

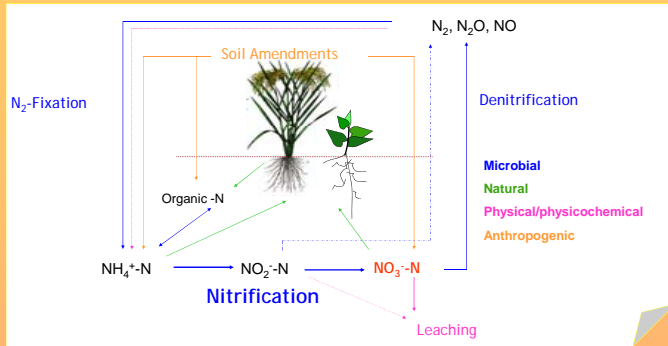
Can Allelopathic Rice (*Oryza sativa*) Effectively Inhibit Nitrification?



Warshi Dandeniya, Antonio DiTommaso and Janice E. Thies, Cornell Univ., Ithaca, NY

wsd24@cornell.edu

Importance of nitrification for rice



Nitrification is a microbiologically mediated process in which NH_4^+ is oxidized to NO_3^- under unsaturated soil conditions. Nitrate is subject to leaching and is a substrate for denitrification. Thus, N is more readily lost from the root zone. Physical and economic water scarcity frequently force farmers to cultivate rice in unsaturated soils, which may lead to reduced N use efficiency (NUE), depending on the rice variety's preference for NH_4^+ only or both NH_4^+ and NO_3^- .

If a plant prefers to take up N as NH_4^+ it will benefit by having the ability to inhibit nitrification in root zone.



How can nitrification be inhibited?

- Secrete secondary metabolites that impair growth of other organisms - **Allelochemicals**
- Compete strongly for NH_4^+ against the nitrifiers
- Favor fast-growing heterotrophs that will outcompete slow-growing nitrifiers

Evidence for biological nitrification inhibition (BNI) in: *Brachiaria humidicola*, *Sorghum bicolor*, *Helianthus annuus*, and *Laymus racemosus* (wild relative of wheat)

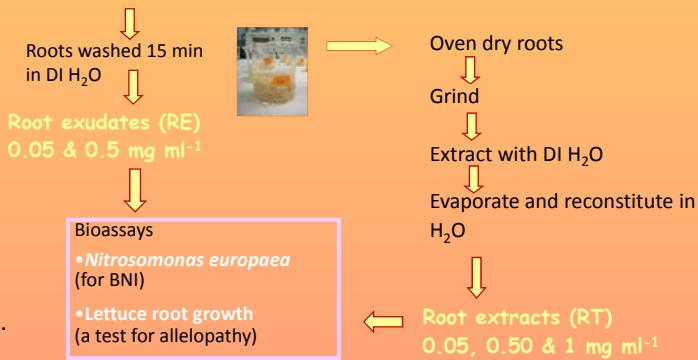
Experimental approach

Rice varieties:

- Allelopathic (PI312777, PI338046)
- Non-allelopathic (IR55423)
- New breeding line (IR80508-B-57-3-B)



Rice was grown in a capillary mat system in split-plot design
Main plots – with or without water stress
Roots were harvested 14 days after emergence



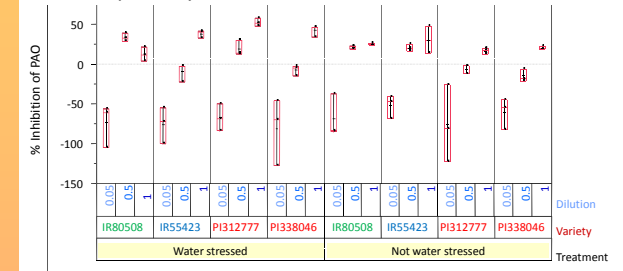
- Un-inoculated controls and N-Serve standards (for BNI) were used
- Experiment was repeated in full to verify the results
- pH of RT and RE were measured at different dilution levels

Allelopathic rice

- Some rice varieties secrete allelochemicals that inhibit the growth of some weeds
- Potential candidates to look for BNI

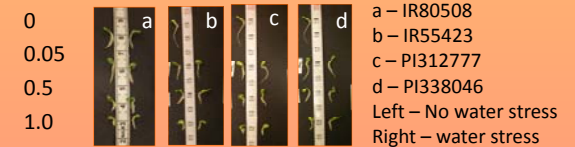
Major findings

Inhibition of potential ammonia oxidation (PAO) activity of *N. europaea* by rice root extracts



- RE at 0.5 and RT at 0.05 mg ml^{-1} ↑ PAO
- BNI and lettuce root growth inhibition: RT > RE

Lettuce growth inhibition by RT (mg ml^{-1})



- BNI of *N. europaea* was correlated with lettuce root growth inhibition ($r^2 = 0.70$, $P = 0.05$)
- pH of exudates and extracts was not significantly different among treatments
- PAO inhibition at 1.0 mg ml^{-1} of RT of PI312777 and PI338046, in the water-stressed treatment, was equivalent to that achieved by 5 ppm N-Serve

Conclusions and Future directions

Allelopathic rice varieties tested have potential BNI activity against *N. europaea* at 1.0 mg ml^{-1} concentration

Studies need to be extended to soil systems, because....

- Allelochemicals will be diluted in the soil solution
- Allelochemicals may become physically protected, thus not contact organisms
- Allelochemicals may serve as substrates for heterotrophic microorganisms
- Results cannot be generalized to all nitrifiers from examining only *N. europaea*

Molecular studies are ongoing using RNA extracted from soils in which these varieties were grown.