

Control of Thrips with the Entomopathogenic Fungus *Metarhizium anisopliae*

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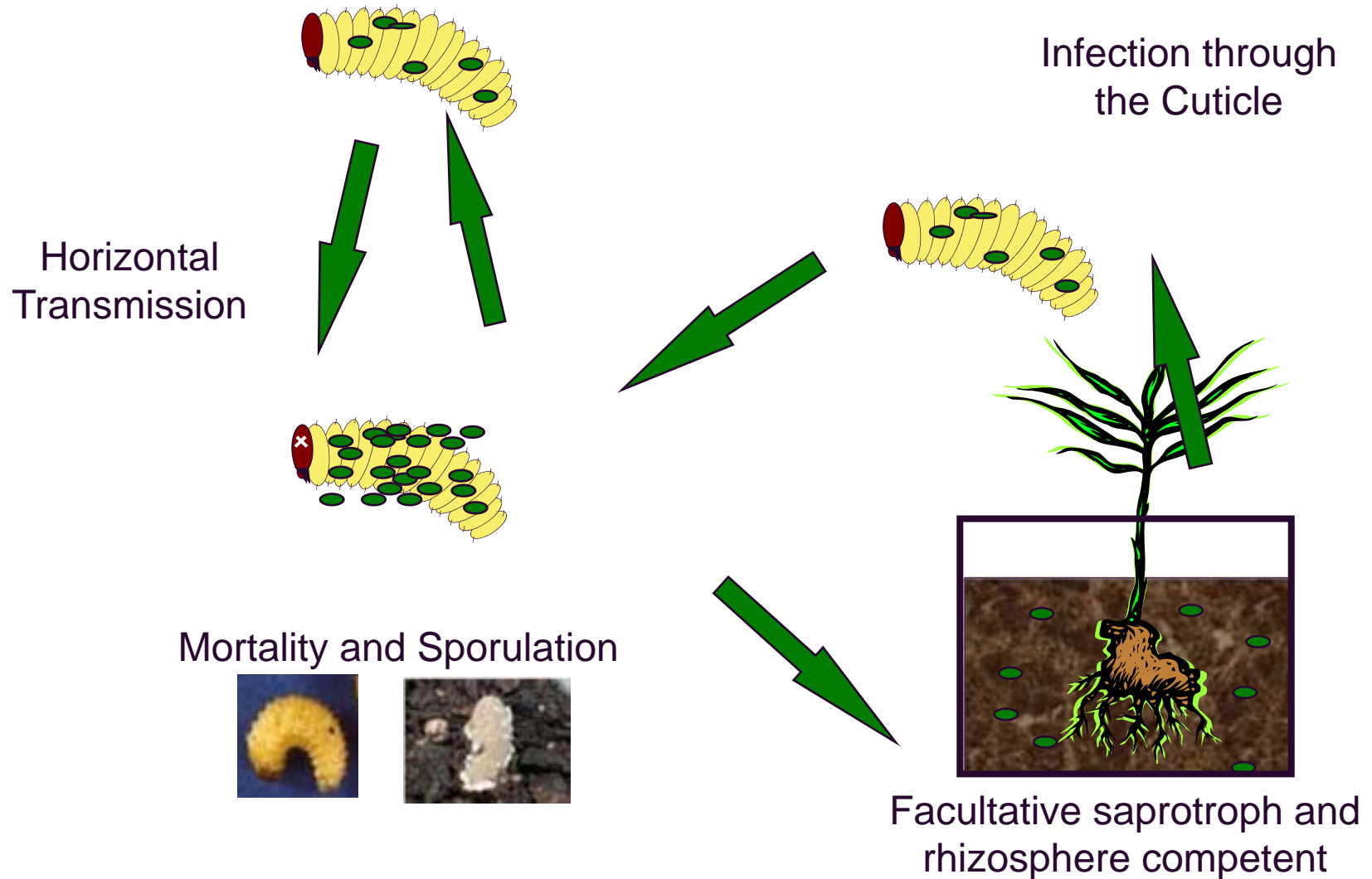
Overview

- Metarhizium Biology
- Products' key features
- Efficacy Overview
- Example Markets
 - Vegetable & Strawberries in California
 - Vegetable Production in Southern Europe
 - Table Grape Production in Southern Europe
 - Ornamentals in Holland
- Methods Development
- Beneficial Insect Compatibility

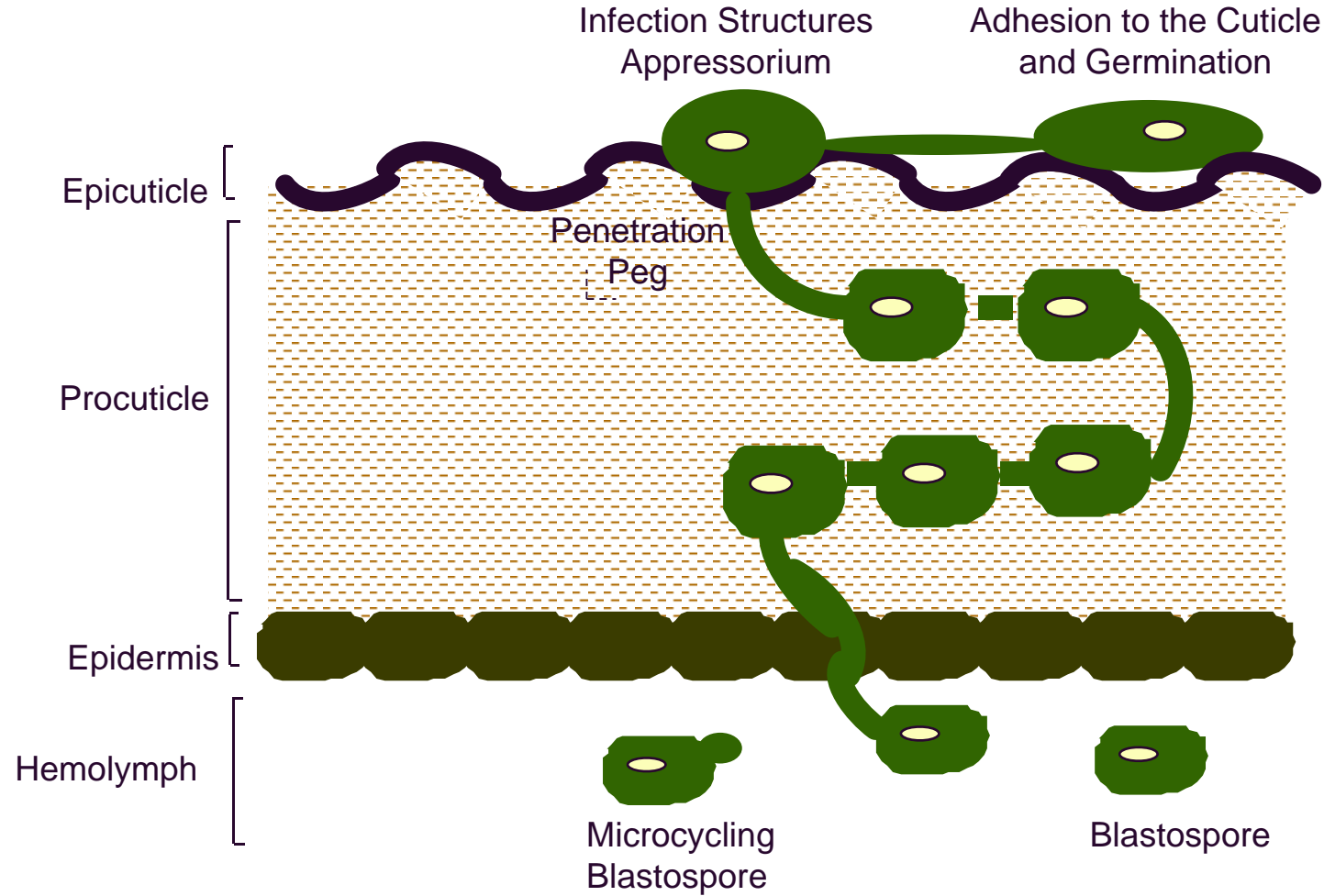


Metarhizium Biology

Simplified Life Cycle of *Metarhizium anisopliae*



The Infection Process





Products' Key Features

Products' Key Features

- Met52 (Bio1020) is available as rice-based granular and will be available as an emulsifiable concentrate.
- Biologically-based product
 - Excellent toxicology profile.
 - Contact mode of action with no knock down effect.
 - Applied like a chemical insecticide.
 - Environmental factors can impact efficacy.
- Excellent fit in insecticide resistance management.
- Valuable tool in IPM with chemistry and beneficials.
- Excellent for reducing pesticide residues.



Efficacy Overview

Efficacy Trials Summary

Nursery and Ornamentals

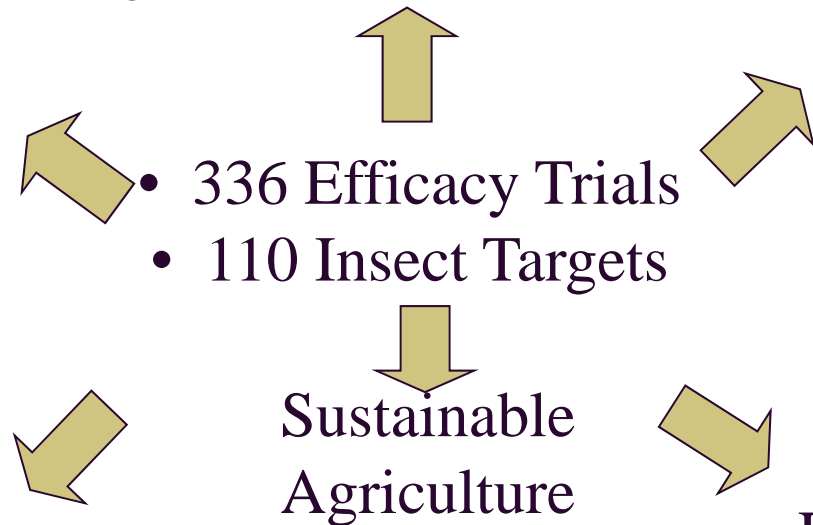
- A – black vine weevil, whiteflies, mites, **thrips**
- B – oriental beetle, aphids, plant bugs
- C – fungus gnats, leaf feeding beetles, leafhoppers, caterpillars
- D - slugs, borers

Lawn and Landscape

- A – ticks, chinch bugs
- B – billbugs, mole crickets, craneflies, annual bluegrass weevil
- C – white grubs

Apiculture

- Varroa mite (C)



PCO

- A – houseflies, mosquitoes
- B – bedbugs
- C - fire ants, termites

Sustainable Agriculture

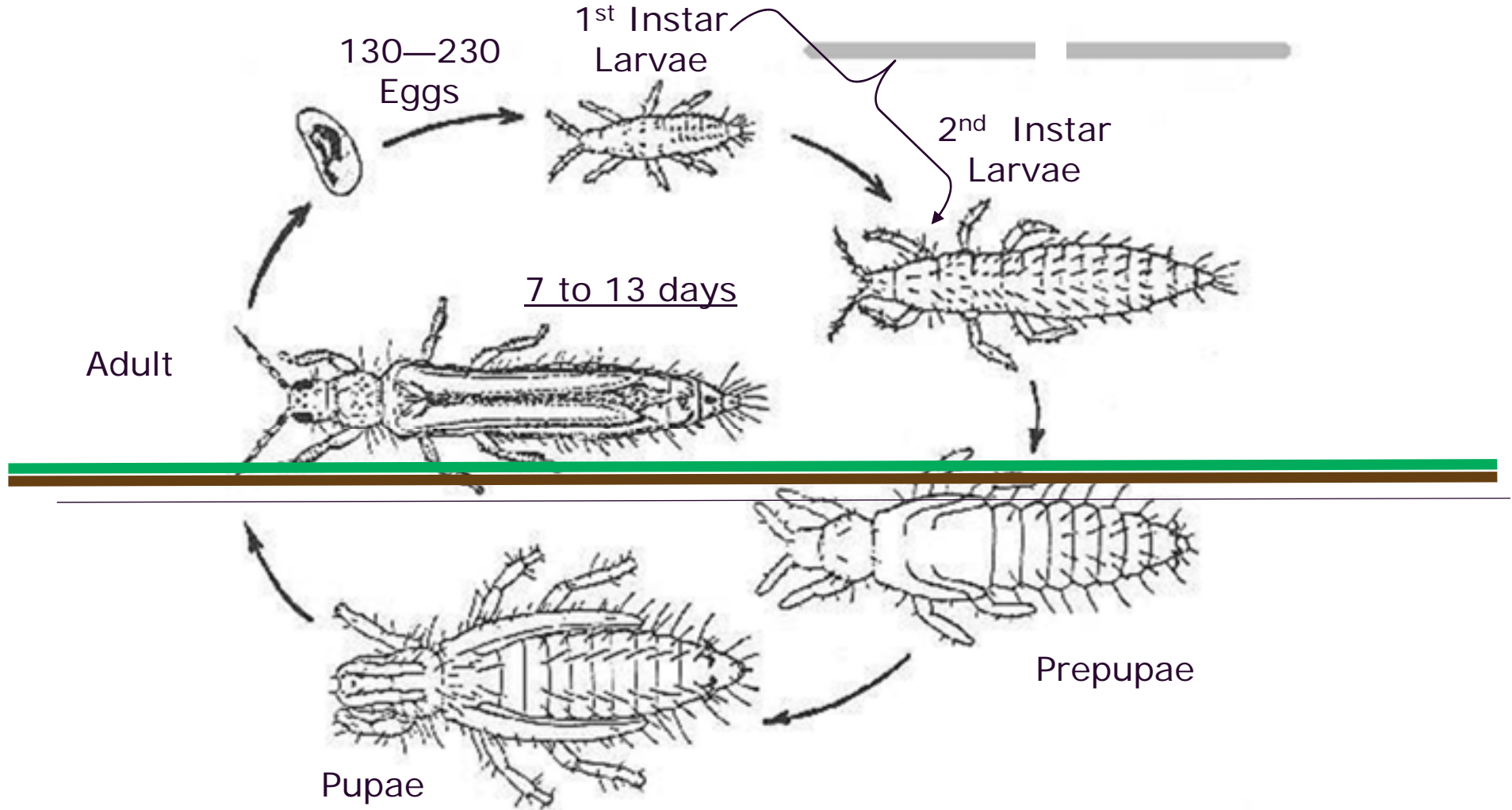
- A – **thrips**, weevils, whiteflies, mites, psyllids, wireworms,
- B – aphids, root maggots, corn rootworm, ticks, stored grain beetles, flies
- C – leafhoppers, caterpillars
- D – slugs, stinkbugs

Forestry

- Asian longhorn beetle (A)
- Pine Weevil (B)

Western Flower Thrips (*Frankliniella occidentalis*)

Feeding Foliar Stages



Non-Feeding Soil Stages

Thrips Control – Foliar

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% Control (Range) of Thrips In Protected Crops

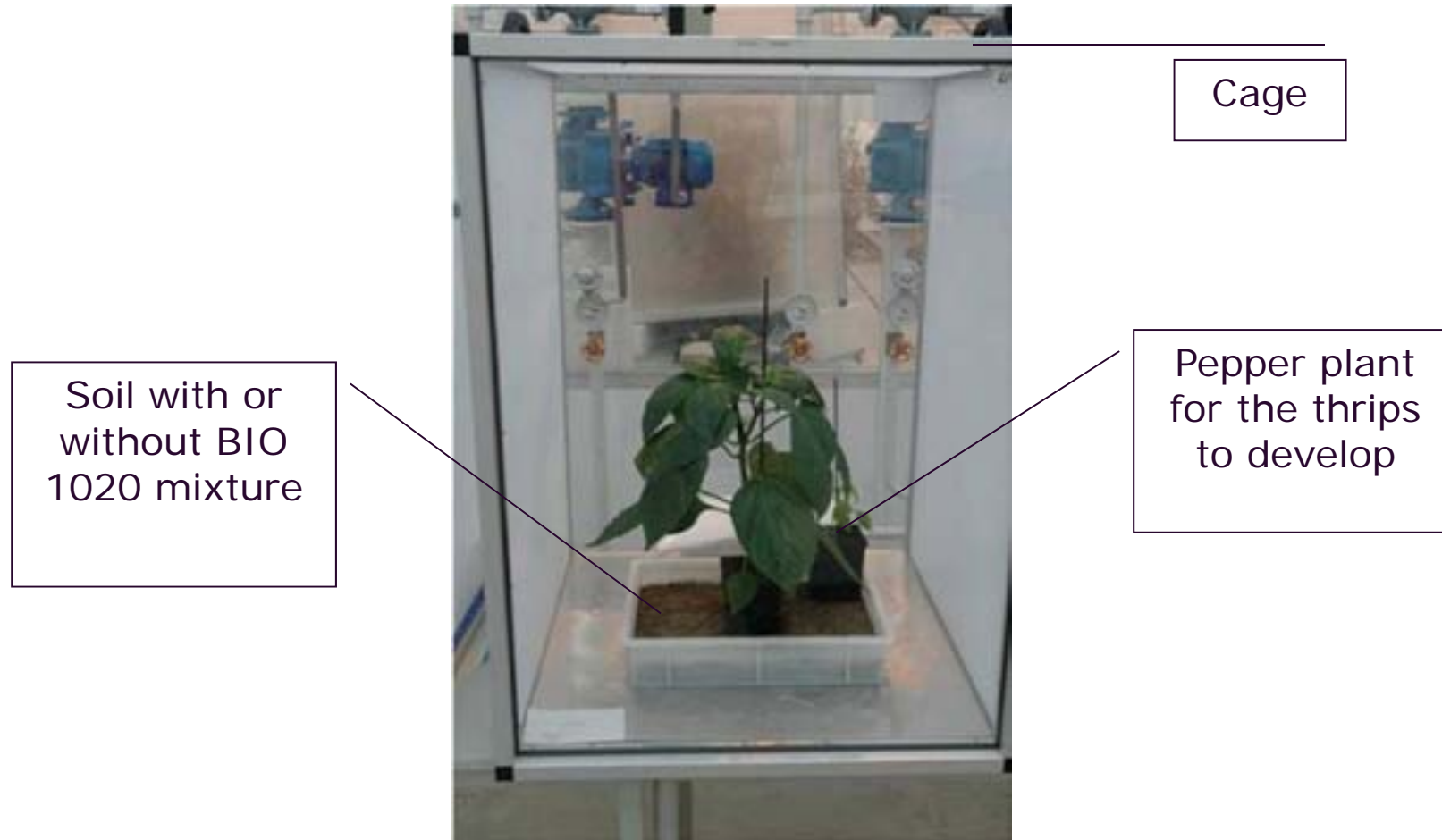


Crop	Country	Life Stage	Met52 EC 1.25L/Ha	Abamectin	Spinosad	Acrinathrin
Pepper	Spain	L	81 (70-100)		81 (40-100)	
Pepper	Spain	A	71 (47-90)		78 (60-100)	
Pepper	Spain	L	93 (74-100)		86 (67-100)	
Pepper	Spain	A	92 (76-100)		86 (71-95)	
Pepper	France	Total	85 (72-95)	90 (84-96)		
Pepper	Italy	Total	56 (38-67)		79 (52-91)	
Zucchini	Spain	Total	40 (21-47)		56 (43-71)	
Zucchini	Spain	Total	68 (34-81)		69 (57-83)	
Eggplant	Italy	Total	71 (49-87)		77 (42-95)	
Strawberry	France	L	79 (68-88)			50 (32-72)
		Ave	74		77	

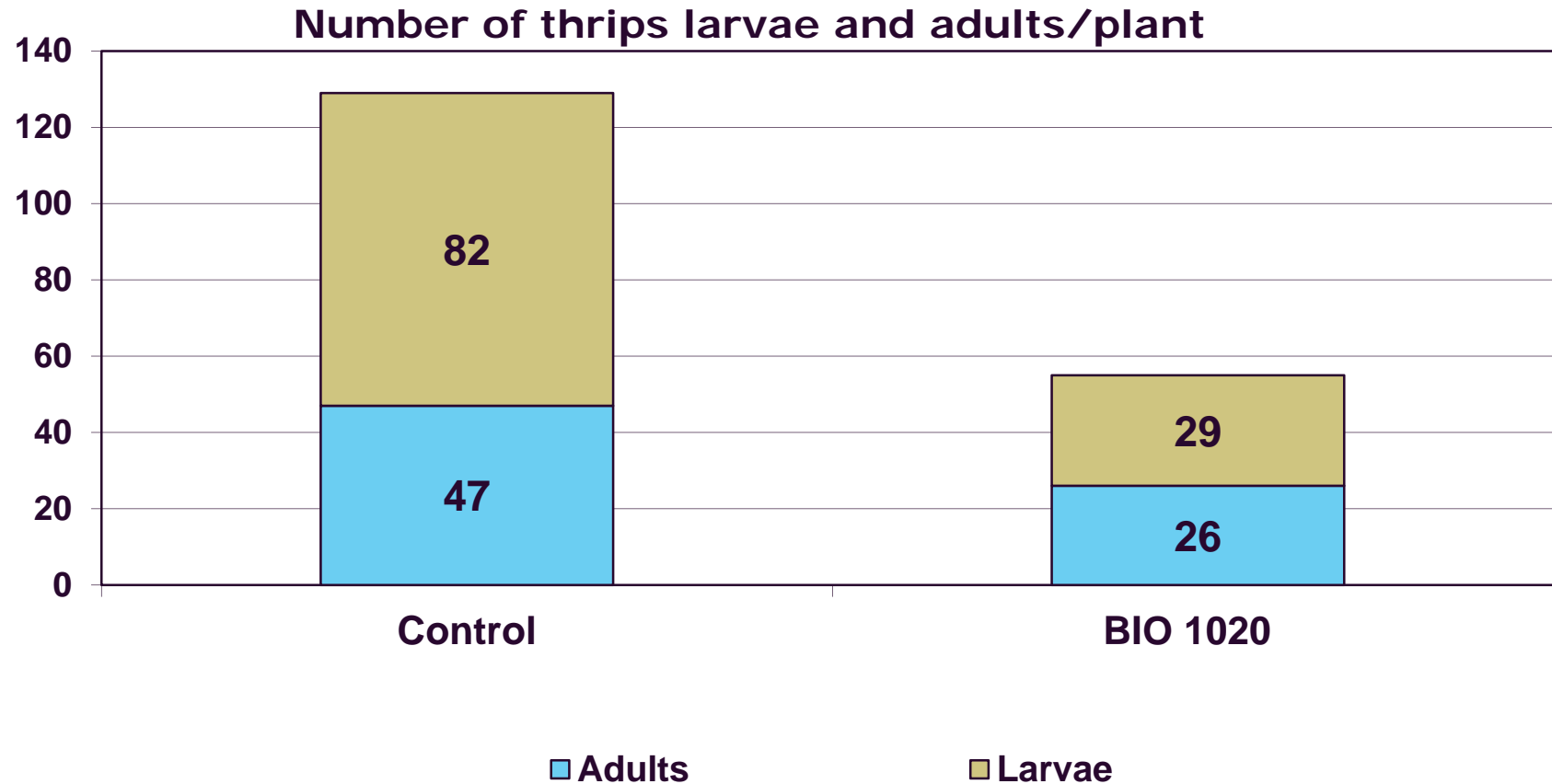
Thrips Soil

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Testing soil efficacy WUR (Wageningen University location Bleiswijk)



Soil Efficacy (Wageningen University): *F. occidentalis*



Substrate: potting soil

Other Publications on Control of Thrips Pupae with Met52:

Ansari et al (2007) *Biological Control*. 40: 293-297

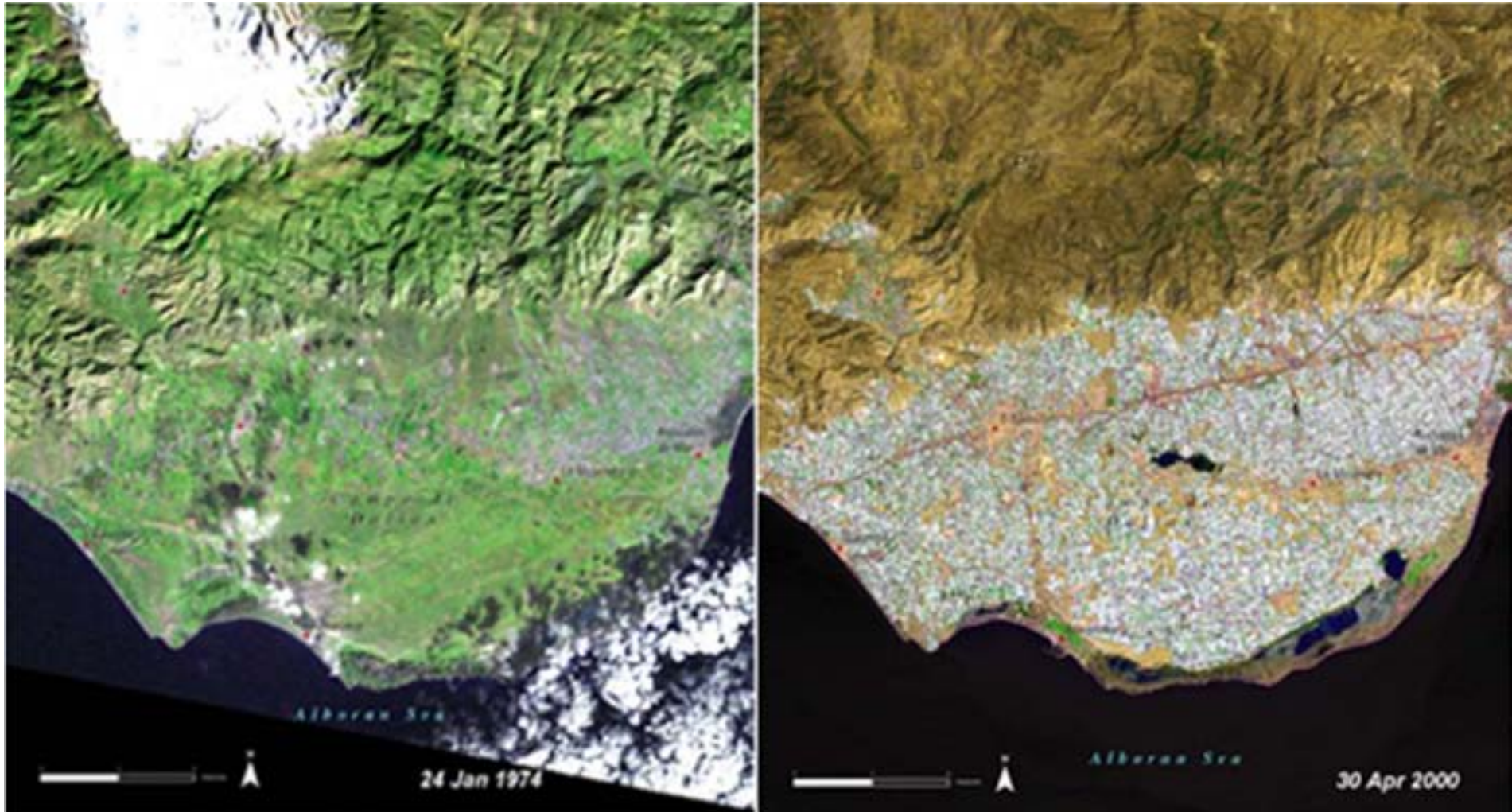
Ansari et al (2008) *Entomologia Experimentalis et Applicata* 127 : 80–87

Heyler et al (1995) *Ann. Appl Biol.* 127: 405-412



Example Crop Targets

Intensive Glasshouse Vegetable Production (Alicante, Spain from Space)



1974

2000

Ornamentals in Holland (Boom for Beneficials & Spray Delivery)



Lettuce & Strawberry in California



Table Grapes, S. Europe





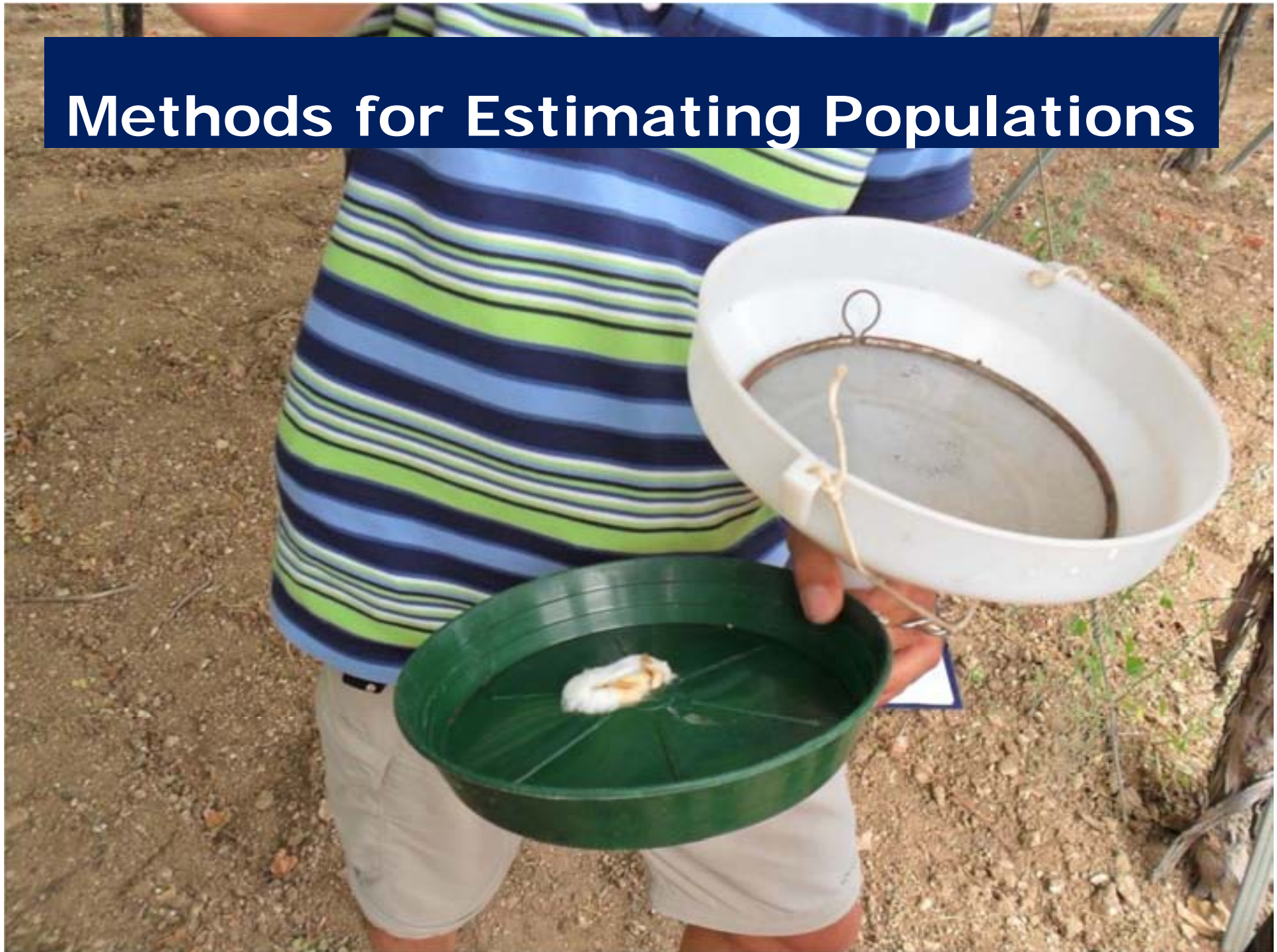
Onions & Leeks in N. Europe





Methods Development

Methods for Estimating Populations



Impact of Migration



Application Methods for Thrips Pupae





Beneficial Insects and Mites

Beneficials Being Evaluated for Compatibility



Pest (s)	Crop (s)	Beneficial Spp.
Mites	Pepper, Tomato, eggplant	<i>Amblyseius californicus</i>
Thrips, mites	Pepper, eggplant	<i>Amblyseius cucumeris</i>
Thrips	Pepper, eggplant	<i>Amblyseius degenerans</i>
Thrips, whitefly	Pepper, cucurbits, eggplant	<i>Amblyseius swirskii</i>
Aphids	Pepper, cucurbits, eggplant	<i>Aphidius colemani</i>
Aphids	Pepper, cucurbits, eggplant	<i>Aphidius ervi</i>
Leafminer	Tomato	<i>Diglyphus isaea</i>
Whitefly	Tomato	<i>Encarsia formosa</i>
Whitefly	Pepper, tomato, cucurbits, eggplant	<i>Eretmocerus mundus</i>
Whitefly	Pepper, tomato, cucurbits, eggplant	<i>Eretmocerus eremicus</i>
Whitefly	Eggplant, tomato	<i>Macrolophus caliginosus</i>
Whitefly	Eggplant, tomato	<i>Nesidiocoris tenuis</i>
Thrips	Pepper	<i>Orius laevigatus</i>
Mite	Pepper, eggplant	<i>Phytoseilius persimilis</i>
Mite	Grape	<i>Typhlodromus pyri</i>
Mite	Grape	<i>Kampimodromus aberrans</i>
Generalist	Grape +	<i>Chrysopa sp.</i>
Generalist	Grape +	<i>Adalia sp.</i>
Generalist	Grape +	<i>Coccinella sp.</i>

Met52 Applied to Bee Hives for Varroa Mite Control (3 x 10E10 spores/hive) – No Negative Effects



James, R. R., Hayes, G., and J. E. Leland. 2006. Field trials on the microbial control of Varroa with the fungus *Metarhizium anisopliae*. *Apiculture Research*. November. 968-972.

Summary

- *Metarhizium anisopliae's* mode of action makes it an excellent tool for resistance management.
- Met52 has application to a broad range of insect targets.
- Met52 EC has demonstrated control of thrips competitive with chemical standards.
- Met52 has application for foliar and soil dwelling thrips.
- Data indicates compatibility with pollinators, predators, and parasitoids and we are confirming compatibility for all key beneficials.

Questions?



Fungicide Compatibility

Foliar Fungicides Being Evaluated for Compatibility



Class	FRAC#	Fungicides
2-6-dinitro anilines	29	fluazinam
acylalanine	4	metalaxyl
cinnamic acid amide	40	dimethomorph
cyanoacetamide-oxime	9	cyprodinil
dicarboximides	2	Iprodione
dithiocarbamate	M3	mancozeb, propineb, thiram
ethyl phosphonate	33	Fosetyl-al
hydroxyanalide	17	Fenhexamid
inorganic	M1	Cu sulfate
phenylpyrrole	29	fludioxinyl
phthalimides	M4	captan
Phthalonitrile	M5	chlorothalonil
pyrazole-carboxamide	7	boscalid
pyridinyl-methyl-benzamide	3	flupicolide
quinone	M9	Dithianon
strobilurin	11	Azoxystrobin, fluoxastrobin, pyraclostrobin, trifloxystrobin
Triazole	43	difenoconazol, penconazole, prothioconazole, tebuconazole