FUNGICIDES FOR BERRY FRUIT: NEW AND CURRENT OPTIONS

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Berry Fungicide Registration
Numerous fungicides from all major chemistry groups are registered for use on berry crops in New York. However, the number and type of registered fungicides is highly dependant on the economic value of the crop and the prevalence of disease problems. For example, strawberries are the most widely planted berry crop in New York (http://usda.mannlib.cornell.edu/MannUsda/homepage.do) and have more fungicides registered for disease control than other berry crops. Pristine WG, a new and potent fungicide, is registered for use against the more prevalent problem of strawberry leaf spot, but not for strawberry leaf scorch or leaf blight. These trends are the result of EPA regulations requiring substantial testing and fees (http://www.epa.gov/pesticides/regulating/registering/) for each crop-disease combination added to a fungicide’s label. Consequently, registrants are simply unable to afford the process of registering their compounds for every crop-disease combination, but for the most part, they have registered all of their premiere fungicides for the most important New York berry disease concerns.

New fungicide registrations for berry disease control occur when fungicides labeled on other crops receive registrations for new berry crop-disease combinations. Cornell Cooperative Extension (CCE), along with grower commodity groups and private consultants, facilitate the registration process by working with chemical companies to identify the key disease concerns for which fungicide registrations are needed. Needs may result from emergence of new disease problems or as a result of fungicide resistance issues or discontinuation of old fungicide products. CCE and commodity groups can request that the registrant apply for the registration of new uses once EPA tolerances have been established for berry crop-fungicide chemistry combinations. This process can take some time as label changes must be registered with both the EPA and with the New York State Department of Environmental Conservation. In the interim, fungicide registration needs can be met temporarily by applying for FIFRA 2(ee) Recommendations and FIFRA Section 18 Emergency exemptions. FIFRA 2(ee) Recommendations are exemptions allowing limited deviation from the labeled use directions including application to non-target pests on labeled hosts, while Section 18 emergency exemptions allow the use of an unregistered pesticide to meet the short term needs of a commodity emergency. These two exemptions have been essential for meeting fungicide needs in New York, particularly on currants and blueberries.

Berry Fungicide Classification
Fungicides are classified by the EPA into one of three main categories: conventional, minimum-risk, and biopesticide. The Fungicide Resistance Action Committee (FRAC), an organization committed to prolonging the effectiveness of fungicides, classifies fungicides on the basis of chemistry and mode of action. The following section describes the three categories and the key fungicide chemistries labeled for berries in New York.

Conventional Pesticides
**Multi-site inhibitors:** Mode of Action (MOA): multi-site contact inhibition

Multi-site inhibitor fungicides are generally inexpensive, have good protectant activity, are low risk for resistance development due to non-specific modes of action, but have little or no post-infection activity.

**Inorganic: FRAC Codes: M1, M2:**
Fungicides in this group include copper and sulfur-based products. These fungicides are inorganic in that they contain no carbon, but confusion may arise as fungicides in this group are labeled for organic production, and hence may be vernacularly referred as organic fungicides. This group includes the copper hydroxide, copper salt, and copper sulfate products, and the liquid lime-sulfur and wettable sulfur products. These fungicides are widely labeled for diseases on all berry crops.
Organic: FRAC Codes: M3, M4 M5;
Berry fungicides in this group include ziram and thiram (dithiocarbamates), captan (phthalimide), and chlorothalinil (chloronitrile). These have multi-site non-specific action and are at low risk for resistance, hence their persistence in the industry for several decades. Formulated products of these fungicides are widely labeled for diseases on all berry crops.

Single-site inhibitors
Single-site inhibitor fungicides are generally newer and therefore more expensive, have both protectant and post-infection activity, and have a propensity for resistance development due to highly specific modes of action.

Iprodione (dicarboximide); FRAC Code: 2; MOA: Lipid biosynthesis
These fungicides include generics of Iprodione and Rovral, which are primarily labeled for control of gray mold (Botrytis infections) on blueberries, brambles, and strawberries. They are high risk for resistance, especially in Botrytis.

Thiophanate-methyl (thiophanates); FRAC Code: 1; MOA: Cell division
These fungicides include generics of Topsin-M, which are only labeled for control of gray mold and a few foliar diseases of strawberries. They are effectively benzimidazoles in terms of chemistry, which are high risk for resistance development, especially in Botrytis.

Mefenoxam (phenylamides); FRAC Code: 4; MOA: RNA Synthesis
These are not true fungicides in a strict sense as they are only efficacious against straminipiles, a group of aquatic organisms that include Pythium and Phytophthora. Ridomil Gold is the only product labeled for berries and is used to manage Phytophthora diseases such as red stele and leather rot of strawberries and root rot of blueberries and brambles. This chemistry is also at high risk for resistance development.

Fludioxonil (phenylpyrroles) quinoxyfen (quinolines); FRAC Code: 12 & 13; MOA: Cellular signal transduction; Cyprodinil, pyrimethanil (Anilinopyrimidines); FRAC Code: 9; MOA: Amino acid biosynthesis
Switch is a formulation of Fludioxonil and Cyprodinil labeled primarily for Botrytis diseases and anthracnose and mummyberry disease of blueberry. Scala is a formulation of pyrimethanil labeled for use on Botrytis fruit rot of strawberry. Recently, Quintec, a formulation of quinoxyfen, was labeled for use on strawberry powdery mildew. All of these fungicides have a propensity for resistance development.

Fenhexamid (Hydroxyanilides) & Myclobutanil, Fenbuconazole (Demethylation Inhibitors); FRAC Codes: 17 & 3; MOA: Sterol biosynthesis inhibition
Sterol biosynthesis inhibiting (SI) fungicides are considered to be fairly potent fungicides with good post-infection activity. Elevate (Fenhexamid) and Captevate (Fenhexamid and Captan) are labeled for numerous blueberry, strawberry, and bramble diseases, particularly anthracnose. Nova 40W (Myclobutanil) is the only demethylation inhibitor (DMI) currently labeled for berries and is labeled for foliar diseases of brambles and strawberry such as powdery mildew. There is also a new 2(ee) recommendation for use of Nova 40W on currants for white pine blister rust management. Indar (Fenbuconazole) and Orbit (Propiconazole), two potent DMIs, are currently being registered for use on some blueberry and strawberry diseases, but are unlikely to be registered in New York for the 2007 growing season. The SI fungicides have a propensity for resistance development, and some have a history of resistance problems in tree fruit.

Azoxystrobin & Pyraclostrobin (Quinone outside Inhibitors); FRAC Code: 11; MOA: Respiration inhibition
Quinone outside Inhibitors (QoI) (a.k.a. Strobularins, Strobys) are newer fungicides and are considered slightly less potent than the SIs, but also have good post-infection activity. Abound (Azoxystrobin) was one of the first QoI fungicides available and is labeled for numerous berry diseases including powdery mildew and anthracnose. Cabrio EG (Pyraclostrobin), and Pristine WG {Pyraclostrobin & boscalid (Dicarboximides; FRAC Code 2)} are some of the newest QoI fungicides and are widely labeled for berry diseases in New York. In particular, Cabrio EG is specifically marketed for use on small fruits. Also, there is a new 2(ee) recommendation for the use of Cabrio EG on currants for management of white pine blister rust. Unfortunately, these fungicides also have a propensity for resistance development, but there are currently no reports of widespread control failures.
Minimum-risk pesticides
Minimum-risk pesticides are exempt from EPA and NY registration as they contain active and inert ingredients with low toxicity and low risk of ground contamination (http://www.epa.gov/oppbppd1/biopesticides/regtools/25b_list.htm). Since they are unregulated, these pesticides can be variable in their effects and should be used with caution.

JMS Stylet-Oil is similar to a minimum-risk pesticide in that the active ingredient, paraffinic oil (white mineral oil), is on the EPA’s 4A list for permitted inert ingredients in minimum risk pesticides. JMS Stylet-Oil also comes in an organic-approved formulation and is registered in New York for use on powdery mildew of strawberries and Ribes, and white pine blister rust on Ribes.

Biopesticides
Biopesticides are pesticides derived from natural sources including animals, plants, bacteria and even mineral sources. These vary in type, cost, and efficacy depending on the product and disease treated. However, they are at low risk for resistance development, and are considered environmentally benign, which allows many of them to be labeled for use in organic production.

Bacillus-based biopesticides: Serenade (Bacillus subtilis) and Sonata (Bacillus pumilis) are formulated bacteria that prevent disease by production of anti-microbial metabolites. These products are registered for control of mummyberry disease, botrytis blights, powdery mildew and leaf rusts of blueberry, and powdery mildew of strawberry. However, their efficacy against these diseases has not been evaluated in New York.

Phosphorus acid products: This group contains phosphorous acid-based products such as Phostrol and Aliette WDG. These fungicides are converted to phosphite ions, which are responsible for boosting plant defenses and inhibiting fungi. These compounds are primarily registered for controlling Phytophthora diseases on blueberries, brambles and strawberries. However, ProPhyt is also registered against certain blueberry leaf spots including anthracnose, for which it is reported to be fairly effective.

Putting this Information Use
The FRAC classification scheme can be put to good use when designing a spray program for a given berry disease. The newer single-site inhibitor conventional fungicides all have a propensity for resistance, but are potent and have potential post-infection activity. To use this group of fungicides effectively in your spray programs, first cross reference the recommended fungicides for your disease and berry crop combination in the Cornell Pest Management Guidelines for Berry Crops with the FRAC code listing presented here or on their website. When choosing compounds for your spray program consider the following to minimize the propensity for the evolution of fungicide resistance in local berry pathogen populations: 1) Select or alternate with fungicides with different FRAC codes; 2) Never use two single-site inhibitor fungicides with same FRAC code in succession; 3) consider using co