Impact of soil management on disease suppression of soil borne pathogens in arable fields

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Introduction

Enhanced soil suppressiveness against plant pathogens is a promising strategy to control diseases and crop losses. Improved management practices are developed, however, the effect of soil management treatments on the level of disease suppressiveness in the field is mostly unknown. To acquire this knowledge, samples from several field experiments comparing different soil treatments have been evaluated for disease suppression in two bioassays.

Research question

- Which soil management treatments enhance disease suppression under field conditions?

Material and methods

Field soils from experiments with several soil management treatments were tested in bioassays with garden cress (*Lepidium sativum*) and sugar beet (*Beta vulgaris*) by scoring the disease rate after artificial infection of the soils with respectively *Pythium ultimum* and *Rhizoctonia solani* AG2-2IIIB (Fig. 1). These two pathogens are known to react differently on the biotic and abiotic factors in soil, and as such used as indicator for general and specific suppressiveness.

Figure 1. Bioassays to assess disease suppression of field soils after artificial inoculation with plant-pathogens: (A) damping off in cress by *Pythium ultimum*, (B) disease spread in sugar beet by *Rhizoctonia solani* AG2-2IIIB.

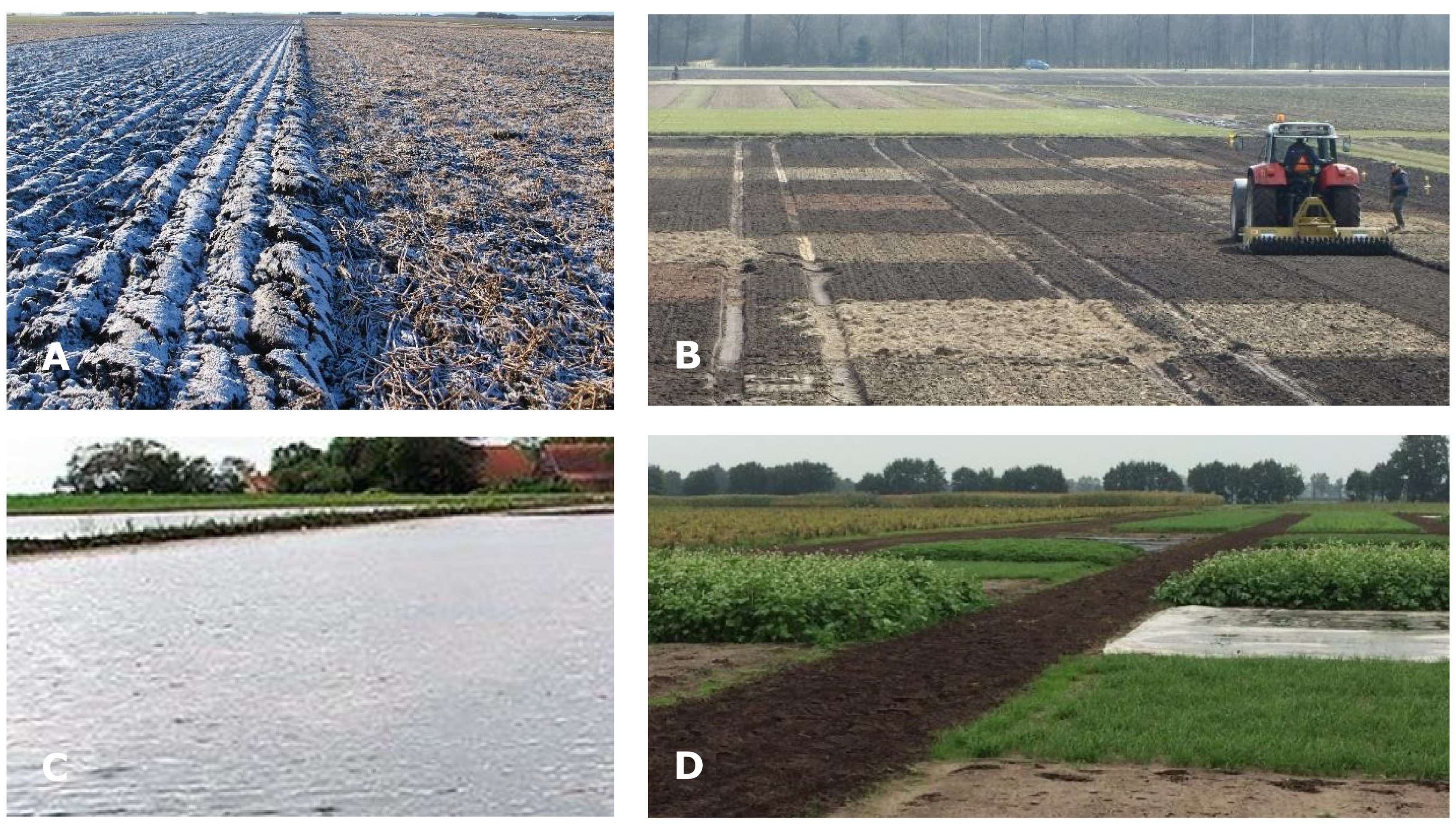

Figure 2. Field experiments with different soil management treatments used for soil sampling: (A) reduced tillage, (B) organic amendments, (C) inundation, (D) several soil health treatments.

Results

Pythium suppressiveness in field soil was in general enhanced by reduced tillage and the addition of several organic products. Also clay content of the soil had a positive effect on Pythium suppressiveness.

Rhizoctonia suppressiveness in field soil was not consistently influenced by tillage. And although organic products with high chitin and keratin levels stimulated Rhizoctonia suppressiveness in pot experiments, this effect could not be attained in field trials up to now. Nevertheless, Rhizoctonia suppressive soils did occur among arable fields of farmers, but how to create such suppressiveness is unclear. One of the factors involved could be the presence of the pathogen itself in the field being a precondition to evoke disease suppression, since Rhizoctonia decline is a well-documented phenomenon for several crops.

Table 1. Schematic presentation of the effects of different soil management treatments on Pythium and Rhizoctonia disease suppression in the field evaluated with bioassays. Symbols indicate: Positive ☺ ☺, neutral 😐, and negative ☹ effect

Treatment	Disease suppression	Reference
Reduced tillage	Pythium ☺ Rhizoctonia 😐	https://doi.org/10.1016/j.apsoil.2022.104646
Compost amendment	Pythium 😐 / ☺ Rhizoctonia 😐	https://doi.org/10.1007/s00248-023-02215-9
Chitin amendment	Pythium ☺ Rhizoctonia 😐	https://doi.org/10.1007/s00248-023-02215-9
Keratin amendment	Pythium ☺ Rhizoctonia 😐	https://doi.org/10.1007/s00248-023-02215-9
Anaerobic soil desinfestation	Pythium ☺ Rhizoctonia 😐	https://doi.org/10.1007/s00248-023-02215-9
Inundation	Pythium ☹ Rhizoctonia 😐 / ☹	https://doi.org/10.18174/561880
Clay soil compared to sandy soil	Pythium ☺ Rhizoctonia 😐	https://doi.org/10.18174/589138

Conclusions

- Soil management in the field:
  - can affect disease suppressiveness measured in bioassays,
  - affect Pythium and Rhizoctonia suppressiveness in a different manner,
  - has a stronger effect on general (Pythium) than specific (Rhizoctonia) suppressiveness.
- Bioassays are valuable as indicator for disease suppressiveness of soils, but translation to the actual field situation, including seasonal fluctuations, is still a challenge.

Acknowledgements

Research was part of projects TKI-AF-15261, TKI-AF-16064, LWV2042 and KB-34-008-001. We acknowledge funding by Topsector Agri&Food, Dutch Ministry of Agriculture, Nature and Food Quality, and BO Akkerbouw.

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