

Project Number	VIE36 IF02		
Project Title	Reducing reliance on pesticides and improving food safety through use of Systemic Acquired Resistance (SAR) for disease control in vegetables		
Vietnamese Institution	Southern Fruit Research Institute (SOFRI)		
Australian Institution	Faculty of Agriculture, Food and Natural Resources, University of Sydney		
Commencement Date	February 2006	Completion Date	July 2006
Objectives			
<ol style="list-style-type: none"> 1. To investigate the replacement of fungicides and pesticides with natural or synthetic compounds that induce production of the plant's natural defences to control disease. The response is known as systemic acquired resistance (SAR). 2. To investigate the use of GRAS (Generally Regarded as Safe) chemicals as an effective control of plant diseases. 			
Activities			
<ol style="list-style-type: none"> 1) The 2 month field trial, conducted on cucumber crops, will commence in February 2006 at the SOFRI Research Station. 2) The trial will include 8 treatments with 4 replicate plots of 50 plants/ plot. 3) The treatments, to be applied at fortnightly intervals beginning 7 days after sowing, in the trial will be: <ul style="list-style-type: none"> • Silica SAR inducer • Thiovit (Sulfur) GRAS protective spray • BTH SAR inducer • Thiovit + Silica • Thiovit + BTH • Tea Tree oil formulation GRAS protective spray • Commercial fungicide • No treatment 4) Some plants within each block will be inoculated with powdery mildew 48 hrs prior to spraying to ensure there is some disease pressure on the trial. 5) The treatments will be used on their own as well as in combination in an effort to understand the longevity of the SAR response under Vietnamese conditions and disease pressure. 6) The trial plots will be assessed weekly for incidence and severity as described below and the yield and dry weight of the plants will be recorded at the end of the trial. 7) At least one field day using the trial plots will demonstrate the benefits of SAR and GRAS to farmers and researchers. 			
Milestones			Expected Date
Nb	Milestone Description	Deliverables	
1	CARD Contract Signed	• Research Agreement signed. Milestones and payment schedules in place	November 2006
2	Research Report	• A summary report of all trial results, together with an evaluation of the potential for SAR and GRAS compounds as commercial alternatives to fungicides for vegetable production in Vietnam. This report is also expected to analyse the potential financial benefits of SAR and GRAS for smallholder farmers in Vietnam.	June 2005

FINAL REPORT

(Report of Pilot SAR trial on Cucumbers in Vietnam, February 2006)

Introduction

Fungicides are currently the principle management tool for control of crop plant pathogens, however there is continuing pressure for safer control methods to reduce the risk of residues, reduce the incidence of disease resistance and reduce harm to the environment. One strategy is to replace fungicides and pesticides with natural or synthetic compounds that induce production of the plant's natural defences to control disease. The response is known as systemic acquired resistance (SAR). The other is to use GRAS (Generally Regarded as Safe) chemicals which can control plant diseases. These compounds are not dangerous to human health and not expensive. Therefore, all vegetable growers can easily integrate SAR or GRAS technology into their existing disease control strategies.

Integrating SAR or GRAS compounds means that the number of synthetic pesticide applications can be dramatically reduced. Systemic fungicides are very effective for disease control however disease resistance can develop quickly if they are over used. The integration of SAR and GRAS chemicals means that the development of resistance is delayed which is another important benefit for growers.

SAR technology has only recently been introduced in many developed countries including Australia. In Australia, it has been recognized as an important part of an integrated disease control strategy in industries such as cotton and increasingly horticulture. Enhanced plant protection through SAR is not used in Vietnam. This project aimed to carry out a field trial at the SOFRI Research Station in the Mekong Delta to demonstrate the potential benefits of using these chemicals as part of an integrated disease control strategy for cucumbers.

Experimental Plan

The chemicals were sent to SOFRI, Vietnam from the University of Sydney including MSDS sheets for each one using the freight company DMG Australia in January 2006.

The field trial was conducted on cucumber crops planted on the 13th February 2006 on a grower's property near SOFRI. The trial ran for 2 months with the final harvest on the 22nd March 2006. Robyn McConchie and Jenny Jobling visited SOFRI on the 22nd February to help set up the trial and apply the first application of chemicals (Photos 1, 2 and 3).



Photo 1. Robyn and Cuong writing labels



Photo 2. Cuong walking to trial site



Photo 3. Jenny mixing chemicals for trial

The trial included 9 treatments with 4 replicate plots of 24 plants/ plot. The plots went across the channel with 12 plants either side of the channel. There were 2 plants at the beginning and end of each plot that were untreated buffer plants.

The treatments in the trial were:

		Rate/timing
1. Silica (AgSil (71%) 25A)	SAR inducer	1g/L pH 6.5, weekly
2. Thiovit (Sulfur)	GRAS protective spray	2g/L, weekly
3. BTH (Bion)	SAR inducer	0.1g/L, weekly 50ppm active ingredient
4. Thiovit + Silica		alternate weekly
5. Thiovit + BTH		alternate weekly
6. Timorex (Tea Tree oil)	GRAS protective spray	10mL/L, (1% solution) weekly
7. Commercial fungicides	Ridomil + Antracol	recommended rate alternate weekly
8. Silica + Thiovit + Ridomil	Integrated strategy	weekly rotation
9. Water		weekly

All treatments had a wetting agent added and the pH of silica was adjusted to pH 6.5 using 5M HCl (5ml/L). The chemicals were applied until there was leaf run-off.

The trial plots were labelled and the plants that were to be assessed weekly for disease incidence and severity were tagged prior to the application of the first spray. The chemicals were applied in the cool of the morning (Photos 4, 5, 6 and 7).



Photo 4. Cuong organising plot and block labels



Photo 5. Tagging plants



Photo 6. Counting plants each plot had 4 untreated buffer plants



Photo 7. Spraying plants

Treatment application and assessment

The treatments were applied at weekly intervals beginning 7 days after sowing. They were applied on the 22nd Feb, 1st March, 7th March, 15th March and the 22nd March.

The trial plots were assessed weekly for incidence and severity as described below and the yield was recorded at the end of the trial.

1. Disease severity

The severity of the top leaf surface was assessed. Ten leaves per replicate plot were selected at random each week, 5 from either side of the channel. Two leaves from the top, 1 from the middle and 2 from the bottom were taken to give a range of leaf ages. We had expected powdery mildew to be the main disease but downy mildew was the dominant disease as the weather was too hot for powdery mildew. The severity of downy mildew was recorded each week as a percentage of leaf area with symptoms of downy mildew.

2. Assessment of disease incidence

For each treatment, incidence was scored by counting the number of plants (out of a total number of 5 data plants per plot per replicate) that had symptoms of downy mildew. This assessment was recorded weekly.

3. Yield measurements

As the fruit reached marketable size harvesting began on the 18th March and continued every day until the 22nd March. Fruit were saleable when they reached a size of at least 18 – 20cm long and were straight. Curved and small fruit were deemed unsaleable. The total yield was determined by recording the number and weight of fruit for each treatment. The number of saleable fruit per replicate plot was also recorded.



Photo 8. Harvesting and weighing cucumbers



Photo 9. Marketable fruit



Photo 10. Unmarketable fruit

RESULTS AND DISCUSSION

Severity of Disease

The results from this field trial show that the softer SAR and GRAS chemicals were at least as effective for controlling downy mildew as the commercial fungicide treatment (Ridomil + Antracol) when used on cucumbers in the MyTho area in Vietnam (Figure 1).

The combined treatment of Silica (SAR), Sulfur (GRAS) and Ridomil (Systemic fungicide) applied in a 3 weekly rotation had the lowest mean incidence of downy mildew 36 days after planting (Figure 1). However this treatment was not significantly different from other treatments including BTH and Sulfur rotated weekly and Tea tree oil (Figure 2). This means that there are potentially several options for growers in terms of the disease control strategy for downy mildew. More work is needed to confirm these results for different seasons, locations and cucurbit crops but these results are very promising.

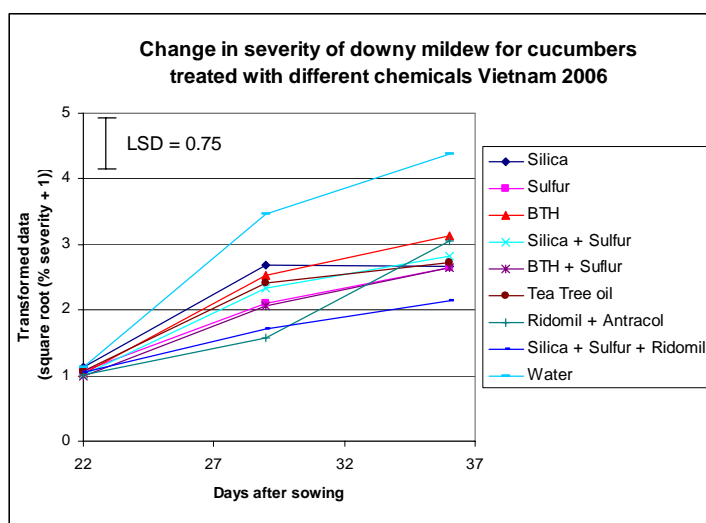


Figure 1. The effect of different chemicals on the severity of downy mildew on cucumbers in Vietnam 2006 (n=10 leaves, analysis done on transformed data).

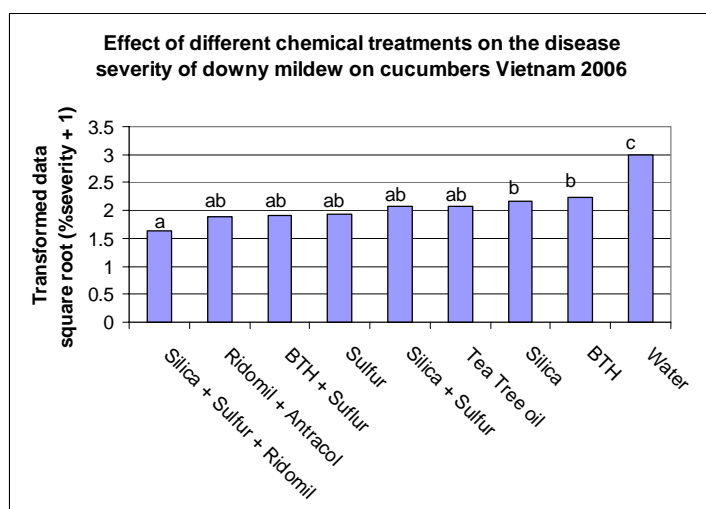





Figure 2. The effect of different chemicals on the incidence of downy mildew on the cucumbers in Vietnam. There was a significant main effect for treatment.

The raw severity data was transformed prior to analysis. It is important to note that the sampling for severity included 2 young leaves, 1 middle ages leaf and 2 old leaves samples on either side of the channel giving a total of 10 leaves. In most cases the young leaves showed no disease symptoms and so the average data does not indicate the very severe symptoms seen in the water treatment for example. In the water treatment the disease severity was up to 70 to 80% for infected leaves. In most other treatments the severity of symptoms in the older leaves ranged from 10 to 50%.

Table 1 shows the visual effects of the treatments and the leaves for the Silica + Sulfur + Ridomil look as green as the Ridomil + Antracol treatment with only the older bottom leaves showing severe symptoms. The water treatment as was expected has very few green leaves after 36 days as a result of very severe levels of downy mildew infection.

Table 1. Visual effects of the main treatment for controlling downy mildew.

Visual effects of chemical treatments 36 days after sowing.

Silica + Sulfur + Ridomil

Ridomil + Antracol

Water

Fruit Yield and Quality

Plants with healthy leaves are able to produce higher yields of marketable fruit. Again there was no significant difference between the marketable yield or total fruit numbers of the chemical treatment Ridomil + Antracol and combinations of softer SAR and GRAS compounds (Figure 3). The combined treatment of Silica + Sulfur + Ridomil in a three week rotation looks promising however BTH alone performed well and may be even more

effective in combination with Sulfur + Ridomil. This treatment was not trialled in this field trial but this combination will be tested in future work.

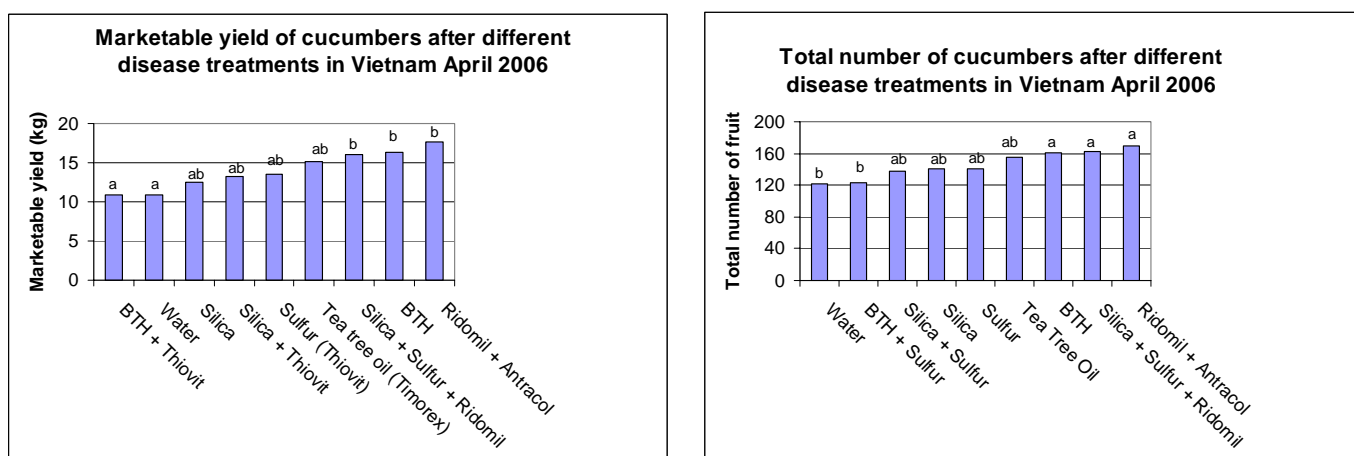


Figure 3. The effect of different chemicals on the marketable yield and total number of cucumbers in Vietnam 2006.

Cost Benefit Analysis

One of the key drivers for change will be the cost benefit to the growers for using different control strategies. In work already completed in China using SAR in melons it was shown that there was a 12% cost benefit for growers for using SAR chemicals as they were cheaper and also had the advantage of providing a postharvest storage benefit. A similar result would be expected in Vietnam. It is also important to emphasise the indirect benefits from using softer chemical options and they include a reduction in chemical residues which improves the credibility of Vietnamese products on export markets and a benefit to the environment and to human health for reducing the level of residues in the environment.

Some of the chemicals are currently available or registered for use in Vietnam such as Sulfur and Silica (as a fertiliser). Others such as BTH and Tea tree oil are registered for us in other countries but not currently in Vietnam. If these these GRAS chemicals are registered in other countries then the registration process in Vietnam is much more straightforward and would not be a limitation for commercialising an integrated disease control strategy in Vietnam.

This pilot trial demonstrated the potential for SAR and GRAS chemicals for disease control in vegetable production in Vietnam. Further work is needed to confirm these results and to develop the best integrated strategy for a range of field conditions.

Achievement of Expected Project Outcomes

The specific outputs for this project were as follows:

- Evaluation of the use of SAR and GRAS compounds as commercial alternatives to fungicides for vegetable production in Vietnam.

Achieved: SAR and GRAS chemicals were as effective as commercial fungicides for downy mildew control in this pilot field trial.

- Vietnamese researchers from SOFRI will learn the basic physiology of the SAR response as well as being able to introduce SAR as a practical solution for farmers.

Achieved: The researchers at SOFRI were given two introductory lectures on the physiology of SAR and were shown how to run small glasshouse trials to determine if the chemicals do induce a systemic response. The field trial was done very well and showed that SAR or GRAS compounds in combination with a systemic fungicide would be the best disease control strategy.

- This project will lead to identification of products that will successfully replace the synthetic fungicides to which diseases have become resistant.

Achieved: This project showed that all the SAR and GRAS chemicals have potential in an integrated disease control strategy. More work is required to determine the best combination under a range of field disease pressures.

- The project also provides an opportunity to demonstrate safe chemical use to researchers and farmers

Partially Achieved: We were able to demonstrate safe preparation methods in the laboratory and as far as possible in the field. However, this objective was not achieved as fully as we would have liked. The pilot trial did identify the need for more chemical safety training for growers in an effort to encourage them to use to safer practices.

- This trial is also an opportunity for the University of Sydney and SOFRI to develop protocols for plant disease field trials that could be used in future pesticide evaluation trials.

Achieved: The staff at SOFRI did an excellent job running and managing the field trial. The initial experimental design and sampling protocols were worked through in collaboration with the University of Sydney. These protocols can be confidently implemented in future trials

Future Work

1. To repeat the field trials to validate the initial results under different field conditions.
2. Trial different combinations of the SAR and GRAS chemicals used in this pilot trial to determine the most effective integrated disease control strategy for cucurbits in Vietnam. In particular, develop protocols that reduce the total numbers of sprays and therefore save on labour.
3. To run workshops and field days to demonstrate the effectiveness of an integrated disease control strategy as well as to provide another opportunity for training in safe handling and disposal of chemicals.