From R&D through to commercialisation: Developing an effective IPM system

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Drivers of change

Moving from production supported by chemical inputs, to ones utilizing **biological** and **ecosystem health** approaches:

- Societal – worker and environmental health

- Regulatory – withdrawal of registration for existing pesticides, reside issues, incentives (e.g. the EU's 2009 Sustainable Use Directive)

- Resistance – many older products are failing

- Economic – markets demanding foods without residues, produced using 'sustainable' methods

The Canadian landscape for biological products
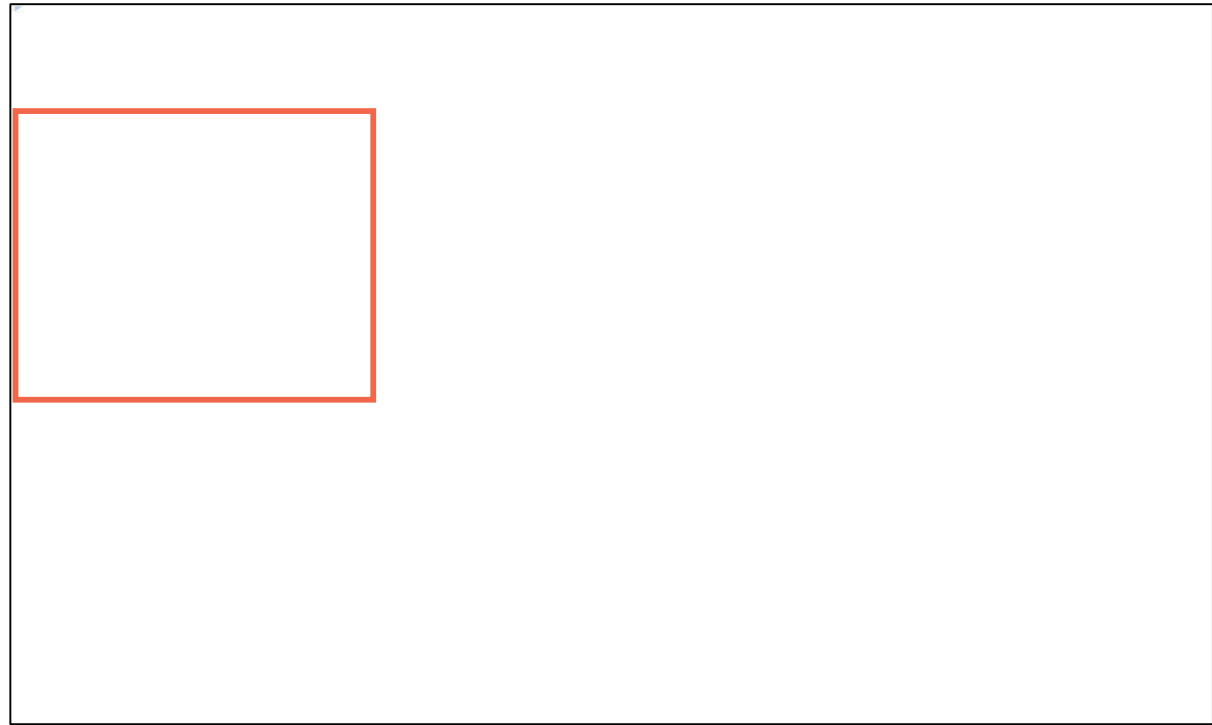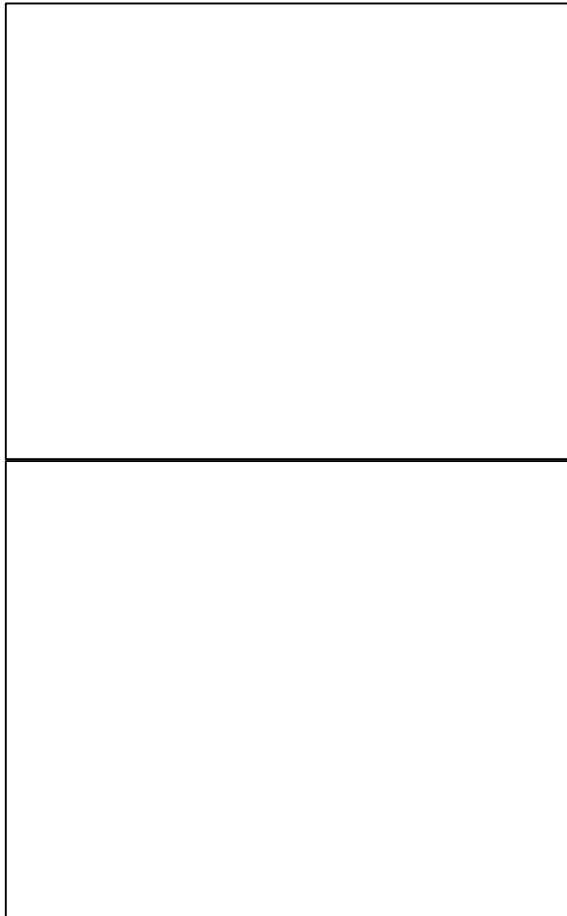
How can we help practitioners achieve sustainability goals?
End-users' needs should help to drive the RD&D agenda

PESTS	DISEASES
Compatible sprays	Reduce cost
Improve quality (consistency, better efficacy)	Improve product efficacy
BCA combinations to improve efficacy	Improved application methods/ease of use
Aphid control	More biocontrol products
Reduce cost	
BCAs for new pests and invasives	
BCAs for new crops	

Must be able to demonstrate the value proposition

Research
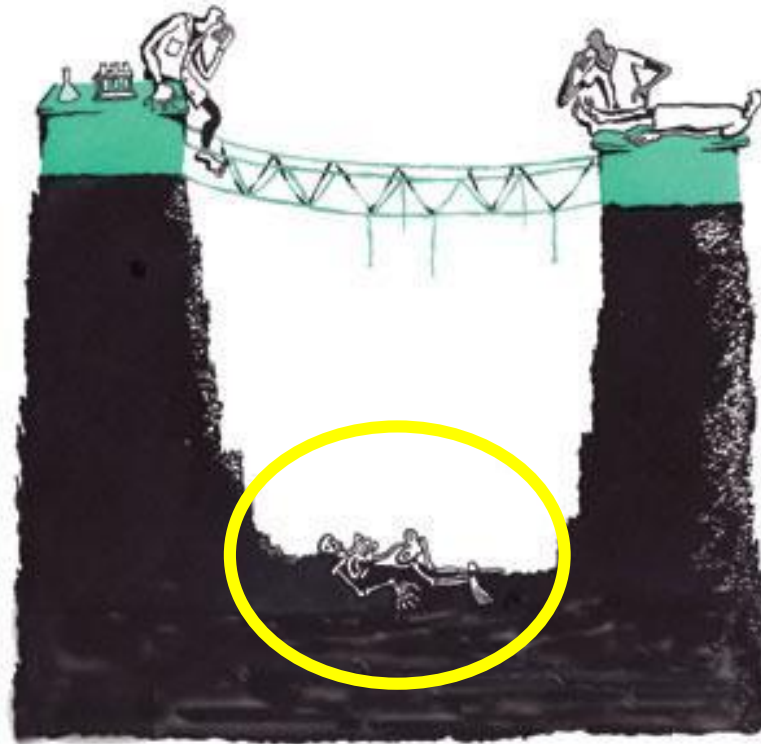
Practice

The Valley of Death
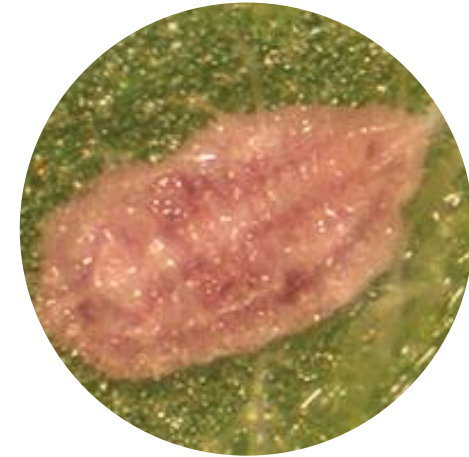**Where good ideas come to die**

Where do we place our research emphasis?

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Research → Adoption →
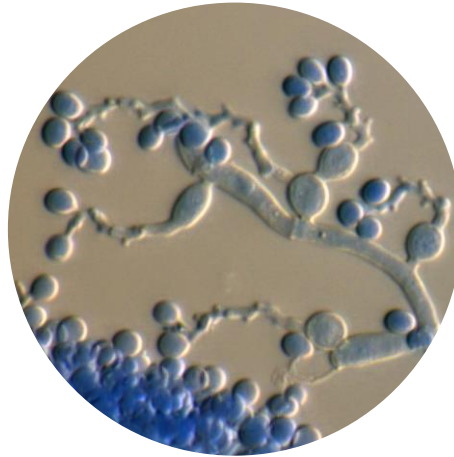
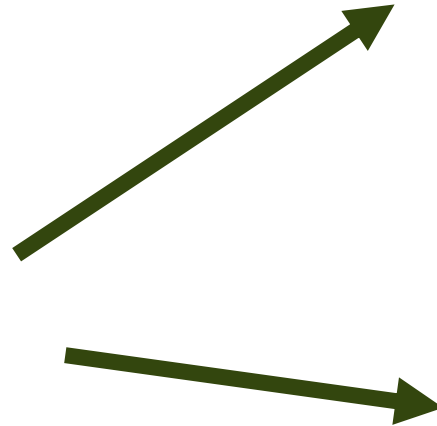Efficacy is a good starting point but is not the only measure

Need to consider consistency, compatibility, strategic use, broader measures of **value**
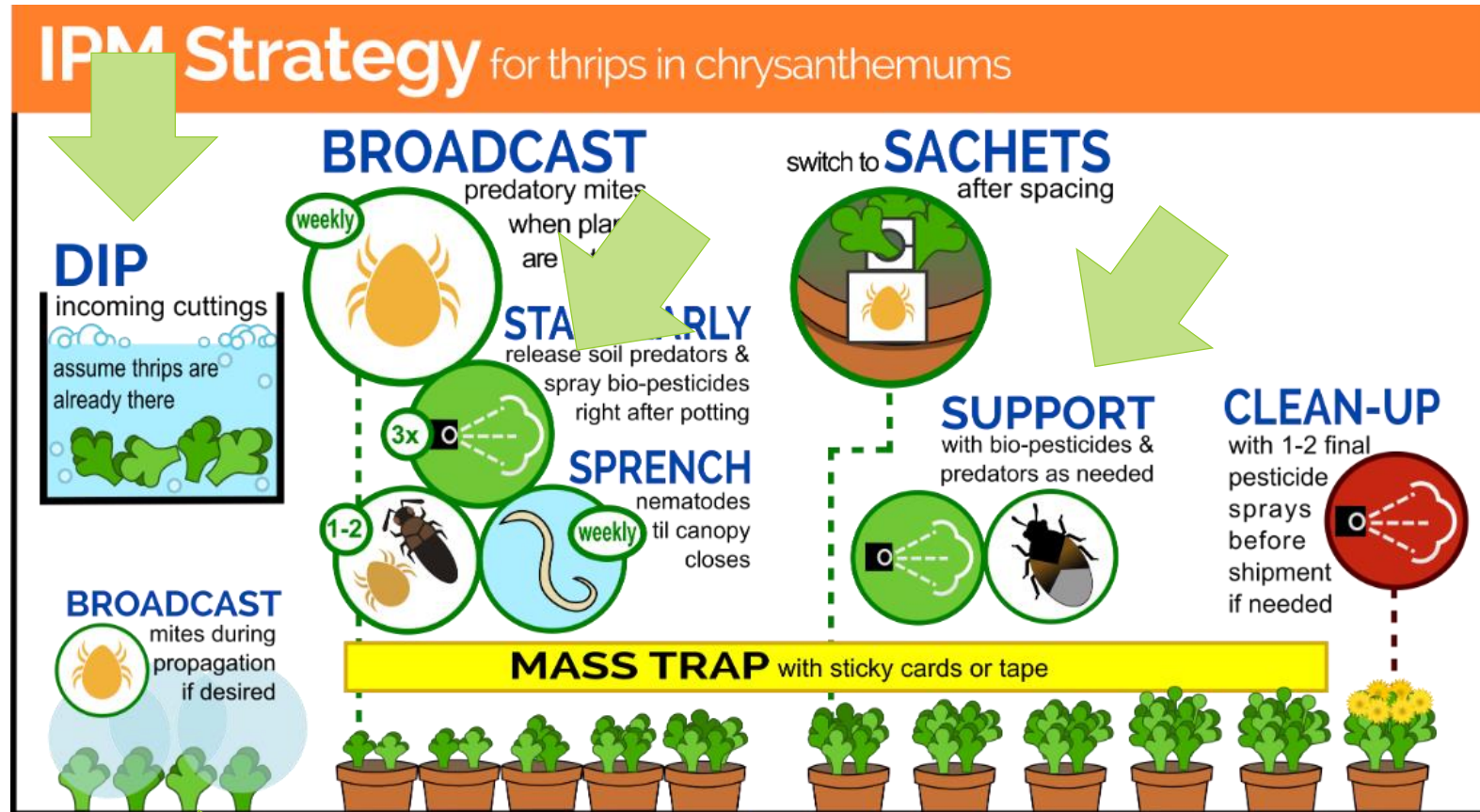
Systems approach

- Take a holistic view of the 'system'

- All components work together to provide the desired level of control

- The production system should address underlying weaknesses that allow organisms to reach pest status

- Biologicals will then function more efficiently within that system
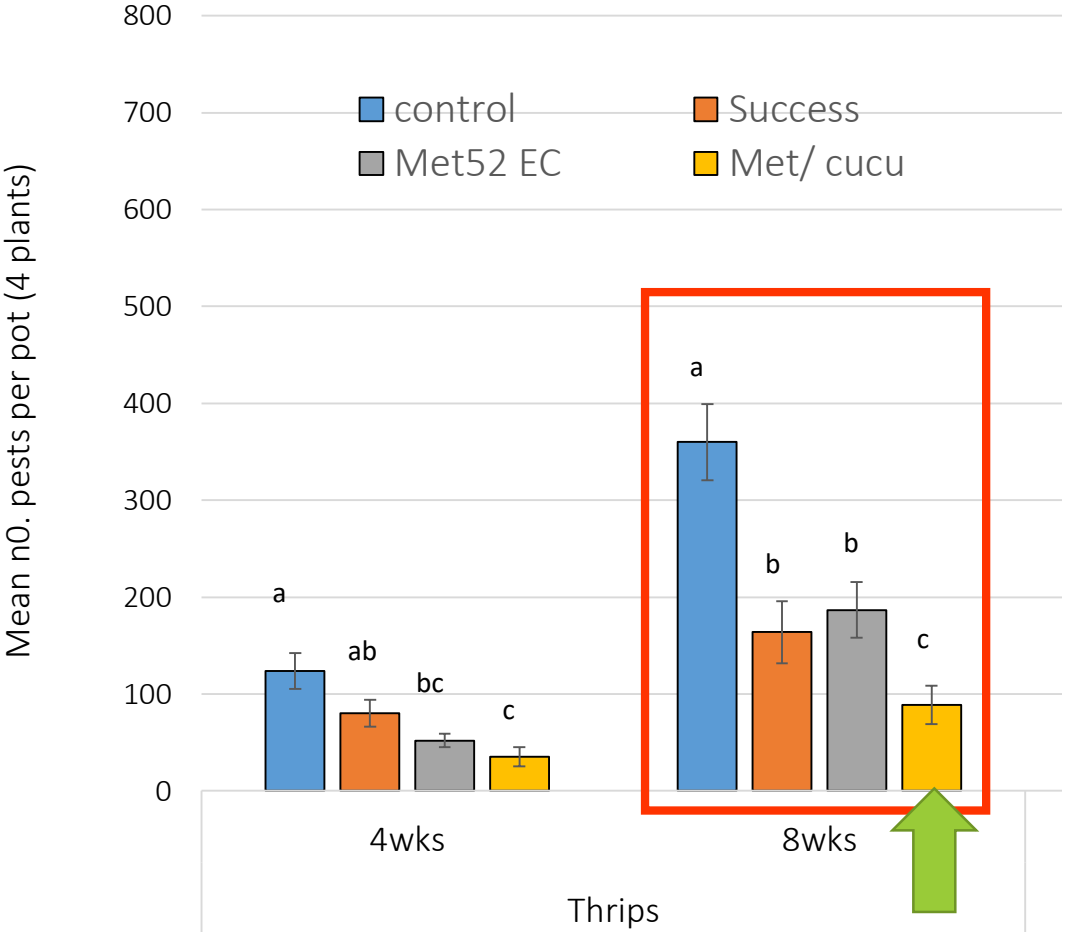
RIGHT CONTROL AGENTS

Effective Pest control

RIGHT PLANT

RIGHT ENVIRONMENT
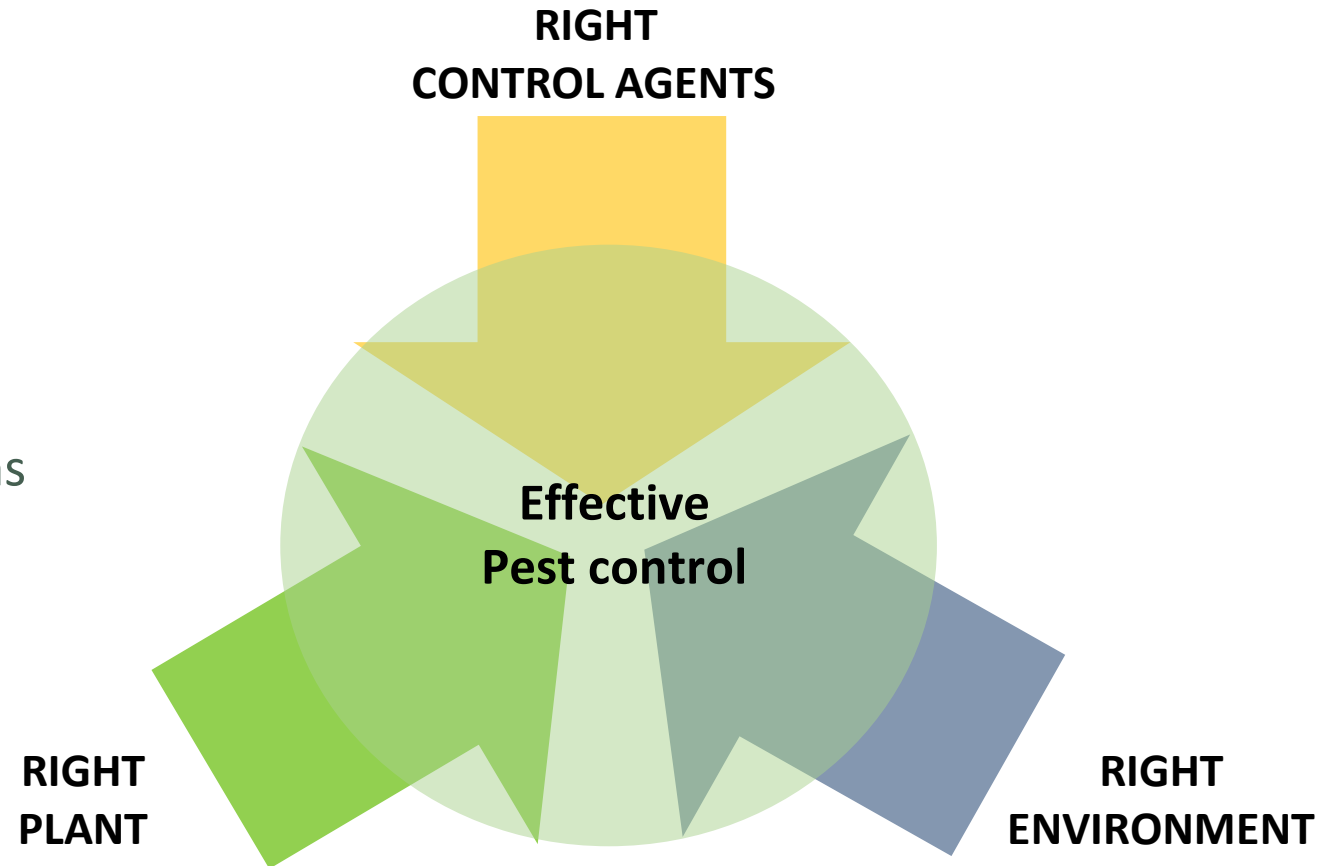
Compatibility is essential
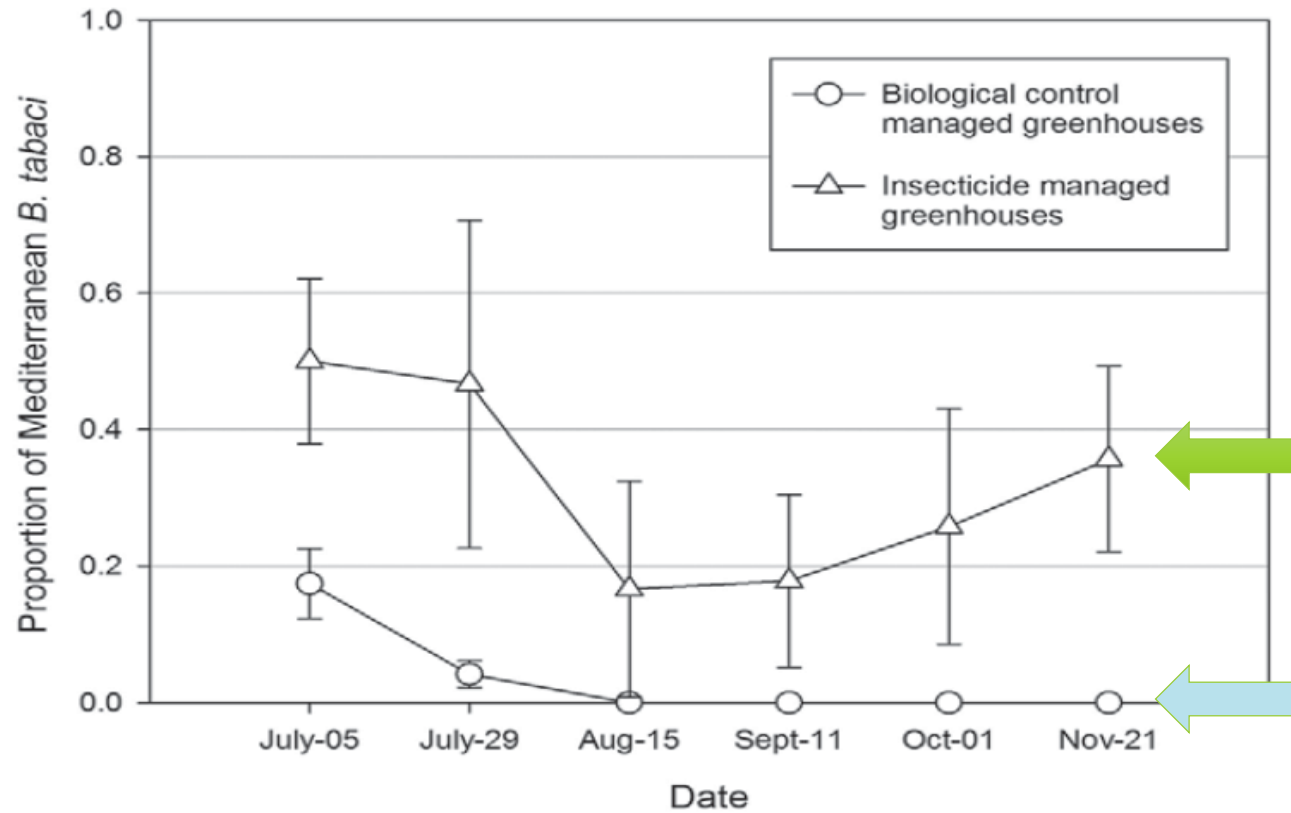
IPM strategy for thrips

© Ashley Summerfield, Vineland

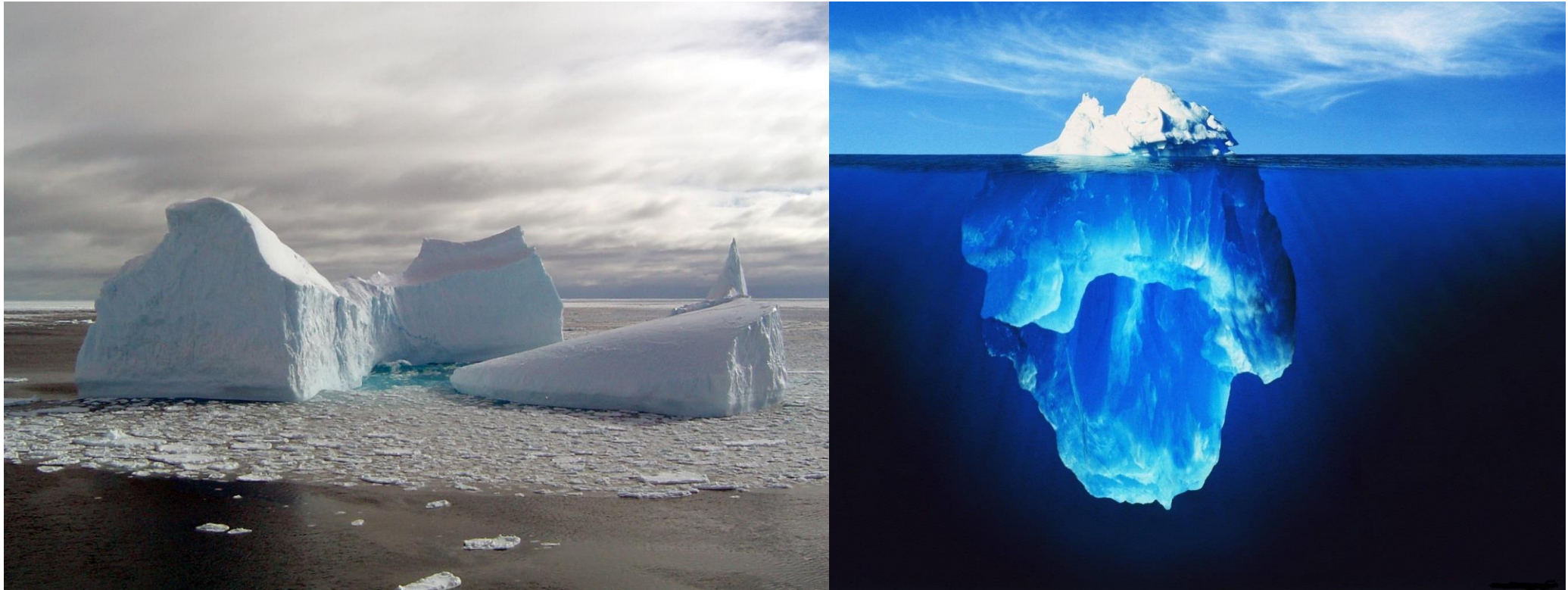# Met52 EC plus *Neoseiulus cucumeris* (sachets)

Use of biocontrol to overcome *Bemisia* resistance

Demographic trends of *B. tabaci* Mediterranean or Q biotype populations in commercial poinsettia crops under biological or insecticide-based management. (Frewin et al. 2014)

IPM encompasses more than just 'control agents'

We need to consider the whole picture, not just what we see on the surface!

Effect of fertilizer on pest populations

- Most greenhouse ornamental crops over-fertilized
  - 50 to 75% reductions possible (Shelp et al, 2017)

- Lower fertilizer (esp. N), fewer pests?

- Can we slow down pest population growth and improve biocontrol performance?

Reducing fertilizer in chrysanthemums

- Organic N levels in leaves affected by fertilizer rates

- Thrips numbers increased with increasing fertilizer (N) levels

- Can we use biostimulants to improve nutrient access and uptake?
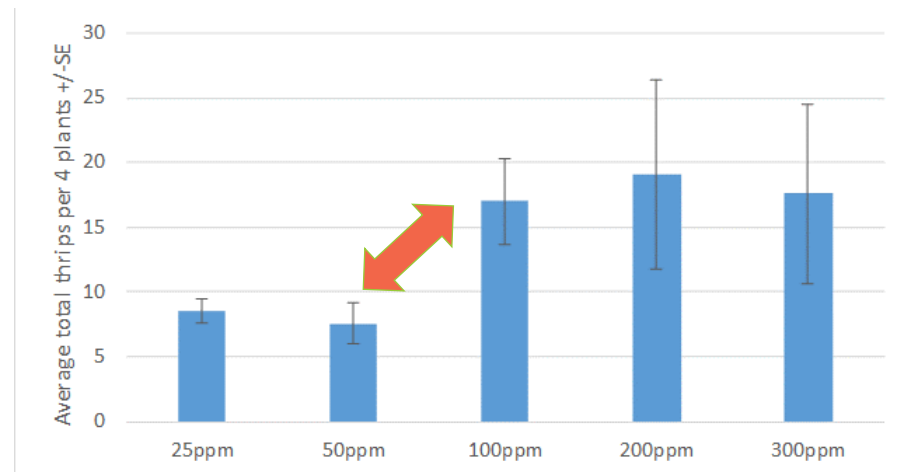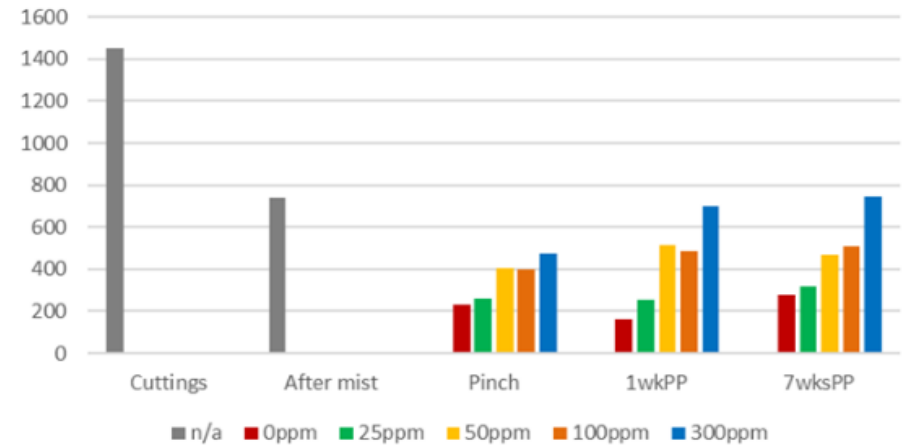
Biofungicides and biostimulants

Antagonism

- Toxins/enzymes kill or inhibit other microorganisms

Predation/Parasitism

- Microbial agent attacks or consumes the pathogen

Competition

- Outcompetes pathogen for space or nutrients on the root surface

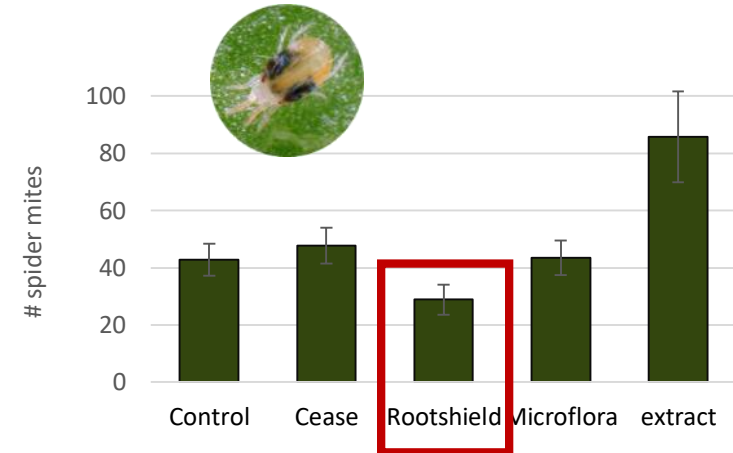## Induced resistance

- Activates plant defences, stress response

Gliocladium catenulatum (Prestop®) vs *Rhizoctonia solani*

Microbe-induced plant responses

Can also affect pests

Fewer spider mites on tomatoes treated with *Trichoderma harzianum* T22

- Slower spider mite development
- Variety-specific response

Plants infested with potato aphids, roots colonized by *Trichoderma* T22

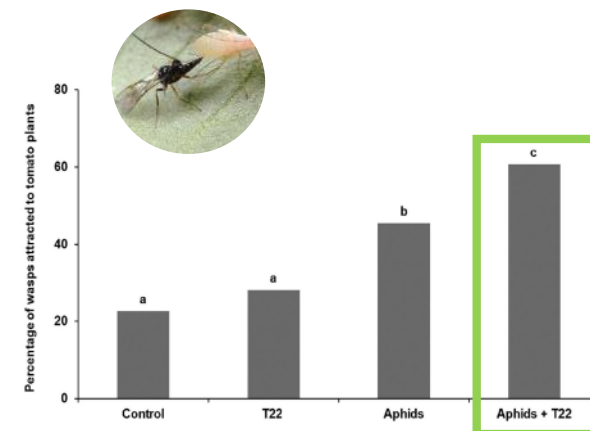- Increased recruitment of *A.ervi*
- Enhanced production of VOCs

Fig. 1 Flight behavior of *Aphidius ervi* females (%) toward tomato plants: treated with *Trichoderma harzianum* T22, infested by aphids, their combination and control (no T22, no aphids). Letters assigned by *G*-test for independence ($P < 0.05$).

Substrate plus microbes

1. PRO-MIX® BX

2. PRO-MIX BX + Mycorrhizae™ (*Glomus intraradices* PTB297)

3. PRO-MIX BX + Biofungicide™ (*Bacillus pumilus* PTB180) + Mycorrhizae

Effect on plant development and pests

- Plants grown at two fertilizer rates:
  - 50 and 200 ppm N
- Biomass production enhanced in low fertilizer regime with microbes
  - Equal to plants grown at 200 ppm N
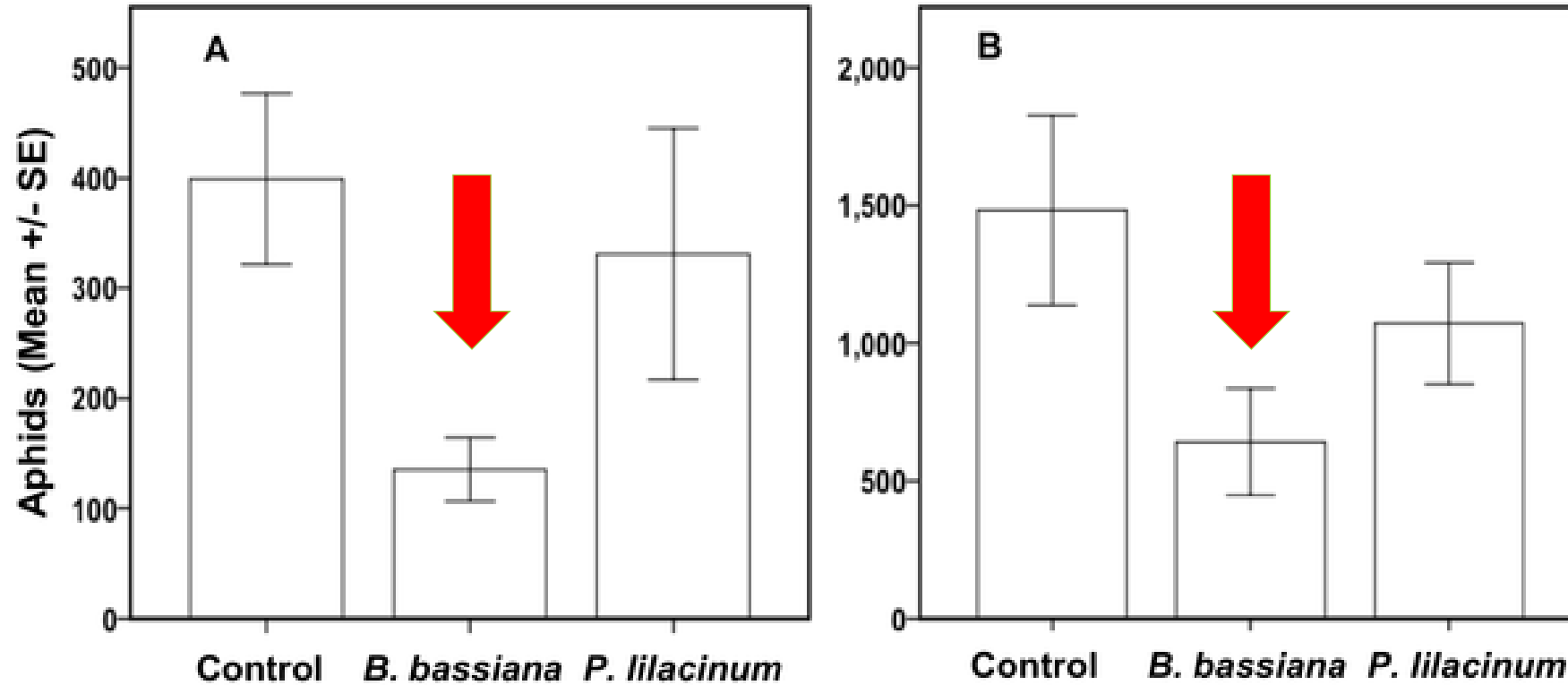- Thrips population growth lower on plants grown in augmented media
  - ca. 30% lower

No production 'penalty'

Effect on thrips creates conditions where bioprotectants work better
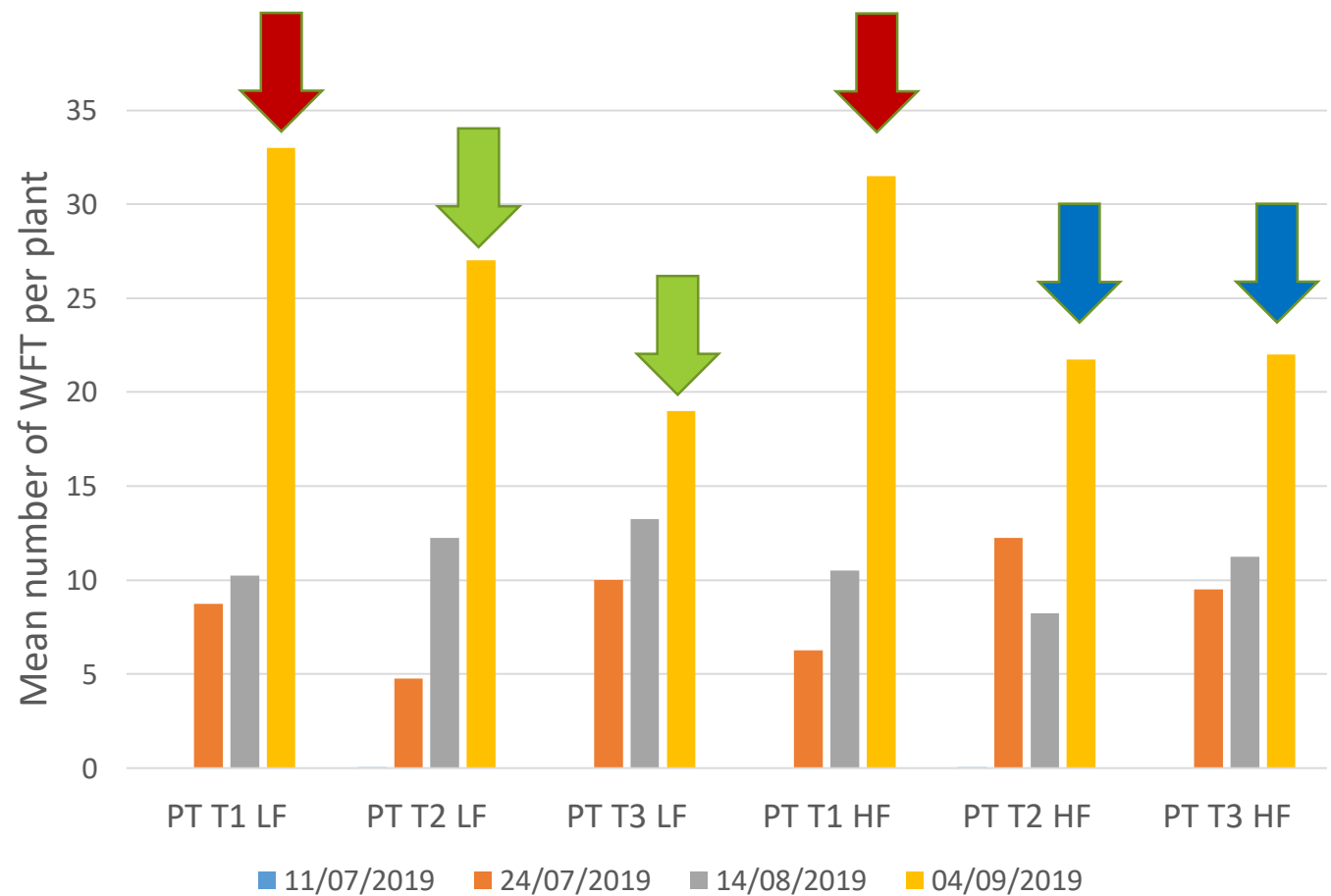
Vineland data – do not reproduce

Effects of endophytic fungi on pest reproduction

Castillo Lopez D, Zhu-Salzman K, Ek-Ramos MJ, Sword GA (2014) The Entomopathogenic Fungal Endophytes Purpureocillium lilacinum (Formerly Paecilomyces lilacinus) and Beauveria bassiana Negatively Affect Cotton Aphid Reproduction under Both Greenhouse and Field Conditions. PLOS ONE 9(8): e103891. https://doi.org/10.1371/journal.pone.0103891
https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0103891

What role do microbes have in crop production?

Plant benefits that may be derived from using microbials

- direct/indirect effects on pests
- improved stress tolerance (abiotic, biotic)
- improved access to nutrients (growth)

Ecological role and impact

- *in planta*, *ex planta*, in the rhizosphere
- duration and magnitude of effect
- compatibility in IPM

What is the value proposition?

The importance of extension/outreach activities to success

Passive dissemination

- Websites
  - Includes 'how-to' videos, pest ID information, IPM options
- Articles in trade publications (hard copy and online) on IPM and supporting strategies

Active dissemination

- Workshops
- Grower conferences
- On-site visits, work directly with IPM managers, crop consultants
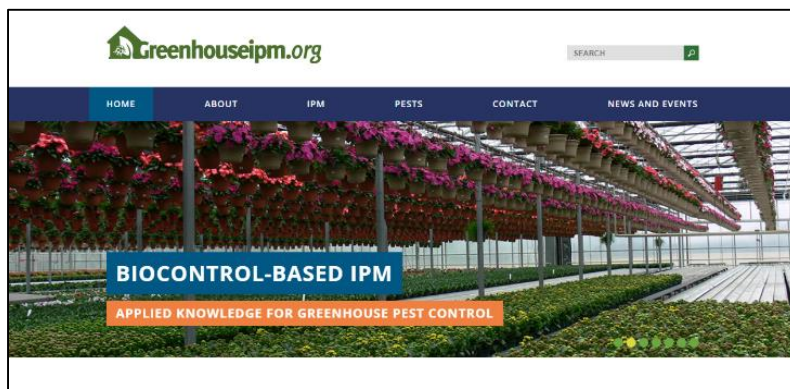
The biological future: Realizing the potential

- How to integrate into a production system

- Success requires
  - understanding what growers need to know
  - understanding what the bioprotection agent <u>can</u> do
  - understanding when, where, and how to apply

- Demonstrate broader benefits to crop resilience
  - resource use efficiency, improved productivity
  - less energy dealing with stress, more on production

- Consistency
  - consistent quality, reproducible benefits

- Strategic value
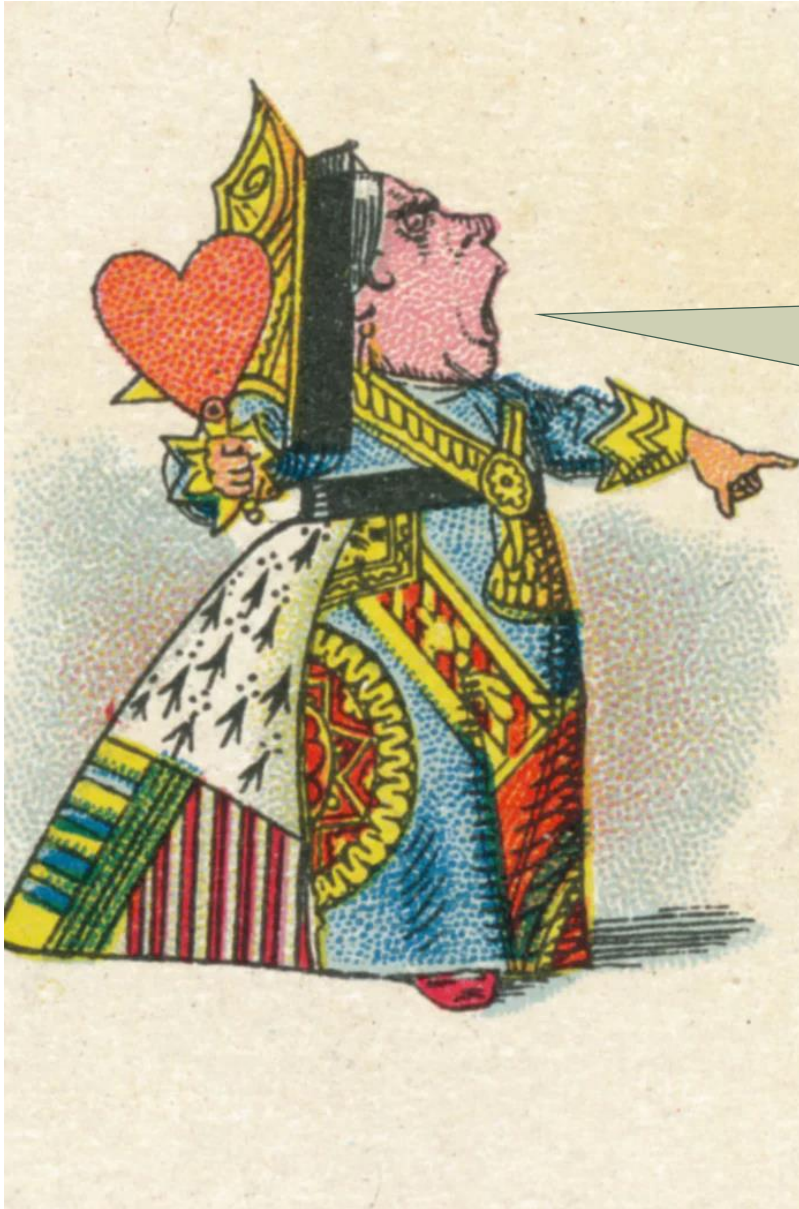
Alice's Adventures in **Wonderland**. 1865. Lewis Carroll.

So use biologicals in your IPM programs!

...ta... ...g you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!

Thank you

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