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Fungicide resistance: How to prevent the development of fungicide resistance in strawberry pathogens - Dan Legard

In the past, fungicides like Benlate® lost their effectiveness in controlling disease because the target pathogens developed resistance to them. During the last two seasons we have seen signs that resistance may be developing towards some newer fungicides. In recent trials at the University of Florida-GCREC we have observed an apparent reduction in efficacy for Nova® and Quadris® in the control of powdery mildew and anthracnose fruit rot, respectively. If this reduction in control is due to the development of resistant pathogens then this would seriously limit the ability of growers to control these diseases.

Tractor application of fungicides at GCREC-Dover

Fungicides are the most important tool growers have to manage disease in annual strawberry. And like other tools, it is important to understand how to use fungicides properly so that they can continue to control disease. Other pests like insects, mites, and to a certain extent weeds, can often be effectively controlled with pesticides after they are observed in a field. Effective control of disease on the other hand, relies on preventing the start of epidemics and with strawberry this involves the regular application of fungicides.

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However, the regular use of fungicides can lead to the development of pathogens resistant to fungicides. Fungicide resistance is the result of a genetic mutation within the target pathogen that causes it to have a reduced sensitivity to one or more fungicides. These mutations typically occur at very low frequencies in the pathogen population and cause resistance by 1) reducing the uptake of the fungicide by the fungus, 2) enabling the fungus to detoxify it or by 3) altering the target site for the fungicide. When there are resistant individuals in a population, use of a fungicide will selectively inhibit the sensitive strains allowing resistant strains to increase and, if not properly managed, ultimately produce a population of pathogens resistant to the fungicide

Fungicides can be grouped by mode of action and by similarities in their chemical structure. I have listed some fungicides that have been used on strawberry grouped based on their chemical structure (fungicide class) in Table 1. Some fungicides are systemic and typically site-specific. That is they control fungi by disrupting a single metabolic process or structural function such as cell division, sterol synthesis, nucleic acid synthesis, etc. Fungicides like benomyl (Benlate®), iprodione (Rovral®), and mycobutanil (Nova®) are site specific and a single mutation at the target site can enable strains of a fungus to become resistant. Other fungicides like captan and sulfur are mainly protectant (i.e. they do not get translocated within the plant like systemic fungicides) and control fungi by interfering with many metabolic processes. Because they attack multiple target sites in the fungus it is rare or almost impossible for resistance to develop.

Intensive or exclusive use of systemic or single-site fungicides often leads to the development of resistance problems. Repeated application of a fungicide increases the selection pressure on the pathogen population. It is also important to use fungicides at rates that are adequate to control the disease and reduce the reproduction of the pathogen. Applying systemic or single target site fungicides at below labeled rates can also lead to the development of resistant pathogens.

Production practices that favor increased disease pressure also increase the likelihood of fungicide resistance. Using excessive nitrogen and/or tight plant spacing may result in a dense plant canopy that prevents good coverage with fungicides or inhibits the ability of harvesters to remove diseased fruit from the plant, resulting in more disease. The increase in disease results in the need for additional applications of fungicide which favors the development of resistance.

The best way to manage fungicide resistance is to prevent it from developing. Strategies for managing fungicide resistance should be based on each fungicide / pathogen combination and should integrate cultural practices with proper fungicide use to minimize the selection for resistant pathogens. Cultural methods such as using certified disease-free transplants, minimizing overhead irrigation, using resistant cultivars and proper row spacing, and avoiding harvest when plants are wet, reduce disease, reduce the need for fungicides and ultimately reduce selection of pathogens resistant to fungicides.

Cautious and judicious use of fungicides is required on a crop with serious disease control problems like strawberry. Growers should always consider either tank mixing or alternating the application of systemic or single-target site fungicides that have a moderate to high risk of resistance developing with protectant fungicides that have multiple target sites. Growers should also avoid rotating fungicides in the same class (see Table 1) as they typically have the same target-site and cross resistance among fungicides can develop.

Basics for resistance management: 1) Use the best cultural practices available to minimize disease. 2) Limit the number of applications of high-risk / single-site fungicides in a single season. Do not apply for a full season. 3) Alternate or tank-mix high-risk / single site fungicides with a low-risk / protective fungicide. 4) Apply fungicides at adequate rates (do not apply below minimum labeled rate). 5) Apply fungicides as a preventative whenever possible.

Fungicide resistance management for specific diseases: Anthracnose- Regular applications of captan throughout the season. Use lower rates early in the season before disease is seen and the top labeled rate later in the season when disease pressure is highest. Add applications of Quadris® at full labeled rate on a 14 day schedule during the late season or when the first symptoms of disease are observed. Powdery mildew- Alternate applications of sulfur with Nova® on a 7 day schedule during the early season when conditions typically favor powdery mildew epidemics. Botrytis fruit rot- Apply captan or thiram at lower labeled rates during the early season when disease pressure is low and at full labeled rate during mid to late season when disease pressure is high. During the peak bloom period that typically begins in mid to late January, alternate applications of Elevate® and Switch® every 7 days for 4 to 6 weeks or until the end of February.

Table 1. Characteristics of several fungicides commonly used on strawberry and their relative risk for developing resistance problems.

Fungicide class	Trade name	Common name	Protectant or systemic	Resistance risk
Benzimidizoles	Benlate®*	benomyl	systemic	high
	Topsin M®	thiophanate-methyl	systemic	high
Dicarboximides	Rovral®	iprodione	systemic	moderate
Phenylamides	Ridomil Gold®	mefenoxam	systemic	high
Sterol inhibitors	Nova®	mycobutanil	systemic	moderate
Phthalimides	Captan, Captec®	captan	protectant	low
Strobilurins	Quadris®	azoxystrobin	locally systemic	moderate - high
Hydroxy-anilides	Elevate®	fenhexamid	locally systemic	moderate (?)
Anilinopyrimidine +Phenylpyrrole	Switch® **	cyprodinil fludioxonil	systemic protectant	high low
Inorganics	Kocide®	copper hydroxide	protectant	low
	Sulfur	sulfur	protectant	low
Other	Aliette®	forsetyl-aluminum	systemic	low

* Benlate® is no longer labeled for use on strawberry or other crops.
** Switch® is composed of two active ingredients, a systemic component (cyprodinil) and a protectant (fludioxonil).

Strawberries in France - Craig Chandler

In June, I visited some commercial strawberry farms in the Aquitaine, Limousin, and Loire Valley regions of France. These areas are as far north as Nova Scotia, but their winter climate is not as severe because of the influence of the Gulf Stream, which has a warming effect on all of Western Europe. Commercial strawberry growers in France use predominantly an annual protected culture production system with fruit grown in either greenhouses or large plastic tunnels. These structures improve early fruit production and protect the crop from freezes and rain.

'Gariguette' and 'Darselect' are probably the main short-day cultivars used in central France, although 1.9 million plants of 'Sweet Charlie' were also grown there last year. Most of the transplants used in France are bare-root frigo plants. Frigo plants are plants that have been dug from the nursery after going dormant (between December and February) and held in cold storage at 28 °F (-2 °C) until transplanted. In France, frigo plants are typically set in mid July. Such plantings may produce some fruit in the fall, but the main production is from April – June the next year). Day neutral cultivars, such as 'Mara des Bois', 'Seascape', and 'Diamante', are planted in March for late spring, summer, and fall production.

Raised beds in large tunnel

Traditionally, French growers use raised (ground) beds covered with black polyethylene mulch. Their tunnels will cover three or four double-row beds, depending on the size of the tunnel. Some growers are now using a tabletop hydroponic system because it eliminates the need for soil fumigation, and is easier to harvest. According to Frederic Angier, of Angier International (nursery), a picker can harvest 88 pounds (40 kg) of fruit per hour from the tabletop system, while in the raised bed system a picker only averages 55 pounds (25 kg) per hour. Plant densities in the tabletop system are very high (10 plants per m^2) compared to plantings in west central Florida (approx. 4 plants per m^2). For an expanded article on strawberries in France, please visit our web site at http://strawberry.ifas.ufl.edu

Tabletop hydroponic system in large tunnel

Cover crops in Strawberry - John R. Duval

As summer arrives, few crops are grown on farms that will be planted with strawberries this fall. The use of cover crops on unused land improves soil quality, suppresses weed growth, and prevents erosion from heavy summer rains. The ideal cover crop is one that germinates and grows quickly to suppress weeds, produces abundant biomass to improve soil structure, and does not provide a good host for sting nematode. By quickly forming a dense canopy, cover crops can shade out weeds and reducing the amount of herbicide and tillage needed for a field. Green manure crops will increase soil organic matter which improves the soil's nutrient and water holding capacity, drainage, and increases soil aggregation, providing a better substrate for subsequent crops. Increased soil organic matter promotes the growth of beneficial bacteria and fungi which help suppress pathogenic soil microbes. Leguminous cover crops (such as Iron Clay pea) can provide a source of slow release nitrogen (as the plant decomposes), and up to 100 lbs. of nitrogen can be gained per acre. Hairy Indigo (*Indigofera hirsuta*) can provide sting and root-knot nematode suppression. Cover crops should be thoroughly incorporated into the soil several weeks before the field is to be fumigated and planted to allow decomposition of large pieces of plant material that may hamper fumigation and mulch applications. As the methyl bromide phase out continues, the selection of cover crops to help minimize soil related problems and improve the soil environment will become an important BMP (best management practice) for strawberry field management.

Cover crop planted in strawberry field

Center Update - Christine Manley

Renovations continue at GCREC with the installation of three new growth chambers and completion of plans for a new climate controlled greenhouse. Our farm crew finished removing the old irrigation system and we will begin installing a new computerized irrigation system this summer. We are currently finishing the installation of new air handling systems and other renovations in the lab and office buildings.

Laser leveling began June 28

AgriTech 2002 is scheduled for August 28 and 29 at the Arthur Boring Building in Plant City. The program will provide an opportunity to gain core CEU credits for those who qualify. On Tuesday, August 28th the University of Florida, IFAS will be presenting several talks from variety updates to nematode management. In addition, GCREC will have educational booths on entomology, weeds, plant nutrition, and diseases. If you would like more information regarding AgriTech call Florida Strawberry Growers Association at (813) 752-6822 or visit their website at www.straw-berry.org/agritech.html.

The use of trade names in this publication is solely for the purpose of providing specific information. It is not a guarantee or warranty of the products named, and does not signify that they are approved to the exclusion of others of suitable composition. Use pesticides safely. Read and follow directions on the manufacturer's label.

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