**Hop Research Council 2021 Research RFP**

November 5, 2022.

**Project Title: Screening Post Emergence Herbicides for Basal Application in Hops**

**Project summary:** This proposal aims to develop new options for chemical weed control in hops. In 2023, we propose to work with four active ingredients that were identified as potentially suitable for hops based on crop tolerance, weed control spectrum, and reduced toxicity. The herbicides and respective sites-of-action WSSA group numbers were: tiafenacil (14), glufosinate (10), florpyrauxifen-benzyl (4), and the biological herbicide MBI-015. These compounds have known activity against crucial weed species that are problematic in hops, including, but not limited to: Canada thistle, field bindweed, Kochia, yellow nutsedge, and annual grasses. The findings of this study will support registrations and help identify new use patterns for the active ingredients being evaluated for registration.

**Proposed Duration:** Continuous work on weed management research in hops; this document is for the fourth year (2023).

**Project leader:**

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**Cooperators:** TBD

**Funds requested:**

**2023:** 34,600 ($30,000 +$*4,600\**) \* crop destruct funds paid directly to collaborating grower if needed.

**Other Funding Sources and Support:**

Washington Hops – We have requested an extension of this project scope into Washington State, although that request is not listed in this budget.

**Send Funds to:**

Agricultural Research Foundation, 1600 SW Western Blvd., Suite 320

Oregon State University, Corvallis, OR 97333.

Attn: Charlene Wilkinson; Phone (541) 737-3228 Email: Charlene.Wilkinson@oregonstate.edu

**Project Title:** Screening Post Emergence Herbicides for Basal Application in Hops

*Statement of Problem:*

Chemical weed management options in hop yards are restricted to a small group of herbicides. Few of these herbicides are effective in controlling problematic weeds like field bindweed (*Convolvulus arvensis*), Canada thistle (*Cirsium arvense*), yellow nutsedge (*Cyperus esculentus*), and kochia (*Bassia scoparia*). Additional herbicide options with different sites-of-action in hops would contribute mightily to better herbicide resistance management (Norsworthy 2012). Herbicide resistance is a problem in many weed species, including kochia, which is resistant to herbicide groups 2, 4, 5, and 10 in the western US (Heap 2020). Although less common, herbicide resistance has also been reported in perennial weeds like Canada thistle in Europe (Heap 2020). Environmental and human health concerns, as in the case of paraquat, can further limit herbicide availability. The identification of new active compounds would provide effective weed management options to hop growers while reducing the risk of selection for herbicide resistance.

**Relationship to Hop Research Council Research Priority:**

Disease research:

2. Novel crop production practices, including biocontrols (sustainability) – biological herbicide

4. Mitigation of export market access issues due to MRL’s

Agronomic Research:

8. Herbicide resistance management

9. Herbicide screening

**Objectives:**

1. To evaluate hops response to herbicides tiafenacil, florpyrauxifen-benzyl, and MBI-015.
2. To assess tiafenacil and glufosinate for spring pruning or crowning of hops.

**Justification and importance of proposed research:**

This project aims to develop new tools for chemical weed control in hops. These new tools will help the industry cope with important problems like herbicide-resistance management and meeting export market MRL’s targets. Four herbicide groups were identified for this project, WSSA group 4 - synthetic auxins, group 14 – PPO inhibitor, group 10 – glutamine synthesis inhibitors, and a biological herbicide MBI 015 that belongs to a new herbicide mode of action. The active ingredient identified for evaluation in group 4 is florpyrauxifen-benzyl; in group 14, tiafenacil; and in group 10, glufosinate.

Tiafenacil has been evaluated in hops since 2019, and this year was the first year we recorded crop injury in a one-year-old planting. However, the damage was transient and did not affect plant growth or yield. We will conduct a second year of treatment to the same plants to record the long-term impact required to support registration. Glufosinate is expected to receive registration in the fall of 2022, but the current label will allow in-season application. Furthermore, the new European MRL for glufosinate is lower than the US and will likely require US growers to use lower glufosinate rates and treatments during dormant or spring pruning. We are generating data to support the label expansion. We will continue the evaluation of florpyrauxifen in dormant hops, as this herbicide may help with winter weed control. Florpyrauxifen-benzyl is a synthetic auxin with low volatility and low toxicity to humans. The last herbicide is MBI-015, a new biological herbicide with activity in broad leaves and exempt from MRL by the EPA. We will initiate testing to support MBI-015 registration in hops.

**Procedures:**

1. To evaluate hops response to herbicides tiafenacil, florpyrauxifen, and MBI-015.
2. To assess tiafenacil and glufosinate for spring pruning or crowning of hops.

Field studies will be conducted in commercial hop yards located in Salem and Independence, Oregon, in the Willamette Valley on sites no larger than 0.2 acres each. Evaluations will be made over two consecutive years at each location. All fields will be managed following farm-standard practices. The experiment will be initiated when the crop reaches 6 to 8 ft tall or no later than four weeks after training. Treatments will be applied by a back-pack sprayer calibrated to deliver 20 GPA and equipped with drift-reduction nozzles generating coarse droplets. Applications will target the lower 2 ft of the plants. Each herbicide will be tested at three rates in two sequential applications: 1X - equivalent to the anticipated field rate, 2X - twice the field rate, and 4X - four times the field rate. To identify the crop tolerance, florpyrauxifen will be tested at multiple rates ranging from 3 to 42 fl oz at two growth stages. All treatments will include an ammonium sulfate source and methylated seed oil adjuvant.

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| Table 1. List of herbicide active ingredients, trade name, and proposed field rate for crop safety screening.  |
| Treatment | Trade name | Field rate (product) |
| Florpyrauxifen-benzyl (4) | Loyant | 3 to 21 fl oz |
| Tiafenacil (14) | Reviton | 0.08 lb ai (3 fl oz) |
| MBI-015 (unknown) | TBD | 0.008lb ai (TBD) |

The experimental unit (plot) will include three hop plants (six strings). Treatments will be arranged in a randomized complete block design with four replicates; they will be repeated in the following season. Evaluations will include visual estimation of basal hop control in the treated zone (hop base) and above the treated area (crop injury), and crop height, internodal length, number of internodes, and length of primary and lateral branches. Assessments will be made during the growing season at 1, 2, 4, 8, 10, 12, and 16 weeks after treatment. Plants will be harvested using a commercial picker (5p, HopsHarvester, Honeoye Falls, NY). Data will be submitted to ANOVA and means compared by Tukey’s test. Funds for the establishment of a research hop yard to be built at OSUs Lewis Brown Farm are being requested this year. A plot of 1 acre is being prepared for a short-trellis yard installation at Lewis Brown farm.

1. To assess tiafenacil and glufosinate for spring pruning or crowning of hops.

Spring pruning or crowning is an essential production practice to maximize yield in hops and reduce powdery mildew (*Podosphaera macularis*) (Probst et al. 2016). The 2021 visual estimates of crop injury suggest that both tiafenacil and glufosinate are safe when applied in the spring over the top of cv. ‘Nugget’ hops. Crop height and yield are being monitored. A field study will be conducted at Lewis Brown Research Farm, Corvallis, OR, in 2023 to evaluate glufosinate, tiafenacil, and tiafenacil over two consecutive seasons. Crop desiccation and weed control will be assessed 2 and 4 weeks later. Hop shoot length and soil coverage will be recorded. Plants will be trained, and bine growth and plant development will be evaluated monthly. The experiment will be organized as a randomized complete block with four replicates and will be repeated in 2024.

**Outcomes:**

The findings of this project will identify new herbicidal active ingredients and sites-of-action to be labeled for use in hops. Additional herbicides will provide growers new tools to manage difficult-to-control weeds and reduce herbicide resistance selection pressure. In preparation for this project, the commercial, regulatory, and biology representatives from Corteva, BASF, ISK, and MarroneBio, the registrants of the previously listed active ingredients, were consulted. ISK and BASF representatives visited research plots in 2022. The registrants support this work and will be involved throughout the research process to ensure the required data is generated for the potential registration of compatible active ingredients. If and when appropriate, the IR-4 program will be involved, as the project PI is actively engaged in IR4 activities in the Pacific Northwest.

**Extension and Outreach activities:**

Research findings become the basis of new weed management recommendations to be disseminated through the PNW Weed Control Handbook. In addition, information will be shared during the Hop Research Council and other events. However, registering a new herbicide is a long-term process, and releasing this information to the industry takes place upon completion of any registrations.

**Time-frame**

The research for the second year of study will be conducted from January 2023 to October 2023. Data analysis and reporting will be available for the Hop Research Council by the end of the calendar year 2023.

**Anticipated work in future years (2024)**

Results from HRC-funded work completed in 2022 guided the direction of this proposal. Our goal is to validate the initial findings during 2023. Evaluation of new use patterns of tiafenacil and glufosinate will be initiated in 2021. Still, it is necessary to conduct tolerance testing on the same plants over two seasons to validate crop tolerance. This validation work will continue in 2023. This project will expand and optimize the use of herbicides in hop production for difficult weed control, to manage weed herbicide resistance, and for the hop plant crowning.

**References:**

Heap, I., 2020. The International Survey of Herbicide Resistant Weeds. http://weedscience.org/, Accessed date: September 02, 2020

[HRC] Hop Research Council, 2019. The Hop Research Council Research Priorities. <http://hopresearchcouncil.org/>. Accessed date: November 05, 2019.

Norsworthy, J. K., Ward, S. M., Shaw, D. R., Llewellyn, R. S., Nichols, R. L., Webster, T. M., ... & Witt, W. W. (2012). Reducing the risks of herbicide resistance: best management practices and recommendations. Weed Science, 60(SP1), 31-62.

Probst C, Nelson ME, Grove GG, Twomey MC, Gent DH (2016) Hop powdery mildew control through alteration of spring pruning practices. Plant Disease 100:1599-1605

Westra, E. P., Nissen, S. J., Getts, T. J., Westra, P., & Gaines, T. A. (2019). The survey reveals frequency of multiple resistance to glyphosate and dicamba in kochia (*Bassia scoparia*). Weed Technology, 33(5), 664-672.

**Budget**

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| Budget: |  |
| Expenditure | Total amount requested (2022) |
| Salaries – Faculty research assistant  | $ 11,038 |
| Employee benefits (71 %) | $ 7,837 |
| Undergraduate students ($17/h) | $ 6,376 |
| Travel ($0.56/mile) (1,785 miles) | $ 1,000 |
| Plot fees | $1,250 |
| Materials ( product, field supplies) | $ 2,500 |
| Sub-total | $30,000 |
| Crop destruct (pending on collaborator needs) | $ 4,600 (to be paid directly to collaborators if needed) |
| Total | $ 34,600. |

Budget Narrative

Salaries: Funding for 0.2 FTE equivalent for a Faculty research assistant. The annual salary was calculated at $55,000 plus $7,810 for other payroll expenses (OPE) at 71%.(<https://research.oregonstate.edu/osraa/forms-and-rates/other-payroll-expense-ope-information-and-estimated-rates>). The FRA salary increase by 20% in 2022 as part of employee retention.

Salary for 375 h of undergraduate students assistance is requested at $6,376 at $17/h, including benefits. Students are assisting with hop planting, training, irrigation, and harvest.

Travel Mileage – $1,000 is requested for travel. Multiple trips per season are made to each research location for approximately 1,600 miles at $0.62/mile.

Plot fees: $1,250 is requested to cover plot fees at the Lewis Brown Research farm.

Materials. We request $2,500 to procure materials and supplies, including strings, sampling supplies, maintenance material, pesticides, personnel protective gear, and consumables.

Crop destruct: up to $4,600 in crop destruct charges to cover the equivalent of 0.2 A in two locations. Estimated at $12/plant. This funding will not be paid to the ARF, but directly to the collaborator if needed.