

Biological control of root diseases - especially with Trichoderma

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In natural soils a great number of micro-organisms live together and compete with one another for space and nutrients. Some of the microbes are pathogenic (i.e. can cause plant diseases). Others live on waste material and don't harm the plants. Others are even beneficial to plants by working against pathogens or by supporting plant health. Unfortunately, most soilless cultures do not have such a rich diversity of microbes as natural soils have. Integrated control and biological control (bio-control) of root diseases aim at adding beneficial microbes that can suppress or antagonise a particular pathogen.

How biological control works

Biological control may act in different ways (Postma, 1996). The mode of action of bio-control agents (beneficial fungi, bacteria) can be for instance:

- competition for nutrients
- competition for root exudates
- competition for space or infection sites on the roots (wounds)
- stimulation of root growth
- induction of resistance in the plant
- micro-parasitism (one organism invading another)

Generally, bio-control products work as preventatives of diseases; they are not knockdowns of diseases, as chemical fungicides are.

Bio-control species and products

Biological control is being investigated in several countries, and various organisms are being studied, for instance:

- Some species of the fungus *Trichoderma* to control various disease
- Some non-pathogenic strains of *Fusarium* fungus may suppress *Fusarium* wilt
- The bacterium *Bacillus subtilis* works against a number of root diseases
- Strains of some fungi, bacteria and yeast species can suppress *Sclerotinia*

Some companies are producing bio-control products commercially. For instance *Bacillus subtilis* is produced in Germany and marketed by Bayer as a bio-control product under the name FZB. It is being tested and used in Europe, but it is not registered in New Zealand, and cannot be imported without going through quarantine. *Trichoderma* is at the moment the most important bio-control agent in New Zealand. *Trichoderma*-based products are produced locally by Agrimm Technologies and Gro-Chem, as well as overseas (e.g. Israel, USA).

How Trichoderma works

Trichoderma species belong to a small family of beneficial fungi that are commonly found in soils in nearly all parts of the world. Basically, *Trichoderma* species live on plant debris and organic matter in soil, while some strains are parasitic on other fungi. *Trichoderma* can be introduced into soils, growing media or woody plants. It is important that abundant populations are established and maintained, to form a protective barrier to root pathogens. If colonisation is patchy, the results will be patchy too.

Pathogens that can be controlled by *Trichoderma* include *Pythium*, *Phytophthora*, *Fusarium*, *Rhizoctonia*, *Sclerotinia* and *Verticillium*. *Trichoderma* is used in the culture of vegetables, flowers, orchards, viticulture, sports turf and in landscaping.

Pathogen control in soilless cultures - part 15

The modes of action of Trichoderma include: competition and antagonism against pathogens, production of certain compounds against pathogenic fungi; parasitism on pathogenic fungi; inducing the self-defence mechanism of plants (elicitor response). Trichoderma improves plant health and vigour, and may perhaps stimulate nutritional uptake when abundant populations are established in the root zone. Trichoderma has a protective and immunising effect on the host plant. It can survive long term within the host plant without causing any damage to the plant.

Products

There is a range of Trichoderma-based products on the New Zealand market. Some products contain a mixture of various species or strains of Trichoderma to make them more versatile. Agrimm products also contain nutrients for Trichoderma. Some products that are most relevant for greenhouse growers are:

'Trichodry' (Agrimm), a dry mix for vegetable seedling production. It is to be mixed at a rate of 1 kg per m³ sowing media. Of course the media should not contain any fungicides, as that would kill Trichoderma.

'Trichoflow' (Agrimm), a wettable powder that can be dispersed in water for spray or drench application. It is to be applied at planting and repeated every four weeks at a rate of 1 kg per 5000 m². The application rate and frequency should be increased during periods of plant stress.

'DRH CI' (Gro-Chem) is a dry mix blended with a food source and is suitable for direct application to soil or media at 20-100 gram per hectare for vegetables, fruit trees, ornamentals and flowers. Water extracts may be added to nutrient solutions. DRH CI (Dr Robert Hill Compost Inoculant) is a mixture of a number of strains of Trichoderma, isolated from New Zealand soils, and produced by Gro-Chem NZ Ltd under a licence agreement from HortResearch.

'TRI-D25', manufactured in California, and marketed by an Australian company.

'Trichoprotection' is not a product but a plant protection programme promoted by Agrimm. It recommends the regular use of their Trichoderma-based products, with different formulations at different crop stages.

Experiments

Various test and experiments have shown that a Trichoderma may improve plant establishment, enhance root growth, protect against soil and water borne pathogens, and hence decrease root diseases. A recent experiment conducted by Dr Ian Harvey of PLANTwise at Lincoln shows the benefits of Trichoderma (see photo). Cucumber plants were grown in sawdust and half of the plants were treated according to the 'Trichoprotection' programme, whereas the others were untreated. The roots grew much more vigorously in the treated than in the untreated bags, and the fresh weight of the root system was more than double. In other cases, yield increases from 12% to more than 50% have been reported with Trichoflow. Generally the incidence of root diseases is significantly reduced due to Trichoderma products.

Soilless cultures

No Trichoderma products were especially developed for soilless cultures or water cultures (NFT, DFT). Some are said to be suitable for mixing in the nutrient solution of soilless cultures, either closed or run-to-waste systems. It is always important that the water is free of fungicides, as they would kill the Trichoderma. Some Trichoderma products have shown positive results in media-based cultures especially those with high organic content. For instance in sawdust it is possible that Trichoderma is supported by the sawdust itself. There is anecdotal evidence that Trichoderma established well in sand and rockwool. Agrimm reports that it improved root growth and reduced root diseases in NFT systems too. In water cultures the efficacy depends on colonisation of roots. In environments with little organic material, the products containing nutrients for Trichoderma are probably advantaged. It is likely that the water must be agitated to ensure oxygen supply.

Advantages

Advantages of bio control include:

- Pathogens do not develop resistance against a bio-control product;
- Bio-control agents pose no health hazards;
- They pose no environmental hazards;
- They leave no chemical residue on the produce.

Advantages of *Trichoderma* spp. include:

- They are harmless to humans and livestock;
- They act against a wide range of pathogenic fungi;
- They uses various modes of action;
- They perpetuate themselves by producing ample spores;
- They grow extremely rapidly and quickly colonise the soil;
- They can promote nutrient uptake and enhance plant growth.

Conclusion

The prospects of biological products for biological control, suppression of root diseases, and enhancement of root growth and health are promising. Bio-control products are meant as preventatives not knockdowns. So far only few biological products are available, and none have been specifically developed for soilless (water) cultures. Products based on the fungus *Trichoderma* are the most relevant for greenhouse horticulture in New Zealand at present. There are reports of positive effects in media-based cultures, and indications of efficacy in water cultures. Research on biological control is continuing. More products will be developed and hopefully some good products will become available for use in soilless (water) cultures.

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Photo

The difference between two cucumber plants grown in sawdust, one treated according to the 'Trichoprotection' programme, and one untreated (photo Ian Harvey & Agrimm).