



# **Integrated Pest Management in Peppermint Growing in South East Australia**

**A report for the Rural Industries Research  
and Development Corporation**

by Fred Bienvenu

October 2002

RIRDC Publication No 02/127  
RIRDC Project No DAV-178A

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ISBN 0 642 58526 1  
ISSN 1440-6845

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*Publication No. 02/127*  
*Project No. DAV178A*

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Published in October 2002.  
Printed on environmentally friendly paper by Canprint

# Foreword

This project has established that there is potential to introduce a successful Integrated Pest Management (IPM) program for use in Australian peppermint crops. Successful development and implementation IPM in Australian peppermint production will result in less pesticide usage, less environmental impact, less damage from pests and higher economic return for peppermint producers.

This project was funded from RIRDC Core Funds that are provided by the Federal Government.

This report, a new addition to RIRDC's diverse range of over 850 research publications, forms part of our Essential Oils and Plant Extracts R&D program, which aims to support the growth of a profitable and sustainable essential oils and natural plant extracts industry in Australia.

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**Simon Hearn**

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Rural Industries Research and Development Corporation

# Acknowledgements

Rural Research Development Corporation (RIRDC) for their support for this and other essential oil projects.

David Williams – NRE-ISIA - for detailed information and assistance with project design and implementation. David has long been at the forefront of IPM in pome and stone fruits and also strawberry crops.

Dr Mark Morris – Research Agronomist - Entomologist, A.M. Todd Company, OR, USA. – for discussions and suggestions based on experience in the establishment of IPM in USA peppermint producing areas.

Dr Len Coop - Oregon State University, Corvallis, OR. USA Visiting Fellow in Australia 2001 – for discussions and project suggestions. Len, in conjunction with Ralph Berry, has developed web based IPM programs for mint growers in the USA. These programs allow grower interaction and use established thresholds for control measures.

Jeff Bienvenu – for field study assistance, collection and survey of insect and other pest species.

Corryong Essential Oils and Vicmint Pty. Ltd. for the agronomic care of the peppermint sites and access to their respective properties. It is of considerable importance to the success of this project that both producer groups embrace the ideals of IPM as a practical alternative to “knee-jerk” pest control measures.

## Abbreviations

IPM – Integrated Pest Management  
TSM – Two Spotted Mite (*Tetranychus urticae*)

# Contents

<b>Foreword</b> .....	<b>iii</b>
<b>Acknowledgements</b> .....	<b>iv</b>
<b>Abbreviations</b> .....	<b>iv</b>
<b>Executive Summary</b> .....	<b>vi</b>
<b>Introduction</b> .....	<b>1</b>
<b>1. Objectives</b> .....	<b>2</b>
<b>2. Methodology</b> .....	<b>2</b>
Seasonal Conditions: .....	2
<b>3. Results</b> .....	<b>3</b>
Pest spectrum in Victorian peppermint fields.....	3
Sampling of TSM .....	4
Testing TSM Sampling in the field .....	4
Results following release of predators .....	6
<b>4. Discussion</b> .....	<b>7</b>
Potential for control.....	7
Potential for predator over-wintering .....	7
<b>5. Recommendations</b> .....	<b>8</b>
<b>6. References and further reading:</b> .....	<b>8</b>

# Executive Summary

Two Spotted Mite (TSM) is one of the most difficult horticultural pests to control and constitutes a very significant and real risk to stable commercial peppermint oil production. No integrated pest management protocols have previously been established in Australia to minimise this risk.

The incidence of Two Spotted Mite is increasing annually in commercial peppermint crops in both areas of Victoria and Tasmania. Significant yield loss occurred in 1998/99 and producers have largely attributed this loss to TSM. Under dry conditions high levels of Two Spotted Mite infestation result in excessive leaf loss, particularly lower leaf. This can have adverse effects on oil quality.

IPM studies in peppermint production in the major growing areas of the world have been surveyed. Liaison with fellow researchers around the world has been established and programs using IPM on US peppermint crops were reviewed.

The most common insects/mites in local peppermint fields in 2000/01 have been identified. This study was a one-year project established to identify whether there was a realistic opportunity to establish a successful IPM program in Australian peppermint crops.

The predator *Phytoseiulus persimilis* for Two Spotted Mite control was released into Victorian peppermint crops and its impact on TSM studied over time.

Reductions in Two Spotted Mite populations attributable to *Phytoseiulus persimilis* have been observed. Follow-up monitoring has shown that populations of *Phytoseiulus persimilis* have been able to over-winter in the two major peppermint production areas in Victoria.

Procedures for the sampling and monitoring of Two Spotted Mite and the predator *Phytoseiulus persimilis* populations have been successfully established.

This project has established that there is potential to introduce a successful IPM program for use in Australian peppermint crops. Successful implementation of the outcomes of this work could result in less pesticide usage, less environmental impact, less damage from pests and higher profits for peppermint producers.

# Introduction

The acarid, *Tetranychus urticae* - Two Spotted Mite (TSM) is a difficult pest to control and increasingly constitutes a very significant risk to commercial peppermint oil production. There are no integrated pest management protocols established for use in peppermint crops to minimise this risk in this country. TSM incidence is increasing annually in commercial peppermint crops in both areas of Victoria and Tasmania. Significant yield loss occurred in 1998/99 and producers have largely attributed this loss to TSM.

Under dry conditions high levels of TSM infestation result in excessive leaf loss, particularly lower leaf. This can reduce the quality of peppermint oil by altering the oil profile.

The most obvious effect would be a reduction in the desirable oil component - menthol. Loss of lower leaves results in a change in the relative level of the major oil components menthol and menthone. The prevalence of Two Spotted Mite varies from year to year with the “harder” or drier years being the most suited to Two Spotted Mite outbreak

There are other insect pests identified in Australian peppermint crops and inappropriate treatment (eg: synthetic pyrethroids) of these occasional pests can markedly affect the natural insect/mite biodiversity within the crop. An unintended consequence can be the removal of natural and introduced TSM predators. This can lead to a rapid increase in TSM numbers and damage.

Field surveys of commercial crops were used to establish which pests are present in peppermint fields in southern Australia and the range of controls currently used or available. Observation plots were used to establish the effectiveness and rate of dispersion of introduced predator mites and their likely persistence. These plots were also used to provide a field survey to establish the range of naturally occurring predators and the impact of current pest control practices on these predators.

This project has established the potential for developing suitable monitoring; sampling and techniques to assess TSM impact on south eastern Australian peppermint crops.

This successful pilot project has been the precursor of the RIRDC project DAV-190A, *Implementing IPM in Australian Peppermint Crops*.

# 1. Objectives

To establish an interim protocol for minimising two-spotted mite (TSM) impact on south eastern Australia peppermint crops.

To develop suitable sampling techniques for assessing TSM in peppermint crops.

To evaluate the potential to develop an effective integrated pest management program for peppermint production in south eastern Australia based on effective control of TSM.

# 2. Methodology

A field survey of commercial peppermint crops has been carried out to establish which pests are present in peppermint fields in south eastern Australia and the range of controls currently used and/or available. Collections and monitoring trips were made to the major peppermint growing areas in Victoria. Hand lenses and head magnifiers were employed as viewing aids. Pests were identified using standard Departmental reference material.

Steps to establish the best sampling techniques were based on literature surveys and personal links to colleagues in the IPM field in the peppermint growing areas in the USA. A visit to NRE Victoria by a practising specialist in IPM in peppermint crops in the USA yielded much useful information. The information obtained from the literature and personal contacts were tested and methods of monitoring best suited for use in peppermint production areas in Australia were evaluated.

Observation plots in the King Valley and in the Corryong district have attempted to establish the effectiveness and dispersion of introduced predator mites and their likely persistence. Supplies of approximately 30,000 *Phytoseiulus persimilis* were released on the two major properties. Bio Protection Pty. Ltd supplied the *Phytoseiulus persimilis* in canisters each containing approximately 10,000 predators raised on TSM on a substrate of bean leaves. *Phytoseiulus persimilis* is a native of Chile and has proved adaptable to Victorian environmental conditions and its beneficial attributes are used in a wide range of horticultural crops.

The predatory mites were released into the plant canopy at a height about two-thirds from the bottom of the stem. This placement was used to reduce the light and wind effects on the predators and to aid establishment.

Sampling and monitoring techniques varied from collection and storage in cool rooms to “in the field” sampling and recording. Sampling for several predator generations was required to ensure that the life cycle would be complete. Further details are available in the results section.

At the end of the season an evaluation of the potential to effectively introduce IPM (based on control of TSM) was developed.

## Seasonal Conditions:

The season began with an extremely wet spring that delayed the onset of the major incidence of TSM. In previous years spraying for the mite has been in November due to damage already evident. This year numbers of TSM were very low in the test sample plots (and surrounding areas) at an equivalent time of the year. Some concerns were held that there would be difficulty in establishing the predator mite due to the lack of food sources for it to survive in the field.

From the end of November the season turned to being very dry thus making the conditions more favourable to TSM than to the predator. By mid-December there were substantial numbers of TSM in pockets across the fields. Seasonal conditions “normalised” from January through to harvest in mid February.

# 3. Results

## Pest spectrum in Victorian peppermint fields

The following insect and mite populations have been identified in monitored peppermint crops.

### List of invertebrate populations noted during the study include:

**Thrips** (possibly *Thrips imaginis*) identification is unclear.

**Lacewings** of *Micromus tasmaniae*, and *Plesiochrysa ramburi* have been detected in very low numbers but not uncommon.

**Mealy bugs** species in small numbers.

**Aphid** species of various stages have been found. After TSM, the green aphids are the most common of the small insects found. However numbers rarely reach more than one per leaf but are commonly more than one per plant.

**Looper** caterpillar species can be seen in densities of up to one per five plants, occasionally higher.

**Common Spotted Ladybirds** (*Harmonia conformis*) are to be often found but generally at low population levels.

**Mite eating Ladybird** (*Stethorus spp.*) have been noted but at very low levels.

**Plague Soldier Beetle** (*Chaulinathus lugubris*) is commonly found sometimes in abundance but at low levels during the study period.

**European Red Mite** (*Panonychus ulmi*) found only in the later samplings. Identification of these mites however is uncertain and needs to be taken further.

**Two Spotted Mite** (*Tetranychus urticae*) see text.

**Predatory Mite** (*Phytoseiulus persimilis*) see text.

**Long Horned Grasshopper** (*Torbia perfecta*) can be at very high numbers with damage to leaves appearing to be significant. The actual effects and long term damage however are not as bad as perceived by growers.

**Wingless Grasshopper** (*Phaulacridium vittatum*) – same as for Long Horned Grasshopper.

**Predatory Shield Bug** (*Oechalia schellebergii*) were found in considerable numbers as eggs and some adults. This bug is a known predator of *Heliothus sp.*, itself a minor pest in peppermint in the region. The presence of predators like Predatory Shield Bug could explain why *Heliothus sp* do not appear to get to the economic threshold of damage in Victorian peppermint crops. Indiscriminate application of pesticides could readily unbalance this potential control agent.

**Flea Beetle** (*Nisotra sp.* Chrysomelidae: Alticinae) is found to be very common in the early stages of the monitoring. This typical flea beetle is identical in size, shape and colour to the Mint Flea Beetle found in the USA peppermint producing areas of Washington and Oregon.

Samples of these beetles were sent to CSIRO Division of Entomology and Tom Weir identified them as one of six species of native beetles in the genus *Nisotra* in 1989. Unfortunately, CSIRO could not get down to species level, as the samples sent did not fully match the limited species in their collection. However, the identification to *Nisotra* genus level was clear.

*Nisotra* in Australia is more kind to Australian peppermint growers than its USA counterpart, as it has several life cycles per year and thus can be more easily controlled without overlapping with withholding periods for chemical applications close to harvest times.

[Note:]

The USA pest species, which causes problems for US mint producers, is *Longitarsus waterhousei*. This species is closely related to the beneficial Flea Beetle *L. jacobaeae* which has been released in Australia as a biological control agent for the weed, Ragwort *Senecio jacobaea*. The beetle,

*Longitarsus waterhousei*, has a larval stage, which causes considerable damage to the underground parts of the peppermint plant. On maturing the beetles feed on sections from the leaf and may cause some defoliation. The flea beetle in the USA tends to only appear above ground and in the herbage at about harvest time. For this reason the pest is very difficult to control in the USA and they only have one generation per year.

This is the first detailed surveillance inside the crop canopy of peppermint crops. There is no doubt that many more species of insects and acarids are likely to be found in Australian peppermint crops. Some interesting fungal presences have been also noticed.

## Sampling of TSM

The sampling methods chosen from the literature and discussions with colleagues aimed at providing a good level of sensitivity. The first method used (a radiating spoke arrangement) appeared, at first, to provide a stable, consistent method of capturing, storing and counting the TSM and predator mites from the plots.

TSM were shown to be fairly immobile when kept cool and in the dark. The limit to their wanderings appeared to be from one side of the leaf to the other and even this journey was rarely made. The ratios of TSM on the under side of the leaf to the upper side of the leaf was comparable in both fresh and stored samples.

This method does not provide a good level of understanding of the density of very mobile insects and other pests. Consequently, visual on-site observations at each plot station were employed for these recordings.

Areas outside the sampling zone were noted on both properties with populations of TSM flaring to serious proportions. Despite the very wet conditions experienced early in the season there was the potential to develop into a serious pest problem in the time from December to January. Rapid build up is normally attributed to balances being broken between pest and predator by inappropriate chemical usage. In this case it was from the large change in climatic conditions suiting one species better than another.

## Testing TSM Sampling in the field

A test "in the field" sampling was made using head magnifiers (distributed by Jaycar Electronics cat. QM-3510) to count TSM in Corryong.

Magnification of 2.3 has been found to be satisfactory in the identifying and counting of TSM and the fast moving predators, *Phytoseiulus persimilis*. At this magnification a reasonable degree of accuracy is possible. While closer magnification does provide better detail, it reduces the field of vision, depth of field and leads to more personal fatigue. For the times when more magnification is required head magnifiers have a drop-down single lens that doubles the magnification. Use of this lens system has proved to be of considerable advantage in terms of accuracy but requires more manpower to achieve the sample number of surveyed leaves.

Paddocks were traversed by walking in a "Z", or "M" pattern depending on the paddock shape. Peppermint stems were collected at 5 stations across each irrigation bay. From each of the five stations 15 plant stems were collected and leaves inspected from the bottom, middle and top of the stems for mites (adults and eggs). The total leaves surveyed per bay were 5(stations) x 15 (stems) x 3 (leaf positions) = 225 leaves scanned. The best use of manpower was utilising 3 scanners and one recorder. A recorder would be capable of maintaining the input from more than three scanners.

It is commonly accepted in the USA that economic damage to mint plants begins to occur when populations of TSM reach five per leaf. Feeding injury caused by densities greater than five mites per leaf increases water stress, reduces photosynthesis, and alters terpene metabolism, resulting in elevated levels of menthol and neomenthol and decreased levels of pulegone. The ability to “manage” the crop back to optimal yields is impaired by greater than five TSM per leaf.

Similar studies performed on TSM in peppermint in the USA, classify the leaves as "infested" if the mites (adults and nymphs) number five (5) or more. Because of differing conditions in Australian peppermint crops a cut off point of ten (10) and above was employed to maintain some higher level of accuracy. This may allow more accurate thresholds to be developed for local peppermint crops. The number of mites per leaf was recorded as observed until numbers of 10 or more were present. ie: numbers in excess of 10 were also recorded as ten.

In the USA (Berry et al) a typical commercial sample rate of 14 individual field sites per 15 hectares (or slightly less than one field site per hectare) is most frequently used. Each site is monitored for mites by examining a total of 45 leaves (15 leaves each from the bottom, middle, and top) from 15 randomly selected mint stems per site. This level of sampling is much broader than that attempted in this study and has evolved after baselines were determined by studies.

A typical regime derived from monitoring in the USA (Berry et al) suggests remedial treatment of TSM in the field when the following conditions are met.

1. Check that there are no predator mites present in the samples  
**and**
2. If 18 or more of the leaves in the 45-leaf sample taken at each site are infested with five (5) or more TSM.

A consideration is also given to estimate the number of TSM eggs on the leaves. Egg numbers can be used as a predictor of emerging infestations.

TSM populations can increase very rapidly during hot, dry weather and even after an insecticide application if the pesticide depletes the predators more than the TSM. During peak growth periods fields should be inspected twice weekly.

## Results following release of predators

The following figure 1 shows the combined results from counting of TSM in peppermint fields in the Corryong region. These results are indicative of the magnitude of responses achieved following the release of *Phytoseiulus persimilis*. Harvesting peppermint removes all the above ground herbage and this brings to a halt the potential to continue counting over the autumn period.

Observation of untreated blocks of peppermint indicated that the population of TSM maintained high levels or increased over the same period as the decrease was observed on treated blocks.

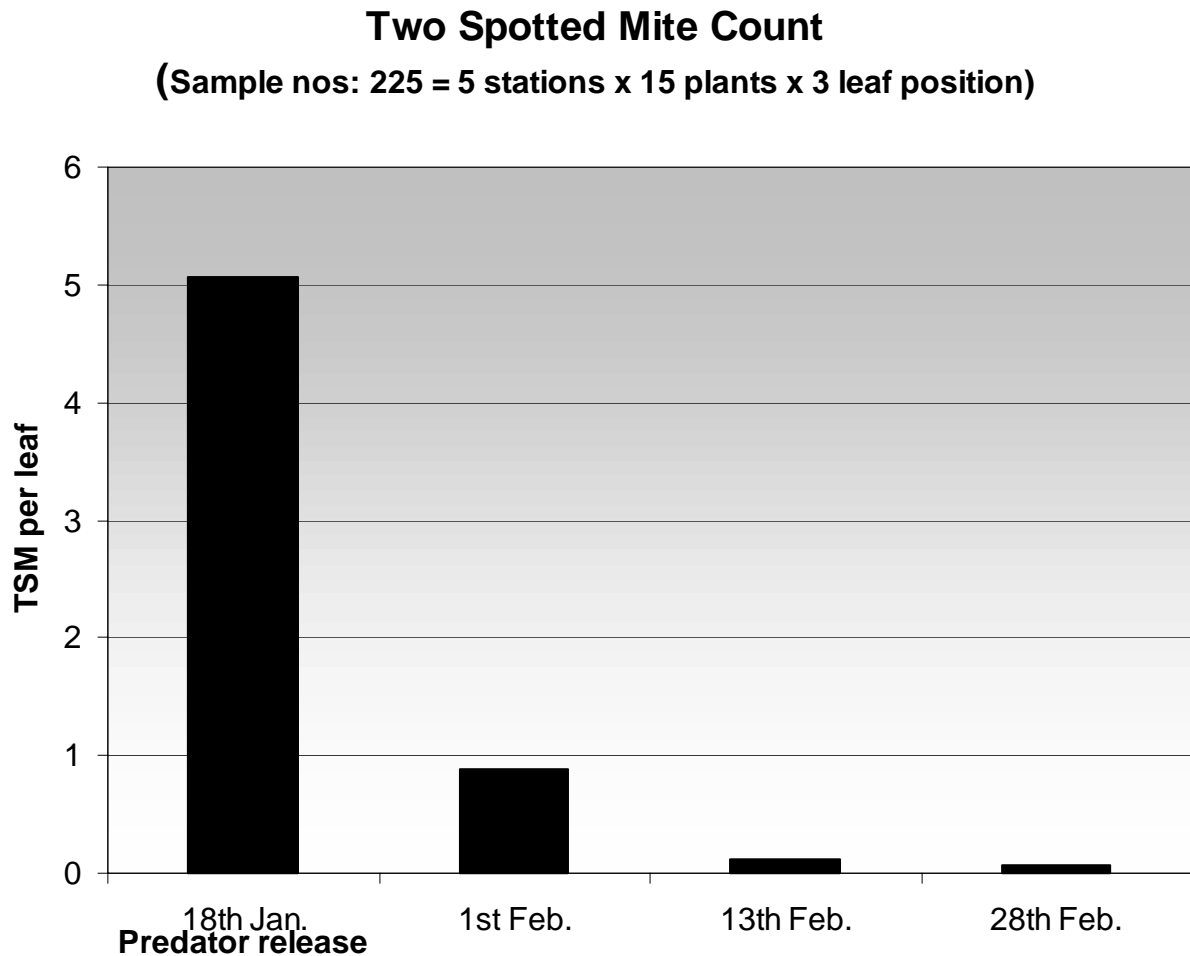


Figure 1.

## 4. Discussion

Peppermint producers and agricultural chemical representatives have been consulted to assist in establishing an interim protocol for minimising two-spotted mite (TSM) impact on south eastern Australian peppermint crops. Overseas literature and research covering IPM techniques and implementation have been utilized and techniques evaluated to see which may have relevance for adoption under Australian conditions.

A range of techniques were surveyed to develop suitable sampling techniques for assessing TSM in Australian peppermint crops. Findings from these studies will have direct benefit for future study. From the methods examined it appears that better results are to be obtained by direct field surveying and counting of TSM and predators. This will mean that a larger group of trained observers will be required to perform the counting but for a lesser time.

The first method tried involved collection of samples and the use of cool rooms for short-term storage of samples to allow for the use of a single observer over an extended time frame. This technique may not be as accurate for detection of the predator mites. *Phytoseiulus persimilis* mites are much more mobile than TSM and even if kept cool their higher rate of movement results in a greater chance of missing detection. At the very least, the time taken to check each leaf is doubled as both sides need to be checked. Typically TSM only frequent the underside of the leaf and after many leaves were scrutinised we elected to omit the upper side of the leaf with no noticeable impact on the quality of the scrutiny for finding TSM.

### Potential for control

Results shown in figure 1 indicate that *Phytoseiulus persimilis* can rapidly reduce TSM. The scale of results are dependant on following a program which includes the absence of toxic pesticides.

### Potential for predator over-wintering

Observations made since the completion of this pilot study have shown that *Phytoseiulus persimilis* can in fact survive an over-winter period as they were detected in areas close to the areas where releases were made the previous year. This situation was true in the two major Victorian growing areas of King Valley and Corryong.

In the Corryong district, in 2001/2002, positive sightings were made in an area of the previous season's release, a kilometre from the release area for 2001/2002. These sightings were made only two weeks following the 2001/2002 release and have been designated as part of a remnant population over-wintering from 2000/2001.

In the King Valley production area, a similar but even more clear-cut situation occurred with sightings observed in 2001/2002. There were original releases of *Phytoseiulus persimilis* as part of the study in the 2000/2001 season. However in the year of the sightings, no releases had been made. The *Phytoseiulus persimilis* found in 2001/2002 could only have been survivors over-wintering from the previous season 2000/2001.

This augurs well for the potential to establish a permanent *Phytoseiulus persimilis* population in Australian peppermint. Seasonal climatic differences may well make the hope for continual over-wintering uncertain but at present there is considerable hope.

## 5. Recommendations

Evaluation of the potential to develop an effective integrated pest management program for peppermint production in south eastern Australia based on effective control of TSM has been successfully completed. The need for an IPM program for Australian peppermint is apparent and the many positive sightings indicate that the predator mite *Phytoseiulus persimilis* can survive and reduce TSM populations during the critical months of peppermint production.

To implement a successful IPM program in peppermint several key developments are required.

The identification and integration of chemical and sustainable bio-control methods practices that will maximise yield of high quality peppermint oil.

The development of data required to support registration (minor use or full) of predator “friendly” pesticides

Establishment of an industry reference group to facilitate and implement the use of a practical IPM program.

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