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ALLELOPATHIC EFFECTS OF *RHAZYA STRICTA* ON SEED GERMINATION OF SOME RANGE PLANT SPECIES (15)

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ABSTRACT

Rhazya stricta Decne., an evergreen poisonous shrub, has invaded large areas of overgrazed rangelands in Saudi Arabia. To understand the mechanism by which this noxious plant spreads, a laboratory experiment was conducted to assess its allelopathic potential to the germination of some range plants. Leachates were prepared from fresh and dry foliage of *R. stricta*. Seeds were germinated in petri dishes moistened with either leachates or tap water. Leachates inhibited germination with fresh foliage leachate being most severe. Complete germination inhibition was observed in *Farsetia aegyptia* and *Pennisetum divisum*. *Haloxylon salicornicum* and *Lasiurus scindicus* were the least affected. Rate of germination was also significantly reduced. *H. salicornicum* was the least affected (56 and 25% in presence of dry and fresh leachates respectively), while other species were drastically reduced. Washing and regermination of the remaining non-germinated seeds indicated that seed viability of *F. aegyptia* and *P. divisum* may have been lost in presence of leachates. Osmotic effects of leachates may have contributed to germination inhibition in *Atriplex halimus*, *Achillea fragrantissima*, *L. scindicus* and *R. stricta*. While inhibiting early germination of other species, *R. stricta* needs enough water to leach water soluble inhibitor present in its seeds which in turn would also be sufficient to overcome osmotic effect of foliage leachate.

Keywords: Allelopathy, Germination, *Rhazya stricta*, Leaf leachate

INTRODUCTION

In Saudi Arabia, rangelands extend over more than 128 m.ha. The majority of these rangelands (60%) are in poor to fair conditions **(Kingery, 1971)**. Several authors (e.g. **Heady, 1963; Allred, 1968 and Tag EI-Din, 1983**) have recognized the decline in productivity of rangelands, decrease of some important range plant species and increase in unpalatable ones over the last few decades. One of the most troubling unpalatable species, is *Rhazya stricta*, an evergreen poisonous shrub. This shrub has invaded large areas of rangelands **(Allred, 1968)**. The species is reported to contain alkaloides **(Att ur Rahman *et al* 1989; 1991)** which are recognized as allelopathic agents **(Putnam and Duke, 1978)**.

Plant-plant interferences in natural habitat may occur through two possible mechanisms; direct competition for necessary growth factors or through addition of toxic factors to the environment (allelopathy). When rainfall passes through the intact green foliage or falls on decomposed

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litter, many organic compounds including allelopathic agents are released into the soil **(May and Ash, 1990 and Dormaar & Willms, 1992)**. Their presence in the soil in sufficient quantities has both detrimental and beneficial ecological consequences **(Whittaker, 1970)**. Allelopathic effects on germination of various range grasses were reported from extract components of litter in grasslands **(Johnston, 1961 and Bokhari, 1978)**. It is also thought that fire and allelopathy are the principal factors involved in regulating composition of fire-prone communities **(Williamson *et al* 1989)**. The presence of phytotoxins is therefore considered a factor affecting competition **(Rice, 1984)**.

To investigate the mechanism by which *R. stricta* has invaded overgrazed rangelands, a laboratory experiment was conducted to evaluate its allelopathic potential on some range plant species. The aims of the study were to: (1) determine the effect of dry and fresh foliage leachates of *R. stricta* on seed germination of some selected range plant species and (2) assess the sensitivity of tested species to germinate in presence of leachates.

MATERIAL AND METHODS

Leachate from dry leaves of *Rhazya stricta* was prepared by soaking crushed leaves in warm water at a ratio of 1:10 weight to volume for 12 hours **(Muller and Muller, 1965)**. The leachate from fresh leaves was prepared by soaking fresh leaves in boiled water at a ratio of 2:10 weight to volume and then left to cool for 12 hours to increase diffusion of soluble chemical into an aqueous phase **(Neill and Rice, 1971 and Jackson and Willemsen, 1976)**. Leachates were filtered using Wattman No. 1 paper.

One hundred seeds of each species were equally divided into four replicates. Seeds were germinated in petri dishes using germinating paper. About 10 ml of leachate or water was used to moisten seeds throughout the duration of the experiment. Seeds were considered germinating when the radicle appeared. Germinating seeds were counted and discarded daily. Study duration was 21 days. Non-germinated seeds treated with leachate were washed in tapwater and regerminated using tapwater to determine if germination failure was due to indirect effect through osmotic inhibition. The experiment was run in a growth chamber. Temperature was constant at 25 ± 2°C, light duration was 12 hours and light intensity was 1350 F.C. Petri dishes were arranged and analyzed as split plot design in which treatments were in the main plots and plant species were in the sub plots. Germination was expressed as the final percentage of germination and rate of germination was calculated after **Maguire (1962)** as follows:

Rate of germination = $\sum$ (% seed germinated on an incubation day/Number of days of incubation).

Species used in the study were *Farsetia aegyptia* Turra. *Atriplex halimus* L., *Haloxylon salicornicum* (Moq.) Bge (Bge.) Botsch., *Achillea fragrantissima* (Forssk.) Sch.-Bip.

Lasiurus scindicus Henr., *Pennisetum divisum* (Gmel.) Henr. and *Rhazya stricta* Decne. Seeds of *R. stricta* were immersed in running tapwater for 2 hours before leachate treatment were applied as it is reported that seeds contain a water soluble chemical germination inhibitor **(El-Naggar, 1965).**

RESULTS AND DISCUSSION

Considering the main treatments, leachates of *Rhazya stricta* foliage decreased germination of all species significantly (P<0.001) with germination of all species being most severely affected in presence of fresh foliage leachate compared to the control. The mean percentage germination of all species was 92.21, 31.86 and 19.21% for control, dry foliage leachate and fresh foliage leachate respectively (Table 1). Results from different localities and different allelopathic plants were reported to affect germination of range plant species **(Johonston, 1961; Bokhari, 1978 and Williamson *et al* 1989)**. Contrary to the present results, **May and Ash (1990)** reported less suppressive effect of leachate from intact fresh leaves of *Eucalyptus* spp. than dry foliage on tested plants. Apparently, soaking intact fresh leaves of *R. stricta* in boiled water may have released more toxic compounds that would not be released under natural conditions. There were significant differences (P<0.001) among species over the three treatments. Germination varied between 71.67% in *H. salicornicum* and 28.33% in *R. stricta* (Table 1) and there was a significant interaction between treatments and species. The differences in germination response of tested species were expected and are in agreement with those of **Patil (1994)** who reported variations in germination response of various field crops in the presence of *Glyricidia maculata* leaf extract.

Complete inhibition of germination occurred in *F. aegyptia* and *P. divisum* in response to both leachates. *Haloxylon salicornicum* was the least affected in presence of dry foliage leachate and had a final germination percentage of 97%, 75% and 43% under control, dry foliage and fresh foliage leachates respectively (Table 1). *L. scindicus* was the least affected in presence of fresh foliage leachate and had a final germination of 97.5%, 64% and 47.5% under control, dry foliage and fresh foliage leachates, respectively. However, it was not significantly different from *H. salicornicum*. Germination of the other tested species, including *R. stricta* was drastically inhibited in the presence of both leachates (Table 1). Considering the variation in germination among species in the control treatment, the percentage reduction in germination was calculated. *Farsetia aegyptia* and *P. divisum* were completely inhibited by both leachates. *Rhazya stricta* ranked the third in sensitivity to both leachates (Table 1). *Haloxylon salicornicum* and *L. scindicus* were the least affected by dry and fresh foliage leachates. Thus, overall species ranking in leachate sensitivity was as follows: *F. aegyptia = P. divisum > R. stricta > A. halimus > A. fragrantissima > H. salicornicum = L. scindicus*.

Table 1. Germination percentage and reduction % in seed germination of selected range species in presence of dry and fresh foliage leachates of *Rhazya stricta*

Species	Control	Dry foliage		Green foliage	
		% germination	% reduction	% germination	% reduction
Achillea fragrantissima	99.00	48.00	51.52	21.00	78.79
Atriplex halimus	93.00	25.00	73.12	21.00	76.34
Farsetia aegyptia	100.00	00.00	100.00	00.00	100.00
Haloxylon salicornicum	97.00	75.00	22.68	43.00	52.58
Lasiurus scindicus	97.50	64.00	23.08	47.50	51.28
Pennisetum divisum	87.00	00.00	100.00	00.00	100.00
Rhazya stricta	72.00	11.00	84.72	02.00	97.22
Means	92.21	31.86	65.02	19.21	79.46
$LSD_{0.05}$	5.108	16.799		18.613	

Not only percentage of germination was affected, but also the rate of germination was reduced significantly ($P<0.001$) by both leachates with species, being most affected by the fresh foliage leachate (Table 2). *Haloxylon salicornicum* had the highest rate of germination and was significantly different from any other species. *Rhazya stricta* was similar to *F. aegyptia* and *P. divisum* in having the lowest rate of germination (1.09 and 0.06 seed/day under dry and fresh foliage leachates respectively). Similar results were reported by **Madgil and Kapil (1990)** for *Trifolium pratense* and *Amaranthus paniculatus* seeds treated with leaf extracts of *Pinus roxburghii* and *Rhododendron arboreum* although there was no significant effect on final percentage germination of tested species. When germination is delayed, seedling would have little chance to emerge as duration of soil moisture availability at seed bed is usually short under arid conditions.

Significant differences ($P<0.001$) in germination percentage occurred among species when seeds were washed from leachates and regerminated (Table 3). No significant differences were observed between the two treatments or their interaction with species. Seeds of *H. salicornicum* did not germinate, indicating that viability of the very few non-germinating seeds may have been lost in presence of leachates. Seeds of *P. divisum* and of *F. aegyptia* (about 98%) failed to germinate after washing, possibly due to loss of viability in presence of *R. stricta* foliage leachates. The four remaining species had relatively high percentage of germination especially *L. scindicus* indicating that osmotic inhibition by the leachate solution may have been involved (Table 3). **Wardle *et al* (1992)** warned that allelopathic effects were over estimated when osmotic effects were not taken into account. If germination of *R. stricta* was inhibited by osmotic effect of the leachates, it should then be possible to hypothesize that any amount of rainfall required to leach the germination inhibitory chemicals from seeds **(EI-Naggar, 1965)** would also be sufficient to overcome the osmotic influence of its allelopathic leachates.

It is thought that one possible mechanism by which *R. stricta* may have spread into overgrazed rangelands is through allelopathic effects on germination of range plants. Furthermore, the results have some practical significance. Giving that all other constraints are under control, direct seeding of deteriorated rangelands with least sensitive range plant species such as *L. scindicus* and *H. salicornicum* should have great success. Sensitive range plants such as *F. aegyptia*, *P. divisum* and *A. halimus* would be feasible only under low cover or complete eradication of *R. stricta*.

Table 2. Rate of germination (seeds/day) and reduction % in rate of seed germination of selected range plant species in presence of dry and fresh foliage leachates of *Rhazya stricta*

Species	Control	Dry foliage		Green foliage	
		% germination	% reduction	% germination	% reduction
Achillea fragrantissima	88.95	10.44	88.27	04.18	95.30
Atriplex halimus	19.19	03.49	81.84	04.31	77.54
Farsetia aegyptia	80.83	00.00	100.00	00.00	100.00
Haloxylon salicornicum	86.25	56.33	34.69	25.64	70.28
Lasiurus scindicus	64.38	12.27	80.95	07.75	87.97
Pennisetum divisum	18.13	00.00	100.00	00.00	100.00
Rhazya stricta	39.56	01.09	97.25	00.06	99.84
Means	56.75	11.94	83.29	05.99	90.13
$LSD_{0.05}$	4.789	8.669		05.008	

Table 3. Germination percentage of remaining non-germinated seeds after washing from leachates of *Rhazya stricta*

Species	Dry foliage	Green foliage	Mean
Achillea fragrantissima	23.48	09.03	16.25
Atriplex halimus	29.23	27.35	28.29
Farsetia aegyptia	02.00	02.00	02.00
Haloxylon salicornicum	00.00	00.00	00.00
Lasiurus scindicus	43.75	25.00	34.38
Pennisetum divisum	00.00	00.00	00.00
Rhazya stricta	25.30	16.30	20.80
$LSD_{0.05}$	12.604	30.628	17.497

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التأثير الأليلوباثي لنبات الحرمل *Rhazya stricta* على إنبات بذور بعض نباتات المراعي

(١٥)

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يهدد انتشار الحرمل بتغيير التركيب النباتي لمساحات واسعة من أراضي المراعي في المملكة العربية السعودية. ومن أجل فهم الآلية التي يغزو بها هذا النبات المراعي المتدهورة، أجريت دراسة معملية للتعرف على قدرته في التأثير الأليلوباثي على إنبات بذور بعض نباتات المراعي. تم إضافة المستخلص الراشح للأوراق الغضة أو الجافة إلى البذور ومقارنتها باستخدام الماء للإنبات في أطباق بترى.

تبين من النتائج أن لراشح الحرمل تأثيراً مثبطاً لإنبات البذور وكان ذلك أشد عند استخدام راشح الأوراق الغضة. ولقد كان هناط تثبيط كامل لإنبات بذور الجربة *Farsetia aegyptia* والثيموم *Pennisetum divisum*. وقد كانت بذور الرمث *Haloxylon salicornicum* والهشمة (الضعة) *Lasiurus scindicus* الأقل تأثراً. ولقد أظهرت النتائج كذلك أن لراشح الحرمل تأثيراً مثبطاً لسرعة الإنبات.

كانت بذور الرمث أقل بذور النباتات تأثراً من حيث انخفاض سرعة الإنبات كما أظهرت نتائج إعادة إنبات البذور المتبقية بعد غسلها ومعاملتها بالماء فقط، أن بذور الجربة والثيموم فقدت حيويتها عند تعرضها لراشح أوراق الحرمل بينما كان للراشح تأثير أسموزي بجانب تأثيره الأليلوباثي في بذور القطف *Atriplex halimus* والقيصوم والهشمة والحرمل نفسه.

وبناء على هذه النتائج فإنه يمكن أن يكون من أسباب انتشار الحرمل في المراعي المتدهورة تأثيره الأليلوباثي المثبط لإنبات بذور الأنواع الأخرى.