

The enemy of my enemy is my friend?

Rice is the most important staple crop for two billion people in the world. However, the production system where rice is grown submerged in water (paddy fields) is under threat due to changing weather conditions. Due to urbanization, governments have to furthermore make choices on how to spend their fresh water supplies around cities. The Chinese government has, for example, already abandoned the use of submerged rice around their capital city. To limit the use of fresh water for the production of rice, an alternative production system is being implemented, named “aerobic rice”. With this method, rice is grown in well-drained, non-puddled, and non-saturated soils as most other cereals are grown.

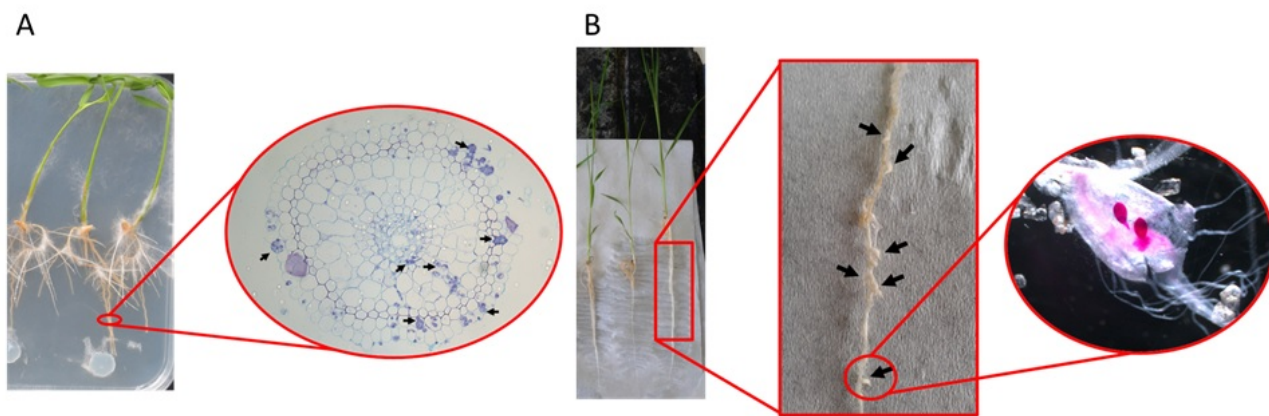


Fig. 1. Infection of *P. arrhenomanes* (A) and root-knot nematodes (B) on rice. A: Roots are stunted and brownish and when looked inside the root (close-up view), oomycete structures (hyphae) are visible (arrows, stained with trypan blue). B: Rice seedlings infected with nematodes. Hook-shaped galls (arrows) are formed on the root (1st close-up view). Inside these galls nematodes can be seen (2nd close-up, stained with fuchsin acid).

This uses three times less water compared to the traditional paddy fields. Although this method is promising, continuous cultivation of aerobic rice in the same field results in yield loss. Among other factors, the yield reduction was attributed to a new array of diseases that can build up large population densities in aerobic soil. Two of the most devastating pathogens that cause disease in aerobic rice are oomycetes (*Pythium* spp.) and root knot nematodes called *Meloidogyne graminicola* (nematodes). Infested soil with either of these diseases causes significant yield losses on Asian rice varieties. *Pythium* species mainly cause stunting and seedling mortality on young plants within the first week after germination (Fig. 1A). Thereafter *Pythium* species are not known to cause disease on rice. The other pathogen, root knot nematodes colonize the root system and induce hook-shaped galls (Fig. 1B) which they use to feed from the plant. During one rice season the nematode can reproduce 4 to 5 times under favourable conditions, resulting in devastating

effects on plants and therefore yield.

In the past, scientists studied single pathogen-host interactions where they focus on the effect of one pathogen on the host, to understand the disease development. However, plants are under simultaneous attack by multiple pathogens, which also interact with each other. One would expect that two virulent pathogens attacking the same host would result in increased damage to the host. However, in our study we show that the presence of *Pythium arrhenomanes* reduces the yield loss caused by the nematode. Furthermore we show that the presence of *P. arrhenomanes*, without causing damage to the rice plant, reduces the number of nematodes in the root and the reproduction rate compared to single nematode infected plants. Our data shows that in 27 day old plants there are between 2.4 to 3.7 times fewer nematodes in the root when *P. arrhenomanes* is present. In line with this, we observed that after 62 days significantly fewer nematodes emerged from the root when cut open. The delay in establishment and development of *M. graminicola* became stronger with higher *P. arrhenomanes* infection pressure. The plant benefits from this antagonism between the two pathogens with increased yield compared to *M. graminicola* single infected plants.

It remains however to be elucidated through which mechanism *P. arrhenomanes* antagonises the nematode. Possible hypotheses are (i) less attraction of the nematodes towards the roots through a change in the root exudates, (ii) colonization of the galls by *P. arrhenomanes* resulting in direct competition for available nutrients, or (iii) induction of plant defence responses by *P. arrhenomanes* against *M. graminicola*. The fact that one pathogen can antagonize another pathogen, opens an unexplored array of possibilities to look at biocontrol metabolites from these pathogens.

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Publication

[Interactions between the oomycete *Pythium arrhenomanes* and the rice root-knot nematode *Meloidogyne graminicola* in aerobic Asian rice varieties.](#)

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