Pulsed Water Mists for Suppression of Strawberry Powdery Mildew

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- Misting can suppress powdery mildew without elevating the risk of other pathogens
- Misting for 1 minute four times a day resulted in powdery mildew suppression comparable to commercial fungicide applications
- Daily, weekly, or twice-weekly mist applications reduced the incidence of powdery mildew by up to 65%

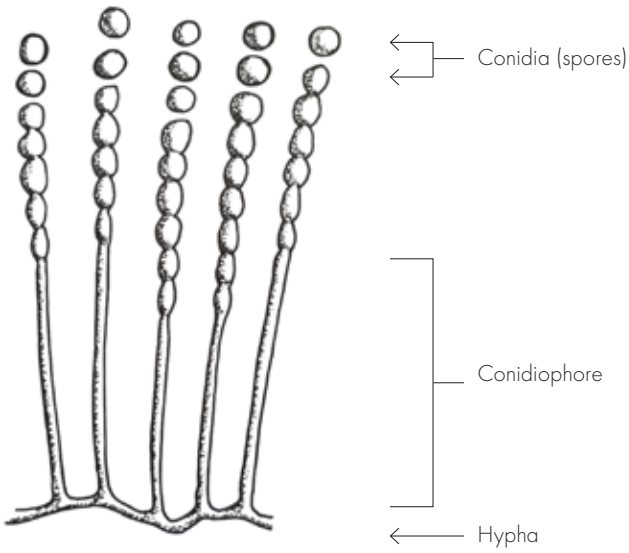

Figure 1. (L) Microscopic view of powdery mildew on a leaf, and (R) diagram showing the structure of strawberry powdery mildew *(Podosphaera aphanis)*. Photo credit: (L) Paul Bachi, University of Kentucky Research and Education Center, Bugwood.org, (R) Helen Newman

Could something as simple as water help control powdery mildew?

Many powdery mildews thrive in humid environments but free water films on plant surfaces can inhibit some species, including strawberry powdery mildew (*Podosphaera aphanis*).

The Research Council of Norway, the Norwegian Agriculture Agency, and the USDA funded research investigating how water droplets or films suppress strawberry powdery mildew and how this might be practically applied in commercial production systems. This article summarises the findings of the research.

How water interacts with powdery mildew

Laboratory and simulated rainfall trials investigated how water droplets and films impact powdery mildew colonies.

In the laboratory, water droplets applied to strawberry leaves were seen to collect powdery mildew spores (conidia) as they travelled across the leaf surface. Spores are highly hydrophobic and can be seen accumulating in groups on the surface of water droplets (Figure 2).

Figure 2. Water droplet rolling over a strawberry leaf with powdery mildew spores seen attaching to its surface
Photo credit: Belachew Asalf

Strawberry leaves are self-cleaning. Their waxy cuticle allows dust and other loosely attached particles to be washed off with water. Droplets of water that fall on a strawberry leaf bead together into larger droplets that roll over the surface and collect various particles and fungal spores before falling to the ground. This self-cleaning effect of leaves is known as the "Lotus effect".

Water applied in simulated rainfall trials also readily removed powdery mildew spores. Rainfall was simulated over four days in wind tunnels with a single 20-second pulse that applied 0.3mm each day. Of the total spores removed by the simulated rain, 65% were removed on the first day, 19% were removed on the second day, 11% on the third day, and 5% on the fourth.

Under the microscope, it was evident that not only were spores removed by the simulated rainfall, but after the first 20-second pulse (0.3mm) of simulated rainfall, conidiophores and hyphae were damaged (Figure 3).

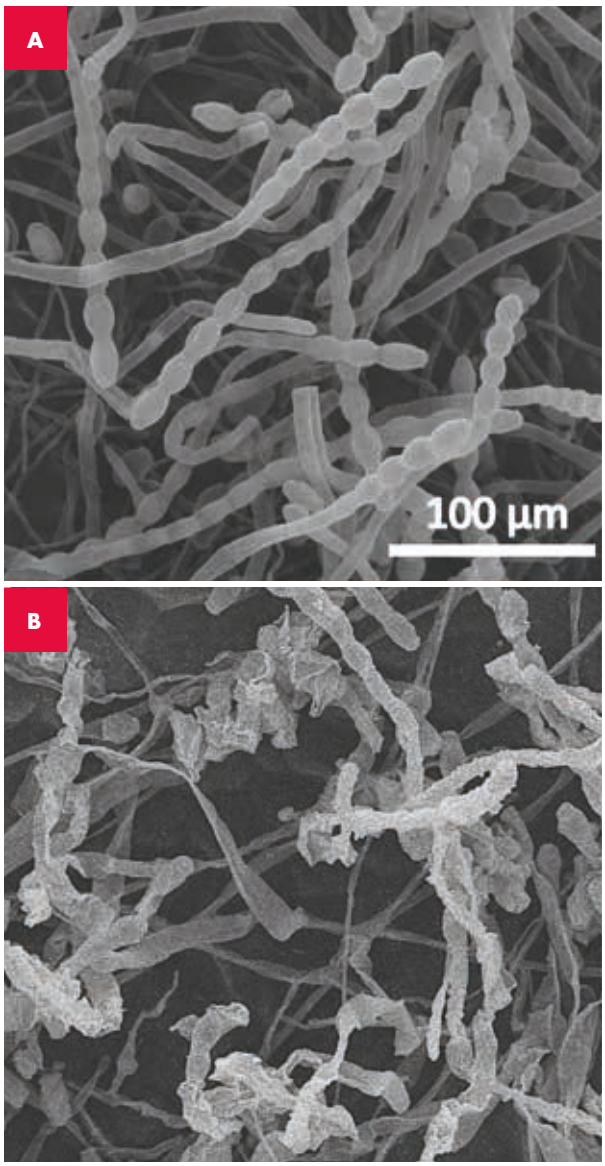

Figure 3. Scanning electron micrograph of powdery mildew (A) before, and (B) after exposure to a 20-second pulse of simulated rain (53 mm/h).
Photo credit: David Gadoury

Field experiments

Field experiments were conducted to see if low-volume pulses of water mist could be used in commercial settings to inhibit powdery mildew without causing negative impacts.

Pulsed mist under high tunnels (Norway)

Cultivar: *Korona*

Environment:
Ventilated high plastic tunnels. Plants were grown in the ground with a straw mulch layer over the soil. (Figure 4)

Treatments:

- Pulsed water mist applied daily at 11 am, 12.30pm, 2 pm, and 3.30pm for 1 minute
- Weekly applications of sulfur
- Alternate weekly fungicide treatments applied to run-off (approximately 1000 L/ha)
- Twice weekly water application using the same method and water rates as the fungicides

Figure 4. AK Palaplast, Stable Special Sprayers Green (modified to reduce spray diameter and flow rates 540ml/minute) in plastic high tunnel experiments in Norway.
Photo credit: Belachew Asalf

Field experiments

Pulsed mist under high tunnels and in open fields (Florida)

Cultivar: Sensation Florida 127

Environment:
Plants were grown in raised beds covered with plastic mulch under two different growing environments: high tunnels and open fields. (Figure 5)

Treatments:

- Pulsed water mist applied daily at 6am, 8am, 10am, and 12pm for 1 minute
- Pulsed water mist applied daily at 6am for 1 minute
- Pulsed water mist applied weekly at 6am for 1 minute
- Standard (calendar-based) fungicide treatment

Figure 5. MaxiJet Inc. Max-Cone Down Fan MAU36D1 spray jets (660ml/minute) in Florida experiments (A) plastic high tunnels, and (B) open field. Photo credit: Rodrigo Onofre

Field experiments

Greenhouse experiments with pulsed mist and UVB (Norway)

Cultivar: Korona

Environment: Greenhouse with a constant temperature of 20°C and Relative Humidity (RH) of 80%. Plants received 18 hours of natural sunlight and 6 hours of darkness each day. Daylight was supplemented if radiation was below 200 W/m^2. Plants were grown in peat-based substrate.

Treatments:

- Pulsed water mist treatments applied daily at 2pm for 1 minute
- UVB light (3.6 ± 0.2 W/m^2) daily for 4 minutes, 1 hour after sunset

Results

- All experiments showed that pulsed water mists can control powdery mildew
- Misting for 1 minute four times a day resulted in disease suppression comparable to commercial fungicide applications, suppressing powdery mildew by up to 92% compared to the untreated control
- Less frequent, daily, weekly, or twice-weekly, mist applications reduced the incidence of powdery mildew by up to 65% compared with the untreated control

Greenhouse experiments were a little more complicated. Powdery mildew was more severe on the upper leaf surface than on the underside of the leaf in greenhouse plants.

A single 1-minute application of water every day in a greenhouse with high disease pressure reduced powdery mildew severity on the upper leaf surface but did not control powdery mildew sufficiently on the underside of the leaf.

The UVB treatment significantly reduced powdery mildew on both sides of the leaves (Figure 6).

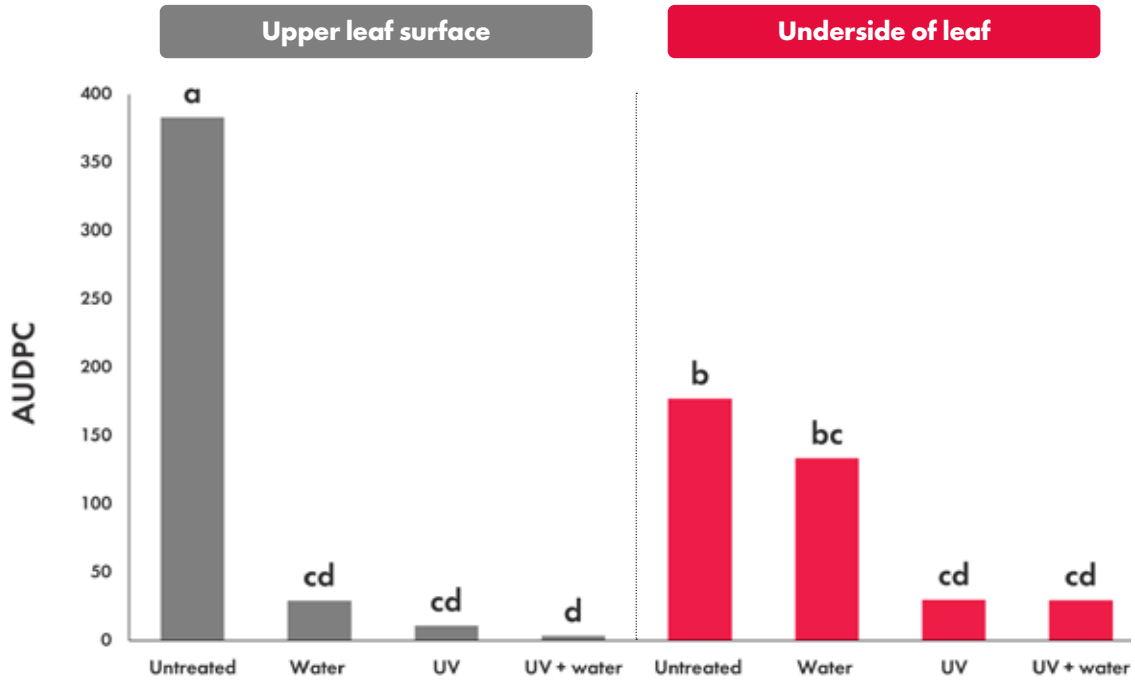

Figure 6. Effect of treatments in greenhouse experiments on the upper leaf surface compared to the underside of the leaf. AUDPC is a measure of disease progression.

What about Botrytis?

In the first year of the experiment in the high tunnel in Norway, there was a slight increase in Grey mould (*Botrytis cinerea*) on the fruit in the treatments with 1-minute water misting four times per day.

The increase was not statistically significant compared with the untreated control and did not occur in the second year of the experiment. There was no increase in Botrytis, or any other disease favoured by moist conditions, in any of the other experiments.

Rapid drying of the pulsed mist is essential to the success of this treatment, particularly on fruiting crops. Night-time applications of mist and applications under moist conditions should be avoided.

In the experiments, water droplets normally rolled off the leaves and residual moisture was generally dry within 30 minutes of the midday water applications.

Evaporation of residual water will depend on the weather conditions and density of the canopy. Sensors or weather forecasting tools may be needed to support decision-making.

Conclusion

Misting has been shown to provide a commercially relevant degree of suppression of powdery mildew without elevating the risk of other pathogens.

If used cautiously and systematically, pulsed misting of water on strawberry plants could help manage powdery mildew in glasshouse, high-tunnel, and possibly also field production systems and strawberry nurseries.

Where water supplies or equipment are limiting, mist applications could be used strategically (less frequently), using application methods other than sprinklers, as part of an integrated approach to powdery mildew management.

Please refer to the original article by Asalf et al. 2021 for full details of the experiments or contact the corresponding author Belachew Asalf: belachew.asalf.tadesse@nibio.no

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