

Evaluation of leaf treatment products to control late blight in organic potato production

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Introduction: Potato late blight (*Phytophthora infestans*) can cause severe losses in potato yield and quality in organic farming. Still, in organic production *P. infestans* can only be effectively controlled by the application of copper fungicides. Due to their accumulation in the soil and expected detrimental effects on the environment and non-target organisms, a reduction in the usage of copper fungicides is urgently required.

Within the course of a project aiming at the reduction and avoidance of copper in organic farming, trials are being performed investigating the use of different Cu-free products for the control of *P. infestans* leaf infections. The tests will allow the identification of potential alternatives replacing or amending copper based fungicides in the future.

Methods: We have tested several commercial and non-commercial organic products and preparations in both *in vitro* leaf assays and field trials. In total, 15 Cu-free alternative products were tested so far.

In the *in vitro* **abscised leaf assay**, leaves were inoculated approx. 3 hours after spray application of the product. In our optimised setup a water agar plug kept a 50- μ l-droplet of a sporangial suspension (5 sporangia/ μ l) of *P. infestans* in place, ensuring equal infection pressure in all variants, even when leaf surface properties were altered by the product. Leaves were incubated at 15°C for 5 days and disease rated as number of leaves and % leaf area affected. Each test consisted of 10-15 leaflets per product.

Products tested

Preparations based on microorganisms:

- *Bacillus subtilis* (Serenade)
- *Pythium oligandrum* (Polyversum)
- *Aureobasidium pullulans* (BoniProtect, ~ forte)

Preparations based on plant extracts:

- garlic extract
- commercial garlic product (AMN BioVit)
- knotweed product (Regalia)
- commercial citrus extract (ViCare)

Mineral substances:

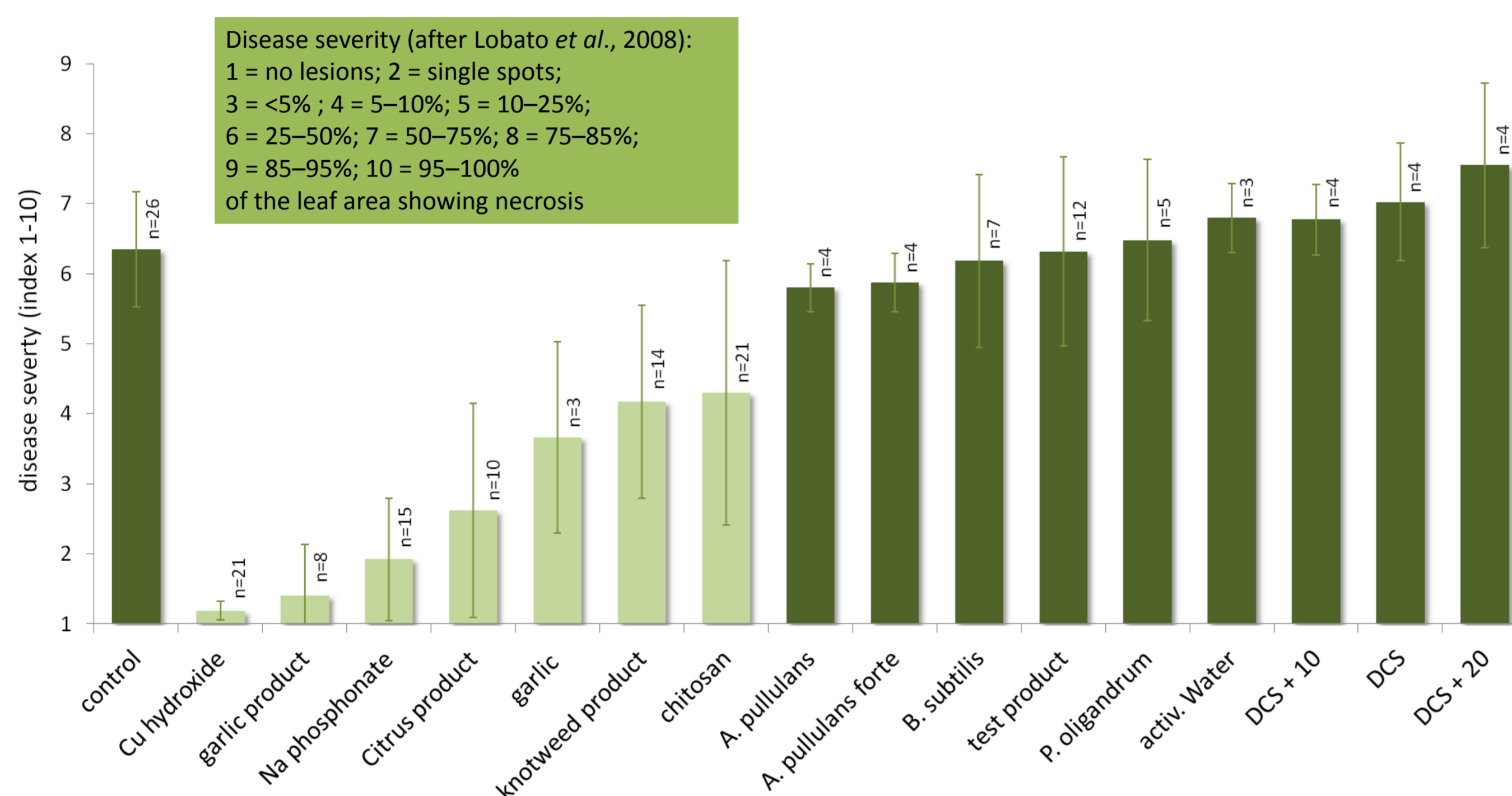
- dolomite clay suspension (DCS)
- DCS + 10% calcium hydroxide
- DCS + 20% calcium hydroxide
- activated water + zeolith/ clioptilolith (Desanol)

Pure chemical substances:

- Sodium phosphonate (test product)
- commercial chitosan (ChitoPlant)

Unknown:

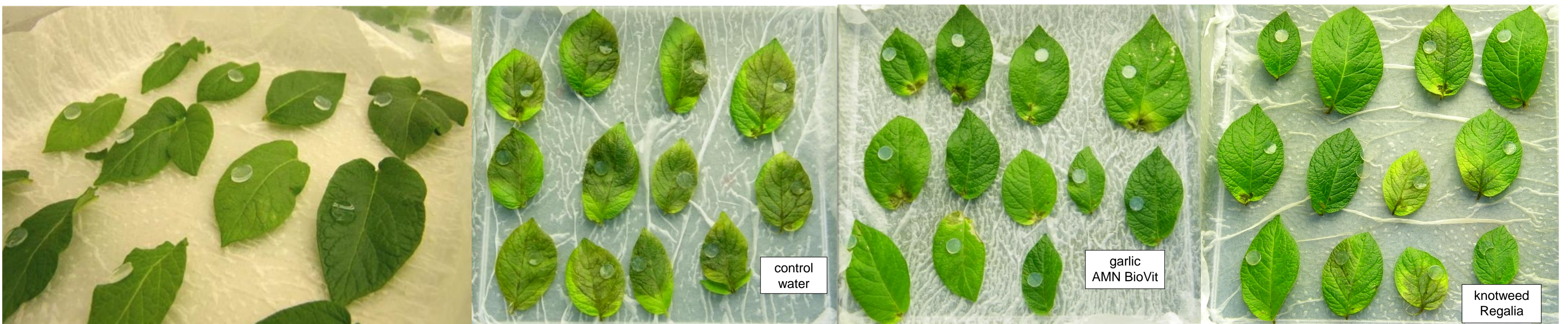
- Test product (supplier IBD)



Results: Only few of the substances tested in our laboratory assays proved to be effective against *Phytophthora* leaf infections.

Among the most promising agents was a **commercial garlic product** which was almost as effective as the copper control with regard to disease incidence and severity. Sodium **phosphonates**, although highly effective, are currently not acceptable in organic farming due to residues problems. **Chitosan** and a **knotweed product** were of intermediate efficacy. Chitosan, however, was shown to be highly variable in its control capabilities. The **citrus product** also provided fairly good protection, but has been banned from the market in the meantime.

Results of the *in vitro* leaf assays of a total of 15 products + control and Cu: mean disease severity in up to 29 experiments. n = number of test performed with the product. Light green columns differ significantly from the control at $p \leq 0.05$ (Dunnett's Multiple Comparison Test).



Discussion: In addition to the laboratory assays described above, **field tests** were performed with a selection of Cu-free leaf treatment products in 2012 (*Bacillus*, chitosan, and citrus). The field trials showed that even products that provided good protection in *in vitro* tests were not effective under field conditions. Thus, these products alone are unlikely to be a full substitute for copper in the medium or short term. Therefore, mixed or alternating applications of copper and Cu-free products will be tested during the further course of the project. The promising garlic product and the knotweed product have not yet been tested in the field and will be included in field trials in 2013.

Together with other agricultural and technical measures (such as leaf removal or seed treatment) foliar applications can be part of a **management strategy** to reduce the extent of leaf infections and to minimise the deposition of sporangial inoculum on the soil surface and the potato crop in organic farming. Such tuber infestations are thought to be among the major pathways of *Phytophthora* inoculum onto the field, serving as starting points for subsequent late blight epidemics.