EVALUATION OF FUNGICIDES FOR CONTROL OF *ACREMONIUM* SP. AND *ALTERNARIA* SP. FLOWER SPOTTING ON CALLA LILIES

M. BRAITHWAITE[1], K.W.L. KNIGHT[1], D.J. SAVILLE[2] and B.J.R. ALEXANDER[1]

[1] *N.Z. Plant Protection Centre, MAF Quality Management, P O Box 24, Lincoln.*
[2] *AgResearch, P O Box 60, Lincoln.*

ABSTRACT

The efficacy of 11 fungicides for protection against fungal infections and/or controlling newly established infections of *Acremonium* sp. and *Alternaria* sp. on calla lily flowers (*Zantedeschia* sp.) was assessed in a greenhouse pot trial. Each fungicide was applied either 1 day before or 1 day after inoculation with fungal spores. Benomyl, chlorothalonil, difenoconazole, E2752, fluazinam, mancozeb, prochloraz and terbuconazole, with the addition of a wetting agent, applied as either protectants or eradicants, reduced disease severity caused by *Acremonium* sp. Cyprodinil, E2752, fluazinam, mancozeb, prochloraz and terbuconazole protected against *Alternaria* sp. infection. Chlorothalonil, difenoconazole, mancozeb, prochloraz and terbuconazole controlled new infections caused by *Alternaria* sp.
Keywords: *Zantedeschia*, *Acremonium*, *Alternaria*, fungicides, disease control

INTRODUCTION

Flower spotting on calla lilies (*Zantedeschia* species) has been identified as an important problem in many calla growing areas of New Zealand and considerable losses have been reported (S. Ensore pers. comm.). Canterbury growers had an estimated 100,000 blooms rejected for export in 1993. Growers have observed that the occurrence of spotting is often associated with prolonged wet or humid periods and can develop either in the field or later in storage. Many of the commonly grown cultivars are affected. Recent research has identified several fungi (*Acremonium* sp., *Alternaria* sp. and *Botrytis cinerea* Persoon) associated with flower spotting (Braithwaite unpublished; Knight *et al.* 1995). *B. cinerea* has been observed throughout the calla growing areas of New Zealand, whereas *Acremonium* sp. is most commonly found in the South Island and *Alternaria* sp. in the North Island (Braithwaite unpublished).

Many growers have experienced difficulty in controlling flower spotting. This paper reports on the results of a pot trial which evaluated the efficacy of 11 fungicides, applied either prior to or after inoculation with fungal spores, in controlling flower spot caused by *Acremonium* and *Alternaria* species.

METHODS

Three separate fungicide trials (1. *Acremonium* pre-inoculation, 2. *Acremonium* post-inoculation, 3. *Alternaria* pre- and post-inoculation) were conducted on 3-month-old flowering calla lily plants, (cultivar "black magic"), in an environmentally controlled greenhouse at Lincoln. Single plants were grown from tubers, pre-dipped in GA_3 at 100 mg/l to promote flowering, and planted in a bark/sand/soil mix in black polythene PB8 planter bags.

Spore suspensions of *Acremonium* sp. and *Alternaria* sp. were prepared from 2-week-old cultures grown on prune extract agar (PEA) using a 0.1% aqueous solution of Tween 20 as a wetting agent. Resultant suspensions, adjusted to 1×10^4 spores/ml,

were applied to flowers to the point of run-off using a badger air brush applying 0.3 ml/sec at 6.7 kPa. Immediately after inoculation, a plastic bag was placed over each plant to maintain a high relative humidity (necessary for infection). Bags were removed 3 days later.

The protectant and erradicant properties of 11 fungicides (Table 1) were tested. Pre-inoculation fungicide treatments or water controls were applied 1 day prior to pathogen inoculations. Post-inoculation fungicide treatments or water were applied 1 day after pathogen inoculations. All fungicide treatments included the wetting agent Tween 20 at a concentration of 0.1%. All treatments were applied to flowers to the point of run-off with a Home and Garden Trigger, hand-held pneumatic sprayer. An untreated control was included in Trial 1 to ensure that no pre-existing infections occurred. Treatments for each of the three trials were arranged in a randomised block design. Each fungicide treatment was replicated four times. The untreated control was replicated eight times in Trial 1, and the water control was replicated 8, 12, and 20 times in Trials 1, 2 and 3 respectively. Each replication consisted of a single flower.

Plants were assessed for disease severity 7 and 14 days after pathogen inoculation. The total number of lesions per flower (disease severity) was recorded. Data were subjected to a square root transformation prior to analysis of variance.

TABLE 1: Fungicides applied to calla lilies.

Common name	Trade name	Percent ai	Application rate (g ai/100 litres)
vinclozolin	Ronilan	50	50
cyprodinil	Chorus 50WG	50	25
captan	Captan 50 WP	50	100
terbuconazole	Folicur	25	19
chlorothalonil	Bravo FL	50	150
benomyl	Benlate	50	25
prochloraz	Octave	50	50
E2752	(experimental)	50	100
mancozeb	Mancozeb 80 W	80	160
difenoconazole	Score 250 EC	10	5
fluazinam	Shirlan	50	200

RESULTS

The disease severity on plants inoculated with *Acremonium* sp. was high (mean of 150 spots per flower) in the absence of fungicides (Table 2). Benomyl, chlorothalonil, difenoconazole, E2752, fluazinam, mancozeb, prochloraz and terbuconazole, applied as either protectants or eradicants significantly ($P<0.05$) reduced the disease severity caused by *Acremonium* sp. compared to the water control. Cyprodinil and vinclozolin showed no protectant or eradicant activity against *Acremonium* sp. and captan had no protectant effect against this pathogen.

The severity of the disease caused by the *Alternaria* sp. was low (mean of 13 spots per flower) in the absence of fungicides. Mancozeb, prochloraz and terbuconazole, applied as either protectants or eradicants, significantly ($P<0.05$) reduced the severity of *Alternaria* sp. compared to the control. Cyprodinil, E2752 and fluazinam significantly ($P<0.05$) reduced the disease severity of *Alternaria* sp. when applied as protectants, and chlorothalonil and difenoconazole significantly ($P<0.05$) reduced the disease severity of *Alternaria* sp. when applied as eradicants. Benomyl and vinclozolin had no effect on the disease severity of *Alternaria* sp. Chlorothalonil and difenoconazole had no protectant activity against *Alternaria* sp., and benomyl, cyprodinil, E2752 and fluazinam had no eradicant activity against *Alternaria* sp.

A pale orange spotting was observed on flowers treated with one formulation of fluazinam when applied at the recommended rate. The problem was avoided when the

wetting agent was not used in the spray mix and an alternative formulation used. No other phytotoxicity problems were observed with any of the other treatments.

TABLE 2: Disease severity[1] caused by *Acremonium* sp. (Trials 1 and 2) and *Alternaria* sp. (Trial 3) on calla flowers (cv. Black magic), where fungicides were applied either one day prior to, or one day after spore inoculation.

Treatments	Trial 1 (*Acremonium*) Pre-inoculation (1 assessment)		Trial 2 (*Acremonium*) Post-inoculation (Mean of 2 assessments)		Trial 3 (*Alternaria*) Pre-inoculation (Mean of 2 assessments)		Trial 3 (*Alternaria*) Post-inoculation (Mean of 2 assessments)	
1. water control	13.4	(180)[2]	10.9	(119)	3.6	(13)	3.6	(13)
2. vinclozolin	13.2	(174)	8.2	(67)	1.6	(2)	2.2	(5)
3. cyprodinil	16.5	(272)	7.9	(62)	1.1*	(1)	1.4	(2)
4. captan	17.3	(299)	-	-	-	-	-	-
5. terbuconazole	0.9*	(1)	0.7*	(1)	0.0*	(0)	0.2*	(0)
6. chlorothalonil	0.0*	(0)	0.7*	(1)	3.1	(9)	0.7*	(1)
7. benomyl	1.9*	(4)	1.6*	(3)	6.4	(41)	1.4	(2)
8. prochloraz	0.0*	(0)	2.2*	(5)	0.0*	(0)	0.4*	(0)
9. E2752	0.0*	(0)	0.8*	(1)	1.3*	(2)	1.6	(3)
10. mancozeb	0.0*	(0)	0.9*	(1)	0.0*	(0)	0.3*	(0)
11. difenoconazole	0.4*	(0)	0.9*	(1)	1.5	(2)	0.8*	(1)
12. fluazinam	0.0*	(0)	2.3*	(5)	1.0*	(1)	2.3	(5)
13. untreated control[3]	0.0*	(0)	-	-	-	-	-	-
Treatments included in statistical analysis (set A)	1 - 4		1 - 3		All except 5, 8, 10			
LSD (5%) values								
Water vs. one fungicide (set A)	11.9		5.7		2.3		2.3	
Water vs. one fungicide not in (set A)	6.9		2.9		0.9		0.9	

[1] Mean number of lesions per flower.
[2] Square root transformed means are presented, with backtransformed means in parentheses.
[3] Untreated control = no fungal inoculation.
***** Indicates treatment significantly different from water control at $P<0.05$.

DISCUSSION

Under similar inoculation conditions, there was considerable difference between the disease severity caused by the two fungi. In the absence of fungicides *Acremonium* sp. produced severe disease symptoms, with a mean of 150 spots per flower whereas *Alternaria* sp. produced a mean of 13 spots per flower. The symptoms caused by *Acremonium* sp. were similar to those observed in the field and suggest this fungus may be the more aggressive pathogen, especially under conditions of high humidity. Little is known about the epidemiology of *Acremonium* sp. on calla lilies. Since this is a recently identified pathogen of this crop (Knight *et al.* 1995), further research aimed at determining the life cycle of this fungus is required.

In these trials, the traditional protectant fungicides chlorothalonil and mancozeb provided effective disease eradiation of both *Acremonium* sp. and *Alternaria* sp. when

applied one day after inoculation. This was an unexpected result since neither of these fungicides become systemic within the plant. In previous inoculation trials (Braithwaite unpublished), *Acremonium* sp. was shown to produce visual disease symptoms two days after inoculation. Therefore, sufficient time was allowed for the infection process to begin when fungicides were applied in Trial 2. Possibly the thin structure of the flower or some aspect of the infection process with *Acremonium* sp. or *Alternaria* sp. may explain this observation.

These three trials have identified fungicides capable of protecting against and controlling new infections of both fungi tested. Fluazinam, E2752, mancozeb, prochloraz and terbuconazole provided protection against both pathogens. In contrast, the fungicides chlorothalonil, difenoconazole, mancozeb, prochloraz and terbuconazole controlled new infections of both fungi. This provides calla growers with a range of fungicides from different chemical groups and with different modes of action (protectant and systemic) to control these diseases. Pathogen strains may develop that are resistant to some of these fungicides, and growers should adopt strategies that would minimize such an occurrence (Hartill 1995).

These fungicides were evaluated in controlled environmental conditions. They now need to be tested under commercial growing conditions at several sites throughout New Zealand to allow a reliable spray programme to be developed for growers.

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