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What the mildew? A perspective on another challenging year managing powdery mildew

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There has been a lot of talk this season about powdery mildew pressure that has been difficult to manage. It might be easy to write off mildew management problems to fungicide resistance, since both FRAC 3 (DMI) and FRAC 11 (strobulorins) resistance have been found to occur at a high frequency in isolates of *E. necator* (powdery mildew pathogen) from Oregon, Washington, and California. However, the occurrence of resistance is not always directly correlated to loss of field control. There are fields with severe disease pressure where we did not find fungicide resistance and low disease levels in fields using FRAC 3 and FRAC11 fungicides with resistance.

There are a multitude of factors that go into managing powdery mildew, and a miscalculation in any one of them can result in a mildew epidemic that is difficult to manage. Even if you have fungicide resistant isolates, they may not be the main cause of a mildew outbreak.

Fungicide application interval is often the cause of run-away powdery mildew epidemics. Folks say I was on a "X day" application interval so there is no way that interval was the cause. However, days between applications is not what manages an epidemic. Epidemics are a function of the time susceptible plant tissue is left unprotected and the amount of inoculum deposited onto it. Thus, in a season like this one, with rapid shoot growth, a significant portion of tissue could be unprotected or minimally protected, for example, when a young leaf receives sulfur and then triples in size in the next few days. Even systemic fungicides can be diluted by rapid plant growth. Even short periods of inadequate fungicide coverage could be long enough for disease to get a foothold because we do not have eradicative fungicide options. I do not know of data showing a product will eradicate established mildew colonies other than time. This inoculum source will be a constant frustration and require shorter intervals than you might think.

Long application intervals in the spring are usually fine because the typical cool and overcast spring weather in the Pacific Northwest slows plant growth and is less favorable to disease development with a new generation every 15 to 21 days. However, the same conditions that are conducive for rapid plant growth also favor rapid fungal growth and spore production with as few as five days between generations. If you see more than two or three nodes added to shoots or laterals, it is time to get the sprayer back out for another round.

Fungicide selection is another potential reason for disease control failure. Oils are popular and have their place in a management program; however, they do not offer prolonged protection from infections. I have not seen any data that convinces me they are eradicants. Instead, I consider them as "knock-down" products that can delay sporulation and growth for a few days but do not kill sporulating colonies or give suitable protection against new infections after application. Oils are best mixed with a protectant, particularly if using them back-to-back in the early spring. Growers must also consider how oils affect the ability to alter a spray program. If it's necessary to wait 14 days before following with a sulfur application; is there enough management flexibility to react to rapid shoot growth that can occur in warm spring?

Now to consider sprayer calibration and coverage. These are two different concepts. Spray calibration is essentially the volume of spray material from each nozzle. It is relatively easy to measure but it only predicts the potential of how much fungicide will land on the leaf. How much is actually getting there is a far more difficult measurement and is a function of tractor speed, droplet size and velocity, leaf area in the canopy, and nozzle orientation. The slower the tractor speed the better coverage; even without changing the gallons per acre. Droplet size is a function of nozzle traits and pressure that changes as the nozzle wears – droplets get larger as the nozzle orifice enlarges due to abrasion caused by high pressure water with particles (e.g. sulfur, wettable powders) flowing through it. Bigger droplets bounce more often from plant surfaces which results in a lot of wasted fungicide on the ground. Smaller droplet sizes can dry up before hitting the leaf and float away with the air currents – especially if spraying every other row. It is a good idea to use spray cards every application to check coverage of the targets you are most concerned about – fruit and leaves deep in the canopy. Put cards on the sides of clusters and underside of leaves because most mildew is found on the underside of leaves in the spring. You might be surprised by how little coverage you get.

An improperly calibrated sprayer is throwing money away. Let's do some math. Conservatively, assume a sprayer is overspraying by 1 gal/A after every 100 acres treated and seven applications to 50 acres are made per season. That means you will be losing 3 gallons/A at the last application or 150 gallons over 50 acres. That is 3 acres of an application and 4 hours of time. These numbers do not account for the reduction in coverage or disease control.

Now let's talk about coverage, i.e. getting droplets to both sides of the leaves and around all the berries. Some will say that they are only concerned about the fruiting zone, since this is what will be harvested. However, the odds do not bode well for this approach. Optimistically assume that 95% coverage from a fungicide application resulting in a one in million chance a spore will land on an unprotected surface. Further assume on May 15th there are 53 leaves per foot of row (leaf area index ~0.5) with 1% of the leaves infected with a single 0.25 in^2 mildew colony that can produce 10,000 spores a day. This means that every day on a 100 foot row you will have 53 new infections occurring with the inoculum load compounding every 5 to 10 days. There are going to be millions of spores a day bombarding the fruit once fruit set arrives. The odds are just not in our favor.

Common coverage issues include: 1) suckers that are almost completely missed by the sprayer; 2) shoots well above the top wire or draping over sprayers such that little deposition of fungicide occurs to the shoot tips; 3) too little air or spray velocity, or turbulence so that only the outer leaves are covered and insufficient spray material reaches the underside of leaves or the clusters; 4) spray volumes that are too small for the leaf area present; 5) spray floating to the sky because nozzles are not pointing at the canopy; 6) uneven canopy growth with sprayer nozzles aimed for the average, leaving a fair bit of tissue unprotected. All of these can result in an epidemic that is harder to control and may appear like fungicide resistance. It also will speed the development of fungicide resistance since mildew will be exposed to less than optimal doses.

Many growers wondered why the epidemic roared on despite the high temperatures this season. Isn't mildew supposed to be killed by temperature above 95°F? The effect of temperature is at the scale of the fungus. Think of a spore as the Goodyear Blimp and a leaf as the Willamette Valley. There is a wide range of microclimates where the blimp can land. This year there was ample soil moisture, resulting in vigorous shoot growth. This resulted in a lot of shaded leaves and plenty of water for evaporative cooling at the leaf surface due to transpiration. In other words, there was a lot of leaf area that did not see temperatures above 95°F. Also, high vigor means more hedging and more lateral development, making denser canopies that reduce spray coverage and more young succulent tissue for infection. The odds really are not in our favor.

One last consideration, leaf removal is a great way to increase spray coverage of the fruit and reduce disease development. It can be done before bloom without impacting fruit quality. However, opening up the canopy can also help mildew spores get to the clusters so you need to make sure they are protected. Apply fungicide right after leaf removal, and not just before it.

As an industry, we need to become far more communicative about the disease pressure in each block. The wind does not discriminate; it moves spores whereever it blows, and to some distance. As vineyards get closer together and more continuous, your neighbors problems become your problems and your problems become theirs. Most growers are confident they can manage high disease pressure if they know it is there. However, it far more difficult to manage high disease pressure when blindsided. Talk with neighbors and share how things are going, and it will go a long way to helping manage powdery mildew within a region. Everyone will benefit. The best managers have blocks that get away from them for whatever reason – labor shortage, tractor or sprayer breakdowns. There is no shame in it, but not informing neighbors of the potential for higher disease pressure could make management for you and them much more difficult – spores blow both ways. You should also consider coordinating fungicide rotation with neighbors so that there is not continuous exposure to the same fungicide group among vineyards.

If you are concerned about fungicide resistance, please send us plant material (3420 NW Orchard Avenue Corvallis, OR 97330) or drop us an email (walt.mahaffee@ars.usda.gov). We have a rapid (2-3 days from receipt of a sample) molecular assay to test for FRAC 11 resistance. All other fungicides require time-consuming bioassays. Unfortunately, we have limited capacity to conduct bioassays and will only be able to examine a subset of samples sent to us. If sending samples, please provide spray records for 2016 and 2017 with your sample. We will select which samples get processed in bioassays.