Curlleaf Cercocarpus[1] Seed Dormancy Yields to Acid and Thiourea[2]

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On many winter deer ranges there is a need to re-establish browse species that can be seeded directly on the range. Sufficient knowledge about proper planting techniques has been gained through research to enable seeding two species—antelope bitterbrush *(Purshia tridentata* (Pursh) DC) and fourwing saltbush *(Atriplex canescens* Nutt.) —on a few important deer winter ranges.

Another species which meets many requirements for improving certain winter ranges is curlleaf cercocarpus *(Cercocarpus ledifolius* Nutt.). Its seasonal growth is considered an excellent deer food. It is ecologically adapted to many locations where deer winter; it grows high enough so it can be browsed above deep snow; and it produces frequent seed crops that can be harvested and processed at nominal costs (Plummer, Stapley and Christensen, 1959).

But most attempts to establish this species by direct seeding on the range have failed. Failure is attributed largely to poor seed germination because of dormancy. Overwintering in moist soil or 30 to 90 days of artificial stratification breaks dormancy, but neither method has proved entirely practical.

This paper reports a study which promises an answer to the problem. A two-step treatment using sulfuric acid and thiourea produced over 75 percent germination in comparison to 14 percent from untreated seeds.

Methods

A total of 29 variations of 4 basic treatments consisting of thiourea, sulfuric acid, hot water and pre-chilling were applied to seed at the following intensities:

Treatment	*Intensity*
Thiourea (3 percent)	1, 2, 4, 8, 16, and 24 hours
Sulfuric acid (concentrated)	5, 10, 20, 30, 60, and 90 minutes
Hot water	Steep in 1 liter to room temperature (70°F.)
Pre-chilling	0° and 5°C., 1 to 8 days

The thiourea treatment consisted of immersing seed in a 3-percent solution for the specified period at room temperatures. The concentrated sulfuric acid bath was followed with a tap water rinse, then a neutralizing dilute bicarbonate of soda solution, and finally another rinse in tap water. The hot water treatment con-

[1] *Plants of the* Cercocarpus *genus are almost universally known in the West as "mountain-mahogany." However, in the new Forest Service Checklist "cercocarpus" was adopted as the approved common name. This action stems from Federal Trade Commission hearings on fair trade practice in "Mahogany" which ruled that "mahogany" should not be employed for any plants but species of the genus* Swietenia *(Hayes and Garrison, 1960).*

[2] *Contribution from cooperative investigation between the Experiment Station and the California Department of Fish and Game. Work was done under Federal Aid in Wildlife Restoration Act, Pittman-Robertson Research Project W51R, entitled "Game Range Restoration."*

[3] *The research reported herein was conducted by Dr. Liacos at the Pacific Southwest Forest and Range Experiment Station, U. S. Forest Service, while he was in the United States under sponsorship of the Technical Assistance Program, International Cooperation Administration, U. S. State Department, as a visiting scholar at the University of California, Berkeley. Since 1959, he has continued his studies in this country as a participant in the World Wide Research Program, National Academy of Sciences, and returned to Greece in 1961.*

sisted of steeping the seed in one liter of boiled water until it cooled to room temperatures before removing the seeds. Seed in the combination hot-water bath and acid tests were air-dried for about 24 hours and then treated with thiourea. No rinse was applied to any seed following the thiourea bath. The pre-chilled seeds were put directly into the dishes after their removal from the cold room. All other seeds were air-dried for about 24 hours before they were set out to germinate.

Each test included 8 replications of 50 seeds placed on moist blotters in pre-sterilized covered Petri dishes and maintained at temperatures of 60° to 68°F. for 30 days. Germination was considered to have occurred when the seed radicle had elongated ¼ inch or more. Unusual or questionable germination was checked by planting such seeds at ¼-inch depth in vermiculite flats. Only those which emerged were considered capable of germinating.

Seed quality was determined by cutting 200 randomly selected seeds. Pure live seed in this lot was 54 percent. Germination percentages were adjusted to this base. Qualitative tests for saponin, a large group of complex glycosides known to inhibit seed germination in other western browse species, were determined with a Lieberman-Burchard reagent, a mixture of sulfuric acid and acetic anhydride (Van Atta and Guggolz, 1958).

Acid and Thiourea Give Best Performance

Curlleaf cercocarpus seed germination was substantially and significantly increased by soaking the seed in concentrated sulfuric acid for either 5 or 20 minutes followed by a 4-hour soaking in the thiourea solution. Seed thus treated yielded over 72 percent germination; untreated seed less than 14 percent (Figure 1). An analysis of variance on the differences between treatments showed that these two treatments in combination had significantly better germination ($P=.01$) than all others.

The 30-minute sulfuric acid bath broke dormancy, but it damaged some seed. Also at this treatment level almost all germination stopped within 2 weeks. With a 60-minute acid soak more than three-fourths of the seeds shed their coats on initial sprouting. Seeds thus affected failed to emerge when planted in the flats. Of the seeds soaked in the acid for 90 minutes, none germinated. No damage occurred with the combination acid-thiourea treatments or with the untreated seeds (Figure 2).

The hot water bath was harmful; nearly complete inability to germinate indicated that the embryos may have been destroyed by this treatment. Pre-chilling was unsuccessful; germination of all pre-chilled seed lots was less than that of untreated seeds.

Soaking in thiourea for 4 hours or more hastened the average rate of germination about 3 days as compared with no treatment (Figure 1). Thiourea applied for less than 4 hours after an acid bath did not speed up germination.

Seventy-five percent or more of the total germination from both acid and thiourea alone or in combination took place within the first 13 days. Untreated seed required 19 days to reach the same level. Although germination was most rapid with sulfuric acid treatment, it ceased after about 12 days but continued with most of the other seed treatments.

Thiourea Reduces Mold on Seeds

Mold development was suppressed on all-thiourea treated seeds in Petri dishes. One of the molds identified as a *Penicillium* sp., developed very slowly on the seeds bathed in thiourea. In the

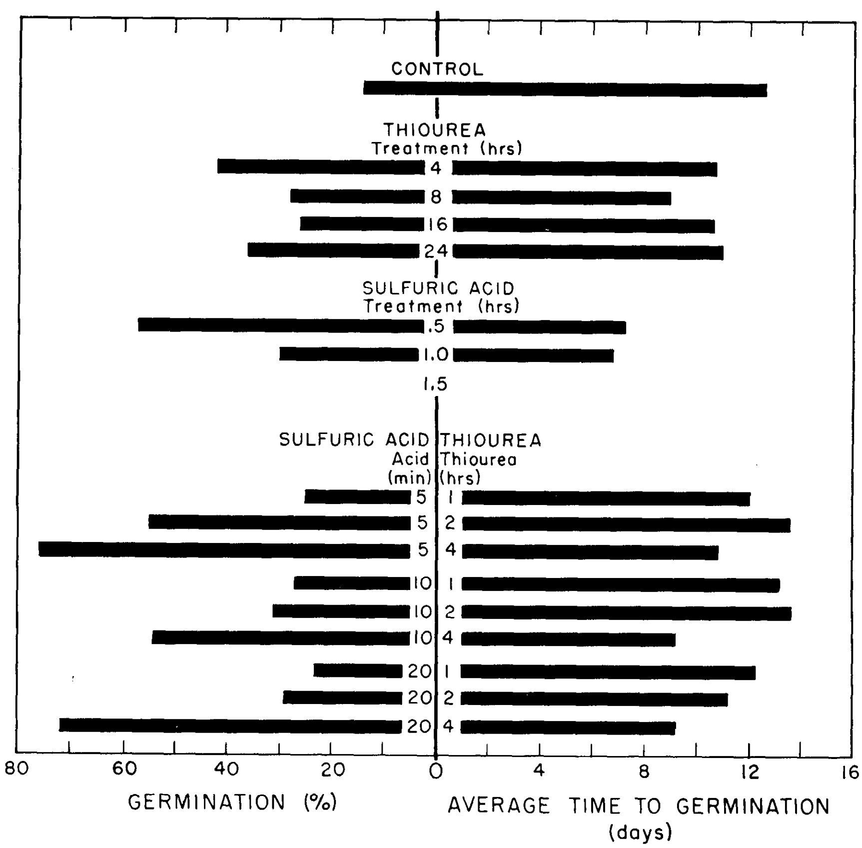

FIGURE 1. Treatment effects on curlleaf cercocarpus seed germination in 30-day tests.

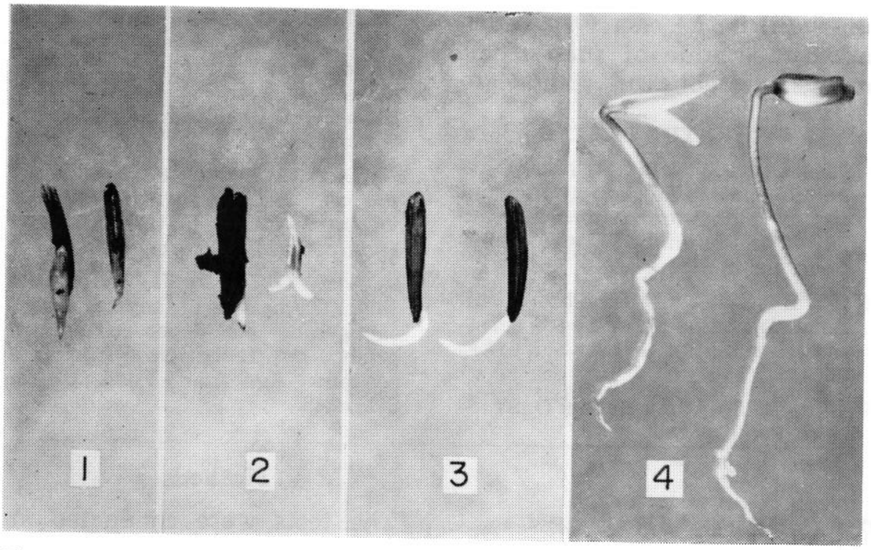

FIGURE 2. Seed and seedlings of curlleaf cerocarpus. 1. Untreated seed. 2. Malformed seedlings from 60-minute sulfuric acid soak. 3. Newly germinated seedlings from 5-minute acid, 4-hour thiourea soak. 4. Healthy seedlings resulting from the acid-thiourea treatment.

other treatments, it appeared within a few days and spread profusely. This condition was especially pronounced on seeds receiving the hot water bath (Figure 3). When the tests were stopped, all treatments except those with thiourea showed widespread mold accumulations surrounding the seeds. Under such conditions, the radicle turned brown and many seedlings failed to develop properly.

It was not determined whether the thiourea treatment inhibited or reduced harmful fungi when seed was planted in the soil. Nevertheless, it minimized an aggravating problem which frequently complicates seed analysis germination tests (U. S. Dept. Agr., 1952).

Saponin Suspected Cause of Dormancy

A strong color reaction was received when portions of the seed coat were introduced into the Liebermann-Burchard reagent, indicating that a saponin was probably present. No color response occurred when endosperm material was tested with the same reagent. The amount of saponin present and the effect this material has on germination was not determined for this species. However, the pattern obtained in these tests parallels that received in tests with fourwing saltbush, in which it was established that enough saponin was in the seed coat bracts to reduce germination (Nord and Van Atta, 1960).

Summary and Conclusions

Using 29 variations of 4 basic treatments consisting of thiourea, sulfuric acid, hot water, and pre-chilling demonstrated that seed dormancy of curlleaf cercocarpus can be broken without overwintering in the soil or extended stratification. The best results were obtained by a 5-minutes concentrated sulfuric acid bath followed by 4-hour immersion in 3-percent thiourea. This treatment combination yielded 76-percent germination as compared to 14 percent for untreated seed. Soaking the seed for 4 hours or longer in thiourea hastened germination by 2 to 3 days on the average. The sulfuric acid treatments overcame dormancy but damaged the seed. Either a hot-water bath or pre-chilling treatment reduced germination on seeds in Petri dishes. Mold formation was reduced by all thiourea treatments. Among the

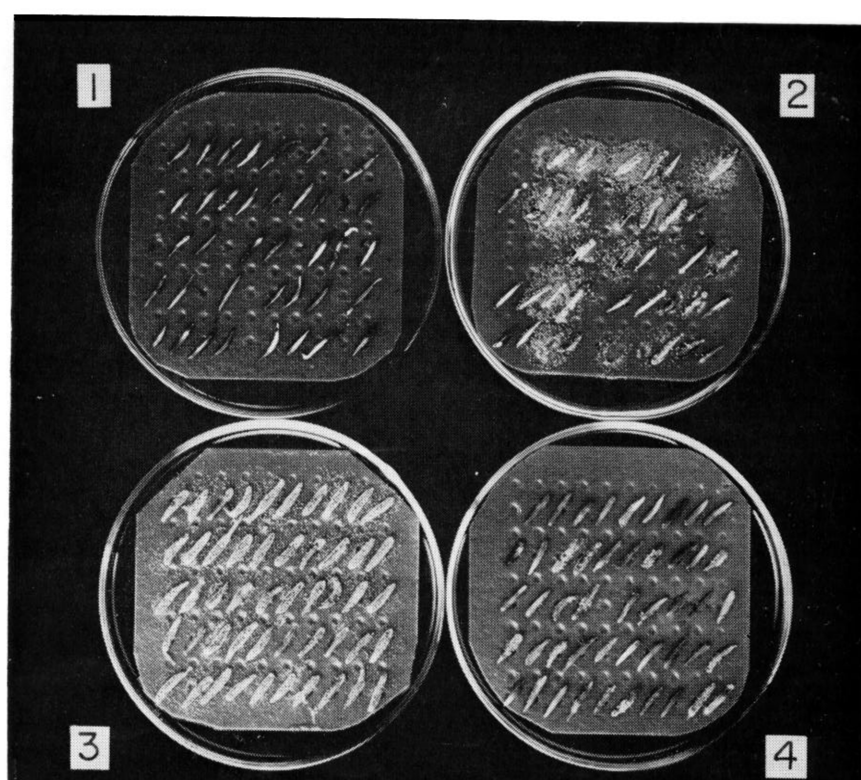

FIGURE 3. Mold was suppressed on currlleaf cercocarpus seed treated with thiourea. 1. Sulfuric acid-thiourea. 2. Sulfuric acid alone. 3. Hot water. 4. Untreated (control).

agents and conditions inducing dormancy saponin in the seed coat was suspected of contributing to this condition.

By using the combination of sulfuric acid and thiourea, seed may be pretreated, dried, and stored in readiness for spring planting. This procedure should produce good germination as well as eliminate the hazards of premature seed sprouting and the need for care in handling stratified seed. Trial field plantings will be necessary to determine the value of such treatments in establishing stands.

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