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Clubroot control in vegetable brassicas using soil-incorporation of fungicides

A report prepared for

The New Zealand Vegetable and Potato Growers' Federation Inc., Crop Care Holdings Ltd and Elliot Chemicals Ltd.

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CROP & FOOD RESEARCH
Mana Kai Rangahau

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CONTENTS

1 EXECUTIVE SUMMARY

The efficacy of four fungicides (benomyl, mancozeb, fluazinam and flusulfamide in nine treatments) as soil-incorporations or soil-drenches for control of clubroot was evaluated on Chinese cabbage 'Wong Bok' in clubroot-infested land. Each fungicide suspension was sprayed onto trial plots, rotary hoed into the soil and plots were then planted with seedlings. The benomyl suspension was drenched about the root system after transplanting seedlings. Soil-incorporation of mancozeb (3.0 kg ai/ha), flusulfamide (1.2 kg and 2.4 kg ai/ha) and fluazinam (2.0 kg ai/ha) reduced clubroot severity. All treatments (except fluazinam @ 1.5 kg ai/ha) gave higher plant top weights than the untreated control. The soil-incorporation technique of fungicide application was less labour-intensive than soil-drenching. It is also a time-saving and cost-effective technique.

2 INTRODUCTION

Clubroot of brassicas, caused by the protozoan *Plasmodiophora brassicae* continues to be a serious problem throughout New Zealand vegetable brassica-growing areas. It has long been recognised as an economically important disease that is difficult to control. Many fungicides have been tested for efficacy against *P. brassicae*. Compounds that have given good control of clubroot include: benomyl, captafol (Tate, 1977; Tate & Cheah, 1983), chlorothalonil, fostyl-Al, thiabendazole and thiophanate-methyl (Humpherson-Jones, 1993). More recently, new fungicides (e.g. fluazinam and flusulfamide) and mancozeb have also been found to be effective (Humpherson-Jones, 1993; Dixon *et al.*, 1994). Of these, only benomyl and a mixture product of chlorothalonil plus thiophanate-methyl are registered in New Zealand as transplant and soil-drench treatments for clubroot control (O'Connor, 1994).

In the last three seasons (1995-97) good clubroot control has been achieved with soil-incorporated calcium cyanamide (Cheah, 1995). We have also found that fluazinam, flusulfamide and mancozeb soil drench treatments gave effective control of the disease (Falloon *et al.*, 1997). Through frequent contact with brassica growers regarding the practical use of these effective fungicides for clubroot control, we were advised that further research was required on more practical methods of fungicide application that are cost-effective and less labour intensive. The objective of this study was to evaluate promising fungicides as a soil-incorporated treatment for control of clubroot.

3 MATERIALS AND METHODS

3.1 Trial establishment

A trial was carried out in clubroot-infested Dannevirke silt loam (pH 6.2) on 10 September 1997 near Levin. The soil was thoroughly cultivated. Fungicide treatments were prepared as suspensions to give the desired concentrations (Table 1). These were band sprayed onto trial plots and then rotary hoed into the soil to a depth of about 15 cm. Chinese cabbage cv. Wong Bok seedlings (8 weeks old) were immediately transplanted into the plot. Control plots were sprayed with water and rotary hoed. Benomyl (standard control) suspension was drenched by hand about the root systems of transplant. Each treatment plot consisted of a single row of 20 plants, spaced at 0.3 m with 1.0 m spacing between rows. The experimental design was a randomised block with five replications. Crop management followed routine commercial practices.

3.2 Disease assessment

Plants were harvested at maturity (24 November 1997) and individual plant top weights were measured. All root systems were lifted and scored for club root on a 0-4 scale, where 0 = healthy roots and 4 = completely clubbed (Fig.2).

3.3 Statistical analysis

A non-parametric test (Kruskal and Wallis, 1952) was used to compare treatments for disease scoring data because of their highly skewed nature. Analysis of variance was used for the top weight data. This method uses the ranking of the observations to compare treatments. Analyses were carried out using the Minitab statistical programme.

4 RESULTS

All the experimental plots were severely infested with clubroot as indicated by generally high scores (4) in all plots (Figs.1 and 3). The non-parametric test indicated that treatments 4 and 6 had reduced ($P < 0.1$) clubroot severity compared to the control and treatments 5 and 9 also gave some reduction ($P \simeq 0.13$ and $P \simeq 0.3$ respectively). The benomyl soil-drench did not control the disease. When comparing individual chemical groups (mancozeb, flusulfamide and fluazinam), flusulfamide gave a lower severity score than mancozeb ($P \simeq 0.11$) and fluazinam ($P < 0.05$). All treatments (except treatment 8) gave greater top weights than the untreated control (Table 1). Treatments 2, 5 and 6 gave significantly heavier ($P < 0.1$) top weights than the untreated control.

Table 1: Mean top weight of Chinese cabbage 'Wong Bok' plants harvested from field plots of clubroot-infested soil to which different fungicide treatments had been applied.

No.	Treatment	Mean top weight[1] (g/plant)
1.	Untreated control (water; soil-incorporated)	245
2.	Benomyl (soil drench; 0.1 g ai/200 mℓ/pl)	383
3.	Mancozeb (soil-inc.; 1.0 kg ai/ha)	293
4.	Mancozeb (soil inc.; 3.0 kg ai/ha)	283
5.	Flusulfamide (soil-inc.; 1.2 kg ai/ha)	362
6.	Flusulfamide (soil-inc.; 2.4 kg ai/ha)	402
7.	Fluazinam (soil-inc.; 0.7 kg ai/ha)	319
8.	Fluazinam (soil-inc.; 1.5 kg ai/ha)	232
9.	Fluazinam (soil-inc.; 2.0 kg ai/ha)	313
	LSD (P = .05; df = 35)	149

[1] 20 plants per plot.

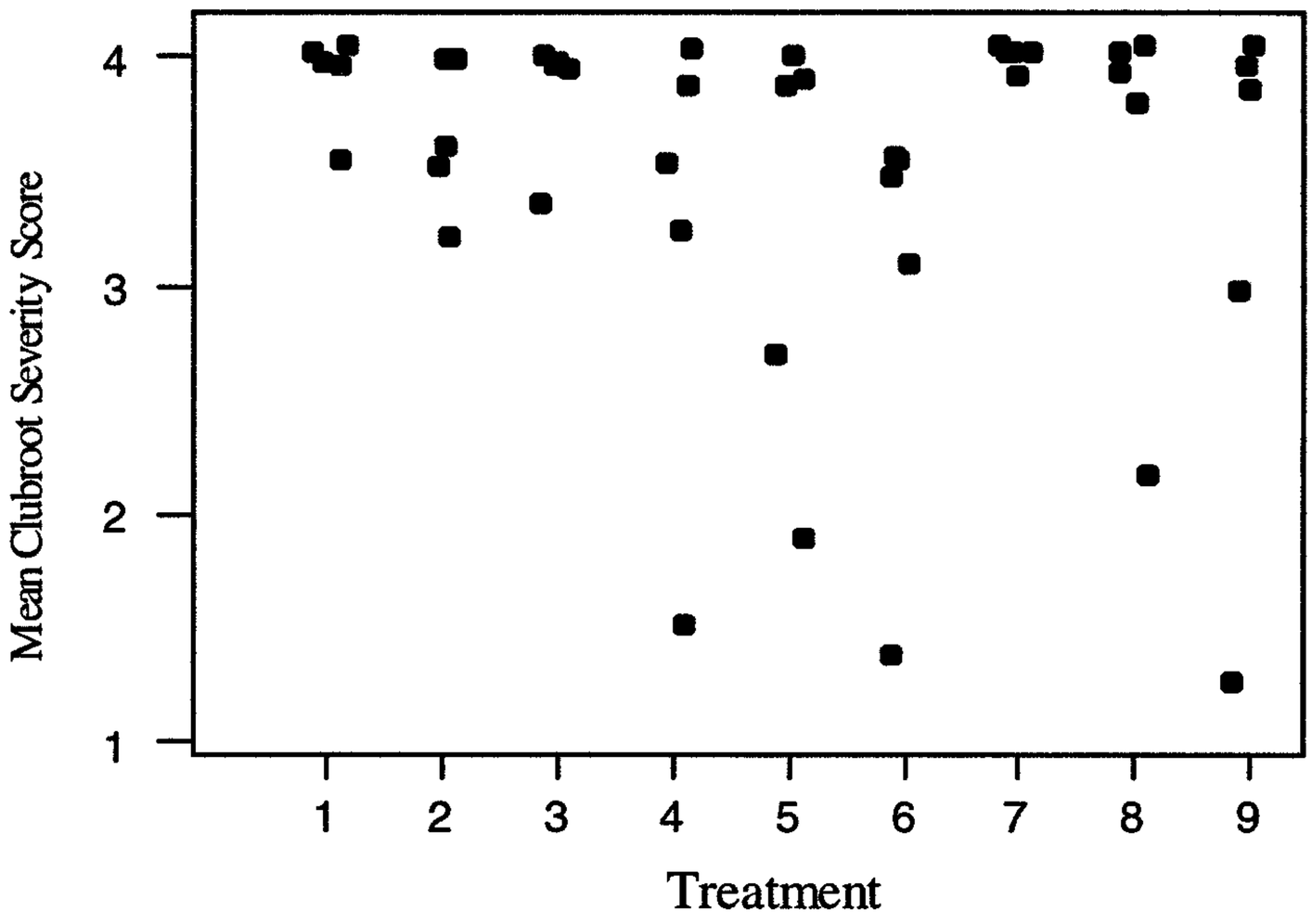

Figure 1: Distribution of mean clubroot severity scores on Chinese cabbage 'Wong Bok' roots for each fungicide treatment. (Fungicide treatments as in Table 1).

5 DISCUSSION

In this trial, the presence of high inoculum of *P. brassicae* in all plots has provided a rigorous test of the treatments for their ability to control the clubroot. Our results show that some treatments applied as soil-incorporations are effective for clubroot control, and also increased plant top weight. In this test, although the benomyl soil-drench, a recommended control method, did not significantly reduce disease severity, it did increase the top weights. In a previous trial (Cheah and Page, 1997) we have also observed similar results with benomyl soil-drenches which significantly increased yield while providing only a marginal clubroot control. Benomyl has also been reported to stimulate yield in cauliflower crops (Cheah *et al.*, 1981).

In two separate trials carried out at the same time (not reported here), we also found that soil-drenches of the same treatments were not effective. This is probably because a limited area around the root zone is treated when fungicides are applied using a soil-drench method compared with a soil-incorporated application method. Also, we have observed that plants treated using the soil-drench method showed infection, or clubbing, generally on the tips of root systems, but the main (tap) roots were disease-free. This indicates that soil-drenching of fungicides is sufficient to protect the main root system but does not protect roots growing out of the drenching area.

Our results also indicate that generally only high rates of the fungicides gave significant reduction of clubroot. These lower rates may provide sufficient control when infection was not severe. Dixon *et al.* (1994) showed that soil-incorporation of flusulfamide at low rates (0.6 kg and 0.9 kg ai/ha) significantly reduced clubroot in soil where the disease was not severe.

Our results suggest that fungicide treatment alone will not provide full protection against clubroot infection. In the last three seasons (1995-97) good progress has also been made toward identifying clubroot-resistant cultivars. We have found that Chinese cabbage 'Taler', broccoli 'Hanamori' and Brussels sprout 'Dolmic' are tolerant of the disease (Falloon *et al.*, 1997). This study suggests that fungicides and disease resistance have potential as components of an integrated clubroot management strategy.

Soil incorporation of chemicals is less labour intensive and is also time- and cost-saving compared with soil drenching. Soil incorporation of chemicals is therefore more likely to be accepted by brassica growers for clubroot control.

6 RECOMMENDATIONS

1. Soil-incorporation of chemicals is less labour intensive, takes less time and more cost-effective compared to soil-drenching.

2. To improve clubroot control, soil-incorporation of fungicide should be carried out in high soil pH (preferably pH 7.0 above by liming).

3. Fungicide treatments alone will not provide a full protection against clubroot infection. Integration of fungicide, liming and resistant cultivars should be practiced to minimise the infection.

7 ACKNOWLEDGEMENTS

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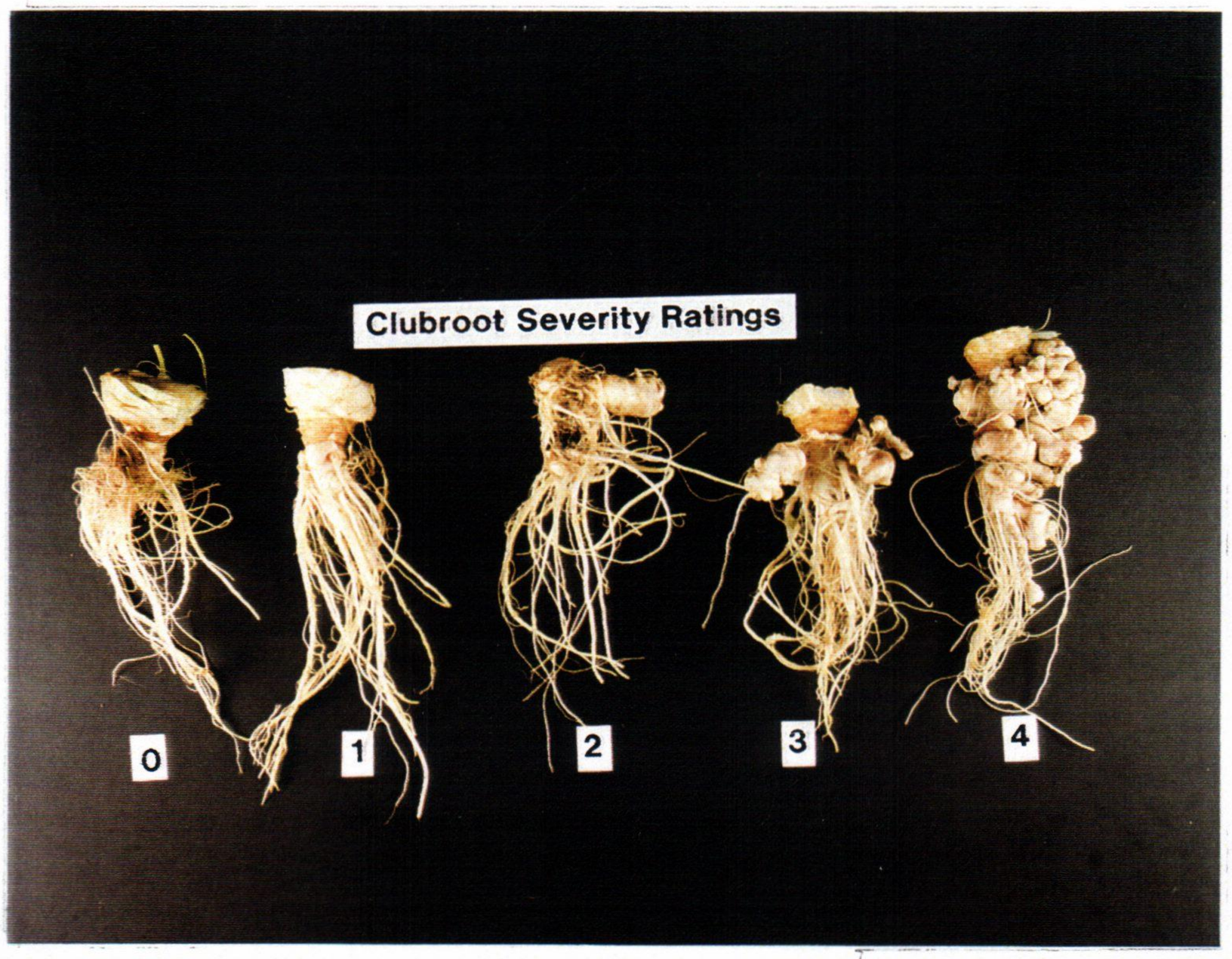


Figure 2: Clubroot disease severity scoring.

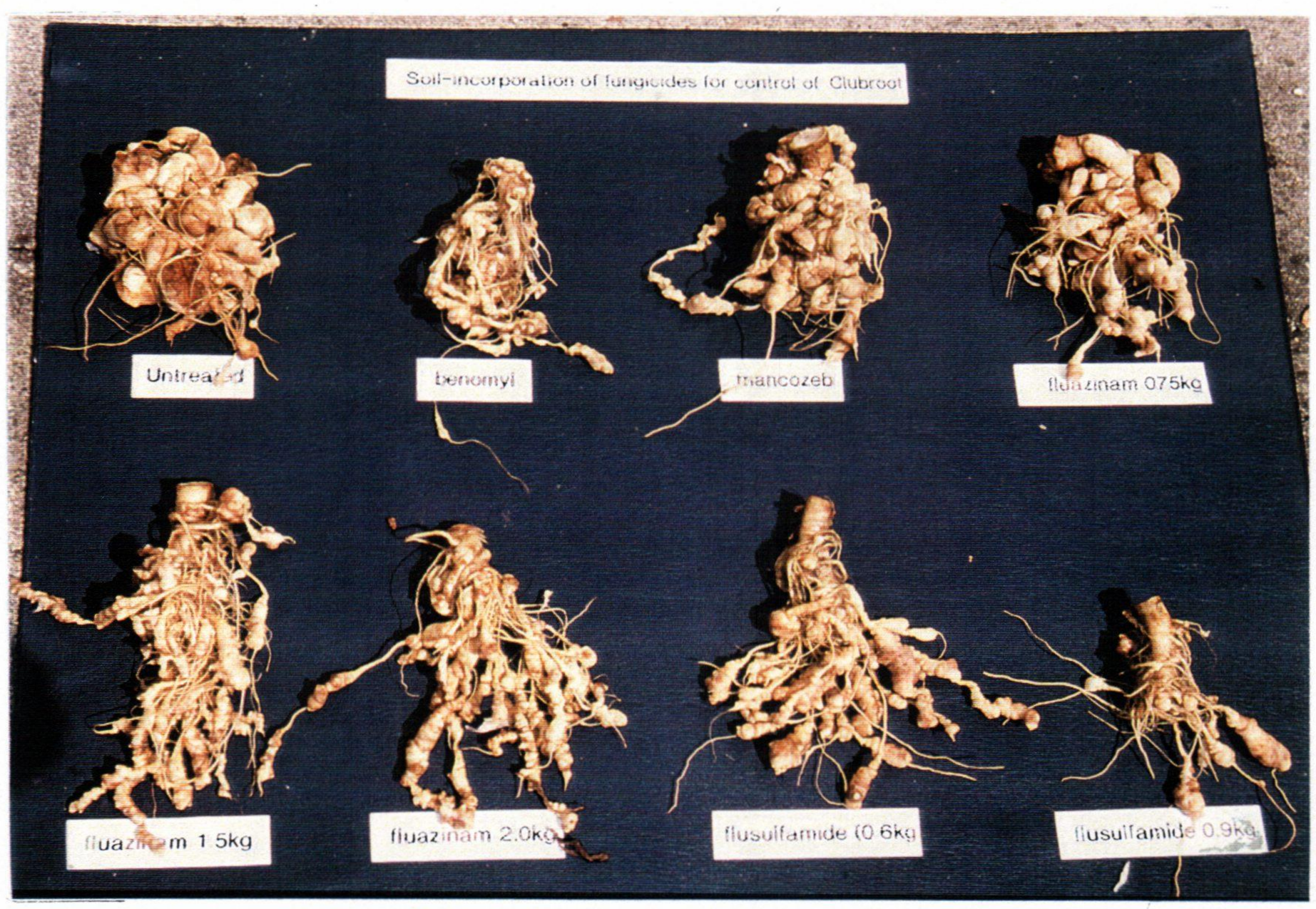
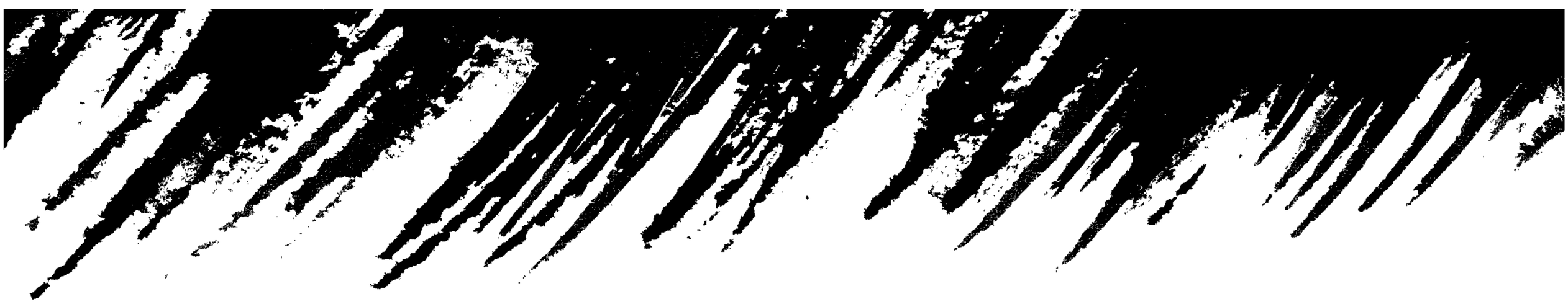


Figure 3: Clubroot severity after soil-incorporation of different fungicide treatments.



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