Fungicide Resistance Management Guidelines for Vegetable Crops Grown in the mid-Atlantic region - 2014

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Photo cover: Bacterial wilt of cucumber (left) (photo by K. Everts) and bacterial leaf spot on infected strawberry leaf (right) (photo by P. Nitzsche)

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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

We are happy to distribute the 8th Edition of this guide. Since 2007, over 20,000 FRAC guides have been distributed in the mid-Atlantic and surrounding region representing over 100,000 A of vegetable production.

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 68 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 2014 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 2014 Commercial Vegetable Productions Recommendations Guide for your state.

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.

How to use this fungicide resistance management guide

This guide contains FRAC tables for the crop groups listed in the 2014 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 2014 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, 26 labeled fungicides that include 19 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).

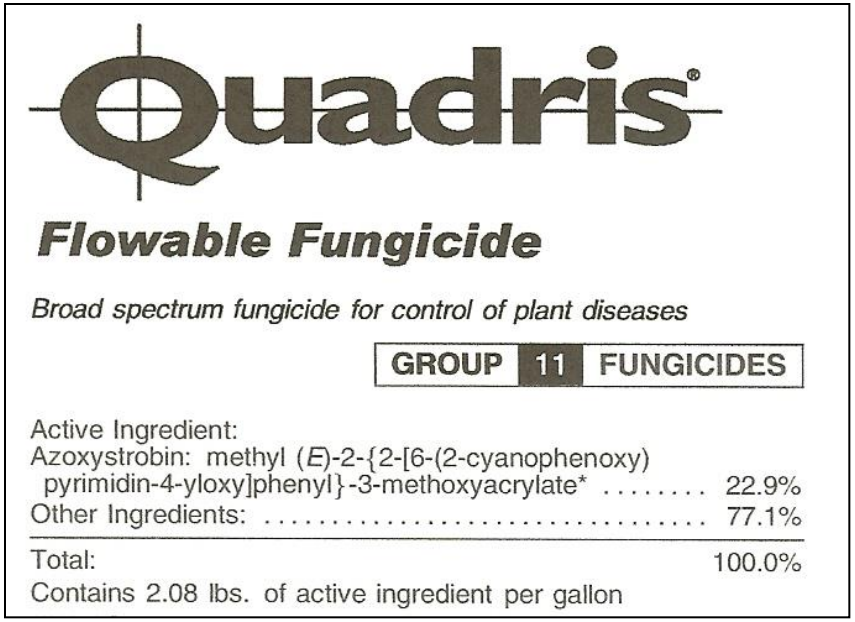


Figure 1. Front of Quadris™ label with FRAC code listed below tradename.

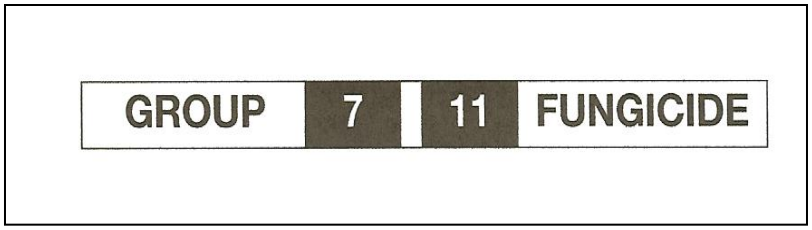
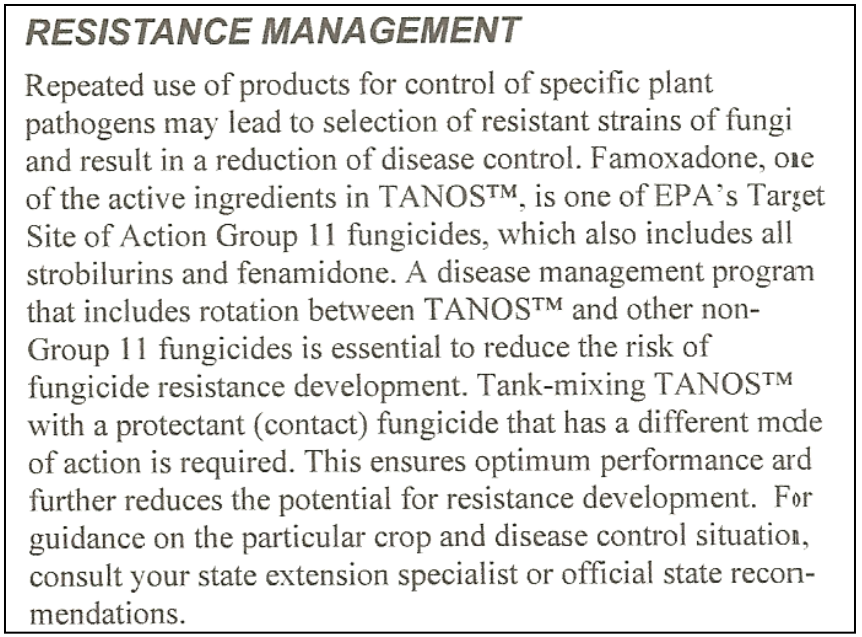


Figure 2. FRAC codes for Pristine™ containing the two active ingredients: boscalid (FRAC code 7) + pyraclostrobin (FRAC code 11)

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	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 with high risk FRAC codes. Rotate with other FRAC codes
chlorothalonil	chlorothalonil	M5	L		x	x	
Folicur	tebaconozole	3	M			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			
Quadris	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 - 2014

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	Anthracnose	Web blight (*Rhizoctonia*)	Cottony leak (Pythium blight)	Bacterial blight	Bacterial brown spot	Common bean rust	Root rots	Lima bean downy mildew	Lima bean pod blight	Gray mold	White mold (*Sclerotinia*)	Southern blight	Fungicide Resistance Management Guidelines
				L	H^R	L	L	L	L	L	M	L	H^R	M	L	
fixed copper	copper	M1	L				x	x			x					Multi-site protectant MOA, use alone or in tank mix with high risk fungicides and in rotations with other FRAC codes
Cueva	copper octanoate	M1	L				x	x								
chlorothalonil	chlorothalonil	M5	L						x[b]							
thiophanate-methyl	thiophanate-methyl	1	H										x[a]	x[a]		High risk, always tank mix with other FRAC codes, apply no more than 4 lbs per crop season
iprodione	iprodione	2	M-H										x[b]	x[b]		
Folicur	tebuconazole	3	M						x							High risk, always tank mix and rotate with other FRAC codes.
Rally	myclobutanil	3	M						x[b]							
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 Pythium and Rhizoctonia
Endura	boscalid	7	M										x[a]	x[a]		No more than 2 applications per season, rotate with other FRAC codes
Fontelis	penthiopyrad	7	M						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
Switch	cyprodinil + fludioxonil	9 + 12	M										x	x		Tank mix and rotate with 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					
Quilt Xcel	azoxystrobin + propiconazole	11 + 3	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.
Omega	fluazinam	29	L										x	x		Low risk, rotate with other FRAC codes
Prophyt, K-Phite, Rampart, Phostrol	phosphorous acids	33	L			x					x					Low risk for resistance, see labels
Forum	dimethomorph	40	L-M								x	x				Tank mix and rotate with other FRAC codes
Contans	*Coniothyrium minitans*	bio	L											x		Low risk biological control, consult label

Fungicide resistance management guidelines for beans grown in the mid-Atlantic region - 2014

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]Use Endura + thiophanate-methyl for snap beans only

[b]Snap bean only

Beans

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off (*Pythium*)	Cercospora leaf spot and other foliar diseases	Pocket rot (*Rhizoctonia*)	Fungicide Resistance Management Guidelines
				L	M	L	
fixed copper	copper	M1	L		x		Multi-site MOA, low risk protectant, see label
Folicur	tebuconazole	3	M		x		High risk, always tank mix and rotate with other FRAC codes.
Tilt	propiconazole	3	H		x		
MetaStar	metalaxyl	4	H	x			High risk, for control of damping-off caused by Pythium
Ridomil Gold	mefenoxam	4	H	x			
Ultra Flourish	mefenoxam	4	H	x			
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x		x	For use at planting; will help control Pythium and Rhizoctonia
Fontelis	penthiopyrad	7	M		x		
Reason	fenamidone	11	H^R		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
Gem	trifloxystrobin	11	H^R		x		
Headline	pyraclostrobin	11	H		x		High risk, Rotate with 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 - 2014

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	Bacterial Blight	Alternaria leaf blight	Cercospora leaf blight	Powdery mildew	White mold (*Sclerotinia*)	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 with high risk FRAC codes and in rotations with other FRAC codes
chlorothalonil	chlorothalonil	M5	L			x	x	x			Multi-site MOA, use alone, or in tank mix with high risk FRAC codes and in rotations 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
Ridomil Gold	mefenoxam	4	H^R	x							Hisk risk for resistance development
Ultra Flourish	mefenoxam	4	H^R	x							
Fontelis	penthiopyrad	7	M			x	x				Moderate risk, tank mix
Endura	boscalid	7	M			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				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			
Pristine	pyraclostrobin + boscalid	11 + 7	H			x	x	x			
Contans	*Coniothyrium minitans*	bio	L						x		Low risk biological control, consult label

Fungicide resistance management guidelines for carrots grown in mid-Atlantic region - 2014

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 (*Pythium*)	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			Low-risk, No more than 4 applications per season
fixed copper	copper	M1	L		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.
chlorothalonil	chlorothalonil	M5	L					x		x	
iprodione	iprodione	2	M-H			x[a]					Moderate to high-risk, No more than 2 application per crop
MetaStar	metalaxyl	4	H	x							High risk, rotate with other FRAC codes
Ridomil Gold	mefenoxam	4	H	x							High risk, rotate with other FRAC codes
Ridomil Gold Bravo	mefenoxam + chlorothalonil	4 + M5	H							x	High risk, rotate with other FRAC codes
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x							For use at planting; will help control Pythium and Rhizoctonia
Endura	boscalid	7	M						x	x	Moderate risk, tank mix and rotate
Fontelis	penthiopyrad	7	M						x	x	No more than 2 sequential applications, rotate with other FRAC codes
Switch	cyprodinil + fludioxonil	9 + 12	M							x	Moderate risk, tank mix and rotate
Quadris	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	
Terraclor	pentachloronitrobenzene	14	L-M				x				Low to moderate
Ranman	cyazofamid	21	M				x				Moderate risk, tank mix
Aliette	aluminum tris	33	L					x			Low risk, do not tank mix with copper
Revus	mandipropamid	40	M					x			Tank mix with protectant fungicide, rotate with other FRAC codes
Presidio	fluopicolide	43	H					x			Rotate with other FRAC codes
Zampro	ametoctradin + dimethomorph	45 + 40	M					x			Moderate risk, tank mix
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 - 2014

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

[a] For use on broccoli only
[b] Also for Alternaria leaf blight

Cole Crops

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	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 with high risk fungicides and in rotations with other FRAC codes
Mancozeb	mancozeb	M3	L		x			x		x	x		x	
Gavel	zoxamide + mancozeb	M3 + 22	L-M						x				x	
chlorothalonil	chlorothalonil	M5	L					x		x	x	x	x	
Topsin M	thiophanate-methyl	1	H							x				High risk, tank mix, rotate
Folicur	tebuconazole	3	M^R								x	x		High risk, always tank mix, and rotate with other FRAC codes
Rally	myclobutanil	3	M^R									x		
Procure	triflumizole	3	M^R									x		
Inspire Super	difenconazole + cyprodinil	3 + 9	H							x	x	x		High risk, rotate with other FRAC codes
MetaStar	metalaxyl	4	H^R	x										Hisk risk, resistance known. 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
Switch	cyprodinil + fludioxonil	9 + 12	M								x			Moderate risk, tank mix and rotate
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			
Quadris Top	azoxystrobin + difenconazole	11 + 3	H							x				
Pristine	pyraclostrobin + boscalid	11 + 7	H^R							x	x	x		
Tanos	fomoxadone + cymoxanil	11 + 27	M						x	x			x	
Ranman	cyazofamid	21	M						x				x	Moderate risk, tank mix
Curzate	cymoxanil	27	L-M										x	Moderate risk, tank mix
Previcur Flex	propomocarb HCL	28	L-M										x	Low risk, tank mix
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					
Presidio	fluopicolide	43	H						x				x	
Zampro	ametoctradin + dimethomorph	45 + 40	M						x				x	Moderate risk, tank mix
Torino	cyflufenamid	U6	M									x		Moderate risk, tank mix

Fungicide resistance management guidelines for cucumber grown in the mid-Atlantic region - 2014

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 and 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 with high risk FRAC codes and in rotation with 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 with other FRAC codes
Ultra Flourish	mefenoxam	4	H^R	x			
Quadris	azoxystrobin	11	H			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	
Flint	trifloxystrobin	11	H			x	
Quadris Top	azoxystrobin + difenconazole	11 + 3	H			x	High risk, rotate with other FRAC codes
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		Tank mix and rotate with other FRAC codes

Fungicide resistance management guidelines for eggplant grown in mid-Atlantic region - 2014

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	White rot	Botrytis leaf blight (Blast)	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 with high risk FRAC codes and in rotations with other FRAC codes
iprodione	iprodione	2	M-H		x				Moderate to high-risk, No more than 2 application per crop
Folicur	tebuconazole	3	M		x		x		Medium risk, tank mix, rotate with other FRAC codes
Inspire Super	difenconazole + cyprodinil	3 + 9	H			x	x		High-risk, rotate with other FRAC codes
Ridomil Gold	mefenoxam	4	H	x[a]					High risk for resistance
Ultra Flourish	mefenoxam	4	H	x[a]					
MetaStar	metalaxyl	4	H	x[a]					
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x[ab]					For use at planting; will help control Pythium and Rhizoctonia
Endura	boscalid	7	M			x	x		Moderate risk, tank mix and rotate with other FRAC codes
Quilt	azoxystrobin + propiconazole	11 + 3	M-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. Please check labels and rates. Amounts of active ingredients vary between the different combinations.
Quilt Xcel	azoxystrobin + propiconazole	11 + 3	M-H			x	x	x	
Quadris	azoxystrobin	11	H	x[b]			x	x	High-risk, rotate and tank mix with 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	
Cannonball	fludioxonil	12	M		x				For use at planting
Forum	dimethomorph	40	M					x	Tank mix and rotate with other FRAC codes

Fungicide resistance management guidelines for garlic grown in mid-Atlantic region - 2014

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] for *Pythium*
[b] for *Rhizoctonia*

Garlic

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off	Downy mildew	Leaf spots	Fungicide Resistance Management Guidelines
				L	M	M	
fixed copper	copper	M1	L		x	x	Multi-site MOA, use alone, or tank mix with high risk FRAC codes
Folicur	tebuconazole	3	M			x	Tank mix and rotate with other FRAC codes
Ridomil Gold	mefenoxam	4	H	x[a]			High risk
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x			For use at planting; will help control Pythium and Rhizoctonia
Fontelis	penthiopyrad	7	M			x	No more than 2 sequential applications, rotate with other FRAC codes
Switch	cyprodinil + fludioxonil	9 + 12	M			x	Rotate with other FRAC codes
Quadris	azoxystrobin	11	H	x	x	x	High risk, tank mix and/or rotate with a FRAC code M fungicide.
Cabrio	pyracolstrobin	11	H		x	x	
Aliette	aluminum tris	33	L		x[b]		Low risk, do not tank mix with copper
Forum	dimethomorph	40	M		x		Tank mix and rotate with other FRAC codes

Fungicide resistance management guidelines for greens grown in mid-Atlantic region - 2014

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

[a] for Turnip Greens Only
[b] for Mustard Greens Only

Greens

Fungicide	Active Ingredient(s)	FRAC code	Risk Management	Damping-off caused by Pythium, Rhizoctonia, Phytophthora	Bacterial spot	Fungal leaf molds and spots	Late blight	Botrytis	Powdery mildew	Downy mildew	White mold	Fungicide Resistance Management Guidelines
				L	H^R	L-M	H^R	H^R	H^R	H^R	M	
Champ, Champion*, Cuprofix Disperss, Kocide, Camelot	copper hydroxide, copper sulfate, copper salts	M1	H^R		x	x		x		x		Protectant, low risk, see labels for details
sulfur*	sulfur	M2	L						x			Protectant, use low rate
Mancozeb, Dithane	EBDC	M3	L	x		x						Protectant, low risk
Fontelis	penthiopyrad	7	M			x			x		x	Medium risk
Pageant	pyraclastrobin + boscalid	7 + 11	M - H					x				
Scala	pyrimethanil	9	M -H			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			x	For Botrytis stem canker; low to medium risk
Decree	fenhexamid	17	L					x				Low risk
Ranman	cyazofamid	21	M	x						x		Low to medium risk
Agri-mycin 17	streptomycin sulfate	25	H	x	x							Low risk
Previcur Flex	propamocarb HCL	28	L-M	x								Low to medium risk
Micora	mandipropamid	40	L-M	x			x			x		
Contans*	*Coniothyrium minitans*	Bio	L								x	Biological control agents, refer to label for rates and application specificities
Companion	*Bacillus subtillus*	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		x				
Surround	kaolin clay	NC	NC						x			Forms a white clay film
Zerotol*, Oxidate*	hydrogen dioxide	NC	NC	x		x			x	x		Contact disinfestant, no residual activity
M-Pede	potassium salts	NC	NC						x			
Armicarb, Kaligreen, Milstop*	potassium bicarbonate	NC	NC			x			x			
Ultra fine oils*	horticultural oils	NC	NC						x			Use low rates, see labels

Fungicide resistance management guidelines for selected vegetable crops grown in high tunnels and greenhouses in mid-Atlantic region - 2014

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	Damping off	Purple blotch	Downy mildew	White rot	Fungicide Resistance Management Guidelines
				L	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
Inspire Super	difenconazole + cyprodinil	3 + 9	H		x			High-risk, rotate with other FRAC codes
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x				For use at planting; will help control Pythium and Rhizoctonia
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 - 2014

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	Downy mildew	Leaf spots	Bottom rot (*Rhizoctonia*)	Lettuce drop (*Sclerotinia*)	Gray mold (*Botrytis*)	Fungicide Resistance Management Guidelines
				L	M^R	L	L	M	H^R	
iprodione	iprodione	2	$M\text{-}H^R$				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					
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x			x			For use at planting; will help control Pythium and Rhizoctonia
Fontelis	penthiopyrad	7	M			x				Moderate risk, tank mix
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
Reason	fenamidone	11	H		x					
Cannonball	fludioxonil	12	H					x	x	Tank mix and rotate
Botran	dichloran	14	$L\text{-}M^R$						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
Forum	dimethomorph	40	L-M		x					Tank mix and rotate, do not apply consecutive applications
Revus	mandipropamid	40	H		x					
Zampro	ametoctradin + dimethomorph	45 + 40	M		X					Moderate risk, tank mix
Contans	*Coniothyrium minitans*	bio	L					x		Low risk biological control, consult label

Fungicide resistance management guidelines for lettuce grown in mid-Atlantic region - 2014

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 (*Pythium*)	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 with high risk fungcides and in rotations with 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, always tank mix with FRAC code M fungicides, and rotate with other FRAC codes
Folicur	tebuconazole	3	M					x	x		
Procure	triflumizole	3	M^R						x		
Inspire Super	difenconazole + cyprodinil	3 + 9	H		x			x	x		High risk, rotate with other FRAC codes
MetaStar	metalaxyl	4	H	x							High risk, mefenoxam-insensitivity in Phytophthora 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 Pythium and Rhizoctonia
Fontelis	penthiopyrad	7	M						x		Moderate risk, tank mix
Switch	cyprodinil + fludioxonil	9 + 12	M					x			Moderate risk, tank mix and rotate
Quadris	azoxystrobin	11	H^R		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.
Cabrio	pyraclostrobin	11	H^R		x						
Reason	fenamidone	11	H		x						
Pristine	pyraclostrobin + boscalid	11 + 7	H^R		x			x	x		
Tanos	fomoxadone + cymoxanil	11 + 27	M				x			x	
Quadris Top	azoxystrobin + difenconazole	11 + 3	H		x						
Quintec	quinoxyfen	13	H						x		High risk for resistance, tank mix with FRAC code M and rotate
Ranman	cyazofamid	21	M				x			x	Tank mix with FRAC code M fungicides and rotate with other
Gavel	zoxamide + mancozeb	22 + M3	L-M				x			x	Low to moderate risk, 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	
Forum	dimethomorph	40	L-M				x			x	
Revus	mandipropamid	40	L-M				x				
Presidio	fluopicolide	43	H				x			x	
Zampro	ametoctradin + dimethomorph	45 + 40	M				x			x	Moderate risk, tank mix
Torino	cyflufenamid	U6	M						x		Moderate risk, tank mix

Fungicide resistance management guidelines for muskmelon grown in mid-Atlantic region - 2014

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

Muskmelon

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Bacterial disease	Damping-off (*Pythium*)	Neck rot	Downy mildew	Purple blotch (*Alternaria*)	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								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	x	x			
chlorothalonil	chlorothalonil	M5	L					x	x			
iprodione	iprodione	2	H^R			x		x	x	x		High risk
Folicur	tebuconozole	3	H								x	Rotate with other FRAC codes
Inspire Super	difenconazole + cyprodinil	3 + 9	H						x			High risk, rotate with other FRAC codes
Ridomil Gold	mefenoxam	4	H		x							High risk
Uniform	mefenoxam + azoxystrobin	4 + 11	H		x							For use at planting; will help control Pythium and Rhizoctonia
Endura	boscalid	7	M					x	x			Moderate risk, tank mix and rotate
Scala	pyrimethanil	9	M						x			Tank Mix and rotate
Switch	cyprodinil + fludioxonil	9 + 12	M						x	x		Moderate risk, tank mix with FRAC code M fungicide and rotate with other FRAC codes
Quadris	azoxystrobin	11	H				x	x	x			High risk. Tank mix with FRAC code M fungicides, rotate with other FRAC codes
Cabrio	pyraclostrobin	11	H				x			x		
Reason	fenamidone	11	H				x	x				
Quilt	azoxystrobin + propiconazole	11 + 3	M-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. Please check labels and rates. Amounts of active ingredients vary between the different combinations.
Quilt Xcel	azoxystrobin + propiconazole	11 + 3	M-H				x	x	x			
Quadris Opti	azoxystrobin + chorothalonil	11 + M5	M				x	x	x			Rotate with other non-FRAC code 11 fungicides
Pristine	pyraclostrobin + boscalid	11 + 7	H				x	x	x	x		
Omega	fluazinam	29	L					x				Low-risk for resistance development

Fungicide resistance management guidelines for onions grown in mid-Atlantic region - 2014

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 (*Pythium*)	Bacterial leaf blight	Septoria leaf spot	Fungicide Resistance Management Guidelines
				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
Tilt	propiconazole	3	H			x	High risk, tank mix with a protectant fungicide, and rotate with fungicides from other FRAC codes
Ridomil Gold	mefenoxam	4	H	x			High risk for resistance development
MetaStar	metalaxyl	4	H	x			
Ultra Flourish	mefenoxam	4	H	x			
Fontelis	penthiopyrad	7	M			x	Moderate risk, tank mix
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x			For use at seeding; will help control Pythium and Rhizoctonia
Quadris	azoxystrobin	11	H			x	High risk, tank mix with a protectant fungicide, and rotate with fungicides from other FRAC codes
Cabrio	pyraclostrobin	11	H			x	

Fungicide resistance management guidelines for parsley grown in mid-Atlantic region - 2014

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

Parsley

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off (*Pythium*) and Root rot	Powdery mildew	White mold (*Sclerotinia*)	Ascochyta blight	Fungicide Resistance Management Guidelines
				L	L	M	H^R	
sulfur	sulfur	M2	L		x			Low risk, protectant fungicide, use alone or rotate with a fungicide with high-risk FRAC code
MetaStar	metalaxyl	4	H^R	x^b				High risk for resistance development
Ridomil Gold	mefenoxam	4	H^R	x^b				
Ultra Flourish	mefenoxam	4	H^R	x^b				
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x^{ab}				For use at planting; will help control Pythium and Rhizoctonia
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	*Coniothyrium minitans*	bio	L			x		Low risk biological control, consult label

Fungicide resistance management guidelines for peas grown in mid-Atlantic region - 2014

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
[b] Pythium only

Peas

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off (*Pythium*)	Bacterial leaf spot	Anthracnose fruit rot	Phytophthora blight - crown rot phase	Phytophthora blight - fruit rot/foliar 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 with high-risk fungicides
Manzate Pro-Stick	mancozeb	M3	L			x				
chlorothalonil	chlorothalonil	M5	L			x				
Ridomil Gold Copper	mefenoxam + copper	4 + M1	H - M^R					x		Rotate with other FRAC codes
MetaStar	metalaxyl	4	H^R				x			Hisk risk, resistance known. Only apply if Phytophthora strains are mefenoxam-sensitive
Ridomil Gold	mefenoxam	4	H^R				x			
Ultra Flourish	mefenoxam	4	H^R				x			
Priaxor	boscalid + pyraclostrobin	7 + 11	H			x				Rotate with other FRAC codes
Quadris	azoxystrobin	11	H	x		x				High-risk,rotate with other FRAC codes. No consecutive applications.
Cabrio	pyraclostrobin	11	H			x				
Quintec	quinoxyfen	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 use only
Previcur Flex	propomocarb HCL	28	L-M	x						Low risk, tank mix
Revus	mandipropomid	40	L-M					x		Tank mix and rotate with other FRAC codes
Forum	dimethomorph	40	L-M					x		
Presidio	fluopicolide	43	H				x	x		

Fungicide resistance management guidelines for peppers grown in mid-Atlantic region - 2014

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 blight	Gummy stem blight	Anthracnose	Powdery mildew	Downy mildew	Fungicide Resistance Management Guidelines
				L	L	L	H^R	H^R	H^R	L	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	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	x		
Procure	triflumizole	3	M^R								x		
Inspire Super	difenconazole + cyprodinil	3 + 9	H						x	x	x		High risk, rotate with other FRAC codes
Ridomil Gold	mefenoxam	4	H^R	x									Hisk risk, resistance known. Only apply if Phytophthora strains are mefenoxam-sensitive
Ultra Flourish	mefenoxam	4	H^R	x									
MetaStar	metalaxyl	4	H^R	x									
Uniform	mefenoxam + azoxystrobin	4 + 11	H	x									For use at planting; will help control Pythium and Rhizoctonia
Fontelis	penthiopyrad	7	M								x		Moderate risk, tank mix
Switch	cyprodinil + fludioxonil	9 + 12	M						x	x			Tank mix and rotate with other FRAC codes
Quadris Top	azoxystrobin + difenconazole	11 + 3	H			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
Pristine	pyraclostrobin + boscalid	11 + 7	H^R						x	x	x		
Tanos	famoxadone + cymoxanil	11 + 27	M					x				x	
Quintec	quinoxyfen	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
Gavel	zoxamide + mancozeb	22 + M3	L-M									x	Low to moderate risk, rotate with other FRAC
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				x	
Revus	mandipropamid	40	L-M					x				x	
Presidio	fluopicolide	43	H					x				x	
Zampro	ametoctradin + dimethomorph	45 + 40	M									x	Moderate risk, tank mix
Torino	cyflufenamid	U6	M								x		Moderate risk, tank mix

Fungicide resistance management guidelines for pumpkin and winter squash crops grown in mid-Atlantic region - 2014

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

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	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 with high-risk fungicides
Ridomil Gold	mefenoxam	4	H	x	x			High risk for resistance development
Ultra Flourish	mefenoxam	4	H	x	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
Quadris	azoxystrobin	11	H			x	x	High risk, tank mix and rotate with other FRAC codes
Cabrio	pyraclostrobin	11	H			x	x	
Presidio	fluopicolide	43	H	x[a]	x		x	Tank mix and rotate with other FRAC codes

Fungicide resistance management guidelines for radishes, rutabagas and turnips grown in mid-Atlantic region - 2014

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] For Pythium Only

Radish, Rutabaga, and Turnip

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	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 with other FRAC codes
fixed copper	copper	M1	L		x	x	x	Use alone and rotate
Ridomil Gold	mefenoxam	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
Ultra Flourish	mefenoxam	4	H^R	x	x	x		
MetaStar	metalaxyl	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 help control Pythium and Rhizoctonia
Fontelis	penthiopyrad	7	M				x	Moderate risk, tank mix
Quadris	azoxystrobin	11	H		x	x	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
Cabrio	pyraclostrobin	11	H		x	x	x	
Reason	fenamidone	11	H		x	x		
Tanos	famoxadone + cymoxanil	11 + 27	M		x	x		
Ranman	cyazofamid	21	M		x			Low risk, do not tank mix with copper
Aliette	fosetyl-Al	33	L		x	x		
Revus	mandipropomid	40	L-M		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 - 2014

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	Anthracnose fruit rot	Gray mold	Fungal leaf blight, leaf scorch and leaf spot	Red stele and Phytophthora crown rot	Powdery mildew	Fungicide Resistance Management Guidelines
				L	H^R	H^R	H^R	L	H^R	
fixed copper	copper	M1	L	x						Low risk protectants, multi-site MOA, use alone, or tank mix and rotate with high-risk fungicides
Thiram	thiram	M3	L^R		x	x				
Captec	captan	M4	L^R				x			
Captan	captan	M4	L^R		x	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			High risk for resistance development
Rovral	iprodione	2	H^R				x			High risk for resistance development
Mettle	Tetraconazole	3	M						x	Moderate to high risk, tank mix and rotate with other FRAC codes
Rally	myclobutanil	3	M				x		x	
Procure	triflumizole	3	M						x	
Inspire Super	difenconazole + cyprodinil	3 + 9	H						x	High risk, rotate with other FRAC codes
Ultra Flourish	mefenoxam	4	H^R					x		High risk for resistance development, Can be applied as spray or through drip irrigation
MetaStar	metalaxyl	4	H^R					x		
Ridomil Gold	mefenoxam	4	H^R					x		
Fontelis	penthiopyrad	7	M			x				Moderate risk, tank mix
Abound	azoxystrobin	11	H^R							High-risk, tank mix with FRAC code M fungicides and rotate with other non-FRAC code 11 fungicides
Cabrio	pyraclostrobin	11	H^R		x		x		x	
Pristine	pyraclostrobin + boscalid	11 + 7	H		x		x		x	
Quintec	quinoxyfen	13	H						x	Tank mix and rotate with other FRAC codes
Switch	cyprodinil + fludioxonil	9 + 12	M		x	x				Moderate risk, tank mix and rotate with other FRAC codes
Elevate	fenhexamid	17	L		x	x				Low risk, rotate with other FRAC codes
K-Phite, Prophyt, Rampart, Phostrol	phosphorous acid	33	L					x		Low risk, see label
Aliette	fosetyl-al	33	L					x		Low risk, use as pre-plant dip or spray application, see label
Torino	cyflufenamid	U6	M						x	Moderate risk, tank mix

Fungicide resistance management guidelines for strawberries grown in mid-Atlantic region - 2014

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	Plectosporium blight	Scab	Phytophthora Crown and Fruit Rot	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 with high risk fungicides and in rotations with 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 with a FRAC code M fungicides and rotate with other FRAC codes
Folicur	tebuconazole	3	M					x		
Procure	triflumizole	3	M^R					x		
Inspire Super	difenconazole + cyprodinil	3 + 9	H					x		High risk, rotate with other FRAC codes
Ridomil Gold	mefenoxam	4	H^R	x			x			Hisk risk, resistance known. Only apply if Phytophthora strains are mefenoxam-sensitive
MetaStar	metalaxyl	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		Moderate risk, tank mix
Quadris Top	azoxystrobin + difenconazole	11 + 3	H		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
Pristine	pyraclostrobin + boscalid	11 + 7	H					x		
Tanos	fomoxadone + 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
Gavel	zoxamide + mancozeb	22 + M3	L-M				x		x	Low to moderate risk
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	
Forum	dimethomorph	40	L-M				x		x	
Revus	mandipropamid	40	L-M				x			
Presidio	fluopicolide	43	H				x		x	
Zampro	ametoctradin + dimethomorph	45 + 40	M						x	Moderate risk, tank mix
Torino	cyflufenamid	U6	M					x		Moderate risk, tank mix

Fungicide resistance management guidelines for summer squash crops grown in mid-Atlantic region - 2014

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

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 with high risk fungicides and in rotations with other FRAC codes
chlorothalonil	chlorothalonil	M5	L	x	x	
Prosaro	prothioconazole	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.
Tilt	propiconazole	3	M	x	x	
Quadris	azoxystrobin	11	H	x	x	
Aproach	picoxystrobin	11	H	x	x	
Headline	pyraclostrobin	11	H	x	x	
Headline AMP	pyraclostrobin + metconazole	11 + 3	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	azoxystrobin + propiconazole	11 + 3	M-H	x	x	
Quilt Xcel	azoxystrobin + propiconazole	11 + 3	M-H	x	x	
Stratego	trifloxystrobin + propiconazole	11 + 3	M-H	x	x	
Stratego YLD	trifloxystrobin + prothioconazole	11 + 3	M-H	x	x	
Priaxor	pyraclostrobin + fluxapyroxad	11 + 7	M-H	x	x	No more than 2 applications per season, rotate with other FRAC codes

Fungicide resistance management guidelines for sweetcorn grown in mid-Atlantic region - 2014

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 (*Pythium*)	Bacterial Canker	Bacterial spot and speck	Early blight	Septoria leaf spot	Leaf mold (*Fulvia/Cladosporium*)	Anthracnose fruit rot	Alternaria fruit rot	Buckeye rot	Grey mold	Late blight	Powdery mildew	Timber rot (White mold)	Fungicide Resistance Management Guidelines
				L	L	H^R	H^R	L	L	L	L	L	H^R	H^R	H^R	M	
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 with high risk fungicides and rotate
chlorothalonil	chlorothalonil	M5	L				x	x		x	x		x	x			
mancozeb	mancozeb	M3	L			x	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 with other FRAC codes
MetaStar	metalaxyl	4	H^R	x													High risk, resistance known
Ridomil Gold	mefenoxam	4	H^R	x								x					
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	mefenoxam + chlorothalonil	4 + M5	M									x					
Flouronil	mefenoxam + chlorothalonil	4 + M5	M									x					
Endura	boscalid	7	M				x	x		x	x		x				Rotate with other FRAC codes
Fontelis	penthiopyrad	7	M				x	x		x							
Priaxor	fluxapyroxad + pyraclostrobin	7 + 11	H				x	x		x	x						No more than 2 applications per season, rotate with other FRAC codes
Switch	cyprodinil + fludioxonil	9 + 12	M										x				Rotate with other FRAC codes
Quadris	azoxystrobin	11	H				x	x		x	x						High risk, tank-mix with protectants; rotate with other non-FRAC code 11 fungicides
Cabrio	pyraclostrobin	11	H				x	x		x	x				x		
Flint	trifloxystrobin	11	H				x	x		x	x						
Reason	fenamidone	11	H											x			
Quadris Top	azoxystrobin + difenconazole	11 + 3	H				x	x		x	x						
Tanos	famoxadone + cymoxanil	11 + 27	H				x	x		x	x	x		x			
Terraclor	PCNB	14	L-M														Use in transplant water
Ranman	cyazofamid	21	M - H											x			Tank mix with a protectant, rotate
Gavel	zoxamide + mancozeb	22 + M3	L-M				x	x		x	x	x		x			Rotate with other FRAC codes
Curzate	cymoxanil	27	L-M											x			Tank mix with a protectant, rotate
Previcur Flex	Propamocarb HCL	28	L-M											x			Tank mix with a protectant, rotate
Aliette	fosetyl-al	33	L	x													Low risk
Catamaran	potassium posphite + chlorothalonil	33 + M5	L						x								
Forum	dimethomorph	40	L-M											x			Tank mix with a protectant, rotate
Revus Top	mandipropamid + thiophanate methyl	40	L-H				x	x	x	x	x			x	x		
Presidio	fluopicolide	43	H											x			Tank mix with a protectant, rotate
Contans	*Coniothyrium minitans*	bio	L													x	Biological control, see label

Fungicide resistance management guidelines for field-grown tomatoes in mid-Atlantic region - 2014

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

TOMATO

Fungicide	Active Ingredient(s)	FRAC CODE	Risk Management	Damping-off (*Pythium*)	Bacterial fruit blotch	Alternaria leaf blight	Phytophthora Crown and Fruit Rot	Anthracnose	Gummy stem blight	Powdery mildew	Downy mildew	Fungicide Resistance Management Guidelines
				L	L	L	H^R	L	H^R	H^R	H^R	
Actigard	acibenzolar-S-methyl	P1	L		x							Low-risk, rotate with other FRAC codes
fixed copper	copper	M1	L		x							Multi-site MOA, use alone, or in tank mix with high risk fungicides and in rotations with other FRAC codes
Mancozeb	mancozeb	M3	L			x	x	x				
chlorothalonil	chlorothalonil	M5	L			x		x	x	x	x	
Topsin M	thiophanate-methyl	1	H					x				High risk for resistance development
Rally	myclobutanil	3	M^R							x		High risk, tank mix, and rotate with other FRAC codes
Folicur	tebuconazole	3	M						x	x		
Procure	triflumizole	3	M^R							x		
Inspire Super	difenconazole + cyprodinil	3 + 9	H			x			x	x		High risk, rotate with other FRAC codes
Ridomil Gold	mefenoxam	4	H^R	x								High risk, Mefenoxam resistance known in mid-Atlantic region
Ultra Flourish	mefenoxam	4	H^R	x								
MetaStar	metalaxyl	4	H^R	x								High risk for resistance development
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
Luna Experience	fluopyram + tebuconazole	7 + 3	M						x	x		High risk, rotate with other FRAC codes
Switch	cyprodinil + fludioxonil	9 + 12	M						x			Moderate risk, tank mix and rotate with other FRAC codes
Quadris	azoxystrobin	11	H			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
Cabrio	pyraclostrobin	11	H			x		x				
Reason	fenamidone	11	H			x						
Quadris Top	azoxystrobin + difenconazole	11 + 3	H			x		x				
Pristine	pyraclostrobin + boscalid	11 + 7	H			x		x	x	x		
Luna Sensation	trifloxystrobin + fluopyram	11 + 7	H			x				x		
Tanos	fomoxadone + cymoxanil	11 + 27	M				x	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	
Gavel	zoxamide + mancozeb	22 + M3	L-M				x				x	Protectant, low to moderate risk
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	
Forum	dimethomorph	40	L-M				x				x	
Revus	mandipropamid	40	L-M				x					
Presidio	fluopicolide	43	H				x				x	
Zampro	ametoctradin + dimethomorph	45 + 40	M				x				x	Moderate risk, tank mix
Torino	cyflufenamid	U6	M							x		Moderate risk, tank mix

Fungicide resistance management guidelines for watermelon grown in mid-Atlantic region - 2014

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*)	Verticillium wilt	Fungicide Resistance Management Guidelines
				L	H^R	L	L	M	L	H^R	L	
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							
chlorothalonil	chlorothalonil	M5	L	x	x							
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	mefenoxam	4	H^R						x	x		High-risk, resistance known in Late blight and Pink rot
Ultra Flourish	mefenoxam	4	H^R						x	x		
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
Priaxor	fluxapyroxad + pyraclostrobin	7 + 11	H	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
Quadris	azoxystrobin	11	H^R	x		x	x					
Gem	trifloxystrobin	11	H^R	x								
Headline	pyraclostrobin	11	H^R	x								
Reason	fenamidone	11	H^R	x								
Quadris Top	azoxystrobin + difenconazole	11 + 3	H	x								
Quadris Opti	azoxystrobin + chlorothalonil	11 + M5	M	x								
Tanos	famoxadone + cymoxanil	11 + 27	M-H	x	x							
Ranman	cyanofamid	21	H		x				x	x		Always tank mix with a protectant, rotate
Gavel	zoxamide + mancozeb	22 + M3	L-M		x							Rotate with other FRAC codes
Curzate	cymoxanil	27	L-M		x							Tank mix with protectant fungicide, rotate with 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	x							Tank mix with protectant fungicide, rotate with other FRAC codes
Forum	dimethomorph	40	L-M		x							
Revus	mandipropamid	40	L-M		x							
Revus Top	mandipropamid + difenconazole	40 + 3	L-M	x	x							Rotate with other FRAC codes
Presidio	fluopicolide	43	H		x					x		Rotate with other FRAC codes
K-Pam HL, Vapam HL	Na-,K-methyldithiocarbamate	NC									x	soil fumigants, see labels

Fungicide resistance management guidelines for potatoes grown in mid-Atlantic region - 2014

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

White Potato

2014 Fungicide Application Schedules

Crop: Pumpkin	Example Cucurbit Fungicide Application Schedules										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Notes:**
Date	7/15	7/22	7/31	8/7	8/14	8/23	9/1	9/8	9/18		
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		

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

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

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

2014 Fungicide Application Schedules

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

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

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

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