

## **Ecological Studies on Tha-noun (*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 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* that 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 area 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. Hence the present study was carried out to investigate the occurrence, host range, and the effect of tha-noun (*Cistanche phelypaea*) on its host plants in Al-Ahsa Oasis, Saudi Arabia.

### **Materials and Methods :**

#### **Field Study**

Several excursions were carried out to survey the occurrence of the root parasite tha-noun 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 quadrates were used in this study. The quadrates were laid along 360-m transect lines. 20 such transects were used. Each transect was marked by posters at 12 m intervals. Tha-noun 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:

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

$$\text{Relative Frequency (RF)} = \frac{\text{Frequency value for a species}}{\text{Total of frequency values for all species}} \times 100$$

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

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

Relative dominance (percentage cover) (PC) =

$$\frac{\text{The total lengths of lines covered by a species}}{\text{Total length of lines examined}} \times 100$$

Importance value (IV) =

The total of the three relative measures (RF + RD -PC).

### **The greenhouse experiment :**

The selected host crops: garden beet (*Beta vulgaris*), chard (*B. vulgaris* subsp. *cicla*), spinach (*Spinacia olerace*) and atriplex (*Atriplex leucoclada*) were tested in a greenhouse environment. The experiment was conducted at the Agricultural and Veterinary Training and Research Center, King Faisal University, to investigate their response to the parasitism of *Tha-noun*. Sixty 30-cm plastic pots were arranged in four 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 *tha-noun* seeds of 2000 (Th 2) in the first set. In the second set the top half of the soil was also thoroughly mixed with 1.0 g of *Tha-noun* seeds of 2001 (Th3). The third set was used as untreated control (Th1). 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<sup>0</sup>C/23<sup>0</sup>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 (*tha-noun*), 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 seventeen species (182 dicots and 35 monocots) of flowering plants were recorded for the studied areas (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).

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Table 2 shows the standard statistical measurements for the vegetation of Al-Hassa Oasis and the adjacent areas. These measurements include the frequency, the relative frequency, the density, the relative density, the relative dominance, (i.e. the percentage cover) and the importance value. The importance value was calculated only for the most abundant species of the area.

Table 3 shows the most important host plants of Tha-noun, and number and percentage of tha-noun 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, except, spinach, were highly significantly ( $P < 0.01$ ) affected by tha-noun treatments (Tables 4a and 4b). The effect of tha-noun was more severe on atriplex compared to other host plants while spinach was not affected by the parasite.

The host plants significantly affected the means of the tested parameters of tha-noun, i.e. number of tha-noun plants per host and the dry matter of thanoun per host. Beet exceeded the other host plants in sustaining more number of tha-noun plants per host, while atriplex exceeded them in accommodating more dry matter of tha-noun per host (Tables 5a and 5b). However, Tha-noun 1 was found to exceed Tha-noun 2, both in number and dry matter per host plant.

**Table (1)**  
Number of families, genera and species of the flora of Al-Ahsa Oasis.

Family	Genera	Species
Dicotyledons		
Amaranthaceae	2	4
Apiaceae	2	2
Asteraceae	22	36
Brassicaceae	9	9
Boraginaceae	3	7
Capparaceae	2	2
Caryophyllaceae	5	7
Chenopodiaceae	14	26
Convolvulaceae	2	3
Cucurbitaceae	2	2
Cuscutaceae	1	3
Cynomoriaceae	1	1
Euphorbiaceae	3	7
Fabaceae	11	22
Geraniaceae	2	2
Lamiaceae	4	6
Malvaceae	1	2
Neuradaceae	1	1
Orobanchaceae	2	3
Plantaginaceae	1	7
Polygonaceae	2	2
Portulacaceae	1	1
Primulaceae	1	2
Resedaceae	1	2
Rhamnaceae	1	2
Solanaceae	5	7
Tamaricaceae	1	5
Zygophyllaceae	3	9
Subtotal	105	182
Monocotyledons		
Areaceae	1	1
Cyperaceae	1	3
Juncaceae	1	1
Poaceae	21	29
Typhaceae	1	1
Subtotal	25	35
Total	130	217

Table ( 2 )  
 Density, Relative density, Frequency, and Relative dominance of the most  
 important plant species of Al-Ahsa Oasis.  
 (Analysis based on 1.5 m radius circle quadrates)

Species	D	RD (%)	F	RF (%)	PC (%)	IV (%)
<i>Arthrocnemum macrostachyum</i>	0.02	2.02	0.08	2.30	1.80	6.12
<i>Rostaria pumila</i>	0.11	11.11	0.23	6.61	1.10	18.82
<i>Aleuropus logopoides</i>	0.06	6.06	0.20	5.75	8.35	20.16
<i>Suaeda aegyptiaca</i>	0.03	3.03	0.13	3.74	8.26	15.03
<i>Panicum turgidum</i>	0.06	6.06	0.30	8.62	13.84	28.52
<i>Zygophyllum qatarense</i>	0.14	14.14	0.67	19.30	16.70	50.14
<i>Sasola baryosma</i>	0.07	7.07	0.27	7.80	6.14	21.01
<i>Suaeda monoica</i>	0.07	7.07	0.18	5.20	6.23	18.50
<i>Stipa capensis</i>	0.05	5.05	0.09	2.60	3.14	10.79
<i>Panicum repens</i>	0.06	6.06	0.15	4.31	1.50	11.87
<i>Bassia muricata</i>	0.03	3.03	0.13	3.74	1.43	8.20
<i>Eragrostis barrelierii</i>	0.03	3.03	0.07	2.01	1.70	6.74
<i>Anabasis articulata</i>	0.03	3.03	0.13	3.74	5.50	12.27
<i>Zygophyllum simplex</i>	0.02	2.02	0.13	3.74	5.00	10.76
<i>Cyperus conglomerates</i>	0.04	4.04	0.12	3.45	4.52	12.01
<i>Zygophyllum coccineum</i>	0.03	3.03	0.15	4.31	2.30	9.64
<i>Stipagrostis ciliata</i>	0.06	6.06	0.21	6.03	3.60	15.69
<i>Seidlitzia rosmarinus</i>	0.02	2.02	0.14	4.02	4.02	10.06
<i>Suaeda vermiculata</i>	0.06	6.06	0.10	2.87	5.06	13.99

**Table (3)**  
 Number of Tha-noun 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 Tha-noun plants per host plant	Percentage of Tha-noun plants per host plant (%)
Zygophyllum qatarense	456	245 (53.7%)*	268	23.5
Zygophyllum coccineum	217	166 (76.50%)		
Zygophyllum coccineum	217	166 (76.50%)	180	15.8
Zygophyllum simplex	166	98 (59.0%)	122	10.7
Suaeda aegyptiaca	214	139 (65.0%)	156	13.7
Suaeda monoica	157	78 (49.70%)	84	7.4
Suaeda vermiculata	166	84 (50.60%)	95	8.3
Anabasis articulata	95	46 (48.40%)	58	5.1
Arthrocnemum macrostachyum	89	35 (39.30%)	45	3.9
Salsola baryosma	233	129 (55.40%)	133	11.7
Seidlitzia rosmarinus	96	38 (39.60%)	44	3.9
Total	1889	1058 (56.0%)	1141	

\* Number in parenthesis is percentage of parasitized host plant.

Table ( 4 a )  
 The effect of Tha-noun on growth traits of its host plants (average over two seasons  
 (2001/2002 – 2002/2003), (Mean  $\pm$  s.d.),  
 (Each value is an averaged of 10 readings, 2 years  $\times$  5 replicates)

Host	Treatment	Plant height (cm)	Root length (cm)	Dry weight (g)
Beet	T <sub>1</sub>	36.24 $\pm$ 6.1a*	35.7 $\pm$ 10.7a	28.7 $\pm$ 7.1a
	T <sub>2</sub>	34.6 $\pm$ 6.4a	23.4 $\pm$ 8.2b	19.84.8b
	T <sub>3</sub>	35.1 $\pm$ 6.7a	25.0 $\pm$ 5.9b	23.9 $\pm$ 6.1b
Chard	T <sub>1</sub>	96.4 $\pm$ 2.6a	27.2 $\pm$ 1.5a	43.1 $\pm$ 1.0a
	T <sub>2</sub>	86.5 $\pm$ 1.7b	24.8 $\pm$ 5.7b	39.8 $\pm$ 5.8b
	T <sub>3</sub>	87.80 $\pm$ 1.4b	26.7 $\pm$ 5.0a	40.7 $\pm$ 2.7b
Spinach	T <sub>1</sub>	19.4 $\pm$ 2.7a	11.0 $\pm$ 1.8a	10.3 $\pm$ 2.3a
	T <sub>2</sub>	19.6 $\pm$ 2.1a	11.6 $\pm$ 1.3a	10.6 $\pm$ 2.1a
	T <sub>3</sub>	19.4 $\pm$ 2.6a	11.4 $\pm$ 1.5a	10.5 $\pm$ 2.0a
Atriplex	T <sub>1</sub>	159.4 $\pm$ 6.2a	63.1 $\pm$ 2.7a	126.3 $\pm$ 6.0a
	T <sub>2</sub>	89.2 $\pm$ 5.0b	44.4 $\pm$ 2.4b	60.8 $\pm$ 5.3b
	T <sub>3</sub>	89.2 $\pm$ 6.0	46.2 $\pm$ 2.8b	55.2 $\pm$ 4.7b

T<sub>1</sub>: Plants not treated with Tha-noun (control).

T<sub>2</sub>: Plants treated with Tha-noun seeds of 2000.

T<sub>3</sub>: Plants treated with Tha-noun seeds of 2001.

\* Means with the same letter in each column for each trait are not significantly different according to Duncan's multiple range test.

**Table ( 4 b )**

**The effect of tha -noun 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 × 5 replicates × 2 years)**

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

T<sub>1</sub>: Plants not treated with Tha-noun (control).

T<sub>2</sub>: Plants treated with Tha-noun seeds of 2000.

T<sub>3</sub>: Plants treated with Tha-noun seeds of 2001.

\* Means with the same letter in each column for each trait are not significantly different according to Duncan's multiple range test.

**Table ( 5 a )**

Number of tha-noun plants per host and dry matter of tha-noun (g) per host.

(Each value is an average of 20 readings = 2 treatments × 2 years × 5 replicates).

Treatment	Number of tha-noun plants/host	Dry matter of tha-noun plants/ host
Beet	10.10a*	16.83b
Chard	3.90b	7.01c
Spinach	0.00c	0.00d
Atriplex	5.50b	22.9a

\* Means with the same letter in each column for each trait are not significantly different according to Duncan's multiple range test.

**Table ( 5 b )**

Number of tha-noun plants per host and dry matter of tha-noun (g) per host. (Each value is an average of 30 readings = 3 host plants × 2 years × 5 replicates).

Treatment	Number of tha-noun plants/host	Dry matter of tha-noun plants/ host
Th <sub>1</sub>	8.63a*	18.10a
Th <sub>2</sub>	4.37b	13.10b

Th<sub>1</sub> = Tha-noun plants developed from tha-noun seeds of 2000.

Th<sub>2</sub> = Tha-noun plants developed from than-noun seeds of 2001.

Th<sub>n</sub> = Number of tha-noun plants per host.

Th<sub>w</sub> = Tha-noun dry matter (g) per host.

\* Mean 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.

**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 not all of the tested host plants were found to be affected by Tha-noun (*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 Tha-noun (Farah, 1987). Among the study plant species of Al-Ahsa Oasis, only ten plant species were found to be parasitized by tha-noun, namely *Anabasis articulata*, *Arthrocnemum macrostachyum*, *Salsola baryosma*, *Seidlitzia rosmarinus*, *Suaeda aegyptiaca*, *S. monoica*, *S. vermiculata*, *Zygophyllum coccineum*, *Z. qatarense* and *Z. simplex*. If we add to this list, other recorded host plants e.g. *Suaeda priunosa* and *Tamarix aphylla* (Farah, 1987) as well as the cultivated host plants species: *Atriplex leueoclada*, *Beta vulgaris* and *Beta vulgaris* subsp. *cicla*, a group of 15 plants species will classified as the most preferable host plants by tha-noun in Al-Ahsa area. *Zygophyllum qatarense*, the most important species (50.14 IV) was found to accommodate the highest number of Tha-noun plants (268) compared with other hosts. Thus *Z. qatarense* could be considered as the most important host of Tha-noun in Al-Ahsa Oasis. However, continued spread of this noxious parasite in the natural vegetation of Al-Ahsa Oasis, could results in unforeseen problems such as limitation of the growth and productivity of the important forage plants. This is in agreement with the finding reported by Scharpf *et al.*, (2001) for *Viscum album* and alder (*Alnus*) stands in California.

Under greenhouse conditions, the tested host plants showed great variation in their response to the parasitism of the root parasite, tha-noun. All the tested host plants, except spinach, were affected significantly ( $P < 0.01$ ). 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, tha-noun was 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, tha-noun 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 factors to tha-noun.

It could be concluded that Tha-noun as a potential root parasite affects the natural vegetation population size, and the growth and development of the cultivated vegetation e.g. beet, Chard and Atriplex.

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**دراسة بيئية على طفيل الذانون**  
*Cistanche phelypaea* (L.) Cout. (*Orobanchaceae*)  
**في واحة الأحساء بالمملكة العربية السعودية**

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**المخلص :**

إن نبات الذانون *Cistanche phelypaea* (L.) والذي ينتمي إلى الفصيلة الهالوكية (*Orobanchaceae*) يعتبر طفيلاً جذرياً إجباري التطفل، ويعتمد كلياً في غذائه على العائل للحصول على الماء والعناصر المعدنية والمواد العضوية. وقد وجد أن هذا النبات يتطفل على عدد من النباتات البرية والمزروعة في منطقة واحة الأحساء في المملكة العربية السعودية.

وتشمل العوائل الطبيعية نباتات الشنان *Arthrocnemum macrostachyum* والعجرم *Seidlitzia rosmarinus* والضمران *Salsola barysoma* والحمض *Anabasis articulata* وثلاثة أنواع من جنس السويد (*Suaeda*) وثلاثة أنواع من جنس الرطريط *Zygophyllum*. بينما تشمل النباتات المزروعة: نبات الشمندر *Beta vulgaris* ونبات السلق *Beta vulgaris* subsp. *Cicla* والقطف *Atriplex leucoclada*، في حين وجد أن نباتات السبانخ *Spinacia oleracea* مقاوم لتطفل الذانون.