TWO FORESTS SPECIES WITH A POTENTIAL FOR REFORESTATION AND TIMBER PRODUCTION

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ABSTRACT

P. oocarpa Schiede ex Schltdl., and P. douglasiana Martínez support the forest industry because they produce sawn wood, resin, chips, posts, needles, cones, and seeds, and also are used during reforestation and restoration zones. The aim of this study was to define the amount of P. oocarpa and P. douglasiana plants produced in nurseries by state and their timber volume for harvesting for the industry. The reforestation potential was defined using two effective reforestation efforts, while the annual and average timber production was estimated from the databases of the species included in the state reports from Mexico. For P. oocarpa, a total average 13 436 040 plants were produced in eight states, where Chiapas, Guerrero, and Nayarit had the higher production; while 2 641 236 plants were produced in three states for P. douglasiana, in which Nayarit reached the higher amount. For both species, total plants had a potential to reforest 14 615.71 ha. The average total volume produced was 77 288.19 m³: P. douglasiana had the higher timber volume produced (57 093.30 m³) that P. oocarpa (20 194.88 m³). Jalisco state was the largest timber producer for P. douglasiana (93.8%) while Chiapas for P. oocarpa (50.24%). The production values estimated intent to be a basis for decision-making during forest management and conservation.

Keywords: Conifers species of Mexico, forest management, Pinus douglasiana, P. oocarpa.

1. INTRODUCTION

For Mexico, P. oocarpa Schiede ex Schltdl., and P. douglasiana Martínez are two species that live in different ecological conditions. The first species has a great range distribution from northwestern Mexico (Sierra Madre Occidental) southward up to Chiapas. It is found in different environmental conditions as dry-temperate (annual precipitation 500–2000 mm) to humid subtropical (Perry, 1991), altitude range from 500–2300 m a.s.l., and often occurs in pure stands or pine-oak woodland (Farjon, 2017). The second species harbors in the mountains of Mexico W at elevations ranging from 1400–2500 m a.s.l. with a precipitation average of 1 000 mm; this occurs in pine forest or pine-oak forest (Farjon, 2017).

Both species support the forest industry annually because they produce sawn wood, resin, chips, posts, needles, cones, and seeds (Semarnat, 2016; Flores and Moctezuma-López, 2021); products used to manufacture cellulose, paper and derivatives, furniture, house building, sleepers, packing boxes, frames, moldings, and plywood (Semarnat, 2016). Flores et al. (2021) indicate that these species provide economic benefits to the country but they demand management with the least possible impact; there are general studies that have examined the timber production for the Pinus genus but not for species by state. Studies by Moctezuma and Flores (2020) and Flores et al. (2021) indicated that Mexican pines produce an average 8 501 million Mexican pesos annually (85.1 % of the total money of all forest species under exploitation), and that most of the timber is obtained from the east of the country.

On the other hand, P. oocarpa and P. douglasiana are used during reforestation and restoration areas. According to Flores et al. (2021), for the first species 13 436 040 plants are produced on average per year all over the country while for the second 2 641 236; this amount of plants could be used in order to reduce forest land degradation. Although there is a work has been done to date, more studies need to be conducted to ascertain the reforestation potential by species in each state.

This study aimed to define the amount of P. oocarpa and P. douglasiana plants produced in nurseries by state and their timber volume for harvesting for the industry. This information was identified as being important to help the forest owners to manage both species in a sustainable form.

2. MATERIALS AND METHODS

2.1. Reforestation Potential

The reforestation potential was defined using two effective reforestation efforts: number of plants produced in nurseries, and percentage survival of planted plants; all of these by state. The first effort was determined based on Conafor data (2019) for total seedlings planted from 2016 to 2018. The second effort was assessed the percentage of seedling survival defined by Conafor (2010).

2.2. Timber Production

The annual and average timber production was estimated from the databases of the species included in the state reports of the Ministry of Environment and Natural Resources (Semarnat, 2013 to 2017). For the total national volume, the percentage contribution of each species was also calculated. On the other hand, the annual and average volumes of timber produced from 2013 to 2017 in each state were determined, using the Flores method (2019).

3. RESULTS AND DISCUSSION

It was evaluated the reforestation potential of two Mexican pines species in which Pinus oocarpa was the better than P. douglasiana. For P. oocarpa, a total average 13 436 040 plants were produced in eight states, where Chiapas, Guerrero, and Nayarit had the higher production; while 2 641 236 plants were produced in three states for P. douglasiana, in which Nayarit reached the higher amount (Table 1). The total amount of plants had a potential to reforest 14 615.71 ha; specifically, 12 214.58 with 48% average survival for P. oocarpa and 2 401.12 ha with 59% average survival for P. douglasiana.

Table 1: Pines plants produced in Mexico in the 2016–2018 period by state.

Species / State	Plant production per year			
	2016	2017	2018	Mean
Pinus oocarpa				
Chiapas	6 500 000	9 461 038	8 209 610	8 056 883
Estado de México	800 000	549 573	700 000	683 191
Guerrero	2 460 000	2 550 000	2 050 000	2 353 333
Jalisco	500 000	0	250 000	250 000
Michoacán	605 000	850 000	452 000	635 667
Nayarit	1 120 000	1 166 500	598 398	961 633
Sinaloa	500 000	250 000	286 000	345 333
Zacatecas	200 000	0	250 000	150 000
Total	12 685 000	14 827 111	12 796 008	13 436 040
Pinus douglasiana				
Jalisco	966 500	766 698	200 000	644 399
Michoacán	100 000	0	0	33.333
Nayarit	2 375 000	2 200 000	1 315 512	1 963 504
Total	3 441 500	2 966 698	1 515 512	2 641 236

According to Flores et al. (2021), P. oocarpa is the third species most used in Mexico during the reforestation zones due to this pine posse large natural distribution and is managed in several management programs. However, some states produce other species but not the target pine and reduce his reforestation potential. P. douglasiana is the eleventh species most produced in the country but the amount tends to be reduced yearly. For both species, it is necessary to increase their reforestation efforts in order to support the national restoration strategy. During the reforestation process, it is mandatory to know the species' tolerance to adverse conditions (rainfall, soil, frost, drought, and high temperatures) of the plantation site to reach a higher survival rate.

On the other hand, the amount of average total volume produced was 77 288.19 m^3. P. douglasiana had the higher timber volume produced (57 093.30 m^3) that P. oocarpa (20 194.88 m^3). Jalisco state was the largest timber producer for P. douglasiana (93.8%) while Chiapas for P. oocarpa (50.24%) (Table 2).

Table 2: Annual and average timber produced in Mexico in the 2013–2017 period by state based on species distribution.

Species / State	Timber production per year (m^3)					
	2013	2014	2015	2016	2017	Mean
Pinus oocarpa						
Chiapas	5 009.94	19 585.77	23 187.80	2 141.24	807.58	10 146.47
Chihuahua	6.08	0.00	0.00	0.00	33.63	7.94
Colima	0.00	0.00	0.00	0.00	0.00	0.00
Durango	0.00	0.00	0.00	0.00	0.00	0.00
Edo. México	0.00	0.00	0.00	0.00	0.00	0.00
Guanajuato	0.00	0.00	423.54	0.00	0.00	84.71
Guerrero	0.00	0.00	0.00	23 817.76	25 866.60	9 936.87
Hidalgo	0.00	0.00	0.00	0.00	0.00	0.00

Jalisco	0.00	0.00	0.00	0.00	0.00	0.00
Michoacán	0.00	0.00	0.00	0.00	0.00	0.00
Nayarit	0.00	0.00	0.00	0.00	0.00	0.00
Oaxaca	0.00	0.00	0.00	0.00	0.00	0.00
Puebla	0.00	0.00	0.00	0.00	0.00	0.00
Querétaro	0.00	0.00	0.00	0.00	0.00	0.00
San Luis Potosí	0.00	0.00	0.00	0.00	0.00	0.00
Sinaloa	0.00	0.00	0.00	0.00	0.00	0.00
Sonora	0.00	0.00	0.00	0.00	0.00	0.00
Zacatecas	0.00	0.00	0.00	48.66	45.82	18.90
Total	5 016.02	19 585.77	23 611.34	26 007.66	26 753.63	20 194.88
Pinus douglasiana						
Chihuahua	13.67	196.15	0.00	0.00	100.00	61.96
Colima	0.00	0.00	0.00	0.00	1 768.60	353.72
Durango	0.00	0.00	0.00	0.00	0.00	0.00
Guerrero	0.00	0.00	0.00	7 486.97	8 122.72	3 121.94
Jalisco	5 013.67	54 442.99	80 414.68	48 204.97	79 702.11	53 555.68
Edo. México	0.00	0.00	0.00	0.00	0.00	0.00
Michoacán	0.00	0.00	0.00	0.00	0.00	0.00
Nayarit	0.00	0.00	0.00	0.00	0.00	0.00
Oaxaca	0.00	0.00	0.00	0.00	0.00	0.00
Sinaloa	0.00	0.00	0.00	0.00	0.00	0.00
Zacatecas	0.00	0.00	0.00	0.00	0.00	0.00
Total	5 027.34	54 639.14	80 414.68	55 691.94	89 693.43	57 093.30

P. douglasiana and P. oocarpa play an important role in the Mexican Gross Domestic Product, in which the Pinus is the main genus used during the production of 8.5 million m^3 of roundwood (FAO, 2020; Semarnat, 2020). This characteristic demand the implementation of sustainable management programs that seek to increase productivity and guarantee the continuity of species.

5. CONCLUSIONS

P. oocarpa is most produced in nurseries and most used during the national reforestation program than P. douglasiana, but possed a lower survival rate. However, P. douglasiana had a higher timber volume produced than P. oocarpa. The production values estimated intent to be a basis for decision-making during forest management and conservation.

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