Juniper Extract and Deficient Aeration Effects on Germination of Six Range Species[1]

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Highlight

Juniper foliage extract significantly decreased seed germination for three of six range species tested. Deficient aeration severely decreased germination for two species and completely inhibited germination of the other four.

Field observations have indicated that plant species and varieties most resistent to inhibitors from juniper, and to poor aeration, might be most likely to succeed on heavy clay soils previously occupied by juniper. For this reason we investigated the effects of Utah juniper (*Juniperus osteosperma* (Torr.) Little) foliage extract and deficient aeration on seed germination of 6 species important for range seeding in the pinyon–juniper woodland.

Suppression of understory vegetation by juniper is a common phenomenon that occurs over many thousands of acres in Arizona and New Mexico (Arnold et al., 1964). The effect is most pronounced on heavy clay soils, particularly those which are poorly drained and poorly aerated (Jameson, 1965). Jameson (1961) found that both aqueous and alcohol extracts of leaves and herbaceous stems from Utah, alligator, and one-seed juniper inhibited growth of wheat radicles in germinating seed. Jameson (1965) hypothesized that there was an accumulation of phytotoxins from juniper leaves under conditions of poor aeration and drainage. In later work with vegetation consisting mainly of pinyon, juniper, and an understory of blue grama, Jameson (1966) concluded that tree litter rather than competition for moisture and nutrients was the reason for the absence of blue grama under the tree canopies.

Johnsen (1962) found that water extracts from old litter, recent litter, and fresh foliage of one-seed juniper had little effect on the germination of blue grama caryopses. In later work Johnsen (unpublished data[2]) grew blue grama in pots with mixtures of soil and foliage litter from Utah, alligator, and one-seed juniper, and he observed no significant effects on seedling emergence or growth. In other work, however, he found that both soil adjacent to juniper roots and groundup roots mixed with potting soil inhibited leaf growth of blue grama, sideoats grama, and wheat. Alligator juniper exerted the greatest effect and Utah juniper the least. Sideoats grama was the most sensitive species tested and blue grama the least.

Aeration effects on seed germination mainly result from the interaction of O_2 and CO_2. Hart and Berrie (1966) working with wild oats under different gaseous environments, found O_2 essential for germination and CO_2 also important. Three % CO_2, by volume, allowed germination in light whereas 20% CO_2 inhibited germination in both light and darkness at all O_2 concentrations. Dasberg et al. (1966) compared germination of 4 range grasses with wheat in atmospheres containing various concentrations of O_2 and CO_2. Wheat germination was relatively insensitive to concentrations of O_2 ranging from 0 to 21% and CO_2 from 0 to 15%. Response of the grasses was fairly uniform. They decreased in rate and final germination percentage with decreasing O_2 concentrations. Fifteen % CO_2 combined with 20% O_2 also decreased both the rate and final amount of germination, but these effects were much smaller than the O_2 effects. Any CO_2 depressing effects at lower O_2 concentrations were apparently masked by O_2 acting as the limiting factor.

Materials and Methods

We used a randomized complete block design consisting of 6 species, 3 treatments, and 4 replications. Species tested were Nordan crested wheatgrass (*Agropyron desertorum* (Fisch. ex Link) Schult.), Luna pubescent wheatgrass (*A. trichophorum* (Link) Richt.), fourwing saltbush (*Atriplex canescens* (Pursh) Nutt.) collected 20 miles south of Winslow, Arizona, sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.) collected on the lower part of the Beaver Creek watershed south of Flagstaff, Arizona, Capitan blue grama (*B. gracilis* (HBK.) Lag. ex Steud.), and weeping lovegrass (*Eragrostis curvula* (Schrad.) Nees).

Amounts of seed used were measured by weight and were based on previous germination tests in which number of viable seed per pound of seed matter had been determined. The following amounts per replication were used for the different species: Nordan crested wheatgrass 966.2 mg, Luna pubescent wheatgrass 1,265.9 mg, fourwing saltbush 1,765.7 mg, sideoats grama 866.1 mg, Capitan blue grama 866.0 mg, and weeping lovegrass 816.0 mg.

Untreated seed was germinated in petri dishes with one layer of filter paper under and another over the seed. Four cc of distilled water were used to wet the filter paper in each dish for the deficient aeration and the control treatments. The juniper extract treatment consisted of substituting 4 cc of extract for the distilled water.

Utah juniper extract was prepared from oven-dry leaves and herbaceous stems ground to pass through a 20-mesh screen. A light petroleum ether extraction was made for 3 hr to defat

[1] Contribution from the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, in cooperation with the Rocky Mountain Forest and Range Experiment Station and the University of Arizona, Agricultural Experiment Station.

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the ground vegetation. Juniper leaves are waxy so that water extraction without preparatory treatment is difficult. Defatting is a standard laboratory procedure that greatly improves the efficiency of water extraction. The material was redried and then mixed with distilled water in the proportions of 3 g oven dry juniper to 100 ml of water. Finally the mixture was centrifuged, filtered, and the solid residue discarded. The juniper extract had a pH of 4.5. Tests using hydrochloric acid dilutions have shown that a pH as low as 2 is not detrimental to seed germination.

The deficient aeration treatment was accomplished by removing the petri dish covers and placing the bottoms with the seed into 2 desiccators. The desiccators were then flushed with CO_2 and the lids sealed on. No CO_2 measurements were made but O_2 readings taken with an oxygen meter on the desiccator atmospheres just before sealing showed slightly less than 5% O_2. Since approximately 75% of the O_2 was replaced we assumed an equal proportion of N_2 replacement, and calculated CO_2 concentration to be about 75%.

All treatments were germinated in 2 germinators. The petri dishes with the juniper extract and control treatments were stacked directly on the wire germinator shelves. The sealed desiccators with the CO_2 treated seed were also placed on wire shelves in the same germinators. Germinators were kept at room temperature which fluctuated from a diurnal maximum of 80 F to a nocturnal minimum of 60 F. Free water was kept in the bottoms of both the desiccators and the germinators to prevent the seed from drying out. Seed was germinated over a 72-hr period and then examined. Seeds were considered to have germinated and were counted as such when the radicle had ruptured the seed coat.

Data were analyzed by analysis of variance and the Duncan multiple range test.

Results and Discussion

Seed germination was affected by the Utah juniper extract with significant differences among the 6 species tested (Table 1). Blue grama, crested wheatgrass, and sideoats grama exhibited the greatest sensitivity to the inhibitors in the juniper extract as evidenced by a marked reduction in seed germination. Weeping lovegrass and pubescent wheatgrass were only slightly sensitive with small variations that were not significant. Seed germination of fourwing saltbush actually appeared to be stimulated by the juniper extract. The increase, however, was so variable that it was not significant.

The juniper extract favored heavy fungus growth, especially with seed of fourwing saltbush and pubescent wheatgrass. This growth appeared to destroy some of the seeds before they were able to start germinating and may have exerted a confounding influence on the results.

Deficient aeration decreased seed germination of all six species. Germination was 9.25% of the control for fourwing saltbush and 0.74% for blue grama. No germination occurred for seed of crested wheatgrass, pubescent wheatgrass, sideoats grama, and weeping lovegrass. The weeping lovegrass seed became transparent after it imbibed water. The embryo then appeared green and viable but without any sign of growth or of breaking through the seed coat.

With deficient aeration there was a complete absence of fungus on the moist filter paper in the petri dishes. This absence of growth was in strong contrast to the other 2 treatments, especially the juniper extract, where heavy fungus growth was prevalent.

The germination period was set at 72 hr so that only initial vigorous germination would be measured. Results, therefore, are influenced by effect of juniper extract and CO_2 on rate as well as amount of seed germination. Over a longer time period more seed probably would have germinated and changes in proportions of treated seed to control might have occurred.

No attempt was made to separate effects of O_2 and CO_2 on seed germination. Instead, extreme conditions of deficient aeration were simulated by reducing the O_2 and increasing the CO_2 concentrations. Then, the effect of this simulated condition on seed germination was determined. The interaction of deficient aeration with juniper phytotoxins was not investigated though it may be important for some range soils.

Caution should be exercised in extrapolating germination inhibition effects from laboratory to field conditions. Absorption or incubator characteristics could nullify or accentuate the action of the inhibitors under various conditions.

Table 1. Percent germination[1] of 6 range species as affected by Utah juniper extract and deficient aeration.[2]

Treatment	Blue grama	Crested wheatgrass	Sideoats grama	Weeping lovegrass	Pubescent wheatgrass	Fourwing saltbush
Utah juniper extract	28.54	32.38	60.36	90.17	102.71	134.08
Deficient aeration	0.74	0.00	0.00	0.00	0.00	9.25

[1] Percentage of the control for each species after a 72 hour germination period.
[2] Values underscored by the same line are not significantly different at the 5 percent level.

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