Thiourea Solution Temperature and Bitterbrush Germination and Seedling Growth

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Highlight: *Antelope bitterbrush (*Purshia tridentata *(Pursh) DC.) seed is commonly soaked in a solution of thiourea to break seed dormancy for spring planting. "Warm" thiourea solutions have been reported to cause seedling deformities. To determine what range of "warm" temperature solutions can cause deformities, four seed collections were treated at 18 temperatures (30°F to 200°F) in increments of 10°F. Normal germination and seedling growth resulted between 60°F and 140°F. Below 60° rate of germination declined slightly, but seedling growth was normal. Seedling deformities began to show up above 140°F, and germination decreased rapidly. Deformities consisted of annular cracks around the hypocotyls and detached root caps. Solution temperatures between 60°F and 140°F are recommended.*

Antelope bitterbrush (*Purshia tridentata* (Pursh) DC.) is one of the most important browse plants for deer and livestock in the West. Continued overuse by deer, cattle, and sheep along with disease, insects, and age have damaged or destroyed many valuable bitterbrush stands. Studies have been conducted in several states to determine the best species and methods to replace these stands. In many areas, bitterbrush has proved to be the best species to replace bitterbrush.

To improve deer ranges, land managers commonly seed bitterbrush. Germination of bitterbrush seed is a problem, however, since it has a dormant embryo. In natural establishment or in fall seeding, this dormancy is overcome by the seed overwintering in the soil (Hubbard and Sanderson, 1961). For spring planting the dormancy must be overcome artificially. Hormay (1943) recommended stratifying the seed in wet sand for 5 to 8 weeks at 30°F to 40°F. This method takes time and produces wet, soft seed which is difficult to handle and is easily damaged. Pearson (1957) found that soaking bitterbrush seed in a 3% solution of thiourea for 3 to 5 minutes would break dormancy. These seeds can be dried and handled easily.

Thiourea treatment has worked out well in California–both in the laboratory and in the field (Hubbard and Pearson, 1958). But, Brown and Martinsen (1959), working in Washington, found some seedlings deformed after dormancy was broken by treating with "warm" thiourea solution. Many of their seedlings "rolled up in a tight curl and often failed to emerge above the surface in sand flats." This deformity was not found in bitterbrush treated with a "cold" solution.

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To define solution temperatures which might cause seedling deformities, we treated seed from several sources at a range of solution temperatures extending beyond that generally available from domestic water supplies (about 40° to 140°F).

Methods

Thiourea Treatment

Antelope bitterbrush seed was collected in four areas representative of its range in California. Seed from all four collections had been used in previous laboratory and field experiments and were known to be typical in germination and growth.

Each collection sample was divided into 18 lots of 70 grams each. Four lots, one from each collection, were treated at a different solution temperature in 200 ml of a 3% solution of thiourea for 5 minutes (Hubbard, Nord, and Brown, 1959). Temperatures ranged from 30°F to 200°F in increments of 10°F, ± 1°F. After treatment the seeds were drained and dried at room temperature on gauze pads.

From each lot, 150 seeds were placed on presoaked germination blotters in three petri dishes with 50 seeds per dish. Petri dishes were watered and seeds checked daily for the following 15 days. The number of seeds germinated and abnormalities were recorded at each check. The dishes were maintained at 70°F, ± 5°F. Seeds having a one-half inch hypocotyl were declared germinated. Germinated seeds were carefully planted in flats filled with a suitable soil material and allowed to grow from 64 to 172 days. Emergence and seedling development were observed.

Water treatment

To separate any thiourea-temperature interaction, we treated one seed collection as previously described in distilled water only. Afterward the seed coats were removed by hand after treatment to allow germination.

Planting Position

We felt there was a possibility that geotropism working on the hypocotyls of seeds planted upside down may have caused the curled seedlings found by Brown and Martinsen (1959). Therefore, we conducted a test of the effect of planting position on emergence. Sixty "normal" germinated seeds from one lot treated at 80°F were selected. Twenty were planted upright (hypocotyl down), 20 were planted inverted (hypocotyl up), and 20 were planted horizontal. Emergence and seedling development were observed daily.

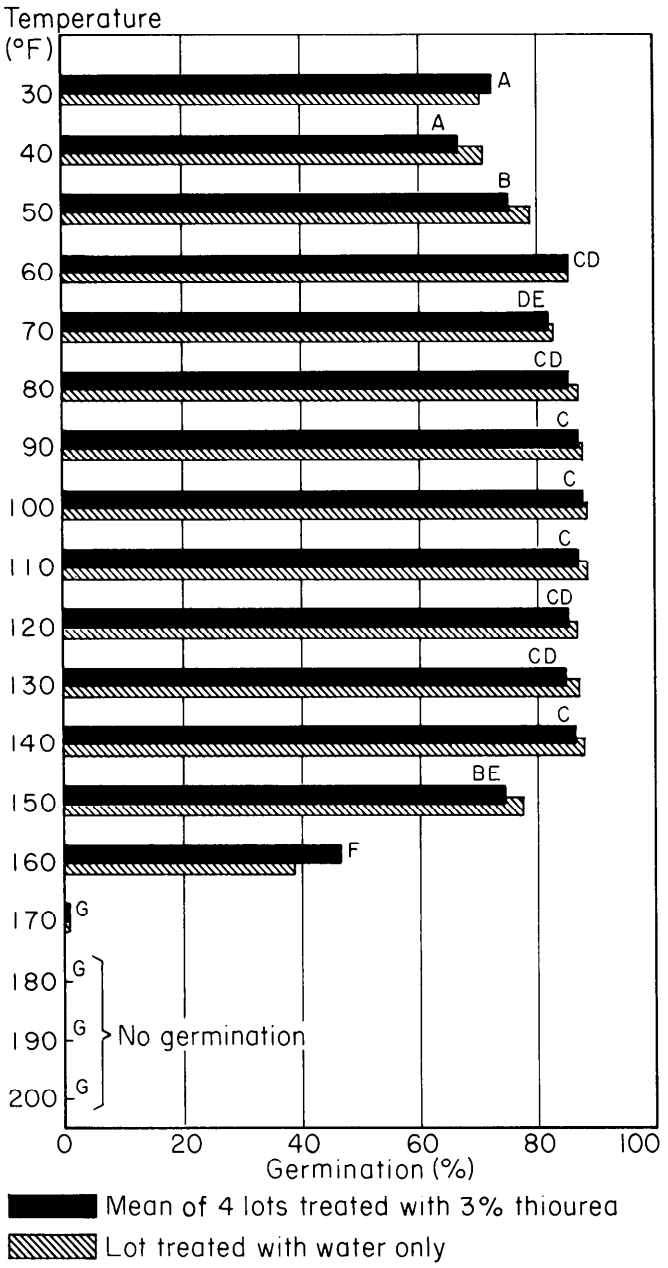

Fig. 1. *Total germination of bitterbrush seed at 15 days, by solution temperature. Thiourea treatments followed by the same letter do not differ significantly at the 5% level according to Duncan's New Multiple Range Test.*

Results

Germination

All four seed collections responded similarly throughout the range of temperatures tested. They did not differ significantly in germination between 60°F and 140°F (Fig. 1)—nor were there any seedling abnormalities. Germination decreased slightly below 60°F, but still no abnormalities developed. Above 140°F, germination decreased rapidly, and abnormalities began to show up. At 150°F, germination dropped about 15% below normal and a few germinating seeds had small cracks in the hypocotyl. At 160°F, germination dropped to about half of normal and about half of the germinating seeds had deep annular cracks in the hypocotyl. Many of the root caps were loose and separated before the germinating seeds died. At 170°F, only 0.4% of the seed germinated, and they all showed the annular crack and detached root caps. Deep cracks in the hypocotyl were lethal in all cases (Fig. 2).

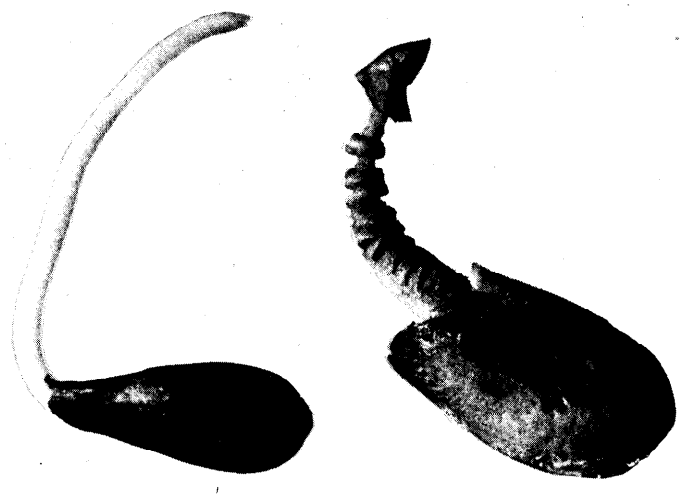

Fig. 2. *Heat-damaged bitterbrush seed (left) and normal seed (right).*

Temperatures which produced lower germination percentages also produced slower germination rates.

Seeds treated in thiourea and those treated in water-only at the same temperature did not differ significantly in germination. Again, the seeds treated in water had the seed coats removed to permit germination.

Emergence and Seedling Development

With few exceptions seedlings that appeared normal when they were moved from the petri dish to the flat emerged and grew normally. Of seeds treated at 30°F through 140°F, 99% emerged normally. Damping-off and other losses reduced this rate to 75% at the end of the growth period. These losses were not correlated with temperature treatment.

Seedlings grown in the flats averaged 1¾ inches tall, with four whorls containing 15 true leaves.

At 150°F, only 51% of the seeds emerged and only 50% of these survived the growth period. At 160°F, 14% emerged and 14% of the emerged seedlings survived the growth period.

All germinated seeds that were deformed but produced half-inch hypocotyls were planted separately and labeled individually in the flats. None of these emerged.

Seeds treated with water-only, at different temperatures and with seed coats removed after treatment, had rates of emergence and survival, and germination, about equal to those treated with thiourea solutions. We can therefore assume little or no interaction between temperature and thiourea.

Planting Position

All seeds planted upright or horizontal produced normal seedlings. All seeds planted inverted were slow to emerge. Two of the inverted seeds produced curled seedlings, as described by Brown and Martinsen (1959), and two produced seedlings with cotyledons in the soil and hypocotyls in the air. These seedlings would have died if they had been allowed to grow in this position. After being turned over, they grew normally.

Conclusions

The four seed collections used in this study showed no deformities after being treated with thiourea solution at temperatures from 30°F through 140°F. This spans the full range of water temperatures generally available from a domestic supply. Under field conditions, temperatures would probably be limited to an even narrower range. And under

"normal" conditions, temperature-induced seedling deformities probably would not be a problem.

Planting seed inverted appears to cause curling and death of the seedling and may be the cause of some loss in field planting. However, it is not practical to control seed position in field plantings and the problem should not be of major concern.

Deformities did occur at temperatures above 140°F. Some seed collections might be slightly more sensitive to solution temperature. Furthermore, germination was reduced slightly below 60°F. Therefore we recommend that thiourea solution temperatures be kept between 60°F (15.6°C) and 140°F (60°C).

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