CROP & FOOD RESEARCH
Mana Kai Rangahau
Horticulture New Zealand
MAF Sustainable Farming Fund


INTEGRATED MANAGEMENT OF COVERED CROPS

David Teulon
Bruce Searle
and
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SFF Project – Working Groups

- New incursions - Chris Sinnott, Ben Smith/George Tregidga, John Thompson, Terril Marais, Stephen McKennie
- New biologicals – Terril Marais, Jason Culbert, Hamish Alexander/Jason Cochrane, John Thompson, Ben Smith/George Tregidga, Alan Cliffe
- Chemicals and resistance – Terril Marais, Stephen McKennie, Alan Cliffe, Jason Culbert, Hamish Alexander/Jason Cochrane, John Thompson, Ben Smith/George Tregidga
- Energy efficiency – John Wordsworth, Jason Culbert, Hamish Alexander/Jason Cochrane, David Barton, Ben Smith/George Tregidga, Elly Nederhof
- Technology transfer – As appropriate
- C&FR staff - Bruce Searle, David Teulon, Peter Workman, Mette Nielsen, Ron van Toor, Ian Scott, Melanie Davidson, Nicholas Martin

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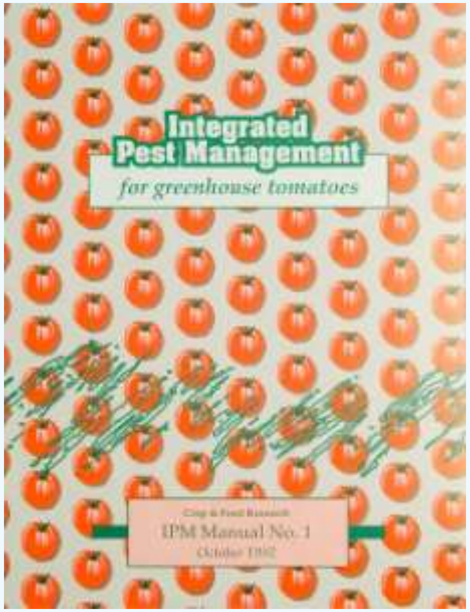
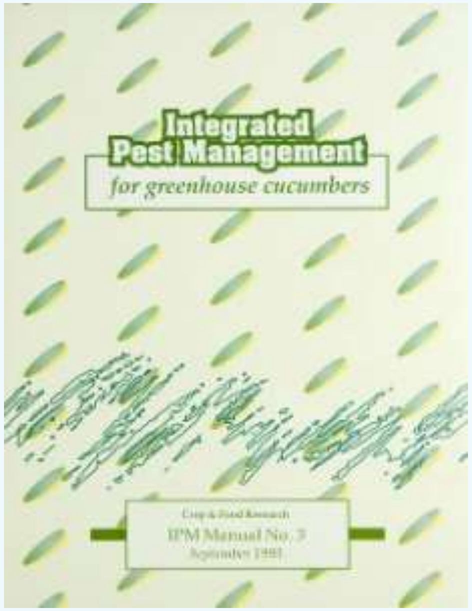
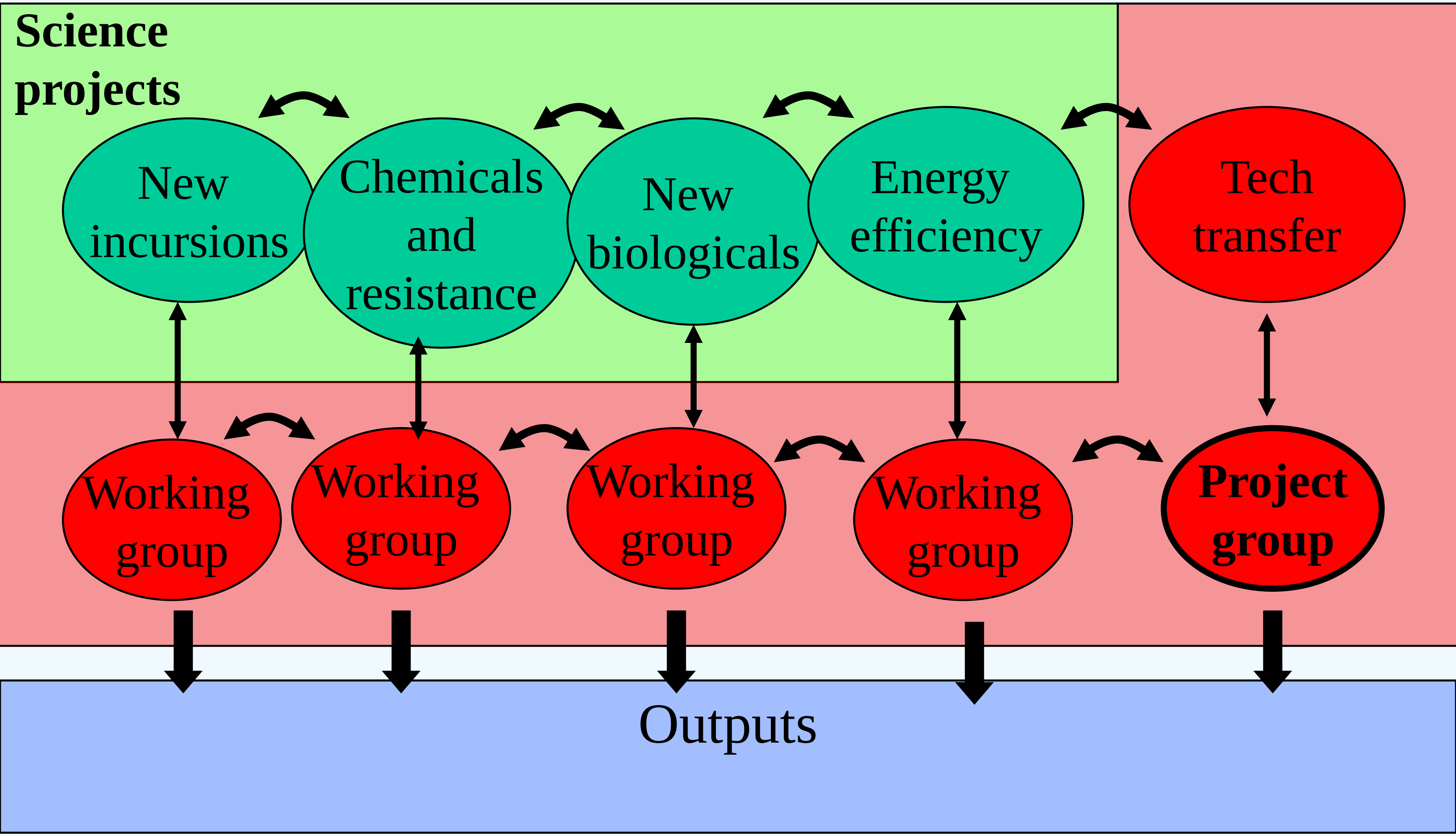




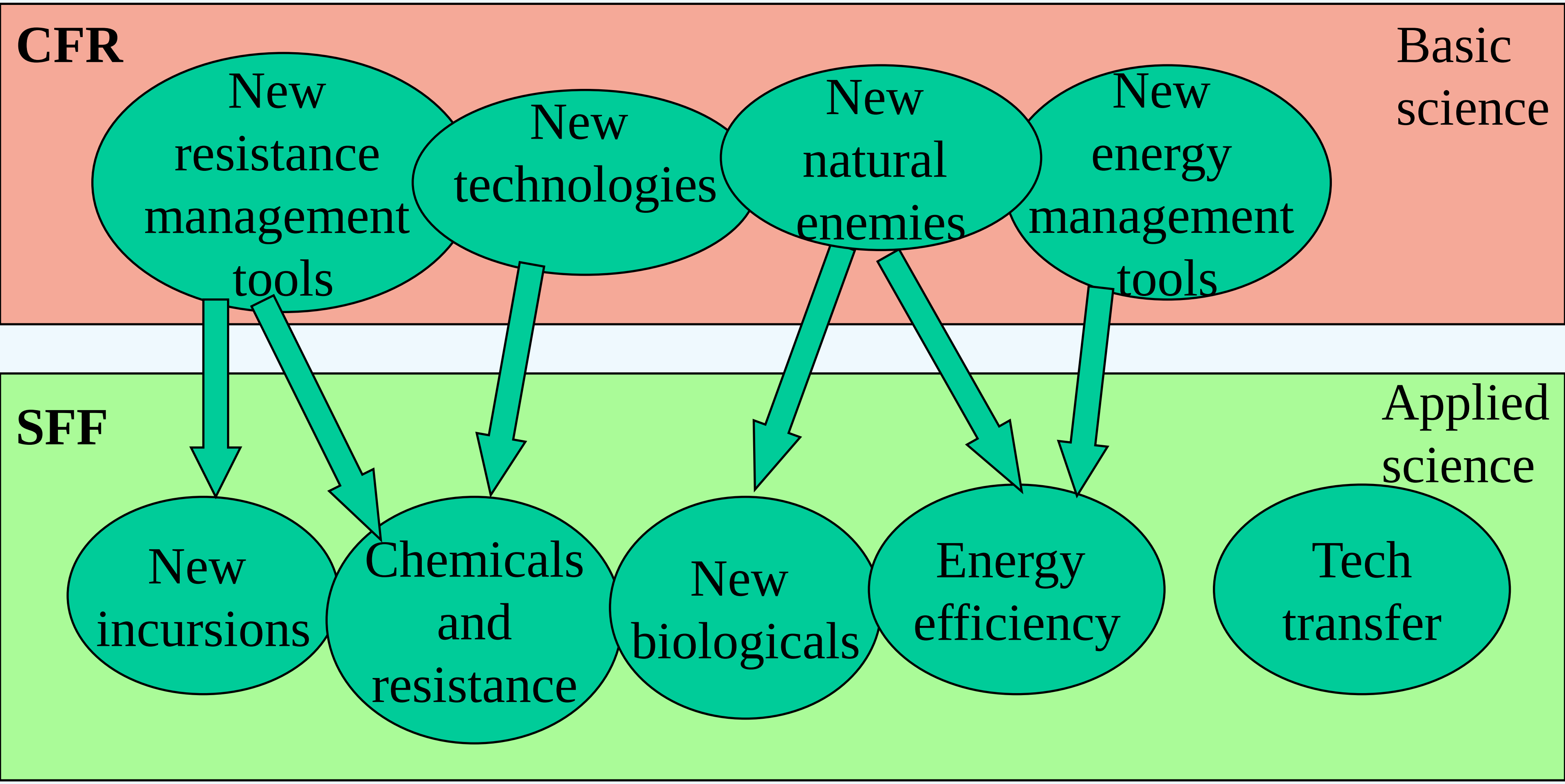
Current project origins

- Designed to build-on previous energy efficiency projects
- Stakeholder workshop priorities:
  - Desire to have IPM but must be effective
  - Impact of increasing energy costs on IPM
  - Options under IPM: biologicals and chemicals
- Response to recent insect incursions

SFF Project structure



SFF Project – CFR Project Link



Additional links to MAF funded project on whitefly incursions and C&FR internally/FRST funded project on semiochemicals

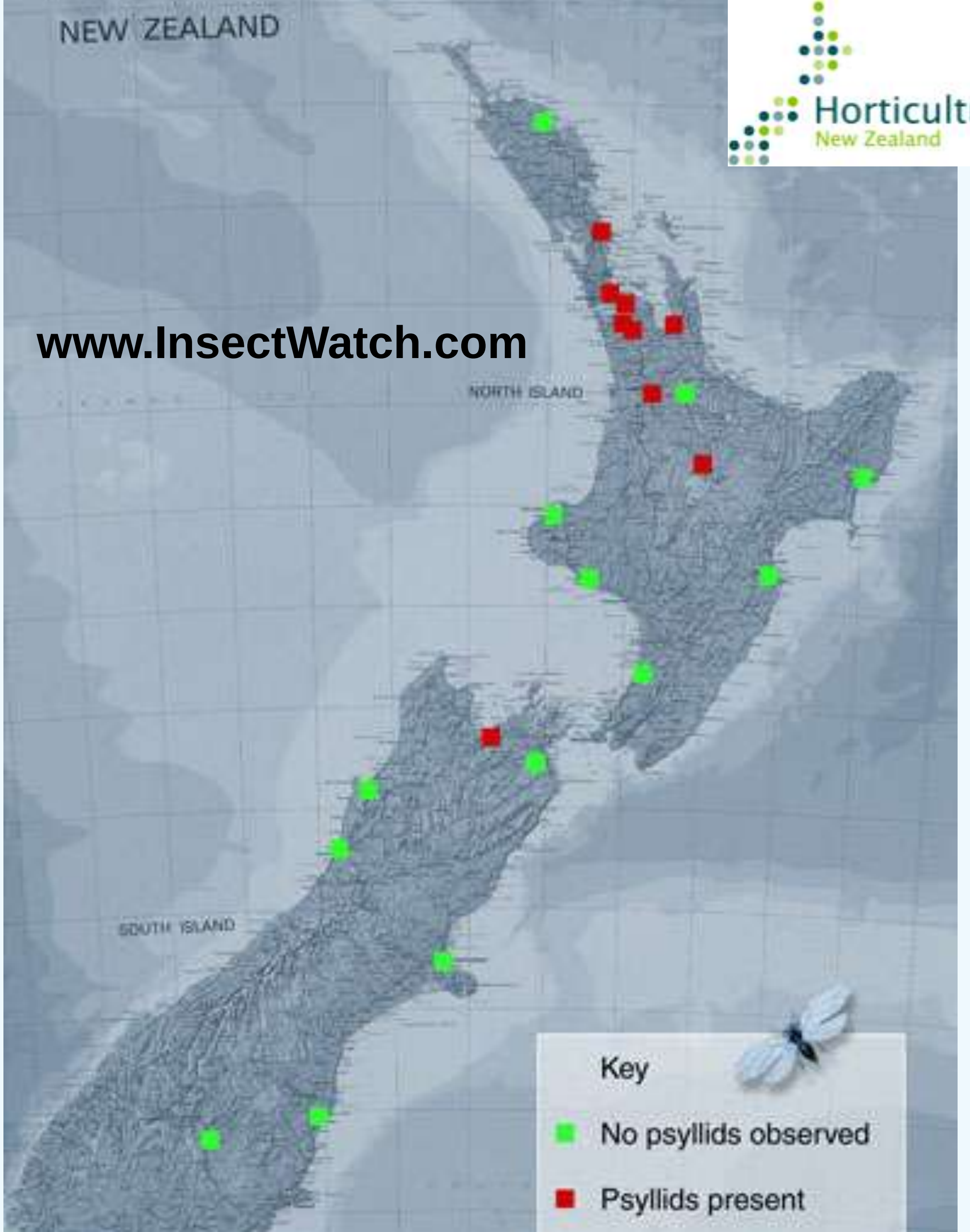
1: New incursions/internal pathways

- **Issue**: Two recent insect incursions (sweet potato whitefly Q, potato/tomato psyllid) are proving very difficult to control
- **Response**: Establish current distribution of each pest and determine their internal pathways for dispersal
- **Outcome**: Internal pathways understood to limit ongoing impact of these and future pests
- **Key staff**: Teulon, Scott, Workman, Nielsen

New pests - Origins and Distributions

- Potato/tomato psyllid, *Bactericera cockerelli*
  - Detected in Auckland in 2005
  - Originated from America
  - Unknown how it was introduced into New Zealand
  - Today the psyllid is found in Nth Auckland, Auckland, Waikato, Coromandel, Taupo and Nelson

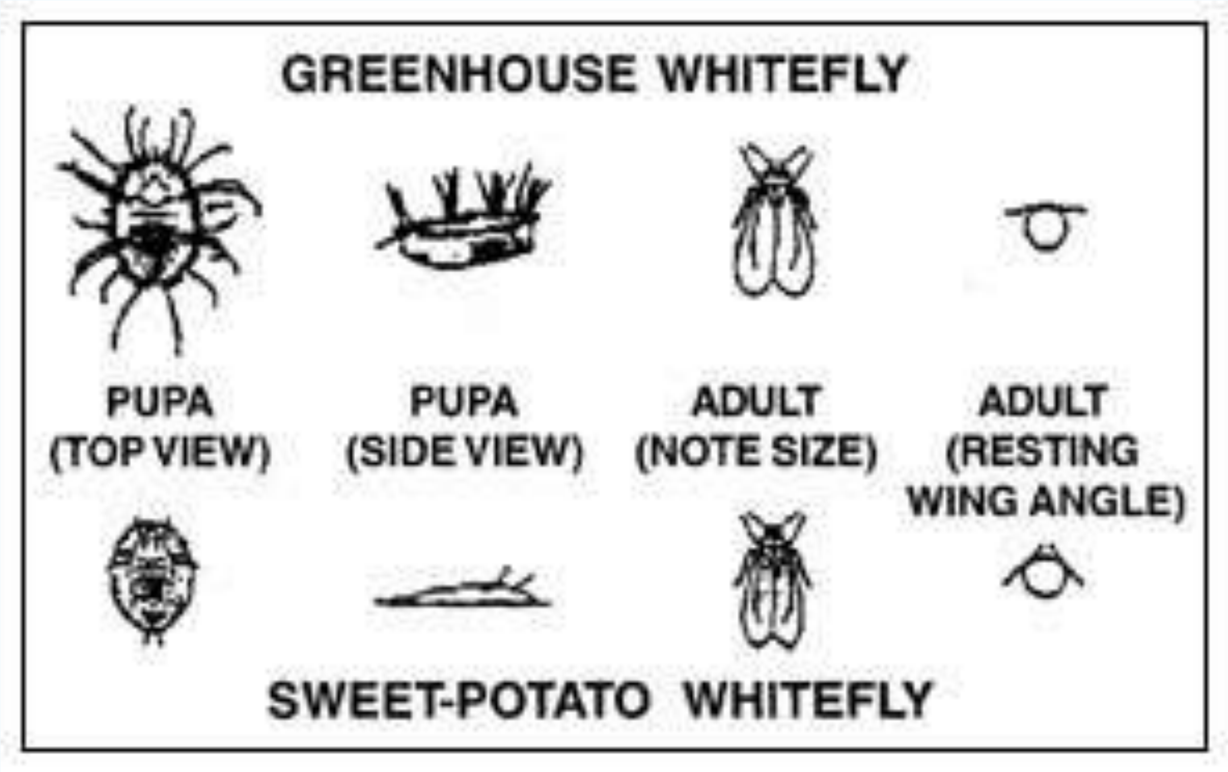
Current potato/tomato psyllid distribution



New pests - Origins and Distributions

- Sweet potato whitefly, *Bemisia tabaci*
  - Biotype B?
    - Spread from Israel from 1980's
    - First detected in Auckland in 1991 on poinsetias
    - MAF survey: Wide spread on the NI on ornamentals
    - Origin unknown, possibly India or Pakistan
  - Biotype Q
    - Spread from Spain from 1997
    - First detected in Auckland in 2006 on greenhouse capsicums
    - MAF survey: June to August 2006, biotype Q was found only at Hamilton Botanical Gardens but on multiple hosts
  - Either Q represents a new, independent incursion in NZ or biotype B was incorrectly identified in '90s
  - Resistance to OPs, carbamates, pyrethroids (B) PLUS neonicotinoids & IGRs (Q)

New pests - Origins and Distributions



NATURE|Vol 443|26 October 2006

THE CHRISTMAS INVASION

The cheerful leaves of the poinsettia could be hiding an unwelcome visitor this festive season. **Rex Dalton** goes in search of the whitefly, a potentially devastating pest.

Bemisia tabaci survey December 2006

Christchurch

- Five outlets, one each from the north, south, east, west and central locations around Christchurch
- Five poinsettia plants were purchased from each location on 19 Dec 2006 and inspected for *B. tabaci*
- All of the individuals screened from the samples showed positive results using the *B. tabaci* (biotype Q) discriminating primer set.

	No. adults per plant				
Outlet	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5
1	**15**	**5**	**9**	**10**	**2**
2	**2**	**1**	**0**	**0**	**1**
3	**19**	**7**	**14**	**24**	**5**
4	**2**	**1**	**6**	**1**	**10**
5	**3**	**0**	**4**	**27**	**1**

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Bemisia tabaci survey December 2006

Auckland

- Five outlets were visited around Auckland City
- Five poinsettia plants were purchased from each outlet on 21 December except at outlet 5
- The Auckland samples are in process of identification

	No. adults per plant [a]24 nymphs				
Outlet	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5
1	1	0	0	0	0
2	0	0	0	0	0
3	0	1[a]	0	0	0
4	1	0	0	0	0
5	0	0	0	0	0

2: New pesticides and resistance management

- **Issue**: New and current pests require new pesticides that are compatible with biocontrol agents and other beneficials
- **Response**: Identify and establish the efficacy of new pesticides along with resistance management strategies to ensure their ongoing use
- **Outcome**: A greater selection of compatible pesticides available for control of key pests. Practical resistance management programmes developed
- **Key staff**: van Toor, Nielsen, Martin

Insecticides effective on pests in covered crops

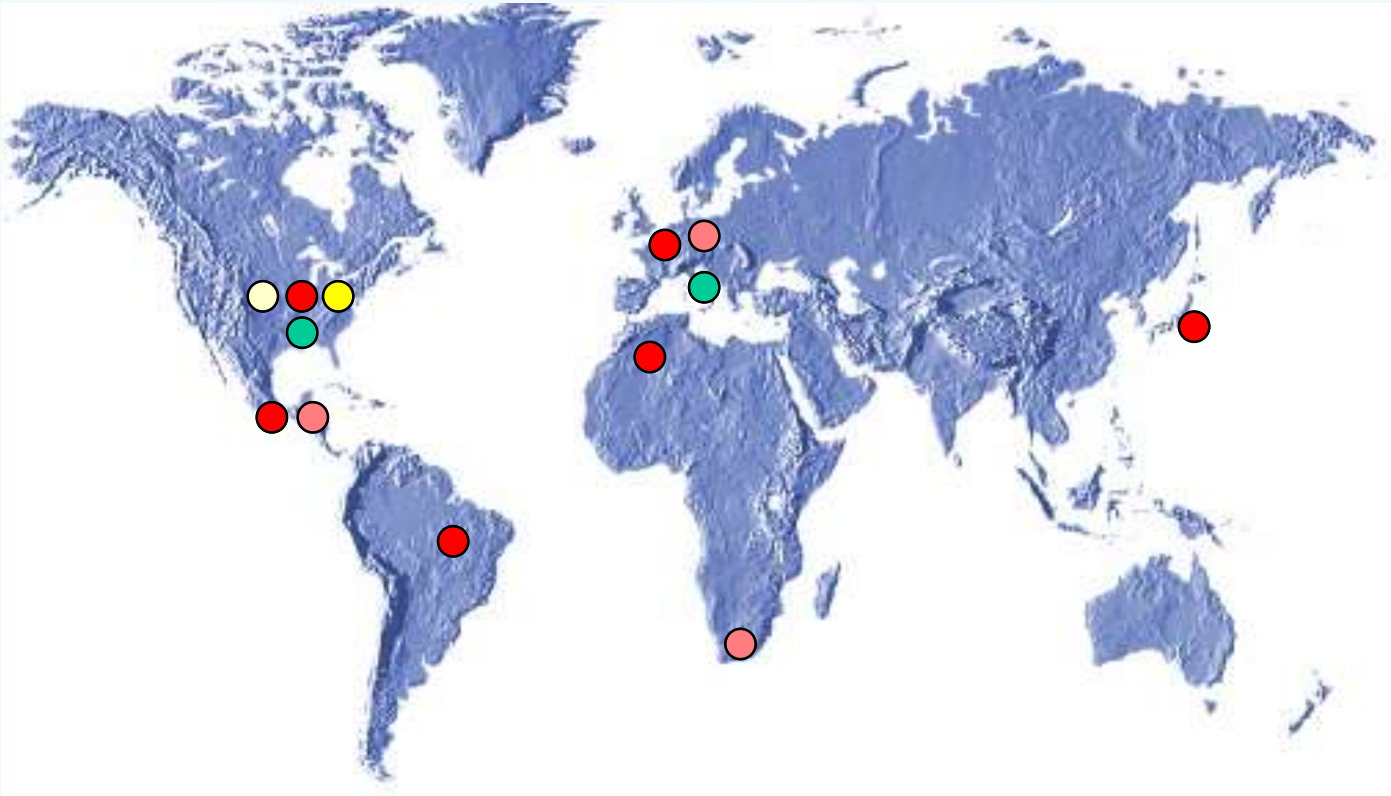
Reg. NZ	Whitefly	Psyllids	Thrips
Covered crops	abamectin (IPM) buprofezin (IPM) dichlorvos methomyl neem oil (IPM) permethrin/pirimiphos-methyl pirimiphos-methyl pymetrozine (IPM) pyrethrum tau-fluvalinate	abamectin (IPM) buprofezin (IPM) dichlorvos methomyl neem oil (IPM) permethrin/pirimiphos-methyl pirimiphos-methyl pymetrozine (IPM) pyrethrum tau-fluvalinate	abamectin (IPM) neem oil (IPM)
Other crops	endosulfan imidacloprid drench thiacloprid drench (IPM)	diflubenzuron (IPM) imidacloprid spinosad (IPM) sulphur (IPM) thiacloprid drench (IPM)	diflubenzuron (IPM) fipronil imidacloprid drench/foliar lufenuron (IPM) maldison methamidophos spinosad (IPM) thiamethoxam drench thiacloprid drench (IPM)
Not reg.	acetamiprid (IPM) pyriproxyfen (IPM) spiromesifen (IPM)	amitraz (IPM) flufenoxuron (IPM) kaolin (IPM) pyriproxyfen (IPM) spiromesifen (IPM) sucrose octanoate (IPM) teflubenzuron (IPM)	acetamiprid (IPM) emamectin (IPM) chlorfenapyr pyridalyl pyriproxyfen (IPM) thiocyclam (IPM)

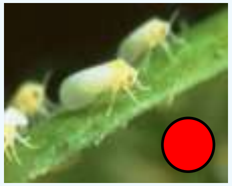
Insecticide resistance recorded in covered crops

	Whitefly		Psyllid	Thrips	
	Bemisia tabaci *(note Q > B)*	***Trialeurodes vaporariorum***	***Bactericera cockerelli***	***Frankliniella occidentalis***	***Frankliniella intonsa***
World-wide	imidacloprid thiacloprid buprofezin dimethoate emamectin endosulfan λ-cyhalothrin methomyl permethrin/pirimiphos-methyl pirimiphos-methyl pymetrozine pyriproxyfen tau-fluvalinate thiamethoxam	imidacloprid dimethoate λ-cyhalothrin	imidacloprid? spinosad	abamectin acephate acrinathrin chlorpyrifos endosulfan fipronil formetanate λ-cyhalothrin thiocyclam	acrinathrin endosulfan
NZ	????	buprofezin methomyl pirimiphos-methyl	????	dimethoate λ-cyhalothrin methomyl methamidophos	????

Covered crops: Neonicotinoid resistance in 16 years

Ralf Nauen, Bayer CropScience





1996
Almeria,
Spain

Whitefly
Bemisia tabaci

2006
Italy
USA

Cotton aphid
Aphis gossypii

2006
Holland
Germany

Whitefly
Trialeurodes vaporariorum

2006
USA

Potato/tomato psyllid
Bactericera cockerelli ?

Suggested resistance management programme: Tomatoes - whitefly and psyllids

- Pre-flowering: thiacloprid drench + foliar synergist (PBO) if resistant; Low toxicity to bumblebees
- Flowering: pymetrozine after 6 wks, with PBO if resistance
- Flowering/fruit set: pyriproxyfen ovacide
- Flowering/fruit set: buprofezin after 3 wks to kill juveniles
- Fruit: spiromesifen to sterilise males & kill mature stages
- Fruit: spiromesifen to kill next cycle of mature stages
- Fruit: permethrin/pirimiphos-methyl (Attack) or tau-fluvalinate; ‘clean-up’
- Methomyl or pirimicarb; ‘clean-up’

3: Biological control agents

- **Issue**: A limited number of biocontrol agents for key pests, including new incursions, in NZ
- **Response**: Identify biocontrol agents from overseas and within NZ, prioritise the ones likely to give the best results and where appropriate introduce new agents for key pests
- **Outcome**: A greater selection of biocontrol agents available for key pests
- **Key staff**: Workman, Teulon, Nielsen, Davidson

Biological control agents (BCA) for psyllids

↓ C&FR ↓ HortNZ

New Zealand: Commercially available	Potential to develop: in New Zealand	Overseas:
There are no commercially available BCA for psyllids in New Zealand	*Adalia bipunctata* (ladybird)	*Tamaraxia triozae* (parasitoid)
	Harmonia conformis (ladybird)	*Chrysoperla carnea* (lacewing)
	Cleobora mellyi (ladybird)	
	Drepanacra binocular (lacewing)	



Biological control agents (BCA) for whitefly

↓ C&FR ↓ HortNZ

New Zealand: Commercially available	Potential to develop: in New Zealand	Overseas: Commercially available
Encarsia formosa (parasitoid)	*Encarsia pergandiella* (parasitoid)	*Delphastus catalinae* (ladybird)
	Eretmocerus eremicus (parasitoid)	*Dicyphus Hesperus* (predatory mired)
	Amblyseius limonicus (predatory mite)	*Macrolophus caliginosa* (predatory mired)
	Cecidomyid (predatory gall midge)	*Amblyseius swirskii* (predatory mite)
	Engytatus nicotianae (mired, omnivorous)	*Eretmocerus mundus* (parasitoid)
	Drepanacra binocular (lacewing)	*Eretmocerus eremicus* (parasitoid)

Biological control agents (BCA) for thrips

↓ C&FR ↓ HortNZ

New Zealand: Commercially available	Potential to develop: in New Zealand	Overseas: Commercially available
Neoseiulus cucumeris (predatory mite)	*Amblyseius limonicus* (predatory mite)	*Orius laevigatus* (predatory bug)
Hypoaspis aculeifer (predatory mite)	*Orius vicinus* (predatory bug)	*Amblyseius degenerans* (predatory mite)
Steinernema feltiae (nematode)	*Ceranisus menes* (parasitoid)	*Typhlodromips montdorensis* (predatory mite)
		Amblyseius swirskii (predatory mite)

4: Balancing Crop Production with Pest Management

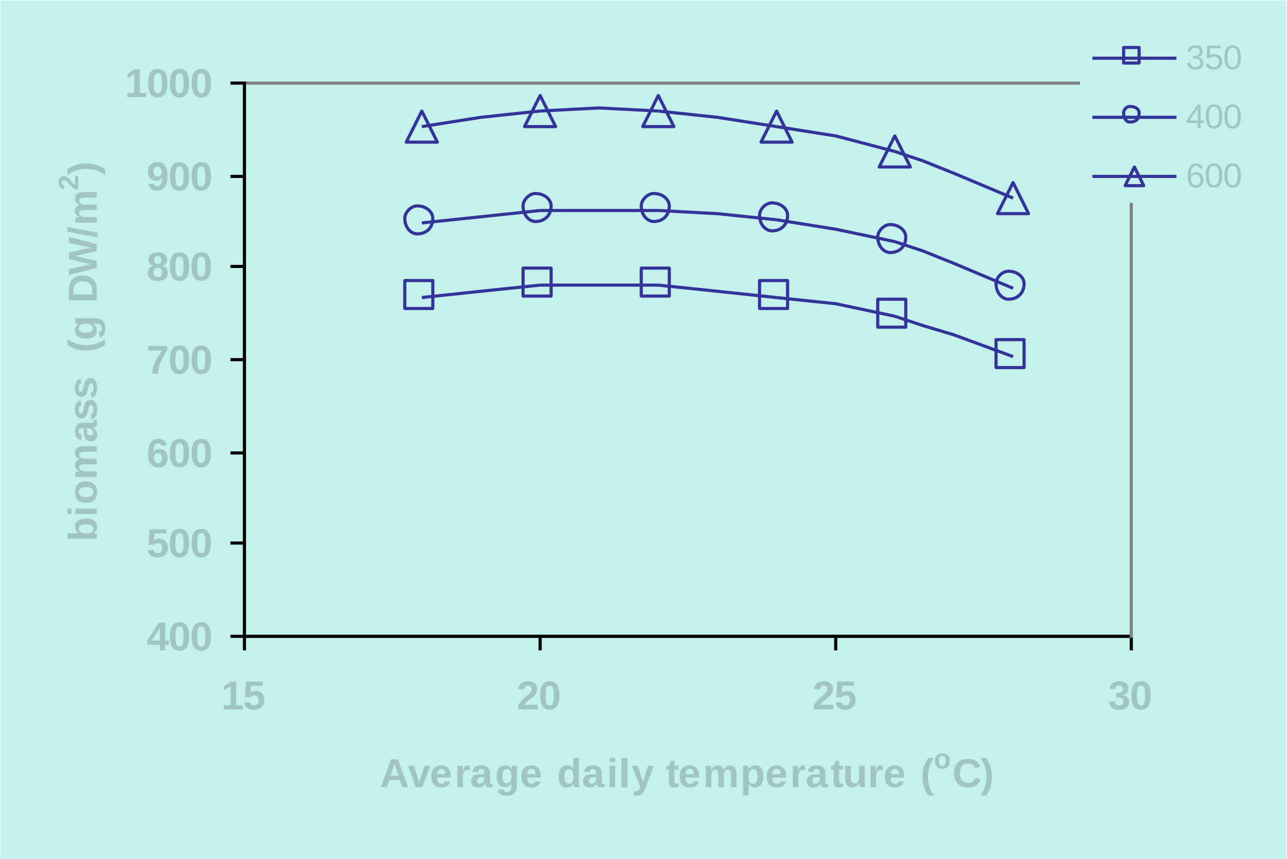
- **Issue**: Reduction of energy inputs into the system will affect growth and also insect pest/beneficial's interaction
- **Response**: Identify best environment for beneficial insect use, evaluate economics of CO_2 use and identify models to help understand the system.
- **Outcome**: New management tools to help make decisions on managing greenhouse environments during crop growth, to maximise growth and optimise pest control
- **Key Staff**: Searle

Balancing Crop Production with Pest Management

- Is CO_2 use worthwhile?
- Can light be used more efficiently?

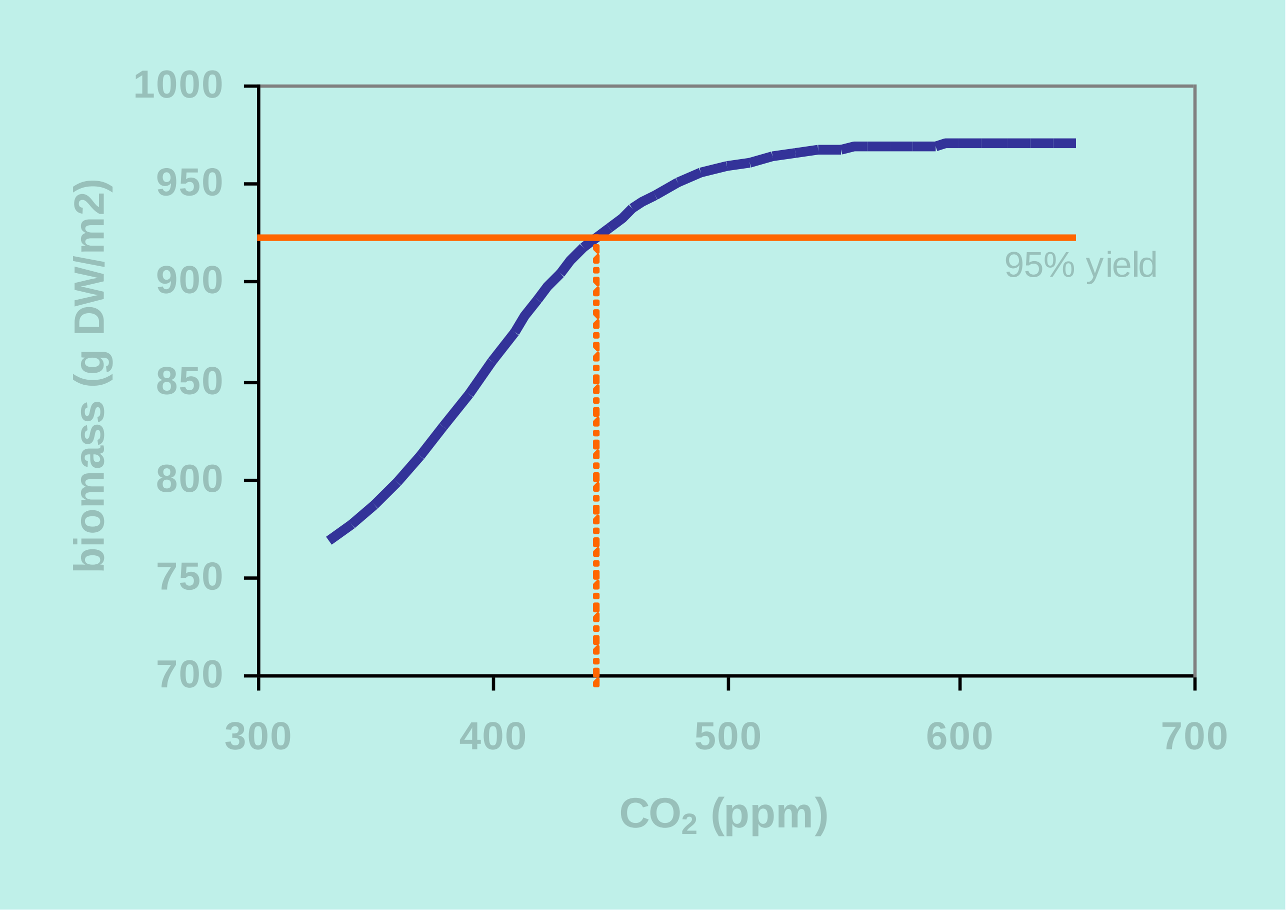
- Experiments to cover all possible scenarios prohibitive
- Instead use a crop model to evaluate these factors

Crop response to temperature at different CO_2 levels



Not very responsive to temperature – optimum 20-22ºC

Crop responds to CO_2



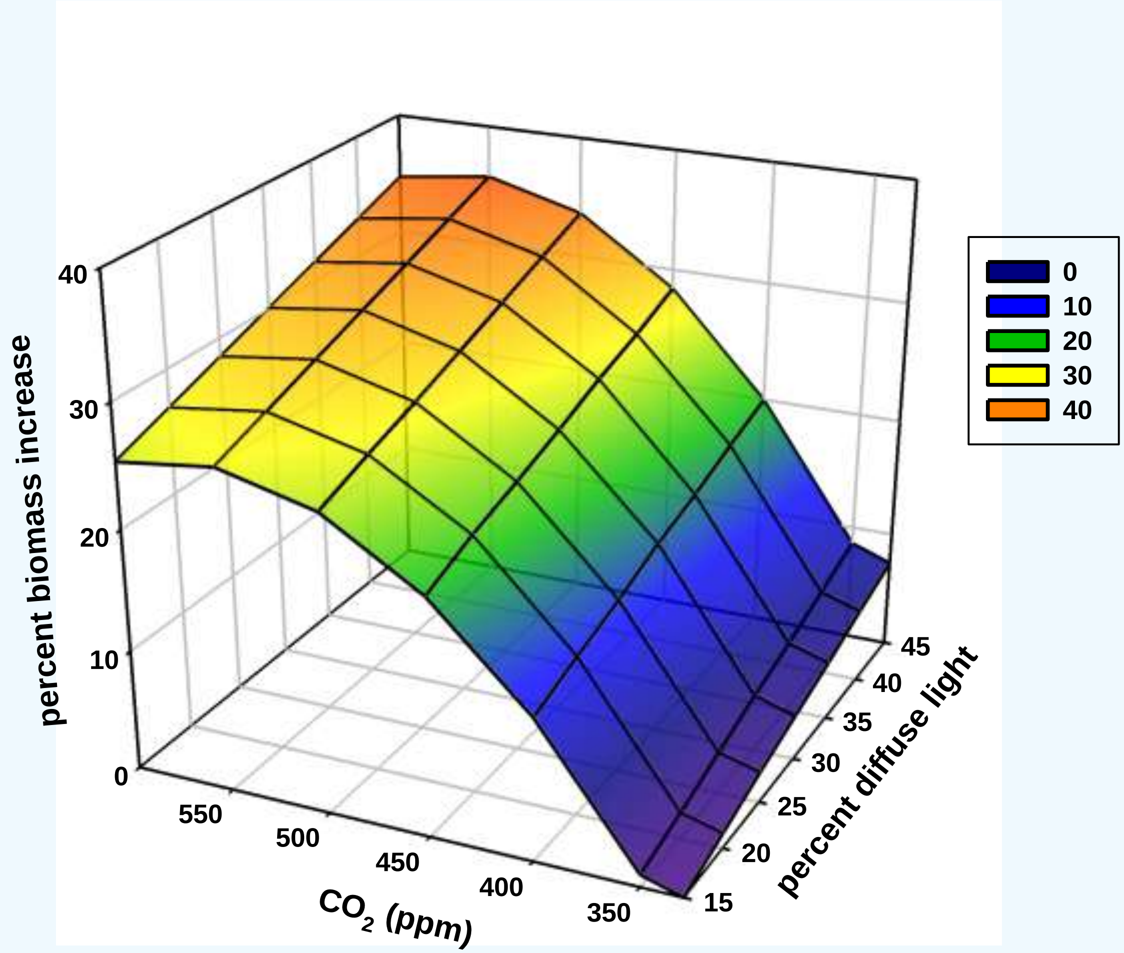
Increasing CO_2 above 440 ppm probably not economic

Effect of light

- Solar radiation can be
  - Direct (on a sunny day)
  - Diffuse (on a cloudy day)

- Use of CO_2 is more efficient with diffuse light
- May be able to increase the amount of diffuse light in greenhouses by use of different coatings/screens

Effect of light

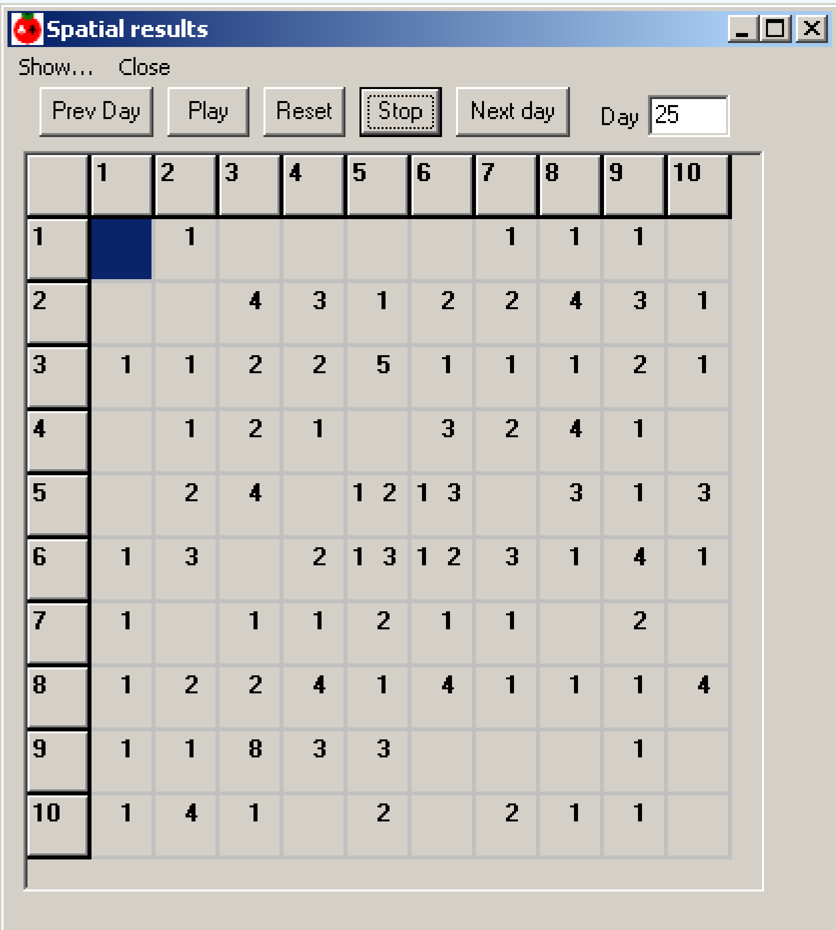


Increasing diffuse light can increase yields by 9%

Some initial conclusions

- CO_2 use is worthwhile up to 440 ppm
- Further increases in CO_2 above 440 ppm will increase yields but may not be an efficient use of energy
- Increasing diffuse light can increase yields by 9% at a given CO_2 level

Encarsia-whitefly model



	1	2	3	4	5	6	7	8	9	10
1		1					1	1	1	
2			4	3	1	2	2	4	3	1
3	1	1	2	2	5	1	1	1	2	1
4		1	2	1		3	2	4	1	
5		2	4		1 2	1 3		3	1	3
6	1	3		2	1 3	1 2	3	1	4	1
7	1		1	1	2	1	1		2	
8	1	2	2	4	1	4	1	1	1	4
9	1	1	8	3	3				1	
10	1	4	1		2		2	1	1	

- Modelling Encarsia-whitefly interactions on tomatoes to identify best conditions for whitefly control
- Models growth of insects in response to temperature
- Identifies parasitized whitefly
- Each grid is an identified location in greenhouse

What else?

- Model canopy energy flows and micro-climates to identify conditions conducive to fungal infection and possibilities for reducing energy inputs while maintaining ideal canopy micro-climates for plant growth

5: Technology transfer

- **Issue**: How is information best communicated and presented in ways that are useful to growers
- **Response**: The project will have established working groups to ensure interaction of science conclusions with practical grower concerns
- **Outcome**:
  - Information presented in formats that are appropriate and useful, including web
  - Plan for implementation of ongoing technology transfer for industry completed
- **Key staff**: As appropriate