RESISTANCE MANAGEMENT 2018 - 2020

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Pesticide resistance is **an inheritable** (genetic) characteristic of a pest that makes it less sensitive to a pesticide and can occur in **all** types of pests (weeds, insects, fungi, etc.). Repeated use of the same pesticide (or pesticides with the same mode of action) over time kills pests that are susceptible to the pesticide and leaves behind individuals that are less sensitive. These then reproduce and pass on the genes that let them survive pesticide exposure to their offspring. The goal in resistance management is to not repeatedly use compounds that fall within the same group. Resistance management may include alternating products with different modes of action or limiting the total number of applications per season.

International groups have been founded to foster a cooperative approach to resistance management. They have assigned group numbers to pesticides to help growers make decisions on how to rotate pesticides. They are based on mode of action – how and where the chemicals in the pesticide work on the target.

In an effort to manage resistance with our pesticides, most labels now come with a "group" number assigned to them. The group number is specific for each type of pesticide (e.g., Group 1 insecticides have no relation to Group 1 herbicides). The following 3 pages show the groupings for our cranberry pesticides. Some active ingredients are available under several different product names, and different active ingredients have the same mode of action. When rotating pesticides for resistance management, use the **group number** as your guide and NOT the product name or active ingredient.

The group number is located on the first page of the label, and is usually displayed similarly to this example:

GROUP **5** **INSECTICIDE**

Insecticide Resistance Action Committee (IRAC) (http://www.irac-online.org/)
The Insecticide Resistance Action Committee (IRAC) has been formed to assemble the information for insecticides. For cranberry, organophosphates and neonicotinoids have the most compounds within their group. We are reliant on several compounds in these groupings. As long as growers remember to alternate between groupings and not repeat same mode-of-action compounds over and over, we should be able to keep newer compounds viable for decades. See Cranberry Insecticides by grouping on the next page.

Fungicide Resistance Action Committee (FRAC) (http://www.frac.info/home)
The group that advises for fungicide resistance is the Fungicide Resistance Action Committee (FRAC). Their goal is to prolong the effectiveness of fungicides that are likely to encounter resistance problems. For cranberry, Ridomil and Abound are fungicides that are at high risk for resistance development, while Indar and Proline are at medium risk. They should not be used repeatedly and should be carefully alternated with other fungicides from other groupings. See Cranberry Fungicides by grouping on following pages.

Herbicide Resistance Action Committee (HRAC) (http://www.hracglobal.com/pages/Home.aspx)
The Herbicide Resistance Action Committee and The Weed Science Society of America (WSSA) have both developed similar classification systems of herbicides. WSSA uses numbers instead of letters to designate the categories. A key step in resistance management is to minimize the continuous use of herbicides with the same mode of action through rotations and combinations of products. One of the purposes of these classification systems is to make it easier for farmers and farm advisors to understand which herbicides share the same mode of action without having to actually know the biochemical basis.

In cranberry, our biggest concern for developing resistance is our reliance on Callisto. Be sure to rotate other compounds into your herbicide schedule. Do not treat the same bog with Callisto year after year. See Cranberry Herbicides by grouping on following pages.

Insecticide Resistance Action Committee (IRAC) Grouping for cranberry insecticides

IRAC GROUP	TRADE NAME	ACTIVE INGREDIENT	MODE OF ACTION	CHEMICAL FAMILY
1	**Diazinon**	diazinon	Acetylcholine esterase inhibitor	Organophosphates and carbamates
	Imidan	phosmet		
	Lorsban	chlorpyrifos		
	Orthene	acephate		
	Sevin	carbaryl		
3	**Pyganic**	pyrethrin	Sodium channel modulators	Pyrethrins
4A	**Actara**	thiamethoxam	Nicotinic acetylcholine receptor competitive modulators	Neonicotinoids
	Admire (+others)	imidacloprid		
	Assail	acetamiprid		
	Belay	clothianidin		
	Scorpion	dinotefuran		
4C	**Closer**	sulfoxaflor		Sulfoximines
5	**Delegate**	spinetoram	Nicotinic Acetylcholine receptor allosteric activators	Spinosyns
	Entrust	spinosad		
11	**Dipel Xentari Biobit**	*Bacillus thuringiensis*	Microbial disruptors of insect midgut membranes	*Bacillus thuringiensis*
15	**Rimon**	novaluron	Inhibitors of chitin biosynthesis	Benzoylureas
18	**Confirm**	tebufenozide	Ecdysone agonists / molting disruptors	Diacylhydrazines
	Intrepid	methoxyfenozide		
21	**Nexter**	pyridaben	Mitochondrial complex / electron transport inhibitor	Meti acaracides
22	**Avaunt**	indoxacarb	Voltage-dependent sodium channel blockers	Oxadiazines
23	**Oberon**	spiromesifen	Inhibitors of acetyl CoA carboxylase	Tetramic acid derivatives
	Movento	spirotetramat		
28	**Altacor**	chlorantraniliprole	Ryanodine receptor modulators	Diamides

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Fungicide Resistance Action Committee (FRAC) Grouping for cranberry fungicides

FRAC GROUP	TRADE NAME	COMMON NAME	MODE OF ACTION	GROUP NAME	CHEMICAL GROUP	Resistance Development Risk
4	**Metastar** **Ridomil,** **Ultra Flourish**	mefenoxam metalaxyl	**A1**: RNA polymerase I	PA – fungicides (PhenylAmides)	acylalanines	**High Risk**
11	**Abound**	azoxystrobin	**C3**: cytochrome bc1 at Qo site	QoI-fungicides Strobilurins	methoxy-acrylates dihydro-dioxazines	**High Risk** (Single site fungicide)
	Aftershock, **Evito**	fluoxastrobin				
3	**Indar** **Proline**	fenbuconazole prothioconazole	**G1**: c14-demethylase in sterol biosynthesis	DMI-fungicides (DeMethylation Inhibitors)	triazoles	**Medium Risk** (Single site fungicide)
19	**OSO** **Ph-D**	Polyoxin D zinc salt	**H4**: chitin synthase	polyoxins	peptidyl pyrimidine nucleoside	**Medium Risk**
33	**Aliette** **Legion**	fosetyl-Al aluminum-tris	Unknown	phosphonates	ethyl phosphonates	Low Risk Multi-site fungicide
	Alude, Confine Fosphite, **Fungi-Phite,** **K-Phite, Oxiphos,** **Phiticide, Phostrol,** **ProPhyt, Rampart,** **Reliant, Reveille**	phosphorous acids and salts				
M1	**Badge, Champ, Copper, Kentan, Kocide, MasterCop, Nordox, NuCop, Top Cop**	copper (salts)	**M1**: Multi-site contact activity	inorganic	inorganic	Low Risk Multi-site fungicide
M3	**Ferbam**	ferbam	**M3**: Multi-site contact activity	dithiocarbamates EBDC's (Ethylene bis dithio carbamate)	dithiocarbamates	Low Risk Multi-site fungicide
	Dithane, Manzate, Penncozeb, Roper	mancozebs				
M5	**Bravo,** **Chloronil,** **Echo Equus,** **Initiate,**	chlorothalonil	**M5**: Multi-site contact activity	chloronitriles	chloronitriles	Low Risk Multi-site fungicide

Herbicide Resistance Action Committee (HRAC) Grouping for cranberry herbicides

Group numbering from Weed Science Society of America (WSSA) at right

HRAC GROUP	TRADE NAME	ACTIVE INGREDIENT	MODE OF ACTION	CHEMICAL FAMILY	WSSA GROUP
A	**Select, Intensity**	clethodim	Inhibition of acetyl CoA carboxylase (ACCase)	Cyclohexanedione 'DIMs'	**1**
	Poast	sethoxydim			
C1	**Simazine**	simazine	Inhibition of photosynthesis at photosystem II	Triazine	**5**
F1	**Evital**	norflurazon	Bleaching: Inhibition of carotenoid biosynthesis at the phytoene desaturase step (PDS)	Pyridazinone	**12**
F2	**Callisto, Explorer, and others**	mesotrione	Bleaching: Inhibition of 4-hydroxyphenyl-pyruvate-dioxygenase (4-HPPD)	Triketone	**27**
G	**Roundup**	glyphosate	Inhibition of EPSP synthase	Glysine	**9**
K3	**Devrinol**	napropramide	Inhibition of VLCFAs (Inhibition of cell division)	Acetamide	**15**
L	**Casoron**	dichlobenil	Inhibition of cell wall (cellulose) synthesis	Nitrile	**20**
	Quinstar	quinclorac		Quinoline carboxylic acid	**26**
O	**Quinstar**	quinclorac	Action like indole acetic acid (synthetic auxins)	Quinoline carboxylic acid	**4**
	2,4-D, Weedar 64	2,4-D		Phenoxy-carboxylic acid	
	Stinger, Spur	clopyralid		Pyridine carboxylic acid	