Precision Sowing Longleaf Pine Seed in Bare-root Seedling Nurseries

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ABSTRACT. Commercial vacuum precision seed sowers were modified to precision sow longleaf pine seed in two southern bare-root forest tree nurseries. Satisfactory seedling density and spacing for production of top quality seedlings can be obtained with the modified sower if seed purity is at least 95% and germination potential is at least 70%. Potential limiting factors encountered and suggestions for improvements are discussed.

ADDITIONAL KEYWORDS: Precision seed sowers, longleaf pine, seeder modifications, quality seed, quality seedlings.

Introduction

Longleaf pine (Pinus palustris Mill.) was previously the dominant tree species on approximately 60 million acres on the Southern Coastal Plain and Sandhills of Georgia and North and South Carolina (Croker 1987). This southern pine is well adapted to well-drained, deep, sandy sites. It is comparatively resistant to the fusiform rust fungus, Cronartium quercuum f. sp. fusiforme, grows to a large size, and produces wood of excellent quality for a variety of forest products (Wahlenberg 1946). However, there are only about 5 million acres presently forested in longleaf pine, and the species accounts for only about 2.5 percent (approximately 50 million seedlings) of the annual southern pine seedling production. Longleaf plantings have a recurrent history of failures primarily resulting from inferior seedling quality, protracted slow growth in the characteristic "grass stage", and the extreme susceptibility of seedlings to the brown-spot foliage blight (caused by Mycosphaerella dearnessii - Syn. Scirrhia acicola) during the grass stage (Cordell et al. 1989).

Recently, longleaf pine reforestation has received considerable attention. In addition, key components of longleaf pine seedling quality have been identified and Wakeley's (1954) seedling grading rules for this species have been expanded. Seedling morphological characteristics have been utilized to develop nursery management procedures for the consistent production of high-quality seedlings for increased field survival, reduced disease hazard, and increased growth (Cordell et al. 1989). Desirable characteristics associated with high-quality bareroot longleaf pine seedlings include a root collar diameter of at least 10 mm (0.4 in.), at least 6 primary lateral roots 2 mm or more in diameter, a highly fibrous root system, and a minimum of 25% of feeder roots ectomycorrhizal (Cordell et al. 1989).

Close control of seedling and row spacing are needed to produce a high proportion of seedlings with these characteristics (Hatchell, 1985). In addition to producing seedlings of uniform size, uniform spacing facilitates lateral root pruning which significantly increases root fibrocity and ectomycorrhizal development. The standard bare-root nursery drill on row spacing of 15 cm (6 in.) permits scheduled root pruning to promote maximum root and ectomycorrhizae development. Controlled spacing between seedlings promotes the development of larger root collar diameters and better quality seedlings (Scarbrough and Allen, 1954; White, 1981; Lauer, 1987; Cordell et al. 1989).

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Precision sowing of longleaf pine seed has been a problem in southern nurseries, however, because the seed shape is irregular and its accompanying wing is very difficult to completely separate from the seed. Longleaf seed has been sown by a variety of methods including both hand and machine broadcasting. At the USDA Forest Service Ashe, Mississippi nursery, a number of methods have been utilized in sowing longleaf pine seed during the 1980's. These included custom-built and modified commercial seeders. However, none of these seeders or methods have provided the desired longleaf nursery seedling density or spacing.

Methods

Only recently have precision seed sowers become available to forest tree nurseries in the United States. These machines pull a partial vacuum through specifically sized and spaced holes on a rotating drum or disc, which picks up and then drops individual seeds. A wide range of precise sowing rates can be obtained through adjustments to tractor speed, drum or disc rotation speed, and the vacuum pressure. Very precise spacing and density are possible with small to medium-sized seeds of high purity and germination capability (Lafluer 1986). Irregular shape caused by incomplete wing removal, low seed purity, and poor germination of longleaf pine seeds resulted in unacceptable seed sowing results with a standard Summit precision sower.

Consequently, the Summit seed sower was modified to accommodate the "irregularities" of longleaf pine seeds. The first requirement was to obtain high-quality seeds with 95 + percent purity and 70 + percent germination potential. Modifications to the Summit machine included the addition of an agitator in each seed hopper to minimize the "bridging" effect of the longleaf seed. The agitator also minimized seed "doubles" and promoted the attachment of single seed at each seed hole. A second modification involved custom-built seed drums to either sow 8 double offset rows per seedbed or 15 single rows per seedbed. A third modification involved the addition of a computer system for controlling seeding rates. This machine was purchased by the United States Department of Energy (DOE) for the production of high-quality longleaf pine seedlings at the Taylor SC State Nursery as part of a cooperative 5-year contract for forestation at the Savannah River Station (SRS), Aiken, SC. The supplemental modifications were made by the manufacturer in 1988.

Results

The modified summit sowers provided acceptable longleaf pine seeding results at two southern nurseries. At the Taylor Nursery, effective results were obtained in both 1988 and 1989. Using seed with a 70 percent germination potential, the actual seedbed density in 1988 and 1989 was 14 and 13 seedlings/ft2, respectively. Seed spacing within the offset double seed drill rows was also satisfactory. A single seed was sown in 75 percent of the planting spots. At the Ashe Nursery, all 15 seed rows were equally spaced at 3 inches apart and seed spacing within rows was sufficient to obtain the desired spacing within rows at least 75 percent of the time.

Using these two machines, seeds were operationally sown for approximately 10 million longleaf pine seedlings at these two nurseries during each of the 1988 and 1989 growing seasons.

Observations and detailed measurements showed that 90 +% of these custom-grown longleaf seedlings had root collar diameters of 10 + mm (.4 + in.) at harvest time. Spring and fall sowing dates were utilized at the Taylor, SC and Ashe, MS Nurseries, respectively.

Discussion and Conclusion

Although the modified Summit vacuum seeders were considered successful in controlling the density and spacing of longleaf pine seedlings in two bare-root nurseries, several factors must be considered for their operational application in southern nurseries.

First, the sowing must be done at a relatively low speed as compared to other seeders. Best success has been achieved between 0.75 and 1.0 mile per hour. Speeds in excess of 1.0 mile per hour may cause seeds to be thrown forward off the seed drum and nullify the controlled spacing. Because the rotational speed of the vacuum seeding drum may be varied relative to the tractor's ground speed, the drum's rotational speed must be calibrated and maintained with the most effective seeding at 20 to 25 rpm's. If the drum rotates too slowly, there is insufficient agitation in the hoppers and seeds often are not picked up by the vacuum drum. If the drum rotates too fast, seeds may be thrown over the drum onto the ground by momentum rather than being picked up singly by the holes in the drum. This is a highly significant factor when the seeder is moving down a slope greater than 1%. As with all vacuum precision seeders, the operator must concentrate on seed placement (quality) rather than sowing speed (quantity).

Second, seed agitation in the hoppers is required for precision sowing of longleaf pine with a vacuum seeder. Unlike loblolly and slash seeds, longleaf seed will not be picked up by the vacuum drum without agitation. Because of their odd shape and the partial wings, longleaf pine seeds tend to interlock and bridge in the hopper. Efforts to precision sow longleaf seeds without agitation have always failed. Agitation in the seed hoppers has also been found to be most effective when the vacuum drum is running between 20 and 25 rpm's and with the oscilating agitators extended about 2.5 mm (1 in.) deep into the seeds.

Third, vacuum pressure must be adjusted and monitored to consistently pick up single longleaf seeds on the vacuum drum. If the pressure is too low the seeds will not be picked up. If the pressure is too high, more than one seed will be picked up by each vacuum hole, and two or more seeds will fall at each seed location on the bed. Whenever the rotational speed of the seeding drum is changed, the vacuum must also be checked and adjusted as needed. The desired vacuum may also change when different seed lots with different size and shape seeds are sown.

Fourth, the seeds must be as clean and have as high germination as possible. Debris and trash is picked up by the vacuum seeder and sown the same as seeds. Because longleaf seeds cannot be totally dewinged, they should be rescalped just prior to sowing to remove any newly broken wings. Seed germination potential should be at least 70% to obtain satisfactory sowing results. Attempting to sow seeds at high rates to compensate for poor germination potential generally results in poor seedling spacing.

Although the longleaf pine seeding results were generally satisfactory, there are opportunities for additional improvements. A consistent supply of longleaf seed from the proper source and with high purity (95 + %) and seed germination potential of 70 +% is urgently needed. Without quality seeds, it is virtually impossible to obtain adequate spacing of longleaf pine. Additional modifications are also needed to the vacuum seed drum including attachments to improve the seed pickup and singulation on the holes.

Finally, a more effective and less-destructive method of dewinging longleaf pine seeds would be highly beneficial in obtaining even more precise seed sowing results.

Literature Cited

Cordell, C.E., R.L. Anderson, and A.G. Kais. 1989. How to identify and control brown-spot disease on longleaf pine. USDA For. Serv., Region 8, Atlanta, GA. Protection Report R8-PR15. January, 1989. 9 p.

Cordell, Charles E., Glyndon E. Hatchell, and Donald H. Marx. 1990. Nursery culture of bare-root longleaf pine seedlings. In: Proceedings of the Symposium on the Management of Longleaf pine. April, 1989. Southern Forest Experiment Station, USDA Forest Service, New Orleans, LA. General Tech. Rpt. 5075. pp. 38-51.

Croker, T.C., Jr. 1987. Longleaf pine: a history of man and a forest. USDA For. Serv., For. Rept. R8-FR7, Atlanta, GA. 37 pp.

Hatchell, G.E. 1985. Nursery cultural practices affect field performance of longleaf pine. In: Proceedings of the International Symposium on Nursery Management Practices for the Southern Pines. Auburn University, AL, and Union of Forest Research Organization. pp. 148-156.

Lafleur, L. 1986. Bare-root nursery precision seed sowing. Canadian Forestry Service Research Note. pp. 19-20.

Lauer, Dwight K. 1987. Seedling size influences early growth of longleaf pine. Tree Planters' Notes 38:(1).16-17.

Scarbrough, N.M. and R.M. Allen. 1954. Better longleaf seedlings from low density nursery beds. Tree Planters' Notes 18:(1).29-32.

Wahlenberg, W.B. 1946. Longleaf pine. First edition. Charles Lathrop Pack Forestry Foundation, Washington, DC. 429 pp.

Wakeley, Philip C. 1954. Planting the southern pines. USDA For. Serv. Agric. Monograph No. 18 233 pp.

White, J.B. 1981. The influence of seedling size and length of storage on long-leaf pine survival. Tree Planters' Notes 32:(1) 3-4.