

**AGRICULTURAL RESEARCH FOUNDATION
INTERIM REPORT
FUNDING CYCLE 2020 – 2022**

TITLE: Powdery Mildew Risk Associated with Hemp Production in Western Oregon

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EXECUTIVE SUMMARY: Hemp belongs to the plant family, Cannabaceae, that is quite small in terms of the number of members; *Cannabis* (hemp, marijuana) and *Humulus* (hop) are the two economically important crops in this plant family. Although both hop and hemp can develop powdery mildew, the two fungi that incite powdery mildew on hemp and hop were thought to be uniquely pathogenic on their respective plant host, i.e. host specific and unable to infect the other plant species. The fungus, *Podosphaera macularis*, was first discovered on hops in Washington, Oregon, and Idaho during the late 1990s. During 2018 and 2019, greenhouse growers of hemp plants in western Oregon reported powdery mildew on leaves and buds of several hemp cultivars and the powdery mildew fungus was identified as *Golovinomyces ambrosiae*. Potted hop plants inoculated with *Golovinomyces*, however, appear immune to infection, so scientists speculate that hop is resistant to *Golovinomyces* in the field. Researchers in New York working with feral strains of *Podosphaera* found that when *P. macularis* was inoculated onto both detached leaves and 10-14 day old seedlings of three hemp varieties, the fungus infected ‘Anka’ and Wild Horse’ hemp varieties (Weldon et al. 2020) and when the two mating types of *P. macularis* were inoculated together on ‘Anka’ hemp seedlings, the pathogen was able to undergo sexual recombination and produce sexual spores on hemp plants. This mating type information is critical for the hop growers in the Pacific Northwest as only one of two required mating types (MAT1-1) is currently found here. A hemp field established on the OSU Botany Farm for a gray mold management study was found to be naturally-infected with *P. macularis* in 2020. A hemp field survey was conducted in western Oregon at three time points (shortly after transplanting, mid-season, and late-season right before harvest) to determine the incidence of powdery mildew. Powdery mildew was detected at 13 hemp field sites in Oregon on the final survey date. Both genera of powdery mildew fungi were detected in the hemp fields located in the Willamette Valley but *Golovinomyces ambrosiae* was the predominant species found. Only one mating type, MAT1-1, was been detected in the *P. macularis* strains found on hemp in Oregon during 2021.

OBJECTIVES: (1) Determine the prevalence and identity of powdery mildew fungal species that occur on hemp plants grown in western Oregon, and (2) evaluate the susceptibility of hemp lines for susceptibility to powdery mildew, and (3) communicate results to stakeholder partners to accelerate learning and maximize the impact of this project.

PROCEDURES: We surveyed hemp fields generally at three time points -- shortly after transplanting (June), midseason (mid to late July), and late season (mid-Sep to early-Oct). In each hemp field, we established two transects of 100 plants per transect and examined 10 leaves on each plant for the presence of powdery mildew. In the late season survey time point, the leaves remaining were generally those associated with bud development. When powdery mildew was found in the field, leaf samples were collected for obtaining the fungal tissue from eight different colonies for each affected field at each time of surveying. We extracted DNA from these powdery

mildew samples and conducted genetic typing with established procedures to determine the fungal species (*Golovinomyces* sp. and *P. macularis*) as well as genomic information (virulence genes) and the mating type of *P. macularis* samples.

SIGNIFICANT ACCOMPLISHMENTS TO DATE: Objective 1. During 2021, we surveyed more hemp fields than was first proposed and included sites not only in western Oregon, but also in southern Oregon and central Washington, where hops are also grown (Yakima Valley of WA). A total of 21 fields were surveyed in Oregon (Fig. 1) and 11 sites were surveyed in Washington.

Most sites were surveyed at the three time points and powdery mildew was not detected at any sites on the earliest survey date. By the mid-season sampling date, powdery mildew was detected in two hemp fields (OR-10 and OR-19) in the Willamette Valley. On the last survey date, powdery mildew was more widespread and disease was detected in 13 hemp fields (OR-1, OR-2, OR-4,

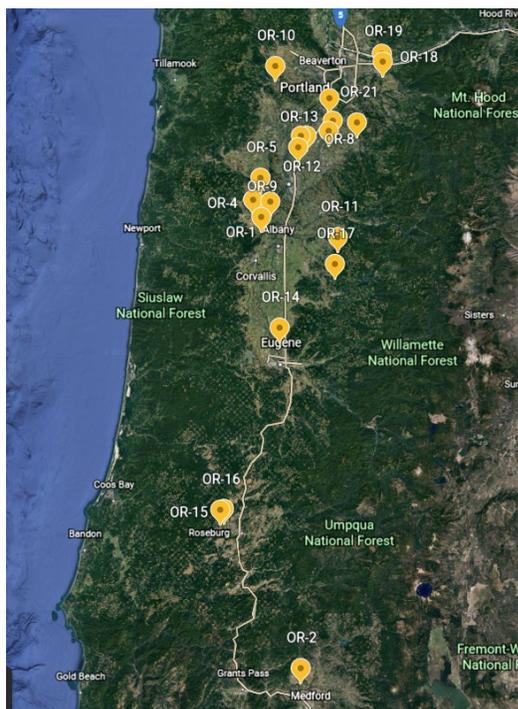


Figure 1. Hemp field sites in Oregon that were surveyed for powdery mildew in 2021.

OR-5, OR-6, OR-7, OR-8, OR-9, OR-10, OR-13, OR-15, OR-19, and OR-21). No powdery mildew was detected in any of the Washington hemp fields during the three survey dates but field infections were observed by growers in October and they provided samples of powdery mildew fungus for genomic testing.

All of the powdery mildew field samples contained *Golovinomyces ambrosiae* based on genomic typing, and several of the fields were found to also contain *P. macularis*, with the latter fungus making up 8.6% of the powdery mildew-positive samples collected. Genomic evaluations of the *P. macularis* samples collected during 2021 show that there are two known fungal populations represented; the population in the Willamette Valley contains the V6 gene (allowing the fungus to infect hop plants with resistance gene R6) while the population found in Yakima Valley in Washington was non-V6. Evaluation of the mating type of the *P. macularis* sample collection shows that only one mating type (MAT1-1) is currently occurring on hemp in the Pacific Northwest, consistent with the mating type known to occur on hop.

Objective 2. Powdery mildew spreader plants have been started in an OSU greenhouse section. Hop plants (variety Symphony) are infected with a population of *P. macularis* strains collected from hop and hemp plants (variety White CGB) infected with a *Golovinomyces ambrosiae* collected from a hemp field in 2021. Testing with the *P. macularis* strain has shown that this isolate is also pathogenic on hemp (variety White CGB). Plans are underway for recruiting interested breeders for participation in the OSU greenhouse screenings of hemp lines with both powdery mildew fungi.

Objective 3. Presentations have been made at two meetings to date:

- Wiseman, M. S., and Gent, D. H. 2022. Powdery mildew on hemp and the implications for hop. Washington Hop Industry Annual Meeting, January 5.

- Wiseman, M. S., and Gent, D. H. 2021. Powdery mildew associated with hemp production in the Pacific Northwest. Oregon Hop Commission. November 17.

Additional presentations are planned for hemp growers to occur this winter and meeting planning is underway. Updates have been made in the Pacific Northwest Plant Disease Management Handbook hemp disease sections for the 2022 edition that will be published this spring.

ADDITIONAL FUNDING RECEIVED DURING PROJECT TERM: We were successful to date with obtaining extramural funding (\$29,981 from the Western IPM program) as well as cooperative agreements with the USDA-ARS (\$94,357 from Oct 2021 through Sep 2023) and the Global Hemp Innovation Center (\$50,000 for 2022 federal cycle).

FUTURE FUNDING POSSIBILITIES: NIFA program areas such as Crop Protection and Pest management as well as regional program areas such as the Western IPM Center and the Washington State Special Crops Block Grant, etc.