Mauritius Research Council

Investigation into the level of Insecticide resistance in Liriomyza populations in Mauritius

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Investigation into the level of insecticide resistance in *Liriomyza* populations in Mauritius

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Introduction

Liriomyza trifolii (Burgess) and *L. huidobrensis* (Blanchard) (Diptera: Agromyzidae) occur on many agricultural and ornamental plants in Mauritius. The former is recorded on about 24 plant species and the latter on 18. With such as a wide spectrum of host plants (crops, ornamental and weeds) and coupled with a high biotic potential, these two species can build up high populations during favourable climatic conditions.

Growers protect their crops from pest damage by spraying their fields on a calendar basis either with insecticides such as, methamidophos, deltamethrin, flufexuron and abamectin. Growers have reported that that these products have become ineffective and they tend to either increase dosages or use mixtures of insecticides to achieve synergistic effect.

Work undertaken during Phase I of the MRC Project

During 1997–1998, bioassay techniques were used to determine the level of insecticide resistance in laboratory reared *L. huidobrensis* to four insecticides (methamidophos, deltamethrin, flufenoxuron and abamectin) commonly used by growers.

At recommended rates, methamidophos, deltamethrin and flufenoxuron were found ineffective against *L. huidobrensis*. On the other hand, signs of resistance development to abamectin by *L. huidobrensis* were detected.

So far, research has not been undertaken to monitor the level of resistance in *Liriomyza* population at field level.

Research undertaken during Phase II

The proposed work programme was to:

(1) monitor field resistance of *Liriomyza* spp. (*L. huidobrensis* and *L. trifolii*) to products used by farmers
(2) investigate into the effects of insecticides on their parasitoids, and
(3) monitor the seasonal abundance of *Liriomyza* spp. and existing parasitoids

Monitoring field resistance of *Liriomyza* spp. to products used by farmers

Methodology

The steps to determine the response of field populations to insecticides were two-fold:

(1) Laboratory rearing of adults from pupae collected from field, and
(2) Determination of the response of these adults to insecticides

Rearing of adults from pupae collected from field

Three sites (Plaissance, Mapou and Plaine Sophie) were selected. From each site, 6 fields (each of about 0.5 hectare) under tomato and/or bean cultivation were earmarked. The control practices of growers were monitored throughout the crop cycle. Samples of leaves attacked by *Liriomyza* spp. were collected after every treatment (15 days) and kept in perspex cages in laboratory.

Emerging flies were identified and newly emerged adults (1-2 day old) of *L. huidobrensis* and *L. trifolii* used in the topical assays.

Topical Assays

Methodology

10 sets of 10 flies were anaesthetised with CO_2 for 5 to 10 seconds. CO_2 gas was introduced via plastic tubing from the supply tank to a pooter. Anesthesia using a very low pressure of gas (approx. 0.4 L/Min) for a relatively short period (approx. 20 sec) did not cause mortality of flies and treated flies recovered rapidly after topical application.
An Arnold hand micro-applicator equipped with a calibrated 1 ml syringe and a very fine bore canula was used for applications. The delivery rate used was 0.5 µl. In this study and in further experiments dilutions of chemical compounds were made using acetone (98 %). Dilutions were made serially from a 2ml/L stock solution.

Anaesthetised flies were transferred to a filter paper supported on a stiff card. With the micro-applicator, 0.5 µl of the prepared solution (as a single drop) was applied to the thorax of flies.

After treatment of each set, the flies were held in a holding unit, which comprised of 200-ml vial that was attached to a second vial (Fig 1). The optimum number of sets of flies to be used in bioassays was determined by the calculation of a travelling mean mortality.

A bean plant cutting had previously been placed in the upper vial. The stem reached the water in the lower container through a hole in the upper vial and was secured by means of a cotton wool. The upper lid of the vial containing the insects had apertures fitted with cheese (etamine) cloth to allow aeration thus minimising condensation. The treated flies were observed after 24 hours and dead ones recorded to determine the percentage mortality.

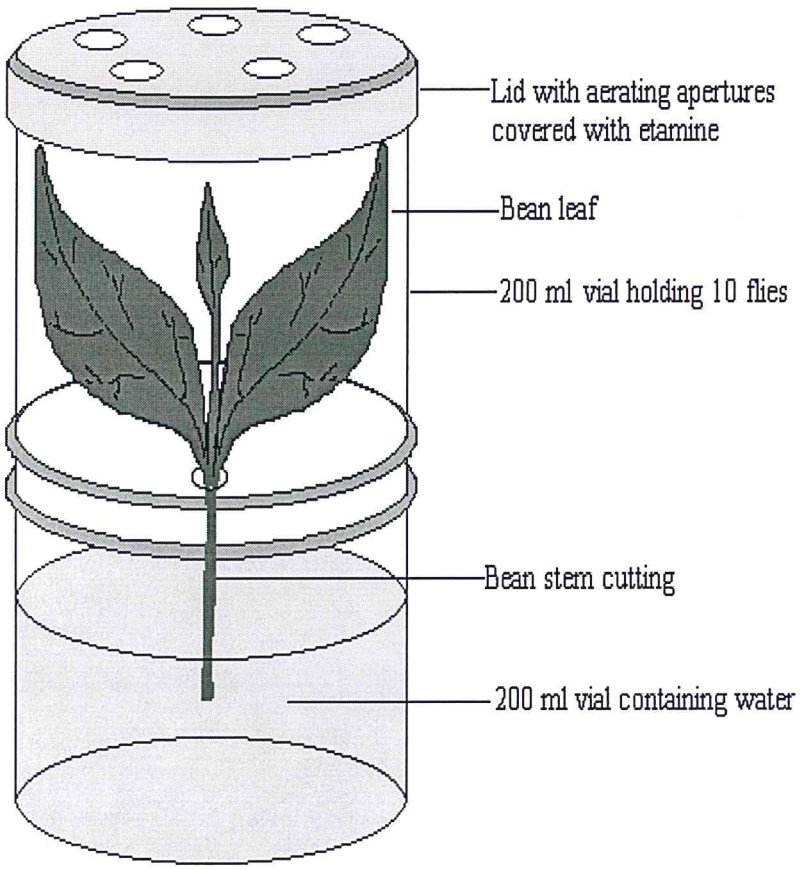


Figure 1: Holding unit assembly for recovery of *Liriomyza huidobrensis* adults topically treated with insecticide

Control Experiments

It quite often happens that a proportion of insect's die during the experiment from natural causes or from causes unconnected to the insecticide used (control mortality). The magnitude of this mortality may be estimated from "control" batches, treated in the same way as the test insects except for the exposure to toxicant. This "control mortality", if it is appreciable, will affect the precision of the results and a correction is usually applied using the following equation known as Abott's formula (Techniques for Testing Insecticides by Busvine 1971).

Monitoring of the seasonal abundance of *L. trifolii* and *L. huidobrensis* and their parasitoids

The study was carried out at four sites (Mapou, Plaissance, Plaine Sophie and Reduit). Treated plots were selected from farmers' (treated) fields at Mapou, Plaine Sophie and Plaissance and untreated ones set at Mapou and Plaisance Demonstration Centres and Réduit Research Research Station (CRS).

In each site, a plot of (5 x 5 m) with bean (var. Long Tom) plantation was set at the Demonstration Centre as control (without treatment) and a 2nd one from farmer's treated field. From each plot, 3 samples of 15 leaves (attacked by *Liriomyza* spp.) were collected as from 4-leaf stage at 15-day intervals. The samples from treated fields were taken irrespective of insecticide treatments.

The samples of leaves were kept in individual glass vials for about 50 days in laboratory to ascertain complete emergence of flies and parasitoids. Emerging flies were identified and specimens of parasitoids for sent CABI for identification.

Results

Monitoring of field resistance of *Liriomyza* spp. to insecticides

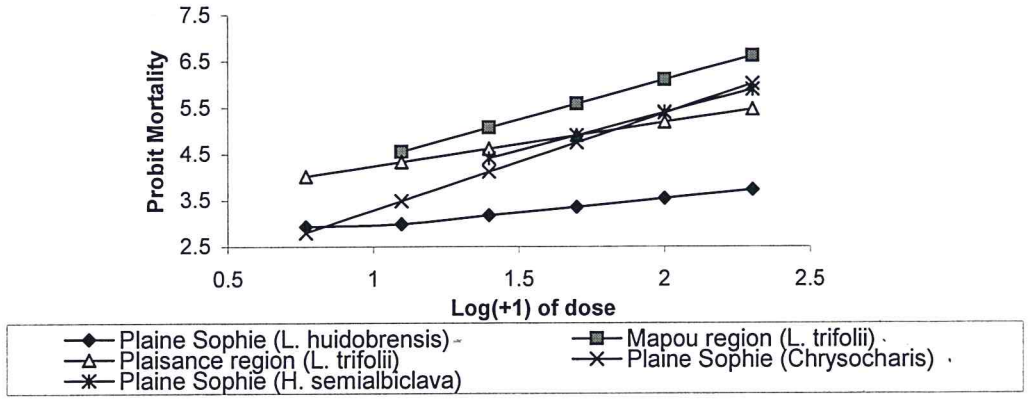
The percentage mortalites in test candidates (*Liriomyza* adults from different sites) with recommended doses of deltamethrin (Decis 2.5 EC), methamidophos (Tamaron 600 SC) and abamectrin (Vertimec 1.8 EC) varied greatly among sites.

At Plaissance, deltametrin, at the rate of 0.5 mL/ Litre of water, induced 48 % mortality in *L. trifolii* adults. A comparatively lower percentage in mortality was observed by methamidophos (41 %) and abamectrin (37 %). At Plaine Sophie, the percentage mortalities in *L. huidobrensis* adults by treatment with deltamethrin, methamidophos and abamectrin were 11 %, 13 % and 17 % respectively. abamectin

Highest percentage mortalities were observed in individuals from Mapou by the products at recommended doses. 78 % of the test adults were killed with deltamethrin, 62 % by methamidophos and 44 % by abamectin.

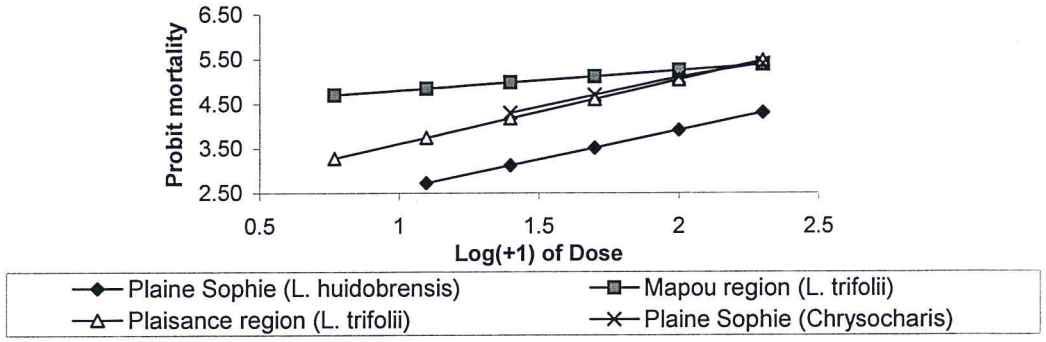
The probit analysis graph (Fig. 2) also shows that deltamethrin (at recommended dose) was not effective against *L. huidobrensis* adults from Plaine Sophie but effective against *L. trifolii* adults from Mapou and Plaissance.

Fig 2.0: Log_{10}/dosage Probit of Leafminers and its parasitoids with Decis 2.5 EC at 3 different localities in Mauritius



Methamidophos was also not effective against *L. huidobrensis* adults at various doses (Fig. 3). Individuals from Plaissance showed a similar type of response to the product.

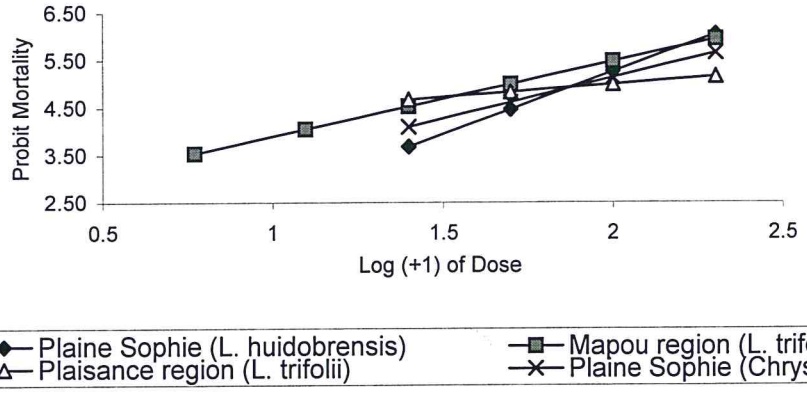
Fig 3.0: log_{10}/dosage Probit of Leafminers and its parasitoids with Tamaron 600 SC at 3 different localities in Mauritius



Abamectin induced a low mortality percentage in *Liriomyza* adults (Fig.4). This is a natural phenomenon as the product, as an insect growth regulator, has less impact on adults as compared to larvae.

It is also observed that the product (abamectin) did not affect the adult parasitoid, *Chyrsocharis* sp., a predominant species of *L. huidobrensis*.

Fig 4.0: Log_{10}/Dosage of Leafminers and its parasitoids at 3 different localities in Mauritius with Vertimec



Monitoring of the seasonal abundance of *L. trifolii* and *L. huidobrensis* and their parasitoids

The two species (*L. trifolii* and *L. huidobrensis*) were present at Mapou, Plaisance, Reduit and Plaine Sophie but at varying proportions and at different times of the year. High numbers of adults emerged from treated and untreated leaves and this shows that the successive treatments effected by growers did not reduce the *Liriomyza* populations.

Abundance of *Liriomyza* spp. at Mapou

In the untreated plot, the average number of *L. trifolii* adults per leaf ranged from 1.9 to 30.8 during February-July and in September and October and was about 7.9 during the remaining period of the year (Fig. 5). The average number of adults per leaf was higher than that in the untreated plot throughout the year (Fig. 5). Emergence of adult *L. huidobrensis* was negligible (<1.2/leaf) in untreated and treated plots during January-June and reached to a maximum of 2.2 in untreated and 5.2 in treated plots during July-November.

Abundance of *Liriomyza* spp. at Plaissance

In the untreated plot, the average number of *L. trifolii* adults per leaf ranged from 3.9 to 25.8 during January-June and 0.1 to 7.1 during July-December. The numbers reached up to 17.2 per leaf during the 1st half of the year (Fig. 6). On the other hand, *L. huidobrensis* adults was negligible (<1.0/leaf) in untreated and treated plots during January-June but was highest in treated plot in October and December.

Abundance of *Liriomyza* spp. at Reduit

Liriomyza trifolii and *L. huidobrensis* adults emerging per leaf was low (<1.3/leaf) during January-June. During the remaining period, the average number of *L. trifolii* and *L. huidobrensis* adults ranged from 0.3 to 2.7 and 0.2 to 45.7 respectively. (Fig.7).

Abundance of *Liriomyza* spp. at Plaine Sophie

The average number of *L. trifolii* adults per leaf ranged from 1.2 to 9.1 during January-May and was comparatively low (<0.4/leaf) during the remaining period (Fig. 8).

Abundance of parasitiods of *Liriomyza* spp. at the four sites

Two species of parasitoids *Hemitarsonemus semialbiclava* and (*Chrysocharis* sp.) (Hymenoptera: Eulophidae) were recorded in both untreated and treated plots.

At Mapou, the average number of adults of *H. semialbiclava* and *Chrysocharis* sp. in the untreated and plots ranged from 0.3 to 5.9 and 0.4 to 5.6 respectively during January-November (Fig.5). Similar trend was observed in the emergence of parasitoids at Plaisance, Reduit and Mapou.

Discussion

Liriomyza trifolii was more abundant in the northern region (Mapou) and *L. huidobrensis* in the Central Plateau (Plaine Sophie) and southern region Plaissance. Laboratory testing have shown that the three products, in particular methamidophos and deltamethrin, did not induce the same level of mortalities in adults of *L. huidobrensis* and *L. trifolii* raised materials collected from the three study sites. Methamidophos and deltamethrin were not effective against *L. huidobrensis* adults at recommended doses or even when at increased dosages but effective against *L. trifolii* at recommended doses. Abamectin is an insect growth regulator and has minimum effect *Liriomyza* adults.

Liriomyza huidobrensis seemed to have developed resistance to the organophosphate (methamidophos) and pyrethroid (deltamethrin) insecticides. The use of these insecticides on a calendar basis (without rotation of other products) could be one factor for the build up of resistant *Liriomyza* populations. Consequently, treatments with these products would not control the pest even at increased dosages. On the other hand, their use can adversely affect the population *H. semialbiclava* and *Chrysocharis* sp. These two parasitoids were present in low numbers at the three sites.

Research indicates that growers were using methamidophos and deltamethrin irrationally against both species of *Liriomyza*. These products have become ineffective and control recommendations had to be examined and updated

Conclusion

Metamidophos is longer recommended against *Liriomyza* control. Furthermore, the Pesticide Control Board has prohibited import of this organophosphate because it is hazardous to pubic health.

Growers have been sensitized in the selective use of pesticides and treatment on a calendar basis was discouraged. Research was conducted on other control options to control *Liriomyza trifolii* in onion cultivation. Yellow sticky traps were found to be effective tool to monitor and mass capture *Liriomyza* adults. The use of trpas is being extended to various crops (potato, tomato, etc) susceptible to *Liriomyza* attack. An updated control recommendation has been proposed to growers. This has greatly reduced the prophylactic spraying and even increase the efficiency of insecticide use. Research is further pursued on an Integrated Pest Management Programme against the pests.

Figure 5. Average number of *Liriomyza* and parasitoid adults emerging per leaf in treated and untreated bean plot at Mapou

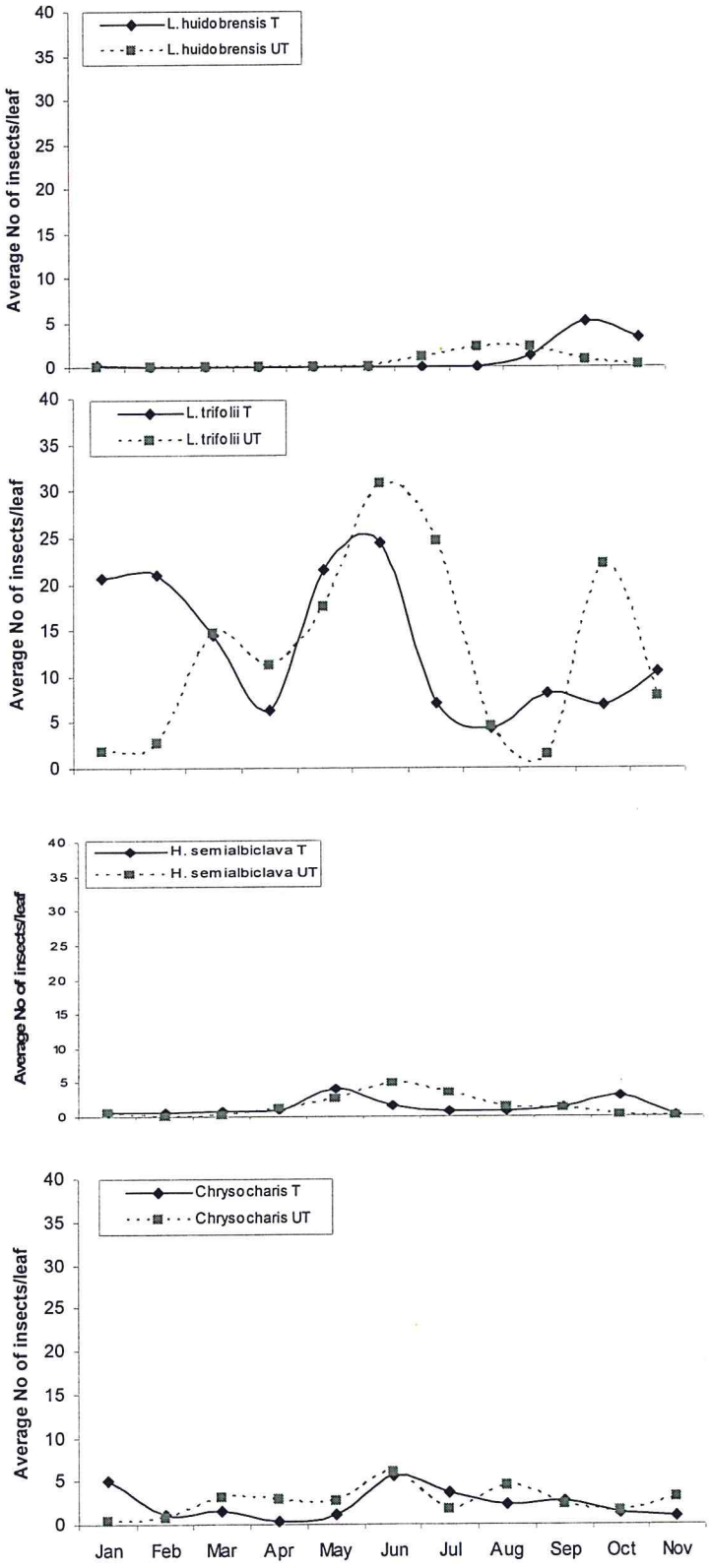


Figure 6. Average number of *Liriomyza* and parasitoid adults emerging per leaf in treated and untreated bean plot at Plaisance

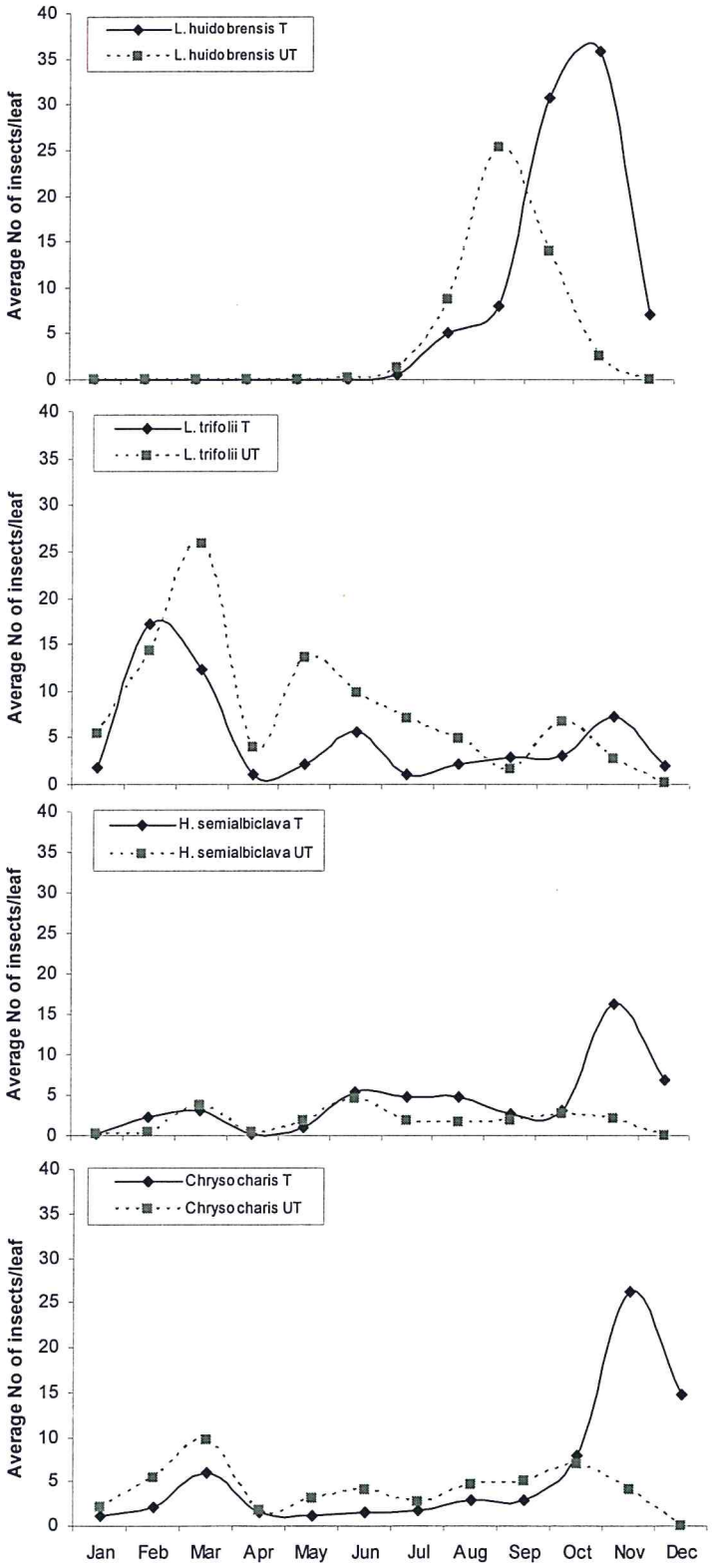


Figure 7. Average number of *Liriomyza* and parasitoid adults emerging per leaf in treated and untreated bean plot at Reduit

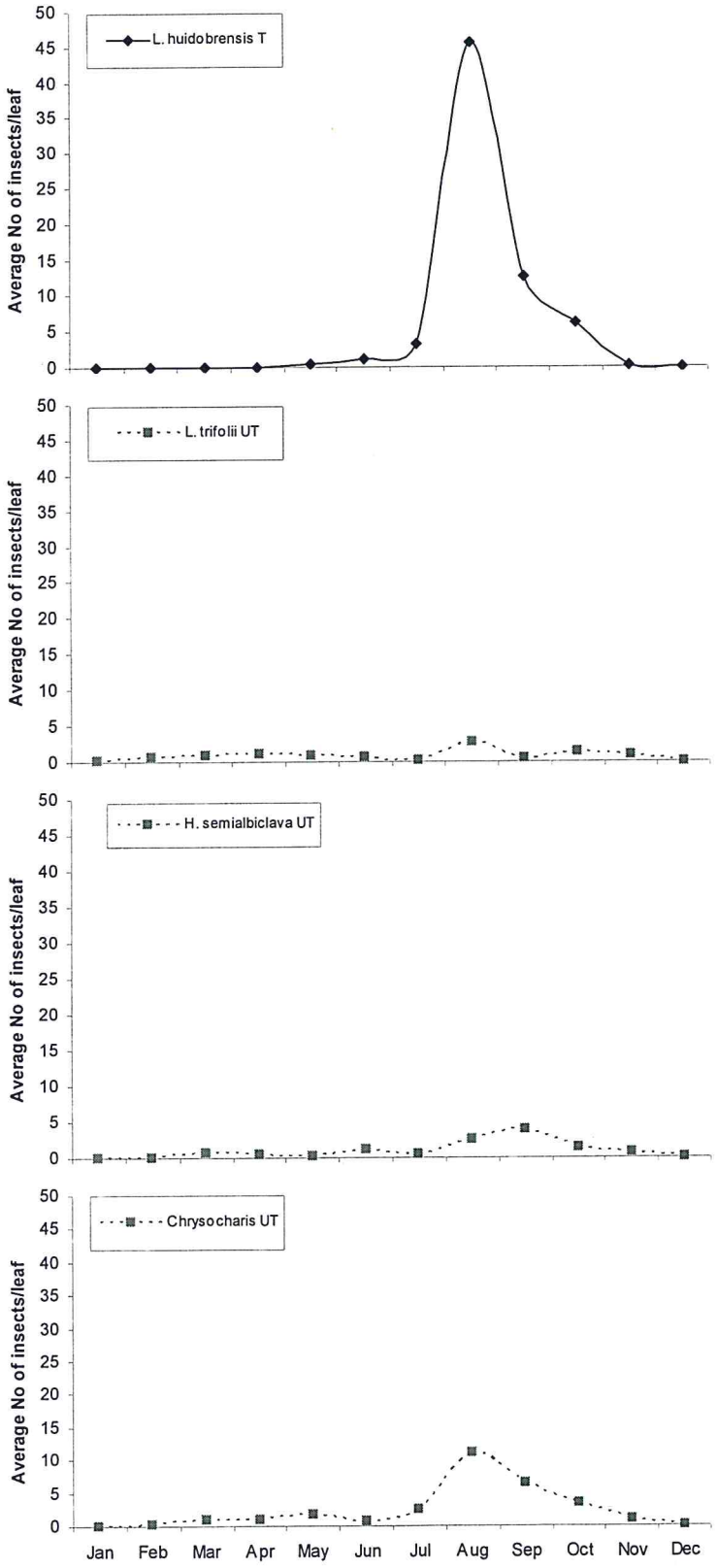


Figure 8. Average number of *Liriomyza* and parasitoid adults emerging per leaf in treated and untreated bean plot at Plaine Sophie