Agromyzid Leafminers and Their Parasitoids on Vegetables in Northern Vietnam

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Abstract

Leafminers (serpentine leafminers), *Liriomyza* spp. (Diptera: Agromyzidae) are serious insect pests that attack many vegetable crops and wild plants. Field surveys were conducted in 6 provinces of northern Vietnam during 2004-2006 with the aim of recording leafminer species, their parasitoids and seasonal dynamics of leafminers on vegetable crops. There are 31 species of host plants of *Liriomyza* spp.; tomato, French bean, longbean, cucumber and sweet brassica are seriously attacked. Leaf damage at harvesting period is very high, at about 85-90%. Seven leafminer species found were *Liriomyza sativae*, *L. chinensis*, *L. bryoniae*, *Liriomyza* sp., *L. katoi*, *Chromatomyia horticola* and *Phytomyza* sp. *Liriomyza sativae* is the most abundant species which infested 23 out of the 31 vegetable and wild plant species, followed by *Liriomyza* sp. In addition, fifteen hymenopteran parasitoid species associated with the leafminers were found. Among them, *Neochrysocharis formosa* and *Chrysocharis pantheus* were abundant species. In spring, the incidence of infestation by leafminer on tomato, French bean and yard long bean increased from the start to the end of the season. The percentage of parasitism varied according to plant stage and leafminer density.

Keywords: leafminer, vegetables, parasitoids, *Liriomyza* spp., Vietnam

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Introduction

Vegetables play a very important role in our lives, because they provide human nutrition (Ta Thu Cuc et al., 2000). Leafminers are important insect pests which infest many plants and have become major pests of vegetables in Vietnam (Anderson et al., 2002; Tran et al., 2005). The most important leafminer species are *Liriomyza sativae* (Blanchard), *L. chinensis* (Kato), *L. bryoniae* (Kaltenbach), and *Chromatomyia horticola* (Goureau). The main reason that has caused leafminer infestation on vegetables to rapidly increase in Vietnam is an over-use of chemical insecticides.

Agromyzid leafminers on vegetables in Vietnam are known to have rich natural parasitoids. Eighteen species of parasitoids have been recorded from *Liriomyza* spp. in central and southern Vietnam (Tran et al., 2005). Some surveys for leafminers and their parasitoids on vegetable crops have been conducted in Vietnam (Anderson et al., 2002; Ha, 2001; Thien An, 2000; Tran et al., 2005), but very few surveys have been performed on seasonal dynamics of leafminers and their parasitoids in the open fields. The objectives of this study were to determine the diversity and seasonal dynamics of leafminers and their parasitoids in commercial vegetable crops in northern Vietnam.

Material and Methods

Field surveys of leafminers and their parasitoids were conducted in some areas of six provinces of northern Vietnam being Sapa tower (high land of Lao Cai province), Lang Son city, Hai Phong city, Dan Phuong (Ha Tay), Que Vo (Bac Ninh), Dong Anh and Gia Lam (Hanoi) from June 2004 to May 2006.

Leaves infested by leafminer were randomly collected from commercial vegetable fields and weeds (Table 1) every 3 months in Sapa tower, Lang Son city, Hai Phong city, Que Vo (Bac Ninh) and Dan Phuong (Ha Tay), Hanoi city. Samples were randomly collected monthly.

To obtain leafminer by yellow trap, five yellow traps were randomly placed on each vegetable plantation which was commonly infested by leafminer. Leafminers caught by yellow trap were numbered after 5 days at each stage of each plant.

For seasonal dynamics of leafminers associated with parasitoids, surveying was conducted weekly on commercial vegetables: tomato (*Licopersicon esculentum*), French bean (*Phaseolus vulgaris*) and yard long bean (*Vigna sesquipedalis*). Thirty leafminer-infested leaves were collected from each vegetable, placed in plastic bags, labeled with the name of the crop, date, location and collector name(s). Samples were brought into the laboratory, maintained under room temperature and kept moist. The infested leaves were checked daily for fly and parasitoid emergence. The number of fly adults and wasps was recorded upon emergence. All flies and wasps were kept in small vials with 70% ethanol.

Identification of leafminer flies was performed by Dr. Arild Andersen and Dr. A. Iwasaki. Parasitoids of the families Eulophidae and Pteromalidae were identified by Dr. Kazuhiko Konishi while parasitoids of the families Braconidae, Aphelinidae, Diapriidae and Cynipoidae were identified by Dr. Khuat Dang Long.

Calculation of the ratio of leafminer species obtained from yellow traps during the growing season was performed as follows:

Ratio of each species (%) = No. of each fly species caught /Total number of flies caught × 100

Frequency of parasitism (F) was evaluated by the rate of parasitized larvae, and noted as follows:

+: Low (<10% of parasitized larvae);

++: Medium (10-20% of parasitized larvae);

+++: High (>20% of parasitized larvae).

The percentage parasitism of leafminer was estimated by the number of wasps emerging per number of leafminers observed on each surveying to all samples of leafminer-infested leaves of tomato, French bean and yard long bean.

Results and Discussion

1. *Host plant composition of leafminer in nothern Vietnam*

Leafminers (*Liriomyza* spp.) have been reported as serious pests since the 1980s. *L. sativae*, and *L. trifolii* especially have attacked some vegetable crops in California (Jonhson et al., 1980; Spencer, 1981; Trumble, 1981). They have also become a serious problem in vegetable production in Hangzhou area, Zhejiang province, southeast China as well as in the rest of China (Chen et al., 2003). In order to find out the diversity of host plants of leafminer (*Liriomyza* spp.) in northern Vietnam, observation was done during 2004-2006, and the results are shown in Table 1.

The data of Table 1 show that there are 31 species belonging to 9 families of plant found in some provinces of northern Vietnam. Within these some vegetable plants are seriously attacked by leafminer, like tomato, phaseolid, French bean, yard long bean and cucumber. Others less infested include pumpkin, luffa, sweet brassica and green onion.

2. *Leafminer composition in northern Vietnam*

The composition of insect pests in general and of serpentine leafminer in particular, is influented by many factors. It can be changed by climate, plant species, technology, and especially by chemical insecticides. It thus differs from place to place, and from year to year. The collection of leafminers obtained in northern Vietnam is shown in Table 2 and Table 3.

In northern Vietnam, there were 7 species of serpentine leafminer recorded over two years (2004-2006). In these *L. sativae* attacked the most plants (about 24 host plants), followed by *Liriomyza* sp. Others have been found on a few plants. Ha (2001) showed that for leafminer surveying conducted in 10 provices in northern Vietnam, *L. sativae* was the dominant species. The same observation was made by Andersen et al. (2002) on surveying leafminers in 27 provinces of northern and southern Vietnam. Thus, *L. sativae* is the most abundant leafminer species found on vegetables all over Vietnam. *L. chinensis* has been found only on green onion very recently. From Andersen et al. (2002), *L. chinensis* was found only on *Allium* spp. in three provinces in the north part of Vietnam, and only one province in the north east of Hanoi (Bac Ninh). Two other provinces are situated in the northeast south region (Dong Nai and Ba Ria). Tran et al. (2005) reported *L. chinensis* was common on onion in central and southern regions of Vietnam. The present study has shown that *L. chinensis* is found only on green onion.

Agromyzid fly is attracted by the colour yellow, so using yellow traps is an efficient method to catch them. The data in Table 3 shows that, *Liriomyza sativae* B. and *Liriomyza* sp. are the most abundant species on vegetable plants. Among the three

plant stages estimated, in the flower-fruit stage the number of serpentine leafminers attacking tomato and French bean is much higher than at other stages. On long bean, only two leafminer species could be caught.

3. *Parasitoid composition of leafminer in northern Vietnam*

The parasitoid species' composition is summarized in Table 4. In total 15 hymenopteran species of six families (7 Eulophids, 2 Braconids, 3 Pteromalids, one Aphelinidae, one Diapriid and one Cinipoid) were found. Among these *Neochrysocharis formosa* (Westwood) is the most abundant, followed by *Chrysocharis penteus* (Walker). Others are rarely obtained. According to Tran et al. (2005), there were 18 species of parasitoids of leafminer collected from infested vegetable leaves in central and southern Vietnam during 2002 - 2004. Most of them (83.3%) were Eulophids, and *N. formosa*, *C. pentheus* and some others predominated. In China, Chen et al. (2003) reported about 11,000 parasitoid adults were reared from the leafminers collected, obtaining 14 hymenopteran species of four families. From these, 11 belong to the family Eulophidae. Thus eulophid wasps are important species for controlling leafminers on vegetable plants.

In this present study, most parasitoids are solitary, mainly larval parasitoids except for two species which belong to Braconidae and which are larval - pupal parasitoids. These data show that parasitoids of leafminers are rich in diversity. They are promising for consideration as potential biological control agents. However further studies of their biology and ecology are needed.

4. *Relationship between leafminer and their parasitoids on vegetable crops in northern Vietnam*

Parasitoids sometimes prove to be efficient in controlling pests. In order to find out the relationship between them on vegetable crops, surveying weekly has been done on tomato, french bean and long beans in Gia Lam, Hanoi. The results are shown in Tables 5, 6, 7 and in Figures 1, 2 and 3.

The data in Table 5 and Figure 1 show that the percentage of leaf damage increased from 10.7 in early stages of tomato until up to 90.7 at last harvesting period and similarly the density of leafminer increased continuously. The same situation exists for leafminer parasitoids. When the number of leafminer larvae increased, there was more occasion for wasps to oviposit their eggs also. Therefore, the correlation coefficient between leafminer density and the percentage of parasites is very high (r = 0.82).

For French beans (Table 6, Figure 2), the correlation coefficient between leafminer density and their parasites is medium (r = 0.54). This phenomenon can be explained by saying that the percentage of parasitized larvae is high at an early stage. This means that parasitoids decreased the population of leafminers and so the density of leafminers decreased until the harvesting stage, but parasitoids still maintain their percentage of parasitism.

The data in Table 7 and Figure 3 show that leafminer density on long bean is rather lower than on tomato and French bean, but the rate of leaf damage seems to be the same. The correlation coefficient between leafminer density and their parasitism on long bean is close (r=0.73). From this survey data, parasitoids have shown their potential in controlling leafminers on vegetable crops.

Conclusion

Thirty-one plant hosts of leafminer were collected in northern Vietnam belonging to 9 families. Among these some vegetables are very commonly

infected such as tomato, phaseolids, French bean, long bean and cucumber. Seven species of leafminer have been collected with *L. sativae* being the most common, followed by *Liriomyza* sp. The yellow trap was attractive to leafminer adults. About 2-4 *Liriomyza* spp. were obtained on vegetable beans and tomato. Most of them were *Liriomyza sativae* (>80%).

Fifteen species of larval parasitoid and larval – pupal parasitoids of leafminers, in 6 families of Hymenoptera were collected. The most common are *N. formosa* and *C. pantheus.* Damage to leaves on vegetable beans and tomatoes was very high (90-95%). Also parasitized larvae were rather high reaching 39-40% at some plant stages. The correlation coefficient between leafminer and parasitized larvae was close on tomatoes (r = 0.82) and long beans (r = 0.73), but rather close on French bean (r = 0.54). These coefficients mean that leafminer parasitoids have an important role in controlling leafminer population in vegetable fields.

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References

Anderson, A., Nordhus, E., Thang, V.T., An, T.T.T., Hung, H.Q. and Hofsvang, T. 2002. Polyphagous *Liriomyza* species (Diptera : Agromyzidae) in vegetables in Vietnam. **Trop Agric (Trinidad)** 79: 241-246.

Jonhson, M.W., Oatman, E.R. and Wyman, J.A. 1980. Effects of insecticides on populations of the vegetable leafminer and associated parasites on summer pole tomatoes. **Ibid** 73: 61-66.

Ha, Q.H. 2001. Study of leafminers in vegetables and beans in Hanoi and the surrounding area. **Vietnamese J Plant Protection** 3: 10-14 (in Vietnamese with English summary).

Spencer, K.A. 1981. A revisionary study of the leafmining flies (Agromyzidae) of California. **Univ Calif Publ** No. 3273.

Ta Thi Thu Cuc, Ho Huu An and Nghiem Thi Bich Ha, 2000. **Vegetable course.** Hanoi, Vietnam: Agricultural Publishing House.

Thien An, T.T. 2000. Some preliminary results of study on leafminer, *Liriomyza trifolii*. **Vietnamese J Plant Protection** 2: 8-13 (in Vietnamese with English summary).

Tran Dang Hoa, Tran Thi Thien An and Massami Takagi, 2005. Agromyzid leafminers in central and southern Vietnam: survey of host crops, species composition and parasitoids. **Bull Inst Trop Agr, Kyushu Univ 28-1** (Special Issue): 35-41.

Trumble, J.T. 1981. *Liriomyza trifolii* could become a problem on celery. **Calif Agric** 35: 30-31.

Xue-xin Chen, Fa-yong Lang, Zhi-hong Xu, Jun-hua He and Yun Ma, 2003. The occurrence of leafminers and their parasitoids on vegetables and weeds in Hangzhou area, Southeast China. **Bio-Control** 48: 515-527.

Table 1. Host plant composition of leafminers in nothern Vietnam.

No	Family		Frequency[1]
	Common name	Scientific name	
I	Cucurbitaceae		
1	Pumpkin	*Cucurbita maxima* Duch.	++
2	Luffa	*Luffa cylindrica* L.	++
3	Pear melon	*Momordica cochinchinensis* (Lour) Spreng	+
4	Chinese melon	*Melo sinensis* L.	++
5	Cucumber	*Cucumis sativus* L.	+++
II	Brassicaceae		
6	Sweet brassica	*Brassica chinensis* L.	++
7	Chinese brassica	*B. juncea* (L.) Czern.	+
8	Kolhrabi	*B. oleracea* L. var. *caulorapa* Pasq.	+
9	Chinese brassica	*B. cernua* Forbes.	+
10	Brassica	*B. campestris* L.	+
11	Water Cress	*Rorippa nasturitum aquaticum* (L.)	+
12	Wild brassica	*R. bengalensis* (DC.) Hara.	+
III	Solanaceae		
13	Tomato	*Lycopersicum esculentum* Mill.	+++
14	Potato	*Solanum tuberosum* L.	+
15	Small egg plant	*S. undatum* Poir.	+
16	Purple egg plant	*S. melogena* L. var. *esculentum*	+
17	?	*Physalis ungulata* L.	+
IV	Fabaceae		
18	Phaseolid	*Phaseolus vulgaris* L.	+++
19	French bean	*P. vulgaris* L.	+++
20	Peanut	*Arachis hypogae* L.	+
21	Bonavist bean	*Lablab purpureus* L.	+
22	Long bean	*Vignus esquipedalis* W.	+++
V	Asteraceae		
23	Chrysanthemum	*Tagetes erecta* L.	+
24	Spanish needle	*Bidens pilosa* L.	+
25	Garden rocket	*Chrysanthemum cronamun* B.	+
26	Lettuce	*Lactuca sativa* L.	+
27	Mugwort	*Artemisia vulgaris* L.	+

[1] *+: Low (<25% leaves infested); ++: Medium (25 – 60% leaves infested); +++: High (> 60% leaves infested)*

Table 1. Host plant composition of leafminers in nothern Vietnam. (Cont.)

No	Family		Frequency[1]
	Common name	Scientific name	
VI	Amaranthaceae		
28	?	*Chenopodium polyspermum* (L.)	+
VII	Lamiaceae		
29	Basil	*Ocimum basilicum* L.	+
VIII	Apiaceae		
30	Celery	*Apium graveolens* L.	+
IX	Liliaceae		
31	Green onion	*Allium ascalanicum* L.	++

[1] *+: Low (<25% leaves infested); ++: Medium (25 - 60% leaves infested); +++: High (> 60% leaves infested)*

Table 2. Leafminer composition obtained during the year 2004-2006 in northern Vietnam.

No.	Scientific name	Host plants
1	*Liriomyza sativae* Blanchard	*Luffa cylindrica*, *Cucumis sativus*, *Solanum undatum*, *Brassica chinensis*, *B. juncea*, *B. oleracea* L. var. *caulorapa*, *Melo sinensis*, *Rorippa bengalensis*, *Tagetes erecta*, *Lantana camrama*, *Cucurbita maxima*, *Phaseolus* spp., *Lycopersicum esculentum*, *Vignus esquipedalis*, *Chenopodium polyspermum*, *Ocimum basilicum*, *Arachis hypogae*, *Chrysanthemum cronamun*, *Artemisia vulgaris*, *Physalis ungulata*, *Momordica cochinchinensis*, *Bidens pilosa*, *Lablab purpureus*...
2	*Liriomyza* sp.	*Bidens pilosa*, *L. esculentum*, *Phaseolus vulgaris*, *Vignus esquipedalis*
3	*L. katoi* Sasakawa	*Artemisia vulgaris*
4	*L. bryoniae* Kaltenbach	*L. esculentum*, *Phaseolus* spp.
5	*L. chinensis* (Kato)	*Allium ascalanicum*
6	*Chromatomyia horticola* Goureau	*L. esculentum*, *Momodica cochinchinensis*, *C. cronamun.*
7	*Phytomyza* sp.	*C. cronamun*, *Cucumis sativus*

Table 3. Leafminer composition obtained from yellow traps located on some vegetable plantations in spring 2006 in Hanoi, Vietnam.

Plant stage	Plant name	No. of individuals/trap	Leafminers	
			Species	Ratio (%)
6 – 8 leaves	French bean	211	*Liriomyza sativae* B.	92.4
			Liriomyza sp.	7.6
	Tomato	108	*L. sativae* B.	79.6
			Liriomyza sp.	18.5
			L. bryoniae K.	1.9
	Long bean	157	*L. sativae* B.	85.3
			Liriomyza sp.	14.7
Flower – Fruit	French bean	255	*L. sativae* B.	88.6
			Liriomyza sp.	9.4
			L. bryoniae K.	2.0
	Tomato	121	*L. sativae* B.	81.0
			Liriomyza sp.	12.4
			L. bryoniae K.	2.0
			Chromatomyia horticola G.	2.6
	Long bean	170	*L. sativae* B.	82.9
			Liriomyza sp.	17.1
Harvesting	French bean	207	*L. sativae* B.	91.8
			Liriomyza sp.	8.2
	Tomato	97	*L. sativae* B.	83.5
			Liriomyza sp.	13.4
			C. horticola G.	4.1
	Long bean	137	*L. sativae* B.	78.8
			Liriomyza sp.	21.2

Table 4. Parasitoid composition of leafminer in northern Vietnam.

No.	Scientific name	Family	Host stage	Frequency[1]
	Hymenoptera			
1	*Neochrysocharis formosa* (Westwood)	Eulophidae	Larvae	+++
2	*Neochrysocharis* sp.	‘’	‘’	++
3	*N. beasleyi*	‘’	‘’	+
4	*Chrysocharis pentheus* (Walker)	‘’	‘’	+++
5	*Hemiptarsenus* sp.	‘’	‘’	+
6	*Unidentified*	‘’	‘’	+
7	*Quadrastichus* sp.	‘’	‘’	
8	*Opius* spA.	Braconidae	Larvae-pupae	+
9	*Opius* spB.	‘’	Larvae-pupae	+
10	*Splangia cameroni* Perkins	Pteromalidae	Larvae	++
11	*S. endius* Walker	‘’	‘’	+
12	*Pachycrepoideus vindemiae* (Rondani)	‘’	‘’	+
13	*Unidentified*	Aphelinidae	‘’	+
14	*Unidentified*	Diapriidae	‘’	+
15	*Unidentified*	Cynipoidae	‘’	+

[1] *+: Low (<10% of parasitized larvae); ++: Medium (10-20% of parasitized larvae); +++: High (> 20% of parasitized larvae)*

Table 5. Leafminer density, leaf damage and parasitized larvae on tomato in spring 2005, 2006 at Da Ton, Gia Lam, Hanoi.

Development stage of plant	Leafminer density (Ind./leaf)	Leaf damage (%)	Parasitized larvae (%)
6 - 7 leaves	0.08	10.7	4.4
7 - 9 leaves	0.14	18.0	9.6
Forming flower	0.45	30.0	19.4
Flowering	0.82	42.6	26.0
Flowering-young fruit	1.01	57.3	30.5
Fruit developing	0.97	69.0	25.0
Harvesting	1.64	80.7	30.0
Harvesting	2.61	88.0	38.8
Harvesting	2.41	90.7	26.7

Table 6. Leafminer density, leaf damage and parasitized larvae on French bean in spring 2005, 2006 at Da Ton, Gia Lam, Hanoi.

Development stage of plant	Leafminer density (Ind./leaf)	Leaf damage (%)	Parasitized larvae (%)
6 – 8 leaves	0.35	17.5	11.1
8 – 10 leaves	0.63	26.0	14.9
10 – 12 leaves	1.19	32.7	18.5
Forming flower	1.62	48.7	25.7
Flowering	2.03	64.7	31.0
Flowering-young fruit	3.19	79.3	35.6
Fruit developing	2.93	82.7	31.9
Harvesting	2.57	85.3	28.8
Harvesting	1.41	90.4	31.1
Harvesting	1.10	92.0	39.6
Harvesting	0.84	94.5	33.7

Table 7. Leafminer density, leaf damage and parasitized larvae on long bean in spring 2004, 2005 at Da Ton village, Gia Lam, Hanoi.

Development stage of plant	Leafminer density (Ind./leaf)	Leaf damage (%)	Parasitized larvae (%)
4 – 6 leaves	0.16	14.0	6.3
6 – 8 leaves	0.27	24.0	8.2
8 – 10 leaves	0.36	30.7	11.9
10 -12 leaves	0.86	52.0	18.4
Flowering	1.08	58.7	26.0
Flowering-young fruit	1.25	73.7	28.9
Fruit developing	0.99	81.0	20.7
Harvesting	1.72	84.0	32.3
Harvesting	2.85	87.3	38.9
Harvesting	0.69	90.0	40.8

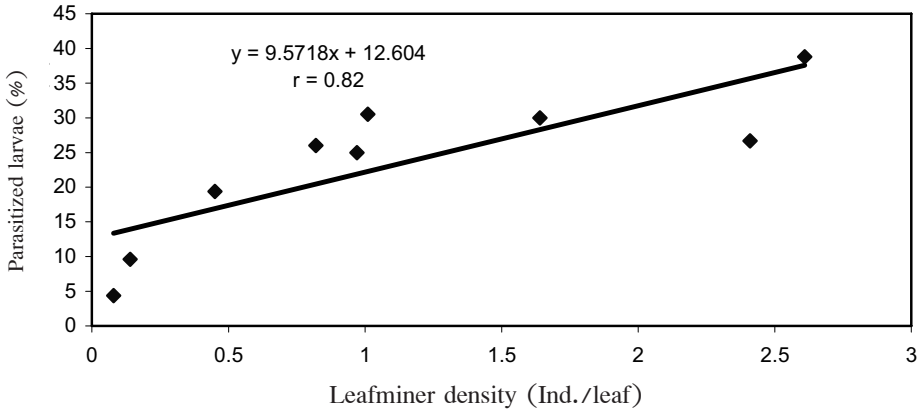

Figure 1. Relationship between leafminer density and the percentage of parasitism on tomato in spring 2005 & 2006 in Gia Lam, Hanoi.

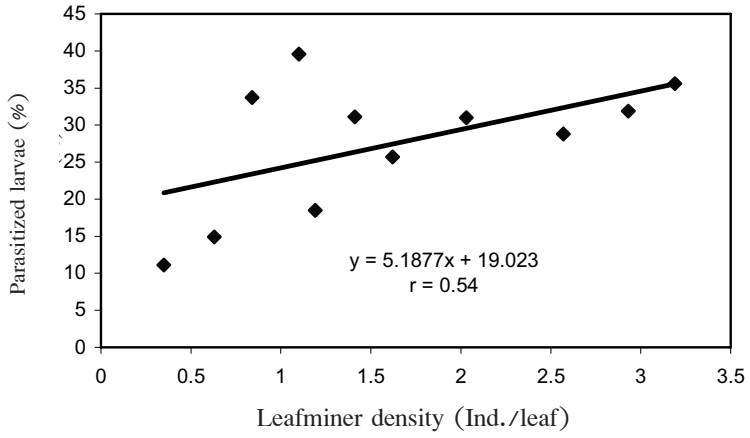

Figure 2. Relationship between leafminer density and the percentage of parasitism on French bean in spring 2005 & 2006 in Gia Lam, Hanoi.

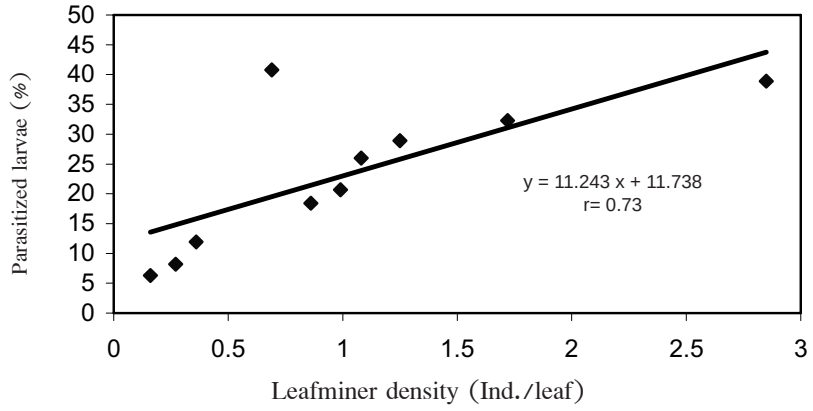

Figure 3. Relationship between leafminer density and the percentage of parasitism on long bean in spring 2005 & 2006 in Gia Lam, Hanoi.