Practical Protocols for Biological Control of Diseases affecting Lowbush Blueberries

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Biological control has become a practical option for controlling mummyberry, Phomopsis canker, botrytis, and Sclerotinia berry drop, the four principal diseases affecting lowbush blueberries in the eastern and central Canada. Numerous field tests have shown that foliar sprays of the fungal agent *Clonostachys rosea* can control each of these diseases when applied according to practical protocols that were developed and tested in blueberry field trials. The trials were done in Prince Edward Island during 2011 to 2014 and in Ontario and Quebec in 2014.

Biological control involves the use of *Clonostachys* which is formulated as a powder. The powder contains high concentrations of living spores of *Clonostachys.* For applying the agent in the crop, the powder is dispersed in water together with a sticker-spreader to form a spray material. To be effective the spores must germinate after they are applied to the plants. During germination a tiny tube grows from the spore onto the plant surface and enters the leaf or flower. Once inside a microscopic cluster of fungal material forms among plant cells close to the site of entry. No symptoms develop that might betray the presence of the fungus; the plants appear absolutely normal. The fungus persists at these microscopic sites until the plant tissues naturally senesce or are irritated by the presence of a pathogen. *Clonostachys* becomes activated inside the plant should a disease organism such the mummyberry fungus (*Monilinia*) attempt to attack nearby tissues.

Successful biological control requires that the *Clonostachys* spores remain alive and able to germinate and penetrate into the plant in adequate numbers at appropriate times in the growing season. To facilitate appropriate use of *Clonostachys* the following protocols were developed and tested:

#1. STORAGE AND HANDLING OF THE POWDER FORMULATION OF *Clonostachys*:

To minimize possible inactivation or killing of spores present in the powder the following measures are important.

- Formulated *Clonostachys* powders are best stored in a refrigerator at about 4°C. The spores may survive and retain their activity for up to 9-12 months at 4°C.
- During short-term shipping (a day or two) the formulation should be kept at 20 – 24°C or lower. NEVER expose *Clonostachys* to high temperature (e.g. at 32°C or higher) even for a few minutes, as could occur in a vehicle on a sunny day.
- When using the formulation in the field during warm weather it should be kept cool such as in a cooler with ice.

#2. PREPARATION OF THE SPRAYER AND SPRAY MATERIAL:

Steps are needed that prevent or minimize loss of activity or killing of the spores in the spray material.

- TANK: The tank should be thoroughly washed and free from any fungicide, other pesticides or other residual materials prior to use for *Clonostachys.*

- WATER QUALITY: Water used to prepare the *Clonostachys* spray suspensions material:
    - ✓ should *not* be chlorinated, or chlorine levels must be less than 3 ppm. Chlorine kills the spores.
    - ✓ pH should be between 5-8.
    - ✓ should have a moderate temperature (e.g. 14-20°C); i.e. not warm and not cold. Well water should be held to increase the temperature.
- SPRAY CONCENTRATION: Use ONLY the recommended concentration of *Clonostachys* formulation in the spray mix. This concentration is based on treatment doses established during many scientific trials and is appropriate against each of the target diseases.
- STICKER – SPREADER: Use of an appropriate surfactant such as Agral 90 or natural based vegetable oils at the correct concentration can substantially improve the performance of *Clonostachys* sprays in blueberry crops. AVOID USE OF alcohol based stickers.
- SPRAY PRESSURE AND TYPES OF NOZZLES: Good coverage is key. Fan or cone shaped nozzles have been proven to work, and spray pressure should be adequate for spray to reach under the leaf canopy.

SPRAY APPLICATION:

- TIME OF DAY: Climatic conditions in the crop during a period of up to 12 hours or more following a spray application are critical for the spores to germinate and penetrate into the plant. The spores need at least 7-8 hours of leaf wetness when the temperature of the wet period averages 14-18°C and 10-12 hours at 10-13°C. The fungus does not establish well at lower temperatures. Wetness on the leaves can be from the spray itself, dew, mists and light rain. Heavy rain is deleterious.

  In most cases it is better to apply sprays late in the day to take advantage of the overnight humid period. In practice it may be helpful to check weather forecasts 2-3 days ahead of when a spray is called for (see "timing during the season" below) in regard to temperatures and rain events.

  Sprays should not be applied during the day, especially when conditions are dry and sunny. Such conditions may inactivate many of the spores.
- SPRAYING: spray volume of 156 L/acre (385.5 L/ha).
- AGITATION OF SPRAY MATERIAL: Spray material in the tank should be continuously well agitated during operation (but not heated by the agitation equipment).

TIMING OF *Clonostachys* SPRAY APPLICATIONS DURING THE CROP SEASON:

Normally at least two sprays are needed to obtain good suppression of the target diseases. Spray timing and targeting protocols have been developed based on scientific knowledge of the pathogen cycles and the weather and crop conditions that favour disease outbreaks. The pathogens can strike the crop almost immediately after budbreak as the weather warms in spring. Successful treatment at this stage delays disease increase during the succeeding weeks. However, temperatures following spray applications at that time may be too low for success.

Treatment of the flowers is extremely important because the flowers are the main avenues by which incoming spores of the four target pathogens infect the berries. The pathogens often cause the flowers or berries to rot or drop and may interfere with pollination. Sprays during the bloom period have always given the best results in terms of disease control and yield benefits.

#1. At about the third leaf stage can help to suppress outbreaks of each of the four target diseases (mummyberry, Phomopsis, Botrytis and Sclerotinia) if the weather is sufficiently warm.
#2. Four to six days before flowering begins, especially if spray #1 was not applied or the conditions turned out to be too cold (as may occur with spray #2).
#3. At 20% bloom.

The objective is to treat as many of the open flowers in the crop as possible. Given that the bloom period may last for up to 14 days and beyond, this is clearly a challenge, especially in crops with many blueberry clones that collectively flower over a long period of time.
#4 In crops with extended bloom periods a second bloom spray may be well justified at about 70-80 % bloom.