UNIVERSITY OF FLORIDA EXTENSION
Institute of Food and Agricultural Sciences

Berry Times

IFAS

Volume II, Issue 8 August 2002

Improved Pesticide Rotation Plan to Manage Insecticide/Miticide Resistance

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Arthropod resistance to pesticides has been a problem in strawberry culture since the early era of synthetic organic pesticides. A notable example of the problem comes from the twospotted spider mite and the miticides developed for its control. Since the 1960s, spider mites have become resistant to several miticides, including malathion, dicofol (Kelthane®), fenbutatin-oxide (Vendex®), pyrethroids, and abamectin (Agri-Mek®).

Methods to manage resistance have included reducing the selection pressure of pesticides by emphasizing rotations among pesticides of different chemical classes and limiting repeated applications of pesticides within identical classes. This method is flawed in that pesticides of multiple chemical classes sometimes disrupt biological processes (mode of action) that are identical. Rotations between those increase the selection pressure toward a resistant pest population. Traditional rotational schemes allow rotations between organophosphate and carbamate classes, but both are acetylcholine esterase inhibitors that interfere with neural transmission at the synaptic cleft.

Some advocate that farmers rotate among pesticides of different modes of action rather than of different chemical classes. By this plan, rotations would provide for selection of one pesticide from the organophosphates and carbamates (inhibit acetylcholine esterase) and one pesticide from pyrethroids and organochlorines (cause nerve axons to leak sodium ions). Adoption of this plan could reduce the selection pressure in a pest population toward pesticides of each mode of action and should result in an increased period of effectiveness for many of our valuable products.

We have developed a table that presents the insecticides and miticides registered in Florida for strawberry, their modes of action and related group codes. The table is available at our Web site: http://strawberry.ifas.ufl.edu/prodguide.htm. Growers should minimize the application of products to the same arthropod species from a single mode of action group in order to reduce selection pressures toward resistance. Rather, they should make their choices for pesticide rotations among different modes of action. No code is given to products to which resistance is unlikely. Our plan does not restrict their use beyond those imposed by product labels.

Table 1. Mode of action codes for strawberry insecticides and miticides[z,y]

Code[x]	Active Ingredient	Trade Names	Chemical Class[w]	Mode of Action and Notes
1	Metaldehyde	Deadline®/Trails End®	Acetaldehyde polymer	GABA system disrupter.
2	Abamectin	AgriMek®	Macrocyclic Lactone	GABA agonist, which opens chloride channels preventing nerve re-polarization at neuromuscular unction.
3	Carbaryl	Sevin®	Carbamate	Acetyl Cholinesterase Inhibitor.
3	Malathion	Malathion®	Carbamate	Acetyl Cholinesterase Inhibitor.
3	Methomyl	Lannate®	Carbamate	Acetyl Cholinesterase Inhibitor.
3	Azinphos-methyl	Guthion®	Organophosphate	Acetyl Cholinesterase Inhibitor.
3	Chlorpyrifos	Lorsban®	Organophosphate	Acetyl Cholinesterase Inhibitor.
3	Diazinon	Diazinon®	Organophosphate	Acetyl Cholinesterase Inhibitor.
3	Naled	DiBrom®	Organophosphate	Acetyl Cholinesterase Inhibitor.
4	Azadirachtin	Azatin®	Tetranortriterpenoid	Ecdysone metabolism inhibitor and blocks styloconic receptors.

5	*Bacillus thruingiensis aizawai*	Xentari®	Unique Biological Fermentation Product	δ-Endotoxin causes gut paralysis.
6	Endosulfan	Thiodan®/Phaser®	Organochlorine	Axonic Poison (Sodium channels leak sodium ions).
6	Dicofol	Kelthane®	Organochlorine	Axonic Poison (Sodium channels leak sodium ions).
6	Methoxychlor	Methoxychlor®	Organochlorine	Axonic Poison (Sodium channels leak sodium ions).
6	Bifenthrin	Brigade®	Pyrethroid	Axonic Poison (Sodium channels leak sodium ions).
6	Fenpropathrin	Danitol®	Pyrethroid	Axonic Poison (Sodium channels leak sodium ions).
6	Pyrethrum + Piperonyl butoxide	Pyrenone®	Pyrethrum	Axonic Poison (Sodium channels leak sodium ions).
6 &7	Pyrethrum + Rotenone	Pyrellin®	Pyrethrum	Axonic Poison (Sodium channels leak sodium ions) and Inhibits electron transport.
7	Propargite	Omite®	Organosulfur	Inhibits ATPase.
7	Fenbutatin-oxide	Vendex®	Organotin	Oxidative phosphorylation inhibitor/uncoupler
8	Cinnamaldehyde	Cinnamite®	Unique	Specific mode of action unknown.
9	Hexythiazox	Savey®/Hexygon®	Carboxamide	Ovicide/larvacide, specific mode of action unknown.
10	1,3-Dichloropropene	Telone II®	Organochlorine	Broad Biological toxicant.
11	*Beauveria bassiana*	Botanigard® Naturalis® L	Unique Biological Agent	Unique Fungal Entomopathogen.
	Refined Petroleum Distillate	Ultra-Fine Oil	Refined Petroleum Distillate	Suffocation. Resistance to oil is unlikely.
	Clarified hydrophobic extract of neem oil	Trilogy®	Botanical Oil	Suffocation. Resistance to oil is unlikely.
	Potassium salt of fatty acid	M-Pede®	Potassium salt of fatty acid	Pesticidal soap, breaks cuticular surface tension causing insect to dehydrate. Resistance to soap is unlikely.
	Potassium salt of fatty acid	Insecticidal Soap®	Potassium salt of fatty acid	Pesticidal soap, breaks cuticular surface tension causing insect to dehydrate. Resistance to soap is unlikely.

[z,] Minimize repeated use of products possessing identical codes on any arthropod community.
[y] Mention of a product does not constitute a recommendation by the University Florida, nor does it warrant or imply warranty of activity.
[x] Codes only apply to this table.
[w] Read and follow products labels.

The San Luis Valley and UF/IFAS Strawberries - Jim Sumler

"Perhaps if we go forward in the search we may stumble upon the thing which we are looking for, but if we stay where we are, nothing will come to light" Plato *Theaetetus*

The San Luis Valley in south central Colorado is 120 miles long and 45 miles wide, and an average altitude of 7,600 feet. The San Juan and Sangre de Cristo Mountains border three sides of the valley and provide a natural barrier to some disease and insect problems. The valley is an agricultural center where potatoes, alfalfa and barley predominate. Smaller acreages of vegetable crops

The UF/IFAS strawberry seedling program in Monte Vista, Colorado is progressing.

include spinach, head lettuce and carrots. Major soils in the agricultural areas are a loamy sand with a high water table, usually at a depth of 2 to 5 feet. The soil is alkaline, around pH 8, which can cause some minor element deficiencies.

The San Luis Valley Research Center operated by Colorado State University is currently conducting a strawberry research project with a Valley grower. This involves the use of row covers and different planting dates to establish early plantings for nursery production. So far there seems to be some success with using row covers for early establishment.

The UF/IFAS strawberry seedling program is progressing along the usual stages. Seeds planted in late April in a greenhouse near Center, Colorado were subjected to some rather low temperatures in May, most nights with temperatures in the 20s (Fahrenheit). Although the greenhouse was heated, high winds made it difficult to maintain optimum temperatures. The low temperatures probably delayed seed germination; however, germination greatly increased in mid June when greenhouse low temperatures were in the 50s. Seedlings were transferred from seed trays to peat pellets beginning on 25 June, and with the help of Margaret Sanderson a total of 4,498 seedlings were set. Some seed trays were saved after the seedlings were dug and more seeds are now germinating. These new seedlings may be dug later if time allows and a back order of peat pellets arrives in time. This would allow a later planting of strawberries to determine if this would be practical there. The seedlings that have been transferred to peat pellets were planted in the field beginning on 16 July. In September two daughter plants from each seedling will be dug and shipped to Florida for evaluation in the fruiting field at GCREC-Dover.

Fungicide resistance management: The nursery challenge - Dan Legard

Last month I talked about fungicide resistance and how fruit growers could minimize the risk of pathogens developing resistance by carefully managing their use of fungicides. However, since annual fruit production fields are typically established with transplants from either high elevation or Canadian nurseries, fungicide use in nurseries also can be important in the development of fungicide resistance in pathogens. For Colletotrichum crown rot (*C. gloeosporioides*), if fungicide resistance develops in a fruiting field, it may be able to over-summer in Florida on weed hosts around the field. However, the pathogens for anthracnose fruit rot (*C. acutatum*) and powdery mildew (*Sphaerotheca macularis*) do not appear to over-summer in Florida, so it is most likely that fungicide resistant strains would develop only in nurseries.

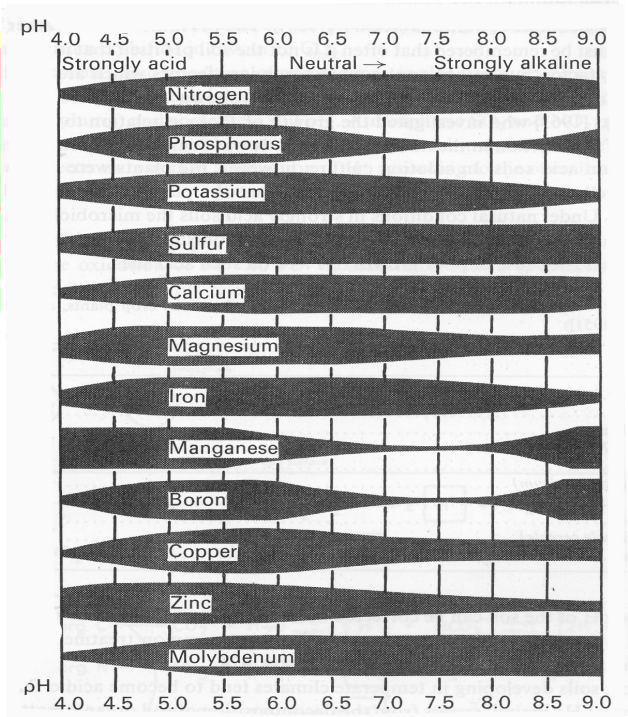
The proper use of fungicides in nurseries is critical for the production of disease-free transplants and to prevent the development of fungicide resistant pathogens. Many manufactures limit or prohibit the use of pesticides in nursery situations because of the greater likelihood of fungicide resistance developing when the same fungicides are used in both nursery and fruiting fields. However, there is a clear benefit for using fungicides in nurseries to help prevent the establishment of pathogens on transplants and reduce the spread of disease after transplanting. It is also more cost effective to treat plants in a nursery than after they have been transplanted in the fruiting field.

I would suggest that nurseries continue to use fungicides as directed by the label and employ the same fungicide resistance management strategies we recommended for fruit production fields (Berry Times July 2002). By using sound disease control programs in both the nursery and the fruiting field we should be able to control disease and prevent the development of fungicide resistant pathogens.

Soil pH management for the 2002 - 2003 season - John Duval

With the 2002-2003 season just two months away it is time to start thinking about soil fertility. Soil testing should be conducted now to allow analytical results to be returned and fertilizer and lime orders to be placed.

pH is the measure of soil acidity and it affects chemical, physical and biological properties of the soil. The availability of nutrients in the soil is the main concern for growers (see figure). While pH affects the availability all nutrients, micro elements (manganese, boron, copper, and zinc) are more severely affected than macro nutrients. The best pH for production of strawberry is between 6.0 and 6.5 with 6.2 being optimum. Soil test results should give a recommendation for the amount of lime to apply to raise the pH into this range. Liming materials are also beneficial in adding calcium and magnesium to fruiting fields. Lime should be broadcast and thoroughly incorporated prior to bed formation.



The wide portions of the bands indicate the zones of greatest nutrient availability. (Mengel and Kirkby 1987)

Center Update – Christine Manley

After two months of work, our horticulture building is occupied once again by our plant breeding and plant physiology programs. A new air handling system has been installed, new ceiling panels replaced the old, fresh paint covers the walls, and a new room especially designed to hold our growth chambers was constructed in the former storage area. Next will be the installation of our new computerized irrigation system. Bids have been received and the work should begin shortly.

We are pleased to announce that Steve MacKenzie, Biological Scientist in our Plant Pathology Department, has been accepted to the Ph.D. graduate program at the University of Florida and awarded an Alumni Fellowship. He will be under the supervision of Dr. Dan Legard and will continue working on strawberry research at our center in between commutes to Gainesville. As a result of Steve's departure, a new face will be found at GCREC-Dover. Teresa Seijo will be joining Dr. Legard's program. Teresa worked with Dr. Bob McGovern in the Bradenton plant pathology program, where she conducted research on various vegetables. With Dr. McGovern accepting a position in Gainesville, Teresa was given some options, and we are happy she elected to try her hand at strawberries.

We would also like to welcome Camille Esmel who will be working with Dr. John Duval on her MS degree in strawberry nutrition. Camille has a B.S. degree in Environmental Horticulture from the University of New Hampshire in Durham and specialized in crop production and nutrition. Her experience and enthusiasm will be welcomed at GCREC Dover.

AgriTech 2002 is schedule for August 27 and 28 with IFAS presentations scheduled for Wednesday, August 28. For complete information call the Florida Strawberry Grower's Association at (813) 752-6822 or visit their website at http://www.straw-berry.org.

New growth chambers will be used for a variety of experiments including a hydroponic experiment on nitrogen levels.

A monthly newsletter of the University of Florida Institute of Food and Agricultural Sciences, Gulf Coast Research and Education Center, and Florida Cooperative Extension Service.
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