GERMINANT REFORESTATION: A TECHNOLOGY FOR MINE SPOIL RECLAMATION[3]

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Abstract.--Germinant reforestation is a technology where pine seedlings, less than ten days old, are outplanted in cylindrical mesh containers. Cost is comparable to greenhouse-grown containerized seedlings, however plantability is improved on sites too difficult for planting with either containerized or bare-root stock.

INTRODUCTION

Planting trees on mine spoils is generally more challenging and less successful than reforestation or afforestation of areas primarily managed for forest production. Spoils characteristically have a harsh environment, and planting success is often poor. The low survival is associated with droughty conditions and the difficulty of planting in the rocky materials. Mine spoils are typically low in organic matter and low in available nutrients, and may even have chemically detrimental conditions. In some areas, containerized conifer seedlings grown in the greenhouse for 3 to 4 months have been shown to be successful on coal-mine spoils and other difficult sites (Buchanan 1974, Davidson and Sowa 1974A, 1974B, and Barnett 1983). Containerized seedlings have also been shown by several workers to be more successful than bare-root nursery stock but the cost is generally much higher.

An alternative method of planting mine spoils was described by Anderson and Williamson (1974) in Southern California. They planted newly germinated Coulter pine (*Pinus coulteri*) seeds on a mine site and found survival to be 2 to 3 times better than that of bare-root seedlings and considerably less expensive. The seed was germinated on vermiculite-filled flats and planted when the radicle length ranged between 1.2 and 3.8 cm. One hundred of the germinated seed could be planted per hour as compared to 20 nursery seedlings in the same time. DeVelice and Buchanan (1974, 1978) used the germinated seed technique for a reforestation project in New Mexico using ponderosa pine (*Pinus ponderosa*). Nine day old seedlings were planted when radicle lengths ranged between .25 and 4.75 cm and they found seedling survival to average slightly over 33 percent at eight locations. In these studies, where germinated seed was used, the authors recommend that the young seedlings be covered by a screen cap to protect them from bird and rodent depredation.

Since 1978 the use of germinated ponderosa pine seedlings have been studied at New Mexico State University as a reforestation method for the southwest. The seedlings are called GERMINANTS. This paper is a description of how germinant technology could have application for the reforestation or afforestation of mine spoils.

TECHNOLOGY

Since 1978 a variety of methods at New Mexico State University have been developed and tested to more economically plant the germinant. One of the greatest challenges has been to devise a system that will provide inexpensive protection of the seedling during the first year. The method now recommended has been successfully used since 1984. Basically the germinant is grown in a cylindrical mesh tube that is half filled with substrate. The upper half of the tube is above ground to protect the seedling and the lower half is planted so the substrate is flush with ground level. A germinant is actually a 6 to 9 day old containerized seedling that is planted with the container.

The containers used are called Rigid Seedling Protection Tubes which are available from Reforestation Suppliers Inc., Eugene, Oregon. The size of tube available is almost limitless, the ones used for ponderosa pine germinants are 2.5 cm diameter and 15 cm long. The tube is made of plastic that will decompose in about 2 years. The substrate used is produced by Germinant Technology Inc., Las Cruces, New Mexico. Seeds are germinated in the half-filled tubes in growth chambers for 6 to 9 days and then transferred to the field planting site. The planting can be accomplished by using either a dibble for rock-free soils or small pick, hoe, or rock hammer on the more rocky soils. A small cavity 7 to 8 cm deep is created, and the containerized germinant is planted by placing the tube vertical in the cavity and then back-filling soil until the surface is flush with the top of the substrate.

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STUDIES

During the past ten years numerous studies have been conducted by New Mexico State University evaluating germinant reforestation. Early studies centered on the use of bare-root germinants. The main limitation to the bare-root germinant was effectively protecting the seedling from rodents and birds during the first year. The half-filled containerized germinant method was attempted a few times but was first used successfully in a study conducted in 1984. In this study ponderosa pine germinants were compared to 6 month greenhouse-grown containerized seedlings. The study conducted in the Sacramento Mountains of south central New Mexico involved planting a total of 4800 seedlings on a three hectare plantation. Survival was always higher for the containerized seedlings than the germinants but the Cost Of Surviving Trees (COST) was nearly the same for seedlings given similar treatments of site preparation and predator protection. The COST of planting bare-root nursery stock has been nearly $3.00 [1] and the COST estimated for the "best" treatment in the 1984 study ranged from $0.96 to $0.70 for germinants and containerized seedlings, respectively.

In 1985, a seven hectare plantation, nearby the 1984 study, was planted with a total of 11520 ponderosa pine germinants. The planting area was a location where bare-root nursery and conventional container stock normally can not be planted because the soils are very shallow and rocky. The survival of germinants one year after planting, averaged 20 percent at a COST of slightly less than $1.00.

Germinants planted by the Forest Service [2] in 1986 were purchased in small quantities at $255.00/M and were hand planted at an average rate of 40 per hour on what were considered difficult sites.

ADVANTAGES

Use of the germinant method allows several advantages over other reforestation methods.

Since germinants are less than 10 days old, they can be produced very rapidly, thus creating a short lead-time for the initiation of a planting operation. Because they are produced in growth chambers, germination requirements are controlled for sensitive species and can be made available any time of the year. The range of seedling types is almost unlimited and seed efficiency is greatly enhanced. Their ease of planting allows more to be out-planted during a planting window, than methods that are more labor intensive. The system also has the capability of being automated when sites are accessible.

The germinants are well adapted for planting in rocky and/or shallow soils where planting is difficult and seedlings are often planted incorrectly. In some instances germinants have been planted 2 to 3 times faster than bare-root or containerized seedlings on these soils.

LIMITATIONS

Germinants like any method will have disadvantages and often common sense will avoid many of the pitfalls.

One of the most important considerations is protection from the rodent and bird depredation. Total failure results for planting unprotected seedlings while seedling protection has made the system economical. Initial cost of germinants is generally cheaper than container grown stock but more expensive than bare-root nursery stock. The best evaluation is the actual COST. Planting is not recommended if freezing temperatures are expected to occur within 30 days after planting.

The production of germinants does require a growth chamber that will optimize the seedling germination requirement and substrate use is more economical if the seed germinates uniformly and without disease.

RECOMMENDATIONS

Germinant reforestation like any technology is not the ultimate system for every condition. The method has been effective in the southwest for the planting of what have been considered difficult planting sites, that were formerly forested. The system has advantages and limitations, and these must be considered for the areas intended for application.

Germinants are recommended for rocky sites. Containerized seedlings often will perform better than germinants on deep relatively rock-free soils. Germinants are inexpensive and easy to plant but difficult to effectively protect from depredation. Containerized germinants afford protection from rodents and birds during the first 1 to 2 years. This system can be adapted for most any species planted, and as a total system is comparable in cost to other methods. Germinant reforestation has greater flexibility than present methods and when coupled with good management, it can be an effective reclamation tool. However, the technology will probably always be considered a little *radicle:*

[1] USDA Forest Service Estimated COST for Lincoln National Forest, southcentral New Mexico, 1980. Personal Communication.

[2] USDA Forest Service, Lincoln National Forest, Cloudcroft district, Cloudcroft, New Mexico.

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