

**Ecological studies on Thanoun (*Cistanche phelypaea* (L.)
Cout.(Orobanchaceae) in Al-Ahsa Oasis, Saudi Arabia**

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ABSTRACT

The angiospermic root parasite (*Cistanche phelypaea* (L.) Cout. (Orobanchaceae) is an obligate root parasite which totally depends on its host for water, minerals and organic nutrients. In Al-Ahsa Oasis, Saudi Arabia, it was found to occur on a number of natural and cultivated plant species. The natural hosts include: *Arthrocnemum macrostachyum*, *Anabasis articulata*, *Salsola baryosma*, *Seidlitzia rosmarinus*, *Suaeda aegyptiaca*, *Suaeda monoica*, *Suaeda vermiculata*, *Zygophyllum coccineum*, *Zygophyllum simplex*, *Zygophyllum qatarense*. The cultivated species were *Beta vulgaris*, *Beta vulgaris* subsp. *cicla*, and *Atriplex leuoclada*. However, *Spinacia oleracea*, a cultivated species, was found to be resistant.

INTRODUCTION

The genus *Cistanche* which belongs to the family Orobanchaceae includes 16 species. They form an attractive group of phanerogamic root parasites. The occurrence of the genus is restricted to certain arid and semi arid regions of Africa, Asia and the Mediterranean including parts of Southern Europe (Blatter, 1921; Agrawal, 1984; Musselman, 1984).

In Saudi Arabia, three species of the genus *Cistanche* Hoffm. et. Link have been reported: *C. Phelypaea* (L.) Cout., *C. tubulosa* (Schenk.) R. Wight and *C. violacea* (Desf.) G. Beck (Collenette, 1985). The first species is the most common and is distributed throughout nearly all phytogeographical zones of Saudi Arabia (Farah, 1991).

However, little information is available regarding the ecology of these plants.

The present study was carried out to investigate the occurrence, host range, reproductive biology and phenology of thanoun (*Cistanche phelypaea*) in Al-Ahsa Oasis, Saudi Arabia.

MATERIALS AND METHODS

Field Study: Several excursions were carried out to survey the occurrence of the root parasite thanoun and its host plants among the native plants communities (natural vegetation) of Al-Ahsa Oasis (25°22

N'latitude; 49°34' E longitude) and its surrounding areas (Ugair, Salwa, Faidaht Um Al-Sous). A total of 600, 1.5 m radius circle quadrats were used in this study. The quadrats were laid along 360-m transect lines. 20 such transects were used, where each one (transect) was marked by posters at 12 m intervals. Thanoun and its host plant species were collected. Only those plants attached to the parasite were recorded as hosts. Nomenclature follows Migahid (1978). The standard statistical measures of vegetation were applied according to Curtis (1959) and Mathew et al (1993) as follows:

Frequency (F):
$$\frac{\text{Number of quadrats (plots) in which a species occurs}}{\text{Total number of quadrats (plots) sampled}}$$

Relative Frequency (RF) :

$$\frac{\text{Frequency value for a species}}{\text{Total of frequency values for all species}} \times 100$$

Density (D) :
$$\frac{\text{The total number of individuals of a species}}{\text{The total area of quadrats examined}}$$

Relative Density (RD) :
$$\frac{\text{Density for a species}}{\text{Total density for all species}} \times 100$$

Relative dominance (percentage cover) :

$$\frac{\text{The total lengths of lines covered by a species (C)}}{\text{Total length of lines examined}}$$

Importance value (IV) : The total of the three relative measures (RF + RD + C).

The greenhouse experiment: The selected host crops (garden beet, chard and spinach) were tested in a greenhouse. The experiment was conducted at the Agricultural and Veterinary Training and Research Center, King Faisal University, to investigate their response to the parasitism of Thanoun. Sixty 30-cm plastic pots were arranged in three sets (15 pots per set). The selected crop plants were raised in the pots, where the top half of the soil was thoroughly mixed with 1.0 g of thanoun seeds of 2000 (Th1) in the first set. In the second set the top half of the soil was also thoroughly mixed with 1.0 g of Thanoun seeds of 2001 (Th2). The third set was used as untreated control (Th0). Treatments were arranged in a completely randomized design with five replicates. A total of 120 pots were used in this experiment during two seasons. Five seeds per pot were sown on 27 November, 2001 and 27 November, 2002. Three weeks after emergence, all pots received a compound fertilizer in the form of N.P.K. (20%, 20%, 20%) at the rate of 70 kg. Ha. The pots were placed in the greenhouse (day and night temperatures were 28°C/23°C). Irrigation has been carried out using tap water every week.

Data were collected for the following host characters : Plant height (cm), root length (cm), total dry weight (biomass) (g). For the parasite (thanoun), the number of individual plants per host and the dry matter of the parasite per host were recorded.

Statistical analysis : Analysis of variance was conducted using the General Linear Models (GLM) procedure of Statistical Analysis System (SAS, 1990).

RESULTS

The natural vegetation : The following results represent the vegetation studies carried out during several excursions, by the investigators, during two consecutive seasons (December-April 2001/2002 and December-April 2002/2003).

Two hundred fifteen species (180 dicots and 35 monocots) of flowering plants were recorded for the studied area (Table 1). From the thirty three families recorded in the area, only four families were characterized with high species richness namely, Asteraceae (36 species), Chenopodiaceae (26 species), Fabaceae (22 species) and Poaceae (29 species). However, from these four families, only Chenopodiaceae was found to accommodate the host plants of thanoun.

Tables 2 and 3 show the standard statistical measurements for the vegetation of Al-Ahsa Oasis and the adjacent areas. These measurements include the frequency (F), the relative frequency (RF), the density (D), the relative density (RD), the cover (C) and the importance value (IV). IV was calculated only for the most abundant species (Ca 13) of the area.

Table 4 shows the most important host plants of Thanoun, and number and percentage of thanoun per host plant. Ten plant species were found to be the most important host plants. They belong to six genera, namely: *Zygophyllum*, *Suaeda*, *Anabasis*, *Arthrocnemum*, *Salsola* and *Seidlitzia*.

The greenhouse experiment : All the studied characters (plant height, root length and dry weight (biomass) of the studied host plants (beet, chard, spinach, atriplex) were highly significantly ($P < 0.01$) affected by thanoun treatments (Tables 5a and 5b). The effect of thanoun was more severe on atriplex compared to other host plants while spinach was not affected by the parasite.

The means of the tested parameters of thanoun, i.e. number of thanoun plants per host and the dry matter of thanoun per host were significantly affected by the host plants. Beet exceeded the other host plants (chard, spinach and atriplex) in sustaining more number of thanoun plants per host, while atriplex exceeded them in accommodating more dry matter of thanoun per host (Tables 6a and 6b). However, Thanoun 1 was found to exceed Thanoun 2, both in number and dry matter per host plant.

DISCUSSION

Parasitic flowering plants have documented as playing a striking role in the ecology of their hosts (Reuter, 1986) particularly by controlling population sizes of their host plants. In the present study, all the tested host plants we found to be affected by Thanoun (*Cistanche phelypaea*). Among the thirty three families recorded in this study, *Cistanche phelypaea* restricted its host range in two families only, Chenopodiaceae and Zygophyllaceae. However, in an earlier study, Tamaricaceae was recorded to include hosts of Thanoun (Farah, 1987). From the list of the flowering plants of Al-Ahsa Oasis, formulated in this study, only ten plant species were found to be parasitized by thanoun. *Zygophyllum qatarense*, the most important species (50.1, IV) was found to accommodate the highest number of Thanoun plants (268) compared with to other hosts. Thus *Z. qatarense* could be considered the most important host of Thanoun in Al-Ahsa Oasis. With the exception of *Arthrocnemum macrostachyum*, *Anabasis articulata* and *Seidlitzia rosmarinus* (less than 50% of their population sizes being parasitized by thanoun), the other seven host plants showed higher parasitized population sizes (more than 50% parasitization by thanoun). If we add to the list of host plants (ten host plant species), of this study, other recorded host plants e.g. *Suaeda pruinosa* and *Tamarix aphylla* (Farah, 1987) and the cultivated host plant species, of the present work, namely: *Atriplex*

leuoclada, *Beta vulgaris* and *Beta vulgaris* subsp. *cicla*, we will end up with 15 plant species as the most preferable hosts of thanoun in Al-Ahsa.

Under greenhouse conditions, the tested host plants showed great variation in their response to the parasitism of the root parasite, zanoun. All the tested host plants, except spinach, were affected significantly ($P < 0.01$) by thanoun treatments. The losses of the biomass of the tested host plants ranged from 0.0%, with spinach up to 56% with atriplex. The spinach plants treated with the parasite, thanoun, were found to be resistant and thus showed no significant differences in all the studied growth characters (plant height, root length, biomass) compared with the untreated plants (control). On the other hand, thanoun decreased the growth components of beet, chard and atriplex, substantially. Similar results were reported by Gwargwer and Weber (2001) in *striga hermonthica* and millet. The relatively better performance of growth characters of chard (i.e. lesser loss percentage) compared with beet and atriplex (higher loss percentage) revealed that chard was less susceptible, while beet and atriplex were highly susceptible hosts. Thus chard may be characterized by having relatively a greater tolerance factor to zanoun.

It could be concluded that Thanoun as a potential root parasite affects the natural vegetation population size, and the growth and development of the artificial vegetation (cultivated plants) e.g. beet, chard and atriplex.

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Table 1. Number of families, genera and species of the Flora of Al-Ahsa Oasis

Taxon	Dicots	Monocots	Total
Family	28	5	33
Genus	105	25	130
Species	180	35	215

Table 2. Density, Relative density, Frequency, Relative frequency, and Relative dominance of the plant species of Al-Ugair. (Analysis based on 150, 3 m diameter circle quadrats).

Species	Density	Relative Density (%)	Frequency	Relative Frequency (%)	Relative Dominance (%)
<i>Arthrocnemum macrostachyum</i>	0.02	2.02	0.08	2.30	1.80
<i>Rostaria pumila</i>	0.11	11.11	0.23	6.61	1.10
<i>Aleuropus logopoides</i>	0.06	6.06	0.20	5.75	8.35
<i>Suaeda aegyptiaca</i>	0.03	3.03	0.13	3.74	8.26
<i>Panicum turgidum</i>	0.06	6.06	0.30	8.62	13.84
<i>Zygophyllum qatarense</i>	0.14	14.14	0.67	19.30	16.70
<i>Salsola baryosma</i>	0.07	7.07	0.27	7.80	6.14
<i>Suaeda monoica</i>	0.07	7.07	0.18	5.20	6.23
<i>Stipa capensis</i>	0.05	5.05	0.09	2.60	3.14
<i>Panicum repens</i>	0.06	6.06	0.15	4.31	1.50
<i>Bassia muricata</i>	0.03	3.03	0.13	3.74	1.43
<i>Eragrostis barrelierii</i>	0.03	3.03	0.07	2.01	1.70
<i>Anabasis articulata</i>	0.03	3.03	0.13	3.74	5.50
<i>Zygophyllum simplex</i>	0.02	2.02	0.13	3.74	5.00
<i>Cyperus conglomeratus</i>	0.04	4.04	0.12	3.45	4.52
<i>Zygophyllum coccineum</i>	0.03	3.03	0.15	4.31	2.30
<i>Stipagrostis ciliata</i>	0.06	6.06	0.21	6.03	3.60
<i>Seidlitzia rosmarinus</i>	0.02	2.02	0.14	4.02	4.02
<i>Suaeda vermiculata</i>	0.06	6.06	0.10	2.87	5.06
Total	0.99		3.48		

Table 3. Importance value (%) of the most important plant species of Al-Ugair.

Sr. No.	Species	Importance Value (%)
1.	<i>Zygophyllum qatarense</i>	50.14
2.	<i>Panicum turgidum</i>	28.52
3.	<i>Salsola baryosma</i>	21.01
4.	<i>Suaeda monoica</i>	18.50
5.	<i>Suaeda aegyptiaca</i>	15.03
6.	<i>Suaeda vermiculata</i>	14.00
7.	<i>Anabasis articulata</i>	12.30
8.	<i>Cyperus conglomeratus</i>	12.01
9.	<i>Zygophyllum simplex</i>	10.08
10.	<i>Seidlitzia rosmarinus</i>	10.1
11.	<i>Zygophyllum coccineum</i>	9.64
12.	<i>Bassia muricata</i>	8.50
13.	<i>Arthrocnemum macrostachyum</i>	6.12

The plant species are arranged in descending order of percentage importance value.

Table 4. Number of Thanoun plants per host plant at Al-Ahsa Oasis, recorded during December 2001 – December 2002.

Host plant	No. of individuals of host plant	No. of parasitized host plant	No. of Thanoun plants per host plant	Percentage of Thanoun plants per host plant (%)
<i>Zygophyllum qatarense</i>	456	245 (53.7%)*	268	23.5
<i>Zygophyllum coccineum</i>	217	166 (76.50%)	180	15.8
<i>Zygophyllum simplex</i>	166	98 (59.0%)	122	10.7
<i>Suaeda aegyptiaca</i>	214	139 (65.0%)	156	13.7
<i>Suaeda monoica</i>	157	78 (49.70%)	84	7.4
<i>Suaeda vermiculata</i>	166	84 (50.60%)	95	8.3
<i>Anabasis articulata</i>	95	46 (48.40%)	58	5.1
<i>Arthrocnemum macrostachyum</i>	89	35 (39.30%)	45	3.9
<i>Salsola baryosma</i>	233	129 (55.40%)	133	11.7
<i>Seidlitzia rosmarinus</i>	96	38 (39.60%)	44	3.9
Total	1889	1058 (56.0%)	1141	

* Number in parenthesis is percentage of parasitized host plant.

Table 5 (a). The growth characters of host plants as influenced by Thanoun, means averaged overall treatments and overall seasons. (Each figure is an average of 30 readings (3 treatments X 5 replicates X 2 years)).

Host plant	Plant height (cm)	Root length (cm)	Dry weight (biomass) (g)
Beet	35.30 c*	28.03 b	24.13 c
Chard	90.23 b	26.23 b	41.20 b
Spinach	19.47 c	11.35 c	10.47 c
Atriplex	112.60 A	51.23 a	80.75 a

Table 5 (b). The effect of thanoun treatments on the growth characters of its host plants, averaged overall hosts and overall seasons. (Each figure is an average of 40 readings = 4 hosts X 5 replicates X 2 years)

Treatments	Plant height (cm)	Root length (cm)	Dry weight (biomass) (g)
T ₁	77.9 a*	34.3 a	51.3 a
T ₂	57.5 b	27.3 b	32.7 b
T ₃	58.0 b	26.1 b	33.3 b

T₁ = Plants not treated with Thanoun (control)

T₂ = Plants treated with Thanouns developed from seeds of 2000

T₃ = Plants treated with Thanouns developed from seeds of 2001.

*Mean followed by the same letter in each column for each factor are not significantly different at P = 0.05, according to Duncan's multiple range test.

Table 6 (a). Number of thanoun plants per host and dry matter of thanoun (g) per host. (Each value is an average of 20 readings = 2 treatments X 5 replicates X 2 years).

Host	Number of thanoun plants per host	Dry matter of thanoun (g) per host
Beet	10.10 a	16.83 b
Chard	3.90 b	7.01 c
Spinach	0.00 c	0.00 d
Atriplex	5.50 b	22.9 a

Table 6 (b). Number and dry matter of thanoun plants per host plant, averaged overall hosts. (Each value is an average of 30 readings = 3 host plants X 2 years X 5 replicates).

Treatment	Number of thanoun plants / host	Dry matter of t hanoun plants / host
Th ₁	8.63 a	18.10 a
Th ₂	4.37 b	13.10 b

Th₁ = Thanoun plants developed from thanoun seeds of 2000.

Th₂ = Thanoun plants developed from thanoun seeds of 2001.

Thn = Number of thanoun plants per host.

Thw = Thanoun dry matter (g) per host.

*Means with the same letter in each column for each factor are not significantly different at P = 0.05 according to Duncan's multiple range test.