Fungicide Terminology

Key Concepts

A fungicide is a chemical agent that kills or inhibits the growth of fungi or fungal-like organisms. A given fungicide can be referred to by at least three names, all of which can be found on the product label (Fig. 5):

**chemical name:** the name of the active ingredient in a fungicide (for example, carbamic acid, \[2-[[1-(4-chlorophenyl)-1H-pyrazol-3-yl]oxy]methyl]phenyl methoxy-, methyl ester).

**common name:** the less technical name of the active ingredient (for example, pyraclostrobin).

**trade name:** the registered name under which the active ingredient is commercially available (for example, Headline). The active ingredient may be marketed under several different trade names.

![Fungicide Label](image)

**Fig. 5.** Identifying the information on a fungicide label. (Headline label courtesy BASF)
Classification Criteria

Fungicides can be classified according to a number of different criteria:

1. mobility in the plant
2. role in the protection of plants
3. breadth of metabolic activity
4. mode of action
5. chemical group or class
6. FRAC code

1. Mobility in the Plant

contact fungicide: a fungicide that remains on the surface of the plant where it is applied but is not absorbed into plant tissue. This type of fungicide has no postinfection activity. Repeated applications are needed to protect new growth of the plant and to replace fungicide that has been washed off by rain or irrigation or degraded by environmental factors such as sunlight.

systemic fungicide: a fungicide that moves into plant tissue and may offer some postinfection activity. Very few fungicides are truly systemic (moving freely throughout the plant). However, some are upwardly systemic (moving up in the plant through xylem tissue), and some are locally systemic (moving into treated leaves and redistributing somewhat within the treated portion of the plant) (Fig. 6).

2. Role in the Protection of Plants

preventive activity: occurs when a fungicide is present on the plant as a protective barrier before the pathogen arrives or begins to develop; that is, the fungicide prevents infection from occurring. (This type of activity is also referred to as protective activity.)

early infection activity: occurs when a fungicide is absorbed by the plant and stops the pathogen in its early developmental stages—usually within 24–72 hours after infection occurs, depending on the fungicide. (This type of activity is sometimes referred to as curative or kickback activity.) Most fungicides that have early infection activity also have preventative activity and are most effective when applied before infection occurs.

antisporulant activity: occurs when a fungicide prevents spores from being produced. In this case, disease continues to develop (for example, lesions continue to expand), but spores are not produced or released, so the amount of inoculum available to infect surrounding plants is reduced.

3. Breadth of Metabolic Activity

single-site fungicide: a fungicide that is active against only one point or function in one of the metabolic pathways of a fungus or against a single critical enzyme or protein needed by the fungus (Fig. 7). This type of fungicide tends to have systemic properties.

multisite fungicide: a fungicide that affects a number of different metabolic sites within the fungus (Fig. 7).

4. Mode of Action

A fungicide’s mode of action is the means by which it kills or suppresses a target fungus or affects specific biochemical processes of the target fungus. Examples of modes of action include damaging cell membranes,  

Fig. 6. Fungicides with systemic activity enter plant tissue and move within the plant (droplet on right); fungicides with translaminar activity move through the leaf from the sprayed surface to the nonsprayed surface (droplet on left). (Courtesy Iowa State University)
inactivating critical enzymes or proteins, and interfering with key processes, such as energy production and respiration.

5. **Chemical Group or Class**

A chemical group or class is a set of chemicals that have a common biochemical mode of action and may or may not have a similar chemical structure. Fungicides approved for use on field crops fall into different chemical groups.

![Fig. 7. Fungicides can affect a single site (droplet on left) or multiple sites (droplet on right) of a fungus. (Courtesy Iowa State University)](image)

### 6. **FRAC Code**

The Fungicide Resistance Action Committee (FRAC) is an organization developed to address the issue of fungicide resistance. This organization developed a code of numbers and letters that is used to distinguish different fungicide groups based on their modes of action. This code is known as the **FRAC code** (see Table 2 for examples). (FRAC codes are discussed in more detail in Part III.)

### Additional Terms

- **active ingredient (a.i.):** the molecule that provides biological activity to control the fungus.
- **adjuvant:** a compound that is tank mixed or included in the pesticide formulation to improve coverage on the plant or penetration into leaf tissue. Adjuvants are also known as spreader-stickers and surfactants.
- **baseline sensitivity:** the amount of fungicide that is able to effectively control a fungal plant pathogen population that has never been exposed to the fungicide.
- **biological fungicide (biofungicide):** a fungicide that is composed of living organisms or their metabolites (such as antibiotics).
- **chemigation:** application of a fungicide through a sprinkler irrigation system (Fig. 8). Chemigation is referred to as fungigation on some fungicide labels.

### TABLE 2. Examples of field crop fungicides with different classifications

<table>
<thead>
<tr>
<th>Properties</th>
<th>Headline</th>
<th>Trade Name(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active ingredient</td>
<td>Pyraclostrobin</td>
<td>Proline</td>
</tr>
<tr>
<td>FRAC code</td>
<td>11</td>
<td>Prothioconazole</td>
</tr>
<tr>
<td>Chemical group or class</td>
<td>Methoxycarbamate (strobilurin)</td>
<td>Mancozeb</td>
</tr>
<tr>
<td>Mode of action</td>
<td>Quinone outside inhibitor (QoI)</td>
<td>Multisite contact activity</td>
</tr>
<tr>
<td>Mobility in plant</td>
<td>Locally systemic</td>
<td>Upwardly systemic</td>
</tr>
<tr>
<td>Role in protection</td>
<td>Protectant and early infection</td>
<td>Protectant</td>
</tr>
<tr>
<td>Breadth of activity</td>
<td>Single site</td>
<td>Multisite</td>
</tr>
</tbody>
</table>
cross-resistance: when a fungus becomes resistant to more than one fungicide within a FRAC code.

fungicide resistance: the reduction in sensitivity to a fungicide by an individual fungus. Fungicides with single-site modes of action are at relatively high risk for developing resistance compared to those with multisite modes of action.

in-furrow: refers to a fungicide applied in the seeding furrow of the targeted crop, usually at planting.

integrated pest management (IPM): an approach that uses a combination of management strategies to reduce yield loss from pests.

monocyclic: refers to a pathogen having only one life cycle in a growing season (Fig. 9).

Fig. 8. A center-pivot chemigation application made to potato. (Courtesy Lyndon Porter)

Fig. 9. White mold of soybean is an example of a disease with a monocyclic life cycle. (Courtesy Iowa State University)
**pathogen**: an organism that causes disease. Pathogens include fungi, fungal-like organisms (for example, oomycetes, such as *Phytophthora* and *Pythium* species), bacteria, viruses, and nematodes.

**phytotoxicity**: the condition in which plant tissue has been damaged by a chemical.

**polycyclic**: refers to a pathogen having multiple life cycles in a growing season. Fungal pathogens with multiple life cycles are often referred to as having repeating spore stages (Fig. 10).

**preharvest interval (PHI)**: the minimum amount of time that must pass between the last pesticide application and harvesting of the crop or grazing or cutting it for livestock feed. Typically, PHIs for fungicides applied to field crops range from 7 to 30 days, depending on the crop and the fungicide. Some fungicides have restrictions based on crop growth stages instead of a specific number of days.

**reduced-risk fungicide**: a fungicide that has less negative impact on humans and the environment, as well as lower potential for accumulation in groundwater, than other fungicides. Many biological fungicides are reduced-risk fungicides.

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*Fig. 10.* Gray leaf spot of corn is an example of a disease with a polycyclic life cycle. The disease cycle repeats throughout the season, and disease progresses up the plant. During the repeating life cycles, infected leaves become the source of inoculum, rather than corn residue. (Courtesy Iowa State University)
**restricted entry interval (REI):** the minimum time between application of a pesticide to a field and when it is safe to reenter that field. All agricultural pesticides labeled after April 1994 are required to have an REI stated on the label. REIs for fungicides, like those for other pesticides, are established to reduce pesticide exposure and are based on product toxicity. REIs range from 12 to 24 hours for most fungicides. Workers should not enter a treated area until the REI has passed.

**restricted use product (RUP):** a pesticide that can be bought and handled only by a licensed, certified pesticide applicator or under the supervision of a certified pesticide applicator.

**translaminar:** a type of activity in which the fungicide is redistributed from the sprayed leaf surface, through the leaf, to the unsprayed leaf surface (that is, it moves from the top of a sprayed leaf to its underside) (Fig. 6, page 5).