

REDUCING BARRIERS TO MAHOGANY REGENERATION  
IN BELJZE: FACTORS AFFECTING GERMINATION,  
SEEDLING SURVIVAL, AND INSECT ATTACK

by  
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## **Abstract**

Mahogany (*Swietenia macrophylla* King) is the most valuable timber species of Belize. Because mahogany is shade-intolerant, it does not regenerate under the conditions created by selective logging, and has become depleted from forests throughout its range. Experiments in the Rio Bravo Conservation and Management Area of Belize were established to evaluate silvicultural methods for enhancing mahogany regeneration in natural forest.

The effects of sowing method, light level, and clearing method on germination and seedling survival and growth were evaluated for mahogany seedlings established from seed or plants in experimental clearings from 500m<sup>2</sup> to 5000m<sup>2</sup> in size. Sowing method had a significant effect on germination, with higher germination rates from seeds embedded in the soil (48%) compared to surface-sown seeds (9%). Light level had little effect on germination, but became an important factor influencing seedling survival and growth to one year of age. One year after sowing, the yield of seedlings from embedded seeds sown in shade under the forest canopy was 12.3%, while the maximum yield of 26% resulted from embedded seeds sown in 500m clearings. Clearing method significantly affected germination and establishment, with bulldozer clearing proving superior to hand felling (34% of embedded-sown seeds were established at one year in bulldozed plots vs. 17% in hand-felled plots).

Half the seedlings had been cleaned at 18 months. Cleaning, the removal of competing trees and vines from around planted seedlings, had been performed to improve the seedling growth. I investigated the effects of cleaning on levels of attack by the mahogany shoot borer, *Hypsipyla grandella* Zeller, the most serious pest affecting mahogany. Cleaning increased levels of shoot borer attack, both in terms of mean number of attacks per seedling (2.5 in cleaned plots, 2.0 in uncleaned) and the proportion of trees affected (91% in cleaned plots, 79% in uncleaned plots). As a result of higher levels of shoot borer attack, seedlings in cleaned plots grew significantly less (15.6 cm in 6 months) than those in plots that were not cleaned (22.4 cm). The surrounding vegetation in uncleaned plots appears make it more difficult for *Hypsipyla* moths to detect host plants, reducing levels of attack. Shoot borer attack varied by season, with a large increase in attacks following the onset of the rainy season. The results of these studies will aid the Programme for Belize in the development of silvicultural techniques for the sustainable management of mahogany-rich forests.

## **Conclusions**

These studies reveal a number of factors that mediate the attack of mahogany seedlings by the mahogany shoot borer, including cleaning treatment, clearing size, clearing method, and seasonal variation in rainfall. Factors that stimulated seedling growth or the flushing of new leaves increased levels of attack by attracting *Hypsipyla* moths. The goal of maximizing seedling growth may be in conflict with the necessity to keep shoot borer attack to a level that ensures that at least some seedlings in each plot mature into commercially viable timber trees. The lack of effective biological or chemical control methods for shoot borers necessitates the evaluation of silvicultural treatments in this light.

*Effects of cleaning and other silvicultural treatments.* The cleaning of competing vegetation from around mahogany seedlings was shown to increase the mean level of shoot borer attacks per seedling and the proportion of seedlings attacked. Apparently because of shoot borer attack, seedlings in cleaned plots grew less than seedlings in plots that were not cleaned. Cleaning of seedling plots is a time- and labor-intensive activity that was not shown to increase seedling growth or vigor, so cleaning seedling plots is not recommended.

The lateral shade provided by vegetation surrounding mahogany seedlings in the clearings that were not cleaned appeared to some offer protection from shoot borer attack, perhaps by masking the chemical signals given off by mahogany that attract *Hypsipyla* moths. Lateral shade may also help seedlings recover from attack by reducing lateral branching at attack sites. Seedlings that have a small number of attacks may retain

commercial form if a single terminal leader and vertical growth are maintained (Mayhew and Newton 1998, Newton et al. 1993). Because mahogany seedlings require high light levels, occasional selective pruning of surrounding vegetation may be necessary to reduce overhead shade, which may be detrimental to long-term seedling survival. Maintaining secondary growth in mahogany plantings may require tradeoffs between increased protection and reduced seedling growth.

Other silvicultural treatments that stimulated seedling growth, such as bulldozer clearing, also increased the level of shoot borer attack. Only increasing clearing size did not increase the level of attack; instead, the number of shoot borer attacks decreased with increased clearing size in cleaned clearings. In clearings that were not cleaned, the size of the clearing did not affect shoot borer attack.

*Effect & of season.* Seasonal variation in rainfall had a strong effect on the level of shoot borer attacks. Following the onset of the rainy season, the mean level of shoot borer attacks per seedling in cleaned plots doubled over the period of only one month. Seasonality of shoot borer attack is an important consideration for the development of control methods, for scheduling the timing of silvicultural treatments, and for the design of sampling strategies.

*Prospects for mahogany enrichment.* Though differences between cleaned and uncleaned plots were highly significant, a large proportion of seedlings (78.6%) was attacked even in clearings that were not cleaned. These levels of attack are consistent with other studies, which report attack rates between 81% and 100% in field trials with seedlings of similar ages (Newton et al. 1998, Mayhew and Newton 1998). Mayhew and Newton (1998) state that forest managers should expect the majority of mahogany seedlings to be attacked when planted within the native range of *H. grandella*. While rates of shoot borer attack this high represent an unacceptable risk for the establishment of mahogany plantations, modest reductions in shoot borer damage may be sufficient for mahogany enrichment with the objective of replacing logged trees in natural forests. Natural densities of mahogany in natural forest may be maintained if only a few trees in each seedling plot escape shoot borer attack and survive to maturity.