2023 Schutter Diagnostic Laboratory Annual Report - Summary

The Schutter Diagnostic Laboratory (SDL) at Montana State University (MSU) is provided as a service to the citizens of Montana for plant pest identification and integrated pest management education. In 2023, the SDL conducted 2,767 plant, plant disease, insect, mushroom, and abiotic diagnoses in all 56 Montana counties and 4 additional states - North Dakota, South Carolina, Texas, and Wyoming.

- 93% of SDL clients thought the timeliness of a response/diagnosis was good or excellent*.
- 95% of SDL clients found the clarity of the information provided with the diagnosis/identification good to excellent*.
- 82% of SDL clients found SDL services very to extremely useful in solving their plant- or arthropod-related problems*.
- 69% of SDL clients adapted their pest management decisions based on recommendations provided in the SDL report*.
- In 2023, SDL diagnoses and identifications impacted between 194,635 and 250,461 acres for samples submitted from agricultural settings. In total, SDL clients who submitted a sample from an agricultural setting saved at least $34,518, corresponding to @2.94/acre**.
- SDL clients who submitted a sample form urban, residential, or horticultural settings saved on average between $3,333 and $6,600 on yard and garden care in 2023 due to SDL diagnoses and recommendations (including lawn treatments, tree spray applications, and pruning)***.

Selected Outputs and Impacts

- We are an important resource for documenting new organisms that occur in our state.
    - Working with local Extension field faculty we confirmed the first two known detections of Palmer amaranth (*Amaranthus palmeri*) in Montana in 2023, allowing appropriate personnel to contain the populations.
    - A black-legged tick (*Ixodes spp*.) retrieved from a hunting dog near Richey, MT in October was determined to be a new tick species in Montana. The tick is currently being examined by a specialist to determine if it is one of two species that vector Lyme Disease. Lyme Disease tick vectors have not been documented yet in Montana.
- Early detection of new invasive species is an important part of our mission. In 2023, we confirmed the identification of the first report of common reed (*Phragmites australis* spp. *australis*) in Gallatin County. This species is a priority 1A noxious weed in Montana, meaning it has very limited presence in our state and the management goals are eradication and prevention of spread. Early detection and proper identification allowed the local weed district and Montana Department of Agriculture personnel to manage the existing stand and prevent spread off-site.
- The diagnoses of environmental or cultural causes of reduced plant health, where disease problems were initially suspected, saved growers and homeowners money from unnecessary treatments and reduced the potential environmental impact associated with pesticide applications.
    - Over 100 submitted woody ornamental samples in 2023 were suspected of disease but were diagnosed as winter injury, making a pesticide application unnecessary.
    - “Five producers [in one county] did not spray Bobcat winter wheat with fungicide because it was diagnosed with Physiological Leaf Spot. At 1000 acres and $6.00 per acre savings, producers saved a total of $30,000.” (Quote by Extension field faculty on the impact of SDL services on their or their clients work in 2023, obtained through SDL Agent Survey 2023)

* Results of the 2023 SDL client survey, n=111, compiled by MSU HELPS Lab.

**Estimates based on n=45 responses to the “acre impact” and “money saved” questions for agricultural samples in the 2023 SDL survey.

*** Estimate based on n=33 survey responses to the “money saved” question for urban/residential and horticultural samples in the 2023 SDL survey.

How MSU Extension field faculty benefited from SDL services in 2023[†]:

- "As an agent, we are pulled in hundreds of different directions so we sometimes do not have the mental or physical capacity, let alone the knowledge, to correctly identify insects or diseases. Knowing there are experts in our corner to help us help producers, landowners and homeowners in our community is valuable and builds our confidence. It gives us exposure to knowledge we would have not known previously, i.e. a pests, the pest's effects and prevention practices. After the ID, I as an agent now know what that pest is called and what information to give next time."
- "Being recently hired in extension, it is awesome to have a group of people I can send samples to and get accurate results. It also helps the community members understand the problem and solution. Community members also see that our diagnosis is the same as that in the lab."
- "The SDL provides the identification assistance necessary to provide detailed educational resources for our clients' needs."
- "Residents have shared that the management recommendations shared by SDL have saved them money, time, and resources. They've saved money by not purchasing products they don't need. They've saved time by receiving accurate and reliable information on their species of concern. They've saved resources in the form of their species of concern, for example a well-established tree that they would like to continue to see thrive on their land."

What other SDL clients appreciated about SDL services in 2023[‡]:

- "SDL staff was extremely constructive and helpful in identifying my problems and suggesting methods of resolution."
- "SDL is a critical resource for plant identification!"
- "If the plant ID had turned out to be Palmer amaranth, the potential for this agriculture county would have been very significant. Luckily, because of the swift response that was received and a negative ID, a lot of time and money was saved. Thank you!"
- "This is a very important service to the agricultural industry."
- "The SDL is an excellent tool for growers and the industry partners who support them. I submit 3-5 samples every year and it greatly helps us recommend the right solution to prevent and solve problems."
- "As a plant breeder SDL is invaluable to identify what pests lines are susceptible to."
- " I have students (Graduate and Undergraduate) submit samples on behalf of Towne's Harvest Garden and affiliated Hort Farm Research Programs routinely. I consider the interaction to be an excellent educational opportunity for the students. Thanks for all that you do."
- "We saved several trees! So, it was a pretty big deal."
- "Lab results were followed up with a phone call and explained very clearly what was going on. Great service."

MONTANA STATE UNIVERSITY
EXTENSION
Schutter Diagnostic Laboratory

† Selected quotes copied verbatim from the 2023 Extension agent feedback survey, n=33, compiled by MSU HELPS Lab.

‡ Selected quotes copied verbatim from the 2023 SDL client survey, n=111, compiled by MSU HELPS Lab.

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Introduction

Montana State University (MSU) and MSU Extension provide plant pest identification through the Schutter Diagnostic Laboratory (SDL). The mission of the SDL is to safeguard Montana agriculture, landscapes, and public spaces from plant pests by offering identification services, management advice, and education. Our recommendations are based on integrated pest management (IPM) principles, where IPM is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic and environmental risks. Our mission also includes early detection of new and invasive pests that may pose a risk to Montana and the U.S. to prevent significant limitations to agricultural production and international trade.

The SDL clients submitting samples to the SDL in 2023 were homeowners/gardeners (38.6%), researchers/specialists (11.9%), agribusiness (9.9%), agent/educator (7.9%), growers/farmers (7%), arborists (5%), crop consultants (5%), landscapers (3%), pest control operators (3%), and regulatory agents (2%), based on 110 survey responses to the 2023 SDL client survey.

In 2023, the SDL conducted a total of 2,767 plant disease, insect/other arthropod, plant, mushroom, herbicide injury, and other abiotic disorders diagnoses through physical, email, and Plant Sample Submission app samples (Table 1).

Table 1. Number of diagnoses by the Schutter Diagnostic Lab in 2023.

Diagnosis Type	**Number of Diagnoses**
Plant Disease	1,174
Arthropods	676
Plant ID	289
Mushroom ID	53
Herbicide Injury	118
Other Abiotic Disorders	457
Total	**2,767**

We received samples from all 56 counties in Montana and 4 additional states - North Dakota, South Dakota, Texas, and Wyoming. Most samples, 60%, were submitted through MSU Extension services, and 40% were submitted from non-extension clientele. Most diagnoses from Extension samples were for Gallatin, Ravalli, Flathead, Park, and Hill counties. Eighty-four percent of Extension samples were from non-commercial clientele while 16% were from commercial sources. For the non-extension samples, 51% were from non-commercial clientele while 49% were from commercial sources. Seventy-nine percent of the sample diagnoses were associated with a weed, disease, or pest while 21% of the diagnoses were from abiotic causes (i.e., winter injury, nutrient imbalance, suspected herbicide injury, drought, or cultural problems).

In addition to diagnostic services, SDL diagnosticians provide outreach materials about pests of concern to clients in Montana. For example, the SDL maintains a Facebook page that has over 1,000 followers. In 2023, we published a total of 34 Facebook posts reaching over 34,238 people, with an average of 32 engaged users per post. Our posts usually focus on timely information about plant diseases, insects, and plant identification for our wide range of clientele.

We also send out Urban Alerts and AgAlerts that inform our clientele about pertinent issues statewide via text or email. The MSU Urban Alert system (612 subscribers) is intended for Extension field faculty, landscape professionals, arborists, and anyone concerned with ornamental plants and vegetables. In 2023

we posted 9 Urban Alerts. The MSU AgAlert system (1,879 subscribers) provides current and research-based information for Montana agricultural clients. There were 10 AgAlerts posted in 2023.

2023 Plant Disease Summary

Diagnostic Staff

Dr. Uta McKelvy, Assistant Professor Extension Plant Pathology
Dr. Eva Grimme, Plant Disease Diagnostician & Associate Extension Specialist III

Other Assistants/Specialists

Erin Gunnink-Troth, Research Associate
Abiya Saeed, Extension Horticulture Specialist
Sarah Eilers, Montana Master Gardener Coordinator
Dr. Cathy Cripps, Mycologist
Dr. Mareike Johnston, Plant Pathologist

Outputs & Impacts

- The accurate and timely diagnosis of plant diseases is key to applying successful management strategies. The SDL team is focusing on integrated pest management strategies to address plant problems. Through collaboration of the SDL team with MSU Extension specialists, best management strategies are developed to effectively address plant health issues.
- In 2023, SDL diagnoses and identifications for agricultural crop samples impacted between 194,635 and 250,461 acres, based on 47 respondents to the "acre impact" question in the 2023 SDL Client Survey.
- "Five producers [in one county] did not spray Bobcat winter wheat with fungicide because it was diagnosed with Physiological Leaf Spot. At 1000 acres and $6.00 per acre savings, producers saved a total of $30,000." (Quote by Extension field faculty on the impact of SDL services on their or their clients work in 2023, obtained through SDL Agent Survey 2023)
- Over one hundred submitted woody ornamental samples were suspected of disease but were diagnosed as winter injury, making a pesticide application unnecessary.
- Suspected fire blight samples were diagnosed utilizing disease diagnostic kits, rapidly confirming the disease on 48% of the suspected samples. Clients were able to implement IPM strategies promptly.
- The SDL is testing in-vitro mint plants for *Verticillium dahliae* for the fourth year. The absence of Verticillium is essential for mint growers to ensure that only healthy plant materials are distributed to customers. In 2023, we tested in-vitro samples of 10 lines. We will continue to support Montana's mint producers by providing this testing service.

Sample Summary

In 2023, the SDL completed 1,174 plant disease diagnoses (agricultural and horticultural samples). Samples submitted by extension personnel (48.5%) consisted of 36.5% non-commercial and 12% commercial entities. Samples submitted by entities outside of MSU Extension accounted for 51.5 % with 31.5% coming from commercial sources and 20% from non-commercial sources.

Small grain crops accounted for 65% of all agricultural crop samples in 2023 (171 samples processed; 50 winter wheat, 44 barley, 27 spring wheat, further durum wheat, millet, oats, corn, and non- specified wheat). Pulse crops (15%) constituted the second-largest group of crop samples (40 samples processed; 16 lentil, 13 dry field pea, 11 chickpea), followed by potato (17 samples). Other crops submitted for disease diagnosis in 2023 included hay (alfalfa, barley, grass, silage), sugar beets, garlic, alfalfa crop, camelina, forage grasses, cowpea, Russian wildrye, and safflower.

Deciduous woody ornamentals accounted for 39% and evergreen woody ornamentals accounted for 33% of the horticulture diagnoses made by the SDL in 2023. Sample hosts of these categories included Colorado blue spruce, blue spruce, pine trees, fir, lilac, juniper, poplar, apple, crabapple, pear, oak, arborvitae, and maple trees.

Fruit and vegetable samples (apple, pear, cherry, raspberry, tomato, garlic, herbs) accounted for 20%, perennial & annual plants for 3%, and turf samples accounted for 5% of the horticulture diagnoses.

Trends from 2023: Agriculture

Agricultural crops accounted for 458 plant disease diagnoses in 2023. Of these, 372 diagnoses identified disease problems (81%) and 84 diagnoses identified abiotic disorders (18%).

Samples were received from 42 of 56 Montana counties, with Gallatin, Pondera, Hill, Teton, and Chouteau counties contributing over 40% of agricultural crop samples. Five plant disease diagnosis requests were received via the sample submission app; two submissions could be identified immediately and submission of a physical sample was suggested for the other three.

Fifty-nine percent of diagnoses that identified a disease problem in 2023 were associated with fungal and fungal-like pathogens. Root, crown, and seedling rots accounted for 25% of all disease diagnoses in agronomic crops in 2023. This represents a decrease compared to 2022 when 50% of all diagnoses associated with fungal and fungal-like pathogens were root and crown rots, corresponding to 154 diagnoses compared to 89 in 2023. Root rots associated with *Fusarium* sp. were very common (15%) affecting barley, chickpea, dry field pea, lentil, garlic, sugarbeet, winter, spring and durum wheat; *Rhizoctonia* sp. (4%) caused root diseases in barley, field peas, lentil, potato, sugarbeet, and wheat; *Cochliobolus sativus* caused common root rot (2%) on barley and spring wheat, while oomycete pathogens (*Aphanomyces* sp. and *Pythium* sp.) caused root rot (2%) on field peas, lentils, and spring wheat.

Fungal foliar diseases accounted for 23% of all crop disease diagnoses in 2023. This represents an increase of more than double compared to 2022 when fungal foliar diseases accounted for 10% of all crop disease diagnoses. This shift can be attributed to increased precipitation received throughout many parts of the state during the 2023 growing season, often associated with heavy winds or hail. Frequent rain events and increased humidity in the canopy favor foliar disease development. Leaf spot diseases accounted for 75% of all fungal foliar diseases in 2023 (17% of all fungal disease diagnoses) and included net blotch (*Drechlsera teres*), spot blotch (*Bipolaris sorokiniana)*, and Scald (*Rhynchosporium secalis*) in barley; tan spot (*Pyrenophora tritici-repentis*) and Stagonospora leaf spot (*Parastagonospora nodorum*) in winter, spring, and durum wheat; Septoria leaf spot (*Septoria pisi*), Ascochyta blight (*Ascochyta* sp./spp.), Stemphylium (*Stemphylium* sp./spp.), and Anthracnose (*Colletotrichum sp./spp.*) in field peas; and spring black stem (*Phoma medicaginis*) and Stemphylium leaf spot (*Stemphylium* sp.) in alfalfa. Other fungal foliar diseases observed in agricultural crop samples included downy mildew in camelina and field pea, white mold in garlic and lentil, and stripe rust on barley and durum wheat.

Post-harvest and storage disorders associated with fungal pathogens accounted for 10% of all crop disease diagnoses in 2023. This included mold issues in hay and silage associated with *Alternaria* sp., *Aspergillus* sp., *Penicillium* sp., *Botrytis* sp., *Rhizopus* sp., and *Mucor* sp.; black point (*Alternaria* sp.) and sooty molds in barley and winter wheat grain; skin blotch (*Embellisia allii*) and Penicillium decay (*Penicillium hirsutum*) in garlic; and Fusarium dry rot (*Fusarium* sp./spp.), black dot (*Colletotrichum coccodes*), and water rot (*Pythium* sp.) in potato.

Six percent of disease diagnoses were associated with bacterial pathogens in 2023. *Xanthomonas* sp. caused bacterial stripe and/or black chaff on barley, winter, spring, and durum wheat and common bacterial blight on cowpea. *Pseudomonas* sp. caused bacterial leaf blight on field pea, sugar beets, and spring wheat, and bacterial stripe blight on oats. Other bacterial diseases observed in 2023 included post-harvest and storage diseases of potato tubers: bacterial soft rot (*Erwinia* sp./spp.) and common scab (*Streptomyces scabies*).

Few disease diagnoses were attributed to viral disease in 2023 (1% of diagnoses). Four diagnoses identified symptoms of Wheat streak mosaic virus infection and confirmed the presence of the wheat curl mite vector (*Aceria tosischella*) in winter wheat and barley.

The impact of a harsh and very long winter, cold spring, and precipitation-rich summer in 2023 are reflected in abiotic disorder diagnoses. 45% of abiotic disorder diagnoses were attributed to environmental stresses including heat, cold/frost, and drought/water stress. Cultural problems, nutrient imbalances, hail, and abnormal plant growth accounted for 18, 12, 2, and 1% of abiotic diagnoses, respectively.

Physiological leaf spot was a re-occurring issue in winter wheat in 2023, accounting for 22% of abiotic disorder diagnoses. This disorder reflects a genotype-specific response to environmental conditions and is assumed to be associated with chloride deficiency.

Trends from 2023: Horticulture

Horticultural samples accounted for 754 diagnoses (samples submitted through the Plant Diagnostic Information System [PDIS]) and 48 plant disease diagnoses for electronically submitted samples (i.e., photos in emails and through the sample submission app).

Periods of extreme low temperatures during the 2022/2023 winter resulted in increased winter injury incidence in woody ornamentals (113).

Foliar fungal diseases were predominant during 2023 due to the increased moisture levels in spring. Evergreen samples, especially Colorado blue spruce and blue spruce, were submitted with signs of Rhizosphaera needle cast disease (40) and/or sudden needle drop (23). Pine trees were mainly affected by Dothistroma needle blight (27) and junipers by tip blight (15). In spring, Venturia leaf, twig, and shoot blight was observed on 7 poplar samples. Anthracnose was confirmed this season on English ivy (1), dogwood (1), green ash (2), bur oak (2), poplar (5), and maple (6). Oak leaf blister disease was confirmed on two oak tree samples. Cytospora canker was diagnosed on spruce and Colorado blue spruce trees (9), poplar trees (7), fruit trees (2), willow tree (1), and mountain ash (1). White mold infection was confirmed on lettuce and tomato samples. Powdery mildew infection was confirmed on only three samples, including pumpkin, squash, and maple tree.

Twenty-seven plant samples, including apple, crabapple, pear, mountain ash, and cotoneaster were submitted to the SDL with suspected fire blight infection. Samples were tested with rapid disease diagnostic

kits, confirming positive results on ten apple tree samples, two *Crataegus* spp. samples, and one crabapple sample.

Root rots caused by *Rhizoctonia* sp., *Fusarium* spp., and *Pythium* sp. were only minor diseases this season. Rhizoctonia root rot was confirmed on four turfgrass samples. Pythium root rot was confirmed on one sample each of tomato, African violet, begonia, and turfgrass. Fusarium root rot was diagnosed on turfgrass, garden pea, and tomato.

2023 Insect Diagnostics Summary

Diagnostic Staff

Marni Rolston, Research Associate, Arthropod Diagnostician

Other Assistants/Specialists

Dr. Michael Ivie, Systematic Entomologist, Montana State University
Dr. Casey Delphia, Research Associate/Entomologist, Montana State University
Dr. Frank Etzler, State Survey Coordinator, Montana Department of Agriculture
Abi Saeed, Horticulture Extension Specialist, Montana State University
Dr. Tom Schwan, Chief and Senior Investigator (retired), National Institutes of Health at the Rocky Mountain Laboratories

Outputs & Impacts

- A black-legged tick (*Ixodes spp*.) retrieved from a hunting dog near Richey, MT in October was determined to be a new tick species in Montana. The tick is currently being examined by a specialist to determine if it is one of two species that vector Lyme Disease. Lyme Disease tick vectors have not been documented yet in Montana.
- Swallow bugs and bat bugs were diagnosed from homes in Gallatin, Cascade and Beaverhead counties, ruling out bed bugs and costly insecticide treatments associated with them.
- Beetles were emerging from new construction in a hospital complex in Missoula, MT. The client was grateful to learn that these long-horned boring beetles (*Arhopalus spp.*) would only be a temporary nuisance and that no management was required.
- A beetle closely related to the destructive and highly-regulated khapra beetle was identified in stored grain in Choteau County in August. No regulatory action was required because of this diagnosis.
- In Gallatin County, the exotic powderpost beetle (*Lyctus brunneus*) was confirmed to have emerged from wooden furniture made in China. This species has already been recorded in Montana so it didn't need to be reported. The homeowner was advised to collect all emerged specimens and dispose of them, since they can reinfest wood in homes.

Arthropod Identification Activities and Trends

In 2023, there were 676 arthropod diagnoses; 600 were urban/horticulture samples (89%) and 76 were agriculture-related samples (11%). Of the urban samples, approximately 456 samples were submitted via the Plant Diagnostics Information System (PDIS), 137 were diagnosed via email, and 8 were diagnosed through the sample submission app. For the agricultural arthropod samples, 41 samples were submitted via PDIS, 29 were diagnosed via email, and 5 were diagnosed through the sample submission app. For all insect

diagnoses, 54% were submitted from Extension agents and 46% were submitted directly from non-Extension sources such as homeowners, growers, crop consultants, arborists, and others. For the Extension samples, 91% of the diagnoses were for non-commercial clientele while only 9% were for commercial clients. For the non-Extension diagnoses, 68% were for non-commercial clientele while 32% were for commercial clients. These data follow trends from previous years. Samples were submitted from 46 counties in Montana, and one sample was submitted from Idaho.

Urban/Household Samples

Woody ornamentals represented host plants associated with the greatest number of urban insect diagnoses (46%). The greatest number of woody ornamental insect samples came from apple, arborvitae, ash, aspen, cherry, cotoneaster, cottonwood, elm, juniper, oak, pear, pine, poplar, rose, spruce, and willow. The most common pests associated with these woody ornamentals are shown in Table A1.

For households (14% of all non-commercial diagnoses), the most frequently-submitted arthropods included carpet beetles (21%), flies (13% - dung flies, dark-winged fungus gnats), root weevils (10%), spiders (6%- mostly hobo and wolf spiders), swallow, bed, and bat bugs (6%), carpenter ants (5%), seed bugs (6% dirt-colored seed bugs and Western conifer seed bugs), German cockroaches (5%), and several others were represented (stinkbugs, springtails, duff millipedes, clover mites, Indian meal moths, and Western yellowjackets). All diagnoses included reports that shared the arthropod's ecology, any benefits it might provide to the ecosystem, and clarifications, particularly regarding misconceptions about arthropods like swallow/bat bugs and spiders in the home environment.

Arthropod identifications and diagnoses associated with vegetables made up eleven percent of all non-commercial diagnoses. The main vegetable hosts included beans, garlic, potatoes, rhubarb, squash, and tomatoes. Some of the common pests on these hosts included aphids, beet leafminers, flea beetles, two-spotted spider mites, root maggots, and thrips. In greenhouses, aphids, thrips, and two-spotted spider mites were commonly reported. Clients were provided information about using cultural methods (for example, discarding vegetative debris in/near the garden) or biological methods (for example, introducing parasitic/predatory insects into their garden) to manage and reduce most arthropod pests of vegetables.

Other arthropod identification requests for outside the home/in the yard included goldenrod crab spider, Mormon crickets, Carolina wolf spiders, cat-faced spiders, bumble flower beetles, black flies, blister beetles, prionus borers, flea beetles, garden millipedes, horntails, leafhoppers, giant water bugs, seed bugs, western flower thrips, root weevils, western yellowjackets, boxelder bugs, and sculptured pine borers.

Additionally, we continue to monitor and educate about potential invasive species entering the state. There were many samples sent to the SDL by clients interested to know if they were exotic pests, such as Japanese beetles, emerald ash borers, or brown marmorated stink bugs. Japanese beetles sent in from Yellowstone County were confirmed near Billings again this year, but no specimens of the other two species were confirmed.

Agriculture-related Samples

Seventy-six arthropod samples collected from agricultural settings were submitted to the SDL in 2023. Most of these samples (41%) were from spring wheat and winter wheat. The remaining samples were from a wide range of agricultural crops, including alfalfa, barley, camelina, canola, field peas, potato and corn. Samples were also received from pasture/grasslands, commercial greenhouses, stock tanks, and stored grain bins.

The most common small grain pests were the wheat stem sawfly and the wheat curl mite (Table A2). Other insects diagnosed from wheat and barley included cereal leaf beetle, black grass bugs, grasshoppers, and wheat stem maggot. Insects submitted from alfalfa fields included armyworm, cutworm and blister beetles. Other crop arthropods included *Collops vittatus* (striped beetle) in camelina, false flower beetles in canola, and the corn leaf aphid in sweet corn.

Stored-grain insects were also submitted to the SDL in 2023. The Indian meal moth, an economically important insect pest of stored grain, was confirmed. Management strategies focusing on sanitation were shared with this client. Additionally, a beetle closely related to the destructive and highly-regulated khapra beetle was identified. The producer and Extension field faculty submitted the specimen because they were concerned that it might be the khapra beetle. This situation highlights how the collaborative relationships between the Schutter Lab, Extension field faculty and producers help prevent regulated, non-native insect pests like the khapra beetle from establishing.

A few samples of non-damaging/beneficial arthropods were also submitted from agricultural lands, including parasitic wasp cocoons on wheat, and a carabid beetle in hay. Reports associated with the diagnoses of arthropod pests in agricultural landscapes usually include information about how to preserve these important beneficial arthropods.

2023 Weeds Lab Summary – Plant ID, Mushroom ID, and Herbicide Injury

Diagnostic Staff

Noelle Orloff- Associate Extension Specialist III

Other Assistants/Specialists

Dr. Jane Mangold
Dr. Tim Seipel

Other Cooperators

Dr. Cathy Cripps, Mushroom identification
Dr. Matt Lavin, Plant identification

Outputs & Impacts

- Early detection of agriculturally important pests is an important role of our lab. Two *Amaranthus* species, Palmer amaranth (*A. palmeri*) and waterhemp (*A. tuberculatus*), are of increasing concern in Montana due to their projected economic impact on agriculture. Due to this concern, in 2023 we received 12 *Amaranthus* samples for identification along with numerous questions.
    - Working with local Extension field faculty and other partners, we detected Palmer amaranth in two cases (four samples) and sent the samples for PCR testing for confirmation. Appropriate personnel was informed in order to contain the populations. These are the first known detections of Palmer amaranth in Montana.
    - In the remaining cases where field faculty, clients, and partners were concerned about Palmer amaranth and waterhemp, we identified other common weedy species instead. These identifications saved producers and land managers significant time and money by avoiding unnecessary and costly treatments.

- Early detection of new invasive species is an important part of our mission. In 2023, we confirmed the identification of a first report of common reed (*Phragmites australis* spp. *australis*) in Gallatin County. This species is a priority 1A noxious weed in Montana, meaning it has very limited presence in our state and the management goals are eradication and prevention of spread. The population was found in a newer subdivision in Bozeman. Early detection and proper identification allowed the local weed district and Montana Department of Agriculture personnel to manage the existing stand, as well as work with contractors to make sure construction equipment was properly cleaned to prevent spread off site.
- Mushroom identification is critical for assessing toxicity concerns, and we regularly work with clients on this issue. For example, in 2023 we responded to a mushroom question from a hospital emergency room. A patient had ingested a mushroom, and it was unclear whether symptoms displayed by the patient were related. We were able to quickly relay photos and relevant information to the appropriate expert and confirm that the mushroom was not a species of deadly poisonous fungi, and instead may be expected to cause gastrointestinal symptoms.

Plant Identification Activities and Trends

In 2023, the SDL processed 210 physical specimens for plant identification, and 79 electronic samples (i.e. photos in emails and our sample submission app). Most samples came from non-commercial sources such as government personnel, homeowners, and small acreage landowners. These samples accounted for 83% of sample submissions. Non-commercial samples may be from agency or regulatory personnel, or from residential or small acreage landowners who need information on how to control a plant in their management area or in gardens or small pastures. Samples from commercial clients such as farmers, ranchers, consultants, nurseries, and representatives from agribusinesses accounted for 17% of all submissions. About 65% of plant identification samples were from local Extension offices submitting samples on behalf of their clients. We identified plants from 46 Montana counties and reservations, and three additional states.

Plant identification samples submitted represented 196 unique species. Thirty-six percent of samples were of exotic plants. The most submitted exotic species were roving bellflower (*Campanula rapunculoides*, 6), kochia (*Kochia scoparia*, 5), and tall tumblemustard (*Sisymbrium altissimum*, 4). We also identified four specimens of Palmer amaranth (*Amaranthus palmeri*); a species native to North America but not to Montana. Forty-seven percent of samples were Montana native plants. The most common native species submitted were Powell's amaranth (*Amaranthus powellii*, 3), white sage (*Artemisia ludoviciana*, 3), horseweed (*Conyza canadensis*, 3), and witchgrass (*Panicum capillare*, 3). Notably, we received 12 samples in the Amaranthus genus in 2023, due largely to concern about Palmer amaranth and waterhemp (*A. tuberculatus*).

Fourteen confirmed specimens of state-listed noxious weeds and other state-regulated plants were submitted representing nine unique species (Table 2). The SDL provides a valuable resource where land managers can get accurate information about suspected problematic plants such as noxious weeds.

Mushroom Identification Activities

In addition to plants, we also provide access to mushroom identification assistance. In 2023, Dr. Cathy Cripps assisted the SDL by identifying 51 mushroom samples. These specimens were of 31 different species. All mushroom samples were from non-commercial sources, and were found in mainly lawns, gardens, or natural areas. Clients interested in mushroom identification are most often concerned with edibility or toxicity of mushrooms, and proper identification and guidance are vital for these types of questions.

Table 2. State listed noxious weeds and other regulated plants submitted to the SDL in 2023.

Species	County	Montana Regulation
Palmer amaranth	Daniels, Toole	Restricted seed species
Common reed	Gallatin	Priority 1A noxious weed
Rush skeletonweed	Sanders	Priority 1B noxious weed
Ventenata	Beaverhead, Park, Ravalli	Priority 2A noxious weed
Hoary alyssum	Gallatin	Priority 2B noxious weed
Spotted knapweed	Ravalli	Priority 2B noxious weed
St. Johnswort	Big Horn	Priority 2B noxious weed
Whitetop	Big Horn	Priority 2B noxious weed
Cheatgrass	Ravalli	Priority 3 noxious weed

Herbicide Injury Activities and Trends

We assessed 110 physical samples for potential herbicide injury along with eight electronically submitted samples. This number was a 46% increase compared with sample numbers in 2022. We suspected herbicide injury to be affecting samples in 70% of these cases. Clients in several cases involving damage to property were referred to the Montana Department of Agriculture field offices for assistance with further investigation.

Most herbicide injury cases were from ornamental or vegetable garden settings, where we assessed 77 samples for herbicide injury symptoms. Of these, thirty-five woody ornamental samples showed symptoms consistent with synthetic auxin herbicide injury. This number was a sharp increase compared to 2022, when we saw 17 of these types of samples. These symptoms may have arisen due to factors such as herbicide drift or root uptake after lawn herbicide applications. Twenty-one vegetable samples from home gardens also showed symptoms consistent with synthetic auxin herbicide injury. Based on site histories it is likely most of these occurred because of herbicide carryover in garden amendments or newly purchased topsoil. Other issues we encountered in residential landscapes included woody plants showing glyphosate injury symptoms (three cases). In 17 potential herbicide injury cases plant symptoms were suspected to instead be due to other environmental, insect, or disease-related factors.

Of the 41 commercial agricultural samples we assessed for herbicide injury, there were several different suspected causes of injury. In 11 cases, we observed symptoms consistent with group 14 herbicide injury to pulse crops. We recorded several additional cases where symptoms were consistent with herbicide injury from in-crop or pre-plant applications of herbicide that resulted from situations such as interactions between weather events and herbicide applications. For example, we observed symptoms of contact herbicide injury, and synthetic auxin herbicide injury consistent with in-crop applications. There were a range of other issues suspected on one or two samples including herbicide drift, synthetic auxin carryover in potatoes, and ALS inhibitor carryover in pulse crops and mustard crops. Finally, we assessed 19 crop samples where symptoms were explained by other environmental factors or plant disease rather than herbicides.

Table A1. Common insects and diseases associated with urban/ornamental plant hosts submitted to the Schutter Diagnostic Lab in 2023.

Host Tree	Common Insects/Arthropods	Common Diseases
Apple	Blister mites, codling moth, Eriophyid gall mites, apple-and-thorn skeletonizer	Fire blight
Arborvitae	False spider mites, Fletcher scale	Tip blight
Ash	Gallmaking midges, ash flower gall mite, leafcurl ash aphid, ash plant bug, gall mites, carpenterworm	Anthracnose, Cytospora canker
Aspen/ Cottonwood/ Poplar	Blister mites, clearwinged aspen aphid, aspen leaf miner, poplar bud gall mite, poplar twiggall fly, tortricid leafrollers, poplar leaf-folding sawfly, poplar vagabond aphid, poplar borer, spider mites, oystershell scale	Cytospora canker, Marssonina leaf spot, Venturia leaf, twig & shoot blight
Cherry	gall mites, pearslugs/sawflies	Coryneum blight (Shothole disease)
Cotoneaster	Oystershell scale, spider mites	Cytospora canker
Elm	European elm scale, European elm flea weevil, Eriosoma aphids, Woolly apple aphid	Dutch Elm disease
Fir	Douglas fir beetle, flat-headed borer	Needle cast disease
Juniper	Pine needle scale, adelgids, spruce bud scale, juniper scale, spruce spider mites	Cedar-apple rust, Kabatina tip blight
Lilac	Eriophyid mites, root weevils, lilac borer	Bacterial blight, Powdery mildew
Maple	Cottony maple scale, maple bladdergall mite	Maple anthracnose, Powdery mildew
Oak	Gall wasps-(*Callirhytis* sp.), tussock moths, rough bulletgall wasp	Oak leaf blister
Pine	Adelgids, spruce bud scale, juniper scale pine needle scale, spider mites, sawyer beetles, black pineleaf scale, giant conifer aphids	Dothistroma needle blight, Rhizosphaera needle cast
Plum/Pear/*Prunus* (Other than Cherry)	Blister mites, pearslugs/sawflies	Cytospora canker, Fire blight
Rose	Gall wasps, bristly roseslug, European fruit Lecanium	N/A
Spruce	Cooley spruce gall adelgid, giant conifer aphids, pine needle scale, spruce bud scale, spruce spider mites, Western spruce budworm, white pine/sitka spruce weevil	Rhizosphaera needle cast, Cytospora canker, Sudden needle drop
Willow	Bumble flower beetle	Willow black canker, Cytospora canker, Coral spot

Table A2. Common arthropods and diseases associated with agricultural crop plant hosts submitted to the Schutter Diagnostic Lab in 2023.

Crop host	Common Insects/Arthropods	Common Disease
Alfalfa	Army cutworm, blister beetle	Spring black stem, Stemphylium leaf blight
Barley	Wheat curl mite, cereal leaf beetle	Net blotch, Fusarium root and crown rot, Common root rot, Spot blotch, Bacterial stripe, Scald,
Camelina	Striped beetle	Downy mildew
Chickpea	NA	Fusarium root rot
Dry field peas	NA	Fusarium root rot, Septoria leaf spot, Anthracnose, Ascochyta blight, Pea downy mildew, Rhizoctonia root rot, Bacterial leaf blight
Garlic	Stem and bulb nematode	White mold, Fusarium bulb and crown rot, Embellisia skin blotch
Lentil	NA	Fusarium root rot, Seedling damping off, Rhizoctonia crown and root rot, Aphanomyces root rot
Potato	NA	Bacterial soft rot, Potato canker and black scurf, Common scab, Fusarium dry rot
Sugarbeet	NA	Bacterial leaf blight, Fusarium root rot, Rhizoctonia crown and root rot, Cercospora leaf spot
Wheat	*Spring wheat:* Grasshoppers *Winter wheat*: Black grass bug, wheat curl mite, wheat stem sawfly *Durum wheat*: Cereal leaf beetle	*Spring wheat*: Fusarium root and crown rot, Common root rot, Bacterial leaf blight *Winter wheat*: Tan spot, Fusarium root and crown rot, Wheat streak mosaic disease, Cephalosporium stripe, Take-all *Durum wheat*: Stripe rust, Bacterial leaf blight, Fusarium root and crown rot, Tan spot