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Control of the Leafminer, *Liriomyza huidobrensis* in Potatoes Through IPM

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Executive Summary

The pea leafminer, *Liriomyza huidobrensis* (Blanchard), a native to South America, spread to Europe, Israel and Africa as a pest refractory to insecticides. Leafminers are highly polyphagous, attacking flower and vegetable crops in open fields and greenhouses. Because there are only four translaminar insecticides that are efficacious against the larvae, insecticide resistance problems, even in the larvae, could quickly become a reality.

The objectives of this project are to develop control measures using integrated pest management techniques. Specifically, it is necessary to determine the native parasitoid guild and the extent of control each natural enemy exhibits on the leafminer; to evaluate the effect of larvicides, and to develop a strategy using parasitoid releases and minimal amounts of insecticides to control the leafminer. Scientific benefits will include not only a reduction in intensive use of chemicals and toxic residues, but will also enhance the understanding of the role of parasitoids in the control of pest species in open fields.

In Peru, the following has been accomplished: mass rearing of the leafminer, effect of selective and translaminar insecticides on the fly and it's parasitoids, spatial and vertical distribution of the fly in potato, dynamics of the populations in two different agroecological zones, and survey of parasitoids in coastal regions.

In Israel, work continued on identifying the parasitoids associated with the leafminer. We have learned of another new parasitoid species that emerges from leafminer infested leaves. We have continued working with a new translaminar insecticide, spinosad, for control of larval leafminers in beans and potatoes.

Section I Technical Progress

A) Research Objectives

1. Determine native beneficial insect guild for *L. huidobrensis* in Peru, and the extent to which control is exerted by each species.

2. Determine native beneficial insect guild for *L. huidobrensis* in Israel, and the extent to which control is exerted by each species.

3. Evaluate the efficacy of translaminar larvicides (new and existing) on pest and parasitoid populations.

B) Research Accomplishments

1. Mass-rearing of LMF under controlled conditions.
2. *Effect of selective and translaminar insecticides on LMF and their hymenoptera parasitoids under field conditions.*
3. *Spatial and vertical distribution of Liromyza huidobrensis in Potato.*
4. Dynamic population of LMF in two differents Agro-ecological Zones of Peru.
5. Survey of LMF parasitoids in the coast of Peru.

1. *Mass-rearing of LMF under controlled conditions*

a) Effect of temperature on oviposition, feeding and longevity of LMF female adults

Bean seedlings were used as the host plant. Polyethylene vases (1000 cc) were used as LMF rearing chamber. On the top, they had a hole (6 cm diameter) to permit the pass of air. Inside each vase a tube of glass (50cc) was introduced. It was filled with water to keep the plant alive during the experiment. A couple of recently emergency flies was released within each vase. A total of 30 chamber per each temperature (15°, 18°, 20°, 22° y 26°C) were used. The leaves were changed every 24 hours until LMF females were dead. The number of feeding punctures, eggs and the survivor of females was evaluated

At 20° and 22°C, the total number of eggs/female was similar, but it decrease significantly at 15° and 26°C (Table 1). Al 18°C the highest oviposition and feeding was registered. However, 22° and 26°C are the best temperatures to mass rear LMF.

b) Level of infestation for LMF mass rearing

In the laboratory, under controlled temperature (20°C), four different densities of LMF infestation were evaluated. As an infestation unit, a plot with five plants of bean (*Vicia faba* 30 days old) was considered. In a rearing cage, six plots were arranged. Couples of recently emerged LMF male and female were separated. Densities of 2, 4, 6 and 8 pairs by plot were released inside each rearing cage, with three replicates per density. Every three days (during 14 days), plots were removed from the cages and taken to the greenhouse, to complete the LMF cycle. After 15 days, pupae were recovered.

Number and weight of pupae are showed in Table 2. The highest pupae production was obtained in the treatment with 6 and 8 couple/host unit (5847 and 5429 pupae respectively), without finding differences between them. A clear positive relationship between the infestation level and number of recovered pupae was observed. On the opposite, the relationship between the number of recovered pupae and the weight/pupae was negative.

2. *Impact of selective and traslaminar insecticides on LMF and their hymenopteros parasitoids under field conditions*

The experiment was conducted at CIP's HQ station in Lima (Peru) in a winter potato crop (July-November). Treatments included: cyromazine (Trigard 75PS), abamectin (Vertimec 1.8CE), chlorfluazuron (Atabron 5CE), cartap (Padan 50PS), spinosad (Tracer 120SC), imidacloprid (Confidor 350SC) and an absolute control (no insecticide). *Experimental design*.- A randomized complete block design with four replicates. Experimental plots had 6 rows wide with 20 m long each (105 m2). Plots were treated 60 days after planting with a motorized backpack sprayer at a rate of 300 liter/ha. The four central rows of each plot were considered for evaluations.

Sampling methods. – Samples were collected from the four central rows. Five leaves by plot were randomly collected and taken to the laboratory to emergence of LMF adults or parasitoids. Collections were done 0, 4, 8, 12, 16 and 20 day after spray. *Statistical analysis*.- Before statistical analysis, data were transformed (square root + 1) and analyzed using 1-way analysis of variance (ANOVA). Means were separated by Waller-Duncan test (P=0.05). In order to correct mortality differences of larval infestation before application, Abbott's formula was used.

Cyromazine was the most effective insecticides with a high larval mortality until 20 days after spray, followed by abamectin and spinosad (Figure 1). The parasitoids complex constisted of 8 species: Pteromalidae (*Halticoptera arduine*), Eulophidae (*Chrysocharis caribea, C. flacilla, Diglyphus websteri, D. begini* and *Chrysonotomyia* sp.), Cynipidae (*Ganaspidium* sp.) y Braconidae (*Opius* sp.). Before and after applications *H. arduine* seemed to be the most important parasitoid on the field (Figure 2). The parasitoid population was reduced by chlorfluazuron, cartap, spinosad, and imidacloprid until 8 days after application. Twelve days were needed to recover the normal level of parasitoids in these treatments. Ectoparasitoids (*Diglyphus* spp. And *Chrysonotomyia* sp.) were the most susceptible to chlorfluazuron and imidacloprid applications. Both, the amount individuals by specie and the number of species were affected by cyromazine. In the other hand, the opposite results were showed by abamectin. This study leads us to conclude that abamectin and spinosad can be alternated with cyromazine for better LMF control in the field and maintaining the parasitoids population.

3. *Spatial and vertical distribution of* **Liromyza huidobrensis** *and their hymenoptera parasioids in potato*

The experiment was conducted at CIP's HQ station, Lima (Peru), in a winter potato crop (July-November). Identification of parasitoids and data processing will be done between January and February 2004.

4. Dynamic population of *L. huidobrensis* and parasitoids in two different agroecological zones in Peru

This study is being carried out in two locations of Peru: Huancayo (central highland 3200 m.s.n.m.), and La Molina (central coast 500 m.s.n.m.). Sampling LMF and parasitoids in the fields will end in March 2004. Identification of paratsioids and data processing will be done between June and July 2004.

5. Survey of LMF parasitoids in the coast of Peru

Samples of LMF-infested plants (cultivated and wild species) were collected in the winter season from July to August 2003, in the valleys of the Coast of Peru. A total of 222 samples were taken in 98 localities. Samples were put in paper bags and taken to the laboratory where they were processed. Emerged insects were separated (LMF adults and parasitoids) between October and November. Mounting and identification of parasitoids will be done during January and February 2004. Another survey will be carried out between March and April 2004.

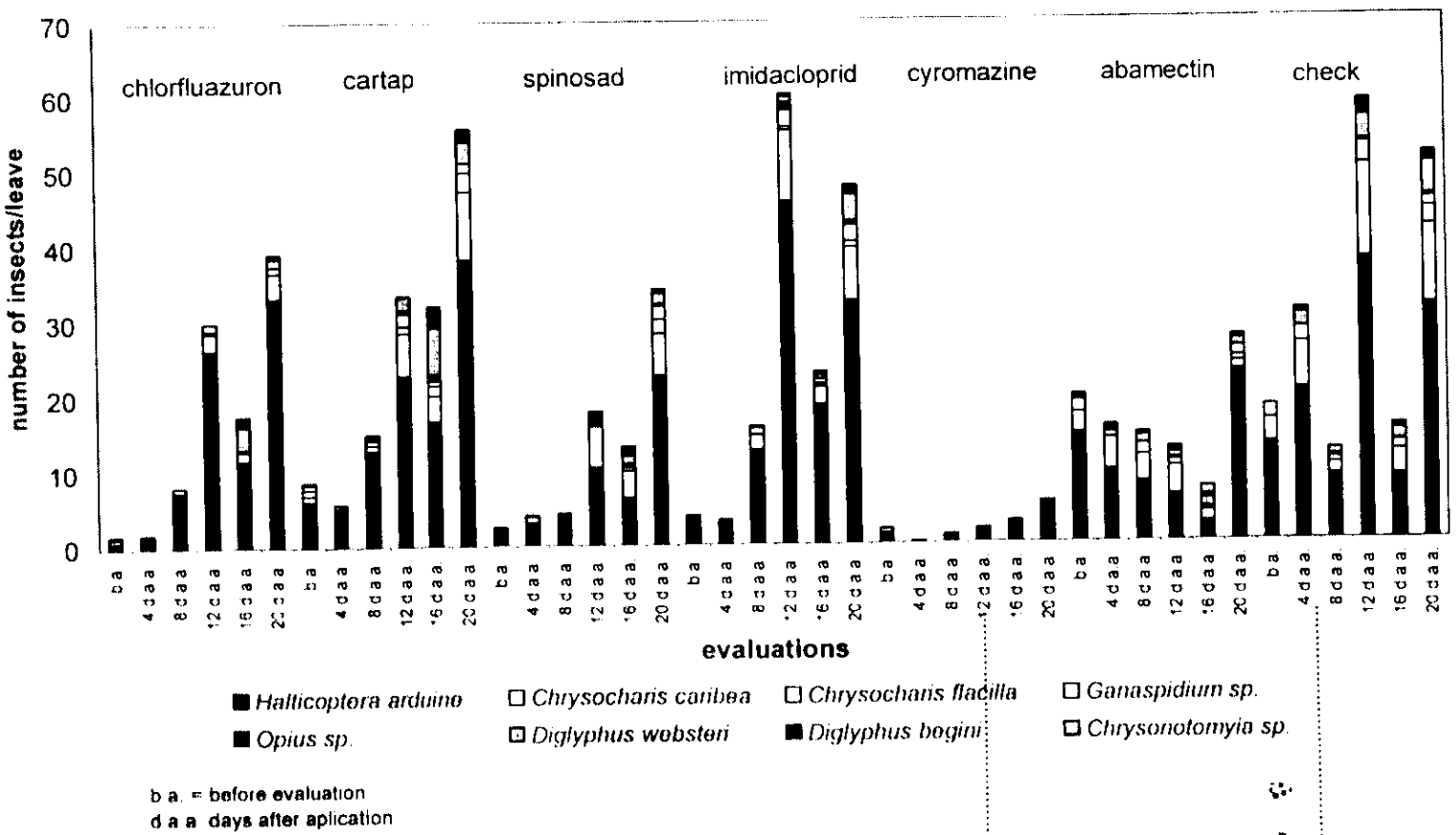
Table 1. Feeding and oviposition response of female *Liriomyza huidobrensis* at five constant temperatures. La Molina, 2003.

Temp. (°C)	n	Means number of eggs per female		Peaks oviposition		Means number of feeding punctures per female		Peaks feeding		Longevity (days)
		Total	Per day	# eggs	day	Total	Per day	# punctures	day	
15	26	72,7	1,0	8,3	21st	2040,7	28,7	119,2	7th	35,9
18	20	169,2	5,5	14,4	16th	3081,4	78,0	234,0	5th	24,4
20	26	112,2	2,4	11,8	11th	2199,6	47,8	206,1	7th	22,5
22	20	111,2	3,6	17,2	4th	2894,8	93,4	315,0	4th	21,4
26	20	88,6	3,4	19,0	4th	2593,0	92,6	459,0	4th	16,8

Table 2. Means number of *Liriomyza huidobrensis* pupae recovered in four different infestation densities. La Molina, 2003.

Nº couples	Infestation times						Total production /plant host		Adults emergency (%)	Weight /pupae (g)	
	1st to 3th day	4th to 6th day	7th to 10th day		11th to 14th day						
2	102.6	231.1	152.2	b	95.7	b	581.6	c	90,3	7.51 (x10^{-4})	a
4	103.6	261.8	207.3	ab	169.9	ab	742.6	bc	89,9	7.41 (x10^{-4})	a
6	123.6	301.2	275.3	a	204.8	a	904.8	ab	88,9	7.24 (x10^{-4})	ab
8	128.8	323.5	279.2	a	243.0	a	974.5	a	90,7	7.06 (x10^{-4})	b

Figure 2. Effect of six insecticides on abundance of LMF hymenoptera parasitoids. La Molina, 2003.



One of the primary objectives in Israel is to determine the parasitoid guild for the leafminer. As such, leaves were collected throughout the winter-spring growing season from two major potato-growing regions in Israel, the central coastal area and the western Negev desert. Previously parasitoids were collected from leafminer infested leaves in the western Negev and only one parasitoid was identified, *Diglyphus isaea*.

1. Parasitoids in Israel

Present research revealed the present of a total of 13 new parasitoids in addition to *D. isaea* (Table 2). This past year, the number of leafminers found was very low and the presence of parasitoids was opposite of that from the previous year. The total number of *Opius* sp. exceeded *D. isaea*; however, the *Opius* sp appeared for one two-week period, whereas *D. isaea* was found the entire season (Table 2)

Table 3. List of parasitoids found in leafminer infested potato leaves.

Parasitoid Species	**South**	**Central**
Diglyphus isaea	19	12
D. crassinervis	0	5
Opius sp.	2	110*
Neochrysocharis formosa	0	0
Platynecheilus cuprifors	0	0
Pnigalio saemius	0	0
Hemiptarsemus zilabsebessi	0	0
Chrysocharis pentherus	0	0
Pediobius metallicus	0	0
Platynodielius cuprifrons	0	0
Neotrichorporodies sp.	0	0
Pteromalus sp.	0	0
Scelionidae	0	0
Trichomalopsis sp.	0	0
TOTAL	21	127
% *D. isaea*	**90.5%**	**0.09%**

* occurred in 1 two-week period

The second major objective is to determine the effects of new translaminar insecticides on leafminer larvae. Since work has already been published by the Israel team on the effects of abamectin, cyromazine, and neem on leafminer larvae, we started working with spinosad, a translaminar insecticide derived from bacteria. Since the colony is maintained on bean plants, we initiated trials with *Phaseolus vulgaris* and treated plants at two concentrations (Figure 2). Spinosad is a highly effective insecticide for controlling leafminers.

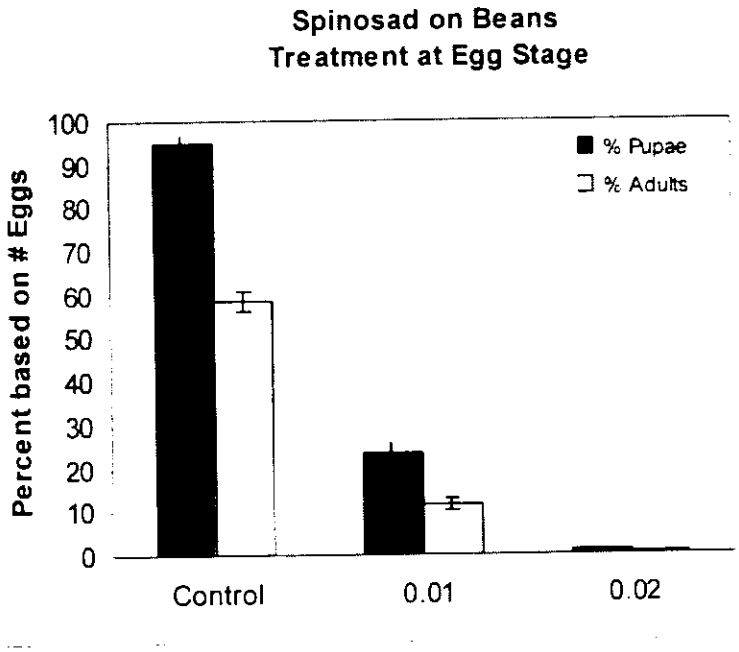


Figure 2. Effect of spinosad on leafminer larvae.

C) Scientific Impact of Collaboration

We have had very good communication and expect to start preparing joint publications soon

D) Description of Project Impact

As the project is just completing the second year, results of the research have not yet been implemented. Currently, in both countries, we are trying to determine the extent of the parasitoid and predator guilds. After the guilds have been determined and their impact on the pest population assessed, we will be able to determine which species to augment in the field. Furthermore, work is currently in progress on the effects of new translaminar insecticides. These with be evaluated for effects on predator and parasitoid populations.

E) Strengthening of Developing Country Institutions

In the first year of this project, the research in Peru has been strengthened by the purchase of equipment. Three new rearing rooms were near completion in October; these will be used for rearing parasitoids and studying the effects of translaminar insecticides on the leafminer as well. Now these rooms are being fully utilized mass rearing the insects.

Direct observation of the development of leafminer larvae as well as observing the behavior of different parasitoid species can now be observed through equipment purchased. Through the use of this type of equipment it was determined that one external parasitoid species (*Diglyphus isaea*) feeds on more than one host. This bears

direct relevance to their impact on pest populations. Parasitoids native to Peru, which do no include *D. isaea*, will be evaluated for this behavior.

F) Future Work

As this project is just completing the second year of activity, much work has been done. Work will continue evaluating and identifying native parasitoids and predators in both countries. Work on control of the leafminer with translaminar insecticides, and their effects on parasitoids will continue. During this year we will start field evaluations of integrated control measures.

Section II

A) Managerial Issues

Dr. Abdelaziz Lagnaoui, the former leader of the Potato Research Group at CIP left a year ago and was only recently and temporarily replaced by Dr. Oscar Ortiz. In July 2004 a permanent head of research, Dr. Jurgen Kroschel, (Acting Head, Dept. of Agronomy, Institute of Plant Production and Agroecology in the Tropics and Subtropics, University of Hohenheim, will be arriving.

On the Israeli side, the technician on the project quite to return to start a Masters Degree program. Her replacement worked for 6 months before she left due to pregnancy. She is expected to return in another 2 months. The rest of the staff, timetables and research sites remain as proposed.

B) Budget

The Israeli P.I. has requested the shift travel and consultant funds to permanent equipment and purchase a high quality camera for the microscope purchased on CDR funds. The reason for this purchase is that the present commercial camera does not produce photos of sufficient quality for a brochure that is being prepared for the growers.

C) Special Concerns

There have been no protocol changes, nor should the necessity arise.

D) Collaboration, Travel, Training and Publications

None.

E) Request for Embassy or AID Actions

None.