Effect of Field Dodder (*Cuscuta campestris* Yuncker) on Some Legume Crops

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Abstract:

Twelve legume crops were tested to study the effect of field dodder (*Cuscuta campestris* Yuncker) on them. The tested crops showed great variations in response to field dodder parasitism. Based on the reduction in host dry weight (biological yield) caused by the parasite, the tested crops were classified into three groups: crops that lost > 50% of the their biological yield were considered highly susceptible, those that lost 10-50% of their biological yield were considered susceptible and those that lost < 10% of their biological yield were considered resistant. The results of the study revealed that among the tested legume crops the first group (the highly susceptible) comprised 6 crops (hyacinth bean, lens, chickpea, broad bean, alfalfa, fodder pea), the second group (the susceptible) comprised 4 crops (fenugreek, Egyptian clover, lupin, garden pea) and the third group (the resistant) comprised 2 crops (kidney bean and vetch). The parasitic damage appeared to be of greater magnitude on hyacinth bean (75% loss of biological yield) and of lesser magnitude on kidney bean (8.1% loss of biological yield) as compared to the other legumes. However, in vetch the parasite had a positive effect on its growth traits (17% increase in biological yield). The significant reductions in the growth parameters of susceptible and highly susceptible crops were associated with a marked increase in shoot yield of field dodder.

Introduction

Cuscuta, which belongs to the family Cuscutaceae, is a genus of cosmopolitan occurrence, thus *Cuscuta* species are widely distributed and colonized a diversity of habitats throughout the temperate and tropical zones (Beliz, 1987). Many species of *Cuscuta* have been introduced to different parts of the world due to similarity of their seeds to those of commercial

crops, especially legumes like alfalfa (*Medicago sativa* L.) and clover (*Trifolium* spp.).

Both legume crops and dodders are economically important. Legume crops constitute a major group of crops in the world. They provide human food, animal feed and material for industrial uses. Their nutritional value as a source of protein has long been recognized. However, only recently legume crops have risen to prominance in the Kingdom of Saudi Arabia (Al-Tahir *et al*. 1989). On the other hand, dodders are regarded as the most important parasitic weeds that represent a serious threat to a wide range of crops, particularly legumes, in Saudi Arabia (Farah, 1991). Four speices of *Cuscuta* were reported in Saudi Arabia. namely, *C*. c*ampestris* Yuncker, *C. hyalina* Roth.,*C. pedicellata* Ladeb and *C*. *planiflora* Tenore (Al-Farhan, 1994). The economic importance of *C. campestris* stems from the fact that it parasitizes several important crop plants and reduces their yield substantially. In addition, this parasite has become one of the major constraints that limit productivity of crops in different parts of the world. The objectives of this work were to study the effect of field dodder (*C. campestris*) on growth and development of twelve legume crops namely, chickpea (*Cicer arietinum* L.), hyacinth bean (*Dolichos lablab* L.), vetch (*Lathyrus sativus* L.), lentil (*Lens culinaris* Miller), Lupin (*Lupinus termis* L.), alfalfa (*Medicago sativa* L.), kidney bean (*Phaseolus vulgaris* L.), fodder pea (*Pisum arvense* L.), garden pea (*Pisum sativum* L.), Egyptain clover (*Trifolium alexandrinum* L.), fenugreek (*Trigonella foenum-gracecum* L.) and broad bean (*Vicia faba* L.) and to estimate the losses occurred due to field dodder parasitism.

Materials and Methods

The experimental seeds: seeds of field dodder were collected from alfalfa fields in Al-Hassa, Eastern Province, Saudi Arabia. The seeds were surface sterilized with 1% sodium hypochlorite solution, rinsed in distilled water, dried and stored in dark at room temperature (26^{o}C). Seeds of legume crops for the experimental work were obtained from different sources including ICARDA (Internaitonal Centre for Agricultural Research in the Dry Areas, Aleppo, Syria), Egypt, Sudan and Saudi Arabia (Table 1).

Table (1)
List of Legume crops tested and their sources

Common Name	Crop species (Scientific Name)	Source
Chickpea	*Cicer arietinum* L.	ICARDA
Hyacinth bean	*Dolichos lablab* L.	Sudan
Vetch	*Lathyrus sativus* L.	ICARDA
Lentil	*Lens culinaris* Miller	ICARDA
Lupin	*Lupinus termis* L.	Al-Hassa, Saudi Arabia
Alfalfa	*Medicago sativa* L.	Al-Hassa, Saudi Arabia
French bean	*Phaseolus vulgaris* L.	Sudan
Fodder pea	*Pisum arvense* L.	Egypt
Garden pea	*Pisum sativum* L.	ICARDA
Egyptian clover	*Trifolium alexandrinum* L.	Egypt
Fenugreek	*Trigonella foenumgraecum* L.	ICARDA
Broad bean	*Vicia faba* L.	Sudan

The Greenhouse Experiment:

The greenhouse experiment was conducted at the Agricultural and Veterinary Training and Research Centre, King Faisal University, Al-Hassa (25^o 22' N latitude; 49^o34' E longitude),Saudi Arabia. The legume crops were raised in 25 cm plastic pots containing a 1:1 mixture of sand and peatmoss. For 50% of the pots the top half of the soil was thoroughly mixed with 0.5 g of field dodder seeds. The other 50% were left without field dodder seeds (untreated control). Treatments were arranged in a completely randomized design with four replications for each crop. Ten seeds per pot were sown on 17th November 1997 and 1998. At planting, all pots received a nitrogenous fertilizer in the form of urea (46% N) at the rate of 70 Kg N/ha. Two weeks after emergence, the seedlings were thinned to three per pot. The pots were placed in a greenhouse (day and night temperatures were $28^oC/23^oC$). Irrigation was practiced using tap water (EC = 2 ds/m, pH= 7.1) every two days. Weeds other than field dodder were controlled by hand every two weeks until the termination of the experiment. Eight weeks after

sowing, data were collected on plant height (cm), number of leaves per plant, while dry weight of shoots (g), dry weight of roots (g), the biological yield (BY) [(dry weight of shoots + dry weight of roots (g)], the number of flowers per plant, and the number of pods per plant; and for the parasite, number of coils per host and dry weight of shoots per host (g) were recorded at harvest. Analysis of variance was conducted using the General Linear Models Procedure of the Statistical Analysis and treatment means were averaged over the two seasons and compared according to Duncan's multiple range test at 5% level of significance (SAS, 1990). Losses from *C. campestris* in the tested crops could be assessed by comparing dodder infested plants with dodder free ones. The relative loss (X%) of the growth trait was calculated according to Kroschel *et al.* (1996) as follows:

$$X\% = \frac{C-T}{C} \times 100$$

Where C is the value of the growth trait in dodder free plants, T is the value of the growth trait in dodder infested plants; while the reduction in the biological yield (BY) was estimated as the average of the reductions in the dry weights of shoots and roots.

Results and Discussion

Field dodder (*Cuscuta campestris* Yuncker) caused variable reductions in the vegetative (plant height, number of leaves per plant, dry weights of shoot and root systems) and reproductive (number of flowers per plant and number of pods per plant) traits of the tested crops (Table 2). Crops tested showed differential behaviour in relation to dodder parasitism. Kidney bean recorded the lowest reductions in all traits, as it had a hypersensitive reaction against field dodder parasitism (Farah, 2000). On the other hand, vetch characters were found to increase in the presence of field dodder instead of being decreased. This may be attributed to the promotive effects of field dodder on vetch growth resulting in more internodes and lateral branches. Similar results were reported by Abdalla and Siddig (1993) in roselle parasitized by *C. hyalina*. The resistance of kidney bean to field dodder has been well documented in literature (Nemli, 1987; Arnaud *et al.,* 1996), but for vetch this is the first record of its resistance to *C. campestris.* The other ten crops showed variable reductions due to field dodder infestation (Table 2). The lowest percent reductions in both plant height and

Table (2)

A summary of the Performance of vegetative and reproductive characters of the tested legume crops under the influence of field dodder showing the percentage loss below the control treatment, averaged over two seasons(1997 and 1998)

Host crop	Plant height (CM)	Number of leaves/plant	Dry weight of shoot system (GM)	Dry weight of root system (GM)	Number of flowers/plant	Number of pods/plant
Chickpea	-14.3i	-11.1i	-44.3c	-62.1c	-90.0a	-90.0a
Hyacinth bean	-49.7b	-45.0a	-53.0a	-68.2a	-90.0a	-90.0a
Vetch	+59.4a	+41.8b	+24.7i	+24.9g	+51.1b	+60.1b
Lentil	-28.5f	-26.1e	-47.8b	-61.9c	0.0f*	0.0g
Lupin	-14.9i	-14.8h	-36.0f	-45.0f	0.0f	0.0g
Alfalfa	-33.0d	-28.0d	-33.8g	-64.9b	0.0f	0.0g
Kidney bean	-14.2i	-10.9i	-14.4j	-18.7h	-13.8e	-16.0f
Fodder pea	-31.0ed	-16.5g	42.0d	-53.3d	-17.1d	-27.6d
Garden pea	-23.3h	-11.8i	-26.1i	-49.1e	-14.5e	-20.0e
Egyptian clover	-43.7c	-27.6ed	-38.8e	-44.5f	0.0f	0.0g
Fenugreek	-30.7e	-35.7c	-30.2h	-53.9d	-35.1c	-36.3c
Broad bean	-26.2g	-23.3f	-41.0d	-60.7c	-90.0a	-90.0a

Statistical analysis applied to the ArcSine (square root transformation) of percentage loss.
Means followed by the same letter in each column are not significantly different at P = 0.05, according to Duncan's multiple range test.
* The perscibed phase was not achieved.

number of leaves per plant were observed in chickpea which amounted to 6.1% and 3.7%, respectively as comapred to the control. Similarly, the lowest percent reduction in dry weight of shoots (19.3%) and dry weight of roots (49.2%) were observed in garden pea and Egyptian clover, respectively. Hyacinth bean consistantly showed the maximum percent reductions in vegetative growth.

Four out of the studied twelve crops; namely, lentil, lupin, alfalfa and Egyptian clover did not reach the flowering stage until the trial termination. Although the rest reached the reproductive stage, they showed great variations in their capacity to produce flowers and pods. The lowest percent reductions in the number of flowers per plant (6.3%) and the number of pods per plant (11.7%) were observed in garden pea, while both characters were completely affected (100% reduction) in chickpea, hyacinth bean and broad bean. Among the various parameters implemented in this study, the reduction in the host biological yield (BY) was used as a criterion to evaluate and to classify the response of the tested crops to field dodder parasitism. Biological yield of the legume crops varied significantly due to treatments (Table 3). Dodder had a detrimental effect on yield attributes leading to low biological yield of hyacinth bean, lentil, chickpea, alfalfa, broad bean and fodder pea and hence considered to be highly susceptible. Fenugreek, Egyptian clover, garden pea and lupin were considered susceptible. Kidney bean and vetch recorded more BY compared with the other crops and so they were resistant (Table 3).Bebawi and Michael (1991), Zaitoun *et al*. (1991) and Al-Menoufi and Farag (1996) reportred that legume crops varied significantly in their response to the infection of parasitic weeds. On the three groups field dodder exhibited great variations (Table 4). It seems that the dry matter of field dodder per host is another reliable criterion to assess the response of the tested crops to field dodder's parasitism, compared to the number of coils of field dodder per host. This is because the dry matter of field dodder is a function of the host resistant level, while the number of coils of field dodder depends mainly on the length of the parasitized organ, e.g. the length of the internode or of the petiole. The resistant crops with 0.08 g mean dry matter of field dodder per host plant, manifested a depressing effect on the parasite growth and consequently the latter dried up and sucucumed due to lack of nourishment

Table (3)

Classification of the tested legume crops (Based on % loss of their biological yield due to effect of field dodder).

Host crop	% loss of host biological yield*	Host response to the parasitism of field dodder
Hyacinth bean	-75.0	Highly susceptible
Lentil	-66.3	Highly susceptible
Chickpea	-65.0	Highly susceptible
Broad bean	-59.3	Highly susceptible
Alfalfa	-56.5	Highly susceptible
Fodder pea	-54.5	Highly susceptible
Fenugreek	-45.3	Susceptible
Egyptian clover	-44.2	Susceptible
Lupin	-42.3	Susceptible
Garden pea	-38.2	Susceptible
Kidney bean	-8.1	Resistant
Vetch	+17.6	Resistant

*The legume crops are arranged in descending order of percentage loss.

Table (4)

Field dodder yield components (number of coils and dry weight of shoot system (g) per host) Field dodder

Host crop	Number of coils Per host	Dry weight of shoot (g) per host
Chickpea	9.00c	0.25 cd
Hyacinth bean 34.33bc	0.62b	0.13de
Vetch	10.66e	
Lentil	15.33de	0.44bc
Lupin	31.66c	0.32cd
Alfalfa	34.66bc	1.80a
Kidney bean	4.00e	0.04e
Fodder pea	28.00cd	0.34c
Garden pea	28.00cd	0.32cd
Egyptian clover	34.66bc	0.38c
Fenugreek	46.33b	0.34c
Broad bean	71.33a	0.36c

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

(Farah, 2000). On the other hand, the parasite did not encounter any resistance on susceptible and highly susceptible crops with 0.34 g and 0.64 g mean dry matter of field dodder per host plant, respectively (Table 4). This is in agreement with with the work of Rao and Reddy (1987), who reported that on green gram china dodder dry matter per individual was 1.88g,while on cluster bean the dodder dry matter per individual was 0.47g. Based on their general performance as influenced by field dodder, the tested twelve legume crops could be ranked as follows:

Hyacinth bean >lentil> chickpea > broad bean > alfalfa > fodder pea > fenugreek > Egyptian clover > lupin > garden pea > kidney bean > vetch.

The parasitic damage appeared to be of a greater magnitude on hyacinth bean and of a lesser magnitude on kidney bean and vetch.

The results of the experiment thus revealed that the cultivation of hyacinth bean, lentil, chickpea, alfalfa, broad bean and fodder pea (highly susceptible crops), and fenugreek, Egyptian clover, garden pea and lupin (susceptible crops) in soils known to be infested with field dodder, should be avoided. The resistant crops (kidney bean and vetch) should be used as trap crops or incorporated in a suitable crop rotation system in order to combat the menace of this serious parasite.

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تأثير حامول الحقل على بعض المحاصيل البقولية

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الملخص :

تم اختبار اثني عشر محصولاً بقولياً لدراسة تأثير طفيل حامول الحقل عليها . وقد أظهرت المحاصيل المدروسة تبايناً كبيراً في استجابتها لتطفل حامول الحقل . ووفقاً للفقد في الوزن الجاف للعائل (الفقد في وزن الناتج الحيوي) الذي سببه الطفيل ، فقد تم تقسم المحاصيل المدروسة إلى ثلاث مجموعات : المحاصيل التي فقدت أكثر من ٥٠٪ من وزنها الحيوي اعتبرت ذات قابلية عالية للإصابة ، وتلك التي فقدت ما بين ١٠ -٥٠٪ من وزنها الحيوي اعتبرت ذات قابلية للإصابة ، والتي فقدت أقل من ١٠٪ من وزنها الحيوي اعتبرت مقاومة . وقد أوضحت نتائج الدراسة اشتمال المجموعة الأولى (ذات القابلية العالية للإصابة) على ٦ محاصيل (اللبلاب ، العدس ، الحمص ، الفول البلدي ، البرسيم الحجازي ، البازلاء العلفية) ، والمجموعة الثانية (ذات القابلية للإصابة) على ٤ محاصيل (الحلبة ، البرسيم المصري ، الترمس ، البازلاء) والمجموعة الثالثة (المقاومة للإصابة) على محصولين (الفاصولياء والجلبان) من جملة المحاصيل المدروسة . وقد ظهر من جراء التطفل أن نبات اللبلاب كان أكثر النباتات تضرراً (٧٥٪ فقد في الوزن الحيوي) بينما كان نبات الفاصولياء أقل تضرراً (٨,١٪ فقد في الوزن الحيوي) مقارنة مع المحاصيل البقولية الأخرى . ومع ذلك ، ففي نبات الجلبان كان للطفيل أثر إيجابي على صفات النمو (١٧,٦٪ زيادة في الوزن الحيوي) ، وارتبطت الفواقد ذات المعنوية في صفات نمو المحاصيل ذات القابلية للإصابة والمحاصيل ذات القابلية العالية للإصابة بزيادة ملحوظة في الناتج الخضري (الوزن الجاف) لحامول الحقل .