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Integrated pest management (IPM) for lettuce — 12-month report to June 2003

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A report prepared for
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Copy 4 of 4

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Contents

1 Project background and introduction

The lettuce industry has initiated a project to develop and implement an integrated pest management (IPM) programme to control insect pests and plant diseases in lettuce to counter concerns about unsustainable crop protection practices and to control the new insect pest, lettuce aphid (LA) (*Nasonovia ribisnigri*).

The project team includes grower groups from the two major producing regions, Pukekohe and Gisborne, and other key industry partners. These parties are working with Crop & Food Research to develop environmentally compatible control strategies and best-grower practices for outdoor lettuce production. The goal is to maximise non-pesticide controls while maintaining the efficacy of available and new pesticides. Vegfed, the agrichemical industry and other industry partners are supporting this MAF Sustainable Farming Fund project.

The project work focuses on replicated field trials at Pukekohe Research Centre (PRC), regional surveys, field trials in commercial crops at LeaderBrand, Gisborne, field days at Pukekohe and the East Coast, and other field and laboratory studies in Canterbury and Auckland.

2 Changes to project

2.1 Tragic loss of colleague

On 6 June Richard Finch, Crop & Food Research business manager for this project, was killed in an aircraft accident along with six other key senior staff from Crop & Food Research. Their deaths are a huge loss to the institute and the scientific community in general. The project team's thoughts and best wishes go out to the family and friends of Richard and the other people killed in this tragic accident.

3 Progress highlights

Key findings for the year include:

- LA is now spread throughout New Zealand, south of Kaitaia.
- Lacewing larvae controlled LA populations in the spring/early summer trial at PRC.

- Foliar insecticides completely failed to control LA in the PRC field trials during the main summer period. Therefore, weekly applications of foliar insecticides are unlikely to provide sufficient control of *Nasonovia* over the summer period to produce saleable lettuces.
- Imidacloprid (Confidor®) gave effective control of LA in trials at PRC from late January onwards. Imidacloprid was applied as a drench to cell transplants immediately before planting (at the rate of 20 and 30 ml/1000 transplants).
- Western flower thrips (WFT), *Frankliniella occidentalis,* was found to be the predominant thrips species in the trials at PRC from early in the second trial period (late January). This is of major concern because WFT is a very effective vector or carrier of TSWV (tomato spotted wilt virus).
- In the early summer survey, 30-46% of lettuce plant specimens collected in Gisborne and Pukekohe had LBVV (lettuce big vein virus) with incidences in worst affected paddocks ranging from 20 to 30%. Incidences of LBVV were higher during summer at Pukekohe, with up to 50% recorded in some crops.
- A key to the identification of all aphids on lettuce in New Zealand has been completed and aphid identification workshops have been held in Pukekohe, Gisborne and Levin.

4 Progress by milestones

4.1 Planning

- The IPM team held its latest meeting at PRC on 30 May 2003, which was followed by a field day for growers and other industry personnel. At the team meeting, progress reports and details of Crop & Food Research project expenditure to the end of April were presented.

Outcomes and plans from that meeting include:

- A new Fruitfed Supplies employee will support the field trials at PRC next summer.
- The presence of LA in New Zealand and WFT in Australia (where it is a major pest of lettuce) provides an opportunity for collaborative work involving Vegfed and AUSVEG.
- The team will (again) approach Dow Agrosciences about them becoming involved in the project, with the increased likelihood that their selective insecticide, spinosad, may be an important control option for WFT and caterpillar pests in lettuce.
- Confidor trials should continue, with emphasis on summer registration trials at PRC, Gisborne, and the South Island, if practicable.
- Repeat the spring trial to further assess the effectiveness of lacewings for controlling LA populations.

- Larger untreated areas are required both at PRC and Gisborne to assess the impacts of natural enemies.
- Suction traps are required for both the Pukekohe and Gisborne regions for monitoring LA. This should be considered as a proposal to Vegfed, and could incorporate monitoring other major aphid pests, i.e. in potatoes.
- Unique laboratory bioassay techniques need to be developed for assessing imidacloprid.
- It would be useful to maintain the original "susceptible" laboratory colony of LA for future resistance bioassays.
- A grower field day will be held on the East Coast in June or July 2003, possibly presented by M Stufkens in place of G Walker, who is on annual leave in July.
- The next team meeting should be in November at PRC to discuss the results of winter disease trials and observe the lacewing spring trial.

4.2 Insect pest control

4.2.1 Insecticide efficacy testing

- Field trials in Canterbury to look at efficacy (kill) and persistence were completed using six foliar insecticides (sprayed on seedling transplants), including the two found to be partially resistant in earlier potter tower tests. Lannate and Orthene again did not give 100% kill, while the other four insecticides did achieve 100% kill. The effects of Orthene, Lannate and Pirimor lasted 1-2 days, Perfekthion and Diazinon 2.5 days, while the synthetic pyrethroid, Karate Zeon at 36 ml/ha, lasted for 4.4 days.
- Karate Zeon gave the best persistence (10 days) under natural re-infestation (no aphids added artificially).

4.2.2 Aphid flight patterns

- Lettuce aphid flights have been monitored and recorded from four suction traps in the Canterbury region and one trap in Hastings. This information is being collated to be placed on the internet site, www.aphidwatch.com.
- Wind vane trapping was discontinued early in 2003 because the wind vanes were not efficient for monitoring LA flights.
- LA has now been recovered from all monitored regions, and has been found as far north as Kaitaia.
- Sexual forms of LA have been found throughout the country.
- LA is found in large numbers on the flowers and buds of a number of common weeds, e.g. *Crepis* spp., *Hieracium* spp. and *Cichorium* sp., in the summer/autumn periods. Very few LA were found on the vegetative growth of these weeds.

4.2.3 *Population dynamics*

- The population dynamics of LA have been monitored weekly in the two summer trials at PRC and every two weeks in the autumn and winter trials. Data have been collated and are available in Excel spreadsheets from Crop & Food Research.

4.2.4 *IPM control options/field trials*

- Confidor (imidacloprid) was added to the summer insect trials at PRC at two rates to assess efficacy against LA and residues in the plants at different growth stages. The summer trials were expanded by 50% to accommodate two additional replicated treatments for the control of LA.

4.2.5 *First insecticide trial*

This trial was conducted at PRC and sampled from 22 October to 17 December 2002.

Summary of protocols:

- 4 treatments, 4 replicates, 300 plants per plot (2 beds of 4 rows x 15 m x 0.4 m spacing)
- Treatments – insecticides applied every 7 days
  - Control – no spray
  - Standard – standard Pukekohe practices
  - *Nasonovia* – target LA; systemic foliar sprays, etc.
  - Selective – use selective insecticides to maximise impact of natural enemies

The trial was sampled weekly using two methods:

1. Scouting – 12 plants per plot x 4 replicates x 4 treatments, counting and recording all insects
2. Destructive sampling – 8 plants per plot x 4 replicates x 4 treatments, counting all insects, collecting samples, identifying and rearing natural enemies (parasitoids and entomopathogenic fungi), and photographing all relevant insects and disease symptoms

Key findings:

- Crop scouting was a poor indicator of LA populations
- LA was the dominant aphid in the trial and was detected on the lettuce plants 7 days after planting.
- In the untreated control the mean number of LA peaked at 40 aphids per lettuce (3 Dec), but this decreased to a mean of 3 per plant at harvest assessment (17 Dec).
- The decline in the LA population in the control treatment was mainly due to predation by larvae of the brown lacewing (Micromus tasmaniae).

- In both the standard Pukekohe spray programme and the treatment aimed specifically at controlling LA (the *Nasonovia* treatment), the mean population peaked at about 5 aphids per lettuce. At harvest the mean number of aphids in the standard and *Nasonovia* treatment were 1.4 and 3.1 aphids per lettuce respectively.
- In the selective treatment where insecticides were selected to maximise the impact of natural enemies, the mean number of LA reached 16 aphids per lettuce. However, at harvest the mean population had decreased to 2.9 aphids per lettuce, probably due to predation by lacewings.
- Although the mean number of aphids at harvest was relatively low, about 50% of all the lettuces had aphids present in the control, selective and LA treatments. However, in the standard treatment only 22% of the lettuce heads were infested.
- At harvest there was no significant feeding damage caused by LA in any of the treatments, including the untreated control.
- NB: Results show that no insecticide treatments were necessary in this trial.

4.2.6 Second insecticide trial

This trial was conducted at PRC and sampled from 28 January to 18 March 2003.

The main trial was planted on 17 January and the additional imidacloprid-drenched plants were planted on 21 January.

Summary of protocols:

Foliar insecticide applications

- 4 treatments, 4 replicates, 300 plants per plot.
- Treatments – insecticides applied every 7 days
  - Control – no spray
  - Standard – standard Pukekohe practices
  - Nasonovia – target LA; systemic foliar sprays, etc.
  - Selective – use selective insecticides to maximise impact of natural enemies
- Weekly sampling – only destructive sampling was undertaken
- Destructive sampling – 8 plants per plot x 4 replicates x 4 treatments, counting all insects, collecting samples, identifying and rearing natural enemies (parasitoids and entomopathogenic fungi), and photographing all relevant insects

Imidacloprid (Confidor) Drench

- 2 treatments, 3 replicates, 144 plants per plot
- The lettuce seedlings were drenched with 2 rates of imidacloprid (10 and 20 ml/1000 plants) 24 hours before planting
- No foliar insecticides were applied to the imidacloprid treatments
- The control treatment plants were taken from the untreated plots of the foliar insecticide trial
- The sampling and scouting was identical to the foliar insecticide trial

Results:

Data have been collated and are being analysed by Crop & Food Research's statistician. Data and graphs from both insect trials are available from Crop & Food Research and were circulated as handouts at the field day on 30 May.

Foliar insecticide applications

- LA was the dominant aphid in the trial and was detected on the lettuce plants seven days after planting.
- None of the foliar insecticide treatments gave satisfactory control of LA.
- At harvest the mean number of aphids per lettuce was: control (885), standard treatment (697), *Nasonovia* treatment (250), and selective treatment (1720)
- All treatments had significant feeding damage and no treatment produced lettuces suitable for market.
- Although the brown lacewing (Micromus tasmaniae) was present, the numbers were lower than in the previous spring trial where it was a major factor in reducing aphid populations.
- Weekly applications of foliar pesticide are unlikely to provide sufficient control of *Nasonovia* over the summer period to produce saleable lettuces.

Imidacloprid drench

- Both imidacloprid drench treatments reduced *Nasonovia* numbers compared to the untreated control over the 7 week trial period.
- The mean number of aphids per lettuce at harvest was higher for the 10 ml rate of imidacloprid (11.3) than for the 20 ml rate (3.0). However, the mean number of aphids per lettuce for both rates of imidacloprid was much lower than found in the control (807).
- The lower rate of imidacloprid also had a higher proportion of the population as wingless aphids (88.9%) compared to the higher rate (47.9%), indicating a higher rate of reproduction on the lettuces that received the lower drench rate.

- Imidacloprid drenches offer lettuce growers a successful control strategy for LA over the summer and early autumn period where there is greatest immigration pressure.
- Alternative control measures to imidacloprid may need to be developed for other periods of the year to prevent over use and the development of resistance.
- Bayer collected lettuce samples during this trial for residue analysis.
- WFT was found to be the predominant thrips species. Also present were onion thrips (Thrips tabaci) and European flower thrips (EFT), Frankliniella intonsa.
- Although there was early thrips damage to small plants, there were no losses due to thrips damage or TSWV at harvest.

4.2.7 Third insect trial

- An extra insect trial was undertaken in autumn as a companion to the first plant disease trial.
- There were three replicated treatments, untreated, 20 and 30 ml of imidacloprid as a drench pre-transplanting.
- Assessments are being made every two weeks by destructive sampling.

Results to mid June:

- Both the 20 and 30 ml treatments were giving good control of LA populations up to mid June.
- Populations of LA in the untreated plants were reaching about 100 per plant.
- Lacewings were present in this trial but numbers were probably too low for good control of LA.
- WFT was the dominant thrips species present in this trial.
- Harvest assessment will be in late June.

4.2.8 Fourth insect trial (planted early June)

- Another extra insect trial was planted in winter to run alongside the second plant disease trial.
- The trial consists of untreated plots, and the main disease trial treated with 30 ml of imidacloprid.
- First assessment of this trial was in mid June. Assessments will be made every two weeks by destructive sampling.

NB: summary graphs (weekly means) and summarised data of all trials are available in Excel files from Crop & Food Research

NB: summary of biological control agents sampled, reared and identified from PRC trials is in Section 4.7 (see below)

4.2.9 *Other insect work*

- Key to identification of all aphids on lettuce in New Zealand completed.
- Aphid identification workshops held in Pukekohe, Gisborne and Levin (39, 7 and 20 attended respectively).

4.3 *Plant disease control*

- Autumn and winter field trials at PRC are underway.
- Trial 1 is a Sclerotinia and Botrytis trial with 10 treatments, including treating with 3 biological control agents.
- Trial 2 is a downy mildew, ringspot and bacterial diseases trial with 12 treatments.
- Both trials will initially focus mainly on foliar chemical control options. Future trials will incorporate application technology, timing, adjuvants, and study the use of resistant cultivars and biological controls.

4.4 *Virus diseases*

- In an early summer survey, 30-46% of lettuce plant specimens collected in Gisborne and Pukekohe had LBVV (lettuce big vein virus) with incidences in worst affected paddocks ranging from 20 to 30%
- There were scattered incidences of the potyviruses LMV (lettuce mosaic virus), TuMV (turnip mosaic virus) and CMV (cucumber mosaic virus).
- A presentation on control of LBVV was made at the field day at PRC on 30 May.
- An early winter virus survey at Pukekohe was completed. Incidences of LBVV were higher than in summer with up to 50% recorded in some crops.
- Further interim observations indicate that viruses such as CMV, BWYV, and LMV are also present, usually as mixed infections.
- A survey of Gisborne crops will be completed by early July.

4.5 *Pesticide resistance management*

- Concerns about pesticide resistance are due to the lack of non-pesticide control options and also a lack of a range of foliar insecticides that can be rotated as a resistance management strategy.
- The project team is working with the agrichemical industry to aid in the registration of new chemistries, in particular the use of imidacloprid for the control of LA.
- Other insecticides for which registration is encouraged are pymetrozine for aphid control and indoxacarb for WFT and caterpillar control (larvae of loopers and tomato fruitworm).

4.6 Looper monitoring

- Large numbers of looper eggs were recorded in the summer trials but did not produce large larval infestations. This was probably due to the persistent use of broad-spectrum insecticides in most of our treatments during this period.
- Larval infestations of looper larvae increased in late summer and autumn but did not require control.
- Only *Thysanoplusia orichalcea* (soybean looper) was recovered from lettuces at Pukekohe.
- Specimens of green looper (*Chrysodeixis eriosoma*) were not recovered from lettuce this season.
- Natural enemies, both parasitic hymenoptera and entomopathogenic fungi, were found to be infecting looper caterpillars in adjacent crops, but no natural enemies were reared from loopers collected from lettuce, apart from two cocoon masses of *Cotesia ruficrus*.
- An important pheromone component for use in monitoring *T. orichalcea* moth flights has been ordered, is being synthesised in France and delivery is expected in August, in time for field trials to be set up in spring.

4.7 Biological control

- Aphid and other general predators were present in the summer trial but they had little impact on populations of LA. These general predators may have controlled other minor pest species.
- Small numbers (four) of mummified aphids of LA were recovered in this period, and all produced adult aphidiid parasitoids provisionally identified as *Aphidius* sp., near ervi. This is a new host association for New Zealand but indications are that this parasitoid is unlikely to be a key natural enemy of LA.
- A naturally occurring entomopathogenic fungus now identified as *Erynia* sp. was isolated from 'diseased' LA from the summer lettuce trial at PRC. Although, large numbers of LA were found to be dead inside lettuce plants during trial assessments, the *Erynia* infected aphids did not produce an epizootic. This event normally occurs when a naturally occurring fungus disease is associated with warm, moist conditions and large host populations.
- In June, infections of LA by *Erynia* sp. became common.

4.8 Technology transfer and IPM manual

- Dr Peter Cameron joined the IPM team, under contract to aid in the development of the information guide in years 1-3.
- Dr Cameron has produced a draft pest and disease list and a preliminary literature review.

- An identification key for aphids on lettuce in New Zealand has been completed and three workshops held in Pukekohe, Gisborne and Levin.
- A scientific paper on spread and distribution of LA in New Zealand has been accepted for the refereed journal, *New Zealand Plant Protection*.
- *New Zealand Plant Protection* has also accepted a poster abstract introducing the project.
- This poster will also be presented at the Vegfed conference in July in Auckland.
- Two grower articles are being prepared, to be submitted for publication in *Grower* in July or August.
- Collections, identifications and taking of photographs of all relevant insects, damage, disease symptoms and other findings in the PRC lettuce trials are continuing. Images have so far been recorded on four CDs and a master slide collection is underway. Together, these will be key resources for the information guide and IPM manual.
- Grower field day held at Pukekohe Research Centre on 30 May attended by 38 persons.

IPM team meeting

The IPM team met after the field on 30 May 2003. A summary of the outcomes from the meeting are:

- Peter Cameron has signed the contract to support the production of an information guide,
- he has presented a preliminary pest and disease list and a preliminary literature review,
- it was considered more appropriate to develop an 'information manual' rather than a 'training manual' in years 1-3,
- content options for the information manual were presented by Peter Cameron and discussed. The proposed contents follow a similar format to the early version of the vegetable brassica IPM manual developed by Peter Cameron and Crop & Food Research.

The information manual should include the following sections:

- identify pests and diseases,
- efficiently monitor crops,
- assess natural enemy populations,
- make control recommendations,
- communicate information,
- select appropriate pesticides,
- apply pesticides with good timing.

Other suggestions for the manual were:

- a folder format is preferred,
- the manual should not include current agronomic practices or economics,
- included in the identification section for pest and diseases should be: life cycles, seasonality, descriptions, photos, damage, and a basic key,
- supporting literature and web sites should be included,
- no application or GROWSAFE details should be included.