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Seed germination of *Loxopterygium guasango*, a threatened tree of coastal Northwestern South America

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Abstract: *Loxopterygium guasango* is a highly threatened dry region tree endemic to coastal Northwestern South America. Seed germination trials using various water, heat, and light treatments yielded a maximum germination of 13%. It is postulated that time of seed harvest is especially important to seed viability of *L. guasango* because the seeds easily desiccate in the harsh arid environment. Suggestions for reforestation are discussed.

Resumen: *Loxopterygium guasango* es un árbol endémico altamente amenazado de la región seca y costera del noroeste de Sudamérica. Ensayos para la germinación de semillas usando varios tratamientos con agua, calor y luz produjeron una germinación de 13%. Se postula que el tiempo de cosecha de la semilla es especialmente importante para la viabilidad de la semilla de *L. guasango* debido a que las semillas se desecan fácilmente en el ambiente árido. Se discuten sugerencias para la reforestación.

Résumé: *Loxopterygium guasango* est une espèce fortement menacée d'arbre endémique de la côte nord-ouest de l'Amérique du Sud. Des essais de germination utilisant différents traitements hydriques, thermiques et lumineux ont permis d'atteindre un taux maximal de germination de 13%. On suppose que la date de récole des graines est tout spécialement importante pour la viabilité des graines de *L. guasango* parce que ces graines se dessèchent rapidement dans un environnement rude et aride. Des suggestions pour le reboisement sont discutées.

Resumo: A *Loxopterygium guasango* é uma árvore endémica fortemente ameaçada que vegeta na região costeira seca noroeste da América do Sul. Os ensaios de germinação de semente, usando vários níveis de factores como a água, temperatura e luz mostraram uma germinação máxima de 13%. Foi postulado que a época de colheita de semente é especialmente importante para a viabilidade da semente da *L. guasango* porquanto a semente desseca facilmente nas condições difíceis do clima árido. Sugestões para a reflorestação são discutidas.

Key Words: Ecuador, dry forest, endangered tree, reforestation, seed bank, seed ecology, *Loxopterygium, guasango*

Introduction

Loxopterygium guasango (Anacardiaceae) is a deciduous tropical dry forest tree that grow in patches in the largely unvegetated areas of coastal southwestern Ecuador (mainly on the Santa Elena Peninsula) and northwestern Peru (Gentry 1993). The region is characterized by a harsh dry season lasting from June to December. Although precipitation records do not exist for the area, the Ecuadorian coastal region

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below one degree south of the equator generally receives less than 1,000 mm of precipitation annually (Dodson & Gentry 1991). The region is described by Dodson & Gentry (1991) as very dry tropical forest.

L. guasango occurs in stands of 10-20 individuals, often mixed in with *Prosopis* spp. and other sparse scrubby vegetation. Many of the stands are found less than 100 m away from the ocean growing in soil that is nearly all sand. The large scale distribution of *L. guasango* is not known, however it probably is endemic to coastal northwestern South America (Gentry 1993; De Elao 1993). The constant exploitation of the specie's durable timber for house pillars, coupled with the explosion of coastal shrimp laboratories and farms in the last 12 years, has most likely contributed to the decimation of *L. guasango* populations. In a report from the Natural Resources University of Guayaquil (Ecuador), *L. guasango* is listed as being in danger of extinction in Ecuador (De Elao 1993).

L. guasango is being promoted in some reforestation projects in Ecuador because of its threatened status, as well as its heartiness, drought tolerance, an ability to repel browsing animals. The bark contains irritating compounds which can cause a strong rash in some people. In this study, factors which could be important for seed germination of this threatened tree species were investigated. The specific objective was to identify seed harvest and germination conditions of *L. guasango* favorable for reforestation efforts.

Natural history and methods

Loxopterygium guasango leaves are pinnately compound and deciduous. Most of the leaves fall off early in the dry season (June-August) and the plant stays leafless until the rains come in January. Flowers are small and numerous, producing single, winged, wind-dispersed fruits at the time of leaf fall. *L. guasango* can be vegetatively propagated from small branch cuttings.

L. guasango seeds were collected directly from four stands (approximately 10 trees in each) in late June, 1994 in Punta Blanca (Santa Elena Peninsula, Ecuador). The seeds were considered mature because their dispersal wings were dry and they could easily be shaken off the tree. Seeds were sown 10 days later in germination beds at the Fundacion Natura office in Manglaralto (80 km north of Punta Blanca). Soil of the germination beds consisted of approximately 75% fine sand, 25% silt, and very little organic matter. Except where noted below, all germination beds received diffused light and were lightly watered on alternate days. Counts of germinated seeds were made at least three times per week for a period of six weeks. Seeds were treated as followes: (1) untreated controls, (2) soaked in 100 °C water for 10 minutes, (3) soaked in tap water for 24 hours, (4) soaked in 100 °C water for 10 minutes and then in tap water for 24 hours, (5) untreated seeds, shielded from light for 3 weeks, and (6) seeds treated for 15 minutes at 100 °C. See Table 1 for sample sizes. It should be noted that each treatment in the germination trials was performed only once. For the purpose of statistics, confidence limits on the percent germination were obtained (and used in the following analyses), however, variance for treatment effect was not obtainable. This design was employed in order to save time and resources, as both were limiting. Although the possibility of experimental biases (e.g., fungal attack) could have altered the treatments, the results described below are in complete concordance with preliminary experiments conducted earlier by the author (A. Agrawal, unpublished data).

In another experiment, 400 seeds (of those collected late June, 1994 and stored in a dark, dry room) were opened in August, 1994, and inspected using a dissecting microscope to be classified as either "alive" or "dead". One hundred undispersed seeds collected from the trees in the same stands on August 12, 1994 were also cut open and examined. Dead seeds were defined as those with either a dry, usually easy to remove, brownish and shriveled embryo or no embryo at all. It should be noted that some (or even all) of the dead seeds may have been aborted seeds. "Alive" seeds were defined as having a somewhat moist, greenish yellow embryo, which did not separate easily from the seed coat and flaked like a dry past when pricked.

Results and discussion

Table 1 summarizes the number and percent of the seeds that germinated. Most seedlings emerged within a month of sowing, and nearly all survived to

Table 1. Summary of results from germination trials of *Loxopterygium guasango* seeds. Details of methods and statistical comparisons are given in the text.

Array	Treatment	Sample size	Number germinated	Percent germinated
1	Control	400	32	8
2	Hot water	100	13	13
3	Soaked	100	8	8
4	Hot water and soak	100	9	9
5	No light	160	13	8
6	Baked	400	0	0

transplanting age, one month later. There were no significant differences among treatments 1-5 ($P > .05$, chi-square test for independence, Zar 1996). Treatment 6, heating the seeds, apparently killed all of the seeds.

Among the seed dissections, 20% of the seeds collected in June were classified as alive, in contrast to 1% of those collected in August. The seeds collected in June were significantly more viable than the seeds collected in August ($P<.001$, chi-square test for independence, Zar 1996).

In general, poor germination of seeds can be attributed to: (1) infestation of seed predator insects or fungal attack; (2) inappropriate germination conditions or treatment; and (3) inviability (see Heydecker 1973). In the present study, a large percentage of the seeds appeared to be inviable. The seed dissections provided data consistent with this, as 20% of seeds were categorized as "alive," while 80% of seeds were labeled "dead". Given this, 65% seed germination of viable seeds (13% overall) was achieved when seeds were treated with a short hot water soak. Unfortunately, germination values for related species are not available in the literature.

If the majority of seeds are not viable, there could be several reasons (reviewed in Fenner 1985): (1) limited nutrient resources; trees often abort a large portion of their seed crop because resources are limited (e.g., Stephenson 1980); (2) genetics; because this species can easily be vegetatively propagated, it is possible that some of the stands have minimal genetic diversity. If so, it is plausible that there may be a high level of seed abortion due to inbreeding (see Silvertown 1980; Wiens 1984); (3) Senescence; as with many tropical seeds, it is possible that the seeds are only viable for a short time after maturation (Vazquez-Yanes & Orozoco-Segovia 1993).

If the seeds are too old and have senesced, are the seeds over-stored (with lost viability after dispersal) or over desiccated (lost viability before dispersal)? The *L. guasango* stands are in completely open and very sunny areas. It should be noted that the "tropical dry forest" in the areas on the Santa Elena Peninsula where these *L. guasango* were found has been removed and never recovered (Dodson & Gentry 1991). It is very likely that the regimes of temperature, sun exposure, and precipitation have been highly altered since the tropical dry forest was cut from this area (Dodson & Gentry 1991; Svenson 1946). Also, given that the seeds were sown within a week of collection, it is unlikely that the seeds have been over-stored, but more plausibly, over desiccated. Although many seeds require desiccation before germination, other seeds which are morphologically similar to *L. guasango* such as the maples (*Acer* spp.), are short lived and lose viability if desiccated (Hartmann & Kester 1983). Short term viability is especially common in tropical seeds (Vazquez-Yanes & Orozoco-Segovia 1993).

The results indicate that by August, 99% of the undispersed seeds were inviable. It appears probable that the *L. guasango* seeds were initially viable but were killed by over-desiccation in the heat and sun before dispersal. This hypothesis is consistent with information on similar wind-dispersed seeds' (temperate *Acer* spp.) inviability due to desiccation. To better understand the seed ecology of *L. guasango*, fresh seeds should be collected, examined, and sown at different intervals. This should be started at the first sign of seeds and be continued on a weekly basis (perhaps May-August). Seeds from several sites should be collected and tested. This could possibly rule out negative effects of poor resources or genetics on seed viability, and also help form a "viability schedule" for seeds from different sites over different times. Lastly, seeds should be tested for germination once collected and stored for various lengths of time.

The coastal regions of Ecuador are heavily degraded and highly altered environments. If *L. guasango* and other species like it are to be saved through the efforts of reforestation projects, we must match each reforested hectare with basic experiments to make the efforts worthwhile.

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