CONTROL OF LEAF SPOTS IN CARROTS AND EARLY BLIGHT IN POTATOES AND TOMATOES WITH DIFENOCONAZOLE

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SUMMARY

Trials were carried out with difenoconazole for the control of *Alternaria/Cercospora* leaf spots in carrots and early blight (*Alternaria solani*) in potatoes and tomatoes. Difenoconazole at 75-125 g/ha gave better control of fungal leaf spots in carrots than the standard protectant mancozeb. Early blight in potatoes and tomatoes was controlled by difenoconazole at 75-250 g/ha applied at a 7-14 day spray interval. This was comparable to, or better than, the standard mancozeb. A 125 g/ha rate of difenoconazole applied at 21 day intervals in carrots and 14 day intervals in potatoes and tomatoes gave optimum level of control of these diseases.

Keywords: difenoconazole, leaf spots, carrots, early blight, potatoes

INTRODUCTION

Leaf spots of carrots are caused by two fungal pathogens *Cercospora carotae* (Passerini) Kaznowski & Siemaszko and *Alternaria dauci* (Kuehn) Groves & Skolko. These are major diseases of carrot crops which can cause complete collapse of the foliage with consequent lower yields and difficulty in harvesting. *Cercospora* leaf spots are brown to grey in colour and more prevalent on young leaves. This disease is favoured by warm humid conditions. *Alternaria* leaf spots are dark brown to black in colour and more common on older leaves. This disease is more prevalent under cool, wet conditions. Infection from both diseases spreads rapidly in wet windy weather. Regular applications of protectant fungicides are normally carried out to control these diseases.

Early blight caused by *Alternaria solani* (Ellis & Martin) Sor., is a disease found wherever potatoes and tomatoes are grown. Brown to black circular dry papery lesions are most often found on older leaves of plants. Older lesions may have concentric raised rings and angular margins defined by the leaf veins. The entire leaf can become chlorotic and later necrotic and, when the disease is severe, plants are often desiccated. Regular spraying with protectant fungicides is carried out to control this disease.

Difenoconazole is a broad spectrum systemic triazole fungicide. It is especially active against *Alternaria* and other leaf spot diseases. Difenoconazole has been tested in New Zealand since 1987 under field conditions on various crops. Previous work reported its efficacy against stemphylium leaf spot (*Stemphylium vesicarium* (Wallr.) Simmons) in asparagus (Follas and Beetz 1991) and blossom blight (*Monolinia fructicola* (Wint.) Honey) in stonefruit (Gawith and Tate 1989). This paper reports on further work with difenoconazole for the control of leaf spots in carrots and early blight in potatoes.

METHODS

Carrots

Three trials were carried out to investigate the control of leaf spots in carrots in the South Auckland and Manawatu areas in 1989 and 1990, on the cultivars 'Manchester Table' and 'Chantenay Red Core'. The trial designs were randomised complete blocks with four-six replicates and 6.5-15 m² plots. Applications of difenoconazole (Score 250 EC) and mancozeb (Dithane M45 80 WP) were made in the equivalent of 300-750 litres of water/ha with a precision CO₂ pressurised backpack sprayer at 300-500 kPa pressure. All treatments in 1990 were applied with a wetting

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agent at 0.025% v/v. Four applications were made from February to April at 17-24 day intervals. Assessments were made at regular intervals for percent leaf area infected on 5-25 plants/plot. Yield evaluations were made by harvesting 1 m² quadrats/plot. The fresh weight of green foliage and carrot root yield were measured.

Potatoes/Tomatoes

During the 1988-89 seasons, five trials were carried out to measure control of early blight; four on potatoes in South Auckland, Hawkes Bay and Manawatu regions and one on tomatoes in the Waikato. The trials were on the potato cultivars 'Rua' and 'Whitu' and the tomato cultivar 'Lucy'. Trial designs were randomised complete blocks with four replicates and 15-30 m² plots. Applications of treatments were made in the equivalent of 500-1000 litres of water/ha with a precision CO₂ pressurised backpack sprayer at 300-500 kPa pressure using hollow cone nozzles. Metalaxyl (to control late blight) and standard insecticides were applied as required over the trial blocks. Depending on the crop growth stage at commencement, three-six applications were made at 7-14 day intervals from late flower (January-February) to early crop senescence (March-April). The trials were commenced prior to, or at, the very first signs of disease. Assessments of the percent leaf area diseased (LAD) were made on 5-10 laterals/plant and 5-10 plants/plot at regular intervals. Yields were assessed in the Manawatu trial by harvesting 9m²/plot.

Statistical analysis was by analysis of variance with mean separation by Duncan's multiple range ($P < 0.05$, $P < 0.01$) with arcsine transformed data where appropriate. All results reported are as untransformed means.

RESULTS AND DISCUSSION

Carrots

Two diseases were identified on the carrot leaves, with *Alternaria* found initially on older leaves lower in the canopy and *Cercospora* occurring on the younger leaves. The diseases were assessed as one leaf spot complex and no attempt was made to separate out the diseases.

Difenoconazole treatments reduced the level of infection ($P < 0.01$) from leaf spots compared with the untreated (Table 1). There was a distinct rate effect with higher rates having lower levels of infection. Difenoconazole at all rates tested had lower levels of infection than the standard protectant fungicide, mancozeb. This was statistically significant ($P < 0.01$) at the 100 and 125 g/ha rates.

TABLE 1: Mean percent leaf area of carrots with leaf spot disease (1989-1990)

Treatment	Rate (g ai/ha)	% leaf area diseased		
		1989	1990	
		South Auckland 28 DAT	Manawatu 23 DAT	Manawatu 14 DAT
difenoconazole	75	41.5 bcBC	15.4 cBC	
difenoconazole	100	31.9 cdCD	13.5 cC	
difenoconazole	125	21.8 dD	9.5 cC	14.5 bB
mancozeb	2400	52.8 abAB	27.8 bB	40.1 aA
untreated	—	63.6 aA*	68.3 aA	46.4 aA

*means in each column followed by the same letter are not different ($P > 0.05$ in lower case, $P > 0.01$ in capitals)

The weight of carrot foliage (Table 2) reflected the level of disease control and was a reliable and direct, objective, measurement to differentiate between fungicide treatments for the level of disease infection. The 100 and 125 g/ha rates of difenoconazole produced higher foliage weights ($P < 0.01$) than either the untreated or mancozeb treatments.

There was no difference ($P>0.05$) in root yields between fungicide treatments and the untreated plots in the South Auckland trial. In the Manawatu trial all rates of difenoconazole increased the root yield and weight/root ($P<0.01$) compared with the untreated plots (Table 2). Only in the 1990 trial was there a difference ($P<0.05$) in root weights between difenoconazole and mancozeb treatments, due to the large difference in leaf infection. There was no difference in yields between the three rates of difenoconazole ($P>0.05$). It appeared that the carrot crop could sustain a loss of significant proportions of foliage before yields were dramatically reduced.

TABLE 2: Yields of roots and foliage fresh weight of carrots after fungicide treatment for control of leaf spots (1989-1990).

Treatment	Rate (g ai/ha)	1989				1990		
		South Auckland		Manawatu		Manawatu		
		foliage t/ha	foliage t/ha	roots t/ha	weight g/carrot	foliage t/ha	roots t/ha	weight g/carrot
difenoconazole	75	14.8 BC	33.8A	177 A	372 A			
difenoconazole	100	22.6 A	36.0A	175 A	372 A			
difenoconazole	125	18.9 AB	37.5A	178 A	372 A	17.3 A	133.6 A	334 A
mancozeb	2400	10.9 C	28.0B	174 A	365 A	7.5 B	106.5 AB	240 AB
untreated	–	11.0 C*	11.0C	131 B	300 B	5.2 B	99.6 B	210 B

* means in each column followed by the same letter are not different ($P>0.01$ in capitals)

Potatoes/Tomatoes

Trials carried out in 1988 using three rates of difenoconazole and two spray intervals demonstrated an excellent reduction in early blight infection from multiple applications initiated as preventative treatments. Difenoconazole at all rates and spray intervals tested gave lower levels of disease than untreated ($P<0.01$) (Table 3). There was no difference ($P>0.05$) between the rates of difenoconazole or between the 7 and 14 day spray interval in the level of disease infection.

The cultivar 'Lucy', used in the tomato trial in 1988, is susceptible to early blight. The untreated plots were heavily diseased on the two lower laterals (15-25% LAD) but less so (0-5% LAD) on the upper eight laterals. Difenoconazole and mancozeb treatments had lower levels of disease infection ($P<0.01$) compared with the untreated (Table 3) and the disease in these treatments was uniformly distributed throughout the plant canopy. Difenoconazole at all rates and spray intervals tested gave lower ($P<0.05$) disease levels than the standard mancozeb. There was no difference ($P>0.05$) between the rates or spray intervals with difenoconazole.

Trials in 1989 on potatoes (Table 4) with three rates of difenoconazole applied at 14 day spray intervals again showed excellent reductions in the level of early blight infection. All rates of difenoconazole reduced ($P<0.05$) the level of early blight compared with untreated, with higher rates having lower disease levels. Although difenoconazole at 125 and 250 g/ha had lower levels of disease than the mancozeb treatments, this was significant only for the 250 g/ha rate in one case (Table 4). Higher tuber yields from the difenoconazole treated crops were also not significantly greater ($P>0.05$) than those of mancozeb or untreated plots. This demonstrated the variability that often occurs in potato crop yields, and the difficulty in isolating the effect of one pathogen out of all the factors that may affect crop yields.

TABLE 3: Mean percent leaf area diseased by early blight infection on potatoes and tomatoes (1988)

Treatment	Rate (g ai/ha)	Spray interval days	% leaf area diseased		
			potatoes		tomatoes
			South Auckland 38 DAT	Hawke's Bay 5 DAT	Waikato 6 DAT
difenoconazole	75	7	0.45 cC	13.8 bB	0.33 cB
difenoconazole	125	7	0.17 cC	7.8 bB	0.16 cB
difenoconazole	125	14	—	—	0.40 cB
difenoconazole	250	14	0.39 cC	6.3 bB	0.52 cB
mancozeb	1600	7	2.53 bB	8.8 bB	1.87 bB
untreated	—	—	8.52 aA*	58.8 aA	8.02 aA

* means in each column followed by the same letter are not different (P>0.05 in lower case, P>0.01 in capitals)

TABLE 4: Mean percent leaf area diseased by early blight infection and yield of potatoes (1989)

Treatment	Rate (g ai/ha)	Spray interval days	% leaf area diseased		Tuber yield
			South Auckland 14 DAT	Manawatu 14 DAT	Manawatu t/ha
			14 DAT	14 DAT	t/ha
difenoconazole	75	14	0.19 bA	15.0 bB	24.0 a
difenoconazole	125	14	0.11 bA	10.0 bcBC	25.5 a
difenoconazole	250	14	0.07 bA	5.0 cC	25.5 a
mancozeb	1600	14	0.73 abA	14.4 bB	22.6 a
untreated	—	—	1.12 aA*	25.0 aA	22.1 a

* means in each column followed by the same letter are not different (P>0.05 in lower case, P>0.01 in capitals)

CONCLUSIONS

Multiple applications of the systemic fungicide difenoconazole gave effective control of the leaf spot complex in carrots and early blight in potatoes and tomatoes. Difenoconazole was superior to the standard mancozeb for control of these diseases. A rate of 125 g/ha, with a spray interval of 21 days for carrots and 14 days for potatoes and tomatoes, appeared to give an optimum level of disease control.

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