TECHNICAL NOTES

Effects of Two Wetting Agents on Germination and Shoot Growth of Some Southwestern Range Plants

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Highlight: Two soil wetting agents (linear sulfonate and alkyl polyethylene glycol ether) were evaluated on inhibition of germination and shoot growth of alkali sacaton, galleta, blue grama, and fourwing saltbush. Sacaton and galleta seeds were germinated in wetting agent solutions (185, 370, and 740 ppm by volume) as well as in sand and a water-repellent coal mine spoil sample treated with the wetting agents at rates equivalent to 23.5, 47, 94 liters/ha. Blue grama and saltbush were germinated only in the sand and spoil samples. Results indicate that in solution culture these wetting agents reduce germination, severely deter shoot growth of both sacaton and galleta, and cause nearly permanent injury to plumules of galleta seeds. Wetting agents applied to sand at the comparable rates cause only minor reduction in shoot emergence and growth of the tested grass species, presumably due to soil sorption of wetting agents. The wetting agents tested are potentially phytotoxic, especially the sulfonate compound to saltbush, but can improve shoot emergence when applied to water-repellent media.

One problem in revegetating coal mine spoils of the arid southwest is poor water infiltration induced by water-repellency (Miyamoto et al. 1977). A previous study shows that the use of wetting agents, especially a linear sulfonate compound, improves water infiltration into water-repellent mine spoils (Miyamoto 1977). Wetting agents are also effective for improving infiltration into water-repellent soils and peat media (e.g., Pelishek et al. 1962; Osborn et al. 1969). However, some wetting agents are toxic to plants (e.g., Endo 1969; Luxmoore et al. 1974; DeBano and Conrad 1974), while others may stimulate plant growth (Parr and Norman 1974). The study was thus made to evaluate inhibitory effects of two soil wetting agents on germination and shoot growth of alkali sacaton (*Sporobolus airoides*), galleta (*Hilaria jamesii*), blue grama (*Bouteloua gracilis*), and fourwing saltbush (*Atriplex canescens*).

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Materials and Methods

Two commercially available wetting agents, "Soil Pen"[1] (linear sulfonate) and "Water-In" (alkyl polyethylene glycol ether), were used. These compounds, especially "Soil Pen" improve water infiltration into water-repellent mine spoils consisting of coal fragments (Miyamoto 1977. The compound "Water In" was studied previously by Luxmoore et al. (1974) and DeBano and Conrad (1974), and is included here for comparison.

Four species (alkali sacaton, galleta, blue grama, and fourwing saltbush) were used for testing. Alkali sacaton and saltbush are used extensively for spoil revegetation in the arid-southwest, while galleta is used only to a limited extent.

Germination tests were conducted for sacaton and galleta by using a solution culture technique under greenhouse conditions (25 to 30°C). Seeds (100 each) were placed into petri dishes containing wetting agent solutions (185, 370, and 740 ppm by volume on an active ingredient basis) in amounts sufficient to wet the seeds; the solutions were changed every 3 days. No adsorptive medium except seeds was placed in the dishes in order to avoid possible sorption of wetting agents. Germination counts were made at 3, 7, and 14 days after seeding. Seeds were considered germinated when shoot or root exceeded the size of seeds. Shoot growth was traced by measuring the length of shoots. As a separate test, seeds germinated in the wetting agent solutions of 185 ppm were transferred into dishes containing distilled water, then the shoot elongation was traced for 3 weeks. Experiments were in triplicate, and the Student-Newman method was used for tests of significance.

[1] The trade name is included here for the convenience of readers and does not imply endorsement by the author, Texas Agr. Exp. Sta. and the Forest Service, U.S. Dep. Agr.

Shoot emergence was determined for the four species by using two growth media: a coarse sand and a mine spoil consisting of coal fragments, both collected from the Fruitland formation in the Navajo Indian reservation. The coarse sand contained approximately 9% silt plus clay fraction. The coal-based spoil was poorly wettable, having a solid-water contact angle of 87° measured by the relative capillary rise method of Letey (1969). These materials were air dried and placed into greenhouse pots (10 cm ID, 12 cm deep). Seeds were placed at a depth of 1 cm. Thereafter, wetting agent solutions in the same concentrations as the solution culture experiments were applied to the surface in amount of 1.25 ml/cm^2. Equivalent rates of active ingredients were 23, 47, and 94 liter/ha (or 2.5, 5, and 10 gallons per acre, respectively). For blue grama and saltbush, only the highest rate was used. Pots were placed under greenhouse conditions (20–30°C for grasses and 15 to 25°C for saltbush) and

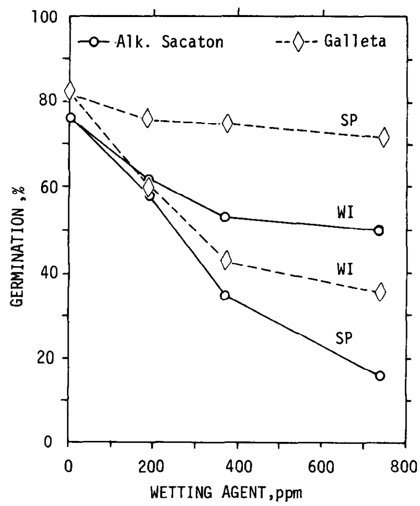

Fig. 1. *Germination of sacaton (solid lines) and galleta (dotted lines) seeds as influenced by the concentration of wetting agent solutions; SP = Soil Pen, WI = Water In.*

Table 1. The average shoot length (cm) of sacaton and galleta grown in distilled water, wetting agent solutions (185 ppm), and in distilled water following the growth in the wetting agent solutions.

Species and days after seeding	Distilled Water	Wetting agents		Distilled following wetting agents	
		SP	WI	SP	WI
Alkali sacaton					
5 days	1.0*	0.2 b	0.1 b	0.2 b	0.1 b
10	1.5 a	0.2 b	0.2 b	0.8 c	0.3 b
21	—	0.5	0.4	1.7	0.6
Galleta					
3 days	3.2 a	0.2 b	0.1 b	0.2 b	0.1 b
10	5.0 a	0.2 b	0.2 b	0.2 b	0.2 b
21	—	0.2	0.2	0.2	0.2

* Numbers followed by the same letter are not significantly different at 5% level between the treatment consisting of different growth media.

irrigated with tap water every 3 days at a rate of 1.25 cm. Seedling counts were made on the 7th and 14th days. Shoot length was also measured on the same days by arbitrarily taking ten shoot samples.

Results and Discussion

Germination of galleta seeds placed in distilled water started within 1 day and virtually finished within 3 days, whereas sacaton continued to germinate up to about 7 days. The germination of both species placed in wetting agent solutions was, however, slow, reaching an apparent plateau within 7 days, then increasing for approximately 5 to 10% for another week. Germination counts made at 2 weeks are shown in Figure 1. Increasing concentrations of wetting agents reduced germination. The germination of sacaton (solid lines) was reduced markedly by "Soil Pen" (SP), whereas galleta tolerated this wetting agent but was severely affected by "Water In" (WI).

Both wetting agents severely deterred shoot growth (Table 1). Table 1 also includes the situation where seeds germinated in wetting agent solution were transferred into distilled water and then the shoot growth was traced (the last two columns). The transfer was made on the 3rd and 5th day after seeding for galleta and sacaton, respectively. This transfer activated shoot growth of sacaton, but not of galleta. The incubation of galleta seeds in these wetting agent solutions for 3 days evidently causes a permanent injury to plumules.

Shoot emergence of galleta from the sand and the coaly spoil started 2 days after seeding and was virtually completed within one week, whereas blue grama and sacaton started emerging approximately 5 days after seeding and continued to emerge for about another 10 days. The emergence of saltbush was slower by several days. Emergence counts made at 2 weeks are given in Table 2. Application of wetting agents reduced emergence in sand, but increased emergence over the control in the mine spoil, except for saltbush. The emergence of saltbush was notably reduced by application of "Soil Pen."

Application of wetting agents to sand and spoil resulted in minor or no measurable reduction in shoot growth of the grass species (Table 2). (Since data from the sand were similar to those from the spoil, they are omitted.) Application of "Soil Pen," however, caused notable reduction in shoot growth of saltbush.

The above data point out that inhibitory effects are reduced when wetting agents are applied to sand and spoils. An observation similar to this is also reported by Endo (1969) and Luxmoore et al. (1974). The major reason is probably soil sorption of wetting agents (Valoras et al. 1969). The leaching of wetting agents by irrigation can be an additional reason, but probably a minor factor as compared to the sorption. If there were no sorption in our tests, wetting agent solution applied initially would have permanently damaged the plumules before leaching took place.

In conclusion, the tested wetting agents should be considered potentially toxic to germination and shoot growth. However, soil application of these wetting agents to the tested rates is not likely to severely deter germination and shoot growth, with a possible exception of saltbush.

Table 2. Shoot emergence and average shoot length as influenced by application of wetting agents to sand and soil.

Species and treatments	Application rate (liter/ha)	Sand	Spoil	
		Emergence (%)	Emergence (%)	Length (cm)
Alkali sacaton				
Control		77 a*	30 a	1.7 a
Soil pen	(47)	65 b	40 b	1.6 a
Soil pen	(94)	61 c	43 b	1.6 a
Water in	(47)	69 b	52 c	1.8 a
Water in	(94)	69 b	58 c	1.9 a
Galleta				
Control		80 a	35 a	4.8 a
Soil pen	(94)	74 b	58 b	4.8 a
Water in	(94)	72 b	52 b	5.0 a
Blue grama				
Control		75 a	28 a	2.8 a
Soil pen	(94)	72 a	56 b	2.1 b
Water in	(94)	75 a	43 c	1.9 b
Saltbush				
Control		22 a	13 a	4.0 a
Soil pen	(94)	6 b	8 b	2.6 b
Water in	(94)	21 a	12 a	3.5 b

* Numbers followed by the same letter are not significantly different at the 5% level from other treatments of different growth media.

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