

Minnesota Wheat Research and Promotion Council
FULL RESEARCH PROPOSAL
For Crop Year 2026 (01/01/2026 to 12/31/2026)

Project Title: Pilot Sampling Program to Screen for Herbicide Resistance in Minnesota Weeds

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Project Period: 01/01/2026 to 12/31/2026

Estimated cost: \$15,000

Abstract:

Minnesota farmers and other agriculture professionals report new cases of weeds overcoming herbicides each year. As herbicide resistances (HR) continue to spread, identifying where and what HR traits are lurking in local weed populations can help inform control strategies. DNA testing is a relatively new method that can rapidly screen for specific HR markers within emerging, in-season weeds. Unfortunately, farmers, crop advisors, and extension staff have limited access to this biotechnology in practice. At the not-for-profit, National Agricultural Genotyping Center (NAGC), we have led a multi-year, statewide initiative to evaluate the distribution of HR in waterhemp and kochia populations in North Dakota. Since 2023, we have received over 1,000 leaf samples via convenient pre-paid collection kits. Collectors receive a personalized and confidential report on Group 2, 9, and 14 herbicide resistances in submitted leaf samples within five days of sample arrival to NAGC. At the end of the cropping season, data are aggregated at the county level to evaluate statewide distribution of HR. At the request of multiple farmers that heard of this program, we propose to pilot a collection and testing program within Minnesota. The aim of this program is to increase awareness to the growing HR crisis and offer new diagnostic technology for Minnesota growers to identify the HR potential of weeds in their fields.

Full Proposal

Background and the importance of this project to the profitability of wheat production in MN:

Weed scientists across the U.S. have identified 134 unique cases of herbicide resistance (HR), the most reported by any country¹. New cases emerge each year, steadily reducing the number of effective herbicide options available to growers. Returning to an era without chemical control is not an option. The potential yield losses from uncontrolled weeds are substantial and while specific losses from waterhemp in wheat have not been quantified, dense infestations can cause major yield reductions in other row crops^{2,3} and likely substantial losses in small grains as well. Kochia, for example, can reduce spring wheat yields by 20% or more under severe infestations⁴. These two species represent only a fraction of the 87 weed species known to exhibit herbicide resistance in U.S. agriculture¹. As both broadleaf and grassy weeds continue to evolve new resistances, effective management depends on identifying which HR traits are present within field populations.

Traditional greenhouse bioassays remain valuable for confirming resistance, but they are slow and resource intensive, often requiring a month or more to complete with limited greenhouse space during winter. DNA-based diagnostics now offer a faster, complementary tool for identifying HR potential. Specifically, DNA tests detect target-site mutations directly from plant tissue, providing submitters results within days and allow testing weeds at any growth stage (seed, seedling, mature plant). The rapid turnaround gives farmers, agronomists, and researchers near real-time insight into HR threats early in the growing season, when weed management decisions have the greatest impact on crop yield.

Building on past successes in North Dakota, the National Agricultural Genotyping Center (NAGC) proposes to offer free HR testing for kochia and waterhemp while expanding detection into grassy weeds such as green foxtail and wild oat. This effort directly supports MN Wheat Research Priority for Spring Wheat Production that focuses on crop protection and pest management.

Research methods:

The objectives of this pilot program are to: 1) distribute convenient, mail-in collection kits across Minnesota, 2) use validated DNA tests to screen for HR potential in pigweed (waterhemp) and kochia samples, and 3) receive green foxtail or wild oat leaf samples to assist with new test development.

Collections – We propose to distribute collection kits across Minnesota (**Deliverable 1**). The collection kits are pre-paid USPS envelopes containing sampling instructions, submission form, and small envelopes to ship leaf samples. We expect many collection kits will be lost or forgotten, so we supply a surplus of kits to regional and county extension offices, commodity groups, and UMN/MSU researchers. Each kit contains four (4) small coin envelopes where submitters can test three pigweeds and/or kochia along with the added option to submit one annual grass weed (green foxtail or wild oat) to assist in our test validations.

Genetic Tests – Each kochia and pigweed sample will be tested at three genetic markers associated with herbicide resistance. We have selected the three most common genetic markers for waterhemp, which include ALS-W574L mutation (Group 2), variation in EPSPS gene copies (Group 9), and the PPO-210 deletion (Group 14). For kochia, we test for the ALS-W574L mutation, variation in EPSPS gene copies, and three tests to determine the presence of PPO mutations. Genetic markers have been linked to HR resistance in peer-reviewed studies and/or greenhouse trials⁵⁻⁶.

Reports – Each submitter is emailed a personalized report containing DNA results from their samples (**Deliverable 2**). The reports list the sample description (weed species, field location) provided by the submitter, explanation of the DNA tests performed, and interpretation of results. All reports comply with ISO/IEC 17025:2017 standards and are only released via email to the individual that submitted the samples. We do not share specific details about the origin of samples and corresponding results to third parties unless we are

provided written consent from the original submitter.

Maps – All results are combined to create maps (county level resolution) to show the distribution of HR genetic markers occurring in weeds throughout the state (**Deliverable 3; see the supplemental document**). We also aggregate data to show within-individual characteristics (i.e., frequency of stacked HR traits).

Green Foxtail and Wild Oat Tests – We are actively working with green foxtail (*Setaria viridis*) and wild oat (*Avena fatua*) to develop DNA tests for resistance markers associated with Group 1 (ACCase inhibitors) and Group 2 (ALS inhibitors) herbicides. We will request Minnesota submitters to consider collecting and sending leaf samples from these species to assist in our test validation for these grassy weeds.

Outline the timeline for completion:

NAGC Timeline for the Pilot Sampling Program in Minnesota – Wheat Cropping Year 2026													
Task	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Distribute collection kits													
Test weeds for HR, report results													
Create HR statewide maps													
New HR Tests – green foxtail & wild oat													

Disseminate research findings:

Research results will be communicated through multiple channels to ensure broad access and practical impact. Statewide maps showing HR trends can be shared widely with participants and the agricultural community. NAGC usually collaborates with University Extension staff on newsletters, commodity group publications, and social media. Findings are shared at regional and national meetings. Last year, PI Bateson provided results at four regional (ND) meetings and at the Western Society of Weed Science Conference in Seattle. If sufficient multi-year data are collected, results can be published in peer-reviewed journals.

List potential collaborators or co-investigators:

We plan to provide resources and collection kits to UMN Extension Regional Offices and Universities within the row crop regions of MN. We can also provide collection kits to specific County Extension Offices interested in participating as well as weed scientists across the state.

Literature Cited

- [1] Heap, I. The International Herbicide-Resistant Weed Database. Accessed on 11/04/2025.
- [2] Hager et al. (2002). Weed science, 50(5), 607-610.
- [3] Steckel & Sprague (2004). Weed Science, 52(3), 359-364.
- [4] Geddes & Sharpe (2022). Crop Protection, 157, 105981.
- [5] Tranel (2021). Pest Management Science, 77(1), 43-54.
- [6] Gaines et al. (2020). Journal of Biological Chemistry, 295(30), 10307-10330.
- [7] Murphy et al. (2019). Weed Science, 67(3), 296-302.

Itemized Budget:

Category	Description	MN Wheat Request	Other Commodities Matching Requests	Totals
Personnel Salary	0.2% FTE	\$8,437.50	\$25,312.50	\$33,750
Fringe Benefits	33.33% of Salary	\$2,812.50	\$8,437.50	\$11,250
Supplies	Kits, Testing, Development	\$3,750.00	\$11,250.00	\$15,000
	Totals	\$15,000	\$45,000	\$60,000

Budget requirements and justification:

Salaries and Wages account for laboratory technician and research analyst time to accession, process, and test all leaf samples within the kits returned to NAGC. The wages also include the time to create collection kits, finalize reports, as well as the technical and administrative review of the results before release to the submitters. Wages also account for the validation time needed to add annual grass weeds to the HR panel. We expect this project to account for 0.2% FTE during the funding period. **Fringe Benefits** are 33.33% of the personnel costs that are needed to conduct the survey and research work for this project.

Supplies

Collection Kits – We anticipate an increasing number of samples collected and shipped to NAGC. For shipping costs, the annual permit fee for Qualified Business Reply Mail (QBRM) via USPS is \$875, purchasing coin envelopes, printing sample and envelope labels (\$350), as well as paying for the return postage at approximately \$2.40 per collection kit (\$204 for 85 kits). Packets of 5-10 kits will be shipped to select UMN regional extension offices and county extraction offices to cover the agricultural landscape \$6/packet.

Testing Samples - Testing costs include reagents and consumables to extract DNA and perform three (pigweed) or five (kochia) DNA tests on every leaf sample. The steady return of kits as well as our ability to test in small batches allows NAGC to offer a research rate of under \$40 per DNA test. The full HR panel (Groups 2, 9, and 14) will continue at this reduced rate because samples can be batched together for processing. We plan to distribute an excess of collection kits (n= 425) with hopes that 85 kits are returned and contain three leaf samples, resulting in 255 total samples. **Because this multi-partner model depends on combined contributions, the number of samples processed within MN will scale with the total level of commodity group support. Expanded funding will directly increase the number of samples tested and the geographic reach of HR surveillance.**

Validations of New Tests – We plan to investigate known genetic markers associated with HR for Groups 1 and 2 in green foxtail and wild oat. Approximately 20% of the total project budget from all contributing groups will be allocated to test development, ensuring continued progress on new tests that support statewide and regional resistance monitoring. Submitters will be provided results from their grassy weed samples at a later date.

List sources and amounts of additional funding for this project:

Given the interest through conversations with MN farmers and wide impacts of weeds across cropping systems, we are submitting the proposal for cost-sharing support to several MN-associated commodity groups.

Organization Name to Support MN testing	Funding Request	Proposal Status - None committed
MN Wheat Research & Promotion Council	\$15,000	Submitted in Nov 2025
MN Soybean Research & Promotion Council	\$15,000	Submit in Dec 2025
MN Corn Research & Promotion Council	\$15,000	Submit in Jan 2026
Northern Canola Growers Association	\$15,000 (MN= \$7500)	Submit in Jan 2026
Northarvest Bean Growers Association	\$15,000 (MN= \$7500)	Submit in Feb 2026
Total for MN Project	\$60,000	