CONTROL OF BLACK FRUIT ROT OF STRAWBERRY

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SUMMARY

In laboratory screening of nine fungicides, dichlofluanid, captan and procymidone were found to be highly effective for the control of black fruit rot (*Colletotrichum acutatum*) of strawberry. In a field trial, dichlofluanid and a mixture of captan/benomyl gave good control of the disease and highest yields. Procymidone and bitertanol did not control the disease effectively. Control strategies are discussed in relation to chemical control and management practices.

INTRODUCTION

Black fruit rot of strawberry caused by *Colletotrichum acutatum* was first recorded in New Zealand in 1977 (Soteris 1981). During the 1978-79 season, the disease was found in Horowhenua on second year strawberry crops. In subsequent years it was commonly observed, but did not appear to cause any yield loss. It was not until 1981-83 seasons that the disease caused significant fruit losses and growers were concerned about the disease.

The disease has not been recorded elsewhere on strawberries except in Australia (McGeachan 1977). However, a similar disease caused by *C. fragariae* has been found in U.S.A. (Horn and Carver 1963).

Symptoms

The first symptoms we observed on infected fruit were small water soaked brown spots, 1-2 mm in diameter. As the disease progressed these spots became darker and enlarged into circular or irregular patches. Over 3-4 days under moist, humid conditions, these lesions expanded rapidly to cover most of the fruit. Mycelium extended around the edge of the lesion to give it a furry appearance. Masses of spores, pink to orange in colour, were produced in the centre of the lesions. Under hot, dry conditions the lesions became black and sunken while the spore masses became darker in colour. The dark spore masses give the disease its name. These symptoms are very similar to those described by McGeachan (1977).

Symptoms are generally found on ripening fruit, but occasionally they have been observed on unripened fruit. The fungus has also been found to cause black lesions on stolons and petioles of runner plants in the nursery (Soteris 1981). The disease has been found on all strawberry varieties examined. Black rot can be latent on the fruit when picked, with symptoms developing during storage.

The Pathogen

Black fruit rot of strawberry is principally a warm weather disease. The fungus produces abundant fruiting bodies (acervuli) and spore masses on the lesions during warm moist conditions. The spores are easily released and dispersed by water drops in wind and rain. A similar spore release pattern was also reported by McGeachan (1977). The fungus grows and reproduces quickly within infected fruit, which soon become dry and mummified. From observations, the fungus is able to remain alive for a long period on these mummified fruit, and may survive in this way over the winter period.

It was found in laboratory tests, that a large number of *C. acutatum* spores can be released from mummified fruits by water drops. These spores can germinate within 24 h in moist conditions.

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MATERIALS AND METHODS

Laboratory Screening

Ripe, unblemished and healthy strawberry fruit cv. 'Red Gauntlet,' complete with stalks were used in the trial.

TABLE 1: Laboratory screening of fungicides for control of black fruit rot of strawberries.

Chemical Common name	Chemical Trade name	Rate (g ai/litre)	% Fruit rot control
benomyl	Benlate 50WP	0.18	25
bitertanol	Baycor 50WP	0.40	48
captafol	Difolatan 50F	1.00	30
captan	Captan 80WP	1.00	60
dichlofluanid	Euparen 50WP	1.00	68
myclobutin	BAS 436.04F	0.35	38
procymidone	Sumislex 25F	0.50	58
triforine	Saprol 20EC	0.25	28
vinclozoline	Ronilan 50WP	0.50	48
inoculated-control	—	—	0
MSD 5%			18

Suspensions of fungicides were prepared in beakers at concentrations shown in Table 1 and the fruit were dipped into these fungicide suspensions and allowed to dry.

The treated fruits were then inoculated with the fungus by dipping them into a spore suspension of *C. acutatum* (10^5 /ml) prepared from pure cultures. Ten fruit were used for each fungicide treatment. Treated fruit were then incubated at room temperature ($20 \pm 2^\circ$) under high humidity in air-tight plastic containers. Fruits from each treatment were kept in separate containers. Controls were also included in each test by dipping the fruit in water.

Disease assessments were made 5 days after the treatment by counting the number of diseased fruit. This experiment was repeated four times to give a total of 40 fruit per treatment.

TABLE 2: Efficacy of fungicides in control of black fruit rot and subsequent yield of strawberry fruit.

Chemical	Rate (g ai/100 l)	% Diseased fruit by wt.	Total marketable yield (t/ha)
bitertanol	30	27.2	21.4
captan + benomyl	100 + 17.5	10.4	26.3
dichlofluanid	100	5.0	27.9
procymidone	37.5	34.7	15.8
untreated control	0	32.7	18.3
MSD 5%		6.2	4.0

Field Trial

First year strawberry plants cv. 'Red Gauntlet' were used in the trial. The trial was planted out in June 1983 in Levin silt loam at Levin Horticultural Research Centre, on raised beds covered with black polythene. Single row plots were 5 m in length. The experimental design was a randomised block with four replications.

Plants were inoculated with spore and mycelium suspensions (10^5 /ml) from pure cultures of *C. acutatum*. Fungicides (Table 2) were then applied to run-off with a knapsack sprayer. The spray programme was commenced on 29 November 1983, a total of five applications being made at 10 day intervals.

Disease severity was assessed by recording the weight of diseased fruit at each harvest. Fruit yields were determined by weighing the marketable fruit.

RESULTS

Laboratory Screening

Dichlofluanid was the most effective fungicide for control of black fruit rot (Table 1). Captan and procymidone were not significantly inferior to dichlofluanid. The other fungicides were less effective in controlling the disease.

Field Trial

In the field trial, dichlofluanid and a mixture of captan/benomyl gave good control of fruit rot and significantly higher yields of marketable fruit (Table 2). Bitertanol and procymidone did not control the disease effectively.

DISCUSSION

The effectiveness of dichlofluanid in controlling black fruit rot confirms the previous test results (Soteros 1981). In the field trial, dichlofluanid and a mixture of captan/benomyl gave good control of the disease. Although captan alone was shown to be effective against the fungus in the laboratory tests, the combination of captan and benomyl was included in the field trial as it has been recommended to control the disease in Australia (McGechan 1977). This mixture has also been recommended for control of other diseases, including powdery mildew and *Mycosphaerella* leaf spot (Hartill *et al* 1983). The effectiveness of this combination was apparently due to captan, as benomyl alone gave poor control in the laboratory tests.

Overseas, benomyl, captafol and captan have been recommended for control of *C. fragariae* (Howard 1971). Although dichlofluanid is not recommended in New Zealand for use on export strawberry crops, it can be incorporated into the spray programme for use in the pre-blossom or post harvest period. Captan and benomyl are used in spray programmes for export crops to control other diseases. They could, therefore, be used to control black fruit rot during fruiting periods.

Spores are spread by water splash, and, therefore overhead irrigation should be avoided as this is likely to spread the disease. As the fungus can survive over winter in mummified fruits, removal of these fruits and other infected plant debris at the end of the season could reduce inoculum considerably for the next season. The combination of chemical applications and good management practices will provide more effective control of the disease.

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