

Resistance of potato against the *Ralstonia solanacearum* species complex

NAO projectendag, 31 March 2023: idea for a TKI project

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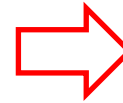


Bacterial wilt/brown rot in potato

- Causative agent; *Ralstonia solanacearum* species complex (RSSC)
- Broad host range (>200 plant species), aggressive, contagious, persistent (soil resident), Q-organism
- High pathogen genetic variety
- No resistant potato varieties are available and resistance sources are limited



Symptoms bacterial wilt/brown rot



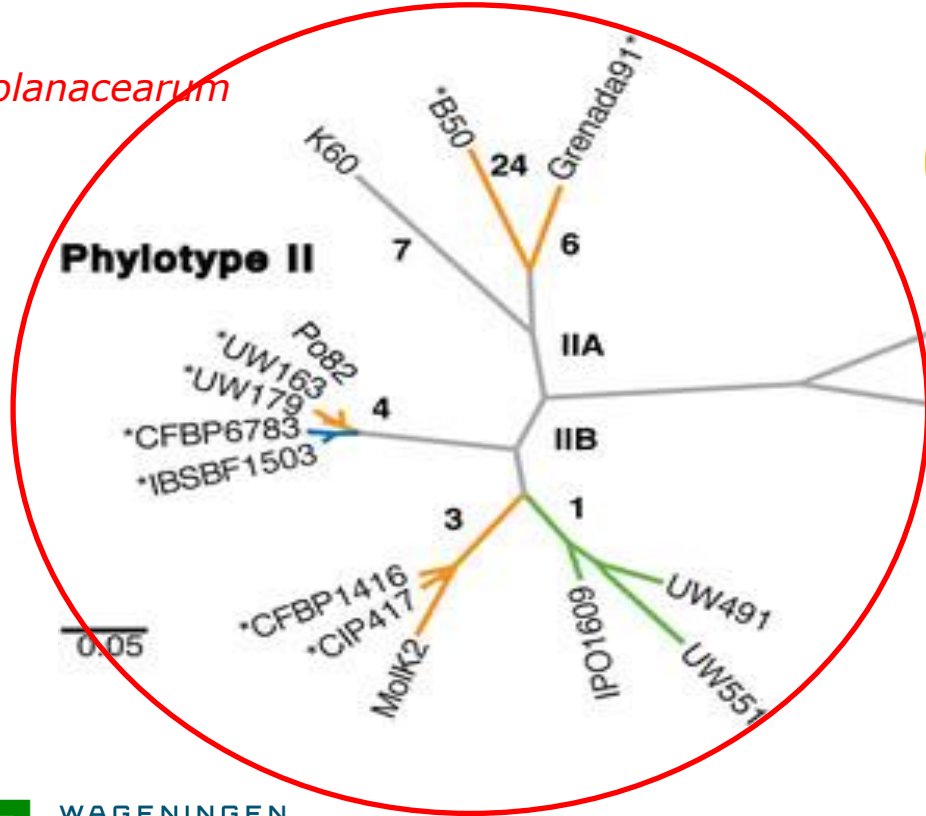
Symptoms bacterial wilt/brown rot



Phylogeny *Ralstonia solanacearum* species complex

R. solanacearum

R. pseudosolanacearum

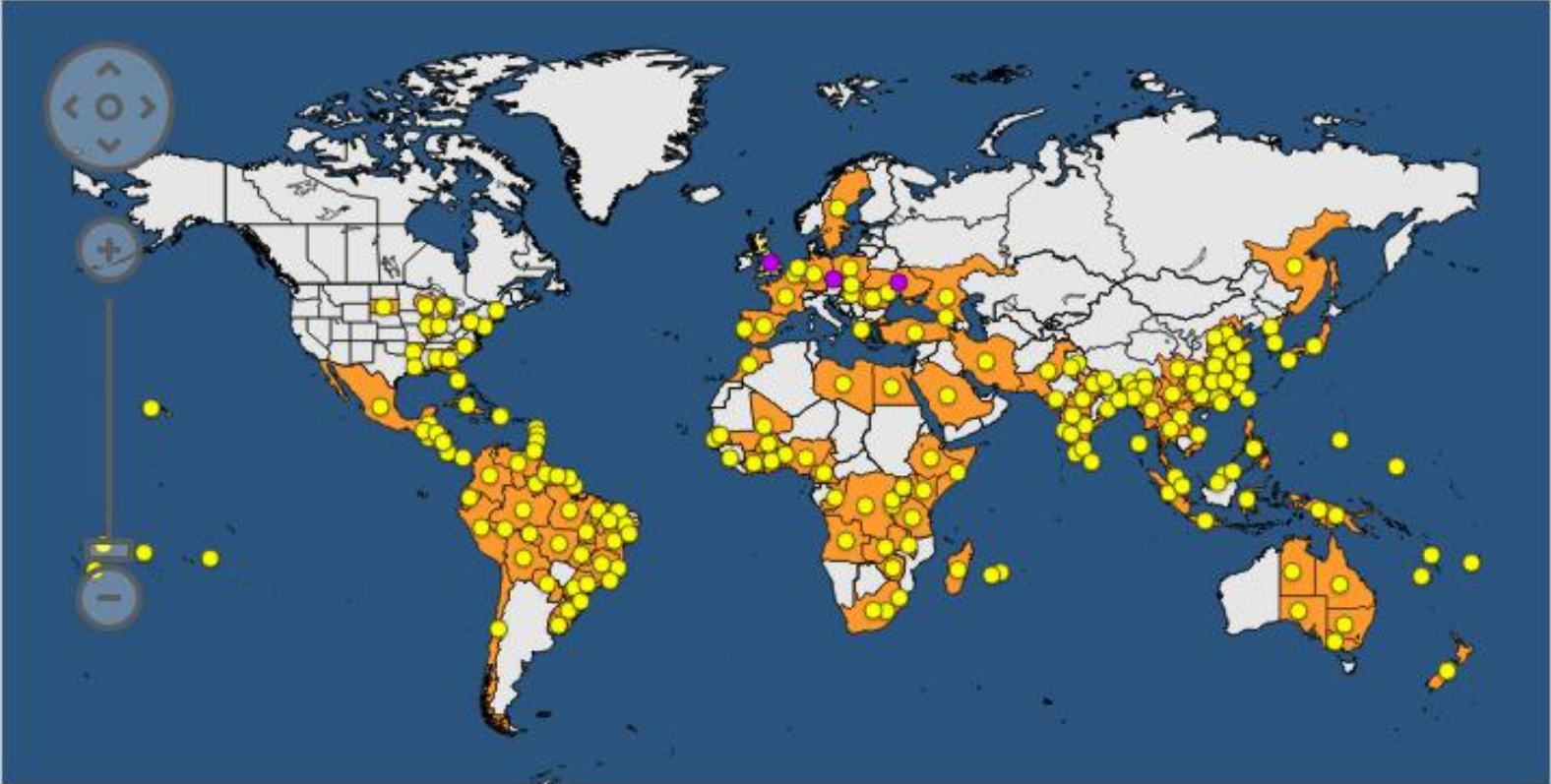


Phylotype III

Phylotype I

Phylotype IV

Distribution map (CABI)



Export Dutch seed potatoes



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POOTGOEDEXPORT IN TONNEN OOGST 2022

Totaal	Totaal	Totaal	Totaal	Totaal	Totaal
31-01-23	31-01-22	oogst '21	31-01-23	31-01-22	oogst '21
EU					
België	20.551	27.078	90.011		
Bulgarije	1.075	1.257	2.800		
Cyprus	4.204	4.271	4.338		
Denemarken	67	92	1.548		
Duitsland	17.540	10.513	112.312		
Eesti	0	0	47		
Finland	0	0	312		
Frankrijk	5.135	5.631	20.000		
Griekenland	5.019	4.943	8.393		
Hongarije	4.072	4.214	5.907		
Ierland	368	191	821		
Italië	20.442	23.295	55.064		
Kroatië	2.318	2.823	5.450		
Letland	0	45	679		
Litouwen	7	0	453		
Luxemburg	257	72	799		
Malta	833	595	595		
Oostenrijk	2.004	1.492	3.510		
Polen	230	294	7.246		
Portugal	9.561	11.081	15.295		
Roemenië	465	333	7.868		
Slovenië	1.315	1.305	2.954		
Slowakije	943	834	4.496		
Spanje	21.747	22.295	39.058		
Tsjechië	519	641	2.711		
Zweden	82	34	1.309		
Totaal EU	129.444	131.909	401.140		
Rest EUROPA					
Albanie	1.011	1.117	1.711		
Bosnië	2.928	2.828	6.832		
Kosovo	95	24	1.000		
Macedonië	329	185	784		
Moldavië	0	43	362		
Montenegro	262	291	1.262		
Oekraïne	55	0	1.005		
Rusland	0	0	3.180		
Servie	685	631	2.888		
Turkije	1.880	1.940	11.870		
Usland	0	0	60		
VK	1.758	1.546	4.115		
Wit-Rusland	480	220	1.815		
Zwitserland	1.709	1.698	3.528		
Diversen	0	0	0		
Totaal	11.157	10.793	40.386		
Totaal Europa	140.601	142.702	441.526		
AMERIKA					
Brazilië	2.850	2.577	3.324		
Cuba	10.075	11.690	11.060		
Dominië Rep.	545	177	205		
Honduras	1.527	1.080	1.214		
Jamaica	1.543	1.409	1.527		
Nicaragua	1.976	1.206	1.475		
Uruguay	732	904	944		
Diversen	459	0	50		
Totaal Amerika	19.707	19.113	20.479		
A Z I E					
Armenië	0	0	1.800		
Azerbeidzjan	316	42	229		
Bangladesh	6.001	2.573	2.881		
Georgië	225	75	275		
Irak	19.028	12.972	14.396		
Iran	0	0	393		
Israël	14.844	14.808	14.833		
Jemen	4.553	2.777	2.777		
Jordanië	3.836	2.855	2.855		
Kazachstan	90	0	380		
Koeweit	336	196	198		
Libanon	13.100	10.818	11.175		
Oezbekistan	721	0	6.140		
Oman	0	0	0		
Pakistan	12.302	12.762	12.762		
Palestina	220	275	275		
Saudi Arabië	20.547	11.137	11.319		
Sri Lanka	625	1.488	1.486		
Syrië	14.247	11.017	11.017		
Thailand	250	275	275		
V.A.E.	0	102	102		
Vietnam	340	630	630		
Diversen	802	290	1.484		
Totaal Azië	112.348	84.890	97.468		
A F R I K A					
Algerije	88.434	82.785	88.815		
Angola	0	0	400		
Botswana	0	100	376		
Egypte	44.549	45.728	45.728		
Kaapverdië	287	362	362		
Kenia	0	25	175		
Libië	8.119	4.902	4.902		
Marokko	28.079	23.793	24.209		
Mauritius	0	0	392		
Senegal	3.571	1.129	1.129		
Sudan	8.873	5.639	5.639		
Tunesië	4.896	3.567	3.567		
Zambia	177	99	833		
Zimbabwe	220	325	1.548		
Diversen	832	675	957		
Totaal Afrika	188.037	169.209	176.930		
OCEANIË					
Diversen	0	0	0		
Totaal Oceanië	0	0	0		
TOT. GENERAAL					
	460.694	415.874	736.403		
stand op					
31-1-2023	460.694	oogst'21	736.403		
31-1-2022	415.874	oogst'20	730.694		
31-1-2021	366.067	oogst'19	760.321		
31-1-2020	408.984	oogst'18	714.537		
31-1-2019	364.036	oogst'17	810.853		

Continent	Nr countries	Tonnes (2022)
EU	26	129.444
Rest Europe	>14	140.601
America	>7	19.707
Asia	>22	112.349
Africa	>13	188.037
Oceania	0	0

Main hosts of RSSC (CABI, 2018, EFSA J. 2019)

Host name	Host family
<i>Annona cherimoya</i> (vrucht Z-Amerika)	Annoceae
<i>Casuarina</i> spp. (boom Australië)	Casuarinaceae
<i>Heliconia</i>	Heliconiaceae
<i>Musa</i> spp. (banana)	Musaceae
<i>Musa x paradisiaca</i> (plantain)	Musaceae
<i>Solanum lycopersicum</i> (tomato)	Solanaceae
<i>Solanum melongena</i> (aubergine)	Solanaceae
<i>Solanum tuberosum</i> (potato)	Solanaceae
<i>Tectona grandis</i> (teak)	Lamiaceae
<i>Zinziber officinale</i> (ginger)	Zingiberaceae

Aim and outline of the project

- To select for resistance against bacterial wilt in wild potato genotypes via the use of newly developed bioassays

Generation of a panel of representative RSSC strains

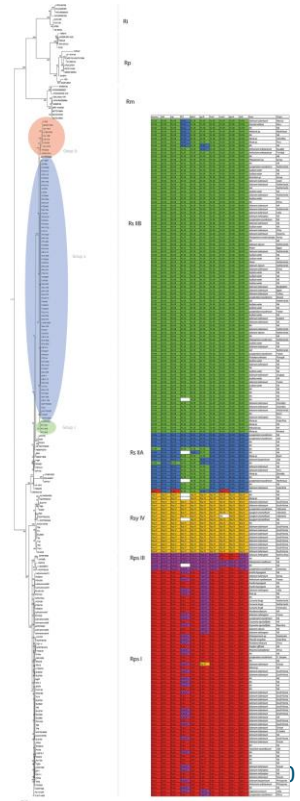
Development of an efficient bioassay

Screening of wild Solanum species for resistance

Genetic research to resistance and effector response genes

Generation of a representative panel of RSSC strains

- Basis is 180 RSSC strains in WUR collection, complemented with strains from international collections
- Whole genome sequencing
- Identification of effectors
- RNAseq to identify highly expressed effectors



Development of bioassays to screen for resistance

- Suitable for testing in quarantine facilities (NL)
- Challenging plants with bacterial cells or effectors
- Using *in vitro* plants, micro- and minitubers etc.,
 - in various substrates (soil, aquaponic, agar media etc.)
 - under various conditions (inoculation - agroinfiltration, temperature, light etc.)
 - Using marked strains (GFP, *Lux*)



Development of *in vitro* inoculation assays



Assay already developed for another bacterial pathogen

Genotype 1 (R)

Genotype 1 (S)

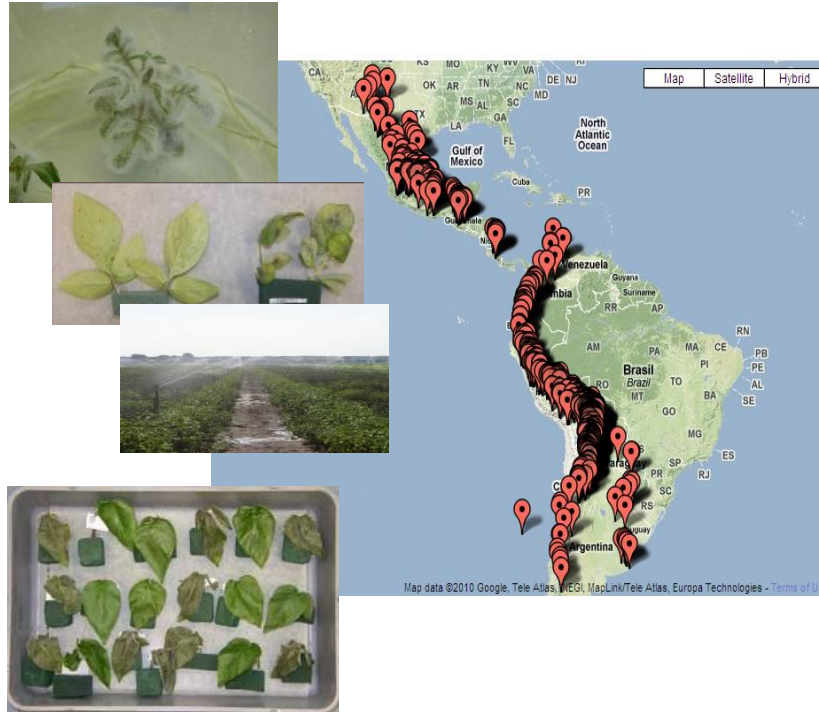
Not inoculated



Inoculated



Search for resistance in center of diversity



- Tuber-bearing *Solanum* germplasm

- 200 species
- 1,000 accessions
- 5,000 genotypes

↓ selection

- Core collection in vitro
- Identify immune receptors

Clonally propagated Solanum Collection (WUR-PBR)

- >600 genotypes
- >300 accessions

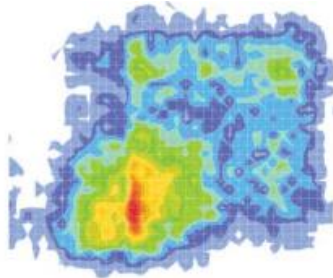


Effectoromics

- Study **pathogen** and **plant**
- **Effector** and **immune receptor**



- Avirulence
- Virulence



Pathogen genome sequence



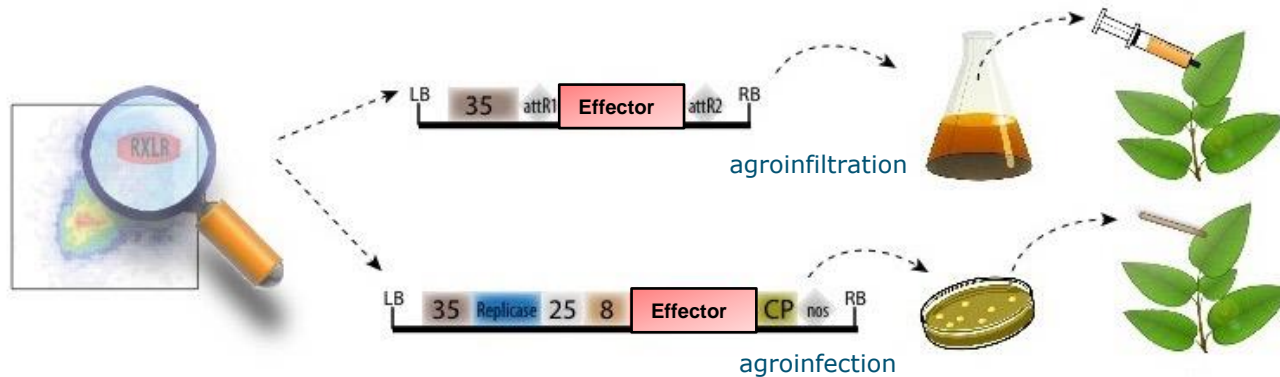
Resistance



Collection of wild potatoes

Effectoromics

Identify immune receptors (*R* genes) by screening for response to effectors



Vleeshouwers et al (2011) *AnnRevPhytopathol*

R genes from wild *Solanum* detected by effectormics

Phytophthora infestans

AVRblb1 Avr3a **RD11/Avr2**

Blb (Rpi-blb1)

Dms (R3a)

Edn (Rpi-edn1)

Snk (Rpi-snk1)

Hjt (Rpi-hjt1)

Sto (Rpi-sto1)

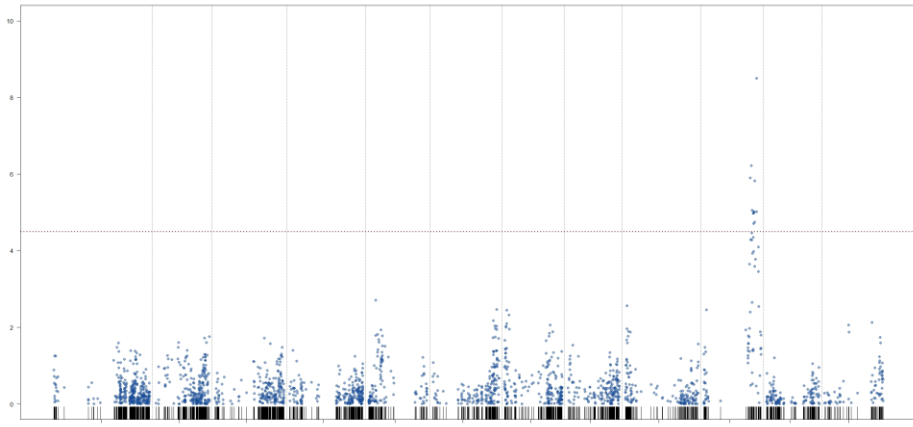
Sto (Rpi-sto2)

Solanum (R gene)

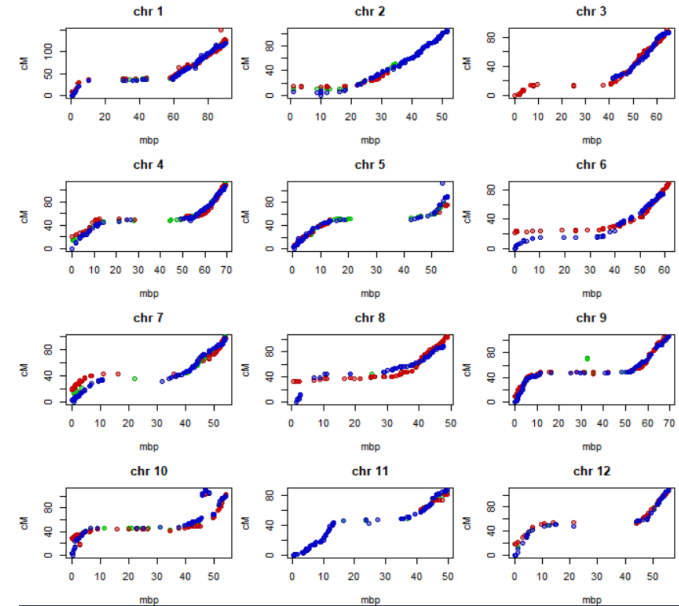


Genetic analysis: Solseq amplicon sequencing

Haplotype tags for GWAS and association mapping



Phased linkage maps for QTL mapping



Deliverables

- Panel of strains of RSSC with representative set of effectors
- Validated bioassays to work with RSSC under quarantine conditions
- Selection of resistance potato genotypes
- Genetic characterisation of effector receptors involved and disease resistance
- Molecular markers for introgression breeding

Towards a TKI project

- Partners:
 - Breeding companies
 - Seed potato growers (NL and countries where RSSC is endemically present)
- Duration: 4-5 years
- Costs: ??

Questions?

