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Potential and research needs for home made bio-pesticides for African Organic Agriculture

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Structure

1. **Background:** crop protection in OA
2. **Practical requirements for home made bio-pesticides**
3. **Example for a successful bio-pesticide:** The Neem Tree
4. **Research needs on bio-pesticides**
5. **Summary and outlook**

The challenges?

Crop losses due to insect pests and diseases affecting food sovereignty to smallholder farmers elsewhere in Africa - the case for Ethiopia

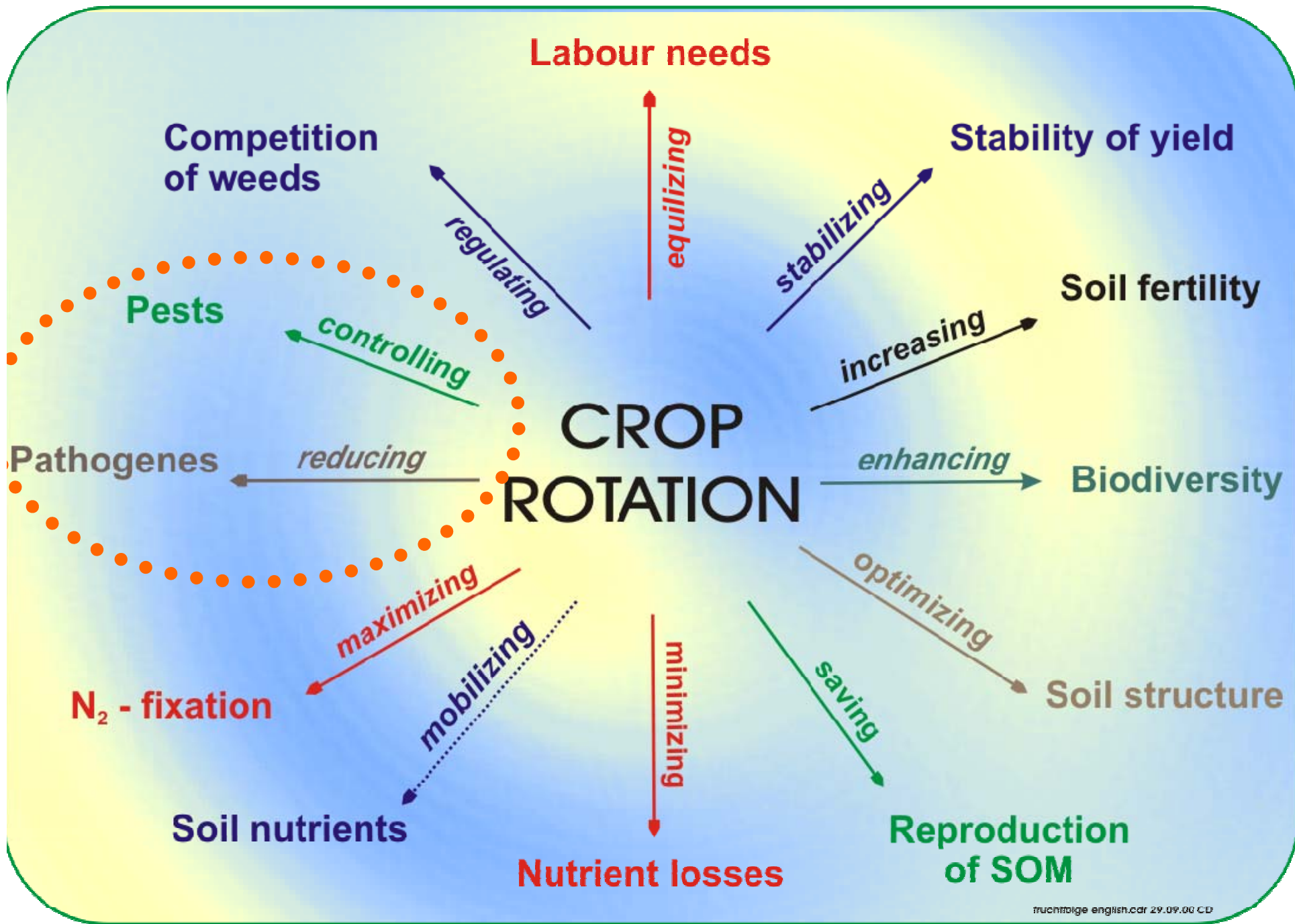
Crop types	Estimated losses (%)
Cereals	32 - 60
Pulses	29 - 63
Vegetables	24 - 49
Citrus	2 - 25
Cotton	36 - 61
Oil seeds	9 - 13
Coffee	10 - 28
Root crops	38 - 50

Tsedeke, 1995; Crow and Shitaye, 1997

Guiding Principles

General aspects of crop protection in Organic Agriculture

- Pest and diseases can often be controlled by the site specific use of indirect control methods such as crop rotation, variety choice and manuring
- Increasing problems are often observed if basic principles of OA are neglected
- Generally problems increase with the cultivation time
- Some vegetables are susceptible to serious crop protection problems
- Permanent crops such as orchards are most prone to pest and diseases
- Post-harvest problems play a prominent role in Africa



General Options

Categories of bio-pesticides suitable for OA

- Botanicals (various forms of liquid plant extracts or powders)
- Anorganic agents (soaps, rock powders, etc.) often combined with bioagents
- Micro-organisms (mainly bacteria and fungi)

Regulatory facts

Major allowed pesticidal compounds in OA

(according to EU-regulation on OA 834/2007)

Name	Description
Azadirachtin	Insecticide, needs recognition
Hydrolised proteins	Attractant
Pyrethrin	Insecticide
Quassia	Insecticide
Micro-organisms	No gmo'S
Pheromones	Only in traps and dispensers
Copper compounds	Fungicide
Mineral oils	Insecticide
Sulphur	Fungicide

Home made bio-pesticides

- ❖ Can be prepared by the farmer himself
- ❖ Low costs, high flexibility
- ❖ Uncertainty about correct preparation and application
- ❖ Need of knowledge and skills



Unexplored potential for small-scale farmers

Requirements for home made bio-pesticides

- **Sufficient availability of raw material on site**
- **Known effects and specific indications of potential agents**
- **Absence of any toxic effect on humans and the environment**
- **Precise knowledge on optimal preparation**
- **Availability of technical infrastructure**
- **Clear indication of optimal application techniques**

Sound criteria - down side effects

Toxicological effects of bio-pesticides

(from top to bottom: decreasing relevance for home made biopesticides)



- Toxicity for humans
- Toxicity for endotherms
- Effect on non-target organisms and predators
- Phytotoxicity
- Behaviour in the environment
- Resistance

Sound criteria's – clean sources

Generation of empirical knowledge on the production of the raw material (plants)

- Biology of plants / growing techniques
- Sufficient biomass production
- Cultivation or wild collection
- Harvesting and conservation

Success stories

Neem Tree (*Azadirachta indica*)

- Origin: tropical Asia (prob. Myanmar), nowadays all over the tropics
- Fast growing, drought and partially salinisation resistant tree, up to 30 m height, up to 50 kg fruits per year, shadowing effect, firewood
- Insecticidal effects of bark, leaves & seeds
- Mode of action (repellence, interference with moulting, feeding activity)
- Use: traditionally: adding leaves to stored cereals for protection against insects
- Nowadays one of the few commercial natural insecticides allowed in OF

Source: www.africanmarketsquare.ca/neemoil.htm



Success stories

Home made preparation of Neem extracts

- ❖ Collection of seeds, removing of fruit pulp
- ❖ Powdering with a mortar
- ❖ Water extraction (min. 5 h) 25 - 50 g powder for 1 liter
- ❖ Filtering and knapsack sprayer application (within max 2 days)
- ❖ the efficacy of leaves is much lower (higher quantities needed)

Lessons from success stories

Problems linked to the use of bio-pesticides

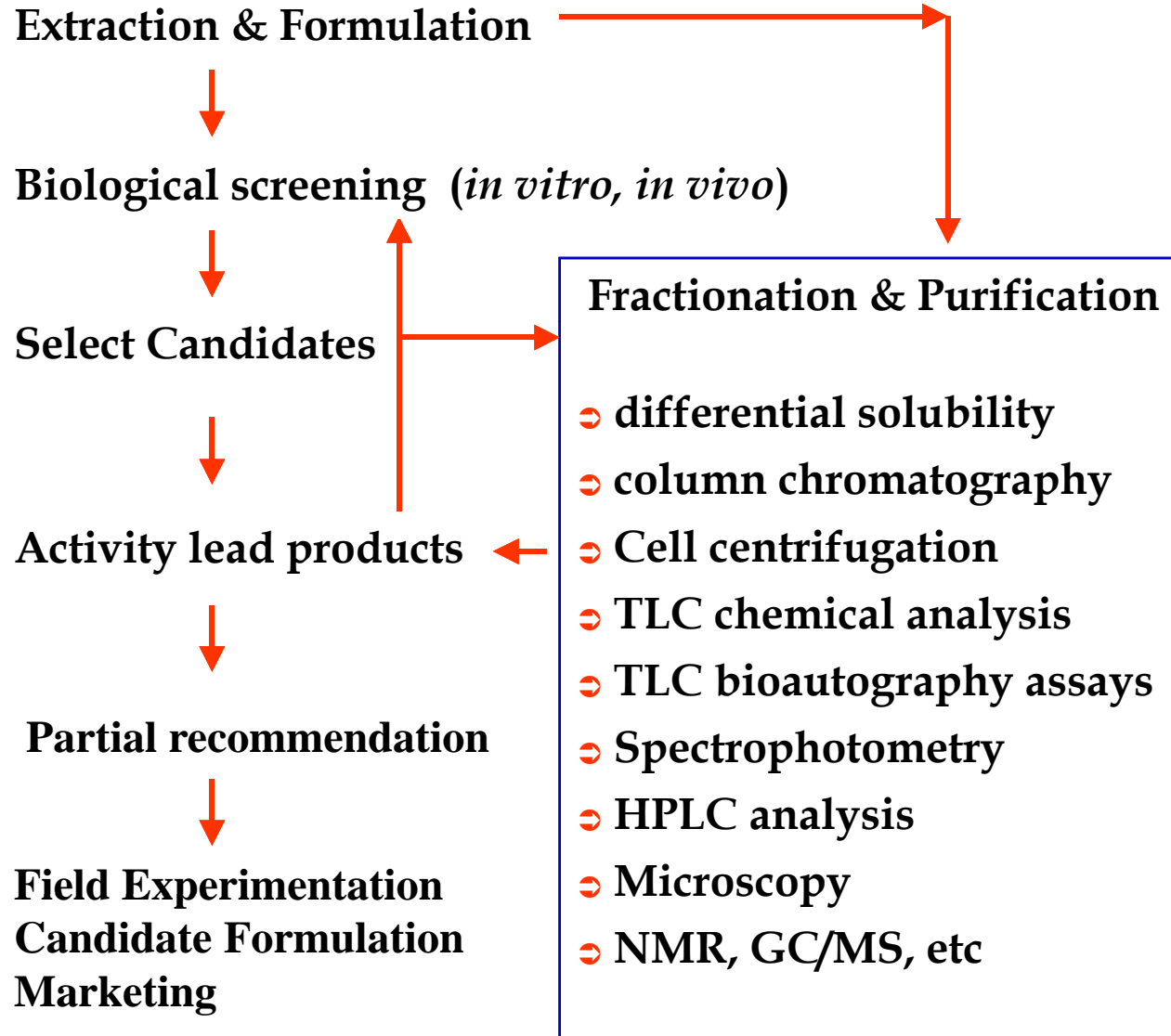
- Insufficient efficacy
- Insufficient reproduceability under different environmental conditions
- Active agents often unknown
- Standardisation not possible
- Problems with application technique
- No general eco- and human toxicological harmlessness
- High production costs

Research needs

- ✓ Systematic screening of new botanicals
- ✓ Extensive analysis of the mode-of-action of tested agents
- ✓ Dose / efficacy calculations / deduction of optimal dosages
- ✓ Optimisation of preparation and application
- ✓ Generation of empirical knowledge on the production and post harvest processing of the raw material (plants)
- ✓ Knowledge dissemination (mainly farmers participatory approaches)
- ✓ Success control

**Research and development experiences of
home made bio-pesticides**

Future Strategy: methodology - HM biofungicides



Future Strategy; capacity building is the very must

Extensive analysis of the mode-of-action of tested agents

Requires sophisticated methods including (electron) microscopic investigations



***P. infestans* haustorium in a plant cell**

(Neuhoff et al. 2002)



Future Strategy- innovative steps

Systematic screening of new botanicals

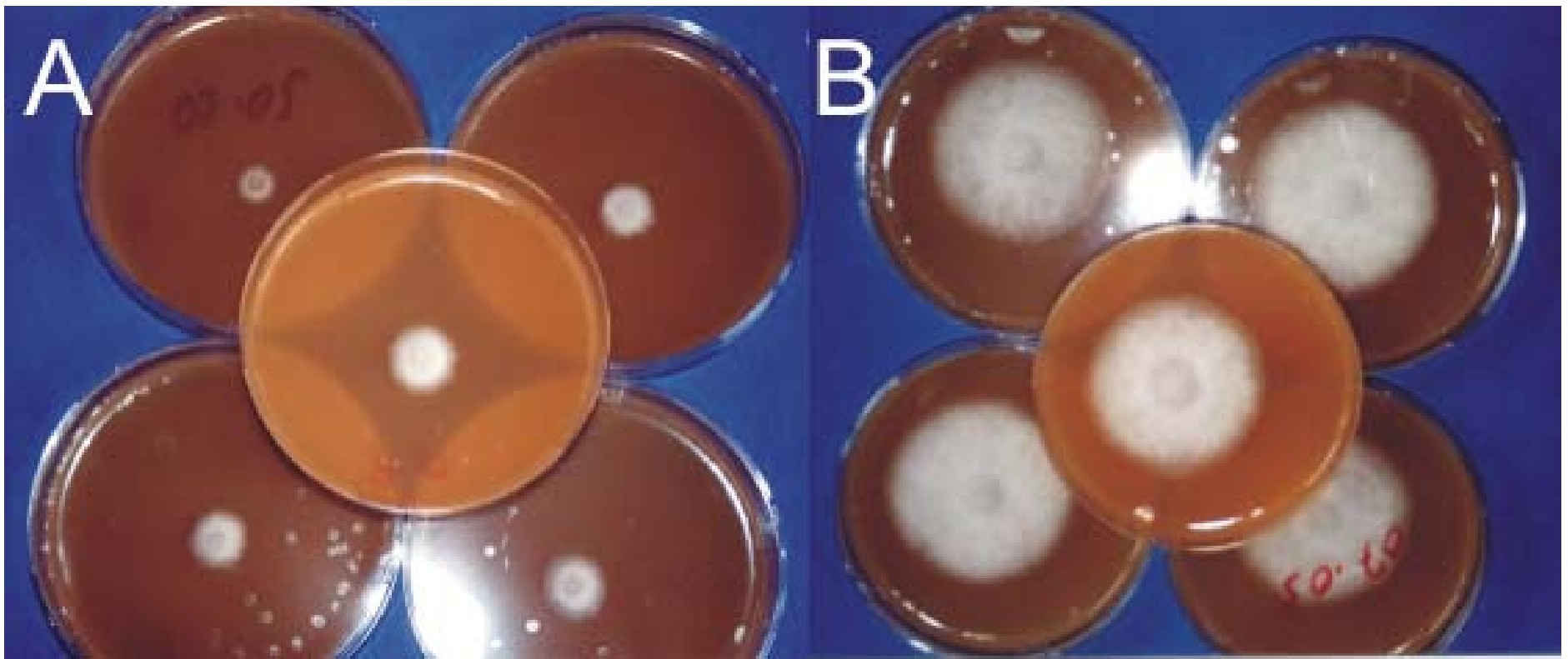
The practical research and development testing methods of biofungicide

1. ***In vitro* mycelium growth inhibitory bioassay**
2. ***In vitro* spore germination bioassay**
3. **Leaf Disc Bioassay *in planta***
4. **Greenhouse experiments *in planta***
5. **Field experimentation**
6. **Factor affecting biological efficacy**

Example: new spectrum of biofungicides like against fungal pathogen of the late blight (*Phytophthora infestans*)

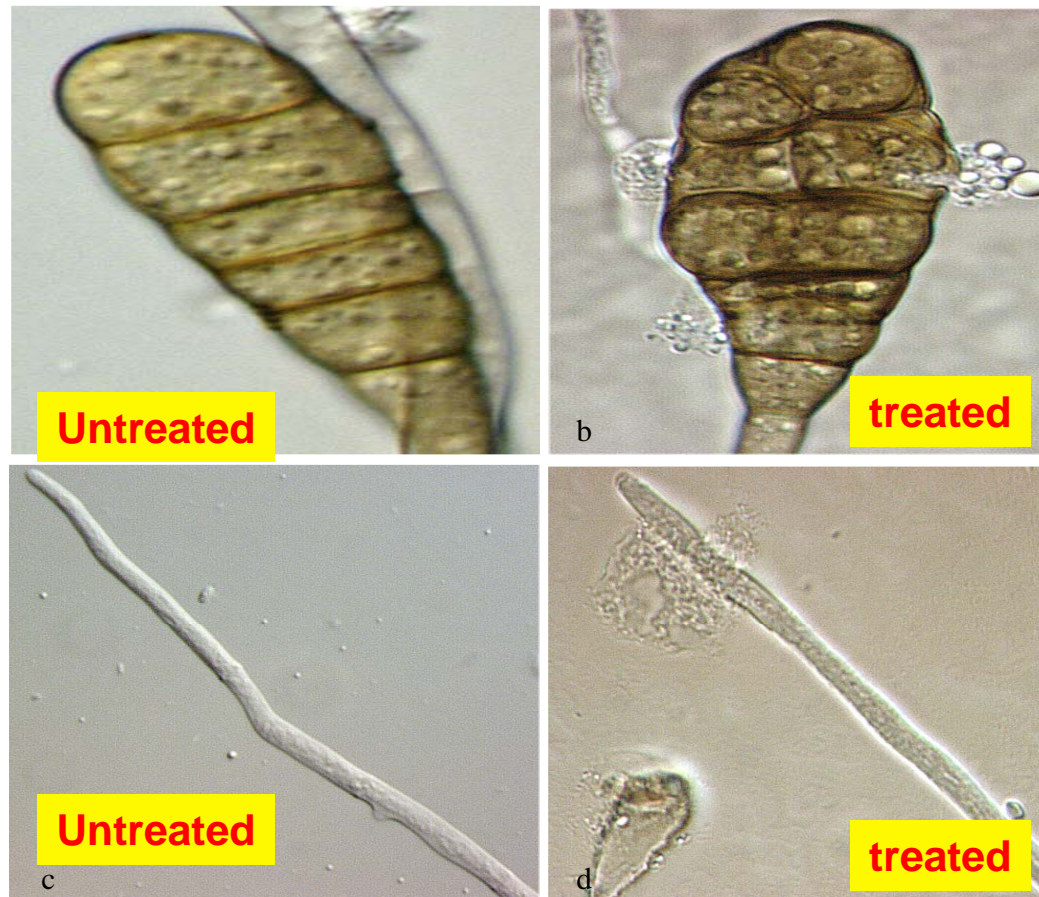
Innovative steps: *in vitro* mycelium growth inhibitory bioassay

Effect of a *H. abyssinica* extracts (at 0.25% m/v) added to a growth medium on mycelium growth of *P. infestans* (A = treated, B = untreated, one week after inoculation).



Innovative steps: in vitro spore germination bioassay

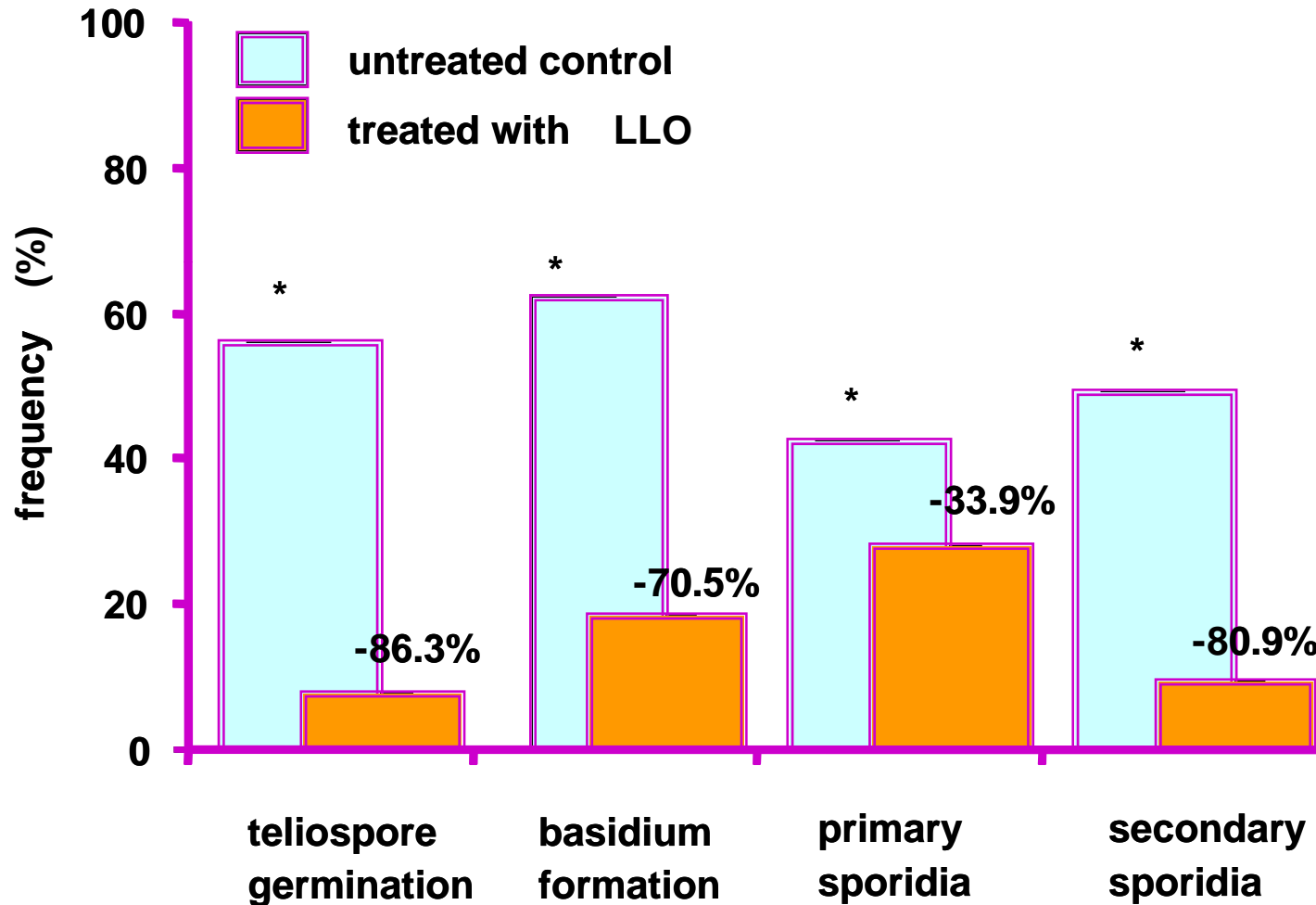
Effects *P. nigrum* extract on the conidia germination and mycelium growth of *Alternaria solani* (*in vitro*)



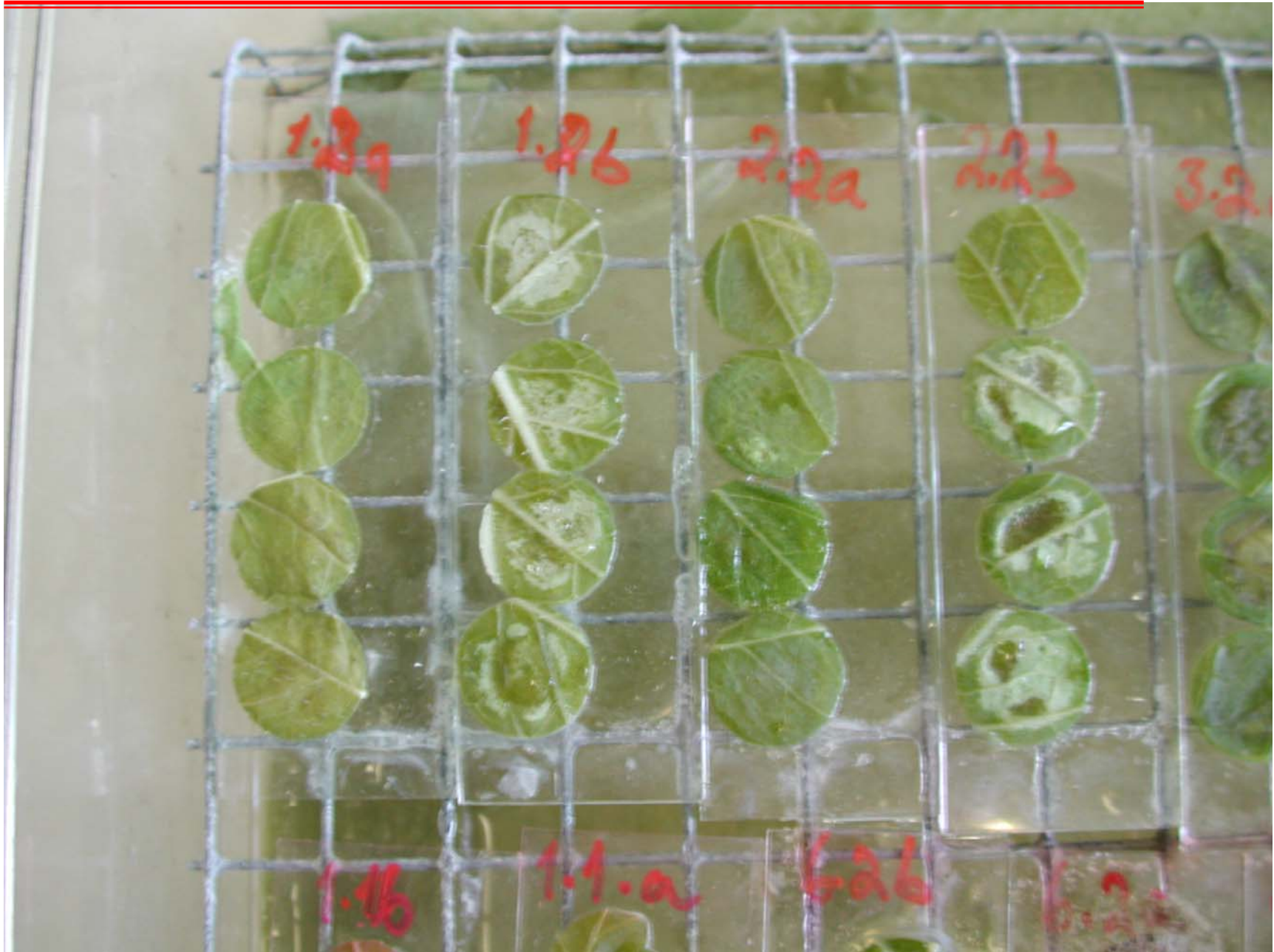
Mekuria et al, 2003

Innovative steps: in vitro spore germination bioassay

Effects of moss-extract on the germination and differentiation of infection structures of teliospores of *Tilletia caries* of wheat



Innovative steps: Leaf Disc Bioassay



Innovative steps: Greenhouse experiments in planta

Effect of ethanolic extracts from sage leaves on *P. infestans* (artificial inoculation, Neuhoff et al. 2003)

Keys:

- **100% damage of untreated plants**
- **Activity depended on application concentration**



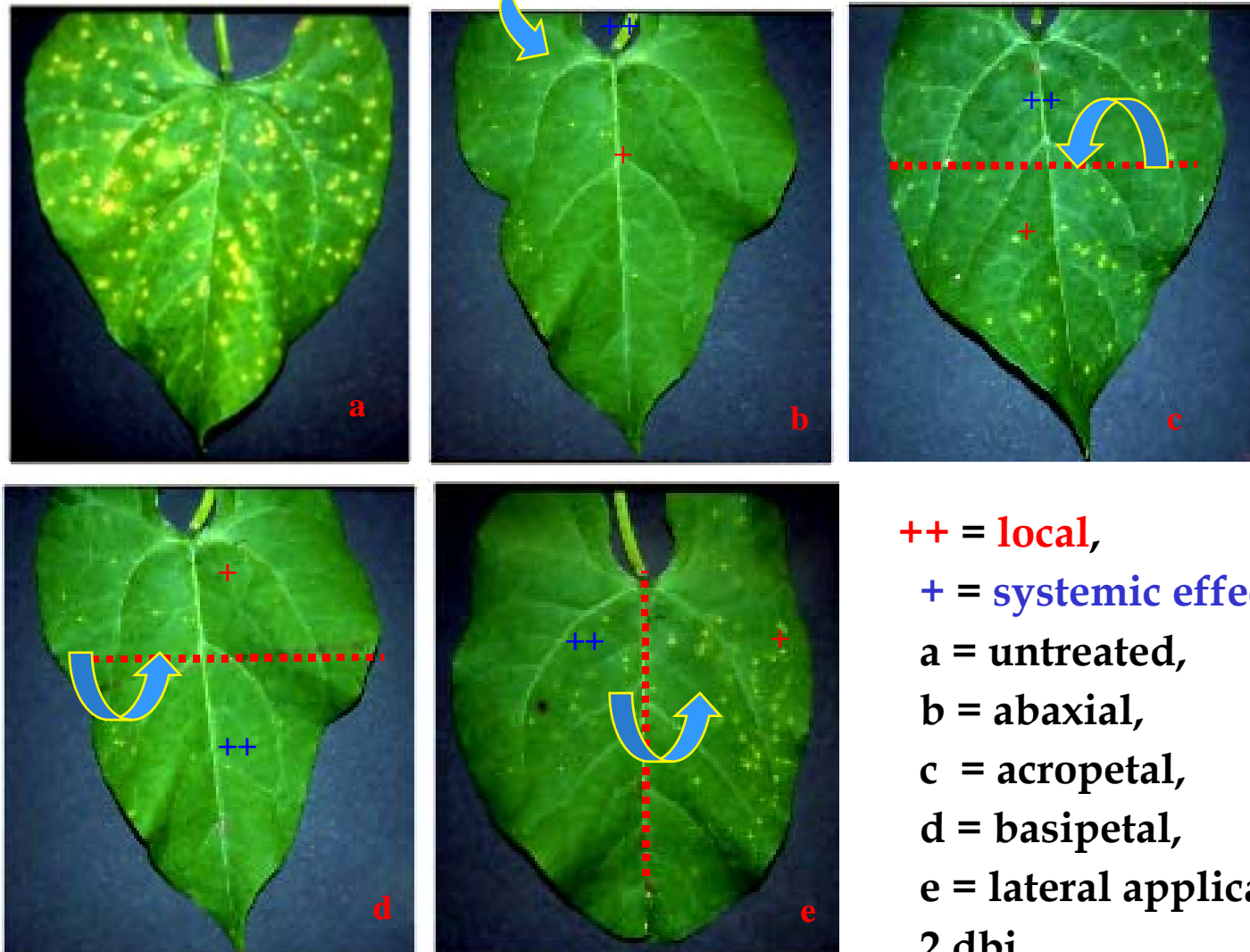
Sage 4%

Control

Sage 2%

Innovative steps: Greenhouse experiments in planta

Systemic activity of the extract (1% mv⁻¹) from the *B. trilobata* against infection density of the bean rust, *Uromyces appendiculatus*



++ = local,
+ = systemic effects,
a = untreated,
b = abaxial,
c = acropetal,
d = basipetal,
e = lateral applications,
2 dbi

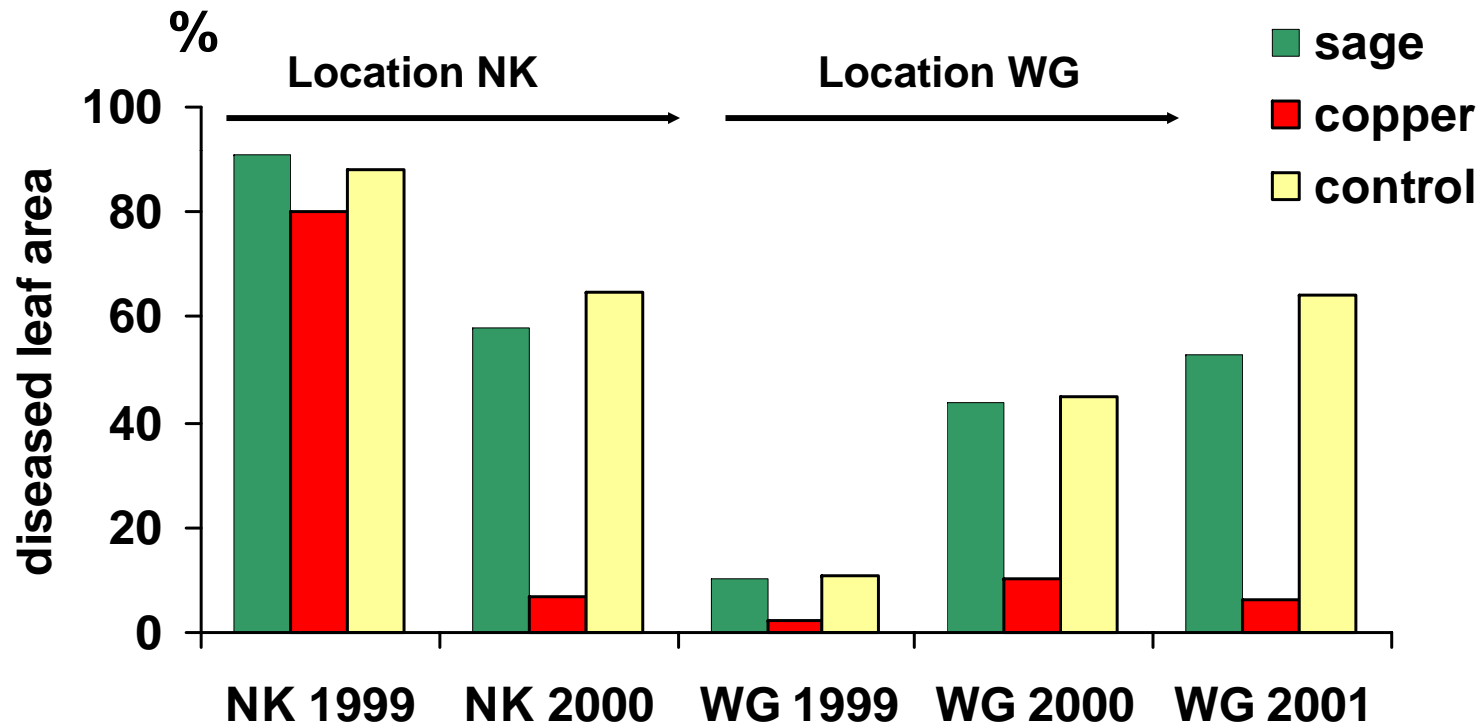
Field Trials



Innovative steps: *field experimentation*

Effects of sage leaf extracts and copper hydroxide treatments on leaf infection status of late blight in organic potatoes

Key; great gaps between in vitro and field efficacy of biopesticides



Date of assessment: 14. Jul. 1999

14. Jul. 2000

22. Jul. 1999

14. Jul. 2000

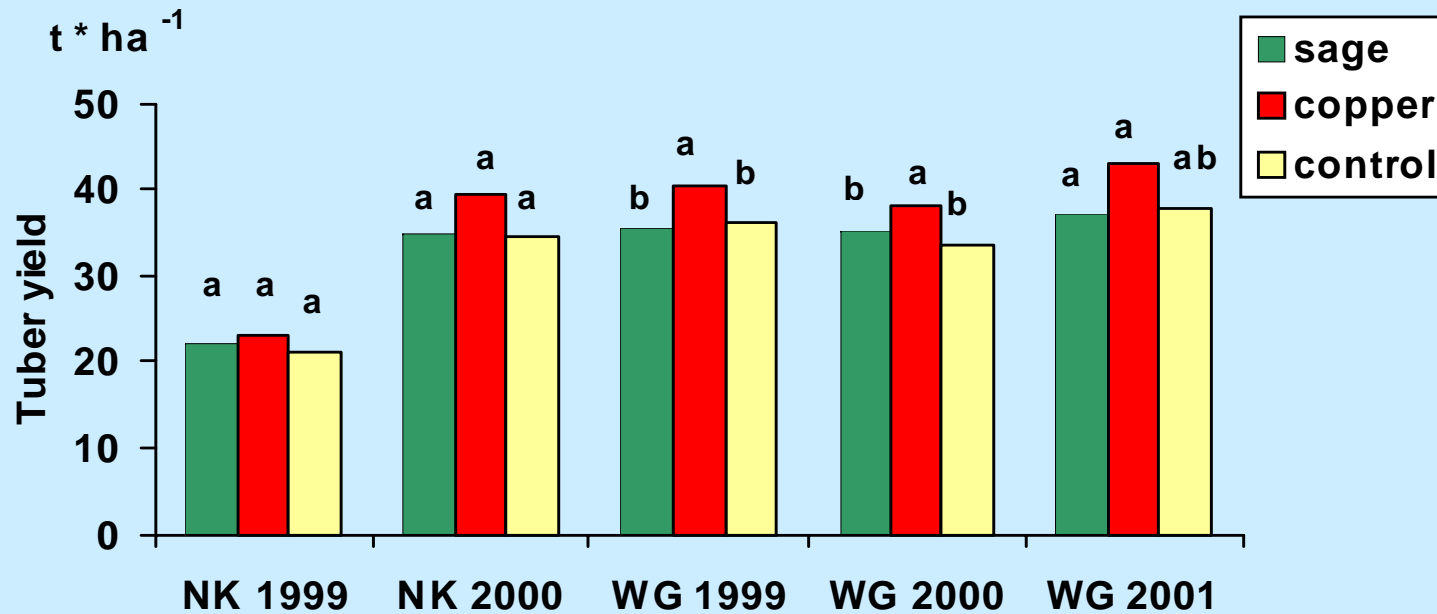
2. Aug. 2001

Site: NK = Niederkrüchten, WG = Wiesengut

Tukey's Test ($\alpha = 0.05$)

Innovative steps: *field experimentation*

Effect of sage leaf extracts and copperhydroxide treatments
on potato tuber yield, 5 trials, two sites, 1999 - 2001

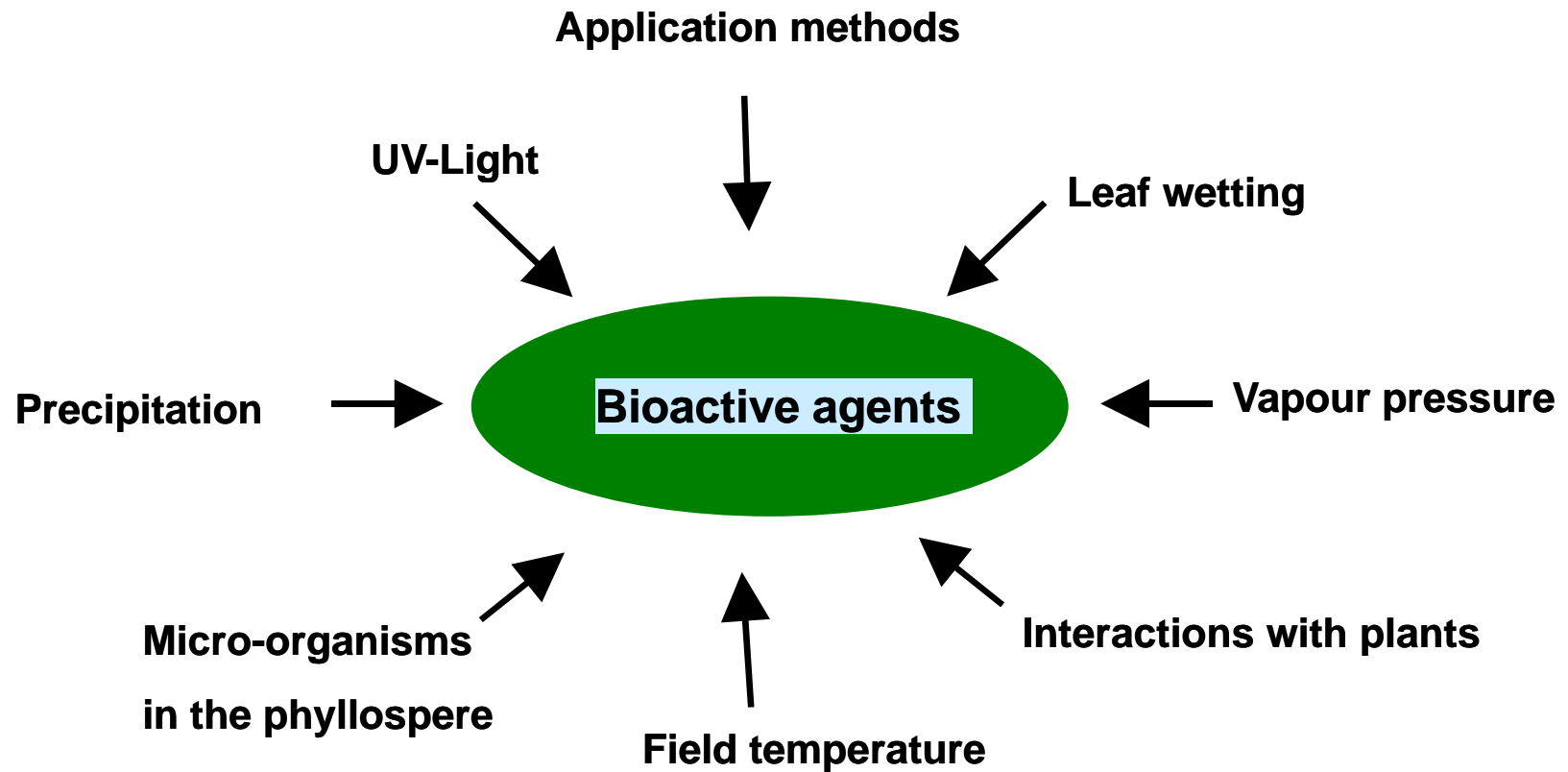


Tukey's Test ($\alpha = 0.05$)

NK = Niederkrüchten, WG = Wiesengut

Innovative steps: factors affecting field biological efficacy

Affecting factors on field efficacy of bio-pesticides



Innovative steps: factors affecting efficacy

Dose - efficacy calculations / deduction of optimal dosages

- ❖ **Minimum doses allowing a acceptable field efficacy have to be calculated**
- ❖ **Prerequisite for an economic use**
- ❖ **Basis for any optimising strategy**

Innovative steps: factors affecting efficacy

**The Minimum Inhibitory Concentration (MIC %) of test oils against
A.flavus & *F. verticelloides* in Ethiopia**

Essential oils	<i>A.flavus</i>	<i>F.verticelloids</i>
Orange peel	0.36	0.46
Rosemary	0.36	0.33
Black cumin	0.19	0.37
Citrodora	0.57	1.0
White cumin	1.0	1.0
Palma Rosa	1.0	1.0
Tossing	0.47	0.84
Black pepper	0.38	0.61
Lavender	0.35	0.68
Mexican tea	0.59	0.87

Summary: call for global research and development networks on biopesticides

Summary and outlook

- Great potential of bio-pesticides
- Systematic research and documentation needed
- Crucial point – efficacy under field conditions

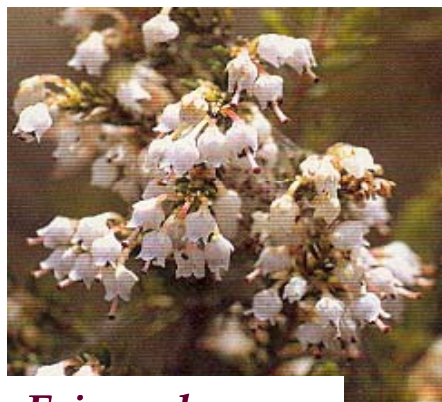
Suggestion

Intensification of international and regional cooperation targeted on

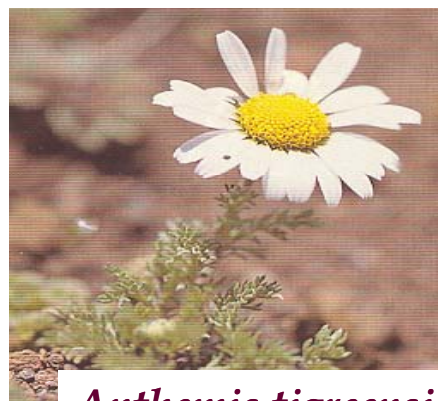
- exchange of knowledge and experiences
- joint laboratory and field trials
- drafting of manuals for users and extension services



Scadoxus multiflorus



Erica arborea



Anthemis tigreensis

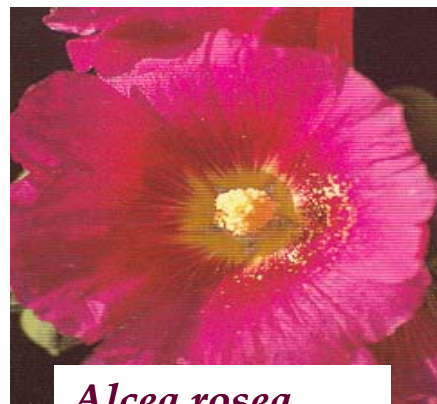


Salix subserrata



Pavonia urens

**Thank you
for your
attention!!!**



Alcea rosea



Clematis simensis



Delphinium dasycaulon



Rosa abyssinica



Adenium obesum



Verbascum sinaiticum