Exploiting Hybrid Potato Breeding for Accelerating Introgression and Stacking of New Resistance Sources against *Phytophthora infestans*  

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Content

- The state-of-the-art in resistance to late blight
- Utilizing hybrid potato breeding for developing resistance to late blight
- Packing up all of the Solanum weapons against late blight
• Up to date, there are about 70 mapped and/or cloned resistance to *P. infestans* (*Rpi*) genes from potato and its wild relatives, and are located on chromosome IV, V, VI, VII, VIII, IX, X and XI.

• Two PRRs were mapped on Scr74-response receptor on chromosome IX and *ELR* chromosome XII.

Haverkort *et al.* (2016)
Breeding potato for a stable resistance against the late blight.
The traditional tetraploid breeding of potato cv. Bionica took about 46 years to introduced the Rpi-blb2 gene from Solanum bulbocastanum.
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Stable resistance

- Hybrid potato breeding
- Mapping-by-sequencing
- Effectoromics
- Rpi genes from Solanum species
- Marker-assisted breeding
Hybrid potato breeding for accelerating introgression and stacking of $Rpi$ genes at Solynta

- Introgression and stacking of new traits can be achieved within few to some years (Lindhout et al., 2011, 2018; Ying et al., 2019).
Hybrid Potato Breeding Scheme

D1 x DS
\[\downarrow\]
D1/DS x D1
\[\downarrow\]
D1(D1/DS) → BC1

\[\emptyset\] → selfing
\[\emptyset\] → selfing
\[\emptyset\] → selfing
\[\emptyset\] → selfing
\[\emptyset\] → selfing

\[\downarrow\]
BC1F6 → P1

\[\downarrow\]
P2

D1 x DS
\[\downarrow\]
D1/DS x D16
\[\downarrow\]
D16/D1/DS × D16/D1/DS → F2

\[\emptyset\] → selfing
\[\emptyset\] → selfing
\[\emptyset\] → selfing
\[\emptyset\] → selfing

\[\downarrow\]
D16/D1/DS

\[\emptyset\] → selfing

\[\downarrow\]
BC1F6 → P3

Ying et al. (2019)
Trait introduction and stacking via marker-assisted backcross breeding

Step 1: Cross

- **Donor parent**: (resistant but commercially unattractive)
- **Resistance gene on chromosome 11**
- **Existing variety**: (not resistant but commercially attractive)

Step 2: Backcross

- 1st backcross with recurrent parent
- 2nd backcross

Step 3: Selfing

Result

- **Existing variety but resistant**

**EU H2020 Project**
The state-of-the-art in resistance to late blight

Utilizing hybrid potato breeding for developing resistance to late blight

Packing up all of the *Solanum* weapons against late blight
*Rpi* genes-donor *Solanum* species used for gene pyramiding

- **S. tarijense** 852-5  
  *Rpi-tar1*, Chr10  
  position ~53 Mb

- **S. avilesii** 478-2  
  *Rpi-avl1*, Chr11  
  position ~1.8 Mb

- **S. chacoense** 543-5  
  *Rpi-chc1*, Chr10  
  position ~53 Mb

- **S. venturii** 283-1  
  *Rpi-vnt1*, Chr9  
  position ~51 Mb
2015: susceptible hybrid x resistant source
2016: marker assisted backcrossings
2017: field trial with double stack resistant hybrid

R1
Susceptible
R1+R2
R2

DEMONSTRATION TRIAL IN 2017
2017 field trial: Diploid potato with double *Rpi* gene stack exhibited higher level of resistance to the *P. infestans* isolate IPO-C over three locations in NL

Ying *et al.* (2019)
2018 field trial: Diploid potato with double \textit{Rpi} gene stack exhibited higher level of resistance to the \textit{P. infestans} isolate Blue-13
Conclusions

• There is an increased level of resistance.
• Variation of resistance conferred by different \textit{Rpi} genes and their combinations, which may differ according to time and location.
• Additional trials over more years and locations are needed to manage resistance genes.
Future research

1. More genetic backgrounds
2. More stacks of *Rpi* gene combinations
3. Repeat field trials over multiple geographic locations
Thank You!


