LIFTING FOREST TREE NURSERY CROPS--AN OVERVIEW

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Abstract--Filling seedling orders with high quality stock is one of the most demanding jobs of the nursery manager. Seedling quality, defined by field performance, is greatly influenced by the timing and methods of lifting. To ensure quality seedlings, lifting must: 1) retain the maximum amount of roots and mycorrhizae, 2) avoid damage to roots and tops, and 3) prevent seedlings from drying out or becoming hot.

Additional keywords: root pruning, root growth potential, Southern pines (Pinus spp.)

INTRODUCTION

The lifting season presents a serious dilemma to many nursery managers. On one hand, success of the seedlings in the field depends on maintaining their quality from nursery to planting site. On the other, millions of seedlings must be lifted, processed, and packaged in a relatively short time during a season having rapid and often unpredictable weather changes.

Before lifting, treatments such as moisture stressing and root pruning may be applied to improve quality and make lifting easier. In terms of seedling quality, the most important aspects of lifting are timing and method. The timing of lifting greatly influences both the morphological characteristics and physiological condition of the seedlings. Lifting methods include various machines that either loosen seedlings for subsequent hand lifting or remove seedlings from the nursery bed and position them for further processing.

LIFTING AND SEEDLING QUALITY

Pre-lifting treatments

The nursery manager has several techniques available to help condition seedlings for lifting. The most common of these are reducing or withholding water and fertilizer and root culture, particularly undercutting and wrenching. The objective of these treatments is to stop shoot growth and induce dormancy.

Perhaps the most effective conditioning treatment is to impose moderate moisture stress in seedlings. Wakeley (1954) recommended the practice, and recently Hennessey and Dougherty (1984) demonstrated the beneficial effects of moisture stress on seedling morphology and physiology. During August and September they stressed loblolly pine (Pinus taeda L.) seedlings by not irrigating them until the pre-dawn plant moisture stress level exceeded 7.5 bars as measured with a pressure chamber. When compared with well-watered stock, the stressed seedlings were shorter, and had larger caliper and greater root growth potential (RGP) when lifted the following January.

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Undercutting, either repeated or followed by wrenching, is an alternative to withholding water and yields similar results (Mexal and Fisher 1984). Undercutting also increases root fibrosity and improves field survival and growth of loblolly pine (Tanaka et al. 1976). The common practice of top pruning does not improve crop uniformity by releasing small seedlings, it merely reduces the height of the very tall seedlings (Mexal and Fisher 1984). Lateral root pruning may be done along with undercutting or wrenching to encourage root development or may be done just before lifting. When done just before lifting, lateral root pruning makes lifting easier and probably reduces root loss and damage.

Lifting date has serious implications for seedling quality. Although height growth may stop and buds set by October, seedlings may continue root and diameter growth and will continue to accumulate dry weight throughout the winter. Seedlings will also undergo continuous changes in physiological condition during the fall and winter when there are no visible signs of growth. Dierauf (1976) showed that early lifted loblolly pine seedlings do not store well and need to be planted within a day or two after lifting to get adequate survival. Loblolly pine seedlings have a chilling requirement that must be met before they can be released from dormancy and exhibit normal budbreak the next spring (Garber 1983). This chilling requirement is met in the late fall, and its length varies with geographic seed source and with half-sib family (Carlson 1985).

Carlson (1985) also showed that physiological condition affects RGP and storability of loblolly pine seedlings. Storage for 21 days depressed RGP of November-lifted seedlings, but it had no effect or improved RGP of January-lifted seedlings. Although the data are not as conclusive, lifting after bud activity begins in the spring is also detrimental to seedling storability (Garber and Mexal 1980).

Once an appropriate lifting season is determined, weather and soil conditions must be monitored. Lifting during freezing weather or when the temperature is high and the relative humidity is low can damage seedlings. The North Carolina Division of Forest Resources has developed standards for lifting and handling seedlings (Jeffries 1983). These standards specify under what weather conditions lifting must cease and what precautions should be taken under suboptimal conditions. Soil texture and moisture also affect the root quality of lifted seedlings. Seedlings are more difficult to lift properly from heavy-textured soils or from soils that are too wet or too dry.

Methods of lifting

Various machines are used to lift seedlings from nursery beds. Some machines only loosen seedlings from the soil; they are then picked up by crews. This is termed "hand lifting." "Machine lifting" uses equipment that not only loosens seedlings but also transports them to a crew of handlers who separate and process them. Lifting machines--or seedling harvesters--either lift the whole bed width on a moving conveyor or lift individual drill rows and transport the seedlings between counter-rotating belts. Belt lifters may lift one, two, or all eight drill rows at a time. Seedling harvesters can lift 400,000 to 1 million seedlings per day (May 1985).

During lifting, by hand or by machine, soil is shaken or knocked from the root systems. Although soil removal is necessary, it invariably results in some loss of roots and mycorrhizae. Loss of root mass adversely affects seedling quality. Loss of lateral roots reduced survival of both slash pine (P. elliottii Engelm.) and longleaf pine (P. palustris Mill.), especially when the seedlings were planted on a droughty site (Wakeley 1954). The root loss also reduced the subsequent growth of the surviving longleaf pines. In a recent study comparing the effects of machine lifting with hand lifting, slash pine seedlings from three of four nurseries studied survived better when carefully hand lifted than when machine lifted (Barnard et al. 1981). Hand lifting by research investigators, however, is not comparable to hand lifting by nursery crews under production pressures. Most nursery managers and researchers believe that, with soil conditions being similar, mechanically lifted seedlings retain a greater proportion of fine roots than do operationally hand-lifted seedlings. Root volume is critical in determining RGP of loblolly pine and also for water uptake after outplanting but before new root growth (Carlson 1986). Much of a seedling's root volume is in secondary and tertiary lateral roots--those most easily damaged during lifting. Fine roots are also easily damaged by temperature extremes and/or dry conditions.

Root exposure between lifting and planting reduces both survival and growth of bare-root stock. Based on the results of several studies with southern pine seedlings, Wakeley (1954) recommended that root exposure be kept as much below 10 minutes as economically possible. Few data are available to explain why exposure can cause mortality. However, in Sitka spruce (Picea sitchensis (Bong.) Carr.), root exposure lowered moisture content of foliage and roots, resulted in higher plant moisture stress after planting, and reduced both root and shoot growth, as well as field survival (Coutts 1981). Furthermore, these effects were greater on seedlings that had either active root or shoot growth than on seedlings in a post dormant condition; i.e., the chilling requirement was met.

Most southern pine nurseries package seedlings for shipping and storage in a packing shed. During lifting, seedlings are put into tubs or canvas slings, so their roots are protected until they are packed. One method of minimizing root exposure and desiccation is to pack the seedlings on the lifting machine. Several variations of this field packing concept are in use. One field packing operation was discussed in detail by Simms (1983).

Numerous studies with the southern pines and with other species around the world consistently point out the relationship between high seedling quality and good field performance. Unlike most nursery practices that can be corrected if problems arise, seedlings get no second chance after lifting. Adoption and diligent application of high quality control standards are the best insurance for preserving seedling quality during lifting. Regardless of the timing or method of lifting, attention must be directed to: 1) retaining the maximum amount of fibrous roots, 2) avoiding damage to roots and tops, and 3) preventing seedling roots from drying out or becoming hot (Brissette et al. 1983).

PRODUCTION CONSTRAINTS DURING LIFTING

Although preserving seedling quality should be the nursery manager's goal

throughout the lifting season, other factors will also require constant attention. The nursery must be responsive to its customers, whether they are part of the same organization, a contract buyer, or a private landowner. These customers need to understand the problems they cause by changing requested delivery dates or numbers of seedlings ordered. The nursery manager must understand that planting schedules cannot always be adhered to and that the greater the distance from the nursery, the more difficult coordination becomes because of weather differences between the two locations. Communication and flexibility are both necessary to ensure good working relations between the nursery manager and the customer.

The size and nature of the crop will also influence how the lifting operations will be conducted. The number of species and seedlots, and how many seedlings of each species are in each seedlot will determine the labor and equipment needs. For example, longleaf pine and many hardwoods cannot be lifted with a belt lifter. Also, some species require more time to lift because of lower densities, size, or other characteristics. These factors must all be considered, along with the effective lifting season (accounting for anticipated lost time for weather and equipment breakdowns), to determine daily or weekly production requirements. The capacity for cold storage, either at the nursery or in the field, will influence lifting schedules. Some factors already discussed, such as the dormancy status of the crop, soil type, and soil moisture conditions are managerial considerations as well as seedling quality constraints during lifting.

Unavoidably, there will be some conflicts between the nursery and the field requiring compromises. There will be days when the weather or soil conditions are marginal for lifting. There will be other times when crew or equipment problems cause delays, followed by attempts to catch up. When demands do cause compromises and seedling quality is involved, good supervision and quality control are essential to minimize the impacts.

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