MULTIFACETED BIOLOGICAL CONTROL OF POSTHARVEST DISEASES OF FRUITS AND VEGETABLES—ALTERNATIVES TO METHYL BROMIDE

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The rapid withdrawal of synthetic pesticides from the marketplace such as methyl bromide has created an urgent need for safe and effective alternative methods to control pests. Biological control offers a logical response to this problem. However, biological control methods often do not provide as effective or consistent results as synthetic pesticides. We have been exploring the use of combined biological control methodologies into a multifaceted biological control strategy for postharvest diseases of fruits and vegetables (1). It is anticipated that such combinations will result in additive and synergistic control that equals or surpasses that by synthetic pesticides.

In our search for biological control methods to include as components in our multifaceted strategy we have taken a broad definition of biological control i.e. "The control of a plant disease by a biological process or its product." By using this definition a number of biological control approaches are available including (a) antagonistic microorganisms; (b) natural plant- or animal-derived fungicides; and (c) induced resistance.

Antagonistic microorganisms- A number of antagonistic microorganisms have been found that will control postharvest diseases (2). Some of these have been patented and industry is attempting to commercialize them. Large-scale pilot tests using these antagonists have provided adequate but inconsistent control of postharvest diseases of citrus and pome fruit. Research is underway to enhance the biological control activity of antagonists for postharvest diseases and some success have been realized. Also, more research is needed on the formulation and application of biocontrol agents.

Natural plant- or animal-derived fungicides- Entomologists have developed a number of effective plant-derived insecticides for the control of insects. Because of past perceptions that fungicides were innocuous, plant pathologists have not been aggressive in exploring plant- or animal-derived fungicides. It is well know that plants contain a number of effective fungicides, yet few have been developed commercially. Animal-derived fungicides such as chitosan have also been underutilized for the control of fungal pathogens. Our research program involves the large-scale testing of plant extracts and essential oils for fungicidal activity.

In our research we have a special interest in natural plant volatiles which are fungicidal. Such compounds may be useful as fumigants and may be effective in controlling latent infections which are difficult to combat with conventional fungicides or biocontrol agents. We have been successful in controlling postharvest rot of peaches and cherries by fumigating them with natural plant volatiles such as benzylaldehyde. It is often difficult to regulate the concentration of such fumigants so that they will control the pathogen and not damage the commodity being treated. We have developed, and are patenting, a time-release formulation of benzaldehyde and other fumigants which overcomes this difficulty.

Induced resistance- Although it has been demonstrated that harvested commodities will respond to certain elicitors by forming biochemical or cytological defenses, few attempts have been made to exploit this phenomenon as a control for postharvest diseases. In our research we have found that low-dose UV light, chitosan, and antagonistic yeasts can "turn on" resistance responses in harvested peaches, apples, citrus, tomatoes, and peppers and extend their shelf-life.

Our studies have revealed that chitosan, low-dose UV light, and certain yeast antagonists are capable of inducing defensive enzymes in harvested commodities such as chitinase and β-1, 3 glucanase. Combinations of certain elicitors with antagonistic yeasts have yielded synergistic control of postharvest diseases of apple.

Multifaceted Biological Control- The three approaches we have taken to the biological control of postharvest diseases have shown promise as alternatives to synthetic fungicides for the control of postharvest diseases. When these methods are applied under semi-commercial conditions (2) encouraging but inconsistent results are obtained. This has prompted our present approach which involves combining these different methods into a "multifaceted biological control strategy." It is anticipated that such combinations will provide additive and synergistic control. Indeed, we have found that combining low-dose UV treatments with antagonistic yeasts provides synergistic control of brown rot of peaches. Also, combining yeasts with certain natural compounds has provided synergistic control. It is hoped that complex multifaceted control methods may be more stable and more difficult for pathogens to resist than solitary methods.

Literature Cited

1. Wilson, C. L. and El Ghaouth, A. 1993. Multifaceted biological control of postharvest diseases of fruits and vegetables. In: Pest Management: Biologically Based Technologies (Lumsden R. D. and Vaughn, J. L., eds) pp. 181-185. American Chemical Society, Washington, DC

2. Wilson, C. L. and Wisniewski, M. E., eds. 1994. Biological Control of Postharvest Diseases — Theory and Practice. CRC Press, Boca Raton, FL 182 p.