SEEDLING DISEASE OF MARROW STEM KALE CONTROLLED WITH FUNGICIDE SEED TREATMENTS

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SUMMARY

Seven fungicides were tested in glasshouse experiments as seed treatments, applied singly or in combinations, for control of seedling disease of Marrow Stem kale (*Brassica oleracea* var. *medullosa*). Treatments were tested in a field soil of high disease potential, that contained *Rhizoctonia solani* and *Pythium* spp. Seed treatments with mixtures of benodanil and captan (1.5 + 1.5 g/kg seed), fosetyl-Al and iprodione (2.0 + 2.5 g/kg), or metalaxyl and either benodanil, captan, iprodione or tolclofos-methyl (all at 1.5 + 1.5 g/kg), gave good control of both pre- and post-emergence seedling disease. Single fungicide treatments were less effective or of no benefit. Routine seed treatment of brassicas with suitable fungicide mixtures is strongly recommended.

INTRODUCTION

Brassicas (*Brassica* spp.), including kale, rape, swede and turnip cultivars, are used widely in New Zealand as spring or summer sown crops to provide high quality autumn or winter forage for grazing animals (Logan 1983). Vegetable brassicas are also important horticultural crops and some oilseed rape is grown in southern parts of the country (Logan 1983). These plants are susceptible at pre- and post-emergence stages of seedling growth to soil-borne fungi, particularly species of *Pythium*, *Rhizoctonia* and *Fusarium* (Gratz 1925; White *et al* 1984; Kaminsky and Verma 1985; unpublished data). These fungi can cause poor seedling establishment and subsequent crop loss (Gratz 1925; Falloon 1980; Hutchison *et al* 1985).

Although different fungicide seed treatments can control different groups among the fungi that cause brassica seedling disease, complete protection against all fungal pathogens has not been satisfactorily obtained (Falloon 1980; White *et al* 1984; Kaminsky and Verma 1985). Our experiments tested several fungicides, particularly mixtures with components chosen to control different groups of fungi, as seed treatments for control of brassica seedling disease.

MATERIALS AND METHODS

A commercial seed line of Marrow Stem kale (*Brassica oleracea* var. *medullosa*) was used in these experiments. The fungicides (Table 1) were added at required rates to 20 g lots of seed in 250 ml capacity glass flasks. Distilled water (0.3 ml) was added, and flasks were shaken vigorously until all fungicide adhered to seed.

Different fungicide seed treatments were tested in two glasshouse experiments. In Experiment 1, six fungicides were applied at two rates (1.5 or 3.0 g ai/kg seed) and in all possible two-way combinations (1.5 + 1.5 g ai/kg; see Fig. 1A). In Experiment 2 fosetyl-Al (not used in Expt. 1) and iprodione were tested alone at different rates, and in two-way combinations (Fig. 1B). Benodanil and metalaxyl treatments were included for comparisons. Germination of seed from each treatment was assessed (Copeland 1978) prior to each experiment, and at the 4 day germination count overall lengths of 25 seedlings from each treatment including untreated seed were measured.

A standardised pot trial was used for both experiments. A field soil (Lismore silt loam; pH 5.3), which had grown a forage rape (*B. napus* ssp. *oleifera*, cv. Wairangi) seed crop followed by volunteer plants during the previous 2 years, was used. This soil

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TABLE 1: Fungicides tested as seed treatments for control of seedling disease of Marrow Stem kale.

Common name	Product name	Formulation
benodanil	Calirus	50% wettable powder
benomyl	Benlate	50% wettable powder
captan	Orthocide 80	80% wettable powder
fosetyl-Al	Aliette	80% wettable powder
iprodione	Rovral	50% wettable powder
metalaxyl	Apron 35SD	35% wettable powder
tolclofos-methyl	Rizolex	20% dust

was shown in preliminary investigations to contain the virulent brassica seedling pathogens *Pythium acanthicum*, *P. irregulare*, *P. ultimum* and *Rhizoctonia solani* AG2-1. Soil (150 g) was placed into unperforated 250 ml capacity plastic pots. Twenty seeds from each treatment were sown into each of 10 pots and covered with 50 g (1 cm depth) of sieved soil. Pots were placed into controlled temperature waterbaths that maintained soil temperatures at 20°C ($\pm$ 0.2°C). Pots were weighed daily and watered to adjust to 75% water holding capacity, and any damped-off seedlings were counted and removed. At 14 days after sowing, all surviving seedlings in pots were counted. Seedling count data was statistically analysed after arcsine square root transformation.

In Experiment 2, damped-off seedlings grown from untreated seed were collected, and fungi from washed stem bases of diseased seedlings were isolated onto agar media (Skipp *et al* 1986) and identified.

RESULTS

Experiment 1

Germination of seed was 99% and was not affected by any of the seed treatments. In the germination assessment, 4-day-old seedlings grown from iprodione-treated seed at rates of 1.5 and 3.0 g ai/kg were respectively 17 and 27% shorter than untreated ($P < 0.05$). Seedlings from mixtures containing iprodione were similarly affected, but no other treatments affected seedling size.

Data from Experiment 1 are summarised in Fig. 1A. Numbers of seedlings which emerged from untreated seed and survived 14 days after sowing were respectively 61% and 39% of the number of viable seeds sown. All single fungicide treatments except benomyl increased seedling emergence, but only metalaxyl gave fewer damped-off seedlings than untreated seed ($P < 0.05$). Several of the fungicide mixtures increased emergence and decreased damping-off of seedlings. The treatments that gave greatest numbers of healthy seedlings 14 days after sowing (83-91% of viable seeds sown) compared with untreated (39%) were benodanil + captan, iprodione + metalaxyl, captan + metalaxyl, metalaxyl + tolclofos-methyl and benodanil + metalaxyl ($P < 0.05$).

Experiment 2

Germination of both untreated and fungicide treated seed was 93%. Four-day-old seedlings treated with iprodione at rates of 2.5, 5.0 and 17.5 g ai/kg were respectively 19, 23 and 74% shorter than untreated ($P < 0.05$). Combinations containing iprodione at 5.0 g ai/kg had similar effects. No other treatments affected seedling length.

Figure 1B summarises results from Experiment 2. Of the number of viable untreated seed sown, 71% emerged and 41% of seedlings survived 14 days after sowing. Some of the single treatments increased seedling emergence but did not prevent post-emergence damping-off ($P < 0.05$). Treatments with mixtures of benodanil + metalaxyl, fosetyl-Al + iprodione or iprodione + metalaxyl increased emergence and decreased damping-off, giving healthy seedlings from 86-94% of the number of viable seeds sown. Different fungicide rates in these mixtures had no significant effect on numbers of healthy seedlings ($P > 0.05$). Seedlings growing from seeds treated with 17.5 g iprodione/kg were about 2/3 the size of those from untreated seeds.

Fig. 1: Mean numbers of emerged, damped-off and healthy Marrow Stem kale seedlings (from 20 seeds sown) 14 days after sowing seed treated with different fungicides into pots containing field soil. A, Experiment 1; B, Experiment 2. * indicates treatments for which mean numbers of healthy seedlings were different ($P < 0.05$) from nil treatment.

Fungi isolated from 32 damped-off seedlings grown from untreated seed in this experiment included (percent of isolates obtained) *Pythium ultimum* (24%), *P. acanthicum* (12%), a sphaerosporangiate *Pythium* sp. (12%), *P. irregulare* (1%), *R. solani* AG2-1 (13%) and *Fusarium oxysporum* (22%). Fungi infrequently isolated were species of *Acremonium*, *Alternaria*, *Fusarium*, *Mortierella* and *Penicillium*.

DISCUSSION

Effects of seedling disease in these experiments were manifested as death of kale seedlings at both pre- and post-emergence stages of growth. The most effective fungicide seed treatments were those that, when compared with nil treatment, gave high levels of seedling emergence (over 90% of viable seeds sown) and prevented or reduced post-emergence damping-off. These effects resulted in up to 130% more healthy seedlings from fungicide-treated than from untreated seed.

The chemicals tested in these experiments have either general antifungal activity (captan) or are more specific against oomycetes (fosetyl-Al, metalaxyl) or *Rhizoctonia*-like fungi (benodanil, benomyl, iprodione, tolclofos-methyl). The results in Experiment 1 suggest that both *Pythium* spp. and *R. solani* caused pre-emergence death of seedlings as both metalaxyl (active against *Pythium* spp.) and benodanil (active against *Rhizoctonia*-like fungi) increased seedling emergence. In Experiment 2, *Pythium* spp. were more important than *R. solani* at pre-emergence stages, as metalaxyl increased emergence and benodanil did not. Both groups of fungi appear to have caused post-emergence damping-off. None of the fungicides tested alone prevented seedling disease at both pre- and post-emergence stages. However, when mixtures of chemicals with concordant activities against both groups of fungi were applied to seed, seedling survival was maximised.

Some of the chemicals tested have systemic properties (benodanil, benomyl, fosetyl-Al, metalaxyl). The test lasted only 14 days and differences between systemic and non-systemic fungicides were not consistent. However, use of systemic fungicides active against oomycetes has given a 177% increase in numbers of field-grown lucerne (*Medicago sativa*) plants at 3 months after sowing (Falloon and Skipp 1982). It seems likely that systemic chemicals could give similar long term protection to brassica seedlings, and use of these compounds is therefore recommended.

Forage, vegetable and oilseed brassica varieties have a common susceptibility to seedling disease caused by soil-borne fungi. This study has demonstrated that fungicide seed treatments can effectively control seedling disease. Non-systemic fungicides (e.g. captan, iprodione or tolclofos-methyl) may adequately control seedling disease when used in appropriate mixtures. However, it is strongly recommended that systemic fungicides active against oomycetes (e.g. metalaxyl or fosetyl-Al) and *Rhizoctonia*-like fungi (e.g. benodanil) should be used in combination for routine treatments of brassica seed.

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