Mexican Conifers' Response to Fertilizer Type Indicates Difference Between Value and Cost

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Mexican forest nurseries produce most seedlings in polyethylene bags containing forest soil. Fertilization practices often are imprecise and use an expensive, slow-release formulation. The objective of this study was to evaluate alternative fertilizer practices using two Mexican conifers: Pinus douglasiana *Mart. and* P. pseudostrobus *Lindl. Seedlings were fertilized with Osmocote™; Peter's Conifer Grow™; and Picomodulus™, a slow-release formulation common to many nurseries in Mexico. The controls were seedlings that were not fertilized.* Pinus pseudostrobus *responded to all fertilizers equally. There was no difference in seedling diameter, dry weight or root to shoot ratio.* Pinus douglasiana, *a species with a seedling grass stage, responded best to Osmocote and Picomodulus. However, of the three fertilizer types, only fertilization during irrigation (that is, "fertigation") with Peter's Conifer Grow resulted in seedling nitrogen contents greater than 2%. Seedlings responded to nitrogen fertilization at least 300 days after seeding, indicating that nursery managers can compensate for inadequate fertilization by instituting a fertilization program at almost any time. With little difference in response, managers should use the most cost-effective fertilization method.* Tree Planters' Notes 46(4):126-129; 1995.

Fertilization is an integral component of nursery production, and nitrogen is the most important nutrient for maximum benefit (Fisher and Mexal 1984). Switzer and Nelson (1963) found that loblolly pine *(Pinus taeda* L.) seedlings required about 120 mg of nitrogen for maximum growth and yield. Furthermore, fertilization effects last well beyond the nursery phase. Increased seedling size and nutritional status increase seedling survival and growth. Van den Driessche (1982) found survival of Douglas-fir *(Pseudotsuga menziesii* (Mirb.)

Franco) was best when seedling nitrogen content was *2%.* Furthermore, Autry (1972) showed that the residual, fertilizer-induced size differences in seedlings resulted in size differences 16 years after outplanting. South and others (1988) found that nursery effects lasted 30 years after outplanting. Thus it is conceivable that nursery fertilizer responses could last throughout a plantation's life.

Although fertilization is important biologically, it is almost insignificant economically. Fertilizer accounts for only 0.03% of container seedling production cost (Landis and others 1995). Thus, the long-term benefits of a well-planned fertilization program can be attained at practically no cost.

Much of the published information on fertilizer response of timber species is based on nurseries in the United States and Canada There is little published information about fertilizer response of timber species native to Mexico. Most seedlings grown for reforestation in Mexico are grown in plastic bags with native forest soil as the growing medium, and many nurseries rely on the inherent fertility of these soils. Consequently, fertilizer use in Mexican nurseries ranges from none to using expensive soluble or slow-release fertilizers (table 1). There is little indication that commercial, agriculturalgrade fertilizers are used in nursery production. The wide range in fertilizer use across nurseries results in a wide range in subsequent seedling size and quality. The objective of this study was to evaluate the response of two Mexican timber species to different fertilization types.

The species selected— *Pinus douglasiana* Mart. and *P. pseudostrobus* Lindl.— are important timber species in central and southern Mexico (Perry *1991). Pinus douglasiana* is found primarily in the states of Guerrero, Jalisco, and Michoacan, between 1,500 and 2,500 m. *Pinus pseudostrobus* is found further east in the states of Hildago, Michoacan, Mexico, Puebla, and Tlaxcala. It grows between 1,600 and 3,200 m. Both species can attain heights of 35 to 40 m. *Pinus douglasiana* has a "grass stage" as a seedling.

Table 3- *Seedling morphology and nutrient content after 145 days under different nutrition treatments*

Species & treatment	Height (cm)	Diameter (m m)	Dry weight Shoot (g)	Root (g)	R/S	Nitrogen (%)	Phosphorus (%)	Potassium (%)
P. pseudostrobus								
Control	2.8 a	0.92 a	0.14 a	0.12 a	.90 a	0.50	0.21	1.37
Conifer Grow™	20.7 c	1.71 b	0.59 b	0.29 b	.50 b	2.19	0.27	1.12
Osmocote™	20.3 c	1.84 b	0.60 b	0.29 b	50 b	1.62	0.20	0.99
Picomodulus™	15.7 b	1.69 b	0.56 b	0.33 b	.61 b	0.86	0.16	0.77
*P. douglasiana**								
Control	-	1.46 a	0.16 a	0.14 a	.77 a	0.44	0.20	1.05
Conifer Grow™	-	1.90 b	0.52 b	0.18 b	.35 c	2.01	0.28	1.51
Osmocote™	-	2.03 bc	0.57 b	0.22 bc	.40 bc	1.55	0.26	1.45
Picomodulus™	-	2.18 c	0.51 b	0.24 c	.48 b	1.06	0.24	1.26

Values followed by the same letter are not significantly different (P=.05).

*Seedling with grass stage.

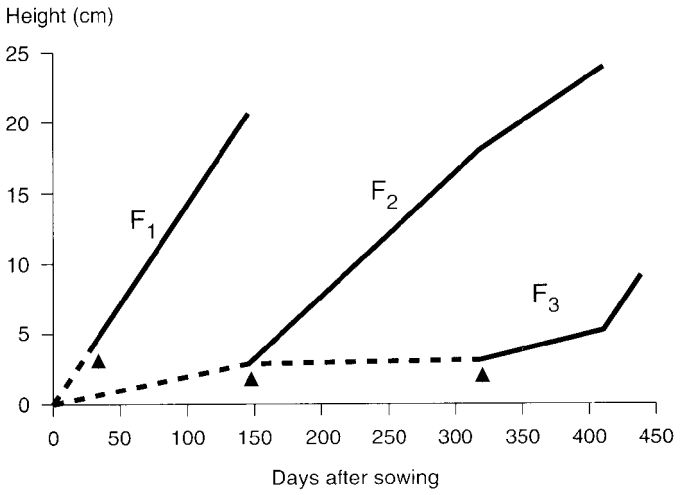

Figure 1— *Height growth of* Pinus pseudostrobus *seedlings in response to fertilization. The initiation of fertilization is indicated by an arrow.*

also responded to fertilization, although the growth rate appeared to be slower. Seedlings fertilized from seeding grew at 1.4 mm/day. Seedlings fertilized after 150 days grew only 0.8 mm/day during the fertilization period, and seedlings fertilized after 324 days grew only 0.5 mm/day during fertilization. Although seedlings maintain the ability to respond to fertilization, the level of response is greatest if fertilization begins shortly after emergence.

Implications

There was little difference in the biological response of these two species to different types of fertilization. 1n fact, both species responded similarly in spite of different growth habits. However, the cost of these fertilizers vary considerably (table 1). Obviously, there is no fertilizer cost associated with a lack of fertilizer, but a different price is paid in poor seedling growth. Granular fertilizers are the least expensive (<N$10/kg N). The commercial fertilizers used in this study range in price from N$100/kg N for Peter's Conifer Grow, to N$122/kg N for Osmocote and more than N$800/kg N for Picomodulus. With no biological difference in response, there is no need to use limited financial resources on a fertilizer costing nearly 7 times more than more cost-effective alternatives. The actual cost per seedling for the Picomodulus fertilizer is even higher because of the tablet's size. The Picomodulus costs about N$0.07/ seedling compared to about N$0.002 for other slow-release or soluble fertilizers. Without a proven benefit, nursery managers should use cost-effective fertilizers, and conduct fertilizer trials periodically to ensure optimum growth rates. Fertilization should begin shortly after emergence, within 1 month of sowing, to maximize seedling growth response.

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