**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, 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](http://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 sites-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 Herbicide 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.
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<th>Core Practice*</th>
<th>Description</th>
<th>Benefit</th>
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<td>1. Scout for weeds and match the management approach to the weed problem.</td>
<td>Use split or sequential applications as recommended on the label. Farms having herbicide resistant weeds should consider using split-application rates in conjunction with different site-of-action herbicides or with non-chemical weed control measures.</td>
<td>Proper calibration and precision application technology can reduce unnecessary herbicide use resulting from overspray, spray overlap, and higher than recommended application rates.</td>
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<td>2. Consider split or sequential application of herbicides.</td>
<td>Evenly incorporate herbicides to the depth recommended on the product label. Improper incorporation, excessive crop residue, or poor soil tillage may result in erratic, streaked or otherwise unsatisfactory weed control. Combine soil-incorporate with another tillage operation to avoid additional field passes and loss of crop residue.</td>
<td>Effective irrigation management reduces leaching of chemicals to groundwater.</td>
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<td>3. For Surface Water Protection: Soil-incorporate herbicides.</td>
<td>Consult with an Ag Consultant/Extension Educator/Local Soil &amp; 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. Maintain specified buffer widths where applicable.</td>
<td>Proper calibration and precision application technology can reduce unnecessary herbicide use resulting from overspray, spray overlap, and higher than recommended application rates.</td>
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<td>4. For Ground Water Protection: Reduce herbicide movement from application site.</td>
<td>Reduce herbicide use in sensitive areas as a precautionary measure to water resources and the environment. It can also slow the development of herbicide resistance in weeds or weed species shifts.</td>
<td>Effective irrigation management reduces leaching of chemicals to groundwater.</td>
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<td>5. For Ground Water Protection: Organic Crop Rotation.</td>
<td>Rotate or combine herbicides with different sites-of-action yet with equivalent activity on target weeds. Evaluate the potential for each herbicide to move off-target by runoff, leaching, and volatilization, and consider the use of alternative crop rotations.</td>
<td>Proper calibration and precision application technology can reduce unnecessary herbicide use resulting from overspray, spray overlap, and higher than recommended application rates.</td>
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<td>6. For Ground Water Protection: Application Rate Technology.</td>
<td>Rotate herbicide sites-of-action.</td>
<td>See Additional Information &amp; References for access to detailed guidance on all recommended practices.</td>
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*For practices related to the use of specific herbicides refer to MDA’s herbicides-specific Best Management Practices. All BMPs are available on the [MDA’s website](http://npic.orst.edu/HPT/).
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:
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


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

Incorporation Effect on Herbicide Loss:

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)
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/programs/gw_section/mapping/platesum/mha_wt.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/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.

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.