



Fungicide Resistance Management Guidelines for Vegetable Crops Grown in the mid-Atlantic region - 2010



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Photo Cover:

Cucurbit Downy Mildew (left): Photo by Beth K. Gugino (Penn State)

Lima Bean Pod Rot (right): Photo by Andy Wyenandt (Rutgers Univ.)

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Mission of the Center

The Northeastern Integrated Pest Management Center fosters the development and adoption of IPM, a science-based approach to managing pests in ways that generate economic, environmental, and human health benefits. The Center works in partnership with stakeholders from agricultural, urban, and rural settings to identify and address regional priorities for research, education, and outreach.

Introduction

In the mid-Atlantic region (NJ, MD, VA, DE, PA) of the United States approximately 221, 000 A of fresh-market and processing vegetable crops are grown each year. Over the past decade, a number of new fungicide chemistries for use in vegetable production have been released in the United States. Many of these fungicides have specific modes-of-action (MOA) that target pathogen development at a single site. Fungicides with a single-site MOA are often considered at- or high-risk fungicides because the chances for fungal resistance to develop are much higher than fungicides with multiple MOA's. In recent years, fungicide resistance has developed in important diseases such as gummy stem blight and powdery mildew in cucurbits and phytophthora (*P. capsici*) in bell pepper in the mid-Atlantic region.

About FRAC

In 2002, the NA-FRAC (North American Fungicide Resistance Action Committee) was established to i) coordinate and identify resources for contact between government, universities, and the public on fungicide resistance management issues, ii) assist in the creation of new working groups in North America for other areas of chemistry, as they are needed and iii) serve as a spokesman for the industry view on fungicide resistance management issues by providing an outlet for comments and position papers from members. Each year the FRAC group publishes a list of FRAC codes for most fungicides and fungicide chemistries. FRAC codes group fungicide chemistries according to class, mode-of-action and resistance-risk.

To date, there are 43 numbered and 3 lettered FRAC groups for ~ 61 listed chemical groups and 179 common names of fungicides. Accordingly, fungicides listed within a given FRAC code share a similar mode-of-action, therefore, may have i) similar risks for resistance development, ii) similar use patterns on multiple crops and iii) exhibit the potential for cross-resistance development.

The purpose of this guide is to i) promote the importance and understanding of FRAC codes in fungicide resistance management ii) prevent the misuse of specific fungicides with a high-risk for resistance development and iii) provide the tools and knowledge to allow growers to develop vegetable disease control programs with an emphasis towards fungicide resistance management.

This guide should be used as a supplement to the 2010 Commercial Vegetable Productions Recommendations Guide for the mid-Atlantic region to help make decisions on vegetable disease control and fungicide resistance management. All fungicide application rates for chemicals listed in this guide are found in the 2010 Commercial Vegetable Productions Recommendations Guide for your state.

Always follow the label and use pesticides safely.

Trade or Brand Names Disclaimer:

The trade or brand names given herein are supplied with the understanding that no discrimination is intended and no endorsement by the Rutgers Cooperative Extension is implied. Furthermore, in some instances the same compound may be sold under different names, which may vary as to label clearances.

How to use this fungicide resistance management guide

This guide contains FRAC tables for the crop groups listed in the 2010 Commercial Vegetable Productions Recommendations Guide for the mid-Atlantic region. Each FRAC table lists all fungicides currently recommended for a particular crop (or crop group) in the 2010 recommendations guides for NJ, DE, MD, VA and PA along with FRAC and risk management codes, diseases for that particular crop or crop group and fungicide resistance management guidelines for each particular FRAC code. For example, in guidelines for pumpkin and winter squash crops grown in the mid-Atlantic region, 21 labeled fungicides that include 15 different FRAC codes are listed with risk management (L = low risk, M = medium risk, H = high risk for resistance development) for eight common pumpkin and winter squash diseases in the region. Also included in each table is the inherent-risk of each particular pathogen (i.e. disease) to develop resistance. Like fungicides, the risk for pathogens to develop resistance are listed as L = low, M = medium or H = high. For each fungicide or pathogen where there has been a reported case of resistance development, a superscript R is next to the risk assessment (e.g. H^R). Most importantly, when the pathogen and the respective FRAC group used to control the pathogen have known resistance development, the x in the box is **red** in color.

Resistance risk assessments (H^R) for pathogens and fungicides.

In order to make the guide more useful and easier to determine which fungicide/pathogen combinations were at most risk for resistance development we included the inherent resistance risks for both the fungicides and pathogens according to FRAC and other reported cases. Thus fungicides and/or pathogens with a superscript ^R have shown a demonstrated potential for resistance development. Importantly, we have taken the most conservative approach and included those which have demonstrated or reported to have resistance in the US and elsewhere, as well as, demonstrated resistance in the field and/or under artificial conditions.

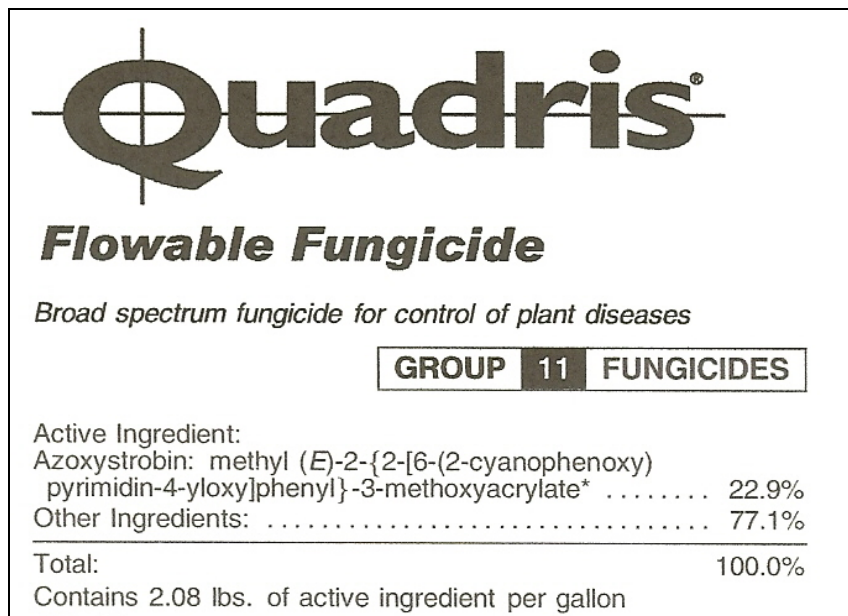
In some cases where there is a superscript R and no red x, even though the pathogen or fungicide has shown resistance development, it has not demonstrated resistance development to that particular fungicide or pathogen and the x remains black.

Fungicide, chemical names, FRAC codes and risk management guidelines are color-coordinated to help distinguish differences based on FRAC code. The far right-hand column of each table includes fungicide resistance management guidelines for each particular FRAC code with specific instructions on risk assessment and/or application instructions.

In the back of the guide are tables which can be used by the grower during the production season to keep track of application dates and fungicide schedules.

Finding FRAC codes on fungicide labels.

FRAC codes can normally be found on the front of the fungicides' label right under the Tradename. FRAC codes are often distinguished by the inverse black and white box with their FRAC code found in the center (Figure 1). If a fungicide contains more than one active ingredient both FRAC codes will be listed in the FRAC code box (Figure 2). For example, Quadris™, belongs to FRAC code 11, the class of fungicides known as the strobilurins. All fungicides with strobilurin chemistry will belong to FRAC code 11. Other FRAC group 11 fungicides include Flint™ (trifloxystrobin) and Cabrio™ (pyraclostrobin)



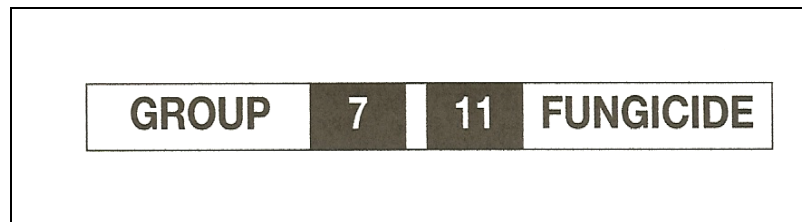
Quadris®
Flowable Fungicide
Broad spectrum fungicide for control of plant diseases

GROUP 11 FUNGICIDES

Active Ingredient:
 Azoxystrobin: methyl (E)-2-{2-[6-(2-cyanophenoxy)pyrimidin-4-yloxy]phenyl}-3-methoxyacrylate* 22.9%
 Other Ingredients: 77.1%

Total: 100.0%
 Contains 2.08 lbs. of active ingredient per gallon

Figure 1. Front of Quadris™ label with FRAC code listed below tradename.



GROUP	7	11	FUNGICIDE
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Figure 2. FRAC codes for Pristine™ containing the two active ingredients: boscalid (FRAC code 7) + pyraclostrobin (FRAC code 11)

If FRAC codes are not found on the front of the label, they can be found within the resistance management section of the label (Figure 3).

RESISTANCE MANAGEMENT

Repeated use of products for control of specific plant pathogens may lead to selection of resistant strains of fungi and result in a reduction of disease control. Famoxadone, one of the active ingredients in TANOS™, is one of EPA's Target Site of Action Group 11 fungicides, which also includes all strobilurins and fenamidone. A disease management program that includes rotation between TANOS™ and other non-Group 11 fungicides is essential to reduce the risk of fungicide resistance development. Tank-mixing TANOS™ with a protectant (contact) fungicide that has a different mode of action is required. This ensures optimum performance and further reduces the potential for resistance development. For guidance on the particular crop and disease control situation, consult your state extension specialist or official state recommendations.

Figure 3. Resistance management guidelines for Tanos™

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Phytophthora (Crown/Spear rot)	Purple spot	Asparagus Rust	Fungicide Resistance Management Guidelines
				M ^R	H ^R	L	
mancozeb	mancozeb	M3	L			x	Multi-site MOA, low risk protectants. Use alone or tank mix w ith high risk FRAC codes. Rotate w ith other FRAC codes
chlorothalonil	chlorothalonil	M5	L		x	x	
Folicur	tebaconozole	3	M			x	High risk of reduced sensitivity, alw ays tank mix and rotate w ith other FRAC codes
Rally	myclobutanil	3	M			x	
MetaStar	metalaxyl	4	H ^R	x			High risk, resistance know n in other crops
Ridomil Gold	mefenoxam	4	H ^R	x			
Ultra Flourish	mefenoxam	4	H ^R	x			
Quadris	azoxystrobin	11	H ^R		x		High risk, tank mix and rotate w ith other FRAC codes, no consecutive applications

Fungicide resistance management guidelines for asparagus grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)

Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, M^R,H^R = Known resistance reported

High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Asparagus

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Anthraxnose	Web blight (<i>Rhizoctonia</i>)	Pythium blight (Cottony leak)	Bacterial blight	Bacterial brown spot	Bean rust	Soybean rust	Root rots ¹	Lima bean downy mildew ²	Lima bean pod blight	Gray mold	White mold (<i>Sclerotinia</i>)	Southern blight	Fungicide Resistance Management Guidelines
			L	H ^R	L	L	L	L	L	L	L	M	L	H ^R	M	L	
fixed copper	copper	M1	L				x	x				x	x				Multi-site protectant MOA, use alone or in tank mix w ith high risk fungicides and in rotations w ith other FRAC codes
chlorothalonil	chlorothalonil	M5	L						x ^c					x ^{a c}			
thiophanate-methyl	thiophanate-methyl	1	H											x ^{ab}	x ^{ab}		High risk, alw ays tank mix w ith other FRAC codes, apply no more than 4 lbs per crop season
iprodione	iprodione	2	M-H											x ^c	x ^c		
Folicur	tebuconazole	3	M						x								High risk, alw ays tank mix and rotate w ith other FRAC codes.
Rally	myclobutanil	3	M						x ^c	x ^d							
Ridomil Gold	mefenoxam	4	H								x						High risk for resistance
Ridomil Gold Copper	mefenoxam + copper	4 + M1	M			x					x	x					Rotate w ith other FRAC codes
Endura	boscalid	7	M											x ^b	x ^b		No more than 2 applications per season
Switch	cyprodinil + fludioxonil	9 + 12	M											x	x		Tank mix and rotate w ith other FRAC codes
Quadris	azoxystrobin	11	H	x	x				x	x	x						High risk, no consecutive applications, no more than 4 applications a season
Headline	pyraclostrobin	11	H	x	x				x	x		x					
Omega	fluazinam	29	L											x	x		Low risk, rotate w ith other FRAC codes
Phostrol	phosphorous acid	33	L									x					Low risk, 24c registration in DE
Fungi-Phite	potassium phosphite	33	L									x					Low risk for resistance
Forum	dimethomorph	40	L-M									x	x				Tank mix and rotate w ith other FRAC codes
Contans	<i>Coniothyrium minitans</i>	bio	L												x		Low risk biological control, consult label

Fungicide resistance management guidelines for beans grown in the mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)

Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Known resistance reported

High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

¹ Only azoxystrobin is effective for Rhizoctonia

² The United States has a Section 3 for Ridomil Gold Copper for Downy mildew control on lima beans

^a Use chlorothalonil + thiophanate-methyl for snap beans only

^b Use Endura + thiophanate-methyl for snap beans only

^c snap bean only

^d section 18 for all succulent and other beans and peas in DE

Beans

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Pythium damping-off	Leaf spot	Pocket rot	Fungicide Resistance Management Guidelines
			L	M	L		
fixed copper	copper	M1	L		x		Multi-site MOA, low risk protectant, see label
MetaStar	metalaxyl	4	H	x			High risk, for control of damping-off caused by <i>Pythium</i>
Ridomil Gold	mefenoxam	4	H	x			
Ultra Flourish	mefenoxam	4	H	x			
Headline	pyraclostrobin	11	H		x		High risk, Rotate w ith other FRAC codes, No consecutive applications. No more than 4 applications per season
Quadris	azoxystrobin	11	H		x	x	
Cabrio	pyraclostrobin	11	H		x		
Fungicide resistance management guidelines for beets grown in the mid-Atlantic region - 2010							
FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA) Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively							

Beets

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Pythium damping-off	Black rot	Blackleg	Clubroot	Downy mildew	White mold (Sclerotinia)	Alternaria leaf blight	Fungicide Resistance Management Guidelines
			L	L	L	L	M	M	L		
Actigard	acibenzolar-S-methyl	P1	L					x ^b			Low -risk, No more than 4 applications per season
fixed copper	copper	M1	L		x						Multi-site MOA, use in tank mix w ith high risk FRAC codes and in rotations w ith other FRAC codes. Consult labels for rates and crops.
chlorothalonil	chlorothalonil	M5	L					x		x	
iprodione	iprodione	2	M-H			x ^a					Moderate to high-risk, No more than 2 application per crop
Ridomil Gold	mefenoxam	4	H	x							High risk, rotate w ith other FRAC codes
Ridomil Gold Bravo	mefenoxam + chlorothalonil	4 + M5	H					x		x	High risk, rotate w ith other FRAC codes
Endura	boscalid	7	M						x	x	Moderate risk, tank mix and rotate
Switch	cyprodinil + fludioxonil	9 + 12	M							x	Moderate risk, tank mix and rotate
Quadris	azoxystrobin	11	H	x				x		x	High risk, tank mix w ith FRAC code M fungicides. Rotate w ith other FRAC codes.No consecutive applications
Cabrio	pyraclostrobin	11	H					x		x	
Terraclor	pentachloronitrobenzene	14	L-M				x				Low to moderate
Aliette	aluminum tris	33	L					x ^b			Low risk, do not tank mix w ith copper
Contans	Coniothyrium minitans	bio	L						x		Low risk biological control, consult label

Fungicide resistance management guidelines for selected cole crops grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)

Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop

High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Cole Crops

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Pythium damping-off	Bacterial Blight	Alternaria leaf blight	Cercospora leaf blight	Powdery mildew	White mold (<i>Sclerotinia</i>)	Storage rots	Fungicide Resistance Management Guidelines
				H ^R	L	H ^R	M	H ^R	M	L-H	
copper, fixed	copper	M1	L		x						Multi-site MOA, use alone, or in tank mix w ith high risk FRAC codes and in rotations w ith other FRAC codes
chlorothalonil	chlorothalonil	M5	L			x	x	x			Multi-site MOA, use alone, or in tank mix w ith high risk FRAC codes and in rotations w ith other FRAC codes
Mertect	thiobendazole	1	H							x	High risk, for control of gray mold and sclerotinia in storage
Ridomil Gold	mefenoxam	4	H ^R	x							Hisk risk
Ultra Flourish	mefenoxam	4	H ^R	x							
Quadris	azoxystrobin	11	H			x	x				High risk, Tank mix w ith FRAC code M protectants and rotate w ith other FRAC codes. Do not apply FRAC code 11 fungicides in consecutive applications
Cabrio	pyraclostrobin	11	H			x	x	x			
Pristine	pyraclostrobin + boscalid	11 + 7	H			x	x	x			
Contans	<i>Coniothyrium minitans</i>	bio	L						x		Low risk biological control, consult label

Fungicide resistance management guidelines for carrots grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Known resistance reported
 High risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Carrots

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Pythium damping-off	Angular leaf spot	Belly rot	Cottony leak	Scab	Phytophthora fruit rot	Anthracnose	Gummy stem blight	Powdery mildew	Downy mildew	Fungicide Resistance Management Guidelines
			L	L	L	L	H ^R	H ^R	L	H ^R	H ^R	H ^R		
fixed copper	copper	M1	L		x				x					Multi-site MOA, use in tank mix w ith high risk fungicides and in rotations with other FRAC codes
Mancozeb	mancozeb	M3	L		x			x		x			x	
Gavel	zoxamide + mancozeb	M3 + 22	L-M						x				x	
chlorothalonil	chlorothalonil	M5	L					x		x	x	x	x	High risk, tank mix, rotate
Topsin M	thiophanate-methyl	1	H							x				
Folicur	tebuconazole	3	M ^R								x	x		
Rally	myclobutanil	3	M ^R									x		High risk, always tank mix, and rotate with other FRAC codes
Procure	triflumizole	3	M ^R									x		
MetaStar	metalaxyl	4	H ^R	x										
Ridomil Gold	mefenoxam	4	H ^R	x			x							High risk, resistance known. Only apply if Phytophthora strains are mefenoxam-sensitive
Ultra Flourish	mefenoxam	4	H ^R	x			x							
Switch	cyprodinil + fludioxonil	9 + 12	M							x				
Quadris	azoxystrobin	11	H ^R			x				x	x			High Risk, PM and DM resistance known in mid-Atlantic. Tank mix with FRAC code M fungicides and rotate with as many different FRAC codes as possible. No consecutive applications.
Cabrio	pyraclostrobin	11	H ^R							x	x			
Pristine	pyraclostrobin + boscalid	11 + 7	H							x	x	x		
Tanos	fomoxadone + cymoxanil	11 + 27	M						x	x			x	
Ranman	cyazofamid	21	M						x				x	
Curzate	cymoxanil	27	L-M										x	Moderate risk, tank mix
Previcor Flex	propomocarb HCL	28	L-M										x	Low risk, tank mix
Forum	dimethomorph	40	M						x					Tank mix with a FRAC code M fungicide and rotate with as many different FRAC codes as possible
Revus	mandipropamid	40	M						x					
Presidio	fluopicolide	43	H						x				x	

Fungicide resistance management guidelines for cucumber grown in the mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)

Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Known resistance reported

High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Cucumber

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Phytophthora blight - crown rot phase	Phytophthora blight - fruit rot/foliar phase	Leaf spots and fruit rots	Fungicide Resistance Management Guidelines
				H ^R	H ^R	H ^R	
fixed Copper	copper	M1	L		x	x	Multi-site MOA, use alone or in tank mix w ith high risk FRAC codes and in rotation w ith other FRAC codes
chlorothalonil	chlorothalonil	M5	L			x	
Ridomil Gold	mefenoxam	4	H ^R	x			High risk, mefenoxam-resistance known in mid-Atlantic region. Tank mix w ith other FRAC codes
Ultra Flourish	mefenoxam	4	H ^R	x			
Quadris	azoxystrobin	11	H			x	High-risk, rotate and tank mix w ith other FRAC codes. Do not apply FRAC code 11 fungicides in consecutive applications.
Cabrio	pyraclostrobin	11	H			x	
Flint	trifloxystrobin	11	H			x	
Forum	dimethomorph	40	M	x	x		Tank mix and rotate w ith other FRAC codes

Fungicide resistance management guidelines for eggplant grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Known resistance reported
 High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Eggplant

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Pythium damping-off	White rot	Botrytis leaf blight	Purple blotch	Downy mildew	Fungicide Resistance Management Guidelines
			L	L	H ^R	L	M		
chlorothalonil	chlorothalonil	M5	L			x	x	x	Low risk, multi-site MOA, use alone, or in tank mix w ith high risk FRAC codes and in rotations w ith other FRAC codes
Folicur	tebuconazole	3	M		x		x		Medium risk, tank mix, rotate w ith other FRAC codes
Ridomil Gold	mefenoxam	4	H	x					High risk for resistance
Ultra Flourish	mefenoxam	4	H	x					
MetaStar	metalaxyl	4	H	x					
Endura	boscalid	7	M			x	x		Moderate risk, tank mix and rotate w ith other FRAC codes
Quadris	azoxystrobin	11	H	x			x	x	High-risk, rotate and tank mix w ith other FRAC codes. Do not apply any FRAC code 11 fungicide in consecutive applications.
Cabrio	pyraclostrobin	11	H					x	
Pristine	pyraclostrobin + boscalid	11 + 7	H			x		x	
Forum	dimethomorph	40	M					x	Tank mix and rotate w ith other FRAC codes

Fungicide resistance management guidelines for garlic grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Known resistance reported
 High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Garlic

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off	Downy mildew	Leaf spot	Fungicide Resistance Management Guidelines
			L	M	M		
fixed copper	copper	M1	L		x	x	Multi-site MOA, use alone, or tank mix w ith high risk FRAC codes
Folicur	tebuconazole	3	M			x	Tank mix and rotate w ith other FRAC codes
Ridomil Gold	mefenoxam	4	H	x			High risk
Switch	cyprodinil + fludioxonil	9 + 12	M			x	Rotate w ith other FRAC codes
Quadris	azoxystrobin	11	H	x ^a		x	High risk, tank mix and/or rotate w ith a FRAC code M fungicide.
Cabrio	pyraclostrobin	11	H			x	
Aliette	aluminum tris	33	L		x		Low risk, do not tank mix w ith copper
Forum	dimethomorph	40	M		x		Tank mix and rotate w ith other FRAC codes

Fungicide resistance management guidelines for greens grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop
 High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Greens

Fungicide	Active Ingredient(s)	FRAC code	Risk Management	Damping-off caused by	Bacterial spot	Fungal leaf molds and spots	Late blight	Botrytis	Powdery mildew	Downy mildew	White mold	Fungicide Resistance Management Guidelines
				Pythium, Rhizoctonia, Phytophthora	L	H ^r	L-M	H ^r	H ^r	H ^r	H ^r	
Messenger*	harpin protein	P	L		x	x						Plant defense activator
Champ, Champion*, Cuprofix Ultra, Kocide, Camelot	copper hydroxide, copper sulfate, copper salts	M1	H ^r		x	x				x		Protectant, low risk, see labels for details
sulfur*	sulfur	M2	L						x			Protectant, use low rate
Mancozeb, other EBDC's	EBDC	M3	L			x						Protectant, low risk
Topsin M	thiophanate-methyl	1	H								x	High risk
Endura	boscalid	7	M					x				Medium risk
Scala	pyrimethanil	9	M-H			x		x	x			Rotate with other FRAC codes
Terraclor	PCNB	14	L-M	x								For certain container grown vegetables
Botran	dicloran	14	L-M					x			x	For Botrytis stem canker; low to medium risk
Ranman	cyazofamid	21	M	x								Low to medium risk
Gavel	zoxamide + mancozeb	22 + M3	L-M				x			x		Low to medium risk
Agri-mycin 17	streptomycin sulfate	25	H		x							Low risk
Previcur flex	propamocarb HCL	28	L-M	x								Low to medium risk
Contans*	Coniothyrium minitans	Bio	L								x	Biological control agents, refer to label for rates and application specificities
Serenade MAX*, Rhapsody*	Bacillus subtilis	Bio	L	x	x	x						
Sonata*	Bacillus pumilus	Bio	L			x	x		x	x		
Plantshield HC*, SoilGard*, RootShield*	Trichoderma sp.	Bio	L	x				x	x			
Actinovate	Streptomyces lydicus	Bio	L	x		x		x	x	x		
Mycostop*, Mycostop Mix*	Streptomyces griseoviridis	Bio	L	x				x				Contact disinfectant, no residual activity
Zerotol*, Oxidate*	hydrogen dioxide	NC	NC	x		x			x	x		
Armcarb, Kaligreen, Milstop*	potassium bicarbonate	NC	NC			x			x			Use low rates, see labels
Ultra fine oils*	horticultural oils	NC	NC						x			

Fungicide resistance management guidelines for selected vegetable crops grown in high tunnels and greenhouses in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action (MOA); * = OMRI approved; NC = not classified
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop
 Fungicides with similar MOA (ie. same FRAC code number) should not be sprayed consecutively.

High Tunnel and Greenhouse

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Purple blotch	Downy mildew	White rot	Fungicide Resistance Management Guidelines
			L	M	M		
chlorothalonil	chlorothalonil	M5	L	x	x		Multi-site MOA, low risk protectant fungicide, use alone, or tank mix with high-risk FRAC codes
Folicur	tebuconazole	3	M	x	x	x	Tank mix and rotate with other FRAC codes
Endura	boscalid	7	M	x			Moderate risk, tank mix and rotate
Quadris	azoxystrobin	11	H	x	x		High risk, tank mix or rotate with a FRAC code M protectant fungicide
Cabrio	pyraclostrobin	11	H	x	x		
Pristine	pyraclostrobin + boscalid	11 + 7	H	x	x		
Forum	dimethomorph	40	M		x		Tank mix and rotate with other FRAC codes

Fungicide resistance management guidelines for leeks grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop
 High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Leeks

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Pythium damping-off	Downy mildew	Leaf spots	Bottom rot	Lettuce drop (Sclerotinia)	Gray mold	Fungicide Resistance Management Guidelines
				L	M ^R	L	L	M	H ^R	
iprodione	iprodione	2	M-H ^R				x	x		Moderate to high risk
MetaStar	metalaxyl	4	H ^R	x	x					High risk for resistance development. Application for damping-off control will also help suppress early-season downy mildew development.
Ridomil Gold	mefenoxam	4	H ^R	x	x					
Ultra Flourish	mefenoxam	4	H ^R	x	x					
Endura	boscalid	7	M				x	x	x	Moderate risk, tank mix and rotate
Quadris	azoxystrobin	11	H		x	x				High risk, tank mix with FRAC code M protectants and rotate with other FRAC codes. No consecutive applications
Tanos	fomoxadone + cymoxanil	11 + 27	H		x					
Botran	dichloran	14	L-M ^R					x	x	Low to medium risk
Previcur Flex	propomocarb HCL	28	L-M		x					Tank mix with FRAC code M fungicide, rotate with other FRAC codes
Aliette	aluminum tris	33	L ^R		x					Low risk, do not tank mix with copper, rotate with other FRAC codes
Forum	dimethomorph	40	L-M		x					Tank mix and rotate, do not apply consecutive applications
Revus	mandipropamid	40	H		x					
Contans	Coniothyrium minitans	bio	L					x		Low risk biological control, consult label

Fungicide resistance management guidelines for lettuce grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Known resistance reported
 High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Lettuce

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Pythium damping-off	Alternaria leaf blight	Scab	Phytophthora blight	Gummy stem blight	Powdery mildew	Downy mildew	Fungicide Resistance Management Guidelines
			L	L	H ^R	H ^R	H ^R	H ^R	H ^R		
fixed Copper	copper	M1	L				x				Multi-site MOA, use alone or in tank mix w ith high risk fungicides and in rotations w ith other FRAC codes
mancozeb	mancozeb	M3	L		x					x	
chlorothalonil	chlorothalonil	M5	L		x	x		x	x	x	
Rally	myclobutanil	3	M ^R						x		High risk of reduced sensitivity, alw ays tank mix w ith FRAC code M fungicides, and rotate w ith other FRAC codes
Folicur	fluazinam	3	M						x		
Procure	triflumizole	3	M ^R						x		
MetaStar	metalaxyl	4	H	x							High risk, mfenoxam-insensitivity in Phytophthora know n in region. Only apply if strains are mfenoxam-sensitive
Ridomil Gold	mefenoxam	4	H	x							
Ultra Flourish	mefenoxam	4	H	x							
Quadris	azoxystrobin	11	H ^R		x						High Risk, PM and DM resistance know n in mid-Atlantic region. Tank mix w ith FRAC code M fungicides and rotate w ith other FRAC codes.
Cabrio	pyraclostrobin	11	H ^R		x						
Reason	fenamidone	11	H		x						
Pristine	pyraclostrobin + boscalid	11 + 7	H		x			x	x		
Tanos	fomoxadone + cymoxanil	11 + 27	M				x			x	
Quintec	quinoxifen	13	H						x		High risk for resistance
Ranman	cyazofamid	21	M				x			x	Tank mix w ith FRAC code M fungicides and rotate w ith other FRAC codes
Gavel	zoxamide + mancozeb	22 + M3	L-M				x			x	Low to moderate risk, rotate w ith other FRAC codes
Curzate	cymoxanil	27	L-M							x	Tank mix w ith FRAC code M fungicides; rotate w ith other FRAC codes
Previcur Flex	propomocarb HCL	28	L-M							x	
Forum	dimethomorph	40	L-M				x				
Revus	mandipropamid	40	L-M				x				
Presidio	fluopicolide	43	H				x			x	

Fungicide resistance management guidelines for muskmelon grow n in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries w ith similar mode-of-action, specific site (MOA)
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Know n resistance reported
 High-risk fungicides w ith similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Muskmelon

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Bacterial disease	Pythium damping-off	Neck rot	Downy mildew	Purple blotch (<i>Alternaria</i>)	Botrytis leaf blight	Stemphylium leaf blight	White rot	Fungicide Resistance Management Guidelines
			L	L	H	H ^R	L	H ^R	H ^R	L		
fixed copper	copper	M1	L	x				x				Low risk, multi-site MOA, use alone, or tank mix w ith high-risk FRAC codes and rotate w ith other FRAC codes
mancozeb	mancozeb	M3	L				x	x				
chlorothalonil	chlorothalonil	M5	L					x	x			
iprodione	iprodione	2	H ^R			x	x	x	x	x		High risk
Folicur	tebuconazole	3	H								x	Rotate w ith other FRAC codes
Ridomil Gold	mefenoxam	4	H		x							High risk
Ridomil Gold Copper	mefenoxam + copper	4 + M1	M									Rotate w ith other FRAC codes
Ridomil Gold Bravo	mefenoxam + chlorothalonil	4 + M5	M				x	x				Rotate w ith FRAC code M fungicides
Ridomil Gold MZ	mefenoxam + mancozeb	4 + M3	M				x	x				Rotate w ith other FRAC codes; tank mix and rotate
Endura	boscalid	7	M					x	x			
Scala	pyrimethanil	9	M					x	x			Tank Mix and rotate
Switch	cyprodinil + fludioxonil	9 + 12	M					x	x	x		Moderate risk, tank mix w ith FRAC code M fungicide and rotate w ith other FRAC codes
Quadris	azoxystrobin	11	H					x	x			High risk. Tank mix w ith FRAC code M fungicides, rotate w ith other FRAC codes
Cabrio	pyraclostrobin	11	H				x			x		
Pristine	pyraclostrobin + boscalid	11 + 7	H				x	x	x	x		
Reason	fenamidone	11	H					x				
Quadris Opti	azoxystrobin + chlorothalonil	11 + M5	M				x	x	x			Rotate w ith other non-FRAC code 11 fungicides
Telone	1,3-dichloropropene + chloropicrin	NC	NC								x	Soil fumigant, see label
Vapam HL	sodium methyldithiocarbamate	NC	NC								x	Soil fumigant, see label

Fungicide resistance management guidelines for onions grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA), NC = not classified
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Known resistance reported
 High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Onions

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Pythium damping-off	Leaf Spot, canker and mildew	Fungicide Resistance Management Guidelines
				L	L	
chlorothalonil	chlorothalonil	M5	L		x	Low risk, protectant fungicide. Use alone, or rotate with high-risk FRAC codes or tank mix
Ridomil Gold	mefenoxam	4	H	x		High risk for resistance development
Quadris	azoxystrobin	11	H		x	High risk, tank mix or rotate with FRAC code M fungicide
Cabrio	pyraclostrobin	11	H		x	

Fungicide resistance management guidelines for parsnips grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Known resistance reported
 High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Parsley

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	White mold (<i>Sclerotinia</i>)	Damping-off	Ascochyta blight	Fungicide Resistance Management Guidelines
			M	L	H ^R		
Ridomil Gold	mefenoxam	4	H		x		High risk for resistance development
Endura	boscalid	7	M	x		x	Moderate risk, tank mix and rotate with other FRAC codes
Quadris	azoxystrobin	11	H		x ^a	x	High risk for resistance development, tank mix and rotate with other FRAC codes
Headline	pyraclostrobin	11	H			x	
Contans	<i>Coniothyrium minitans</i>	bio	L	x			Low risk biological control, consult label

Fungicide resistance management guidelines for peas grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Known resistance reported
 High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

^a Rhizoctonia only

Peas

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off	Bacterial leaf spot	Anthracnose fruit rot	Phytophthora blight - crown rot phase	Phytophthora blight - fruit rot/foiar phase	Southern blight	Fungicide Resistance Management Guidelines
			L	H ^R	L	H ^R	H ^R	L		
fixed Copper	copper	M1	L		x			x		Low risk, protectant fungicides, use alone or tank mix w ith high-risk fungicides
chlorothalonil	chlorothalonil	M5	L			x				
Ridomil Gold Copper	mefenoxam + copper	4 + M1	H - M ^R					x		Rotate w ith other FRAC codes
MetaStar	metalaxyl	4	H ^R	x			x			Hisk risk, resistance know n. Only apply if Phytophthora strains are mefenoxam-sensitive
Ridomil Gold	mefenoxam	4	H ^R	x			x			
Ultra Flourish	mefenoxam	4	H ^R	x			x			
Quadris	azoxystrobin	11	H			x				High-risk,rotate w ith other FRAC codes. No consecutive applications.
Cabrio	pyraclostrobin	11	H			x				
Flint	trifloxystrobin	11	H			x				
Tanos	fomoxadone + cymoxanil	11 + 27	M		x	x		x		
Terraclor	PCNB	14	L - M						x	Use in transplant w ater
Agri-Mycin, Agri-strep	streptomycin	25	H ^R		x					Greenhouse use only
Revus	mandipropomid	40	L-M					x		Tank mix and rotate w ith other FRAC codes
Forum	dimethomorph	40	L-M					x		
Presidio	fluopicolide	43	H					x		

Fungicide resistance management guidelines for peppers grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)

Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Known resistance reported

High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Peppers

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off	Angular leaf spot	Plectosporium blight	Scab	Phytophthora	Gummy stem blight	Powdery mildew	Downy mildew	Fungicide Resistance Management Guidelines
			L	L	L	H ^R	H ^R	H ^R	H ^R	H ^R		
fixed Copper	copper	M1	L		x			x				Multi-site MOA, use alone, or in tank mix with high risk fungicides and in rotations with other FRAC codes
sulfur	sulfur	M2	L							x		
chlorothalonil	chlorothalonil	M5	L			x	x		x	x	x	
Rally	myclobutanil	3	M ^R							x		High risk of reduced sensitivity, always tank mix, and alternate with other codes
Folicur	tebuconazole	3	M						x	x		
Procure	triflumizole	3	M ^R							x		
Ridomil Gold	mefenoxam	4	H ^R	x				x				High risk, resistance known. Only apply if Phytophthora strains are mefenoxam-sensitive
Ultra Flourish	mefenoxam	4	H ^R	x				x				
MetaStar	metalaxyl	4	H ^R	x								
Switch	cyprodinil + fludioxonil	9 + 12	M						x			Tank mix and rotate with other FRAC codes
Quadris	azoxystrobin	11	H ^R									High Risk, PM and DM resistance detected in mid-Atlantic region. Tank mix with FRAC code M fungicides and rotate with other FRAC codes
Cabrio	pyraclostrobin	11	H ^R			x						
Flint	trifloxystrobin	11	H			x						
Pristine	pyraclostrobin + boscalid	11 + 7	H						x	x		
Tanos	famoxadone + cymoxanil	11 + 27	M					x			x	
Ranman	cyazofamid	21	M					x			x	Tank mix with FRAC code M fungicide and rotate, do not tank mix with copper
Curzate	cymoxanil	27	L-M								x	Tank mix with a FRAC code M fungicide, rotate with as many different FRAC codes as possible to avoid resistance issues
Previcur Flex	propamocarb HCL	28	L-M								x	
Forum	dimethomorph	40	L-M					x				
Revus	mandipropamid	40	L-M					x				
Presidio	fluopicolide	43	H					x			x	

Fungicide resistance management guidelines for pumpkin and winter squash crops grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)

Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Known resistance reported

High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Pumpkin and Winter Squash

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Pythium damping-off	Downy mildew	Leaf spots	White rust	Fungicide Resistance Management Guidelines
			L	M	L	L		
fixed copper	copper	M1	L		x	x		Use alone, or tank mix and/or rotate w ith high-risk fungicides
Ridomil Gold	mefenoxam	4	H	x				High risk for resistance development
Ultra Flourish	mefenoxam	4	H	x				
Ridomil Gold Copper	mefenoxam + copper	4 + M1	M				x	High risk, rotate w ith other FRAC codes
Quadris	azoxystrobin	11	H			x	x	High risk, tank mix and rotate w ith other FRAC codes
Cabrio	pyraclostrobin	11	H			x	x	

Fungicide resistance management guidelines for radishes, rutabagas and turnips grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Known resistance reported
 High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Radishes, Rutabagas and Turnip

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Pythium damping-off	Downy mildew (Blue mold)	White rust	Leaf Spots and Anthracnose	Fungicide Resistance Management Guidelines
				L	M	L	L-M	
Actigard	acibenzolar-S-methyl	P1	L		x	x		Low -risk, rotate w ith other FRAC codes
fixed copper	copper	M1	L		x	x		Use alone and rotate
Ridomil Gold	mefenoxam	4	H ^R	x				High risk for resistance. At-planting applications for root rot control w ill also help w ith early-season down y mildew control
Ultra Flourish	mefenoxam	4	H ^R	x				
MetaStar	metalaxyl	4	H ^R	x				
Ridomil Gold Copper	mefenoxam + copper	4 + M1	L		x	x		Rotate w ith other FRAC codes
Quadris	azoxystrobin	11	H		x	x	x	High risk, tank mix w ith FRAC code M fungicides and rotate w ith FRAC codes
Cabrio	pyraclostrobin	11	H			x	x	
Reason	fenamidone	11	H		x			
Tanos	fam oxadone + cym oxanil	11 + 27	M		x			
Aliette	fosetyl-Al	33	L		x	x		Low risk, do not tank mix w ith copper
Revus	mandipropomid	40	L-M		x			
Presidio	fluopicolide	43	H		x	x		Tank mix and rotate w ith other FRAC codes

Fungicide resistance management guidelines for spinach grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Known resistance reported
 High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Spinach

Fungicide	Active Ingredient(s)	FRAC CODE	Resistance Risk	Anthraco nose fruit rot	Gray mold	Red stele and Phytophthora crown rot	Powdery mildew	Fungicide Resistance Management Guidelines
			L	H ^R	H ^R	L	H ^R	
fixed copper	copper	M1	L					Low risk protectants, multi-site MOA, use alone, or tank mix and rotate w ith high-risk fungicides
Thiram	thiram	M3	L ^R		x			
Captan	captan	M4	L ^R	x	x			
Captevate	Captan + fenhexamid	M4 + 17	L	x	x			Low risk, no more than 2 consecutive applications
Topsin M	thiophanate-methyl	1	H ^R		x		x	High risk for resistance development
iprodione	iprodione	2	H ^R					Use as a preplant dip
Rally	myclobutanil	3	M				x	Moderate to high risk, tank mix and rotate w ith other FRAC codes
Procure	triflumizole	3	M				x	
Ridomil Gold	mefenoxam	4	H ^R			x		High risk for resistance development
Abound	azoxystrobin	11	H ^R	x				High-risk, tank mix w ith FRAC code M fungicides and rotate w ith other non-FRAC code 11 fungicides
Cabrio	pyraclostrobin	11	H ^R	x			x	
Pristine	pyraclostrobin + boscalid	11 + 7	H	x	x			
Switch	cyprodinil + fludioxonil	9 + 12	M		x			Moderate risk, tank mix and rotate w ith other FRAC codes
Elevate	fenhexamid	17	L		x			Low risk, rotate w ith other FRAC codes
Aliette	fosetyl-al	33	L			x		Low risk, use as pre-plant dip or spray application, see label

Fungicide resistance management guidelines for strawberries grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Known resistance reported
 High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Strawberry

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off (Pythium)	Plectosporium blight	Scab	Phytophthora blight	Powdery mildew	Downy mildew	Fungicide Resistance Management Guidelines
			L	L	H ^R	H ^R	H ^R	H ^R		
fixed Copper	copper	M1	L				x			Multi-site MOA, use alone, or in tank mix w ith high risk fungicides and in rotations w ith other FRAC codes
Mancozeb	mancozeb	M3	L		x					
chlorothalonil	chlorothalonil	M5	L		x	x		x	x	
Rally	myclobutanil	3	M ^R					x		High risk, tank mix w ith a FRAC code M fungicides and rotate w ith other FRAC codes
Folicur	tebuconazole	3	M					x		
Procure	triflumizole	3	M ^R					x		
Ridomil Gold	mefenoxam	4	H ^R	x			x			Hisk risk, resistance know n. Only apply if Phytophthora strains are mefenoxam-sensitive
MetaStar	metalaxyl	4	H ^R	x			x			
Ultra Flourish	mefenoxam	4	H ^R	x			x			
Cabrio	pyraclostrobin	11	H		x					High Risk, PM and DM resistance detected in mid-Atlantic region. Tank mix w ith FRAC code M fungicides and rotate w ith other FRAC codes
Flint	trifloxystrobin	11	H		x					
Pristine	pyraclostrobin + boscalid	11 + 7	H					x		
Tanos	fomoxadone + cymoxanil	11 + 27	M				x		x	
Ranman	cyazofamid	21	M				x		x	Tank mix w ith FRAC code M fungicide and rotate, do not tank mix w ith Cu
Gavel	zoxamide + mancozeb	22 + M3	L-M				x		x	Low to moderate risk
Curzate	cymoxanil	27	L-M						x	Tank mix w ith a FRAC code M fungicide, rotate w ith as many different FRAC codes as possible to avoid resistance issues
Previcur Flex	propomocarb HCL	28	L-M						x	
Forum	dimethomorph	40	L-M				x			
Revus	mandipropamid	40	L-M				x			
Presidio	fluopicolide	43	H				x		x	

Fungicide resistance management guidelines for summer squash crops grow n in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries w ith similar mode-of-action, specific site (MOA)
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Know n resistance reported
 High-risk fungicides w ith similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

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Summer Squash

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Leaf spots and blights	Rust	Fungicide Resistance Management Guidelines
				L	L	
Mancozeb	mancozeb	M3	L	x	x	Multi-site MOA, use alone, or in tank mix w ith high risk fungicides and in rotations w ith other FRAC codes
chlorothalonil	chlorothalonil	M5	L	x	x	
Tilt	propiconazole	3	M	x	x	Tank mix w ith FRAC code M fungicide and rotate w ith other FRAC codes. Check labels for days betw een applications and days to harvest restrictions.
Headline	pyraclostrobin	11	H	x	x	
Quadris	azoxystrobin	11	H	x	x	
Quilt	azoxystrobin + propiconazole	11 + 3	M-H	x	x	
Stratego	trifloxystrobin + propiconazole	11 + 3	M-H	x	x	

Fungicide resistance management guidelines for sweetcorn grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Known resistance reported
 High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Sweet Corn

Fungicide	Active Ingredient(s)	FRAC CODE	Resistance Risk	Pythium damping-off	Bacterial Canker	Bacterial spot and speck	Early blight	Septoria leaf spot	Anthracnose fruit rot	Alternaria fruit rot	Buckeye rot	Grey mold	Late blight	Powdery mildew	Timber rot (White mold)	Southern blight	Fungicide Resistance Management Guidelines
			L	L	H ^R	H ^R	L	L	L	L	H ^R	H ^R	H ^R	M	L		
Actigard	acibenzolar-s-methyl	P1	L		x	x											No more than 6 applications per season
Fixed copper(s)	copper	M1	L		x	x											Low risk protectant fungicides. Use alone, or tank mix w ith high risk fungicides and rotate
chlorothalonil	chlorothalonil	M5	L				x	x	x	x		x	x				
mancozeb	mancozeb	M3	L				x	x	x	x			x				
Cuprofix MZ	copper + mancozeb	M1 + M3	L				x										
ManKocide	mancozeb + copper	M3 + M1	L				x										
Rally	myclobutanil	3	M											x			Rotate w ith other FRAC codes
MetaStar	metalaxyl	4	H ^R	x													High risk, resistance know n
Ridomil Gold 4E	mefenoxam	4	H ^R	x													
Ultra Flourish	mefenoxam	4	H ^R	x													
Ridomil Gold Copper	mefenoxam + copper	4 + M1	M								x						Moderate risk, rotate w ith other FRAC codes
Ridomil Gold Bravo	mefenoxam + chlorothalonil	4 + M5	M								x						
Flouronil	mefenoxam + chlorothalonil	4 + M5	M								x						
Endura	boscalid	7	M				x	x	x	x		x			x		Rotate w ith other FRAC codes
Switch	cyprodinil + fludioxonil	9 + 12	M									x					Rotate w ith other FRAC codes
Quadris	azoxystrobin	11	H				x	x	x	x							High risk, tank-mix w ith protectants; rotate w ith other non-FRAC code 11 fungicides
Cabrio	pyraclostrobin	11	H				x	x	x	x				x			
Flint	trifloxystrobin	11	H				x	x	x	x							
Tanos	famoxadone + cymoxanil	11 + 27	H				x	x	x	x	x		x				
Terraclor	PCNB	14	L-M												x		
Ranman	cyazofamid	21	M - H										x				Tank mix w ith a protectant, rotate
Gavel	zoxamide + mancozeb	22 + M3	L-M				x	x	x	x	x		x				Rotate w ith other FRAC codes
Curzate	cymoxanil	27	L-M										x				Tank mix w ith a protectant, rotate
Previcur Flex	Propamocarb HCL	28	L - M										x				Tank mix w ith a protectant, rotate
Aliette	fosetyl-al	33	L	x													Low risk
Forum	dimethomorph	40	L-M										x				Tank mix w ith a protectant, rotate
Revus Top	mandipropamid + thiophanate methyl	40	L-H				x	x	x	x							
Presidio	fluopicolide	43	H										x				Tank mix w ith a protectant, rotate
Contans	<i>Coniothyrium minitans</i>	bio	L												x		Biological control, see label

Fungicide resistance management guidelines for tomatoes grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries w ith similar mode-of-action, specific site (MOA)
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Know n resistance reported
 High-risk fungicides w ith similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

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Tomato

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off	Angular leaf spot	Plectosporium blight	Scab	Phytophthora blight	Gummy stem blight	Powdery mildew	Downy mildew	Fungicide Resistance Management Guidelines
			L	L	L	H ^R	H ^R	H ^R	H ^R	H ^R		
fixed Copper	copper	M1	L		x			x				Multi-site MOA, use alone, or in tank mix with high risk fungicides and in rotations with other FRAC codes
sulfur	sulfur	M2	L							x		
chlorothalonil	chlorothalonil	M5	L			x	x		x	x	x	
Rally	myclobutanil	3	M ^R							x		High risk of reduced sensitivity, always tank mix, and alternate with other codes
Folicur	tebuconazole	3	M						x	x		
Procure	triflumizole	3	M ^R							x		
Ridomil Gold	mefenoxam	4	H ^R	x				x				High risk, resistance known. Only apply if Phytophthora strains are mefenoxam-sensitive
Ultra Flourish	mefenoxam	4	H ^R	x				x				
MetaStar	metalaxyl	4	H ^R	x								
Switch	cyprodinil + fludioxonil	9 + 12	M						x			Tank mix and rotate with other FRAC codes
Quadris	azoxystrobin	11	H ^R									High Risk, PM and DM resistance detected in mid-Atlantic region. Tank mix with FRAC code M fungicides and rotate with other FRAC codes
Cabrio	pyraclostrobin	11	H ^R			x						
Flint	trifloxystrobin	11	H			x						
Pristine	pyraclostrobin + boscalid	11 + 7	H						x	x		
Tanos	famoxadone + cymoxanil	11 + 27	M					x			x	
Ranman	cyazofamid	21	M					x			x	Tank mix with FRAC code M fungicide and rotate, do not tank mix with copper
Curzate	cymoxanil	27	L-M								x	Tank mix with a FRAC code M fungicide, rotate with as many different FRAC codes as possible to avoid resistance issues
Previcur Flex	propamocarb HCL	28	L-M								x	
Forum	dimethomorph	40	L-M					x				
Revus	mandipropamid	40	L-M					x				
Presidio	fluopicolide	43	H					x			x	

Fungicide resistance management guidelines for pumpkin and winter squash crops grown in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Known resistance reported
 High-risk fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

Watermelon

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management		Early blight	Late blight	Rhizoctonia stem canker	Black scurf (Rhizoctonia)	White mold	Leak (Pythium)	Pink rot (Phytophthora)	Fungicide Resistance Management Guidelines
			L	H ^R								
Mancozeb	mancozeb	M3	L	x	x							Protectants, low -risk, use alone or tank mix w ith high-risk FRAC codes, alternate w ith other FRAC codes
Polyram	metiram	M3	L	x	x							
chlorothalonil	chlorothalonil	M5	L	x	x							
thiophanate-methyl	thiophanate-methyl	1	H						x			High risk, rotate w ith other FRAC codes
iprodione	iprodione	2	M-H						x			Moderate to High risk
Ridomil Gold Copper	mefenoxam + copper	4 + M1	M							x	x	Rotate w ith other FRAC codes and w ith other Ridomil / protectant fungicide combinations
Ridomil Gold MZ	mefenoxam + mancozeb	4 + M3	M							x	x	
Ridomil Gold Bravo	mefenoxam + chlorothalonil	4 + M5	M							x	x	
Ridomil Gold	mefenoxam	4	H ^R							x	x	High-risk, resistance know n in Late blight and Pink rot
Ultra Flourish	mefenoxam	4	H ^R							x	x	
Moncut	flutolanil	7	L-M			x	x					Low to Moderate risk
Endura	boscalid	7	M-H	x					x			Rotate w ith other FRAC codes
Quadris	azoxystrobin	11	H ^R	x		x	x					High-risk for resistance, tank-mix w ith a protectant (M) fungicide, Do not apply FRAC code 11 fungicides consecutively. Reduced sensitivity has been reported in Early blight control
Gem	trifloxystrobin	11	H ^R	x								
Headline	pyraclostrobin	11	H ^R	x								
Reason	fenamidone	11	H ^R	x								
Quadris Opti	azoxystrobin + chlorothalonil	11 + M5	M	x								
Tanos	famoxadone + cymoxanil	11 + 27	M-H	x	x							
Blocker	PCNB	14	L - M			x	x					Apply at planting
Ranman	cyanofamid	21	H		x					x	x	Alw ays tank mix w ith a protectant, rotate
Gavel	zoxamide + mancozeb	22 + M3	L-M		x							Rotate w ith other FRAC codes
Curzate	cymoxanil	27	L-M		x							Tank mix w ith protectant fungicide, rotate w ith other FRAC codes
Previcur Flex	propamocarb HCL	28	L-M		x							
Omega	fluazinam	29	L		x				x			Low -risk for resistance development
Super Tin	triphenyltin hydroxide	30	L-M	x								Tank mix w ith protectant fungicide, rotate w ith other FRAC codes
Forum	dimethomorph	40	L-M		x							
Revus	mandipropamid	40	L-M		x							
Revus Tops	mandipropamid + difenconazole	40 + 3	L-M	x	x							Rotate w ith other FRAC codes

Fungicide resistance management guidelines for potatoes grow n in mid-Atlantic region - 2010

FRAC code: M = multi-site MOA, numbered codes = chemistries w ith similar mode-of-action, specific site (MOA)
 Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Know n resistance reported
 High-risk fungicides w ith similar MOA (i.e. same FRAC code number) should not be sprayed consecutively

White
Potato

White
Potato

