Hymenopterous Parasitoids of Leafminer, *Liriomyza sativae* on Vegetable Crops in South Sumatera

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Abstract

Surveys from March to August 2005 at lowland areas in South Sumatera were conducted to determine parasitoid species attacking *Liriomyza sativae* in vegetable crops, i.e. long bean (*Vigna sinensis*), current tomato (*Lycopersicum pimpeneliifolium*), cucumber (*Cucumis sativus*), and vegetable sponge (*Luffa cylindrica*). Leafminer-infested leaves of the host plants were collected every two-week. The laboratory observation was carried out to identify parasitoid species, and to determine the apparent parasitism of *L. sativae* by those parasitoids. Fourteen species of the hymenopterous parasitoids found in the vegetable crops were *Asecodes* sp., *Chrysonotomyia* sp., *Diglyphus albiscapus*, *Diglyphus* sp., *Diphoropria kushell*, *Diphoropria* sp., *Gronotoma* sp., *Hemiptarsenus varicornis*, *Neochrysocharis okazakii*, *Neochrysocharis* sp., *Opius* sp., *Quadrasticus liriomyzae*, *Quadrastichus* sp, and a mymarid wasp (an unidentifiable species). In South Sumatera, all the parasitoids except *H. varicornis* were reported for the first time parasitizing *L. sativae* larvae. The apparent parasitism by those parasitoids amounted to 42.86%. *H. varicornis* was the most abundant compared to the others.

Keywords: Parasitoid, vegetable, *Liriomyza sativae*

Introduction

Leaf miner, *Liriomyza sativae* has spread virtually worldwide from South America (Weintraub & Horowitz 1995). In Indonesia, the leaf miner was first found in 1996 in West Java (Rauf *et al.* 2000). Since this time the pest has spread to many vegetable production areas throughout Java and Sumatera where it caused heavy damage on cucumber. Several farmers reported yield losses as high as 60% (Rauf & Shepard 2001). In early 2000, *L. sativae* also was found in South Sumatera (Herlinda 2003). It is now an economic pest of great important, especially on cucumber, tomato, and beans in South Sumatera (Herlinda 2003; Herlinda *et al*. 2003).

L. sativae is highly polyphagous insect that infests a large number of horticultural crops and weeds (Waterhouse & Norris 1987). *L. sativae* can cause direct and indirect damage (Minkenberg & van Lenteren 1986). Direct damage by larval feeding on palisade parenchyma tissue can reduce the photosynthetic capacity of the plant up to 62% (Johnson *et al*. 1983). Indirect injury occur when both adult males and females feed (Matteoni & Broadbent 1988). Adult females perforate the upper and lower leaf epidermis with their ovipositor to feed and lay eggs. It results in cosmetic damage to the crops also facilitates the spread of various plant diseases (Miranda *et al.* 1998).

Liriomyza spp. are known to have many natural enemies, particularly in their native home in the New World (Murphy & LaSalle 1999). Indigenous parasitoid communities of *Liriomyza* spp. are diverse within their native ranges and there is evidence that in pesticide free areas these can regulate leafminers. They can also be diverse in their adventive ranges in continental areas, as invading *Liriomyza* spp. quickly attract local parasitoids (Weintraub & Horowitz1995). Throughout Indonesia, a number of parasitoids of *Liriomyza huidobrensis* have been recorded (Rauf *et al.* 2000). In West Java, 19 species of parasitoids of *L. sativae* were found (Susilawati 2002), but in South Sumatera they have not been reported, yet. To control the leaf mining flies by the parasitoid, it is necessary first to

identify the parasitoid species, and to determine its potential. The objectives of this study were to identify species of *L. sativae* parasitoids associated with vegetable crops, i.e. long bean (*Vigna sinensis*), current tomato (*Lycopersicum pimpeneliifolium*), cucumber (*Cucumis sativus*), and vegetable sponge (*Luffa cylindrica*) in South Sumatera, and to determine the apparent parasitism of *L. sativae* by those parasitoids..

Materials and Methods

Surveys for *L. sativae* infested crops were done in Gelumbang, Kayu Agung, Inderalaya, Talang Kelapa, Sukarami, Talang Buruk, and Kenten. Each location was visited at two-week intervals from March to August 2005. The rainy season lasted from March to April and the dry one lasted from May to August. Leaves of different host plants infested by the leafminer collected were over 100 per host per location. Species of the host plants were recorded. The host plants in each location were long bean, current tomato, cucumber, and vegetable sponge. The area of each field crop in all locations varied (0.25-1 ha).

In the laboratory, the leaf samples from different host plants and locations were held in different insect boxes (diameter 35 cm, height 50 cm) at room temperature (24-26 ^{o}C). *L. sativae* and its parasitoids emerged from the field samples were recorded daily, and preserved in vials containing 70% ethyl alcohol. The parasitoids were identified using insect external morphology and according to Konishi (1998).

The number of parasitoids emerged were analyzed by tabulation, and data were presented to tables and graphic description. The apparent parasitism that was percentage of the number of parasitoids emerged divided by the total insect hosts and adult parasitoids emerged was determined according to Valladares and Salvo (2001).

Results

We found 14 species of hymenopteran parasitoids associated with *L. sativae* on vegetable crops in South Sumatera (Figure 1, 2, and 3). They were *Asecodes* sp., (Hymenoptera: Eulophidae), *Chrysonotomyia* sp. (Hymenoptera: Eulophidae), *Diglyphus albiscapus* (Hymenoptera: Eulophidae), *Diglyphus* sp., *Diphoropria kushell*, (Hymenoptera: Diapriidae), *Diphoropria* sp., *Gronotoma* sp. (Hymenoptera: Eucoilidae), *Hemiptarsenus varicornis* (Hymenoptera: Eulophidae), *Neochrysocharis okazakii* (Hymenoptera: Eulophidae), *Neochrysocharis* sp., *Opius* sp. (Hymenoptera: Braconidae), *Quadrasticus liriomyzae* (Hymenoptera: Eulophidae), *Quadrastichus* sp., and a mymarid wasp (an unidentifiable species from Mymaridae). All the parasitoids parasitized the larvae of *L. sativae*.

The most common parasitoid found on long bean field was *N. okazakii*, the apparent parasitism by this species varied (8-21%) (Table 1). The parasitism increased in dry season from May to August, but in rainy season it was lower (Figure 4). The highest level of the total parasitism reached 40%.

There were nine parasitoid species found on current tomato field (Table 2). The parasitoid that was the most frequently found during surveys on this field was *D. albiscapus*, its parasitism amounted 18.1%. The parasitism began to increase on May, and gradually increased as the dry season occured. The highest level of the total parasitism on the current tomato field reached 42.1%.

The apparent parasitism by the parasitoids attacking *L. sativae* associated with cucumber was low in the beginning of the surveys, and then increased rapidly during May up to the last survey (August) (Table 3). *H. varicornis* was the most abundant parasitoids compared to the others found on cucumber field. The peak parasitism by this parasitoid was 22.7% and occurred in May.

H. varicornis was also the most common parasitoids found on vegetable sponge field. We found 11 parasitoid species on this field (Table 4). The apparent parasitism by those parasitoid increased rapidly in May (42.86%). The parasitism of *L. sativae* by the parasitoids on this field was the highest compared to the others found on other fields.

Discussion

We found a total of 14 species, of these 14 there were 9 species of eulophid parasitoids. This family is one of the cosmopolitan parasitoids of *Liriomyza* spp. around the world (Waterhouse & Norris 1987). Rauf and Shepard (2001) reported among 13 parasitoid species of *L. huidobrensis* found in Indonesia, 10 species of eulophid parasitoids (*Asecodes* sp., *Chrysocharis* sp., *Cirrospillus ambiguus*, *Closterocerus* sp., *Hemiptarsenus varicornis*, *Neochrysocharis formosa*, *Neochrysocharis* sp., *Pnigalio* sp., *Quadrastichus* sp., *Zagrammosoma* sp.), and only one spesies of Eucoilidae (*Gronotoma* sp.), Braconidae (*Opius* sp.), and Pteromalidae (*Sphegigaster* sp.). Murphy and LaSalle (1999) have been reviewed that a total of 37 parasitoid species of *Liriomyza* spp. was found in Asia and 26 species of those were Eulophid, and 4 pteromalid, 3 braconid, and 4 eucolid parasitoids. In South Sumatera, all the parasitoids except *H. varicornis* were reported for the first time parasitizing *L. sativae* larvae.

More parasitoid species found on cucumber field than the other locations due to some parasitoids have host crop preferences. Coll (1998) has shown that particular host plant species are likely to influence the incidence of particular parasitoids. For example, *Diglyphus* spp. prefer exploiting the *Liriomyza* spp. in celery to other host plants (Johnson & Hara 1987). Some parasitoids have weed preferences (Genung, 1981). It is important to determine the host plant species that could enhance the action of leaf miner parasitoids.

Schuster *et al.* (1992) reported that weed patches near crops are important reservoirs for *Liriomyza* parasitoids.

The abundant and parasitism by the parasitoids in this investigation varied among the crops. The most abundant and higher level of the parasitism on cucumber and vegetable sponge was mainly exerted by *H. varicornis*, but on the long bean and current tomato, the highest parasitism was caused by *N. okazakii* and *D. albiscapus*, respectively. However, Johnson and Hara (1987) found that *Diglyphus* and *Neochrysocharis* had tomato preferences. Rauf & Shepard (2001) reported *H. varicornis* was the most common parasitoid found in Indonesia. It is also one of the cosmopolitan parasitoids of *Liriomyza* around the world (Waterhouse & Norris 1987). Although many species parasitoids are polyphagous, some are influenced by the host plant. Unsuccessful in attempts to augment the impact of *Liriomyza* parasitoid could be caused by a unfavoured host (Johnson & Mau1986).

Levels of the parasitism by parasitoids found on all host plants were also affected by season. The parasitism increased in the dry season, but decreased in the rainy season. In the dry season, population of *Liriomyza* usually increases, and it is followed by higher parasitism by its parasitoids. The parasitism usually increases as the host population increases, and it is low when the host is low. Palumbo *et al.* (1994) has shown the parasitism by leafminer parasitoid is found to be density dependent.

Acknowledgements

Financial support of this research was provided by the 13th Competitive Research Grant, General Directorate of Higher Education, Department of National Education (Budget Year 2005, Contract Number: 021/SPPP/PP/DP3M/IV/2005, April 11th 2005). The parasitoid species was identified by Dr. Chandra Irsan, a taxonomist of Sriwijaya University.

Literature Cited

Coll M. 1998. Parasitoid activity and plant species composition in intercropped systems. *In.* Pickett Ch, RL Bugg (eds.). Enhancing biological control. Berkeley, CA, USA: University of California Press. Pp. 85-119.

Genung WG. 1981. Wedd hosts of *Liriomyza* and parasite incidence in the celery agroecosystem at Belle Glade Florida. *In* Schuster DJ (ed). Proceedings of the Institute of Food and Agricultural Science, Industry Conference on the Biological Control of *Liriomyza* leafminer. Lake Buena Vista, FL, USA, -4 November 1981. Pp 61-69.

Herlinda S. 2003. Ecology of *Liriomyza* spp. (Diptera: Agromyzidae) in Field Vegetables In South Sumatera. *In*: Organic Farming and Sustainable Agriculture in the Tropics and Subtropics. Proceedings of an International Seminar, Palembang Oktober 8-9, 2003. Palembang: Sriwijaya University Publishers, Inc.

Herlinda S, Ismail, Y Pujiastuti. 2003. Populasi dan Serangan *Liriomyza* sp., serta Jenis Parasitoidnya di Pertanaman Tomat Ranti di Daerah Inderalaya, Sumatera Selatan. *In*: Agricultural Research Issues, Cooperation of Western State Universities in Agricultural Sciences. Proceedings of a national Seminar, Pontianak, June 9-10 2003. Pontianak: Tanjungpura University Publishers, Inc.

Johnson MW, AH Hara. 1987. Influence of host crop on parasioids (Hymenoptera) of *Liriomyza* spp. (Diptera: Agromyzidae). *Environ. Entomol.* 16:339-344.

Johnson MW, RFL Mau. 1986. Effects of intercropping beans and onions on populations of *Liriomyza* spp. And associated parasitic Hymenoptera. *Proc. Hawaiian Entomol. Soc.* 27:95-103.

Konishi K. 1998. *An Illustrated key to the Hymenopterous Parasitoids of Liriomyza trifolii in Japan*. Reprinted from The Miscellaneous Publication of the National. Institute of Agronomic Environmental Sciences. No. 22. March. 1998, Japan.

Matteoni JA, AB Broadbent. 1988. Wounds caused by *Liriomyza trifolii* (Diptera: Agromyzidae) as sites for infection of Chrysanthemun by *Pseudomonas cichorii. Can. J. Plant. Pathol.* 10:47-52.

Minkenberg OPJM, JC van Lenteren. 1986. The leafminer *Liriomyza trifolii* and *Liriomyza bryoinae* (Diptera: Agromyzidae), their parasites and their host plants: A review. *Agric. Univ. Wageningen Papers* 86(2):1-50.

Miranda MM, M Picanco, GLD Leite, JC Zanuncio, J De Clercq. 1998. Sampling and non-action levels for predators and parasitoids of virus vectors and leafminers of tomato in Brazil. *Meded. Fac. Landbouwkd. Toegep. Biol. Wet. Univ. Gent.* 63:519-526.

Murphy ST, J LaSalle. 1999. Balancing biological control strategies in the IPM of New World invasive *Liriomyza* leafminers in field vegetable crops. Biocontrol News and Information. 20: 91-104.

Palumbo JC, CH Mullis, FJ Nayes. 1994. Composition seasonal abundance, and parasition of *Liriomyza* (Diptera: Agromyzidae) species on lettuce in Arizona. *J. Econ. Entomol.* 87:1070-1077.

Rauf A, BM Shepard. 2001. Current status on the biology, ecology and management of *Liriomyza* spp. in Indonesia with emphasis on *Liriomyza huidobrensis*. Paper Presented at seminar on Invasive Arthropod of Vegetables and Economic Food Crops, Kuala Lumpur 13-14 March 2001.

Rauf A, BM Shepard, MW Johnson. 2000. Leafminers in vegetables, ornamental plants and weeds in Indonesia: surveys of host crops, species composition and parasitoids. International Journal of Pest Management 46: 257-266.

Schuster DJ, TG Zoebisch, JP Gilreath. 1992. Ovipositional preferences and larval development of *Liriomyza trifolii* on selected weeds. *In* Poe SL (ed). Proceedings of Third Annual Industry Conference on the Leafminer. San Diego, CA, USA, 8-10 November 1982. Pp. 137-145.

Susilawati. 2002. Komposisi dan kelimpahan parasitoid lalat penggorok daun, *Liriomyza sativae* (Blanchard) (Diptera: Agromyzidae). Thesis: Graduate Program, Bogor Agricultural Institute, Bogor. 26 p.

Valladares G, A Salvo. 2001. Community dynamics of leafminers (Diptera: Agromyzidae) and their parasitoids (Hymenoptera) in a natural habitat from Central Argentina. *Acta Oecologica* 22: 301-309.

Waterhouse DF, KR Norris. 1987. Biological Control: Pacific Prospects. Melbourne. Inkata Press. 454pp.

Weintraub PG, AR Horowitz. 1995. The newest leafminer pest in Israel, *Liriomyza huidobrensis*. Phytoparasitica 23: 177-184.

Table 1. Apparent parasitism by parasitoids of *L. sativae* on longbean

Period	Apparent parasitism (%) by parasitoid species														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	(%)
March 11th															0
March 25th						12	18								30
April 8th				6.2	3.1										9.3
April 22nd		4.1													4.1
May 28th				24				16							40
June 18th		12.5		12.5		8.3									33.3
June 30th				20.8						16.6					37.4
July 16th	4		8			8	12								32
July 30th	4.3	8.6				17.3									30.2
August 6th						21	5.2								26.2

1 = *Opius* sp.; 2 = *H. varicornis*; 3 = Asecodes sp.; 4 = *D. albiscapus*; 5 = *Diglyphus* sp.; 6 = *N. okazakii*; 7 = *Neochrysocharis* sp.; 8 = *Q. liriomyzae*; 9 = *Quadrastichus* sp.; 10 = *Gronotoma* sp.; 11 = *D. kushell*; 12 = *Diphoropria* sp.; 13 = a mymarid wasp (an unidentifiable species); 14 = *Chrysonotomyia* sp.

Table 2. Apparent parasitism by parasitoids of *L. sativae* on current tomato

Period	Apparent parasitism (%) by parasitoid species														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	(%)
March 11th				11.5											11.5
March 25th				6.2	9.3										15.5
April 8th						9.6	3.2								12.8
April 22nd					10.3	3.4									13.7
May 28th			5.7	14.2					11.4						31.3
June 18th				7.6		7.6									15.2

June 30th				11.5	7.6	19.2		3.8						42.1
July 16th							18.5	7.4	3.7					29.6
July 30th		10	10									5		25
August 6th				18.1	4.5		18.1							40.7

1 = *Opius* sp.; 2 = *H. varicornis*; 3 = Asecodes sp.; 4 = *D. albiscapus*; 5 = *Diglyphus* sp.; 6 = *N. okazakii*; 7 = *Neochrysocharis* sp.; 8 = *Q. liriomyzae*; 9 = *Quadrastichus* sp.; 10 = *Gronotoma* sp.; 11 = *D. kushell*; 12 = *Diphoropria* sp.; 13 = a mymarid wasp (an unidentifiable species); 14 = *Chrysonotomyia* sp.

Table 3. Apparent parasitism by parasitoids of *L. sativae* on cucumber

Period	Apparent parasitism (%) by parasitoid species														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	(%)
March 11th											15.3				15.3
March 25th		8.3											10		18.3
April 8th						5.9									5.88
April 22nd		9.5													9.5
May 28th	13.6	22.7													36.3
June 18th			5							26.3					31.3
June 30th					13	8.6	4.3								25.9
July 16th						13	8.6	8.6	4.3						25.9
July 30th		5.8			11.7					23					40.5
August 6th		12		16	1.2										29.2

1 = *Opius* sp.; 2 = *H. varicornis*; 3 = Asecodes sp.; 4 = *D. albiscapus*; 5 = *Diglyphus* sp.; 6 = *N. okazakii*; 7 = *Neochrysocharis* sp.; 8 = *Q. liriomyzae*; 9 = *Quadrastichus* sp.; 10 = *Gronotoma* sp.; 11 = *D. kushell*; 12 = *Diphoropria* sp.; 13 = a mymarid wasp (an unidentifiable species); 14 = *Chrysonotomyia* sp.

Table 4. Apparent parasitism by parasitoids of *L. sativae* on vegetable sponge

Period	Apparent parasitism (%) by parasitoid species														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	(%)
March 11th															0
March 25th	14.2														14.2
April 8th		16		4.7											20.7
April 22nd		8	8												16
May 28th		9.53		33.33											42.86
June 18th	8.6							21.7							30.3
June 30th	8	12													20
July 16th						18.1	13.6								31.7
July 30th										18.1	9	9			36.1
August 6th		5								10	10	10		4.1	39.1

1 = *Opius* sp.; 2 = *H. varicornis*; 3 = Asecodes sp.; 4 = *D. albiscapus*; 5 = *Diglyphus* sp.; 6 = *N. okazakii*; 7 = *Neochrysocharis* sp.; 8 = *Q. liriomyzae*; 9 = *Quadrastichus* sp.; 10 = *Gronotoma* sp.; 11 = *D. kushell*; 12 = *Diphoropria* sp.; 13 = a mymarid wasp (an unidentifiable species); 14 = *Chrysonotomyia* sp.

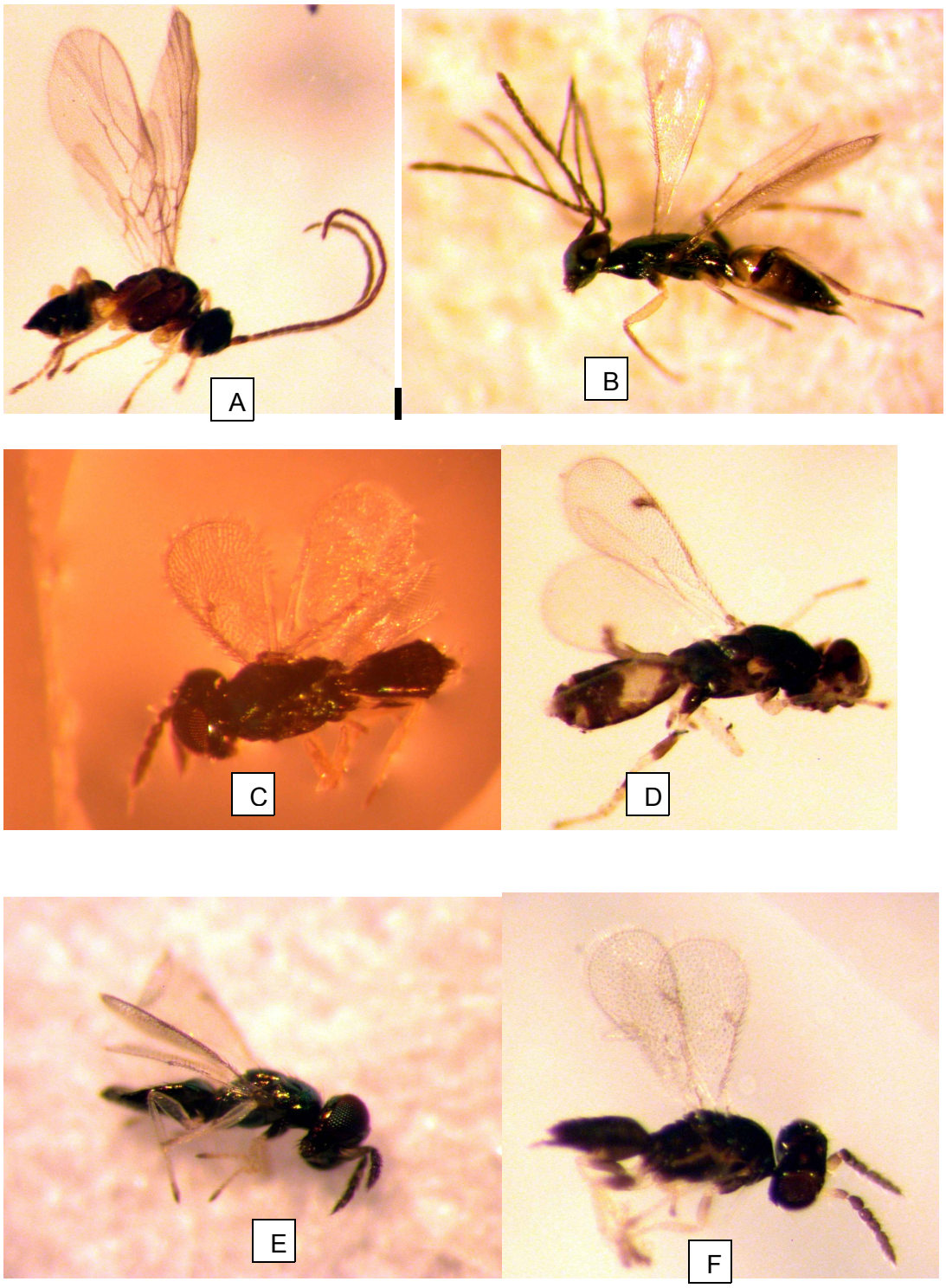

Figure 1. Adult parasitoids of *L. sativae*: (A) *Opius* sp.; (B) *H. varicornis*; (C) *D. albiscapus*; (D) *Diglyphus* sp.; (E) *N. okazakii*; and (F) *Neochrysocharis* sp.

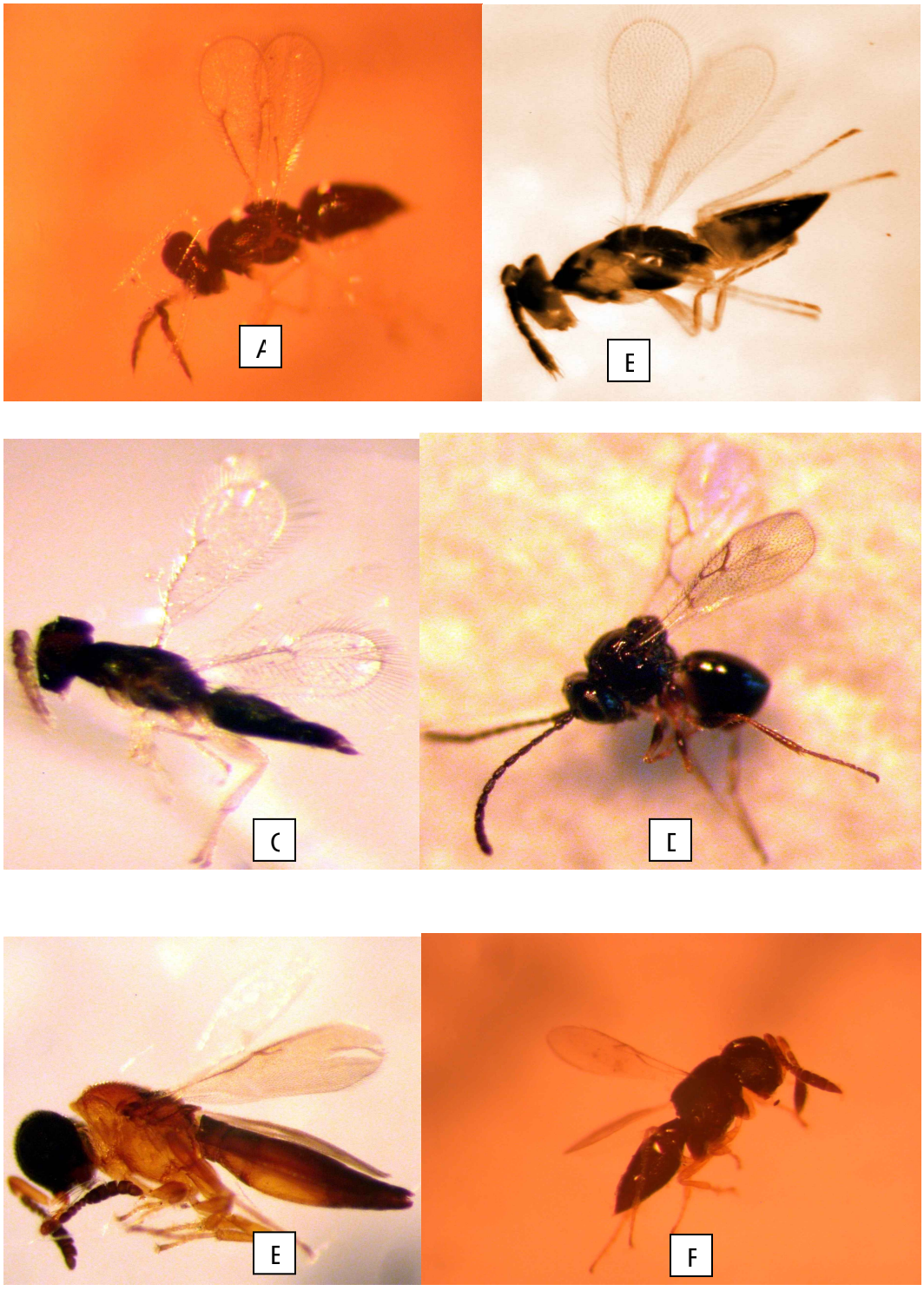

Figure 2. Adult parasitoids of *L. sativae*: (A) *Asecodes* sp.; (B) *Quadrasticus liriomyzae*; (C) *Quadrastichus* sp.; (D) *Gronotoma* sp.; (E) *D. kushell*; and (F) *Diphoropria* sp.

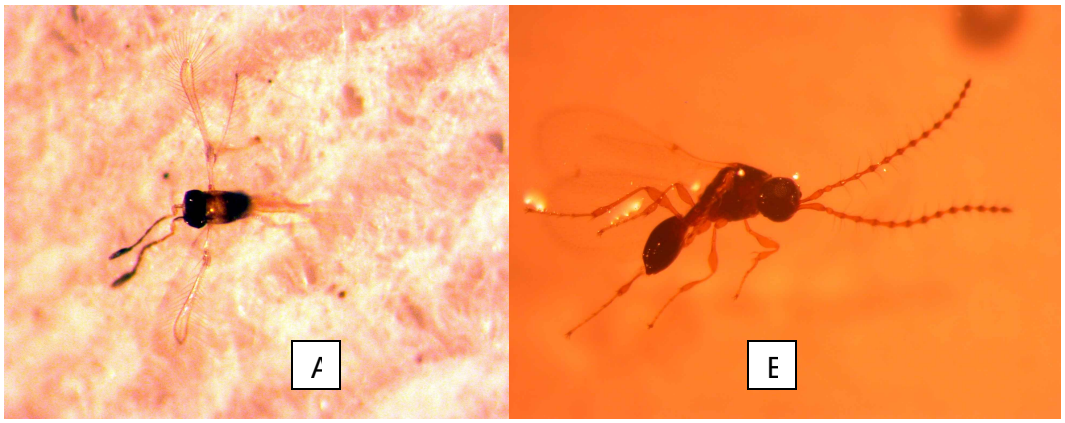

Figure 3. Adult parasitoids of *L. sativae*: (A) a mymarid wasp (an unidentifiable species); and (B) *Chrysonotomyia* sp.

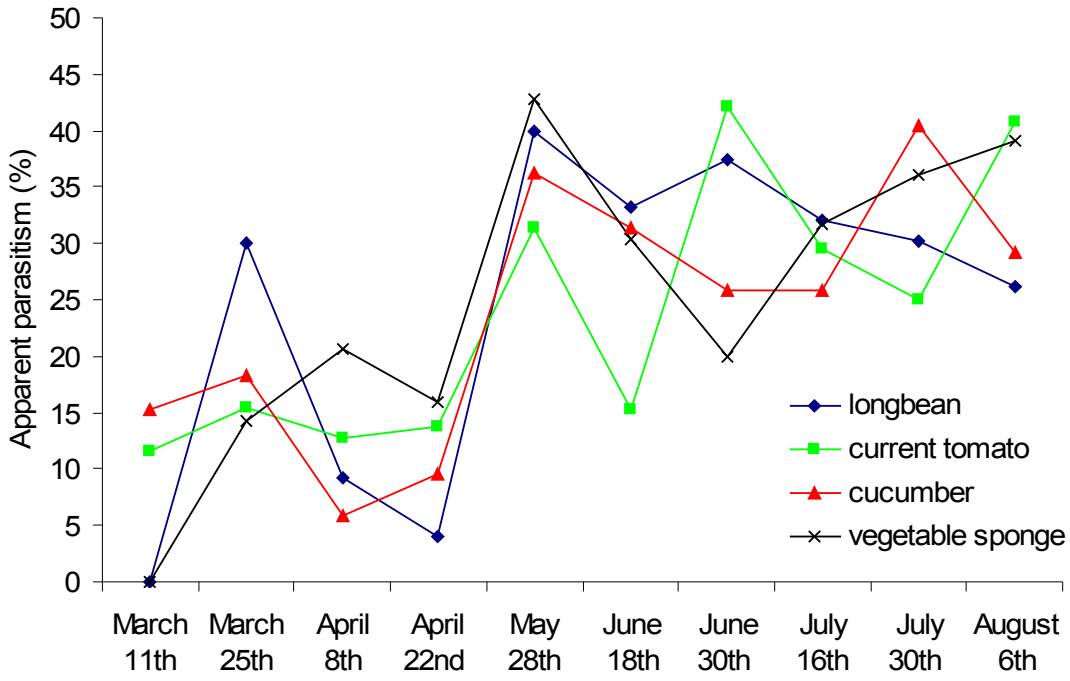

Figure 4. Apparent parasitism dynamics of *L. sativae* on vegetable crops