DEPARTMENT OF AGRICULTURE

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Water Quality Best Management Practices for All Agricultural Herbicides

To protect Minnesota's water resources, the Minnesota Department of Agriculture (MDA), along with University of Minnesota Extension and other interested parties, has developed a set of core voluntary Best Management Practices (BMPs). These BMPs should be adopted when applying all agricultural herbicides in Minnesota. The BMPs may also refer to mandatory label use requirements. Always read product labels. Additional information and references accompany the BMPs.

The MDA has also developed voluntary BMPs (on separate pages) for use with specific herbicides due to their presence in Minnesota's groundwater or surface water from normal agricultural use. The herbicide specific BMPs should be adopted when using herbicides that have been, or whose breakdown products have been, frequently detected in groundwater (acetochlor, atrazine, metolachlor, and metribuzin) or those detected at concentrations of concern in surface water (acetochlor and atrazine). If the BMPs are proven ineffective, mandatory restrictions on herbicide use and practices may be required. For information on monitoring results for herbicides in Minnesota's water resources, refer to the MDA's Monitoring and Assessment webpage: *www.mda.state.mn.us/monitoring*.

Careful use of herbicides – as part of an Integrated Weed Management Plan – can help protect water resources from contamination and reduce the levels of herbicides currently in Minnesota's waters. Combine and rotate herbicides with different sites-of-action and use full label rates of herbicides to delay weed resistance. Proper use and application promotes efficient and economical use of herbicides.

State and federal law can require that the use of a pesticide be limited or curtailed due to the potential for adverse impacts on humans or the environment. The Minnesota Pesticide Control Law (Minn. Stat. 18B) outlines state regulatory authority to prevent these impacts. The Minnesota Groundwater Protection Act (Minn. Stat. 103H) allows for potential regulations on the use of herbicides frequently detected in groundwater. In addition, there are other state and federal laws that could lead to restrictions on the use of herbicides contributing to surface water impacts. Adopting these BMPs, and a sensible and cautious attitude regarding the proper use of herbicides, will help growers to maintain access to a variety of herbicides as important and diverse tools in the effort to control weeds and protect water resources.

Best Management Practices (BMPs) for Herbicide Use

- Voluntary BMPs are designed to prevent and minimize the degradation of Minnesota's water resources while considering economic factors, availability, technical feasibility, implementation, effectiveness, and environmental effects.
- From a practical standpoint, these BMPs are intended to reduce the movement of herbicides to the environment and to encourage the efficient use of herbicides, chemistry rotation, and non-chemical approaches to weed control. These practices should be part of an Integrated Weed Management Plan to reduce development of herbicide resistant weeds, save costs, and increase profitability.

Integrated Weed Management

Reducing crop losses by combining cultural, chemical, and mechanical techniques in ways that favor the crop and suppress weed populations and vigor.

See "Additional Information & References" for more details and practical examples.

The BMPs are provided as a series of options. Producers, agronomists, and educators should select those options that are the most appropriate for a given farming operation, soil types and geography, tillage and cultivation practices, and irrigation and runoff management. The MDA encourages development of Integrated Weed Management Plans for every Minnesota farm (see "Additional Information and References" for more information). **Always read the product label. Label use requirements and application setbacks are legally enforceable.**

Water Quality Best Management Practices for All Agricultural Herbicides

Core Practice*	Description	Benefit
1. Scout fields for weeds and match the management approach to the weed problem.	Scout for weeds and map infestations throughout the year. Determine whether weed control will result in significant crop yield benefits. Carefully match weed control options to the weed pressure present. Include non-chemical methods such as tillage, cover crops, and crop rotation to suppress weeds. Use herbicides only in situations where they are necessary and will be cost-effective. Use herbicides with long-lasting effect ("residual control") only in fields that have high densities of target weeds, weeds with extended emergence periods, or in fields where weed information is lacking (e.g., newly rented or purchased acres), or in fields infested with resistant weeds. Consider post-emergent weed control alternatives for weed escapes. Zero tolerance for seed production of certain invasive and herbicide resistant weeds is advised.	Responding accurately to specific weed pressures, using post-emergent control and using alternative chemical and non-chemical (e.g., cultivation) controls can prevent water resource impacts.
2. For Surface Water Protection: Soil-incorporate herbicides.	Evenly incorporate herbicides to the depth recommended on the product label. Improper incorporation, excessive crop residues, or poor soil tilth may result in erratic, streaked or otherwise unsatisfactory weed control. Combine soil incorporation of herbicides with another tillage operation to avoid additional field passes and loss of crop residue.	Research indicates incorporation of herbicides makes them less vulnerable to being lost in runoff and reaching nearby streams, lakes, and surface tile inlets.
3. For Surface Water Protection: Evaluate surface drainage patterns in your field and install filter strips and establish buffer zones for streams, sinkholes, and tile inlets.	Consult with an ag consultant/Extension educator/Local Soil & Water Conservation District/Natural Resources Conservation Service to determine strategies to reduce herbicide loss to surface water. In addition to required label setbacks or buffers, install vegetative filter strips and establish buffers along vulnerable surface waters, karst features, tile inlets, and sinkholes. Consider using herbicides with low risk of runoff or non-chemical weed control methods in sensitive areas. The "Herbicide Properties Tool" (*http://npic.orst.edu/HPT/*) provides information about an herbicide's potential to move off-target by runoff, leaching, and volatilization based on its water solubility, soil half-life, and groundwater ubiquity score (leaching potential.	Filters and buffers reduce field runoff and setbacks eliminate applications where losses are most likely. Reducing use of herbicides known to move to surface water reduces the potential for surface water contamination.
4. For Groundwater Protection: Determine the depth to groundwater in your fields and consider protective practices in vulnerable areas.	Consult with an ag consultant/Extension educator/Local Soil & Water Conservation District/Natural Resources Conservation Service to identify areas vulnerable to groundwater contamination, such as, shallow water table, permeable soils, karst soils, sinkholes, and areas near wells (including active, abandoned, drainage wells). Maintain label required setbacks/restrictions from sensitive areas. Consider using herbicides with low leaching potential (*http://npic.orst.edu/HPT/*) or non-chemical weed control methods in sensitive areas. Seal abandoned wells.	Reducing herbicide use in sensitive areas reduces the potential for groundwater contamination. Adhering to label groundwater advisories and exclusions reduces aquifer pollution.
5. Rotate herbicide sites-of-action (chemistry).	Year-to-year, rotate herbicides with different sites-of-action and within season, layer or sequentially apply herbicides with different sites of action for effective control and to mitigate the development of resistance. Consider tank-mixing two different site-of-actions to gain further activity against more persistent targets. Use herbicides along with other effective weed control practices, such as utilizing field scouting to target applications, crop rotation (including rotation of herbicide-tolerant crops), cover crops, and mechanical weed control.	Reduces the total annual loss of particular herbicides to water resources and the environment. Slows the development of herbicide resistance in weeds or weed species shifts.
6. Apply herbicides at the correct rate	Apply herbicide at label specified rates. The recommended rate may depend on factors such as soil type, soil organic matter content, soil pH, crop species/growth stage, target weed species, and weed size/growth stage.	Using correct application rates increases efficacy which may reduce the need for subsequent applications.
7. For Ground Water protection: Develop an Irrigation Water Management Plan.	If you irrigate, implement a water management scheduling plan that uses a soil probe, rain gauge, daily crop water use estimations, and a soil water balance technique.	Effective irrigation management reduces leaching of chemicals to groundwater.
8. Develop an Irrigation Water Management Plan.	If you irrigate, implement a water management scheduling plan that uses a soil probe, rain gauge, daily crop water use estimations, and a soil water balance technique.	Effective irrigation management reduces leaching and runoff of chemicals.

*For practices related to the use of specific herbicides refer to MDA's herbicides-specific Best Management Practices.
All BMPs are available on the ww.mda.state.mn.us/herbicidebmps. See "Additional Information & References" for access to detailed guidance on all recommended practices.

Additional Information & References

This information accompanies the Minnesota Department of agriculture's voluntary Water Quality Best Management Practices (BMPs) for agricultural herbicides. The information and references are not additional BMPs; rather, they provide more detailed guidance to support a producer's management program for the proper use of all herbicides and are provided in support of the voluntary BMPs.

Weed Research and Herbicide Resistance Information

University of Minnesota Applied Weed Science Research Program:

Weed and pesticide management information. *http://appliedweeds.cfans.umn.edu*

Herbicide Resistant Management. *https://extension.umn.edu/weed-management/herbicide-resistance-management*

Take Action, Herbicide Resistance Management:

Herbicide Site of Action information. *www.takeactiononweeds.com*

How to Use Herbicide Site of Action Charts:

Purdue University (video). *www.youtube.com/watch?v=fBegM4XcJ4Y*

Take Action on Resistance. *https://iwilltakeaction.com/resources/herbicide-classification-chart/*

International Survey of Herbicide Resistant Weeds:

Industry and academic collaboration to monitor herbicide resistance. *www.weedscience.org*

Pesticide Use

Minnesota Department of Agriculture (MDA):

Pesticide Best Management Practices. *www.mda.state.mn.us/pesticide-fertilizer/pesticide-best-management-practices*

Integrated pest management information. *www.mda.state.mn.us/pesticide-fertilizer/integrated-pest-management*

Pesticide sales and use information. *www.mda.state.mn.us/pesticide-fertilizer/pesticide-use-sales-data*

University of Minnesota Extension:

Assistance with Integrated Weed Management Plan development. *https://extension.umn.edu/local*

Pesticide Safety and Environmental Education. *https://extension.umn.edu/pesticide-safety-and-environmental-education/pesticide-safety-and-certification*

State University Weed Control Guides

Iowa, Corn, and Soybean Production. *https://store.extension.iastate.edu/Product/12150*

North Dakota Field Crops. *www.ag.ndsu.edu/weeds*

South Dakota Pest Management Guides. *https://extension.sdstate.edu/south-dakota-pest-management-guides*

Wisconsin, Pest Management in Field Crops. *https://patstore.wisc.edu/secure/collection/commercial/49*

How to Calculate Herbicide Rates and Calibrate Herbicide Applicators:

www.extension.umn.edu/agriculture/weeds/herbicides/how-to-calculate-herbicide-rates

Soils & Water

Local Soil and Water Conservation District (SWCD) Offices:

Assistance with water table information and soil, groundwater, and surface water maps. *www.maswcd.org*

USDA - Natural Resources Conservation Service (NRCS)

Assistance with water table information, identification of vulnerable soils and sensitive areas, soil maps, and pest and weed management planning, *www.mn.nrcs.usda.gov* and click on "Technical Service Provider".

To locate offices for local assistance, click on Minnesota on the US map. *https://offices.sc.egov.usda.gov/locator/*

Soil survey information is available on-line. *http://websoilsurvey.nrcs.usda.gov/app/*

Minnesota Department of Natural Resources (MDNR)

Minnesota Hydrogeology Atlas (MHA): Information for some areas of the state on water table depth and groundwater pollution sensitivity. *www.dnr.state.mn.us/waters/groundwater_section/mapping/index.html*

University of Minnesota Extension

Assistance with soil and water information and development of irrigation plans. *www.extension.umn.edu/offices*

Tillage and Soil Management: *www.extension.umn.edu/soil-and-water/soil-management-and-health*

Irrigation Management. *www.extension.umn.edu/agriculture/irrigation*

Minnesota Department of Agriculture (MDA)

Information about monitoring and assessment of water resources for pesticide impacts: *www.mda.state.mn.us/monitoring*

See also "Irrigation Management". *www.mda.state.mn.us/ag-weather-irrigation-management-resources*

Additional Information: Integrated Weed Management

Use one or more of the following strategies to help effectively manage weeds while protecting the environment. Develop an Integrated Weed Management Plan in consultation with University of Minnesota Extension educators, Natural Resources Conservation Service and Soil & Water Conservation District personnel, certified crop advisors, and local agronomists.

Develop an Integrated Weed Management Plan for your field(s). The MDA encourages the development of Integrated Weed Management Plans for every Minnesota farm (see opposite side of this page for additional information and references). Start slow if you like. Try the practices on a few fields and build from there.

Document recent chemical use. This information is important when planning for rotating herbicide chemistries to combat herbicide resistant weeds.

Introduce a post-harvest cover crop, introduce a small grain or perennial forage, and rotate among a wider variety of crops to disrupt weed life cycles and control weeds while using fewer chemicals.

Don't assume that more is better. It may cost more to achieve 100% elimination of weeds than is gained through increased yield. Work with a certified crop advisor to determine the economic level of injury your field can sustain with reduced or no herbicide. Consider a zero-tolerance threshold for herbicide-resistant or invasive problem weeds.

Proper application timing. Apply herbicides under optimal environmental conditions and at the appropriate time of year, crop growth stage, and weed growth stage specified on the label. Doing so can improve weed control and reduce the availability of herbicides for runoff or leaching.

Use a rotary hoe, harrow, or cultivator as part of integrated approaches to weed control. Mechanical weed control can reduce herbicide program costs and reduce herbicide environmental impacts.

Consider planned, periodic use of herbicide-resistant (HR) crops in cropping sequences and rotate HR crops to prevent the use of herbicides having same site of action. HR crops should be considered as part of a planned rotation of herbicide chemistries to avoid the selection of herbicide resistant weeds or weed species shifts.

Work with your local agronomist and University Extension Educators to determine where alternative weed control practices can be introduced.

Consider unintended consequences when selecting BMPs:
The potential for unintended consequences should be considered when evaluating specific BMPs and other actions to protect and manage surface water or groundwater.

For more information or questions please
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