

Families of Fungicides for Turfgrass

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Common Name	FRAC Code ²	Trade Names ¹	Mode of Action	Placement/Mobility	Concern Over Resistance	Comments
Chemical Family: Dithiocarbamates						
Mancozeb	M3	Fore, Mancozeb, Dithane T/O, Protect T/O	general	contact	low	These types of fungicides have broad-spectrum control properties and are used as protectants. Early development of these started in the 1930's.
Thiram	M3	Spotrete, Defiant, Thiram				
Chemical Family: Dicarboximides						
Iprodione	2	Chipco 26GT, Raven Iprodione Pro, 18 Plus	specific	local penetrant	moderate to high (not persistent)	The dicarboximides were developed in the mid-1970's. These fungicides have broad-spectrum activity.
Vinclozolin	2	Touché, Curalan				
Chemical Family: Benzimidazoles						
Thiophanate-methyl	1	Cleary's 3336 T methyl Pro, T-Storm	specific	systemic (upward)	high	This family of fungicides became available in the late 1960's and ushered in the era of systemic fungicides. The development of resistance to the benzimidazoles is a serious problem.
Chemical Family: Sterol Inhibitors or Demethylase Inhibitors						
Fenarimol	3	Rubigan	specific	systemic (upward)	high	This group of fungicides was introduced in the late 1970's and has broad-spectrum activity. At times, referred to as the SI's or DMI's. The development of resistance to this family of fungicides is a serious problem.
Myclobutanil	3	Eagle				
Triademefon	3	Bayleton, Accost				
Propiconazole	3	Banner MAXX, Spectator, ProPensity, Kestrol, ProPimax				
Triticonazole	3	Trinity				
Metconazole	3	Tourney				
Chemical Family: Strobilurins						
Azoxystrobin	11	Heritage	specific	systemic (upward)	high	First product available in 1997. The chemical structures are found in various naturally-occurring, wood-decaying fungi. Broad spectrum disease management chemical tools.
Trifloxystrobin	11	Compass	specific	local penetrant	high	
Pyraclostrobin	11	Insignia	specific	local penetrant	high	
Fluoxastrobin	11	Disarm	specific	systemic (upward)	high	
Chemical Family: Carboxamides or Anilides						
Flutolanil	7	ProStar	specific	systemic (upward)	low	The first family of successful systemic fungicides to hit the market in 1966. With the exception of Emerald, carboxamide fungicides are highly effective against Rhizoctonia and other basidiomycetes.
Boscalid	7	Emerald	specific	systemic (upward)	moderate to high	
Additional Fungicides... each is in a different chemical family						
Chlorothalonil	M5	Daconil, Manicure, Pegasus, Echo	general	contact	low	Listed are other important fungicides. Some give broad spectrum control. Since these compounds represent different chemical groups, they are placed together here. Chlorothalonil is a protectant fungicide, PCNB is usually considered to be a protectant but may be locally systemic.
PCNB	14	Terraclor, Turfcide, Revere, FFII, PCNB, Defend, Engage	general	contact	low	
Fludioxonil	12	Medallion	specific	contact	low to moderate	
Polyoxin D zinc salt	19	Endorse	specific	local penetrant	moderate	
Oomycete (<i>Pythium</i>) Fungicides ... in different chemical families						
Mefenoxam	4	Subdue MAXX, Apron (seed treatment with Metalaxyl)	specific	systemic (upward)	high	Few diseases besides those caused by <i>Pythium</i> species or closely related water molds (Oomycetes) like yellow tuft, are controlled. Azoxystrobin (Heritage) and Pyraclostrobin (Insignia) are unique with activity against both <i>Pythium</i> species (Oomycetes) and the fungi. Fosetyl-aluminum is a true systemic exhibiting both upward and downward movement in plants. It is also unique in that it moves in the phloem (symplastic transport) as compared to all other systemic fungicides that are transported in the xylem (apoplastic transport).
Propamocarb	28	Banol	not well known	systemic (upward)	low	
Pyraclostrobin	11	Insignia	specific	local penetrant	high	
Fosetyl-Aluminum	33	Prodigy, Chipco Signature, Autograph	not well known	systemic (up & down)	low	
Azoxystrobin	11	Heritage	specific	systemic (upward)	moderate to high	
Chloroneb	14	Teremec SP	general	contact (local penetrant)	low	
Ethazole (Etridiazole)	14	Koban, Terrazole, Truban	general	contact	low	
Cyazofamid	21	Segway	specific	local penetrant	moderate to high	
phosphite (salts of phosphorous acid)	33	Magellan, Biophos, Resyst, Alude, Vital	general	systemic (up & down)	low	

¹Product list by trade name may not be all inclusive.

²FRAC codes indicate the biochemical target site of action, according to the Fungicide Resistance Action Committee. M3 and M5 indicate multi-site inhibitor, with no significant risk of resistance.

Products that contain more than one fungicide:

Product Name:	Active Ingredients:
Armada	triadimefon + trifloxystrobin
Concert	propiconazole + chlorothalonil
ConSyst, Spectro, Peregrine	thiophanate-methyl + chlorothalonil
Headway	azoxystrobin + propiconazole
Instrata	propiconazole + chlorothalonil + fludioxonil
Junction	copper hydroxide + mancozeb
LESCO Twosome	fenarimol + chlorothalonil
MANhandle	myclobutanil + mancozeb
Prostar Plus	triadimefon + flutolanil
Proturf Fluid Fungicide, Dovetail	iprodione + thiophanate-methyl
Proturf Fluid Fungicide II	metalaxyl + triadimefon
Proturf Fluid Fungicide III	triadimefon + thiram
Proturf Fungicide IX	thiophanate-methyl + chloroneb
Tartan	triadimefon + trifloxystrobin + stress guard
Systar	thiophanate-methyl + flutolanil
26/36 Fungicide	iprodione + thiophanate-methyl

FRAC - Fungicide Resistance Action Committee

FRAC is a Specialist Technical Group of CropLife International (Formerly Global Crop Protection Federation, GCPF).

The purpose of FRAC is to provide fungicide resistance management guidelines to prolong the effectiveness of “at risk” fungicides and to limit crop losses should resistance occur.

The main aims of FRAC are to:

1. Identify existing and potential resistance problems.
2. Collate information and distribute it to those involved with fungicide research, distribution, registration and use.
3. Provide guidelines and advice on the use of fungicides to reduce the risk of resistance developing, and to manage it should it occur.
4. Recommend procedures for use in fungicide resistance studies.
5. Stimulate open liaison and collaboration with universities, government agencies, advisors, extension workers, distributors and users of products.

FRAC Code: Numbers and letters are used to distinguish the fungicide groups according to their cross resistance behavior. The numbers were assigned according to the time of product introduction to the market. The letters refer to F = host defense inducers, M = multi-site inhibitors, and U = unknown mode of action and unknown resistance risk.

For more information go to - <http://www.frac.info/frac/menu.htm>