The Use of Jet 5 in Propagation

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INTRODUCTION

The importance of good hygiene in reducing disease spread around the nursery, and particularly for propagation, is well established.

Jet 5 was introduced in 1993 and has become one of the leading disinfectants for use in the U.K. on and in glasshouse structures, benches, pots, trays, irrigation lines, capillary matting, sand beds, and equipment. A number of qualities make Jet 5 particularly suitable for use in nursery stock production. It is an equilibrated, stabilised formulation of peracetic acid. It is a highly effective disinfectant with broad spectrum activity against viruses, bacteria, fungi, yeast, algae, and their spores. It also has some reported activity against nematodes.

The activity against plant pathogens has been well established by various research workers including Loschenkohl et al. (1990), Kleinhempel et al. (1987), *Secor* (1988), *Meier* (1990), *Linfield* (1991), and *Horticulture Research International Bulb Seminar* (1996).

Under normal conditions a contact time of 10 min will give complete disease control. This period should be extended when heavy soiling is present on the surface being cleaned.

Jet 5 decomposes rapidly after use to form the harmless by-products oxygen and water, with traces of acetic acid. Jet 5 does not adsorb onto surfaces. These properties make it an ideal disinfectant for use in propagation, where even traces of chemicals can disrupt the rooting process. At recommended rates it has been used for seed surface disinfection in cress and mung beans, which have shown improved rates of germination.

Many plant pathogens are spread by water-borne spores and the propagation area provides an ideal environment for disease development. The principal fungal diseases spread via water are *Pythium*, *Phytophthora*, *Thielaviopsis*, and *Fusarium*.

Recent research has focussed on disinfection of water, the activity of Jet 5 against these water-borne pathogens, and plant safety, particularly through overhead irrigation lines. This paper reports the results of recent trials and grower experiences with Jet 5 and highlights areas for further development.

MATERIALS AND METHODS

In all trials Jet 5 (5% peracetic acid, 27% hydrogen peroxide, mixed with surfactants and stabilisers), was tested under laboratory and field conditions.

Efficacy Tests in Vitro. In trials, conducted at HRI Efford by Tim Petit, Jet 5 was tested, at concentrations of 0.2 ppm and above peracetic acid (PAA), on irrigation water collected from drainage ditches or ponds from five nurseries. Dilutions of PAA were established using Merckoquant 1001 test steps. The efficacy of known concentrations of PAA against the mobility and germination of zoospores was tested against a zoospore suspension prepared by the method of Petit and Regg (1991).

These suspensions were mixed 1 : 1 (v/v) in Petri dishes and incubated overnight at 20C. Assessment by microscope was made once after mixing and again the following morning. The efficacy of PAA as Jet 5 was also tested against the germination and viability of spores of *Fusarium oxysporum* and *Thielaviopsis basicola*. Spore solutions of 103 spores were mixed with various concentrations of Jet 5 solution. These were incubated overnight at 24C. These were then sampled and grown on PDA plates until countable colonies appeared in the zero PAA control.

Efficacy Tests in Vivo. At HRI Efford, four concentrations of Jet 5 were tested on four different plant species to test for crop safety. Application was by overhead irrigation at rates of 0, 250, 500, and 1000 ppm PAA in a recirculatory system. The plant species were chosen because of their known sensitivity to chlorine-treated water: *Berberis* ×*ottawensis* f. *purpurea*, *Calluna vulgaris* 'Sunrise', *Chamaecyparis lawsoniana* 'Ellwood's Gold', and *Pyracantha coccinea* 'Red Column'. The plants were grown in 2-litre containers in a standard growing medium and assessed on four occasions for phytotoxic effects on leaves and effects on overall height.

In Holland, ProAgro has tested Jet 5, at concentrations of 1% and above, on 67 plant species and culitvars to evaluate both plant safety and the effectiveness of controlling moss, algae, and liverwort. All these trials were conducted on commercial holdings, on plants in their final container.

RESULTS

Efficacy in Vitro. At HRI Efford, Jet 5 applied to recirculated water containing a natural infection of *Phytophthora* zoospores caused immediate encystment. Complete mortality of zoospores and cysts occurred at concentrations of 20 ppm PAA and above.

Table 1. Effects of Jet 5 on germinating *Phytophthora cryptogea* in irrigation water.

Source of water	Assessment type	Concentration of peracetic acid (ppm)				
		0	0.2	2.0	20	50
1	D	52	68	46	2	0
	C	48	32	54	96*	100*
2	D	52	60	6	0	0
	C	42	12	50	100*	100*
3	D	32	-	28	0	0
	C	68	-	72	100*	100*
4	D	0	0	0	0	0
	C	100	100	100	100*	100*
5	D	45	15	5	0	0
	C	55	85	95	100*	100*

D = direct germination (% germination of zoospores), C = cyst formation (% of zoospores encysting)
* Nonviable cysts.

Table 2. Effects of peracetic acid on the viability of colony forming units (cfu) on *Fusarium oxysporum* and *Thielaviopsis basicola* in irrigation water.

Fusarium oxysporum				
PAA conc. (mg litre^{-1})	0	2.5	25	50
% cfu plate^{-1} (% of max. value)	100	82	23	0
Thielaviopsis basicola				
PAA conc. (mg litre^{-1})	0	2.5	25	50
% cfu plate^{-1} (% of max. value)	84	94	26	0

[a]The actual mean maximum number of cfu plate^{-1} for *F. oxysporum* was 69.3.
[b]The actual mean maximum number of cfu plate^{-1} for *T. basicola* was 97.5.

Efficacy in Vivo and Jet 5 Effect on Nursery Stock Foliage. Treatments of up to 250 ppm PAA as Jet 5 produced no adverse effects on the four species tested. *Berberis* showed a statistically significant reduction in height but this would have had no commercial significance. A reduction in the levels of moss and liverwort was also noted in trials where Jet 5 had been applied at concentrations of 125 ppm PAA and above.

Table 3. Assessments of percentage foliar damage (scorch) in four nursery stock species after application of Jet-5-treated water via overhead irrigation.

	PAA concentration (mg litre^{-1})			
	0		25	
	Assessment date		Assessment date	
Taxa	29 July	27 Sept.	29 July	27 Sept.
Chamaecyparis	0.53[a]	0	0.47	0.13
Berberis	0	0	0	0
Pyracantha	0	0	0	0
Calluna	-	0	-	0

[a]Mean scores of fifteen plants for percent foliar scorch severity.

Table 4. Assessments of percentage foliar damage (scorch) in four nursery stock species after application of Jet-5-treated water via overhead irrigation.

	PAA concentration (mg litre^{-1})			
	0		125	
	Assessment date		Assessment date	
Taxa	31-Sept.-96	16-April-97	31-Sept.-96	16-April-97
Chamaecyparis	0	1.0	0	0.9
Berberis	0	0	0	0
Pyracantha	0	3.2	0	2.3
Calluna	0	78.5	0	69.2

Table 5. Assessments of plant height (cm) in four nursery stock species after application of Jet-5-treated water via overhead irrigation.

Taxa	PAA concentration (mg litre^{-1}) 0	25	Statistical significance[b]
Chamaecyparis	6.8[a]	5.7	NS
Berberis	26.7	13.4	Sig. P = 0.05
Pyracantha	22.9	19.9	NS
Calluna	-	-	-

[a]Values presented are the means of fifteen replicate plants and are the differences between individual plant heights recorded at two sample times (7/29/96 and 9/27/96).
[b]Treatments were compared by simple analysis of variance.

In Holland, ProAgro carried out field trials using Jet 5 at concentrations of 1.0% to 2.5% (500 to 1250 ppm) PAA for the control of algae, moss, and liverwort, as a single application. At 1% concentration no crop damage was seen on plants in their final containers. At 2.5% concentration slight damage was seen on *Gaultheria mucronata* (syn. *Pernettya mucronata*), *Cytisus nigricans* 'Cyni', *Gultheria* spp., *Hydrangea macrophylla* 'Maculata' (syn. *H. variegata*), and *Lavandula* ×*intermedia* 'Grappehall'.

Results Derived From Other Sources. In the U.K., various nursery stock growers have been experimenting with Jet 5 to reduce disease spread via irrigation water. Hillier Nurseries has treated three forms of laurels, *Prunus laurocerasus* 'Rotundifolia', 'Otto Luyken', and 'Zabeliana', to reduce the spread of the fungal syndrome known as "shothole" (*Stigmina carpophila*, *Trochila carpophila*, etc). Since adopting this strategy Hillier reports high levels of completely clean crops. Isis Nursery reports similarly good results when using Jet 5 in propagation. When treating *Caryopteris*, *Garrya elliptica*, and other plants during rooting, this nursery found reductions in botrytis and improved rooting. Leaf spots, believed to be of bacterial origin, were also reduced (Dr. P. Orton at Askham Bryan College, York). He has discovered that Jet 5 as a 1% dip for 5 min was extremely effective in the preparation of roses for micropropagation and was found to be totally safe on semiripe and softwood *Rosa* plant material. Jet 5 also "rescued" a *Hosta* culture contaminated with bacteria. A significant number of in vitro growing plantlets tolerated the treatment. Where damage occurred it was transitory and plantlets eventually recovered. In unreported trials by Geoff White of HRI Wellsbourne, various disinfectants were compared for their ability to reduce the spread of pythium. The tests were designed to assess the chemicals under severe conditions. The most effective treatment was Jet 5.

DISCUSSION AND CONCLUSION

Phytophthora spores (zoospores and cysts) and *Fusarium* spores were effectively killed in vitro by use of Jet 5 at 50 ppm PAA and above. The source of the water in the trial had little effect on disease control results. A PAA concentration of 100 ppm was required for total kill of *Thielaviopsis*.

Applications of Jet 5 to four species known to be sensitive to chlorine damage showed no foliar phytotoxicity at concentrations of up to 125 ppm PAA. (This crop safety work has been confirmed in trials on vines, potatoes, and lettuce).

In laboratory tests on irrigation water, PAA as Jet 5 controlled *Phytophthora, Fusarium, Thielaviopsis*, and *Pythium*. Overhead applications to a wide range of nursery stock species have shown good reductions in disease spread with no phytotoxicity at up to 125 ppm PAA. A reduction in the spread of bacterial diseases has been achieved by commercial applications of Jet 5 as a water disinfectant. Bacterial control has been achieved on plants in propagation.

LITERATURE CITED

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