

Fungicides Grouped by Mode of Action and Relative Risk for Developing Resistance Problems

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 From Fungicide Resistance Action Committee (FRAC) (<http://www.frac.info/>)

Mode of action group	Sub-group ¹	Group name	Common name	Trade names	Action ²	Uses ³	Risk ⁴
A (nucleic acid synthesis)	A1 (4)	phenyl amide	metalaxyl	Ridomil, Allegiance	S	ST, F, S	H
			mefenoxam (metalaxyl-M)	Ridomil Gold, Apron, Subdue, Ultra Flourish, Ridomil Gold MZ (+ mancozeb)	S	ST, F, S	H
B (mitosis and cell division)	B1 (1)	benzimidazole	thiabendazole	Mertect, Apl-Luster, LST	S	ST, PH	H
		thiophanate	thiophanate-methyl	Topsin M, Cleary's 3336, T-Methyl, OHP 6672, Thiophanate Methyl, Spectro (+ chlorothalonil)	S	ST, F, S	H
	B3 (22)	benzamide	zoxamide	Gavel (+ mancozeb)	S	F	L-M
C (respiration)	C2 (7)	carboxamide	carboxin	Vitavax	S	ST	L
			flutolanil	Moncut, ProStar, Artisan (+ propiconazole)	S	ST, F, S	L-M
			boscalid	Endura, Emerald, Pristine (+ pyraclostrobin)	S	F, S	L-M
	C3 (11)	QoI (strobilurin)	azoxystrobin	Abound, Amistar, Heritage, Quadris, Protege, Dynasty, Quilt (+ propiconazole)	S	F, S, ST	H
			pyraclostrobin	Cabrio, Insignia, Headline, Pristine (+ boscalid)	S	F, S	H
			kresoxim-methyl	Cygnus, Sovran	S	F	H
			trifloxystrobin	Flint, Compass, Gem, Trilex, Absolute (+ tebuconazole), Stratego (+ propiconazole)	S	F, S, ST	H
			fenamidone	Reason	S	F	H
			famoxidone	Tanos (+ curzate)	S	F	H
	C5 (29)	dinitroaniline	fluzinam	Omega	P	F, S	L
	C6 (30)	organo tin	triphenyl tin hydroxide	Super Tin, Agri-Tin	P	F	L
D (amino acids and proteins)	D1 (9)	anilino-pyrimidine	cyprodinil	Vanguard, Switch (+ fludioxanil)	S	F	M
			pyrimethanil	Scala	S	F	M

¹Subgroups represent specific target sites within a mode of action; cross-resistance may occur within subgroups; FRAC code is in parenthesis. FRAC code is based on time of product registration and potential for cross-resistance within subgroups.

²P = protectant, S = systemic or penetrant.

³S = soilborne diseases, F = foliar diseases, ST = seed treatment, PH = post-harvest treatment.

⁴The resistance risk is assigned based on the worst case-scenario. For example, dicarboximide resistance is serious for some Botrytis diseases, but resistance problems have not developed with other uses. Seed treatment uses are considered low-risk regardless of the fungicide's properties.

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	D4 (25)	antibiotic (bactericide)	streptomycin	Agri-Mycin, Agri-Strep	P	ST, F	H
	D5 (41)	antibiotic (bactericide)	oxytetracycline	Mycoshield	P	F	H
E (signaling)	E1 (13)	quinoline	quinoxifen	Quintec	P	F	M
	E2 (12)	phenylpyrrole	fludioxonil	Maxim, Scholar, Medallion, Switch (+ cyprodinil)	P	ST, F, PH	L
F (lipids and membranes)	F1 (2)	dicarboximide	iprodione	Rovral, Chipco 26019, Iprodione, 26GT	P	F, S	L-M
			vinclozolin	Ronilan, Curalan	P	F, S	L-M
	F3 (14)	aromatic hydrocarbon	chloroneb	Nu-Flow D, Nu-Flow ND	P	ST, S	L-M
			dichloran	Botran	P	F, S, PH, ST	L-M
			PCNB	Terraclor, PCNB, Turcide, Terra-Coat	P	ST, S	L
			etrifiazole	Terrazole, Terramaster	P	S	L-M
	F4 (28)	carbamate	propamocarb HCl	Previcur Flex, Banol	S	F, S	L-M
	F5 (40)	cinnamic acid	dimethomorph	Acrobat	S	F	L-M
G (sterol synthesis)	G1 (3)	demethylation inhibitor (DMI)	fenarimol	Rubigan	S	F, S	M
			imazalil	Flo-Pro IMZ, Nu-Zone, Deccozil	S	ST, PH	L-M
			difenconazole	Dividend	S	ST	L
			fenbuconazole	Enable, Indar	S	F	M
			myclobutanil	Nova, Rally, Eagle, Systhane, Laredo	S	F, S	M
			propiconazole	Tilt, Orbit, Banner Maxx, Propiconazole, PropiMax, Bumper, Propensity, Quit (+ azoxystrobin), Stratego (+ trifloxystrobin)	S	F, S	M
			tebuconazole	Folicur, Raxil, Orius, Elite	S	F, S, ST	M
			tetraconazole	Domark, Eminent	S	F	M
			triadimefon	Bayleton, Strike	S	F, S	M
			triadimenol	Baytan	S	ST	L
			triflumizole	Procure, Terraguard	S	F, S	M
	G3 (17)	hydroxyanilide	fenhexamid	Elevate, Captevate (+ captan)	P	F	L-M

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Mode of action group	Sub-group ¹	Group name	Common name	Trade names	Action ²	Uses ³	Risk ⁴
H (cell wall synthesis)	H4 (19)	polyoxins	polyoxin	Endorse	S	F, S	M
P (plant defense activator)	P1 (P)	benzo-thiadiazole	acibenzolar-S-methyl	Actigard, Blockade	S	F	L
U (unknown mode of action)	U1 (27)	cyanoacetamideoxime	cymoxanil	Curzate, Tanos (+ famoxadone)	S	F	M
	U2 (33)	phosphonate	fosetyl-AL	Aliette, Chipco Signature	S	F	L
			phosphorous acid	Phostrol	S	F	L
			potassium phosphite	Fosphite, Prophyt	S	F	L
M (Multi-site activity)	M1 (M1)	inorganic	copper salts	Kocide, Cuprofix, Tenn-Cop, Basic Copper, Champ, Nu-Cop, COC, Nordox, Strech	P	F	L
	M2 (M2)	inorganic	sulfur	Microthiol, Sulfur, Super Six, Thiolut, Thiosperse	P	F	L
	M3 (M3)	dithiocarbamate	ferbam	Ferbam	P	F	L
			mancozeb	Dithane, Penncozeb, Manzate, Fore, Mankocide (+ copper)	P	F, ST	L
			maneb	Maneb, Manex, Pentathlon	P	F, ST	L
			metiram	Polyram	P	F	L
			thiram	Thiram, Defiant	P	F, ST	L
			ziram	Ziram	P	F	L
	M4 (M4)	phthalimide	captan	Captan, Captec	P	F, ST	L
	M5 (M5)	chloronitrile	chlorothalonil	Bravo, Equus, Echo, Daconil, Concord, Spectro	P	F, S	L
	M7 (M7)	guanadine	dodine	Syllit, Dodine	P	F	M