Abstract
As part of our ongoing work to study the mechanisms of fungal epidemiology in vineyards, the investigation of the transport physics of fungal spores has led to the development of new equipment and methodologies for use in performing and analyzing particle plume experiments. Although these techniques have been used specifically for spore and microsphere transport experiments, they could be tapped for use in a variety of different studies both in vineyards and in other canopy types. Between the years of 2009 and 2014, five field campaigns were performed by our team in commercial vineyards in Oregon’s Willamette Valley. Over the course of those years, many ideas on how to disperse, collect, quantify, and analyze the microspheres used to study plume dispersion in the vineyard were tried and developed. This included the design of new equipment, the novel use of existing technologies, the improvement of ideas utilized by others, and the incremental improvement of all of these from year to year as campaigns continued. Among the methodologies was the use of inert, fluorescent microspheres as a fungal spore analog. The invention of simple rotating-arm impaction trapezoids mounted on low profile aluminum masts that were deployed in large arrays, and the use of a FluoSens microscope with specific excitation filters and imaging software for use in quantifying the microsphere concentrations. The impaction trap arrays and an array of microsphere release devices were operated using a wireless network, thus allowing for real-time monitoring and simple deployment. This also allowed for independent control for plumes emitted in different directions based on the wind direction. These techniques have enabled for incredibly detailed research into particle plume dynamics in a vineyard.

Microscopic Sampling

- Rotating Rod Impaction Traps [1,4]
  - 5VDC pancake motor: 2500 RPM
  - Cross-arm with a 4.3 cm radius
  - Rods coated in vacuum grease: applied via hexane bath
  - 5 traps mounted to towers:
    - 80/20 Aluminum T-channel
    - Highest arm raised via cord & pulley

- 42 tower arranged in arrays
  - N winds, 22 used in 2013-14, 20 used in 2011 [1,5]
  - W winds, 23 used in 2013-14 [3]
  - Dual N, 42 used. 23 at north array, 20 at south array on other side of hill crest [2014]
  - LongN = 25 used in 2013 [A]

- Impaction traps, release devices controlled remotely
  - Xbee controller on each
  - Wireless modem used to send commands to Xbees
  - Independent control of groups of trap towers and release devices

Meteorological Equipment

- Meteorological & energy budget data
  - 10m tower
  - 6 Sonic Anemometers
  - Other sensors (radiation, soil, leaf)
- Low Energy Measurement Stations (LEMS) [6]
  - Anemometer, Temp., Pressure, Humidity, Total radiation, Surface Temp
  - 2 & 14 used in 2013 & 2014
- High resolution temperature gradients
  - Fine-wire TGCs: CSATs + Rake
  - Distributed Temperature Sensor
  - 6 x 1 m resolution down 1 row

Sample Collection & Processing

- White rods in 2010-13, switched to black for improved imaging in 2014
- Rods color coded by height
- Rods hand collected onto plates labeled for tower & event
- Labeled plates examined with a stereo microscope
- Each microsphere color identified with excitation and lens filters
- Microspheres hand counted thus far very time consuming
- Automated counting being developed

Finalized Techniques & Future Developments

- Microspheres suspended in Ethanol emitted from ultrasonic nozzles
- Collected by inexpensive but effective impaction traps
- Use dark colored rod substrates with thin film of grease
- Automatic particle counting in microscope using image processing techniques

Field Sites Used

- Wildood Vineyard, Monmouth
  - Flat site used in 2010-2013
  - 14° 49’ 28” N, 122° 14’ 15” W
  - N-to-S rows spaced at 2.45 m
  - Canopy height, h = 2.00-2.15 m
- Lone Star Vineyard, Amity
  - Complex site used in 2014
  - 45° 4’ 8” N, 123° 5’ 48” W
  - Row spacings, 1/2-2.45 m
  - Canopy heights, h = 1.78-2.0 m

References


[1] The other poster by the same authors at this conference.

Acknowledgements

- NSF Grant: AGS 1255662
- USDA Project: 5358-22000-039-00D

32nd Conference on Agricultural & Forest Meteorology, 22nd Symposium on Boundary Layers & Turbulence, SLC UT, June 2016
NMiller@Eng.Utah.Edu

Methodologies for Particle Dispersion Experiments in Plant Canopies
*University of Utah, SLC, UT **USDA-ARS, Corvallis, OR

Plant Particle Releases
Inert fluorescing polyethylene microspheres [1]:
- Cospheric Inc.
  - 4 separate colors used
  - 10-45 μm diameters → mean ± 35 μm
- Ultrasonic Nozzles: Sonera Inc. (2013-14) [3]
  - Spheres suspended in a 0.05% v/v Tween 20 solution at 0.5 g/ml
  - Suspension in ethan oil with continuous stirring will be used in 2016
- Sonic Pump: Harvard Apparatus
- Simultaneous releases from multiple heights
  - Devices held using 3-finger clamps
  - 2-3 heights from fruiting wire to h

Figure 1: Diameter distributions of the different colors of microspheres

Figure 2: The 4 colors of microspheres from Cospheric LLC

Figure 3: The release devices and the syringe pump used with the ultrasonic nozzles

Figure 4: Rotating rod impaction trap

Figure 5: Tower of rotating rod impaction traps in the vineyard

Figure 7: The TC rake & 2 LEMS deployed in the vineyard with anemometers above & below h (2014)

Figure 8: Meteorological tower in the vineyard

Figure 9: SQ110, CNRI, & LI200

Figure 10: Rods collected onto their respective labeled plates

Figure 11: Illuminated microspheres under the stereoscopic microscope

Figure 12: Google Earth images of the 2 vineyards. Tower location marked in Wildwood (2011). Tower & LEMS locations marked in Lone Star.