New eco-friendly technique protects rice plants against devastating fungal infection

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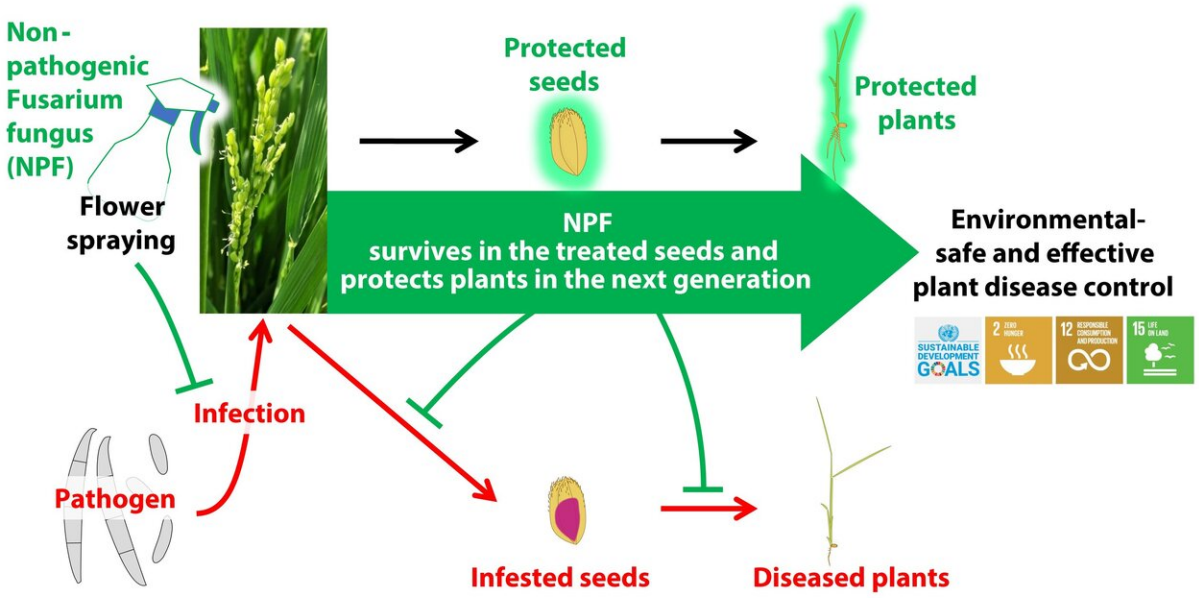

Spraying rice flowers with a non-pathogenic fusaria produces seeds carrying the non-pathogenic fusaria and controls seedborne bakanae disease.. disease Credit: Tsutomu Arie, Tokyo University of Agriculture and Technology

Researchers have developed a new technique to protect rice seeds against fungal infections that can ruin up to half of all rice crops in the world. The biocontrol method, which involves inoculation of flowers with a different fungus that doesn't cause disease and using seeds harvested from the flower to grow crops, is even better at protecting rice

plants from diseases than existing fungicide approaches, and could also be used against similar pathogens that affect other staple crops.

The extremely destructive seedborne *bakanae* disease, which affects rice plants everywhere in the world that the staple crop is grown, is currently typically combatted with either chemical fungicides or by hot-water treatment of seeds, all of which face growing challenges to their effectiveness.

However, researchers have developed a new anti-*bakanae* technique that actively encourages the spread of a different, non-pathogenic variety of fungus, that has been shown to outcompete the disease-causing fungus on rice seeds. This biocontrol method not only delivers protection against *bakanae* disease as effectively as traditional methods, but can also prevent *bakanae* disease from affecting the seeds, which current techniques cannot.

The researcher's findings are reported in the journal *Applied and Environmental Microbiology* on January 4, 2021.

The pathogenic fungus *Fusarium fujikuroi* produces gibberellic acid, a plant growth hormone, on rice plants and drives abnormal elongation and etiolation. The affected plants appear pale yellow or white, produce no edible grains, and suffer from weak stems that topple over, hence the name *bakanae*, Japanese for "foolish seedling." Losses in the field are substantial wherever the disease emerges, but particularly severe in Asian countries, where the disease can hit 20-50% of crops.

Throughout agriculture, efforts to reduce conventional pesticide use are widespread in order to limit negative impacts on other organisms, but the additional problems that conventional methods of tackling *bakanae* disease face only add to the need to come up with an alternative. None of these techniques have been very stable, and thus lead to disease

outbreaks. They are also not very efficient at combating deeply infected seed stocks. On top of this, existing chemical fungicides also increasingly face challenges from fungicide-resistant strains of the fungus.

The new biocontrol technique, developed by plant pathologists at Tokyo University of Agriculture and Technology, involves spraying rice flowers with a non-pathogenic strain of the fusaria fungus and produces rice seeds carrying the non-pathogenic fusaria. Testing against conventional techniques showed roughly the same level of effectiveness, both against transmission of the disease to seeds, but also transmission among offsprings.

"Investigation under the microscope suggests that the non-pathogenic strain out-competes its cousin, preventing the pathogenic fungi from colonizing the seed, while the growth of the 'good' fungus causes no harm," said Tsutomu Arie, professor and Hiroki Saito, graduate student at the Laboratory of Plant Pathology, Graduate School of Agriculture, Tokyo University of Agriculture and Technology.

As the spread of the good fungus appears to completely replace the bad fungus, the technique should also work on heavily affected seed stocks.

Because rice seeds are usually stored for about six months over the winter before sowing in Japan, the non-pathogenic fusaria in seeds needed to survive at least this amount of time. So to track how long the protection lasted, the researchers genetically tweaked the fungus to make them fluorescent. Six months later, microscopic investigations found that fungal mycelia were still fluorescent, demonstrating they were still there and out competing their "bad" fungus cousins.

The reproductive mechanics of other staple crops in the Poaceae family of grasses that the rice plant belongs to, such as wheat, barley and corn

are similar enough that the technique could work on fungal infestations that affect these plants as well. The researchers now aim to test their new method on these crops, as well as on tomatoes, spinach, lettuce, and carrots.

More information: Hiroki Saito et al, Spray Application of Nonpathogenic Fusaria onto Rice Flowers Controls Bakanae Disease (Caused by Fusarium fujikuroi) in the Next Plant Generation, *Applied and Environmental Microbiology* (2020). DOI: 10.1128/AEM.01959-20

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