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## Reproductive indicators in natural populations of Douglas-fir in Mexico

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**Abstract.** The reproductive capacity in nine Mexican Douglas-fir populations was determined by analyzing seed production traits from 144 trees collected in 2001. Significant variation was found for all traits among populations; they contributed between 21% and 43% of total phenotypic variation found in these traits, indicating broad differences in reproductive capacity for that particular year. Seed efficiency (filled seed/seed potential) varied from 14% to 42% among populations; all populations from Central Mexico had a seed efficiency below 25%. The proportion of developed that were empty seeds varied from 0.40 to 0.81 among populations, whereas seed size varied also from 0.88 to 1.21 g per 100 seeds among them. Average ratio of filled seed weight to cone weight (reproductive efficiency) was 29.6 mg g<sup>-1</sup>, but it varied three-fold between populations with extreme values. Populations with larger cones had greater seed potential and heavier seed but not necessarily higher reproductive or seed efficiency. Most reproductive indicators were significantly correlated with latitude, with lower values in the marginal populations from Central Mexico, in the southern extreme of the species range. Given these results, the need for conservation of Douglas-fir populations in Central Mexico is discussed.

### Introduction

Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) is one of the most valuable timber trees in the world. It is grown in plantations in several countries in Europe, South America, New Zealand and Australia, as well as throughout its extensive natural range in western North America (Hemann and Lavender 1999). The latitudinal range of Douglas-fir goes from 55°00' N in British Columbia, Canada, to 17°10' N in the mountains of Oaxaca in Southern México (Domínguez-Alvarez 1994; Debreczy and Rác 1995). After the last ice age, increase in global temperature forced conifers to retreat northward, fragmenting the distribution and reducing the size of Douglas-fir populations in the southern extreme of its range in Mexico.

The high deforestation rate, along with unplanned seed harvests for Christmas tree plantings, endangers several Douglas-fir populations in Mexico. In addition, the anticipated climate change may trigger a new northward migration for these populations (Melillo 1999; Iverson and Prasad 2002),