Title Development of biological control strategies for integrated management of pre- and postharvest diseases of apple in Pennsylvania

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Abstract

The objective of this research was to develop biological controls for foliar and fruit diseases that can be implemented into existing conventional, reduced risk and potentially organic apple production systems to reduce the use of fungicides needed to maintain a quality product.

Four isolates were tested in a two-year field study on biological control of pre- and postharvest diseases at the Penn State Fruit Research and Extension Center in Biglerville, PA. Bacteria were applied to 'Golden Delicious' and 'Rome Beauty' trees in May or in May +June. Foliar apple scab severity was assessed weekly using a 7-point rating scale to estimate the percent leaf area scabbed. While a synergistic effect was not observed in treatments combining pre- and postharvest application strategies, there was an additive effect as pre-harvest applications of the biocontrol bacteria were able to reduce foliar and fruit scab. Futher, these pre-harvest effects persisted postharvest by suppressing bitter rot, but were enhanced by the addition of a postharvest application of the same isolate.

Five isolates were tested in a field experiment conducted at the PSU Department of Horticulture research farm in Rock Springs, PA to evaluate integration of bacteria with soluble silicon and chitosan for apple scab disease suppression. Application of Chitosan to 'Cortland' leaves in May and June did not reduce foliar apple scab severity compared to the non-treated control. Further research on the concentration of chitosan as a foliar spray and combination with biocontrols is needed to determine the potential for apple scab control. Application of the potassium silicate product, AgSil alone or in combination with bacteria, to 'Cortland' leaves in May and June did not significantly reduce apple scab severity on leaves. No significant reduction in fruit scab was observed for any of the amendment or bacterial isolate treatments.

The combination of bacteria with chitosan was also evaluated for suppression of the postharvest diseases bitter rot and blue mold. Application of chitosan to apple wounds alone or in combination with *B. megaterium* isolate A3-6 or Ae-1, *B. mycoides* isolate A1-1, or *Brevibacillus laterosporus* isolate FLS-1 significantly reduced bitter rot and blue mold lesion size on both 'Golden Delicious' and 'Rome Beauty'

fruit.Future experiments evaluating postharvest disease suppression when chitosan is applied in combination with our isolates as a fruit coating (applied as a dip or spray) will provide insights into the level of control that could be achieved in a commercial setting.

The bacteria *B. mycoides* isolate A1-1, *B. megaterium* isolates A3-6 and Ae-1 and *B. cereus* isolate FLS-5 significantly reduced bitter rot lesion size and were able to colonize fruit wounds at room and storage temperatures. Population levels of isolates A3-6 and Ae-1 were typically log 2 lower than isolate FLS-5 at 2°C and log 1 lower at 20°C, suggesting that the mechanism of disease suppression does not involve competition for space or nutrients. Scanning electron microscopy was used to investigate the mechanism of postharvest disease suppression by these isolates. Observations of wounded tissue colonized with *B. megaterium* isolate A3-6 showed attachment of bacterial cells to hyphae of *C. acutatum.* Furthermore, sections of the hyphae where bacterial cells had attached were damaged and collapsed. Further experimentation is needed to more conclusively elucidate the mechanism of bitter rot suppression by isolate A3-6.

The potential for integration of the collected bacterial isolates into existing apple management programs was evaluated. The combination of our biological control agents with fungicides or antibiotics may provide significant benefits by reducing the variability in disease management associated with biological control agents while reducing the rate of chemical used without compromising disease suppression. The disease management potential of our isolates combined with other BCAs with documented activity against the overwintering or secondary phase of apple scab represents an additional area of research to develop and optimize biological strategies for apple. (Abstract shortened by UMI.)