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Evaluation of soil fumigants (metam sodium and Calcium cyanamide) for control of violet root rot in carrots

A report prepared for the
New Zealand Vegetable and Potato Growers' Federation Inc.

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1 EXECUTIVE SUMMARY

Violet root rot of carrots, caused by *Rhizoctonia crocorum*, has become a major problem for carrot growers in the Ohakune region. Two field trials were carried out at growers' properties to evaluate two soil fumigants (metam and Calcium cyanamide) for the control of the disease. We found that although neither of the soil fumigants was very effective for control of violet root rot metam gave a useful reduction in disease incidence in the harvested crop, especially where the disease was very severe. Calcium cyanamide had possibly increased disease incidence in one trial. Metam gave a slight increase in carrot yield but the increase was not significant at the 5% level. We also found that *R. crocorum* produces pinkish mycelial mat covering soil surface during winter. This mycelium could be the over-wintering inoculum for causing the disease on the new crop.

Most commercial carrot cultivars appear to be susceptible to violet root rot and there are no effective chemicals against the disease. The main control measures therefore, involve cultural practices, for example, crop rotation (with cereals), good soil drainage, liming to increase pH, early harvesting of the crop and measures to prevent the spread of infested soil.

Further field evaluation trials should be carried out to confirm the potential of metham and to screen for other effective fungicides for the control of violet root rot.

Research is required to determine the role of the mycelial mat in the epidemiology of violet root rot of carrots.

2 INTRODUCTION

Fresh carrots have become a promising export crop to Asia. Export value has risen from $1.0 million in 1993 to about $5.0 million in 1996. Violet root rot of carrots (Fig. 1), caused by *Rhizoctonia crocorum* DC. ex Fr., has become a major problem for carrot growers in the Ohakune region (central North Island) of New Zealand. Leaves of infected plants become chlorotic and die. Infection in a crop starts as small patches that increase in size (Fig. 2). Lesions on infected roots are first purplish in colour and then turn cinnamon-brown (Fig. 3). If infected roots are pulled out of the ground an abnormally large mass of soil clings to the surface of the lesion (Fig. 4).

Violet root rot was first reported five years ago in the Ohakune region and since then has caused serious economic losses. During the last two seasons some crops have not been harvested due to severe infection and also out of concern that inoculum may spread to healthy ground. The Fresh Vegetable Committee of the New Zealand Potato Growers Federation (Vegfed) has identified strategies for controlling violet root rot as a top priority research requirement. For this reason and because the area concerned comprises some 1000 ha of growing land it is urgent that the control measures applicable to the disease are developed. To date there is no chemical control. In the past, metam has been used to control nematodes, soil-borne fungi, insects and weed seeds (Shurtleff et al. 1983). Calcium cyanamide has also been shown to be effective in the control of clubroot of brassicas (Cheah 1995).

The objective of this project was to carry out two field trials to evaluate the efficacy of two soil-fumigants (metam and Calcium cyanamide) for the control of violet root rot in carrots.

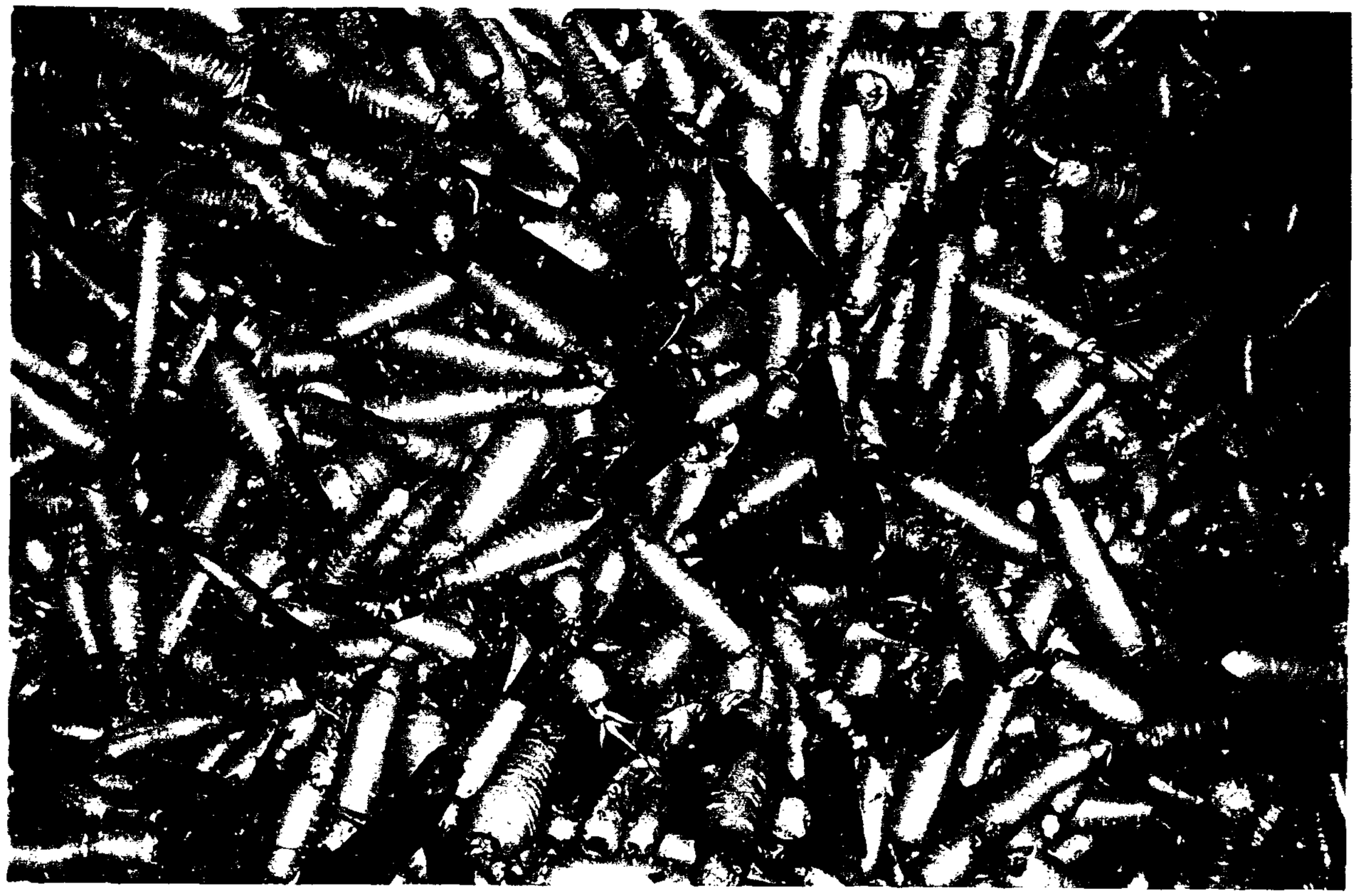

Fig. 1: Carrots were rejected due to violet root rot infection.

Fig. 2: Above ground symptoms on leaves: chlorosis and death patches.

Fig. 3: *(Above)*
Violet root rot on carrot roots.

Fig. 4: *(Left)*
Infected roots with mass of soil clings to the surface of the lesions.

3 MATERIALS AND METHODS

Two trials (trial sites at S Pearson and R Wilson) were carried out in violet root rot-infested ground at Ohakune. Soil was cultivated thoroughly in November 1996 and temperature was recorded (10 cm deep) at about 20°C.

A fumigation rig was calibrated so that it delivered the correct amount of fumigants. Metam (Fumasol) was boom sprayed onto individual plots and immediately rotary hoed into the ground. The fumigant boom was attached to the front of the rotary hoe and the fluid was pumped through the spray system. TK1.5 jets with a 12 volt deflo jet pump unit was used and run at 140 KPa. Jets were set 50 cm apart. The tractor forward speed was 2 kph and gave a calculated coverage of 600 l/ha. The second metam treatment at 1200 ℓ/ha was obtained by a double pass. The Calcium cyanamide (Perlka) was applied with a low spreader to a calculated rate of 400 kg/ha (Table 1). The plot was rotary hoed immediately after the application. Control plots were untreated.

Field plots were 75 m long by 0.8 m wide. Two rates of metam fumigant, one of Calcium cyanamide and an untreated control were included (Table 1). A randomised block layout with four replications was used.

Carrots (cultivar Bolero) were seeded with a mechanical drill in 20 cm-wide band on the raised beds. Two rows were planted in each bed. Crop management followed routine commercial practice.

3.1 Disease assessment

On 27 August the roots of the carrots at the two sites were harvested. At S. Pearson block, a 30m section along each row was harvested with a carrot harvester. Carrots were washed, graded and sorted into diseased, nematodes infested (root knots and forking), and healthy roots. The weight of each category was recorded, and the total yield (tonnes per hectare) of carrots was estimated.

At R. Wilson block, four x 1m plots were manually dug in random positions along each row (because Mr Wilson was concerned about the contamination of disease to healthy soil). Carrots were sorted into diseased and healthy roots and the number for each category were recorded.

4 RESULTS

4.1 Disease assessment at Pearson's block

None of the fumigation treatments gave a significant reduction ($P<0.05$) in the incidence of violet root rot in harvested carrots, although metam treatments had a lower incidence than the untreated controls (Table 1). Calcium cyanamide had significant higher ($P<0.05$) percentage of violet root rot than the metam treatments. There were no significant differences between the two metam rates, nor between the metam treatments and the untreated control. None of the treatments tested had a significant effect on nematode count on carrots.

Metam treatments (treatments 2 and 3) gave significantly ($P<0.05$) higher yields than Calcium cyanamide treatment, but none of these treatments gave significantly higher yields than the untreated control.

Table 1: Percentage of violet root rot and nematode incidence and yield of carrots after soil fumigation treatments in S Pearson's block, Ohakune.

Treatment		Rate (per ha)	Violet root rot (%)	Nematode (%)	Yield (t/ha)
1	Untreated	-	8.4	2.4	99.7
2	Metam	600 ℓ	3.1	2.6	114.2
3	Metam	1200 ℓ	4.2	4.4	110.6
4	Calcium cyanamide	400 kg	27.5	3.4	81.1
	LSD ($P< 0.05$)	-	20.0	3.3	19.3

4.2 Disease assessment at Wilson block

Incidence of violet root rot was much higher in the Wilson block (Table 2) than on the Pearson block (the mean percentage of infested carrots in the untreated plots being 62% and 8% respectively). There was no indication of any effect of the rate of metam on disease incidence, with the two rates averaging 19.2%. This reduction, to about one third of the untreated plots, was significant at the 10% level.

The calcium cyanamide treatment gave disease incidence similar to that of the untreated plots (Table 2), but the incidence was sufficiently higher to establish that the average of the two metam treatments was significantly lower ($P<0.05$) than the Calcium cyanamide treatment.

Table 2: Percentage of violet root rot of carrots after soil fumigation treatments in R Wilson's block, Ohakune.

Treatment		Rate	Violet root rot (%)
1	Untreated		62.4
2	Metam	600 ℓ	20.1
3	Metam	1200 ℓ	18.3
4	Calcium cyanamide	400 kg	67.4
	LSD (P<0.05)	-	51.0
	(P<0.10)	-	41.0

5 DISCUSSION

These results show that soil fumigation with metam or Calcium cyanamide did not give effective control of violet root rot in carrots. One of the possible explanations for this is that *R. crocorum* produces a thick pink mycelial mat on the soil surface during winter (Fig. 4). These mycelial mats may join with the adjacent mats to form a larger mat covering the soil surface (Fig. 5 and 6). We have also seen large fragments of these mats still remaining in the soil despite the soil having been ploughed and well rotary-hoed. Soil fumigation may not be effective in penetrating the mycelial mat to give a complete kill of the fungus.

It has been shown that the disease can be suppressed with high nitrogen levels in the soil (Garrett 1949) or high soil pH (Valder 1958). In this trial, Calcium cyanamide was selected because it contains 20% nitrogen and can increase soil pH as it hydrolyses (Rieder 1981). The results from one of our trials that Calcium cyanamide gave a higher disease incidence and lower yields are possibly due to the patchiness of the fungal infection in the field, which led to less precision in the treatment effects than usually occurs in field trials of this size.

Most commercial carrot cultivars appear to be susceptible to violet root rot (Dalton et al. 1981) and no chemicals have been shown to be effective against the disease (Snowdon 1991), the main control measure, therefore, should involve cultural practices, for example crop rotation (with cereals), good soil drainage, liming to increase pH, early harvesting of crops and prevention of spreading infested soil. It is also important to remove and destroy mycelial mats from the field to prevent the spread of the disease. Work (funded by Vegfed 1997/98) is in progress in Ohakune to evaluate some other effective fungicides as a soil-incorporation, along with cultural practices to control violet root rot on carrots.

The results for metam, although not conclusive in these trials, were encouraging. Where the infestation with *R. crocorum* was very heavy (Wilson block) the incidence of infested carrots was greatly reduced by both rates of this treatment and this reduction (to less than half the levels of untreated plots) was in fact fairly consistent in both trials. Further work to confirm these results would be useful.

The observed results in the Wilson block correspond to an increase in non-diseased yield from under 40%, where no treatment was applied, to about 80% with metam. This result was achieved with either rate, so 600 ℓ/ha could be suitable for this chemical; and lower rates should be tested to determine whether they give useful reductions in incidence of *R. crocorum* in carrots.

Fig. 5: *(Above)* Pinkish mycelial mats were produced on the soil surface by the disease during winter.

Fig. 6: *(Left)* Carrots were completely rotted by violet root rot disease.

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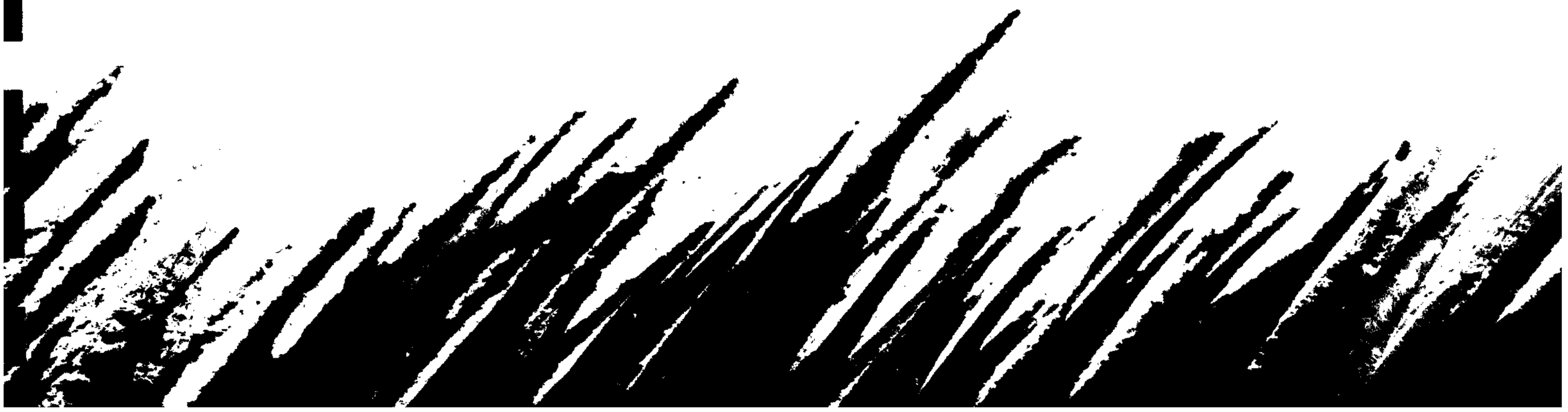

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