

ratio of UV radiation or to a significant difference in pest numbers found between Superstrength 400 tunnels and all of the other tunnels, during the harvest period.

Growing *Chrysanthemum* species and bell pepper (*Capsicum annuum*) under films that selectively decrease the amount of infrared light has been shown to reduce stem elongation, plant height and plant weight (Hoffmann, 1999a; Li et al., 2000). However, in our experiment we found that *Escallonia* plants grown under Super-green 720, an infrared filtering film, had significantly higher weights than those grown under the other films. Further work is required to examine this result.

We would also like to focus on particular plant-film interactions so that we can develop production systems in which, for example, plants are initially grown under a growth-promoting film and then transferred to a film that enhances flower or foliage colour. Such systems could reduce production time while improving aspects of quality.

### LITERATURE CITED

- Hoffman, S. 1999a. The effect of UV-radiation on colours of leaves and flowers of ornamental plants. *Gartenbauwissenschaft* 64(2):88-93.
- Hoffman, S. 1999b. The effect of photoselective cladding materials on the growth of ornamental plants II. Effect of UV range on stem elongation. *Gartenbauwissenschaft* 64(4):183-189.
- Li, S., N.C. Rajapakse, R.E. Young, and R. Oi. 2000. Growth responses of chrysanthemum and bell pepper transplants to photoselective plastic films. *Scientia Hort.* 84(3-4):215-225.

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## Disease Management on Nurseries: Cultural Aspects and Developments in Chemistry®

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### INTRODUCTION

Disease control and prevention on nurseries has always been complex because of the diversity of plant species and cultivars, the range of cultural systems, the lengthy production periods, and the number of times plants are moved.

To add to the complexity, the globalisation of trade in ornamentals has seen the introduction of previously unknown pathogens such as *Phytophthora ramorum*. In Ireland, the incidence of this disease and of fire blight (*Erwinia amylovora*), is still relatively low (Table 1a and 1b).

We are also seeing the withdrawal of many plant protection products, resulting in fewer approved products for nursery stock use. Nurseries are increasingly using substances such as nutritional chemicals, micronutrients, and plant derivatives to help manage diseases. In future growers will need to take an integrated approach involving cultural practices as well as chemical applications to prevent and control diseases.

### CULTURAL ASPECTS

Successful control demands constant vigilance and attention to detail. Cultural aspects are of prime importance and the application of fungicides and other meth-

**Table 1a.** Incidence of *Phytophthora ramorum* in Ireland, 2003.

	Garden centres and nurseries	Public or private parkland	Forest or wild
No. of sites inspected	146	33	75
No. of positive locations	31	0	3

80% of positives were on rhododendrons with the remaining 20% on *Viburnum* spp.

**Table 1b.** Incidence of *Erwinia amylovora* in Ireland, 2003.

	Garden centres and nurseries	Parks or private gardens
No. of samples	Total number of 1,912	
No. of positive locations	1	11

All plants involved were *Cotoneaster taxa* or *Sorbus intermedia*.

ods can only be regarded as supplementary. Standard cultural disease control practices include:

- Use of clean stock. Consider the source and not just the price of bought-in stock.
- Avoidance of contamination of compost and water by covering both with polythene.
- Provision of good drainage.
- Maintenance of balanced growth by adequate irrigation and feeding.
- Maintenance of adequate ventilation of crops under protection.
- Regular use of disinfectant, particularly on floors, benches, and trays.
- Avoidance of growing directly on grit or pebble, particularly disease-susceptible plants.
- Avoidance of overcrowding and provision of adequate space for air circulation within blocks of plants.

## DEVELOPMENTS IN CHEMICAL CONTROL

Fungicides are essential as part of an integrated programme to control nursery diseases. In Ireland, many nationally approved cereal and other arable fungicides are used on nursery crops, legally at growers' risk where there are off-label specifications. The following is an outline of some of the products being used against the main diseases.

Readers in other countries should note that some of the pesticides mentioned below may not be supported by label recommendations or have approval for the specific use stated. In Ireland at the time of writing these products are label-approved and recommended for at least one major agricultural crop so may currently be applied to ornamental nursery stock where there is an off-label specification, if the user accepts the risk of any crop damage. Readers in other countries will need to ascertain the situation with regard to availability and use of any of the materials mentioned under local regulations on pesticide registration and use.

**Downy Mildew.** Downy mildew is one of the major diseases of nursery stock, affecting a wide range of species particularly roses, hebes, and laurels. Downy mildew control accounts for 17% of global fungicide sales. Some plant taxa are more resistant than others but discontinuing susceptible taxa is not always an option. Chemical products being used and tested include:

- Fosetyl-aluminium 80% w/w (Aliette 80 WG), specifically for downy mildew.
- Metalxyl-m 4% + mancozeb 64% (Ridomil Gold), also effective against other diseases.
- Propamocarb 722 g·L<sup>-1</sup> (Proplant), effective against phytophthora and pythium.
- Fluazinam (Shirlan), for outdoor use only. Avoid human contact with the crop for 10 days.
- Dimethomorph 7.5% w/w + mancozeb 66.7% w/w (Acrobat MZ). For heavy infestations, Acrobat MZ has proved to be an excellent product to combine with Shirlan.
- Azoxystrobin 250 g·L<sup>-1</sup> (Amistar). Only two applications per season should be used to guard against risk of fungicide resistance.

**Powdery Mildew (PM); Black Spot (BS), and Rust (R).** Three prevalent diseases against which the following products have been used (approximate duration of activity in days shown in brackets):

- Azoxystrobin 250 g·L<sup>-1</sup> (Amistar), (PM, R, BS), (14–16)
- Bupirimat 250 g·L<sup>-1</sup> (Nimrod) (PM), (8–10)
- Fenarimol 12% (Rubigan) (PM, BS), (10–14)
- Flusilazol 125 g·L<sup>-1</sup> + carbendazim 125 g·L<sup>-1</sup> (Punch C) (PM, R, BS) (25–28)
- Propiconazol 250 g·L<sup>-1</sup> (Tilt 250 EC) (PM, R, BS) (18–21)
- Tebuconazole 250 g·L<sup>-1</sup> (Folicur) (M, R, BS) (18–21)
- Trifloxystrobin 125 g·L<sup>-1</sup> (Twist) (PM, R, BS) (18–21)
- Myclobutanil 60 g·L<sup>-1</sup> (Systhane 6 Flo) (PM) (safe fungicide)
- Imazalil 200 g·L<sup>-1</sup> (Fungaflor) (PM) (mainly used for protected crops)

Newer products such as Punch C and Twist have been used on specific crops in trials carried out by I.P.P.S. member Dr. Heinrich Lösing in Pinneberg, Germany, and are giving protection up to 28 days or even longer (pers. commun.). Slight damage has been observed following the use of Punch C on roses (pers. commun.). However, their widespread use is not advisable without trialling on small batches. Powdery mildew is also becoming more prevalent on a range of species and cultivars.

There are new chemicals from the strobilurin group being continuously developed. Many of the new products combine active ingredients from the strobilurin and azol groups, both of which are strong against powdery mildew. Products approved for use on cereals in Ireland, which contain such actives include Allegro (kresoxim-methyl + epoxiconazole), Opera (pyraclostrobin + epoxiconazole), and Sphere (trifloxystrobin + cyproconazole).

**Botrytis.** Grey mould (*Botrytis cinerea*) is a common and serious disease of many container-grown ornamentals. Serious winter losses have been recorded in crops such as lavenders, heathers and hebes. The standard products used to control it

have been Bravo 500 (chlorothalonil), Octave (prochloraz), and Rovral WP (iprodione) which is no longer available in Ireland. Elvaron M (tolyftuanid) has replaced Elvaron WG (dichlofluamid) and is very effective. On heathers, hebes, and lavenders, Amistar (axoxystrobin) and Unix (cyprodinil) have been used in botrytis control programmes with good results and no apparent damage.

**Shot Hole.** *Prunus laurocerasus* has replaced *×Cupressocyparis leylandii* as the number one hedging plant for the Irish market. Crop losses from shot-hole fungus are substantial on many nurseries particularly on crops grown from bare-root transplants potted on. The disease appears to be less of a problem on plants rooted and grown in liner pots. It appears that there are several pathogens responsible for the disease including *Stigminta carpophila*. Repeated applications of copper-based fungicides have proved to be completely ineffective. Outside of cultural practices, products containing mancozeb have proved to be the most effective for controlling and preventing the spread of the disease. Repeat applications are needed after 20 mm of rain or irrigation. This fungicide is not translocated so new growth appearing after application is not protected, requiring repeat applications.

**Phoma Leaf Spot.** *Phoma viburnii* is a common and widespread disease on *Viburnum tinus* with *P. cylindrospora* becoming more apparent on *Vinca major* and *V. minor*. *Vinca minor* 'Illumination' is very prone to it. Octave and Bavistin DF have been the standard fungicides used. More recently, Punch C has been used with excellent results.

**Cordylina Crown Rot.** *Cordylina australis* and various cordylina cultivars are now being produced in large quantities under protection, for the major sales period in May-June. Crown rotting at soil level results in considerable losses in many crops. The disease is associated with the soil and water-borne fungi *Phytophthora*, *Pythium*, and *Fusarium*. Once plants are infected, after potting on, it is extremely difficult to control the disease. Drenching liners with Proplant (propamocarb hydrochloride) and Aliette 80 WG (fosetyl-aluminium) has proved very effective, provided standard hygiene and cultural practices are also carried out.

## CONCLUSION

As many new agents for disease control come on the market, their adoption for widespread use will be based on further research and development. In the short term, chemicals, combined with good cultural practices, will play a major role in preventing and controlling diseases. The importance of having access to a wide range of fungicides will be the key to combating the wide range of fungal species affecting hardy nursery stock.

## LITERATURE CITED

Lösing, Dr. Heinrich. Pers. Commun. LWK-Gartenbauzentrum, Bismarkstrasse 49, 25421 Pinneberg, Shleswig-Holstein, Germany.