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Effect of *Rhazya stricta* Foliage Leachate on Seedling Growth and Survival of Some Range Plant Species

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ABSTRACT. *Rhazya stricta.* an evergreen poisonous shrub is rapidly invading large areas of rangelands in Saudi Arabia. A laboratory study was conducted to investigate the effect of its dry foliage leachate on seedling growth and survival of some range plants including *R. stricta* its self at different stages of seedling growth. Results indicated that seedlings were more susceptible to allelopathic effects at their early days of growth. Seedling growth was depressed and hence survival was negatively affected. Root growth was more restricted than shoots. Species varied in their response to leachate. Sensitivity ranking of species was as follows: *R. stricta = Achillea fragrantissima > Farsetia aegyptia > Atriplex halimus > Lasiurus scindicus.* Least sensitive species and species having fast and vigorous seedling growth should be selected for revegetation of *R. stricta* invaded range sites.

Introduction

Association and disassociation patterns between certain plants species are widely known. Such phenomena may be governed by direct competition for necessary growth factors or through addition of allelopathic chemicals into the soil environment (Rice, 1984). It has been documented that allelopathy may play an important role in plant-plant interference (Johnston, 1961; Rasmussen and Rice 1971; Newman and Rovira, 1975; Bokhari, 1978; Rice, 1984). The allelopathic effects include germination inhibition (Gressel and Holm, 1964; Al-Saadawi and Rice, 1982a,b; Williamson *et al.,* 1992*;* Patil, 1994), seedling growth retardation (Al-Saadawi and Rice, 1982a,b; Conard, 1985; Bhatt and Todoria, 1990; Kalburtji and Mosjidis, 1993a,b) and poor seedling survival (Conard, 1985; Smith, 1990).

Rhazya stricta Decne. (Apocynaceae), an evergreen poisonous shrub, is extensively invading large areas of deteriorated rangelands in Saudi Arabia. The species occurs over most rangelands in the Kingdom (Allred, 1968; Migahid, 1989). Assaeed (1996) reported that *R. stricta* was a co-dominant species in a

low diverse vegetation of a deteriorated range site. He suggested that one mechanism by which this species spreads is through its allelopathic effects on other species.

The objectives of this study were to: 1) Investigate the effect of *R. stricta* dry foliage leachate on growth and survival of seedlings of some range plant species and 2) Assess the sensitivity of tested species to the leachate in terms of seedling growth and survival.

Materials and Methods

Leachate from air dried leaves of *Rhazya stricta* Decne was prepared by soaking leaves in tap water at a ratio of 1: 10 weight to volume for 12 hours (Muller and Muller, 1956). Leachate was filtered using Watman No. 1 paper.

Seeds of *Achillea fragrantissima* (Forssk.) Sch.- Bip., *Atriplex halimus* L., *Farsetia aegyptia* Turra, *Lasiurus scindicus* Henr. and *R. stricta* were sown in 10 cm diameter pots filled with sandy soil. Seeds of *R. stricta* were immersed in running tap water for 2 hours before sowing as it is reported to contain a germination chemical inhibitor (El-Naggar, 1965). Plants were thinned to 10 seedlings of uniform size per pot 10 days after sowing. Pots were randomly assigned to one of four irrigation treatments with dry foliage leachate of *R. stricta* for a period of 10 days at ages of 10, 20, 30 and 40 days from sowing. Another set of pots was irrigated with tap water as a control treatment. Seedlings were grown in a growth chamber. Temperature was 25 ± 2°C constant, light duration was 12 hours and light intensity was 1350 F.C. The experiment was arranged and analyzed as a split plot design with four replicates (Gomez and Gomez, 1984; SAS, 1988). Main plots were assigned to leachate treatments white species occupied the subplots. At the end of the experiment (60 days from sowing), seedling survival, shoot height, root length and total biomass were recorded.

Results and Discussion

A summary of analysis of variance (Table 1) indicated high significant differences ($P < 0.01$) among leachate exposure time treatments in all measured growth parameters. Species, also, responded differently ($P < 0.01$) to *R. stricta* leachate in all studied traits except for biomass where the difference between species was significant at $P < 0.05$ (Table 1). A high significant interaction ($P < 0.001$) occurred between treatments and species except for seedling biomass (Table 1).

Seedling growth and survival were highly depressed by *R. stricta* foliage leachate. The effect was more pronounced when seedlings were exposed at an earlier age to leachate. No differences were observed between seedlings exposed at 10 and 20 days from sowing in terms of shoot and root length.

However, seedling exposure at 30 days differed significantly from other treatments in both traits (Table 2). Shoot length was less affected compared to root length at initial growth of seedlings. However, at more advanced growth (30 and 40 days from sowing), shoots and roots were equally affected. This result was in agreement with findings of other workers (Conard, 1985; Yoder-Williams and Parker, 1987; Bhatt and Todaria, 1990). Root growth retardation would expectedly be reflected on top growth as indicated by the present results. However, Rivard and Woodard (1990) observed continuous shoot growth in *Typha latifalia* irrespective of extremely restricted root development in presence of an allelopathic agent.

TABLE 1. A summary of analysis of variance of the effect of *Rhazya Stricta* leachate on seedling shoot length, root length, biomass and survival of five range species.

Source	d.f.	Shoot length	Root length	Biomass	Survival
Replication	3	NS	NS	NS	NS
Treatments (A)	4	* *	* *	* *	* *
Error (a)	12				
Species (B)	4	* *	* *	*	* *
A × B	16	* *	* *	NS	* *
Error (b)	60				

* and ** indicate significant differences at $P < 0.05$ and $P < 0.01$ respectively. NS not significant at $P = 0.05$

TABLE 2. Percent reduction in shoot length, root length, biomass and survival of seedlings irrigated with water containing *Rhazya stricta* leachate at different seedling ages.

Seedling age	Shoot length	Root length	Biomass	Survival
- days -	% reduction relative to control			
10	67.86	79.27	87.02	60.59
20	66.87	72.13	81.16	55.66
30	54.74	53.77	70.65	45.27
40	34.85	36.03	58.95	22.02
$LSD_{(0.05)}$	10.95	12.19	10.95	15.94

Similarly, seedling biomass was highly depressed especially at early days of growth (87 and 81 % reduction at 10 and 20 days growth respectively). However, when leachate was applied to 40 days old seedlings, the impact on biomass was less severe (59% reduction). Several researchers have reported similar results in different species (Smith, 1989; Bhatt and Todaria, 1990; Kalburtji and Mosjdis, 1993a). Reduction in total biomass may have been substantially contributed by root restriction especially at initial seedling growth.

Further, the present results did not indicate any seedling growth recovery when exposed to leachate at initial growth.

Seedling survival was drastical1y reduced by leachate. Seedling loss was highest when seedlings were exposed at their initial growth (61 % reduction). At age of 40 days from sowing, only 22% of seedlings were lost which was significantly less than any other treatment (Table 2). Other workers reported similar results (Conard, 1985; Smith, 1989). The present results indicate that young seedlings were more Susceptible to growth retardation and death in presence of *R. stricta* than older ones.

Species varied in their response to leachate. *A. fragrantissima* and *R. stricta* were the most severely affected both in terms of seedling growth and survival (Table 3). *Lasiurus scindicus* was the least affected in all measured parameters except shoot length where *F. aegyptia* was affected the least. Seedling growth traits of *L. scindicus* were equally more affected (40-44% reduction), than survival (12% reduction). Although seedling survival of *F. aegyptia* was slightly affected (16% reduction), biomass was severely affected (76% reduction) and was mostly due to restriction of root growth (Table 3). *Atriplex halimus* behaved in a similar manner to *F. aegyptia*. The variation among species in response to leachate is normal and is in agreement with results reported by several researchers (Bhatt and Todaria, 1989; Smith, 1989; and 1990).

TABLE 3. Percent reduction in shoot length, root length, biomass and survival of seedlings in five range plant species irrigated with water containing *R. stricta* leachate.

Species	Shoot length	Root length	Biomass	Survival
% reduction relative to control				
A. fragrantissima	83.48	87.98	94.91	85.62
A. halimus	39.85	40.53	72.40	27.56
F. aegyptia	29.82	43.82	76.13	16.00
L. scindicus	43.97	40.19	39.48	12.12
R. stricta	83.27	88.97	89.31	88.12
$LSD_{(0.05)}$	15.61	10.59	13.25	17.67

Significant interactions were observed between species and time of seedling exposure to leachate in seedling shoot, root growth and survival. All species were more affected as leachate was applied at early days of growth with root growth being more restricted (Table 4). Shoot and root length of *A. fragrantissima* were decreased by 34% and 52% respectively as seedlings were exposed to leachate at age of 40 days. Shoots of *A. halimus, F. aegyptia* and *L. scindicus* were moderately decreased as seedlings were exposed to leachate at age of 10 days but the effect diminished as seedlings grew. Seedling shoot and root length of *R. stricta* were very restricted when exposed to leachate at age of 30 days (81 % and 85% reductions respectively). Although no significant interaction occurred between

species and time of seedling exposure to leachate on their effect on biomass, seedling biomass generally decreased as seedlings were exposed earlier to leachate.

TABLE 4. Seedling shoot length, root length, biomass and survival (60 days) of five range plant species irrigated with water containing *R. stricta* leachate at different seedling ages.

Treatment	*A. fragrantissima*	*A. halimus*	*F. aegyptia*	*L. scindicus*	*R. stricta*
Shoot length (mm)					
10	0.00	14.20	7.65	30.43	0.00
20	0.00	13.80	8.63	32.48	0.00
30	0.00	17.78	10.68	38.78	3.28
40	1.90	18.53	12.70	30.83	8.50
Control	2.88	26.735	14.13	59.13	17.60
$LSD_{(0.05)}$	0.88	5.38	3.00	16.72	8.63
Root length (mm)					
10	0.00	15.73	15.50	105.60	0.00
20	0.00	15.55	20.28	191.0	0.00
30	0.00	22.53	48.84	230.45	11.88
40	16.33	30.70	62.93	179.57	22.35
Control	33.95	35.53	65.63	295.38	77.60
$LSD_{(0.05)}$	8.08	6.49	14.24	62.85	26.75
Biomass (g)					
10	0.00	0.0133	0.0112	0.0788	0.00
20	0.00	0.0110	0.0145	0.1377	0.00
30	0.00	0.0403	0.0170	0.1525	0.005
40	0.0163	0.0462	0.0260	0.1595	0.0112
Control	0.0798	0.1003	0.0720	0.2183	0.038
$LSD_{(0.05)}$	0.0158	0.033	0.0132	0.07	0.012
Survival %					
10	0.0	72.5	35.0	55.0	0.0
20	0.0	47.5	47.5	80.0	0.0
30	0.0	65.0	62.5	80.0	10.0
40	57.5	97.5	65.0	75.0	37.5
Control	100	97.5	62.5	82.5	100
$LSD_{(0.05)}$	28.85	22.68	28.0	26.46	34.74

Seedling survival in response to time of leachate application varied from one species to another but generally increased with seedling age (Table 4). No seedling survival was observed for *A. fragrantissima* when leachate was applied at age 30 days or less. However, 57% of seedlings survived at age of 40 days. Survival of *A. halimus* seedlings was not seriously depressed compared to other species. However, survival at 10 days of age was significantly higher than at age of 20 days and slightly higher than at age of 30 days (Table 4). Both *F. aegyptia* and *L. scindicus* seedlings survival increased as the time of leachate application was delayed with *F. aegyptia* being more sensitive to leachate throughout the growing period. Complete loss of *R. stricta* seedlings was observed when leachate was applied at ages less than 30 days. Furthermore, survival was low at more advanced ages. This indicates an autotoxic effect of *R. stricta* which is also found in other allelopathic desert plants such as *Cleome droserifolia* (Hegazy and Fadl-Allah, 1995).

In conclusion, this study showed that the allelopathic effect of dry foliate leachate of *R. stricta* restricted seedling root and shoot growth with roots being more severely affected in younger seedlings. Consequently, biomass and survival were also affected especially at early days of growth. Species varied in their response to leachate. The overall species ranking in sensitivity to leachate was as follows: *R. stricta* = *A. fragrantissima* > *F. aegyptia* > *A. halimus* > *L. scindicus*. Therefore, giving that all climatic factors are at their optimum, selection of species for revegetation of *R. stricta* invaded rangelands should be based on the criteria of fast and vigorous seedling growth in presence of *R. stricta* leachate. Otherwise, *R. stricta* should be partly or completely eliminated.

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تأثير المستخلص الورقي الراشح لنبات الحرمل *Rhazya stricta* في نمو بادرات بعض نباتـــات المـــراعي وبقائها

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الملخص. يغزو نبات الحرمل *Rhazya stricta* مناطق واسعة من أراضي المراعي في المملكـــة العربية السعودية. وقد أجريت هذه الدراسة المعملية لاختبار تأثير المستخلص الورقي علـــى نمو وبقاء بادرات بعض نباتات المراعي في أعمار مختلفة. ولقد أوضحت نتائج الدراســـة أن البادرات كانت أكثر عرضة للتأثير الأليلوباثي للمستخلص في أيام نموها الأولى. كمـــا أثـــر المستخلص سلباً في نمو البادرات ومن ثم انخفض معدل بقائها. وكانت الجذور أشد تأثراً من المجموع الخضري. كما اختلفت الأنواع النباتية في استجابتها لمستخلص الحرمـــل الراشـــح وكان ترتيبها من الأعلى إلى الأقل تأثراً كالتالي: الحرمل وبدرجة مساوية تقريبـــاً للقيـــصوم *Achillea fragrantissima* يليهما نبات الجربة *Farsetia aegyptia* ثم القطف *Atriplex halimus* ثم الضعة *Lasiurus scindicus*. لذلك عند التفكير في إعـــادة زراعـــة المراعـــي المتدهورة والموبوءة بالحرمل، فإن اختيار النوع المناسب يتوقف على مدى سرعة وقوة نمـــو البادرة وقلة تأثرها بالفعل الأليلوباثي للحرمل.