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Desert Horse Purslane Weed as an Alternative Host for Amaranth Leaf Webber, Hymenia recurvalis in Taiwan 【Scientific note】

假海馬齒作為草螟 (Hymenia recurvalis) 之 替代寄主植物【科學短訊】

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Abstract

The amaranth leaf webber (Hymenia recurvalis) feeds on several kinds of weed and crop plants in addition to its main host plant, amaranth. The larvae overwhelmingly prefer to feed on a weed host, Trianthema portulacastrum (desert horse purslane). The growth and development of H. recurvalis was assessed on T. portulacastrum and one of its usual host plants, Amaranthus viridis. The larvae of H. recurvalis grew significantly faster on T. portulacastrum, although the larval mortality was also significantly higher. Adults lived longer on T. portulacastrum than amaranth. However, there were no differences observed in pupal mortality, pupal period, pupal weight, adult emergence, fecundity, egg period and egg hatching. Hence, T. portulacastrum may be an alternative host plant for the population build-up of this noxious pest during host-free seasons.

摘要

草螟除取食主要作物莧菜，亦取食多種雜草及其他作物，且該幼蟲偏好取食假海馬齒。進一步評估草螟幼蟲在假海馬齒及野莧菜上之生長發育情形，結果顯示幼蟲在假海馬齒上之發育速度較快，但死亡率也較高；成蟲在假海馬齒上的存活期間較長。蛹死亡率、蛹期、蛹重、成蟲羽化率、成蟲繁殖力、卵期及卵孵化率則不具有顯著差異。由此可知，當田間缺乏野莧菜，草螟仍可在假海馬齒植株上發育生長，並使族群增長。

Key words: Hymenia recurvalis, Trianthema portulacastrum, Amaranthus viridis, life-cycle

關鍵詞: 草蛾、假海馬齒、野莧菜、生活史。

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ABSTRACT

The amaranth leaf webber (*Hymenia recurvalis*) feeds on several kinds of weed and crop plants in addition to its main host plant, amaranth. The larvae overwhelmingly prefer to feed on a weed host, *Trianthema portulacastrum* (desert horse purslane). The growth and development *of H. recurvalis* was assessed on *T. portulacastrum* and one of its usual host plants, *Amaranthus viridis*. The larvae of *H. recurvalis* grew significantly faster on *T. portulacastrum*, although the larval mortality was also significantly higher. Adults lived longer on *T. portulacastrum* than amaranth. However, there were no differences observed in pupal mortality, pupal period, pupal weight, adult emergence, fecundity, egg period and egg hatching. Hence, *T. portulacastrum* may be an alternative host plant for the population build-up of this noxious pest during host-free seasons.

Key words: *Hymenia recurvalis*, *Trianthema portulacastrum*, *Amaranthus viridis*, life-cycle

Introduction

About 70 species have been recognized in the genus *Amaranth* (Ebert *et al*., 2011) and more than 400 varieties of the plant are found throughout the world in temperate and tropical climates. Amaranth is typically consumed as a leafy vegetable and the grain of some species can be used as a cereal. Some species are considered to be ornamental plants or weeds (O'Brien and Price, 1989; Kauffman and Weber, 1990). Among the 70 species, 17 species including *A. tricolor, A. dubius, A. blitum, A. palmeri, A. hybridus*, *A. viridis* and *A. spinosus* are vegetable amaranths with edible leaves, while *A. hypochondriacus, A. cruentus* and *A. caudatus* are grain species with edible seeds (Teutonico and Knorr, 1985; Ebert *et al*., 2011). Vegetable amaranth is a rich source of proteins, minerals such as calcium, iron and phosphorous, and vitamins A, C and K, riboflavin, niacin, vitamin B6 and folate (Makobo *et al*., 2010; Ebert *et al*., 2011). Amaranth has been consumed in China

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for more than 400 years; it is commonly found in Asia, Australia, New Zealand, the Americas, the Caribbean, and Africa (Pande, 1972; O'Brien and Price, 1983). This nutritious plant has an important place in the diets of people in tropical Asia, Africa and the Americas.

Pests and diseases are important constraints in amaranth production. The amaranth leaf webber, *Hymenia recurvalis* F. (Lepidoptera: Pyralidae), causes significant yield loss in amaranth. The larvae form webs that enfold the leaves, and feed from inside the webs on the soft leaf tissue to extract chlorophyll. Complete leaf skeletonization occurs in severe infestations. *Hymenia recurvalis* can migrate long distances (Miyahara, 1993); the pest influx may lead to serious crop damage in the new location. Although amaranth serves as its main host, *H. recurvalis* also has been recorded on maize, beet root, sweet potato, eggplant, bean and cucurbits (Narayanan *et al*., 1957; James *et al*., 2010). The pest feeds on weeds such as desert horse purslane (*Trianthema portulacastrum,* synonym *T. monogyna*) in arid and semi-arid regions of India (Pande, 1972), and alligator weed (*Alternanthera philoxeroides*) in China (Gao *et al*., 2006). A severe infestation of *T. portulacastrum* by *H. recurvalis* was observed during June – October 2009 in southern Taiwan. The larvae completely defoliated the plant and sometimes fed on the succulent stems. Investigations were carried out under laboratory conditions on the suitability of this weed as an alternative host for larvae of *H. recurvalis*.

Materials and Methods

Insects: A colony of *H. recurvalis* was established from a population collected from the fields of AVRDC – The World Vegetable Center, Shanhua (23°08'29"N, 120°19'15"E), Taiwan, and maintained in an insectary. The larvae were reared on amaranth leaves (*A. viridis*) at 27 ± 1°C, 70 ± 10% RH, and a photoperiod of L14: D10 h until pupation. The adults were maintained in acrylic cylinders (1,766.25 cm^2 area, 30 cm long) covered with nylon nets at both ends for mating and oviposition, and they were provided with 10% honey solution. Folded paper towels were used as the substrate for egg laying. Eggs were transferred from the acrylic cylinders after three days and were maintained until they hatched. The neonate larvae (hatched within 24 h) were used for the experiments.

Plant material: Amaranth and desert horse purslane leaves were collected from pre-flowering, vegetative stage plants in the field to feed the larvae.

Monitoring growth and development: For each host species, 10 replications following a completely randomized design were maintained. For each replication, a cylinder containing the plant leaves of either amaranth or desert horse purslane was maintained. Hence, there were 20 cylinders in total, and each replication had 50 larvae. The neonate larvae were reared on the host plant leaves. The leaves were placed in cylinders at the rate of 5 g per cylinder for first two larval instars, 10 g for the third instar larvae and 15 g for fourth instar onwards. The leaves were changed for fresh leaves on alternate days. The cylinders were maintained at 27 ± 1°C, and 70 ± 10% RH, with a photoperiod of L14:D10 h until pupation. When the adults emerged, they were maintained as described above until the egg laying and hatch. Various parameters such as larval mortality, larval duration, pupal mortality, pupal period, pupal weight, adult emergence, adult longevity, fecundity, egg period and egg hatching were recorded. Data were subjected to analysis of variance (ANOVA) and Duncan's Multiple Range Test (DMRT) for mean comparisons (Gomez and Gomez, 1984). To normalize the residuals, *arc sine* transformation was used for percentage data, before performing the ANOVA. For non-transformed data, the co-efficient of

Table 1. Growth and development of *Hymenia recurvalis* on amaranth and desert horse purslane

Host plant	Larva		Pupa		Pupal weight (mg) ± SD	Adult emergence (%)	Adult longevity (day) ± SD	Fecundity (no/female/ day) ± SD	Egg period (days) ± SD	Egg hatch (%)
	Mortality (%)	Larval period (day) ± SD	Mortality (%)	Pupal period (day) ± SD						
Amaranth	2.40 (6.86) b	9.71 ± 1.13 a	1.39 (6.75)	8.11 ± 0.69	68.13 ± 6.74	60.92 (51.71)	4.99 ± 0.36 b	10.04 ± 3.27	8.71 ± 1.25	48.63 (44.23)
Trianthema portulacastrum	28.00 (31.67) a	8.48 ± 0.88 b	1.42 (6.84)	7.99 ± 0.96	73.24 ± 4.35	64.81 (53.81)	5.68 ± 0.79 a	11.09 ± 3.96	7.82 ± 0.48	57.10 (49.14)
F value	81.66	7.32	0.20	0.10	4.06	0.38	6.26	0.42	4.40	2.77
p value	< 0.0001	0.01	0.66	0.75	0.06	0.55	0.02	0.53	0.05	0.11
LSD	5.77	0.96	-	-	-	-	0.58	-	-	-
CV (%)	-	11.18	-	10.34	8.02	-	11.56	34.40	11.47	-

In a column, means followed by same letter (s) are not significantly different by DMRT at 5% level
Figures in parentheses are *arc-sine* transformed values

variations (CVs) and standard deviations were also calculated, and included in the results to derive conclusions.

Results and Discussion

Although the larvae of *H. recurvalis* grew significantly faster ($F_{1,18df} = 7.32$; $p = 0.01$), the larval mortality was significantly higher ($F_{1,18df} = 81.66$; $p < 0.0001$) on the weed host (*T. portulacastrum*) (Table 1). However, there was no difference observed in pupal mortality, and the pupal period was similar recording about eight days on both amaranth and *T. portulacastrum* (Table 1). Pupal weight also did not differ significantly recording 68.13-73.24 mg per pupa. Hence, the adults emerged without any difference on both the hosts. However, the adults lived slightly longer (5.68 days) on *T. portulacastrum*, compared to amaranth ($F_{1,18df} = 6.26$; $p = 0.02$). The fecundity (10.04-11.09 eggs/female/day), incubation period (7.82-8.71 days) and the egg hatching (48.63-57.10%) did not vary significantly when the *H. recurvalis* fed and developed on both the hosts.

Hymenia recurvalis was found to feed actively on *T. portulacastrum* in Taiwan during May to October. This is in agreement with a similar observation from India where the insect was most active on this weed from July to October (Pande, 1972). In general, the egg period varied from 3 to 9 days (Bhattacherjee and Menon, 1964; Pande. 1972; James *et al*., 2010). We also found a similar egg period in the current study. The larval period was three to four weeks in West Africa (James *et al*., 2010) and 12-18 days in India (Pande, 1972). However, the larval period was much shorter in the current study, only about 9-10 days. This may be due to the differences in the prevailing temperatures in Taiwan and other parts of the world. For instance, under laboratory conditions of 18.6 ± 2°C and 70 ± 5% RH, the larval period lasts for almost four weeks (Seham *et al*., 2006). Similarly, the pupal period was slightly more than two weeks under these conditions, whereas it was slightly more than a week in the current study, which was conducted at 27 ± 1°C, and 70 ± 10% RH. One striking difference in the current study is the drastic reduction in adult longevity. The adults lived only for about six days, compared with two to four weeks recorded in earlier studies (Seham *et al*., 2006; James *et al*., 2010). Longevity may depend on the host plant on which the insect develops. For instance, the average longevity of male and female *H. recurvalis* was 3.5 and 6 days, respectively, when the insect was fed on *T. monogyna* in western India (Pande, 1972). However, it did not affect the fecundity. Because the lifecycle is completed within a month on either amaranth or on *T. portulacastrum*, the insect is able to produce multiple generations in a year in Taiwan. Earlier reports also documented that *H. recurvalis* produced many generations in a year under tropical conditions (James *et al.*, 2010).

Because of its preferential feeding on certain weeds, some researchers proposed that *H. recurvalis* could be used as a biocontrol agent against those weeds. Pande (1972) considered its potential to control *T. portulacastrum* and *A. viridis* – both rainy season (July-October) weeds in Rajasthan, a northwestern province of India. Gao *et al.* (2006) considered *H. recurvalis* as an efficient biocontrol agent for alligator weed in Nanjing, China. However, it is not acceptable to use *H. recurvalis* as a biocontrol agent against noxious weeds because of the great damage it can cause in important vegetable crops.

Hymenia recurvalis can feed and develop on *T. portulacastrum* as efficiently as on its usual host plant, amaranth. On *T. portulacastrum,* it completes its lifecycle quite rapidly, and hence it is capable of producing multiple generations in a year. Thus, the removal of *T. portulacastrum* especially during the off-season when amaranth is not present in the field should be included as part of integrated pest management strategies to control *H. recurvalis* on amaranth and other vegetables.

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假海馬齒作爲草蛾（*Hymenia recurvalis*）之替代寄主植物

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摘　　要

草蛾除取食主要作物莧菜，亦取食多種雜草及其他作物，且該幼蟲偏好取食假海馬齒。進一步評估草蛾幼蟲在假海馬齒及野莧菜上之生長發育情形，結果顯示幼蟲在假海馬齒上之發育速度較快，但死亡率也較高；成蟲在假海馬齒上的存活期間較長。蛹死亡率、蛹期、蛹重、成蟲羽化率、成蟲繁殖力、卵期及卵孵化率則不具有顯著差異。由此可知，當田間缺乏野莧菜，草蛾仍可在假海馬齒植株上發育生長，並使族群增長。

關鍵詞：草蛾、假海馬齒、野莧菜、生活史。

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