Technical Notes
Germination of 2 legumes in leachate from introduced grasses

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Abstract

Kleberg bluestem [*Dichanthium annulatum* (Forsk.) Stapf] and buffelgrass (*Cenchrus ciliaris* L.) may produce phytotoxic chemicals that inhibit germination and growth of legumes planted in seeding mixtures with grasses. We determined the effects of leachate from these introduced grasses on seed germination of Illinois bundleflower [*Desmanthus illinoensis* (Michx.) MacM.] and partridge pea (*Cassia fasciculata* Michx.). Percent germination of Illinois bundleflower seeds on substrata moistened with Kleberg bluestem root or buffelgrass leaf leachate was lower than that of seeds placed on substrata moistened with distilled water. Buffelgrass root leachate reduced germination of partridge pea more than did root leachate from Kleberg bluestem or leaf leachate from Kleberg bluestem or buffelgrass. Results of these laboratory experiments indicate that field studies are warranted to determine the effects of buffelgrass on establishment of partridge pea and Illinois bundleflower in order to help land managers select the optimum combination of species for rangeland seeding.

Key Words: buffelgrass, *Cenchrus ciliaris*, Kleberg bluestem, *Dichanthium annulatum*, Illinois bundleflower, *Desmanthus illinoiensis*, partridge pea, *Cassia fasciculata*, allelopathy

Kleberg bluestem [*Dichanthium annulatum* (Forsk.) Stapf] and buffelgrass (*Cenchrus ciliaris* L.) are exotic forage grasses commonly planted on Texas rangelands. Both may produce toxic chemicals that inhibit germination and growth of other plant species (Akhtar et al. 1978, Dirvi and Hussain 1979, Hussain et al. 1982).

Native legumes in seeding mixtures with grasses enhance the value of the plantings for wildlife and livestock and provide an economical source of nitrogen (Call 1985). Illinois bundleflower [*Desmanthus illinoensis* (Michx.) MacM.] and partridge pea (*Cassia fasciculata* Michx.) are native legumes currently used in range seeding in Texas (Everitt and Gausman 1984, Everitt and Heizer 1984). Our objective was to determine the effects of leachate from Kleberg bluestem and buffelgrass on seed germination of Illinois bundleflower and partridge pea.

Materials and Methods

Fresh roots and leaves of buffelgrass and Kleberg bluestem were randomly collected in August and September 1985 from improved pastures 4 km north of Kingsville, Texas. Soil was rinsed from the roots and leaves of both species with tap water, and then 200 g of each sample was soaked in 2 L of distilled water for 48 hours at 22° C (Bokhari 1978). Leachate and plant parts of each species were filtered through 4 layers of cheese cloth and then vacuum filtered through Whatman No. 541 filter paper. The filtrate was stored in a refrigerator at 2–4° C for 24 hours before use.

Water potential of leachate samples was measured before each experiment with a freezing point depression osmometer. Water potential of Kleberg bluestem leaf and root, and buffelgrass leaf and root leachates averaged -0.08 and -0.10, and -0.13 and -0.10 MPa, respectively. The pH of distilled water, Kleberg bluestem leaf and root, and buffelgrass leaf and root leachates averaged 6.01, 5.48, 55.1, 4.98, and 5.01, respectively.

Partridge pea (accession PI-43061) and Illinois bundleflwer (accession PI-43401) seeds were obtained from the USDA Soil Conservation Service Plant Materials Center at Knox City, Texas. Seeds were individually scarified before use in each experiment. Fifty seeds each of partridge pea and Illinois bundleflower were germinated on substrata moistened with 100 ml of either distilled water or leachate. The substrata consisted of 2 layers of 11 cm diameter filter paper on a layer of creped cellulose placed in 13 by 14 by 5 cm plastic boxes. The boxes were placed in sealed plastic bags to minimize evaporation. For each species and treatment, 4 plastic boxes were arranged in a randomized complete block design within a controlled environment chamber set at alternating temperatures of 15° C for 12 hours (with darkness) and 25° C for 12 hours (with fluorescent lights). Photosynthetic photon flux density averaged 25 umol • m^{-2} •s^{-1}. Experiments were repeated 3 times using a separate collection and extraction each time. The number of germinated seeds was recorded every 3 days for 15 days. This period was selected because germination peaked in 3 days and few seeds germinated after 9 days.

The germination rate index (GRI) was calculated as the summation of the germination percentage at each count divided by the total number of days for germination (Maguire 1962). The corrected germination rate index (CGRI) was obtained by dividing GRI by the final germination percentage and then multiplying by 100 (Evetts and Burnside 1972, Hsu et al. 1985). Seeds were considered germinated when the root was more than 5 mm long and at least part of 1 cotyledon was visible. Radicle lengths of 3 randomly selected seedlings in each box were determined at the end of each experiment.

Percent germination data were arcsine transformed for analysis. Values presented in the text are untransformed means. Analysis of variance for a randomized block design and 3 replications in time and Tukey's HSD test were used to compare the effect of treatments on seed germination, radicle length, and corrected germination rate index (Walpole and Meyers 1978).

Results and Discussion

Germination of Illinois bundleflower seeds on substrata moistened with Kleberg bluestem root or buffelgrass leaf leachate was lower than that of seeds on substrata moistened with distilled water (Table 1). Radicles of seedlings on substrata moistened with Kleberg bluestem leaf or root and buffelgrass leaf leachate were shorter than those of seedlings on substrata moistened with distilled water. The corrected germination rate index did not differ significantly ($P>0.05$) among treatments and between treatments and the control.

Germination of partridge pea seeds on substrata moistened with root or leaf leachate of both species was lower than that of seeds on

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Table 1. Effects of Kleberg bluestem and buffelgrass leachate on mean percent germination, radicle length (cm), and corrected germination rate index (CGRI) of Illinois bundleflower and partridge pea at 15–25° C (12 hours with darkness, 12 hours with light).

Species and germination parameter	Leachate treatment				
	Control (Distilled water)	Kleberg bluestem		Buffelgrass	
		Leaf	Root	Leaf	Root
Illoinis bundleflower					
% germination[1]	91.3a[2]	85.2ab	79.8bc	69.7c	82.6ab
Radicle length	2.6a	1.8b	1.7b	0.9c	2.2ab
CGRI	31.7a	29.2a	30.3a	30.8a	30.5a
Patridge pea					
% germination	89.3a	81.0b	77.5b	80.0b	67.2c
Radicle length	2.3a	2.3a	1.9a	0.8b	0.9b
CGRI	30.6a	28.0b	29.1ab	28.1b	27.7b

[1]Percent germination data were arcsin transformed for analysis.
[2]Means in the same row followed by the same letter are similar ($P>0.05$) according to Tukey's HSD test.

substrata moistened with distilled water (Table 1). Buffelgrass root leachate reduced germination of partridge pea more than did the other leachates. Kleberg bluestem leaf and root leachate did not affect radicle lengths of partridge pea seedlings, but buffelgrass leaf and root leachate did. The corrected germination rate index of seeds placed on substrata moistened with Kleberg bluestem leaf and buffelgrass leaf and root leachate was less than that of seeds placed on substrata moistened with distilled water.

Effects of Kleberg bluestem and buffelgrass leachate on germination of Illinois bundleflower and partridge pea were possibly confounded with the osmotic potential of the leachate solutions. Bell (1974) stated that results of tests for allelopathy with leachate solutions that have concentrations exceeding 50 milliosmoles (about –0.11 MPa) should be interpreted with care because plant growth may have been reduced by osmotic effects rather than by phytotoxins. Germination of Illinois bundleflower seeds is reduced by –0.2 MPa osmotic potentials imposed by polyethylene glycol solutions (Everitt and Gausman 1984). Percent germination of partridge pea seeds in –0.1 and –0.2 MPa polyethylene glycol solutions is similar to percent germination in distilled water (0 MPA) (Everitt and Heizer 1984).

The clearest evidence of phytotoxicity was the effect of buffelgrass roots on partridge pea germination. Germination of partridge pea seeds on substrata moistened with buffelgrass root leachate was lower than that of seeds on buffelgrass leaf leachate, which had a more negative osmotic potential, and was lower than that of seeds on Kleberg bluestem root leachate, which had a similar osmotic potential (Table 1). Root growth was also less on buffelgrass root leachate than on Kleberg bluestem root leachate.

Concentrations of leachates used in this study were similar to those used by other investigators (Rice 1972, Bokhari 1978) but concentrations of phytotoxins leached from Kleberg bluestem and buffelgrass in the field are unknown. Because our laboratory studies provided evidence of phytotoxity, greenhouse and field studies to determine the effects of buffelgrass on establishment of partridge pea and Illinois bundleflower are warranted.

Literature Cited

Akhtar, N., H.H. Naqvi, and F. Hussain. 1978. Biochemical inhibition exhibited by *Cenchrus ciliaris* Linn. and *Chrysopogon aucheri* (Bioss) Stapf. Pak. J. For. 28:194-200.

Bell, D.T. 1974. The influence of osmotic pressure in tests of allelopathy. Trans. Ill. State Acad. Sci. 67:312-317.

Bokhari, U.G. 1978. Allelopathy among prairie grasses and its possible ecological significance. Ann. Bot. 42:127-136.

Call, C.A. 1985. Storage life of Illinois bundleflower and western indigo seed. J. Range Manage. 38:500-503.

Dirvi, G.A., and F. Hussain. 1979. Allelopathic effects of *Dichanthium annulatum* Forsk.) Stapf. on some cultivated plants. Pak. J. Sci. Ind. Res. 22:194-197.

Everitt, J.H., and H.W. Gausman. 1984. Germination of Illinois bundleflower and velvet bundleflower seeds. J. Rio Grande Valley Hort. Soc. 37:43-48.

Everitt, J.H., and R.B. Heizer. 1984. Seed germination characteristics of maximilian sunflower *(Helianthus maximiliani)* and partridge pea *(Cassia fasciculata).* J. Rio Grande Valley Hort. Soc. 37:49-54.

Evetts, L.L., and O.C. Burnside. 1972. Germination and seedling development of common milk weed and other species. Weed Sci. 20:371-378.

Hsu, F.H., C.J. Nelson, and A.G. Matches. 1985. Temperature effects on germination of perennial warm-season forage grasses. Crop Sci. 25:215-220.

Hussain, F., H.H. Naqvi, and I. Ilahi. 1982. Interference exhibited by *Cenchrus ciliaris* and *Bothriochloa pertusa.* Bull. of the Torrey Bot. Club. 109:513-523.

Maguire, J.D. 1962. Speed of germination-aid in selection and evaluation for seedling emergence and vigor. Crop Sci. 2:176-177.

Rice, L.R. 1972. Allelopathic effects of *Andropogon virginicus* and its persistence in old fields. Amer. J. Bot. 59:752-755.

Walpole, R.E., and R.H. Meyers. 1978. Probability and statistics for engineers and scientists. Macmillan Publishing Co., N.Y.