Green challenges: improving resilience of horticultural systems using concepts from soil microbial ecology

Annemieke van der Wal, Suzanne Breeuwsma, Caroline van der Salm, Jantineke Hofland-Zijlstra

Objectives

The project Green Challenges aims to substantially reduce the use of chemical plant protection products by focussing on a number of innovations. One of these innovations is to use and stimulate the natural resilience of the plant- and soil system. In this study, we investigate how we can measure and positively stimulate plant- and soil resilience in horticultural systems.

Plant resilience

Plant defences can be either preformed (constitutive defences) or be produced only upon attack (induced defences). The defences range from structural defences to toxic chemical compounds. Induced plant defences are produced in response to a wide variety of organisms, such as bacteria, nematodes and insects. Different types of induced resistance can be recognized (Fig. 1). The systemic acquired resistance (SAR) is triggered upon pathogen attack, or by chemical inducers and can include the production of pathogenesis-related (PR) proteins. Induced systemic resistance (ISR) can be triggered by root colonization with plant-growth-promoting rhizobacteria (PGPR) or by plant-growth-promoting-fungi (PGPF). Induced defences can be adjusted during greenhouse crop cultivation.

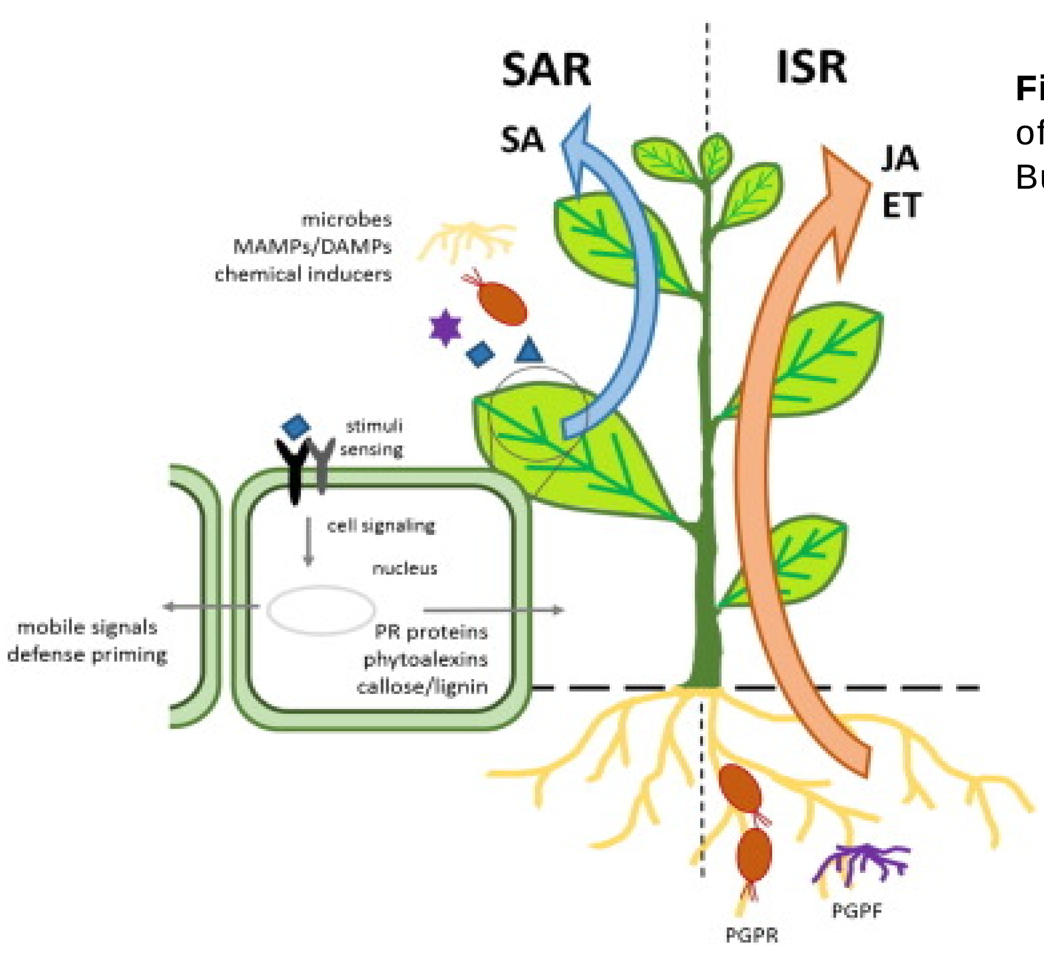

Figure 1. Scheme of different types of induced resistance. Source figure: Burketova et al., 2015.

Soil resilience

Soil resilience is governed by microbial community composition and soil physico-chemical properties affecting their functioning. Different mechanisms can explain the suppression of pathogens in soils or substrates and can be used to steer soil resilience:

1. Direct disease suppression by introducing antagonistic bacteria.
2. Increasing the competition between bacteria and fungi in the rhizosphere by introducing organic materials.
3. Increasing the natural resistance of plants by introducing non-pathogenic micro-organisms, such as rhizobacteria.

Approach

Three important greenhouse plants (tomato, Kalanchoe and lisianthus, Picture 1) will be cultivated under optimal conditions and different treatments will be applied that are supposed to positively stimulate either plant and/ or soil resilience:

1. Addition of organic substrates: compost tea, wood chips, champost.
2. Addition of antagonistic bacteria and fungi: *Bacillus subtilis*, *Pseudomonas simiae*, *Trichoderma asperellum*.
3. Addition of PGPR, PGPF and chemicals to increase plant resilience: *Pseudomonas simiae*, *Trichoderma harzianum*, COS-OGA (oligochitosans and oligopectates) and silicon.

A B C

Picture 1. Pilot experiment, testing the virulene of pathogens on selected greenhouse crops. A: Tomato stem infected with Fusarium solani, B: Tomato leaves infected with *P. infestans,* C: Lisianthus infected with *Fusarium oxysporum*.

After two weeks, plants will be infected by their three relevant pathogens (*Fusarium solani* and *Phytopthora infestans* on tomato, *P. nicotianae* on Kalanchoe and *Fusarium oxysporum* on lisianthus) (Picture 1). Disease development, plant responses (via measurement of PR proteins, jasmonic acid, salicylic acid and plant secondary metabolites) and responses of the soil microbial community (via measurement of total microbial activity and total fungal biomass) will be determined.

Follow up research

The most promising natural products will be selected. Selection will be based on products that showed maximum disease suppression and positively stimulated both plant- and soil microbial community responses. A combination of products will be tested to optimize the resilience of horticultural systems.

Acknowledgements

This study is financed by the Ministry of Economic Affairs, Agriculture and Innovations and the Dutch Productboard of Horticulture.

Wageningen University & Research
P.O. Box 20, 2665 ZG Bleiswijk
Contact: Annemieke.vanderwal@wur.nl
T + 31 (0)317 48 37 88, M +31 (0)6 28 39 75 17
www.wur.nl