Salt Tolerance of Five Varieties of Wheatgrass during Seedling Growth

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Highlight: The salt tolerance of five relatively recently released varieties of wheatgrass was evaluated in a 6-week greenhouse study. Barton western wheatgrass (*Agropyron smithii* Rydb.) tended to be more sensitive to salinity than Arriba or Rosana western wheatgrass. Critana thickspike wheatgrass (*A. dasystachyum* [Hook.] Scribn.) tended to be more salt tolerant than the western wheatgrasses but was not as salt tolerant as Jose tall wheatgrass (*A. elongatum* [Host] Beauv.).

Salinity is a widespread problem in arid and semiarid regions. It is also a man-induced problem in soils where irrigation and rising water tables cause an increase in soluble salts. Of recent concern are the salinity problems associated with some coal mine spoils and processed oil shale wastes. One approach to the problem is to seed salt-tolerant species.

It would be desirable for the species selected to fit into the overall land use plan and pose minimum management problems. Thus in many cases, use of indigenous salt-tolerant species or selections within species would be preferred.

The purpose of this study was to determine the salt tolerance during the seedling stage of four recently released varieties of western and thickspike wheatgrasses. These species are native to extensive areas of the western United States. Tall wheatgrass, a species known to have outstanding salt tolerance, was used as a standard.

Materials and Methods

Five named varieties of *Agropyron*, representing three species, were obtained from Soil Conservation Service Plant Materials Centers. All have been released since 1970 except Jose tall wheatgrass, which was released in 1965 (Hanson 1972). The five varieties are identified as follows:

Variety	*Species*	*Common name*	*SCS center*
Arriba	*A. smithii*	western wheatgrass	Los Lunas, N. Mex.
Barton	*A. smithii*	western wheatgrass	Manhattan, Kans.
Rosana	*A. smithii*	western wheatgrass	Bridger, Mont.
Critana	*A. dasystachyum*	thickspike wheatgrass	Bridger, Mont.
Jose	*A. elongatum*	tall wheatgrass	Los Lunas, N. Mex.

The loam soil in which the grasses were grown was the A1 horizon from a Platner series (Aridic paleustoll). Two-liter paper pots with plastic liners were each filled with 2 kg of soil. The field capacity of this soil was 17% of the air-dry weight.

Six salinity treatments plus an untreated soil check were replicated three times. Salts were added in solution at a rate of 340 ml per pot at the time of planting. These solutions were prepared using mixtures of NaCl, $CaCl_2$, and distilled water in such proportions to maintain the sodium adsorption ratio at a constant level of 3. At this level, the sodium hazard is low and soil structure and permeability are maintained. One hundred ppm N and 50 ppm P were added to each pot.

After harvest a vertical cross section of the soil from one pot per salinity treatment per replication was sampled for electrical conductivity. The six salinity treatments were designed to obtain saturation extract conductivity values of 2, 4, 6, 10, 15, and 20 mmhos/cm; the average EC's of the soils from the six treatments were: 2.3, 3.8, 6.1, 9.3, 15.3, and 18.3, respectively. These values are close to the predicted values which will be used in the discussion to follow. The EC of the check soil was 0.68 mmhos/cm. Soils with saturation extract EC values of 4 mmhos/cm and greater are considered saline, EC values of 16 mmhos/cm and greater are extremely saline (Richards 1954). The study was planted on February 12, 1976, and harvested on March 25, 1976. All pots were watered twice daily in an effort to keep moisture levels close to field capacity. Soil moisture dropped no more than 20% below field capacity on the hottest days. During the third week all pots were thinned to 20 plants per pot. The study was harvested 6 weeks after planting. Tops were clipped 1 cm above ground level and were oven dried for 24 hours at 60°C prior to weighing.

Results

A comparison of above-ground dry matter yields (Table 1) shows Jose tall wheatgrass to be the outstanding producer of the five varieties tested. This was to be expected since the vigor and high salt tolerance of this species is widely recognized (Forsberg 1953; Dewey 1960; Rauser and Crowle 1963). Yields of Critana thickspike wheatgrass were similar to yields of Arriba and Rosana western wheatgrass at salinity levels of 4 mmhos/cm and greater. Barton western wheatgrass yielded significantly less than Critana thickspike wheatgrass at salinity levels of 4, 6, and 10 mmhos/cm. There were no significant differences in yield among the western wheatgrass varieties except that Arriba out-yielded Barton in the 6 mmhos/cm treatment.

Table 1. Yields of above-ground dry matter (g/pot) for five wheatgrass varieties as influenced by salinity treatments.

	Salinity treatments (mmhos/cm)						
Variety	Control	2	4	6	10	15	20
Jose	2.14a*	2.52a	2.36a	2.17a	1.58a	0.66a	0.36a
Critana	1.43b	1.47c	1.58b	1.26b	0.71b	0.24b	0.07b
Arriba	1.67b	1.86b	1.53bc	1.24b	0.61bc	0.16b	0.07b
Rosana	1.54b	1.77b	1.51bc	1.09bc	0.59bc	0.17b	0.07b
Barton	1.65b	1.66bc	1.30c	0.92c	0.54c	0.17b	0.02b

* Any two means within the same salinity treatment followed by the same letter are not significantly different at the 0.05 level.

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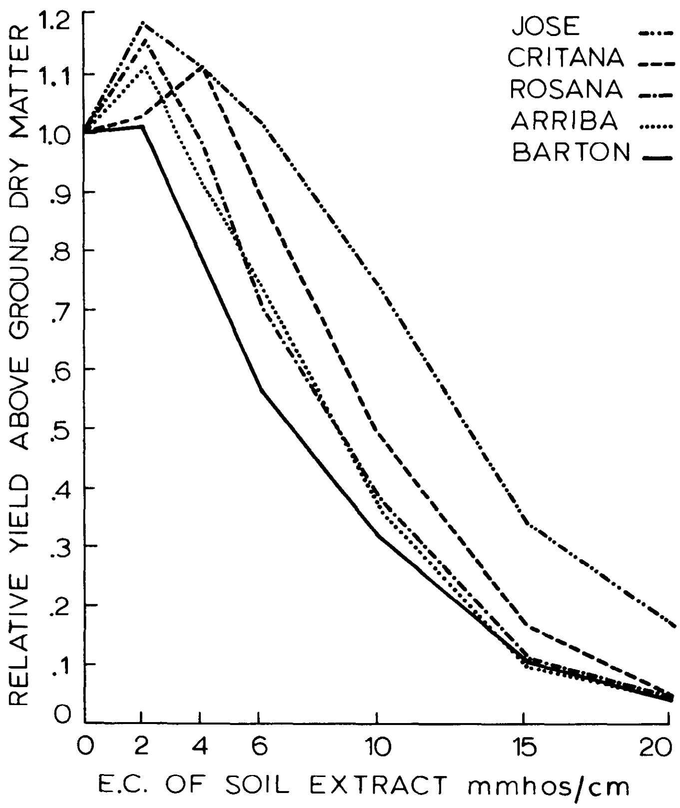

Fig. 1. *Relationships of relative yield of five wheatgrass varieties to electrical conductivity of soil extract.*

The yield of the roots as a function of the salinity treatments followed the same trend as the tops but the mass was slightly greater. The Jose variety produced about twice as much root mass as any of the other varieties. Root weights are not included in this report as we are not confident that all roots were recovered by the washing techniques used.

Dry matter yields are useful in pointing out differences in growth rates among varieties, but salt tolerance per se is best evaluated on the basis of relative plant yields when grown under saline as compared to nonsaline conditions. Thus relative yields were calculated and plotted for each variety at each salinity level using the yield of the control of that variety as the standard (Fig. 1).

When comparing relative yields, the greatest differences among varieties existed at the 6 mmhos/cm level where all varieties were significantly different (0.05 level) except Arriba and Rosana. Consistent trends in differences in salt tolerance among some varieties at EC's of 6 mmhos/cm and greater are apparent in Figure 1.

Salt tolerance can be compared using a salt tolerance index, which is the EC of the soil saturation extract at which yields are reduced 50% from the control (Richards 1954). Thus by using Figure 1, we can rank the five varieties in this study with their respective salt tolerance indexes as follows: (1) Jose, 13 mmhos/cm; (2) Critana, 10 mmhos/cm; (3) Arriba and Rosana, 8.5 mmhos/cm; (4) Barton, 7 mmhos/cm.

The salt tolerance of the western wheatgrass varieties in this study was considerably less than the salt tolerance of tall wheatgrass. This is in agreement with the findings of Forsberg (1953), who reported on seedling success and forage yields of these species in a field study. In contrast, Richards (1954) rated western wheatgrass high in salt tolerance. The latter rating was for productivity of western wheatgrass that was established under nonsaline conditions and then subjected to salinity treatments. Thus the reader is cautioned that salt tolerance indexes can be expected to vary with the stage of growth and environmental conditions, particularly moisture regime and type of salt.

In summary, Jose tall wheatgrass was considerably more salt tolerant than the western and thickspike wheatgrass varieties tested. Critana thickspike wheatgrass produced significantly greater relative yields at an intermediate salinity level (6 mmhos/cm) than the western wheatgrass varieties. The western wheatgrass varieties Arriba and Rosana produced greater relative yields than the Barton variety at the intermediate salinity level. At the higher salinity levels, differences among the western and thickspike wheatgrass varieties were less and generally not significant.

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