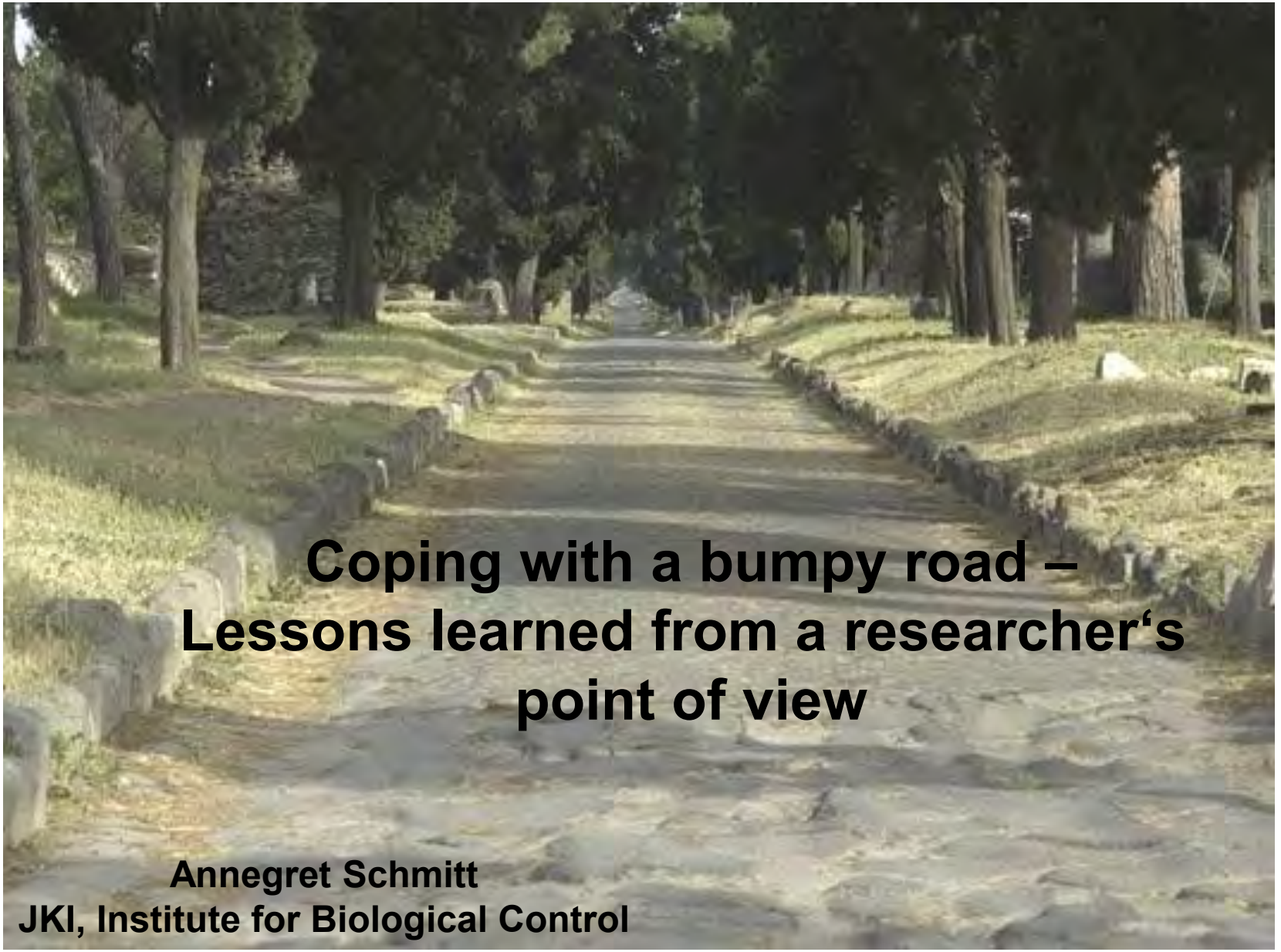

Coping with a bumpy road – Lessons learned from a researcher‘s point of view

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IOBC mission and objectives

- IOBC promotes research, development and implementation of **biological control** and **integrated pest management (IPM)** of pests and diseases in agricultural crops and forests
- IOBC is focussed on **sustainable control methods**
  - environmentally safe
  - economically feasible
  - socially acceptable

IOBC mission and objectives

- IOBC promotes **international cooperation** in research and development of biological control and IPM/IP through

  - international **working groups** and commissions on specific biocontrol and IPM topics

  - organisation of **conferences**, meetings and symposia

  - facilitation of **training** in biocontrol and IPM

20 Working Groups

- **Crop-focused**: Citrus, olives, viticulture, fruit crops, oilseed crops, field vegetables, protected crops, oak forests, stored products, date palms (in prep.)
- **Pest-focused**: Mite pests, plant pathogens
- **Method-focused**: Induced resistance in plants, GMO's in IPM, landscape management, pheromones and other semio-chemicals, pesticides and beneficials, multitrophic interactions in soil, insect pathogens and entomoparasitic nematodes

Important research aspects for the development of a botanical and potential „bumps“

- Identification of candidates
- Identification of spectrum of activity (crops/pathogens)
- For promising crops/pathogens: determination of efficacy under (semi-)commercial conditions
- Identification of active compounds and mode of action
- Identification of additional positive features
- Identification of bottle necks
- Troubleshooting and optimization

  (e.g. extraction procedure, application timing according to mode of action, application equipment, formulation)

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Example from own research:
Giant knotweed (*Fallopia (*formerly *Reynoutria) sachalinensis*)

***F. sachalinensis,* Polygonaceae**
Young shoots are eaten like asparagus;
Plant was introduced as fodder plant and ornamental

Plant extract for plant protection is commercialized

Enthousiastic researchers ...

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Spectrum of activity against plant diseases

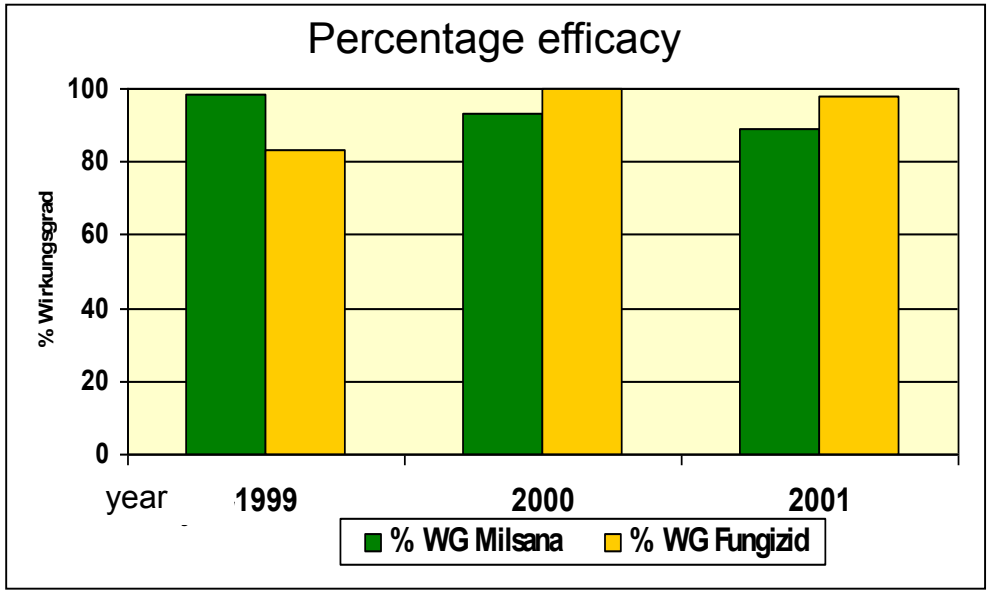
- **In the greenhouse**
  - Powdery mildew in cucumber, tomato, pepper, begonia, cereals (++)
  - Grey mould in begonia and cucumber flowers, young tomato and pepper plants, ornamentals (++)
  - Rust in carnation and beans (+)
  - Tobacco mosaic virus (+)

- **In open-field**
  - Powdery mildew in grape vine (++), roses (depending on cultivar), cereals, strawberry, ornamental trees (+)
  - Grey mould in grape berries (+)

++ highly effective; + moderately effective

Powdery mildew on tomato (*Oidium neolycopersicum*)

Greenhouse trial



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Powdery mildew on cucumber (*Podosphaera xanthii*)

Greenhouse trial

Water-treated control

Application of Milsana in 7-day intervals

Greenhouse trials with Milsana in cucumber/powdery mildew

	Efficacy [%]	Yield increase (total weigth) over control [%]
Germany	85.8	24.7
Greece	98.3	21.6
The Netherlands		

Disease severity at the end of the trials: 89-100%

Greenhouse trials with Milsana in cucumber/powdery mildew

	Efficacy [%]	Yield increase (total weigth) over control [%]
Germany	85.8	24.7
Greece	98.3	21.6
The Netherlands	28.5	

Disease severity at the end of the trials: 89-100%

Greenhouse trials with Milsana in cucumber/powdery mildew

	Efficacy [%]	Yield increase (total weigth) over control [%]
Germany	85.8	24.7
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The Netherlands	28.5	29.5

Disease severity at the end of the trials: 89-100%

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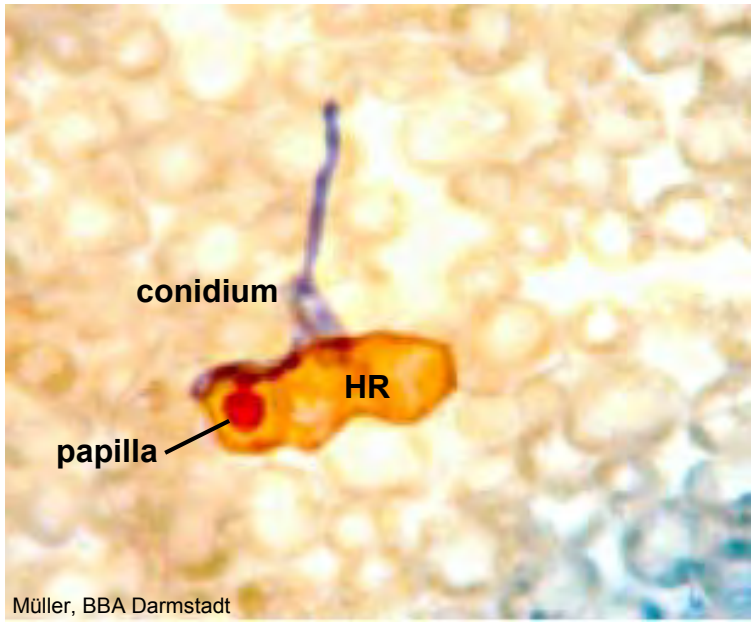
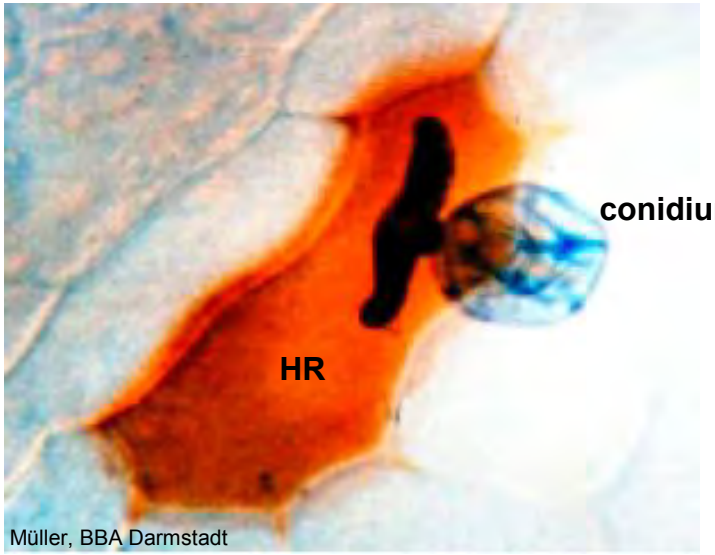
Site-specific defense mechanisms after treatment with Milsana (cucumber/powdery mildew)





Hypersensitive response (HR) at the infection site

Site-specific production of flavonoid phytoalexins induced after Milsana treatment (cucumber / powdery mildew)

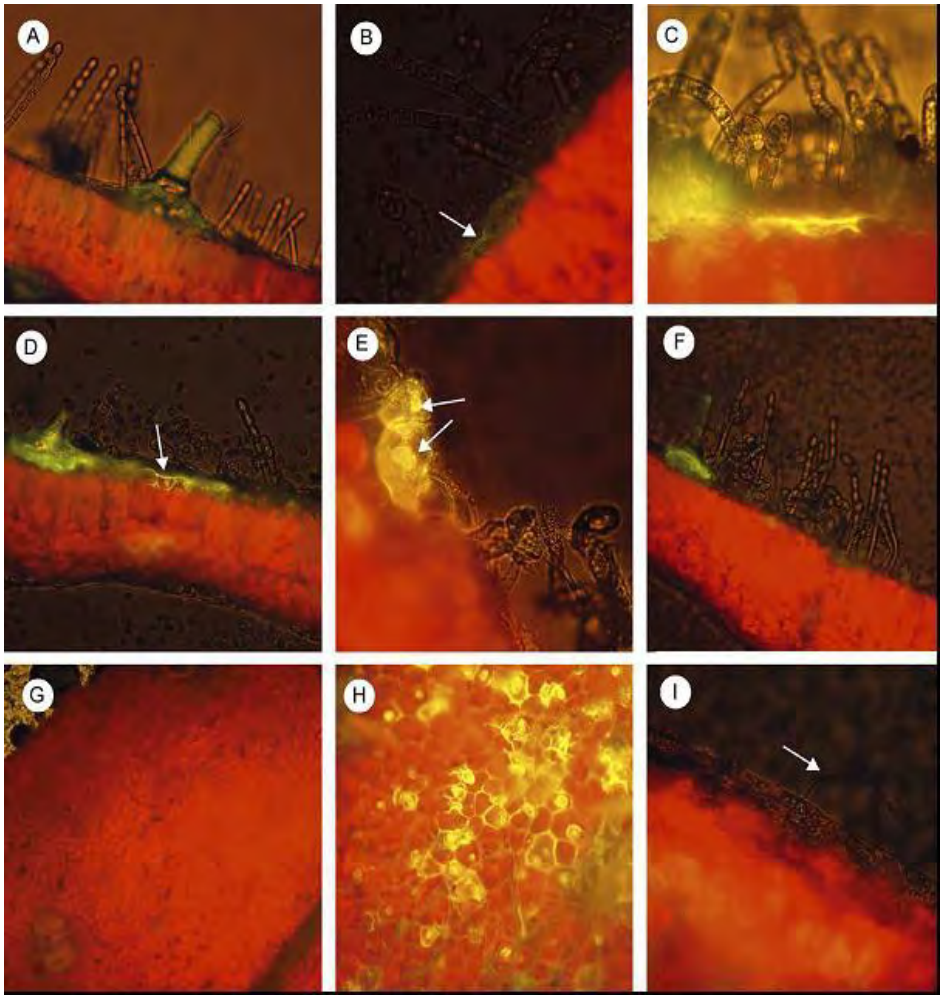


Fig. 3. Fluorescence microscopy analysis (488 nm) of fresh transverse-sectioned leaf tissues from inoculated (E - I +), and elicited/inoculated (E + I +) cucumber plants sampled at different times following the first Milsana treatment.
(A) E + I + leaf at time 0 h (200 X).
(B) An E + I + leaf 4 h after elicitation, the arrow indicates a faint yellow autofluorescence visible within the periphery of infected epidermal cells (400 X).
(C), An E + I + leaf 20 h after elicitation (400 X) and; (D) an E + I + leaf 30 h after elicitation, the arrow indicates yellow autofluorescence visible within the entire periphery of an infected epidermal cell and within the haustorial complex of this cell (100X).
(E) An E + I + leaf 48 h after elicitation, the arrows indicate yellow autofluorescence visible within the haustorial complexes of infected epidermal cells (400X).
(F) An E - I + leaf at 48 h (100 X) and;
(G), the surface view of an E - I + leaf at 48 h (100 X).
(H) The surface view of an E + I + leaf at 48 h (200 X). (I) An E + I + leaf 96 h after elicitation, the arrow indicates a collapsed conidial chain (200 X).

From McNally et al., Physiological and Molecular Plant Pathology 63 (2003) 293–303

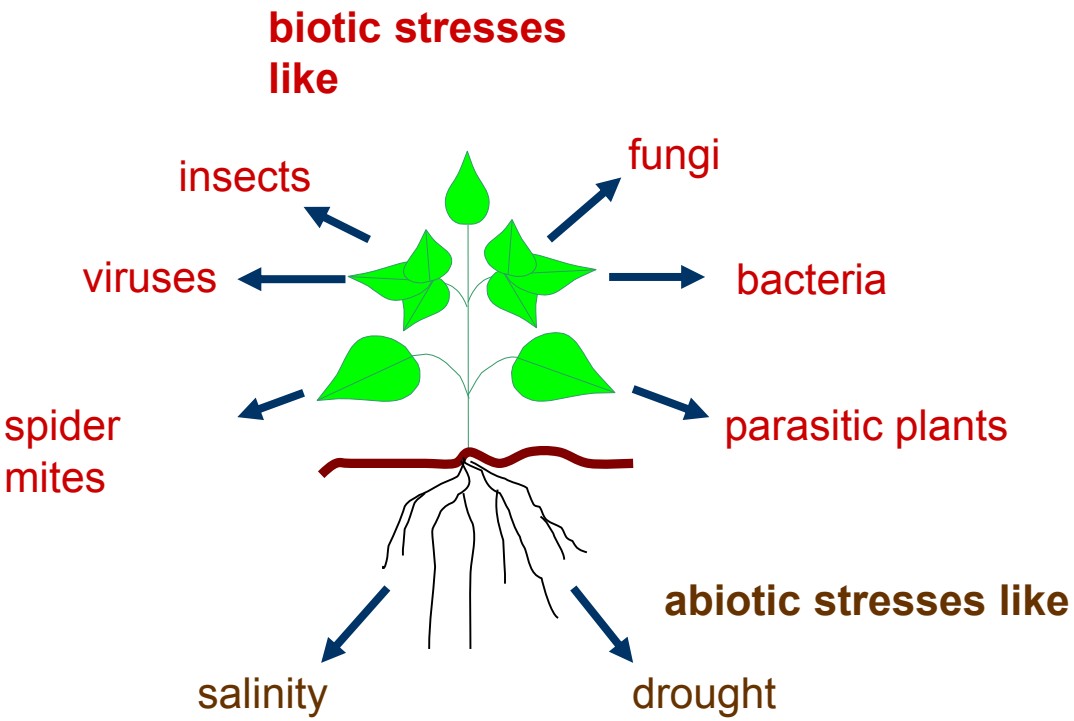
Mode of action

- **Induced resistance** – reduction or lack of symptoms

- **Induced tolerance** – productivity despite of symptoms

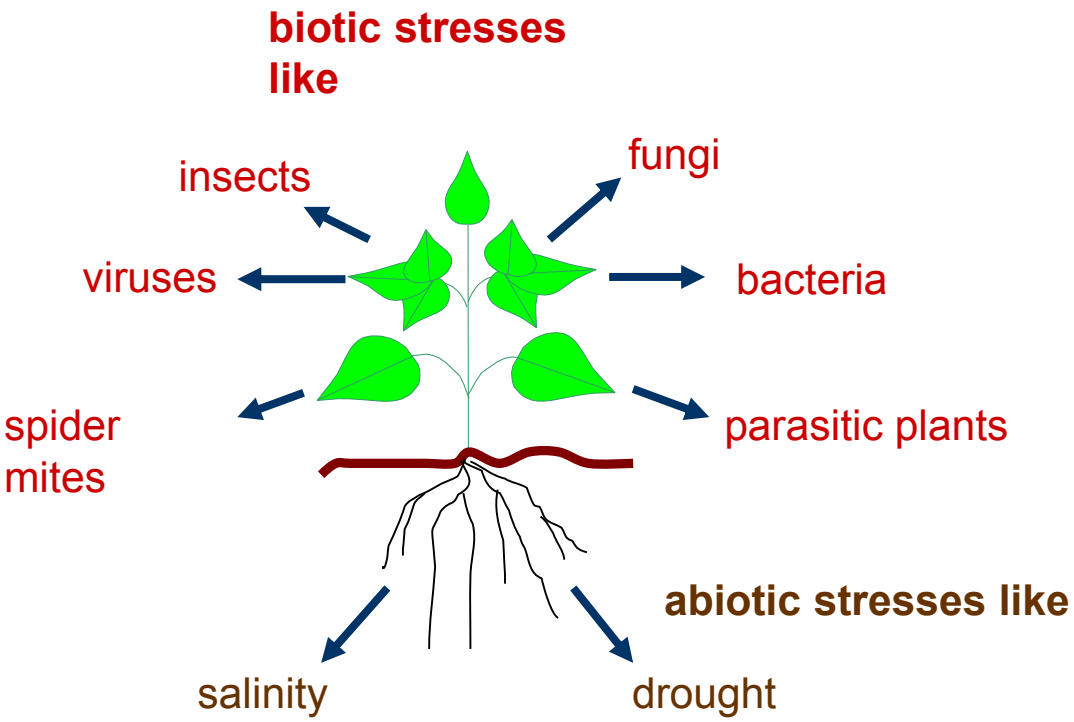
Mode of action

- Induced resistance / induced tolerance active against



Mode of action

- Induced resistance / induced tolerance active against



Induced tolerance can lead to enhanced productivity despite of infestation e.g. via

- enhanced growth of photo-synthetically active biomass
- changes in source-sink ratio
- mal-nutrition of pathogens

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General effects of *F. sachalinensis* extracts on the plant

- Increase in chlorophyll content
- Increase in photosynthetic activity
- Reduced side shoot development, enhanced main shoot development
- Influence on general habitus
- Reduced senescence
- Enhanced flower induction, flower size

Effects of *F. sachalinensis* extracts on flower size of Rex-begonia

control

treatment with Milsana

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Commercialized product:

Plant extract based on the above-ground parts of *Fallopia* (formerly *Reynoutria) sachalinensis*

- extract found in a screening in BBA (now JKI) in 1988
- developed by BBA together with BASF Limburgerhof
- finally commercialised

  in Germany as plant strengthener under the name **MILSANA®** by BIOFA and

  in USA as biopesticide under the name **REGALIA®** by Marrone Bio Innovations

  in 2012 Syngenta announced a new product under the name **SAKALIA®**

F. sachalinensis

- commercialized plant extract used in plant protection in Europe and USA
- high efficacy in protected and open-field crops against a variety of pathogens
- plant extract with broad spectrum of additional positive features
- plant extract with well defined and investigated mode of action
- suitable for organic and integrated farming
- minimal risk for development of resistance due to its mode of action

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Nevertheless, the road leading from research to marketing was long and sometimes „bumpy“!

Lessons learned from a researcher´s point of view

- In the 1990s many of the large agrochemical companies did not reach the economic goals expected from a „green product“. Their development was discontinued.

- Incentives for small comapanies can be characterized by passion and commitment. Many SMEs survived despite of modest sales and profits. They found a balance between costs and revenues and continuted in specialty markets.

(after Ravensberg, 2010, Thesis)

- Since very recently, big agricultural companies show again increasing interest in biological / natural products. There are several cases where well-established biocontrol companies have been taken-over.

„Member states disregard biocontrol, chemical companies discover their potential“

„... we have experienced engagement into biological control before with unsuccessful outcome, why these activities are very critically followed.“

(Ehlers, 2013, IOBC–WPRS Bulletin 90)

Further important aspects

Agriculture as a whole needs reliable availability of biological / natural products!

- Niche markets and minor use situations need biological solutions and companies willing to invest in such products.

From experience in the past, mostly SMEs have been willing to do so.

- SMEs often are required as partners in publicly funded research programs.

Where does the current trend of SMEs inclusion in big companies lead us?

Summary of potential „bumps“

- Level of efficacy (Which level is acceptable / necessary? Comany and farmer attitude?)
- Crop (cash-crop / niche-crop?)
- Anticipated market potential (What are the goals?)
- Fitting of a product into the companie´s portfolio (Competition between chemicals and biologicals?)
- Drivers for development and marketing of natural substance-based products
    - sustainable demand in company for green plant protection products?
    - political situation (EU legislation; consumer and farmer demands)?
- Confidentiality (publication / patenting / non-disclosure?)
- Registration (costs; time to marketing etc.; plant strengthener – plant protection product)

How to cope with the „bumps“

- Liaise with a well suited company as early as possible
- Find funding possibilities
- Keep intense and open exchange with the company on all important aspects (research and marketing focusses)
- Jointly address bottle necks and work on solutions
- Be patient
- Make use of the expertises of each of the partners
- Be open-minded for final use in practice (use in strategies vs. stand-alone use)

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