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Potato Fungicide ***Best Management Practices to Prevent Drift and Minimize Volatilization***

The Minnesota Department of Agriculture (MDA), along with University of Minnesota Extension and other interested parties, has developed Best Management Practices (BMPs) to prevent pesticide drift when applying liquid fungicides to potatoes. These BMPs are designed to prevent fungicide drift and minimize volatilization, and to protect bystanders and off-target areas.

The BMPs (see table) include:

- Mandatory application requirements on product labels
- Voluntary practices to prevent drift and minimize volatilization

The BMPs are designed to address airborne fungicide exposure concerns for applicators, bystanders and residents near potato fields treated by groundboom or aerial equipment. The BMPs also address prevention of drift to nearby sensitive plants, crops, and wildlife.

As with other pesticides, potato fungicide applications can result in offsite movement (drift) if not applied properly. Following label directions and these BMPs can prevent drift under a variety of application and weather scenerios. All drift from a treatment area is considered illegal, and properly reported incidents will be investigated by the MDA. Fungicide volatilization from soil and plants can also result in offsite movement. Offsite movement can be minimized by applying fungicides during appropriate weather conditions, by using properly calibrated equipment, by employing proper application techniques, and by other practices.

Fungicides vary in their potential impacts on human health and the environment. Acute and short-term inhalation, skin and eye irritation hazards are a concern, as are possible chronic health hazards such as cancer. Applicators are responsible for protecting themselves and bystanders from fungicide exposures. Non-target terrestrial and aquatic animals are also vulnerable to fungicides lost from fields. These BMPs and application requirements on product labels are designed to protect human health and the environment, even with repeated applications that can occur in a growing season.

Citizens in Minnesota have expressed concerns about the presence of potato fungicides and other pesticides in air. Such detections may be indicative of drift or volatilization from agricultural or lawn and garden use, and can lead to misuse complaints, applicator investigations and financial penalties. Risk evaluation suggests that fungicide concentrations were below USEPA levels of concern.

State and federal law allow for restrictions on the use of a fungicide to address unreasonable adverse impacts on humans or the environment. Adopting the BMPs for use of fungicides in potato production – as part of an Integrated Pest Management Plan – can help growers maintain access to these chemicals as important and diverse tools for controlling crop diseases.

Best Management Practices for Potato Fungicide Use

- The primary purpose of the BMPs is to address exposure concerns for applicators, bystanders and residents near agricultural fields.
- From a practical standpoint, the BMPs are intended to prevent drift of potato fungicides. BMPs also encourage adoption of an Integrated Pest Management program to save costs, reduce development of disease resistance, and protect human health and the environment.

Integrated Pest Management (IPM)
Reducing crop losses by integrating *cultural*, *chemical, biological* and *mechanical* techniques in ways that favor the crop and suppress disease and pest occurrence.

See "Additional Information & Resources" for more information on cultural, biological and chemical practices to minimize disease pressure on potatoes in the field.

Adoption of BMPs begins by carefully reading product labels and following all application requirements, including adherence to use rate and wind-speed maximums, application setbacks or other requirements. Then, select one or more voluntary practices to further prevent drift and minimize volatilization. Producers, crop consultants and educators should select options most appropriate for a given farming operation, nearby population dynamics, soil types and geography, and cultural practices. The MDA encourages development of Integrated Pest Management Plans for every Minnesota farm (see "Additional Information and Resources" for more information). **Always read the product label. Label use requirements are legally enforceable.**

Potato Fungicide *Best Management Practices to Prevent Drift and Minimize Volatilization*

Core Practice*	Description	Benefit
1. Establish an IPM program to minimize fungicide use. **Apply fungicides only when necessary.** (see cultural, biological and chemical practices to minimize disease pressure on potatoes in the field on page 4)	➢ Work with professionals to establish an IPM program focusing on cultural and biological control options and using fungicides only when necessary. ➢ Scout fields and apply appropriate fungicides only when necessary[1], then follow all label directions to limit the potential for drift and volatilization. ➢ Use all available local agriculture weather networks and disease prediction models to properly time fungicide applications. ➢ Walk fields often to look for early signs of disease in vulnerable locations. ➢ Follow recommended rates, application schedules, and don't exceed per acre maximum use rates. Products may have state-specific maximums for local disease management needs.	Early disease detection and understanding of weather conditions allows for more effective and better timed fungicide applications. Properly timed applications limits annual fungicide use, thereby reducing the potential for offsite movement and human exposure.
2. Review labels for drift management requirements, "Spray Drift Precautions," and any "Aerial Drift Reduction Advisory Information."	➢ Each fungicide label must be reviewed for enforceable language related to drift. ➢ Some popular potato fungicides have specific drift reduction requirements such as outer nozzle distances on aircraft wingspans, and spray direction/angle relative to the air stream. ➢ Some labels also carry non-mandatory drift reduction recommendations.	Compliance with label directions ensures that drift is appropriately mitigated in accordance with USEPA's risk assessments. Advisory drift reduction recommendations further mitigate the potential for drift.
3. Apply fungicides within ideal range of weather conditions.	➢ **Wind** -Apply when wind speeds <10 mph, but not during still conditions[2]. Still conditions encourage variable wind direction and high inversion potential[3]. Inversions occur when air close to the ground becomes cooler than the air above the canopy. Inversions usually develop overnight and can persist until the next day. ➢ **Temperature and relative humidity** –Do not spray during high temperature (>90°F) and low relative humidity (<50%) conditions which encourage evaporation of spray droplets[4].	Applying in good weather conditions can maximize efficacy and mean the difference between offsite drift (and potential exposure concerns, misuse claims and enforcement investigations) and no drift!
4. Select spray equipment and calibrations that reduce drift and evaporation.	➢ **Nozzle** -Choose low-drift nozzles that have wide angles, operate at low pressures, produce medium to coarse droplet sizes[5] (200 to 400 microns, yellow or blue color droplet size code), *and minimize "fines" (droplet size <200 microns).* ➢ **Droplet Size** -Target droplet spectrums at 285-350 VMD[6] (volume mean diameter) ➢ **Pressure -**Low pressure increases VMD of spray droplets. Apply at recommended nozzle pressure to minimize VMD of spray droplets. Also consider solid stream nozzles operated at medium pressures. ➢ **Spacing and orientation** -For groundbooms, consider a 110° spray pattern nozzle with a 15° inclination and use a low boom height[7]. For aerial applications, choose controlled droplet booms and reduce boom length to <65-75% of wing length or 85% of rotor width[6] ➢ **GPS Systems** –Use GPS systems for accurate sprays.	These practices give wind less opportunity to catch nozzle spray and, in the case of aircraft, reduce redistribution of spray by flight activity. Small droplets drift and evaporate! Droplets < 300 microns can drift 42 feet in 5 mph winds, while larger, 600 micron droplets might drift 11 feet under similar conditions. GPS systems can assist with application buffer compliance, application overlap and gaps, and reducing fungicide waste.
5. Minimize volatilization of applied fungicide.	➢ Choose fungicides with low vapor pressures. Fungicides with vapor pressures $\geq 10^{-5}$ mm Hg are considered to exhibit intermediate to high volatility under field conditions. Volatility potential increases as temperature increases. ➢ Consider using adjuvants that prevent drift and evaporation, and that minimize volatilization.	Minimizing volatilization of fungicides (from plant and soil surface) protects offsite impacts to humans and the environment.
6. Calibrate application equipment periodically to prevent drift. Conduct pattern testing.	➢ Sprayer calibration is important to establish optimum use of fungicide for disease control without waste, drift and volatilization. The most important drift-reduction components of calibration involve measurement of droplet size along with accuracy of spray placement. ➢ Pattern testing ensures distribution of fungicide across the swatch is uniform and that non-target areas are not subject to drift. ➢ Avoid high application speeds/rapid speed changes. ➢ Attend a calibration clinic[8] to facilitate adoption of best practices for aerial sprays.	Calibration ensures that all efforts undertaken in selection of fungicide and nozzles, operating pressures, spray patterns, etc. will actually contribute to drift reduction and minimizing volatilization.

***For other practices related to the use of pesticides used on crops grown in rotation with potatoes, refer to MDA's www.mda.state.mn.us/bmps See "Additional Information & References" for access to more information on all recommended practices.**

ADDITIONAL INFORMATION & RESOURCES

This information accompanies the State of Minnesota's Drift and Volatilization Reduction Best Management Practices (BMPs) for agricultural fungicides. 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 fungicides, and are provided in support of the BMPs.

BMP References

[1] University of Maine Cooperative Extension, "Field Scouting: A Tool for Potato Pest Management"
[2] University of Kentucky, "Aerial Application of Pesticides," http://www.uky.edu/Ag/PAT/cat11/cat11.htm#drift
[3] University of Nebraska Extension, "Spray Drift of Pesticides" http://ianrpubs.unl.edu/epublic/live/g1773/build/g1773.pdf
[4] Ohio Agricultural Research and Development Center, "Using Foliar fungicides to manage soybean rust" http://oardc.osu.edu/soyrust/2007edition/fungisoyrust.pdf
[5] Virginia Cooperative Extension, "Nozzles: Selection and Sizing" Publication 442-032 (2009). http://pubs.ext.vt.edu/442/442-032/442-032_pdf.pdf
[6] DuPont Crop Protection, "Aerial Applications: Best Management Practices" http://www2.dupont.com/Production_Agriculture/en_US/assets/downloads/pdfs/K-22705.pdf
[7] South Dakota Cooperative Extension Service, North Dakota Extension Service and USDA "Selecting Drift-Reducing Nozzles" FS 919, Rev. 7/08. http://pubstorage.sdstate.edu/AgBio_Publications/articles/FS919.pdf
[8] National Agricultural Aviation Association, http://www.agaviation.org/content/operation-safe

Additional references for preventing drift and minimizing volatalization

- Droplet Spectrum: Online models and smartphone apps (for iPhone and Android mobile devices) help aerial sprayers estimate spray droplet size based on various input parameters like nozzle size, orientation, spray pressure and airspeed. http://apmru.usda.gov/aerial/HomePage.htm
- University of Minnesota Extension, Chapter 9 (pp 216-224) of Private Pesticide Applicator Safety Education Manual 19th Edition (2012) http://www.extension.umn.edu/Pesticides/ppat_manual/Chapter%209.pdf
- USEPA, "Guidance for Reporting on the Environmental Fate and Transport of the Stressors of Concern in Problem Formulations for Registration Review, Registration Review Risk Assessments, Listed Species Litigation Assessments, New Chemical Risk Assessments, and Other Relevant Risk Assessments,"(2010) http://www.epa.gov/pesticides/science/efed/policy_guidance/team_authors/endangered_species_reregistration_workgroup/esa_reporting_fate.pdf
- National Agricultural Aviation-Syngenta, "50 ways to treat your pesticide" http://www.syngentacropprotection.com/Env_Stewardship/sustainable_ag/50_Ways_Aerial.pdf

Drift Complaints, Enforcement and Penalties

It can be helpful for applicators to become familiar with the process associated with drift complaints, alleged illegal applications of pesticides, enforcement and penalties.

The Minnesota Department of Agriculture (MDA) is the state agency responsible for investigating complaints of illegal pesticide use. Visit http://www.mda.state.mn.us/chemicals/pesticides/complaints.aspx for more information. The MDA receives complaints at 651-201-6333 Monday thru Friday from 8 AM to 4:00 PM. After hours, complaints can be reported to the Minnesota Duty Officer at 800-422-0798 out state and 651-649-5451 in the Minneapolis/St. Paul seven county metro area.If you believe that an applicator or bystander has been exposed to pesticide spray or dust drift and have health-related questions, you should also contact a physician, local poison control center, or health department for assistance.

Federal and State Regulatory Program Activities

Anticipate changes in the regulatory status of drift reduction/ mitigation and compliance by doing the following:

- Be certain to read each product label annually to ensure that there have been no changes in application requirements or recommended mitigation practices.
- Contact the Minnesota Department of Agriculture or your own state's pesticide regulatory agency to get updates on USEPA's activities in "Drift Reduction Technology" (DRT). Select pesticide product labels will soon begin to carry DRT ratings for application technology (e.g., nozzles). Generally, application buffer distances from sensitive sites (lakes, streams, residential areas, etc.) will be reduced for applicators using approved technology that reduces drift.
- Visit drift-related MDA and partner webpages:
    - Become familiar with how MDA processes pesticide complaints related to drift: http://www.mda.state.mn.us/chemicals/pesticides/complaints.aspx
    - Consult the registry of pesticide-sensitive areas, known as "Driftwatch" to help protect pesticide-sensitive crops and habitats from drift: http://www.driftwatch.org/

Integrated Pest Management Practices to Minimize Disease Pressure on Potatoes in the Field

Cultural In addition to implementing BMPs to prevent drift and minimize volatilization, various cultural practices can be used to limit disease pressure on potatoes. Below is a brief overview of some important cultural practices that aid in potato disease management.

Crop rotation[a]: Rotating out of potatoes reduces the amount of inoculum in the soil and can lessen the impact of some diseases. Longer rotations enhance soil fertility, help maintain soil structure, and reduce pest problems, conserve soil moisture. Potatoes should be planted no more than once every three years.

Personally inspect[b] and buy certified seed[c]: Purchasing clean and certified seed can help limit the amount of inoculum introduced to the field. If more than five percent of a seed lot contains disease it should not be used. Also, when possible, use a disease resistant potato variety[d].

Sanitation practices[e]: Clean and disinfect equipment, tools, trucks and storages. Limit movement of machinery and personnel between operations.

Properly manage nutrient needs[f]: A healthy plant resists pathogen attack. Both under fertilization and over fertilization can create favorable environments for disease outbreak. Nutrient applications should be based on plant demand. Understand the current soil nutrient levels, the potential for nutrient loss and the growth potential of the potato cultivar.

Clear all infected cull piles[g], eliminate volunteer potatoes[h] and remove weeds[i]: Cull piles, volunteer potatoes and weeds can be hosts for harmful diseases. Implement host elimination strategies combining various mechanical and herbicidal practices.

Limit leaf tissue moisture[j]: Many plant diseases require moisture on leaf tissue to infect the plant. Also, water is a good vehicle for disease dissemination. Potatoes should be irrigated at night, ideally after dew formation. Avoid leaf wetness for over 10 hours, watering in the morning before potato leaves have dried from evening dew, watering in the evening so leaves don't have a chance to dry before dew formation. Understand shade patterns on a field.

Limit soil compaction[k]: Compacted soil leads to poor drainage, which increases the amount of water available in the environment. Some management techniques include, but are not limited to: managing traffic, minimizing axle load, maintain proper tire inflation pressure and avoid entering wet fields.

Maintain field records[e]: Having detailed records of disease occurrence in a field will allow for more effective fungicide management in future years. Before the growing season, evaluate potential micro climates where disease pressure may be the highest. Avoid planting potatoes in these locations. Maintain records of where initial disease outbreaks occur and incorporate that information into disease management plans.

Biological Biological control options should be considered whenever available. Formulations of some biocontrol agents such as *Bacillus subtilis* are commercially available for use on potato crop.

Chemical Use the correct fungicides and rotate chemistries. Most fungicides only work on specific diseases and repeated use of one fungicide class can lead to disease resistance. Understand which fungicides are effective on the targeted disease(s) and rotate between fungicide chemistries throughout the growing season. Before applying fungicides, check with local extension for any known fungicide resistant issues.

Use fungicides only when necessary. Fungicides can be harmful to entomopthogenic fungi that help in natural control of pests such as aphids.

IPM References

[a] University of California Davis, IPM Online "Potato Crop Rotation"
[b] University of Maine Cooperative Extension, Bulletin #2412 "Selecting, Cutting and Handling Potato Seed"
[c] Minnesota Department of Agriculture "Potato Inspection"
[d] Washington State University Research and Extension, "Potato Varieties: A Comprehensive List"
[e] University of Idaho Extension "Cultural Controls for Potato Late Blight"
[f] USDA-ARS, Northwest Irrigation and Soils Research Laboratory "Nutritional Requirements of Potatoes"
[g] University of Idaho Extension "Disposal of Cull Potatoes"
[h] University of Idaho College of Agriculture Cooperative Extension System, CIS 1048 "Volunteer Potato Control"
[i] University of Maine Cooperative Extension "Chemical Weed Control in Potatoes"
[j] University of California Davis IPM Online "Potato Irrigation"
[k] University of Minnesota Extension "Soil Compaction: Causes, Effects, and Control"
All referenced websites were accessed in January, 2014.