



FRAC
LIST OF PLANT PATHOGENIC
ORGANISMS RESISTANT TO DISEASE
CONTROL AGENTS

Revised January 2009

Important notes

The scope of the list.

The FRAC codes used in this document refer to those used in the FRAC Code List. The entries are listed by their Mode of Action code, with the Chemical Group Codes and Group Names also being given for reference. *For more information please refer to the latest edition of the FRAC Code list.*

This list is extensive in identifying those plant pathogens that have shown some form of resistance to the modes of action given and to the respective chemical groups.

Take care in using this list.

Care must be taken in using the information because:

1. Inclusion of a pathogen in this list only demonstrates that it can become resistant. It does not indicate that pathogen populations in specific geographical areas or locations are resistant. Seek local advice for specific localities. Information may also be found at the FRAC web page for specific chemical Working Groups. See www.frac.info
2. Resistance in plant pathogens can take many forms and it is important to realise the differences when consulting this list. The 'Remarks' column gives guidance on the form of resistance found and can be interpreted as:

Laboratory mutation / selection: Indicates that the resistance has been selected for using various techniques including mutation by UV light, or chemical mutagenesis. Such research illustrates that resistance can happen and can provide information on the resistance mechanism, but is not a reliable indicator of the probability that resistance will happen when the chemical is used in the field.

Field trial: Indicates that resistance has been found in limited field trials. Very often such trials use application schedules that are different to commercial practice and/or are designed to pressurise pathogen populations into becoming resistant in an attempt to quantify the resistance risk. Such trials show that resistance can be generated but do not give reliable indications that resistance will occur if products are used as recommended.

Field: Indicates that resistant isolates have been found in commercially treated fields. This does not mean that the resistance was always extensive enough to cause complete disease control failure, but does indicate a need for active resistance management.

3. For pathogens capable of infecting several host genera / species e.g. *Botrytis cinerea*, the list does not include reference to all known crops. For such pathogens it is reasonable to assume that if resistance is known, all areas of use are at risk and resistance management strategies should be used.

Cross – resistance between chemicals in a particular group.

Resistance and cross-resistance between molecules in a particular group is not always absolute due to different activity spectra shown by group members. Be careful when making assumptions about cross-resistance patterns and if in any doubt refer to FRAC or the manufacturer.

A note on taxonomy

This list has been compiled using the taxonomy in use at the time the report was made. In some cases organisms have been reclassified since the original report and names have changed. Where names have changed recently, users of this list are advised to search using the old name as well as the new one.

Further guidance

Please see information published by FRAC and contained in the FRAC Monographs, available for download from the FRAC webpage www.frac.info

Updates

Additions to the list are welcome. Please notify the FRAC Secretary giving full details of Journal reference. Note that unconfirmed reports will not be included.

A note on mercury:

Mercury was a traditional seed treatment for cereals. It is no longer used and, as such, does not appear in the FRAC list of fungicides. Resistance did develop to it in *Pyrenophora avenae* on oats, Noble *et al.* (1966), and for *Pyrenophora graminea* on barley, Clark (1985).

INDEX OF FRAC CODES
For more detail on these codes see the FRAC Code List

Mode of Action Code and Target Site	Group Name	FRAC Group Code
A: NUCLEIC ACID SYNTHESIS		
A1: RNA polymerase I	PA Fungicides Phenylamides	4
A2: adenosine deaminase	Hydroxy – (2-amino) pyrimidines	8
A3: DNA/RNA synthesis (proposed)	Heteroaromatics	32
A4: DNA topoisomerase type II (gyrase)	Carboxylic acids	31
B: MITOSIS AND CELL DIVISION		
B1: β -tubulin assembly in mitosis	MBC fungicides, Methyl Benzimidazole Carbamates	1
B2: β -tubulin assembly in mitosis	N-phenylcarbamates	10
B3: β -tubulin assembly in mitosis	Benzamides	22
B4: cell division (proposed)	Phenylureas	20
B5: delocalisation of spectrin like proteins	Benzamides	43
C: RESPIRATION		
C1: Complex I, NADH oxidoreductase	Pyrimidinamines	39
C2: Complex II, succinate-dehydrogenase	SDHI fungicides	7
C3: Complex III, cytochrome bc1 (ubiquinol oxidase at Qo site (cyt b gene))	QoI fungicides, Quinone Outside Inhibitors	11
C4: Complex III, cytochrome bc1 (ubiquinone reductase) at Qi site	QiI fungicides (Quinone Inside Inhibitors)	21
C5: Uncouplers of oxidative phosphorylation	-	29
C6: Inhibitors of oxidative phosphorylation. ATP synthase	Organo tin compounds	30
C7: ATP production (proposed)	Thiophene carboxamides	38

D: AMINO ACIDS AND PROTEIN SYNTHESIS		
D1: Methionine biosynthesis (proposed) (<i>cgs gene</i>)	AP fungicides. Anilinopyrimidines	9
D2: Protein synthesis	Enopyranuronic acid antibiotic	23
D3: Protein synthesis	Hexapyranosyl antibiotic	24
D4: Protein synthesis	Glucopyranosyl antibiotic	25
D5: Protein synthesis	Tetracycline antibiotic	41
E: SIGNAL TRANSDUCTION		
E1: G-proteins in early cell signalling (proposed)	Quinolines	13
E2: MAP/Histidine-kinase in osmotic signal transduction (<i>os-2, HOG1</i>)	PP fungicides. Phenylpyrroles	12
E3: MAP/Histidine-kinase in osmotic signal transduction (<i>os-1, Daf1</i>)	Dicarboximides	2
F: LIPIDS AND MEMBRANE SYNTHESIS		
F1	Formerly dicarboximides	
F2: Phospholipid biosynthesis, methyl transferase	Phosphoro thiolates and dithiolanes	6
F3: Lipid peroxidation (proposed)	AH fungicides (Aromatic Hydrocarbons)(chlorophenyls, nitroanilines and heteroaromatics)	14
F4: Cell membrane permeability, fatty acids (proposed)	Carbamates	28
F5: Phospholipid biosynthesis and cell wall deposition (proposed)	CAA fungicides. Carboxylic Acid Amides	40

G: STEROL BIOSYNTHESIS IN MEMBRANES		
G1: C14 demethylase in sterol biosynthesis (<i>erg11/cyp51</i>)	DMI fungicides. DeMethylation Inhibitors. SBI Class 1	3
G2: Δ^{14} reductase and $\Delta^8 - \Delta^7$ isomerase in sterol biosynthesis (<i>erg24, erg2</i>)	Amines ('morpholines'). SBI class II	5
G3: 3-keto reductase, C4-demethylation (<i>erg27</i>)	Hydroxyanilides. SBI class III	17
G4: Squalene epoxidase in sterol biosynthesis (<i>erg1</i>)	SBI class IV	18
H: GLUCAN SYNTHESIS		
H3: Trehalase and inositol biosynthesis	Glucopyranosyl antibiotic	26
H4: chitin synthase	Polyoxins	19
I: MELANIN SYNTHESIS IN CELL WALL		
I1: Reductase in melanin biosynthesis	MBI-R Melanin Biosynthesis Inhibitors - Reductase	16.1
I2: Dehydratase in melanin biosynthesis	MBI-D Melanin Biosynthesis Inhibitors - Dehydratase	16.2
P: HOST PLANT DEFENCE INDUCTION		
P1: Salicylic acid pathway	Benzo-thiadiazole BTH	P
P2: benzisothiazole	Benzisothiazole	P
P3: thiadiazole-carboxamide	Thiadiazole-carboxamide	P
P4 (proposed):	Natural compound	P

UNKNOWN MODE OF ACTION		
unknown	Cyanoacetamide-oxime	27
unknown	Phosphonates	33
unknown	Phthalamic acids	34
unknown	Benzotriazines	35
unknown	Benzene-sulfonamides	36
unknown	Pyridazinones	37
unknown	Thiocarbamate	42
Microtubule disruption (proposed)	Thiazole carboxamide	U5
unknown	Phenyl-acetamide	U6
unknown	Quinazolinone	U7
Actin disruption (proposed)	Benzophenone	U8
NOT CLASSIFIED		
unknown	Diverse	NC
MULTI-SITE CONTACT ACTIVITY		
Multi-site contact activity	Inorganic (copper)	M1
	Inorganic (sulphur)	M2
	Dithiocarbamates and relatives	M3
	Phthalimides	M4
	Chloronitriles (phthalonitriles)	M5
	Sulfamides	M6
	Guanidines	M7
	Triazines	M8
	Quinones	M9

LIST OF RESISTANT PATHOGENS

MOA Code	FRAC Group Code	Pathogen	Common name	Crop	Reference	Remarks
		A NUCLEIC ACID SYNTHESIS				
A1	4	PA Fungicides (PhenylAmides). RNA polymerase 1				
		<i>Bremia lactucae</i>	Downy mildew	Lettuce	Crute <i>et al.</i> 1987; Crute & Harrison 1988	field, genetics
		<i>Peronospora destructor</i>	Downy mildew	Onion	Wright 2004	-
		<i>Peronospora hyoscyami</i> (syn. <i>P tabacina</i>)	Blue mold	Tobacco	Bruck <i>et al.</i> 1982	field
		<i>Peronospora tabacina</i>	Blue mold	Tobacco	Bruck <i>et al.</i> 1981	field
		<i>Peronospora viciae</i>	Downy mildew	Pea	Falloon <i>et al.</i> 2000	field
		<i>Phytophthora cactorum</i>	Crown rot / leather rot	Strawberry	Bal <i>et al.</i> 1987	field
				American ginseng	Hill & Hausbeck 2008	field
		<i>Phytophthora capsici</i>	Stem rot	Lima bean pods	Davey <i>et al.</i> 2008	field
		<i>Phytophthora cinnamomi</i>	Root rot	Avocado	Darvas & Becker 1984	field
		<i>Phytophthora citricola</i>	Rot / die back		Joseph & Coffey 1984	<i>in-vitro</i> mutation
		<i>Phytophthora citricola</i>	Dieback	Azalea	Ferrin & Kabashima 1991	field / laboratory
		<i>Phytophthora citrophthora</i>	Collar rot / foot		Serrhini <i>et al.</i> 1985	<i>in-vitro</i>

			rots			
		<i>Phytophthora citrophthora</i>	Collar rot / foot rots		Angeles Diaz Borrás & Vila Aguila 1988	<i>in vitro</i>
		<i>Phytophthora erythroseptica</i>	Pink rot	Potato	Lambert & Salas 1994 Taylor <i>et al.</i> 2002	field field
		<i>Phytophthora infestans</i>	Late blight	Potato	Davidse <i>et al.</i> 1981 Hartill <i>et al.</i> 1983 Davidse <i>et al.</i> 1983	field field field
		<i>Phytophthora infestans</i>	Late blight	Poroporo	Hartill <i>et al.</i> 1983	field
		<i>Phytophthora megasperma fsp. glycinea</i>	Root rot	Soybean in-vitro	Lambooy & Paxton 1992	laboratory selection
		<i>Phytophthora megasperma fsp. medicaginis</i>	Root rot	Lucerne	Davidse 1981	laboratory selection
		<i>Phytophthora nicotianae</i>	Root rot	Ornamentals	Hu <i>et al.</i> 2008	field
		<i>Phytophthora palmivora</i>	Root rot	-	Lucas <i>et al.</i> 1990	laboratory induction
		<i>Phytophthora parasitica</i>	Downy mildew	Periwinkle	Ferrin & Kabashima 1991	field / laboratory
		<i>Phytophthora parasitica var. nicotianae</i>	Black shank	Tobacco	Shew 1985	laboratory
		<i>Phytophthora porri</i>	Downy mildew	Leek	Locke <i>et al.</i> 1997	field
		<i>Phytophthora sojae</i> (syn. <i>P. megasperma</i>)	Stem / root rot	Soybean	Bhat <i>et al.</i> 1993	laboratory
		<i>Phytophthora</i> sp.	Root rot	African violet	Romano & Edgington 1985	field
		<i>Plasmopara halstedii</i>	Downy mildew	Sunflower	Albourie <i>et al.</i> 1998	field
		<i>Plasmopara viticola</i>	Downy mildew	Grapevine	Staub & Sozzi 1981 Bosshard & Schuepp 1983 Leroux & Clerjeau 1985	field field

		<i>Pseudoperonospora cubensis</i>	Downy mildew	Cucumber	Reuveni <i>et al.</i> 1980	field
		<i>Pythium aphanidermatum</i>	Damping off	-	Sanders & Soika 1988	field
		<i>Pythium aphanidermatum</i>		Not specified / creeping bent grass	Sanders <i>et al.</i> 1990	<i>in-vitro</i> mutation / field
		<i>Pythium aphanidermatum</i>	Damping off	Ornamentals	Moorman <i>et al.</i> 2002	field
		<i>Pythium cylindrosporium</i>	Damping off	Ornamentals	Moorman <i>et al.</i> 2002	field
		<i>Pythium dissotocum</i>	Root rot	Carrot	White <i>et al.</i> 1988	field
		<i>Pythium dissotocum</i>	Root rot	Ornamentals	Moorman <i>et al.</i> 2002	field
		<i>Pythium heterothallicum</i>	Damping off	Ornamentals	Moorman <i>et al.</i> 2002	field
		<i>Pythium irregulare</i>	Damping off	Ornamentals	Moorman <i>et al.</i> 2002	field
		<i>Pythium splendens</i>	Damping off	Ornamentals	Moorman <i>et al.</i> 2002	field
		<i>Pythium spp.</i>	Cavity spot	Carrot	White <i>et al.</i> 1988	field / laboratory
		<i>Pythium ultimum</i>	Watery wound rot	Potato	Taylor <i>et al.</i> 2002	field
		<i>Pythium ultimum</i>	Damping off	Ornamentals	Moorman <i>et al.</i> 2002	field
A2	8	Hydroxy (2 amino) pyrimidines adenosine-deaminase				
		<i>Erysiphe graminis</i> f.sp. <i>hordei</i>	Powdery mildew	Barley	Hollomon 1978	field
		<i>Sphaerotheca fuliginea</i>	Powdery mildew	Cucurbits	Schepers 1984 O'Brien <i>et al.</i> 1988	field
A3	32	Heteroaromatics DNA / RNA synthesis (proposed)				
		No resistance recorded				
A4	31	Carboxylic acids				

		<i>Erwinia amylovora</i>	Fire blight	Pear	Manulis <i>et al.</i> 2003, Kleitman <i>et al.</i> 2005	field survey
B MITOSIS AND CELL DIVISION						
B1	1	MBC fungicides (Methyl Benzimidazole Carbamates)				
		<i>Alternaria alternata</i>	Alternaria rot	Citrus	Sitton & Pierson 1982	field
		<i>Ascochyta byj</i>	Ascochyta blight	Vegetables	Steekelenburg 1973	laboratory
		<i>Ascochyta pinodes</i>	Leaf spot	Pea	Molinero <i>et al.</i> 1993	laboratory
		<i>Ascochyta pisi</i>	Leaf spot	Pea	Molinero <i>et al.</i> 1993	laboratory
		<i>Aspergillus nidulans</i>	Bearings rot	Banana	Hasti & Georgopoulos 1971	laboratory
		<i>Botryodiplodia theobromae</i>	Botryodiplodia rot	Fruits (Mango)	Spalding 1982	Laboratory
		<i>Botrytis allii</i>	Neck rot	Onion	Viljanen-Rollinson <i>et al.</i> 2007	Field (New Zealand)
		<i>Botrytis cinerea</i>	Grey mold	cyclamen	Bollen & Scholten 1971	laboratory
		<i>Botrytis cinerea</i>	Chocolate spot	Beans	Harrison J G 1984	field
		<i>Botrytis cinerea</i>	Grey rot	Grapes / Vines	Ehrenhardt <i>et al.</i> 1973 Leroux <i>et al.</i> 1982 Elad <i>et al.</i> 1988	field cross resistance to phenylcarbamates, Group 10
		<i>Botrytis cinerea</i>	Grey mould	Lisianthus	Elad <i>et al.</i> 2008	field
		<i>Botrytis elliptica</i>	Grey rot	Lily	Chastagner & Riley	field

					1987 Hsiang & Chastagner 1990	
		<i>Botrytis squamosa</i>	Leaf blight	Alliacea	Presly & Maude 1982	laboratory
		<i>Botrytis tulipae</i>	Fire blight	Tulip	Chastagner & Riley 1987	field
		<i>Ceratocystis ulmi</i>	Dutch elm disease	Elm	Brasier & Gibbs 1975	laboratory
		<i>Cercospora apii</i>	Early blight	Celery	Berger 1973	field
		<i>Cercospora arachidicola</i>	Leafspot	Peanut	Clarke <i>et al.</i> 1974; Littrell 1974	field
		<i>Cercospora beticola</i>	Leafspot	Sugar beet	Georgopoulos & Dovas 1973	field
		<i>Cercospora musae</i>	Leafspot	Banana	See <i>Mycosphaerella musicola</i>	
		<i>Cercosporidium personatum</i>	Late Leafspot	Peanut	Clarke <i>et al.</i> 1974	field
		<i>Cladobotryum dendroides</i>	Cobweb disease	Mushrooms	McKay <i>et al.</i> 1998	laboratory
		<i>Cladosporium carpophilum</i>	Scab	Peach, Nectarine	Chandler <i>et al.</i> 1978	field
		<i>Cladosporium cladosporioides</i>	Fruit rot	Fruits	Dekker 1972	review
		<i>Cladosporium cucumerinum</i>	Cladosporium	Cucurbits	Dekker 1972	review
		<i>Cladosporium fulvum</i>	Flower rot	Fruits	Staunton 1975	field
		<i>Coccomyces hiemalis</i>	Cherry leaf spot	Cherry	Jones & Ehret 1981	field
		<i>Colletotrichum cereale</i>	Anthracnose	Turfgrass	Wong <i>et al.</i> 2008	field
		<i>Colletotrichum coffeanum</i>	Coffee berry disease	Coffee	Cook & Pereira	field
		<i>Colletotrichum gloeosporioides</i>	Anthracnose	Pome fruit	Spalding 1982	laboratory
		<i>Colletotrichum lindemuthianum</i>	Anthracnose	Bean	Meyer 1976	review
		<i>Colletotrichum musae</i>	Anthracnose	Banana	Griffie 1973	field
		<i>Corynespora cassicola</i>	target spot	tomato	Date <i>et al.</i> 2004	field
		<i>Cryptocline cyclaminis</i>	Anthracnose	Cyclamen	Garibaldi <i>et al.</i> 1987	field

		<i>Cylindrocladium scoparium</i>	Stem canker	Eucalyptus	Prest &Poppe 1988	field
		<i>Didymella bryoniae</i>	Gummy stem blight	Cucurbits	Malathrakis & Vakalounakis 1983 Steekelenburg 1987	field
		<i>Didymella lycopersici</i>	Stem rot	Tomato		
		<i>Drechslera oryzae</i>	Brown spot	Rice	Annamali & Lalithakumari 1987	laboratory
		<i>Elsinoë fawcetti</i>	Scab	Citrus	Whiteside 1980a Ieki 1994	field
		<i>Elsinoë veneta</i>	Anthracnose	Raspberry	Munro <i>et al.</i> 1988	field
		<i>Erysiphe cichoracaerum</i>	Powdery mildew	Cucurbits	Abelentsev & Savchenko 1980	field
		<i>Erysiphe graminis</i>	Powdery mildew	Cereals	Vargas 1973	field
		<i>Erysiphe polygoni</i>	Powdery mildew	Cowpeas	Rodriguez & Melendez 1984	field
		<i>Erythronium spp.</i>	Yellow fawn	Lily	Duineveld & Beijersbergen 1975	field
		<i>Fulvia fulva</i> also see <i>Cladosporium fulvum</i>	Leaf mold	Tomato	Miao & Higgins 1986	laboratory
		<i>Fusarium nivale</i>	Pink snow mold	Wheat	Tanaka <i>et al.</i> 1983	field
		<i>Fusarium culmorum</i>	Fusariose	Potato / Pink	Seppanen 1983 Hanson <i>et al.</i> 1996	field
		<i>Fusarium oxysporium f. sp. dianthi</i>	Fusariose	Oeillet	Tramier & Bettachini 1974	field
		<i>Fusarium oxysporium f. sp. gladioli</i>	Fusariose	Gladiolus	Magie & Wilfret 1974	field
		<i>Fusarium oxysporium f. sp. lycopersici</i>	Fusariose	Tomato	Thanassoulopoulos <i>et al.</i> 1970	laboratory
		<i>Fusarium oxysporium f. sp. tulipae</i>	Fusariose	Tulip	Valaskova 1983	laboratory
		<i>Fusarium oxysporium f. sp.</i>	Fusariose	Melon	Bastels-Schooley &	laboratory

		<i>Melonis</i>			MacNeil 1971	
		<i>Fusarium roseum</i>	Fusariose	Rosa, turf	Smiley & Howard 1976	field
		<i>Fusarium roseum</i> var <i>sambucinum</i>	Dry rot	Potato	Tivoli <i>et al.</i> 1986	field
		<i>Fusarium solani</i> f. <i>sp. pisi</i>	Fusariose	Solanacea	Richardson 1973	field, laboratory
		<i>Fusarium sulphureum</i>	dry rot	Potato	Hanson <i>et al.</i> 1996	field
		<i>Fusicladium effusum</i>	Scab	Pecan	Littrell 1977	
		<i>Gibberella fujikuroi</i>	Fusariose	rice	Ogawa 1988	field
		<i>Gloeosporium</i> spp.	Fruit rot	Apple		
		<i>Guignardia citricarpa</i>	Black spot	Citrus	Herbert & Grech 1985	field
		<i>Helminthosporium solani</i>	Silver scurf	Potato	Geary <i>et al.</i> 2007	field (USA)
		<i>Hypomyces rosellus</i>	Cobweb disease	Mushrooms	Fletcher & Yarham 1976	field
		<i>Leveillula taurica</i>	Powdery mildew	Tomato	Jones & Thompson 1982	field
		<i>Monilinia cinerea</i>	Brown rot	Rosa	Abelentsev & Golyshin 1973	laboratory
		<i>Monilinia fructicola</i>	Brown rot	Pome fruit	Jones & Ehret 1976	field
		<i>Monilinia fructigena</i>	Brown rot	Pome fruit	Abelentsev & Golyshin 1973	laboratory
		<i>Monilinia laxa</i>	Brown rot	Pome fruit	Ogawa <i>et al.</i> 1981	field
		<i>Mycogone perniciosa</i>	Wet bubble	Mushrooms	Fletcher & Yarham 1976	field
		<i>Mycosphaerella brassicicola</i>	Ring spot	Brassicas		
		<i>Mycosphaerella citri</i>	Greasy spot	Citrus	Whiteside 1980b	field
		<i>Mycosphaerella fijiensis</i>	Black spot	Banana	Stover 1979	field
		<i>Mycosphaerella fragariae</i>	Leaf spot	Strawberry	Remiro & Kimati 1974	field
		<i>Mycosphaerella melonis</i>	Leaf spot /	Strawberry	Kato <i>et al.</i> 1984	field

			gummy stem blight			
		<i>Mycosphaerella musicola</i>	Yellow spot	Banana	Joya C 1982	field
		<i>Neurospora crassa</i>	Red mold	Bread	Sisler 1971	laboratory
		<i>Oidiopsis taurica</i>	Powdery mildew	Artichoke		
		<i>Oidium begoniae</i>	Powdery mildew	Begonia		
		<i>Penicillium brevicompactum</i>			Bollen & Scholten 1971	laboratory
		<i>Penicillium corymbiferum</i>	Rot	Crocus	Bollen & Scholten 1971 Jarvis & Hargreaves 1973	laboratory field
		<i>Penicillium digitatum</i>	Green rot	Citrus / Pome fruit	Wild 1983	field
		<i>Penicillium expansum</i>	Blue mold	Pome fruit / pear	Wicks 1977	field
		<i>Penicillium fructigenum</i>		various	Iida W 1975	field
		<i>Penicillium italicum</i>	Blue rot	Citrus	Muirhead 1974; Yu 1981	field
		<i>Penicillium oxalicum</i>	Stem rot	Cucurbits		
		<i>Penicillium sclerotigenum</i>		Yellow yam	Plumbley <i>et al.</i> 1984	field
		<i>Pezicula alba</i>	Ripe spot	Pome fruits	Bielenin 1986	field
		<i>Phoma clematidina</i>	Wilt	Clematis	*	
		<i>Phoma tracheiphila</i>	Malsecco	Citrus	Gilmenez & Luisi. 1978	field
		<i>Phomopsis citri</i>	Stem-end rot	Citrus	Spalding 1982	laboratory
		<i>Podosphaera leucotricha</i>	Powdery mildew	Fruit trees	Suta & Radulescu 1986	laboratory
		<i>Pseudocercospora herpotrichoides</i>	Eyespot	Cereals	Griffin <i>et al.</i> 1982	field
		<i>Pyrenopeziza brassicae</i>	Light leaf spot	Oilseed rape	Ilott <i>et al.</i> 1987	laboratory

		<i>Rhynchosporium secalis</i>	Leaf blotch/scald	Barley		
		<i>Rhizoctonia solani</i>	Brown rhizoctonia	Solanacea	Martin <i>et al.</i> 1984	laboratory
		<i>Sclerotinia fructicola</i>	Brown rot	Stone fruits	Whan J H 1976	field
		<i>Sclerotinia homeocarpa</i>	Dollar spot	Grass	Cole 1974 Detweiler <i>et al.</i> 1983 Wong S P 2003	field
		<i>Sclerotinia sclerotium</i>	Sclerotiniose	Oilseed rape		
		<i>Sclerotium spp.</i>	Stem rot	Alliaceae/Potato/Carrot		
		<i>Septoria apiicola</i>	Leaf spot	Celery		
		<i>Septoria leucanthemi</i>	Leaf spot	Chrysanthemum	Paulus <i>et al.</i> 1976	field
		<i>Septoria tritici</i>	Leaf spot	Cereals	Griffin & Fisher 1985	laboratory
		<i>Sphaerotheca fuliginea</i>	Powdery mildew	Cucurbits	Schroeder & Providenti 1971; Naegler <i>et al.</i> 1977	field
		<i>Sphaerotheca humuli</i>	Powdery mildew	Ornamental flowers	Iida 1975	field
		<i>Sphaerotheca pannosa</i>	Powdery mildew	Rosa / Peach tree	Jarvis & Slingsby 1975	field
		<i>Sporobolomyces roseus</i>	Pink yeast	Rosa (mutation)	Nachmias & Barash 1976	laboratory
		<i>Stagonospora curtisii</i>	Leaf scorch	Ornamental flowers / Narcissus	Saniewska 1985	field
		<i>Talaromyces flavis</i>		Fruits	Katan <i>et al.</i> 1984	laboratory
		<i>Tapesia yallundae</i>	Eyespot	Cereals	see <i>P. herpotrichoides</i>	field
		<i>Tapesia acuformis</i>	Eyespot	Cereals	see <i>P. herpotrichoides</i>	field
		<i>Trichoderma harzianum</i>	Green mold	Soil / Mushrooms	Eastburn & Butler 1986	field

		<i>Uncinula necator</i>	Powdery mildew	Grapes / Vines	Naegler <i>et al.</i> 1977; Pearson 1980 Pearson & Taschenberg 1980	field
		<i>Ustilago hordei</i>	Barley covered smut	Barley	Ben-Yephet Y <i>et al.</i> 1975	laboratory
		<i>Venturia inaequalis</i>	Scab	Pome fruit	Kiebacher & Hoffmann 1976	field
		<i>Venturia nashicola</i>	Scab	Pome fruit	Ishii & Yamaguchi 1981	field
		<i>Venturia pirina</i>	Scab	Pome fruit	Shabi & Ben-Yephet 1976	field
		<i>Verticillium albo-atrum</i>	Verticillium	Pome fruits	Ververke 1983	laboratory
		<i>Verticillium dahliae</i>	Verticillium	Pome fruit / Solanacea	Locke & Thorpe 1976 McHugh & Schreiber 1984	field
		<i>Verticillium fungicola</i>	Verticillium	Mushrooms	Fletcher & Yarham 1976; Samuels & Johnston 1980	field
		<i>Verticillium malthousei</i> (= <i>V fungicola</i>)	Verticillium	Mushrooms	Lambert & Wuest 1973	field
		<i>Verticillium tricorpus</i>	Wilt	Tomato		
B2	10	N-phenyl carbamates: β tubulin assembly in mitosis				
		<i>Botrytis cinerea</i>	Grey mold	Grapevine	Elad <i>et al.</i> 1988 Katan <i>et al.</i> 1989 Elad <i>et al.</i> 1992	cross resistance to phenylcarbamates, Group 10 field field

		<i>Corynespora cassicola</i>	Target spot	Tomato	Date <i>et al.</i> 2004	field
		<i>Neurospora crassa</i>			Fujimura <i>et al.</i> 1994	resistance mechanism
		<i>Verticillium fungicola</i>	Dry bubble	Mushroom	Bonnen & Hopkins 1997	field isolates
B3	22	Benzamides β tubulin assembly in mitosis				
		No resistance recorded				
B4	20	Phenylureas cell division (proposed)				
		<i>Rhizoctonia solani</i>	Seedling damping-off	Various vegetables and ornamentals	Chen <i>et al.</i> 1996	laboratory
B5	43	Methyl-benzamides De-localisation of spectrin like proteins				
		No resistance recorded				
C: RESPIRATION						
C1	39	Pyrimidineamines: Complex 1 NADH Oxido-reductase				
		No resistance reported				
C2	7	SDHI fungicides (Succinate dehydrogenase inhibitors) Complex II succinate dehydrogenase				
		<i>Alternaria alternata</i>	Alternaria late blight	Pistachio	Avenot & Michallides 2007	field

					Avenot <i>et al.</i> 2008	resistance mechanism
		<i>Aspergillus nidulans</i>			White & Georgopoulos 1986	mutant study
		<i>Coprinus cinereus</i>			Ito <i>et al.</i> 2004	mutation study and genetic analysis
		<i>Botrytis cinerea</i>	Grey mould	Grapevine Strawberry	FRAC 2007 FRAC 2007	field field
		<i>Botrytis elliptica</i>	Grey mould	Lilly	FRAC 2007	field
		<i>Corynespora cassiicola</i>	Corynespora leaf spot	Cucumber	Miyamoto <i>et al.</i> 2007 Ishii <i>et al.</i> 2007	field (greenhouses) molecular mechanism
		<i>Didymella bryoniae</i>	Gummy stem blight	Cucurbits	FRAC 2007 Stevenson <i>et al.</i> 2008	field field
		<i>Mycosphaerella graminicola</i>	Leaf spot	Wheat	Skinner <i>et al.</i> 1998	laboratory mutation study
		<i>Podosphaera xanthii</i>	Powdery mildew	Melon	FRAC 2007	field
		<i>Ustilago maydis</i>	Smut	Maize	Keon <i>et al.</i> 1991	laboratory mutation study
		<i>Ustilago nuda</i>	Loose smut	Barley	Leroux & Berthier 1988	field
C3	11	QoI fungicides (Quinone outside Inhibitors) Complex III cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)				
		<i>Alternaria alternata</i>	Alternaria late blight	Pistachio	Ma <i>et al.</i> 2003 Avenot & Michallides 2007	field / laboratory field

		<i>Alternaria alternata</i>	Alternaria blotch	Apple	Ishii 2008	field
		<i>Alternaria arborescens</i>	Alternaria late blight	Pistachio	Ma <i>et al.</i> 2003	field / laboratory
		<i>Alternaria mali</i>	Alternaria blotch	Apple	Lu <i>et al.</i> 2003	field
		<i>Alternaria solani</i>	Leaf spot	Potato	Pasche <i>et al.</i> 2002, 2004, Pasche <i>et al.</i> 2005 Pasche & Gudmestad 2008	field resistance mechanism fitness of F129L
		<i>Alternaria tenuissima</i>	Alternaria late blight	Pistachio	Ma <i>et al.</i> 2003	field / laboratory
		<i>Blumeria graminis</i> , see <i>Erysiphe graminis</i>				
		<i>Botrytis cinerea</i>	Grey mold	Strawberry Strawberry, citrus	Markoglou <i>et al.</i> 2006 FRAC 2007 Ishii 2008	mutation study Field, G143A, Germany Field, Japan
		<i>Colletotrichum graminicola</i>	Leaf spot	Annual bluegrass / bent grass	Avila-Adame <i>et al.</i> 2003	field
		<i>Colletotrichum gloeosporioides</i>	Anthracnose	Strawberry	Ishii 2008	field
		<i>Corynespora cassiicola</i>	Leaf spot, target spot	Cucumber	Ishii 2004	field
		<i>Didymella bryoniae</i>	Gummy stem blight	Cucurbits Watermelon	Olaya & Holm 2001 Langston 2002 Stevenson <i>et al.</i> 2002	field field field
		<i>Didymella rabiei</i>	Ascochyta blight	Chickpea	Gossen & Anderson 2004	field

		<i>Erysiphe graminis tritici</i>	Powdery mildew	Wheat	Heaney <i>et al.</i> 2000 Sierotzki <i>et al.</i> 2000a	field resistance mechanism
		<i>Erysiphe graminis hordei</i>	Powdery mildew	Barley	Heaney <i>et al.</i> 2000	field
		<i>Erysiphe necator</i> : see also <i>Uncinula necator</i>				
		<i>Glomerella cingulata</i> (<i>Colletotrichum gloeosporioides</i>)	Anthracnose	Strawberry	Ishii 2004	
		<i>Mycosphaerella fijiensis</i>	Black sigatoka	Banana	Heaney <i>et al.</i> 2000 Sierotzki <i>et al.</i> 2000b Chin <i>et al.</i> 2001	field resistance mechanism field
		<i>Mycosphaerella graminicola</i> See also <i>Septoria tritici</i>	Leaf spot	Wheat	Armand <i>et al.</i> 2003 Clark 2005 Fraaije <i>et al.</i> 2005 Gisi <i>et al.</i> 2005	field field, review field field
		<i>Mycovellosiella natrassii</i>	Leaf mold	Eggplant / aubergine	Yano & Kawada 2003 Ishii 2004	field / laboratory field
		<i>Microdochium spp.</i>	Stem / head blight	Cereals	FRAC 2008	field, France, G143A confirmed
		<i>Pseudoperonospora cubensis</i>	Downy mildew	Cucumber	Heaney <i>et al.</i> 2000	field
		<i>Plasmopara viticola</i>	Downy mildew	Grapevine	Heaney <i>et al.</i> 2000 Gullino <i>et al.</i> 2004 Sierotzki <i>et al.</i> 2005	field field review
		<i>Podosphaera fusca</i>	Powdery mildew	Cucumber	Ishii <i>et al.</i> 2001 Fernandez-Ortuno <i>et al.</i> 2006 Fernandez-Ortuno <i>et al.</i> 2008	Field Resistance mechanism

		<i>Podosphaera xanthii</i>	Powdery mildew	Cucurbits	McGrath & Shishkoff 2003a, b	field trial
		<i>Pseudoperonospora cubensis</i>	Downy mildew	Cucumber	Heaney <i>et al.</i> 2000 Ishii <i>et al.</i> 2001	field field
		<i>Pyrenophora teres</i>	Net blotch	Barley	FRAC Semar <i>et al.</i> 2007	field molecular analysis (F129L)
		<i>Pyrenophora tritici-repentis</i>	Tan spot	Wheat	Reimann & Deising 2005 FRAC	field field
		<i>Pyricularia grisea</i>	Gray leaf spot	Perennial ryegrass	Vincelli & Dixon 2002 Kim <i>et al.</i> 2003	field field / resistance mechanism
		<i>Pythium aphanidermatum</i>	Damping of	Turf	Gisi <i>et al.</i> 2002 Olaya <i>et al.</i> 2003	laboratory field / resistance mechanism
		<i>Ramularia colli-cygni</i>	Necrotic leaf spot	Barley	FRAC 2006	field
		<i>Rhynchosporium secalis</i>	Scald, leaf blotch	Barley	FRAC 2008	Field, single isolate, Picardie
		<i>Saccharomyces cerevisiae</i>			Di Rago <i>et al.</i> 1989	resistance mechanism
		<i>Septoria tritici</i> See also <i>Mycosphaerella graminicola</i>	Leaf spot	Wheat	Fraaije & Lucas 2003	field
		<i>Sphaerotheca aphanis var aphanis</i>	Powdery mildew	Strawberry	Ishii 2008	field
		<i>Sphaerotheca fuliginea</i>	Powdery mildew	Cucumber	Heaney <i>et al.</i> 2000 Ishii <i>et al.</i> 2001	field field
		<i>Stemphyllium vesicarium</i>	Brown spot	Pears	FRAC 2006	field

		<i>Stemphyllium vesicarium</i>	Purple spot / sand blast	Asparagus	FRAC 2006	field
		<i>Uncinula necator</i> (see also <i>Erysiphe necator</i>)	Powdery mildew	Grapevine	Wilcox <i>et al.</i> 2003	field
		<i>Ustilago maydis</i>	Smut	Maize	Ziogas <i>et al.</i> 2002	laboratory mutants
		<i>Venturia inaequalis</i>	Scab	Apple	Zheng <i>et al.</i> 2000 Farber <i>et al.</i> 2002 Steinfeld <i>et al.</i> 2002 Dux <i>et al.</i> 2005	laboratory mutants field trial field field
C4	21	Oil fungicides (Quinone inside Inhibitors) Complex III cytochrome bc1 (ubiquinone reductase) at Qi site				
		<i>Phytophthora capsici</i>	Stem / fruit rot	General	Kousik & Keinarth 2008	Not specified
		<i>Saccharomyces cerevisiae</i>			Di Rago & Colson 1988	the basis of resistance
C5	29	Oxidative phosphorylation uncouplers				
		<i>Botrytis cinerea</i>	Grey mold	Adzuki bean	Tamura 2000	field (fluazinam)
C6	30	Organo tin compounds Inhibitors of oxidative phosphorylation, ATP synthase				
		<i>Cercospora beticola</i>	Leaf spot	Sugar beet	Giannopolitis 1978, Giannopolitis & Chrysayi- Tokousbalides M 1980	
C7	38	Thiophene carboxamides ATP production (proposed)				

		<i>Gaeumannomyces graminis</i>	Take-all	Wheat	Joseph-Horne <i>et al.</i> 2000 Russell <i>et al.</i> 2001 Freeman <i>et al.</i> 2005	field field / laboratory field
D AMINO ACIDS AND PROTEIN SYNTHESIS						
D1	9	AP fungicides (Anilinopyrimidines) Methionine biosynthesis (proposed) (cgs gene)				
		<i>Botrytis cinerea (Botryotinia fuckeliana)</i>	Grey mold	Grapevine	Forster & Staub 1996 Chapeland <i>et al.</i> 1999 Sergeeva <i>et al.</i> 2002 Baroffio <i>et al.</i> 2003	field experiments field field experiments
		<i>Botrytis cinerea</i>	Grey mould	Lisianthus	Elad <i>et al.</i> 2008	field
		<i>Penicillium expansum</i>	Blue mould	Apple	Li & Xiao 2008	Mutation study
D2	23	Enopyranuronic acid antibiotic. Protein synthesis				
		<i>Streptomyces lividans</i>			Nomura <i>et al.</i> 1991	laboratory
		<i>Pyricularia oryzae</i>	Rice blast	Rice	Sakurai & Naito 1976	laboratory cross resistance study
D3	24	Hexopyranosyl antibiotic. Protein synthesis				
		<i>Bacillus subtilis</i>		Not specified	Tominaga & Kobayashi 1978	Mutation
		<i>Pyricularia oryzae</i>	Rice blast	Finger millet	Taga <i>et al.</i> 1979	field isolates
		<i>Pyricularia oryzae</i>	Rice blast	Rice	Ito & Yamaguchi 1977	field field

					Sakurai <i>et al.</i> 1977 Sakurai & Naito 1976	laboratory cross resistance study
D4	25	Glucopyranosyl antibiotic (streptomycin). Protein synthesis				
		<i>Erwinia amylovora</i>	Fire blight	Pear Pear Various Pear, apple, quince	Moller <i>et al.</i> 1972 Schroth <i>et al.</i> 1979 Basim <i>et al.</i> 2001 Manulis <i>et al.</i> 2003	field surveys
		<i>Erwinia caratovora</i>	Bacterial stalk rot	Maize	Chakravarti & Anilkumar 1969.	<i>In-vitro</i>
		<i>Pseudomonas cichorii</i>		Lettuce	Matsuzaki <i>et al.</i> 1981	field
		<i>Pseudomonas lapsa</i>	Bacterial stalk rot	Maize	Chakravarti & Anilkumar 1969.	<i>In-vitro</i>
		<i>Pseudomonas syringae</i> pv. <i>syringae</i>	Blossom blast, canker	Pear	Spotts & Cervantes 1995	field
		<i>Pseudomonas syringae</i> pv. tomato	Bacterial speck	Tomato	Silva & Lopes 1995	field
		<i>Pseudomonas viridiflava</i>		Lettuce	Matsuzaki <i>et al.</i> 1981	field
		<i>Xanthomonas campestris</i> pv <i>vesicatoria</i>		Pepper and tomato	Minsavage <i>et al.</i> 1990	
D5	41	Tetracycline antibiotic. Protein synthesis				
		<i>Erwinia amylovora</i>	Fire blight	Apple, pear	Lacy <i>et al.</i> 1984 Basim <i>et al.</i> 2001	field strain selection field
		<i>Pseudomonas syringae</i> pv. tomato	Bacterial speck	Tomato	Silva & Lopes 1995	field

		<i>Pseudomonas syringae</i> pv. <i>syringae</i>	Blossom blast, canker	Pear	Spotts & Cervantes 1995	field
E: SIGNAL TRANSDUCTION						
E1	13	Quinolines. G-proteins in early cell signaling (proposed)				
		<i>Erysiphe graminis</i> f. sp. <i>hordei</i>	Powdery mildew	Barley	Hollomon <i>et al.</i> 1997	mutation
E2	12	PP fungicides (Phenylpyrroles). MAP / Histidine-kinase in osmotic signal transduction (os-2, HOG1)				
		<i>Alternaria brassicicola</i>	Leaf spot	Brassicas	Avenot <i>et al.</i> 2005	field / laboratory resistance mechanism
		<i>Botryotinia fuckeliana</i>	Grey mold	Grapevine	Faretra & Pallastro 1993	mutation
		<i>Fusarium</i> spp.	Seed piece decay	Potato	Peters <i>et al.</i> 2008	Not specified
		<i>Penicillium digitatum</i>	Green mould	Not specified	Kanetis <i>et al.</i> 2008	Isolates from packing houses but no crop losses
		<i>Penicillium expansum</i>	Blue mould	Apple	Li & Xiao 2008	Mutation study
E3	2	Dicarboximides. MAP / Histidine-kinase in osmotic signal transduction (os-1, Daf1)				
		<i>Alternaria alternata</i>	Leaf spot	Passionfruit	Hutton D G	laboratory / field
		<i>Alternaria</i> spp. <i>alternata</i> , <i>tenuissima</i> , <i>arborescens</i> group	late blight	Pistachio	Ma & Michailides 2004	field / induced
		<i>Alternaria brassicicola</i>	Leaf spot	Brassicas	Avenot <i>et al.</i> 2005	field / laboratory resistance

						mechanism
		<i>Alternaria dauci</i>	Leaf spot / blight	Carrot	Strandberg 1984 Fancelli & Kimati 1991	laboratory
		<i>Botryosphaeria dothidea</i>	Panicle / shoot blight	Pistachio	Ma <i>et al.</i> 2001	laboratory / field
		<i>Botrytis cinerea</i>	Grey mold	Cucumber	Steekelenburg 1987	field
		<i>Botrytis cinerea</i>	Grey mold	Grapevine	Holz 1979 Leroux <i>et al.</i> 1982	field
		<i>Botrytis cinerea</i>	Grey mold	Strawberry	Davis & Dennis 1979	field
		<i>Botrytis cinerea</i>	Grey mould	Lisianthus	Elad <i>et al.</i> 2008	field
		<i>Botrytis elliptica</i>	Grey mold	Bulbs	Hsiang & Chastener 1990	field
		<i>Botrytis squamosa</i>	Leaf blight	Onion	Tremblay <i>et al.</i> 2003	laboratory
		<i>Botrytis tulipae</i>	Tulip fire	Tulip	Chastagner & Riley 1987	field
		<i>Didymella bryoniae</i>	Grey mold	Cucumber	Steekelenburg 1987	field
		<i>Microdochium nivale</i>	Snow mold	Grass / golf course	Pennucci <i>et al.</i> 1990	field
		<i>Monilinia fructicola</i>	Brown rot / twig / blossom blight	Stone fruit	Penrose <i>et al.</i> 1985 Elmer & Gaunt 1994	field
		<i>Monilinia laxa</i>	Brown rot	Apple	Katan & Shabi 1981	laboratory
		<i>Neurospora crassa</i>			Grindle 1984	laboratory mutation
		<i>Pyrenopeziza brassicae</i>	Light leaf spot	Oilseed rape / brassicas	Ilott & Ingram 1987	laboratory selection / mutation
		<i>Sclerotinia homeocarpa</i>	Dollar spot	<i>Agrostis palustris</i> (bent grass)	Detweiler <i>et al.</i> 1983	field
		<i>Sclerotinia minor</i>	Basal rot	Lettuce	Hubbard <i>et al.</i> 1997	field
		<i>Sclerotinia minor</i>	Sclerotinia	Peanut	Brenneman <i>et al.</i>	laboratory

			blight		1987 Smith <i>et al.</i> 1995	field
		<i>Stemphylium vesicarium</i>	Brown spot	Pear	Alberoni <i>et al.</i> 2005	field
		<i>Ustilago maydis</i>	Smut	Maize	Orth <i>et al.</i> 1994	laboratory mutation
F LIPIDS AND MEMBRANE SYNTHESIS						
F1	Formerly dicarbox- imides	Reclassified into E3				
F2	6	Phospho-thiolates and dithiolanes. Phospholipid biosynthesis, methyltransferase				
		<i>Bipolaris oryzae</i>	Rice	Rice blast	Annamalai & Lalithakumari 1992	mutagenesis and field
		<i>Pyricularia oryzae</i>	Rice	Rice blast	Uesugi 1981	mutation and field
F3	14	AH fungicides (Aromatic Hydrocarbons, chlorophenyls, nitroanilines, and heteroaromatics). Lipid peroxidation (proposed)				
		<i>Botrytis cinerea</i>	Grey mold	Glasshouse vegetables	Esuruoso & Wood 1971 Hartill <i>et al.</i> 1983	laboratory / field cross resistance studies with dicarboximides, Group 2
		<i>Phytophthora drechsletii</i>	-	-	Zhu Zhi-feng <i>et al.</i> 2006	Laboratory UV mutation, etridiazole
		<i>Rhizoctonia solani</i>	-	-	Anilkumar & Pandourange Gowda	PCNB <i>in-vitro</i> adaptation

					1981 Van Bruggen & Arneson 1984	Tolclofos-methyl, <i>in-vitro</i> adaptation
		<i>Sclerotium rolfsii</i>	Southern blight / stem rot	Peanut	Shim <i>et al.</i> 1998	field
F4	28	Carbamates. Cell membrane permeability, fatty acids (proposed)				
		<i>Pythium</i> spp. (propamocarb) <i>P. aphanidermatum</i> <i>P. cylindrosporium</i> <i>P. dissotocum</i> <i>P. heterothalicum</i> group F <i>P. irregulare</i> <i>P. splendens</i> <i>P. ultimum</i>	Damping off	Not specified but tested on geranium seedlings	Moorman <i>et al.</i> 2002, Moorman & Kim 2004	glasshouse isolates
F5	40	CAA fungicides (Carboxylic acid amides). Phospholipid biosynthesis and cell wall deposition (proposed)				
		<i>Phytophthora capsici</i>	Stem and fruit rot	Peppers	Young <i>et al.</i> 2001 Young <i>et al.</i> 2005	laboratory selection cross resistance study
		<i>Phytophthora infestans</i>	Late blight	Potato	Dereviagina <i>et al.</i> 1999 Stein & Kirk 2003 Yuan <i>et al.</i> 2006	unstable field isolates mutation mutation
		<i>Phytophthora parasitica</i>	Black shank	Tobacco	Chabane <i>et al.</i> 1993	mutation
		<i>Plasmopara viticola</i>	Downy mildew	Vines	Gisi <i>et al.</i> 2007	Inheritance of resistance

G: STEROL BIOSYNTHESIS IN MEMBRANES						
G1	3	DMI Fungicides (DeMethylation Inhibitors) SBI Class I. C14-demethylase in sterol biosynthesis (<i>erg11 / cyp 51</i>)				
<p>IMPORTANT NOTE: The DMI group includes several areas of chemistry (See FRAC Code List) and many molecules. Individual molecules can differ widely in their activity spectrum. Cases are known where resistance to one molecule does not always lead to resistance to another molecule. Reasons for this phenomenon are not always clear but appear to be linked to differences in the intrinsic levels of activity between molecules. If in any doubt assume that cross resistance can happen.</p>						
		<i>Aspergillus nidulans</i>	-	-	De Waard & van Nistelrooy 1979	genetic study
		<i>Blumeriella jaapii</i>	Leaf spot	Cherry	Proffer <i>et al.</i> 2006	field
		<i>Botrytis cinerea</i>	Grey mold	Vegetables Various	Elad 1992 Stehmann & De Waard 1996	field laboratory investigation of lack of intrinsic activity
		<i>Cercospora beticola</i>	Leaf spot	Sugar beet	Henry & Trivellas 1989 Karaoglanidis <i>et al.</i> 2000	Laboratory mutants Field isolates
		<i>Cladosporium caryigenum</i>	Scab	Pecan	Reynolds <i>et al.</i> 1997	cross resistance, laboratory
		<i>Colletotrichum gloeosporioides</i>	Anthraco-nose	Mango	Gutierrez-Alonso <i>et al.</i> 2003	postharvest / laboratory
		<i>Erysiphe graminis</i> f .sp. <i>hordei</i>	Powdery mildew	Barley	Fletcher & Wolfe 1981	field

		<i>Erysiphe graminis</i> f. sp. <i>tritici</i>	Powdery mildew	Wheat	De Waard <i>et al.</i> 1986	field
		<i>Fusarium fujikuroi</i>	-	-	Zhao Zhi-hua <i>et al.</i> 2007	Laboratory mutation (prochloraz)
		<i>Fusarium solani</i> . See <i>Nectria haematococca</i> var <i>cucurbitae</i>	Cucurbits	Foot rot	Kalamarakis <i>et al.</i> 1991	genetic study
		<i>Microdochium (Fusarium) nivale</i>	-	-	Cristani & Gambogi 1993	Laboratory
		<i>Monilinia fructicola</i>	Twig blight, brown rot	Stone fruit	Nuninger-Ney <i>et al.</i> 1989 Elmer <i>et al.</i> 1992	Laboratory Field
		<i>Mycosphaerella fijiensis</i>	Sigatoka	Banana	Anonymous 1992	
		<i>Mycosphaerella graminicola</i>	Leaf spot	Wheat	Metcalf <i>et al.</i> 2000 Mavroedi & Shaw 2005 HGCA 2005 Cools <i>et al.</i> 2005	field experiments field experiments field laboratory
		<i>Mycovellosiella natrassii</i>	Leaf mold	Eggplant	Yamaguchi <i>et al.</i> 2000	field
		<i>Nectria haematococca</i> var <i>cucurbitae</i>	Cucurbits	Foot rot	Kalamarakis <i>et al.</i> 1991	laboratory genetics
		<i>Penicillium digitatum</i>	Citrus	Green mold	Eckert 1987	Laboratory selection
		<i>Penicillium italicum</i>	-	Blue mold	De Waard <i>et al.</i> 1982	laboratory
		<i>Pseudocercospora herpotrichoides</i> Lente or R type	Eyespot	Wheat	Leroux & Marchegay 1991	field
		<i>Puccinia horiana</i>	White rust	Chrysanthemum	Cevat 1992 Cook 2001	field field
		<i>Puccinia striiformis</i>	Yellow / stripe rust	Wheat	Bayles <i>et al.</i> 2000 Napier <i>et al.</i> 2000	sensitivity shift laboratory

		<i>Pyrenophora teres</i>	Net blotch	Barley	Sheridan <i>et al.</i> 1985	field
		<i>Pyrenophora tritici-repentis</i>	Tan spot	Wheat	Reimann & Deising 2005	field
		<i>Rhynchosporium secalis</i>	Leaf blotch, scald	Barley	Hunter <i>et al.</i> 1986 Kendall & Hollomon 1990 Kendall <i>et al.</i> 1993 Cooke <i>et al.</i> 2004	Glasshouse field Field isolates field
		<i>Sclerotinia homoeocarpa</i>	-	-	Vargas <i>et al.</i> 1992	laboratory
		<i>Septoria tritici</i>				See <i>Mycosphaerella graminicola</i>
		<i>Sphaerotheca fuliginea</i>	Powdery mildew	Cucumber	Schepers 1983, 1985a, 1985b	field
		<i>Sphaerotheca mors-uvae</i>	Powdery mildew	Blackcurrant	Goszczyński <i>et al.</i> 1988	field
		<i>Sphaerotheca pannosa</i>	Powdery mildew	Nectarine	Reuveni 2001	field
		<i>Trichoderma koningii</i>	-	-	Figueras-Roca <i>et al.</i> 1996	Laboratory
		<i>Uncinula necator</i>	Powdery mildew	Grapevine	Steva <i>et al.</i> 1990 Reidi & Steinkellner 1996 Miller & Gubler 2003	field field field
		<i>Ustilago avenae</i>	Loose smut	Oats	Hippe & Koller 1986	laboratory
		<i>Ustilago maydis</i>	Smut / blister smut	Maize	Walsh & Sisler 1981	laboratory
		<i>Venturia inaequalis</i>	Scab	Apple	Stanis & Jones 1985; Köller <i>et al.</i> 1991	field laboratory
		<i>Venturia nashicola</i>	Japanese pear scab	Pear	Tomita & Ishii 1998	field

G2	5	Amines (Morpholines) SBI Class II. Δ^{14} reductase and $\Delta^8 - \Delta^7$ isomerase in sterol biosynthesis (<i>erg24 / erg2</i>)				
		<i>Erysiphe graminis tritici</i>	Powdery mildew	Wheat	Napier <i>et al.</i> 2000	sensitivity shift
		<i>Erysiphe graminis hordei</i>	Powdery mildew	Barley	Napier <i>et al.</i> 2000	sensitivity shift
		<i>Nectria haematococca</i>			Lasseron-De Felandre <i>et al.</i> 1999	laboratory mutants
		<i>Ustilago maydis</i>	Smut	Maize	Markoglou & Ziogas 1999, 2000, 2001	laboratory mutants
G3	17	Hydroxyanilides (SBI class III). 3-keto reductase C4-demethylation (<i>erg27</i>)				
		<i>Botrytis cinerea (Botryotinia fuckeliana)</i>	Grey mold	Grapevine	Baroffio <i>et al.</i> 2003 Ziogas <i>et al.</i> 2003	field experiments mutants
		<i>Botrytis cinerea</i>	Grey mould	Lisianthus	Elad <i>et al.</i> 2008	field (low frequency)
G4	18	SBI Class IV. Squalene epoxidase in sterol biosynthesis (<i>erg1</i>)				
		No resistance recorded				
		H: GLUCAN SYNTHESIS				
H3	26	Glucopyranosyl antibiotic (validamycin). Trehalase and inositol biosynthesis				
		<i>Coprinus cinereus</i>			Shim <i>et al.</i> 1994	
H4	19	Polyoxins. Chitin synthase				

		<i>Cochliobolus heterostrophus</i>			Gafur <i>et al.</i> 1998	laboratory mutation
		<i>Alternaria alternata</i>	Black leaf spot	Pear	Gasonshi & Takanashi	
		<i>Alternaria kikuchiana</i>	Alternaria leaf blotch	Apple, pear	Hori <i>et al.</i> 1976	laboratory study on resistance mechanism
		<i>Alternaria mali</i>	Black leaf spot	Apple	Hwang & Yun 1986	field isolates
		<i>Alternaria solani</i>		Not specified	Maria & Sullia 1986	laboratory adaptation study
		<i>Sclerotium rolfsii</i>		Not specified	Maria & Sullia 1986	laboratory adaptation study
I: MELANIN SYNTHESIS IN CELL WALL						
I1	16.1	MBI-R (Melanin biosynthesis Inhibitors: Reductase). Reductase in melanin biosynthesis				
		<i>Magnaporthe grisea / Pyricularia oryzae</i>	Rice blast	Rice	Zhang <i>et al.</i> 2006	UV light generated mutants
I2	16.2	MBI-D (Melanin biosynthesis Inhibitors: Dehydratase). Dehydratase in melanin biosynthesis				
		<i>Magnaporthe grisea / Pyricularia oryzae</i>	Rice blast	Rice	Yamaguchi <i>et al.</i> 2002 Sawada <i>et al.</i> 2004 Takagaki <i>et al.</i> 2004 Yamada <i>et al.</i> 2004	Field field resistance mechanism field
P: HOST PLANT DEFENCE INDUCTION						

P1	P	Benzo-thiadiazole BTH. Salicylic acid pathway				
		No resistance recorded				
P2	P	Benzisothiazole				
		No resistance recorded				
P3	P	Thiadiazole-carboxamide				
		No resistance recorded				
P4	P	Natural compound (Laminarin)				
		No resistance recorded				
U: UNKNOWN MODE OF ACTION						
unknown	27	Cyanoacetamide oximes				
		<i>Plasmopara viticola</i>	Downy mildew	Grapevine	Gullino <i>et al.</i> 1997	field
unknown	33	Phosphonates				
		<i>Bremia lactucae</i>	Downy mildew	lettuce	Brown <i>et al.</i> 2004	field
		<i>Phytophthora citrophthora</i>	Collar rot / foot rots		Angeles Diaz Borrás & Vila Aguila 1988	<i>in-vitro</i>
		<i>Plasmopara viticola</i>	Downy mildew	Grape vine	Khilare <i>et al.</i> 2003	field
		<i>Pythium aphanidermatum</i>		Not specified	Sanders <i>et al.</i> 1990	<i>in-vitro</i> mutation
unknown	34	Phthalamic acids				

		No resistance recorded				
unknown	35	Benzotriazines				
		No resistance recorded				
unknown	36	Benzene-sulfonamides				
		No resistance recorded				
unknown	37	Pyradazinones				
		No resistance recorded				
unknown	42	Thiocarbamate				
		No resistance recorded				
	U5	Thiazole carboxamides. Microtubule disruption (proposed)				
		No resistance recorded				
unknown	U6	Phenyl-acetamide				
		<i>Sphaerotheca cucurbitae</i>	Powdery mildew	Cucumber	Hosokawa <i>et al.</i> 2006	Glasshouses, Japan

		<i>Xanthomonas axonopodis</i> pv <i>citri</i>	Citrus canker	Grapefruit	Canteros 2002	Field
Multi-site contact activity	M2	Inorganics, sulphur				
		No resistance recorded				
	M3	Dithiocarbamates and relatives				
		<i>Botrytis cinerea</i>	Grey mold	Not specified	Barak & Edgington 1984	laboratory study
		<i>Helminthosporium halodes</i>	Leaf spot	Sugar cane	Reddy & Anilkumar 1989	laboratory study
	M4	Phthalimides				
		<i>Botrytis cinerea</i>	Grey mold	Not specified	Barak & Edgington 1984	laboratory study
		<i>Botrytis cinerea</i>	Grey mold	Grapevine	Fourie & Holz 2001	laboratory
		<i>Botrytis cinerea</i>	Grey mold	Glasshouse cucumber	Malathrakis 1989	glasshouse
	M5	Chloronitriles (phthalonitriles)				
		<i>Botrytis cinerea</i>	Grey mold	Not specified	Barak & Edgington 1984	laboratory study
		<i>Botrytis cinerea</i>	Grey mold	Glasshouse cucumber	Malathrakis 1989	
	M6	Sulphamides				
		<i>Botrytis cinerea</i>	Grey mold	Glasshouse cucumber	Malathrakis 1989	
	M7	Guanidines				

		<i>Venturia inaequalis</i>	Scab	Apple	Szkolnik & Gilpatrick 1969, 1971	Dodine
Multi-site contact activity		<i>Hypomyces</i>	-	-	Kappas & Georgopoulos	Dodine, induced resistance
		<i>Penicillium digitatum</i>	Green mold	Citrus	Wild 1983	
		<i>Penicillium italicum</i>	Blue mold	Lemon	Hartill <i>et al.</i> 1983	<i>in-vitro</i>
	M8	Triazines No resistance recorded				
M9	Quinones No resistance recorded					

References

A

- Angeles Diaz Borrás M, Vila Aguilar R (1988). In-vitro resistance of *Phytophthora citrophthora* to metalaxyl and fosetyl-Al.
- Anonymous (1992). Sterol biosynthesis inhibitors – risk of resistance and recommended antiresistance strategies. Recommendations of the FRAC-DMI Working Group for 1992. *Gesunde Pflanzen* **44**, 361 – 365
- Abelentsev V I, Golyshin N M (1973). Adaptatsiya nekotorykh fitopatogennykh gribov k benomilu. *Kimila v Sel'skom Khoz* **11**, 432-436
- Abelentsev V I, Savchenko V I (1980). Resistance of the causative agent of powdery mildew of cucumbers to benzimidazole fungicides. *Khimiya v Sel'skrom Khozyaistve* **18**, 31 - 33
- Alberoni G, Collina M, Pancaldi D, Brunelli A (2005). Resistance to dicarboximide fungicides in *Stemphylium vesicarium* of Italian pear orchards. *European Journal of Plant Pathology* **113**, 211-219
- Albourie J-M, Tourville J, Tourviellie De Labrouhe D (1998). Resistance to metalaxyl in isolates of the sunflower pathogen *Plasmopara halstedii*. *European Journal of Plant Pathology* **194**, 235 – 242
- Amand O, Calay F, Coquillart L, Legat T, Bodson B, Moreau J-M, Maraite H (2003). First detection of resistance to QoI fungicides in *Mycosphaerella graminicola* on winter wheat in Belgium. *Communications in Agricultural and Applied Biological Sciences* **68**, 519-531
- Anilkumar T B, Pandourange Gowda K T (1981). Growth and stability of penta chloronitro benzene resistant isolate of *Rhizoctonia solani*. *Zentralblatt fuer Bakteriologie Parasitenkunde Infektionskrankheiten und Hygiene Zweite Naturwissenschaftliche Abteilung Mikrobiologie der Landwirtschaft der TEchnologie und des Umweltschutzes* **136**, 502-504
- Annamalai P, Lalithakumari D (1987). Cross resistance in edifenphos resistant mutant of *Dreschlera oryzae*. *Indian Phytopathology* **40**, 296
- Annamalai P, Lalithakumari D (1992). Development of resistance in *Bipolaris oryzae* against edifenphos. *Mycological Research* **96**, 454-460
- Avenot H, Simoneau P, Iacomini-Vasilescu B, Bataille-Simoneau N (2005). Characterisation of mutations in the two component histidine kinase gene AbNIK1 from *Alternaria brassicicola* that confer high dicarboximide and phenylpyrrole resistance. *Current Genetics* **47**, 234-243
- Avenot H F, Michailides T J (2007). Resistance to pyraclostrobin, boscalid and Pristine (pyraclostrobin plus boscalid) in *Alternaria alternata* isolates from California. *Phytopathology* **97**, (7, Suppl. S) S5 Jul 2007.
- Avenot H F, Sellam A, Karaoglanidis G, Michailides T J (2008). Characterization of mutations in the iron-sulphur subunit of succinate dehydrogenase correlating with boscalid resistance in *Alternaria alternata* from California pistachio. *Phytopathology* **98**, 736-742
- Avila-Adame C, Olaya G, Koller, W (2003). Characterisation of *Colletotrichum graminicola* isolates resistant to strobilurin related QoI fungicides. *Plant Disease* **87**, 1426-1432

B

- Bal E, Gilles G, Creemers P, Vandergeten-Bollen J (1987). *Mededelingen van de Faculteit Landbouwwetenschappen Universiteit Gent* **52**, 881 – 894

- Barak E, Edgington L V (1984). Cross resistance of *Botrytis cinerea* to captan, thiram, chlorothalonil and related fungicides. *Canadian Journal of Plant Pathology* **6**, 318-320
- Baroffio C A, Siegfried W, Hilber U W (2003). Long-term monitoring for resistance of *Botryotinia fuckeliana* to anilinopyrimidine, phenylpyrrole and hydroxyanilide fungicides in Switzerland. *Plant Disease* **87**, 662-666
- Basim H, Ozturk S B, Unlu A, Yegen O, Zeller W (2001). Evaluation of *Erwinia amylovora* strains in Turkey for resistance to streptomycin, oxytetracycline and copper. *Phytopathology* **91**, S6
- Bastels-Schooley J, MacNeil B H (1971). A comparison of the mode of action of three benzimidazoles. *Phytopathology* **61**, 816-819
- Bayles R A, Stigwood P L, Clarkson J D S (2000). Shifts in sensitivity of *Puccinia striiformis* to DMI fungicides in the UK. *Acta Phytopathologica et Entomologica Hungarica* **35**, 381 - 382
- Ben-Yephet Y, Henis Y, Dinour A (1975). Inheritance of tolerance to carboxin and benomyl in *Ustilago hordei*. *Phytopathology* **65**, 563 – 567
- Berger R D (1973). Disease progress of *Cercospora apii* resistant to benomyl. *Plant Disease Reporter* **57**, 837 - 840
- Bhat R G, McBlain B A, Schmitthenner A F (1993). The inheritance of resistance to metalaxyl and to fluorophenylalanine in mating of homothallic *Phytophthora sojae*. *Mycological Research* **97**, 865 – 870
- Bielenin A (1986). Resistance to benzimidazole fungicides in *Pezizula* spp. *Ochr. Rosl.* **30**, 16-17
- Bollen G J, Scholten G (1971). Acquired resistance to benomyl and some other systemic fungicides in a strain of *Botrytis cinerea* in cyclamen. *Netherlands Journal of Plant Pathology* **77**, 83 – 90
- Bonnen A M, Hopkins C (1997). Fungicide resistance and population variation in *Verticillium fungicola*, a pathogen of the button mushroom, *Agaricus bisporus*. *Mycological Research* **101**, 89-96
- Bosshard E, Schuepp H (1983). Variability of selected strains of *Plasmopara viticola* with respect to their metalaxyl sensitivity under field conditions. *Zeitschrift fuer Pflanzenkrankheiten und Pflanzenschutz* **90**, 449 – 459
- Brasier C M, Gibbs J N (1975) Methyl benzimidazole-2-yl carbamate tolerance in aggressive and nonaggressive isolates of *Ceratocystis ulmi*. *Annals of Applied Biology* **80**, 231 – 236
- Breneman T B, Phipps P M, Stipes R J (1987). Sclerotinia blight of peanut relationship between *in vitro* resistance and field efficacy of dicarboximide fungicides. *Phytopathology* **77**, 1028-1032
- Brown S, Koike S T, Ochoa O E, Laemmien F, Michelmore R W (2004). Insensitivity to the fungicide fosetyl-aluminum in California isolates of the lettuce downy mildew pathogen *Bremia lactucae*. *Plant Disease* **88**, 502-508
- Bruck R, Gooding G V Jr, Main C E (1981). Evidence for resistance to metalaxyl in isolates of *Peronospora tabacina*. *Phytopathology* **71**, 558
- Bruck R, Gooding G V Jr, Main C E (1982). Evidence for resistance to metalaxyl in isolates of *Peronospora hyoscyami*. *Plant Disease* **66**, 44 – 45

C

- Canteros B (2002). Control of citrus canker caused by strains of *Xanthomonas axonopodis* pv *citri* susceptible and resistant to copper. *Phytopathology* **92**, S116 (meeting abstract)
- Cevat H (1992). Japanse roest terug van nooit weggeweest. nu maatregelen nemen om aantasting in najaar te voorkomen. *Vakblad voor de Bloemisterij* **29**, 32 – 33
- Chabane K, Leroux P, Bompeix G (1993). Selection and characterisation of *Phytophthora parasitica* mutants with ultraviolet induced resistance to dimethomorph or metalaxyl. *Pesticide Science* **39**, 325-329
- Chakravarti B P, Anilkumar T B (1969). *Hindustan Antibiotics Bulletin* **12**, 73-74
- Chandler W A, Daniell J W, Littrell R H (1978). Control of peach diseases in annorchard having benomyl tolerant *Cladosporium carpophilum*. *Plant Disease Reporter* **62**, 783 – 786
- Chapeland F, Fritz R, Lanen C, Gredt M, Leroux P (1999). Inheritance and mechanisms of resistance to anilinopyrimidine fungicides in *Botrytis cinerea* (*Botryotinia fuckeliana*). *Pesticide Biochemistry and Physiology* **64**, 85-100
- Chastagner G A, Riley K (1987). Occurrence and control of benzimidazole and dicarboximide resistant *Botrytis* spp. on bulb crops in Western Washington and Oregon USA. *Phytopathology* **77**, 1237
- Chen Y R, Huang J W, Chen L C (1996). In vitro inspection of pencycuron fungicide: Resistant *Rhizoctonia solani* Ag-4 and its interfering factors. *Plant Protection Bulletin (Taichung)* **38**, 313-328
- Chin K M, Wirz M, Laird D (2001). Sensitivity of *Mycosphaerella fijiensis* from banana to trifloxystrobin. *Plant Disease* **85**, 1264-1270
- Clark E M, Backman P A, Rodriguez-Kabana R (1974). *Cercospora arachidicola* and *Cercosporidium personatum* tolerance to benomyl and related fungicides in Alabama peanut fields. *Phytopathology* **64**, 1476 – 1477
- Clark M R M (1985). Barley leaf stripe mercury resistance. In: *British Crop Protection Council Monograph No. 31. Fungicides for Crop Protection: 100 Years of Progress, Vol 2, Bordeaux Mixture Centenary Meeting*. BCPC Publications, Croydon, England. pp. 351-354
- Clark W (2005). QoI resistance in *Mycosphaerella graminicola* in the UK: implications for future use of QoI fungicides. *Proceedings of the BCPC International Congress, Crop Science & Technology* 283-290
- Cole H, Warren C G, Sanders P L (1974). Fungicide tolerance – a rapidly emerging problem in turfgrass disease control. *Proceedings International Turfgrass Research Conference*. **2D**, 344-349
- Cook R T A, Pereira J L (1976). Strains of *Colletotrichum coffeanum* the causal agent of coffee berry disease tolerant to benzimidazole compounds in Kenya. *Annals of Applied Biology* **83**, 365 – 379
- Cooke L, Locke T, Lockley K D, Phillips A N, Sadiq M D S, Coll R, Black L, Taggart P J, Mercer P C (2004). The effect of fungicide programmes based on epoxyconazole on the control and DMI sensitivity of *Rhynchosporium secalis* in winter barley. *Crop Protection* **23**, 393-406.
- Cools H J, Fraaje B A, Lucas J A (2005). Molecular mechanisms correlated with changes in triazole sensitivity in isolates of *Mycosphaerella graminicola*. *Proceedings of the BCPC International Congress, Crop Science & Technology 2005*, 267-274

- Cristani C, Gambogi P (1993). Laboratory isolation of *Microdochium (Fusarium) nivale* mutants showing reduced sensitivity to sterol biosynthesis inhibitors. *Rivista di Patologia Vegetale* **3**, 49 - 57
- Crute I R, Norwood J M, Gordon P L (1987). The occurrence, characteristics and distribution in the United Kingdom of resistance to phenylamide fungicides in *Bremia lactucae* (lettuce downy mildew). *Plant Pathology* **36**, 297 - 315
- Crute I, Harrison J M (1988). Studies on the inheritance of resistance to metalaxyl in *Bremia lactucae* and on the stability and fitness of field isolates. *Plant Pathology* **37**, 231 – 250

D

- Darvas J M, Becker O (1984). Failure to control *Phytophthora cinnamomi* and *Pythium splendens* with metalaxyl after its prolonged use. *Citrus and Subtropical Fruit Journal* **603**, 9 – 11.
- Date H, Kataoka E, Tanina K, Sasaki S, Inoue K, Nasu H, Kasuyama S (2004). Sensitivity of *Corynespora cassicola*, causal agent of Corynespora target spot of tomato, to thiophanate methyl and diethofencarb. *Japanese Journal of Phytopathology* **70**, 7-9
- Davey J F, Gregory N F, Mulrooney R P, Evans T A, Carroll RB (2008). First report of mefenoxam resistant isolates of *Phytophthora capsici* from lima bean pods in the Mid-Atlantic region. *Plant Disease* **92**, 656
- Davidse L C (1981). Resistance to acylalanine fungicides in *Phytophthora megasperma* f. sp. *medicaginis*. *The Netherlands Journal of Plant Pathology* **87**, 11-24
- Davidse L C, looijeu D, Turkenstein L J, Van Der Wal D (1981). Occurrence of metalaxyl resistant strains of potato blight in Dutch potato fields. *The Netherlands Journal of Plant Pathology* **87**, 65 - 68
- Davidse L C, Danial D L, Van Westen C J (1983). Resistance to metalaxyl in *Phytophthora infestans* in the Netherlands. *The Netherlands Journal of Plant Pathology* **89**, 1 – 20
- Davis R P, Dennis C (1979). Use of dicarboximide fungicides on strawberries and potential problems of resistance in *Botrytis cinerea*. *Proceedings of the British Crop Protection Conference, Pests & Diseases* 193 – 201
- De Waard M A, Van Nistelrooy J G M (1979). Mechanisms of resistance to fenarimol in *Aspergillus nidulans*. *Pesticide Biochemistry and Physiology* **10**, 219 – 229
- De Waard M A, Groeneweg H, Van Nistelrooy J G M (1982). Laboratory resistance to fungicides which inhibit ergosterol biosynthesis in *Penicillium italicum*. *Netherlands Journal of Plant Pathology* **88**, 99 – 112
- De Waard M A, Kipp E M C, Horn N M, Van Nistelrooy J G M (1986). Variation in sensitivity to fungicides which inhibit ergosterol biosynthesis in wheat powdery mildew. *Netherlands Journal of Plant Pathology* **92**, 21 – 32
- Dekker J (1972) In: Marsh R W, *Systemic Fungicides*. John Wiley & Son, New York. pp 156-174
- Derevyagiana M K, Matskavichus G, D'Yakov Yu T (1995). Changes of resistance to dimethomorph of *Phytophthora infestans* (Mont.) D By. isolates during cloning. *Mikologiya i Fitopatologiya* **29**, 44-47

- Dereviagina M K, Elanski S N, Diakov Yu T (1999). Resistance of *Phytophthora infestans* to the dimethomorph fungicide. *Mikologiya i Fitopatologiya* **33**, 208-213
- Detweiler A R, Yargas J M Jr., Danneberger T K (1983). Resistance of *Sclerotinia homoeocarpa* to iprodione and benomyl. *Plant Disease* **67**, 627 – 630
- Di Rago J P, Colson A-M (1988). Molecular basis for resistance to antimycin and diuron Q-cycle inhibitors acting at the Q-I site in the mitochondrial ubiquinol-cytochrome C reductase in *Saccharomyces cerevisiae*. *Journal of Biological Chemistry* **263**, 12564-12570
- Di Rago J-P, Coppee J-Y, Colson A-M (1989). Molecular basis for resistance to myxothiazol mucidin strobilurin A and stigmatellin cytochrome B inhibitors acting at the center of the mitochondrial ubiquinol cytochrome C reductase in *Saccharomyces cereviaiae*. *Journal of Biological Chemistry* **264**, 14543-14548
- Duineveld Th L J, Beijersbergen J C M (1975). On the resistance to benomyl of fungi isolated from bulbs and corms. *Acta Horticulturae (Wageningen)* **47**, 143-148
- Dux H, Sierotzki H, Meier-Runge F, Gisi U (2005). Sensitivity of *Venturia inaequalis* populations to anilinopyrimidine, DMI and QoI fungicides. In: Modern Fungicides and Antifungal Compounds IV. Eds. H-W Dehne, U Gisi, K-H Kuck, P E Russell, H Lyr. BCPC, Alton, UK pp. 45-54

E

- Eastburn D M, Butler E E (1986). The occurrence of benomyl resistant isolates of *Trichoderma harzianum* in Costa Rican soils. *Phytopathology* **76**, 1066 (abstract)
- Eckert J W (1987). *Penicillium digitatum* biotypes with reduced sensitivity to imazalil. *Phytopathology* **77**, 1728
- Elmer P A G, Gaunt R E (1994). The biological characteristics of dicarboximide resistant isolates of *Monilinia fructicola* from New Zealand stone fruit orchards. *Plant Pathology* **43**, 130 – 137.
- Ehrenhardt H, Eichhorn K W, Thate R (1973). Zur Frage der Resistenzbildung von *Botrytis cinerea* gegenüber systemischen Fungiziden. Nachrichtenblatt des Deutschen Pflanzenschutzdienstes (Braunschweig) **25**, 49 – 50
- Elad Y (1992). Reduced sensitivity of *Botrytis cinerea* to two sterol, biosynthesis inhibiting inhibiting fungicides: fenetrazole and fenethanil. *Plant Pathology* **41**, 47 – 54
- Elad Y, Yunis H, Katan T (1992). Multiple fungicide resistance to benzimidazoles dicarboximides and diethofencarb in field isolates of *Botrytis cinerea* in Israel. *Plant Pathology* **41**, 41-46
- Elad Y, Shpialter L, Korolev N, Mamiev M, Rav David D, Dori I, Ganot L, Shmuel D, Matan E, Messika Y. (2008) Integrated chemical and cultural control for grey mould (*Botrytis cinerea*) management in Lisianthus. In: Modern Fungicides and Antifungal Compounds IV. Proceedings of the 15th International Reinhardtsbrunn Symposium. Eds. Dehne H-W, Gisi U, Kuck K-h, Russell P E, Lyr H. (in press)
- Elmer P A G, Braithwaite M, Saville D J (1992). Changes in triforine sensitivity in populations of *Monilinia fructicola* from Hawkes Bay orchards. *Proceedings of the 45th. New Zealand Plant Protection Conference* **45**, 138 – 140

Esuruoso O F, Wood R K S (1971). The resistance of spores of resistant strains of *Botrytis cinerea* to quinterozone tecnazene and dicloran. *Annals of Applied Biology* **68**, 271-279

F

Falloon R E, Follas G B, Butler R C, Goulder D S (2000). Resistance in *Peronospora viciae* to phenylamide fungicides: reduced efficacy of seed treatments of pea (*Pisum sativum*) and assessment of alternatives. *Crop Protection* **19**, 313 – 325

Fancelli M I, Kimati H (1991). Occurrence of iprodione resistant strains of *Alternaria dauci*. *Summa Phytopathologica* **17**, 135-146

Farber R B K, Chin K M, Leadbitter N (2002). Sensitivity of *Venturia inaequalis* to trifloxystrobin. *Pest Management Science* **58**, 261-267

Faretra F, Pollastro S (1993). Isolation, characterisation and genetic analysis of laboratory mutants of *Botryotinia fuckeliana* resistant to the phenylpyrrole fungicide CGA-173506. *Mycological Research* **97**, 620-624

Fernandez-Ortuno D, Perez-Garcia A, Lopez-Ruiz F, Romero D, de Vicente A, Tores J A (2006). Occurrence and distribution of resistance to QoI fungicides in populations of *Podosphaera fusca* in south central Spain. *European Journal of Plant Pathology* **115**, 215 – 222

Fernandez-Ortuno D, Tores J A, de Vincente A, Perez-Garcia A (2008). Field resistance to QoI fungicides in *Podosphaera fusca* is not supported by typical mutations in the mitochondrial cytochrome b gene. *Pest Management Science* **64**, 694-702

Ferrin D M, Kabashima J N (1991). *In-vitro* insensitivity to metalaxyl of isolates of *Phytophthora citricola* and *Phytophthora parasitica* from ornamental hosts in Southern California USA. *Plant Disease* **75**, 1041 – 1044

Figueras-Roca M, Cristani C, Vannacci G (1996). Sensitivity of Trichoderma isolates and selected resistant mutants to DMI fungicides. *Crop Protection* **15**, 615 – 620

Fletcher J T, Yarham D J (1976). The incidence of benomyl tolerance in *Verticillium fungicola*, *Mycogone pernicioso* and *Hyphomyces rosellus* in mushroom crops. *Annals of Applied Biology* **84**, 343 – 354

Fletcher J S, Wolfe M S (1981) Insensitivity of *Erysiphe graminis* f. sp. *hordei* to triadimefon, triadimenol and other fungicides. *Proceedings of the Brighton Crop Protection Conference, Pests & Diseases* 633 - 640

Forster B, Staub T (1996). Basis for use strategies of anilinopyrimidine and phenylpyrrole fungicides against *Botrytis cinerea*. *Crop Protection* **15**, 529-537

Fourie P H, Holz G (2001). Incomplete cross-resistance to folpet and iprodione in *Botrytis cinerea* from grapevine in South Africa. *South African Journal of Enology and Viticulture* **22**, 3-7

Fraaije B A, Burnett F J, Clark W S, Motteram J, Lucas J A (2005). Resistance development to QoI inhibitors in populations of *Mycosphaerella graminicola* in the UK. In: *Modern Fungicides and Antifungal Compounds IV*. BCPC, Alton, UK pp. 63-72

Fraaije B A, Lucas J A (2003). QoI resistance development in populations of cereal pathogens in the UK. *Proceedings of the BCPC International Congress – Crop Science & Technology* 689 – 694

FRAC. Where a reference is given as ‘FRAC’ please refer to the FRAC website: www.frac.info and the appropriate Working Group page. When a date is given, this indicates the first report to the FRAC Working Group

- Freeman J, Ward E, Gutteridge R J, Bateman G L (2005). Methods for studying population structure, including sensitivity to the fungicide siltthiofam, of the cereal take-all fungus, *Gaeumannomyces graminis* var. *tritici*. *Plant Pathology* **54**, 686-698
- Fujimura M, Kamakura T, Inoue K, Yamaguchi I (1994). Amino acid alterations in the beta-tubulin gene of *Neurospora crassa* that confer resistance to carbendazim and diethofencarb. *Current Genetics* **25**, 418-422

G

- Gafur A, Tanaka C, Shimizu K, Ouchi S, Tsuda M (1998). Genetic analysis of *Cochliobolus heterostrophus* polyoxin resistant mutants. *Mycoscience* **39**, 155-159
- Garibaldi A, Migheli Q, Gullino M L (1987). Evaluation of the efficacy of several fungicides against *Cryptocline cyclaminis* on Cyclamen. *Meded. Fac. Landbouwwet. Rijksuniv. Gent* **52**, 859-865
- Gasonshi K, Takanashi K (1973). Resistance of pear black spot pathogen to polyoxin. *Annals of the Phytopathological Society of Japan* **39**, 173-174
- Geary B, Johnson D A, Hamm P B, James S, Rykbost K A (2007). Potato silver scurf affected by tuber seed treatments and locations, and occurrence of fungicide resistant isolates of *Helminthosporium solani*. *Plant Disease* **91** 315-320
- Georgopoulos S G, Dovas C (1973). A serious outbreak of strains of cercospora beticola resistant to benzimidazole fungicides in northern Greece. *Plant Disease Reporter* **62**, 205 – 208
- Giannopolitis C N (1978). Occurrence of strains of *Cercospora beticola* resistant to tri-phenyl tin fungicides in Greece. *Plant Disease Reporter* **62**, 205-208
- Giannopolitis C N, Chrysayi-Tokousbalides M (1980). Biology of tri phenyl tin resistant strains of *Cercospora beticola* from sugar beet. *Plant Disease* **64**, 940 – 942
- Gilmenez V I, Luisi N (1978). Tolerance to benomyl in *Phoma tracheiphila*. *Phytopathologia Mediterranea* **17**, 77 (abstract)
- Gisi U, Pavic L, Stanger C, Hugelshofer U, Sierotzki H (2005). Dynamics of *Mycosphaerella graminicola* populations in response to selection by different fungicides. . In: *Modern Fungicides and Antifungal Compounds IV*. BCPC, Al;ton, UK pp. 89-102
- Gisi U, Sierotzki H, Cook A, McCaffery A (2002). Mechanisms influencing the evolution of resistance to Qo inhibitor fungicides. *Pest Management Science*. **58**, 859-867
- Gisi U, Waldner M, Kraus N, Dubuis P H, Sierotzki H (2007). Inheritance of resistance to carboxylic acid amide fungicides in *Plasmopara viticola*. *Plant Pathology* **56** 199-208
- Gossen B D, Anderson K L (2004). First report of resistance to strobilurin fungicides in *Didymella rabiei*. *Canadian Journal of PLant Pathology* **26**, 411
- Goszczynski W, Cimanowski J, Bachnacki R (1988). First note on the occurrence of a strain of *Sphaerotheca mors-uvae* Schw. –Berk. with decreased ensitivity to triadimefon. *Fruit Science Reports (Skierniewice)* **15**, 181 – 184

- Goto M, Hikota T, Nakajima M, Takikawa Y, Tsuyumi S (1994). Occurrence and properties of copper resistance in plant pathogenic bacteria. *Annals of the Phytopathological Society of Japan* **60**, 147-153
- Griffie P J (1973). Resistance to benomyl and related fungicides in *Colletotrichum musae*. *Transactions of the British Mycological Society* **60**, 433 - 439
- Griffin M J, Drummond M, Yarham D J, King J E, Brown M (1982). Benzimidazole resistance in *Pseudocercospora herpotrichoides*, the cause of eyespot disease of cereals. *International Society for Plant Pathology, Chemical Control Newsletter* **1**, 7 – 8
- Griffin M, Fisher N (1985). Laboratory studies on benzimidazole resistance in *Septoria tritici*. *ulletin OEPP* **15**, 505 – 512
- Grindle M (1984). Isolation and characterisation of vinclozolin resistant mutants of *Neurospora crassa*. *Transactions of the British Mycological Society* **82**, 635-644
- Gullino M L, Mescalchin E, Mezzalama M (1997). Sensitivity to cymoxanil in populations of *Plasmopara viticola* in northern Italy. *Plant Pathology* **46**, 729-736
- Gullino M L, Gilardi G, Tinivella F, Garibaldi A (2004). Observations on the behaviour of different populations of *Plasmopara viticola* resistant to QoI fungicides in Italian vineyards. *Phytopathologia Mediterranea* **43**, 341-350
- Gutierrez-Alonso J G, Gutierrez-Alonso O, Nieto-Angel D, Teliz-Ortiz D, Zavaleta-Mejia E, Delgadillo-Sanchez F, Vaquera-Huerta H (2003). Evaluation of resistance to imazalil, prochloraz, and azoxystrobin of *Colletotrichum gloeosporioides* (penz.) Penz. y Sacc. isolates and control of Mango (*Mangifera indica* L.) anthracnosis during postharvest. *Revista Mexicana de Fitopatologia* **21**, 379 - 382

H

- Hanson L E, Schwager S J, Loria R (1996). Sensitivity to thiabendazolwe in Fusarium species associated with dry rot in potatoes. *Phytopathology* **86**, 378-384
- Harrison J G (1984). *Botrytis cinerea* as an important cause of chocolate spot in field beans. *Transactions of the British Mycological Society* **83**, 631-638
- Hartill W F T, Tompkins G R, Kleinshaw P J (1983). Development in New Zealand of resistance to dicarboximide fungicides in *Botrytis cinerea* to acylalanines in *Phytophthora infestans* and to guazatine in *Penicillium italicum*. *New Zealand Journal of Agricultural Research* **26**, 261 – 270
- Hasti A C, Georgopoulos S G (1971). Mutational resistance to fungitoxic benzimidazole derivatives in *Aspergillus nidulans*. *Journal of General Microbiology* **65**, 371-374
- Heaney S P, Hall A A, Davies S A, Olaya G (2000). Resistance to fungicides in the QoI-STAR cross resistance group: current perspectives. *Proceedings of the BCPC Conference – Pests & Diseases* 755 - 762
- Henry M J, Trivellas A E (1989). Laboratory induced fungicide resistance to benzimidazole and azole fungicides in *Cercospora beticola*. *Pesticide Biochemistry and Physiology* **35**, 89 – 96

- Herbert J A, Grech N M (1985). A strain of *Guignardia citricarpa*, the citrus black spot pathogen, resistant to benomyl in South Africa. *Plant Disease* **69**, 1007 (abstract)
- HGCA (2005). Wheat Disease Management Guide – 2005 Update. Home Grown Cereals Authority, London UK
- Hill S N, Hausbeck M K (2008). Virulence and fungicide sensitivity of *Phytophthora cactorum* isolated from American ginseng gardens in Wisconsin and Michigan. *Plant Disease* **92**, 1183-1189
- Hippe S, Koller W (1986). Ultrastructure and sterol composition of laboratory strains of *Ustilago avenae* resistant to triazole fungicides. *Pesticide Biochemistry and Physiology* **26**, 209-219
- Hollomon D W (1978). Competitive ability and ethirimol sensitivity in strains of barley powdery mildew. *Annals of Applied Biology* **90**, 195-204
- Hollomon D W, Wheeler I, Dixon K, Longhurst C, Skylakakis G (1997). Defining the resistance risk of the new powdery mildew fungicide quinoxifen. *Pesticide Science* **51**, 347-351
- Holz B (1979). Über eine Resistenzercheinung von *Botrytis cinerea* an Reben gegen die neuen Kontaktbotrytizide im Gebiet der Mittelmose. *Weinberg und Keller* **26**, 18 – 25
- Hori M, Kakiki K, Misato T (1976). Mechanism of polyoxin resistance in *Alternaria kikuchiana*. *Journal of Pesticide Science* **1**, 31-40
- Hosokawa H., Yamanaka H., Haramoto M, Sano S, Yokota C, Hamamura H. (2006), Occurrence and biological properties of cyflufenamid-resistant *Sphaerotheca cucurbitae*. *Japanese Journal of Phytopathology* **72**: 260-261 (Japanese abstr.).
- Hsiang T, Chastagner G A (1990). Parasitic fitness of benzimidazole and dicarboximide resistant isolates of *Botrytis cinerea* *Botrytis elliptica* and *Botrytis tulipae*. *Phytopathology* **80**, 978
- Hu J H, Hong C X, Stomberg E L, Moorman G W (2008). Mefenoxam sensitivity and fitness analysis of *Phytophthora nicotianae* isolates from nurseries in Virginia USA. *Plant Pathology* **57**, 728-736
- Hubbard J C, Subbarao, Koike S T (1997). Development and significance of dicarboximide resistance in *Sclerotinia minor* isolates from commercial lettuce fields in California. *Plant Disease* **81**, 148-153
- Hunter T, Jordan V W, Kendall S J (1986). Fungicide sensitivity changes in *Rhynchosporium secalis* in glasshouse experiments. *Proceedings of the British Crop Protection Conference, Pests & Diseases* 523 – 536
- Hutton D G (1988). The appearance of dicarboximide resistance in *Alternaria alternata* in passionfruit in South-East Queensland Australia. *Australasian Plant Pathology* **17**, 34-36
- Hwang B K, Yun J H (1986). Variability in sensitivity to polyoxin B of isolates of *Alternaria mali* and decreased fitness of polyoxin resistant isolates. *Journal of Phytopathology* **115**, 305-312

I

- Ieki H (1994). Emergence of benzimidazole resistant strains of *Elsinoe fawcetti* Jenkins in citrus orchards in Japan. *Annals of the Phytopathological Society of Japan* **60**, 501 – 506

- Iida W (1975). On the tolerance of plant pathogenic fungi and bacteria to fungicides in Japan. *Japanese Pesticide Information* **23**, 13-16
- Ilott T W, Ingram D S, Rawlinson C J (1987). Studies of fungicide resistance in *Pyrenopeziza brassicae* cause of light leaf spot disease of oilseed rape and other brassicas. *Transactions of the British Mycological Society* **88**, 515-523
- Ishii H (2004). Fungicide resistance: a factor limiting integrated disease control. *Proceedings of the 15th. International Plant Protection Congress* Ed. Guo Yu-yuan. p. 216
- Ishii H, Yamaguchi A (1981). Resistance of *Venturia nashicola* to thiophanate-methyl and benomyl existence of weakly resistant isolates and its practical significance. *Annals of the Phytopathological Society of Japan* **4**, 528 – 533
- Ishii H, Fraaije B A, Sugiyama T, Noguchi K, Nishimura K, Takeda T, Amano T, Hollomon D W (2001). Occurrence and molecular characteristics of strobilurin resistance in cucumber powdery mildew and downy mildew. *Phytopathology* **91**, 1166-1171
- Ishii H, Noguchi K, Tomita Y, Umemoto S, Nishimura K (1999). Occurrence of strobilurin resistance in powdery mildew and downy mildew on cucumbers. *Annals of the Phytopathological Society of Japan* **65**, 655
- Ishii, H., Fountaine J., Miyamoto, T., Nishimura, K. and Tomita, Y. (2007), Occurrence of a mutation in the succinate dehydrogenase gene found in some isolates of cucumber *Corynespora* leaf spot fungus resistant to boscalid. *Japanese Journal of Phytopathology* **74**: in press (Japanese abstr.).
- Ishii H (2008). Fungicide research in Japan, an overview. *In: Modern Fungicides and Antifungal Compounds IV. Proceedings of the 15th International Reinhardtsbrunn Symposium*. Eds. Dehne H-W, Gisi U, Kuck K-h, Russell P E, Lyr H. (in press)
- Ito I, Yamaguchi T (1977). Occurrence of kasugamycin resistant rice blast fungus influenced by the application of fungicides. *Annals of the Phytopathological Society of Japan* **43**, 301-303
- Ito Y, Maraguchi H, Seshime Y, Oita S, Yanagi S O (2004). Flutolanil and carboxin resistance in *Coprinus cinereus* conferred by a mutation in the cytochrome b560 subunit of succinate dehydrogenase complex (Complex II). *Molecular Genetics and Genomics* **272**, 328 – 335

J

- Jarvis W R, Hargreaves A J (1973). Tolerance to benomyl in *Botrytis cinerea* and *Penicillium corymbiferum*. *Plant Pathology* **22**, 139-141
- Jarvis W R, Slingsby K (1975). Tolerance of *Botrytis cinerea* and rose powdery mildew to benomyl. *Canadian Plant Disease Survey* **55**, 44
- Jones A L, Ehret G R (1976). Isolation and characterisation of benomyl tolerant strains of *Monilinia fructicola*. *Plant Disease Reporter* **60**, 765 – 769
- Jones A L, Ehret G R (1981). Resistance of *Coccomyces hiemalis* to benzimidazole fungicides. *Plant Disease* **64**, 767 – 769
- Jones W B, Thompson S V (1982). The effects of fungicide treatments on yield and quality of tomato plants infected with *Leveillula taurica*. *Phytopathology* **72**, 970 (abstract)
- Joseph M C, Coffey M D (1984). Development of laboratory resistance to metalaxyl in *Phytophthora citricola*. *Phytopathology* **74**, 1411 – 1414

Joseph-Horne T, Hollomon D W, Heppner C (2000). Silthiofam interferes with mitochondrial function in 'take-all' disease of wheat. *Proceedings of the Brighton Crop Protection Conference – Pests & Diseases* 883-888

Joya C (1982). Identification of sigatoka pathogens and monitoring for benzimidazole resistance. *Phytopathology* **72**, 453

K

Kalamarakis A E, De Waard M A, Ziogas B N, Georgopoulos S G (1991). Resistance to fenarimol in *Nectria haematococca* var *cucurbitae*. *Pesticide Biochemistry and Physiology* **40**, 212 – 220

Kanetis L, Forster H, Jones C A, Borkovich K A, Adaskaveg J E (2008). Characterization of genetic and biochemical mechanisms of fudioxonil and pyrimethanil resistance in field isolates of *Penicillium digitatum*. *Phytopathology* **98** 205-214.

Kappas A, Georgopoulos S G (1968). Radiation induced resistance to dodine fungicide in *Hypomyces*. *Experientia (Basel)* **24**, 181 – 182

Karaoglanidis G S, Ionnidis P M, Thanossouloupoulos CC (2000). Reduced sensitivity of *Cercospora beticola* isolates to sterol demethylation inhibiting fungicides. *Plant Pathology* **49**, 567 – 572

Katan T, Shabi E (1981). REsistance to dicarboximide fungicides in laboratory isolates of *Monilinia laxa*. *Phytoparasitica* **9**, 231-232

Katan T, Dunn M T, Papavizas G C (1984). Genetics of fungal resistance in *Talaromyces flavus*. *Canadian Journal of Microbiology* **30**, 1079-1087

Katan T, Elad Y, Yunis H (1989). Resistance to diethofencarb NPC in benomyl resistant field isolates of *Botrytis cinerea*. *Plant Pathology* **38**, 86-92

Kato T, Suzuki K, Takahashi J, Kamoshita K (1984). Negatively correlated cross resistance between benzimidazole fungicides and methyl N-(3, 5-dichlorophenyl) carbamate. *Journal of Pesticide Science* **9**, 489-495

Kendall S J, Hollomon D W (1990). DMI resistance and sterol 14-alpha demethylation in *Rhynchosporium secalis*. *Proceedings of the British Crop Protection Conference Pests & Diseases* 1129-1134

Kendall S J, Hollomon D W, Cooke L R, Jones D R (1993). Changes in sensitivity to DMI fungicides in *Rhynchosporium secalis*. *Crop Protection* **12**, 357 – 362

Keon J P R, White G A, Hargreaves J A (1991). Isolation, characterization and sequence of a gene conferring resistance to the systemic fungicide carboxin from the maize smut pathogen, *Ustilago maydis*. *Current Genetics* **19**, 475-481

Khilare V C, Deokate A S, Ganawane L V (2003). Occurrence of aluminium phosethyle (allitte) resistance in *Plasmopara viticola* causing downy mildew of grapevine in Maharashtra. *Journal of Phytochemical Research* **16**, 239 – 241

Kiebacher H, Hoffmann G M (1976). Benzimidazole resistance in *Venturia inaequalis*. *Zeitschrift fuer Pflanzenkrankheiten und Pflanzenschutz* **83**, 352 – 358

Kim Y-S, Dixon E W, Vincelli P, Farman M L (2003). Field resistance to strobilurin (QoI) fungicides in *Pyricularia grisea* caused by mutations in the mitochondrial cytochrome b gene. *Phytopathology* **93**, 891-900

- Kleitman F, Shtienberg D, Blachinsky D, Oppenheim D, Zilberstaine M, Dror O, Manulis S (2005). *Erwinia amylovora* populations resistant to oxolinic acid in Israel: prevalence, persistence and fitness. *Plant Pathology* **54**, 108-115
- Köller W, Smith F D, Reynolds K L (1991). Phenotypic instability of flusilazole sensitivity in *Venturia inaequalis*. *Plant Pathology* **40**, 608 – 611
- Kousik C S, Keinath A P (2008). First report of insensitivity to cyazofamid among isolates of *Phytophthora capsici* from the southeastern United States. *Plant Disease* **92**, 979

L

- Lacy G H, Stromberg V K, Cannon N P (1984). *Erwinia amylovora* mutants and *in planta* derived trans conjugants resistant to oxytetracycline. *Canadian Journal of Plant Pathology* **6**, 33-39
- Lambert D H, Wuest P J (1973). Tolerance of *Verticillium malthousii* isolates to benomyl in relation to linear growth, geographical origin, spray volume or zineb tolerance. *Phytopathology* **63**, 203 (abstract).
- Lambert D H, Salas B (1994). Metalaxyl insensitivity of *Phytophthora erythroseptica* isolates causing pink rot of potato in Maine. *Plant Disease* **78**, 1010
- Lamboy J S, Paxton J D (1992). Metalaxyl sensitivity selection within *Phytophthora megasperma* fsp. *glycinea*. *Plant Disease* **76**, 932 – 936
- Langston D (2002). Quadris resistance in Gummy Stem Blight confirmed. *Georgia Extension Vegetable News*. **2**, 1
- Lasseron-De Falandre A, Debieu D, Bach J, Malosse C, Leroux P (1999). Mechanisms of resistance to fenpropimorph and terbinafine, two sterol biosynthesis inhibitors, in *Nectria haematococca*, a phytopathogenic fungus. *Pesticide Biochemistry and Physiology* **64**, 167-184
- Leroux P, Lafon R, Gredt M (1982). Resistance of *Botrytis cinerea* to benzimidazole and dicarboximide fungicides situation in Alsace Bordeaux and Champagne vineyards France. *Bulletin OEPP* **12**, 137 - 144
- Leroux P, Clerjeau M (1985). Resistance of *Botrytis cinerea* and *Plasmopara viticola* to fungicides in French vineyards. *Crop Protection* **4**, 137 – 160
- Leroux P, Berthier G (1988). Resistance to carboxin and fenfuram in *Ustilago nuda* Jens. Rostr. the causal agent of barley loose smut. *Crop Protection* **7**, 16-19
- Leroux P, Marchegay P (1991). Caractérisation des souches de *Pseudocercospora herpotrichoides* agent du Piétin-verse des céréales, résistantes au prochloraze, isolées en France sur blé tendre d'hiver. *Agronomie* **11**, 767 – 776
- Li H X, Xiao C L (2008). Characterization of fludioxonil resistant and pyrimethanil resistant phenotypes of *Penicillium expansum* from apple. *Phytopathology* **98**, 427-435
- Littrell R H (1974). Tolerance in *Cercospora arachidicola* to benomyl and related fungicides. *Phytopathology* **64**, 1377 - 1378
- Littrell R H (1977) Population dynamics and control of benomyl tolerant and sensitive pecan scab strains. *Proceedings of the American Phytopathological Society* **3**, 1976
- Locke T, Thorpe I G (1976). Benomyl tolerance in *Verticillium dahliae* Kleb. *Plant Pathology* **25**, 59

- Locke T, Scrace J, Peace J M (1997). Resistance of *Phytophthora porri* to metalaxyl. *Pesticide Science* **51**, 371 – 374
- Lu Y L, Sutton T B, Ypema H (2003). Sensitivity of *Alternaria mali* from north Carolina apple orchards to pyraclostrobin and boscalid. *Phytopathology* **93**, S54 (Abstract)
- Lucas J A, Bower L A, Coffey M D (1990). Fungicide resistance in soil-borne *Phytophthora* species. *EPPO Bulletin* **20**, 199-206

M

- Ma, Z, Michailides T J (2004). Characterization of iprodione-resistant *Alternaria* isolates from pistachio in California. *Pesticide Biochemistry and Physiology* **80**, 75 – 84
- Ma Z, Felts D, Michailides T J (2003). Resistance to azoxystrobin in *Alternaria* isolates from pistachio in California. *Pesticide Biochemistry and Physiology* **77**, 66 - 74
- Ma Z, Luo Y, Michailides T J (2001). Resistance of *Botryosphaeria dothidea* from pistachio to iprodione. *Plant Disease* **85**, 183-188
- Magie R O, Wilfret G J (1974). Tolerance of *Fusarium oxysporum* f sp. *gladioli* to benzimidazole fungicides. *Plant Disease Reporter* **58**, 256 – 259
- Malathrakis N E (1989). Resistance of *Botrytis cinerea* to dichlofluanid in greenhouse vegetables. *Plant Disease* **73**, 138-141
- Malathrakis N E, Vakalounakis D J (1983). Resistance to benzimidazole fungicides in the gummy stem blight pathogen *Didymella bryoniae* on cucurbits. *Plant Pathology* **32**, 395 – 400
- Manulis S, Kleitman F, Shtienberg D, Shwartz H, Oppenheim D, Zilberstaine M, Shabi E (2003). Changes in the sensitivity of *Erwinia amylovora* populations to streptomycin and oxolinic acid in Israel. *Plant Disease* **87**, 650-654
- Maria R, Sullia S B (1986). Acquired resistance of *Alternaria solani* and *Sclerotium rolfsii* to polyoxin D. *Journal of Phytopathology* **116**, 60-66
- Markoglou A N, Ziogas B N (1999). Genetic control of resistance to fenpropimorph in *Ustilago maydis*. *Plant Pathology* **48**, 521-530
- Markoglou A N, Ziogas B N (2000). Genetic control of resistance to tridemorph in *Ustilago maydis*. *Phytoparasitica* **28**, 349-360
- Markoglou A N, Ziogas B N (2001). Genetic control of resistance to the piperidine fungicide fenpropidin in *Ustilago maydis*. *Journal of Phytopathology* **149**, 551-559
- Markoglou A N, Malandrakis A A, Vitoratos A G, Ziogas B N (2006). Characterization of laboratory mutants of *Botrytis cinerea* to QoI fungicides. *European Journal of Plant Pathology* **115**, 149 - 162
- Martin S B, Lucas L T, Campbell CL (1984). Comparative sensitivity of *Rhizoctonia solani* and *Rhizoctonia* like fungi to selected fungicides in vitro. *Phytopathology* **74**, 778 – 781
- Matsuzaki M, Azegami K, Chata K-I (1981). Streptomycin resistance in pathogenic bacteria isolated from diseased lettuce. *Annals of the Phytopathological Society of Japan* **47**, 297-300
- Mavroedi V I, Shaw M W (2005). Sensitivity distributions and cross resistance patterns of *Mycosphaerella graminicola* to fluquinconazole, prochloraz and azoxystrobin over a period of 9 years. *Crop Protection* **24**, 259-266

- McKay G J, Egan D, Morris E, Brown A E (1998). Identification of benzimidazole resistance in *Cladobotryum dendroides* using a PCR-based method. *Mycological Research* **102**, 671 – 676
- McGrath M T, Shishkoff N (2003a). Resistance to strobilurin fungicides in *Podosphaera xanthii* associated with reduced control of cucurbit powdery mildew in a research field. *Phytopathology* **93**, S59
- McGrath M T, Shishkoff N (2003b). First report of the cucurbit powdery mildew fungus (*Podosphaera xanthii*) resistant to strobilurin fungicides in the United States. *Plant Disease* **87**, 1007
- McHugh J B, Schreiber J R (1984). Tolerance of *Verticillium dahliae* to benzimidazoles. *Plant Disease* **68**, 424 – 427
- Metcalf R J, Shaw M W, Russell P E (2000). The effect of dose and mobility on the strength of selection for DMI fungicide resistance in inoculated field experiments. *Plant Pathology* **49**, 546-557
- Meyer E (1976). Resistance development against systemic fungicides benzimidazole derivatives in *Colletorichum lindemuthianum*. *Mitteilungen aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft* (**166**), 7 – 135
- Miao V, Higgins V J (1986). Detection of induced susceptibility in tomato using mutants of *Cladosporium fulvum* tolerant to cycloheximide or benomyl. *Canadian Journal of Botany* **64**, 1299-1305
- Miller T C, Gubler W D (2003). *Uncinula necator* retains high resistance levels to triadimefon in a survey of California populations despite product absence for fourteen years. *Phytopathology* **93**, S113
- Minsavage G V, Cantero B I, Stall R E (1990). Plasmid mediated resistance to streptomycin in *Xanthomonas campestris* pv *vesicatoria*. *Phytopathology* **80**, 719-723
- Miyamoto T., Ishii H., Seko T., Tomita Y., Kobori S. and Ogawara T. (2007), Occurrence of boscalid-resistant isolates of cucumber *Corynespora* leaf spot fungus (*C. cassiicola*). *Japanese Journal of Phytopathology* **74**: in press (Japanese abstr.).
- Molinero V, Leroux P, Tivoli B, Champion R, Said J (1993). Resistance to benzimidazole fungicides in pathogens of Ascochta diseases of peas. *Seed Science and Technology* **21**, 531 – 535
- Moller W J, Beutel J A, Reil W O, Zoller B G (1972). Fire blight resistance to streptomycin in California. *Phytopathology* **62**, 779
- Moorman G W, Arora N, Kim S H (2002). Propamocarb resistance in species of *Pythium*. *Phytopathology* **92**, S58 (meeting abstract)
- Moorman G W, Kang S, Geiser D M, Kim S H (2002). Identification and characterisation of *Pythium* species associated with greenhouse floral crops in Pennsylvania. *Plant Disease* **86**, 1227 – 1231
- Moorman G W, Kim S H (2004). Species of *Pythium* from greenhouses in Pennsylvania exhibit resistance to propamocarb and mefenoxam. *Plant Disease* **88**, 630-632
- Muirhead T F (1974). Resistance to benzimidazole fungicides in blue mold of citrus in Queensland. *Australian Journal of Experimental Agriculture and Animal Husbandry* **14**, 698 – 701
- Munro J M, Dolan A, Williamson B (1988). Cane spot (*Elsinoe veneta*) in red raspberry: infection periods and fungicidal control. *Plant Pathology* **37**, 390-396

N

- Nachmias A, Barash I (1976). Decreased permeability as a mechanism of resistance to methylbenzimidazol-2-yl carbamate in *Sporobolomyces roseus*. *Journal of General Microbiology* **94**, 167 – 172
- Naegler M, Diaconu V, Alexandria A A (1977). The resistance of powdery mildew vine *Uncinula necator* and powdery mildew cucumbers *Sphaerotheca fuliginea* to benzimidazole systemic fungicides. *Analele Institutului de Cercetari Pentru Protectia Plantelor* **12**, 345 – 352
- Napier B A S, Bayles R A, Stigwood P L (2000). Sensitivity of powdery mildew and yellow rust to DMI, morpholine and strobilurin fungicides in England and Scotland. *Proceedings of the BCPC Conference Pests & Diseases*, 427-434
- Noble M, Maggarvie Q D, Hams A F, Leaf L L (1966). Resistance to mercury of *Pyrenophora avenae* in Scottish seed oats. *Plant Pathology* **15**, 23-28
- Nomura H, Paik S-Y, Izuhara M, Sugiyama M (1991). Resistant mechanisms to blasticidin S in *Streptomyces lividans*. *Korean Biochemical Journal* **24**, 327-330
- Nuninger-Ney C, Schwinn F J, Staub T (1989). *In vitro* selection of sterol biosynthesis inhibitor (SBI) resistant mutants in *Monilinia fructicola* (Wint.) Honey. *Netherlands Journal of Plant Pathology* **95**, 137 – 150

O

- O'Brien R G, Vawdrey L L, Glass R J (1988). Fungicide resistance in cucurbit powdery mildew *Sphaerotheca fuliginea* and its effect on field control. *Australian Journal of Experimental Agriculture* **28**, 417-424
- Ogawa K (1988). Damage by Bakanae disease and its chemical control. *Japanese Pesticide Information* **52**, 13-15
- Ogawa J M, Manji B T, Bose E A (1981). Detection of benomyl resistant *Monilinia laxa* on apricots. *Phytopathology* **71**, 893
- Olaya G, Cleere S, Stanger C, Burbidge J, Hall A, Windass J (2003). A novel potential target site QoI fungicide resistance mechanism in *Pythium aphanidermatum*. *Phytopathology* **93**, S67
- Olaya G, Holm A (2001). Sensitivity of *Didymella bryoniae* isolates to azoxystrobin. *Phytopathology* **91**, S67-S68
- Orth A B, Sfarra A, Pell E J, Tien M (1994). Characterization and genetic analysis of laboratory mutants of *Ustilago maydis* resistant to dicarboximide and aromatic hydrocarbon fungicides. *Phytopathology* **84**, 1210-1214

P

- Pasche J S & Gudmestad N C (2008). Prevalence, competitive fitness and impact of the F129L mutation in *Alternaria solani* from the United States. *Crop Protection* **27**, 427-435
- Pasche J S, Piche L M, Gudmestad N C (2005). Effect of the F129L mutation in *Alternaria solani* on fungicides affecting mitochondrial respiration. *Plant Disease* **89**, 269-278
- Pasche J S, Wharam C M, Gudmestad N C (2004). Shift in sensitivity of *Alternaria solani* to QoI fungicides. *Plant Disease* **88**, 181 – 187

- Pasche J S, Wharam C M, Gudmestad N C (2002). Shift in sensitivity of *Alternaria solani* (potato early blight) to strobilurin fungicides. *Proceedings of the BCPC Conference Pests & Diseases* 841-846
- Paulus A O, Nelson J, Besemer S (1976). Resistance of *Septoria leucanthemi* to benzimidazole fungicides. *Plant Disease Reporter* **60**, 695 - 697
- Pearson R C (1980). Occurrence of benomyl resistant strains of *Uncinula necator* on grapes in New York USA. *Phytopathology* **70**, 467
- Pearson R C, Taschenberg E F (1980). Benomyl resistant strains of *Uncinula necator* on grapes. *Plant Disease* **64**, 677 – 680
- Pennucci A, Beever R E, Laracy E P (1990). Dicarboximide resistant strains of *Microdochium nivale* in New Zealand. *Australasian Plant Pathology* **19**, 38-41
- Penrose L J, Koffmann W, Nicholls M R (1985). Field occurrence of vinclozolin resistance in *Monilinia fructicola*. *Plant Pathology* **34**, 228-234
- Peters R D, Platt H W, Drake K A, Coffin R H, Moorehead S, Clark M M, Al-Mughrabi K I, Howard R J (2008). First report of fludioxonil resistant isolates of *Fusarium* spp. causing potato seed-piece decay. *Plant Disease* **92**, 172
- Plumbly R A, Hernandez M A, Thompson A K (1984). Benomyl tolerance in a strain of *Penicillium sclerotigenum* infecting yams and the use of imazalil as a means of control. *Tropical Agriculture* **61**, 182-185
- Presly A H, Maude R B (1982). Tolerance in *Botrytis squamosa* to iprodione. *Annals of Applied Biology* **100**, 117-127
- Prest G de, Poppe J (1988). Efficacy of fungicides against *Cylindrocladium scoparium* and their influence on Azalea cuttings. *Meded. Fac. Landbouwwet. Rijksuniv. Gent* **53**, 643-650
- Proffer T J, Berardi R, Ma Z, Nugent J E, Ehret G R, McManus P S, Jones A L, Sundin G W (2006). Occurrence, distribution, and polymerase chain reaction-based detection of resistance to sterol demethylation inhibitor fungicides in populations of *Blumeriella jaapii* in Michigan. *Phytopathology* **96**, 709 – 717

QR

- Reddy K P, Anilkumar T B (1989). Resistance development to mancozeb in *Helminthosporium halodes*. *Mysore Journal of Agricultural Sciences* **23**, 184-188
- Redi H, Steinkellner S (1996). Proof of sensitivity reduction with oidium towards DMI fungicides in Austrian viticulture. *Mitteilungen Klosterneuburg* **46**, 181-188
- Reimann S, Deising H B (2005). Inhibition of efflux mediated fungicide resistance in *Pyrenophora tritici-repentis* by a derivative of 4'-hydroxyflavone and enhancement of fungicide activity. *Applied and Environmental Microbiology* **71**, 3269-3275
- Remiro D, Kimati H (1974). Resistencia a benomil e tiofanato em *Mycosphaerella fragariae* (Tul.) Lind. *Biologico* **40**, 22-24
- Reuveni M (2001). Improved control of powdery mildew (*Sphaerotheca pannosa*) of nectarines in Israel using strobilurin and polyoxin B fungicides; mixtures with sulfur; and early bloom applications. *Crop Protection* **20**, 663-668
- Reuveni M, Eyal H, Cohen Y (1980). Development of resistance to metalaxyl in *Pseudoperonospora cubensis*. *Plant Disease* **64**, 1108 – 1109
- Reynolds K L, Brenneman T B, Bertrand P F (1997). Sensitivity of *Cladosporium caryigenum* to propiconazole and fenbuconazole. *Plant Disease* **81**, 163 – 166

- Richardson L T (1973). Adaptive tolerance of *Fusarium solani* to benzimidazole derivatives *in vitro*. *Canadian Journal of Botany* **51**, 1725-1732
- Rodriguez R, Melendez P L (1984). Chemical control of cowpea powdery mildew and foliar spots. *Journal of the Agricultural University P. R.* **68**, 445-455
- Romano M L, Edgington L V (1985). Resistance to metalaxyl in *Phytophthora* crown rot and root rot of African violet. *Canadian Journal of Plant Pathology* **7**, 448 – 449
- Russell P E, Gaujard C, Creange P, Daniels A (2001). Aspects of take-all control by fluquinconazole. *In: Modern Fungicides and Antifungal Compounds III*. Eds. H-W Dehne, U Gisi, K-H Kuck, P E Russell, H Lyr. AgroConcept GmbH, Bonn. pp. 91-102

S

- Sakurai H, Naito H (1976). A cross resistance of *Pyricularia oryzae* to kasugamycin and blasticidin S. *Journal of Antibiotics (Tokyo)* **29**, 1341-1342
- Sakurai H, Kwano M, Goh N, Yaoita T, Aoyaki K, Naito H (1977). Sensitivity distribution of physiologic races of *Pyricularia oryzae* to kasugamycin. *Journal of Antibiotics (Tokyo)* **30**, 607-609
- Samuels G J, Johnston P R (1980) Benomyl and the Verticillium diseases of cultivated mushrooms. *New Zealand Journal of Agricultural Research* **23**, 155 - 157
- Sanders P L, Soika M D (1988). Metalaxyl resistance frequency in overwintering populations of *Pythium aphanidermatum* from metalaxyl control failure sites. *Phytopathology* **78**, 1510
- Sanders P L, Coffey M D, Greer G D, Soika M D (1990). Laboratory induced resistance to fosetyl aluminium in a metalaxyl resistant field isolate of *Pythium aphanidermatum*. *Plant Disease* **74**, 690-692
- Saniewska A (1985). Red staining of Narcissi leaves. *Ochr. Rosl.* **29**, 19-20
- Sawada H, Sugihara M, Takagaki M, Nagayama K (2004). *Pest Management Science* **60**, 777-785
- Schabi E, Ben-Yephet Y (1976). Tolerance of *Venturia pirina* to benzimidazole fungicides. *Plant Disease Reporter* **60**, 451 – 454
- Schepers H T A M (1983). Decreased sensitivity of *Sphaerotheca fuliginea* to fungicides which inhibit ergosterol biosynthesis. *Netherlands Journal of Plant Pathology* **89**, 185 – 187
- Schepers H T A M (1984). Persistence of resistance to fungicides in *Sphaerotheca fuliginea*. *Netherlands Journal of Plant Pathology* **90**, 165-171
- Schepers H T A M (1985a). Development and persistence of resistance to fungicides in *Sphaerotheca fuliginea* in cucumbers in the Netherlands. *Doktorthesis Proefschrift van de Landbouwhogeschool te Wageningen*
- Schepers H T A M (1985b). Changes during a three year period in the sensitivity to ergosterol biosynthesis inhibitors of *Sphaerotheca fuliginea* in the Netherlands. *Netherlands Journal of Plant Pathology* **91**, 105 - 118
- Schroedder W T, Providenti R (1969). Resistance to benomyl in powdery mildew in cucurbits. *Plant Disease Reporter* **53**, 271 – 275
- Schroth M N, Thomson S V, Moller W J (1979). Streptomycin resistance in *Erwinia amylovora*. *Phytopathology* **69**, 565-568

- Semar M, Strobel D, Koch A, Klappach K, Stammler G. (2007). Field efficacy of pyraclostrobin against populations of *Pyrenophora teres* containing the F129L mutation in the cytochrome b gene. *Journal of Plant Diseases and Protection* **114**, 117-119
- Seppanen E (1983). Different tolerances of 14 *Fusarium* spp. to thiophanate-methyl. *Annales Agriculturae Fenniae* **22**, 120-121
- Sergeva V, Nair N G, Verdana J R, Shen C, Barchia I, Spooner-Hart R (2002). First report of anilinopyrimidine resistant phenotypes in *Botrytis cinerea* on grapevines in Australia. *Australasian Plant Pathology* **31**, 299-300
- Serrhini N, Maraitte M, Meyer J A (1985). *In-vitro* selection of strains of *Phytophthora citrophthora* resistant to metalaxyl. *Bulletin OEPP* **15**, 443 - 450
- Sheridan J E, Grbavac N, Sheridan M H (1985). Triadimenol insensitivity in *Pyrenophora teres*. *Transactions of the British Mycological Society* **85**, 338 – 341
- Shim J-Y, Choi H-T, Yoon K-S (1994). Cell biological changes of validamycin resistant strain in *Coprinus cinereus*. *Korean Journal of Mycology* **22**, 31-35
- Shew H D (1985). Response of *Phytophthora parasitica* var *nicotianae* to metalaxyl exposure. *Plant Disease* **69**, 559 – 562
- Shim M-Y, Starr J L, Neller K P, Woodard K E, Lee T A Jr. (1998). Distribution of isolates of *Sclerotium rolfsii* tolerant to pentachloronitrobenzene in Texas peanut fields. *Plant Disease* **82**, 103-106
- Sierotzki H, Kraus N, Assemat P, Stanger C, Cleere S, Windass J, Gisi U (2005). Evolution of resistance to QoI fungicides in *Plasmopara viticola* populations in Europe. *In: Modern Fungicides and Antifungal Compounds IV*. Eds. H-W Dehne, U Gisi, K-H Kuck, P E Russell, H Lyr. BCPC, Alton, UK pp. 73-80
- Sierotzki H, Wullschleger J, Gisi U (2000a). Point mutation in cytochrome b gene conferring resistance to strobilurin fungicides in *Erysiphe graminis* f. sp. *tritici* field isolates. *Pesticide Biochemistry and Physiology* **68**, 107-112
- Sierotzki H, Parisi S, Steinfeld U, Tenzer I, Poirey S, Gisi U (2000b). Mode of resistance to respiration inhibitors at the cytochrome bc1 enzyme complex of *Mycosphaerella fijiensis* field isolates. *Pest Management Science* **56**, 833-841
- Silva V L D, Loppes C A (1995). *Pseudomonas syringae* pv. tomato resistant to streptomycin and oxytetracycline in tomato plants treated or not with agricultural antibiotics. *Fitopatologia Brasileira* **20**, 80-84
- Sisler H D (1971). Mode of action of benzimidazole fungicides. *Proceedings of the 2nd International Congress of Pesticide Chemistry IUPAC, Tel-Aviv*, p. 323
- Sitton J W, Pierson C F (1982). Interaction and control of *Alternaria* stem decay and blue mold in Anjou pears. *Phytopathology* **72**, 1008 (Abstract)
- Skinner W, Bailey A, Renwick A, Keon J, Gurr S, Hargreaves J (1998). A single amino-acid substitution in the iron-sulphur protein subunit of succinate dehydrogenase determines resistance to carboxin in *Mycosphaerella graminicola*. *Current Genetics* **34**, 393-398
- Smiley R W, Howard, R J (1976). Tolerance to benzimidazole derivative fungicides by *Fusarium roseum* on Kentucky blue grass turf. *Plant Disease Reporter* **60**, 91 – 94

- Smith F D, Phipps P M, Stipes R J, Brenneman T B (1995). Significance of insensitivity of *Sclerotinia minor* to iprodione in control of *Sclerotinia* blight of peanut. *Plant Disease* **79**, 517-523
- Spalding D H (1982). Resistance of Mango pathogens to fungicides used to control postharvest diseases. *Plant Disease* **66**, 1185-1186
- Spotts R A, Cervantes L A (1995). Copper, oxytetracycline and streptomycin resistance of *Pseudomonas syringae* pv. *syringae* strains from pear orchards in Oregon and Washington. *Plant Disease* **79**, 1132-1135
- Staub T, Sozzi D (1981). Résistance au métalaxyl en pratique et les conséquences pour son utilisation. *Phytiatrie – Phytopharmacie* **30**, 283 – 291
- Stanis V F, Jones A L (1985). Reduced sensitivity to sterol inhibiting fungicides in field isolates of *Venturia inaequalis*. *Phytopathology* **75**, 1098 – 1101
- Starndberg J O (1984). Efficacy of fungicides against persistence of *Alternaria dauci* on carrot seed *Daucus carota*. *Plant Disease* **68**, 39-42
- Staunton W F, Kavanagh T (1975). Resistance of fungal pathogens to benomyl in Ireland and results of alternative spray programmes for disease control. *Proceedings of the British Insecticide and Fungicide Conference* **8**, 1-4
- Steekelenburg N A M van (1973). *Ascochyia bij chrysanth*; resistent geworden tegen benomyl (Benlate). *Vakbl. Bloemistrierij* **28**, 13
- Steekelenburg N A M van (1987). Resistance to benzimidazole and dicarboximide fungicides in *Botrytis cinerea* and *Didymella bryoniae* in cucumbers in the Netherlands. *Medelingen van de Faculteit Landbouwwetenschappen Universiteit Gent* **52**, 875-880
- Stehmann C, De Waard M A (1996). Sensitivity of populations of *Botrytis cinerea* to triazoles, benomyl and vinclozolin. *European Journal of Plant Pathology* **102**, 171-180
- Stein J M, Kirk W W (2003). The generation and quantification of resistance to dimethomorph in *Phytophthora infestans*. *Plant Disease* **88**, 930 - 934
- Steinfeld U, Sierotzki H, Parisi S, Gisi U (2002). Comparison of resistance mechanisms to strobilurin fungicides in *Venturia inaequalis*. In: *Modern Fungicides and Antifungal Compounds III*. Eds. H-W DEhne, U Gisi, K-H Kuck, P E Russell, H Lyr. AgroConcept GmbH, Bonn. pp. 167-176
- Steva H, Cartolaro P, Gomes da Silva M T (1990). Tolerance of powdery mildew of SBI fungicides: situation for 1989. *Phytoma* **419**, 41 – 44
- Stevenson K L, Langston D B, Seebold K W (2002). Resistance to azoxystrobin in the gummy stem blight pathogen in Georgia. *Phytopathology* **92**, S79
- Stevenson K L, Langston D, Sanders B F (2008). Baseline sensitivity and evidence of resistance to boscalid in *Didymella bryoniae* *Phytopathology* **98**:S151
- Stover R H (1979). Field observations on benomyl tolerance in ascospores of *Mycosphaerella fijiensis* var. *difformis*. *Transactions of the British Mycological Society* **72**, 518 – 519
- Suta V, Radulescu M (1986). Investigations on the integrated control of apple diseases in the orchards with biotypes of *Venturia inaequalis* and *Podosphaera leucotricha* (Ell et Ev.) Salm resistant to benzimidazolyc and triforine fungicides. *Hortscience* **23**, 747 (abstract)

Szkolnik M, Gilpatrick J D (1969). Apparent resistance of *Venturia inaequalis* to dodine in New York apple orchards. *Plant Disease Reporter* **53**, 861 - 864

Szkolnik M, Gilpatrick J D (1971). Resistance of *Venturia inaequalis* to N dodecyl guanidine acetate. *Phytopathology* **61**, 132

T

Taga M, Nakagawa H, Tsuda M, Ueyama A (1979). Identification of 3 loci controlling kasugamycin resistance in *Pyricularia oryzae*. *Phytopathology* **69**, 463-466

Takagaki M, Kaku K, Watanabe S, Kawai K, Shimizu T, Sawada H, Kumakuru K, Nagayama K (2004). Mechanism of resistance to carpropamid in *Magnaporthe grisea*. *Pest Management Science* **60**, 921-926

Tamura O (2000). Fluazinam resistance in leguminous *Botrytis cinerea* and resistance management. *Abstracts of the 10th. Symposium of Research Committee on Fungicide Resistance* pp 7-16

Tanaka F, Saito I, Miyajima K, Tsuchiya S, Tsuboki K (1983). Occurrence of thiophanate methyl tolerant isolates of *Fusarium nivale* synonymy *Gerlachia nivalis* a causal fungus of snow mold of winter wheat in Japan. *Annals of the Phytopathological Society of Japan* **49**, 565 – 566

Taylor R J, Sales B, Secor G A, Rivera V, Gumestad N C (2002). Sensitivity of North American isolates of *Phytophthora erythroseptica* and *Pythium ultimum* to mefenoxam (metalaxyl). *Plant Disease* **86**, 797 – 802

Thanassoulopoulos C C, Giannopilitis C N, Kitsos G T (1970). Evaluation of sensitiveness and development of resistance of *Fusarium oxysporum* f.sp. *lycopersici* to benomyl. *Phytopathologische Zeitschrift* **70**, 114-120

Tivoli B, Deltour A, Molet D, Bedin P, Jouan B (1986). Isolation of thiabendazole resistant strains of *Fusarium roseum* var *sambucinum* from potato tubers. *Agronomie* **6**, 219 – 224

Tominaga A, Kobayashi Y (1978). Kasugamycin resistant mutants of *Bacillus subtilis*. *Journal of Bacteriology* **135**, 1149-1150

Tomita Y, Ishii H (1998). Reduced sensitivity to fenarimol in Japanese field strains of *Venturia nashicola*. *Pesticide Science* **54**, 150 - 156

Tramier R, Bettachini A (1974). A strain of *Fusarium oxysporum* f sp. *dianthi* resistant to systemic fungicides. *Annales de Phytopathologie* **6**, 231 – 236

Tremblay D M, Talbot B G, Carisse O (2003). Sensitivity of *Botrytis squamosa* to different classes of fungicides. *Plant Disease* **87**, 573-578

U

Uesugi Y (1981). Resistance to fungicides in *Pyricularia oryzae*. *Journal of pesticide Science* **6**, 239-246

V

Valaskova E (1983). The influence of various carbon and nitrogen sources on mycelium growth and resistance stability in a benomyl tolerant strain of *Fusarium oxysporum* f sp. *tulipae*. *Sbornik UVTIZ (Ustav Vedeckotechnických Informací pro Zemedelství) Ochrana Rostlin* **19**, 251 -260

- Van Bruggen A H C, Arneson P A (1984). Resistance in *Rhizoctonia solani* to tolclofos methyl. *Netherlands Journal of Plant Pathology* **90**, 95 – 106
- Vargas J M Jr. (1973). A benzimidazole resistant strain of *Erysiphe graminis*. *Phytopathology* **63**, 1366 – 1368
- Vargas J M Jr., Golembiewski R, Detweiler A R (1992). Reduced sensitivity of *Sclerotinia homoeocarpa* to DMI fungicides. *Phytopathology* **82**, 1069
- Veeverke K (1983). Resistance of *Verticillium albo-atrum* Reinke et Bert. to benomyl and trimorfamid. *Zbl. Mikrobiol.* **138**, 565-568
- Viljanen-Rollinson S L H, Marroni M V, Butler R C (2007). Reduced sensitivity to carbendazim in isolates of *Botrytis allii*. *New Zealand Plant Protection* **60** 108-113
- Vincelli P, Dixon E (2002). Resistance to QoI (strobilurin-like) fungicides in isolates of *Pyricularia grisea* from perennial ryegrass. *Plant Disease* **86**, 235-240

W

- Walsh R C, Sisler H D (1981). Cross resistance patterns of fenarimol resistant isolates of *Ustilago maydis*. *Phytopathology* **71**, 771 - 772
- Whan J H (1976). Tolerance of *Sclerotinia fructicola* to benomyl. *Plant Disease Reporter* **60**, 200 – 201
- White G A, Georgopoulos S G (1986). Thiophene carboxamide fungicides structure activity relationships with the succinate dehydrogenase complex from wild type and carboxin resistant mutants of *Aspergillus nidulans*. *Pesticide Biochemistry and Physiology* **25**, 188-204
- White J G, Stanghellini M E, Ayoubi L M (1988). Variation in the sensitivity to metalaxyl of *Pythium* spp isolated from carrot and other sources. *Annals of Applied Biology* **113**, 269 – 278
- Whiteside J O (1980a). Detection of benomyl tolerant strains of *Elsinoe fawcetti* in Florida citrus groves and nurseries. *Plant Disease* **64**, 871-872
- Whiteside J O (1980b). Tolerance of *Mycosphaerella citri* to benomyl in Florida USA citrus groves. *Plant Disease* **64**, 300 – 302
- Wicks T (1977). Tolerance to benzimidazole fungicides in blue mold (*Penicillium expansum*) on pears. *Plant Disease Reporter* **61**, 447-449
- Wilcox W F, Burr J A, Riegel D G, Wong F P (2003). Practical resistance to QoI fungicides in New York populations of *Uncinula necator* associated with quantitative shifts in pathogen sensitivities. *Phytopathology* **93**, S90
- Wild B L (1983). Double resistance by citrus green mold *Penicillium digitatum* to the fungicides guazatine and benomyl. *Annals of Applied Biology* **103**, 237 – 242
- Wong F P, De la Carda K A, Hernandez-Martinez R, Midland S L (2008). Detection and characterization of benzimidazole resistance in California populations of *Colletotrichum cereale*. *Plant Disease* **92**, 239-246
- Wong S P (2003). Past, current and future challenges for fungicide resistance management for turfgrass pathogens. *Phytopathology* **93** supplement6, S114
- Wright P J (2004). Resistance of *Peronospora destructor* (onion downy mildew) to metalaxyl fungicides. *New Zealand Plant Protection* **57**, 347. (Conference Proceedings)

XYZ

- Yamada N, Motoyama T, Nakasako M, Kagabu S, Kudo T, Yamaguchi I (2004). Enzymatic characterisation of scytalone dehydratase Val75Met variant found in melanin biosynthesis dehydratase inhibitor (MBI-D) resistant strains of the rice blast fungus. *Bioscience Biotechnology and Biochemistry* **68**, 615-621
- Yamaguchi J, Inada M, Matsuzaki M (2000). Occurrence of DMI fungicide resistant isolates of *Mycovellosiella natrassii* Deighton, causal fungus of leaf mold of eggplant. *Japanese Journal of Phytopathology* **66**, 78 – 84
- Yamaguchi J., Kuchiki F., Hirayae K., So K. (2002), Decreased effect of carpropamid for rice blast control in the west north area of Saga prefecture in 2001. *Japanese. Journal of Phytopathology* **68**: 261 (Abstr.).
- Yano K, Kawada Y (2003). Occurrence of strobilurin-resistant strains of *Mycovellosiella natrassii*, causal fungus of leaf mold of eggplants. *Japanese Journal of Phytopathology* **69**, 220-223
- Young D H, Kemmitt G M, Owen J (2005). A comparative study of XR-539 and other oomycete fungicides: Similarity to dimethomorph and amino acid amides in its mechanism of action. *In: Modern Fungicides and Antifungal Compounds IV*. Eds. H-W Dehne, U Gisi, K-H Kuck, P E Russell, H Lyr. BCPC, Alton, UK pp. 145-152
- Young D H, Spiewak S L, Slawecki R A (2001). Laboratory studies to assess the risk of development of resistance to zoxamide. *Pest Management Science* **57**, 1081-1087
- Yu K-S (1981). Studies on the fungicide resistance of citrus blue mold fungus. *Plant Protection Bulletin (Taichung)* **23**, 193 – 200
- Yuan S K, Liu X L, Si N G, Dong J, Gu B G, Jiang H (2006). Sensitivity of *Phytophthora infestans* to flumorph: *in vitro* determination of baseline sensitivity and the risk of resistance. *Plant Pathology* **55**, 258-263
- Zhang C Q, Zhu G N, Ma Z H, Zhou M G (2006). Isolation, characterization and preliminary genetic analysis of laboratory tricyclazole resistant mutants of the rice blast fungus, *Magnaporthe grisea*. *Journal of Phytopathology (Berlin)* **154**, 392 – 397
- Zhao Zhi-hua, Mang Xi-ming, Fan Jie-ru, Liu Liang, Lfu Xi-Ii (2007). Effect of prochloraz on growth and development of prochloraz sensitive strain and its resistant mutants in *Fusarium fujikuroi*. *Nongyaoxue Xuebao* **9** 251-256
- Zheng D, Olaya G, Koller W (2000). Characterization of laboratory mutants of *Venturia inaequalis* resistant to the strobilurin related fungicide kresoxim-methyl. *Current Genetics* **38**, 148-155
- Zhu Zhi-feng, Pan Hong-yu, Zhang Hao, jiang Hui, Yuan Shan-kui, Qing-ping Yan (2006). Induction and characteristics of mutants of *Phytophthora drechsletii* resistant to etridiazole. *Nongyaoxue xuebao* **8** (4) 323-326 (Chinese)
- Ziogas B N, Markoglou A N, Tzima A (2002). A non-mendelian inheritance of resistance to strobilurin fungicides in *Ustilago maydis*. *Pest Management Science* **58**, 908-916
- Ziogas B N, Markoglou A N, Malandrakis A A (2003). Studies on the inherent resistance risk to fenhexamid in *Botrytis cinerea*. *European Journal of Plant Pathology* **109**, 311-317