Virus turns deadly fungus from foe to friend in plants

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A photograph of the bright-yellow-blossom rapeseeds, which are the main ingredient for canola oil. Credit: Daohong Jiang

Researchers have discovered that a fungal virus (also called a mycovirus) can convert deadly fungal pathogens into beneficial fungus in rapeseed plants. Once transformed, the fungus boosts the plant's immune system, making the plant healthier and more resistant to diseases. These findings, published on September 29 in the journal *Molecular Plant*, indicate that some fungal viruses can be used for developing "plant vaccines" to improve crop health and enhance crop yield.

Rapeseeds that cover farm fields with bright yellow blossoms like a fuzzy golden blanket are the main ingredients of our household cooking staple—canola oil. Besides serving as vegetable oil, the plants are also a crucial crop for animal feed and biodiesel worldwide. However, rapeseed farms experience significant losses from the fungal pathogen, Sclerotinia sclerotiorum, which causes stem rot, lesions and kills the plants within a few days after infection.

"The virus we identified can convert the fungus from a deadly pathogen in different plants to an endophytic fungus like a gentle sheep and protect these plants," says the senior author Daohong Jiang, a professor at Huazhong Agricultural University in China. Endophytic organisms live within a plant for at least part of its life cycle without causing diseases, maintaining a symbiotic relationship. "The research is important because we know plants have endophytic fungus, but where did it come from? The fungal virus might have played a role in the evolution of these fungi and that's something we can look into in the future."

When infected by the mycovirus, the rapeseed-threatening fungus loses its virulence. Instead of killing the plant, the virus-infected fungus lives peacefully within the plant and even comes with some benefits. Jiang and his colleagues infected the rapeseeds by inoculating seeds with virus-infected fungus fragments and observed a boost in the plants' immune system, an 18 percent increase in weight and more root growth. These plants not only grew bigger and stronger, but it could also resist other diseases.

The fungal pathogen, Sclerotinia sclerotiorum, infects and kills rapeseed plants. White mass is the hyphae of this fungus (arrows). Credit: Daohong Jiang

"The fungal virus might be a good thing for the fungus because the fungus now recognizes the plant as 'home' instead of killing it," says Jiang. "The virus turned a foe to a friend."

In the rapeseed fields, fungus-infected fragments also suppressed stem rot, stimulated plant growth and improved seed yield by 6.9—14.9 percent. Virus-infected fungal pathogens become a novel way to tackle crop diseases by decreasing the virulence of lethal pathogens. Moreover, the researchers found that the fungal virus can be transmitted to other fungal pathogens quickly and efficiently throughout the field, which are ideal traits to develop "plant vaccines."

A photograph of a rapeseed field at Chongqing City. Credit: Daohong Jiang

"If you treat the seed with virus-infected fungus, the fungus will grow with the plant throughout its life," says Jiang. "Just like how we vaccinated our kids when they were born, the protection is life-long."

Jiang noted that fungal pathogens are a topic that scientists haven't been able to control in agricultural settings. Currently, there are no plants with fungal-pathogen-resistance for these pathogens who attack a wide variety of plants. Fungi cause more than 80 percent of crop disease and destroy one-third of all food crops annually, causing economic loss and impacting global poverty.

"This fungal disease is also prevalent in the United States. Besides rapeseeds, the fungus also attacks sunflowers, beans and other crops," says Jiang. "Our prevention method and research idea may benefit many others who are engaged in similar work and benefit agricultural production. It has a lot of potentials."

More information: *Molecular Plant*, Zhang et al.: "A 2 Kb Mycovirus Converts A Pathogenic Fungus into Beneficial Endophyte for Brassica napus Protection and Yield Enhancement" www.cell.com/molecular-plant/f … 1674-2052(20)30293-8 , DOI: 10.1016/j.molp.2020.08.016

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