

Short communication

Nurses for *Brosimum alicastrum* reintroduction in secondary tropical dry forest

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Abstract

Brosimum alicastrum Sw. is a multi-purpose species and it is dominant in some American tropical forests. In Western Mexico, forests dominated by *B. alicastrum*, called *mojoter*as, have been dramatically altered. The present work aims to supply basic elements for the reintroduction of *mojoter*as in the Sierra de Manantlán Biosphere Reserve. The question we posed was: Are there nursing species for the reintroduction of *B. alicastrum* seedlings in secondary tropical dry forest? A hundred randomly chosen 2-year-old *B. alicastrum* seedlings were planted in five treatments: under the covering of 80 individuals belonging to four species (*Tabebuia chrysantha* (Jacq.) G. Nicolson, *Thouinia serrata* Radlk., *Acacia macilenta* Rose and *Acalypha cincta* Muell. Arg.) and 20 on open ground. After 1 year, the survival of *Brosimum alicastrum* seedlings was significantly different among the treatments ($G^2 = 12.11$, $P < 0.05$). The treatments with the highest significant *B. alicastrum* seedling survival rate were under the covering of *Acalypha cincta* and *Thouinia serrata* (55 and 40%, respectively), whereas under the covering of *Acacia macilenta*, *Tabebuia chrysantha* and on open ground, the survival rate was the lowest (<5%).

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1. Introduction

Brosimum alicastrum Sw. (Moraceae) is an important species in the composition of many American tropical forests (Burkey, 1994; Ibarra-Manríquez et al., 1997; Kammesheidt et al., 2001; Godínez-Ibarra and López-Mata, 2002). It is a species mainly used as forage, food and medicine in various places of Mexico

(Ayala and Sandoval, 1995; Sánchez-Velásquez et al., 2002). In the Sierra de Manantlán Biosphere Reserve, *B. alicastrum* is known as *mojote*. It is widely appreciated due to its multiple uses, and it is the dominant species in some forests called *mojoter*as. Unlike other places in Mexico (such as the State of Yucatan, Gillespie et al., 2004), *B. alicastrum* individuals in the Sierra de Manantlán are not pruned and can grow up to 30 m tall. Cattle eat leaves and fruits only when they fall to the ground, which happens during the critical dry season and when little forage is available for cattle (Carranza-Montañó et al., 2003). As time

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went by, *mojoteras* were being replaced by pasture ground and secondary vegetation (pers. obs.).

Plantations of *Brosimum alicastrum* alone offer a forage production potential (Pérez et al., 1995). Nevertheless, production costs rise due to the necessity of keeping the plantations free from competing plants in the first years of growth (Ayala and Sandoval, 1995). It has been proved that *mojote* seedlings can thrive under specific shadow conditions. Its seeds are dispersed by bats, which habitually perch under tree crowns (Galindo-González, 1998; Montgomery and Chazdon, 2002). Because of the characteristics of its seeds and its tolerance to shadow, *B. alicastrum* is considered a late successional species (Kammesheidt, 2000). The understanding of successional patterns is needed for reintroduction projects or successional reforestation programmes with productive purposes (Lugo, 1988; Herrera et al., 1990). Nursing is a necessary mechanism for introducing important groups of plants into ecosystems (e.g. Valiente-Banuet and Ezcurra, 1991; Reyes-Olivas et al., 2002). The present work has the objective to supply basic elements for the reintroduction of *mojoteras* in the Sierra de Manantlán Biosphere Reserve. The question we posed was: Are there nursing species for the reintroduction of *B. alicastrum* seedlings in secondary tropical dry forests?

2. Methods

2.1. Study area

This work was carried out in the Zenzontla *ejido* (4344 ha), municipality of Tuxcacuesco, Jalisco, Mexico, located in the Sierra de Manantlán Biosphere Reserve between 19°42' and 19°35'N and 104°10' and 104°02'W. The climate is tropical dry, warm and sub-humid with an average temperature of 22 °C and 900 mm yearly rainfall (Martínez et al., 1991). The rainy season is limited to the summer, causing forage resource availability problems for cattle in the dry season (Hernández-Vargas et al., 2001). The dominant vegetation in the landscape is the tropical deciduous forest (TDF), also called tropical dry forest (see Rzedowski, 1978 for details on this kind of vegetation). Patches with different successional states and management history form the TDF in the Sierra de Manantlán. Eighty-five percent of tree

species in TDF have at least one use, medical and food principally. Actually there are few locations in the Sierra de Manantlán where *B. alicastrum* is a dominant species (Sánchez-Velásquez et al., 2002).

2.2. Experimental design and analysis

A hundred 2-year-old *B. alicastrum* seedlings (30 ± 5 cm tall), produced under nursery conditions, were randomly chosen. The seedlings were planted in five treatments: under the covering of 80 individuals belonging to four species (*Tabebuia chrysantha*, *Thouinia serrata*, *Acacia macilenta*, and *Acalypha cincta*), and 20 on open ground (control). *Brosimum alicastrum* seedlings were planted at a distance between 1 and 2 m from the base of each selected tree. The average covering radius was: *Tabebuia chrysantha* 4.76 ± 1.28 m, *Thouinia serrata* 4.7 ± 0.9 m, *Acacia macilenta* 3.81 ± 1.11 m, and *Acalypha cincta* 2.41 ± 0.93 m. Clearings were also randomly chosen and larger than 500 m². Each *B. alicastrum* seedling was measured when planted, and after 12 months with respect to base diameter and total height. Survival was also recorded at the end of the study. All sites have northwest position (70–80°E) and slopes between 60 and 50%.

Survival (number of individuals at the end of the study) of *B. alicastrum* seedlings was compared through log-linear models (Everitt, 1977) using the SAS CATMOD procedure (SAS Institute, 1996). The growth rates in height and diameter were analysed using analysis of variance in the SAS GLM process. Growth rate, both in height and diameter, was calculated through the following equation: $G_r = (\ln X_2 - \ln X_1) / T$, where G_r is the growth rate, X_2 the height (or diameter) in time 2, X_1 the height (or diameter) in time 1, and t the time. As at the end of the study only one *B. alicastrum* individual under *Acacia macilenta* and *Tabebuia chrysantha*, respectively, were found, these species were not used in variance analysis.

3. Results

Brosimum alicastrum seedling survival was significantly different among the treatments ($G^2 = 12.11$, $P < 0.05$) (Fig. 1). Under the covering of *Acalypha cincta* and *Thouinia serrata*, we found the highest

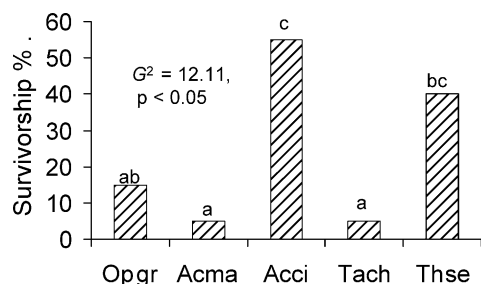


Fig. 1. Number of surviving *Brosimum alicastrum* individuals (%) under the crowns of *Acalypha cincta* (Acci), *Acacia macilenta* (Acma), *Tabebuia chrysantha* (Tach), *Thouinia serrata* (Thse) and on open ground (Opgr). The same letter at the top of each bar indicates that there is no significant difference ($P > 0.05$).

significant *B. alicastrum* seedling survival rate (55 and 40%, respectively), whereas under *Acacia macilenta* and *Tabebuia chrysantha*, and on open ground, the lowest rate (<5%) was recorded. Nevertheless, for both, final height as well as diameter of *B. alicastrum*, no significant differences were found among treatments ($F = 1.05$, $P > 0.05$ and $F = 1.89$, $P > 0.05$, respectively). Height (cm) and diameter (cm), respectively, of *B. alicastrum* seedlings at the end of the study per treatment, were: *Tabebuia chrysantha* 5 and 0.45, *Thouinia serrata* 14 ± 5.17 and 0.52 ± 0.08 , *Acacia macilenta* 25 and 0.70, *Acalypha cincta* 5.7 ± 5.6 and 0.4 ± 0.08 and on open ground 19.33 ± 10 and 0.56 ± 0.08 .

4. Discussion

Studies have been carried out to understand important ecological processes and use them in the rehabilitation of degraded ecosystems (Aronson et al., 1993a,b; Bainbridge et al., 1995). Nursing is an important process for regeneration and consequently a valuable tool for rehabilitation and conservation projects (e.g. Bainbridge et al., 1995; Ashton et al., 1997; D'Antonio and Meyerson, 2002).

The present work suggests the potential of the presence of nursing species such as *Acalypha cincta* and *Thouinia serrata* for the reintroduction of *B. alicastrum* forests in the Sierra de Manantlán. Reintroduction of *mojoterias* would serve a double purpose: its regional conservation, and producing forage in the most precarious dry season, marked by the lack of

cattle forage. Although *B. alicastrum* is a species that survives in the shadow, care should be taken not to plant it in very dark places in the forest, because of the high seedling mortality, that has been recorded in those places (Montgomery and Chazdon, 2002). *Tabebuia chrysantha*, *Thouinia serrata*, *Acacia macilenta*, and *Acalypha cincta* are deciduous species (Ramón Cuevas, personal comment), so they do not create extreme shadow conditions during the dry season, each species, however, might create different shade intensity during the rainy season, which could be the reason for the differences among *B. alicastrum* seedling mortality rates. The cause of mortality could not be observed in the field and neither were other environmental variables recorded. Therefore, it was not possible either to infer the co-existence mechanism, or to explore the degree of correlation between environmental variables and *B. alicastrum* seedling survival. Nevertheless, the results suggest that the composition of canopy species is a factor that may contribute to create a heterogeneous environment, and in its turn, it can be a mechanism to maintain different degrees of co-existence among species (e.g., Coomes and Grubb, 2003).

Other studies have proved that near the edges there is less *B. alicastrum* seed depredation than inside the forest (Burkey, 1993, 1994). It would be interesting to explore the effect of edges on *B. alicastrum* seedling survival in degraded areas.

5. Conclusion

Results suggest the important potential held by species classified as nursing, in degraded areas in tropical dry forest in the west of Mexico, for the reintroduction of *B. alicastrum*; especially *Acalypha cincta* and *Thouinia serrata*.

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