Phytophthora resistance in hybrid potato breeding

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true potato seeds

How something this small can change the world

Actually, this small seed is a true gamechanger

Our mission

Drastically improve the worlds 3rd food crop

25 grams of seed vs 2500 kilo of seed tubers
50% more yield
50% less chemical input
30% less CO2 emissions

Hybrid breeding resolves two major drawbacks that potato currently faces

1 Challenge of healthy starting material

Instead of sexual multiplication of starting material like in many other crops, potato relies on **clonal multiplication** making it extremely **slow**, **bulky**, **contaminated** with diseases, difficult to ship and store.

Hybrid breeding *enables sexual multiplication instead of clonal propagation*

- *Replace 2500 kg tubers with 25 grams seed*
- *Allow manifold faster scaling-up of the supply chain*

2 No major advances in new varieties

Most varieties are susceptible to diseases such as Late Blight. **Little genetic gain** has been realized over the last century.

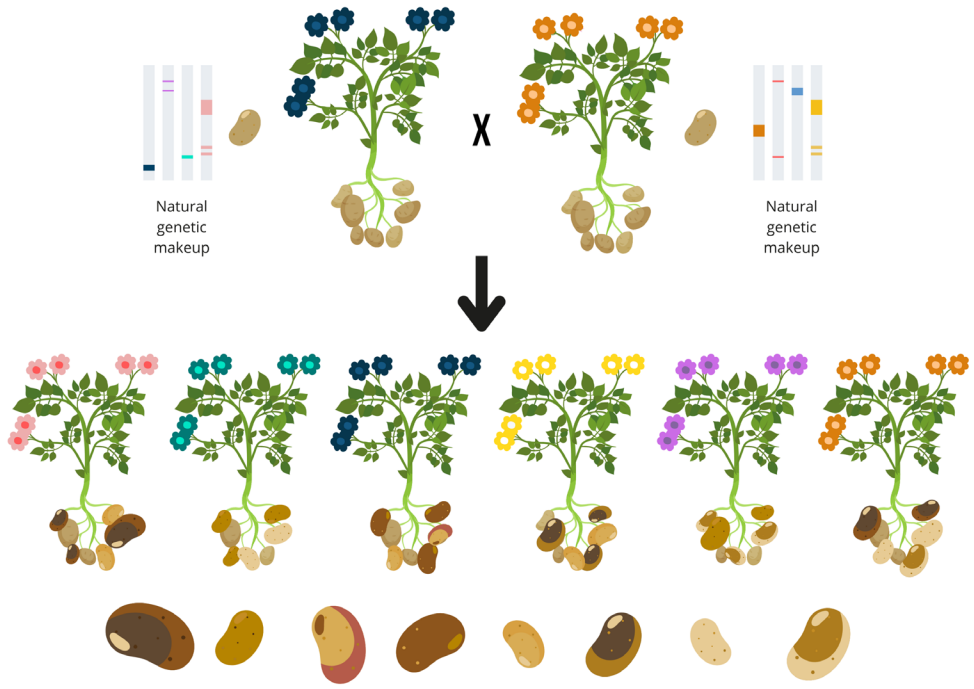
Hybrid breeding *enables better, faster and more efficient breeding*

- *New variety development in 2-4 years vs 15-20 years*
- *Targeted breeding without having to use GM*

Hybrid breeding enables faster and better variety development

TRADITIONAL POTATO BREEDING

Complex and unpredictable

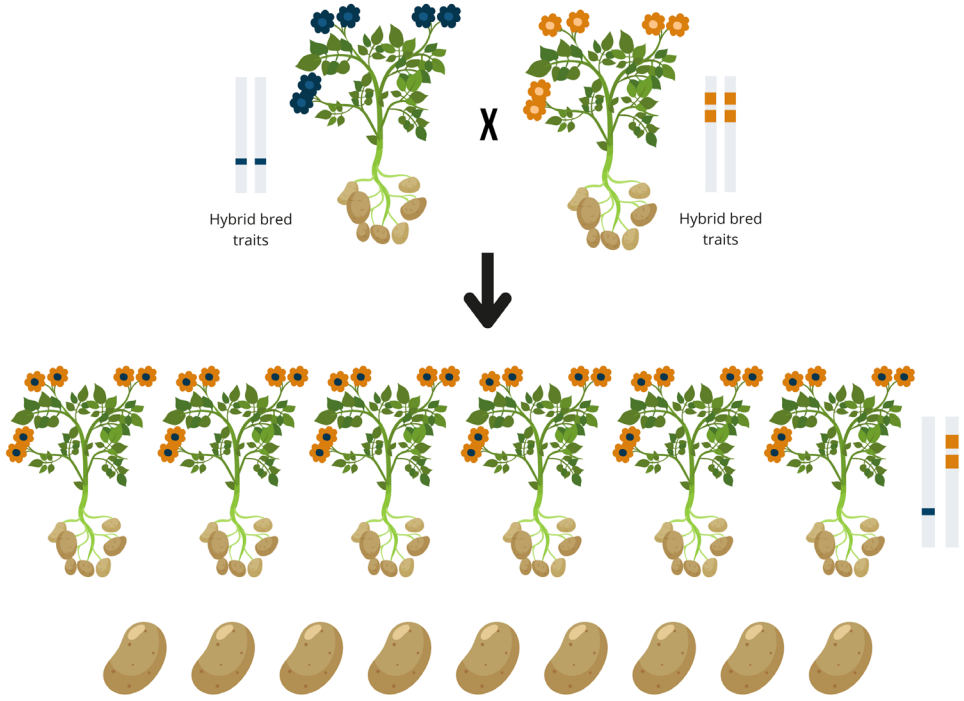


Outcomes are **RANDOM.**

Targeted breeding for selected traits can take **15-50 YEARS.**

HYBRID POTATO BREEDING

Fast and predictable



Offspring are **IDENTICAL.**

Targeted breeding for selected traits only takes **2-4 YEARS.**

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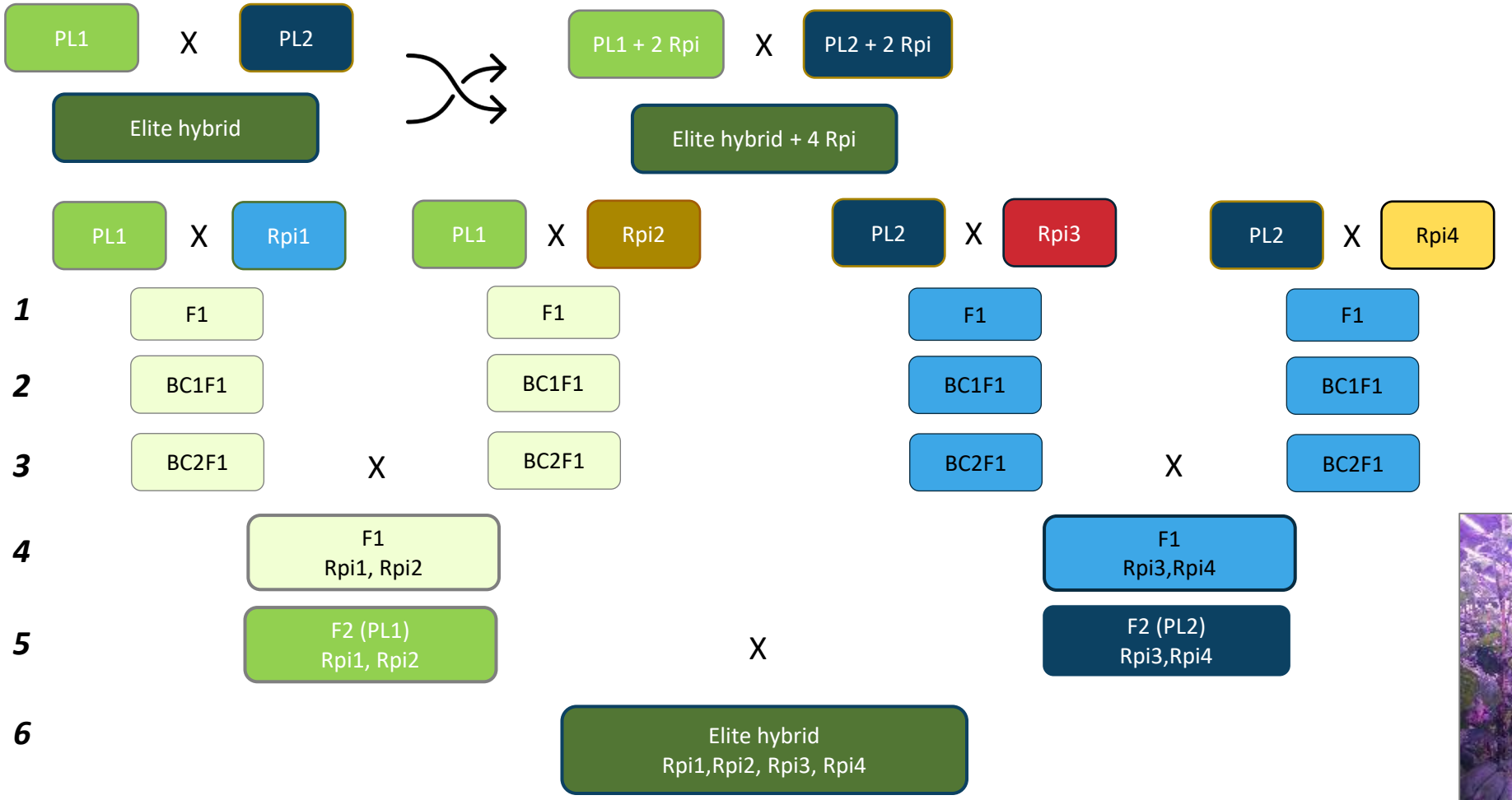
How can hybrid breeding help combat Late Blight?

Line conversion: Stacking Rpi genes

Marker assisted gene stacking: quadruple gene stack in 2 yrs; near isogenic to elite hybrid



6 generations

3 generations per year

2 years

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Marker assisted selection

Genetic analysis

- Ca. 1000 genome wide multi-allelic probes

Selections made during backcrossing using bio-informatics tool:

- Intogression region, locus trait of interest
- Homozygosity percentage
- Similarity recurrent parent line
- Markers for other known relevant traits

End result: converted hybrid

- Ca. 95% identical to original hybrid

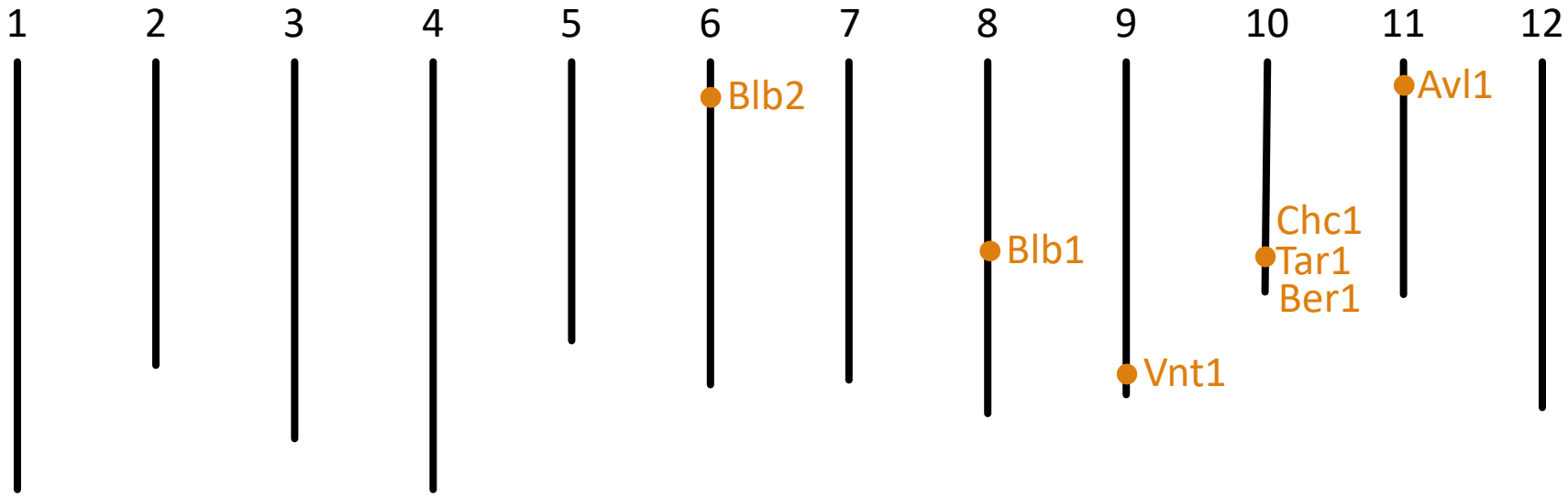
Result: Near identical hybrids with added (multigene) LB resistance

Performance converted hybrid in Kenya

Which genes, how to combine?

Current Solynta hybrids can have combinations of up to 5 Rpi genes:

- Rpi-blb1; chr8 (van der Vossen et al. 2003)
- Rpi-blb2; chr6 (van der Vossen et al. 2005)
- Rpi-vnt1; chr9 (Foster et al. 2009)
- Rpi-chc1/-tar1/-ber1; chr10 → shown by Monino-Lopez et al. (2021) to be allelic variants of the same gene
- Rpi-avl1; chr11 (Verzaux et al. 2011)



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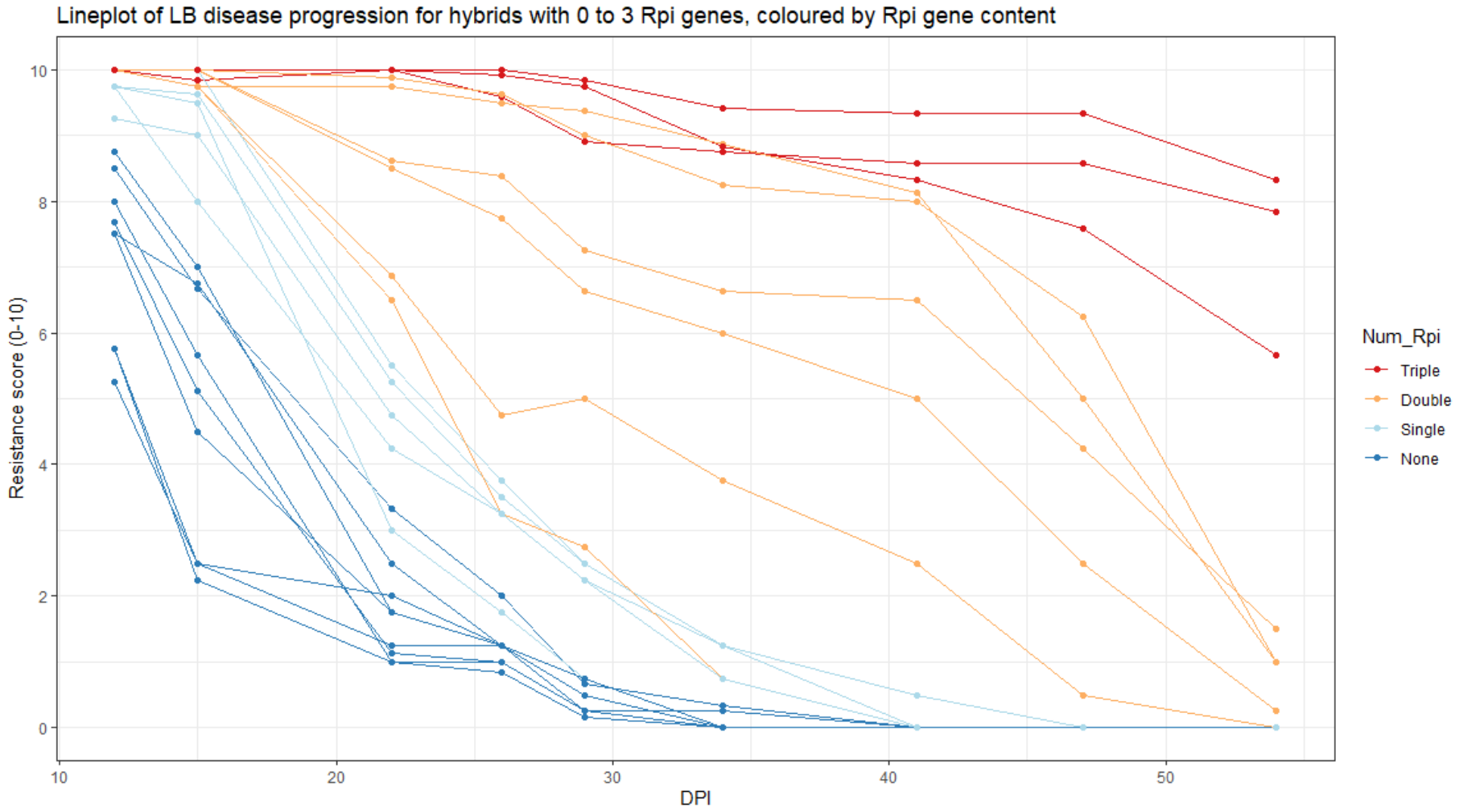
Efficacy of Rpi-gene stacks: LB field trial 2023 (seedling grown crop), inoculated with EU_36A2



Adding Rpi genes delays infection, each additional gene delays infection further, but infection cannot be avoided

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Integrated crop management

Rpi-gene stacks vs. ICM control strategy (ResPot)

Trial field sprayed based on “Blight App” + results bait field (no chemical control)

- Blight App: predicts infection risks based on weather conditions (infection period)
- Hybrids with 1 Rpi gene: postpone first spray application 5 infection periods
- Double stack hybrids: postpone until one Rpi is insufficient in bait field
- Triple stack hybrids: postpone until two Rpi’s are insufficient in bait field

Hybrid	Rpi combination	# of fungicide treatments
20HY0214	None	9
SOLHY012	None	9
19HY5122	Chc	6
21HY0281	Ber	6
21HY5509	Chc + Vnt	6
21HY0289	Avl + Chc	5
21HY5462	Avl + Tar + Vnt	4

Dr. Bert Evenhuis, WUR

- Blight app reduces fungicide applications to 9 in a season
- Triple stack Rpi hybrid further reduces fungicide application up to 4

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Comparative test on level of Late Blight resistance of new Solynta variety and 3 local commercial varieties, in Carlow, Ireland, 2023.

Thank you