Enhanced Disease Resistance in Plants

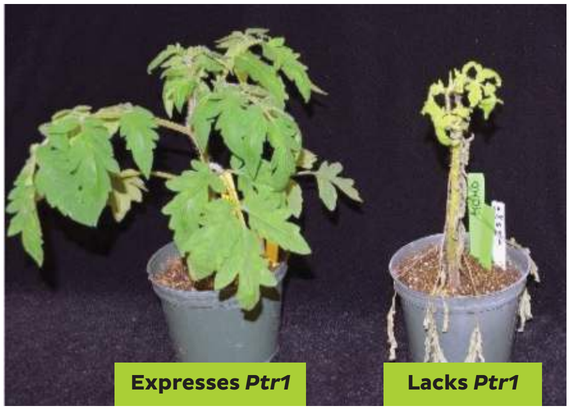
The *Ptr1* Technology Confers Resistance To Multiple Bacterial Pathogens

GENETIC ENGINEERING | AGRICULTURE | BACTERIAL DISEASE CONTROL

TECHNOLOGY HIGHLIGHTS

- BTI and Cornell scientists have identified the *Ptr1* gene in *Solanum lycopersicoides*, a wild relative of tomato
- Domesticated tomato varieties lack a functional copy of the *Ptr1* gene
- Tomato lines expressing the *S. lycopersicoides Ptr1* gene remained free of bacterial speck disease in the field during a natural outbreak
- The *S. lycopersicoides Ptr1* gene confers resistance to major bacterial pathogens causing wilt, speck and spot disease in plants
- Traditional plant breeding or genetic engineering approaches can be used to transfer or restore *Ptr1* functionality in tomatoes and possibly other crops such as eggplant

EFFECTIVENESS OF THE *PTR1* TECHNOLOGY



Ptr1 confers resistance to bacterial speck disease.

Plants were inoculated with 1 x 10^4 cfu/mL NYS-T1 race 1 *P. syringae* pv. tomato strain, which expresses the AvrRpt2 protein.
Photographs were taken 7 days after inoculation.

LICENSING OPPORTUNITIES

Genetic engineering
Exclusive licenses are available on a species per species basis

Masker-assisted plant breeding
Non-exclusive licenses available

COLLABORATION/R&D OPPORTUNITIES

BTI and the Martin lab will consider proposals for company-sponsored research or participation in SBIR or STTR grants. An area of particular interest is the application of the *Ptr1* technology to species other than tomatoes.

INTELLECTUAL PROPERTY

ENHANCED DISEASE RESISTANCE IN PLANTS
U.S. Application 16/916,757
Status: pending
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Assignees: Boyce Thompson Institute and Cornell University

Key Facts About The Technology

BACKGROUND INFORMATION

Bacterial speck causes severe necrotic lesions on different parts of the plant, affecting fruit yield and quality, requiring chemical treatment to avoid significant economic losses.

The Pto/Prf genes confer genetic resistance to race 0 strains of *P. syringae* by coding for a serine/threonine cytoplasmic kinase and a nucleotide-binding leucine-rich repeat (NLR) protein. These proteins form a complex that recognizes the bacterial type III effectors AvrPto or AvrPtoB

However, the widespread use of the Pto/Prf genes in the 1980s has led to the emergence of race 1 strains of *P. syringae* lacking AvrPto and AvrPtoB

Ptr1, by detecting the presence of the bacterial protease AvrRpt2 present in race 1 strains, confers strong resistance against bacterial speck.[1, 2] Ptr1 also recognizes the *P. syringa* effectors HopZ5, AvrRpm1 and AvrB.[3]

Bacterial spot disease is caused by members of the Xanthomonas genus, By recognizing the effector AvrBst, Ptr1 also confers resistance to bacterial spot disease.[3]

BROAD RESISTANCE TO BACTERIAL PATHOGENS

Ptr1 confers resistance to bacterial wilt disease.

Plants were soil drench-inoculated with 50 mL of 10^8 cfu/mL of *R. pseudosolanaceraum* CMR15. which expresses AvrRpt2 homolog RipBN. Photographs were taken 13 days after inoculation.

Bacterial wilt is caused by members of the Ralstonia genus. Ptr1 was first found to recognie RipBN present in strains of phylotype III.[3] Ptr1 also recognizes the effector RipE1, commonly found in all Ralstonia phylotpyes [4].

Ptr1 has been proposed as a key component of a stacking strategy for durable resitance to a broad range of bacterial diseases.[5]

HOW TO USE *PTR1* IN TOMATO

Genetic engineering:
A *Ptr1* gene insertion or the correction of the pseudogene present in cultivated tomato are possible.

Marker-assisted plant breeding:
Introgression of the *Ptr1* gene into tomato varieties is also possible.

HOW TO USE *PTR1* IN OTHER PLANTS

Use in *Solanacea*:
Genomic data indicates that Ptr1 may have been lost across tomato and eggplant cultivars. Analyzed accessions of tobacco, pepper and potato presented a functional copy of *Ptr1* [2]. Some cultivated varieties/lines however may have lost *Ptr1* during domestication.

Use in other crops:
Research is needed to determine whether the introduction of *Ptr1* could confer resistance in plants outside of the *Solanaceae* family.

References

[1] The *Ptr1* Locus of *Solanum lycopersicoides* Confers Resistance to Race 1 Strains of *Pseudomonas syringae* pv. *tomato* and to *Ralstonia pseudosolanacearum* by Recognizing the Type III Effectors AvrRpt2 and RipBN. Mazo-Molina *et al*., Mol Plant Microbe Interact. 2019 32(8):949-960.
[2] *Ptr1* evolved convergently with *RPS2* and *Mr5* to mediate recognition of AvrRpt2 in diverse solanaceous species. Mazo-Molina *et al*., Plant J. 2020 103(4):1433-1445.
[3] Ptr1 and ZAR1 Immune Receptors Confer Overlapping and Distinct Bacterial Pathogen Effector Specificities. bioRxiv preprint doi: https://www.biorxiv.org/content/10.1101/2022.05.16.492216v1.
[4] The Core Effector RipE1 of *Ralstonia solanacearum* interacts with and cleaves Exo70B1 and is recognized by the Ptr1 immune receptor. Tsakari *et al*., bioRxiv preprint doi: https://www.biorxiv.org/content/10.1101/2022.08.31.506019v3.
[5] Tackling Multiple Bacterial Diseases of *Solanaceae* with a Handful of Immune Receptors. Kim *et al*., Hortic Environ Biotechnol. 2022 63:149-160.

MEET OUR FACULTY/INVENTOR

Greg Martin is Professor in the School of Integrative Plant Science, Plant Pathology and Plant-Microbe Biology Section at Cornell University. Greg Martin is also a member of the National Academy of Sciences.

The Martin lab at BTI studies the molecular basis of bacterial infection processes, plant disease susceptibility, and plant immunity using biochemistry, bioinformatics, cell biology, forward and reverse genetics, genomics, molecular biology, plant breeding, plant pathology and structural biology.

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