Project title: Elucidating the implication of hydromulching hop beds

Project summary:
This project aims to improve our understanding of the cultural and economic feasibility of applying hydromulch on hop beds to improve the sustainability of hop production. Hydromulching is a technique that involves the application of a slurry mixture of water, mulch, and various additives to the soil surface. The hydromulch would be applied after hops have emerged from the ground and drip irrigation laid out. The study will investigate the effects of hydromulching hop beds on weed pressure, soil water retention, and soil temperature insulation. In addition, the project will investigate the influence of hydromulching on hop plant growth performance and secondary metabolite quality. This will involve monitoring parameters such as biomass, hop cone yield, and quality metrics such as oil content, alpha and beta acid content, and metabolomics analysis of the volatile compounds. The study's findings will contribute to the existing knowledge base surrounding hop cultivation techniques and provide insight to hop growers, agronomists, and other stakeholders involved in the brewing industry, enabling informed decisions regarding the adoption and implementation of hydromulching practices.

Proposal duration: Two years, 2024-2025 NEW PROPOSAL

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Amount requested: $11,000

Other funding sources and support:

USDA-ARS Hop Horticultural Program will support the project by purchasing a Hydromulch applicator ($5,000) and mulching products ($500). Additionally, the program's technician will contribute time (0.05 FTE) to the project.

Send funding to: Contact the project leader for details.

Project title: Elucidating the implication of hydromulching hop beds

Statement of problem: The forecast for air temperatures and water availability in the Pacific Northwest are expected to change significantly over the next few decades. A rise in atmospheric temperatures of nearly 2° F has already been observed in Washington State over the last 100 years and projections indicate an average temperature increase of 5.8° F in the Pacific Northwest by 2050 (Kunkel, K.E., et al., 2013; Mote, P.W. et al., 2013). Moreover, there has been a considerable decline of approximately 20 percent in the snowpack of the Western region over the past six decades, with Washington, Oregon, and Idaho experiencing a notable reduction in available water (Scott and Lindsey, 2022).

In the context of hop cultivation, weed management poses a significant challenge for growers, both in terms of labor and expenses, regardless of whether they employ chemical or mechanical approaches. Chemical weed management confronts emerging concerns regarding residue accumulation, product loss due to legislation, and herbicide resistance. On the other hand, mechanical weed control encounters challenges associated with disease transmission, which can negatively impact crop health.

Justification and importance of proposed research: Investigating the impact of hydromulching as a cultural management strategy for improving soil conditions and reducing weed pressure is of utmost importance due to the current lack of comprehensive studies on hop production, as well as looming higher air temperatures and drought. It is also critical that hydromulching is evaluated for its effects on yield and quality is of utmost importance due to the current lack of comprehensive studies in this area. While prior research has explored the effects of hydromulching in other crops, there remains a significant knowledge gap specific to hops. Understanding the potential influence of hydromulching on hop cultivation can provide valuable insights for hop growers and agronomists, enabling them to optimize their practices and make informed decisions.

Research conducted on crops with physiological characteristics similar to hops, such as grapes, has demonstrated the significance of air and soil temperatures in determining yield and quality performance. For instance, exposure of grapevine roots to temperatures above their optimal range has been shown to reduce primary root length and lateral root density, resulting in decreased exploration of soil volume and impaired water and nutrient uptake (Koevoets et al., 2016). Temperature has also been found to impact hormonal relations in plant roots, including cytokinins and abscisic acid (Walker and Winter, 2006; Field et al., 2020; Bernardo et al., 2021). Fluctuations in soil temperature have been shown to affect grapevine root morphology, influencing factors such as size, architecture, and overall functioning (Luo et al., 2020; Gavelienė et al., 2022).

In previous research, hydromulch applications were attributed to reducing the emergence of perennial weeds, suggesting that this technique could be used as a complementary non-chemical wee control method, reducing subsequent hand-weeding (Mas et al., 2021).

By bridging the existing research gap and examining the specific effects of hydromulching on hop yield, quality, and physiological responses, this proposed study will contribute to the

knowledge base surrounding hop cultivation techniques. The findings will provide crucial insights into the interplay between hydromulching, soil temperature, soil water retention, any observed changes in hop growth, secondary metabolite production, and overall plant health. This knowledge will be instrumental in guiding hop growers, agronomists, and stakeholders in the brewing industry, empowering them to make informed decisions regarding the adoption and implementation of hydromulching practices. Ultimately, this research will contribute to the optimization of hop cultivation techniques, ensuring sustainable production and enhancing the quality of hops used in brewing.

Objectives:

- Assess the impact of hydromulching hop beds on weed pressure, soil water retention, and soil temperature insolation performance.
- Evaluate hop yield and quality metrics.
- Determine the direct cost of hydromulching hop beds.

Procedures/Methods to accomplish objectives:

The study will be conducted on two-year old Cascade hops owned and managed by Wyckoff Farms, located in Prosser, WA. The site is irrigated using drip irrigation. The experiment design will be laid out in a complete randomized design and replicated six times. The data will be analyzed using JMP Pro v.15, utilizing a simple t-test to determine any statistical differences between the treatments.

The hydromulch applications, using paper hydraulic mulch plus a tackifier will be made using a consumer-grade hydromulch applicator. The application will be made after the field has been cultivated, pre-emergence chemical applied, and drip irrigation laid out. The hydromulch will be applied at a rate of 0.25 gallons per square foot, banded 1 ½ feet wide on each side of the row.

Irrigation will be scheduled to maintain the soil moisture between the soil's field capacity and 65% of the readily available water in the soil. Soil moisture and temperature data will be collected from probes installed between two healthy plants at depths of six and 12 inches below the surface. The probes will be scheduled to collect data on a 15-minute interval.

The plots will be managed using grower standards, making sure that plant performance is maximized from proper nutrition, weed and pest management, and training.

Objective 1. Assessing weed pressure will involve evaluating the density and species composition cultivated in each of the plots. This assessment will be conducted every two weeks during the season using visual scouting techniques. Soil water retention and soil temperature insulation will be evaluated using probes that simultaneously measure soil moisture and temperature. Soil moisture data will provide us with data that will reveal water consumption under hydromulch and bare soil from the change of soil moisture over time. Soil temperature will be processed to calculate the daily temperature fluctuation from the low and high temperature, as well as soil temperature growing degrees, which will provide us with insight into the overall temperature effect during the whole season.

Objective 2. The plots will be harvested after hop cones have reached a dry matter content between 20% and 25%. Hop cone total yield will be calculated from the total hop cone wet weight multiplied by the percent dry matter of a small dried sub-sample (≈2 lbs). Hop cone quality will be assessed by measuring alpha and beta acid content, and total oil content, as well as other metabolites such as flavonoids and polyphenols.

Objective 3. Direct cost will be determined by identifying the resources needed to make the hydromulch application. This could include machinery, labor, materials, and other inputs. Once the required resources have been identified, the nest step is to estimate the cost of each. This will involve researching market prices and contacting suppliers for quotes. Labor is often a significant part of the cost and thus will be added to the overall cost.

Outcomes: The overall outcome of this work will provide insight on the economic and cultural feasibility of using hydromulch to improve sustainability in hop production.

Objective 1: This work will offer valuable knowledge regarding the cultural viability of utilizing hydromulch as a means to reduce weed pressure in hop beds. Furthermore, it will provide understanding of the insulating properties of hydromulching, particularly in terms of its impact on minimizing soil maximum temperatures and enhancing minimum temperatures. Additionally, the research will investigate the influence of hydromulching on soil water evaporation and distribution characteristics.

Objective 2: This research endeavors will enhance our understanding of the effects of hydromulching on hop yield, specifically in relation to hop cone yield and secondary metabolites. Moreover, it will provide insights into the impact of regulating temperature extremes on the quality of hop cones, including their effects on polyphenol and flavonoid compounds.

Objective 3. This project will provide insight into the economic cost of adopting and implementing hydromulching in hop production.

Extension and Outreach Activities: The results will be shared with industry stakeholders via presentations during various industry gatherings, including the Annual American Hop Convention and HRC Summer Meetings. Additionally, upon concluding the study, the findings will be made available as a technical bulletin and submitted for publication as a manuscript.

See appendix A and B for "Time Frame for Objectives" and "Project Budget."

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Appendix A

Time Frame for Objectives:

FY2024

Jan-March

- Identified plots and randomly assigned treatments
- Ensure research site is clean

March-May

- Site is cultivated and pre-emergence herbicide applied
- Soil water content and temperature probes are installed and begin collecting data
- Hydrumulch application is made
- Begin collecting weed pressure observations

May-Oct

- Begin collecting dry matter content data
- Plots are harvested and yield data is collected
- Hop cones are kilned and samples analyzed by third-party lab

Oct-Dec

- PIs and collaborators meet to discuss observations and decide on direction

FY2025

Jan-March

- Results are presented at the annual American Hop Convention
- Identified plots and randomly assigned treatments
- Ensure plots are clean

March-May

- Site is cultivated and pre-emergence herbicide applied
- Soil water content and temperature probes are installed and begin collecting data
- Hydrumulch application is made
- Begin collecting weed pressure observations

May-Oct

- Begin collecting dry matter content data
- Plots are harvested and yield data is collected
- Hop cones are kilned and samples analyzed by third-party lab

Oct-Dec

- PIs and collaborators meet to discuss observations

FY2026

- Results are presented at the annual American Hop Convention
- Findings are submitted for publication as a manuscript

Appendix B

Project budget:

Expenditure	**FY2024**	**FY2025**
Temporary Student Employee[1]	$8,700	$9,000
Chemical analysis[2]	$1,500	$1,500
American Hop Convention registration fees	$800	$800
Total	$11,000	$11,300

[1]A temporary employee will be hired to aid in collecting data from the research site and help with harvest and other postharvest duties. We have estimated that we will need assistance for three months at a cost of $2,900 per month for a total cost of $8,700.

[2]Hop cone quality will be assessed by a third-party laboratory, who will assess for alpha and beta acid content, oil content, and oil metabolic analysis. For this service, we estimate a cost of $125 per sample for a total cost of $1500 for 12 samples.