Mandipropamid
a new fungicide for the control of late blight in potatoes

F. Huggenberger & G. Knauf-Beiter

EuroBlight Workshop, Bologna

May 2-5, 2007

REVUS™

syngenta®

Summary: mode of action, resistance risk

Mandipropamid may interfere with the biosynthesis of phospholipids and inhibit the cell wall deposition (to be confirmed)

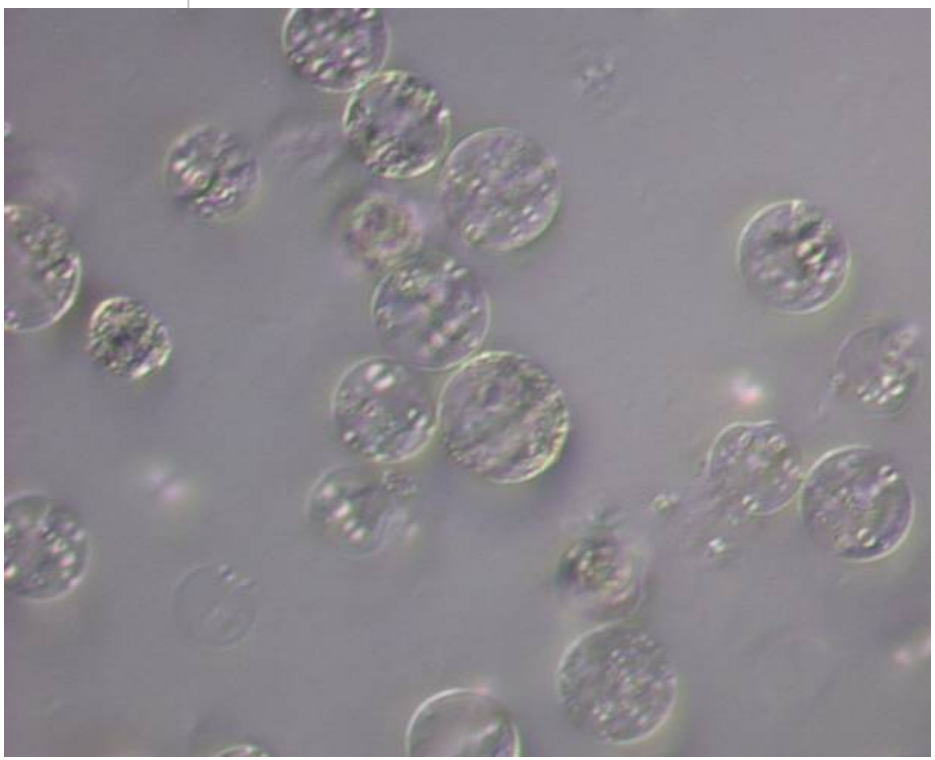
Mandipropamid belongs to the mode of action group of the carboxylic acid amides (CAA) fungicides (FRAC group 40)

Based on extensive studies, the resistance risk in *Phytophthora infestans* to CAA-fungicides is judged as low

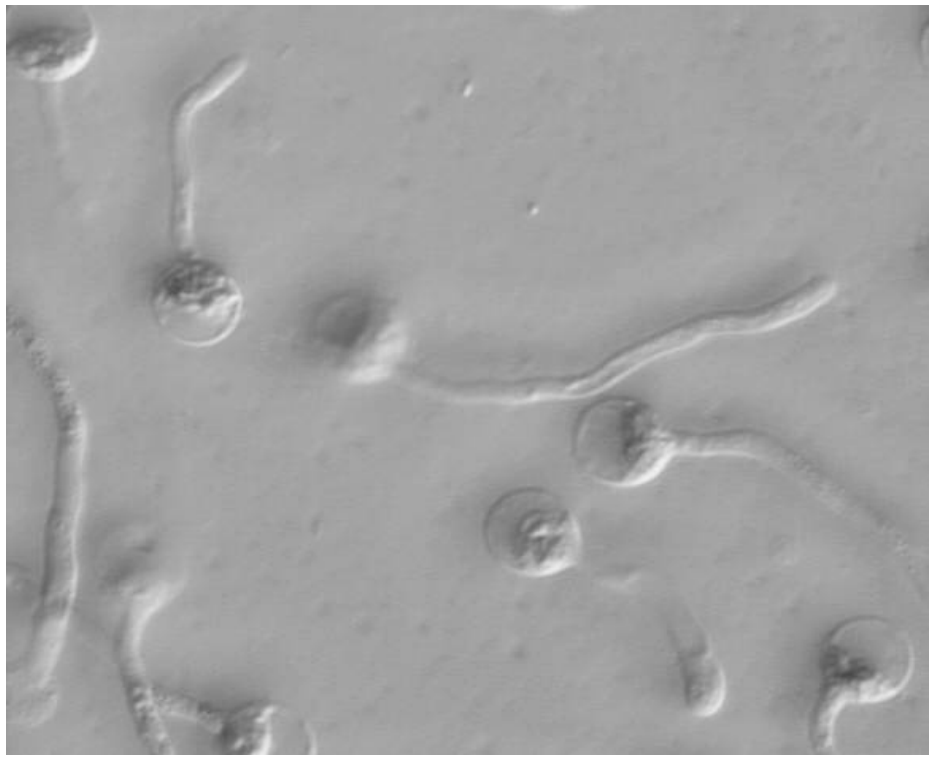
- **no resistant isolates detected in field populations**
- **no resistant isolates in forced selection experiments**
- **artificial laboratory mutants are not stable**
- **no cross- resistance to other mode of action groups**

FRAC recommendations: maximum 50 % out of all applications for late blight control with CAA-fungicides

Inhibition of germination of zoospores in vitro



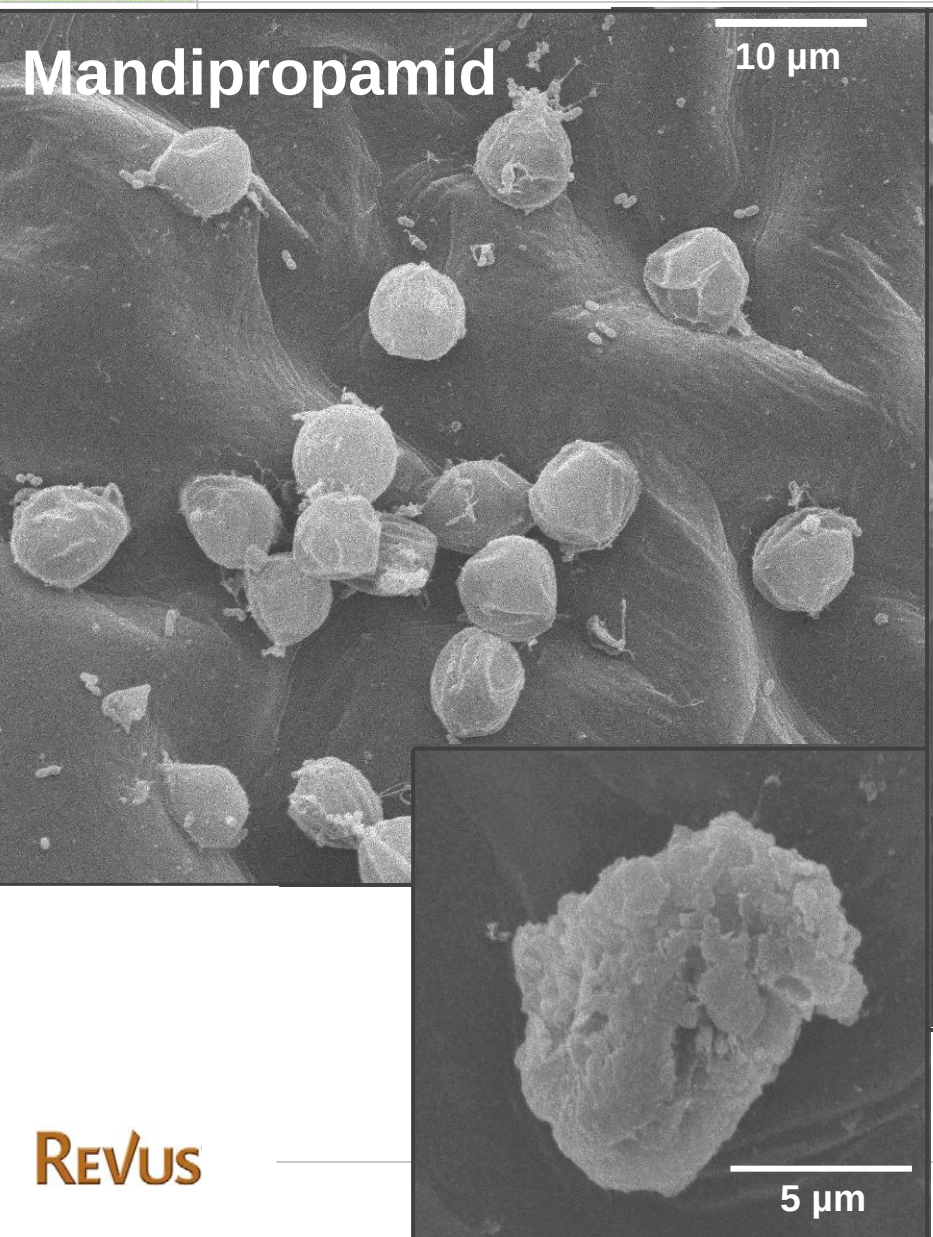
Mandipropamid

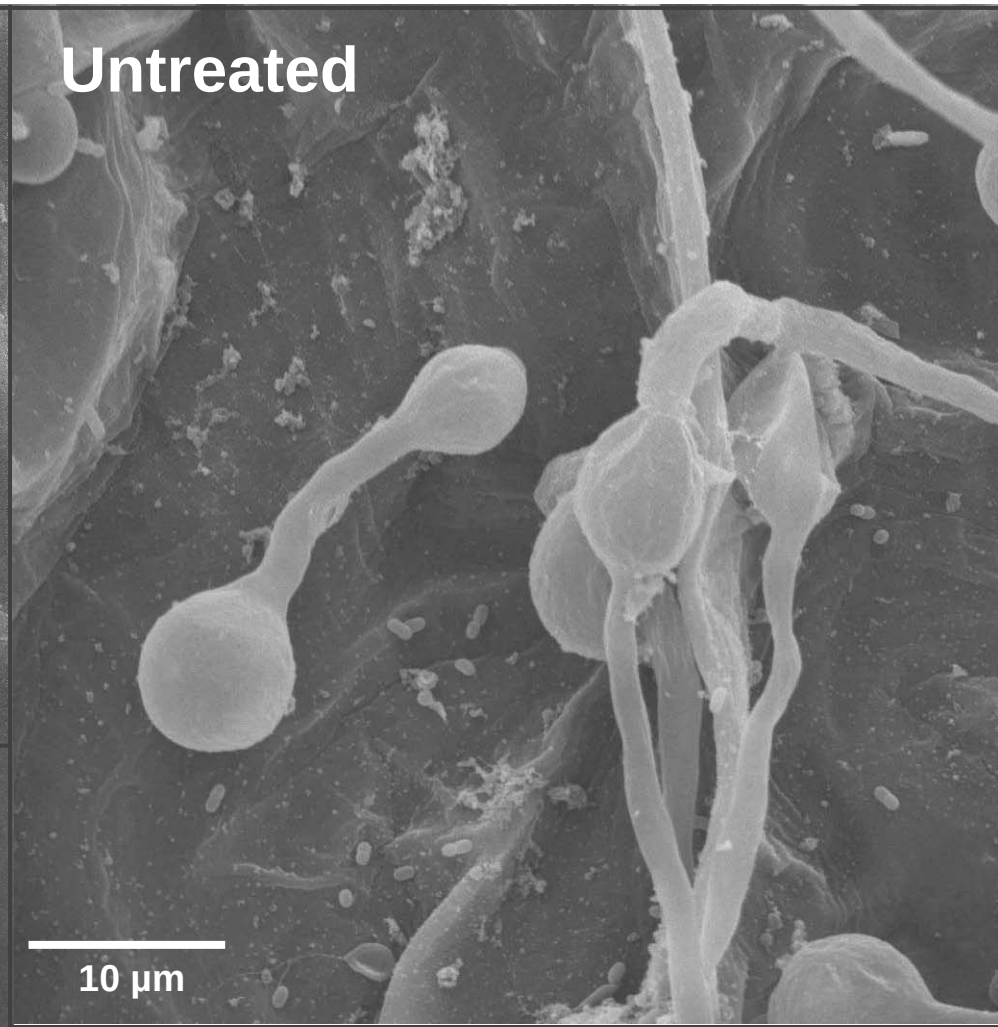


Untreated

Y. Cohen & U. Gisi; activity of mandipropamid (Revus®) and related fungicides against Phytophthora infestans, 2007

Inhibition of germination of zoospores in planta





J. Thompson & L. Cooke; SEM study of effect of mandipropamid on infection of potato leaves by P. infestans, Queens University Belfast, UK 2007

REVUS

syngenta

Intrinsic activity of mandipropamid (MPD) and dimethomorph (DMM) in vitro and in planta

Test, type of activity	EC50 ppm		Evaluation
	MPD	DMM	
Zoospores germination *in vitro*	< 0.0005	0.002	% germinated zoospores
Sporangia direct germination *in vitro*	< 0.0005	0.041	% germinated sporangia
Zoospore and sporangial direct germination on detached potato leaves	< 0.0005	0.082	number of sporulating leasions
Mycelial growth *in vitro*	0.03	0.3	% activity

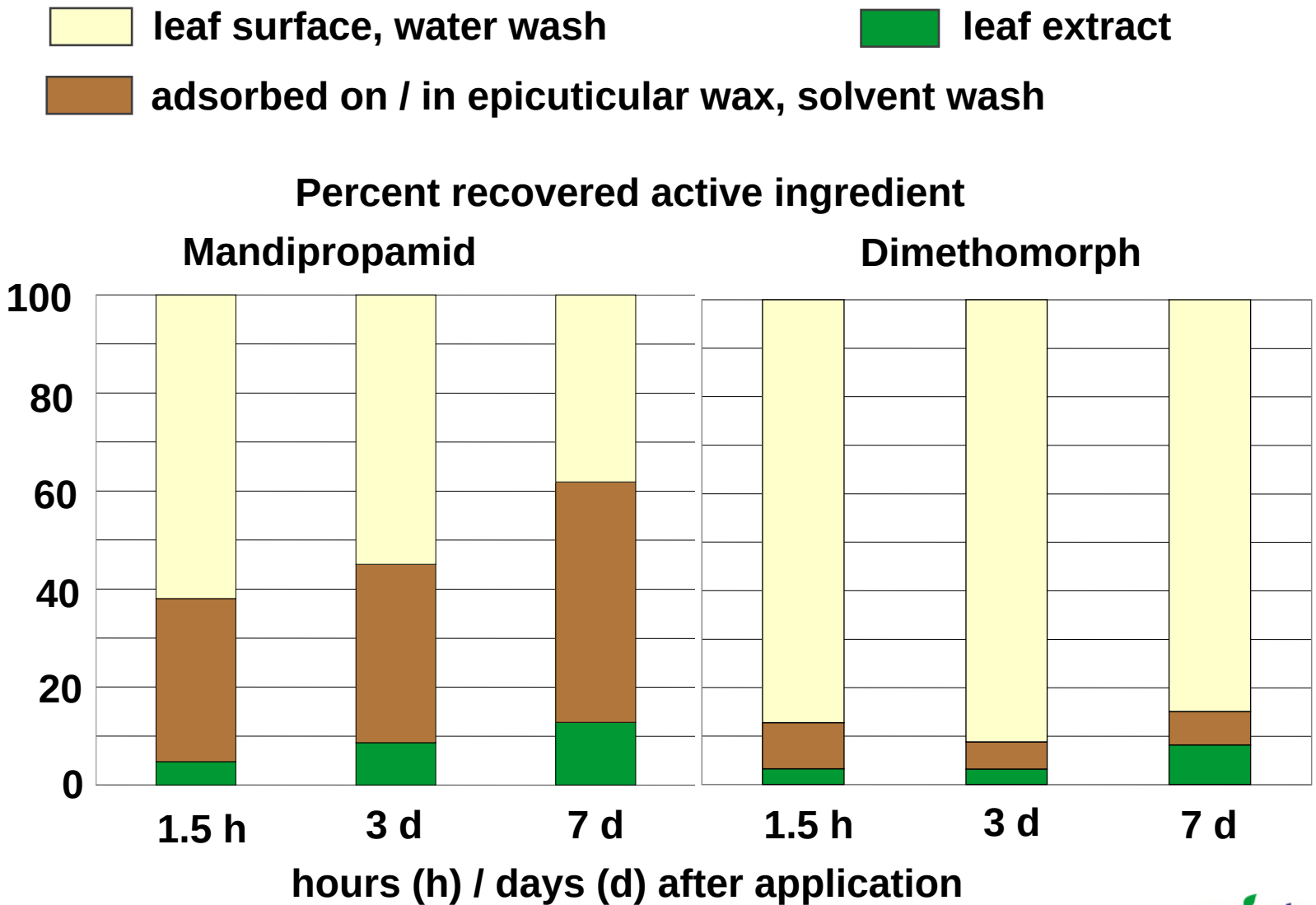
Y. Cohen & U. Gisi, activity of mandipropamid (Revus®) and related fungicides against Phytophthora infestans, 2007;
G. Knauf-Beiter, Syngenta test results, 2007

Summary: Intrinsic activity in laboratory tests

Mandipropamid is highly active against germination of zoospores and sporangia at very low concentrations (EC_{50} < 0.0005 ppm)

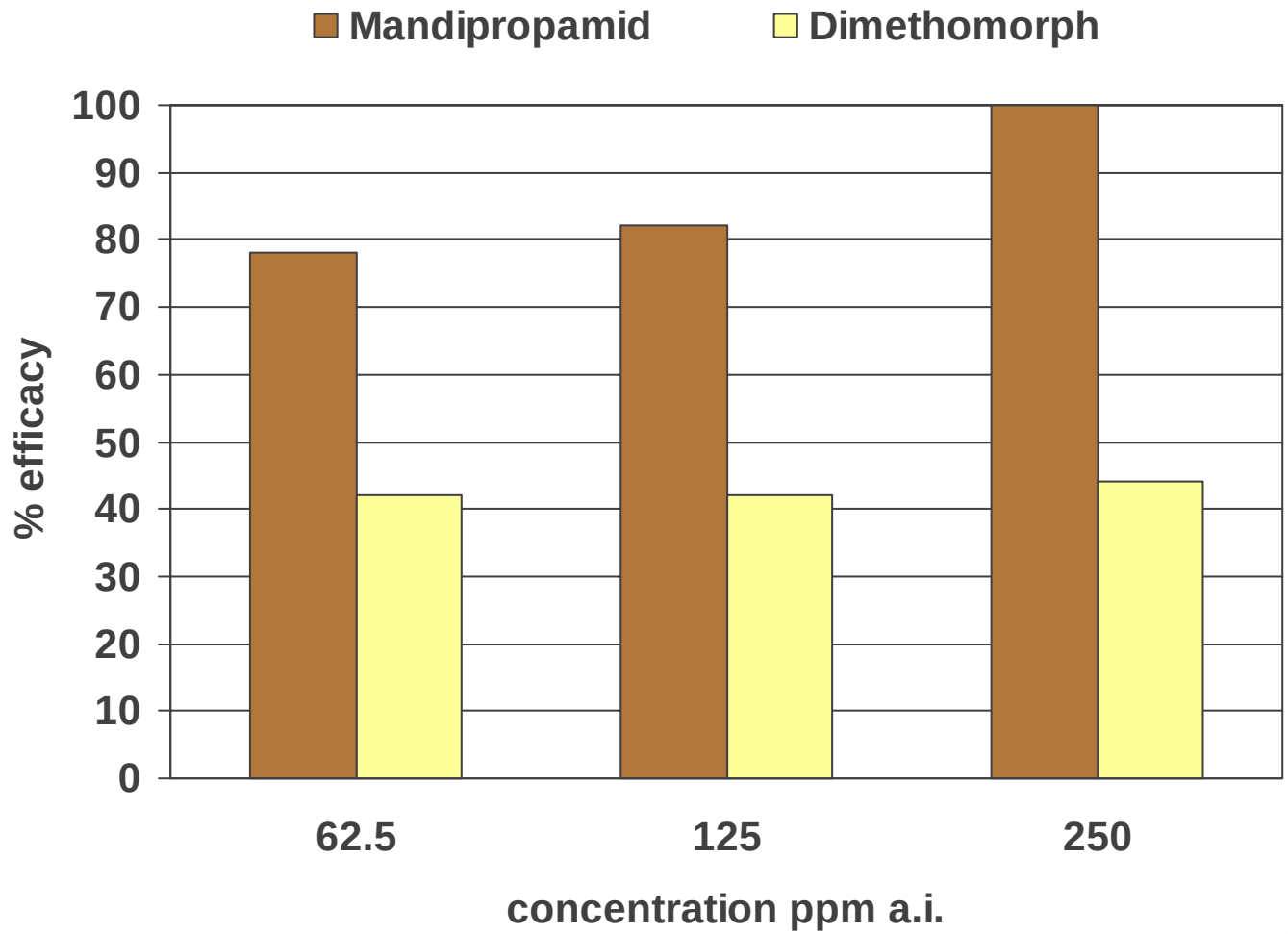
At higher concentrations Mandipropamid also inhibits mycelial growth and sporulation

Distribution of active ingredients in plant tissue



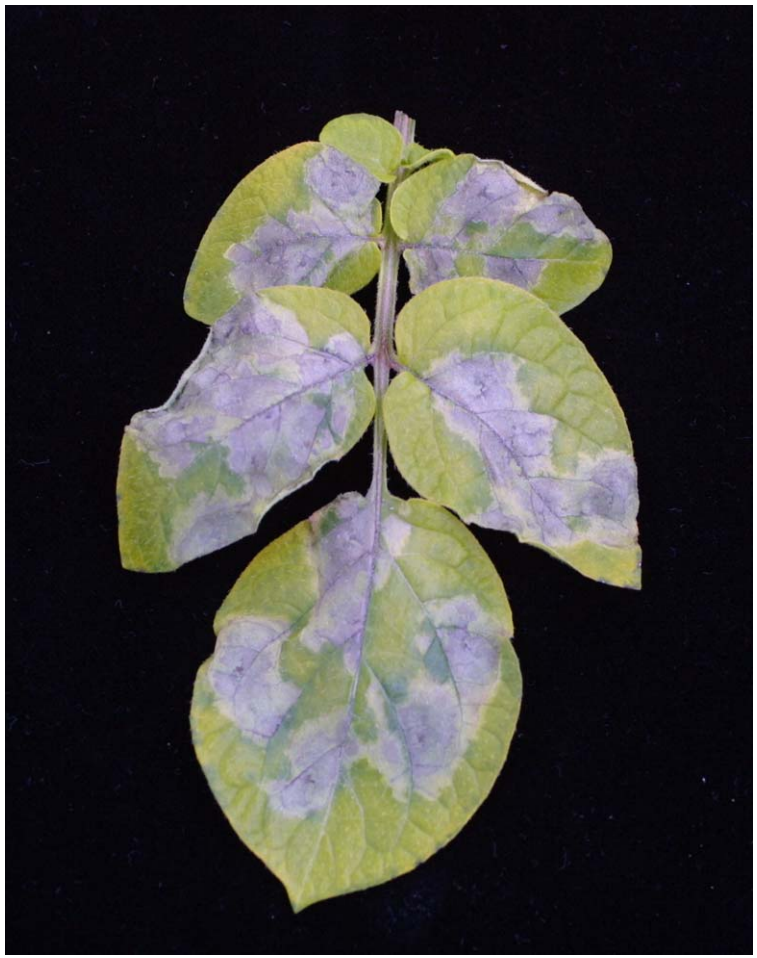
Translaminar activity

Products applied to upper leaf surface of potato plants, inoculation on lower leaf surface of detached leaves, eval. % inf. leaf area 6 days after inoculation



Translaminar activity

Untreated



Mandipropamid 250 ppm

REVUS

syngenta

Uptake and translocation

Mandipropamid has a high affinity to wax:

log P_{ow} 3.2 at 25°C

The solubility of Mandipropamid in water is relatively low

4.2 ppm at 25°C

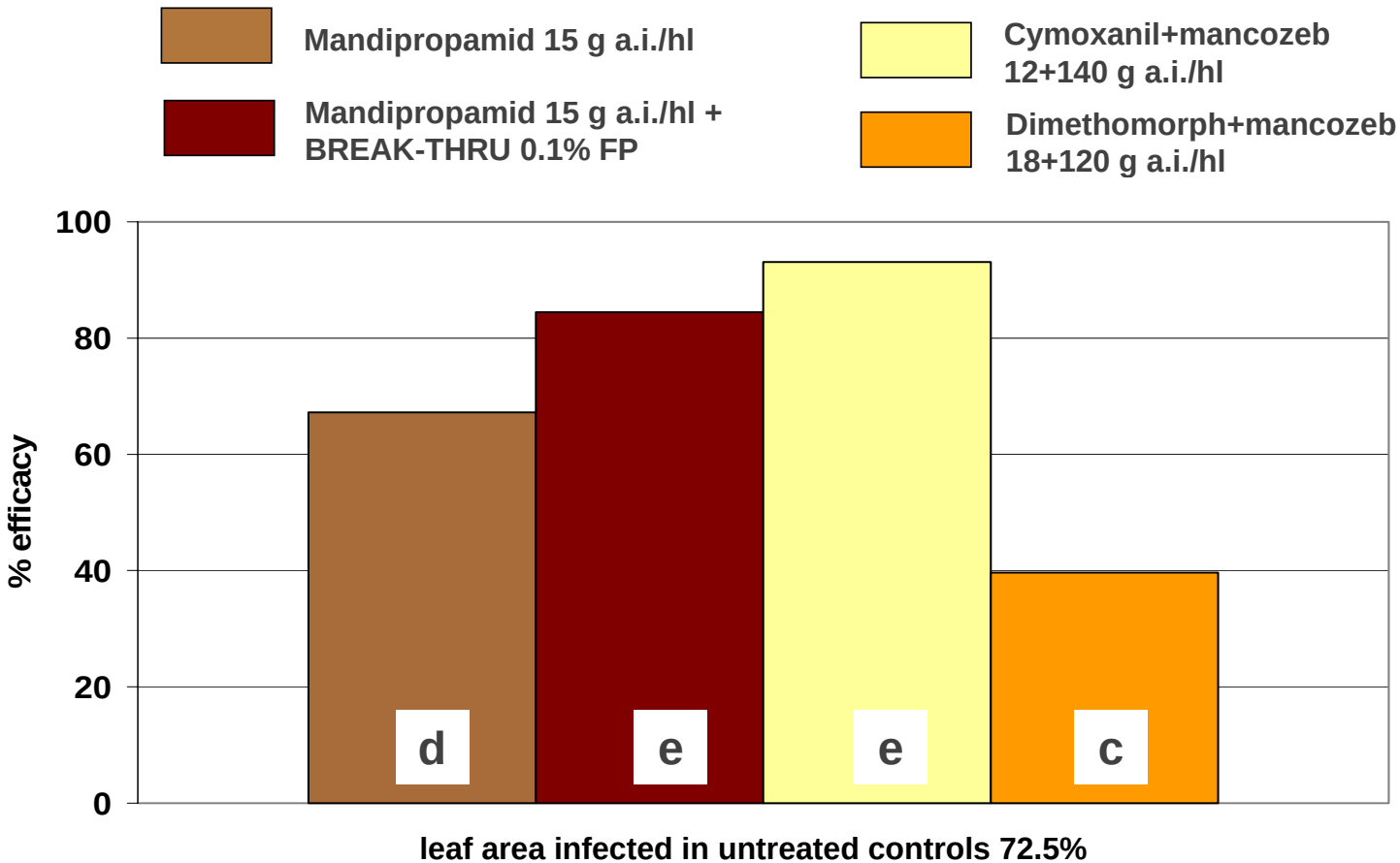
Rapid adsorption to the waxy layer of plant surfaces leads to a stable protective layer of the active ingredient

Gradual uptake into the plant tissue provides protection of the opposite leaf surfaces by translaminar movement

There is limited redistribution of Mandipropamid around the points of application

Curative activity under greenhouse conditions, large plants, Stein 2006

Methodology: fungicides applied to large greenhouse grown plants, curative treatments 1 day after inoculation with $1x10^4$ sporangia/ml, evaluation of infected leaf area 11 days after inoculation (first symptoms 4 days after inoculation)



REVUS

syngenta

Summary: preventive, curative and antisporulant activity in greenhouse tests

Mandipropamid provides excellent, long lasting preventive activity

Under greenhouse conditions curative and antisporulant activities are variable depending on experimental conditions

Strong effects of adjuvants can be observed under green-house conditions for compounds with relatively low water solubility

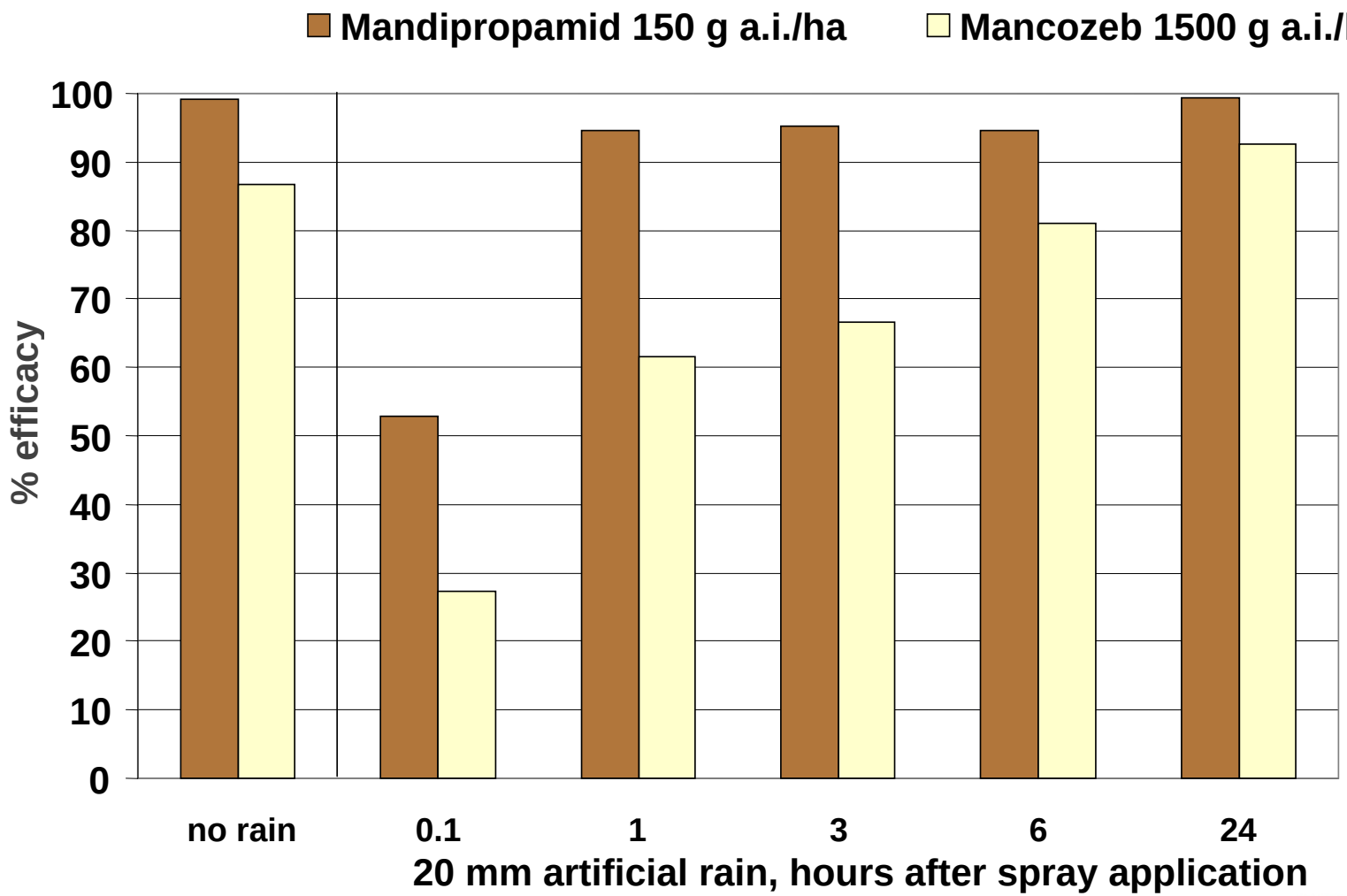
In greenhouse tests in potatoes the curative activity of Mandipropamid is lower than cymoxanil but similar to other translaminar compounds

The curative / antisporulant activity of Mandipropamid is only partial but can contribute to its overall efficacy under field conditions

Mandipropamid based products are recommended as preventive treatments

Rainfastness test under greenhouse conditions, large plants, Stein 2002

Methodology: fungicides applied 16.10. to large greenhouse grown plants, inoculation 1-2x10^4 sporangia/ml after last rain event, evaluation of infected leaf area on 25.10. (first symptoms 21.10.)

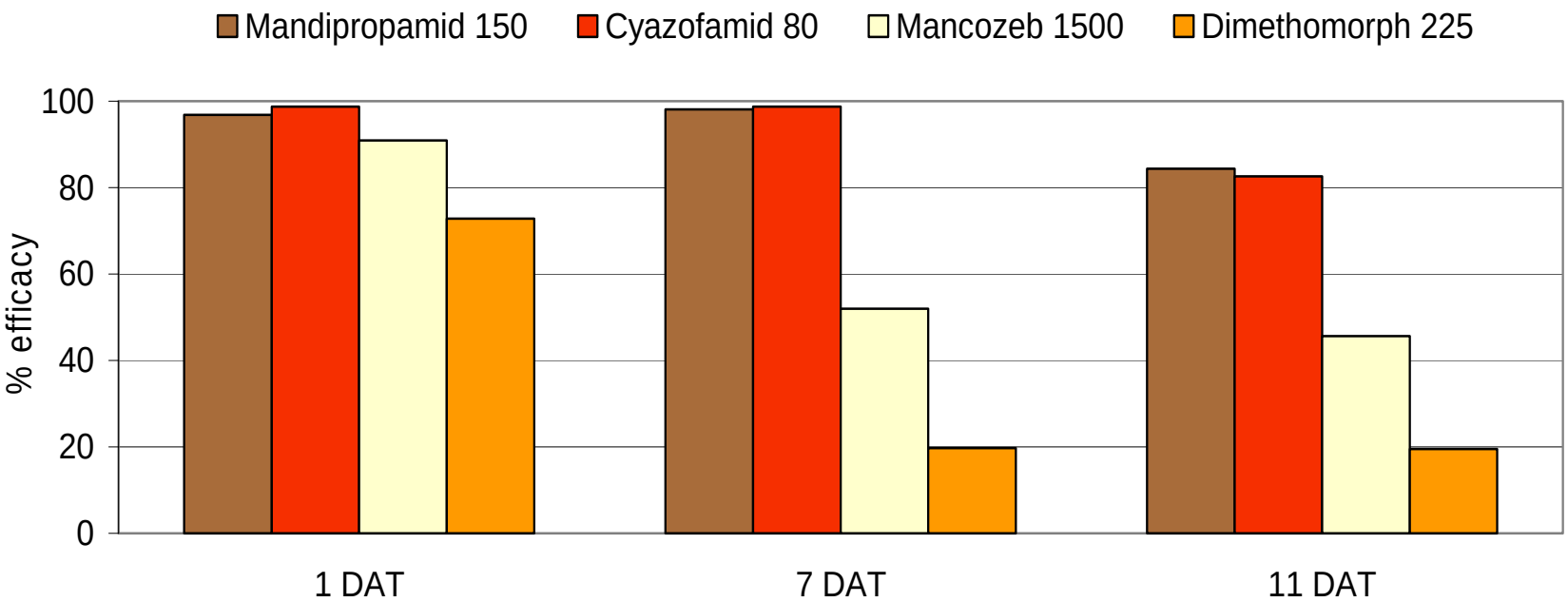


REVUS

syngenta

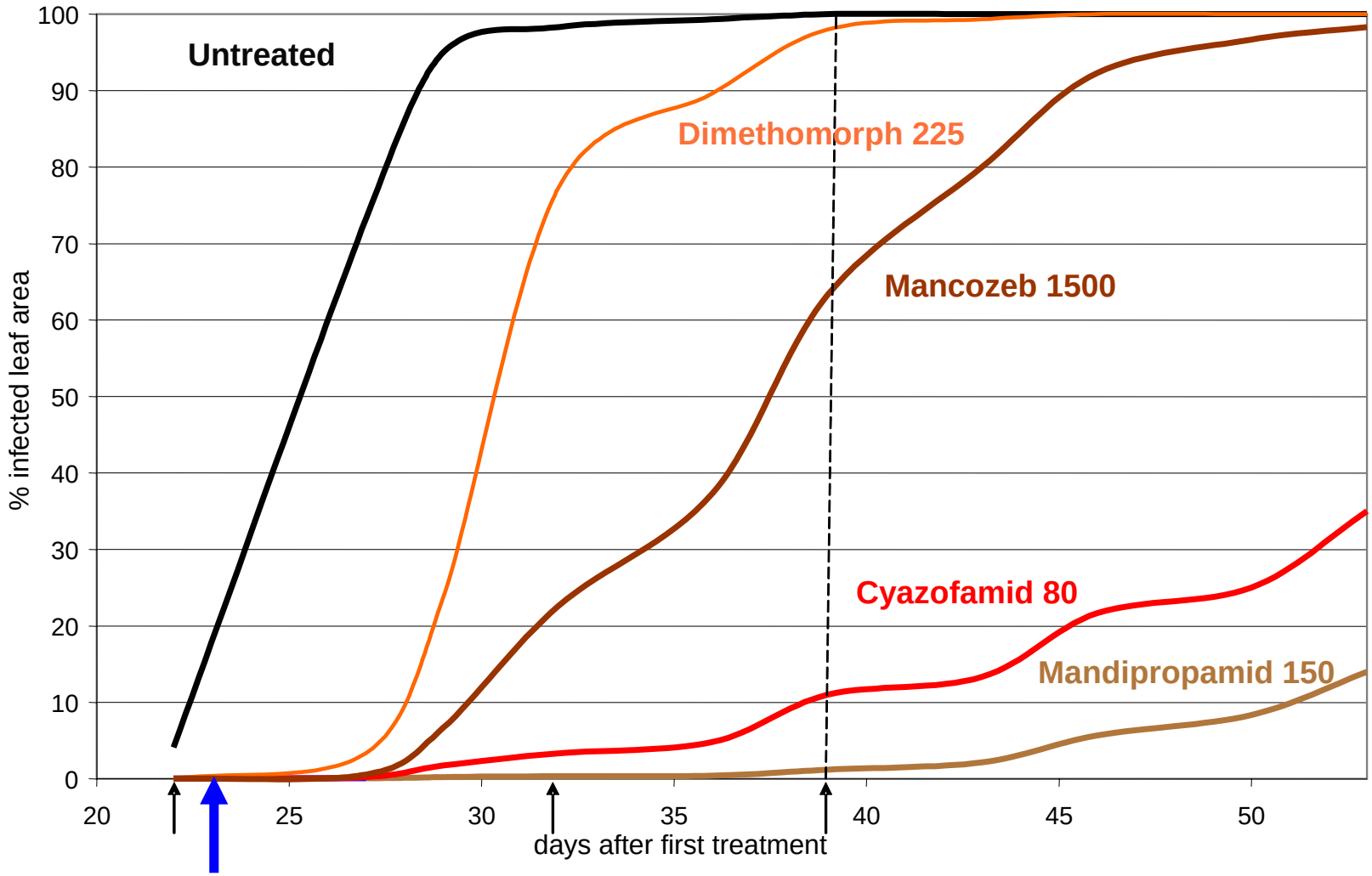
Duration of activity and rainfastness
Stein 2006, field / laboratory evaluation

Methodology: fungicides applied to field plots, leaves sampled at 1, 7 and 11 days after treatment, inoculation in laboratory, evaluations of infected leaf area 4-6 days after inoculation



DAT	0	2	4	5	7	8	9	10
Rainfall mm	18.4	0.6	31.8	1.2	16.8	5.2	14.8	15.4

Rainfastness and duration of activity, Les Barges, trial CHDLFZ423 2006



REVUS

syngenta

Methodology of different rainfastness studies under greenhouse and field conditions, 2006

Study	PPO Holland	TU Munich	SPV France
Treatment of plants	in greenhouse	in greenhouse	in field
Amount of rain (mm)	0, 20, 40, 80	>80	0, 27, 85 (1)
Rain after treatment (hours)	1	3-6	24-48
Sampling of leaves after treatment (days)	3, 7	1	3, 5, 7
Inoculation with droplets of spore concentrations/ml (3)	$1x10^4$	$2x10^5$	$1x10^4$-$1x10^5$ (2)
Results	rainfastness persistence	rainfastness	rainfastness persistence (translaminarity)

(1) additional rainstorm of 48 mm occured five days after treatment
(2) separate inoculation and evaluation on upper and lower leaf surfaces
(3) bioassay in laboratory with detached leaves in all tests

Summary of results of rainfastness studies under greenhouse and field conditions, 2006

Products	PPO Holland	TU Munich	SPV France
Mandipropamid	**+++**	**+++**	**+++ (*)**
Cyazofamid+adj.	**+++**	**+++**	**+++**
Zoxamid+mancozeb			**++(+)**
Dimethomorph+mancozeb		**++(+)**	**+(+)**
Cymoxanil+mancozeb	**+**	**++**	
Fluopicolide+propamocarb	**++**		
Fluazinam	**+++**		**+**
Mancozeb		**+(+)**	**+**

Mandipropamid at 150 g a.i./ha, reference standards applied at recommended appl. rates

(*) Mandipropamid also provided excellent protection of lower leaf surface through translaminar movement throughout the test

REVUS

syngenta

Summary: rainfastness and duration of activity under greenhouse and field conditions

Excellent rainfastness as soon as the spray deposit has dried (approx. 1 hour after treatment)

Stable surface deposit in waxy layer of plant surfaces results in excellent, long lasting disease control

Rainfastness, long lasting and translaminar activity of Mandipropamid can explain the consistently excellent disease control observed under field conditions

Overall Summary

- Excellent efficacy against foliar blight
- Excellent efficacy against tuber blight
- Consistently high yield of marketable tubers
- High reliability independent of weather conditions
- Excellent rainfastness
- Excellent safety profile
- Suitable for IPM programs