Allelopathic Effects of Kochia on Blue Grama

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Abstract

The allelopathic effects of kochia aqueous extracts found in kochia *(Kochia scoparia* L. Roth.) on seed germination and seedling growth of blue grama (*Bouteloua gracilis* [H.B.K.] Lag.) were studied in laboratory experiments. Extracts were from regrowth, whole tops, leaves, and stems, representing the vegetative and reproductive phenologies. Inhibition of seed germination did not occur. However, seedling radicle and shoot growth were significantly ($P<0.05$) affected. Inhibition declined significantly with concentrations of the solutions and advancing phenological stage. Similarly, hot water extracts inhibited growth more than cold water extracts. The data suggest possible inhibitory effects of kochia litter under field conditions, but detailed studies are lacking.

Key Words: germination, inhibition, leaf extracts

Allelopathy is a direct or indirect harmful/stimulating effect by one plant (including microorganisms) on another through production of chemical compounds that escape into the environment (Rice 1979). The phytotoxic effects of the chemical and duration of impact depend on concentration of the compounds, their phytotoxic potential on the susceptible plants and resistance to degradation. Several compounds have been identified as exhibiting allelopathy (Rice 1974). Among them are phenolics, flavonoids and alkaloids, which have been isolated from kochia foliage (Lodhi 1979); these compounds have also been grouped as antiquality and unpalatability components of forages (Martem 1973).

Kochia (*Kochia scoparia* L. Roth) is an early pioneering annual in denuded areas of the Southwest (Spowls 1981) and on mine spoil materials (Wali and Freedman 1973). However, longevity of dominance does not exceed 3 years (Wali and Iverson 1978), after which there is patchiness and ingress of other plant species into formerly kochia-dominated vegetation. These authors attributed the successional patterns to unidentified phytotoxins produced by decaying kochia foliage inducing autotoxicity. These conclusions were confirmed by Lodhi (1979).

This study was conducted to examine the allelopathic potential of kochia aqueous extracts from (a) different phenological stages, (b) plant fractions and (c) method of extraction on germination and seedling growth of blue grama (*Bouteloua gracilis* [H.B.K.] Lag.).

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Materials and Methods

Preparation of Aqueous Extracts

Kochia forage samples were collected several times during the summer and early fall 1984.

Cold and hot water were used to extract the phytotoxins. Freeze dried samples of kochia regrowth, whole tops, leaves and stems were ground to pass through a 2-mm mesh screen. One gram of ground sample was weighed into 250-ml flasks containing 100 ml of deionized water. With cold water extraction, the mixture was thoroughly shaken every 20 min for 1 h. With hot water extraction, the flasks containing the mixture were placed in a water bath containing boiling water and allowed to stand for 1 h. The extracts were filtered through Whatman No. 540 paper into clean 250-ml flasks and stored at room temperature.

Germination

Blue grama seeds (Acc. No. Hachita) were obtained from the Plant Matrials Center, Los Lunas, New Mexico. Seeds were washed in running water, soaked for 5 min in sodium hypochlorite (0.50% concentration) for disinfectation and rinsed with deionized water 3 times. One hundred seeds germinated in petri dishes on Whatman No. 4 filter paper with 5 ml of the aqueous extracts and deionized water as control. The petri dishes were incubated in dark at room temperature (20–30° C), and germination counts were made after 24 and 36 h. Germination was considered complete after the radicle and shoot had emerged. The experimental arrangement was a completely randomized design with 2 replications per solution at each sampling period.

Effect of Extracts on Radicle and Shoot Growth

Concentrations of extracts were 1 g of kochia material per 100 ml and 1 g of material per 200 ml. Dilutions of the extracts were added to each petri dish as a final volume of 5 ml. Ten disinfected seeds were grown in each petri dish. Experimental design, replications and growth conditions were as described in germination test. After 5 days incubation, shoot and radicle length were determined.

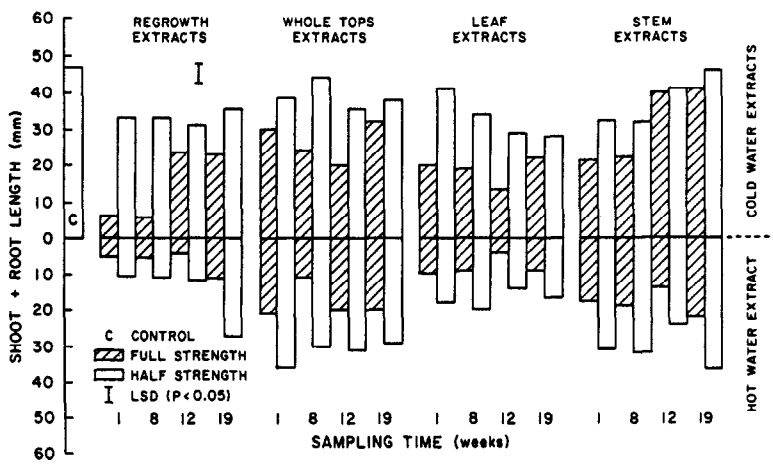

Fig. 1. *Growth of blue grama seedlings incubated in different concentrations of kochia.*

Results

Germination

Mean seed germination results are shown in Table 1. Kochia aqueous extracts had no significant ($P<0.05$) effect on germination of blue grama seeds at all concentrations of the solutions. Kochia extracts collected at different phenologic stages had no effect on germination.

Table 1. Average germination percentage (± standard errors) of blue grama seeds treated with kochia extracts.

Treatment	Germination
	%
Control	98 ± 2
Kochia Extracts	
(1) regrowth	92 ± 1
(2) whole tops	93 ± 3
(3) leaf	92 ± 2
(4) stem	94 ± 3
LSD	non-significant

Seedling Growth and Cold Water Extracts

Both concentrations of cold water extracts depressed blue grama seedling growth significantly ($P<0.05$), with degree of inhibition diminishing with increasing proportion of kochia stems in the extracted sample (Fig. 1). Growth depression from whole top extracts was intermediate ($P<0.01$) and stem extracts last ($P<0.05$). Blue grama growth with half concentrations of extract were about half or more of that observed with full strength extracts, and inhibition at both concentrations was significant ($P<0.05$)

Hot Water Extracts

The effect of hot water extraction was an increase in the extent of suppression by all concentrations (Fig. 1 and 2). Overall suppression was higher ($P<0.05$) than with cold water extracts. Growth in full concentration extracts from leaves and regrowth were most depressed ($P<0.001$), while that from whole tops and stems were similar ($P<0.01$). Depression by half concentration followed a similar pattern, but at reduced levels.

Discussion

Allelopathy expresses itself in many ways, such as seed germination inhibition (Rice 1974). However, in this study, kochia toxins had no effect on seed germination of blue grama. These results are similar to those reported by Lodhi (1979). The lack of toxicity of kochia extracts suggests that its rapid establishment of new sites (Wali and Iverson 1978) is mainly attributable to the large seed reserves and initial rapid seedling growth rate. The aqueous extracts inhibited seedling growth of blue grama and the extent of inhibition was proportional to concentration of the extracts. These observations are similar to those obtained by Qasem and Abu-Irmaieh (1984) and Rasmussen and Einhelling (1975) on inhibition of wheat and sorghum seedling growth, respectively. Results of this study confirm the report by Lodhi (1979) that kochia toxins are allelopathic and that inhibition was proportional to the concentration of the toxins. The study also confirmed that toxins had variable threshold concentration to effect allelopathic potential. The specific toxins were not identified and their concentrations in the extracts were not quantified in this study. The presence of toxins in the soil where kochia was growing was also not demonstrated. Possible ecological effects of these toxins need further study.

Extracts from mature foliage and the stem fraction were less inhibitory to growth than those from regrowth or leaves. This suggests a dilution effect to the toxins, particularly by the stem fraction. It appears that heat facilitated release of the toxins to the medium. This could occur by either rupturing the cell structure or possibly breaking the chemical bonds binding the complexes (Rice 1979) or simple temperature solubility affects if the toxin is indeed a kochia toxin. There are no data indicating whether temperature and moisture play a similar role under range conditions as regards kochia.

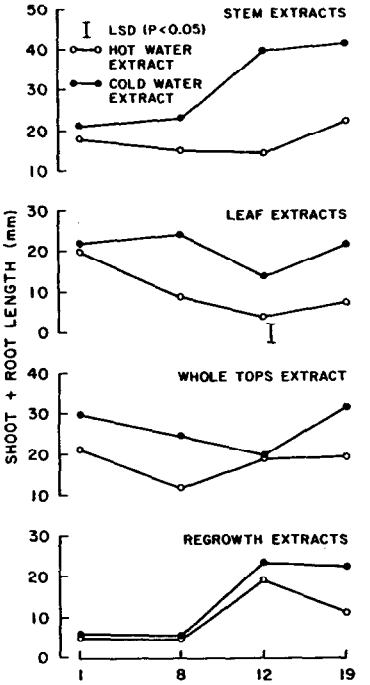

Fig. 2. *Growth of blue grama seedlings incubated in full concentrations of kochia extracts collected from plants 1, 8, 12 and 19 weeks of emergence.*

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