SCREENING OF PLANT EXTRACTS FOR CONTROL OF POWDERY MILDEW IN SQUASH

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Powdery mildew of squash, caused by *Sphaerotheca fuliginea*, is a common and serious disease throughout New Zealand according to a survey by the Fresh Vegetable Research and Development Committee (unpublished data). The disease can reduce photosynthetic area of leaves, and in severe cases, defoliate plants, effects that are likely to reduce yield and quality of fruit (Cohen *et al.* 1993).

Methods for disease control currently available to commercial growers include repeated applications of elemental sulphur or demethylation inhibitor (DMI) fungicides, but these do not always provide adequate disease suppression (R. Wood, pers. comm.). It is possible that the lack of control may be due to fungicide-resistant strains of powdery mildew fungi in squash crops. Fungicide resistance in populations of cucurbit powdery mildew has been reported in Australia (O'Brien *et al.* 1988; O'Brien 1994) and the USA (Paulus *et al.* 1976). Furthermore, the increasing concerns for public health, the environment and the expanding competition in the agricultural market motivates growers to seek disease control strategies that use reduced amounts of synthetic fungicides. For these reasons there is a need for new and effective means of disease control that pose less risk to human health and the environment.

Plant extracts, including vegetable oils, have been used to control powdery mildew in cucurbits (Martin and Salmon 1930) and extracts of the giant knotweed plant, *Reynoutria sachalinensis*, have been shown to be effective in controlling the disease on apple, begonia and cucumber (Herger *et al.* 1988). Other materials including sodium bicarbonate (Currey 1924), mineral oil (Elmer and Ferrandino 1993) and potassium silicate (Menzies *et al.* 1992), have also been shown to reduce the severity of powdery mildew infection. This paper reports the screening of these materials and some biological control agents for control of powdery mildew in squash.

Dried and milled preparations of the leaves of *Reynoutria* were supplied by Dr I. Harvey of AgResearch, Canterbury Agricultural Science Centre, Lincoln. Extracts were prepared by adding the powder to tap water at the required rate (Table 1). The preparation was left to stand for 1 h and then filtered through two layers of cheese cloth. This filtrate was used to treat the squash leaves. Vegetable oils were purchased from a local pharmacy. Solutions were prepared by adding the oil to distilled water at the required rate and shaking the mixture well before use.

Biological control agents used were isolates which have previously been shown to be effective against *Botrytis cinerea* or *Penicillium* spp. (Cheah and Tran 1995). Cultures of individual isolates to be tested were grown on nutrient yeast dextrose agar plates (NYDA: 20 g of agar, 8 g of nutrient broth, 4 g of yeast extract, 1.5 g of dextrose and 1 litre of distilled water) for 2 days. Cell suspensions of the isolates were made by taking a loop of the culture diluted in sterile distilled water in a test tube and the cell concentrations were adjusted to about 1×10^7 cells/ml.

Squash *(Cucurbita maxima)* plants were raised in a glasshouse at Levin Research Centre until 6-8 weeks old. Treatments were applied by brushing the extract filtrates, oil suspensions or cell suspensions of biological control agents onto the leaves with paint brushes. After the leaves had dried (1.5 h), each leaf was inoculated with spores of *S. fuliginia* from diseased leaves by brushing with a paint brush.

In the preliminary screening, five leaves per treatment per plant were used. The procedure was repeated to provide two replicates of each treatment. For final tests, similar methods were used except that each treatment was replicated five times. Disease assessments were made by estimating the percentage of leaf infection on each leaf 7 days after incubation at 24°C in a glasshouse. Data were analysed using GLM procedures of the Genstat package.

Over 20 plant extracts, 10 biocontrol agents and 10 chemicals were screened. Three plant extracts and one isolate of *Acremonium* sp. showed promising control of powdery mildew. These four materials (Table 1) were tested again on squash plants using the above methods. In this test, triadimefon (Bayleton 5DF), a recommended fungicide was included for comparison and water was to find out whether it could suppress the disease as claimed (Jarvis and Slingsby 1977). Plants in the water treatment were continuously wetted for up to 24 h after inoculation by intermittent misting with water.

Results showed that three plant extracts significantly reduced powdery mildew from 30% to about 1% (Table 1). *Reynoutria* extracts and olive oil were the most effective in controlling the disease. No phytoxicity was observed on the treated plants.

TABLE 1: Effect of plant extracts, water and *Acremonium* sp. on incidence of powdery mildew in squash.

Treatment	Rate (per litre)	Percentage infection
Reynoutria extract	20.0 mg	1.3 d[1]
Olive oil	20.0 ml	1.8 d
Rapeseed oil	20.0 ml	3.0 c
triadimefon (5DF)	1.0 g	16.1 b
Water	-	23.2 a
Acremonium sp.	1×10^7 spores/ml	23.7 a
Untreated control	-	29.8 a

[1] Any two means followed by the same letter are not significant at $P<0.05$

Our results agree with those obtained by Herger *et al.* (1988) with *Reynoutria* extract, and by Haberle and Schlösser (1993) with rapeseed oil. Our results also show that olive oil is an effective treatment; this appears to be the first report of powdery mildew control with olive oil. The mode of action of these plant extracts is still unknown (Herger *et al.* 1989; Haberle and Schlösser 1993).

Water has been implicated in the suppression of powdery mildew (Jarvis and Slingsby 1977), but in our trials it was relatively ineffective. This indicated that the effectiveness of *Reynoutria* extract was due to the extract and not water. In our preliminary screening, *Acremonium* sp. reduced disease incidence, but it did not perform as well in this trial. *Acremonium alternatum* has been shown to be effective for control of powdery mildew in cucurbits (Malathrakis 1985).

If these plant extracts (Table 1) perform as well on field crops, as in glasshouse tests, they would be good substitutes for fungicides, or could be mixed with fungicides for the control of powdery mildew, to avoid the problem of resistance to fungicides in *S. fuliginea*.

The use of plant extracts for control of powdery mildew would be seen as a positive response to public concern about the adverse effects of pesticides on human health and in the environment. For example, olive oil is used in cooking, as a food additive and medicine. It is therefore unlikely to cause human health or environmental problems.

Further work is planned to test these extracts on squash plants in the field and to study the mode of action.

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RELEASE AND ESTABL
A PARASITOID OF
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biological control

In New Zealand, the sowthistle a
sowthistle and blackcurrant. Spring
curling damage requiring insecticid
In 1992, biological control was cho
parasitoid *Aphidius sonchi*, which h
and Woolcock 1986), but was no
collected in Australia and reared in t
of parasitoid host range were carrie
submitted to the MAF Regulatory A
(Stufkens and Farrell 1994).

Release of *A. sonchi* was autho
on sowthistle aphids at Lincoln and
(mummies) and adult parasitoids w
market gardens at 1-2 sites in all
Marlborough. First releases were m
1994, and in other regions (Table
Canterbury, where parasitoids w
establishment of *A. sonchi* was surve
were searched at release sites, and
Mummies and live sowthistle aphid
parasitoids emerging from mumm
determined by dissection of c. 100

TABLE 1: Rate of parasitism
sowthistle by *Aphi*
1994 and May 199

Region	%	Novem SE
Waikato	19	2.1
Bay of Plenty	24	3.5
Hawke's Bay	20	1.7
Manawatu	0	-
Marlborough	10	1.3
Nelson	3	0.9
N. Canterbury	0	-
mid Canterbury	0	-
S. Canterbury	0	-
Southland	0	-

n Total aphids dissected