Use of the Seafood Byproduct Chitosan for Management of Botrytis on Floriculture Crops

Grey mold, caused by the fungus Botrytis cinerea, is a common disease that infects many greenhouse crops worldwide. Also known for causing leaf blight, blossom blight, bud rot, and stem canker, to name a few, the pathogen has created headaches for growers for decades. Botrytis cinerea has a wide host range affecting many ornamental crops, particularly those with thick succulent petals. The greenhouse provides an ideal environment for the growth and spread of the fungus. To make matters worse, the fungus has developed resistance to several classes of fungicides. An integrated approach combining chemical, biological, and cultural tactics is the most effective way to manage Botrytis in the greenhouse.

The success of an integrated pest management (IPM) approach is only as good as the tools available and our knowledge of how to use them effectively. It is important for growers to have alternative control methods to use in rotation with fungicides to manage disease and mitigate fungicide resistance. The use of biopesticides and natural products has been gaining attention as IPM tools. Chitosan, a derivative of chitin, is a promising natural compound documented to have antifungal and disease suppressive properties (Figure 1). Chitin is one of the most abundant polymers on earth and is an important component of all insect and crustacean exoskeletons. Chitin is also a structural component in fungal cell walls. Some companies have begun utilizing waste from the seafood industry as a source of chitosan for use in agriculture as a new crop protection product. Chitosan has been used successfully in postharvest to prevent storage rot and extend the shelf life of perishable fruits and vegetables. Little is known about the potential for chitosan to reduce disease on foliage and flowers and if chitosan acts synergistically with standard fungicide or biopesticide spray programs.

Figure 1: What is chitosan, and how can it be used in agriculture?

Photo created by A. Poleatewich using Canva.com

What’s the potential for chitosan use in ornamentals? Promising, but there are some details to be sorted out. Research has shown that the efficacy of chitosan can depend on concentration, chitosan type, crop species, and plant parts treated (vegetative vs. reproductive). Dr. Anissa Poleatewich’s lab at the
University of New Hampshire and Dr. Ryan Dickson’s lab at the University of Arkansas have put several chitosan materials to the test against Botrytis using petunia and geranium as model crops. We evaluated unformulated reagent grade chitosan (Sigma Aldrich) and two commercial chitosan products, Tidal Grow™ (Tidal Vision Inc.) and ARMOUR-Zen® (Botry-Zen Ltd).

**Chitosan can be phytotoxic when applied at high concentration**

Although higher doses tend to correspond with greater disease control, chitosan can cause phytotoxicity, in part because it’s not soluble in water and must be dissolved in acid. Phytotoxic doses, however, vary based on formulation, crop plant, and plant part. In our research, reagent-grade chitosan (dissolved in acetic acid) caused phytotoxicity on petunia and geranium leaves when applied at concentrations of 0.5% and greater (Figure 2). The commercial products caused phytotoxicity when applied at concentrations greater than 1.0%. Based on our findings, it is important for growers to follow crop-specific recommendations from product suppliers to avoid these side effects.

**Chitosan has direct antimicrobial activity**

To determine if chitosan is directly toxic to *B. cinerea*, we conducted laboratory experiments in which *B. cinerea* was grown in petri dishes amended with several rates of chitosan. Growth of the fungus was reduced when exposed to solutions containing reagent-grade chitosan at 1% or greater. The physiochemical properties of the chitosan used (such as molecular weight) influenced antimicrobial activity against *B. cinerea*. The commercial products also reduced the growth of *B. cinerea* at concentrations greater than 0.5% (Figure 3).

**Figure 1. Petunia plants four days post chitosan application. Phytotoxicity was observed at higher rates of chitosan and on the acetic acid control.**

**Figure 3. Radial fungal growth of *B. cinerea* on water control plates (Top row) and minimal fungal growth on plates amended with Tidal grow at 0.5% (bottom row).**
Disease suppressive effects

Reagent-grade chitosan reduced disease on petunia leaves by up to 50% compared to the water control when applied at 0.4% (Figure 4). The high molecular weight reagent grade chitosan reduced disease on petunia leaves up to 89% when applied at 0.5%. For the commercial products, Tidal Grow™ applied at 0.75% reduced disease up to 31%, and ARMOUR-Zen® reduced disease by 75% when applied at 1%. We did not observe the suppression of disease on petunia flowers.

Figure 4. Petunia leaves challenged with *B. cinerea* 24 hours post chitosan/water application in a detached leaf assay. Leaves treated with chitosan exhibited smaller gray mold lesions compared to the water control.

Takeaways

Chitosan products were effective at reducing disease severity caused by *B. cinerea* on leaves but not on flowers. Chitosan may have the potential to reduce disease on flowers indirectly by reducing foliar infections, which often spread to flowers. Our research suggests that chitosan may have potential as a new tool for growers to use as part of their IPM program. Additional research is needed to evaluate efficacy compared to fungicides and to investigate compatibility with other grower practices.

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