Seed Scarification Requirements for *Robinia neomexicana.*

by:

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Introduction

The recent increased demand for native and exotic plant material for ornamental and reclamation work has created several new challenges to nursery growers. Little is known about the production of these species and what has been published is spread out in publications traditionally not available to growers. These challenges often begin with germination. Several of these species have recalcitrant seed with significant scarification and stratification requirements to overcome dormancy and germinate. Failure to address these obstacles to germination results in inadequate germination and loss of production time and greenhouse space. Considerable research on seed treatments has been conducted on traditionally grown species. However, even within a species scarification and stratification requirements for optimum germination vary. Many of the new species requested for reclamation activities occur in high stress environments. These plant species have evolved dormancy mechanisms, which help ensure species survival, that must be overcome before the seed germinates.

Leguminous and actinorhizal trees and shrub species are often recommended for disturbed land revegetation. Actinhorizal species such as alder (*Alnus* spp.) or snowberry (*Symphoricarpos oreophilus*) form symbiotic associations with a filamentous bacteria, *Frankia* which fixes nitrogen in a process similar to the more commonly known legume/*Rhizobium* system. Many of the woody plant species in these groups are considered early colonizers (invaders) of disturbed sites. Their ability to fix atmospheric nitrogen allow these plants to survive in nutrient deficient sites.

Three legume species, honey locust (*Gledistia triancanthos*), black locust (*Robinia pseudoacacia*), and New Mexico locust (*R. neomexicana*) are often used in ornamental plantings and to revegetate disturbed sites in the southern Rocky Mountains. Research on the dormancy mechanisms of these legumes indicates that scarification treatments are required for adequate germination (Deno 1995). The literature recommends a range of scarification treatments including boiling water or acid

scarification treatments (Dirr and Heuser 1987; Mac Donald 1986). Published reports vary on the most effective treatments within each of these species.

Published works on the seed propagation of New Mexico locust is lacking. A survey of several southwestern container growers indicated a range of treatments are currently being used to satisfy scarification requirements in this species. Most treatments were either mechanical or involved soaking seed in water baths heated to near boiling temperatures. All nurseries had been using single seed sources to meet production needs.

The objectives of this study were to determine the best seed scarification treatments for New Mexico locust to improve germination speed and overall germination percentage; and, to determine the variability in the efficacy of these treatments within the species.

MATERIALS AND METHODS

Three leguminous species were used in this study. Honey locust (F.W. Schumacher, Sandwich, MA); black locust (Lawyer Nursery, Plains, MT); and five sources of New Mexico locust. Seeds of New Mexico locust were collected from 5 sources growing in a state wide provenance study located at the Los Lunas Plant Material Center, Los Lunas, NM. New Mexico locust seed pods were collected in the Fall of 1996 and stored in a seed barn until early winter 1996 at which point seed was extracted and placed in refrigerated storage.

Eleven seed scarification treatments were evaluated in this study. The treatments were: control, leach, mechanical scarification, water temperature with 4 levels of soak temperatures (70^{0} , 80^{0}, 90^{0} and 100^{0}C) and acid soak with 4 levels of soak time durations (1, 2, 5 and 10 minutes). Control treatments seeds were soaked for 24 hours in tap water at room temperature (22°C) prior to sowing. Leach treated seeds were placed into an apparatus that allows for a continuos flow of tap water through seeds. Leach treated seeds were placed into this apparatus for 24 hours prior to sowing. Mechanical scarification was done in a Forsberg scarifier for 1 second. The scarifier drum was lined with 100 grit sand paper. Seeds were removed from scarifier and soaked for 24 hours in tap water then sown. The four water temperature treatments were conducted in a beaker filled with tap water heated on a electric hot

plate. Seven (1 for each seed source) test tubes filled with tap water were placed into the beaker water bath. Water bath temperature was raised to each respective temperature (70^0, 80^0, 90^0 and 100^0C), then removed from hot plate and seeds placed into their appropriate test tubes within water bath. Seeds were left in the tubes to soak for 24 hours prior to sowing. The four acid treatments were done by placing seeds into concentrated sulfuric acid (H_2SO_4) for each duration (1, 2, 5 and 10 minutes). Seeds were removed from the acid and rinsed thoroughly. Rinsed seeds were soaked in tap water for 24 hours prior to sowing.

Following the 24-hour soak, seeds were sown into 164 cm^3 Ray-leach Super Cells (Steuwe & Sons, Corvalis, OR) containing a 2:1:1 peat:perlite:vermiculite media. Two seeds were sown per container. Seed was placed on top of the media and covered by a light coating of perlite to prevent dessication. After sowing, containers were placed in a greenhouse. Greenhouse temperatures were 20 - 22°C days and 16 - 18°C nights. Photoperiod was a 10-hr light/14-hr dark with the dark cycle being interrupted twice at 5 hours and 10 hours with 30 minute light periods. Artificial light used to extend the ambient light period and light interruptions was provided by 1000-watt high pressure sodium vapor lamps suspended 3 meters above the containers. Racks were misted four times daily and irrigated every 5 days to ensure adequate moisture for germination.

To evaluate treatment efficacy, germination percent, days to 50% of the observed germination (G_{50}) and germination length (days to last germination) were measured. The study design was a randomized complete block with three blocks. Each seed source/scarification treatment combination was replicated with 50 seeds in each block. Data was analyzed using analysis of variance. Data reported here are treatment means $\pm$ standard errors.

Results

Mean seed weights for 50 seed and their associated standard errors are listed in Table 1. New Mexico locust seed weight varied between seed source ranging from 0.92 g/50seed to 1.40 g/50 seed (Table 1).

Table 1. Mean Seed Weight of 50 seeds with their associated Standard Error (SE) for Seed Sources of *Gleditsia triacanthos*, *Robinia neomexicana* and *R. pseudoacacia*.

Species	Source	Mean Seed Weight (g) ± SE[1]
Gleditsia triacanthos	Schumacher Seed Co.	10.58 ± 0.05
Robinia neomexicana	Los Lunas Source 1	0.92 ± 0.01
Robinia neomexicana	Los Lunas Source 2	1.40 ± 0.01
Robinia neomexicana	Los Lunas Source 3	1.29 ± 0.01
Robinia neomexicana	Los Lunas Source 4	1.09 ± 0.01
Robinia neomexicana	Los Lunas Source 5	1.23 ± 0.01
Robinia pseudoacacia	Lawyer Nursery	1.06 ± 0.01

[1] number of samples = 33.

Mechanical scarification and the two highest water bath treatments produced the fastest germination rates in honey locust (Table 2). These three treatments achieved 50% germination within six days whereas control seedlings required, on average, 16 days. Mechanical scarification resulted in the greatest total gerrnination in this species (69%; Figure 1). Higher water bath temperatures and longer acid soak durations also improved germination percentage. Water bath temperatures of 90°C and 100°C resulted in the second and third best total germination (30% and 47% respectively). No treatments significantly shortened the duration to complete germination (Figure 2).

In black locust, total germination was not significantly enhanced by any of the scarification treatments evaluated. Only the 70°C water bath treatment and the 2

Table 2. Treatment effects upon number of days to G_{50} for *Gleditisia triacanthos*, *Robinia neomexicana* and *R. pseudoacacia*.

Treatments	G_{50} (days)		
	Gleditsia triacanthos	*Robinia neomexicana*	*R. pseudoacacia*
Control	16±3	10±1	6±1
Leach	19±2	12±1	6±1
Mechanical	6±3	8±1	10±1
70° C	17±1	9±1	7±1
80° C	10±3	10±1	7±1
90° C	6±1	8±1	7±1
100° C	6±1	7±1	7±1
Acid 1 min.	15±4	7±1	6±1
Acid 2 min.	12±2	7±1	5±1
Acid 5 min.	9±2	7±1	6±1
Acid 10 min.	12±2	8±1	6±0

Table 3. Treatment effects upon number of days to G50 for 5 sources of *Robinia neomexicana*.

Treatments	G50 (Days)				
	Source 1	Source 2	Source 3	Source 4	Source 5
Control	9±1	9±1	11±2	14±1	9±2
Leach	13±2	12±3	11±1	15±3	7±0
Mechanical	8±1	6±2	10±0	8±1	8±1
70° C	11±1	7±1	6±1	13±1	9±3
80° C	14±2	6±1	8±1	11±1	10±1
90° C	12±2	6±1	6±1	7±1	8±1
100° C	10±1	6±1	7±1	6±2	8±1
Acid 1 min.	8±1	6±1	7±1	9±1	7±1
Acid 2 min.	9±2	7±0	6±1	7±1	7±1
Acid 5 min.	9±1	7±1	5±1	7±1	7±1
Acid 10 min.	10±1	9±2	7±1	9±1	5±1

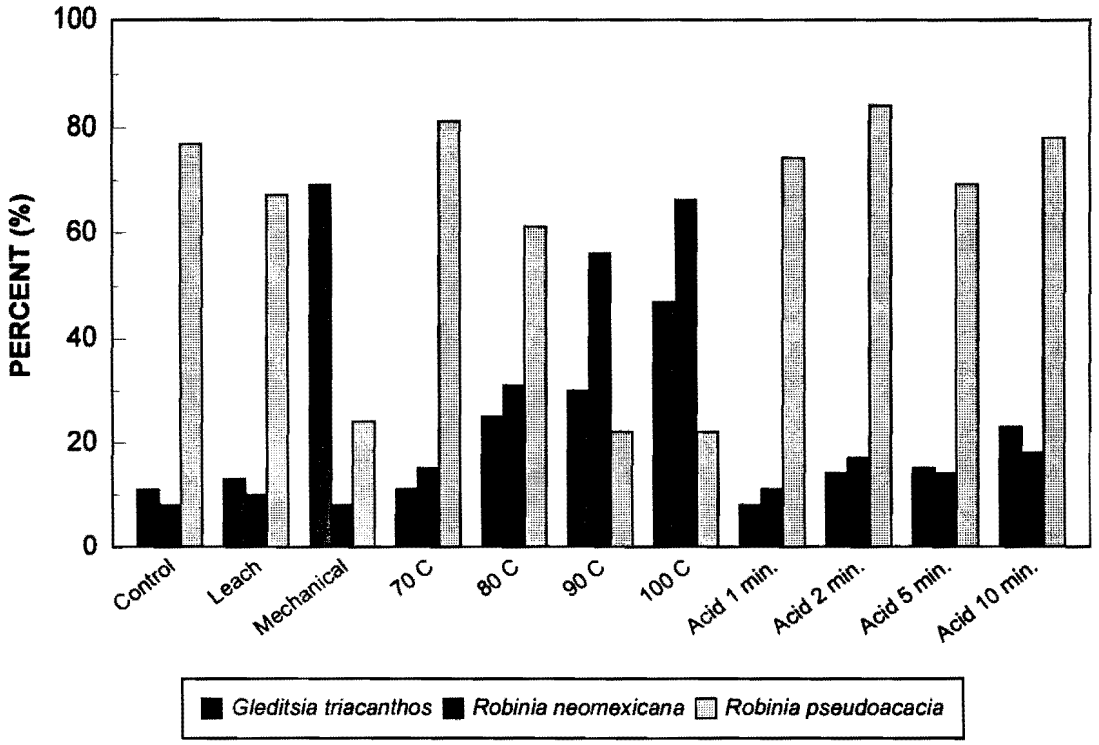

Figure 1. The influence of stratification treatment on the germination percent of *Gledistia tricanthos, Robinia neomexicana,* and *R. pseudoacacia.*

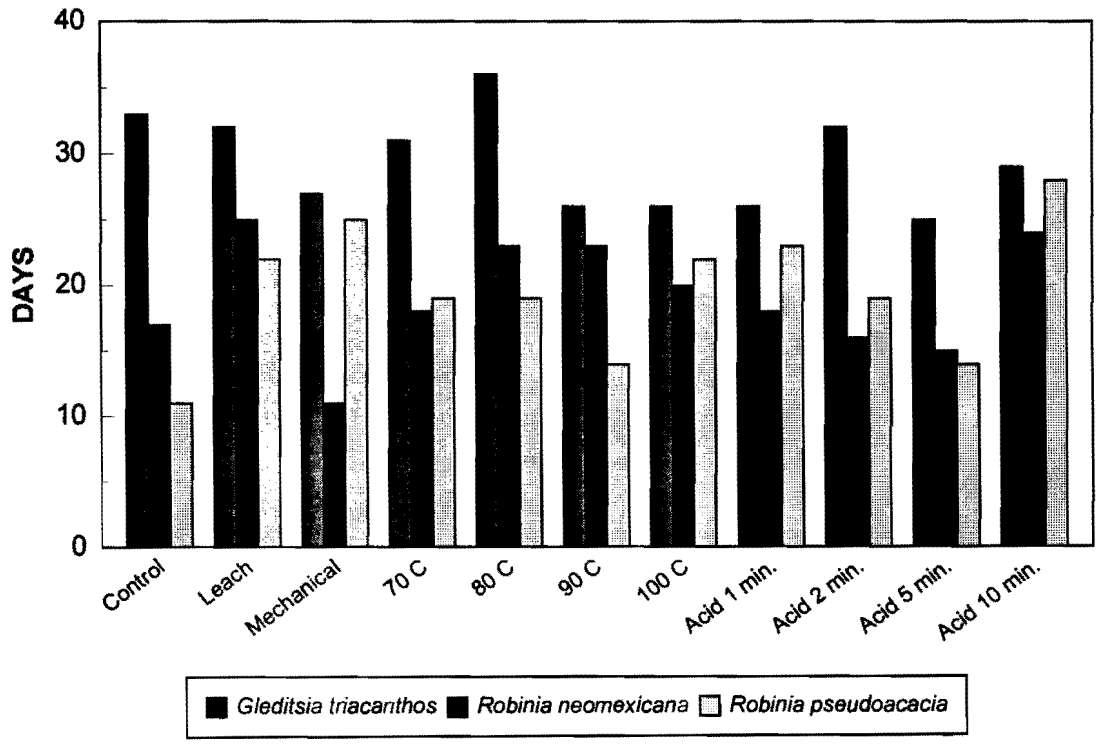

Figure 2. The influence of stratification treatment on the number of days to complete germination for *Gledistia tricanthos, Robinia neomexicana,* and *R. pseudoacacia.*

minute exposure to concentrated sulfuric acid improved total germination to 81% and 83%, respectively. The control group averaged 78% germination. Many of the scarification treatments reduced total germination. Total gemination was negatively related to water bath temperature from 70°C to 100°C. Also, no scarification treatment shortened germination duration. Every scarification treatment prolonged gemination with some treatments (acid scarification for 10 minutes) taking almost 3 times as long to achieve total germination (Figure 2).

Higher water bath temperatures and acid scarification treatments increased germination rate on average in New Mexico locust (Table 2). However this trend was variable across the seed sources evaluated. Three of the five sources evaluated had faster germination rates, in some cases as much as 50% faster, when exposed to hot water baths (Table 3). In the other two sources, germination rates were either unaffected or detrimentally affected by the hot water treatments. Ecotype variability in germination speed was observed for the acid scarification and mechanical scarification treatments. Leaching treatments resulted in prolonging the number of days to reach G_{50} in three of the sources. Only one source exhibited faster germination with the leaching treatment.

Averaged across all five sources of New Mexico locust, the water bath treatments had the greatest effect on promoting total germination (Figure 1). The three highest water bath temperatures, 80°C, 90°C, and 100°C improved total germination from 8% for the control group to 31%, 56%, and 66%, respectively. This trend was similar across all but one source of New Mexico locust (Figure 3). That particular source, Source 3, total germination was only significantly enhanced by the 100°C treatment. Source 1 had over a 15 fold increase in germination percent when exposed to the 100°C water bath. Acid scarification treatments all increased total germination, however, only the 10 minute acid scarification treatment exceeded 20% germination. The response to acid scarification varied significantly among the sources of New Mexico Locust evaluated. Sources 2 and 4 responded most favorably to the acid scarification treatments. On average, the leach and mechanical treatments had germination rates similar to the control treatment. However, three of the five sources had significantly reduced rates of germination after mechanical scarification. One

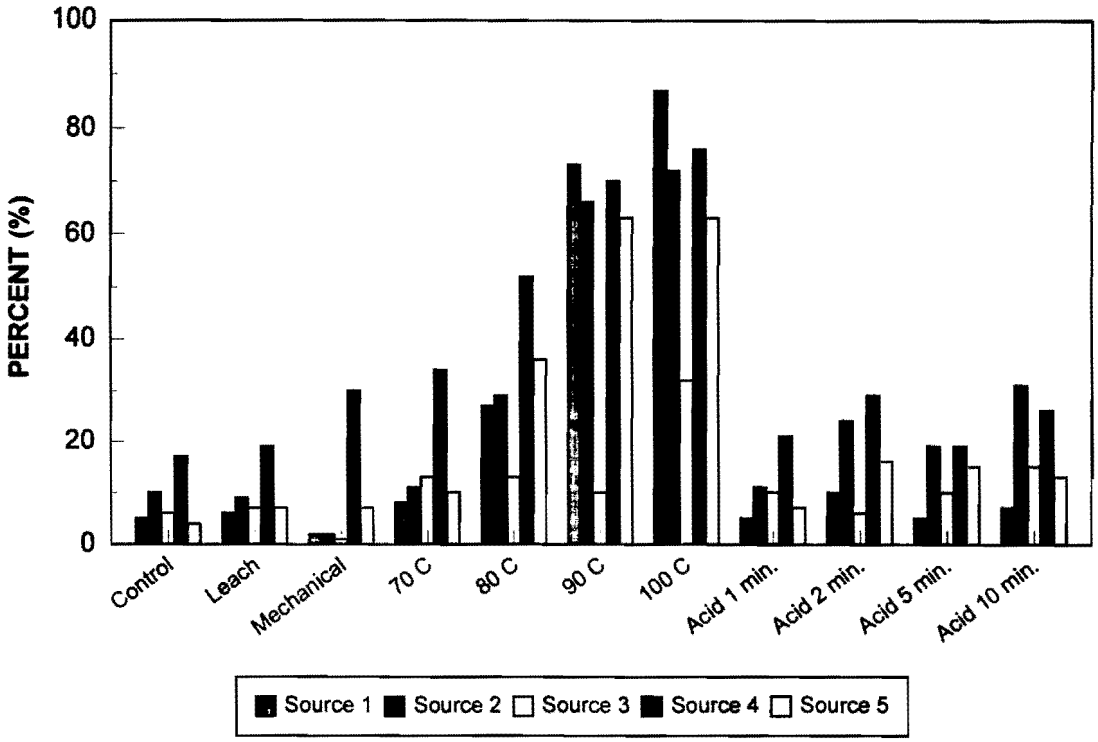

Figure 3. The influence of stratification treatment on the germination percent of five sources of *Robinia neomexicana*.

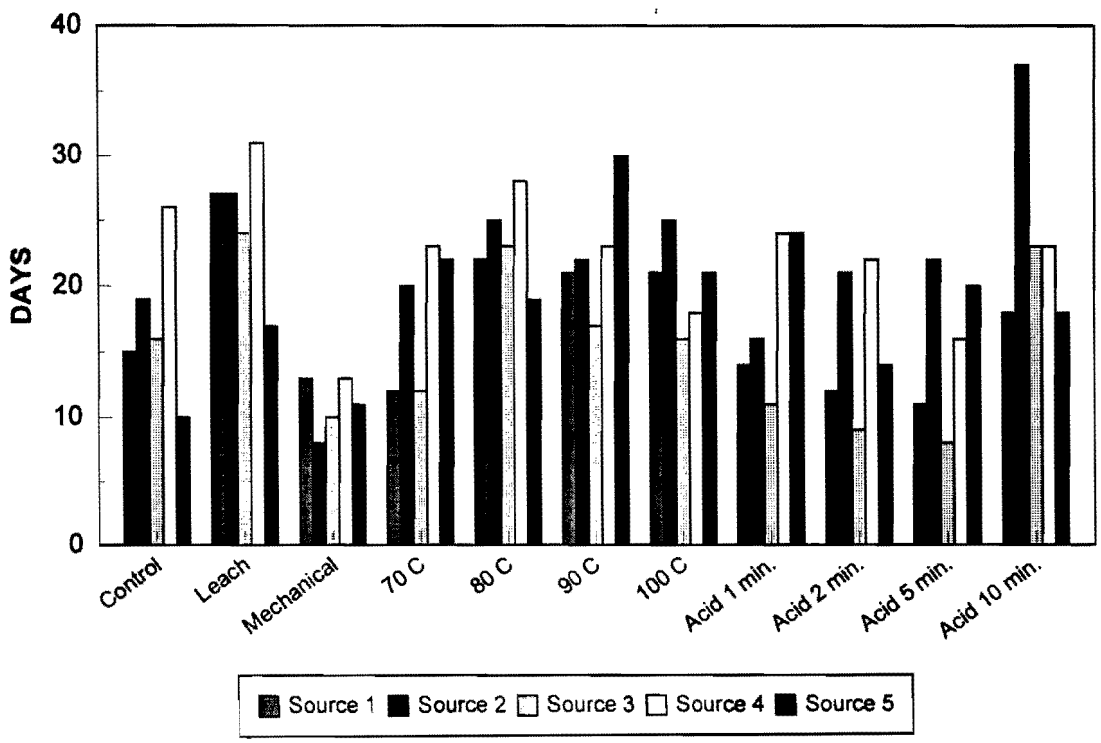

Figure 4. The influence of stratification treatment on the number of days to complete germination for five sources of *Robinia neomexicana*.

source, Source 4 responded favorably to mechanical scarification with an increase of almost two-fold in germination percent.

On average, only the mechanical scarification treatment reduced germination duration (Figure 2). Most treatments slightly increased the number of days to total germination. Source 4 was an exception to this trend with only the leach and 80°C treatments extended the germination window (Figure 4). The increases in germination duration were 5 days for the leach treatment and 3 days for the 80°C treatment.

Applications

New Mexico locust, like many other woody legumes, requires scarification to achieve maximum germination. When averaged across the five seed sources examined in this study, placing seeds in a 100°C water bath and allowing them to cool to room temperature (23°C) for 24 hours generates maximum germination. However, in one source evaluated, increase in total germination was negligible when compared to seeds placed in a 90°C water bath. While overall germination speed (G_{50}) is slightly prolonged (1 day) by these treatments. In three of the five sources evaluated, hot water bath treatments produced the fastest germination rates. Germination duration was extended by most scarification treatments; however, most scarification treatments resulted in improved germination rates.

Of all the scarification treatments evaluated, the water bath treatments are probably the easiest for production nurseries to use. The equipment required to conduct this type of stratification is common place. The acid scarification treatments may require hazardous materials handling equipment and skilled personnel. The seed coats of the sources of New Mexico locust we examined were too thin for our mechanical scarification apparatus. Possibly using a finer grit paper liner would have produced more even abrasion of the seed coats. It does not appear New Mexico locust has any hydrophilic seed coat inhibitors based on the lack of response to the leaching treatment.

Literature Cited

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