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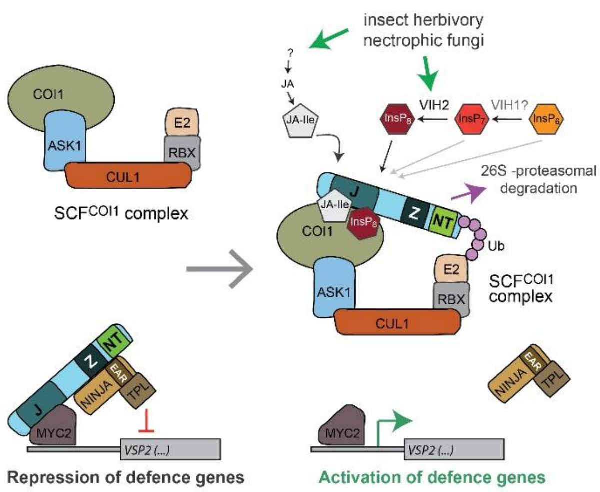
Plants with Increased Pathogen Defences

Technology Description



In nature and in agricultural ecosystems, plants are under constant threat by a wide range of harmful pathogens and pests, including bacteria, fungi, oomycetes, nematodes, viruses and insect herbivores. Plants developed sophisticated strategies to perceive these attackers and to trigger effective immune responses.

We identified inositol pyrophosphates such as $InsP_7$ and $InsP_8$ as important co-factors of the plant jasmonate receptor (SCF^{COI1}) complex which triggers defences against necrotrophic fungi and insect herbivores.

Here we present strategies for strengthening plant defences against these attackers by increasing inositol pyrophosphates ($InsP_7$ and/or $InsP_8$).

Innovation

Up to now: The use of genetically modified (GM) plants that express Bt-toxins of *Bacillus thuringiensis*. A major problem with this strategy is the development of Bt-toxin-resistant insect populations. In addition, there is a lack of public acceptance of GM plants, and Bt-plants have been reported to also damage non-pest insects.

Now: GM plants with increased $InsP_7$ and/or $InsP_8$ induce the full range of plant endogenous defence strategies against pathogens. Alternatively, membrane permeable precursors of $InsP_7$ and/or $InsP_8$ can be applied to non-GM plants and are processed into the active defence molecules by cell-endogenous hydrolytic activities.

Applications

- Generation of GM plants in which the production of endogenous $InsP_7$ and/or $InsP_8$ is increased.
- Increase of internal $InsP_7$ and/or $InsP_8$ in a non GM-approach by application of membrane permeable inositol pyrophosphate precursors.

Advantages

- Less risk of the occurrence of resistant pathogen populations.
- Pyrophosphat precursors are processed to natural, biodegradable molecules. Long term side effects for the environement are not expected.
- Higher public acceptance of GM crops because of using endogenous plant defence mechanisms.

Requested Cooperation

Industrial licensing partner and collaborations

IP Status

Patent Pending, Priority Date 2014-11-12

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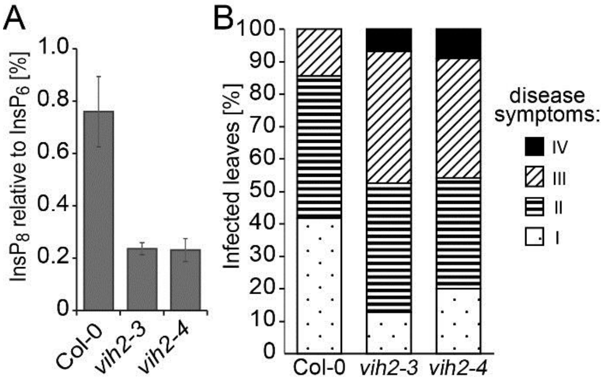
Experimental Data

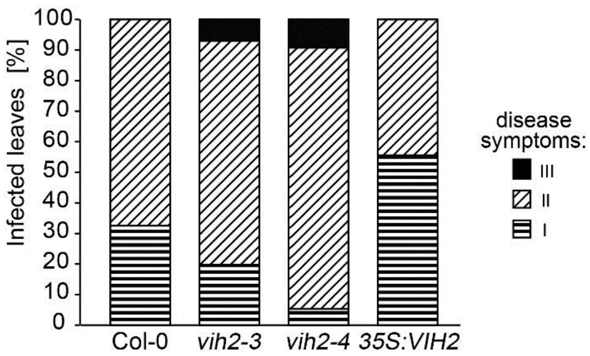
$InsP_8$ is Required for Resistance against Necrotrophic Fungi



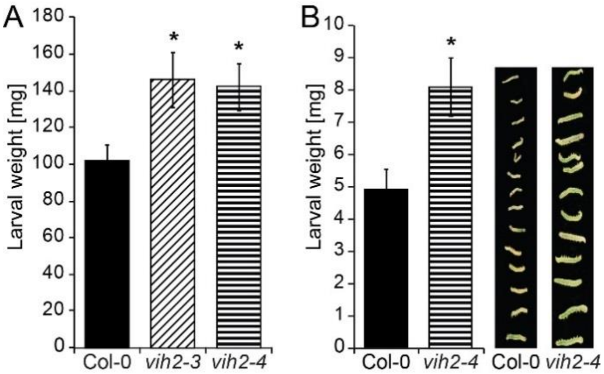
Arabidopsis thaliana plants (Col-0 ecotype) in which $InsP_8$ levels are reduced (*vih2-3* and *vih2-4* T-DNA insertion lines) as shown in **(A)** exhibit decreased defences against the fungal necrotroph *Botrytis cinerea* **(B)** indicating that $InsP_8$ is an important plant defence molecule against necrotrophic fungal pathogens. Disease symptoms were scored double blind-folded and are based on lesion diameter and colour: Class I (≤ 2 mm); Class II (≤ 2 mm with chlorosis); Class III (2-4 mm with chlorosis); Class IV (> 4 mm and chlorosis). Data analyses by Chi -square test (number of plants, n = 20), differences between Col-0 and the *vih2* lines are significant (P< 0.001).

Plants with Increased $InsP_8$ are more Resistant to Necrotrophic Fungal Pathogens

Arabidopsis thaliana plants (Col-0 ecotype) in which $InsP_8$ levels are reduced (*vih2-3* and *vih2-4* T-DNA insertion lines, see panel 1) show decreased defences also against the fungal necrotroph *Alternaria brassicicola* while an increase in $InsP_8$ (here by constitutive over-expression of the VIH2 kinase domain under control of the *35S* promoter) renders plants more tolerant. This provides proof of concept that $InsP_8$ is an important plant defence molecule that can be used to increase plant resistance against necrotrophic fungal pathogens.



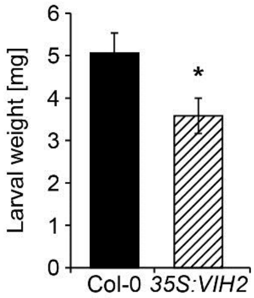
Inositol Pyrophosphate $InsP_8$ is Required for Resistance against Insect Herbivores



Arabidopsis thaliana plants (Col-0 ecotype) in which $InsP_8$ levels are reduced (*vih2-3* and *vih2-4* T-DNA insertion lines, see panel 1) show de-creased defences against herbivorous insects as evidenced by increased larval weight of the small cabbage white butterfly, *Pieris rapae* **(A)**, and the cabbage moth *Mamestra brassicae* **(B)**, (n= 20; t-Test; * $p < 0.02$). This suggests that $InsP_8$ is an important plant defence molecule. Plant genotype-dependent size differences of *M. brassicae* larvae are visualized by photographs on the right.

Plants with Increased $InsP_8$ are more Resistant against Insect Herbivores

Increase in $InsP_8$ (here by constitutive over-expression of the VIH2 kinase domain under control of the *35S* promoter) shows increased plant defences against *Mamestra brassicae* caterpillars (n=20; t-Test; * $p < 0.05$). This provides proof of concept that $InsP_8$ is an important plant defence molecule that can be used to increase resistance against herbivorous insects.



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