NY229

Evaluation of indigenous biological control agents for thrips and broad mite on ornamentals

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HRDC Project NY229 Evaluation of indigenous biological control agents for thrips and broad mite on ornamentals

Technical Summary

Eight phytoseiids and one ascid mite were found associated with the broad mite, as was a fungus of the *Verticillium lecanii* group. The eight phytoseiids were *Amblyseius lenis (=sullivani), A. herbicolus (=deleoni), A. masiaka (=barkeri), A. montdorensis, A. queenslandicus, A. waltersi, A. neovictoriensis* and *A. lailae*. The ascid was *Lasioseius nr. queenslandicus*. Four species of predaceous phytoseiids and one anthocorid were found associated with thrips. These were *A. montdorensis, A. herbicolus (=deleoni), A. masiaka (=barkeri),* and *A. lenis (=sullivani)*. The anthocorid was *Orius tantillus*.

The polyphagous whitefly, *Trialeurodes vaporariorum*, which co-occurs with broad mite, was found to carry the pest. Up to 25% of whiteflies were with mites, usually singly, but up to 11 mites/whitefly have been observed. The practical implications for the industry are obvious. These results have been published. In addition, Dr Uri Gerson made substantial use of his time in Australia in examining Australian mite fauna. A number of publications have been produced from this work.

Our discovery of a *Verticillium lecanii* fungus associated with broad mite and aphids has some significance that should be followed up. The climate (especially in the more humid north) is ideal for these organisms and efforts should be made to look for them. Many can easily be mass-reared in the laboratory and applied in the field. Studies should also be made to determine whether indigenous predators are beginning to evolve resistance to pesticides.

The three predatory mite species evaluated showed considerable potential for use as biocontrol agents against broad mite and thrips. In conjunction with HRDC project NY513 (IPM in greenhouse crops) these mite species will be developed further. The commercial implications will also be developed, if feasible, under the auspices of this project. It is recommended that cooperation continue between researchers to further develop the potential already determined under this project to fruition. The whitefly-broad mite phoresy has significance for control of both pest species and this will be further explored under Project NY513.

HRDC Project NY229 Evaluation of indigenous biological control agents for thrips and broad mite on ornamentals

Industry Summary

The search for acarine (mite) biocontrol agents for thrips and broad mite was successful with nine predatory mites found associated with the broad mite, as was a fungus. Four species of predatory mites and one anthocorid bug have been found associated with thrips. Three out of all of these species were identified as having the greatest potential for control of thrips and broad mite. Species A produced promising results in the laboratory and in the field for control of broad mite and proved easy to mass-rear. Species B showed potential as a thrips biocontrol agent and is worthy of further trialing. And Species C, as mentioned above, showed potential in laboratory studies for control of broad mite. Further trials will be conducted with these mites on growers properties as part of HRDC Project NY513.

The phoretic relationship between broad mite and whitefly (where whitefly carries broad mite attached to its legs) was also discovered. The ability of whitefly to carry broad mite has implications for growers with both pests in their crops, as the whitefly may be responsible for spreading broad mite through their plants. In addition, Dr Uri Gerson made substantial use of his time in Australia in examining Australian mite fauna, with implications for industry explored in greater detail in the project report.

One important consideration in using biocontrol agents to control broad mite as reflected in this trial is that broad mite numbers can often be significant in a crop before the grower realises that they are present. This creates problems in using beneficials as the pest population may already be substantial and causing economic damage before the beneficial is released into the crop. The predator is disadvantaged by the high pest numbers as control with such a pest:predator ratio takes much longer as reflected by the field trial results. Only very efficient monitoring by a trained person on susceptible crops can alleviate this problem and provide a much better chance of long term control for the pest. For that reason, it is recommended that if a suitable predatory mite becomes generally used by industry for control of broad mite, that only effective monitoring be used to manage the biocontrol.

(i) Background and summary:

In the UK and Europe integrated pest management (IPM) on greenhouse vegetable crops is now a reality, with production and sale of a large range of biological control agents. These are used commercially on ornamentals in the UK. One organism used in Europe and the USA, but not is Australia is the phytoseiid (predatory) mite *Amblyseius cucumeris.* This mite attacks twospotted mite, broad mite and thrips larvae, all important pests of ornamentals. Such a predator has potential to extend IPM on ornamentals in Australia, at present restricted to the use of the Chilean predatory mite (*Phytoseiulus persimilis*) to manage miticide resistance in twospotted mite (TSM).

Amblyseius bellinus occurs naturally in Australia and NZ and some authorities (eg. Collyer, NZ J Zool 9:191 and Walter, UQ) consider it to be synonymous with *A. cucumeris.* This project initially intended to examine the potential of *A. bellinus* as a greenhouse predator, but a lack of specimens despite repeated collecting trips in likely habitats forced us to concentrate on other potential species.

A second phytoseiid, *Amblyseius victoriensis*, is an effective predator on broad mite in citrus. It occurs in hot, dry areas and should thrive in greenhouses, however a closely related species, Species C (the name should remain confidential due to commercial considerations), was found in far greater numbers in coastal areas suggesting that it prefers the hot, more humid environs found in coastal greenhouses, where the bulk of potential users of IPM are located. This species was concentrated on in preference to *A. victoriensis* and showed worthwhile potential as a biological control agent.

Eight phytoseiids and one ascid mite were found associated with the broad mite, as was a fungus. Four species of predaceous phytoseiids and one anthocorid have been found associated with thrips. Three out of all of these species were identified as having the greatest potential for control of thrips and broad mite. Species A produced promising results in the laboratory and in the field for control of broad mite and proved easy to mass-rear. Species B showed potential as a thrips biocontrol agent and is worthy of further trialing. And Species C, as mentioned above, showed potential in laboratory studies for control of broad mite.

The phoretic relationship between broad mite and whitefly was also discovered and the results published. The ability of whitefly to carry broad mite has implications for growers with both pests in their crops. In addition, Dr Uri Gerson made substantial use of his time in Australia in examining Australian mite fauna. The results of these endeavours are listed later and publications produced are also listed.

(ii) Objectives

The original research schedule was about looking at and for natural biocontrol agents for broad mite and thrips. Following the death of the Principal Researcher, Dr Neil Gough, in August 1992, it was decided to concentrate on the broad mite, making the search for thrips predators a secondary target. The discovery of Melon thrips (*Thrips palmi*) and Western flower thrips (*Frankliniella occidentalis*) in Queensland and much of the rest of Australia, shifted the focus from broad mites to thrips, although the progress made with evaluating broad mite predators was pursued.

The primary aim of the project, to evaluate native acarine predators for control of broad mite and thrips, was achieved with many species identified associated with the pest species, several species evaluated and species with commercial potential indicated.

(iii) Research methodology

The basis of the project relied on methods for collecting and rearing thrips, broad mites and predatory mites. These are detailed as follows:-

Collecting thrips

Thrips were collected in the field by beating seed or flower heads over a large white tray, usually a tote box lid. Specimens were then aspirated into vials and either preserved in 70%-alcohol or kept alive for laboratory and glasshouse experimentation. Where large numbers were present, whole seed or flower heads were collected in plastic bags, returned to the laboratory and transferred to an Tullgren funnel to extract the thrips. Cumbungi pollen (from the water reed, *Typha orientalis*) was used as a supplemental food source for field collected thrips as required.

Collecting broad mites

Broad mite were collected in the field by picking infested leaves from growers properties. As broad mite populations can be quite high before damage occurs and the grower is aware of their presence, it was not difficult to collect sufficient stocks to begin rearing the mites for trial use.

Collecting predatory mites

Three methods were used to collect predatory mites associated with thrips. Soil dwelling mites, such as *Hypoaspis* sp. were collected by using a soil-insect trap half-buried in soil and leaf litter. The trap comprised a 200 mm long, 100 mm diameter PVC pipe with the bottom end covered with coarse grade mesh, baited with roughly chopped garlic pieces and the top covered with an end cap. The traps were left in the ground for a week and then checked for mites attracted to the garlic. Mites present were washed off, sorted and identified.

Predatory mites were also collected from plants infested with thrips. Mites were collected either by beating the foliage and pootering as detailed previously, or picked up individually with a fine camel hair brush. Mites were placed in 70% alcohol for identification or kept alive for rearing. The third method involved the use of lure plants. Thrips-infested plants were placed in unsprayed bush or cropping situations and left for a week to a fortnight, then thoroughly checked for predatory mites.

Rearing thrips

Several methods for thrips rearing were evaluated, though most proved to be relatively unsuccessful for long term culturing. Two methods were suitable for medium term rearing and these are detailed below. As Western flower thrips was not available in the Indooroopilly area, the related *Frankliniella schultzei* was used for rearing. Live bean plants in 15 cm pots were used inside rearing cages. Glass slides smeared with honey were placed within the cages and cumbungi pollen was dusted on the bean leaves as food sources, although the higher humidity in the cages tended to cause fungal growth on the pollen after a couple of weeks. Proper rotation of plants within the cages and regular weekly introductions of fresh plants reduced this problem. Much caution has to be taken with cleanliness to reduce the possibility of contamination of the culture with other insect and mite pests, most notably twospotted mite, aphids and whitefly. This method proved most successful and relatively low maintenance compared to other methods, although long term stability of the culturing method was difficult to achieve.

The second method was an adaptation of the technique of Ian Greene (University of California, Davis, pers.comm.), using green bean pods. Fresh green beans obtained from a supermarket (or preferably from additional plants grown in the glasshouse, as they were guaranteed free from chemical residues) were washed in mild detergent, then mild bleach and then towel dried. Four bean pods were smeared with dilute honey solution then placed in a glass jar with a fine mesh top and gasket to prevent escapes. Plastic takeaway food containers with side and top screening to reduce humidity increase within the container were also trialed, but were not secure enough to prevent thrips escapes. Approximately 50 adult *F. schultzei* were added to the beans and allowed to oviposit for three days before the adults were blown off the bean pods, which were then removed and placed in a fresh jar along with a couple of fresh pods. After a day or two, the eggs hatch and larvae can be collected for experimentation. A week later, pupae have developed. Fresh pods must be added regularly as the beans become mouldy very quickly. Care must also be taken with the choice of container, as thrips are very adept at escaping even apparently well sealed jars or containers. The method is useful for obtaining thrips of a certain age, but is more labour intensive than rearing on whole bean plants in cages.

Rearing broad mites

Several methods were used to rear broad mites. The most successful, long term methods involved the use of shot potato tubers. Six 12 cm pots were planted with a sprouted potato tuber each week and broad mite introduced to the plant on the third week. The infested leaves were harvested from the fourth week on and used for laboratory trials or for supplemental feeding of the predatory mite cultures. Silver beet were also used as a substrate for broad mite as was small citrus fruit (lemons, limes and cumquats) but best results were obtained using potato tubers.

Rearing predatory mites

Three methods were used to rear predatory mites. Maintenance cultures were established on arenas following the technique of McMurtry and Scriven (1965), later refined by James and Whitney (1993), with some modifications. A 20 x 30 cm plastic tray was used for the arena with a kitchen sponge or Wettex® sponge layers placed in the centre (allow at least a 2 cm gap all around the sponge to prevent escapes). Water was added to soak the sponge to saturation and the water level adjusted so that it was not higher than the sponge. A rearing surface was placed on the sponge; a number of surfaces were trialed including floor tile, PVC, parafilm® and perspex, but abraded cut-out ice-cream container lids were found to be most satisfactory. Two or three "water-wells" in the substrate provided moisture and encouraged some fungal growth on the arena. Some methods use a tissue or tanglefoot barrier around the arena edge, but my experience showed that once the predators are familiarised with the arena, few will run off and drown.

Food was provided by placing small vial lids stocked with cumbungi pollen and others with stored product mites (*Tyrophagus putrescentiae, Acarus siro* or *Rhizoglyphus* sp.). Broad mite-infested potato leaves were also provided every few days for the mites that fed on them. Oviposition sites were provided by blackening an acetate sheet, folding it in a W shape and placing it over a finely tufted cotton wool strand. The arenas were kept in a netted enclosure (to prevent contamination by other insects) in a 26°C and 75% RH rearing room.

Predatory mites were also reared in one litre jars supplied with the stored product mites listed above. A number of substrate mixes were trialed, but the exact proportion of the ingredients was found not to be vital, as long as the moisture content was satisfactory for both predators and prey. Rolled oats, wheat germ, bran, torula yeast, dried tomatoes, corn flakes and soya flour were all used in the substrate mix. Rearing in glass jars (standing in water trays to prevent escapes and contamination) is less labour intensive, but more unstable than other methods.

The third predatory mite rearing method proved to be most stable and successful in terms of numbers produced. Predators were reared on green bean plants dusted with cumbungi pollen. No other food source was provided and predator numbers per leaf averaged between 40 and 50 for several species reared in this manner. The leaves were easily harvested for mite release in the field and no pest species are introduced at the same time. Fungal problems do develop on the pollen dusted leaves, but usually not until well after optimal harvesting time. Contamination with other insect pests can be a problem and close monitoring and careful hygiene is vital. One other difficulty is the supply of cumbungi pollen in sufficient quantity to mass rear on a large scale. The water reed produces pollen for only a few weeks in October/November and pollen production can be very variable depending on rainfall. Harvested pollen can be stored in the freezer and is still viable for up to two years. This method of mass rearing is certainly suitable for production of predatory mites in sufficient quantity for small scale field releases.

As initial surveys failed to discover any natural enemies, broad mite was cultured on silver beet and potato plants in the glasshouse. Plants were then placed in the bush and natural enemies recovered from them. Subsequent field surveys also found a number of mites associated with both broad mites and thrips. All but one phytoseiid have been identified, but these identifications must remain confidential due to commercial considerations. The most hopeful predators were reared in the glasshouse and the laboratory. The predatory mites were reared on arenas and on soybean plants dusted with cumbungi pollen. The latter method proved most favourable for producing large numbers of mites for evaluation in field trials.

Preliminary laboratory studies were conducted to evaluate field collected species. These were performed by using leaf disks on agar plates carrying either thrips or broad mite individuals of a set number, with the predatory mites placed on the disks and observed for feeding on the pests. Three species were shown with considerable potential for use as commercial biocontrol agents. It is anticipated that as part of the recently commenced HRDC national IPM project on greenhouse crops (NY513) we will be able to further trial these likely biocontrol agents and hence advertise for Expressions of Interest for commercial production of at least one, if not more, of these beneficials. The potential commercial implications worldwide for the development and production of these organisms will require a cooperative approach from researchers and the HRDC.

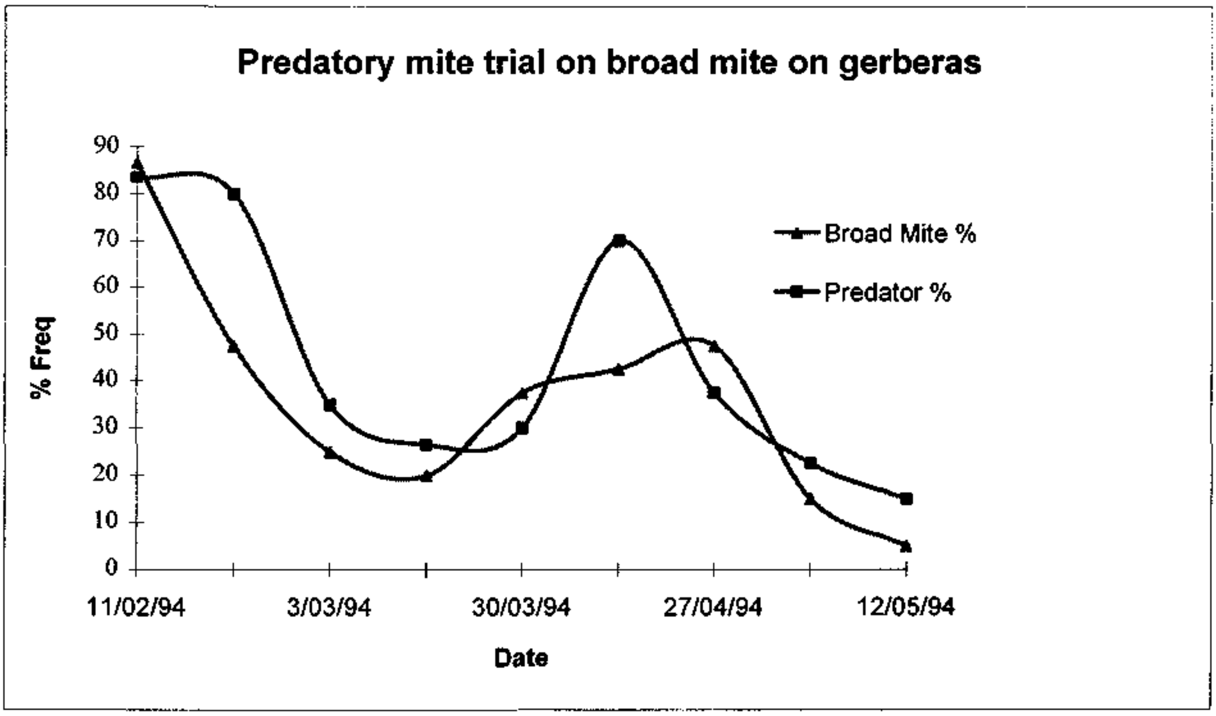
(iv) Results and discussion

Eight phytoseiids and one ascid mite were found associated with the broad mite, as was a fungus of the *Verticillium lecanii* group. The eight phytoseiids were *Amblyseius lenis (=sullivani), A. herbicolus (=deleoni), A. masiaka (=barkeri), A. montdorensis, A. queenslandicus, A. waltersi, A. neovictoriensis* and *A. lailae.* The ascid was *Lasioseius nr. queenslandicus.* Four species of predaceous phytoseiids and one anthocorid were found associated with thrips. These were *A. montdorensis, A. herbicolus (=deleoni), A. masiaka (=barkeri),* and *A. lenis (=sullivani).* The anthocorid was *Orius tantillus.*

Initial laboratory studies through observations of potential predators feeding on the pest species determined the most promising candidates for field trials. Three field trials in all were conducted. Two were unsuccessful - one conducted on thrips-infested *Ficus* using Species B failed as the grower mistakenly cropped the experimental plants in mid-trial. This was unfortunate as Species B had shown considerable potential in laboratory studies as being a voracious predator of thrips and it had established on the field trial plants and was reducing the pest population. The other trial was on broad mite on fuchsias using Species A and suffered from undue weather conditions (an unexpected cold snap) that greatly affected predator and pest numbers on the trial plants. The third trial was conducted at Higgs nursery, Wynnum on greenhouse-grown gerberas using Species A. The results are shown in Table 1 and in the graph following. Although the broad mite numbers in the gerberas were significant prior to the first release of the predatory mites, a reduction of broad mite numbers followed. Although no further Species A were released in the crop, its numbers increased in response to an increase in broad mites and hence reduced the pest population down to a manageable level.

Table 1: Species A on broad mite on gerbera, Wynnum

Date	Leaves with broad mite	% broad mite	Leaves with Species A	% Species A	Containers released
11.2.94	17	86.6	17	86.6	2½
21.2.94	9.5	47.5	16	80	3
3.3.94	5	25	7	35	4
16.3.94	4	20	5.3	26.6	
30.3.94	7.5	37.5	6	30	
13.4.94	8.5	42.5	14	70	
27.4.94	9.5	47.5	7.5	37.5	
5.5.94	3	15	4.5	22.5	
12.5.94	1	5	3	15	



One important consideration in using biocontrol agents to control broad mite as reflected in this trial is that broad mite numbers can often be significant in a crop before the grower realises that they are present. This creates problems in using beneficials as the pest population may already be substantial and causing economic damage before the beneficial is released into the crop. The predator is disadvantaged by the high pest numbers as control with such a pest:predator ratio takes much longer as reflected by the field trial results. Only very efficient monitoring by a trained person on susceptible crops can alleviate this problem and provide a much better chance of long term control for the pest.

Dr Uri Gerson, while he was here, also made some progress on related mite work, which should be reported as it is of advantage to industry. This includes work on natural acarine enemies of armoured scale insects. Members of the family Hemisarcoptidae are important parasites and/or predators of armoured scale insects, and some species have been used in biocontrol. The genus has not hitherto been recorded from Australia. Two apparently-undescribed species were found: one, rather rare, parasitising white louse scale (*Unaspis citri*) at Nambour. The other was quite common at Mareeba, in one case attacking 40% of an oriental scale (*Aonidiella orientalis*) population on papaws. A culture of this species was initiated in the laboratory and following Dr Gerson's departure, was handed over to Dr David Walter, at the University of Queensland for further development. These findings are in the process of being published (see Publication List).

The polyphagous whitefly, *Trialeurodes vaporariorum*, which co-occurs with broad mite, was found to carry the pest. Up to 25% of whiteflies were with mites, usually singly, but up to 11 mites/whitefly have been observed. The practical implications for the industry are obvious. These results have been published (see Publications List).

The second family of natural acarine enemies, the Cheyletidae, are common predators of armoured scale insects, although their effectiveness is undetermined. Two new species were described, several new records established, and a key prepared for all 30 known Australian species. Discoveries were also made of members of two other families, the Eupalopsellidae and Stigmaeidae. Two new species in the former family were described and a new genus, *Neilstigmaeus*, (named after Dr Neil Gough) was described in the Stigmaeidae. These two papers have been published (see Publication List).

Dr Gerson also made other discoveries, such as natural predators of the lychee erinose mite and new species of false spider mites (Tenuipalpidae). (See Publications List).

(v) Implications and recommendations

Although the predaceous mites of the family Phytoseiidae are fairly well known in eastern Australia, there is no doubt that many more remain to be described. Limited as this project has been in time and staff, our collections indicate that indigenous predators may attack many local and introduced pest species. Furthermore, many predaceous mites in other families may play a role in pest control. It follows that ongoing systematic studies and routine backup facilities are essential for biocontrol studies utilising mites.

Our discovery of a *Verticillium lecanii* fungus associated with broad mite and aphids has some significance that should be followed up. Surprisingly little is known in Australia about fungal diseases of mites. The climate (especially in the more humid north) is ideal for these organisms and efforts should be made to look for them. Many can easily be mass-reared in the laboratory and applied in the field. Studies should also be made to determine whether indigenous predators are beginning to evolve resistance to pesticides.

The three predatory mite species evaluated showed considerable potential for use as biocontrol agents against broad mite and thrips. In conjunction with HRDC project NY513 (IPM in greenhouse crops) these mite species will be developed further. The commercial implications will also be developed, if feasible, under the auspices of this project. It is recommended that cooperation continue between researchers to further develop the potential already determined under this project to fruition. The whitefly-broad mite phoresy has significance for control of both pest species and this will be further explored under Project NY513.

(vi) Intellectual property

Nil.

Publications List

Gerson, Uri. (1994) The Australian Eupalopsellidae (Acari: Prostigmata) Invertebr. Taxon. 8: 63-73.

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Acknowledgments

This study was initiated by the late Dr. Neil Gough, and without his foresight much of the advances made would not have eventuated. Dr. Uri Gerson was invaluable during and after his sabbatical here on the project and continues to maintain an interest in acarology in Australia. This study was also capably assisted by Ms Kimberley Sadler and field work was conducted at Redlands Nurseries and Higgs Nursery with thanks going to John Bunker and Nev Higgs respectively for their cooperation and kind assistance.

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