



USE OF THAXTOMIN A AS A SELECTIVE AGENT FOR SCREENING POTATO GENOTYPES FOR RESISTANCE TO COMMON SCAB

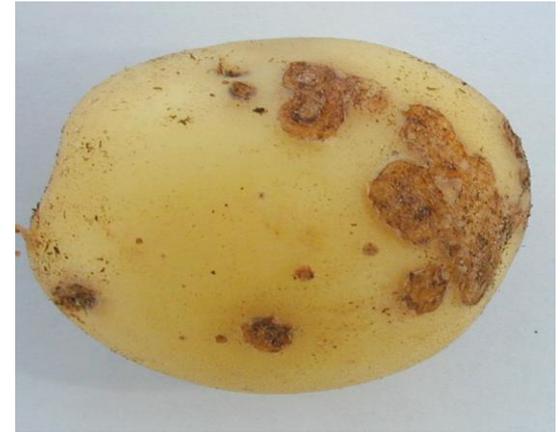
EAPR Pathology Section Meeting

Jerusalem, Israel, 17 – 21 November 2013

Lea Hiltunen, Minna Ylikantola, Elina Virtanen & Jari Valkonen

Potato common scab

- Occurs worldwide
- Affects the quality of tubers
- Caused by several species of the genus *Streptomyces*
 - Multicellular, filamentous, Gram-positive Actinobacteria
 - Well known for production of secondary metabolites
 - Seed- and soil-borne
 - Able to live saprophytically
 - Can infect other tap root crops



Pathogenicity in the genus *Streptomyces*

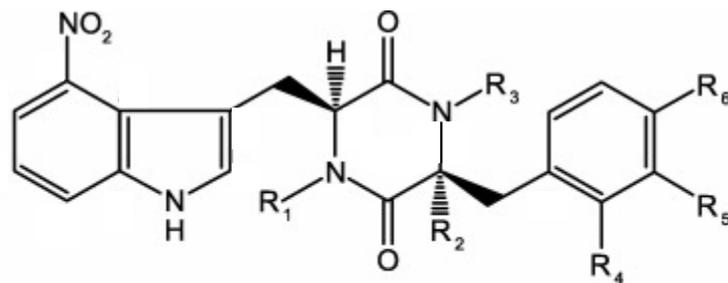
Thaxtomin

- Phytotoxin
- The main pathogenicity determinant
- The mode of action: inhibition of cellulose biosynthesis in plant cells

Other factors involved, but not essential to pathogenicity

- Virulence related genes are present in some plant pathogenic *Streptomyces* species

Thaxtomins



Compound		R ₁	R ₂	R ₃	R ₄	R ₅	R ₆
1	Thaxtomin A	Me	OH	Me	H	OH	H
2	Thaxtomin A <i>o</i> -isomer	Me	OH	Me	OH	H	H
3	Thaxtomin C	Me	H	H	H	H	H
4	Thaxtomin B	Me	OH	Me	H	H	H
5	C-14 deoxy thaxtomin B	Me	H	Me	H	H	H
6	Hydroxythaxtomin C	Me	OH	H	H	H	H
7	Thaxtomin A <i>p</i> -isomer	Me	OH	Me	H	H	OH
8	Hydroxythaxtomin A	Me	OH	Me	H	OH	OH
9	15-de- <i>N</i> -methylthaxtomin A	Me	OH	H	H	OH	H
10	12-de- <i>N</i> -methylthaxtomin A	H	OH	Me	H	OH	H
11	des- <i>N</i> -methylthaxtomin C	H	H	H	H	H	H

No reliable control measures

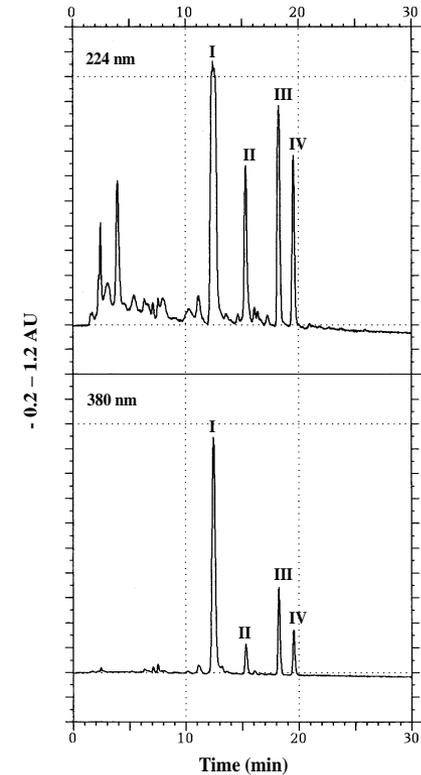
Measure	Reliability
Clean seed	Insufficient; <i>Streptomyces</i> is endemic, ubiquitous, soil-borne
Low soil pH (< 5.2)	Can fail, environmentally unfriendly
Irrigation during early tuber formation	Successful in some locations
Crop rotation	Ineffective
Soil amendments	Results variable, inconsistent
Sulfur fertilisers	Reduces scab severity in some locations
Chemical control (soil fumigation)	Environmentally unfriendly, expensive
Seed treatment with chemicals	Insufficient
Biological control	Has potential, but results variable
Resistant plant varieties	Most reliable, cost-effective and environmentally friendly, but no known complete resistance

Can we utilise thaxtomins in resistance breeding?

- Would it be possible to use thaxtomins for screening potato genotypes *in vitro* for thaxtomin sensitivity?
- Does the thaxtomin sensitivity *in vitro* reflect scab sensitivity in the field?

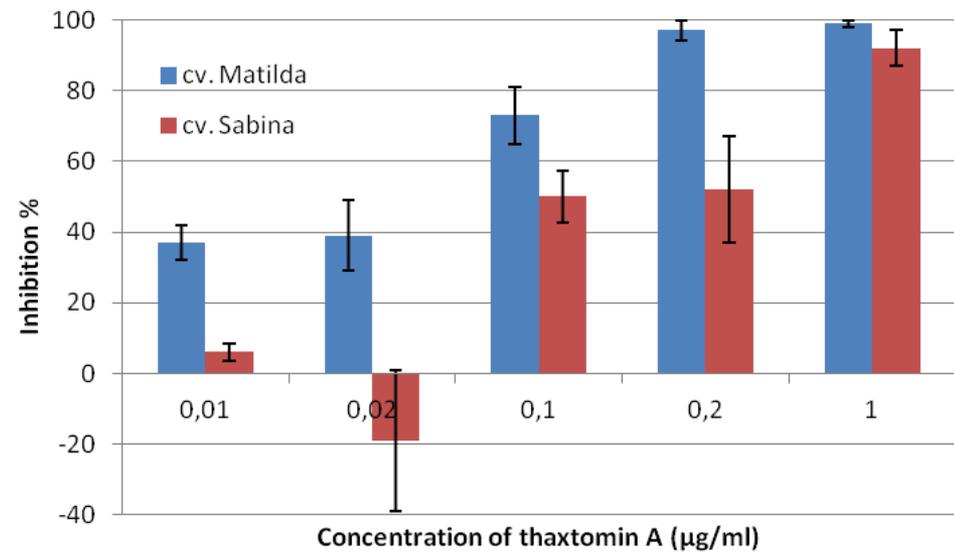
Production of thaxtomins *in vitro*

- Thaxtomins were produced by culturing strains of *S. scabies* and *S. turgidiscabies* in oat meal broth
- Four thaxtomin compounds were isolated and identified



Compound	R ₁	R ₂	R ₃	R ₄	R ₅	R ₆
I Thaxtomin A	Me	OH	Me	H	OH	H
II Thaxtomin A <i>o</i> -isomer	Me	OH	Me	OH	H	H
III Thaxtomin B	Me	OH	Me	H	H	H
IV C-14 deoxy thaxtomin B	Me	H	Me	H	H	H

Effects of thaxtomins on micropropagated potato



Inhibition of growth by thaxtomins

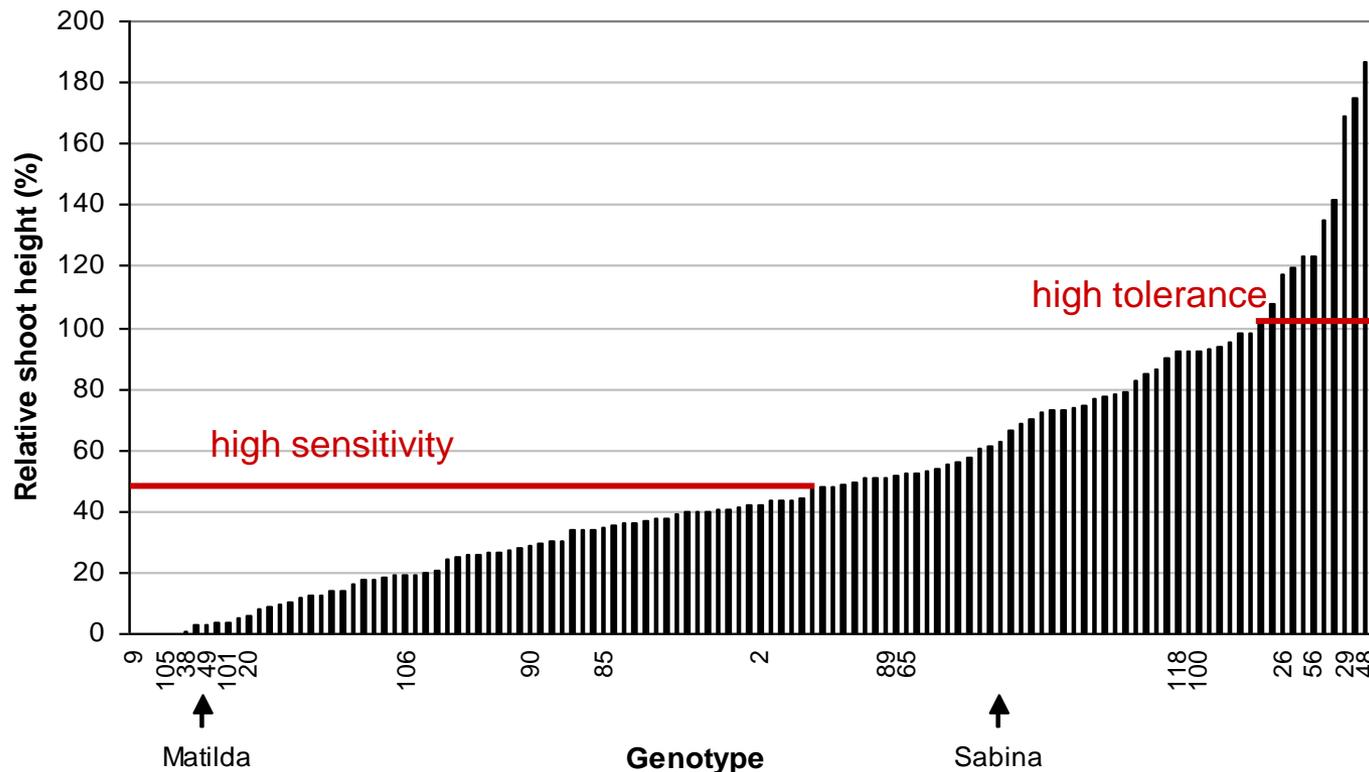
Table 2. Values for 50% Inhibition of Growth (I_{50}) for Different Thaxtomin Compounds on Three Cultivars of Micropropagated Potato

potato cv.	compound	I_{50}^a (ppb)
Matilda	thaxtomin A	30
	thaxtomin A ortho isomer	40
	thaxtomin B	70
	C-14 deoxythaxtomin B	160
Sabina	thaxtomin A	90
	thaxtomin A ortho isomer	400
	thaxtomin B	550
	C-14 deoxythaxtomin B	590
Nicola	thaxtomin A	70
	thaxtomin A ortho isomer	>1000
	thaxtomin B	80
	C-14 deoxythaxtomin B	>1000

^a I_{50} is the concentration that reduced shoot growth by 50% as compared to the control. ppb, parts per billion.

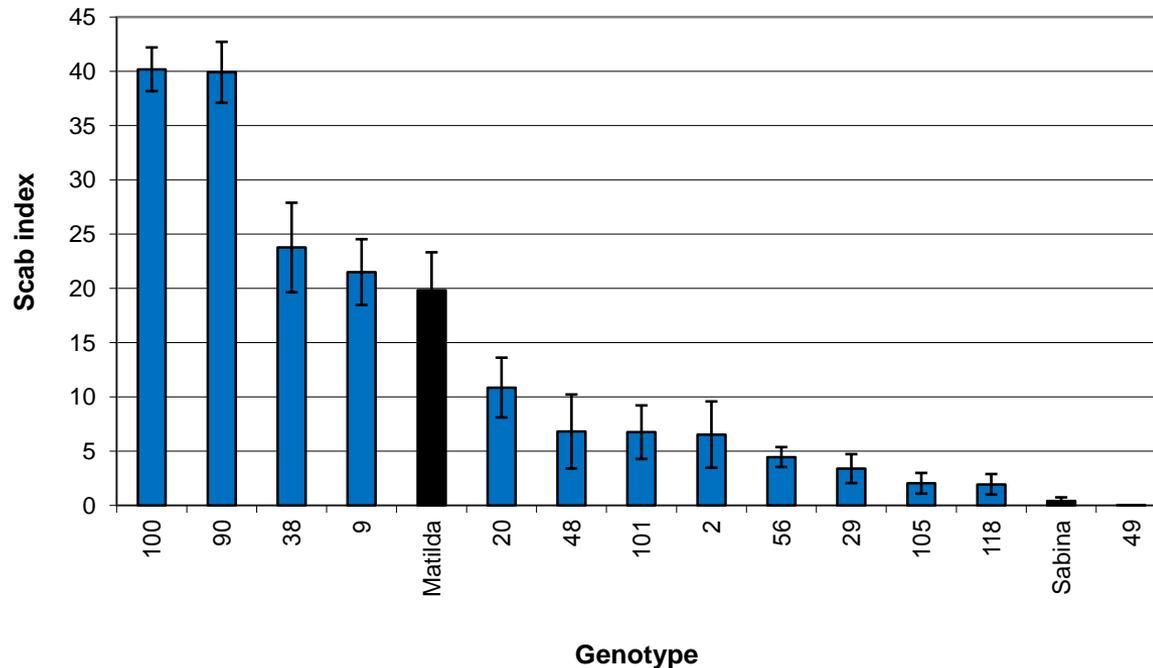
Hiltunen *et al.*, J Agric Food Chem 2006

Responses of potato genotypes* to thaxtomin A *in vitro* (0.1 µg ml⁻¹) ranged from total inhibition of growth to stimulated growth



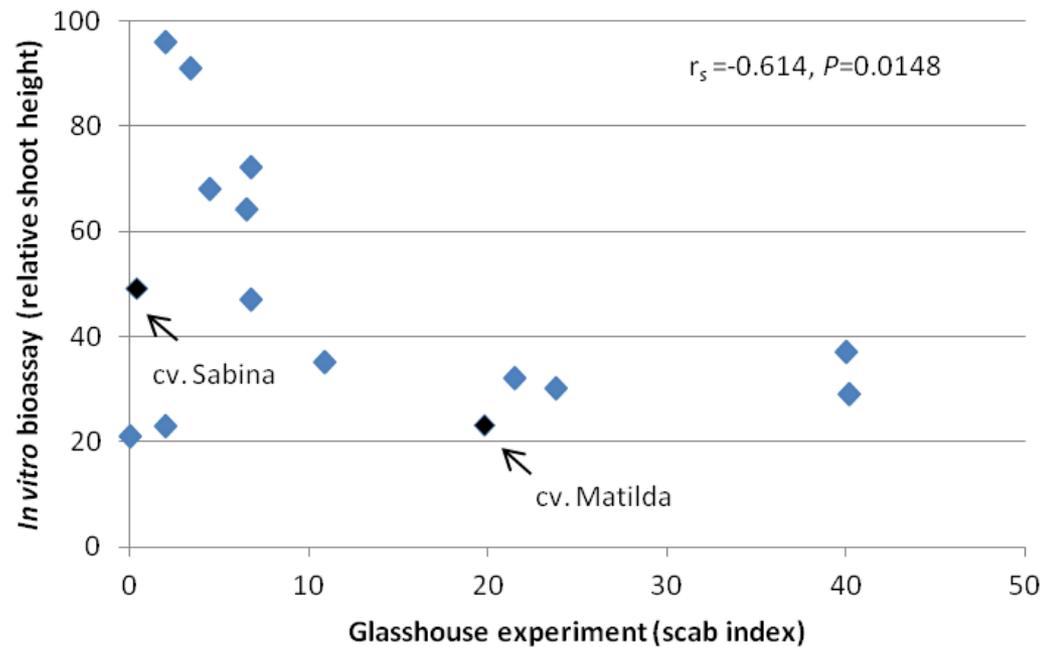
Hiltunen *et al.*, Plant Pathol 2011

The selected potato genotypes were tested for their sensitivity to common scab in the glasshouse

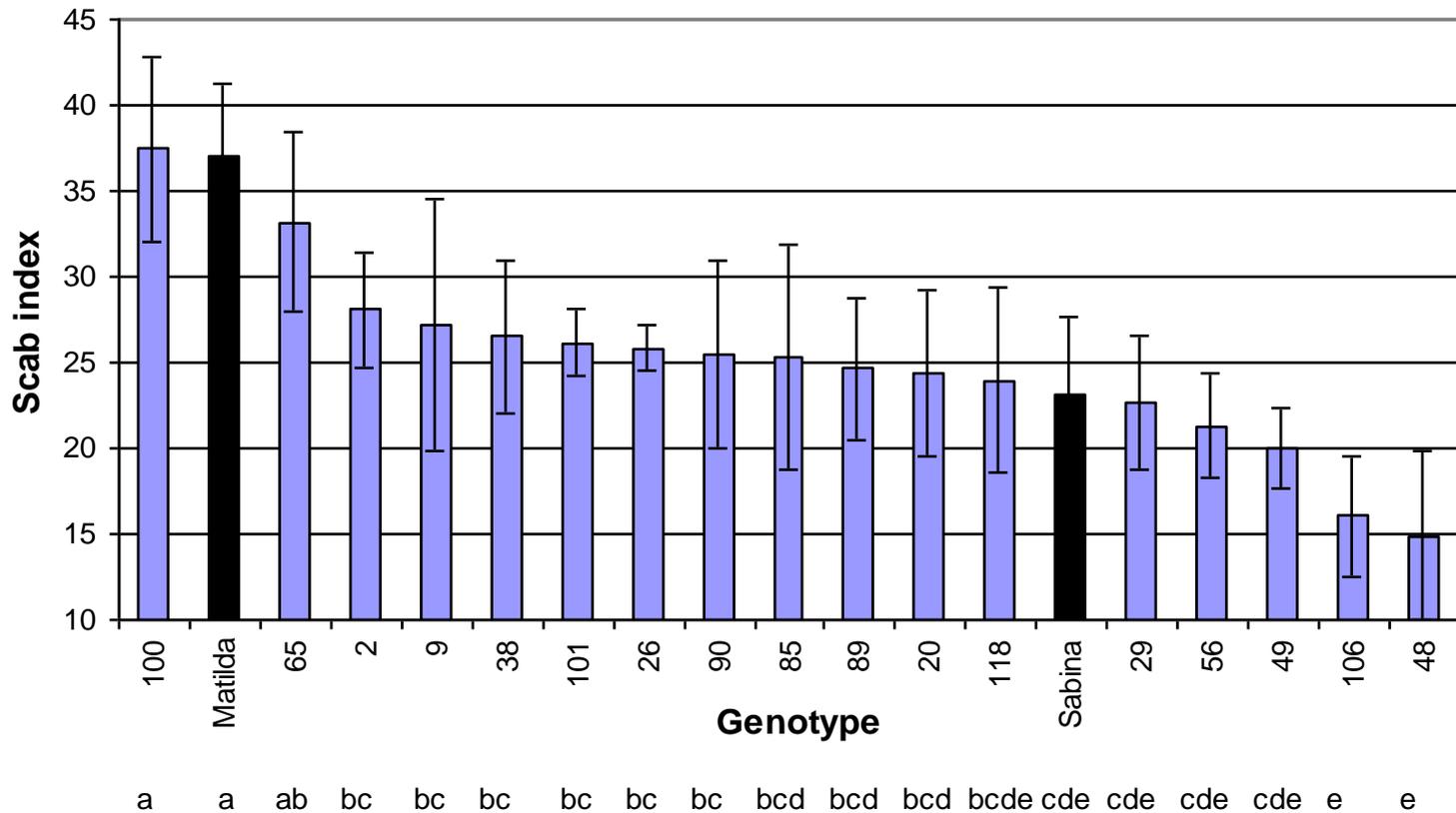


Scab index = scab type x surface area covered by scab x 100/33

Correlation of the results from the *in vitro* bioassay and the glasshouse experiment

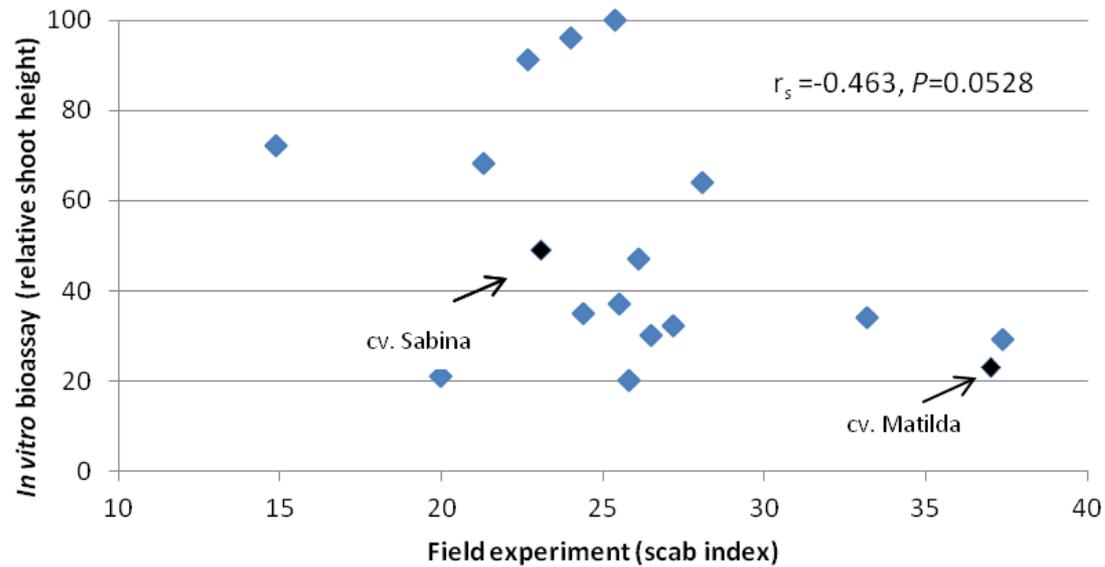


The selected potato genotypes showed variable resistance to common scab in the field



Scab index = scab type x surface area covered by scab x 100/33

Correlation of the results from the *in vitro* bioassay and the field experiments



Summary

The *in vitro* bioassay utilizing thaxtomin A as a selective agent

- Revealed differences between potato genotypes in thaxtomin sensitivity
- Predicted differences between genotypes in their tolerance to common scab in the glasshouse and in the field
- Could be used in resistance screening programs



Acknowledgements

University of Helsinki

Department of Applied Biology,
Divisions of Pharmaceutical Biology and
Pharmaceutical Chemistry

Into Laakso

Tuula Laine

Jouko Närhi

Lahja Pesonen

Kati Takala

Anja Weckman

MTT Agrifood Research Finland

Arjo Kangas

Anu Kankaala

Anna Sipilä

Tapio Uotila

Tiina Väyrynen

Charles University, Czech Republic

Vladimír Chobot

Thank you!

