ECOLOGY OF *Liriomyza* spp. (DIPTERA: AGROMYZIDAE) IN FIELD VEGETABLES IN SOUTH SUMATERA

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ABSTRACT

Surveys during January up to June 2003 were conducted to record host species of *Liriomyza* leaf miner, to determine the leafminer damage, to detect adult population of this leaf miner, and to identify the leafminer parasitoid species. Leafminer-infested leaves of host plants were collected every three weeks for determining the parasitoid species. This leafminer-infested leaves were also used to identify species of *Liriomyza* host plants. Leafminer adult population and damage on tomato leaves were recorded weekly. The population was monitored with yellow sticky traps. The result showed that a total of 53 species of plants could be infested by the leafminer. Foliage damage caused by leaf miner activity of *Liriomyza* larvae caused linear, irregular (serpentine), whitish or greenish mines. Heavily damaged crops appeared as if they had been scorched by fire. Throughout tomato growing season, level of foliage damage caused by the leafminer reached 40.33%. The adult population was associated with crop phenology and weather condition. Number of adults trapped increased with the increasing the crop age. The population during rainy days was generally low. We found six species of hymenopteran parasitoids associated with *Liriomyza*. The parasitoids found including *Hemiptarsenus varicornis*, *Quadrasticus* sp., *Opius* sp., *Neochrysocharis* sp., *Granotoma* sp., and one unknown species of Eulophidae. The most common parasitoid found was *H. varicornis*. The parasitism by this parasitoid reached 9.76% on cabbage field at Pagar Alam.

Keywords: Host plant species, damage, population, parasitoids, *Liriomyza* spp., and vegetable crops

INTRODUCTION

Field vegetable growing worldwide is under siege from three *Liriomyza* spp. (Diptera: Agromyzidae) leafmining flies, *Liriomyza sativae* (Blanchard), *Liriomyza trifolii* (Burgess), and *Liriomyza huidobrensis* (Blanchard). The damage caused by these flies on their host plants is very similar. The larval stages bore and feed within the leaves of the host plants, and at high fly densities this feeding can severely reduce yields (Spencer, 1989). Beside the damage caused by the larvae, feeding punctures by adult stages cause loss vigour and reduce the photosynthetic capacity (Johnson et al., 1983). Yield losses in general can be considerable. More recently, *L. huidobrensis* has been

reported to have caused up to 70% yield losses in potato, beans, and tomato in some areas of Indonesia (Shepard *et al.*, 1998).

Control of agromyzid leafminers using sinthetic and natural insecticides has been extensively researched and commonly used by smallholder farmers (Rauf & Shepard, 2001). In Indonesia, especially in South Sumatera, farmers attempt to control these pests throught the frequent applications of the insecticides. They always treat as often as twice a week. However, the farmers were not satified with the efficacy of these controls. The insecticides were unable to kill the larvae within leaf tissues. Insecticide resistance by these leafminers has been well documented (Smith 1986; Rathma et al., 1995). Other control techniques being optimum for leafminer have to be developed. Biological control for the leafminer has been reported to be effective (Rauf et al., 2000; Rauf & Shepard, 2001). The biological control is an important keystone of integrated pest management (IPM).

Basic information on the ecology of *Liriomyza* is necessary for integrated management of this pest. That information in field vegetable crops in South Sumatera. is lacking. Thus, this research was conducted to record host species of *Liriomyza* leaf miner, to determine the leafminer damage, to detect adult population of this leaf miner, and to identify the leafminer parasitoid species.

MATERIALS AND METHODS

Surveys were conducted from January until May 2003 at Inderalaya and Pagar Alam in District of South Sumatera. At Inderalaya, the temperature and relative humidity during surveys were 26.5^{o} C and 85.5%, respectively. At Pagar Alam, the temperature was 25^{o} C. Rainfall was 7.8 mm/day at Inderalaya and 12 mm/day at Pagar Alam. The elevation at Inderalaya is 5 m above sea level (asl), and 900 m asl at Pagar Alam.

Host Plant Species and Damage by *Liriomyza* spp.

Method. To record host species of *Liriomyza* leaf miner, we took surveys at the center of vegetables in Inderalaya and Pagar Alam. The host leaves infested by this pest were collected weekly. The plant hosts collected included crops and weeds. The plant hosts founded were identified at Laboratory of Plant Pests, Plant Pest and Disease Department, Faculty of Agriculture, Sriwijaya University.

This *Liriomyza* damage was recorded in the field tomato plot (2,400 m^2) in Inderalaya. The plot was divided into 3 subplot (800 m^2). From the subplot, we took 10 % of plant population to determine the damage of *Liriomyza.* Determination of damage by *Liriomyza* i.e. 0 = no damage; 1 = > 0 damage ≥ 25%; 2 = > 25 damage ≥ 50%; 3 = > 50 damage ≥ 75%; dan 4 = >75 damage ≥ 100%. The symptoms of foliage damage were also recorded and documented.

Data Analysis. The level of foliage damage were tabulated.

***Liriomyza* Population and Its Parasitoids**

Method. This *Liriomyza* population was monitored in field tomato plot (2,400 m^2) in Inderalaya. The plot was divided into 3 subplot (800 m^2). The population was monitored using yellow sticky traps writing after Robin & Mitchell (1985). The sticky traps were ca. 19,5 by 14 cm^2 with sticky material on trap surface ca. 144 cm^2. The traps were placed within the subplot in field tomato. The population was monitored with 6 traps per subplot. The traps placed at 50 cm above ground for 3 x 24 hours. The population monitored from a week until 10 weeks after transplanting.

The parasitoids of larval *Liriomyza* were recorded by sampling larval infested leaves of the tomato, cabbage, mustard, other vegetables, and weeds every three weeks (at 3, 6, 9 weeks after transplanting) in Inderalaya and Pagar Alam. We sampled 300-400 *Liriomyza* larvae. The infested leaves were examined for the parasitoids emerging every day at Laboratory of Plant Pests, Plant Pest and Disease Department, Faculty of Agriculture, Sriwijaya University. The leaves from different host plants and locations kept in the different plastic containers (15 cm diameter, 20 cm height). The parasitoids emerged were recorded daily. The parasitoids founded were identified in species or genus. Then, the parasitoid kept in vials containing 70 % alcohol.

Data Analysis. The parasitoid species of leaf miner larvae and the rates of the parasitoid parasitism on the larvae were tabulated.

RESULTS AND DISCUSSION

Host Plant Species of *Liriomyza* spp.

Liriomyza is a highly polyphagous insect that infests a large number of vegetable crops and weeds. From our field survey at lowland and highland areas in South Sumatera, we found 19 plant families with 53 species of the plant infested by this pest (Table 1).

Table 1. Host plant species of *Liriomyza* at lowland and highland areas in South Sumatera District

No	Family	Common name (scientific name)	Locations	Guilds
1.	Apiaceae	Indian penny wort (*Centella asiatica*)	hla	Weed
2.	Amaranthaceae	Pigweed (*Amaranthus gracilis*)	lla, hla	Weed
3.	Amaranthaceae	Spiny pigweed (*Amaranthus spinosus*)	lla	Weed
4.	Amaranthaceae	Spinach (*Amaranthus* sp.)	lla	Crop
5.	Amaryllidaceae	Leek (*Allium* sp.)	hla	Crop
6.	Amaryllidaceae	Garlic (*Allium sativum*)	hla	Crop
7.	Amaryllidaceae	Onion (*Allium cepa*)	hla	Crop
8.	Asteraceae	Goat weed (*Ageratum conyzoides*)	Lla, hla	Weed
10.	Asteraceae	Siam weed (*Eupatorium odoratum*)	lla	Weed
11.	Asteraceae	Mile-a-minute (*Mikania micrantha*)	lla, hla	Weed
12.	Asteraceae	Blackjack (*Bidens pilosa*)	hla	Weed
13.	Asteraceae	Corn sow thistle (*Sonchus arvensis*)	hla	Weed
14.	Asteraceae	Seungit (*Porophyllum ruderale*)	hla	Weed
15.	Asteraceae	Sembung (*Blumea lacera*)	hla	Weed
16.	Asteraceae	Patah kemudi (*Emilia sonchifolia*)	hla	Weed
17.	Asteraceae	Jotang (*Spinlanthes labadicensis*)	hla	Weed
18.	Brassicaceae	Cauliflower (*Brassica oleracea* var. *botrytis*)	lla	Crop
19.	Brassicaceae	Mustard (*Brassica juncea*)	lla, hla	Crop
20.	Brassicacea	Cabbage (*Brassica oleracea* var. *botrytis*)	hla	Crop
21.	Brassicaceae	Chinese cabbage (*Brassica chinensis*)	hla	Crop
22.	Brassicaceae	Pe-tsai (*Brassica pekinensis*)	hla	Crop
23.	Brassicaceae	*Sawi lemah* (*Nasturtium indicum*)	hla, lla	Weed
24.	Capparidaceae	Maman (*Cleome rutidosperma*)	lla, hla	Weed
25.	Commelinaceae	Jeworan (*Cyanotis axillaris*)	lla	Weed
26.	Compositae	Kemendilan (*Emilia sonchifolia*)	hla	Weed
27.	Convolvulaceae	*Kangkung* (*Ipomoea reptans*)	lla	Crop
28.	Convolvulaceae	Rayutan (*Ipomoea triloba*)	lla	Weed
29.	Cucurbitaceae	Pumpkin (*Cucurbita maxima*)	lla	Crop
30.	Cucurbitaceae	Musk melon (*Cucumis melo*)	hla, lla	Crop
31.	Cucurbitaceae	Cucumber (*Cucumis sativus*)	lla	Crop
32.	Cucurbitaceae	*Blewa* (*Cucurbita* sp.)	lla	Crop
33.	Cucurbitaceae	Bitter cucumber (*Momordica charantia*)	lla	Crop
34.	Cucurbitaceae	Chayote (*Sechium edule*)	lla	Crop
35.	Cucurbitaceae	Vegetable sponge (*Luffa cylindrica*)	lla	Crop
36.	Cucurbitaceae	Watermelon (*Citrillus lanatus*)	lla	Crop
37.	Lamiaceae	Paci-paci (*Leucas lavandulaefolia*)	hla	Weed
38.	Leguminosae	Bean (*Phaseolus vulgaris*)	hla, lla	Crop
39.	Leguminosae	Buntut kucing (*Uraria logopodioides*)	lla	Weed
40.	Leguminosae	Mung bean (*Vigna radiata*)	lla	Crop
41.	Leguminosae	Long bean (*Vigna sinensis*)	lla	Crop
42.	Loganiaceae	Jukut puntir (*Spigelia anthelmia*)	hla	Weed

Table 1. Continued

No	Family	Common name (Scientific name)	Locations	Guilds
43.	Passifloraceae	Permot (*Passiflora foelida*)	lla	Weed
44.	Portulaceae	Krokot (*Portulaca oleraceae*)	lla	Weed
45.	Rubiacaea	Letah ayam (*Borreria alata*)	hla	Weed
46.	Scrophulariaceae	Sesamun (*Artanema longifolium*)	hla	Weed
47.	Solanaceae	Eggplant (*Solanum melongena*)	hla, lla	Crop
48.	Solanaceae	Tomato (*Lycopersicum esculentum*)	hla	Crop
49.	Solanaceae	Current tomato (*Lycopersicum pimpeneliifolium*)	lla	Crop
50.	Solanaceae	Potato (*Solanum tuberosum*)	hla	Crop
51.	Solanaceae	Ciplukan (*Physalis angulata*)	lla, hla	Weed
52.	Umbelliferae	Carrot (*Daucus carota*)	hla	Crop
53	Umbelliferae	Celery (*Apium graveolens*)	hla	Crop

lla = Lowland area
hla = Highland area

Crops attacked were 27 species mainly in the families of Cucurbitaceae, Leguminosae, Brassicaceae, Solanaceae, Umbellifeae, Amaranthaceae, and Amaryllidaceae. We also recorded 26 species of weeds infested by this leafminer (Table 1). Vegetables crops known as hosts in South Sumatera included tomato, leek, garlic, spinach, onion, cabbage, cauliflower, mustard, cucumber, etc. (Table 1). The species of *Liriomyza* host plants will increase if survey areas are broadened at ornamental field. However, we limited the survey only on the center of vegetable crops. In Hawaii, this pest was reported by Mau & Kessing (1991) attacked more than 30 species of crops including in the families of Cucurbitaceae, Solanaceae, and Brassicaceae.

Damage by *Liriomyza* on tomato

Among 53 species of host plants, damage by *Liriomyza* on tomato was the highest one. Foliage damage on tomato caused by leaf miner activity of *Liriomyza* larvae caused linear, irregular (serpentine), whitish or greenish mines. Heavily damaged tomato appeared as if they had been scorched by fire. Capinera (2001) reported foliage punctures caused by female *Liriomyza* during the acts of oviposition or feeding might cause a stippled appearance on foliage, but this damage was slight compared to the leaf mining activity of larvae. The irregular mine increased in width from about 0.25 mm to about 1.5 mm as the larvae matured. Larvae were easily visible within the mine where they removed the mesophyll between the surfaces of the leaf.

Table 2. Damage by *Liriomyza* on the tomato leaves at Inderalaya

Plant age (weeks)	Damage by *Liriomyza* (%)				
	Plot 1	Plot 2	Plot 3	Total	Average
1	1.29	1.05	6.55	8.89	2.96
2	8.43	13.58	7.40	29.41	9.80
3	7.40	13.00	22.97	43.37	14.46
4	17.65	17.00	27.94	62.59	20.86
5	30.76	25.51	37.44	93.71	31.24
6	26.83	33.19	51.42	111.44	37.15
7	28.70	43.27	49.03	121.00	40.33
8	24.63	60.18	31.76	116.57	38.86
9	13.99	44.16	22.92	81.07	27.02

Table 3. Vertical distribution of *Liriomyza* damage on tomato leaves according to three different strata of canopy

Strata of canopy	Damage by *Liriomyza* (%)			Total (%)	Average (%)
	Plot 1	Plot 2	Plot 3		
Upper stratum	2.71	6.55	7.16	16.42	5.47
Middle stratum	18.57		32.79	80.61	26.87
Lower stratum	41.96	7.16	52.69	152.82	50.94
		29.25			
		58.17			
Total	63.24	93.97	92.64	289.85	83.28
Average	21.08	31.32	30.88	83.28	27.76

The level of *Liriomyza* infestation was associated with crop phenology. Infestation of *Liriomyza* occurred from the beginning of tomato growing season (1 week) until the tomato nearing to be harvested (9 weeks). Infestation on tomato increased slowly during vegetative growth (1-3 week tomato), but it increased rapidly during reproductive one (4-7 week tomato). The heaviest infestation occurred at a 7-week tomato (40.33%) (Table 2), but the infestation decreased when the tomato faced to be harvested (8 and 9-week tomatoes).

Table 3 shows damage by *Liriomyza* on three different strata of tomato leaves at Inderalaya (lowland area) in South Sumatera for one period of growing season. Damage from upper stratum (5.47%) was lower than those of the other two. The middle and lower strata had larger damage than the upper one. Regarding the total damage in all plots (1, 2, and 3), the lower stratum had largest damage as compared to the other two of the plots.

The larger damage on the middle and lower strata could be affected by larger larvae mined those leaves. Capinera (2001) found that the middle and lower strata of tomato leaves were the most important site of *Liriomyza* oviposition, because the leaves of these strata had bigger and thicker leaflets, thus assuring that the larvae had better and more abundant food and space to grow. The adult and larvae of *Liriomyza* were more abundant on the middle and lower strata. This information is useful in conducting both efficient sampling plans and pesticide application on tomato.

Population of *Liriomyza*

The adult population of *Liriomyza* was monitored with yellow sticky traps. The adult population fluctuated, and was associated with crop phenology and weather condition. More flies were captured at the young tomato (4-week tomato). Number of flies trapped decreased with the increasing crop ages. The adult population during rainy days was generally lower than during daylight hours (Figure 1). The rainy days could limit the fly activities of *Liriomyza* adults. Issae & Morcano (1991) reported that fly activities of this *Liriomyza* were more intensive at vegetative growth of tomato than at generative one.

Community Composition of *Liriomyza* Parasitoid

We found six species of hymenopteran parasitoids associated with *Liriomyza* larvae on vegetable crops (tomato and cabbage). The parasitoids found including *Hemiptarsenus varicornis*, *Quadrasticus* sp., *Opius* sp., *Neochrysocharis* sp., *Granotoma* sp., and one unknown species of Eulophidae (Table 4 and 5). Saleh & Herlinda (2002) found 9 species of parasitoids attacking *Liriomyza* larvae at weed and crop fields in South Sumatera.

The most common parasitoid found was *H. varicornis*. At Inderalaya, the highest level of parasitism was caused by *H. varicornis* (3.89%) (Table 4). The parasitism by this parasitoid reached 9.76% on cabbage field at Pagar Alam, and averaged 8.26% (Table 5). Rauf & Shepard (2001) reported *H. varicornis* was the most common parasitoid found in Indonesia, and also most common reared in the laboratory. They also reported level of parasitism by the parasitoids varied (0-100%) among crops and locations. From our surveys, the low parasitism by the complex parasitoids was affected by insecticide usage.

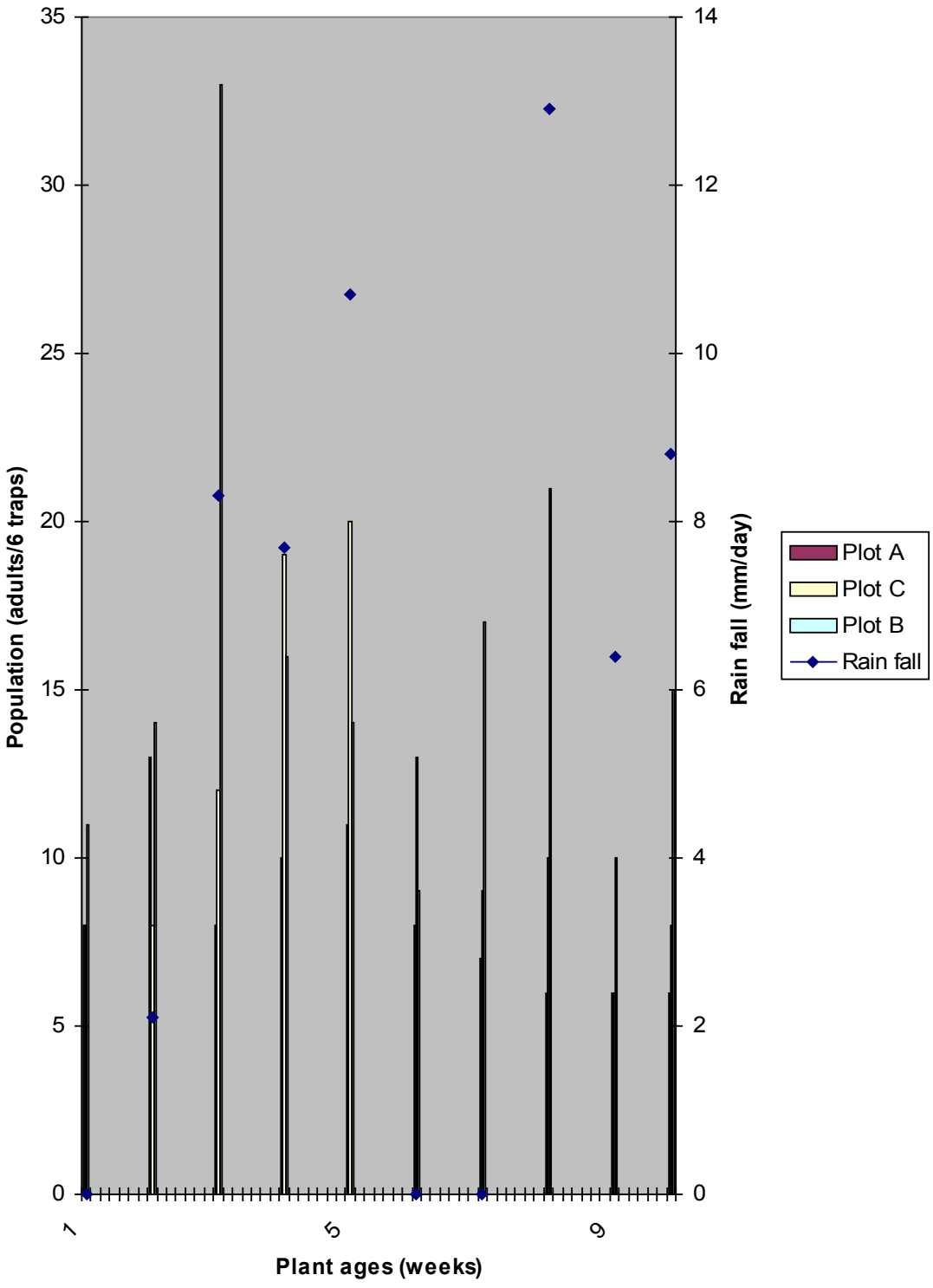

Figure 1. Population of *Liriomyza* during one growing season of tomato at Inderalaya

Table 4. Parasitism by larval parasitoids of *Liriomyza* on tomato field

Location	Time of survey	Crops	Parasitism (%) by:			
			H. varicornis	*Quadrasticus*	*Neochrysocharis* sp	Unknown
Inderalaya	Feb 10, 2003	Tomato	6.25	2.25	4.00	2.00
	Feb 27, 2003	Tomato	2.75	0.25	3.75	1.00
	Mar 24, 2003	Tomato	2.67	0.33	1.67	2.00
Total			11.67	2.83	9.42	5.00
Avarage			3.89	0.94	3.14	1.67

Table 5. Parasitism by larval parasitoids of *Liriomyza* on cabbage field

Location	Time of survey	Crops	Parasitism (%) by:			
			H. varicornis	*Quadrasticus*	*Granotoma*	*Opius* sp.
Pagar Alam	Mar 19, 2003	Cabbage	6.45	-	3.22	-
	Apr 9, 2003	Cabbage	7.69	-	2.56	2.56
	Apr 23, 2003	Cabbage	9.76	2.43	-	-
	May 7, 2003	Cabbage	8.33	-	4.17	-
	May 21, 2003	Cabbage	9.09	-	-	-
Total			41.3	2.43	9.96	2.56
Avarage			8.26	2.43	3.32	2.56

In Conclusion

A total of 53 species of plants could be infested by the leafminer, *Liriomyza*. Foliage damage caused by leaf miner activity of *Liriomyza* larvae caused linear, irregular (serpentine), whitish or greenish mines. Heavily damaged crops appeared as if they had been scorched by fire. Throughout tomato growing season, level of foliage damage caused by the leafminer reached 40.33%. The adult population was associated with crop phenology and weather condition. Number of adults trapped increased with the increasing the crop age. The population during rainy days was generally low. We found six species of hymenopteran parasitoids associated with *Liriomyza*. The parasitoids found including *Hemiptarsenus varicornis*, *Quadrasticus* sp., *Opius* sp., *Neochrysocharis* sp., *Granotoma* sp., and one unknown species of Eulophidae. The most common parasitoid found was *H. varicornis*. The parasitism by this parasitoid reached 9.76% on cabbage field at Pagar Alam.

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