Can Disease Control Ever Be Environment Friendly?

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INTRODUCTION

Modern horticultural crop protection involves a number of practices which are claimed to damage the environment. Growers still make considerable use of pesticides despite a reduction in available chemicals. Diseases continue to be wrongly diagnosed, which may lead to use of inappropriate fungicides and in some cases application of too many chemicals. Many nurseries still allow used irrigation water to drain into water courses and lakes which can result in loss of nutrients and pesticides and a build-up of these potentially damaging chemicals in the environment. The need for good nursery hygiene as part of integrated pest and disease management means many growers use pots, trays and other plastic materials only once before discarding them, thus dumping huge quantities of plastics annually. Specialisation and "factory" nursery methods have created increased risks of epidemic disease development and effective control remains the key to economic production of quality plants.

Some opportunities do exist for the development and application of acceptable disease control programmes. These include the use of rapid disease detection kits and the biological control of plant diseases.

INTEGRATED DISEASE CONTROL PROGRAMMES

There is considerable scope for the development of integrated disease control programmes, in which a combination of cultural and management practices, together with fungicides and biological control measures, are used to control one or more diseases. Such programmes have been successfully developed for some groups of diseases in horticulture, for example apple scab where a knowledge of the effect of weather conditions on spore germination and disease development enables growers to apply the minimum number of sprays to achieve economic disease control.

SAC Auchincruive has developed an integrated control programme for root and stem-base diseases of heaths and heathers. Work began in 1987 to look at the important and damaging fungal disease, rhizoctonia (caused by *Rhizoctonia* spp.). The biology of the fungus and a range of factors which affect the disease were studied. The aim was to develop a programme which would enable growers to achieve complete control of the disease at minimum cost, with minimal fungicide use, and with minimal damage to plants.

It was found that there are several potential sources of *Rhizoctonia* infection on nurseries, including diseased stock plants, cuttings, nursery soil, used pots and trays, capillary matting, benches and polythene, and used compost or compost containing unsterile loam. A disease control programme must, therefore, cover all these. The life-cycle of the pathogen was studied in an attempt to discover how the fungus reproduces and spreads. In the case of *Rhizoctonia* species, spread is comparatively slow as the fungus relies on growth of mycelium to spread. The speed of fungal growth is largely dependent on temperature, relative humidity, compost moisture content, and available nutrients. It was found that certain fungicides give good control of the disease, but that the successful use of chemicals is complicated for several reasons. Heathers, and in fact ericaceous crops in general, are very sensitive to the use of crop protection chemicals. The use of any fungicide on cuttings results in reduced root development and foliar browning. Older plants are much less susceptible to damage from fungicides.

Three years of work provided new information about *Rhizoctonia* on heaths and heathers. A blueprint for control was compiled.

BLUEPRINT FOR RHIZOCTONIA CONTROL ON HEATHERS

It is important to use only new or sterilised nursery materials and fresh or sterilised compost components, since the fungus can exist for long periods on used materials and soil. Old diseased plants are a primary source of the disease so it is important to remove them from the nursery. Stock plant vigour should be maintained by annual re-potting and trimming. Cuttings should be taken from shoot tips where possible, since the risk of *Rhizoctonia* contamination of shoots is less at the top of the plant. Humidity should be reduced by ventilation and plant spacing wherever possible, as the growth of the fungus is much faster in high humidities. If the pH of the propagation compost is less than 4.0, growth of *Rhizoctonia* is slowed or stopped. Plant stress should be avoided, as stressed plants are much more susceptible to disease. This underlines the need for an understanding of the requirements for vigorous plant growth. The correct levels of irrigation and drainage, adequate light, ventilation, and nutrition must be ensured. Fungicide use should be restricted, if possible, to older rooted plants which are less susceptible to phytotoxic damage.

OTHER DISEASES

It is recognised that this blueprint, while effective, may be an over simplification of the situation on most nurseries. Inevitably, more than one potential pathogen is likely to be present. There is little point in altering management or cultural conditions to control one disease if this promotes the development of another. The main root and stem-base diseases which affect heaths and heathers are *Rhizoctonia, Pythium, Phytophthora, Cylindrocarpon, Cylindrocladium, Pestalotiopsis*, and *Fusarium*. Following the work carried out on rhizoctonia, studies were continued to look at some of these. The disease control blueprint for rhizoctonia was extended and modified to include diseases caused by the pathogens *Cylindrocarpon, Cylindrocladium, Pestalotiopsis*, and *Fusarium* species. Many of the control measures which were employed in the rhizoctonia blueprint also apply to the control of these other diseases, but further fungicides are required at some stages of production, also the use of low pH compost may encourage the development of diseases caused by *Cylindrocarpon* and *Fusarium* species. A detailed study of the life cycle and biology of these fungi has enabled control measures to be developed which are genuinely effective in controlling the diseases. In addition to this, fungicide use, phytotoxic damage, and the cost of crop protection are minimised.

RAPID DISEASE DETECTION KITS

Kits for the rapid detection of *Phytophthora, Pythium*, and *Rhizoctonia* were introduced to the U.K. by ADGEN Diagnostic Systems, the commercial arm of

Scottish Agricultural Colleges, in 1994. Marketed under the name ALERT, they enable growers to identify important stem-base and root pathogens in just 10 min, on the nursery with no requirement for scientific skills or special equipment. Conventional laboratory diagnostic procedures may take up to 14 days to identify *Phytophthora*, by which time serious crop damage may have occurred. Rapid diagnostic kits mean growers can take early action to prevent epidemic disease development based on informed decisions. Fungicides can be applied at the beginning of a problem when they are most effective. The correct products can be selected and pesticide inputs optimised. Crop losses are reduced and plant quality and profitability enhanced. Rapid diagnostic kits can also be used to:

- Check the health of cutting material and to monitor the health of crops and stock plants during production.
- Determine the health status of bought-in material prior to potting and setting out on the nursery.
- Guarantee the health of plants about to be dispatched for sale.
- Determine the health status of all crops thereby allowing fungicides to be applied only when required.

BIOLOGICAL CONTROL OF PLANT DISEASES

There is a wide range of successful biological control agents which are commercially available to combat horticultural pests including aphids, whitefly, mealybugs, nematodes, and caterpillars. Growers appreciate that biological control is safe, environment friendly and minimises the chances of resistance developing in the target pest. The development of biological control agents for diseases of horticultural crops has proved much more difficult. Biological controls for plant diseases are still relatively few and far between because there are several criteria which a biological control agent must meet if it is to be commercially successful. It must:

- Be able to be grown in large quantities.
- Survive and remain active in a range of environmental conditions both before and after application.
- Be genetically stable and non-toxic to animals, plants, and the environment.
- Give good control of the target pathogen.

Root-attacking, soil-borne diseases are better targets for biological control than foliage attacking diseases.

There are two reasons for this. Firstly, few chemicals are really effective against soil-inhabiting plant pathogens, so new control methods are desperately needed. Secondly, the soil environment is moist in comparison to the aerial foliage environment and this is more likely to be favourable to biocontrol agents. Examples of target fungal pathogens for disease biocontrol include *Rhizoctonia, Fusarium, Phytophthora, Pythium, Sclerotinia*, and *Verticillium* species. Due to the sensitivity of biological control agents to the physical environment, protected crops are the most suitable candidates for biological protection.

Biological disease control agents occur naturally in many soils and can be divided into three main groups—actinomycetes, bacteria, and fungi. Some of these agents produce antibiotics that inhibit plant growth; others parasitise plant pathogens, obtaining nutrients and growth factors from them; and yet others suppress pathogen growth by competing with the pathogen for space, light, or food. Some biocontrol agents use only one of these modes of action, others use all three. There is an increasing number of commercially available biocontrol agents. One of the most widely studied is the soil-inhabiting fungus *Trichoderma viride*. It is marketed in the U.K. by the Swedish company BINAB Bio-Innovation AB, as Binab T, to control silver-leaf disease in trees, which is caused by the fungal pathogen *Chondostereum purpureum*. It is available as a wettable powder which is used to paint pruning cuts and as 2-mm and 5-mm pellets. The pellets are inserted in infected trees to fight the disease. Binab-T is used more extensively as a control in countries other than the U.K. In Holland and Sweden, for example, it is used on many different flower and vegetable crops against *Botrytis* and many soil-borne fungal pathogens including *Rhizoctonia, Pythium, Fusarium, Verticillium,* and *Sclerotium* species. Mycostop is an example of a actinomycete biocontrol agent. It is marketed by Kemira Biotech, a Finnish company, and is being used extensively in Europe at present. It is currently undergoing registration procedures for use in the U.K. Its main application is in the protected cultivation of bedding and pot plants, cut flowers, bedding, cucumber, melon, and pepper. It is also suitable for use as a seed dressing. Its main targets are the root and stem-base pathogens*Fusarium* and *Alternaria* species, but it also prevents attack by other soil-borne pathogens. Blue Circle is an example of a bacterial biocontrol agent which is marketed for use in the U.S.A. by the American company Stine Microbial Products. It consists of live, naturally occurring, soil bacteria of the species*Pseudomonas cepacia*. The bacteria are applied as a seed treatment or as liquid inoculum. Blue circle is primarily used to control nematodes on corn crops, but it is also being used on horticultural crops such as tomatoes, carrots, peppers, and lettuce to control fungal pathogens such as *Rhizoctonia, Fusarium,* and *Pythium.*

DISEASE SUPPRESSION

Vaminoc is an example of a different type of organism. It is not strictly a biocontrol agent because it does not set out specifically to control disease. It is sold as a high quality vesicular-arbuscular mycorrhizal inoculant for horticultural crops. In other words, it contains beneficial fungi which colonise crop roots. In normal soil conditions, most plant roots form associations with mycorrhizal fungi. This benefits the plant by effectively extending the root system, increasing the availability of water and nutrients, and protecting the root system against certain diseases. Mycorrhizal fungi may be absent from commercial growing media, and Vaminoc aims to replace these naturally occurring organisms. It is claimed that the organism improves nutrient uptake and helps plants to withstand stress due to poor light levels, high temperatures, and root disease. Large-scale trials with commercial cucumbers has shown that crop yield and quality is significantly improved through its use.

There is increasing interest in the use of disease-suppressive growing media as an aid to disease control in ornamentals. Work has been going on in the U.S.A. for several years to look at the effect of naturally occurring disease-suppressive organisms in peats and barks. Certain peats, particularly young, relatively non-decomposed sphagnum peats and some bark products, particularly composted hardwood barks, can make a positive contribution to disease control. Results have shown that damping-off and root rot in bedding plants, pot plants, and hardy ornamentals can be significantly reduced through the use of disease-suppressive media.

CONCLUSIONS

The days of routine applications of fungicide sprays to protect against frequently undetermined risks or fire-brigade approaches to emergency disease control are numbered. In many ways this is not a bad thing, as in many situations it never has been a satisfactory approach to quality plant production. Inevitably, there will be a greater management input required on the part of the grower. However, the end result will be a better and more reliable production which will be done in such a way that the industry can claim that its procedures and products are more environment friendly.

Acknowledgements. The development work on integrated disease management for heathers and the evaluation of ALERT diagnostic test kits were supported financially by the Horticultural Development Council. Scottish Agricultural College receives support from the Scottish Office Agriculture and Food Department.