect heights of seedlings out of the grass stage (≥ 10 cm) only. Within each planting site paired bars reflect significant ($P \leq 0.05$), highly significant ($P \leq 0.01$), and non significant differences, where accompanied by *, **, and NS, respectively. Holmes County comparisons based on only four replications, because one replicate was inadvertently destroyed during the second growing season.

Benomyl root dips have shown variable, but generally positive, effects on the survival and growth of longleaf pine seedlings in the southern United States (Kais and others 1986a, 1986b; Kais and others 1981), in part due to their effects on reducing brown spot needle blight infections. In our study, brown spot was not a factor on any of the three study sites. Nonetheless, we observed significantly improved survival for seedlings root-dipped in the kaolin clay-benomyl slurry on two of our three study sites. This observation, coupled with the generally reduced frequency of root disease indicators (that is, root resinosis and microsclerotia of *M. phaseolina*) detected on dead and dying seedlings removed from root-dipped plots, suggests that the benomyl may have granted some protection from root pathogens. Similar observations and speculations were reported for similarly treated slash pine seedlings on the same sites (Barnard and others 1995b). The possibility requires further study for verification.

Even if the benomyl-kaolin clay root dip did provide protection for seedlings roots against soilborne root pathogens, it is clear that the overall efficacy of this treatment on our test sites was far less than that of scalping. Seedlings in scalped rows not only survived significantly better than root-dipped seedlings on two of our three sites (figure 1), they clearly grew better as well. Improving seedling performance on sites such as those used in our study requires mitigation of a variety of impeding factors including weed competition, insect feeding, etc. (Barnard and others 1995b). This is apparently provided by the scalping treatment.

Scalping has been routinely employed for silvicultural purposes on pasturelands and hayfields in Florida for many years with good success, and preliminary comparative statistics (Barnard and others 1995a) give this procedure high marks when compared to other site preparation practices. We recommend further trials and utilization of this procedure for improving regeneration successes with longleaf pine.

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