EXPERIENCES IN CHIHUAHUA

its growth. This is during the first growth in spring, March and April. It is on this phase that the poisonous weed starts its growth. The principle was that if the weed was overgrazed when it started growth, a heifer would not eat the half pound of green matter required to obtain toxicity. Twelve hundred heifers were on the pasture April 5 through the 30th. Eight were lost but results with the alfombrilla were encouraging. A partial kill seems to have been accomplished. The more tender plants, perhaps the 1960 crop, seem to have died. On this basis, if a kill is achieved on the plants started the previous year and, if as it is claimed, alfombrilla is a short lived perennial, the treatment should control this poisonous weed in 3 to 4 years. This experience should be combined with the previous one.

At the present a last experi-ment is being developed. This

one consists of feeding 2-year-old heifers Morea liquid feed after they had been grazed on wheat as yearlings. Reports on gains cannot be given yet but from visual observation these heifers are doing very well. A check showed 27-month old heifers weighing 880 pounds. The importance of using Morea liquid feed comes from the availability of molasses. It is the only feedstuff available in surplus in the Country.

Curlleaf Cercocarpus¹ Seed Dormancy Yields to Acid and Thiourea²

LEONIDAS G. LIACOS AND EAMOR C. NORD³


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**

<table>
<thead>
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<th>Intensity</th>
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<td>Thiourea</td>
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<td>Sulfuric acid</td>
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<tr>
<td>Hot water</td>
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<td>Pre-chilling</td>
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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-

¹Plants 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).

²Contribution 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 W31R, entitled ‘‘Game Range Restoration.’’

³The 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 1/4 inch or more. Unusual or questionable germination was checked by planting such seeds at %-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 12 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
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 four-wing 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 curlleaf cercocarpus seed treated with thiourea. 1. Sulfuric acid-thiourea. 2. Sulfuric acid alone. 3. Hot water. 4. Untreated (control).](image-url)
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.

LITERATURE CITED

Methods
The tests were conducted at Swift Current, Saskatchewan, on prepared seed beds of Haverhill loam of the Brown (Chesnut) soil zone. The climate at Swift Current is fairly typical of that through southern Saskatchewan, south-eastern Alberta, the eastern half of Montana and western parts of North Dakota. Annual precipitation at Swift Current is about 14½ inches.

Crested wheatgrass (Agropyron cristatum), intermediate wheatgrass (intermediate), streambank wheatgrass (riparium), Russian wild ryegrass (Elymus juncus), green stipa grass (Stipa viridula) and Ladak alfalfa (Medicago media) were the species used throughout the five year seeding trials. Each was seeded by itself in plots 8 feet wide and 40 feet long through a double disc drill equipped with depth control plates which provided for a ¾-inch uniform seeding depth. A uniform rate of seeding was maintained for each date and from year to year by seeding 30 viable seeds per lineal foot of row. Spacing between rows was 12 inches. Four replications in a random block arrangement were used for each seeding date. The seeding date blocks were also randomized as to location.

The trials consisted of 10 seeding dates, 5 during the fall period and 5 commencing in the spring. The fall seedings were

Fall Seeding Versus Spring Seeding in The Establishment of Five Grasses and One Alfalfa in Southern Saskatchewan

The problems in successful establishment of hay and pasture seedings in southern Saskatchewan are major deterrents to increased acreage of perennial forage crops. The ravages of hot dry summers and long cold winters on forage stands are enough to contend with, without adding an establishment problem which might otherwise be avoided or at least controlled as far as possible. For most of the Northern Great Plains area the annual precipitation is 15 inches or less. Throughout the northern half of this area, the winter mean temperatures are below 32°F. from November through March, while the summer months of July, August and September are hot and dry. The five months of frozen soil and the three months of dry summer limits the seeding of forage crops to the remaining four months of the year. There is general agreement among workers that forage seedings in the plains area must be confined to fall or spring, but the recommendations differ as to the most suitable time to seed within these periods. Kirk (1937), Heinrichs (1941), White and Horner (1942), and others have concluded that fall seeding is generally an acceptable time to seed forage crops. In most instances these workers used only one or two species, crested wheatgrass usually being one. Those who did include more species conducted experiments which were often confined to fall seeding dates so that within test comparison of fall and spring seedings were not made. Since that time others have conducted dates of seeding trials with recent reports by Douglas et al. (1960) who favors fall seeding over spring although the type of seed bed influenced establishment more than seeding dates. Frischknecht (1959) discussed the possible advantages from fall seeded grasses in obtaining better stands because of seed vernalization. McGinnies (1960) has shown best establishments from spring seeding, although the 7500-foot elevation where his trials were conducted was considerably higher than that which occurs in plains area.

The dates of seeding trials discussed in this paper were conducted on cultivated land during the five successive years from 1947-48 to 1951-52.

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