

## **HAMMADA ELEGANS-RHAZYA STRICTA COMPETITIVE RELATIONSHIPS IN A DETERIORATED RANGE SITE IN RAUDHAT AL-KHAFFS, SAUDI ARABIA**

A.M. ASSAEED

*Plant Production Department, College of Agriculture, King Saud University  
P.O. Box 2460, Riyadh, 11451, Saudi Arabia*

### **ABSTRACT**

*Rhazya stricta*, an evergreen poisonous shrub, is invading many rangeland areas in Saudi Arabia. A field study was conducted in Raudhat Al-Khafs to assess the relationship between *R. stricta* and *Hammada elegans*, a valuable and a dominant saltbush range plant in the area. Only eight perennial species were found in the site of which *H. elegans* and *R. stricta* were almost exclusively co-dominating the area. Species diversity was low (0.912) indicating a deteriorated condition of the area. Quadrat sampling at three degrees of *R. stricta* invasion (high, medium and low) showed a decreasing trend in plant crown cover and plant biomass of *H. elegans* as *R. stricta* increased. Crown cover of *H. elegans* decreased from 0.75 to 0.46 m<sup>2</sup> and plant biomass decreased by 23% as *R. stricta* density increased from 216 to 716 plants/ha. Further, crown cover of *R. stricta* decreased from 7.4 to 2.46 m<sup>2</sup> and plant biomass decreased by 51% as its density increased. Soil analysis indicated that high plant density of *R. stricta* was associated with relatively higher concentration of P, K, Mg and Cl. The results suggested that competitive relationship may exist between the two species but further research is needed to understand the effect of *R. stricta* on *H. elegans* reproduction and establishment and to determine the proper grazing management that suppresses the invasion of *R. stricta*

### **INTRODUCTION**

Grazing often results in a modification of competitive interactions among species which, in turn, can lead to changes in species composition (Alexander and Thompson, 1982; Archer and Detling, 1984). When grazing becomes more intense, unpalatable species increase as they would have more competitive advantage over grazed species and revegetation may become a necessity under severe deterioration. Plant competition is considered an important factor controlling the process and outcomes of range revegetation (Archer and Pyke, 1991; Pyke and Archer, 1991). Call and Roundy (1991) emphasized the mechanistic approach to understand factors (including competition) governing biological processes that guide revegetation towards biological diversity.

Extensive areas of rangelands in Saudi Arabia have deteriorated due to intense grazing. Several unpalatable plants became more wide spread. Of those species, *Rhazya stricta* Decne. (Apocynaceae) is an evergreen poisonous shrub. The species occurs over most rangelands in Saudi Arabia (Allred, 1968; Migahid, 1989). The

species grows in a wide range of habitat but usually successful in areas normally flooded with rain water (EI-Naggar, 1965).

In Saudi Arabia, the potential for intensive range improvement is of little promise (Heady, 1963) but not impossible if based on sufficient investigation. The present study is aimed to, (1) describe the vegetation of a deteriorated site in Raudhat AI-Khafs, (2) investigate the competitive relationships of *R. stricta* and *Hammada elegans* (Bge) Botsch. (Chenopodiaceae), a palatable desert saltbush, and (3) to relate the degree of *R. stricta* invasion to soil properties.

## MATERIALS AND METHODS

### Site Description:

Raudhat AI-Khafs is a depressed plain, about 3km wide and 25km long. It is located about 100 km northeast of Riyadh (24°27'N, 46°26' E). The area is surrounded by a high escarpment to the east and sand dunes to the west. Several wadi canals drain into the area, thus soil and vegetation are much better than other neighboring areas. The vegetation is mostly dominated by shrubs. These include *Ziziphus nummularia*, *Lycium shawii*, *Hammada elegans*, *Zilla spinosa*, *Convolvulus lanatus* and *Rhazya stricta*. Few grasses are present. These include *Lasiurus hirstutus* and *Cynodon dactylon* (Anonymous, 1980). The area is grazed yearlong and the range condition is deteriorated. Annual precipitation is about 175 mm, occurring mostly during the period from December to April. Mean summer temperature is 35°C and mean winter temperature is 14°C.

### Soil Measurements:

Four soil samples in each level of invasion were taken randomly at two depths (0-20 and 20-40cm). Soil texture, pH, E.C., CaCO<sub>3</sub>% and mineral content of K, P, Mg, Na and Cl were determined as outlined by Black (1955).

### Vegetation Measurements:

The study was conducted in spring 1994 in the southern part of Raudhat AI-Khafs. For vegetation description, thirty 5×5m quadrats in alternate arrangement along five transects (6 quadrats per transect, placed 10m apart) were sampled. Transects were 80 m long, oriented in north-south direction and randomly located in the study site. Density and frequency were measured by counting plant individuals and hence recording the presence or absence of a species in a quadrat. Crown cover was taken as the longest diameter and the longest perpendicular to it for a maximum of 5 representative individuals per quadrat and crown cover was determined as described by Muller-Dombois and Ellenberg (1974). Relative importance percentage (RIMP) was calculated as described by Thalen (1979). Species diversity was calculated to assess species richness and evenness using Shannon-Wiener index (Brewer, 1979).

To study the *H. elegans*-*R. stricta* relationships, an area of about 9 ha was visually divided into three parts according to the level of invasion by *R. stricta* from east to west (high, moderate and low). Six 10×10 m quadrats were randomly selected in each level. In each quadrat, the following parameters were measured: density of mature plants, number of seedlings, standing plant height and crown cover, and average number of follicles on three *R. stricta* plants. Ten follicles from each plant

were also taken for the determination of number of seeds. A preliminary study indicated a good correlation between plant biomass and shrub volume of *R. stricta* and *H. elegans* ( $r^2 = 0.64$  and  $0.57$ , respectively), thus shrub volume, derived from crown cover and plant height, was used to estimate standing biomass of both species. Since interest was focused on testing for existence of interference between the two species rather than examination of long term outcome effects of interference, the study was conducted only for one year. Data were analyzed as a randomized complete block design (Little and Hills, 1978).

## RESULTS AND DISCUSSION

### Vegetation Analysis:

It is clear from Table 1 that *H. elegans* and *R. stricta* are the principle species in the area as they had high RIMP's. *H. elegans* contributed to the vegetation stand in two ways. It had high relative density and high relative frequency while *R. stricta* contributed to the stand through its high relative frequency and relative crown cover. With the exception of *Farsetia aegyptia*, an important range plant which had low RIMP, the rest of species are either increasres in rangelands such as *Pulicaria crispa* or invaders such as *Haplophyllum tuberculata* indicating the severity of site deterioration which is mainly caused by overgrazing. Shannon-Wiener index (H') contains information about two components of diversity; richness and evenness (Odum, 1971). Calculated H' value was low (0.912) indicating a deteriorated condition of the site as few species were encountered. Further, H' value suggests that species diversity is low in terms of species evenness; that is some species are rare while others are more abundant. Raudhat habitat system usually have fertile soil and diverse and productive vegetation (Vesey-Fitzgerald, 1957). Despite the surplus water that the site receives and the relatively high soil fertility compared to the surrounding areas, it is clear that vegetation is far below than what would be expected.

**Table 1:** Relative density, relative frequency, relative crown cover and relative importance percentage (RIMP) of plant species encountered in a deteriorated range site in Raudhat Al-Khafs

Species	Relative density	Relative frequency	Relative crown cover	RIMP
<i>Cleome africana</i>	0.54	4.04	0.35	1.64
<i>Convolvulus deserti</i>	0.11	1.01	6.13	2.14
<i>Farsetia aegyptia</i>	3.79	14.14	1.93	6.62
<i>Hammada e/eigans</i>	69.05	35.35	10.16	38.19
<i>Haplophyllum tuberculata</i>	0.11	1.01	0.70	0.61
<i>Heliotropium ramosissimum</i>	0.22	2.02	0.53	0.92
<i>Pulicarla crispa</i>	18.82	21.21	2.80	14.28
<i>Rhazya stricta</i>	7.36	21.21	77.40	35.32

Although plant density of *H. elegans* was not affected by the change in density of *R. stricta*, there was a decreasing trend in crown cover and a significant decrease in standing biomass (Table 2). Both crown cover and standing biomass of *R. stricta*

decreased significantly by 65 and 51 %, respectively, as *R. stricta* density increased from 216 to 716 plants/ha. Number of seedlings of both species was not affected by increase in density of *R. stricta*. Seed production in *R. stricta* plants showed a positive response (but not significant) to increase in density.

Since the density of *H. elegans* was not changed over the area, the interference in plant biomass may have come from the increase in density of *R. stricta*. It would not be possible to check for the intraspecific competition in *H. elegans*, or its interference with plant biomass and crown cover of *R. stricta*. Grime (1977) suggested that abiotic stresses rather than competitive interactions may govern community structure and function in arid ecosystems. Moreover, Shaltout and Mady (1993) presented some evidence from central Saudi Arabia supporting this claim. However, in a thorough review of research, Fowler (1986) concluded that competition does occur in these systems and that it is an important determinant of plant community structure. The above results suggest that intraspecific interference may exist within individual plants of *R. stricta* and an interspecific interference may exist between the two species in favor of *R. stricta*.

*Hammada elegans* shed seeds between November and December and respond quickly, in terms of germination and seedling establishment to early rainfall (Thalen, 1979). *R. stricta* on the other hand, produces seeds in spring. Seeds may not germinate before the next spring as germination is favored by warm temperatures (Mahmoud *et al.*, 1984) and enough water is needed to leach water soluble inhibitor present in seeds (EI-Naggar, 1965). It is therefore, suggested that interference between the two species at the seedling stage may not occur through direct competition, but other sources of interferences such as allelopathy can not be ruled out as *R. stricta* contains alkaloids which are considered allelopathic agents (Attur Rahman *et al.*, 1989 and 1991) that could be released to the soil.

#### **Soil analysis:**

Soil texture varied from loamy sand in high and moderate degrees of invasion to sandy in low degree of *R. stricta* invasion. Electrical conductivity was very low and little change was observed with change in *R. stricta* density (Table 3). Soil pH was slightly alkaline and remained constant throughout. Calcium carbonate was not also changed. Phosphorus, potassium, magnesium, sodium and chloride were relatively higher in soils of dense *R. stricta*. Similar observations were also reported in association with *R. stricta* (Tag El-Din *et al.*, 1994). In some sandy soils where fertility is expected to be low, *R. stricta* is observed forming pure stands. However, the above results suggest that *R. stricta* is favored by rich soil.

If the grazing pressure is eased, *H. elegans* would likely be a good competitor but further research is needed to confirm and understand the competitive relationship of the two species. A differential removal experiment (Fonteyn and Mahall, 1981) would be an effective mean to gain more information on seedling establishment, growth, reproduction and water status of the two species.

**Table (2):** Some vegetation attributes of *R. stricta* (Rhst) and *H. elegans* (Hael) as affected by the degree of invasion by *R. stricta*

Degree of <i>R. Stricta</i> Invasion	Plant Density (Plants/ha)		Crown Cover (m <sup>2</sup> )		Standing Biomass (g)		Number of Seedlings /ha		Number of Seeds Produced by a <i>R. stricta</i> plant
	Rhst	Hael	Rhst	Hael	Rhst	Hael	Rhst	Hael	
<b>High</b>	716	1000	2.46	0.458	1052.3	306.2	67	933	7476
<b>Medium</b>	450	1233	3.365	0.517	1098.3	324.9	83	1050	5242
<b>Low</b>	216	1200	7.443	0.765	2135.4	395.6	100	667	3256
<i>LSD</i> <sub>0.05</sub>	264	NS	1.012	NS	840.8	79.9	NS	NS	NS

**Table (3):** Soil physical and chemical properties under three degrees of invasion by *R. stricta* (Mean ± SD)

Degree of <i>R. Stricta</i> Invasion	Soil Depth (cm)	EC dS.m <sup>-1</sup>	pH	CaCO <sub>3</sub> %	P	K	Mg	Na	Cl
					(ppm)				
<b>High</b>	0-20	0.25±0.15	8.5±0.10	7.86±1.46	12.00±4.98	261.3±45.5	20.69±4.29	28.10±4.17	59.45±17.9
	20-40	0.21±0.03	8.5±0.05	7.86±1.69	11.25±4.65	262.0±49.8	19.19±4.16	28.70±3.39	47.05±12.7
<b>Medium</b>	0-20	0.15±0.06	8.5±0.14	9.61±0.73	10.25±3.50	141.0±20.9	4.56±0.69	16.90±1.76	15.35±2.0
	20-40	0.12±0.09	8.5±0.13	9.22±0.66	8.67±4.04	128.9±31.3	6.88±0.98	20.60±2.69	14.25±3.7
<b>Low</b>	0-20	0.10±0.02	8.6±0.00	7.28±1.24	5.75±1.89	121.6±34.1	4.88±1.33	16.4±3.13	8.90±2.1
	20-40	0.07±0.01	8.6±0.00	7.47±1.07	4.50±1.08	121.1±40.4	5.25±1.70	16.15±2.65	8.0±2.4

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## العلاقة التنافسية بين نباتي الرمث *Hammada elegans*

### والحرمل *Rhazya stricta* في أحد المواقع الرعوية المتدهورة في روضة الخفس بالمملكة العربية السعودية

عبد العزيز بن محمد السعيد

قسم الإنتاج النباتي - كلية الزراعة - جامعة الملك سعود ، ص ب ٢٤٦٠

الرياض ١١٤٥١ المملكة العربية السعودية

يغزو الحرمل، وهو نبات شجيري سام دائم الخضرة، مساحات شاسعة من مراعي المملكة العربية السعودية. أجريت دراسة حقلية في روضة الخفس قرب مدينة الرياض للتعرف على العلاقة التنافسية بين الحرمل ونبات الرمث وهو نبات شجيري هام وواسع الانتشار. تبين من نتائج دراسة الغطاء النباتي أن هناك ثمانية أنواع نباتية معمرة فقط يسودها الرمث والحرمل. وبلغ معامل التنوع ٠,٩١٢ مما يشير إلى التدهور الواضح في الغطاء النباتي بالمنطقة. أظهرت نتائج الدراسة في ثلاثة مستويات من كثافة الحرمل (عالية، متوسطة، منخفضة) أن هناك اتجاهًا لانخفاض الوزن الخضري والتغطية التاجية لنباتات الرمث بزيادة كثافة الحرمل، إذ انخفض الغطاء التاجي للرمث من ٠,٧٥م<sup>٢</sup> إلى ٠,٤٦م<sup>٢</sup> بينما الوزن الخضري بنسبة ٢٣% عند زيادة كثافة الحرمل من ٢١٦ إلى ٧١٦ نباتاً/هكتار. وكذلك انخفض الغطاء التاجي للحرمل نفسه من ٧,٤٤م<sup>٢</sup> إلى ٢,٤٦م<sup>٢</sup> بينما انخفض وزنه الخضري بنسبة ٥١% عند زيادة كثافته. أشارت تحاليل التربة في الموقع إلى أن هناك زيادة نسبية تركيز عناصر الفوسفور والبوتاسيوم والمغنيسيوم والكلور بزيادة كثافة الحرمل. وبناءً على هذه النتائج، فإن هناك احتمالاً لوجود علاقة تنافسية بين النباتين ولكن الحاجة لا تزال قائمة لمزيد من الدراسات لفهم تأثير نبات الحرمل في تكاثر الرمث وتأسيس بادراته وتحديد أفضل الطرق للحد من انتشاره.