Final Report for Tasmanian component of project VG05044

Project Title: **Further developing integrated pest management for lettuce – Tasmanian commercial trials.**

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Research Providers:

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VG05044 in part

Project Leaders – Tasmanian component

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Purpose:

To build upon a successful demonstration of IPM in iceberg lettuce at Devonport in 2004-5 (VG04067) by growing pilot crops of both iceberg and loose-leaf cultivars on major commercial farms.

Funding:

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Executive Summary

1. In 2004-5 *Nasonovia*-susceptible iceberg lettuce were grown to commercial standards near Devonport in northern Tasmania without the use of imidacloprid (Confidor®) seedling drenches (Project VG04067).
2. The exposure of that success to industry maintained support for continued IPM development in lettuce (initially driven by caterpillar management) despite the appearance of a new pest, the currant lettuce aphid.
3. That success did not lead to the immediate, widespread adoption of IPM in Tasmanian or mainland iceberg lettuce but IPM was successfully maintained and adapted by several Victorian growers in 2005-6.
4. The success did not convince southern Tasmanian growers that IPM would cope with viral diseases transmitted by thrips (not usually an issue for northern Tasmanian lettuce crops) or with loose-leaf cultivars.
5. The current project tested IPM in southern Tasmanians crops of both iceberg and loose-leaf lettuce on the farms of two of the three major growers in the state.
6. Good results were obtained in southern iceberg lettuce although intolerable aphid infestation developed in waterlogged sections of the commercial crops such that these sections were bypassed at commercial harvest.
7. Poor results were obtained in the loose-leaf crops attributable in part to these crops being 60% faster than iceberg crops. Predatory insects have less time to follow and overwhelm mobile aphids. There is less room for error in spacing and timing sequential plantings once supplementary sources of predators in the hinterland dry off. Planting intervals in the current trial were 2-4 weeks whereas one week is not only optimal but closer to commercial practice.
8. IPM for iceberg lettuce has now been proven in several Tasmanian and Victorian commercial crops and could be recommended provided experienced IPM advisors supervise it.
9. The introduction of bagging iceberg lettuce is distracting from the adoption of IPM in Tasmania.
10. Iceberg growers still prefer a strategy based on resistant cultivars but fear that cool season temperate cultivars will be overlooked by commercial breeders.
11. IPM for loose-leaf lettuce requires more empirical development. Provision of nursery vegetation for beneficial insects is impeded by

shortages of land in winter and complexities of weed and irrigation management. However, shorter (weekly) planting intervals are not only closer to commercial practice but also favoured by IPM theory.

12. Loose-leaf growers still prefer a strategy based on resistant cultivars but require cultivars with broad seasonal performance to reduce the necessity for relabelling packages whenever cultivars change.

13. Although a thrips-transmitted virus (TSWV) was feared as the major challenge to IPM in southern Tasmanian lettuce the greater challenge may be short crop duration. Also, growers still doubt whether the thrips/virus issue was addressed because they believe virus pressure was low in 2005-6.

14. Currant lettuce aphid may be at an advantage over beneficial insects in cool temperate autumn conditions so that professional advice should be taken when extending IPM into autumn and winter.

Media Summary

The pest, currant lettuce aphid caused concern on its arrival in Australia in 2004 because it cannot be controlled by conventional, foliar sprays. In a Horticulture Australia project in 2004-5 it was controlled in Tasmanian lettuce crops by farmland predatory insects. The beneficial insects were harnessed by the grower using Integrated Pest Management (IPM) concepts such as sequential, adjacent plantings, looking before spraying and choosing selective or ‘soft’ pesticides as far as possible. The predators entered lettuce hearts, ate the aphids and moved on before harvest. Insecticidal sprays failed because this pest lives deep inside lettuces unlike other aphids.

A few insecticides are systemic. They travel up the sap of lettuce if drenched around the roots. They kill aphids but not caterpillars. It is feared that their introduction will remove the ‘soft options’ for management of caterpillars. Caterpillars and aphids share natural predators that die if they eat poisoned aphids - control of one pest does not integrate with control of another. The use of systemic insecticides against aphids may require a return to hard chemistry against caterpillars. Other pests such as thrips that carry viruses, whiteflies and bugs also complicate the integration of control options.

The aphid arrived in Tasmania in 2004 and then spread to Victoria, New South Wales and South Australia despite interstate quarantine barriers.

The national vegetable levy funded this project to extend the successful results of the 2004-5 project from northern to southern Tasmanian growers In 2005-6, iceberg and loose-leaf lettuces were grown under commercial conditions by two major growers near Hobart. The focus was on aphid susceptible cultivars but a couple of resistant cultivars were examined.

Control in iceberg lettuce was good for six plantings and management of thrips was integrated with that of aphids. Oats were grown near the lettuce beds to provide a supplementary source of predators.

In loose-leaf lettuce control was initially promising but failed after the sixth planting. One reason may be the short life of loose-leaf lettuce crops versus iceberg lettuce - 5 versus 8 weeks. Predators such as brown lacewings, ladybirds and hoverflies lag behind their prey in moving from planting to planting. An additional 2-3 weeks often makes big differences in the final cleanliness of the crop. Gaps of 2-4 weeks in the timing of sequential plantings probably hindered dispersal of predators. An absence of supplementary sources of predators outside the crop may also have become more critical in the fast crops once the hinterland vegetation dried off.

Technical Summary

Pilot crops of either iceberg or loose-leaf lettuce were grown on two major, commercial lettuce farms near Hobart in southern Tasmania to replicate successful IPM with iceberg lettuce in northern Tasmania in the previous season and to extrapolate IPM principles into loose-leaf lettuce.

Six iceberg crops were grown using normal commercial practices except that insect management followed advice from the project team. Each planting comprised 3,000 plants of one cultivar and was long and narrow by commercial standards. Three cultivars (Target, Titanic and Oxley) were used in all. Lettuces were assessed for pest infestation when ready for cutting by commercial standards. Plantings commenced in January 2006 and the last assessment occurred in July 2006. They progressed across a paddock with no reuse of area. Oats were grown on either side of the trial area to foster natural enemies of aphids. Spinosad was applied once to the first five plantings as a possible defence against tomato spotted wilt virus that appeared in early plantings.

Eleven loose-leaf crops were grown using normal commercial practices except that insect management followed advice from the project team. Each planting comprised 3-5,000 plants each of 4-7 red and green cultivars, most often four susceptible cultivars but additionally 2 *Nasonovia*-resistant cultivars in early plantings. Lettuces were assessed for pest infestation when ready for cutting by commercial standards. Plantings commenced in November 2005 and the last assessment occurred in July 2006. They progressed across a paddock with no reuse of area except for additional plantings (P12 and P13) that were very slow in winter and never assessed.

The project team visited crops weekly and discussed management options with the growers. Iceberg lettuce were harvested more or less in total and sold commercially by the grower. Loose-leaf lettuces were not processed by the grower but some small consignments were cut from early plantings by the project team and sold in greengrocery shops.

The mean number (per lettuce) of all aphids in the six iceberg plantings were 1, 9, 26, 5, 19, 12 and 12 respectively. The means include sections of the plantings where higher aphid populations appeared to correlate with waterlogged soil at one end of the beds. Distribution of aphids was clumped. Tomato spotted wilt virus (transmitted by thrips) was present but did not become a major problem. Spinosad was used once in most plantings as a possible defence against spread of the virus. Big vein virus (not transmitted by insects) was the most conspicuous pest or disease causing crop losses.

The mean number (per lettuce) of all aphids in the 11 loose-leaf plantings were 5, 7, 32, 25, 2, 3, 589, 404, 732, 18 and 80. The first six planting were considered promising for a pilot trial although the grower had concerns about the feasibility of washing crops with mean counts of 20-30 aphids per lettuce. Although all major predators remained present in several life stages in lettuce until June they did not control the aphid population after early March. The gap in planting dates between the last successful planting and the first unsuccessful planting (P6 to P7) was large - 30 days compared to a mean of 15 days for the preceding plantings. Fungal infections of aphid appeared in late March in P7 and peaked in May-June but aphids, dead and alive, remained numerous.

Two plantings of loose-leaf lettuces were assessed before as well as at maturity. In P6 aphids declined substantially between 33 and 42 days after planting and in P2 a lesser decline occurred between 33 and 48 days after planting. In the 2004-5 iceberg IPM trial at Devonport substantial decline in aphid populations often occurred as late as weeks 5-7 after planting.

The successful trials in iceberg lettuce at Devonport in 2004-5 and Campania in 2005-6 had substantial areas of irrigated grass, oats or rocket brassica adjoining the lettuces. These probably provided a supplementary source of predators in summer and autumn after the hinterland vegetation dried off. The loose-leaf trial did not have irrigated alternate hosts for aphids and their natural enemies. The large area of dry lucerne near the loose-leaf lettuce contained few beneficial insects.

Although IPM for iceberg lettuce looks promising there remains some concern about sustaining reliable control in later plantings which usually coincide with autumn progressing into winter. Careful attention to detail in timing and spacing of plantings and supplementary vegetation is probably required to ensure reliable control.

IPM for loose-leaf lettuce may require closer attention to timing of sequential plantings to avoid large gaps and provision of carefully placed supplementary sources of predators to reduce the advantage aphids have in dispersal and fast reproduction. Dispersal of currant lettuce aphid may be sustained at a high level because winged forms are produced more continually than in other aphid species (Liu, 2004) and in high proportions at mild temperatures (Diaz and Fereres, 2005) which may assist them to surge ahead of predators.

Currant lettuce aphid continued breeding as least until July – planting P11 had a mean of 80 aphids of all life stages per lettuce. That is, in a cool, temperate Australian district, this aphid maintained substantial populations on ‘summer’ hosts into mid winter.

Introduction

There are several major lettuce growing regions in Australia. Despite the differences in climate and growing seasons between these regions, there are several common insect pests that damage crops. These include native budworm, corn earworm, western flower thrips and several species of aphids. (Scientific names in Appendix 1).

Currant lettuce aphid is a new pest currently spreading across Australia. It is difficult to control because it lives deep inside the head of maturing lettuces secure from foliar insecticides. It is not secure from systemic insecticides or predators such as brown lacewing, ladybirds and hoverflies which can not only follow aphids but mostly move on once aphids are eaten.

Biological control usually relies on the build-up of natural populations of beneficial species, which includes brown lacewing, damsel bug, ladybirds and the microwasp, *Aphidius colemani*, an aphid parasitoid. The use of selective insecticides is critical in fostering populations of the beneficial species. Selective or soft insecticides do not act alone but succeed because they complement rather than disrupt biological control. Unselective insecticides must act alone because they not only kill predators but impair them by sublethal effects such as infertility. These impacts can happen indirectly when predators eat poisoned prey. Also, so-called ‘soft’ or ‘selective’ insecticides vary in their particular effects on each of the beneficial species so that some knowledge is required for their appropriate selection.

In recent years, control strategies for lettuce pests, particularly caterpillars, shifted away from frequent, routine applications of broad-spectrum insecticides. Many growers wish to integrate selective insecticides for caterpillar control with cultural and biological control methods for other pests. There is a risk that systemic insecticidal options for aphid management, which may at first glance seem to selective, will indirectly poison predators common to aphids and caterpillars and undermine the soft options for caterpillar management. Integrated Pest Management (IPM) seeks to integrate the control options for each pest into a safe, sustainable, economic package.

In 2004-5 at Devonport in northern Tasmania a sequence of nine plantings of iceberg lettuce (total 55,000) were grown using the best available IPM knowledge in simulated commercial conditions and the first seven were marketed successfully. Aphid and caterpillars were the prime pests managed. Control declined in the last two plantings possibly because large areas of lettuce treated with systemic seedling drenches were introduced adjacently (disrupting the dispersal of predators as well as killing some of them) and/or because seasonal conditions allowed the aphids to outstrip the dispersal and growth rates of predators.

This project sought:

- to assist major Tasmanian lettuce farms to grow pilot IPM crops;
- to repeat the IPM success in another region (southern versus northern Tasmania) and in other lettuce varieties (loose-leaf as well as iceberg lettuce);

Discussion

Aphid life cycle

Currant lettuce aphid clearly maintained its ‘summer’ breeding cycle well into winter at Richmond and Campania. Mean monthly temperatures at Richmond in June and July were 7.6°C and 7.7°C respectively. Diaz and Fereres (2005) showed that currant lettuce aphid multiplied fastest at constant 24°C and slowest at constant 8°C but remained fecund at 8°C whereas temperatures of constant 28°C stopped reproduction and caused high mortality of existing individuals. They concluded that this aphid is well adapted to reproduce and develop under low temperatures.

Crop duration

The degree of biological control achieved in any particular planting always depends upon the relative numbers of pests (lettuce aphids) and beneficials (lacewings, ladybird beetles, hoverflies or pathogens).

The short duration of loose-leaf crops strains biological control when the target is not artificially inundated with predators or parasites. In some early plantings control came just before the harvest date and often improved in the fortnight following (most plants were not actually harvested but remained for a few weeks before being mowed and cultivated). In P6 aphids declined from 33 to 42 days after planting and in P2 a lesser decline occurred between day 33 and day 48 (Appendix 5). In the 2004-5 iceberg IPM project at Devonport substantial declines in aphid populations occurred in several plantings in weeks 5, 6 and 7 after planting (Report VG04067).

The causes of loss of control in loose-leaf plantings P7-P9 in autumn cannot be clearly identified. For most pests and crops the first planting is regarded as the most likely to fail when waiting for predators to establish in a sequence of adjacent crops. However in the currently reported loose-leaf trial, in the previous iceberg trial at Devonport and in related iceberg trials in Victoria, plantings such as the 6th – 8th have had weakest control rather than the first planting. This is attributed to the aphids producing winged forms which move from early plantings into later plantings before the aphid population becomes high in the early plantings. Significantly, they move into these later plantings before the populations of predators predators have gained control. The 2005-6 iceberg trial at Campania commenced in mid growing season and ended before any such phenomenon became apparent.

Liu (2004) showed that the dispersal rate of currant lettuce aphid is more consistent than in other aphid species because winged forms are produced continually - 10% were winged at all population densities that he observed in field cages but he did not observe extremely crowded populations. Diaz and Fereres (2005) showed that temperature does affect production of winged currant lettuce aphids. The proportion of winged aphids remained below 7% at 16 °C and increased to 40-57% above 20 °C. At the Richmond loose-leaf trial winged currant lettuce aphids were constantly present (Appendix 10 shows temperatures at Richmond). Temperatures in winter were probably marginal and mortality from fungal infections were substantial with perhaps half of the July colonies having conspicuous infections.

Loose-leaf Planting 7 – loss of control

The interval in planting dates between the last successful and the first unsuccessful loose-leaf planting (P6 to P7) was 30 days compared to a mean of 15 days for the preceding plantings. The subsequent gap between planting dates of P7 and P8 was only 6 days.

P7 was planted in mid February when aphids were peaking in P6 and before they succumbed to predation. At 6 days after planting (23 February) there was one winged aphid per red coral plant (adjacent to P6), fewer aphids on intervening cultivars and none on green oak plants, which were furthest from P6. Some red coral plants of P7 adjoining P6 already had colonies of 10 or so juveniles but only one adult ladybird was seen on 80 plants (all cultivars) and no lacewings or hoverfly larvae. By 12 days after planting (1 March) aphids were not conspicuously more abundant in P7. Also seen were four adult white-collared ladybirds on 100 plants, some hoverfly larvae in aphid colonies but no lacewings were seen or vacuumed. In the next three weeks aphids outbred their predators. By 34 days after planting there were 100 aphids per plant although some ladybird adults and lacewing larvae were observed. At 41 days after planting many dead bodies of aphids, relatively many parasitised aphids, hoverfly larvae and ladybird eggs were present but no adult ladybirds and 'few' lacewing larvae were noted in field observations. Fungal disease was also common in the aphids probably accounting for many of the 'dead aphid bodies' recorded but some 'bodies' may have been predated or simply skins shed in growth.

However the numbers of lacewing larvae recorded in the destructive sample on 12 April 2006 (1.9 per plant, 54 days after planting P7) is twice that of any other planting including 'successful' plantings (Appendix 8 or Table 5). This is much more than suggested by the field note made 13 days previously of a 'few'. For ladybirds, both the field notes and the harvest assessment (1.4 adults, larvae and/or eggs per plant) suggest that ladybirds, including eggs, were conspicuous in P7. In subsequent plantings lacewings and ladybird counts at harvest date (P8, 5 May 2006) were low.

In the 2004-5 Devonport iceberg trial control first failed in planting 8 in which the numbers of aphids vacuumed at weeks 2, 3 and 4 were not high but lacewing counts were very low. Lacewings subsequently multiplied until at maturity (20 April 2005, 9 weeks after planting) they were relatively abundant but aphids were much more so. (Report VG094067, Tables 8 and 10)

Looseleaf Planting 10

Substantial biological control was temporarily regained in P10 after its loss in P7-P9. Planting 10 grew through April and May. Cooler 'autumn' temperatures began abruptly in late April (see Appendix 10) perhaps temporarily allowing existing predators to overtake a slowed aphid population but then temperatures declined further to prevent regeneration of the predator population.

One factor that could have contributed to the poor and somewhat erratic level of biological control was the fact that there were not weekly plantings of lettuce, but the interval varied between mostly 2 and 4 weeks (Table 5). That is there was not a continuous, even range of lettuce for aphids and predators to colonise. The aim was to make the lettuce crops the source of predators for later plantings rather than rely on continuous immigration from outside the crop, but this is less likely with longer planting intervals. The greatest movement of predators into lettuce crops is most likely to be in spring, and least in late autumn – winter.

Technology Transfer

The pilot crops of IPM *Nasonovia*-susceptible iceberg lettuce were not encouraging enough for the grower to consider growing more in the next season. The introduction of bagging lettuce for supermarkets will preoccupy his attention in the coming season.

In the longer term this grower wants access to cool season *Nasonovia*-resistant lettuce but fears that most selection trials in Australia will focus on warm season cultivars. The grower sees a resistant cultivar strategy as more consistently reliable. Serious aphid infestations appeared to correlate with waterlogged sections of plantings which the grower avoided harvesting once the problem was recognised. He did not receive other complaints from his market. It would appear that repeated demonstrations of susceptible IPM crops with consistent results are needed.

The pilot crops of IPM *Nasonovia*-susceptible, loose-leaf lettuce failed in P6-P9 and P11 and although results were promising in P1-P5 the grower's field staff had concerns about the washability of 24-30 aphids per plant (P3 and P4). This doubt could not be resolved by a commercial-scale washing test during the project but the grower is continually developing washing technique to better handle all insects. (Similar washing trials are being undertaken in Victoria.)

The grower remains primarily interested in finding *Nasonovia*-resistant cultivars of loose-leaf lettuce to facilitate resting imidacloprid drenches and delay the development of insecticide resistance. There are also issues of long crop durations in winter requiring higher seedling drench rates.

This grower also had concerns about accommodating plantings of non-crop vegetation to foster beneficial insects. The concerns include a shortage of land area in cool months when crop life is extended relatively more than market demand is diminished and the greater complexity in weed and perhaps irrigation management.

Recommendations

IPM for iceberg lettuce should continue to be demonstrated in pilot crops to advisors and commercial growers because it is a viable option provided it is supervised by a competent IPM agronomist. However, replication of success is likely to be needed to overcome scepticism.

IPM for loose-leaf lettuce requires more investigation before it can be demonstrated to growers at a pilot commercial level. However this is best done as subsidised pilot crops with growers working under commercial constraints.

Growers remain most interested in *Nasonovia*-resistant cultivars with special qualities such as iceberg forms suited to Tasmanian spring and autumn conditions and loose-leaf forms with wide seasonal performance to obviate frequent changes in package labels, which must specify cultivars.

Packaging of iceberg lettuce is likely to further complicate delivery of IPM advice because many otherwise transient insects will be trapped with produce.

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