Parasitic Potential-Host Range of Cuscuta sp. and its Impact on *Allium cepa* L. Grown in Jaffna

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Abstract

Cuscuta sp. is a familiarized medicinal plant for centuries but at times it has been reported parasitizing economically important crops like onion (*Allium cepa* L.) and chilli (*Capsicum annum* L). Due to the risk posed by this holoparasitic weed on cultivated crops, a field based research study was carried out with the objective of measuring parasitic potentiality of Cuscuta sp. through identifying minimum length of infective unit as tendril and its host searching ability, estimating biomass loss of *A. cepa* and screening of host range with selected vegetable crops and medicinal plants. Treatments were set up to measure the parasitic potential of Cuscuta sp. on different ages of *A. cepa* at two weeks and four weeks. Results revealed that minimum of five cm long Cuscuta tendril have the capability to initiate infection. Its tendrils have the potential to grow towards its host, *A. cepa* up to 60 cm distance. Therefore, spacing between two adjacent *A. cepa* plots more than 60cm can be practicable to reduce the spreading of Cuscuta sp. At the time of harvesting, biomass loss of leaves and bulbs in two and four weeks old parasitized *A. cepa* were 58.4%, 14.5% and 89.1%, 46%, respectively. Dry weights of Cuscuta sp. were not significantly different at all the weeks. Number of leaves, shoot/root length ratio except number of bulbs, were significantly differed with age of *A. cepa*. Only two weeks old parasitized *A. cepa* yielded small size bulbs. Parasitic potential of Cuscuta sp. was not depend on the age of *A. cepa*. Results of host-parasite interactions showed that *Brassica oleraceae* and *Raphanus sativus* were the non-host crops of Cuscuta sp. Intercropping and crop rotation with non-host crops are the best alternatives in the crop fields suspected with infection of Cuscuta spp.

Key words: Biomass, Cuscuta, Allium cepa, Parasitism

Introduction

Cuscuta sp. is holoparasitic annual weed of the family Convolvulaceae (Lanini and Kogan, 2005). It has been recorded as a problematic parasitic weed to crop plants in agricultural system in semi -humid and semi-arid areas of Africa and Asia (Dawson et al. 1994). It was known as third most troublesome weed of Sri Lanka according to the weed list published by CARP in 2011.

Significant crop losses have been reported due to infestation with Cuscuta in many crops (Marambe et al. 2002). In Sri Lanka, severe infestation of Cuscuta sp. in *Capsicum annum* L., and *Allium cepa* L. (Arulnandy and Padmasiri, 1987), and *Centella asiatica* (L.) Urb. (Anonymous, 1989) have been previously recorded. Wijesundara et al. (2001) reported that more than 100 wild and cultivated species are vulnerable to infestation from this holoparasite.

The invasive characteristics of Cuscuta sp. could be detrimental to the cultivation of many economically important crops. It could also affect the natural ecological balance and floristic composition in natural ecosystem (Jayasinghe et al. 2004). However, there is no quantitative information on the biology, physiology, and distribution of Cuscuta sp. in Sri Lanka (Marambe et al. 2002). Therefore, awareness on this weed should be created among the farmers to safeguard their crops. The study was conducted to determine the host range, parasitic potential of Cuscuta sp. and to quantitatively estimate biomass loss of selected host crop, *A. cepa L.*, by the artificial infestation of Cuscuta sp.

Materials and Methods

The investigations and field study were carried out at the Laboratory of Department of Agric. Biology, Faculty of Agriculture, University of Jaffna. Cuscuta tendril pieces of 2 cm, 5 cm, 10cm and 20 cm lengths were separated and winded up on *A. cepa* with four replicates for each tendril length to identify the minimum length of infective unit. Eight potted *A. cepa* were arranged at 10 cm, 20 cm, 40 cm, 60 cm and 70 cm arcs of circles with three replicates. *A. cepa* parasitized by Cuscuta sp. was placed at the centre of the circle.

This set up was used to determine the host searching ability of Cuscuta sp.

Determination of host range

Twenty two vegetable crops and fourteen medicinal plants were selected to grow in pots for screening of host range. Tested crops were categorized based on the following visual scores.

0 – No attachment
1 – Attachment only
2 – Attachment and spreading
3 – Host was damaged; but not killed
4 – Full damage and Killing of host

Estimation of the biomass loss of Allium cepa L.

Test crop, *A. cepa* (Jaffna local variety), was planted in pots at the rate of 4 bulbs/ pot at recommended spacing. Cuscuta sp. tendril pieces (2 weeks old and 20 cm long) were artificially winded up on selected leaf of two *A. cepa* plants. Three treatments were assigned with six replicates in each treatment.

Treatment 1 – Control; *A. cepa* was not parasitized by Cuscuta sp. (C)

Treatment 2 – Two weeks old *A. cepa* was parasitized by Cuscuta sp. (P-2wk)

Treatment 3 – Four weeks old *A. cepa* was parasitized by Cuscuta sp. (P-4wk)

From 5^{th}-9^{th} week, hosts at each level of infestation were harvested at weekly interval and separated to weigh separately. Plant materials were oven-dried at 70°C until constant weight was achieved.

Completely Randomized Design was used and data for biomass loss were analyzed using one-way ANOVA with SAS statistical software. LSD was used to compare treatments at $\alpha = 0.05$.

Results and Discussion

Infestation potential of the stem of Cuscuta spp.

Minimum of 5cm Cuscuta stem pieces made parasitism. The minimum distance needed to avoid the infestation between two *A. cepa* plants was 60 cm.

Growth Measurements of *A. cepa*

In this experiment, *A. cepa*, not parasitized by Cuscuta sp., shown normal growth curve and dry matter of leaves was increased with the weeks, reached to peak at seventh week then it declined. Onion, parasitized by Cuscuta sp. at two weeks old (P-2wk), showed significant changes at all the weeks and its maximum growth was occurred at sixth week (i.e. after 4 weeks of parasitism) with weight gain of 0.53 g/plant and biomass loss of 37%. Onion, parasitized at four weeks old (P-4wk), resembles control experiment. It reached maximum growth at seventh week (i.e. after 4 weeks parasitism) with 0.91 g/plant weight gain and 15.2% of weight loss. At harvesting stage (8th week),

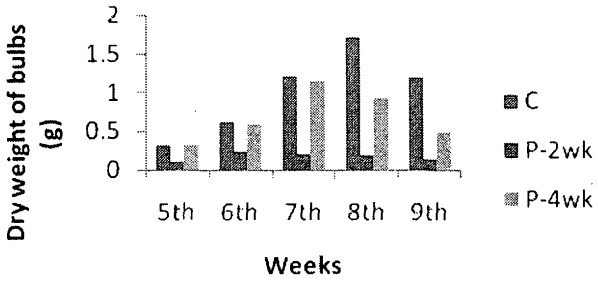

Figure 1: Dry weight of bulbs per plant with time

biomass loss in leaves in P-2wk and P-4wk were 58.4% and14.5%, respectively. It expressed that the early parasitism led to less weight gain than the late parasitism.

Table1. Host crops and non-host crops of Cuscuta sp.

Botanical name	Family
Visual score = 0; No attachment	
Brassica oleraceae	Brassicaceae
Raphanus sativus	Brassicaceae
Visual score = 1; attachment only	
Elucine coracana	Poaceae
Manihot esculenta	Euphorbiaceae
Setaria italica	Poaceae
Sorghum bicolor	Poaceae
Vigna unguiculata	Fabaceae
Zea mays	Poaceae
Visual score = 2; attachment and spreading	
Lycopersicon esculentum	Solanaceae
Phaseolus vulgaris	Fabaceae
Phaseolus mungo	Fabaceae
Visual score = 3; Host was damaged, but not killed	
Sesamum indicum	Pedaliaceae
Visual score = 4; Full damage and killing of host	
Amaranthus spp.	Amaranthaceae
Beta vulgaris	Chenopodiaceae
Capsicum fructuscense	Solanaceae
Centella asiatica	Apiaceae
Cucumus pepo	Curcubitaceae
Daucus carota	Apiaceae
Momordica charantia	Curcubitaceae
Solanum melongena	Solanaceae
Trichosanthus anquina	Fabaceae
Vigna radiata	Fabaceae

Medicinal plants	Family
Visual score = 2	
Azadiracta indica	Meliaceae
Curcuma domestica	Zingiberaceae
Maranta arundinaceae	Marantaceae
Visual score = 3	
Gymnema sylvestre	Asclepiadaceae
Lantana camera	Verbanaceae
Ocimum sanctum	Lamiaceae
Visual score = 4	
Chrysanthemum spp.	Asteraceae
Coelus spp.	Lamiaceae
Datura fastuosa	Solanaceae
Mentha spp.	Lamiaceae
Phyllanthus spp.	Euphorbiaceae
Ricinius communis	Euphorbiaceae
Solanum trilobatum	Solanaceae
Zingeber officinale	Zingiberaceae

In case of dry weight of bulb, control experiment shows steady growth and peaks at 8th week with 1.71 g/bulb. P-2wk was significantly differed with control in all weeks. Its bulb dry weight reached maximum at 6th week. It yielded 0.24 g/bulb of dry weight as maximum with 61.3% of biomass loss. In earlier stage of growth, P-4wk was not significantly differing with control due to less parasitism. P-4wk reached peak dry weight at 7th week with maximum dry weight of 1.14 g/bulb and biomass loss of 5.2%. At 8th week, there was 89.1% of biomass loss in P-2wk and 46% of biomass loss in P-4wk. It could be concluded that the period of parasitism badly influences on the growth and weight gain of the bulbs. Early parasitism exerts more suppressive effect on *A. cepa* L. than the late parasitism.

Dry weight of Cuscuta sp. was significantly differs in 5th and 9th week only in both P-2wk and P-4wk (Fig 1). The differences in the period of parasitism were the reason for this. There was no significant difference in dry weight of Cuscuta sp. in the period 6-8th week due to the vigorous growth rate of Cuscuta sp. At 9th week dry weight of Cuscuta sp. was high in P-4wk. But in P-2wk, it was low due to the death of host and drying of Cuscuta sp.

Even number of bulbs/plant was increased with the week, number of bulbs of both P-2wk and P-4wk was not significantly different with the control in all experiments. It revealed that the parasitism was not influenced on the number of bulbs produced. P-2wk was significantly different in bulb size with control in all the weeks. P-4wk was not significantly different during the 5-9th weeks. Thus it can be concluded that the period of parasitism was influenced based on the bulb size.

Conclusion

Even 5 cm tendril piece of Cuscuta sp. was sufficient to infest the host crop. At harvesting (8th week), biomass loss in leaves and bulbs in 2 week old and 4 week old parasitized *A. cepa* were 58.4%, 14.5% and 89.1%, 46%, respectively. Dry weight of Cuscuta sp. made significant differences only in the initial and last weeks. Growth parameters such as number of leaves and shoot/ root length ratio were significantly different from the control. But, there was no difference in bulb number by parasitism. Bulb diameter varied significantly only by early parasitism. Tendrils of Cuscuta sp. have potential to seek out their host, *A. cepa* until 60 cm distance. Therefore, spacing between two adjacent *A. cepa* plots more than 60cm can be reduced the spreading of Cuscuta sp. Planting of susceptible host in parasitized field will lead to severe threat to these crops. Among the test crops, *Brassica oleraceae* and *Raphanus sativus* were the best non-host crops of Cuscuta spp. (Table 1). Crop rotation and intercropping with non-host crops is possible to prevent the spreading of the Cuscuta sp.

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