Grower Summary

PC 299

Cucumber and tomato: To evaluate new strategies for IPM of spider mites

Final 2011

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Further information

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Headline

Naturalis-L can provide an effective second line of defence to support *Phytoseiulus* against spider mites in cucumber and tomato crops but the technique requires some fine tuning.

Background

For many years the control of spider mites on conventional cucumber and tomato crops was successfully based on a combination of the predatory mite, *Phytoseiulus persimilis*, and the target specific acaricide, fenbutatin oxide (Torq). The predators provided season-long control while the acaricide was used as a second line of defence (SLoD) to slow down the pest population growth when conditions provided it with an advantage over the predator. Torq has now been withdrawn from the market and *Phytoseiulus* rarely provides cost-effective control of spider mites when used alone. A replacement second line of defence is urgently required.

Cost-effective control of spider mites has always been a challenge on organic cucumber and tomato crops because there have been no truly IPM compatible products to use as a second line of defence in support of *Phytoseiulus*. Growers have depended on products with physical action (*e.g.* Eradicoat, Eradicoat T, Savona) but they are only partially effective and expensive because a series of applications are required. Furthermore, they are not selective and repeated applications can harm other components of the IPM programme.

Objective

The overall objective of this project was to develop a new cost-effective IPM strategy against spider mites which would help to minimise the overall use of broad spectrum chemical pesticides in conventional crops.

Summary of the project and main conclusions

Potential second line of defence products

Bifenazate (Floramite) has several properties which made it a suitable candidate to replace fenbutatin oxide as a SLoD product in conventional tomato and cucumber IPM programmes:

- It is from a new chemical group (hydrazine carboxylic acid group), which means there should be no cross resistance to any other products.
- It is effective against all stages of spider mites, including eggs.
- It has a 24hr harvest interval in the Netherlands
- It is claimed to be harmless to all the beneficial organisms currently used in the cucumber and tomato IPM programmes.

Floramite is available for protected edible crops in many other European countries and for

protected strawberries in the UK. When this project was authorised, HDC were seeking an Emergency SOLA for use on tomato and cucumber. If that was rejected by the Chemicals Regulation Directorate (CRD), it was intended to place the product in the 'normal' stream for SOLA. At that stage we had every reason to believe that Floramite would become available to UK growers in the near future. However, the product subsequently became embroiled in the broader registration issues. At present, meaningful trials with Floramite cannot be done on a commercial-scale without destroying produce for the remainder of the season, which is clearly unacceptable. The studies with Floramite have been put on hold pending the outcome of CRD's assessment.

HDC recommended the inclusion of Naturalis-L in this project. Naturalis-L is an oil dispersion formulation containing 7.16% w/w *Beauveria bassiana* ATCC 74040 (2.3×10^7 colony forming units ml^{-1}).

Beauveria bassiana is not new to British researchers. Between 1996 and 2003, it was trialled against pests which attack UK cucumber and tomato crops. The results to 2000 were collated in an HDC summary report (PC 180). Subsequent HDC funded work (PC 163) showed that the product, Naturalis-L, could provide a substantial reduction in spider mite numbers and had potential as a SLoD product to support *Phytoseiulus.* Naturalis-L is now owned by Intrachem Bio Italia who have registered it in the UK (MAPP 14476). It is marketed in the UK by Belchim Crop Protection via a number of distributors.

Proposed IPM strategies

The proposed strategies were based on *Phytoseiulus* as the season-long control measure with minimal use of Naturalis-L as a SLoD at critical times in the pest's population growth. Two strategies were evaluated:

- The first involved releasing small numbers of *Phytoseiulus* into spider mite colonies in the early season and, once established, applying Naturalis-L to slow down the pest's population growth thus allowing the predators more time to achieve control.
- The second strategy was to combat spider mites during hot weather later in the season when they multiply particularly rapidly in the tops of the plants causing serious damage to tomato growing points and webbing on cucumber plants. This may have been a challenge for the entomopathogen because hot dry conditions are not conducive to fungal growth. Furthermore, the primary biological agent, *Phytoseiulus*, prefer cooler conditions lower down the plant and thus contribute less to the overall control of the pest.

The trials

There were a total of six trials; three in cucumber crops and three in tomato crops. The preliminary trial in each crop was to develop experimental techniques, highlight potential difficulties and provide an indication of the level of spider mite control that may be expected under ambient growing conditions in commercial crops. The second and third trials in each crop tested the mid-season and early season strategies respectively. All cucumber trials were done on the 'green form' of *Tetranychus urticae*, while all tomato trials were done on a 'red form' of the *Tetranychus urticae* / *Tetranychus cinnabarinus* complex.

In each case, researchers selected areas of a mature crop with reasonably even infestations of spider mites. *Phytoseiulus* were already established on the plants but numbers were too small to provide control of the spider mite population. In addition, the predatory bugs, *Macrolophus caliginosus*, were present in the preliminary and mid-season tomato trials. Naturalis-L was diluted to 1.5 litres of product per 1,000 litres water (the label rate for this product is 3 litres in 1000 litres but the technical notes suggest trials have shown that a concentration of 1.5 litres per 1000 litres provides similar levels of control in most situations). In the preliminary tomato trial, the product was diluted in 2,000 litres of water, which is half the recommended label rate. All sprays were applied by a NRoSO registered operator using the nursery's own spraying equipment taking care to ensure optimum cover of the undersides of the leaves. Samples were taken of the product and tested at Warwick University to determine the concentration of colony forming units (CFUs). Temperature and relative humidity within the glasshouse during each trial period were monitored and recorded via the nursery's environmental control computers.

In the cucumber trials, numbers of live and dead spider mites and *Phytoseiulus* were recorded in the treated and untreated control plots approximately 7 and 21 days post-treatment. Percentage mortality was calculated to determine the efficacy of each treatment. In addition, we looked at the changes in the proportion of predators to spider mites and the impact on plant damage to determine whether the overall SLoD strategy was successful. A slightly different approach was taken in the tomato trials where we focused on the post-treatment changes in the size of the spider mite and predator populations. In all cases (except the preliminary tomato trial), samples of mite cadavers were incubated on damp filter paper in Petri dishes to encourage fungal growth and thus provide further evidence that death had been caused by infection by *B. bassiana*.

Overall results and conclusions

The results from the three cucumber trials are summarised in Table A. It was reasonable to assume that the difference between the mortality in the untreated controls and the mortality in the Naturalis-L treatment was a direct result of the application of that product and it is those differences that are presented in the table. Mortality of spider mites and *Phytoseiulus* ranged from 27% to 57% and from <0.1% to 12% respectively. Following incubation on damp filter paper, fungal growth was recorded on 10-30% of spider mite cadavers but it was quite rare to see such growth on *Phytoseiulus*. The potential of Naturalis-L to become a reliable SLoD treatment against spider mites can be illustrated by examining the changes in ratios of predators to spider mites over time. We aim for a ratio lower than 1:20 and this was achieved in all three trials. No further action against spider mites was required in any of the treated areas and the plants rapidly grew away from the pest damage. In contrast, all the control plots required additional treatments. The results showed a common trend and clearly indicated that Naturalis-L could provide an effective SLoD treatment to support *Phytoseiulus* against spider mites in cucumber crops.

It is important to highlight observations made on the condition of spider mite cadavers following treatment in all the cucumber trials. In each case, it was noted that a large proportion of the cadavers showed symptoms which were more consistent with death caused by the oil component of the formulation than by fungal parasitism. While this was unexpected, it did not necessarily detract from the success of the trials which were aimed at evaluating the effect of the whole product rather than any single component.

Table A. Summary of mite mortality and ratio of predator to prey in cucumber trials.

		Preliminary trial	**Early-season trial**	**Mid-season trial**
CFUs in product (ml^{-1})*		5.79×10^7	3.04×10^6	2.28×10^7
% mortality	Spider mites	43%	57%	27%
	Phytoseiulus	8%	12%	<0.1%
Fungal growth	Spider mites	20%	20-30%	10-20%
on cadavers	Phytoseiulus	0%	trace	0%
Ratio	Pre-treat	-	1:50	1:45
Phytoseiulus:SM	Post-treat	1:13	1:4	1:18

(* Label states minimum of 2.3×10^7 CFUs per ml^{-1})

The results from the three tomato trials are summarised in Table B. The preliminary and mid-season trials showed a trend which was comparable to the results from the cucumber trials. In each case, control was assisted by *Macrolophus* and the ratio of *Phytoseiulus* to spider mites dropped below the 1:20 level with no further action being required against the pests.

The apparent effect of the oil component of the formulation was again noted in the mid-season trial. Overall, the results of these two trials indicated that Naturalis-L could provide an effective SLoD treatment against spider mites on tomato plants. However, the results in the early-season trial were quite different. Numbers of spider mites in the treated plots increased 5.2 fold during the seven days post-treatment. There was unacceptable damage to the heads of the plants and treatment with the conventional acaricide, spiromesifen (Oberon), was required to prevent serious crop loss.

Table B. Summary of the change in size of mite populations and ratio of predator to prey from the tomato trials.

		Preliminary trial	**Early-season trial**	**Mid-season trial**
CFUs in product (ml^{-1})*		5.79 x 10^7	1.84 x 10^5	6.38 x 10^5
Population change	Spider mites	60% mortality	5.2 fold increase	10 fold decrease
	Phytoseiulus	0% mortality	2.7 fold increase	2 fold increase
	Macrolophus	0% mortality	Very few present	2 fold increase
Fungal growth on cadavers	Spider mites	-	Too few cadavers	5-10%
	Phytoseiulus	-	Too few cadavers	trace
Ratio Phytoseiulus:SM	Pre-treat	-	1:48	1:44
	Post-treat	1:13	1:30	1:3
Ratio Macrolophus:SM	Pre-treat	-	Very few present	1:105
	Post-treat	-	Very few present	1:5

(* Label states minimum of 2.3 x 10^7 CFUs per ml^{-1})

The reason for the failure of the early-season tomato trial was not immediately apparent. The following factors were taken into consideration:

- The laboratory tests showed a low CFU count in the product used in that trial. This was the same production batch as used in the successful mid-season tomato trial; the main difference being that the product used in the early-season trial had been stored according to the manufacturer's recommendations for an additional eight months. A low CFU count had also been recorded in one of the cucumber trials without resulting in treatment failure. Therefore, the treatment failure in the early-season tomato trial could not be solely attributed to the number of CFUs in that batch of Naturalis-L.
- The temperature at the time of application of the early-season treatment was high for the time of year; the means for the 24 hour and 7 day periods post application being 2.6^{o}C and 1.2^{o}C hotter than the mid-season trial respectively. However, the relative humidity

was marginally higher during the early-season trial than the mid-season trial which should have favoured the fungus. The difference in the results could not be attributed to environmental conditions.

- A third consideration was the presence of much greater numbers of *Macrolophus* in the crops in mid-season compared to early-season. However, if that were the main factor, then we might have expected to see more parity between the level of spider mite control in the Naturalis-L plots and the untreated plots. This was not the sole cause of the treatment failure.
- It is possible that the oil in the formulation had a direct impact on the spider mite populations. If so, that would explain why Naturalis-L performed well in the mid-season tomato trial and the early-season cucumber trial despite low CFU counts. However, it would not explain why the product performed badly in the early-season tomato trial unless the oil component of the formulation had degraded during the extended storage period. Since these trials, the manufacturers have modified their recommendations to state that the product should be stored at 4-5^{o}C.

It seems unlikely that we will entirely explain the disparity between the results obtained from the tomato trials.

Financial Benefits

- Spider mites are extremely damaging pests and if left uncontrolled will destroy cucumber and tomato crops. Depending on the time of season, this could result in losses exceeding £100k per hectare. A successful IPM control strategy would eliminate the risk of such losses.
- The cost of control measures varies enormously between nurseries and depends upon the adopted control strategies; the most expensive tend to be those which attempt to control spider mites without any intervention with non-specific synthetic pesticides. If we take into account the cost of biological control products and corrective sprays, as well as the labour required for intensive crop monitoring and repeated release of *Phytoseiulus,* then the total cost can exceed £5k per hectare. It is estimated that an effective IPM compatible SLoD could provide a 60% reduction in the total costs.
- The total financial burden of managing spider mite populations involves a combination of the cost of the various control measures and the losses incurred due to crop damage. However, there are also other less tangible factors to be taken into account, such as the need to satisfy the standards sought by major food retailers and the potential marketing benefits of eliminating the overall use of broad spectrum chemical pesticides.
- There is no doubt that a reliable IPM compatible control strategy for spider mites will have considerable financial benefits for growers.

Action Points

Naturalis-L applied at 1.5 litres of product per 1,000 litres water (half the label rate) can provide an effective second line of defence to support *Phytoseiulus* against spider mites in cucumber and tomato crops. The product has contact action and growers must take care to ensure optimum coverage of the undersides of leaves where the pest is most frequently found. However, the results to date have not been entirely consistent and the technique requires some fine tuning.