

Safe Use of Foliar Fungicides to Manage Crop Diseases

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The safe use of fungicides for field crops is addressed here.

Fungicides have been used routinely in Nebraska to manage certain diseases of wheat, sugar beet and more recently on corn, but the arrival of soybean rust in the U.S. may necessitate the greater use of fungicides in soybean production.

When used correctly, fungicides can effectively reduce disease and prevent yield loss. Individuals responsible for applying fungicides need to understand how to minimize the environmental impacts of fungicides and protect their workers. This NebGuide highlights some important issues regarding the safe use of fungicides labeled for field crops in Nebraska.

Integrated Pest Management

Integrated Pest Management (IPM) combines several strategies to effectively manage pests and minimize fungicide use. These management strategies include the use of resistant crops, cultural methods, scouting and fungicides. Monitoring crops for disease development will help determine when, or if, a fungicide application is warranted. This will reduce costs and minimize unnecessary use of fungicides which can lead to environmental contamination and buildup of fungicide resistance in pathogen populations.

Personal and Environmental Safety

The fungicide label contains important information for applying fungicides safely. Always read and follow the product label prior to application. Labels list where fungicides may be applied, what pests are controlled, how the fungicide should be applied, stored and disposed of, and what safety precautions to follow. Any use of a fungicide that is not consistent with statements on the label is illegal. This law



Figure 1. Triazole injury on a soybean leaf. (Photo: Gustafson)

applies to everyone and is intended to prevent the misuse of fungicides. Apply fungicides only to sites that are identified on the label. Sample fungicide labels can be found online from various sites such as the Greenbook (www.greenbook.com) and Crop Data Management Systems (www.cdms.net) or fungicide manufacturers' Web sites. Remember that these labels are reference or sample labels only. Use them to help make your decisions about control but don't rely on them as the final word. Labels can and often do change, sometimes more than once a year. The label attached to the product along with any supplemental labeling is the official label for that fungicide product.

Risk

The risk in handling, mixing and applying fungicides is manageable. Risk is a function of product toxicity and the potential for personal exposure. The resulting risk formula is:

$$\text{Risk} = \text{Toxicity} \times \text{Exposure}$$

Knowledge of a fungicide's toxicity and the potential for personal exposure allows a user to manage the risk. Toxicity alone does not determine the risk of using a product. For example, gasoline is very toxic when ingested, but can be handled safely and is used widely. It is not possible to change a product's toxicity, but exposure can be managed to keep risk at an acceptable level. More information is available online at <http://pested.unl.edu/>.

Personal Protective Equipment

The proper use of personal protective equipment (PPE) helps prevent or minimize exposure to a fungicide when handling, mixing or during application. Always refer to the product label for specific PPE requirements, which usually are listed under the *Hazards to Humans* section on every label. Note that these requirements may be different for applicators and mixers/handlers.

Restricted Entry Interval

The restricted entry interval (REI) is the time immediately following a fungicide application you must wait before being able to safely re-enter a treated area. The amount of time required is based on the toxicity of the compound. REIs can be as little as four or as long as 72 hours. During the REI, do not enter or allow anyone to enter a treated area or contact anything treated with the fungicide. When the fungicide formulation or application is a "mixture" of active ingredients, the REI is based on the active ingredient that requires the longest restricted re-entry period.

Preventing Environmental Contamination

Fungicides may move off target if good management practices are not followed. Wind can move fungicides off-target through drift. Check the label for specific restrictions, but if none are listed, a good rule of thumb is: *do not spray a fungicide when wind velocities are greater than 10 mph*.

Runoff can be caused by excessive irrigation or rain to an area that has just received a fungicide application. Runoff can contaminate surface water resources, or excess water can move some fungicides downward through the soil profile and into groundwater.

Many labels will have a new section concerning endangered species. It is now required to check endangered species bulletins for the county where you will be applying the fungicide whenever the new sections appear. Not doing so could put you in violation of the label and, therefore the law. The bulletins are only available online at: www.epa.gov/espp/bulletins.htm. The EPA will post the most recent information it has to this Web site. Endangered species of most concern in Nebraska are the Piping Plover and the Interior Least Tern.

Preharvest Interval

The preharvest interval (PHI) is the minimum length of time that must elapse between the last fungicide application and harvest. The PHI usually is given as the number of days that the product can be applied before harvest. In some cases, the last day an application can be made is given as a crop growth stage. In addition to the PHI for grain harvest, some products list a PHI detailing restrictions on grazing or baling crop residues for livestock. Refer to the label for specific PHI for each fungicide.

Material Safety Data Sheets

Material safety data sheets (MSDS) provide important information about the specific chemistry and safe handling of a fungicide. MSDS sheets contain toxicity information, fire control methods, storage instructions and handling information. They should be kept in a book with fungicide labels where fungicides are stored, mixed or applied since they provide essential information on how to handle an emergency situation when fungicides are involved.

Application Timing

Not applying fungicides at the proper time may result in crop damage (see phytotoxicity below), unacceptable fungicide residue levels or a lack of a yield response when applied after a certain crop growth stage. If applied too early there may not be enough disease pressure to justify the cost of application. If applied too late the damage from the disease already has been done and yield may not be recovered.

For example, applying fungicides on wheat when flag leaves are unaffected by disease usually will not result in profitable returns. However, fungicide choice is limited if the plants have reached the heading or flowering stages because of PHI restrictions for some products. Additionally, fungicide applications to dry beans should not be made after natural senescence has begun or after petal drop in sunflowers. Likewise in corn, fungicide applications made after kernel dent, and especially black layer development, likely will not result in an economic return and also exceed the label's PHI for some products. These instances would not be profitable since foliar diseases will not affect the yield at later stages of crop maturity.

Phytotoxicity

Some fungicide labels may warn about a condition called phytotoxicity when applied to a crop. Phytotoxicity may result when the crop is sensitive to the fungicide, the fungicide is applied at a higher than recommended rate, the components in a fungicide mixture interact to damage the crop, the fungicide is applied during unusually hot weather, or the fungicide is applied at sensitive growth stages. Often, phytotoxic symptoms will not cause yield loss. Common injury symptoms from a fungicide application are chlorotic spots on leaves in the upper canopy where plant contact with a fungicide is the highest. The fungicide label will indicate ways to minimize crop injury

Table I. Specific safety warnings on fungicide labels by fungicide class.

	<i>Fungicide Class</i>		
	<i>Triazoles</i>	<i>Strobilurins</i>	<i>Chloronitriles</i>
Signal Words	Caution, Warning, Danger	Caution, Warning	Caution, Warning, Danger
Oral LD₅₀ Range¹	119 – 342 g/200 lb adult	>45 – >454 g/200 lb adult	296 – 816 g/200 lb adult
Dermal LD₅₀ Range	>182 – >458 g/200 lb adult	>362 g/200 lb adult	>181 g/200 lb adult
Toxic to Fish and Aquatic Organisms	Yes	Yes	Yes
Specific Phytotoxicities	Injury to soybeans ² (see <i>Figure 1</i>)	Azoxystrobin will injure apple trees	No known phytotoxicities
Human Response to Exposure	Mainly liver, but other organs (including eyes) can be affected	Liver may be affected	Has been shown to cause kidney tumors in lab animals
PPE Requirements³	Coveralls; eyewear; chemical resistant footwear and gloves; and an apron when mixing and loading	Long-sleeved shirt and pants; shoes plus socks; chemical resistant gloves; eyewear	Long-sleeved shirt and pants; shoes plus socks; chemical resistant gloves; eyewear; a respirator may be required

¹The LD₅₀ (Lethal Dose, 50%) is the dose of active ingredient in the fungicide that is theoretically lethal to 50% of the population. Keep in mind that these are listed according to active ingredient and not the amount of actual product (one pound is 454 grams). A lower number represents higher toxicity. The LD₅₀ is determined using laboratory animals.

²Triazole injury not observed with all products and varies with soybean variety.

³Personal Protective Equipment (PPE) varies with each product. Consult the specific product label.

while at the same time maintaining adequate disease control. For example, triazole based fungicides may cause less crop injury when applied without a surfactant (see *Table I*).

Resistance Management

When a fungicide or a group of fungicides with the same mode of action is used repeatedly, resistance to the fungicide can develop in the target pathogen population, rendering the fungicide ineffective. Resistance management aims to reduce development of fungicide resistance in target pathogens. Resistance management strategies include tank-mixing or rotating fungicides with different modes of action, monitoring for disease development so that fungicides are applied only when necessary, using fungicides preventively, and integrating fungicides into an IPM program.

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**Index: Plant Diseases
Field Crops**

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