FRUIT ROTS OF BERRIES: A NO FRILLS APPROACH TO MANAGEMENT

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The last few berry crop growing seasons have been characterized by wet (2011) or freezing (2012) weather in the spring followed by a drought period from June to August, and finally a wet period for weather from late July to October. In addition, the implementation of season extension practices can keep ripe fruit on plants much longer than the typical field season. In extended season plantings of berry crops, the potential for fruit loss resulting from fruit rots increases with the proportion of ripe remaining on the plant. Luckily, the presence and time that over ripe fruit remains on berry crops will likely be curtailed by the need to harvest fruit quickly to avoid damage by spotted wing drosophila. Given that fruit rot diseases will be of secondary importance in the face of recently emerging devastating invasive pests, a simple set of guidelines needs to be established for managing berry fruit rots so that small fruit producers can focus the majority their efforts on the pests of critical importance. In these proceedings, I will first present a concise set of guidelines for managing fruit rot and include information on key fungicides and important pathogens in later sections.

The "No Frills Approach"

Regardless of the fruit rot and berry crop, there are a few simple guidelines to follow each season that can minimize or prevent the loss due to fruit rot pathogens. These guidelines include the following:

1. Adhere to all proper horticultural crop management practices such as managing weeds and maintaining proper nutrition and irrigation. The proper use of nitrogen and irrigation in the planting is paramount to avoiding fruit rot. Fruit rot fungi are constantly seeking a source of water and free nitrogen and will readily rot fruit if plants are wet and/or over fertilized. Keeping the irrigation restricted to the ground will greatly reduce the risk of fruit rot, especially at harvest. This is why fruit rots rarely occur in covered plantings.
2. Practice delayed dormant application guidelines as relevant to the crop of interest. Delayed dormant applications are especially important for reducing fungal pathogen inoculum in raspberries and blueberries. Although this practice is specifically pertinent for shoot/cane pathogens, the fruit rot pathogens are endemic in the planting will also be affected by any inoculum reduction practices. Lower levels of initial fungal inoculum will slow fruit rot disease epidemics.
3. Make a fungicide application at bloom. Select one of the fungicides suggested below that best manages the fruit rot of prime importance for your planting (e.g. *Botrytis* on raspberry). Many of the fruit rot pathogens can infect flowers or even green fruit in the case of anthracnose. Fruit rot pathogens may blight the flowers or, more tragically, cause latent infections (especially anthracnose). In this case, the fungal pathogen infects the flowers and initiates a rot later when the fruit ripens. Such latent infections will result in fruit rot regardless of the fungicide program used later at harvest as no fungicides will be

able to reach the fungus protected in the developing fruit. Make sure that the bloom time application is made prior to any rain events as many fungicides work best when use protectively. Finally, bloom time applications further reduce the pathogen inoculum that will be present at harvest and as such will slow the rate at which harvest fruit rot epidemics occur.

4. Make 1-2 fungicide applications of one of the fungicides suggested below when fruit100% fruit maturity. Mature fruit are highly susceptible to fruit rot especially if other fruit with sporulating latent infections are present in the planting. An application interval of 14-21 days should be sufficient unless there is more than 2" of accumulated rain and or rotting fruit present in the plantings. In these is instances, you may wish to protect the planting before the next rain. If the planting is in a tunnel or other covered production system, only one pre-harvest application might be warranted to promote shelf life. Many of the fungicides suggested below are safe enough to have DTH of 1 day or 0 days, which allows for considerable flexibility for managing a disease during harvest.
5. Harvest all mature fruit as quickly as possible and cool them quickly. This practice will help manage all pests and diseases by restricting the buildup of pest numbers or disease inoculum.

Key Fungicides

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. There are several key fungicides that provide excellent control of fruit rots and can be used at or near harvest.

Fungicides are classified by the EPA into one of three 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 several key fungicide chemistries labeled for berries in New York. Since the goal of this work to simplify management practices, it will primarily focus on site-specific or single-site inhibitor fungicides most of which function in protective and curative modes and have low DTH requirements.

<u>Single-site inhibitors</u>

Single-site inhibitor fungicides are generally safer, more expensive, have both protectant and post-infection activity, and have propensity for resistance development due to highly specific modes of action (which makes them safer for the environment and non-targets).

Thiophanate-methyl (thiophanates); FRAC Code: 1; MOA: Cell division, Typical DTH: 1

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*.

Fludioxonil (phenylpyrroles) quinoxyfen (quinolines); FRAC Code: 12 &13; MOA: Cellular signal transduction

Cyprodinil, pyrimethanil (Anilinopyrimidines); FRAC Code: 9; MOA: Amino acid biosynthesis, DTH: 0

Switch is a formulation of fludioxonil and cyprodinil labeled primarily for *Botrytis* diseases and anthracnose and mummyberry disease of blueberry. A foliar allowed formulation of fludioxonil is a rare registration, which makes Switch a valuable fungicide option for berries. Scala is a formulation of pyrimethanil labeled for use on *Botrytis* fruit rot of strawberry.

Fenhexamid (Hydroxyanilides) & Myclobutanil, Fenbuconazole (Demethylation Inhibitors); FRAC Codes: 17 & 3; MOA: Sterol biosynthesis inhibition, Typical DTH: 0 to day of harvest

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. Indar 2F is the only demethylation inhibitor (DMI) currently labeled for berries fruit rots and only on blueberries.

Azoxystrobin & Pyraclostrobin (Quinone outside Inhibitors); FRAC Code: 11; MOA: Respiration inhibition, Typical DTH: 0

Quinone outside Inhibitors (QoI) (a.k.a. Strobulurins, 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 mummy berry 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.

Key Fruit Rot Pathogens

Botrytis blossom blight and fruit rot (Gray mold)

Botrytis blossom blight and fruit rot, caused by the fungus *Botrytis cinerea*, is primarily driven by excessive moisture and free sugars, which are readily abundant in open flowers and ripe fruit. As long as there is sufficient moisture, *Botrytis* can infect and colonize blossoms in fairly cold weather, which makes it potentially devastating for NY small fruit. In addition to favoring cool weather, *Botrytis* thrives in situations of overhead irrigation. Once infection has occurred, the fungus will colonize flower and fruit tissue, which becomes covered in fluffy tan to grey colored masses of mycelium and spores. Underneath, the flower or developing fruit will be shriveled and killed.

At bloom, begin scouting for the signs of *Botrytis* blossom blight in your plantings. If discovered, consider protecting your crop with a fungicide that has activity against *Botrytis*. Applying a fungicide now will protect your crop from blossom infections during this period of cold wet weather, and help keep the level of *Botrytis* inoculum down when fruit comes into maturity. Applying fungicides such as Switch, Scala, Pristine WG, and Elevate will provide excellent protection against Botrytis blossom blight. In addition, all of these materials may have some post infection activity against *Botrytis.*

Anthracnose fruit rot

Strawberries: Anthracnose can manifest itself on strawberries in several forms including crown rots, fruit rots, and leaf spots. Of the species of *Colletotrichum* that attack strawberry, only *C. acutatum* is known to be prevalent in the region and it is not one of the species that causes

crown rots. *C. acutatum* blights leaves, petioles, runners, flowers, and most importantly, rots the fruit. On fruit, green or red lesions will start as slightly depressed water-soaked spots that become sunken, larger (>3mm), brown, and finally black. Interestingly, *C. acutatum* needs copious amounts of free moisture and can drain water right out of the fruit, which causes them to become hard and shriveled. The primary sign of this pathogen is the salmon to orange colored ooze (spore massesthat typically form in fruit lesions, but can potentially appear in any plant lesion.

Blueberries: Anthracnose on blueberries is also caused by *C. acutatum.* On blueberries, *C. acutatum* may infect flowers, fruit, bud scales, and even blight young shoot tissue if conditions are favorable. Although shoot and bud blights can be devastating to blueberry operations, anthracnose fruit rot is the most commonly encountered form of the disease in NY production operations. Infection occurs when spores, produced on infected fruit spurs and buds, are dispersed by rain to flowers and developing green fruit. Infection is highly dependent on the availability of free water and may occur at sub optimal temperatures (< 75 °F) if the period of surface wetting is long enough (> 8 hours). Infected flowers can be blighted when inoculum levels are high and the wetting period is long enough. However, blossom and green fruit infections often remain latent until fruit ripening when sugar content is highest. Flowers and fruit with latent infections will appear symptomless, but will begin to rot and become shriveled as the pathogen resumes colonization during ripening. If there is enough free moisture or high relative humidity, orange to salmon-colored spore masses will be produced over the surface of the fruit. The spore masses are composed of countless numbers of spores, which are capable of infecting neighboring berries during rains at harvest and during the sorting and packing process post-harvest.