DEPARTMENT OF AGRICULTURE

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Water Quality Best Management Practices for All Agricultural Herbicides

In order 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). The core voluntary BMPs are provided on the opposite side of this page and 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 unique voluntary BMPs (on separate pages) for the use of 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, alachlor, 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 planning in the use of herbicides – as part of an Integrated Weed Management Plan – can help protect water resources from future contamination and help reduce the levels of herbicides currently in Minnesota's waters. Always rotate herbicides with different site-of-action and use full label rates of herbicides to delay weed resistance. Planning also promotes the 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 insecticide use

- Voluntary BMPs are designed to prevent and minimize the degradation of Minnesota's water resources while considering economic factors, availability, technical feasibility, implementability, 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 program 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. From this 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.**

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Core Practice*	Description	Benefit
1. Scout fields for weeds and match the management approach to the weed problem.	Scout for weeds, then map infestations throughout the year. Determine whether weed control will result in significant crop yield benefits. Carefully match weed control options – including non-chemical control – to weed pressures. 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 (e.g. tillage). 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. Consider split or sequential application of herbicides.	Use split or sequential applications as recommended on the label. Farms having herbicide resistant weeds should consider using split-application rates in conjunction either with different site of action herbicides or with non-chemical weed control measures. Scout fields for weed escapes and be prepared for follow-up weed management including post-emergent herbicide application or inter-row cultivation.	In many cases, a carefully planned herbicide program can result in effective weed control and a reduction in herbicide loss to the environment.
3. 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 make them less vulnerable to being lost in runoff and reaching nearby streams, lakes, and surface tile inlets.
4. 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 agronomist/Extension Educator 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. An "Herbicide Properties Tool" provides information about an herbicide's potential to move off-target by runoff, leaching, and volatilization, http://npic.orst.edu/HPT/. This program considers factors like water solubility, soil half-life, and groundwater ubiquity score (leaching potential) to determine herbicide movement from application site.	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.
5. For Ground Water protection: Determine the depth to groundwater in your fields and consider protective practices in vulnerable areas.	Consult with an Ag consultant/Extension Educator 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/. 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.
6. Rotate herbicide sites of action (chemistry).	Rotate or combine herbicides with different sites of action yet with equivalent activity on target weeds. Evaluate this practice in the context of other effective weed control practices, such as field scouting, crop rotation (including rotation of herbicide-tolerant crops), and mechanical weed control.	In the long term, this practice can help reduce the total annual loss of particular herbicides to water resources and the environment. It may also slow the development of herbicide resistance in weeds or weed species shifts.
7. Use proper application methods.	Calibrate and inspect spray equipment regularly. Do not calibrate spray equipment near water bodies. To reduce spray drift, review herbicide labels for specific requirements/recommendations on use of nozzles, spray boom height, wind speed, buffer width etc. Precision application of herbicides includes auto-steer, auto-boom shutoff, and variable application rate technology, can reduce unnecessary herbicide use resulting from overspray, spray overlap, and higher than recommended application rates.	Proper calibration and precision application ensures the correct application rate is delivered which can reduce potential loss to the environment and reduce costs.
8. 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 worksheet.	Effective irrigation management reduces leaching of chemicals to groundwater.

*For practices related to the use of specific herbicides refer to MDA's herbicides-specific Best Management Practices. All BMPs are available on the www.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 State of Minnesota'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. www.extension.umn.edu/agriculture/weeds/resistance

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
- Purdue University (Bulletin). ag.purdue.edu/btny/weedscience/Documents/MOA%20chart%20how%20to.pdf

International Survey of Herbicide Resistant Weeds:
- Industry and academic collaboration to monitor herbicide resistance. www.weedscience.org

Pesticide Use

Minnesota Department of Agriculture (MDA):
- Best management practices for pesticide use. www.mda.state.mn.us/protecting/bmps/voluntarybmps.aspx
- Integrated pest management information. www.mda.state.mn.us/ipm
- Pesticide sales and use information. www.mda.state.mn.us/chemicals/pesticides/pesticideuse.aspx

University of Minnesota Extension:
- Assistance with Integrated Weed Management Plan development. www.extension.umn.edu/offices
- Pesticide Safety and Environmental Education. www.extension.umn.edu/pesticides

USDA - Natural Resources Conservation Service (NRCS): www.nrcs.usda.gov
- Soil Survey, https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

State University Weed Control Guides
- Iowa, Corn and Soybean Production. www.weeds.iastate.edu/mgmt/2015/WC94.pdf
- North Dakota Field Crops. www.ag.ndsu.edu/weeds
- South Dakota Field Crops. http://igrow.org/agronomy/corn/2016-pest-guides-released
- Wisconsin, Field Crops. http://learningstore.uwex.edu/assets/pdfs/a3646.pdf

Incorporation Effect on Herbicide Loss:
www.ontariosportsman.com/pesticide-documents/Tillage-and-herbicide-incorporation.pdf

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.bwsr.state.mn.us/partners/directories/SWCD_Dir.pdf

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)
- Information for some areas of the state on water table depth, groundwater pollution sensitivity, and karst features: www.dnr.state.mn.us/groundwater/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 Managemen: www.extension.umn.edu/agriculture/soils
- 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/protecting/conservation/practices/irrigation.aspx

Additional Information: Integrated Weed Management

Use one or more of the following strategies to help you cost 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 use except for resistant weeds or invasive weeds with zero thresholds.

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 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 into 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).

Apply herbicides as split or sequential applications to reduce the amount of herbicide on the soil surface during periods of higher rainfall intensities.

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

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