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Implementation phase for integrated pest and disease management (IPM) for outdoor head lettuce

Final report

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Final Report to MAF Sustainable Farming Fund and Horticulture NZ

Project name: Implementation phase of the integrated pest and disease management (IPM) for outdoor lettuce project

Project number: 05/059

Applicant Group: Fresh Vegetable Sector Leafy Crops Product Group of Horticulture NZ

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1 Project objectives

The Leafy Crops Product group (Fresh Vegetable Sector of Horticulture NZ) initiated a two-year implementation phase to transfer technology developed from the previous “IPM for Outdoor Lettuce” SFF project (grant number 02/27) to growers and crop scouts/consultants in 2005. The project team included key growers and industry personnel from the major lettuce-producing regions, Pukekohe, Gisborne and Horowhenua. Horticulture New Zealand, the agrichemical industry and other industry partners supported this MAF Sustainable Farming Fund project.

The project work focused on crop scout training for different regions, replicated field trials at Pukekohe Research Centre (PRC), demonstration trials in commercial crops at Horowhenua and Canterbury, continued monitoring of small insect pests, development of action thresholds for the major insect pests (particularly caterpillar pests), dissemination of results through various publications and presentations, and producing a final version of the IPM manual/guide.

2 Outline of methodology and outcomes

Best pest and disease management practices identified during the development phase of this project (2002–05) were documented in an IPM guide/manual to provide standards for the outdoor lettuce-growing industry of New Zealand. The final version was based on the draft scout training guide produced in January 2006. Research into areas where there were significant knowledge gaps was continued, particularly investigations into better controls for caterpillar pests, improving spray technology for plant diseases and timing of various controls for Sclerotinia rot.

Work fell into 3 main areas: 1) Refinement and validation of IPM strategies, 2) documentation, and 3) dissemination and evaluation.

Milestones are listed below (as per schedule of the project contract) with a summary of outcomes for each milestone:

Milestone 1:

Finish 90% of Chapters 1–9 in IPM manual (June 2006). Finish Chapters 1–10 and available information for the Appendix (December 2006). Complete editorial and formatting work for submission to publishers (June 2007).

Outcomes:

- Final version of IPM guide submitted to Horticulture NZ on 31 August 2007. Delay mainly due to RSI injury to senior author. We would like to acknowledge the tremendous contribution made by Peter Cameron to the production of the IPM guide.

Milestone 2:

Regional seminars to introduce the components of the IPM programme and publicise the IPM manual.

Outcomes:

- Seminars held in Pukekohe, including seminars given at the Vegetable Technical Conference, Pukekohe, March 2006.

- It is recommended that seminars in other regions are synchronised with the distribution of the final format of the IPM guide.

Milestone 3:

Develop training package (December 2005). Undertake training workshops & one-on-one training for crop scouts in Pukekohe (2006) and Horowhenua (2007) regions.

Outcomes:

- The training package was developed including production of 50 copies of a draft information guide for training crop scouts. Three training workshops were held at Pukekohe in 2006 attended by 20 scouts. Two scouts paid for full training (\$2K) (1 at Pukekohe and 1 from Otaki), with 18 trainees paying \$1K each. Prospective scout trainees in other regions (two from each of Gisborne, Horowhenua and Canterbury) paid to attend the training in year 1, rather than waiting a year.
- Consequently, numbers of scouts that paid for training in year 2 were much reduced; only two employees of LeaderBrand Produce paid to be trained. Therefore, training was transferred to their base in Gisborne in year 2. Scout training in year two commenced in June 2007. Further workshops have been postponed under agreement with LeaderBrand until the spring and summer of 2008 to coincide with suitable pest infestations for practical training.

Milestone 4:

Demonstration sites and regional validation trials for insect pest controls in Pukekohe, East Coast, Horowhenua and Canterbury.

Outcomes:

- Demonstration sites were set up in three regions, Pukekohe, Otaki and Canterbury. Demonstration sites were not required in Gisborne.
- Three commercial crops were set up in Pukekohe in spring with large areas planted with no Confidor treatment. These crops were assessed regularly and results showed complete control of lettuce aphid by predators, and effective control of all other pests, apart from minor problems with slugs at crop edges.
- Three small trials were undertaken in the Levin/Otaki region in each of both years, with small plantings of lettuce without Confidor treatment. At four of six sites lettuce aphid was controlled by predators. However, in

each year, 1 crop was infested at harvest. This was probably because in year one the crop was planted too early (late winter) and in year two the crop was planted too late for predator populations to establish. We consider there is excellent potential for a Confidor-free period in spring cropping in Horowhenua, with large populations of the key predator, brown lacewing, present during this period.

- Field trials were conducted at three Canterbury sites in 2005–07 to determine if the standard application rate of Confidor (25 ml/2.5 L water/1000 plants) controlled lettuce aphid populations throughout the growing season. Confidor significantly lowered aphid populations in the outer, wrapper and heart leaves compared to control plants at all times. However, during mid summer natural enemies, such as the brown lacewing (*Micromus tasmaniae*), 11-spotted ladybird beetle (*Coccinella undecimpunctata*) and small hoverfly larvae (*Melanostoma fasciatum*) were sufficient to control lettuce aphids without the need for insecticides. Drenches appear to be required in early spring and late summer to maintain very low levels of lettuce aphid during these periods.
- Overall, we have shown that commercial crops may be grown in spring at Pukekohe without any insecticidal treatments. Also, there is good potential for Confidor-free periods in spring in Gisborne and Horowhenua regions, and in spring (earlier results) and summer periods in Canterbury.

Milestone 5:

Continuous monitoring of aphid and thrips species using suction traps and regular crop monitoring in different regions. Identification and regular updates on website www.aphidwatch.com.

Outcomes:

- Monitoring flights of small insects using suction traps continued at Lincoln, Hastings and Pukekohe sites.
- Monitoring and identification of lettuce aphid continued until June 2007. Results were uploaded onto the aphidwatch website.
- A PhD student at Adelaide University is being supplied with the New Zealand project data on captures of lettuce aphid as part of his biosecurity studies on modelling the movement of aphids.

Milestone 6:

Research trials for validating monitoring (pheromone trapping and crop sampling) and testing best option control systems (action thresholds) for looper caterpillars. Appropriate controls published in IPM manual and NZ Grower.

Outcomes:

- Trials were completed to assess the efficacy of pheromone trapping for male and female moths of soybean looper and their role as monitoring tools for leafy vegetables, both lettuce and brassica crops. A manuscript was submitted and an oral presentation made at an international conference in Beijing (see publications).
- Results show that the male lure and moth trapping apparatus (Scentry traps used overseas for monitoring *Heliothis*) are powerful tools for monitoring soybean looper moths. Peak catches in late spring or early summer (emergence of the second generation of moths) can forecast pest caterpillar infestations.
- Summer trials were undertaken in 2006 and 2007 to assess action thresholds for caterpillar infestations, and also to assess the efficacy of different insecticidal treatments. An action threshold of 0.5 larvae (≥ 10 mm long) was used to decide when a foliar application of a larvicide should be applied. This resulted in a very high proportion of acceptable produce when indoxacarb (Steward®), registered for use on lettuces, and a new insecticide from Du Pont (Coragen®) were used (Steward in both years, Coragen only in 2007). Caterpillar pest pressure was very high in all trials, yet no more than two applications were required when scouting weekly and when using this threshold.
- Other data showed that the new insecticide, Coragen, was particularly IPM-compatible, with populations of predators in this treatment equivalent to populations of natural enemies in the untreated control plots throughout the trial period.

- Du Pont plans to register Coragen for use on lettuce in New Zealand in 2008. Along with Steward, it will result in two IPM-compatible options being available for caterpillar control.
- The crop monitoring systems and action threshold are to be published in the IPM guide and a Grower article (in preparation, see publications).

Milestone 7:

Compilation, analysis and writing up of results from research trials to validate crop scouting and sampling systems, use of action thresholds, decision-making, recording and recommendation systems in management of insect pests (December 2006). Publication in scientific journals and incorporation in IPM manual (June 2007).

Outcomes:

- Crop scouting systems and action thresholds for all the major insect pests are described in the IPM guide and will be detailed in Grower articles that are in preparation (see publications).
- Various other publications are being prepared or are published (see Section 4).

Milestone 8:

Continue to investigate impacts of selective insecticides on natural enemies. Report results in NZ Grower.

Outcomes:

- Laboratory studies have continued on the impact of 'selective' insecticides on natural enemies. Crop & Food Research and FRST funding supported a PhD student (Gabriela Lankin-Vega) to study the impacts of insect predators on various insect pests.
- Major studies were also completed on the indirect, non-target impacts of the three key aphicides (insecticides that target aphid species) on brown lacewing (*Micromus tasmaniae*) populations feeding on lettuce aphid, *Nasonovia ribisnigri*. Data have been analysed and outputs produced – a scientific paper published and a conference presentation in Adelaide (see Section 4).

- Our results suggest that when all three insecticides are applied at approximate recommended field rates to lettuce crops they will have varying indirect non-target effects on *M. tasmaniae* larval predator populations. After three days pirimicarb, pymetrozine and imidacloprid caused 40, 17 and 100% mortality of *M. tasmaniae* larvae respectively.
- Pymetrozine showed the least harmful effects on *M. tasmaniae* larvae, was the most selective of the three insecticides tested, and is the preferred choice to incorporate as a foliar-applied insecticide into an IPM program for lettuce.
- Pymetrozine could be incorporated without major disruption to biological control by *M. tasmaniae* populations, and could reduce build-up of aphid populations, which should lead to further reductions in applications of insecticides to control aphid pests in lettuce.
- More research on the three insecticides tested in this study is required to further understand their impacts on *M. tasmaniae* and other natural enemies in order to maximise their potential as compatible tools for sustainable pest management in lettuce and other crops.
- Grower article in preparation (see publications).

Milestone 9:

Regional validation trials (winter, autumn) for plant disease controls in Pukekohe, Gisborne and Horowhenua.

Outcomes:

- Grower trials carried out at Gisborne and Pukekohe comparing standard and 'IPM-friendly' control measures for *Sclerotinia* lettuce drop demonstrated that 'IPM-friendly' methods (e.g. no procymidone at planting and post-planting, *Trichoderma* in cell transplants, and carbendazim later in season in response to disease outbreaks) provided control of drop as good as standard control methods (e.g. procymidone or carbendazim at planting, and carbendazim 1-3 weeks after planting).
- Field experiments to evaluate the efficacy of several fungicides for control of downy mildew of lettuce were carried out in 2003–07. Based on the results of these experiments, fosetyl-aluminium, metalaxyl plus mancozeb, and

azoxystrobin show promise for control of lettuce downy mildew in New Zealand.

- Results of these trials were published in the NZ Plant Protection Conference proceedings in 2007.

Milestone 10:

Cultivar screening trials for tolerance to Lettuce Big Vein Virus disease. Results published in IPM manual and NZ Grower.

Outcomes:

- A cultivar trial was completed and results have been published in the quarterly report and summary sent to the international vegetable virus working group (IVVWG).
- In this autumn-sown trial none of the trialled cultivars performed as well as those currently sown in winter, i.e. Winguard and Wintergreen. Further work should be done to see if Vegas might be useful sown in spring or summer.
- Further trials are also desirable using some of the newer cultivars to determine their response under our winter growing conditions.
- Latest results published in the IPM guide and a Grower article in preparation.

Milestone 11:

Completion of database of cultivar pest and disease resistance/tolerance attributes. Results published in IPM manual.

Outcomes:

- After consultation with seed suppliers, the original draft database was modified to reflect the new and superseded cultivars and their various disease and pest-resistant characteristics. Latest information published in the IPM guide.
- This database should be updated annually to reflect changes in available cultivars. It would be useful for Horticulture NZ or its representatives to receive updated information and modify the list on behalf of the growers.

Milestone 12:

Research trials at Pukekohe to investigate effects of spray technology and adjuvants for control of downy mildew and other foliar diseases (September 2006). Results published in IPM manual as appropriate and NZ Grower (June 2007).

Outcomes:

- Methods of fungicide spray application were evaluated for their effects on spray coverage on lettuce and control of downy mildew in lettuce in field experiments carried out at Pukekohe in 2005 and 2006. Downy mildew infection rates were significantly affected by spray application water rates with disease incidence lower at 500 L/ha. Spray nozzle type also affected the incidence of downy mildew. Water rate, adjuvant and nozzle type all affected spray coverage on lettuce foliage. Results of these trials were published in the Australasian Plant Pathology Conference Proceedings in 2007.
- Results published in the IPM guide and Grower article in preparation.

Milestone 13:

Trials at Pukekohe on timing of biocontrols, chemicals, and agronomic methods for control of Sclerotinia rot. Appropriate results published in the IPM manual and NZ Grower.

Outcomes:

- Field experiments investigated the efficacy of several fungicides, calcium cyanamide, hydrated lime, and *Trichoderma* on Sclerotinia rot. Effects of treatments on the viability of sclerotia in the soil and the incidence of Sclerotinia rot varied considerably. *Trichoderma* reduced the numbers of viable sclerotia more than any other treatment. Calcium cyanamide, procymidone, carbendazim, Boscalid and Pristine gave best control of Sclerotinia rot. Results of these trials were published in the Australasian Plant Pathology Conference proceedings in 2005 and 2007.
- Results published in the IPM guide and Grower article in preparation.

Milestone 14:

Survey growers to record pesticide use pre- and post-arrival of lettuce aphid to document uptake of IPM strategies and reduction of broad-spectrum insecticides. Report in NZ Grower.

Outcomes:

- A phone survey was undertaken in July. We were only able to obtain survey participants using Crop & Food Research contacts. Therefore, this initial survey would be biased towards growers with some knowledge of the SFF/Hort NZ lettuce projects. Information gained will be reported in the Grower.
- Twenty-three growers were contacted and 12 completed the questionnaire (19 questions). Their responses to key questions are listed below.
 - Are your lettuce crops being scouted for pests and diseases? 10/12 (yes)
 - Are you aware of insect pest management guidelines that take into account the numbers of insects in the crops? 6/12
 - Comparing insecticide use before and after the arrival of lettuce aphid, do you spray more or less foliar insecticides now than before lettuce aphid arrived? 8/12 (less foliar insecticides, 3 answering “no change”)
 - Do you spray more or less broad-spectrum insecticides now than before lettuce aphid arrived? 10/12 (less broad-spectrum insecticides, 2 answered “no change”)

3 Extension activities

See milestones 1, 2, 3, 4, and 9 (above) plus Section 4.

For crop scout training workshops see outcomes in milestone 3.

Also:

March 2006: Presentations by Peter Wright and Graham Walker at grower meetings (Hort NZ Brassica and Leafy crops group), 1 March 2006, Lincoln.

March 2006: Presentation by Graham Walker on IPM at Vegetable Technical Conference 2006, 14–16 March 2006, Pukekohe.

February 2007: Graham Walker and Peter Wright updated growers and Horticulture NZ regional representatives on the SFF IPM projects; 19 February 2007, Pukekohe.

4 Outputs resulting from the project

This includes publications produced from co-funding including, in particular, the FRST programme: Insecticide Risk Reduction in Horticulture (contract no. C06X0301).

Anon. (2006). Saving our salad. Estimating the economic contribution of biotechnology to New Zealands Primary Sector. MORST.

Cameron P, Walker G, Workman P, Wright P, Fletcher J, Stufkens M, Curtis C
Integrated pest management in lettuce; a draft information guide for outdoor head lettuce. New Zealand Institute for Crop & Food Research Limited. January 2006. 131 pages, plus 6 additional resources and 10 appendices.

Cameron PJ, Fletcher JD 2005. Green peach aphid resistance management strategy. In: Pesticide resistance: prevention & management strategies. Martin NA, Beresford RM, Harrington KC ed. Hastings, New Z. New Zealand Plant Protection Society, 2005: 109–114.

Cameron PJ, Walker GP 2005. Tomato fruitworm resistance management and prevention strategy. In: Pesticide resistance: prevention & management strategies 2005. Martin NA, Beresford RM, Harrington KC Ed. Hastings, New Zealand. New Zealand Plant Protection Society, 2005: 55–60.

Curtis C L, Hedderley DI Development of the Tasmanian brown lacewing, *Micromus tasmaniae* reared on the currant-lettuce aphid, *Nasonovia ribisnigri*. In prep.

Fletcher JD, Butler RC, et al. 2005. Lettuce viruses and management of lettuce big-vein disease in New Zealand. 15th Australasian Plant Pathology Society Conference, 26–29 September. Geelong, Victoria.

Fletcher JD, Butler RC, France CM 2005. Virus surveys of lettuce crops and management of lettuce big-vein disease in New Zealand. New Zealand Plant Protection 58: 239–244.

Fletcher JD 2006. Lettuce big-vein disease lettuce cultivar Trial, 2006. Report to international vegetable virus working group (IVVWG).

- Fletcher JD Control of Lettuce big-vein disease in outdoor lettuce. Grower. In prep.
- Martin NA 2005. Thrips insecticide resistance management and prevention strategy. In: Pesticide resistance: prevention & management strategies. Martin NA, Beresford RM, Harrington KC ed. Hastings, New Zealand. New Zealand Plant Protection Society, 2005: 78–89.
- Pearson MN, Clover GRG, Guy PL, Fletcher JD, Beever REB 2006. A review of the plant virus, viroid and mollicute records for New Zealand. Australasian Plant Pathology 35: 217–252.
- Stufkens MAW, Walker GP, Martin NA Lettuce aphid resistance management and prevention strategy. In: Pesticide resistance: prevention & management strategies 2005. Martin NA, Beresford RM, Harrington KC ed. Hastings, New Zealand. New Zealand Plant Protection Society: 115–119.
- Walker G, Cameron P, Workman P, Wright P, Fletcher J, Stufkens M 2007. Information guide for IPM in outdoor lettuce. Auckland, New Zealand Institute for Crop & Food Research Limited. 141 p.
- Walker G IPM for control of caterpillar pests in outdoor lettuce. Grower. In prep.
- Walker G, Workman P, et al. 2005. Integrated pest and disease management (IPM) for outdoor lettuce – final report. Crop & Food Research Confidential Report No. 1467. Auckland, New Zealand Institute for Crop & Food Research Limited. 49 p.
- Walker GP, et al. 2005. Implementation phase of IPM for outdoor lettuce – progress report. Crop & Food Research Confidential Report No. 1511. Auckland, New Zealand Institute for Crop & Food Research Limited.
- Walker GP, et al. 2006. Implementation phase of IPM for outdoor lettuce – progress report. Crop & Food Research Confidential Report No. 1550. Auckland, New Zealand Institute for Crop & Food Research Limited.

Walker GP, et al. 2006. Implementation phase of IPM for outdoor lettuce – Progress report. Crop & Food Research Confidential Report No. 1597. Auckland, New Zealand Institute for Crop & Food Research Limited.

Walker GP, et al. 2006. Implementation phase of IPM for outdoor lettuce – progress report. Crop & Food Research Confidential Report No. 1678. Auckland, New Zealand Institute for Crop & Food Research Limited.

Walker GP, et al. 2006. Implementation phase of IPM for outdoor lettuce – progress report. Crop & Food Research Confidential Report No. 1774. Auckland, New Zealand Institute for Crop & Food Research Limited.

Walker GP, et al. 2007. Implementation phase of IPM for outdoor lettuce – progress report for period from Nov. 2006 to Feb. 2007. Crop & Food Research Confidential Report, Auckland, New Zealand Institute for Crop & Food Research Limited.

Walker GP 2006. IPM for insect pests in outdoor lettuce in New Zealand. Abstract and oral presentation. ANZES Conference, 24–27 September. University of Adelaide, South Australia.

Walker GP, Clearwater JR, et al. 2006. Monitoring of *Thysanoplusia orichalcea* in New Zealand. Oral presentation and manuscript. 5th International workshop on the management of diamondback moth and other crucifer pests. 24–27 October 2006. Beijing, China. In press.

Walker MK, Stufkens MAW, et al. 2006. Indirect non-target effects of aphicides on Tasmanian brown lacewing (*Micromus tasmaniae*) – impacts on IPM. Abstract and oral presentation. ANZES (Australian and New Zealand Entomological Societies) Conference, 24–27 September. University of Adelaide, South Australia.

Walker MK, Stufkens MAW, Wallace AR 2007. Indirect non-target effects of insecticides on Tasmanian brown lacewing (*Micromus tasmaniae*) from feeding on lettuce aphid (*Nasonovia ribisnigri*). *Biological Control* 43: 31–40.

Workman PJ, Walker GP, Winkler S 2007. Incidence and control of thrips on outdoor lettuce at Pukekohe. *New Zealand Plant Protection* 60: 42–49.

Workman P, Walker G, Walker M IPM tools available for control of lettuce aphid. *Grower*. In prep.

Wright PJ 2005. Control of *Sclerotinia* leaf drop of lettuce. 15th Biennial Australasian Plant Pathology Society Conference, 26–29 September. Geelong, Victoria.

Wright PJ 2006. *Sclerotinia* in lettuce. Oral presentation. Vegetable Technical Conference: 14–16 March, Pukekohe. Pukekohe Grower Supplies Ltd.

Wright PJ 2007. Control of *Sclerotinia* leaf drop of lettuce. Poster for the Australasian Plant Pathology Society Conference, Adelaide, September 2007.

Wright PJ 2007. Differential activity of fungicides on germination of sclerotia and mycelial growth of *Sclerotinia minor* and *S. sclerotiorum*. *New Zealand Journal of Crop & Horticultural Science*. Submitted.

Wright PJ 2007. Effects of spray technology and adjuvants for control of downy mildew of lettuce. Poster at the Australasian Plant Pathology Society Conference, Adelaide, September 2007.

Wright PJ 2007. Evaluation of fungicides for control of downy mildew of lettuce. *New Zealand Plant Protection* 60: 307.

Wright P IPM tools for plant diseases in outdoor lettuce. *Grower*. In prep.

5 Future plans

- Horticulture NZ is producing a CD Rom of the information guide and production of 'ute guides' is planned. A number of publications are in preparation, including various articles for the *Grower* (see milestones above for details).
- Crop scout training in Gisborne will be completed in the spring and summer of 2008 to coincide with suitable pest infestations for practical training purposes.

- Future work also includes research funded by FRST in the programme 'Insecticide Risk Reduction in Horticulture' (contract no. C06X0301), including an objective that focuses on the tri-trophic interactions between lettuce cultivars, pests and their natural enemies. This FRST programme finishes in June 2008 but is under renegotiation.
- Future work should include further cultivar screening trials for tolerance to Lettuce Big Vein Virus disease.
- The database of cultivar pest and disease resistance/tolerance attributes should be updated annually to reflect changes in cultivars available.
- The development of effective IPM programmes is an ongoing process. Of particular concern at present are problems with: 1) industry reliance on imidacloprid for control of lettuce aphid – overuse of this product may lead to resistance; 2) any increase in the incidence of Tomato Spotted Wilt Virus would be a major problem for the lettuce industry;, and 3) the level of uptake of IPM technology.
- Further IPM tools need to be developed and tech transfer systems need to be continuously available to encourage maximum uptake of IPM strategies for sustainable control of pests in lettuce.

6 Financial statement

Period	Date	Amount	Balance	Running total
1 Jul-Sep 05	31/01/2006	\$73,756.35	-\$73,756.35	
2 Oct-Dec 05	31/01/2006	\$73,648.67	\$147,405.02	-
3 Jan-Mar 06	18/04/2006	\$88,107.60	\$235,512.62	-
4 Apr-Jun 06	26/07/2006	\$34,712.56	\$270,225.18	-
Implementation			\$236,841.75	
5 Jul-Oct06	16/11/2006	\$84,162.49	\$152,679.26	\$84,162.49
6 - Nov06- Feb07	27/03/2007	\$57,323.91	\$95,355.35	\$141,486.40
7 - march-Jun 07	1/08/2007	\$59,629.50	\$35,725.85	\$201,115.90
8 - Jul-Sep	Sep-07	\$15,000.00	\$20,725.85	\$216,115.90

7 Information dissemination

See Sections 3 and 4. Also, final version of the IPM guide (2007) was submitted to Horticulture NZ on 31 August 2007.