Chemical Root Pruning of Conifer Seedlings in Mexico

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Abstract

Many countries grow seedlings for reforestation in polybags where root spiraling and root egression can decrease seedling survival and growth following outplanting. The overall objectives of this study were to investigate the effect of chemical root pruning on root spiraling, root egression, and nursery performance of *Pinus pseudostrobus*, *P. montezumae*, and *P. greggii* seedlings and in addition, evaluate the effect of morphological characteristics of those seedlings on survival and field performance after outplanting. This research was carried out in 2 nurseries located at New Mexico State University, Las Cruces, New Mexico, and at Colegio de Postgraduados in Montecello-Texcoco, Mexico. Seedlings were grown either in SpinOut®-treated or untreated polybags. Additionally, cultural practices such as growing mixtures and drainage design were also evaluated. In general, seedlings grown in copper-treated polybags had greater height, root collar diameter, and biomass production. Copper treated polybags practically eliminated root spiraling at the bottom of polybags and consistently had less root egression from the bags. In many cases, seedlings exposed to copper had higher root:shoot ratios because of less root egression. Among the treatments evaluated, the combination of copper-treated polybags and copper-treated cloth was one of the best, possibly because this treatment eliminated root spiraling and root pruning is an important cultural practice that can be used under traditional production systems in Mexico to improve seedling quality and consequently improve field performance.

Key Words

Polybags, seedling production, seedling quality

During the last three decades deforestation has become one of the most important ecological problems in Mexico. To counteract this problem, the Mexican government recently has implemented an aggressive reforestation program, including the planting of more than two hundred million seedlings of different species each year. However, more than 60% of those seedlings are still produced under the traditional production system using polybags. In this production system, problems related to poor drainage media, root egression, and root system malformations are common.

Most nurseries in Mexico still use forest soil as the principal component of the growing medium for polybags (Sánchez-Velázquez 1995; Mexal 1997). Sometimes this medium is amended with sand or with small portions of other components but often is used without any amendments. Furthermore, this medium is heavy and often creates a compacted and poorly drained rooting environment, which further reduces root development within the bag (Mexal and others 1994; De la Garza-López 1995).

Root egression is another common problem in the polybag production system. In general, seedlings in polybags are grown side-by-side on the ground. Under these conditions, roots escape the polybags through drainage holes and grow into the soil. These plants utilize the nursery moisture and nutrient runoff in the soil below the bags and therefore grow faster. However, at harvest

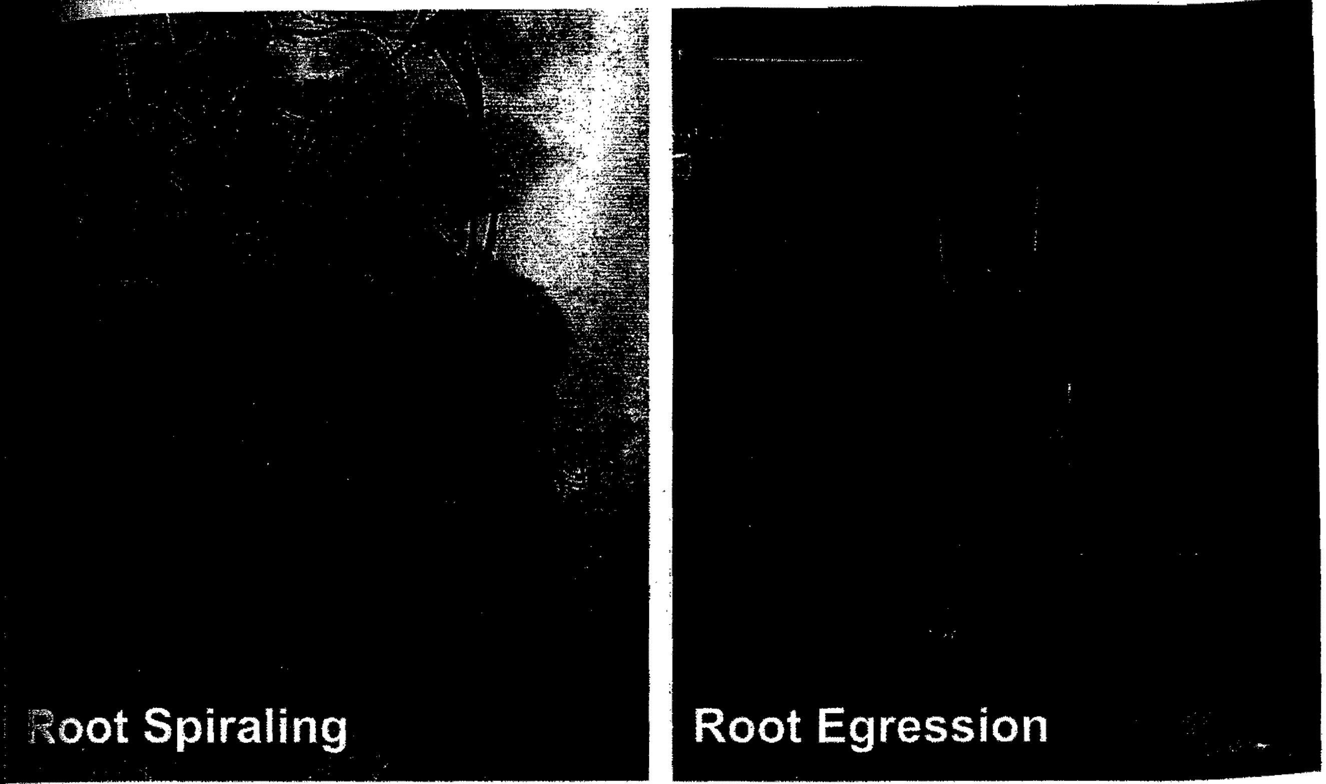

Figure 1. Root spiraling at the bottom and root egression are two common problems associated with the traditional nursery seedling production using polybags.

roots are torn from the plant and left in the nursery beds. Thus, many plants are shipped to reforestation sites with damaged, deformed, or poorly developed root systems that can decrease outplanting survival and growth (Stein 1978). This is a common problem throughout Mexico, even though nursery manuals (Patiño-Valera and Marín-Chávez 1993) recommend lifting the bags to prune the escaping roots at regular intervals. However, few nurseries actually do it.

Nursery production systems using polybags have been also traditionally linked to root system malformations (Josiah and Jones 1992). Furthermore, polybags are considered as poor containers to produce quality seedlings by some (Venator and others 1985). Polybags promote lateral root spiraling and taproot deformation (Figure 1). Container walls tend to change the natural development of lateral roots resulting in malformations that may affect the future development of the plants (Arnold 1996). Therefore, seedlings that develop spiraled root systems may grow poorly some years after outplanting (Bell 1978).

Nursery techniques that produce well-developed, fibrous root systems contribute to overall improved seedling survival and growth (Struve 1993). In natural settings, many conifers develop a lateral root system near the surface (Stein 1978). These roots improve the anchoring and stability of the tree (Burdett 1978) and provide sites for mycorrhizal infection because of their proximity to the soil's microorganism-rich organic layer (McDonald and others 1984). For nursery-grown seedlings, the number and distribution of lateral roots is positively correlated to outplanted seedling performance (Mexal and Burton 1978).

One cultural practice that has been successfully used to control root development and to reduce root malformations is chemical root pruning (McDonald and others 1984; Arnold and Young 1991; Schuch and Pittenger 1996). The application of copper to the interior of containers avoids malformations of the root system and promotes the growth of new lateral roots (Struve and Rhodus 1990). Chemical root pruning using copper treated containers has been documented for many species (Struve and others 1994; Armitage and Gross 1996; Arnold 1996; Crawford 1997) grown principally in United States and Canada. However, little work has been done with chemical root pruning using polybags.

The overall objectives of this study were to investigate the effect of chemical root pruning on seedling quality and nursery performance of *Pinus pseudostrobus*, *P. montezumae*, and *P. greggii* seedlings, and evaluate the effect of morphological characteristics of those seedlings on survival and field performance after outplanting.

The Study

This research was carried out in nurseries located at New Mexico State Unversity, Las Cruces, NM and at Colegio de Postgraduados in Montecillo-Texcoco, Mexico. Three important Mexican pine species, *Pinus pseudostrobus*, *P. montezumae*, and *P. greggii*, were included in this study. Seedlings were grown either in SpinOut®-treated or untreated polybags. Griffin Corporation (Valdosta, GA) provided all polybags. The active ingredient in SpinOut® was copper hydroxide ($Cu(OH)_2$) at a concentration of 7.1%. In addition, other cultural practices such as different growing mixtures and drainage design were also evaluated.

We used two different sizes of polybags: 20 X 10 and 22 X 16 cm where the first dimension is the length and the second is the width of the flattened bags. Thus the width is one half of the circumference. The experiments at New Mexico State University used a commercial medium, Metromix® 702 (50% to 60% composted pine bark fines, 15% to 25% Canadian sphagnum peat moss, 10% to 15% medium grade horticultural vermiculite, and 5% to 15% horticultural perlite). In the case of the experiments established in Mexico, local materials such as forest soil and sand were used in different proportions.

The experimental designs varied according to the objectives of each individual experiment but for all experiments the variables evaluated were survival and the morphological parameters height, root collar diameter, root volume, root dry weight, and shoot dry weight. Shoot and root dry weights were determined after seedlings had been oven dried for 72 hours at 60 °C (140 °F). In some of the experiments, one half of the seedlings produced from each treatment were used for outplanting trials.

Results

Root systems of seedlings produced in copper-treated polybags were visibly more fibrous than non-treated seedlings. These results agree with earlier studies in other species (Wenny and others 1988, Arnold and Struve 1993). More importantly, copper-treated polybags effectively minimized root spiraling and root egression from the polybags. This may help explain the increase in root dry weight for the three species with copper treatment, since most of the roots were kept inside the polybags resulting in a more uniform and efficient distribution of the roots throughout the growing media. In this way, seedlings were able to acquire nutrients and water more efficiently resulting in growth increases. Similar results were found for different species of conifers (Beeson and Newton 1992; Dumroese and Wenny 1997) and hardwoods (Arnold and Struve 1993; Schuch and Pittenger 1996).

For the three species, copper-treated polybags improved morphological characteristics (for example, root collar diameter), which have been linked to outplanting success for bareroot seedlings (Mexal and Landis 1990). Increases in root collar diameter and biomass in combination with reduction or elimination of root spiraling and root egression may also increase the possibility of survival and successful establishment of polybag seedlings after outplanting. Biomass production was improved for all the species produced in copper-treated polybags. For *P. greggii*, there was an increase in height, root collar diameter and root:shoot ratio, for *P. pseudostrobus* there was an increase in root collar diameter and root:shoot ratio, but for *P. montezumae* root collar diameter was increased.

In the case of drainage patterns evaluated for [illegible] *pseudostrobus* and *P. montezumae*, the results [illegible] show a clear tendency. This may result from [illegible] growing medium used for this study. The [illegible] not only had good drainage but also high [illegible] retention capacity. This could be the reason [illegible] even in the more restricted drainage pattern [illegible] accumulation, and thus drainage problems [illegible] avoided. On the other hand, polybags with [illegible] other extreme of drainage patterns (open [illegible] did not show any problems due lack of water. However, in the case of *Pinus greggii* produced in Mexico using traditional growing medium (forest soil amended with different proportions of sand), there was a significant interaction between chemical root pruning and the media used to produce the seedlings. In general, chemical root pruning works well with mixtures containing good drainage. On the other hand, when media drainage was poor, no differences were found between copper-treated and non-treated seedlings. In addition, drainage design significantly affected the morphological variables evaluated. In general, the more drainage the better the nursery performance of the seedlings.

CONCLUSION

Seedling quality can be improved by applying suitable cultural practices during nursery production. These practices, such as chemical root pruning, directly impact the root system resulting in an improvement in seedling quality. It is easy to assume that developing a better root system of the seedlings may increase the opportunity of these to survive after outplanting, and it is possible that increasing seedling survival may help in decreasing the deforestation rate in Mexico.

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