PLANT DISEASE

RESEARCH

INVESTIGATORS: S. Annis, G. Kornelis, J. D'Appollonio
5. TITLE: Improving Control of Mummy Berry

OBJECTIVE(S)

Improve control of mummy berry, caused by *Monilinia vaccinii-corymbosi* (MVC) and Botrytis blight, caused by *Botrytis cinerea*, through research and the deployment and operation of a disease forecasting system using weather stations.

- Provide growers with forecast reports for control of MVC and Botrytis.
- Evaluate the timing of fungicide applications and control of mummy berry symptoms.
- Test the efficacy of new materials, particularly lower risk and organic materials, for their control of mummy berry symptoms.
- Determine the timing of ascospore release for MVC and the effect of weather conditions on spore levels.
- Examine the genetic diversity of MVC populations from wild blueberry fields under different management strategies and in different regions of Maine.

LOCATION(S): Wild blueberry fields in Waldo, Knox, Lincoln, Hancock, Washington counties, and University of Maine, Orono, ME
PROJECT TIMEFRAME: January to December 2019 report of multiple year project

INTRODUCTION

Mummy berry is potentially the most damaging disease on wild blueberries, and there is an IPM program in place providing effective control of mummy berry. There are some gaps in our knowledge of *Monilinia vaccinii-corymbosi* (MVC), causal agent of mummy berry, that affects its control. Disease control could benefit from data on when spores are released which, along with information on the weather conditions that affect infection, could better inform growers on timing of fungicide applications for control. More growers are starting to rotate their fungicides to control this disease, but there are still only a few fungicides that are commonly used for control. One of the interesting management techniques being considered by growers is switching isolated fields from being split as half prune and half crop to being all on one crop cycle. The expectation is that this will interrupt the life cycle of pests, including mummy berry, that only attack the crop year plants, but this has not been evaluated. Knowing the reproductive strategies and population structure of the fungus can provide information on the potential for fungicide resistance and how well management changes may affect the population.

METHODS

<u>Weather Stations</u>

From mid-April in 2019, fifteen weather stations, connected to the internet via cellular modems, were deployed in blueberry growers' fields around Maine from Waldoboro, Lincoln County to Crawford, northern Washington County (Figure 1). Each weather station measured air temperature and leaf wetness at approximately 4" off the ground, soil temperature at 1" below the surface, and soil moisture at 1" to 5" below the surface where most of the blueberry roots are located. Thirteen locations had MVC mummy berry (pseudosclerotia) plots which were checked by growers during April and May.

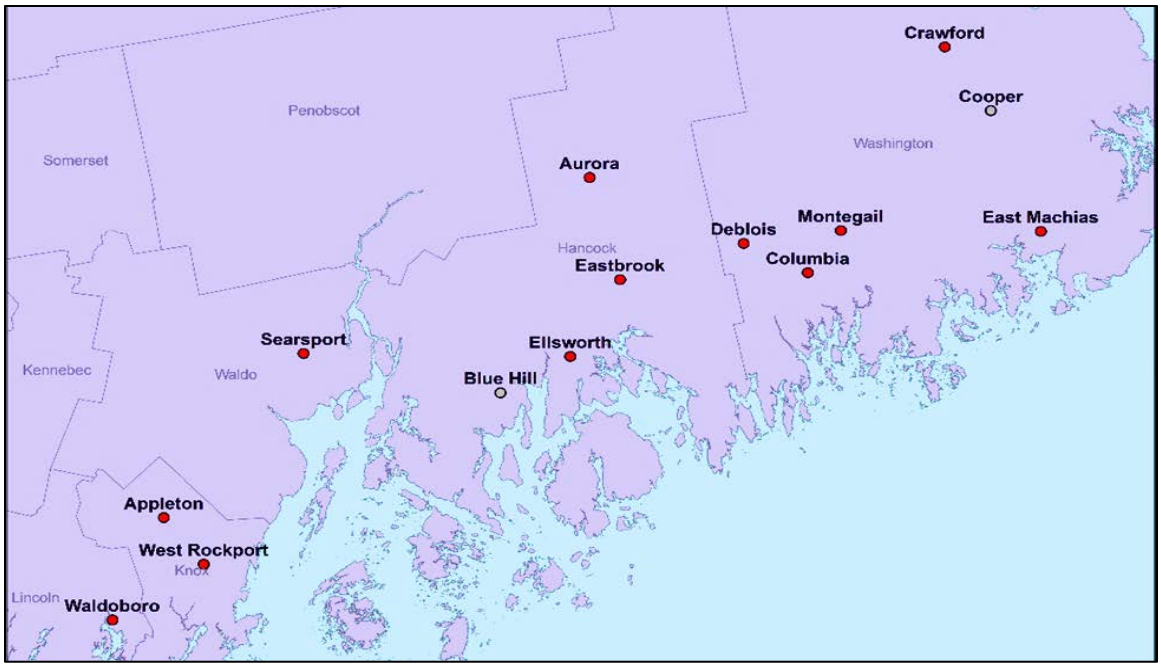

Figure 1. Locations of weather stations and mummy berry plots for 2019. Sites with red markers had a mummy berry plot; sites with gray markers did not.

All fields with weather stations were rated for mummy berry between May 28th and June 10th, 2019. Four 30-m transect ropes with 30 evenly spaced marks were randomly placed in the field around the weather station. The stem closest to each mark on the rope was rated for mummy berry and Botrytis symptoms and the presence or absence of each disease was noted. Stems with top kill, frost, tip midge and red leaf were also recorded.

Fungicide Efficacy Trials

Field trials were set up in a wild blueberry field near Deblois, Washington Co., Maine with a history of mummy berry. The plots were set up in a complete randomized block design with ten fungicide treatments (Table 1) and replicated in each of eight blocks. Fungicide applications were timed using the Mummy Berry disease forecast according to locally monitored conditions of fungal and plant development and weather conditions favoring disease development. More information about the Mummy Berry forecast method can be found in UMaine Cooperative Extension Bulletin #217 and the forecasts for 2019 are available at https://extension.umaine.edu/blueberries/forecast-blog/ . All fungicides were applied on May 2nd and 13th, 2019 except for one treatment which received only the first application of propiconazole on May 2nd. Check plots received no spray applications. A weather station was located within 3.5 miles of the test field.

Disease and frost ratings were made on June 7th, 2019. Ratings consisted of presence/absence of mummy berry symptoms, Botrytis, and frost on 60 blueberry stems in each plot. Phytotoxicity was also rated at the same time disease assessments were made. Blueberries were harvested on August 13th, 2019. Harvesting occurred in a 2-foot strip down each plot center with a mechanical harvester, and the fresh weight was measured. Data were analyzed by plot averages in SAS (Statistical Analysis Software - SAS Cary, NC).

Table 1. Fungicides tested in 2019 for control of mummy berry.

Treatment (Trade Names)	Material	Manufacturer	EPA Regist-ration Number	Application Rate (per acre)	Registration on Wild Blueberries
OSO SC	Polyoxin D zinc salt	Certis USA	68173-4	13 fl oz	Yes
Lifegard WG	Bacillus mycoides J	Certis USA	70051-119	4.5 oz	No
Kenja 400SC (and surfactant Dyne-Amic (0.25%v/v)	Isofetamid	SummitAgro (Helena Chemical company)	71512-22	15.5 fl oz	No
Omega 500F	Fluazinam	Syngenta	71512-1	20 fl oz	No
Inspire Super	Difenoconazole/ Cyprodinil	Syngenta	100-1317	20 fl oz	No
Miravis Duo	Difenoconazole/ Pydiflumetofen	Syngenta	100-1602	13.7 fl oz	Yes
Kphite 7LP	salts of phosphoric acid	Plant Food Systems	73806-1	96 fl oz	No
Propimax, 1st appl. Only	propiconazole	Dow Agrosciences	62719-346	6 fl oz	Yes
Propimax, Both	propiconazole	Dow Agrosciences	62719-346	6 fl oz	Yes

Timing of *Monilinia vaccinii-corymbosi* Ascospores

On April 26th, 2019, a spore trap was placed in a prune field at Blueberry Hill Research Farm (BBHF) in Jonesboro, ME. Another spore trap was placed in a crop field near Long Pond on May 8, and a third was placed in a prune field near Deblois on May 15th. The fields at BBHF and Deblois had weather stations. The number of *Monilinia* ascospores were counted under a microscope at hourly intervals from April 30th to May 23rd, 2019.

Genetic Diversity Among MVC Populations

Katie Ashley, MS Graduate student collected over 300 MVC isolates from 12 wild blueberry fields around Maine (Ashley and Annis, 2019). Each isolate was DNA fingerprinted with 10 microsatellite markers and the genetic diversity of populations of MVC were compared between different regions and management types.

RESULTS

Weather Stations

Monilinia apothecia were found in fields in Midcoast and Hancock starting April 24th and about May 1st in Washington county. In the Midcoast and Hancock, plants in most fields were delayed and plants did not have much susceptible bud tissue until another five to six days past when apothecia were present. In Washington county, apothecia were found at a similar time to when plants were susceptible. Apothecia were produced for about 2.5 to 3.5 weeks. Most wild blueberry growing regions experienced a long cold spring with delayed plant growth and a lot of rain early in April. Many growers were unable to get on their fields early or were unable to get onto their lower, wetter areas of their fields to apply fungicides. Some growers also did not apply fungicides due to costs. The level of inoculum in the field, local weather conditions and management treatments affected the level of disease seen in growers fields (Figure 2). In 2017, field 3 had high levels of mummy berry symptoms (approximately 90% of stems near the weather station). This field was transitioning to organic and had been mowed but not burned in the past. It was burn pruned and now in 2019 had approximately 32% disease.

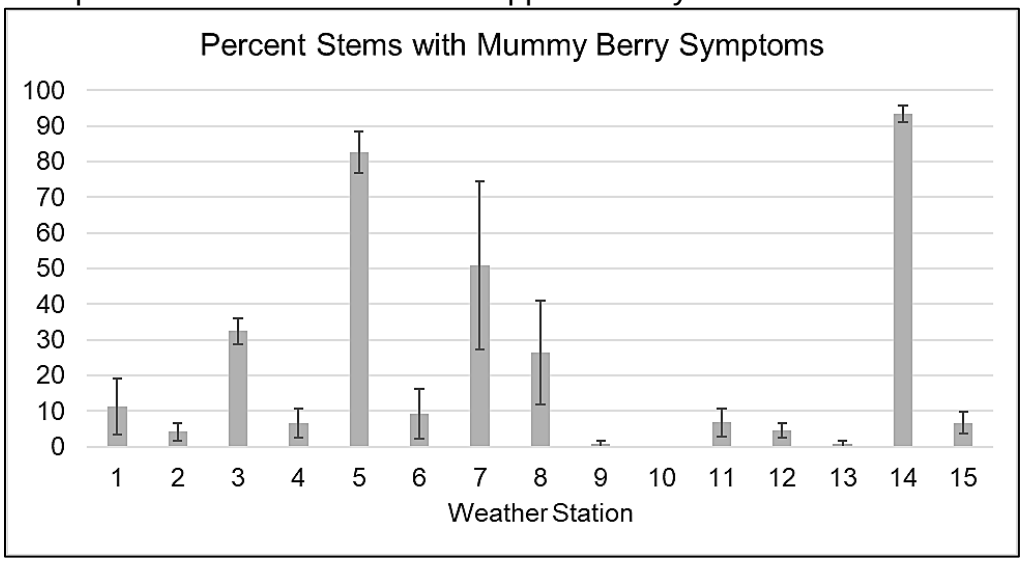

Figure 2. Percent of stems with mummy berry symptoms at weather stations.

Fungicide Efficacy Trial

There was a long, cold spring so development of plants and MVC were delayed until early May at our test site. Apothecia of MVC were present by April 28th in many fields but plants were not developed enough to have sufficient susceptible tissue for fungicide applications (Figure 3). The fungicide application on May 2nd was applied approximately two days before the first infection period when the plants had approximately 30 to 40% of flower buds at F2 (crown stage). A second fungicide application was applied on May 13th, and most MVC apothecia were dried up by May 20th.

There were low levels of mummy berry with only 10% of stems in the check showing disease. Plots treated with Omega 500F, Inspire Super, and Miravis Duo had significantly less mummy berry disease incidence than the untreated check. Other fungicides had lower levels of disease than the check but were not significantly different. Kenja 400SC

had similar levels of disease as two applications of Propimax, which was approximately a third of the disease in the control. OSO SC and Lifegard WG had approximately half the level of disease as the control and show promise as possible organic controls. No phytotoxicity was seen with any of the materials. No symptoms of Botrytis were also seen. There were no significant differences in the yield among the treatments.

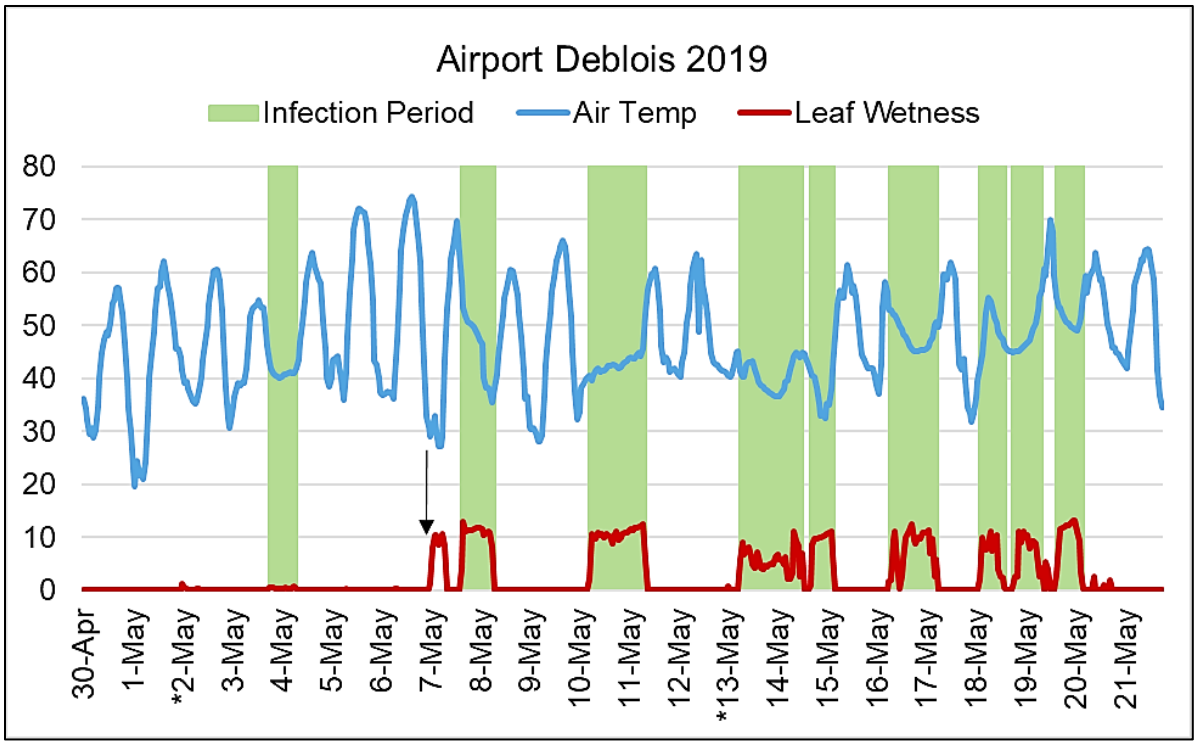

Figure 3. Infection periods at the Deblois site in 2019. Blue line is air temperature and red line is leaf wetness, which were used to determine infection periods (vertical bars) for *Monilinia vaccinii-corymbosi.* Arrow indicates overnight leaf wetness event that was too cold for infection to occur. Stars on dates indicate fungicide applications.

Timing of Ascospore Release

The spore trap at BBHF performed as expected, but the two other spore traps had breakdowns early in the season and only partial collections of ascospores were possible. Ascospores were found from April 30th to May 20th and peaks were seen from May 5th to May 19th. Peaks occurred during leaf wetness events which was not seen in 2018. MVC apothecia were not reported after May 19th, and spores seen from May 21st on are believed to be from another apothecial fungus. Most ascospores were released overnight and into early morning. Further research trying to match ascospore release patterns with weather and field conditions in continuing.

Genetic Diversity Among MVC Populations

MVC populations were found to be highly genetically diverse within a field. With the small sample sizes, no significant differences were found between different management of fields but there may be an effect of field manager. The fungus appears to be mostly out-crossing, but most fields have some self-fertilizing isolates.

CURRENT RECOMMENDATIONS AND DISCUSSION

A long, wet cool spring can result in high levels of mummy berry symptoms, but the effect of inoculum levels and timing of fungicide application need to be determined. Burn pruning can be effective at decreasing MVC inoculum and disease levels. From preliminary data, it appears that later season infection periods are as damaging as early season infection periods, but this needs to be repeated for more years. Ascospore release typically has been higher overnight and in the morning, but this may be affected by weather conditions that are still being evaluated. There is a high level of genetic diversity of MVC within each field and most populations appear to be primarily outcrossing. The genetic diversity of MVC is probably affected by the genetic diversity found in wild blueberry populations. Specific management techniques were not found to affect genetic diversity in the current study, but this may be due to small numbers of fields. There may be some effect of field manager on MVC populations, but this is a minor effect compared to the diversity within fields. Some new fungicides, Omega 500F, Inspire Super, Miravis Duo, Kenja 400 SC, OSO SC and Lifegard WG, show promise in their efficacy as controls for mummy berry and will be tested again in 2020.

NEXT STEPS

- Compare timing of fungicide applications to weather conditions and mummy berry disease levels in growers fields in 2019.
- Compare timing of ascospore release in multiple fields to weather conditions and infection periods.
- Include frost alert and growing degree days in the forecast app.
- Examine the effect of plant stage on effectiveness of control of mummy berry.
- Determine the usefulness of pseudosclerotia models of germination under field conditions.
- Validate the simulation model of mummy berry to field data.
- Retest Omega 500F, Inspire Super, Miravis Duo, Kenja 400 SC, OSO SC and Lifegard WG for their efficacy of mummy berry control in 2020.

REFERENCES

K. Ashley and S.L. Annis 2019. Exploring the genetic structure of *Monilinia vaccinii-corymbosi*, the causal agent of mummy berry, in lowbush blueberry. Poster National Plant Diagnositic Network conference, April 15-19, 2019 Indianapolis, IN.