



Fungicide Resistance Management Guidelines for Vegetable Crops Grown in the mid-Atlantic region - 2019



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Photo cover: Septoria leaf spot on tomato caused by *Septoria lycopersici* (L) and cucumber downy mildew caused by *Pseudoperonospora cubensis* (R).

Cover photos by Beth K. Gugino

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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

Since 2007, FRAC guides have been distributed in hardcopy and online form to stakeholders in the mid-Atlantic and surrounding region.

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 powdery mildew in cucurbits and Phytophthora in pepper.

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 76 FRAC groups within the FRAC code system. 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 2019 mid-Atlantic Commercial Vegetable Production Recommendations guide to help make decisions on vegetable disease management and fungicide resistance management. All fungicide application rates for chemicals listed in this guide are found in the 2019 mid-Atlantic Commercial Vegetable Production Recommendations guide.

DISCLAIMER: The fungicide label is a legal-binding contract between the user and the manufacturer. The user must follow all rates and restrictions as per label directions.

Trade or Brand Names Disclaimer:

Where trade names appear, no discrimination is intended and no endorsement by the Penn State 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 2019 mid-Atlantic Commercial Vegetable Production Recommendations guide. Each FRAC table lists all fungicides currently recommended for a specific crop (or crop group) in the 2019 recommendations guides for NJ, DE, MD, VA and PA along with FRAC and risk management codes, diseases for that specific crop or crop group and fungicide resistance management guidelines for each specific FRAC code. For example, in guidelines for pumpkin and winter squash crops grown in the mid-Atlantic region, 40 labeled fungicides that include 22 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 specific 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 specific 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 specific 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 Trade name. 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).

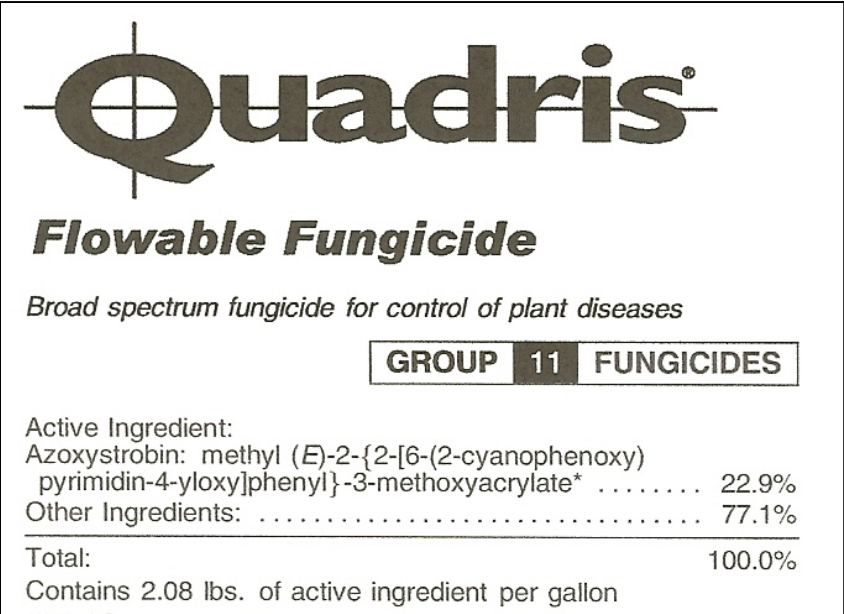


Figure 1. Front of Quadris™ label with FRAC code listed below tradename.

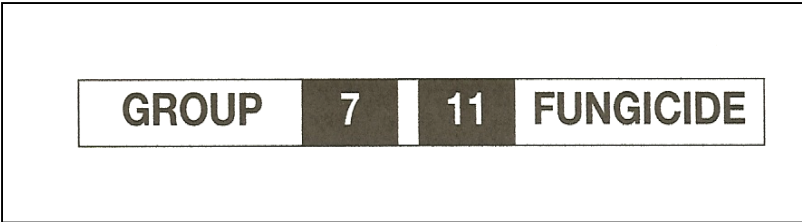


Figure 2. FRAC codes for Pristine™ containing the two active ingredients: boscalid (FRAC code 7) + pyraclostrobin (FRAC code 11)

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	Asparagus rust	Leaf blights (<i>Alternaria</i> and <i>Cercospora</i>)	Phytophthora (Crown & spear rot)	Purple spot	Fungicide Resistance Management Guidelines
				L	L	M ^R	H ^R	
mancozeb	mancozeb	M3	L	X	X			Multi-site MOA, low risk protectants. Use alone or tank mix with high risk FRAC codes. Rotate with other FRAC codes
chlorothalonil	chlorothalonil	M5	L	X	X		X	
Folicur	tebuconazole	3	M	X	X			High risk of reduced sensitivity, always tank mix and rotate with other FRAC codes
Rally	myclobutanil	3	M	X				
MetaStar	metalaxyl	4	H ^R			X		High risk, resistance known in other crops
Ridomil Gold	mefenoxam	4	H ^R			X		
Ultra Flourish	mefenoxam	4	H ^R			X		
Orondis Gold	mefenoxam + oxathiapiprolin	4 + 49	H			X		
azoxystrobin	azoxystrobin	11	H ^R				X	High risk, tank mix and rotate with other FRAC codes, no consecutive applications

Fungicide resistance management guidelines for ASPARAGUS grown in mid-Atlantic region - 2019

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	Damping off & root rots (<i>Pythium</i> , <i>Phytophthora</i> &/or <i>Anthraco</i>)	Anthracnose	Web blight (<i>Rhizoctonia</i>)	Bacterial blight	Bacterial brown spot	Common bean rust	Lima bean downy mildew	Lima bean pod blight	Pythium blight (Cottony leak)	Southern blight	Gray mold (<i>Botrytis</i>)	White mold (<i>Sclerotinia</i>)	Fungicide Resistance Management Guidelines
				L	L	H ^R	L	L	L	M	L	L	L	H ^R	M	
fixed copper	copper	M1	L				X	X								Multi-site protectant MOA, use alone or in tank mix with high risk fungicides and in rotations with other FRAC codes. OMRI options.
chlorothalonil	chlorothalonil	M5	L						X ^b							
thiophanate-methyl	thiophanate-methyl	1	H											X	X	High risk, always tank mix with other FRAC codes, apply no more than 4 lb per crop season. For snap bean only.
Folicur	tebuconazole	3	M						X							Moderate risk, always tank mix and rotate with other FRAC codes. Rally for snap bean only.
Rally	myclobutanil	3	M						X							
Quilt Xcel	propiconazole + azoxystrobin	3 + 11	M-H		X	X			X							Tank mix and rotate with other FRAC codes, consult label for specific instructions
Ridomil Gold	mefenoxam	4	H	X												High risk for resistance
Ridomil Gold Copper	mefenoxam + copper	4 + M1	M							X	X	X				Rotate with other FRAC codes
Uniform	mefenoxam + azoxystrobin	4 + 11	H	X												For use at planting; will help control <i>Pythium</i> and <i>Rhizoctonia</i>
Endura	boscalid	7	M								X			X	X	No more than 2 applications per season, rotate with other FRAC codes. For snap bean only.
Fontelis	penthiopyrad	7	M	X					X					X	X	No more than 2 sequential applications, rotate with other FRAC codes
Priaxor	fluxapyroxad + pyraclostrobin	7 + 11	H		X	X										No more than 2 applications per season, rotate with other FRAC codes. For snap bean only.
Switch	cyprodinil + fludioxonil	9 + 12	M											X	X	Tank mix and rotate with other FRAC codes
azoxystrobin	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						
Ranman	cyazofamid	21	M							X	X	X				Rotate with other FRAC codes
Omega	fluazinam	29	L							X	X			X	X	Low risk, rotate with other FRAC codes
Prophyt, K-Phite, Rampart, Phostrol	potassium phosphite salts	33	L							X	X	X				Low risk for resistance, see labels
Forum	dimethomorph	40	L-M							X	X					Tank mix and rotate with other FRAC codes
Contans	<i>Coniothyrium minitans</i>	bio	L												X	Low risk biological control, consult label, OMRI- approved

Fungicide resistance management guidelines for BEANS grown in the mid-Atlantic region - 2019

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

Beans

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off (<i>Pythium</i> & <i>Phytophthora</i>)	Damping-off (<i>Rhizoctonia</i>)	Leaf spots (<i>Cercospora</i> , <i>Alternaria</i> and others)	Pocket rot (<i>Rhizoctonia</i>)	Fungicide Resistance Management Guidelines
fixed copper	copper	M1	L			x		Multi-site MOA, low risk protectant, see label, OMRI options
tebuconazole	tebuconazole	3	M			x		Moderate to high risk, always tank mix and rotate with other FRAC codes
Tilt	propiconazole	3	H			x		
MetaStar	metalaxyl	4	H	x				High risk, for use at planting
Ridomil Gold	mefenoxam	4	H	x				
Ultra Flourish	mefenoxam	4	H	x				
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x	x		x	
Fontelis	penthiopyrad	7	M			x		Moderate risk, tank mix.
Luna Tranquility	fluopyram + pyrimethanil	7 + 9	M			x		
Merivon	fluxapyroxad + pyraclostrobin	7 + 11	M			x		
azoxystrobin	azoxystrobin	11	H			x	x	High-risk for resistance, tank-mix with a protectant (M) fungicide, Do not apply FRAC code 11 fungicides consecutively. Reduced sensitivity has been reported in early blight control.
Reason	fenamidone	11	H ^R			x		
Cabrio	pyraclostrobin	11	H			x		
Gem	trifloxystrobin	11	H ^R			x		

Fungicide resistance management guidelines for BEETS grown in the mid-Atlantic region - 2019

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	Damping-off (<i>Phytophthora</i> & <i>Pythium</i>)	Bacterial Blight	Alternaria leaf blight	Cercospora leaf blight	Powdery mildew	Southern blight (<i>Sclerotium rolfsii</i>)	Storage rots (<i>Botrytis</i> & <i>Sclerotinia</i>)	Fungicide Resistance Management Guidelines
				H ^R	L	H ^R	M	H ^R	L	L-H	
copper, fixed	copper	M1	L		x						Multi-site MOA, use alone, or in tank mix with high risk FRAC codes and in rotations with other FRAC codes. OMRI options.
chlorothalonil	chlorothalonil	M5	L			x	x	x			Multi-site MOA, tank mix with high risk FRAC codes and rotate with other FRAC codes
Mertect	thiobendazole	1	H							x	High risk, for control of gray mold and sclerotinia in storage
iprodione	iprodione	2	M-H			x					Tank mix and rotate with other FRAC codes, see label for rotational restrictions
Ridomil Gold, Ultra Flourish	mefenoxam	4	H ^R	x							High risk for resistance, tank mix and rotate FRAC codes
Endura	boscalid	7	M			x					Moderate risk, tank mix and rotate FRAC codes
Fontelis	penthiopyrad	7	M			x	x	x	x	x	
Pristine	boscalid + pyraclostrobin	7 + 11	H			x	x	x			High risk for resistance, tank mix and rotate FRAC codes
Merivon	fluxapyroxad + pyraclostrobin	7 + 11	H			x	x	x			
Switch	cyprodinil + fludioxonil	9 + 12	M			x					Moderate risk, tank mix and rotate FRAC codes
azoxystrobin	azoxystrobin	11	H			x	x		x		High risk, tank mix with FRAC code M protectants and rotate with other FRAC codes. Do not apply FRAC code 11 fungicides in consecutive applications
Cabrio	pyraclostrobin	11	H			x	x	x			
Quadris Top	azoxystrobin + difenconazole	11 + 3	H						x		
Omega	fluazinam	29	L						x		Moderate risk, tank mix and rotate FRAC codes
Contans	<i>Coniothyrium minitans</i>	bio	L								Low risk biological control, consult label, OMRI-approved

Fungicide resistance management guidelines for CARROTS grown in mid-Atlantic region - 2019

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	Damping-off (<i>Phytophthora & Pythium</i>)	Damping-off (<i>Rhizoctonia</i>)	Celery leaf curl/anthracnose (<i>Colletotrichum</i>)	Crater and petiole rot/ Basal stalk rot (<i>Rhizoctonia</i>)	Leaf blights (<i>Cercospora & Septoria</i>)	Pink rot (<i>Sclerotinia sclerotiorum</i>)	Fungicide Resistance Management Guidelines
				L	L	M	L	M	L	
copper, fixed	copper	M1	L			x		x		Multi-site MOA, use alone, or in tank mix with high risk FRAC codes and in rotations with other FRAC codes. OMRI options.
chlorothalonil	chlorothalonil	M5	L			x	x	x	x	Multi-site MOA, tank mix with high risk FRAC codes and rotate with other FRAC codes
Quadris Opti	chlorothalonil + azoxystrobin	M5 + 11	L-H				x	x		Moderate risk, tank mix and rotate FRAC codes
propoconazole	propoconazole	3	M					x		
Ridomil Gold, Ultra Flourish	mefenoxam	4	H ^R	x	x					Hisk risk for resistance, tank mix and rotate FRAC codes
Uniform	mefenoxam + azoxystrobin	4 + 11	H		x					
Fontelis	penthiopyrad	7	M					x		Moderate risk, tank mix and rotate FRAC codes
Merivon	fluxapyroxad + pyraclostrobin	7 + 11	H					x		Hisk risk for resistance, tank mix and rotate FRAC codes
Switch	cyprodinil + fludioxonil	9 + 12	M						x	Moderate risk, tank mix and rotate FRAC codes
azoxystrobin	azoxystrobin	11	H			x	x	x		High risk, tank mix with FRAC code M protectants and rotate with other FRAC codes. Do not apply FRAC code 11 fungicides in consecutive applications
Cabrio	pyraclostrobin	11	H			x		x		
Cannonball	fludioxonil	12	M						x	Moderate risk, tank mix and rotate FRAC codes
Contans	<i>Coniothyrium minitans</i>	bio	L						x	Low risk biological control, consult label, OMRI-approved

Fungicide resistance management guidelines for CELERY grown in mid-Atlantic region - 2019

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

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off (<i>Pythium</i>)	Damping-off (<i>Rhizoctonia</i>)	Alternaria leaf blight	Black rot (bacterial)	Blackleg (<i>Phoma</i> - fungal)	Clubroot	Downy mildew	White mold (<i>Sclerotinia</i>)	Fungicide Resistance Management Guidelines
				L	L	M	L	L	L	M	M	
Actigard	acibenzolar-S-methyl	P1	L							x		Low-risk, No more than 4 applications per season, see label
fixed copper	copper	M1	L			x	x	x				Multi-site MOA, use in tank mix with high risk FRAC codes and in rotations with other FRAC codes. Consult labels for rates and crops, OMRI copper options available, chlorothalonil is not labeled for collards, kale and kohlrabi
chlorothalonil	chlorothalonil	M5	L							x		
iprodione	iprodione	2	M-H					x				Moderate to high-risk, for broccoli only, see label
tebuconazole	tebuconazole	3	H					x				High risk, rotate with other FRAC codes, Ridomil Gold is not labeled for collards, kale and kohlrabi
Inspire Super	difenconazole + cyprodinil	3 + 9	H			x		x				
Quadris Top	difenconazole + azoxystrobin	3 + 11	H			x		x				
Ridomil Gold	mefenoxam	4	H	x								
Ridomil Gold Bravo	mefenoxam + chlorothalonil	4 + M5	H			x						
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x	x							For use at planting
Endura	boscalid	7	M			x					x	Moderate risk, tank mix and rotate FRAC codes
Fontelis	penthiopyrad	7	M			x					x	No more than 2 sequential applications, rotate with other FRAC codes
Priaxor	fluxapyroxad + pyraclostrobin	7 + 11	H			x		x				High risk, rotate with other FRAC codes
Switch	cyprodinil + fludioxonil	9 + 12	M			x						Moderate risk, rotate with other FRAC codes
azoxystrobin	azoxystrobin	11	H		x	x				x		High risk, tank mix with FRAC code M fungicides. Rotate with other FRAC codes. No consecutive applications
Cabrio	pyraclostrobin	11	H			x		x		x		
Terraclor	pentachloronitrobenzene	14	L-M						x			Low to moderate risk
Ranman	cyazofamid	21	M						x	x		Moderate risk, tank mix
Aliette	aluminum tris	33	L							x		Low risk, do not tank mix with copper
Phosphite	phosphite	33	L							x		
Revus	mandipropamid	40	M							x		Tank mix with protectant fungicide, rotate with other FRAC codes
Zapro	dimethomorph + ametoctradin	40 + 45	M							x		Moderate risk, tank mix
Presidio	fluopicolide	43	H							x		Rotate with other FRAC codes
Contans	<i>Coniothyrium minitans</i>	bio	L								x	Low risk biological control, consult label, OMRI-approved

Fungicide resistance management guidelines for selected COLE CROPS grown in mid-Atlantic region - 2019

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	Damping-off	Angular leaf spot	Anthracnose	Belly rot	Cottony leak (<i>Pythium</i>)	Downy mildew	Gummy stem blight	Phytophthora fruit and crown rot	Powdery mildew	Scab	Fungicide Resistance Management Guidelines
				L	L	L	L	L	H ^R	H ^R	H ^R	H ^R	H ^R	
Regalia	Extract of <i>Reynoutria sachalinensis</i>	P5	L									X		Low risk biological, consult label, OMRI-approved
fixed copper	copper	M1	L		x									Multi-site MOA, use in tank mix with high risk fungicides and in rotations with other FRAC codes. There are OMRI-approved coppers available.
mancozeb	mancozeb	M3	L		x				x	x			x	
Gavel	mancozeb + zoxamide	M3 + 22	L-M						x		x			
chlorothalonil	chlorothalonil	M5	L			x			x	x			x	
Zing!	chlorothalonil + zoxamide	M5 + 22	L						x					Rotate with other FRAC codes
Ariston	chlorothalonil + cymoxanil	M5 + 27	L-M						x					Rotate with other FRAC codes
thiophanate-methyl	thiophanate-methyl	1	H			x								High risk, tank mix and rotate FRAC codes
Rhyme	futriafol	3	M							x		x		High risk, rotate with other FRAC codes
Rally	myclobutanil	3	M ^R									x		
Proline	prothioconazole	3	M							x		x		
tebuconazole	tebuconazole	3	M ^R							x		x		
Procure	triflumizole	3	M ^R									x		
Aprovia Top	difenconazole + benzovindiflupyr	3 + 7	M-H							x		x		High risk, rotate with other FRAC codes
Luna Experience	fluopyram + tebuconazole	3 + 7	M-H							x		x		High risk, rotate with other FRAC codes
Inspire Super	difenconazole + cyprodinil	3 + 9	H							x		x		High risk, rotate with other FRAC codes
TopGuard	flutriafol + azoxystrobin	3 + 11	H							x		x		High risk, rotate with other FRAC codes
Quadris Top	difenconazole + azoxystrobin	3 + 11	H			x								

Fungicide resistance management guidelines for CUCUMBER grown in the mid-Atlantic region - 2019

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 (continued next page)

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off	Angular leaf spot	Anthraco-nose	Belly rot	Cottony leak (<i>Pythium</i>)	Downy mildew	Gummy stem blight	Phytophthora fruit and crown rot	Powdery mildew	Scab	Fungicide Resistance Management Guidelines
				L	L	L	L	L	H ^R	H ^R	H ^R	H ^R	H ^R	
MetaStar	metalaxyl	4	H ^R	x				x						Hisk risk, resistance known. Pythium damping off. Only apply if Phytophthora strains are mefenoxam-sensitive.
Ridomil Gold	mefenoxam	4	H ^R	x				x						
Ultra Flourish	mefenoxam	4	H ^R	x				x						
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x										For use at planting; will help control Pythium and Rhizoctonia
Fontelis	penthiopyrad	7	M							x		x		Moderate risk, tank mix
Merivon	fluxapyroxad + pyraclostrobin	7 + 11	H			x				x				High risk, rotate with other FRAC codes
Pristine	boscalid + pyraclostrobin	7 + 11	H ^R			x				x		x		
Switch	cyprodinil + fludioxonil	9 + 12	M							x				Moderate risk, tank mix and rotate
azoxystrobin	azoxystrobin	11	H ^R	x		x	x			x				High risk, Rhizoctonia damping-off only, PM and DM resistance known. Tank mix with FRAC code M fungicides, rotate with as many different FRAC codes as possible. No consecutive applications.
Cabrio	pyraclostrobin	11	H ^R			x				x				
Tanos	fomoxadone + cymoxanil	11 + 27	M						x		x			
Ranman	cyazofamid	21	M						x		x			Moderate risk, tank mix and rotate
Curzate	cymoxanil	27	L-M						x					Moderate risk, tank mix
Previcur Flex	propomocarb HCL	28	L-M	x					x					Low risk, tank mix. Pythium damping-off only.
Forum	dimethomorph	40	M						x		x			Tank mix with a FRAC code M fungicide and rotate with as many different FRAC codes as possible.
Revus	mandipropamid	40	M								x			
Zapro	dimethomorph + ametoc-tradin	40 + 45	M						x		x			
Orondis Ultra	mandipropamid + oxathiapi-prolin	40 + 49	H						x		x			
Presidio	fluopicolide	43	H ^R						x		x			
Vivando	metrafenone	50	M									x		
Torino	cyflufenamid	U6	M									x		

Fungicide resistance management guidelines for CUCUMBER grown in the mid-Atlantic region - 2019

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 (continued previous page)

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping off (<i>Phytophthora</i> & <i>Pythium</i>)	Damping off &/or stem rot (<i>Rhizoctonia</i>)	Phytophthora blight - crown rot phase	Phytophthora blight - fruit rot and stem rot phase	Fruit rots (fungal)	Leaf spots (fungal)	Verticillium wilt	Fungicide Resistance Management Guidelines
				L	L	H ^R	H ^R	M	M	L	
fixed copper	copper	M1	L					x	x		Multi-site MOA, use alone or in tank mix with high risk FRAC codes and in rotation with other FRAC codes. There are OMRI-approved coppers available.
chlorothalonil	chlorothalonil	M5	L					x	x		
Aprovia Top	difenoconazole + benzovindiflupyr	3 + 7	H		x						High risk, rotate with other FRAC codes
Quadris Top	difenoconazole + azoxystrobin	3 + 11	H					x	x		High risk, rotate with other FRAC codes
Ridomil Gold, Ultra Flourish	mefenoxam	4	H ^R	x		x					High risk, mefenoxam-resistance known in mid-Atlantic region. Tank mix with other FRAC codes
MetaStar	metalaxyl	4	H ^R	x							
Orondis Gold	mefenoxam + oxathiapiprolin	4 + 49	H	x		x	x				
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x	x						
Fontelis	penthiopyrad	7	M						x		Tank mix and rotate with other FRAC codes
Priaxor	boscalid + pyraclostrobin	7 + 11	H					x			
azoxystrobin	azoxystrobin	11	H		x			x	x		High-risk, rotate and tank mix with other FRAC codes. Do not apply FRAC code 11 fungicides in consecutive applications.
Cabrio	pyraclostrobin	11	H						x		
Ranman	cyazofamid	21	M				x				Rotate with other FRAC codes
Forum	dimethomorph	40	M				x				Tank mix and rotate with other FRAC codes
Presidio	fluopicolide	43	H			x	x				
Vapam HL	metam sodium	NC	L							x	See label for instructions

Fungicide resistance management guidelines for EGGPLANT grown in mid-Atlantic region - 2019

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	Damping-off (<i>Pythium</i>)	Damping-off (<i>Rhizoctonia</i>)	Botrytis leaf blight	Downy mildew	Purple blotch (<i>Alternaria</i>)	White rot (<i>Sclerotium</i>)	Fungicide Resistance Management Guidelines
				L	L	H ^R	M	L	L	
chlorothalonil	chlorothalonil	M5	L			x	x	x		Low risk, multi-site MOA, use alone, or in tank mix with high risk FRAC codes and in rotations with other FRAC codes
iprodione	iprodione	2	M-H						x	Moderate to high-risk, at planting application
tebuconazole	tebuconazole	3	M					x	x	Medium risk, tank mix, rotate with other FRAC codes
Inspire Super	difencconazole + cyprodinil	3 + 9	H			x		x		High-risk, rotate with other FRAC codes
Quilt (or Quilt Xcel)	propiconazole + azoxystrobin	3 + 11	M-H			x	x	x		Tank mix with FRAC code M fungicide and rotate with other FRAC codes. Check labels for days between applications and days to harvest restrictions. Amounts of active ingredients vary between the different combinations.
Ridomil Gold	mefenoxam	4	H	x						High risk for resistance
Ultra Flourish	mefenoxam	4	H	x						
MetaStar	metalaxyl	4	H	x						
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x	x					For use at planting; will help control <i>Pythium</i> and <i>Rhizoctonia</i>
Endura	boscalid	7	M			x		x		Moderate risk, tank mix and rotate with other FRAC codes
Fontelis	penthiopyrad	7	M					x		
azoxystrobin	azoxystrobin	11	H		x		x	x		High-risk, rotate and tank mix with other FRAC codes. Do not apply any FRAC code 11 fungicide in consecutive applications.
Reason	fenamidone	11	H				x			
Cabrio	pyraclostrobin	11	H				x	x		
Pristine	pyraclostrobin + boscalid	11 + 7	H			x				
Cannonball	fludioxonil	12	M						x	For use at planting
Omega	fluazinam	29	L			x	x	x		Rotate with other FRAC codes
Forum	dimethomorph	40	M				x			Tank mix and rotate with other FRAC codes
Zampro	dimethomorph + ametoctradin	40 + 45	M				x			
Orondis Ultra	mandipropamid + oxathiapiprolin	40 + 49	M				x			

Fungicide resistance management guidelines for GARLIC grown in mid-Atlantic region - 2019

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 spots (<i>Alternaria</i> & <i>Cercospora</i>)	Fungicide Resistance Management Guidelines
				L	M	M	
fixed copper	copper	M1	L			x	Multi-site MOA, use alone, or tank mix with high risk FRAC codes, OMRI options
Folicur	tebuconazole	3	M			x	Tank mix and rotate with other FRAC codes
Inspire Super	difenoconazole + cyprodinil	3 + 9	H			x	Rotate with other FRAC codes
Quadris Top	difenoconazole + azoxystrobin	3 + 11	H			x	
Ridomil Gold	mefenoxam	4	H	x			High risk; for turnip greens only
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x			For use at planting; will help control Pythium and Rhizoctonia
Endura	boscalid	7	M			x	No more than 2 sequential applications, rotate with other FRAC codes
Fontelis	penthiopyrad	7	M			x	
Priaxor	fluxapyroxad + pyraclostrobin	7 + 11	H			x	High risk, tank mix and/or rotate with a FRAC code M fungicide.
Switch	cyprodinil + fludioxonil	9 + 12	M			x	Rotate with other FRAC codes
azoxystrobin	azoxystrobin	11	H	x	x	x	High risk, tank mix and/or rotate with a FRAC code M fungicide.
Cabrio	pyraclostrobin	11	H		x	x	
Ranman	cyazofamid	21	M		x		Rotate with other FRAC codes
Aliette	aluminum tris	33	L		x		Low risk, do not tank mix with copper; for mustard greens only
Forum	dimethomorph	40	M		x		Tank mix and rotate with other FRAC codes
Revus	mandipropamid	40	H		x		Tank mix and/or Rotate with other FRAC codes
Zampro	dimethomorph + ametoctradin	40 + 45	M		x		
Presidio	fluopicolide	43	H		x		Tank mix and rotate with other FRAC codes

Fungicide resistance management guidelines for GREENS grown in mid-Atlantic region - 2019

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, root, stem rot (<i>Pythium</i> , <i>Phytophthora</i> , &/or <i>Rhizoctonia</i>)	Bacterial canker, speck, spot, soft rot and other bacterial diseases	Downy mildew	Fungal leaf molds and spots	Gray mold (<i>Botrytis</i>)	Gummy stem blight	Late blight (<i>Phytophthora</i>)	Powdery mildew	Southern blight (<i>Sclerotium</i>)	White mold (<i>Sclerotinia</i>)	Fungicide Resistance Management Guidelines
				L	H ^R	H ^R	L-M	H ^R	H ^R	H ^R	H ^R	M	M	
Regalia	<i>Reynoutria sachalinensis</i>	P5	L								x			OMRI - approved
Champ, Cuprofix Disperss, Kocide, Camelot	copper hydroxide, copper sulfate, copper salts	M1	H ^R			x	x	x			x			Protectant, low risk, see labels for details, OMIR-approved copper and sulfur formulations available
Nordox	cuprous oxide	M1			x		x			x				
sulfur	sulfur	M2	L								x			
mancozeb	mancozeb	M3	L	x			x							
Catamaran	chlorothalonil + potassium phosphite	M5 + 33	L							x				
3336 WP	thiophanate-methyl	1	H			x		x	x		x		x	Rotate with other FRAC codes
Procure	triflumizole	3	M ^R								x			
Fontelis	penthiopyrad	7	M				x		x		x		x	
Pageant	boscalid + pyraclostrobin	7 + 11	M-H					x						
Mural	benzovindiflupyr + azoxystrobin	7 + 11	M-H				x				x			
Scala	pyrimethanil	9	M-H				x	x						
Heritage	azoxystrobin	11	H	x			x							
Emblem	fludioxonil	12	H				x	x	x		x	x		For Botrytis stem canker; low to medium risk
Botran	dicloran	14	L-M				x	x				x	x	For certain container grown vegetables
Terraclor	PCNB	14	L-M	x										Low risk
Decree	fenhexamid	17	L					x						Low to medium risk
Ranman	cyazofamid	21	M	x		x								Low to medium risk

Fungicide resistance management guidelines for select vegetable crops grown in HIGH TUNNELS and GREENHOUSES in mid-Atlantic region - 2019

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action (MOA); NC = not classified

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

Fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively.

High Tunnel and Greenhouse (continued next page)

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off, root, stem rot (<i>Pythium</i> , <i>Phytophthora</i> , &/or <i>Rhizoctonia</i>)	Bacterial canker, speck, spot, soft rot and other bacterial diseases	Downy mildew	Fungal leaf molds and spots	Gray mold (<i>Botrytis</i>)	Gummy stem blight	Late blight (<i>Phytophthora</i>)	Powdery mildew	Southern blight (<i>Sclerotium</i>)	White mold (<i>Sclerotinia</i>)	Fungicide Resistance Management Guidelines
				L	H ^R	H ^R	L-M	H ^R	H ^R	H ^R	H ^R	M	M	
Agri-mycin 17	streptomycin sulfate	25	H		x									For use in transplant production only
Previcur Flex	propamocarb HCL	28	L-M	x										Low to medium risk
Funig-Phite, Rampart	phosphorus acids - mono and di- potassium salts	33	L	x										
Micora	mandipropamid	40	L-M	x		x				x				
Companion, Cease	<i>Bacillus subtilis</i>	44	L	x			x							Microbial biopesticides, refer to label for rates and application specificities, OMRI-approved
Sonata	<i>Bacillus pumilus</i>	44	L			x	x			x	x			
Plantsmead HC, Songard, RootShield	<i>Trichoderma sp.</i>	BM2	L	x				x			x			
Actinovate	<i>Streptomyces lydicus</i>	BM2	L	x		x	x	x			x			
Contans	<i>Coniothyrium minitans</i>	Bio	L										x	
DeBug Tres, Debug Turbo	azadirachtin + neem oil	NC	NC									x	x	OMRI - approved
Basamid G	dazomet (soil fumigant)	NC	NC	x										Restricted use pesticide
Ultra-Pur Oil	horticultural oils	NC	NC								x			Use low rates, see labels
Zerotol, Oxidate	hydrogen dioxide	NC	NC	x		x	x				x			Contact disinfectant, no residual activity, OMRI- approved
Surround	kaolin clay	NC	NC								x			Forms a white clay film, OMRI-approved
Armicarb, Kaligreen, Milstop	potassium bicarbonate	NC	NC								x			OMRI - approved
M-Pede	potassium salts of fatty acids	NC	NC								x			OMRI - approved

Fungicide resistance management guidelines for select vegetable crops grown in HIGH TUNNELS and GREENHOUSES in mid-Atlantic region - 2019

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action (MOA); NC = not classified

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

Fungicides with similar MOA (i.e. same FRAC code number) should not be sprayed consecutively.

High Tunnel and Greenhouse (continued previous page)

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping off (<i>Pythium</i>)	Damping off (<i>Rhizoctonia</i>)	Downy mildew	Purple blotch	White rot	Fungicide Resistance Management Guidelines
				L	L	M	L	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
Inspire Super	difenoconazole + cyprodinil	3 + 9	H				x		High-risk, rotate with other FRAC codes
Quadris Top	difenoconazole + azoxystrobin	3 + 11	H				x		
MetaStar	metalaxyl	4	H ^R	x					High-risk, rotate with other FRAC codes
Ridomil Gold	mefenoxam	4	H ^R	x					
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x					For use at planting; will help control <i>Pythium</i> and <i>Rhizoctonia</i>
Endura	boscalid	7	M				x		Moderate risk, tank mix and rotate
Fontelis	penthiopyrad	7	M			x	x		Moderate risk, tank mix and rotate
Merivon	fluxapyroxad + pyraclostrobin	7 + 11	H			x			High risk, tank mix or rotate with a FRAC code M protectant fungicide
Pristine	boscalid + pyraclostrobin	7 + 11	H			x	x		
azoxystrobin	azoxystrobin	11	H		x	x	x		
Cabrio	pyraclostrobin	11	H			x	x		
Maxim	fludioxonil	12	L - M	x					Seed treatment
Forum	dimethomorph	40	M			x			Tank mix and rotate with other FRAC codes

Fungicide resistance management guidelines for LEEKS grown in mid-Atlantic region - 2019

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	Damping-off	Bottom rot (<i>Rhizoctonia</i>)	Downy mildew	Gray mold (<i>Botrytis</i>)	Leaf spots (<i>Septoria</i> , <i>Anthraco</i> se,	Lettuce drop (<i>Sclerotinia</i>)	Fungicide Resistance Management Guidelines
				L	L	M ^R	H ^R	L	M	
iprodione	iprodione	2	M-H ^R		x				x	Moderate to high risk
Rhyme	flutriafol	3	M					x		Moderate risk, tank mix and rotate
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, Ultra Flourish	mefenoxam	4	H ^R	x		x				
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x	x					For use at planting; will help control Pythium and Rhizoctonia damping-off
Endura	boscalid	7	M		x		x		x	Moderate risk, tank mix and rotate FRAC codes
Fontelis	penthiopyrad	7	M					x		
Merivon	fluxapyroxad + pyraclostrobin	7 + 11	H			x	x	x		High risk, tank mix and rotate
azoxystrobin	azoxystrobin	11	H					x		High risk, tank mix with FRAC code M protectants and rotate with other FRAC codes. No consecutive applications
Reason	fenamidone	11	H			x				
Cannonball	fludioxonil	12	H				x		x	Tank mix and rotate
Botran	dichloran	14	H				x			Low to medium risk
Previcur Flex	propomocarb HCL	28	H			x				Tank mix with FRAC code M fungicide, 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				
Zampro	dimethomorph + ametoctradin	40 + 45	M			x				Moderate risk, tank mix
Contans	<i>Coniothyrium minitans</i>	bio	H						x	Low risk biological control, consult label

Fungicide resistance management guidelines for LETTUCE grown in mid-Atlantic region - 2019

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	Damping-off (<i>Pythium</i> , <i>Phytophthora</i> &/or <i>Rhizoctonia</i>)	Alternaria leaf blight	Bacterial and angular leaf spot	Downy mildew	Fusarium wilt	Gummy stem blight	Phytophthora crown & fruit rot	Powdery mildew	Scab	Fungicide Resistance Management Guidelines
				L	L	H	H ^R	L	H ^R	H ^R	H ^R	H ^R	
Regalia	Extract of <i>Reynoutria sachalinensis</i>	P5	L								x		Resistance not known; use with PM specific fungicides
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; tank mix mancozeb with copper for bacterial diseases
mancozeb	mancozeb	M3	L		x	x							
Gavel	mancozeb + zoxamide	M3 + 22	L				x						Low to moderate risk, rotate with other FRAC codes
chlorothalonil	chlorothalonil	M5	L		x				x			x	Multi-site MOA, use alone or in tank mix with high risk fungicides and in rotations with other FRAC codes
Zing!	chlorothalonil + zoxamide	M5 + 22	L				x						Low to moderate risk, rotate with other FRAC codes
Ariston	chlorothalonil + cymoxanil	M5 + 27	L-M				x						Rotate with other FRAC codes
Rhyme	flutriafol	3	M						x		x		High risk of reduced sensitivity, always tank mix with FRAC code M fungicides, and rotate with other FRAC codes
Rally	myclobutanil	3	M ^R								x		
Proline	prothioconazole	3	M					x	x		x		
tebuconazole	tebuconazole	3	M						x		x		
Procure	triflumizole	3	M ^R								x		
Aprovia Top	difenconazole + benzovindiflupyr	3 + 7	M-H		x				x		x		High risk, rotate with other FRAC codes
Luna Experience	fluopyram + tebuconazole	3 + 7	M-H								x		
Inspire Super	difenconazole + cyprodinil	3 + 9	H		x				x		x		
Quadris Top	difenconazole + azoxystrobin	3 + 11	H		x								
TopGuard	flutriafol + azoxystrobin	3 + 11	H		x								
MetaStar	metalaxyl	4	H	x									High risk, mefenoxam-insensitivity in <i>Phytophthora</i> known in region. Only apply if strains are mefenoxam-sensitive
Ridomil Gold	mefenoxam	4	H	x									
Ultra Flourish	mefenoxam	4	H	x									
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x									For use at planting; will help control <i>Pythium</i> and <i>Rhizoctonia</i>

Fungicide resistance management guidelines for MUSKMELON grown in mid-Atlantic region - 2019

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

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off (<i>Pythium</i> , <i>Phytophthora</i> &/or <i>Rhizoctonia</i>)	Alternaria leaf blight	Bacterial and angular leaf spot	Downy mildew	Fusarium wilt	Gummy stem blight	Phytophthora crown & fruit rot	Powdery mildew	Scab	Fungicide Resistance Management Guidelines
				L	L	H	H ^R	L	H ^R	H ^R	H ^R	H ^R	
Fontelis	penthiopyrad	7	M						x		x		Moderate risk, tank mix
Pristine	boscalid + pyraclostrobin	7 + 11	H ^R		x				x		x		High Risk, PM and DM resistance known in mid-Atlantic region. Tank mix with FRAC code M fungicides and rotate with other FRAC codes.
Luna Sensation	fluopyram + trifloxystrobin	7 + 11	H		x						x		High risk, rotate with other FRAC codes
Merivon	fluxapyroxad + pyraclostrobin	7 + 11	H		x				x				
Switch	cyprodinil + fludioxonil	9 + 12	M						x				Moderate risk, tank mix and rotate
azoxystrobin	azoxystrobin	11	H ^R	x	x								High Risk, PM and DM resistance known in mid-Atlantic region. Tank mix with FRAC code M fungicides and rotate with other FRAC codes.
Reason	fenamidone	11	H		x								
Cabrio	pyraclostrobin	11	H ^R		x								
Tanos	fomoxadone + cymoxanil	11 + 27	M				x			x			High risk for resistance, tank mix with FRAC code M and rotate
Quintec	quinoxifen	13	H								x		
Ranman	cyazofamid	21	M				x			x			Tank mix with FRAC code M fungicides and rotate with other FRAC codes
Curzate	cymoxanil	27	L-M				x						Tank mix with FRAC code M fungicides; rotate with other FRAC codes
Previcur Flex	propomocarb HCL	28	L-M	x			x						
Forum	dimethomorph	40	L-M				x			x			
Revus	mandipropamid	40	L-M							x			
Zapro	dimethomorph + ametoctradin	40 + 45	M				x			x			Moderate risk, tank mix and rotate
Orondis Ultra	mandipropamid + oxathiapiprolin	40 + 49	M				x			x			
Presidio	fluopicolide	43	H				x			x			Tank mix with FRAC code M fungicides; rotate with other FRAC codes
Vivando	metrafenone	50	M								x		
Torino	cyflufenamid	U6	M								x		

Fungicide resistance management guidelines for MUSKMELON grown in mid-Atlantic region - 2019

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

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off (<i>Pythium</i> &/or <i>Rhizoctonia</i>)	Bacterial diseases	Botrytis leaf blight	Botrytis neck rot	Downy mildew	Purple blotch (<i>Alternaria</i>)	Stemphylium leaf blight	White rot	Fungicide Resistance Management Guidelines
				L	L	H ^R	H	H ^R	L	H ^R	L	
fixed copper	copper	M1	L		x							Low risk, multi-site MOA, use alone, or tank mix with high-risk FRAC codes and rotate with other FRAC codes
mancozeb	mancozeb	M3	L		x			x				
chlorothalonil	chlorothalonil	M5	L			x		x	x	x		
iprodione	iprodione	2	H ^R			x	x		x	x		High risk
tebuconazole	tebuconazole	3	H								x	Rotate with other FRAC codes
Inspire Super	difconazole + cyprodinil	3 + 9	H			x			x	x		High risk, rotate with other FRAC codes
Quilt	propiconazole + azoxystrobin	3 + 11	M-H			x			x	x		Tank mix with FRAC code M fungicide and rotate with other FRAC codes. Check labels for days between applications and days to harvest restrictions. Please check labels and rates. Amounts of active ingredients vary between the different combinations.
Quilt Xcel	propiconazole + azoxystrobin	3 + 11	M-H			x		x	x	x		
Ridomil Gold, Ultra Flourish	mefenoxam	4	H	x								High risk, tank mix and rotate with other FRAC codes
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x								For use at planting; will help control <i>Pythium</i> and <i>Rhizoctonia</i>
Endura	boscalid	7	M			x	x		x	x		Moderate risk, tank mix and rotate
Fontelis	penthiopyrad	7	M			x			x	x		Rotate with other FRAC codes
Luna Tranquility	fluopyram + pyrimethanil	7 + 9	M						x	x		Tank mix and rotate
Pristine	boscalid + pyraclostrobin	7 + 11	H			x			x	x		
Merivon	fluxapyroxad + pyraclostrobin	7 + 11	H			x	x					
Scala	pyrimethanil	9	M			x	x		x	x		Moderate risk, tank mix with FRAC code M fungicide and rotate with other FRAC codes
Switch	cyprodinil + fludioxonil	9 + 12	M			x				x		
azoxystrobin	azoxystrobin	11	H			x			x	x		High risk. Tank mix with FRAC code M fungicides, rotate with other FRAC codes
Reason	fenamidone	11	H					x	x	x		
Cabrio	pyraclostrobin	11	H					x	x	x		
Quadris Opti	azoxystrobin + chlorothalonil	11 + M5	M			x		x	x	x		Rotate with other non-FRAC code 11 fungicides
Pristine	pyraclostrobin + boscalid	11 + 7	H			x			x	x		
Omega	fluazinam	29	L			x	x	x	x	x		Low-risk for resistance development
Zampro	dimethomorph + ametoctradin	40 + 45	M					x				Rotate with other FRAC codes
Orondis Opti	oxathiapiprolin + chlorothalonil	49 + M5	M					x				

Fungicide resistance management guidelines for ONIONS grown in mid-Atlantic region - 2019

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	Damping-off (<i>Pythium</i>)	Damping-off (<i>Rhizoctonia</i>)	Bacterial leaf blight	Septoria leaf spot	Fungicide Resistance Management Guidelines
				L	L	L	L	
fixed copper	copper	M1	L			x	x	Low risk, protectant fungicide, use alone or rotate with a fungicide with high-risk FRAC code
Rhyme	flutriafol	3	M				x	Moderate to high risk, tank mix, rotate FRAC codes
TopGuard	flutriafol + azoxystrobin	3 + 11	M - H				x	
MetaStar	metalaxyl	4	H	x				High risk for resistance development
Ridomil Gold	mefenoxam	4	H	x				
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x	x			For use at seeding; will help control <i>Pythium</i> and <i>Rhizoctonia</i>
Fontelis	penthiopyrad	7	M				x	Moderate to high risk, tank mix, rotate FRAC codes
Merivon	fluxapyroxad + pyraclostrobin	7 + 11	H				x	High risk, tank mix with a protectant fungicide, and rotate with fungicides from other FRAC codes
azoxystrobin	azoxystrobin	11	H		x		x	
Cabrio	pyraclostrobin	11	H				x	

Fungicide resistance management guidelines for PARSLEY grown in mid-Atlantic region - 2019

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	Damping-off (<i>Pythium</i>) & Root rot	Damping-off (<i>Rhizoctonia</i>) & Root rot	Ascochyta blight	Powdery mildew	White mold (<i>Sclerotinia</i>) / Gray mold (<i>Botrytis</i>)	Fungicide Resistance Management Guidelines
				L	L	H ^R	L	M	
sulfur	sulfur	M2	L				x		Low risk, protectant fungicide, use alone or rotate with a fungicide with high-risk FRAC code
Aprovia Top	difenoconazole + benzovindiflupyr	3 + 7	M-H				x		Moderate risk, tank mix and rotate with other FRAC codes
MetaStar	metalaxyl	4	H ^R	x					High risk for resistance development
Ridomil Gold, Ultra Flourish	mefenoxam	4	H ^R	x					
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x	x				For use at planting; will help control <i>Pythium</i> and <i>Rhizoctonia</i>
Endura	boscalid	7	M			x	x	x	Moderate risk, tank mix and rotate with other FRAC codes
Priaxor	fluxapyroxad + pyraclostrobin	7 + 11	H			x	x	x	High risk for resistance development, tank mix and rotate with other FRAC codes
azoxystrobin	azoxystrobin	11	H		x	x			
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 - 2019

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

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off and Root rot (<i>Pythium</i> or <i>Rhizoctonia</i>)	Anthraxnose fruit rot	Bacterial leaf spot	Phytophthora blight (Crown rot phase)	Phytophthora blight (Fruit rot / foliar phase)	Southern blight	Fungicide Resistance Management Guidelines
				L	L	H ^R	H ^R	H ^R	L	
Actigard	acibenzolar-S-methyl	P1	L			x				Plant defense activator
fixed copper	copper	M1	L			x		x		Low risk, protectant fungicides, use alone or tank mix with high-risk fungicides
mancozeb	mancozeb	M3	L		x					
chlorothalonil	chlorothalonil	M5	L		x					
Aprovia Top	difenoconazole + benzovindiflupyr	3 + 7	M-H		x					Rotate with other FRAC codes
Topguard	flutriol + azoxystrobin	3 + 11	H		x					
Quadris Top	difenoconazole + azoxystrobin	3 + 11	H		x					
MetaStar	metalaxyl	4	H ^R				x			Hisk risk, resistance known. Only apply if Phytophthora strains are mefenoxam-sensitive
Ridomil Gold , Ultra Flourish	mefenoxam	4	H ^R				x			
Ridomil Gold Copper	mefenoxam + copper	4 + M1	H-M ^R					x		
Orondis Gold	mefenoxam + oxathiapiprolin	4 + 49	H				x	x		High-risk,rotate with other FRAC codes.
Priaxor	boscalid + pyraclostrobin	7 + 11	H		x					Rotate with other FRAC codes
azoxystrobin	azoxystrobin	11	H	x	x				x	
Cabrio	pyraclostrobin	11	H		x					
Quintec	quinoxifen	13	H			x				Section 2ee, see label
Terraclor	PCNB	14	L-M						x	Use in transplant water
Ranman	cyazofamid	21	M				x	x		Rotate with other FRAC codes
Agri-Mycin, Agri-strep	streptomycin	25	H ^R			x				Greenhouse transplant production use only
Previcur Flex	propomocarb HCL	28	L-M	x						Low risk, tank mix
Forum	dimethomorph	40	L-M					x		Tank mix and rotate with other FRAC codes
Revus	mandipropomid	40	L-M					x		
Zampro	dimethomorph + ametoctradin	40 + 45	M					x		
Presidio	fluopicolide	43	H				x	x		

Fungicide resistance management guidelines for PEPPERS grown in mid-Atlantic region - 2019

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	Early blight	Late blight	Pythium leak	Pink rot (<i>Phytophthora</i>)	Rhizoctonia stem canker	Black scurf (<i>Rhizoctonia</i>)	White mold	Verticillium wilt	Fungicide Resistance Management Guidelines
mancozeb	mancozeb	M3	L	x	x							Protectants, low-risk, use alone or tank mix with high-risk FRAC codes, alternate with other FRAC codes
Polyram	metiram	M3	L	x	x							
Gavel	mancozeb + zoxamide	M3 + 22	L-M		x							
chlorothalonil	chlorothalonil	M5	L	x	x							
Zing!	chlorothalonil + zoxamide	M5 + 22	L-M	x	x							Rotate with other FRAC codes
thiophanate-methyl	thiophanate-methyl	1	H							x		High risk, rotate with other FRAC codes
iprodione	iprodione	2	M-H							x		Moderate to High risk
Quash	metconazole	3	M	x								Tank mix, rotate with other FRAC codes
Ridomil Gold Copper	mefenoxam + copper	4 + M1	M			x	x					Rotate with other FRAC codes and with 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, Ultra Flourish	mefenoxam	4	H ^R			x	x					High-risk, resistance known in Late blight and Pink rot
Platinum Ridomil Gold	mefenoxam + thiamethoxam	4 + 4A	H ^R			x	x					High-risk, includes an insecticide
Moncut	flutolanil	7	L-M					x	x			Low to Moderate risk
Endura	boscalid	7	M-H	x						x		Rotate with other FRAC codes
Luna Tranquility	fluopyram + pyrimethanil	7 + 9	M-H	x								Medium to high-risk, tank mix and rotate
Elatus	benzovindiflupyr + azoxystrobin	7 + 11	M-H					x	x			High-risk for resistance, tank-mix with a protectant (M) fungicide, Do not apply FRAC code 11 fungicides consecutively. Reduced sensitivity has been reported in Early blight control
Priaxor	fluxapyroxad + pyraclostrobin	7 + 11	H	x								
azoxystrobin	azoxystrobin	11	H ^R	x				x	x			
Reason	fenamidone	11	H ^R	x								
Headline	pyraclostrobin	11	H ^R	x								
Gem	trifloxystrobin	11	H ^R	x								
Quadris Opti	azoxystrobin + chlorothalonil	11 + M5	M	x								
Quadris Top	azoxystrobin + difenconazole	11 + 3	H	x								
Tanos	famoxadone + cymoxanil	11 + 27	M-H	x	x							Tank mix with protectant fungicide, rotate with other FRAC codes
Ranman	cyanofamid	21	H		x	x	x					
Curzate	cymoxanil	27	L-M		x							
Previcur Flex	propamocarb HCL	28	L-M		x							
Omega	fluzinam	29	L		x					x		Low-risk for resistance development
Super Tin	triphenyltin hydroxide	30	L-M	x	x							Tank mix with protectant fungicide, rotate with other FRAC codes
Forum	dimethomorph	40	L-M		x							
Revus Top	mandipropamid + difenconazole	40 + 3	L-M	x	x							Rotate with other FRAC codes
Presidio	fluopicolide	43	H		x							Rotate with other FRAC codes
Orondis Opti	oxathiapiprolin + chlorothalonil	49 + M5	H		x							High risk, rotate with other FRAC codes
K-Pam HL, Vapam HL	Na-,K-methyldithiocarbamate	NC									x	Soil fumigants, see labels

Fungicide resistance management guidelines for POTATO grown in mid-Atlantic region - 2019

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

Potato

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off (<i>Pythium</i> & <i>Phytophthora</i>)	Damping-off (<i>Rhizoctonia</i>)	Angular & bacterial leaf spot	Downy mildew	Anthrachnose & gummy stem blight	Phytophthora blight	Plectosporium blight	Powdery mildew	Scab	Fungicide Resistance Management Guidelines
				L	L	L	H ^R	H ^R	H ^R	L	H ^R	H ^R	
Regalia	<i>Reynoutria sachalinensis</i>	P5	L								x		Resistance not known; use with PM specific fungicides
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		
mancozeb	mancozeb	M3	L			x							
Gavel	mancozeb + zoxamide	M3 + 22	L				x						Low risk, rotate with other FRAC codes
chlorothalonil	chlorothalonil	M5	L				x	x		x		x	
Zing!	chlorothalonil + zoxamide	M5 + 22	L				x						
Ariston	chlorothalonil + cymoxanil	M5 + 27	L-M				x						
Rhyme	flutriafol	3	M					x			x		High risk of reduced sensitivity, always tank mix, and alternate with other codes
Rally	myclobutanil	3	M ^R								x		
Proline	prothioconazole	3	M					x			x		
tebuconazole	tebuconazole	3	M					x			x		
Procure	triflumizole	3	M ^R								x		
Aprovia Top	difenconazole + benzovindiflupyr	3 + 7	H					x			x		High risk, rotate with other FRAC codes
Luna Experience	tebuconazole + fluopram	3 + 7	H					x			x		
Inspire Super	difenconazole + cyprodinil	3 + 9	H					x			x		
Quadris Top	difenoconazole + azoxystrobin	3 + 11	H							x			
MetaStar	metalaxyl	4	H ^R	x					x				Hisk risk, resistance known. Only apply if Phytophthora strains are mefenoxam-sensitive
Ridomil Gold, Ultra Flourish	mefenoxam	4	H ^R	x					x				
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x	x				x				For use at planting; will help control Pythium and Rhizoctonia
Orondis Gold	mefenoxam + oxathiapiprolin	4 + 49	H						x				High risk, rotate with other FRAC codes

Fungicide resistance management guidelines for PUMPKIN and WINTER SQUASH crops grown in mid-Atlantic region - 2019

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 & Winter Squash (continued next page)

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off (<i>Pythium</i> & <i>Phytophthora</i>)	Damping-off (<i>Rhizoctonia</i>)	Angular & bacterial leaf spot	Downy mildew	Anthraco-nose & gummy stem blight	Phytophthora blight	Plectosporium blight	Powdery mildew	Scab	Fungicide Resistance Management Guidelines
				L	L	L	H ^R	H ^R	H ^R	L	H ^R	H ^R	
Fontelis	penthiopyrad	7	M					x			x		Moderate risk, tank mix
Pristine	boscalid + pyraclostrobin	7 + 11	H ^R					x		x	x		High risk, rotate with other FRAC codes
Merivon	fluxapyroxad + pyraclostrobin	7 + 11	H					x					
Switch	cyprodinil + fludioxonil	9 + 12	M					x					Tank mix and rotate with other FRAC codes
azoxystrobin	azoxystrobin	11	H		x								High risk, rotate with other FRAC codes
Cabrio	pyraclostrobin	11	H										
Flint	trifloxystrobin	11	H										
Tanos	famoxadone + cymoxanil	11 + 27	M				x		x				Moderate risk, tank mix
Quintec	quinoxifen	13	H								x		Tank mix and rotate with other FRAC codes
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			x		x				
Forum	dimethomorph	40	L-M				x		x				
Revus	mandipropamid	40	L-M						x				
Zampro	dimethomorph + ametoctradin	40 + 45	M				x		x				
Orondis Ultra	dimethomorph + oxathiapiprolin	40 + 49	H				x		x				
Presidio	fluopicolide	43	H				x		x				Tank mix, rotate with other FRAC codes
Vivando	metrafenone	50	M								x		
Torino	cyflufenamid	U6	M								x		Moderate risk, tank mix

Fungicide resistance management guidelines for PUMPKIN and WINTER SQUASH crops grown in mid-Atlantic region - 2019

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 & Winter Squash (continued previous page)

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off (<i>Pythium</i>)	Damping-off (<i>Rhizoctonia</i>)	Downy mildew	Leaf spots & powdery mildew	White rust	Fungicide Resistance Management Guidelines
				L	L	M	L	L	
fixed copper	copper	M1	L			x			Use alone, or tank mix and/or rotate with high-risk fungicides, OMRI options
MetaStar	metalaxyl	4	H	x					High risk for resistance development
Ridomil Gold, Ultra Flourish	mefenoxam	4	H	x					
Ridomil Gold Copper	mefenoxam + copper	4 + M1	M					x	High risk, rotate with other FRAC codes
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x	x				For use at planting; will help control Pythium, Rhizoctonia and early season Downy mildew
Luna Tranquility	fluopyram + pyrimethanil	7 + 9	M-H				x		High risk, tank mix and rotate with other FRAC codes
Merivon	fluxapyroxad + pyraclostrobin	7 + 11	H				x		
azoxystrobin	azoxystrobin	11	H		x		x	x	
Cabrio	pyraclostrobin	11	H				x	x	
Ranman	cyazofamid	21	M			x			Tank mix and rotate with other FRAC codes
Presidio	fluopicolide	43	H	x					Tank mix and rotate with other FRAC codes

Fungicide resistance management guidelines for RADISHES, RUTABAGAS, and TURNIPS grown in mid-Atlantic region - 2019

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

Radish, Rutabaga, and Turnip

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off (<i>Pythium</i>)	Downy mildew (Blue mold)	White rust	Leaf Spots and Anthracnose	Fungicide Resistance Management Guidelines
				L	M ^R	L	L-M	
MetaStar	metalaxyl	4	H ^R	x	x	x		High risk for resistance. At-planting applications for root rot control will also help with early-season downy mildew control
Ridomil Gold, Ultra Flourish	mefenoxam	4	H ^R	x	x	x		
Ridomil Gold Copper	mefenoxam + copper	4 + M1	L		x	x		Rotate with other FRAC codes
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x				For use at planting; will also control Rhizoctonia
Orondis Gold	mefenoxam + oxathiapiprolin	4 + 49	H	x				Rotate with other FRAC codes
Fontelis	penthiopyrad	7	M				x	Moderate risk, tank mix
Merivon	fluxapyroxad + pyraclostrobin	7 + 11	H				x	High risk, tank mix with FRAC code M fungicides and rotate with fungicides from other FRAC codes. FRAC code 11 fungicides should not be applied more than twice before rotating to another FRAC code.
Reason	fenamidone	11	H		x	x		
Cabrio	pyraclostrobin	11	H				x	
Tanos	famoxadone + cymoxanil	11 + 27	M		x	x		
Ranman	cyazofamid	21	M		x	x		Low risk, do not tank mix with copper
Aliette	fosetyl-Al	33	L		x	x		
Presidio	fluopicolide	43	H		x	x		Tank mix and rotate with other FRAC codes

Fungicide resistance management guidelines for SPINACH grown in mid-Atlantic region - 2019

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	Angular leaf spot	Anthrachnose fruit and crown rot	Fungal leaf blight, leaf scorch and leaf spot	Gray mold (Botrytis)	Powdery mildew	Red stele and Phytophthora crown rot	Fungicide Resistance Management Guidelines
				L	H ^R	H ^R	H ^R	H ^R	L	
fixed copper	copper	M1	L	x						Low risk protectants, multi-site MOA, use alone, or tank mix and rotate with high-risk fungicides, OMRI options for copper
Thiram	thiram	M3	L ^R				x			
Captan, Captec	captan	M4	L ^R		x	x	x			
Captevate	captan + fenhexamid	M4 + 17	L		x	x	x			Low risk, no more than 2 consecutive applications
Topsin M	thiophanate-methyl	1	H ^R		x	x				High risk for resistance development
Rovral, Nevado, Meteor	iprodione	2	H ^R			x	x			
Rally	myclobutanil	3	M			x		x		Moderate risk, tank mix, rotate with other FRAC codes
Mettle	tetraconazole	3	M					x		
Procure	triflumizole	3	M					x		
Inspire Super	difenconazole + cyprodinil	3 + 9	H					x		Moderate to high risk, rotate with other FRAC codes
Quadris Top	difenoconazole + azoxystrobin	3 + 11	M-H		x	x				
Quilt Xcel	propiconazole + azoxystrobin	3 + 11	M-H		x	x				
MetaStar	metalaxyl	4	H ^R						x	High risk for resistance development, Can be applied as spray or through drip irrigation
Ultra Flourish, Ridomil Gold	mefenoxam	4	H ^R						x	
Luna Privilege	fluopyram	7	M				x	x		Moderate risk, tank mix, rotate with other FRAC codes
Kenja	isofetamid	7	M				x	x		
Fontelis	penthiopyrad	7	M				x	x		
Luna Tranquility	fluopyram + pyrimethanil	7 + 9	M				x	x		
Pristine	boscalid + pyraclostrobin	7 + 11	M		x	x		x		
Luna Sensation	fluopyram + trifloxystrobin	7 + 11	M		x		x	x		
Merivon	pyraclostrobin + fluxapyroxad	7 + 11	M		x	x	x	x		
Switch	cyprodinil + fludioxonil	9 + 12	M		x		x			Moderate risk, tank mix and rotate with other FRAC codes
azoxystrobin	azoxystrobin	11	H ^R		x					High risk, tank mix and rotate with other FRAC codes, resistance reported
AfterShock, Evito	fluoxastrobin	11	H ^R		x					
Cabrio	pyraclostrobin	11	H ^R		x	x		x		
Quintec	quinoxifen	13	H					x		Tank mix and rotate with other FRAC codes
Elevate	fenhexamid	17	L				x			Low risk, rotate with other FRAC codes
Aliette	fosetyl-al	33	L						x	Low risk, use as pre-plant dip or spray application, see label
K-Phite, Prophyt, Rampart, Phostrol	phosphite salts	33	L						x	Low risk, see label
Torino	cyflufenamid	U6	M					x		Moderate risk, tank mix

Fungicide resistance management guidelines for STRAWBERRIES grown in mid-Atlantic region - 2019

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 (<i>Pythium</i> &/or <i>Phytophthora</i>)	Damping-off (<i>Rhizoctonia</i>)	Downy mildew	Phytophthora Crown and Fruit Rot	Plectosporium blight	Powdery mildew	Scab	Fungicide Resistance Management Guidelines
				L	L	H ^R	H ^R	L	H ^R	H ^R	
Regalia	<i>Reynoutria sachalinensis</i>	P5	L						x		Resistance not known; use with PM specific fungicides
mancozeb	mancozeb	M3	L					x			Multi-site MOA, use alone, or in tank mix with high risk fungicides and in rotations with other FRAC codes
Gavel	mancozeb + zoxamide	M3 + 22	L-M			x	x				
chlorothalonil	chlorothalonil	M5	L					x		x	
Zing!	chlorothalonil + zoxamide	M5 + 22	L-M			x					
Ariston	chlorothalonil + cymoxanil	M5 + 27	L-M			x					
Rhyme	futriafol	3	M						x		Moderate risk, tank mix with a FRAC code M fungicides and rotate with other FRAC codes
Rally	myclobutanil	3	M ^R						x		
Proline	prothioconazole	3	M						x		
tebuconazole	tebuconazole	3	M						x		
Procure	triflumizole	3	M ^R						x		
Aprovia Top	difenconazole + benzovindiflupyr	3 + 7	H						x		High risk, tank mix and rotate with other FRAC codes
Luna Experience	tebuconazole + fluopyram	3 + 7	H						x		
Inspire Super	difenconazole + cyprodinil	3 + 9	H						x		
Quadris Top	difenoconazole + azoxystrobin	3 + 11	H					x			

Fungicide resistance management guidelines for SUMMER SQUASH crops grown in mid-Atlantic region - 2019

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

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off (Pythium &/or Phytophthora)	Damping-off (Rhizoctonia)	Downy mildew	Phytophthora Crown and Fruit Rot	Plectosporium blight	Powdery mildew	Scab	Fungicide Resistance Management Guidelines
				L	L	H ^R	H ^R	L	H ^R	H ^R	
MetaStar	metalaxyl	4	H ^R	x			x				Hisk risk, resistance known. Only apply if Phytophthora strains are mefenoxam-sensitive
Ridomil Gold, Ultra Flourish	mefenoxam	4	H ^R	x			x				
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x	x		x				For use at planting; will help control Pythium and Rhizoctonia
Orondis Gold	mefenoxam + oxathiapiprolin	4 + 49	H				x				Moderate to high risk, tank mix and rotate with other FRAC codes
Fontelis	penthiopyrad	7	M						x		
Pristine	boscalid + pyraclostrobin	7 + 11	H ^R					x	x		
azoxystrobin	azoxystrobin	11	H ^R		x						
Tanos	famoxadone + cymoxanil	11 + 27	M			x	x				Tank mix with FRAC code M fungicide and rotate, do not tank mix with copper
Ranman	cyazofamid	21	M			x	x				
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	propomocarb HCL	28	L-M	x	x	x	x				
Forum	dimethomorph	40	L-M			x	x				
Revus	mandipropamid	40	L-M				x				
Zampro	dimethomorph + ametoctradin	40 + 45	M			x	x				
Orondis Ultra	mandipropamid + oxathiapiprolin	40 + 49	M			x	x				
Presidio	fluopicolide	43	H			x	x				
Vivando	metrafenone	50	M						x		
Torino	cyflufenamid	U6	M						x		

Fungicide resistance management guidelines for SUMMER SQUASH crops grown in mid-Atlantic region - 2019

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

Summer Squash (continued previous page)

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Leaf blights and spots	Common and southern rust	Fungicide Resistance Management Guidelines
				L	L	
mancozeb	mancozeb	M3	L	x		Multi-site MOA, use alone, or in tank mix with high risk fungicides and in rotations with other FRAC codes
chlorothalonil	chlorothalonil	M5	L	x		
Prosaro	tebuconazole + prothioconazole	3 + 3	M	x	x	Tank mix with FRAC code M fungicide and rotate with other FRAC codes. Check labels for days between applications and days to harvest restrictions
propiconazole	propiconazole	3	M	x		
Trivapro A+B	propiconazole + benzovindiflupyr + azoxystrobin	3 + 7 + 11	M-H	x	x	Rotate with other FRAC codes
Headline AMP	metconazole + pyraclostrobin	3 + 11	M-H	x	x	Tank mix with FRAC code M fungicide and rotate with other FRAC codes. Check labels for days between applications and days to harvest restrictions. Please check labels and rates. Amounts of active ingredients vary between the different combinations.
Quilt Xcel	propiconazole + azoxystrobin	3 + 11	M-H	x	x	
Stratego	propiconazole + trifloxystrobin	3 + 11	M-H	x	x	
Stratego YLD	prothioconazole + trifloxystrobin	3 + 11	M-H	x	x	
Priaxor	fluxapyroxad + pyraclostrobin	7 + 11	M-H	x	x	No more than 2 applications per season, rotate with other FRAC codes
azoxystrobin	azoxystrobin	11	H	x		Tank mix with FRAC code M fungicide and rotate with other FRAC codes. Check labels for days between applications and days to harvest restrictions
Approach	picoxystrobin	11	H	x		
Headline	pyraclostrobin	11	H	x		

Fungicide resistance management guidelines for SWEET CORN grown in mid-Atlantic region - 2019

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	Damping-off (<i>Pythium</i>)	Bacterial Canker	Bacterial spot and speck	Botrytis fruit rot (Gray mold)	Buckeye rot/fruit rot	Late blight	Leaf mold (<i>Passalora</i>)	Early blight and Septoria leaf spot	Anthracoise & Alternaria fruit rots	Powdery mildew	Southern Blight	Fungicide Resistance Management Guidelines
				L	L	H ^R	H ^R	L	H ^R	L	H ^R / L	L	H ^R	L	
Actigard	acibenzolar-s-methyl	P1	L		X	X									No more than 6 applications per season, see label
fixed copper(s)	copper	M1	L		X	X									
ManKocide	copper + mancozeb	M1 + M3	L			X									Low risk protectant fungicides. Use alone, or tank mix with high risk fungicides and rotate, OMRI-approved coppers available
mancozeb	mancozeb	M3	L			X			X		X	X			
Gavel	mancozeb + zoxamide	M3 + 22	L-M					X	X		X	X			
chlorothalonil	chlorothalonil	M5	L				X		X		X	X			
Zing!	chlorothalonil + zoxamide	M5 + 22	L-M						X		X	X			
Rally	myclobutanil	3	M										X		Tank mix, rotate with other FRAC codes
Aprovia Top	difenoconazole + benzovindiflupyr	3 + 7	M-H								X	X	X		Rotate with other FRAC codes
Inspire Super	difenoconazole + cyprodinil	3 + 9	H								X	X	X		
Quadris Top	difenoconazole + azoxystrobin	3 + 11	H								X	X			
Revus Top	difenoconazole + mandipropamid	3 + 40	M-H						X	X	X	X	X		
MetaStar	metalaxyl	4	H ^R	X											High risk, resistance known
Ridomil Gold, Ultra Flourish	mefenoxam	4	H ^R	X				X							
Ridomil Gold Copper	mefenoxam + copper	4 + M1	M					X							Moderate risk, rotate with other FRAC codes
Ridomil Gold Bravo, Flouronil	mefenoxam + chlorothalonil	4 + M5	M					X							

Fungicide resistance management guidelines for FIELD-GROWN TOMATOES in mid-Atlantic region - 2019

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

Fungicide	Active Ingredient(s)	FRAC CODE	Resistance Risk	Damping-off (<i>Pythium</i>)	Bacterial Canker	Bacterial spot and speck	Botrytis fruit rot (Gray mold)	Buckeye rot/fruit rot	Late blight	Leaf mold (<i>Passalora</i>)	Early blight and Septoria leaf spot	Anthracnose & Alternaria fruit rots	Powdery mildew	Southern Blight	Fungicide Resistance Management Guidelines
				L	L	H ^R	H ^R	L	H ^R	L	H ^R / L	L	H ^R	L	
Endura	boscalid	7	M				x				x	x			Tank mix, rotate with other FRAC codes
Fontelis	penthiopyrad	7	M								x	x			
Priaxor	fluxapyroxad + pyraclostrobin	7 + 11	H								x	x			
Switch	cyprodinil + fludioxonil	9 + 12	M				x								Rotate with other FRAC codes
azoxystrobin	azoxystrobin	11	H								x	x			
Reason	fenamidone	11	H						x						
Cabrio	pyraclostrobin	11	H								x	x	x		High risk, tank-mix with protectants; rotate with other non-FRAC code 11 fungicides
Flint	trifloxystrobin	11	H								x	x			
Tanos	famoxadone + cymoxanil	11 + 27	H					x	x		x	x			
Quintec	quinoxifen	13	H										x		Tank mix, rotate with other FRAC codes
Blocker	PCNB	14	L-M											x	See label
Ranman	cyazofamid	21	M-H						x						Tank mix with a protectant, rotate with other FRAC codes
Curzate	cymoxanil	27	L-M						x						
Previcur Flex	Propamocarb HCL	28	L-M						x						
Aliette	fosetyl-al	33	L	x											
Forum	dimethomorph	40	L-M						x						
Presidio	fluopicolide	43	H						x						

Fungicide resistance management guidelines for FIELD-GROWN TOMATOES in mid-Atlantic region - 2019

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

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off (<i>Pythium</i> , <i>Phytophthora</i> &/or	Alternaria leaf blight	Angular leaf spot	Anthrachnose	Bacterial fruit blotch	Downy mildew	Fusarium wilt	Gummy stem blight	Phytophthora Crown and Fruit Rot	Powdery mildew	Fungicide Resistance Management Guidelines
				L	L	L	L	L	H ^R	L	H ^R	H ^R	H ^R	
Actigard	acibenzolar-S-methyl	P1	L					x						Plant defense activator, low-risk, rotate with other FRAC codes
Regalia	<i>Reynoutria sachalinensis</i>	P5	L										x	Resistance not known; use with PM specific fungicides
fixed copper	copper	M1	L			x		x				x		Multi-site MOA, use alone, or in tank mix with high risk fungicides and in rotations with other FRAC codes, OMRI-approved coppers available
mancozeb	mancozeb	M3	L		x	x								
Gavel	mancozeb + zoxamide	M3 + 22	L-M						x			x		
chlorothalonil	chlorothalonil	M5	L		x		x				x			
Zing!	chlorothalonil + zoxamide	M5 + 22	L-M						x					Rotate with other FRAC codes
Ariston	chlorothalonil + cymoxanil	M5 + 27	L-M						x					Rotate with other FRAC codes
thiophanate-methyl	thiophanate-methyl	1	H				x							High risk for resistance development
Rhyme	futriafol	3	M								x		x	High risk, tank mix, and rotate with other FRAC codes
Rally	myclobutanil	3	M ^R										x	
Proline	prothioconazole	3	M							x	x		x	
tebuconazole	tebuconazole	3	M								x		x	
Procure	triflumizole	3	M ^R										x	
Aprovia Top	difenconazole + benzovindiflupyr	3 + 7	M-H		x						x		x	Rotate with other FRAC codes
Luna Experience	tebuconazole + fluopram	3 + 7	M								x		x	High risk, rotate with other FRAC codes
Inspire Super	difenconazole + cyprodinil	3 + 9	H		x						x			
Quadris Top	difenoconazole + azoxystrobin	3 + 11	H		x		x							
TopGuard	flutriafol + azoxystrobin	3 + 11	H		x		x							
MetaStar	metalaxyl	4	H ^R	x										High risk, Mefenoxam resistance known in mid-Atlantic region
Ridomil Gold, Ultra Flourish	mefenoxam	4	H ^R	x										
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x										For use at planting; will help control Pythium and Rhizoctonia

Fungicide resistance management guidelines for WATERMELON grown in mid-Atlantic region - 2019
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

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off (<i>Pythium</i> , <i>Phytophthora</i> &/or	Alternaria leaf blight	Angular leaf spot	Anthracnose	Bacterial fruit blotch	Downy mildew	Fusarium wilt	Gummy stem blight	Phytophthora Crown and Fruit Rot	Powdery mildew	Fungicide Resistance Management Guidelines
				L	L	L	L	L	H ^R	L	H ^R	H ^R	H ^R	
Fontelis	penthiopyrad	7	M								x		x	Moderate risk, tank mix, rotate FRAC codes
Pristine	boscalid + pyraclostrobin	7 + 11	H		x		x				x			High risk, rotate with other FRAC codes
Luna Sensation	fluopyram + trifloxystrobin	7 + 11	H		x								x	
Merivon	fluxapyroxad + pyraclostrobin	7 + 11	H		x		x				x			
Switch	cyprodinil + fludioxonil	9 + 12	M								x			Moderate risk, tank mix and rotate with other FRAC codes
azoxystrobin	azoxystrobin	11	H	x	x		x							High Risk, PM and DM resistance detected in mid-Atlantic region. Tank mix with FRAC code M fungicides and rotate with other FRAC codes
Reason	fenamidone	11	H		x									
Cabrio	pyraclostrobin	11	H		x		x							
Tanos	fomoxadone + cymoxanil	11 + 27	M						x			x		
Quintec	quinoxyfen	13	H										x	Medium to high risk for resistance, always tank mix with a FRAC code M fungicide, rotate with other FRAC codes
Ranman	cyazofamid	21	M						x			x		
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	propomocarb HCL	28	L-M	x					x					
Forum	dimethomorph	40	L-M						x			x		
Revus	mandipropamid	40	L-M									x		
Zampro	dimethomorph + ametoctradin	40 + 45	M						x			x		
Orondis Ultra	dimethomorph + oxathiapiprolin	40 + 49	H						x			x		
Presidio	fluopicolide	43	H						x			x		Moderate risk, tank mix
Vivando	metrafenone	50	M										x	
Torino	cyflufenamid	U6	M										x	Moderate risk, tank mix

Fungicide resistance management guidelines for WATERMELON grown in mid-Atlantic region - 2019

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 (continued previous page)

2019 Fungicide Application Schedules

Crop:	Applications									
	1	2	3	4	5	6	7	8	9	10
Date										
Farm/Block										
FRAC code										
Chemical										
Rate(s)										
Sprayed for:										

Notes:

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2019 Fungicide Application Schedules

Crop: Pumpkin	Example Cucurbit Fungicide Application Schedules										Notes: _____
	1	2	3	4	5	6	7	8	9	10	
Date	15-Jul	22-Jul	31-Jul	7-Aug	14-Aug	23-Aug	1-Sep	8-Sep	18-Sep		
Farm/Block	RAREC	RAREC	RAREC	RAREC	RAREC	RAREC	RAREC	RAREC	RAREC		
FRAC code	M5 + M1	M5	M5+M3	M5+3	4+M5	11+7	M5+3	M5+M1	M5		
Chemical	Bravo+S	Bravo	Bravo+copper	Bravo+Rally	Bravo	Pristine	Bravo+Rally	Bravo+S	Bravo		
Rate(s)	2pt+2lb	3 pt	2pt ea	2 pt + 5 oz	2 lb	15 oz	2 pt + 5 oz	2pt+2 lb	3 pt		
Sprayed for:	PM	PM	PM,ALS	PM	PM	PM	PM	PM	PM		

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