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Inducibility of resistance in tomatoes against *Phytophthora infestans* by plant strengtheners

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Introduction

Late blight, caused by *Phytophthora infestans* is one of the most destructive diseases of tomatoes affecting organic and conventional tomato production worldwide. Because of a lack of commercial tomato cultivars with effective resistance to this disease, tomato growers have to rely on copper containing agents as a sole option to control this pathogen. It is anticipated that several accreditation agencies will not allow copper usage in organic crops in the future.

Alternative strategies with the emphasis on the "plant strengthening" phenomenon to control late blight in organic farming are being investigated in Europe by several groups (Stephan et al., 2005; Thuering et. al. 2005). There is evidence that some plant strengtheners (PS) based on plant, fungal and compost extracts may boost up plant's defense reactions towards pathogens through induction of resistance (Thuerig et al. 2005; Stephan et al. 2005). Especially the fungal extract PEN (Thuerig et al. 2005; Unger et al. 2006) has potential to control *P. infestans*. In addition to PS, organic soil amendments and fertilizers may also have positive effects on the host's metabolism ultimately limiting plant infestation by *P. infestans*. Combining PS with organic soil amendments/fertilizers might be effective in reducing tomato late blight severity and could become part of a strategy for disease management.

Most tests of PS have been done under standard greenhouse or growth chamber conditions and there is little information on the interaction that might occur between PS and organic amendments. For the practical use, it is important to know if and what kinds of interactions (synergy or antagonism) do exist among different preparations and products. In addition, there is a need to know if, and how strongly plant genotypes will affect the experimental outcome. The

main aim of this research was (i) to determine the performance of the PS Quality, a herbal extract provided by Agro bio products B.V., Netherlands under different environmental conditions, (ii) to identify organic fertilizers that may have positive effects limiting plant infestation by *P. infestans*, and (iii) to test for interactions between organic soil amendments and various PS.

Materials and methods

The effects of Quality were tested on a total of eight cultivars in the glasshouse under controlled conditions (Fig 1). Plants were grown in standard soil and given mineral fertilizer. From seven days after transplanting, plants were watered weekly with 50ml of an aqueous solution of Quality at 4 % in concentration four times; control plants were given water only. BABA (DL-3-amino-n-butanoic acid) which is known to readily tomatoes for resistance to late blight (Cohen 1994) was used as a reference inducer.

In a second experiment, tomato cultivar Matina was grown in soil from an organic field and fertilized to equal nutrient levels with organic fertilizer horn meal or Biofeed basis (Agro bio products B.V., Netherlands) at transplanting. In addition to Quality, the PS Ausma was tested (another herbal extract provided by BIOLAT, Latvia) at a concentration of 1% solution.

The effects of Biofeed basis with or without Quality were compared to standard horn meal application in a commercial type of setup with container grown tomatoes in field soil of the cultivar Philovita in plastic tunnels using adult plants. Plants were treated at fourteen days interval with Quality.

For inoculation, two first lateral leaflets of the youngest completely developed leaves were detached and inoculated with 20µl drops of a solution of $5*10^4$ sporangia ml^{-1}. Trays were kept in the dark for 24h at 17 °C. After 24 h, 16-h light/ 8-h dark cycle was maintained and leaves were sprayed with sterile demineralised water every 2 days. Percent diseased leaf area was assessed from day 5 to 7. All the experiments were conducted with at least four replications and at least repeated once. Depending on the test, either *P. infestans* isolate 101 or 108 collected locally in 2004; both with broad-spectrum virulence on tomatoes were used.

Results

As well susceptibility as inducibility varied greatly among cultivars and inducer used under greenhouse conditions in standard soil. While BABA reduced disease on all cultivars by 67-100% relative to the water treated control, effects were cultivar specific for Quality (Fig. 1). Thus, while there was no significant effect of Quality on the cultivar Bonny Best, the magnitude of the effects ranged from 8 to 47% reduction relative to the water treated control.

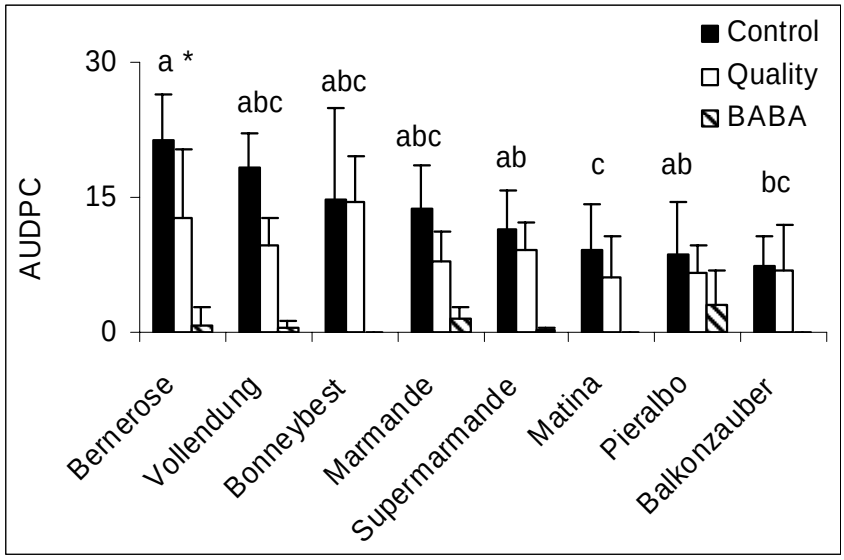

Figure 1. Area under the disease progress curve (AUDPC) of late blight on detached leaves of eight-tomato cultivars grown in standard soil and either treated with Quality or BABA as compared to water. Raw data were standardized against Supermarmande and log-transformed before analysis. Significant differences among water treated tomato cultivars are marked with different letters above the black bars (P≤0.05, Tukey-Kramer, SAS PROC mixed). All effects of BABA were significant at P<0.01; significant effects of Quality are marked

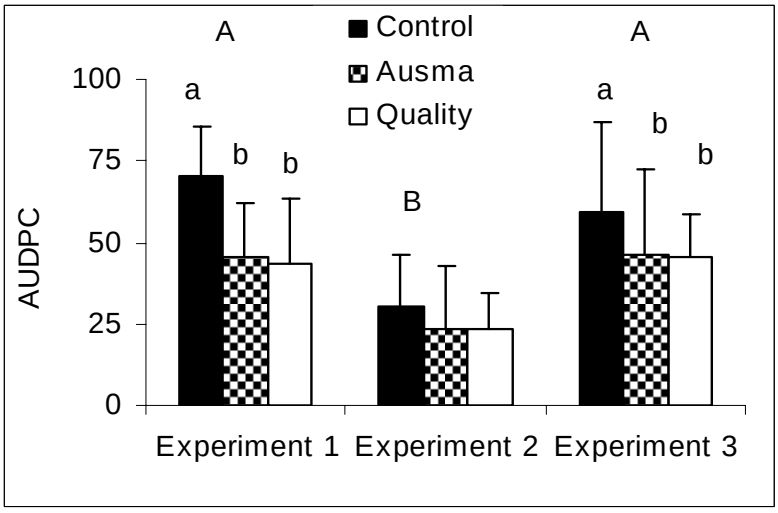

Figure 2 AUDPC of *P. infestans* on tomato cultivar Matina on detached leaves grown under glasshouse condition in field soil. Significant differences among experiments are marked with different upper case letters; significant differences among treatments are marked with different lower case letters (P≤0.05, t- LSD, PROC GLM, SAS).

When grown in field soil amended with Biofeed basis, there was no difference in disease on young plants of tomato cultivar Matina compared to soils amended with horn meal. There was no interaction between PS and soil amendments. Both, Quality and Ausma reduced plant susceptibility significantly in 2 out of 3 experiments (Fig. 2).

Adult plants of Philovita grown in the plastic tunnel were more resistant when fertilized with Biofeed basis than when fertilized with horn meal. This effect was enhanced by the use of Quality (Fig. 3).

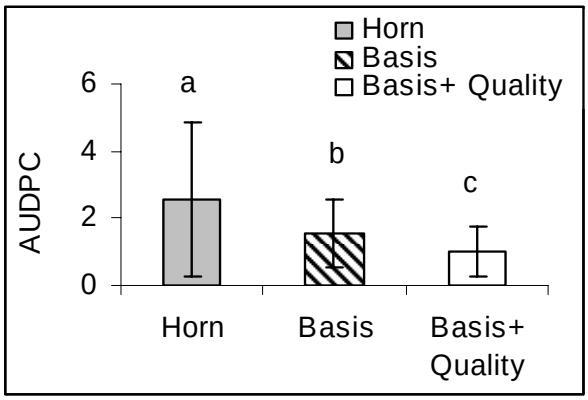

Figure 3. Combined effect of Biofeed basis and Quality on adult plants of Philovita. The presented value is the mean of 2 experiments. Errors bars represent ±SD. Bars followed by the same letters are not significantly different (P≤0.05, PROC GLM, SAS). Mean separation was done by Tukey grouping with the log-transformed data.

Discussion and conclusion

While resistance induction by Quality was much less than by BABA, overall, it reduced the susceptibility of tomatoes independent of plant age, growth substrate or fertilizer used. In an additional unrepeated experiment using PEN and 12 varieties, all cultivars were induced with no cultivar interactions. If these results hold true, then Quality and PEN might trigger different defense reactions by the plants. This warrants research into the underlying mechanisms and into possible synergistic effects of the two compounds. The variety specific effects of Quality indicate that there might be genetic effects that could be explored by breeders.

References

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