Powdery Mildew Spore Detection

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Spore trapping is a promising technology for the detection of airborne powdery mildew sporulation. Coupled with an understanding of how spores are spread, mildew "hot spots" can be managed more effectively. Initial work in this area makes it possible to identify the source of powdery mildew spores entering a vineyard and quantify overall powdery mildew pressure. This is an advance over other popular methods of estimating the incidence of powdery mildew infections.

Erysiphe necator: Asci full of ascospores erupting from a cleistothecium.

Popular methods: Visual Inspection and Disease Forecasting Models

1. Visual scouting during the season is difficult due the nature of early infections. The visual inspection of 1,000 leaves per acre is required to detect powdery mildew on leaves at an incidence level of 1% or lower (Mahaffee et al. 2014). To make matters worse, visual signs of the disease do not appear until well after infection has occurred. Scouting efforts can be more targeted by identifying the most diseased areas from the previous season. During the winter, scouts can find canes with mildew scars near the basal nodes. These will be the coming season's hot spots.

Once the typical grower finds infection in the field during the season, it has already progressed to the point of damage on leaves and shoots and has infected the tissue that will become next year's shoots. In addition, rapidly growing shoots and laterals provide susceptible host tissue for infection between fungicide applications.

2. Disease forecasting models also have their limitations. Areas that were heavily infected the previous season are the primary source of this year's powdery mildew inoculum. The severity of a powdery mildew epidemic is heavily influenced by factors at the vine level such as microclimate, canopy structure, and topography (Mahaffee 2014). Disease forecasting models cannot take those factors into account.

New Method: Molecular Spore Detection

The advantage of **molecular spore detection** is that powdery mildew spores are physically collected in impaction traps using grease coated stainless steel rods. That material is then processed using a type of PCR technology to identify the presence of the spores based on the unique DNA of the pathogen. The construction of a spore trap is relatively simple. A solar panel charges a battery that powers a small motor to spin the trap. The trap itself is a rod covered in grease to catch the spores. The material from the rod is analyzed. The results are easy to interpret visually based on the amount of precipitate in a vial after processing (Mahaffee 2014).

The primary **obstacle to implementation** of this technology is the cost of collecting, shipping and analyzing samples. There is at least one company in California that can perform the analysis (Mahaffee et al. 2014). The economic limitation is the density of clients required to make the collection and processing of traps profitable (Mahaffee 2014). To make spore trapping more viable, researchers from USDA-Oregon, Ohio State University, UC Davis, and the University of Utah have developed a molecular technique utilizing a desktop instrument that growers can use to process spore trap samples themselves (Mahaffee 2014).

The Benefits

Research applying spore trapping technology in commercial vineyards in Oregon found the **number of fungicide sprays could be reduced** without sacrificing disease control. Delaying the first fungicide application until spore release was detected subsequently eliminated an average of 2.3 fungicide applications per year across

43 commercial sites over a five-year period (Mahaffee 2014). Growers in the study brought more acres under spore detection-based management over the course of the study. In one case, a grower placed a single trap in a 100 acre block to use for fungicide decisions based on spore detection (Mahaffee 2014).

In another region protection under high powdery mildew pressure was improved. During a high mildew pressure year in Carneros, California, decisions about spray timings, tractor speed, cultural practices, and materials based on spore detection improved powdery mildew control over previous years.

Finding Disease Populations Resistant to FRAC 11 (QoIs)

Most growers on the Central Coast start fungicide applications at bud break and continue until véraison, rotating chemistries and sticking to the minimum spray intervals. In many cases, this is still not enough to provide 100% prevention. Even with a vigilant rotation of chemistries, it is possible the powdery mildew population in any particular vineyard has become resistant to one of those chemistries. The implication is that the applications of those chemistries during the spray schedule are ineffective and leave a window of 14 days or more without protection.

Captured spores have **been identified as resistant to quinone outside inhibitors** (QoIs, FRAC code 11, example trifloxystrobin) by isolating a mutation in a single gene (Miles et al. 2012). **Current research has shown QoI resistance to be widespread in parts of California and Oregon using these molecular techniques.** This means at least a portion of the fungicides being applied are having little to no effect on powdery mildew (Yamagata et al., 2016). In the future, it should be possible to incorporate this test into the previously developed detection assays on captured vineyard spores and test them for resistance to QoIs. If resistance is found those materials can be removed from the fungicide rotation and powdery mildew control will improve. With funding and research genetic markers for other types of resistance such as demethylation inhibitor fungicides (FRAC code 3, example tebuconaloze) and succinate dehydrogenase inhibitors (FRAC code 7, example boscalid) can be found. When researchers succeed in making this technology affordable, we will be entering a new era of powdery mildew management.

Spore Dispersion Modeling

Another component of spore detection research is **spore dispersion.** Computer models of spore dispersion show that spores travel farthest when the prevailing winds are neither parallel to nor perpendicular to row direction (Mahaffee et al. 2014). Row spacing also has an effect as more spores fall on the ground with wider row spacings. The turbulence created by **the wind hitting the row at an angle distributes the spores higher into the air** allowing them to travel a greater distance. This also increases the difficulty of treating a "hot spot" since the inoculum is not spreading down the row or across neighboring rows in a small, tight pattern. Researchers are developing software that can run on a laptop or a smart phone to allow **growers to model the dispersion patterns** in their own vineyards.

New Tool in the IPM Toolbox

Spore trapping used for spore detection and fungicide resistance testing shows tremendous promise. It is a way of knowing what is happening, when it is happening. As we enter a phase of vineyard redevelopment on the Central Coast there may be new opportunities in the war against powdery mildew. Through design decisions such as row orientation, row spacing, and trellising, powdery mildew pressure and spread can be reduced. Combined with spore detection technology, the use of fungicides can be more efficient with improved control.

References

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