Side-effects of lepidoptericides, used against *Tuta absoluta*, on different biological agents and pollinators

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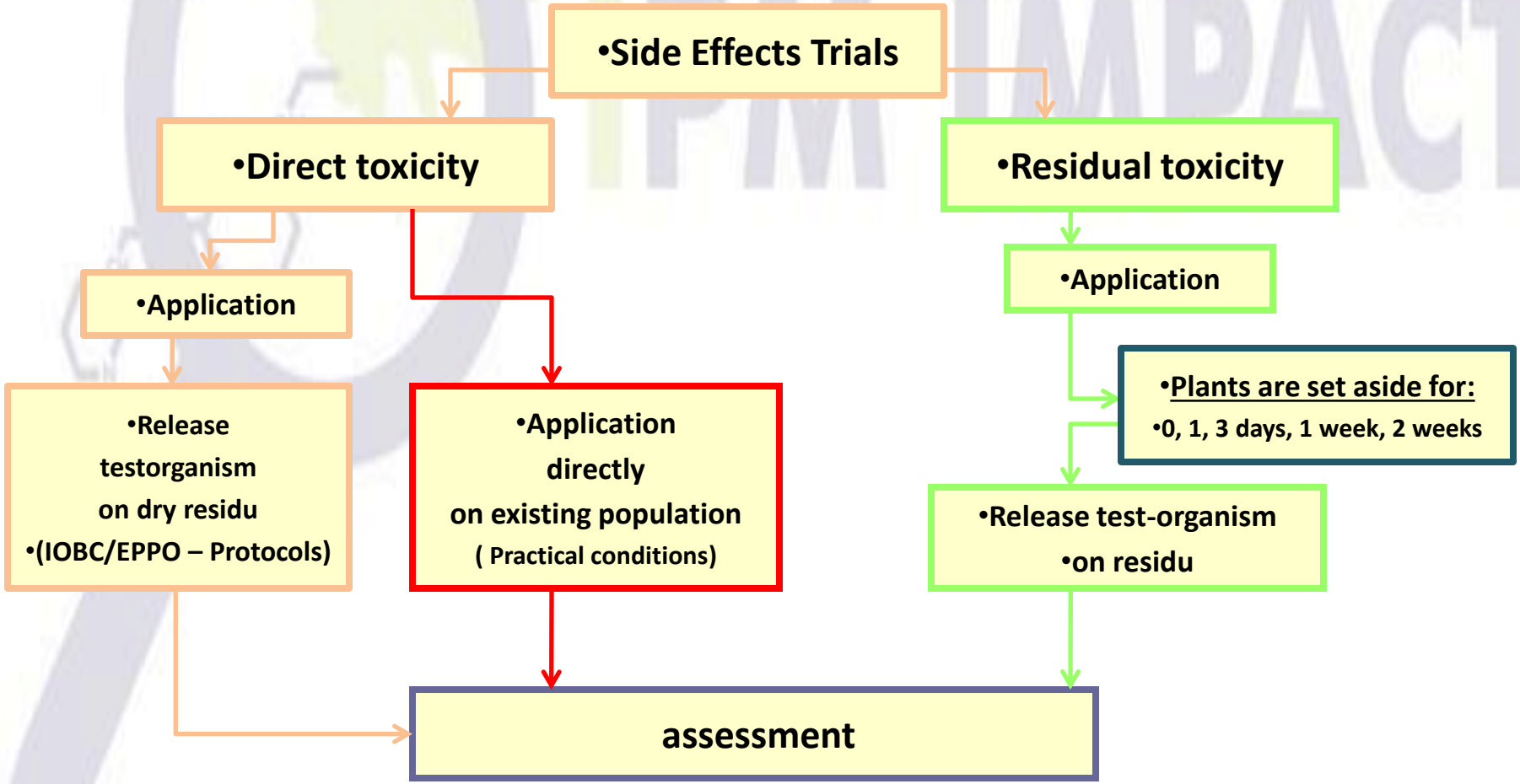
Semi-field trials

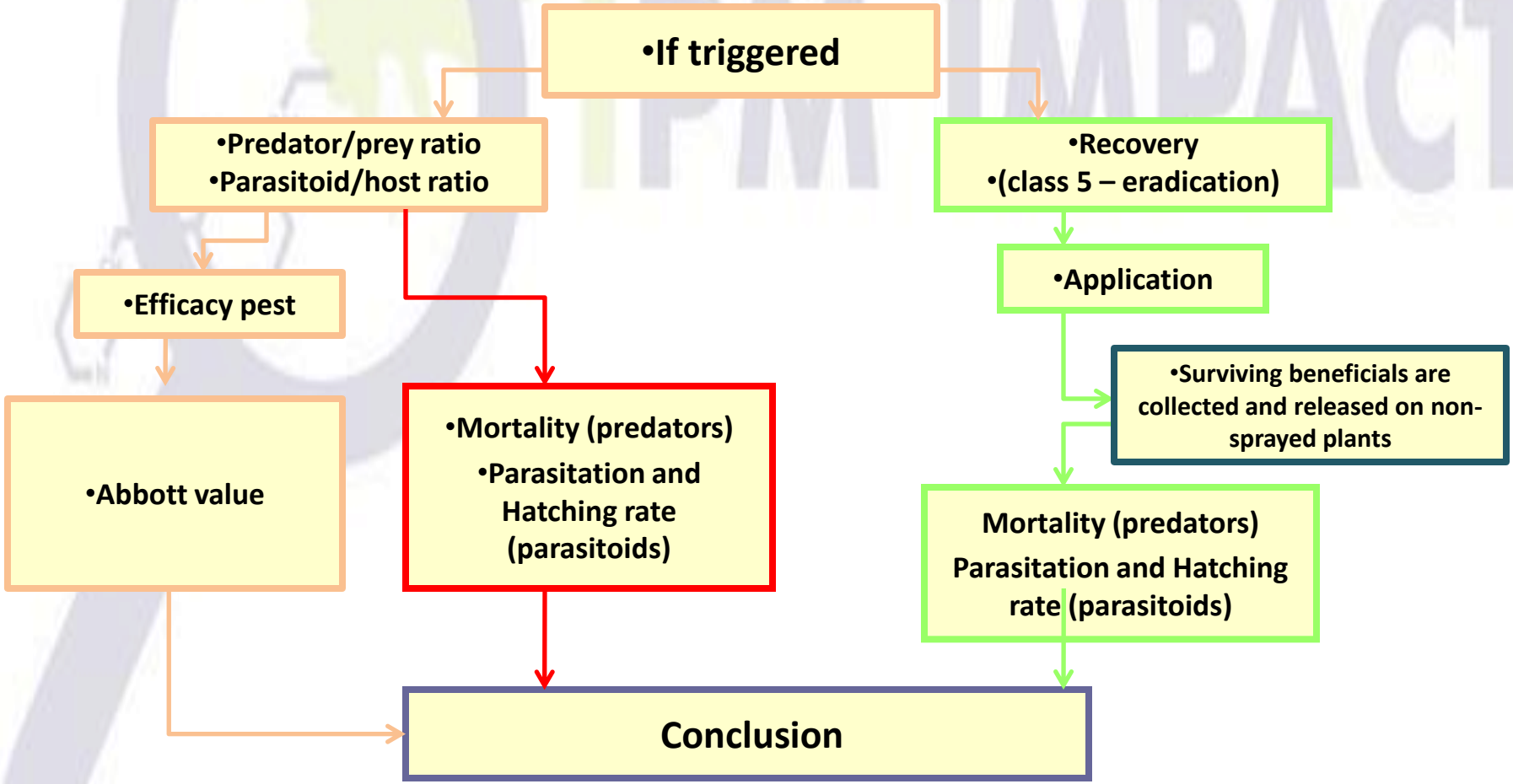
Side Effects Trials (1)

(worst case scenario)



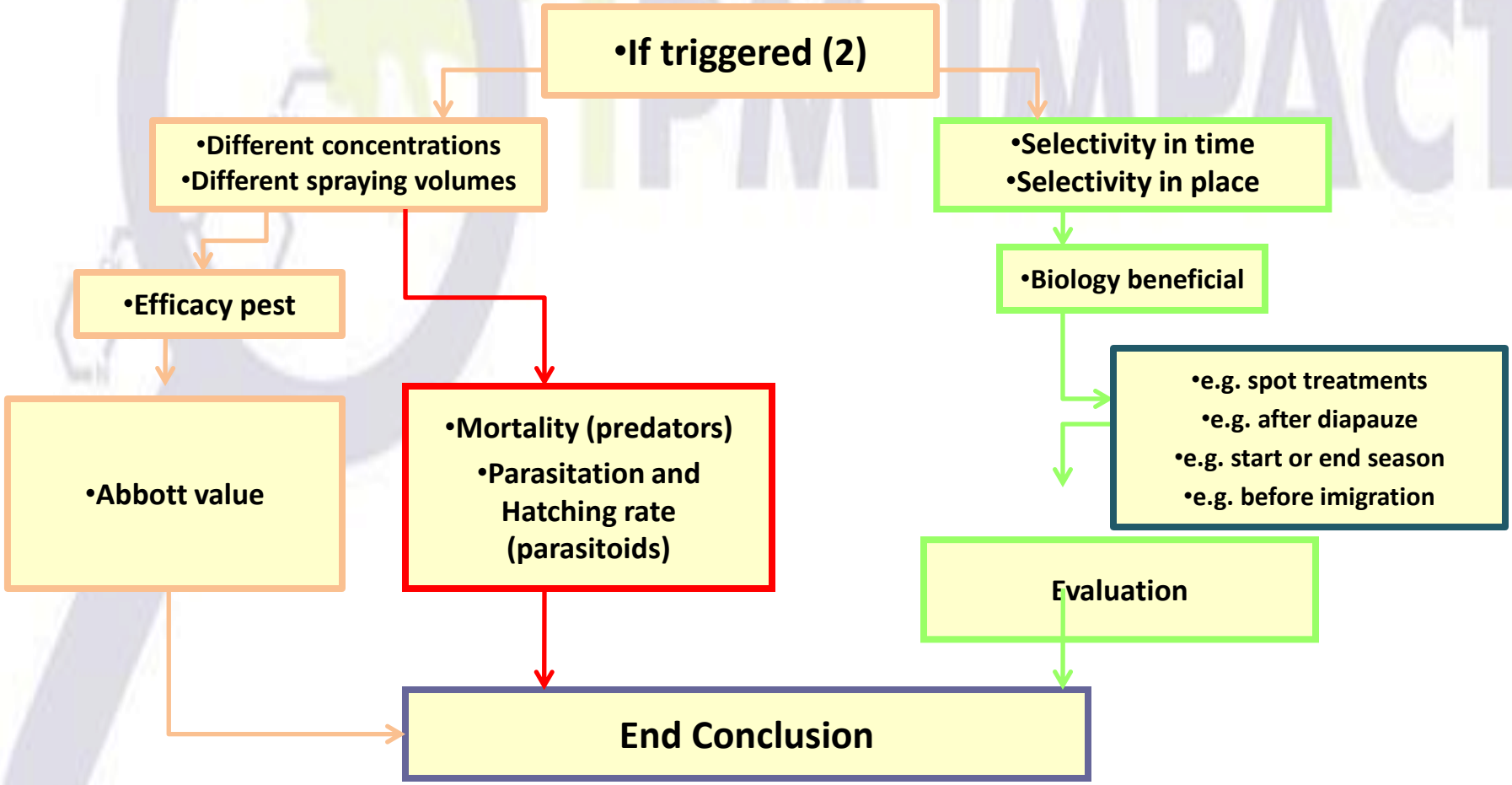
Side Effects Trials (2)

(Worst case scenario)



Side Effects Trials (3)

(practical conditions)



Plant Protection Products against *Tuta absoluta*

1. Chemicals

1. Indoxacarb (Steward, Provaunt, Avaunt,…): Dupont
2. Rynaxapyr (Coragen, Altacor, ….): Dupont
3. Flubendiamide (Fame, Belt, Fenos, …): Bayer
4. Metaflumizone (Alverde, Verismo,…): BASF
5. Spinetoram (Delegate, Radiant,…): Dow
6. Flufenoxuron (Cascade, Tenopa, Floxate,….): BASF
7. Novaluron (Rimon, Counter, Galaxy, …): Makteshim
8. Pyridalil (Nocturn, Pleo, Overture, ….): Sumitomo/Nufarm
9. Emamectine (Affirm, Proclaim, Denim, ….): Syngenta

Plant Protection Products against *Tuta absoluta*

2. Semio-Chemicals

1. Spinosad (Tracer, Conserve, Spintor,…)
2. Abamectine (Vertimec, Agrimec,….)

Plant Protection Products against *Tuta absoluta*

3. Botanicals

1. Neem (Neemazal)
2. Pyrethrine (+PBO) (Bio-Pyretrex)

Tested formulations and dose rates

Active ingredient	Trade naam	Formulation	Dose rate (% form. compound)
indoxacarb	Steward	30 WG	0,0125
rynaxapyr	Coragen	200 SC	0,0125-0,025
flubendiamide	Fame	240 WDG	0,025
metaflumizone	Alverde	240 SC	0,05-0,1
spinetoram	Delegate	25 WG	0,05
flufenoxuron	Cascade	100 WDC	0,05
novaluron	Rimon	100 EC	0,1-0,15
pyridalil	Nocturn	100 EW	0,1
emamectine	Affirm	095 SG	0,15-0,25-0,5
spinosad	Tracer	480 SC	0,04
abamectine	Vertimec	018 EC	0,05
azadirachtin	Neemazal	010 EC	0,3
pyrethrine (+PBO)	Bio-Pyrethrex	20+255 EW	0,5

Efficacy on *Tuta absoluta (living larvae)*
1. Chemicals - semiochemicals

- Very high efficacy (90-100% and almost no signs of damage): spinosad – spinetoram
- High efficacy (80-100% and very small signs of damage): indoxacarb – rynaxapyr – flubendiamide - metaflumizone – pyridalil – emamectine
- Low efficacy (<80 % and fullgrown mines): novaluron - abamectine
- No efficacy (comparable with the water treated control and high damage): flufenoxuron (diflubenzuron – teflubenzuron)

Efficacy on *Tuta absoluta*
2. Botanicals (living larvae)

- Very high efficacy (90-100%): azadirachtin – pyrethrum

Side-effects

Most important beneficials in tomatoes

- *Marcrolophus caliginosus*
- *Nesidiocoris tenuis*
- *Encarsia formosa*
- *Eretmocerus eremicus* and *E. mundus*
- *Diglyphus isaea*
- *Dacnusa sibirica*
- *Phytoseiulus persimilis* T strain (?)

Mirid bugs

- *Macrolophus caliginosus*
- *Nesidiocoris tenuis*

Macrolophus caliginosus

Compound	IOBC larvae	IOBC adult	Existing population larvae	Existing population adult
indoxacarb	1	1	4	4
rynaxapyr	1	1	1	1
flubendiamide	1	1	1	1
metaflumizone	4	4	4	4
spinosad	1	1	4	4
spinetoram	3	3	3	3
pyridalil	1	1	1	1
emamectine	4	4	4	4
azadirachtin	1	1	2	1
pyrethrine	4	4	4	4

Nesidiocoris tenuis

Compound	IOBC larvae	IOBC adult	Existing population larvae	Existing population adult
indoxacarb	1	1	3	2
rynaxapyr	1	1	1	1
flubendiamide	1	1	1	1
metaflumizone	4	4	3	3
spinosad	1	1	3	3
spinetoram	3	2	3	3
pyridalil	1	1	1	1
emamectine	4	4	4	4
azadirachtin	1	1	2	1
pyrethrine	4	4	4	4

Summary mirid bugs part 1

- Safe compounds: rynaxapyr, flubendiamide, pyridalil, azadirachtin
- Very short persistence = safe on dry residu: indoxacarb, spinosad
- Moderately to high toxicity: metaflumizone, spinetoram, emamectine, pyrethrine (+PBO)

Persistence
(Macrolophus caliginosus)

Compound	0 days	1 day	3 days	1 week	2 weeks
metaflumizone	4	4	4	4	4
emamectine	4	3	2	1	1
pyrethrine	4	3	3	1	1

Metaflumizone

(different spraying volumes) - *Macrolophus caliginosus*

Dose rate	100 ml/plant (till run-off)	50 ml/plant	25 ml/plant	10 ml/plant
0,05 % (form. Compound)	4	4	4	4

Metaflumizone

(different concentrations) – *Macrolophus caliginosus*

Dose rate (% form. Compound)	50 ml/plant	25 ml/plant	10 ml/plant
0,05	4		
0,10		4	
0,25			4

Metaflumizone

(field trials) *Macrolophus caliginosus*

Dose rate	Eggs	Larvae	Adults
0,05	3	3	2
0,1	3	3	3

% Mortality on whiteflies (predator/prey ratio)	
Dose rate	**Abbott value**
0,05	10-20
0,1	15-30

Parasitoids

- *Encarsia formosa*
- *Eretmocerus eremicus*
- *E. mundus*
- *Diglyphus isaea*
- *Dacnusa sibirica*
- *Aphidius colemani*
- *A. ervi*

Encarsia formosa

Compound	IOBC adults (reduction in Nb black scales)	Hatching rate	Spraying on black scales – Hatching rate	Reduction in parasitation capacity
indoxacarb	2	1	1	None
rynaxapyr	1	1	1	None
flubendiamide	1	1	1	None
metaflumizone	1-4 (!)	1	3	?
spinosad	2	3	3	Negative
spinetoram	4	4	4	Negative
pyridalil	1	1	1	None
emamectine	3	2	4	None (Tv)
azadirachtin	2	1	2	None
pyrethrine	4	4	2	Negative

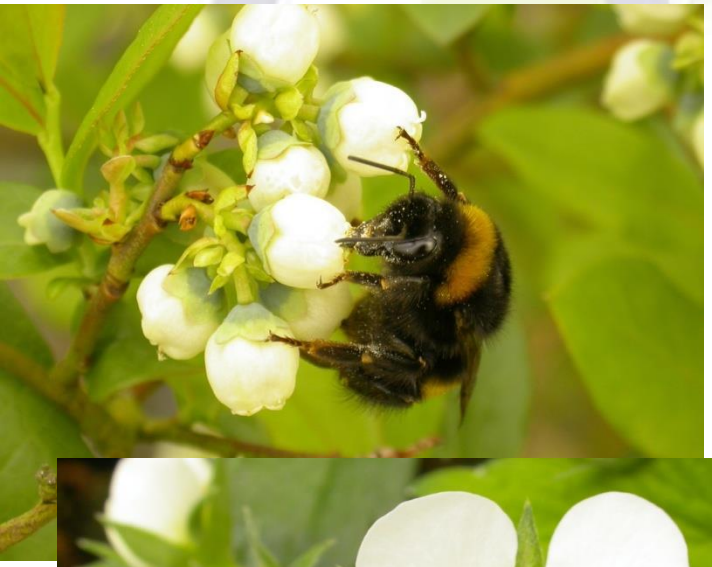
Predatory mites

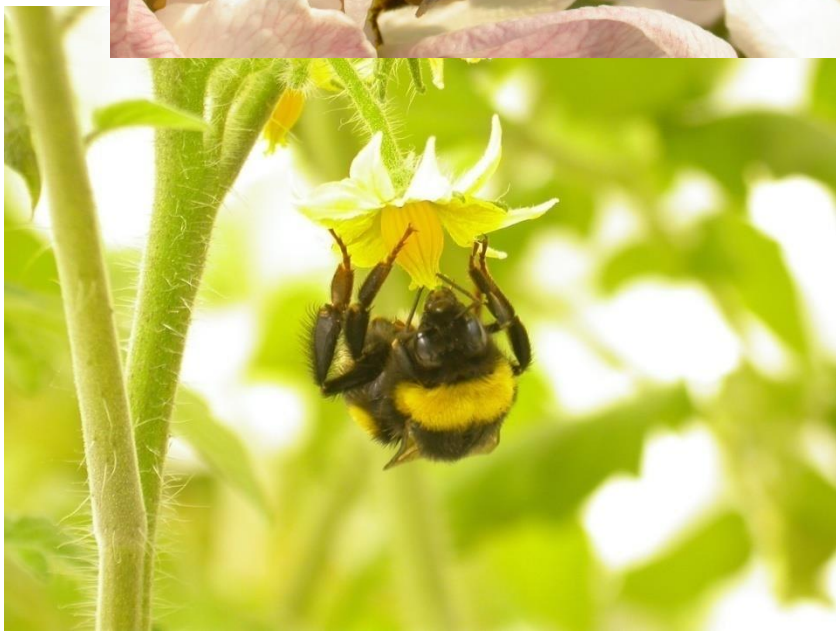
- *Phytoseiulus persimilis*
- *Amblyseius californicus*
- *A. cucumeris*
- *A. swirskii*

Phytoseiulus persimilis

Compound	IOBC adults	Existing population
indoxacarb	1	1
rynaxapyr	1	1
flubendiamide	1	1
metaflumizone	1	1
spinosad	2	4
spinetoram	4	4
pyridalil	1	1
emamectine	3-4	4
azadirachtin	1	2
pyrethrine	4	4

Bumblebees





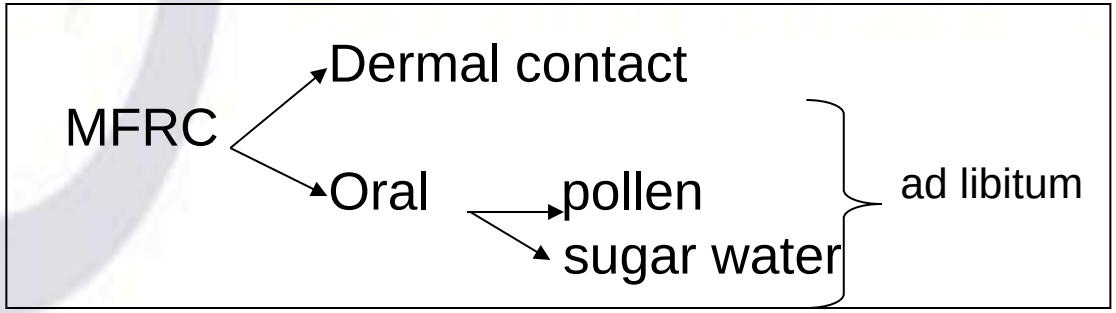
Bombus terrestris dalmatinus

- workers
- labo trials
- climate rooms
- not fertilised(haploid)

Aim of the study

effects → mortality
→ larval development + drone production
→ behaviour

Testing scheme

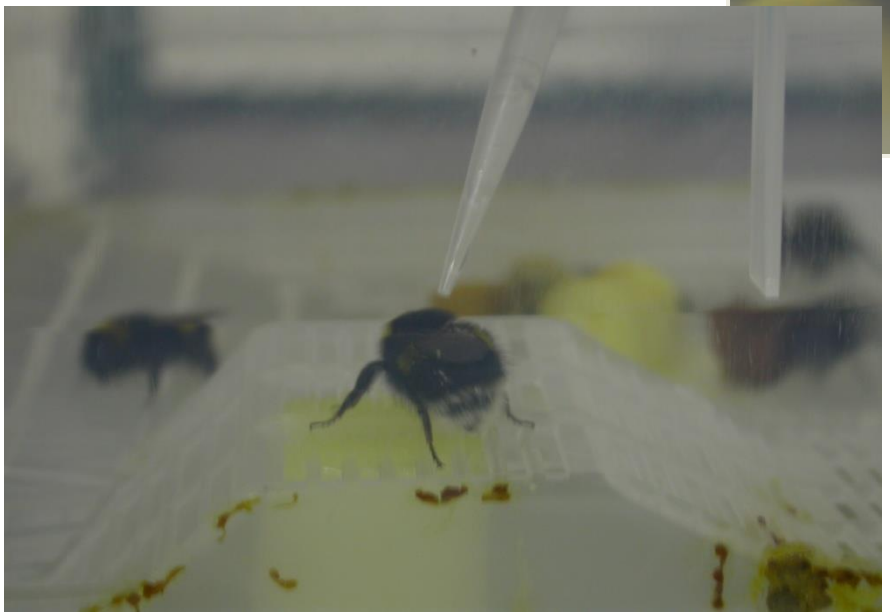


Start: 5 workers of the same age

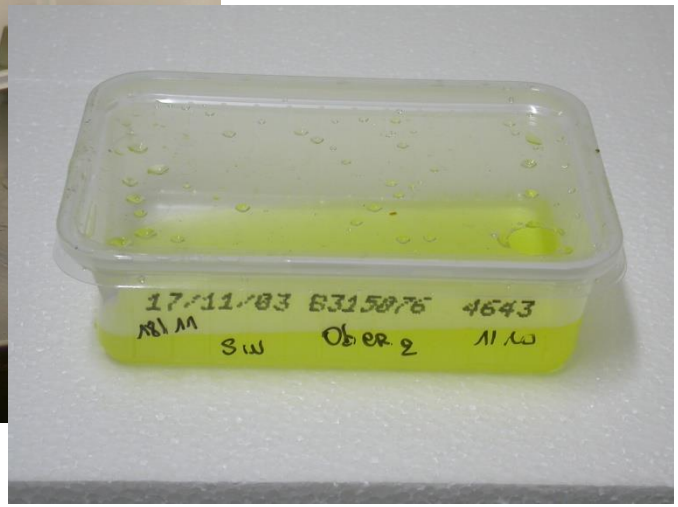
Contact treatment

contact treatment

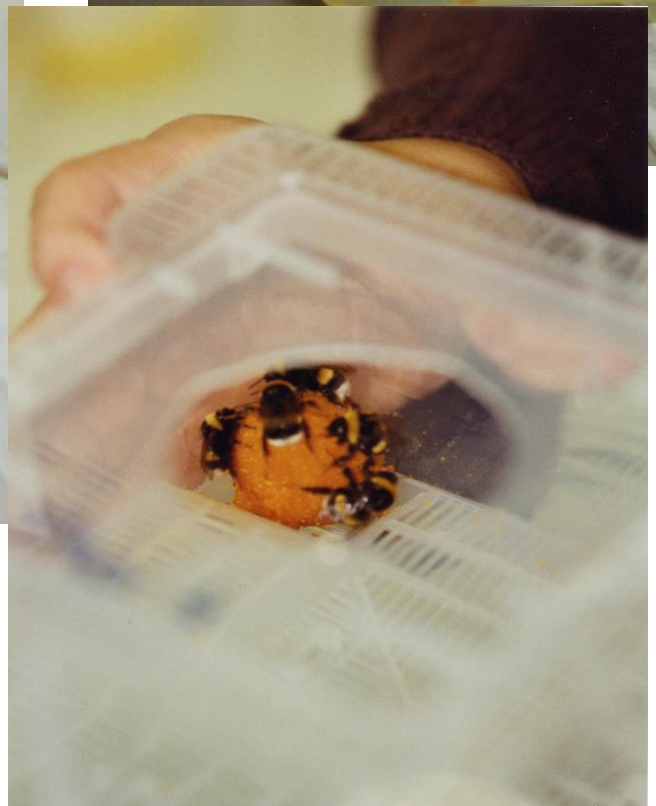
- ✓ 50µl test solution
- ✓ micropipet



Oral sugarwater



Oral toxicity : pollen



Pollen treatment

till saturation

Bumble bee trials

Bombis terrestris dalmatinus
Bombis terrestris terrestris

Compound	Topic		Sugar-water		Pollen		Practice
	Fem.	Drones	Fem.	Drones	Fem.	Drones	
indoxacarb	3	4	4	4	4	4	Close hive 24 h
rynaxapyr	1	1	1	1	1	1	OK
flubendiamide	1	1	1	1	1	1	OK
metaflumizone			1	4			Close hive 24 h
spinosad	4	4	4	4	4	4	Close hive 24 h
spinetoram	4	4	1	4			Close hive 72 h
pyridalil	1	1	1	1	1	1	OK
emamectine	4	4	4	4	4	4	Close hive 24 h
azadirachtin	1	1	1	1	1	1	OK
pyrethrine	4	4	4	4	4	4	Close hive 72 h

Compatibility with biological control and pollinators during tomato growing season + anti-resistance strategies

Start season

(before introduction beneficials)

Metaflumizone

Indoxacarb

On existing population beneficials

Rynaxapyr

Flubendiamide

Pyridalil

Azadirachtin

End season

(MRL – export - Chrysodeixis)

Emamectine -Pyrethrine

Spinosad - Spinetoram

Metaflumizone

Indoxacarb

Conclusion

- Several safe compounds against *Tuta absoluta*
- Implementation for use in IPM schemes in tomatoes possible, even if toxic in the first instance
- IOBC Class 4 (harmful) is a starting point for research, not an end point for use in IPM
- Class 5 : eradication? No recovery possible
- Anti-resistance strategies (IRAC): flubendiamide – rynaxapyr, spinosad – spinetoram, indoxacarb or metaflumizone early or late season
- www.ipm-impact.com