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Biology of the Vegetable Leafminer, *Liriomyza sativae* (Blanchard) (Diptera: Agromyzidae) on Kidney Bean (*Phaseolus vulgaris* L.) and Pak Choi (*Brassica rapa* var. *chinensis*)

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ABSTRACT

Background: The vegetable leafminer, *Liriomyza sativae* (Blanchard) is a serious pest of vegetable and ornamental crops in the whole Vietnam. Previous studies indicate that biology of *Liriomyza* leafminers depends on host plant. The objective of this study was to understand the performance of *L. sativae* on kidney bean (*Phaseolus vulgaris* L.) and pak choi (*Brassica rapa* var. *chinensis*).

Methods: The experiment was carried out at the Laboratory of Entomology, Faculty of Agronomy, University of Agriculture and Forestry, Hue University, Vietnam during 2020 and 2021. The development time of immature stages, longevity and fecundity of *L. sativae* were investigated on kidney bean and pak choi.

Result: The total developmental time from egg to adult emergence of the vegetable leafminer fed on kidney bean was shorter (17.1 days) than that on pak choi (18.2 days). Fecundity of the adults on kidney bean (190.2 eggs) were larger than that on pak choi (73.3 eggs). The results indicated that pak choi was less suitable host plant than kidney bean.

Key words: Fecundity, Host plant preference, Kidney bean, Life cycle, *Liriomyza sativae*, Pak choi.

INTRODUCTION

The vegetable leafminer, *Liriomyza sativae* (Blanchard) (Diptera: Agromyzidae) is a pholyphagous pest of horticultural plants worldwide (Murphy and LaSalle, 1999). Native to the North America, *L. sativae* is widespread over many countries in the world (Askari-Saryazdi *et al.*, 2015; Fourouzan and Farrokh-Eslamlu, 2017; Dnyaneshwar *et al.*, 2018; Barros *et al.*, 2020). *Liriomyza sativae* was also dominant *Liriomyza* species found on various vegetables whole Vietnam (Tran, 2009). While infestations of *L. sativae* on cucumber became more serious in the dry season from October to April when the densities reached a peak of nearly 38 larvae/leaf in the south (Tran *et al.,* 2005) and *L. sativae* was the dominant species on yardlong bean with a frequency of 52% and the severe damage was from July to September in the central region (Tran *et al.*, 2022). Currently, conventional control of the leafminer has been dependent on synthetic chemical insecticides (Tran *et al.*, 2004; Tran and Tran, 2022).

Previous study has indicated that two factors causing differences in biology of *Liriomyza* spp. are temperature and host plant (Tran *et al.*, 2007; Takeda *et al.*, 2020; Fujito *et al.*, 2021). Host plant has an important impact on herbivore development and reproduction (Dixon, 1977; Awmack and Leather, 2002). Host plant preferences in *Liriomyza* leafminers have previously been reported (Musundire *et al.,* 2010). Musundire *et al.* (2010) indicated the characteristics of *L. sativae* (e.g. body size, wing length, hind tibia length, larvae density) were effected by host plants (e.g. *Pisum sativum* L., *Phaseolus vulgaris* L., *Vicia faba* L. and *Solanum lycopersicum* L.). Additionally, the odor of host plants was important role in host plant location of the male and female of *L. sativae* (Zhao and Kang, 2002). In this study, we examined the effects of selected host plants (e.g. kidney bean, pak choi) on development, oviposition, feeding and longevity of *L. satiave*. The knowledge of the basic biological characteristics of this leafminer on different host plants is of fundamental importance for development of an alternative control measure.

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MATERIALS AND METHODS

Plant cultivation and insect rearing

Liriomyza sativae used for the present study originated from a culture reared by Entomology Laboratory, Faculty of Agronomy, University of Agriculture and Forestry, Hue University, Vietnam. A single seed of kidney bean (*Phaseolus vulgaris* L.) or a single seedling of pak choi (*Brassica rapa* var. *chinensis*) was planted in a pot (9 cm × 10 cm) in approximately 1 kg of a mixture soil with pH = 5.2, an organic carbon content of 1.5% and available concentrations of K_2O,

N and P_2O_5 of 4.59 mg, 0.65 mg and 10.5 mg per 100 g of soil, respectively.

Two sub-colonies of *L. sativae* were separately established in a climate-controlled chamber (25±0.5°C and 12L:12D photoperiod) on kidney bean or pak choi. One week after germination for kidney bean or two weeks after germination for pak choi, a tray (32 cm × 44 cm × 6 cm) containing 24 potted plants was placed in a shelf covered with a fine nylon mesh. Leafminer adults were released into the shelf and allowed to oviposit on the plants for 24 hours. Thereafter, the potted plants were maintained under the same condition until all leafminer larvae feeding on the plants reached the last instars. The leaves containing final-instar larvae were cut off and kept in a PET bottle (1.5 l in volume) to gain adult leafminers. The sub-colonies were maintained on these plants for two to three generations prior to their use in experiments.

Immature development

Six plants of each crop were infested with *L. sativae* using the method described above and subsequently placed in an environmental chamber at a constant temperature of 25±0.5°C, 70±10% RH and a 16L: 8D photoperiod. Eggs, which became clearly visible after a few days, were individually located and marked by circling that area of the leaf with a felt-tip pen under a microscope. Egg hatch was determined by inspecting the leaves with the microscope every 12 hours. Only the larvae that had hatched at the same time were monitored for larval development time calculation. Larvae that hatched at different time were killed with an insect pin. Larval instars were distinguished using the method described above. The end of larval development was assessed by collection of pupae from the plants at a 12 hours interval. The pupae were individually placed in petri dishes (6 cm in diameter) containing damp soil and maintained at the same experimental conditions. Adult emergence for each pupa and its sex were daily recorded to determine mean development time.

Longevity, feeding and fecundity

Pupae were randomly removed from the insect rearing cages and placed singly in Petri dishes (6 cm in diameter) containing damp soil and maintained in an environmental chamber at a constant temperature of 25±0.5°C and a photoperiod of 16L: 8D. On the day of emergence, one female and two male flies were released into a cylindrical cage (35 cm × 20 cm × 25 cm) containing two potted plants of kidney bean or pak choi. The cages were made of transparent plastic with openings covered with a fine nylon mesh for air circulation. Honey was not provided to the flies. These were kept in environmental chambers set at 25±0.5°C, 70±10% RH and a 16L:8D photoperiod. Plants were changed daily until the female's death; new males were added if necessary. The feeding punctures and viable eggs were daily counted and longevity of females was determined.

Statistical analysis

Data for developmental times, viable eggs, feeding punctures and longevity was analyzed by *t*-test using StatView ver. 5.0 software (SAS Institute Inc., 1998).

RESULTS AND DISCUSSION

The development of *Liriomyza sativae*

The developmental time of *L. sativae* was significant affected by host plants. The leafminers feeding on kidney bean plants developed more rapidly than those reared on pak choi (Table 1). The duration of egg and larval stages was non significant difference with kidney bean and pak choi. The pupal stage was longer on pak choi than that on kidney bean. The total developmental time from egg to adult emergence of the vegetable leafminer fed on kidney bean was significantly shorter (17.1 days) than that on pak choi (18.2 days) (Table 1). The results were in agreement with the results of (Aroujo *et al*., 2013; Haghani *et al*., 2007). Aroyjo *et al*. (2013) who reported different development period of *L. satiave* on different host plants. Aroyjo *et al*. (2013) reported that the developmental time from egg to adult emergence of *L. sativae* reared on melon (*Cucumis melon* L.) at 25°C lasted 15.9 days. However, Haghani *et al.* (2007) indicated that the total development of *L. sativae* feeding on cucumber plants (*Cucumis sativus* L.) at 25°C was 20.6 days. Since differences in some biological characteristics between different biotypes of an insect (*e.g*. whitefly) (Yao *et al*., 2017) are considered to affect the outcome of their competition, further research on biotypes and its host preference of *L. sativae* could be considered.

The longevity and fecundity of *Liriomyza sativae*

There were no significant differences between the mean longevities of *L. sativae* adults feeding on different host plants (Table 2). The longevities of the female were 10.5 and 9.3 days on kidney bean and pak choi, respectively. The longevities of the vegetable leafminer male were 3.3 and 2.9 days on kidney bean and pack choi, respectively. The longevities of males and females observed in this study differed from other studies on *L. sativae* with longer longevity

Table 1: Developmental time (days) of *Liriomyza sativae* reared on different host plants.

Stage	Host plant		Statistical parameters	
	Kidney bean	Pak choi	t-value	P
Egg	4.3±0.17[a]	4.3±0.21[a]	0.22	0.83
Larva	6.4±0.21[a]	6.7±0.23[a]	1.1	0.28
Pupa	7.1±0.23[b]	8.2±0.23[a]	3.23	<0.01
Egg-adult	17.1±0.32[a]	18.2±0.26[b]	2.24	<0.01

Mean±SE. Mean with the same letters within the same stage are not significantly different by t-test, P<0.05.

Table 2: Feeding, fecundity, longevity, pre-and post-oviposition periods of *Liriomyza sativae* reared on different host plants.

Parameter		Host plant		Statistical parameters	
		Kidney bean	Pak choi	t-value	P
Feeding (no. punctures)		2062.5±154.55^{a}(1378-2958)*	842.5±75.13^{b}(511-1252)	7.10	<0.001
Fecundity (visible eggs)		190.2±12.51^{a}(124-246)	73.3±6.71^{b}(47-114)	8.24	<0.001
Pre-oviposition (day)		1.2±0.13^{b}(1-2)	2.0±0.21^{a}(1-3)	3.21	< 0.01
Post-oviposition (day)		0.6±0.16^{a}(0-1)	1.0±0.29^{a}(0-3)	1.18	0.25
Longevity (day)	Male	3.3±0.15^{a}(3-4)	2.9±0.15^{b}(2-3)	4.63	0.09
	Female	10.5±0.74^{a}(7-14)	9.3±0.54^{a}(7-12)	1.32	0.20

Mean±SE. Mean with the same letters within the same stage are not significantly different by t-test, P<0.05.
*(Range).

than those observed in cowpea plants [*Vigna unguiculata* (L.) Walp] (Costa-Lima *et al*., 2010).

The damage caused by *L. sativae* to plants is very similar to other *Liriomyza* species: larvae mine and feed within the leaves and females produce feeding punctures on the leaves with their ovipositor. The adults feed from all punctures, regardless of whether or not they are used for oviposition (Parrella, 1987). The feeding activity of a female on kidney bean (2062.5 punctures) was significant higher than that on pak choi (842.5 punctures) (Table 2). Leaf punctures can reduce photosynthesis and may kill young plants. Therefore, leaf puncturing and feeding by adult *Liriomyza* undoubtedly serve an important role in host plant loss assessment (Parrella, 1987).

In this study, host plants have a significant effect on *L. sativae* reproduction parameters. On pak choi, the *L. sativae* females took 2.0 days to begin oviposition, whereas it was only 1.2 days on kidney bean. However, there was not significant difference in the vegetable leafminer's post-oviposition period. The vegetable leafminers that fed on kidney bean had higher fecundity. The fecundity was 190.2 and 73.3 eggs on kidney bean and pak choi, respectively (Table 2). A high fecundity of *L. sativae* on cowbean have been also reported by Costa-Lima *et al*. (2010).

Previous studies indicated that different host plants played an important role on the development, survival rate, longevity and fecundity of insect pests (Bertin *et al*., 2013; Tran and Nguyen, 2019). Awmack and Leather (2002) stated that host plant quality and its components like secondary metabolites, nitrogen and carbon is known as key determinant, which directly affects the development, fecundity and reproductive strategies of insect. Zhao and Khang (2002) indicated the odour of kidney bean, *P. vulgaris* attracts both males and females of *L. sativae*, this in turn the host preference of *L. sativae* to kidney bean followed by pak choi.

CONCLUSION

It is concluded from this study that the total developmental time from egg to adult emergence of *L. sativae* fed on kidney bean was shorter (17.1 days) than that on pak choi (18.2 days). Fecundity of the adults on kidney bean (190.2 eggs) were larger than that on pak choi (73.3 eggs). The results indicatated that pak choi was less suitable host plant than kidney bean. Therefore, proper host plant should be applied for minimum the vegetable leafminer damage and the development of resistance plant cultivars should be intended as an integrated pest management measure in the control of *L. sativae*.

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Conflict of interest: None.

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