MINISTRY OF AGRICULTURE, FISHERIES AND FOOD
AGRICULTURAL DEVELOPMENT AND ADVISORY SERVICE
FARM AND COUNTRYSIDE SERVICE
AND
AGRICULTURAL FOOD AND RESEARCH COUNCIL
HORTICULTURAL RESEARCH INTERNATIONAL

REPORT OF A VISIT TO HOLLAND SPONSORED BY THE HORTICULTURAL DEVELOPMENT COUNCIL, TO OBTAIN INFORMATION ON THE MOST RECENT RESEARCH DONE ON THE SOUTH AMERICAN LEAF MINER (LIRIOMYZA HUIDUBRENSIS)

STUDY TOUR
NAALDWIJK, HOLLAND
14-16 NOVEMBER, 1990

M Saynor (ADAS)
and
N Helyer (HRI)

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD
AGRICULTURAL DEVELOPMENT AND ADVISORY SERVICE
FARM AND COUNTRYSIDE SERVICE
AND
AGRICULTURAL FOOD AND RESEARCH COUNCIL
HORTICULTURAL RESEARCH INTERNATIONAL

Report of a Visit to Holland Sponsored by the Horticultural Development Council (HDC), to Obtain Information on the Most Recent Research Done on the South American Leaf Miner (Liriomyza huidubrensis)

Name of officers writing report:	M Saynor (ADAS) and N Helyer (HRI)
ADAS Service and Location:	FCS, Reading RO
Nature of visit:	Visit to meet and discuss pest problems in common with Dutch research workers
Date and location:	14 - 16 November, 1990 Naaldwijke and Berkel en Rodenrijs, near Rotterdam, Holland.
Main topics discussed:	South American Leaf Miner (Liriomyza huidobrensis) [also Western Flower Thrips (Franklinella occidentalis). Use of bumble bees to improve pollination in tomatoes.]

1. OBJECTIVES OF THE VISIT

i. To meet and discuss with Dutch Research Entomologists the results of their most recent experiments and observations on South American Leaf miner (Liriomyza huidobrensis). Such information should enable ADAS and HRI to avoid duplication and ensure that the R & D they do for the HDC is the most cost effective.

ii. Discuss with other researchers at the same research stations their recent results and current views about the control of Western Flower Thrips (Franklinella occidentalis).

2. SUMMARY OF FINDINGS

Liriomyza huidobrensis

i. Leaf miner parasites (Dacnusa sibirica and Diglyphus iseae, in ratio 9:1) controlled L. huidobrensis on tomatoes effectively in a glasshouse trial at Naaldwijk.

ii. The same parasites controlled L. huidobrensis on three commercial crops of tomatoes monitored closely by Koppert B.V., suppliers of the parasites. Effective control was reported on other commercial crops, although less detailed observations were made. Koppert have devised a system whereby growers send them 50 mined tomato leaves each week that are dissected to assess the percentage parasitism, from which they calculate the number and timing of future introductions of parasites.

iii. Because results on tomatoes were so satisfactory no further experiments are planned at Naaldwijk. Koppert intend to sell parasites and to offer the sampling service to tomato growers again in 1991. Based on their observations last year they estimated that it cost growers between £500-£750/ha (2-3 parasites/m^2) to control light infestation and £750-£1000/ha (3-5 parasites/m^2) heavy infestations of L. huidobrensis on tomatoes.

iv. In a preliminary trial at Naaldwijk on iceberg lettuce planted in the winter D. sibirica was found to be more effective than Opius pallipes. Five weekly introductions of D. sibirica, at 0.07 parasites/m^2 made once the leaf miners became active, resulted in 40 per cent of the leaf miners parasitised when the crop was harvested in early April.

v. In a second trial in the same 3 (300 m^2 each) glasshouses, five over-lapping crops of butterhead lettuce were planted, the first on 25 April. About 75 D. sibirica or O. pallipes were released in separate houses, but more D. sibirica and L. huidobrensis probably entered the glasshouses from outside. The first crop was the most heavily mined (40-240 mines/plant in different glasshouses), but eventually 90 per cent of the leaf miners were parasitised by D. sibirica. Up to 100 per cent of the leaf miners were parasitised in the second planting. Numbers of both the pest and the parasites then declined rapidly, although both were still present until the end of the experiment in November.

vi. A modified experiment is planned on lettuce in 1991 in which either D. sibirica or Diglyphus iseae will be used in separate glasshouses, together with "banker plants". It is hoped that these will supplement the regular introductions of the parasites (see Technical Narrative).

vii. Koppert do not have any experience with biological control of L. huidobrensis on commercial crops of lettuce nor at present do they plan to expand into this field.

viii. Researchers at Naaldwijk and at Koppert BV believed liquid oxamyl (Vydate) added to the NFT solution was used extensively to control L. huidobrensis commercially on tomatoes. Oxamyl granules applied before planting, followed by foliar sprays of dichlorvos (as necessary) were the main insecticides used to control this pest on lettuce.

ix. Although not proven conclusively, observations suggested that L. huidobrensis over-wintered successfully outdoors in Holland in 1989-90 in a number of areas. In laboratory experiments pupae survived for a week at -4°C, but not at -18°C.

x. Broad beans are a preferred host of L. huidobrensis and can be used to monitor whether and when the insect is present in an area.

xi. Other topics discussed during the visit included the biological control of Western Flower Thrips, use of bees to pollinate tomatoes and possible collaborative work to test the effects of pesticides on beneficial insects.

3. RESEARCH PRIORITIES IDENTIFIED AS SUITABLE FOR FUNDING BY THE HDC

i. As a result of the visit to Holland considerable changes to the initial proposals for R & D on L. huidobrensis to be done for the HDC by HRI and particularly ADAS, are suggested.

ii. Trials on commercial holdings to develop and test biological methods for the control of L. huidobrensis at present are not compatible with MAFF's current policy against the pest of eradication. It is recommended therefore that where opportunities arise the majority of the ADAS work sponsored by the HDC be concentrated in two other areas. These are the testing further of chemical and/or physical methods of control and biological studies to monitor the occurrence and distribution of L. huidobrensis and levels of natural parasitism.

iii. If circumstances change, trials on the biological control of L. huidobrensis on commercial holdings could be done. Some government fundings should be available to do this.

iv. The most appropriate topics identified for ADAS and HRI to undertake for the HDC are shown in Table 1.

TABLE 1: PROPOSALS FOR R & D ON L. HUIDOBRENSIS TO BE FUNDED BY THE HDC

1. Proposals for Work in Quarantine Containment at HRI

a) Obtain culture of L huidobrensis and maintain it in strict quarantine conditions in an isolation laboratory at HRI, Littlehampton.

b) Study the life cycle of L huidobrensis on lettuce (and possibly other crops) at different temperature regimes, to assess the numbers of generations likely to be completed per crop. The impact on populations of harvesting infested crops would be assessed.

c) Test the effectiveness against L huidobrensis of native species of egg parasites (e.g. Trichogramma) and insect-parasitic nematodes and (against pupae) of soil-acting fungal pathogens.

d) Test the effectiveness and mode of action of novel control measures, such as extracts from the leaves and bark of the neem tree (marketed in the USA for leaf miner control as Margosan O) and "Hugtight" (a sticky material).

e) Obtain and collate information from Holland and the International Organisation for Biological Control (IOBC) on the known side effects of pesticides on leaf miner parasites, including egg parasites. Carry out further tests as required, hopefully in collaboration with Dutch colleagues.

2. Proposals For Work In Glasshouses Principally By ADAS

f) A glasshouse trial on a commercial nursery infested with L. huidobrensis to test further promising insecticides. These include ones identified in laboratory tests at the Central Science Laboratory, Harpenden and ones used abroad to control L. huidobrensis, but not approved for this use in the UK. Candidate insecticides include oxamyl granules, sprays of trichlorphon and dichlorvos. (Residue analyses should be done as necessary and the purchase of blocks of crop and their destruction at the end of the trial may be necessary.)

g) The merits of physical methods of control of leaf miner will be evaluated. These include:

i) Quantitative assessment of the value of large, yellow sticky traps (Master traps) and the relationship between the numbers caught on traps and infestation levels on crops.

ii) Assessment of the potential value of crop covers used either to prevent flies emerging from soil or to prevent females laying their eggs on crops.

h) Biological observations, as opportunities permit, in and around infested commercial nurseries. (In most cases samples (larvae) collected during this work will have to be sent to and maintained in quarantine facilities until adults emerge before they can be identified to species). Observations will include:-

i) Monitoring the incidence of L. huidobrensis outside and at varying distances from glasshouses infested in 1990.

ii) Assessing the natural levels of parasitism in populations outside (if discovered) at different times of the year.

iii) Assessing levels of natural parasitism in glasshouses found to be infested with L. huidobrensis before and after insecticide treatments applied under statutory notice.

4. TECHNICAL NARRATIVE

South American Leaf Miner

The main discussion at Naaldwijk were with Anton van der Linden who works almost entirely on leaf miners, but we also met Dr N A M van Steekelenburg head of the Pests and Diseases Department and Marieke van der Staay. Marieke spends part of her time assessing the side effects of pesticides on beneficial insects and she and Neil Helyer discussed possible collaborative work in this field. This and other areas of co-operation were discussed further with Dr van Steekelenburg.

Van der Linden began work on L. huidobrensis in August 1989 and he has concentrated on assessing the effectiveness on tomatoes and lettuces of the three species of leaf miner parasites (D. sibirica, O. pallipes and D. iseae) available commercially. D. sibirica is almost always more effective than the closely related O. pallipes and van der Linden intends doing little more with the latter. D. sibirica is more effective in the early part of the year, but D. isease is more so in the summer: wild D. iseae from outside often supplement those deliberately introduced.

The experiment on the control of L. huidobrensis on tomatoes was done in a small glasshouse that contained 132 plants. Thirty adult leaf miners (equal numbers of males and females) were released in April and two weeks later 20 parasites were released (D. sibirica and O. pallipes) when there was an average of 1.5 mines per plant. Leaf mining reached a peak of 150 mines per plant in June, but between 40-80 per cent of the larvae were parasitised by

D. sibirica. D. iseae came into the glasshouse from outside in the same month, by July most larvae were dead and by August leaf miner had been virtually eliminated.

Commercially Koppert reported very much the same thing using their commercial product. "Minex" that contains a mixture of D. sibirica and D. iseae (9:1 in the early part of the year: changing up to 8:2 in the summer). Although it may well need to be refined with experience, the sampling and monitoring service Koppert have devised (see Summary) to advise their customers about their further requirements appeared to be sensible and workable.

Two trials were done on lettuce in 1989-90 and another is planned in 1991, all in 3 x 300 m^2 glasshouses. The preliminary trial on iceberg lettuce was planted on 19 December and 4 January and harvested on 10 April. Three L. huidobrensis - infested lettuces were inter-planted in the glasshouse each week for four weeks in January/February. Paper collars were put beneath each to collect pupae to calculate the numbers of larvae leaving plants to pupate: up to 50 pupae were recovered per plant. Either D. sibirica or O. pallipes were released in separate bays and none were released in the third compartment. 20 individuals (1:1 males:females) were released weekly for five weeks between February and March, when leaf miners were most active, making a total of 1 parasite/3 m^2

About 40 per cent of the larvae were eventually parasitised by D. sibirica (but by inference, a much lower level by O. pallipes).

The glasshouses were replanted with butterhead lettuce on 25 April, 23 May, 20 June, 12 July, 15 August and 18 September. Many of the plantings therefore overlapped. The first planting was the most seriously attacked and the level varied in the different bays from 40-240 mines per lettuce. Only 75 D. sibirica or O. pallipes were released per unit, although van der Linden believed that more leaf miners and D. sibirica came into each unit from outside: Large numbers of L. huidobrensis were seen outside in April. About 90 per cent of the leaf mines were parasitised in the first planting and in

the second planting he found every leaf miner parasitised on one occasion. Then the numbers of both leaf miners and parasitoids dropped rapidly, so sampling became difficult. However both were still present in very low numbers until the experiment finished in November.

Next year van der Linden wants to use either D. sibirica or D. iseae (or neither) in the same three glasshouses. As well as liberating adult parasitoids he wants to use "banker plants" to see if these will improve control.

The buttercup leaf miner, (L. ranunculae) has a restricted host range and will not attack lettuces, but it is parasitised by the parasites available commercially. Van der Linden intends to use cultivated Rananculus as the host plant. [This concept is not a new one and indeed ADAS entomologists used parasitised cereal aphids to improve the control of melon-cotton aphids on cucumbers this year. Never-the-less van der Linden should be given full credit if this technique is used and proves successful for the control of L. huidobrensis in the UK].

Van der Linden had observed and done simple experiments to try to determine whether L. huidobrensis could overwinter in Holland. He did not catch any flies in spring in cages he had put over infested plants the previous year. However he found adults outside in various parts of the Westland area (the main glasshouse area) in April before growers reported fresh damage on glasshouse crops. This he concluded suggested pupae had overwintered outside.

In a laboratory experiment adults emerged from pupae that had been kept at -4°C but none emerged after storage at -18°C.

During the summer large numbers of a predatory species of fly, believed to be Coenosia sp., were seen in the glasshouses. These not only caught adult L. huidobrensis on the wing, but were believed to attack the larvae and warrant further investigation.

Prospects for the biological control of L. huidobrensis on lettuce, although at an early stage, look promising. Changing from chemical control to biological control in glasshouses where numbers of the pest are high will obviously be the difficult phase, particularly while L. huidobrensis is subject to statutory control (with insecticides). Van der Linden considered crops harvested in April, May and June to be the ones most difficult to protect biologically. Indeed he wondered if parasites did not "skip a generation" in the early part of the year ie. were inactive for a spell while L. huidobrensis continued to breed. Any change, from chemical to biological methods of control would probably be best done in the summer, when introduced parasites may well be supplemented by wild ones. Such a change in policy is however a matter that must be decided by Plant Health Division (PHD).

Neither organisations had much direct experience with or first hand knowledge of how growers were trying to control L. huidobrensis commercially. Van der Linden said he thought many lettuce growers used oxamyl granules at planting, followed by various sprays including pyrazophos (not very effective) and dichlorovs. Rates of the latter varied depending on the size of the plants.

Koppert believed that on tomatoes liquid oxamyl was added to the water used in NFT/rockwool production systems. This was compatible with biological control (of at least some pests including leaf miners). Where both insecticides and parasites were used it was difficult to know which was the more effective.

Western Flower Thrips

Developments in the control of western flower thrip - WFT (Franklinella occidentalis) were discussed with Pierre M J Ramakers, at Naaldwijk and with Dr Willem Ravensberg of Koppert BV.

WFT rather than the virus it transmits, tomato spotted wilt virus (TSWV) is still the more important problem in Holland as is the case in the UK, but Ramakers believes TSWV will become more serious.

Outbreaks on tomato have been confined almost entirely to crops where the plants were propagated near ornamental plants.

WFT causes serious and widespread damage on cucumbers in Holland now and growers often have to plant three instead of the normal two crops a year. Chemical control on the growing crop is limited, but strenuous efforts are made to eradicate the pest between crops.

Amblyseius is more effective on peppers than it is on cucumbers, as in the UK, but it is not always fully effective on long-season peppers. Mites going into diapause in short days, lack of pollen for them to feed on, low relative humidities and possibly low night temperatures (given to stimulate flowering) may all be contributory factors.

As in the UK there was much interest in Anthocorid bugs at both organisations. Ramakers had worked with a number of species, principally of Orius, and was now concentrating on a North America species O. insidiosus. Provided a critical evaluation was made, alien beneficial species could be imported and released in Holland (not possible in the UK under the Wildlife and Countryside Act). He hoped to find other species, or other populations of O. insidious from more southerly parts of the USA, that would be less likely to go into diapause in short days.

Ramakers had used constant numbers of O. insidiosus, but had varied the numbers (high, medium or low) of WFT in his trials on peppers and cucumbers. On peppers O. insidiosus had controlled both high and medium levels of WFT in one generation, although more damage occurred in the former: control was maintained for 3-4 months. It took two generations of O. insidiosus to control large numbers of WFT on cucumbers and even then control was not complete.

Ramakers fed O. insidious on eggs of a flour moth (Ephestia sp), and originally provided females with French bean pods on which to lay eggs. The petioles of rape plants appeared to be suitable, cheaper alternative to beans, but he was trying to develop a technique more

suited to mass production (and similar to one being developed at HRI). This consisted of two layers of Parafilm with water between them - an "artificial plant". Females would pierce the film and lay their eggs in the trapped water.

Koppert are most interested in Anthocorids. Their top priority is to select the right species. It needs to be effective, have no (or few) shortcomings, be capable of being mass-produced and ideally, be one that can be used in as many countries as possible. O. niger could be reared easily, but was never recovered from crops. O. majusculus was difficult to rear, at least initially. O. insidiosus (from the USA) was the easiest and quickest to rear and had been tested in later summer. Nymphs and young females did not establish, but eggs-laying females (introduced at a later date) did.

Bumble Bees to Improve Pollination in Tomatoes

On the final afternoon we met Koon Altona who is in charge of bumble bee production at Koppert BV. This is a rapidly -developing sides of their business. We were shown a demonstration hive with a clear top so the bees, brood and honey cells could all be seen.

Koppert recommend that hives are changed at regular intervals and told us what they recommend.

Rotation of hives

Weeks from first introduction	1	4	6	8
No. of new hives put in	5	2	3	2 and so on

Costs

Less than 6000 m^2 - 6p/m^2/30 days
More than 6000 m^2 - 5.5p/m^2/30 days

Flowers pollinated by bees normally show "bite" marks on the stamens but in the height of summer flowers develop (and age) so quickly the bites do not show up until flowers are almost dead. It is important therefore in the summer to look at older flowers when checking crops to see that pollination is occurring satisfactorily.

5. GENERAL REMARKS

1. The desirability of R & D on L. huidobrensis in Holland and the UK being complementary was agreed. Work on lettuce was probably necessary in both countries, but the Dutch do not intend to work on other crops such as spinach and radish that have been badly affected in the UK. Van der Linden intends to concentrate on the parasites available commercially, so the UK could usefully assess the potential of other agents (eg. Trichograma egg parasites and insect parasitic nematodes) (HRI initially).

   The value of large sticky traps and crop covers warrants investigation, but the Dutch do not plan to work on these aspects.

   Collaborative work to assess the side effects of pesticides on leaf miner parasites (and possibly other beneficials) was proposed (HRI).

2. It is not possible to do trials on the biological control of L. huidobrensis on commercial crops at present. The trials and studies suggested as suitable for funding by the HDC should however all provide important information needed if and when it becomes possible or desirable to control the pest this way.

3. The commercial development and exploitation of useful new parasites and predators is seriously curtailed by some of the provisions of the UK Wildlife and Countryside Act (and comparable legislation in other countries), because they restrict their introduction and release. An internationally-accepted code of practice, (that is currently being discussed by the IOBC, needs to be agreed as quickly as possible if the further development of integrated pest management (IPM) is not to be seriously restricted.

6. REPORTS AND PAPERS COLLECTED DURING THE VISIT

ANON (1990). Annual Report 1989 of the Glasshouse Crops Research Station, Naaldwijk, The Netherlands.

VAN DER LINDEN, A. (1988). Searching capacity and seasonal dependency of parasites of Liriomyza bryoniae Kalto and Liriomyza trifolli Burgess (Diptera: Agromyzidae). Mededelingen Faculteit Landbouwwetenschappen Rijksuniversiteit Gent, 53/3a, 1988: 955-960.

RAMAKERS, P.M.J. (1989). Simultaneous use of beneficial arthropods for biopollination in fruiting vegetables. Practical Application of Integrated Control in Protected Crops: Joint Experts' Meeting, Antibes, France 16-18 October, 1989 (Pre-publication copy)

RAMAKERS, P.M.J. (1990). Control of Western Flower Thrips, Franklinella occidentalis, with predators. 1 er Symposium Internacional sobre Franklinella occidentalis Perg. Organiza Phytoma-España, Valencia, abril de 1990. (Pre-publication copy).

ITINERARY

14 November	Gatwick to Rotterdam Airport
15 November	Discussion at Glasshouse Crops Research Station, Naaldwijk with Dr. Ir N A M van Steekelenburg, Anton van der Linden Marieke van der Staay Ir Pierre M J Ramakers
16 November	Discussions at Koppert BV, Berkel en Rodenrijs with Dr W J Ravensberg Ing P A Moerman Koon Altana
16 November	Rotterdam - Gatwick Airport

[Photocopies of the visiting cards of most of the people met during the tour appear in Appendix I.]

ACKNOWLEDGEMENTS

This overseas visit formed part of a larger project to study the biology and control of L. huidobrensus, sponsored by the HDC, to whom we are grateful.

We thank all the people we met on the tour for being so helpful. In particular we appreciated the frank and open way Anton van der Linden discussed the results of his most recent (unpublished) trials and his plans for future work.

We also thank Ing. P A 'Ed' Moerman of Koppert BW who organised accommodation and transport that made the visit more effective and so much easier and pleasanter.

APPENDIX I

VISITING CARDS OF PEOPLE MET DURING AN OVERSEAS VISIT TO HOLLAND BY M SAYNOR (ADAS) AND HELYER (HRI), SPONSORED BY THE HDC - 14-16 NOVEMBER, 1990.