Use of a disease nursery to compare the efficacy of sterol-inhibiting fungicides for the control of apple scab and powdery mildew

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Summary

Closely planted, Granny Smith seedlings were used to compare the efficacy of six sterol-inhibiting fungicides clortriafol (Anvil), A7402A, flusilazol (Nustar), RO251297, myclobutanil (Systhane), and penconazole (Topas) and AU23.87 applied every 10 to 14 days or within 3 to 4 days from the start of an infection period for the control of natural infections of *Venturia inaequalis* and *Podosphaera leucotricha*.

All fungicides applied as protectants or eradicants controlled scab. Protectant applications of fungicides also controlled powdery mildew, but the eradicant schedules were less effective than the protectant schedules.

Introduction

Apple scab caused by *Venturia inaequalis* (Cke) Winter and powdery mildew caused by *Podosphaera leucotricha* (Ell. & Ev) Salmon are the two most important diseases of apples in Australia. In most areas up to 12 fungicide applications are required for control each season. Although a wide range of fungicides control both diseases, fungicides such as etaconazole, fenarimol and triadimefon, which inhibit ergosterol biosynthesis (E.B.I.), have, in recent years, been used extensively on pome fruits. These fungicides are effective at low concentrations and have excellent post-infection activity (O'Leary and Sutton 1986). A number of new EBI fungicides have been developed recently (Davis *et al.* 1985; Quinn *et al.* 1986; Schwinn 1983) but few of these have been evaluated or compared on apples under Australian conditions.

This study was undertaken to evaluate the potential of using a disease nursery of naturally infected seedlings to compare the efficacy of recently developed fungicides for the control of apple scab and powdery mildew.

Materials and methods

A disease 'nursery' to evaluate and compare fungicides suitable for the control of apple scab and powdery mildew was established on the Lenswood Research Centre situated in the main apple-growing area of South Australia approximately 30 km east of Adelaide.

One-year-old Granny Smith seedlings were planted in rows 1.5 m apart and approximately 25 m long. Plots consisted of groups of 10 plants each 10 cm apart within the plot and 30 cm apart between plots. Many plants were naturally infected with scab and powdery mildew at the start of the experiment, but to ensure an even dispersal of inoculum, infected leaves that had been collected from an unsprayed apple orchard were scattered evenly along the rows of seedlings before the fungicides were applied.

A 'De Witt' leaf-wetness recorder placed 1 m above ground near the edge of the planting and a thermohydrograph situated 250 m from the area were used to determine 'Mills' periods (Mills and La Plante 1951). Fungicides shown in Table 1 and at the rates shown in Table 2 were applied either every 10 to 14 days or within 3 to 4 days from the start of an infection period. Sprays were applied mainly to alternate rows with most plants in the other rows remaining unsprayed. Five replicates of each treatment were randomized such that each was applied once to each row. Seven protectant and five eradicant applications were made between October and January.

A knapsack sprayer ('Solo') was used to apply 40 ml of the fungicides per plot. The incidence of disease was assessed several times, within 2–3 weeks of an infection period, but only the final assessment, made in March, is shown in Table 2.

The incidence of apple scab and powdery mildew was determined by recording the number of extension shoots per plot with

Table 1 Fungicides evaluated

Product	% active ingredient and formulation	Supplier
Anvil	clortriafol 5% soluble granule	ICI Australia Operations Pty Ltd
A7402A	not disclosed 10% e.c.[A]	Ciba-Geigy Aust. Ltd
RO151297	pyrifenox 48% e.c.	May and Baker Rural
Systhane	myclobutanil 40% w.p.[B]	Rohm and Haas Aust. Pty Ltd
AU23.87	not disclosed 25% w.p.	(Confidential)
Nustar	flusilazol 20% dispersible granule	Dupont Aust. Ltd
Topas	penconazole 10% e.c.	Ciba-Geigy Aust. Ltd
Dithane M 45	mancozeb 80% w.p.	Rohm and Haas Aust. Pty Ltd

[A] e.c., emulsified concentrate.
[B] w.p., wettable powder.

Table 2 Incidence of apple scab and powdery mildew in Granny Smith seedlings sprayed with fungicides either every 10 to 14 days (protectant) or within 3 to 4 days from the start of an infection period (eradicant)

Treatment and rate of product per 100 l		Protectant			Eradicant		
		Scab		Mildew	Scab		Mildew
		No. infected shoots per plot	Rating	No. infected shoots per plot	No. infected shoots per plot	Rating	No. infected shoots per plot
Anvil	40 g	0	–	1.0	0	–	5.6
A7402A[A]	10 ml	0	–	2.0	0	0	2.4
Nustar	10 g	0.2	0.06	0.4	1.0	0.2	1.2
RO151297[A]	10 ml	0	–	0.4	0	–	1.6
Systhane	12.5 g	0	–	0.2	0.6	0.06	2.0
AU23.87	40g	0	–	1.2	0.6	0.06	1.8
Topas[A]	25 ml	0.8	0.1	0.2	1.0	0.12	1.8
Dithane M45	150 g	2.4	0.34	5.2	1.4	0.2	6.4
Nil	–	7.6	1.7	14.2	7.6	1.7	14.2
l.s.d. (0.055)		1.7		2.4	1.1		3.8

[A] Tank mixed with Dithane M45 150 g per 100 l.

one or more infected leaves. Shoots were also rated for severity of apple scab on a 0 to 3 scale where shoots with no infection rated 0 and shoots with most leaves infected rated 3.

Some fungicides were tank mixed with mancozeb as some of the commercial products are likely to be formulated with a protectant fungicide to reduce the likelihood of fungicide insensitive strains developing. The fungicides were evaluated at rates recommended by the manufacturer. Mancozeb was also included as the standard fungicide treatment. No other pesticides were applied to the plots except for two applications of vamidothion in order to control woolly aphid. Overhead irrigation through sprinklers installed 1.5 m above ground was applied several times during summer but did not result in artificial infection periods. Weeds in the area were controlled by paraquat applied before bud burst in early September and by hand hoeing at other times.

Results

Nine infection periods were recorded resulting in severe scab infection in the unsprayed plots. The incidence of disease was low in all sprayed treatments with clortriafol, A7402A and RO151297 controlling apple scab completely when used as protectant or eradicant sprays (Table 2).

There was no significant difference in efficacy between the EBI fungicides whether applied on protectant or eradicant schedules, but all schedules were more effective than the protective program of mancozeb. Similar trends occurred with scab severity as the most severe infections were found in plots sprayed with mancozeb.

Powdery mildew developed on more than half of the plants in the unsprayed plots.

All EBI fungicides controlled powdery mildew compared to the unsprayed treatment with protectant sprays being more effective than those based on the eradicant schedule (Table 2). Mancozeb also had an inhibitory effect on powdery mildew as there was less disease in both protectant and eradicant treatments of mancozeb compared to the unsprayed. No phytotoxicity or growth-inhibiting effect were detected in any treatment.

Discussion

These results have demonstrated that a field planting of Granny Smith seedlings naturally infected with apple scab and powdery mildew is a convenient means of evaluating and comparing the efficacy of newly developed fungicides. By using close planted, 1-year-old seedlings and spraying alternate rows to reduce cross contamination by spray drift between treatments, it was possible to evaluate eight fungicides, each with five replicates, in an area of approximately 500 m^2. This system is most appropriate for preliminary screening experiments or determining more precisely the eradicant properties of fungicides. Dosing the area with infected leaves ensured that the naturally produced inoculum was evenly dispersed and resulted in infection throughout the trial area. In addition, infection periods resulting from rain were accurately determined by monitoring temperature and periods of leaf wetness within the foliage.

The development of both apple scab and powdery mildew in unsprayed barrier rows also ensured that each plot was subject to high levels of inoculum.

Although there was no evidence of vapour activity confounding the results in the present experiment, this possibility should be considered in the layout of treatments in a relatively small trial area. For example, in trials in vines Wicks (unpublished data) and McQuinn (unpublished data) found less powdery mildew developed in unsprayed vines adjacent, but down wind of treated vines compared to mildew in unsprayed vines also adjacent but upwind of vines sprayed with fungicide.

The results reported here show that all fungicides warrant further evaluation. This needs to be done on bearing trees, particularly in the light of recent work by Lock and Andrews (1986) and others who have shown some EBI fungicides severely reduce the yield of apples.

The present results confirm other studies (Davis *et al.* 1985; O'Leary *et al.* 1986; Locke and Andrews 1986; and Wicks and Nitschke 1986) which showed that EBI fungicides are effective for the control of apple scab and powdery mildew. With further development and commercial release of these fungicides the EBI fungicides are likely to dominate fungicide use on apples in the future. Because of the development of strains of apple scab resistant to the EBI fungicide (Stanis and Jones 1985; Thind *et al.* 1986) fungicide mixtures of materials with different modes of action as well as programs that are unlikely to shift fungal populations towards reduced sensitivity to the EBI fungicides should be encouraged.

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