



The Nursery Papers

ESSENTIAL INFORMATION FOR AUSTRALIAN PROFESSIONAL NURSERY OPERATORS

AN INITIATIVE OF THE NATIONAL NIDO PROJECT. ISSN:1326-1495 ISSUE NO:1996#005

Using ultra violet radiation and chlorine dioxide to control fungal plant pathogens in water

Martin Mebalds¹, Andrea van der Linden¹, Michelle Bankier¹ and David Beardsell¹

Both UV light and chlorine dioxide are suitable for controlling fungal plant pathogens in water. Ultra Violet lamps must have sufficient output to allow for a specified flow rate and water quality. A minimum UV transmission of 60% is required for effective disinfestation of water; a survey of 29 properties showed that less than one third could rely on UV treatment to eliminate pathogens. Chlorine dioxide is a very effective chemical for disinfestation of fungal pathogens, however potential phytotoxicity risks have not yet been explored.



Phytophthora cinnamomi

The spores and other reproductive structures of many plant pathogens can be transported in water. *Phytophthora* spp., *Pythium* spp., *Colletotricum* spp. and *Fusarium* spp. can all infect crops if spread in irrigation water. *Phytophthora cinnamomi* in particular is readily spread by irrigating with creek and dam water collected as run-off from infected areas.

The major method of water disinfestation in Australian nurseries is chlorination. Chlorination using in-line chlorine gas injection should be phased out in the near future because it is dangerous. Chlorination of water using hypochlorous acid (sodium or calcium hypochlorite) is the cheapest method of disinfesting

water, however there are few reliable published details on this chemical control of major plant pathogens. Chlorination is unsuitable if the pH of water is above 7.5. Unfortunately a survey of waste water in Australian nurseries has shown that its pH is often above 7.5, so that acidification prior to chlorination is necessary.

UV light

Work at the Institute for Horticultural Development funded by industry and HRDC has shown that UV treatment of water kills the above pathogens, if the UV levels are at least 500,000 $\mu\text{Ws.cm}^{-2}$ (see Table 1). When disinfesting water for human consumption a rate of 17,000 $\mu\text{Ws.cm}^{-2}$ is commonly used. To achieve this level of radiation, the output of UV equipment must be sufficient to allow for the specified water flow rate and the worst likely level of (254nm) UV transmission of the water. A survey of water from 29 properties found that only 7 had UV transmission rates over 60% (good) but 18 had rates less than 50% (totally unacceptable). Filtering generally does not greatly improve UV transmission of water, only one of the 18 became acceptable after filtration to 5 microns; dissolved solids are the main absorbers of this radiation.

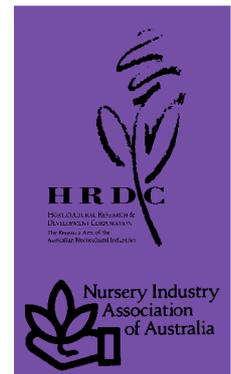


TABLE 1.
Levels of UV radiation required to kill fungal pathogens

| Pathogen | Dose ($\mu\text{W.s.cm}^{-2}$) |
|--------------|----------------------------------|
| A. zinniae | 850 000 η |
| F. oxysporum | 300 000 |
| P. ultimum | 40 000 |
| P. cinnamomi | 43 000 |
| C. capsici | 31 000 |

η *Alternaria zinniae* was the most tolerant because it has dark coloured spores.

Chlorine dioxide

Chlorine dioxide at an active concentration of 3.3 mg/L (ppm) kills spores of *Phytophthora cinnamomi*, *Fusarium oxysporum*, *Colletotrichum capsici*, *Pythium ultimum* and *Alternaria zinniae* in dam water with exposure times of less than 10 minutes (Table 2). The efficacy of chlorine dioxide is not reduced at pH as high as 10. Although chlorine dioxide treatment of water is more expensive than other disinfection methods, it is likely to be very effective in controlling fungal pathogens in recycled water in the Australian nursery and flower industries. Work on phytotoxicity thresholds for chlorine dioxide and its breakdown product chlorite have not yet been completed. It is not known if chlorine dioxide is effective on other plant pathogens including bacteria and nematodes.

TABLE 2.

The minimum concentration of chlorine dioxide to prevent survival of fungal pathogen spores after 2 minutes treatment.

| Pathogen | Active dose (mg/L) ppm |
|--------------|------------------------|
| A. zinniae | 60 * |
| F. oxysporum | 3.3 |
| C. capsici | 0.7 |
| P. cinnamomi | 2.6 |
| P. ultimum | 3.6 |

* Control in tap water after 12 minutes, but not eliminated from dam water

TABLE 3.

Approximate costs of UV and chlorine disinfection. Figures based on treatment levels to disinfect *Phytophthora cinnamomi*.

| Nursery daily water use (L) | UV | | Chlorine dioxide | |
|-----------------------------|------------|------------|------------------|------------|
| | Capital \$ | Op. p.a \$ | Capital \$ | Op. p.a.\$ |
| 5 000 | 2 000 | 300 | 15 000 | 400 |
| 10 000 | 5 000 | 500 | 25 000 | 500 |
| 50 000 | 8 000 | 1 000 | 25 000 | 1 300 |
| 100 000 | 20 000 | 2 000 | 25 000 | 2 500 |

Op. p.a. \$ = operating costs per annum

Acknowledgments

This project was funded by the industry product levy, VFF Flower Growers Group and HRDC. Work has commenced on disinfection of plant pathogens using ozonation and chloro-bromination.

Further reading

Chemical control of Phytophthora cinnamomi in irrigation water. Armitage, P. (1993). Australian Horticulture October 1993, 30-36.

Bromine and chlorine disinfection of nursery water supplies. De Hare, R., Bodman, K. and Forsberg, L. (1994). Combined Proceedings of the International Plant Propagators Society 44: 22-28.

Disinfection of plant pathogens in recycled water using uv radiation and chlorine dioxide. Mebalds, M., van der Linden, A. and Beardsell, D. (1995). HRDC Final Report No. NY320.

A review of possibilities for disinfection of recirculated water from soilless culture. Runia, W. Th. (1995). Acta Horticulturae 382:221-229.

¹ Institute for Horticultural Development, Private Bag 15, South Eastern Mail Centre, Vic. 3176.



Horticultural Research & Development Corporation