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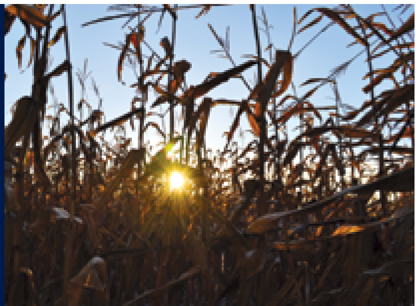
# CORN

## BEST MANAGEMENT PRACTICES

CHAPTER 48



# Corn Foliar Fungicides

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Foliar diseases can lead to premature leaf senescence, and predispose stalks to rotting, poor grain quality, and reduced yields. Common fungal diseases found on corn include common rust, northern corn leaf blight, gray leaf spot, eye spot, anthracnose leaf blight, and Physoderma brown spot. Management of foliar diseases involves managing the surface residue (through rotation or tillage), selecting resistant hybrids, and performing in-season fungicide application. Corn residue on the surface of the soil can increase certain foliar disease problems, such as gray leaf spot and northern corn leaf blight. Although the severity of these diseases varies from year to year, application of foliar fungicides may provide effective control in years of high disease pressure. The purpose of this chapter is to provide guidance on the use of fungicides.

*Figure 48.1 Northern corn leaf blight symptoms on corn. (Courtesy of authors)*

## Introduction

Fungicides are an effective in-season management tool for fungal leaf diseases, and sometimes can reduce chances of stalk rot development. A number of fungicide products that are effective against fungal pathogens on corn are available for use. However, some are more effective on certain pathogens than others. Most of the fungicides available are preventive in nature and stop the fungus from infecting or advancing within the plant. Therefore, timing of a fungicide treatment is critical. If fungicides are applied when the severity is already high, the benefit will be limited.

When deciding whether to apply a foliar fungicide, consider the following:

- The level of disease. Is there a significant amount of disease showing up on the leaves below the ear leaf?
- The current weather. For example, has it been warm and humid? Does the forecast predict continued hot conditions? If yes, disease severity may worsen, so application is advised. If no, disease outbreaks may not reach a critical stage and scouting should continue until corn has passed dent growth stage.
- The corn growth stage. How far along is the corn? If corn is at R5 (dent), diseases most likely will not

influence yield or will be minimal.

- Susceptibility of hybrid(s). For example, most the hybrids have moderate resistance to common rust and therefore, no treatment may be needed.
- Potential yield. If yield is predicted to be low (due to moisture stress, or poor fertility), chances of an economic gain due to fungicide treatment will be low.
- Grain price. When prices are high, it takes only a few bushels to pay for the cost of applying a fungicide (Table 48.1).

Once a fungicide treatment is deemed to be necessary, growers should ensure the sprayer is calibrated to deliver the recommended rate (as per the fungicide label), and that weather conditions are not too windy (> 10 mph) or too hot.

**Table 48.1 The number of corn bushels needed to break even for the cost of fungicide and its application.**

| Price of corn ($) | Application cost ($) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **12.0** | **15.0** | **20.0** | **25.0** | **30.0** | **40.0** | **50.0** |
| 1.5 | 8.0 | 10.0 | 13.3 | 16.7 | 20.0 | 26.7 | 33.3 |
| 2.0 | 6.0 | 7.5 | 10.0 | 12.5 | 15.0 | 20.0 | 25.0 |
| 3.0 | 4.0 | 5.0 | 6.7 | 8.3 | 10.0 | 13.3 | 16.7 |
| 4.0 | 3.0 | 3.8 | 5.0 | 6.3 | 7.5 | 10.0 | 12.5 |
| 5.0 | 2.4 | 3.0 | 4.0 | 5.0 | 6.0 | 8.0 | 10.0 |
| 6.0 | 2.0 | 2.5 | 3.3 | 4.2 | 5.0 | 6.7 | 8.3 |
| 7.0 | 1.7 | 2.1 | 2.9 | 3.6 | 4.3 | 5.7 | 7.1 |
| 8.0 | 1.5 | 1.9 | 2.5 | 3.1 | 3.8 | 5.0 | 6.3 |
| 9.0 | 1.3 | 1.7 | 2.2 | 2.8 | 3.3 | 4.4 | 5.6 |

## Proactive Fungicide Treatments

### *Economic Benefit*

Several research studies have shown that when a fungicide is applied in the absence of disease or very low disease severity, the probability of increasing yield to pay for the treatment decreases significantly (Byamukama et al, 2013; Wise and Mueller, 2011; Pierce et al, 2011). For example, Mueller and Wise (2011) analyzed data from 613 treatment comparisons of strobilurin-treated and nontreated plots over a 10-year period in the Corn Belt region. The fungicides were applied between V14 and R5 (dent) with a majority of treatments being applied between tasseling (VT) and R2 (blister). They reported that when disease severity was less than 5% on the ear leaf at the end grain fill period, the fungicide treatment increased yields 1.5 bu/acre, and when the disease severity was > 5% the yield gain averaged 9.6 bu/acre. These results suggest that there may be some benefit from proactive fungicide applications. The yield enhancement has been linked to improved crop health (stays green longer) and reduced fungal populations. However, these benefits must be balanced against the long-term risk of the fungal pathogens developing resistance. Therefore, to avoid problems associated with unnecessary application of fungicides (such as resistance development, added expenses), growers should always scout to determine the need for a fungicide application.

## Fungicide Efficacy for Control of Corn Diseases - 2016

The South Dakota State University Plant Pathology Extension is a member of the Corn Disease Working Group (CDWG) and has participated in the fungicide efficacy trials. The group has developed the following information on fungicide efficacy for management of major corn diseases in the United States. Efficacy ratings for each fungicide listed in the table were determined by committee members field-testing the materials over multiple years and at multiple locations. Efficacy ratings are based upon level of disease control achieved by product and are not necessarily reflective of yield increases obtained from product application. Efficacy depends upon proper application timing, rate, and application method to achieve optimum effectiveness of the fungicide as determined by labeled instructions and overall level of disease in the field at the time of application. Differences in efficacy among fungicide products were determined by direct comparisons among products in field tests and are based on a single application of the labeled rate as listed in Table 48.2.

**Table 48.2 Systemic fungicides available that have been tested over multiple years and at multiple locations. The table is not intended to be a list of all labeled products[1]. Efficacy categories: NR=Not Recommended; P=Poor; F=Fair; G=Good; VG=Very Good; E=Excellent; NL=Not Labeled for use against this disease; U=Unknown efficacy or insufficient data to rank product. This table is a joint publication by the Corn Diseases Working Group, coordinated by Dr. Kiersten Wise at Purdue University. A list of other fungicides approved fungicide on corn can be found in the crop protection guide for corn, http://igrow.org/up/resources/03-2016-2015.pdf.**

| Fungicide (s) Class | Active ingredient (%) | Product/Trade name | Rate/a (fl oz) | Anthracnose leaf blight | Common rust | Eye spot | Gray leaf spot | Northern leaf blight | Southern rust | Harvest Restriction[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| QoI Strobilurins Group 11 | Azoxystrobin 22.9% | Quadris 2.08 SC<br><br>Multiple Generics | 6.0–15.5 | VG | E | VG | E | G | G | 7 days |
| | Pyraclostrobin 23.6% | Headline 2.09 EC/SC | 6.0–12.0 | VG | E | E | E | VG | VG | 7 days |
| | Picoxystrobin | Aproach 2.08 SC | 3.0–12.0 | VG | VG-E | VG | F-VG | VG | G | 7 days |
| DMI Triazoles Group 3 | Propiconazole 41.8% | Tilt 3.6 EC<br><br>Multiple Generics | 2.0–4.0 | NL | VG | E | G | G | F-G | 30 days |
| | Prothioconazole 41.0% | Proline 480 SC | 5.7 | U | VG | E | U | VG | G | 14 days |
| | Tebuconazole 38.7% | Folicur 3.6 F<br><br>Multiple Generics | 4.0–6.0 | NL | U | NL | U | VG | F-G | 36 days |
| | Tetraconazole 20.5% | Domark 230 ME | 4.0–6.0 | U | U | U | E | U | G | R3 (milk) |
| Mixed modes of action | Azoxystrobin 13.5%<br><br>Propiconazole 11.7% | Quilt Xcel 2.2 SE | 10.5–14.0 | VG | VG-E | VG-E | E | VG | VG | 30 days |
| | Bensovindiflupyr 10.27%<br><br>Azoxystrobin 13.5%<br><br>Propiconazole 11.7% | Trivapro A 0.83<br><br>+ Trivapro B 2.2 SE | A = 4.0<br><br>B = 10.5 | U | U | U | E | VG | E | 7 days (A)<br><br>30 days (B) |
| | Cyproconazole 7.17%<br><br>Picoxystrobin 17.94% | Aproach Prima<br><br>2.34 SC | 3.4–6.8 | U | U | U | E | VG | G-VG | 30 days |
| | Flutriafol 19.3%<br><br>Fluoxastrobin 14.84% | Fortix<br><br>3.22 SC<br><br>Preemptor 3.22 SC | 4.0–6.0 | U | U | U | E | VG-E | VG | R4 (dough) |
| | Pyraclostrobin 28.58%<br><br>Fluxapyroxad 14.33% | Priaxor<br><br>4.17 SC | 4.0–8.0 | U | VG | U | VG | U | G | 21 days |

**Table 48.2 Systemic fungicides available that have been tested over multiple years and at multiple locations. The table is not intended to be a list of all labeled products[1]. Efficacy categories: NR=Not Recommended; P=Poor; F=Fair; G=Good; VG=Very Good; E=Excellent; NL=Not Labeled for use against this disease; U=Unknown efficacy or insufficient data to rank product. This table is a joint publication by the Corn Diseases Working Group, coordinated by Dr. Kiersten Wise at Purdue University. A list of other fungicides approved fungicide on corn can be found in the crop protection guide for corn, http://igrow.org/up/resources/03-2016-2015.pdf.**

| Fungicide (s) Class | Active ingredient (%) | Product/Trade name | Rate/a (fl oz) | Anthracnose leaf blight | Common rust | Eye spot | Gray leaf spot | Northern leaf blight | Southern rust | Harvest Restriction[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| Mixed modes of action | Pyraclostrobin 13.6%<br>Metconazole 5.1% | Headline AMP 1.68 SC | 10.0–14.4 | U | E | E | E | VG | G-VG | 20 days |
| | Trifloxystrobin 32.3%<br>Prothioconazole 10.8% | Stratego YLD 4.18 SC | 4.0–5.0 | VG | E | VG | E | VG | G-VG | 14 days |
| | Tetraconazole 7.48%<br>Azoxystrobin 9.35% | Affiance 1.5 SC | 10.0–14.0 | U | U | U | U | U | G | 7 days |

[1]Additional fungicides are labeled for disease on corn, including contact fungicides such as chlorothalonil. Certain fungicides may be available for diseases not listed in the table, including Gibberella and Fusarium ear rot. Applications of Proline 480 SC for use on ear rots requires a FIFRA Section 2(ee) and is only approved for use in Illinois, Indiana, Iowa, Louisiana, Maryland, Michigan, Mississippi, North Dakota, Ohio, Pennsylvania, and Virginia.

[2]Harvest restrictions are listed for field corn harvested for grain. Restrictions may vary for other types of corn (sweet, seed or popcorn, etc.), and corn for other uses such as forage or fodder.

Many products have specific use restrictions about the amount of active ingredient that can be applied within a period of time or the amount of sequential applications that can occur. Please read and follow all specific use restrictions prior to fungicide use. This information is provided only as a guide. It is the responsibility of the pesticide applicator by law to read and follow all current label directions. Reference to products in this publication is not intended to be an endorsement to the exclusion of others that may be similar. Persons using such products assume responsibility for their use in accordance with current directions of the manufacturer. Members or participants in the CDWG assume no liability resulting from the use of these products.

***Fungicide Resistance***
Fungicide resistance is when a fungicide that used to control a given fungal pathogen, no longer offers any protection against the same fungus. Several factors are responsible for fungicide resistance including:

- The fungicide provides a selection process for pathogens that are resistant or tolerant to the treatment. Practices that increase the risk of fungicide resistance include:
    - Multiple applications of fungicides with same mode of action.
    - Reducing the application rate or using off-label products.
    - Multiple applications of the same mode of action fungicides within a single year.
- High genetic variability within the pathogens.
    - High variability suggests that some pathogens will have inherent tolerance to fungicide.
- High reproduction capacity of the pathogen.
    - Pathogens, which reproduce quickly (e.g., rusts), are likely to have increased diversity and therefore likely to be selected for when fungicides of similar modes of action are applied to the same area in a season.

To avoid fungicide resistance, growers should monitor the performance of the fungicides they use. One way to do this is to leave a strip of a nontreated area (one pass), where the yield and disease severity from the treated and nontreated zones can be compared. If the two areas have comparable disease severity, this would mean that the fungicide had minimal impact on the disease that year and this could probably be due to resistance development. In this case, samples of diseased leaves in the treated area and untreated area should be collected and sent to the SDSU Plant Diagnostic Clinic for fungicide sensitivity testing. Proper disease identification and appropriate fungicide selection is crucial for effective use of fungicides.

The risk of developing fungicide resistance can be reduced by:

- Rotating between different classes of fungicide within a season and also between seasons.
- Scouting to determine the need for a fungicide and avoid applying fungicide when it is not necessary or when it is too late (severe symptom on ear leaf and higher).
- Using a mixture of fungicide classes. Luckily, several fungicide products are "broad spectrum."
- Practicing integrated disease management to reduce disease pressure.
- Following the label directions to determine the rates, growth stage of the crop, compatibility with other pesticides, and safety information.

## Fungicide Classes
Fungicides are classified into groups depending on their mode of action. For instance, some fungicides interfere with fungal protein synthesis, while others interfere with respiration, etc. The Fungicide Resistance Action Committee (FRAC) is an international committee that is responsible for fungicide-resistance monitoring. The panel has developed FRAC codes that classify fungicides into classes with the same mode of action (Fig. 48.2). Fungicide labels contain the FRAC code and fungicides with the same FRAC code belong to the same class. When rotating fungicides, growers should ensure that rotation is made between different FRAC codes. Fungicide resistance has not been reported for corn pathogens in South Dakota.

***Host Resistance in Management of Plant Diseases***
Cultivar selection is a critical step in integrated pest management (IPM). Prior to the use of synthetic chemicals, farmers chose and saved seed from the best yielding and healthiest plants (e.g., bigger corn ears) for the next growing season. Today, planting a carefully selected corn hybrid may be the most important management decision to get maximum yield. Corn hybrids are developed to suit different needs: maturity, resistance to pests and diseases, plant characteristics (plant height, seed color, stalk strength, etc.).

Host resistance/tolerance, when available, is the first line of defense in plant disease management. Disease resistance genes have been bred into hybrids through conventional breeding or genetic engineering. Evolutionarily, plants and pathogens have co-existed together. When plants are attacked by a pathogen, the plants have evolved and developed a resistance gene against this pathogen. Over time, this pathogen also evolves to overcome the resistance gene.

Growers should keep good records on the performance of the hybrids grown to aid in their decision-making process. Monitoring performance of hybrids planted may also help indicate development or change in a pathogen race allowing the pathogen to overcome the resistance gene in the hybrid.

Unlike other traits, like glyphosate resistance, Bt, and other GMO traits, disease-resistance traits, to date, do not add to the cost of seed. Yet host resistance is an effective, sustainable, and affordable plant disease management practice. Several seed companies provide disease ratings for their hybrids making it easier to choose optimum characteristics for the growing conditions. When selecting a hybrid, growers should consider the history of diseases in their fields and cropping practices (such as corn on corn or no-till). For instance, corn on corn under irrigation is likely to have Goss's wilt develop; therefore, a grower in this case would want to plant a Goss's wilt resistant/tolerant corn hybrid.


*Figure 48.2 Example of fungicide labels displaying the FRAC code (circled in blue). Prosaro has FRAC code 3 while Aproach has code 11. These two fungicides belong to two different groups and therefore can be rotated to prevent/manage resistance.*

## References and Additional Information

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