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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 two or three 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, work has commenced on identifying new parasitoids associated with the leafminer. An important complex of 23 parasitoid species has been registered: 8 have been identified and another 15 have been sent to a specialist for identification. Additionally, studies lead to the conclusion that cyromazine, abamectin and spinosad can be alternated by better leafminer control.

In Israel, work commenced on identifying the parasitoids associated with the leafminer. We have learned of 11 new parasitoid species that emerges from leafminer infested leaves; 5 have been identified and another 6 have been sent to a specialist for identification. Additionally we have started working with a new translaminar insecticide, spinosad, for control of larval leafminers in beans and potatoes.

Section I

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

There is a rich complex of parasitoid species that attack the larvae of LMF in the central coast of Peru. Some species have been identified; others are in process of identification or characterization and, in the meantime only the genus is indicated (Table 1). Most parasitoid species (17 of them) belong to the family Eulophidae. The most abundant species are the ectoparasitoid, *Diglyphus* sp. (Eulophidae), and the endoparasitoids *Halticoptera arduine* (Pteromalidae) and *Chrysocharis* spp. (Eulophidae). Other species of parasitoids are present but are less abundant under the conditions of the central coast of Peru.

The experiments on the effect of cyromazine, abamectin, chlorfluazuron, cartap, and an absolute control (no insecticides) on leafminers were conducted at CIP's HQ station in a winter season (July-October). Cyromazine and abamectin were the most effective insecticides against leafminer larvae with 0.6 and 1.9 larvae/leaf respectively, 15 days after first spray. The treatments, spinosad and abamectin mixed white plant oil registered an average of 6.5 and 15.8 larvae/leaf respectively. No significant differences in number of LMF larvae were observed between chlorfluazuron (34.8 larvae/leaf) and the check (34.2 larvae/leaf). In the second spray, cyromazine registered 0.9 larvae/leaf 15 days after spray. No significant differences were found between abamectin (4.1 larvae/leaf), abamectin + vegetable oil (6.5 larvae/leaf) and spinosad (5.3 larvae/larvae) (Figure 1) This study leads us to conclude that cyromazine, abamectin and spinosad can be alternated for better leafminer control in the field.

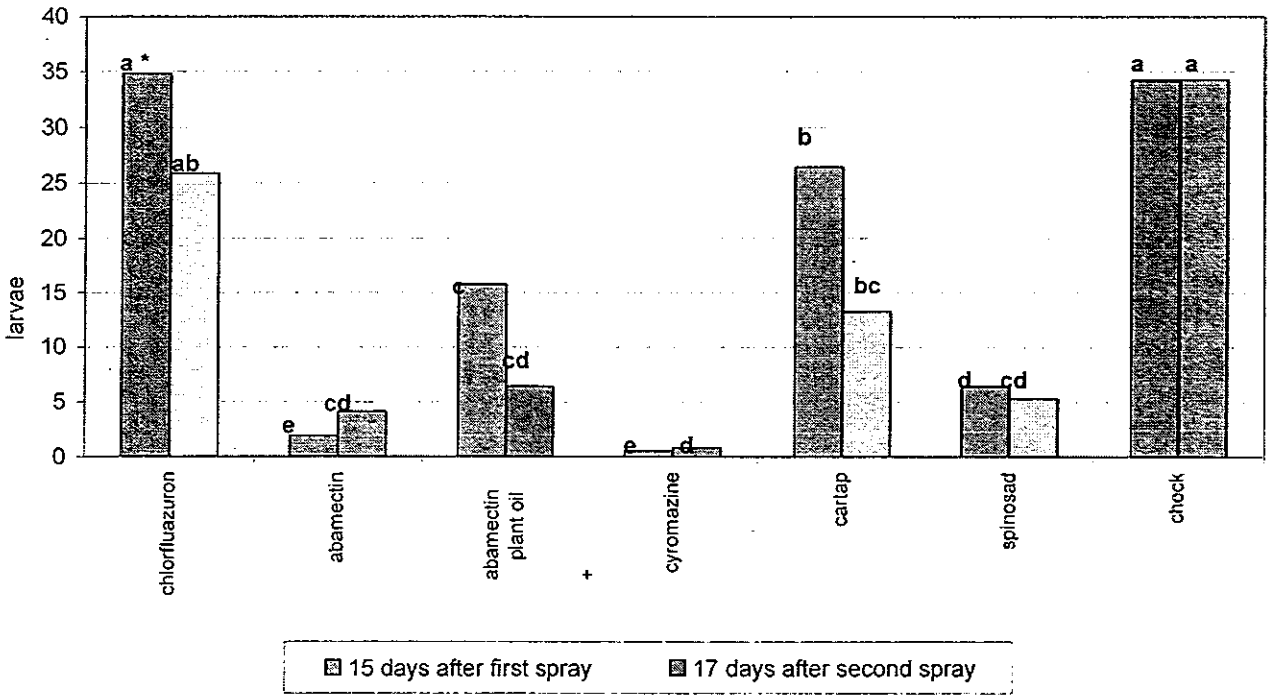
The study on the seasonal occurrence of leafminers and parasitoids was carried out in potato fields in La Molina, from May to November of 2002. Three commercial fields (amarillis, revolucion and tomasa) were evaluated during the autumn, winter and spring seasons. The LMF pressure recorded in 2002 represented the normal trend of the population dynamics in the coast of Peru. Adult population peak occurred in winter (July) and spring (September), with 9075, 15775 and 17038 adults/trap in Amarilis, Revolucion and Tomasa varieties respectively. These peaks coincided with the phenologic age of the potato crop. There was a relatively slow increase during the vegetative growth and a rapid and sustained increase during flowering and maturing, followed by a decline as plants enter into senescence (Figure 2).

Table 1. Species of parasitoids attacking leafminer fly larvae and pupae in the central coast of Peru.

HYMENOPTERA	SUBFAMILY	SPECIES	PARASITISM
BRACONIDAE	Opiinae	***Opius scabriventris***	Endoparasitoid
		Opius sp	Endoparasitoid
EUCOILIDAE		*Ganaspidium* sp.	Endoparasitoid
EULOPHIDAE	Eulophinae	***Diglyphus websteri***	Ectoparasitoid
		Diglyphus begini	Ectoparasitoid
		Diglyphus sp.	Ectoparasitoid
	Tetratischinae	*Diaulinopsis* sp.	Endoparasitoid
	Entedontinae	***Chrysocharis phytomyzae***	Endoparasitoid
		Chrysocharis ainsliei	Endoparasitoid
		Chrysocharis sp. A	Endoparasitoid
		Chrysocharis sp. B	Endoparasitoid
		Chrysocharis sp. C	Endoparasitoid
		Chrysocharis sp. D	Endoparasitoid
		Chrysocharis sp. E	Endoparasitoid
		Chrysonotomyia sp. A	Ectoparasitoid
		Chrysonotomyia sp. B	Ectoparasitoid
		Chrysonotomyia sp. C	Ectoparasitoid
		Closterocerus cinctipennis	Ectoparasitoid
		Closterocerus sp.	Ectoparasitoid
	Elachertinae	Zagrammosoma multilineatum	Ectoparasitoid
PTEROMALIDAE	Miscogasterinae	***Halticoptera arduine***	Endoparasitoid
		Halticoptera sp. A	Endoparasitoid
		Halticoptera sp. B	Endoparasitoid

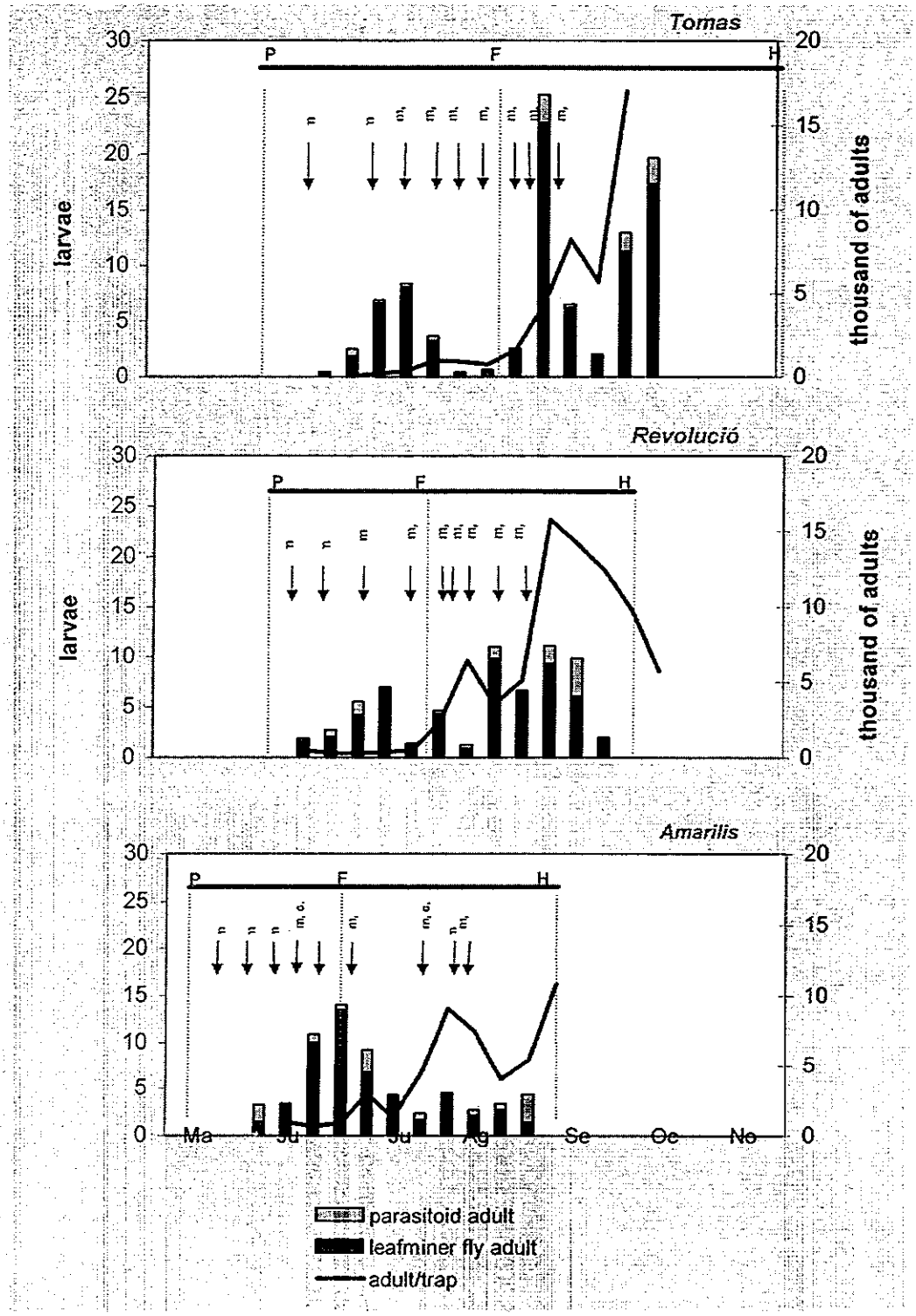
Parasitism: Level of parasitism was very low due to the excessive use of non-selective insecticides (methamidophos). After insecticide applications were stopped in theses fields, the leafminer fly population increased, followed by an increase in the rate of parasitism by indigenous parasitoids. Only five species were recovered in these fields (*H. arduine*, *Chrysocharis* sp., *Diglyphus websteri* and *Ganaspidium* sp.). When little or no insecticides are used, parasitism of LMF larvae during winter (April-August) varies from 35% to 55%. But in early spring (September) total parasitism increases steadily until later spring (November) when percentage of parasitism is near 100%.

Figure 1. Effect of insecticides on LMF infestation under field conditions, La Molina-Peru, 2002.



* the same columns followed by a common letter are not significantly different

Figure 2. Sesasonal variation of LMF population densities in three potato varieties, La Molina-Peru, 2002



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.*

Present research revealed the present of an additional 11 parasitoids in addition to *D. isaea*; five have been identified and another 6 have been sent to an expert for identification (Table 2). Furthermore, this research has shown that there is a significant difference in the number of parasitoids found in the two regions of Israel; *D. isaea* constituted less than 50% of the parasitoids found in the central region, whereas (excluding one date in which 40 *Opius* sp. were collected) it constituted about 85% of the parasitoids found in the southern region. Small farms characterize the central region of Israel, with a large diversity of crops. Agriculture in the western Negev is composed primarily kibbutzim, which have very large tracts of single crops; the kibbutz in this trial along has 450 hectares of potatoes and is surrounded by other large kibbutzim also primarily growing potatoes.

Table 2. List of parasitoids found in leafminer infested potato leaves.

Parasitoid Species	**Central Israel**	**Southern Israel**
Diglyphus isaea	31	103
D. crassinervis	1	1
Opius sp.	0	40
Neochrysocharis formosa	0	2
Platynecheilus cuprifors	3	3
Pnigalio saemius	0	2
B	5	5
Ch	3	1
D	0	2
H	8	1
T	5	0
Y	8	1
TOTAL	64	161
% *D. isaea*	**48.4**	**64.0**

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 3). Spinosad is a highly effective insecticide for controlling leafminers.

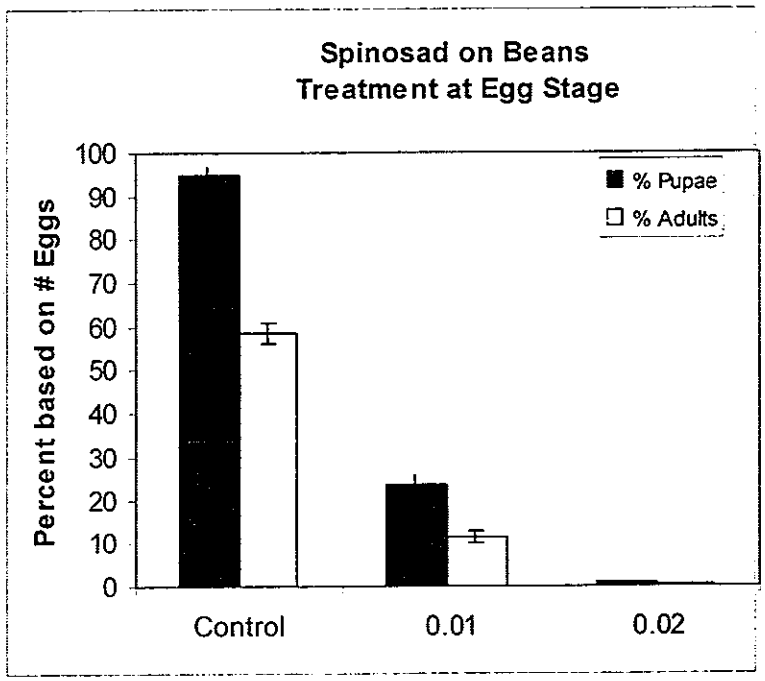


Figure 3. Effect of spinosad on leafminer larvae.

C) Scientific Impact of Collaboration

During the past year, the research team from Israel met with researchers and technicians at the International Potato Center (CIP) in La Molina, Lima, Peru. We visited the research institute, and all locations where field trials were in progress, including the Huaral and Canete Valley, see below.

D) Description of Project Impact

As the project is just completing the first 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.

Additionally, a video camera, attached to a dissecting microscope with sub-stage lighting has been ordered. This will enable direct observation of the development of leafminer larvae as well as observing the behavior of different parasitoid species. 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 first year of activity, there is much work to be 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. In another year we will start field evaluations of integrated control measures.

Section II

A) Managerial Issues

During the Israeli research team visit to Peru we learned that Dr. Abdelaziz Lagnaoui, the leader of the Potato Research Group at CIP will be moving to work at the World Bank. This will not impact on the research project, as the researcher for the project, Norma Mujica, will remain in charge and in direct contact with the Israeli team. The rest of the staff, timetables and research sites remain as proposed.

B) Budget

Since the requested, and granted, shift of funds from Peruvian travel to Peruvian equipment in the first Management Report, there have been no additional changes.

C) Special Concerns

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

D) Collaboration, Travel, Training and Publications

In October (13th – 18th) Ms. Merav Barkalifa and Dr. Phyllis Weintraub visited the International Potato Center in La Molina, Lima, Peru. The Israeli team visited with Dr. Lagnaoui and Ms. Mujica and toured the facilities there, and observed the on

going field trials. Dr. Weintraub gave a lecture on the leafminer fly in Israel. The following two days the Israeli team traveled to and toured the Canente Valley with Ms. Mujica, a major agricultural region in the southern area of the Department of Lima. This is the only valley that has water, because of the Canete River, year round. Two agricultural schools, a research station where beneficial organisms are produced for release in biological control programs and, of course, the field research sites were visited. Several natural enemies, both predators and parasitoids, were observed. Additionally we observed growers implementing the use, developed by Ms. Mujica, of an effective physical control method. Yellow plastic sheets, covered with vegetable oil, were carried through the fields trapping thousands of leafminer flies. Stationary yellow traps (50 x 50 cm) were employed in other fields in the area. The following day we traveled north of Lima to the Chancayllo Valley in Huaral, another large potato growing region. Here potato harvest in addition to visiting several fields were observed. Returning to Lima, there was a follow-up meeting, reviewing the work accomplished and future trials were discussed.

E) Request for Embassy or AID Actions

Since the project is only in it's first year and has been progressing according to schedule, we have no requests for assistance from the Embassy or A.I.D.