

Effect of *Dhanoun (Cistanche phelypaea L. Cout)* on the Performance of Some Cultivated Chenopodiaceous Plant Species

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Abstract

Dhanoun (Cistanche phelypaea L. Cout, family Orobanchaceae) is an obligate root holoparasite on certain wild members of *Chenopodiaceae*, *Zygophyllaceae*, *Tamaicaceae* and *Capparaceae*. However, *Chenopodiaceae* accommodates more host plants compared to the other three families. An outdoor pot experiment was carried out to study the effect of *dhanoun* on four cultivated chenopodiaceous crop species, namely atriplex (*Atriplex leuoclada Boiss*), beet (*Beta vulgaris subsp. vulgaris L.*), chard (*Beta vulgaris subsp. cicla (L.)*), spinach (*Spinacia oleraceae L.*). The studied growth traits (plant height, root length, biomass) of all tested crop species, except spinach, were significantly ($P < 0.01\%$) affected by *Dhanoun*. The reduction in biomass of the tested crop species, as a result of the effect of the parasite, ranged from 0.0% with spinach to 52.0 % with atriplex. Thus, based on their general performance, under the influence of *Dhanoun*, the tested crop plants could be ranked as follows: atriplex > beet > chard > spinach. The damage caused by the parasite (*Dhanoun*) appears to be of a greater magnitude on atriplex followed by beet, and a lesser magnitude on chard. However spinach was not affected by the parasite. In this study, *dhanoun* was found to attack only biennial and perennial host plants, it seldom attacks annual ones.

Keywords: *Atriplex*, *Beet*, *Chard*, *Spinach*, *Dhanoun (Cistanche phelypaea)*, *Chenopodiaceous Plants*, *Parasitism*.

1. Introduction

The occurrence of the genus *Cistanche Hoffmeg.et. Link* (family *Orobanchaceae*) is restricted to certain arid and semi-arid regions of Africa, Asia and Mediterranean area including parts of South Europe [1]-[6]. Based on the records available, members of the genus *Cistanche* were reported as parasites on about 40 plant species belonging to 14 families of flowering plants [1] - [5]. Generally, parasitic flowering plants have documented as playing a striking role in the ecology of their hosts [7], particularly by controlling population sizes of their host plants. (*Cistanche phelypaea L. Cout*), Known as *Dhanoun* in Arabic countries is an obligate root

holoparasite on members of Chenopodiaceae, Zygophyllaceae, Tamaricaceae [5]. and Capparaceae [8]. However, family Chenopodiaceae accommodates more host plants compared to the other families. Most of the recorded host plants of Dhanoun are wild members (natural vegetation) of the above mentioned families. Little information is available pertaining the host range of Dhanoun among cultivated crop species of the four families mentioned above. Therefore the present work was aimed to study the effect of Dhanoun (*Cistanche phelypaea* L. Cout) on the performance of some cultivated chenopodiaceous plant species, namely: beet, chard, spinach and a triplex.

2. Materials and Methods

Experimental seeds

The parasite seeds were collected from Dhanoun (*Cistanche phelypaea* L. Cout) plants parasitizing *Capparis decidua* (Family Capparaceae) shrubs growing among the natural vegetation of Sabaloga Area, Khartoum North (Lat. 15 40` N, Long.32 31` E) Sudan, during March- April 2011. The seeds were sterilized with 1% sodium hypochlorite solution, rinsed several times in distilled water and dried before storage in dark at room temperature (25°C-26°C) until ready for use. Seeds of local varieties of three host plants from the selected four chenopodiaceous crop plant species, namely: garden beet (*Beta vulgaris* subsp. *vulgaris* L.) , chard (*Beta vulgaris* subsp. *cicla* L.), spinach (*Spinacia oleracea* L.) were obtained from a local market in Omdurman, Sudan. Seeds of the fourth host plant, atriplex (*Atriplex leucoclada* L.) were obtained from King Faisal University (Saudi Arabia).

The experiment

The selected varieties of the crop plant species were raised in 30-cm clay pots. The potting soil was a composite containing 66.7% Nile clay and 33.3% sand. The pots were divided into two equal sets. In the first set , the top half of the soil per each pot was thoroughly mixed with 0.5 g of Dhanoun seeds. The second set of pots was used as untreated control. Treatments were arranged in a completely randomized design with five replications. A total of 80 pots were used during two seasons (2011-2012) at the rate of 20 pots per each crop. Five seeds per pot, for each crop, were sown. Two weeks after emergence , the seedlings were thinned to one seedling/pot. Sowing dates were November ,2011 and November, 2012, respectively. 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. Weeds other than Dhanoun were controlled by hand. Irrigation was carried out using tap water every week. The studied host traits included plant height (cm), root length (cm), biomass (dry weight of shoot system + dry weight of root system) (g.) .For the parasite (Dhanoun) , number of parasitic plants per host (ND/H) and biomass of Dhanoun per host

(DWD/H), were recorded. The reduction in biomass (biological yield) of the host was measured according to the following formula [9], with some modifications:

$$\% \text{ Loss of BmH} = \frac{\text{BmF} - \text{BmI}}{\text{BmF}} \times 100$$

Where,

BmH = Biomass of host plant

BmF = Biomass of Dhanoun free host plant (control).

BmI = Biomass of infected host plant

Analysis of Variance

Analysis of variance was conducted using the General Linear Method Procedure of the Statistical Analysis system [10].

3. Results and Discussion

Members of the genus *Cistanche* (family Orobanchaceae) are obligate root holoparasites on their host plants. Dhanoun (*Cistanche phelypaea*) restricted its hosts in four families namely: Cheopodiaceae, Zygophyllaceae, Tamaricaceae [4] and [5]. and Capparaceae [8]. However, Chenopodiaceae accommodates more host plants compared to other families [4]. In the present study, the response of the four cultivated chenopodiaceous crop species i.e. atriplex, beet, chard and spinach to the parasitism of Dhanoun was studied. The tested crops responded differently to the infection of Dhanoun. All the studied host traits (plant height, root length, biomass) were significantly affected ($P < 0.01$ %) by the parasite (Tables 1,2). The parasite decreased the growth traits of all tested crops, except spinach, substantially, e.g. the reductions in biomass of the tested crops ranged from 0.0% with spinach to 52% with atriplex (Table 3), this may be attributed to that they have similar nutritional requirements. These results are in accord with the results reported by other authors [5],[11] and [12]. The reduction in biomass (dry weight of shoot system + dry weight of root system) below the control was considered the most acceptable parameter to measure the severity of Dhanoun parasitism and to evaluate the response of the tested crop species to the parasite. This is because the shoot system is directly concerned with the supply of photosynthates to different parts of the plant, while the root system is concerned with the supply of water and mineral nutrients to the plant, and their infection by parasitic weeds like Dhanoun will ultimately affect the growth and the development of the host crops. However, the effect of Dhanoun on spinach showed no significant differences in all the studied growth traits (Table 1). This may be attributed to the fact that spinach is an annual plant, thus can escape the parasitism of Dhanoun because it matures earlier before the establishment of the parasite on it,

while the other tested crops are either biennial (beet and chard) or perennial (atriplex) (Table 1). Table 4 shows the biomass of Dhanoun (dry weight of Dhanoun per host plant (DWD/H), and the number of Dhanoun plants per host plant (ND/H). DWD/H could be used as another criterion to assess the response of the tested crop plants species to the parasitism of Dhanoun than ND/H. This is because DWD/H is a function of the host resistance/susceptibility level, while ND/H depends mainly on the vigor of the host root system. Chard with only 8.0 g of DWD/H manifested a depressing effect on the growth of Dhanoun. On the other hand, Dhanoun didn't encounter resistance in case of beet and atriplex which accommodated 18.0 g DWD/H and 24.0 g DWD/H, respectively. The relatively better performance of the growth traits of chard (lesser loss percentage below the control) compared to beet and atriplex (higher loss percentage below the control) (Table 3) revealed that chard is less susceptible while beet and atriplex are highly susceptible hosts. Thus, based on their general performance under the influence of Dhanoun, the tested four chenopodiaceous crop plant species could be ranked as follows:

atriplex > beet > chard > spinach.

The damage caused by the parasite (Dhanoun) appears to be of a greater magnitude on atriplex followed by beet and of a lesser magnitude on chard followed by spinach. It could be concluded that Dhanoun as a root holoparasite attacks host plants with long lifespan (biennials and perennials), while plants with short life-span (annuals) can escape the parasitism of Dhanoun because they mature earlier before the establishment of the parasite on them. The significant reductions in the growth traits of the tested crops were associated with a marked increase in the biomass of Dhanoun.

Table 1. The effect of Dhanoun on growth traits of its host plants (averaged over two seasons, 2011-2012, means \pm s.d.) . (each value is an average of 10 readings = 2 seasons + 5 replicates).

Host plant	Treatment	Plant height (cm)	Root length (cm)	Biomass (g)
Atriplex	T1*	162.0 \pm 6.0 a**	65.0 \pm 3.0 a	128.0 \pm 6.0 a
	T2	091.0 \pm 5.0 b	45.0 \pm 2.0 b	62.0 \pm 5.0 b
Beet	T1	38.0 \pm 6.0 a	39.0 \pm 11.0 a	29.0 \pm 8.0 a
	T2	35.0 \pm 7.0 a	25.0 \pm 9.0 b	20.0 \pm 5.0 b
Chard	T1	98.0 \pm 3.0 a	28.0 \pm 2.0 a	45.0 \pm 2.0 a
	T2	88.0 \pm 2.0 b	25.0 \pm 6.0 b	41.0 \pm 5.0 b
Spinach	T1	20.0 \pm 3.0 a	12.0 \pm 2.0 a	11.0 \pm 3.0 a
	T2	20.0 \pm 2.0 a	12.0 \pm 2.0 a	11.0 \pm 2.0 a

T1*= plants not treated with Dhanoun (control), T2= plants treated with Dhanoun.

** Means with the same letter in each column for each factor are not significantly different at P= 0.01, according to Duncan's multiple range test.

Table 2 . A summary of the effect of Dhanoun on the host growth traits (averaged over all host plants (4) and over two seasons,2011-2012, (means \pm s.d.)). (each value is an average of 40 readings= 4 host plantsx 5 replicates x 2 seasons).

Treatment	Plant height (cm)	Root length (cm)	Biomass (g)
T1*	80.0 \pm 56.0 a**	36.0 \pm 19.0 a	53.0 \pm 45.0 a
T2	59.0 \pm 31.0 b	27.0 \pm 12.0 b	34.0 \pm 20.0 b

T1*= plants not treated with Dhanoun (control),T2= plants treated with Dhanoun.

** Means with the same letter in each column are not significantly different at P= 0.01, according to Duncan`s multiple range test.

Table 3. A summary of the performance of the growth traits of the tested crop species showing the percentage loss (%) below the control treatment over all seasons (2011-2012. (each value is an average of 10 readings = 2 seasonsx 5 replicates).

Host plant	Plant height (%)	Root length (%)	Biomass (%)
Atriplex	44.0 (42.11)*a**	31.0 (33.22)b	52.0 (45.00)a
Beet	08.0 (15.68)b	36.0 (36.22)a	31.0 (33.22)b
Chard	10.2 (18.22)b	11.0 (18.44)c	09.0 (18.00)c
Spinach	0.00 (0.00 0)c	0.00 (0.000)d	0.00 (0.000)d

*Figures in parenthesis indicate the arcsine square root transformation of percentage loss.

** Means with the same letter in each column are not significantly different at P= 0.01, according to Duncan`s multiple range test.

Table 4. Biomass of Dhanoun/ host plant (DWD/H)* (g) and Number of Dhanoun plants/host plant (ND/H) (averaged over two seasons,2011-2012, means \pm s.d.) . (each value is an average of 10 readings= 2 seasonsx 5 replicates).

Host plant	Biomass of Dhanoun/host plant (DWD/H (g)	Number of Dhanoun/host plant (ND/H)
Atriplex	24.0 \pm 2.0 a**	06.0 \pm 2.0 b
Beet	18.0 \pm 2.0 b	12.0 \pm 1.0 a
Chard	08.0 \pm 2.0 c	04.0 \pm 2.0 c
Spinach	00.0 \pm 0.0 d	00.0 \pm 0.0 d

*DWD/H=dry weight of Dhanoun plants (=Biomass).

** Means with the same letter in each column are not significantly different at P= 0.01, according to Duncan`s multiple range test.

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