FAR FLUNG Fungi

Bacteria vs Fungus; Using *Bacillus* to control Wet Bubble Disease

Antifungal activity of industrial Bacillus strains against *Mycogone perniciosa*, the causative agent of wet bubble disease in button mushrooms

Novikova I, Titova J. Microorganisms 2023. 11:2056
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Chemical and biological control of wet bubble disease (Hypomyces perniciosus) in mushroom crops

Navarro MJ, Santos M, Dianez F, Gea FJ. Agronomy 2023. 13:1672
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What's it about?

Wet bubble is a widely distributed disease caused by the fungal parasite *Hypomyces perniciosus* (formerly *Mycogone perniciosus*). Recently it has been found that related pathogens, including *M. rosea* and *M. xinjiangensis*, can also cause symptoms.

The pathogen can spread in water, on flies, in air and on the farm staff's hands and clothes. If the disease appears it is essential to minimise spread. This can involve either removing infected mushrooms or covering them with a plastic pot, alcohol or salt. The main control strategy is therefore strict hygiene, particularly preventing spores from infected rooms contacting stored casing. Fortunately, wet bubble is not usually a serious disease, tending to appear late in the growing cycle as the *Agaricus* crop weakens.

However, hygiene alone is not always sufficient. The spores are relatively tough, remaining viable for up to three years and able to withstand 60°C for more than two hours. Although past outbreaks have generally been sporadic, threat from the disease appears to be increasing. According to European researchers, the lack of chemical controls is making management more challenging. In China, wet bubble disease (WBD) has already been reported to reduce yield by 15-30%, and possibly more.

Two recent papers (published in June and August 2023) have examined biological control of WBD using strains of *Bacillus subtilis*. While Novikova and Titova conducted in-vitro trials, Navarro et al. compared efficacy of biological and chemical controls using six crops grown under commercial conditions.

What was found?

Novikova and Titova conducted their trials in-vitro using liquid cultures of *B. subtilis* strains B-10 and M-22. One and seven day old cultures of WBD were sprayed with the *Bacillus* strains.

Both *Bacillus* strains significantly reduced growth on the plates, although the effects were reduced when the WBD culture was more established.

Navarro et al. tested the biological controls Serenade (*B. subtilis*) and Amylo-X (*B. amyloliquefaciens* subsp. *plantarum*), comparing results against the fungicides Daconil (Chlorothalonil 50% CS), Vivando (metrafenone 50% CS) and Sporgon (Prochloraz-Mn 46% WP).

Figure 1. Early and late symptoms of wet bubble disease. Images by N. Cattlin, FLPA, Minden Pictures.

In this case the trials were carried out in experimental mushroom growing rooms under conditions analogous to a commercial farm.

The beds were inoculated by watering the casing with a WBD conidial suspension, with a number of beds left uninoculated as controls. Six trials were conducted using different rates of inoculation, with results varying considerably.

WBD significantly reduced total yield in four of the six trials. The weight of diseased mushrooms ranged from 1 to 20 kg/m^2, further demonstrating the variability of this disease.

The effectiveness of the two *Bacillus* treatments was significantly lower than the chemical fungicides. The biological controls did not greatly reduce disease incidence, with efficacy estimated to be 20% or less. Even when disease incidence was quite low, the *Bacillus* failed to provide effective control. Sporgon was the most effective chemical fungicide, especially under high disease pressure. However, the efficacy of all fungicides declined significantly by the third flush.

The conclusions

Novikova and Titova suggested that *Bacillus* strains showed high efficacy against WBD, especially at the early stages of its development. However, their results are purely in-vitro.

In contrast, Navarro *et al.* expressed disappointment that the products failed to deliver in a more commercial setting, even when disease pressure was low. They conclude that the *Bacillus* products tested were ineffective against WBD at the doses and timing used.

Despite this, the authors state that chemical fungicides are increasingly unacceptable to consumers, so suggest that more studies are needed to search for alternative controls.

Figure 2. Inhibition of *M. perniciosa* development after colonies were sprayed with *B. subtilis* B-10 (above, left) or M-22 (above, right) compared to sterile water (left). From Novikova and Titova, 2023.