Could Plant Pathogens and Pests Become Resistant to Biopesticides?

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The use of biopesticides has become a common practice in many horticultural crop protection programs. Biopesticides are effective tools in integrated pest management (IPM) programs for helping to manage resistance to synthetic chemical pesticides and reduce worker and environmental exposure to synthetic pesticides. Multiple studies have documented the development of resistance by pathogen and pest populations to chemical pesticides. Conversely, the risks of developing resistance to biopesticides are extremely low -- even as biopesticide use continues to increase.

The efficacy of each synthetic pesticide developed over the past 60 years is generally based on one mode of action (MOA) that disrupts or inhibits a specific biochemical pathway or biological function of the target pest. Continuous, extensive and intensive use of synthetic pesticides can inflict very strong and widespread selective pressure on pest and pathogen populations, resulting in rapid emergence of resistant or tolerant pests and pathogens. This phenomenon is also commonly experienced with human and veterinary pathogens where antibiotics have been used extensively, and, often, unnecessarily. In fact, pesticides are grouped into classes based on their MOAs, and end-users are specifically instructed not to over-use certain classes of chemical pesticides.

Nearly all biopesticides are most effectively used as preventive treatments. Since they deploy multiple MOAs to suppress pests and pathogens, development of resistance to these multiple factors by target organisms is extremely unlikely.

Combinations of two or more of the characteristics described below prevent the development of resistance to biopesticides:

- **Competitive exclusion**: Many microbial biopesticides not only grow very effectively in the environments from which they were originally isolated, they can also physically occupy these niches to prevent establishment of pests and pathogens in these spaces. If these microorganisms grow well on plant leaves or in close association with plant roots, they can also provide host plants with a protective barrier against pathogens and certain pests.
- **Production of secondary metabolites**: Since bacterial and fungal biopesticide strains are isolated from very competitive environments, each produces numerous secondary metabolites for protection, survival and competition for nutrients.
- **Predation and parasitism**: Some biopesticide agents physically attack and completely consume specific pathogens and pests. Other biopesticide agents actually act as parasites that feed on detrimental organisms, leading to weakening and eventual death.
- **Induced host resistance and enhancement of plant vigor**: Certain microorganisms used as biopesticides can stimulate subtle biochemical responses in host plants that enhance their abilities to resist or better tolerate pest attack and diseases. In addition, certain microbial biopesticides can also promote plant growth or enhance plant vigor by production of particular secondary metabolites and increasing availability of plant nutrients.
- **Alteration of the soil or plant host environment**: Biopesticides made from soft chemicals or biological extracts chemically or physically change conditions in the soil or on plant surfaces to be unfavorable to the establishment and growth of pests and pathogens.

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- **Disruption of fundamental biological functions, development, and structures of target organisms**: Biorational chemicals and biological extracts can directly inhibit biochemical processes, interfere with developmental pathways of pathogens, and compromise the physical integrity of pests and pathogens.

Because of the nature and diversity of the MOAs presented above, plant pathogens and pests would need to undergo immense physical, biochemical, physiological, and genetic changes to develop resistance to biopesticides. Therefore, the loss of effective biopesticides due to development of resistant pests and plant pathogens is highly unlikely.

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