

## **Biological Control and Natural Products as Alternatives to Synthetic Pesticides**

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**Biological control provides an alternative to the use of synthetic chemicals with the advantages of greater public acceptance and reduced environmental contamination.**

### **FOOD SAFETY—A MAJOR MARKET ISSUE**

Consumer perception of food safety is a major market issue for New Zealand horticultural production. The viability of New Zealand's horticultural industry depends on the efficient production of high quality produce for export. World trends towards reduced pesticide availability and use require effective alternative controls for plant disease.

Many presently used synthetic pesticides will be removed from world markets within the next 5 years because of their toxicity or the high cost to re-register.

Some persistent synthetic pesticides have created environmental problems (e.g., DDT, PCP, and 2,4,5-T). Methyl bromide is used widely in New Zealand as a broad-spectrum fumigant biocide prior to planting for a range of horticultural crops. Up to 10% of the stratosphere ozone loss has been attributed to methyl bromide, resulting in legislative procedures to reduce and eventually halt its production.

Without alternatives to methyl bromide, New Zealand will lose at least 10% of its horticultural exports currently valued at around \$NZ1.5 billion per annum.

Research programmes in HortResearch's Natural Products Group are focused on the urgent need for improved alternative control systems using microbial biological control agents and biodegradable natural products as part of a sustainable, integrated approach to plant pest and disease management.

Development of novel biological controls will enhance the reputation of New Zealand produce on world markets and protect our market access. Biological control also provides an alternative to pesticide use with the advantages of greater public acceptance and reduced environmental contamination.

### **HISTORY**

In natural ecosystems, such as undisturbed native bush of New Zealand, a balance or equilibrium has evolved over the millennia through biodiversity and the interactions between microorganisms, plants, animals, and the environment.

The concept of natural disease suppression achieved by growing plants organically was clearly understood more than 5000 years ago by the Persian philosopher Zarathustra and described in his book, *Zend Avesta*, the earliest and most complete encyclopedia of gardening and agriculture, with an explanation of all the underlying principles of nature.

It shows how all the elements of nature collaborate in a garden, and describes the right way to produce the best foods through cooperation with all natural

forces and Laws.

Intelligent correlation of all the forces and laws of nature, the use of composting, and the development of a worm population form the three pillars of a natural system of food production.

## BIOLOGICAL CONTROL AND NATURAL PRODUCTS

The use of beneficial microorganisms such as biological control agents, seeks to restore the balance so often lost in the crop situation.

*Trichoderma* has been a useful biological control organism, the best strains producing high quantities of 6 pentyl alpha pyrone. This compound has shown good activity against sap-staining fungi, e.g. *Ceratocystis picea*, initially in petri dishes and then on wood. In field trials at a mill site various extracts from fungi and higher plants have given longer anti-sap-stain control than standard commercial products.

A second example comes from *Botrytis cinerea* on fruit while a third concerns the attack by *Armillaria* fungi on trees, kiwifruit, and vines. *Trichoderma* strains can be used to prevent this fungal attack or to permit regained vigour, via injection of *Trichoderma* or the pyrone itself. When a compost containing *Trichoderma* is used with the kiwifruit the vine becomes more vigorous and *Armillaria* is suppressed. Therefore the best delivery system may be the organism itself.

In the case of *Pinus radiata*, dipping the roots in a suspension of *Trichoderma* gave good protection against *Armillaria*. Soil mixes or composts containing *Trichoderma* have given good control of *Phytophthora*.

## INDUCED RESISTANCE

A variety of plant defence responses can be induced by extracts of microbial and plant origin, such compounds are commonly referred to as elicitors. The use of elicitors to activate inducible responses in susceptible plants and thereby increase their resistance to pathogens has been suggested as an alternative approach for crop disease control. This is referred to as induced resistance and it is proposed that the elicitor treatment sensitizes plants to express a more rapid and intense resistance to subsequent attempted infection by pathogens.

Elicitors such as salicylic acid have been shown to induce the activities of phenylalanine ammonia-lyase and peroxidase in both kiwifruit (*Actinidia × deliciosa*) and *Pinus radiata*. These are key enzymes in lignification and phenolic biosynthesis and have been shown to be useful early indicators of a resistance response in other plant species. Further, elicitor treatment has been shown to induce resistance against *Sclerotinia sclerotiorum* in kiwifruit leaves in the laboratory and under orchard conditions. Research on the ability of induced resistance to control fungal pathogens of *P. radiata* is in progress.

## ADVANTAGES OF NATURAL PRODUCTS

Advantages of biological control agents and natural products from microorganisms and plants include:

- Reduced pesticide use and residues—environmental safety, safer produce
- Greater public acceptance
- Produce natural products that are pesticidal
- Production relatively inexpensive

- A renewable resource
- High specific activity—used at a few grams per hectare
- Usually target specific
- Biodegradable—do not persist in the environment, no residues

Research on biologically active natural compounds may also lead to the discovery of novel compounds which are pharmaceutically important or have useful applications in agriculture.

## **CONCLUSION**

The viability of New Zealand's horticultural industry depends on the efficient production of high quality produce for export.

World trends towards reduced pesticide availability and use require effective alternative controls for plant diseases.