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Soil incorporation of fungicides for control of violet root rot of carrots

A report prepared for

The New Zealand Vegetable and Potato Growers' Federation Inc.

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1 EXECUTIVE SUMMARY

A field trial to evaluate seven soil fungicides for control of violet root rot of carrot was established at an Ohakune grower's property (soil pH 6.3) on land known to be heavily infested with the violet root rot pathogen. Fungicide suspensions were prepared to the required concentrations and were then sprayed onto the soil surface of each plot. The plots were rotary hoed to a depth of about 12 cm to incorporate the chemicals into the soil. Seeds of carrots were then sowed onto the trial plots.

We found that none of the fungicides tested were effective for the control of violet root rot, and none increased carrot yield. The main control measures against violet root rot should involve the adoption of appropriate cultural practices and measures to prevent the spread of the disease.

2 INTRODUCTION

Fresh carrots have become one of New Zealand's promising export crops to Asia. Export value has risen from $1.0m in 1993 to about $5.0m in 1996. Violet root rot of carrots, 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. Above ground symptoms of the disease are that leaves of infected plants become chlorotic and later die. Infection in a crop starts as small patches which then increase in size to become large patches (Fig. 1). Lesions on infected carrot roots are first purplish, turning cinnamon-brown with age (Fig. 2). If infected roots are pulled out of the ground, an abnormally large mass of soil clings to the surface of the lesion (Fig. 3). The disease was first reported five years ago in the Ohakune region, and since then has caused serious economic losses. During the last two seasons some of the crops have not been harvested by the growers due to severe infection and also the concern of spreading inoculum to healthy ground. The Fresh Vegetable Committee of the New Zealand and 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, adequate control measures for the disease are urgently required.

In a previous trial (Cheah et al. 1998a), we found that soil fumigation with metam sodium at 600ℓ/ha reduced violet root rot incidence on carrots and increased yields but these effects were not statistically significant ($P>0.05$). However, soil fumigation can be time consuming and expensive. Growers are looking for a cheaper and more practical method of controlling violet root rot. At Crop & Food Research we have developed methods of soil incorporation of chemicals for control of clubroot of brassicas (Cheah et al. 1998b). This technique is cost-effective, time-saving and effective for controlling clubroot.

The objective of the present study was to evaluate seven fungicides in an attempt to develop soil incorporation treatments for the control of violet root rot of carrot.

Figure 1: Above ground symptoms of violet root rot appear as patches of chorotic leaves on carrot plants.

Figure 2: Symptoms of violet root rot on carrot roots.

Figure 3: (Left) Infected carrot root with mass of soil clinging to the surface of the lesions.

Figure 5: (Below) Pinkish mycelial mats of the violet root rot pathogen were produced on the soil surface from diseased carrots during winter.

3 MATERIALS AND METHODS

A field trial to evaluate seven soil fungicides (Table 1) was established at an Ohakune grower's property (silt loam with pH 6.3) on 18 November 1997, on land known to be heavily infested with violet root rot. The soil was thoroughly cultivated. Fungicide treatments were prepared as suspensions to give the desired concentrations (Table 1), and were then band sprayed onto the soil surface of each trial plot. The plots were rotary hoed to a depth of about 12 cm to incorporate chemicals into the soil. Seeds of carrot (cv. Bolero) were then sown with a mechanical sower into the trial plots. Each plot consisted of three rows 10 m long with 0.8 m between rows. The experimental design was a randomised block with six replications for each treatment.

Disease assessment was made on 11 May 1998 by visual scoring (1=healthy leaves, 5=completely dead) of the top leaves and assessing the below ground roots. For root assessment, three 1 m plots were manually dug in random positions along each row. Carrots were washed, graded and sorted into diseased and health roots. The weight of each category were recorded.

Data were analysed with analysis of variance using the Genstat statistical package.

Table 1: **Fungicides tested as soil-incorporated treatments for control of violet root rot of carrots.**

Fungicide			
Common name		Trade name	Rate (ai/ha)
1.	azoxystrobin	Amistar	1.0 kg
2.	fludioxonil	Celest	8.3 ℓ
3.	flusulfamide	Nebijin	1.0 ℓ
4.	hypochlorous acid	Nylate	200 kg
5.	pencycuron	Monceren	2.5 ℓ
6.	quintozene	Terraclor	90 kg
7.	tolclofos-methyl	Rizolex	10 ℓ
8.	untreated		-

4 RESULTS

4.1 Scoring of diseased leaves

A large path of severe infection covered most of the experimental area. All plots within this diseased patch had high disease severity scores on leaves, whereas plots outside the patch had lower scores (Fig.4). Analyses of variance showed that there were no significant differences in disease severity between the fungicide treatments and the control . This indicates that soil incorporation of these fungicide treatments was not effective for control of violet root rot. The disease level in Blocks 3 and 4 was so severe that the plots in these blocks were excluded from calculations of healthy root percentages and yield.

4.2 Root assessments

4.2.1 Healthy roots as a percentage of total

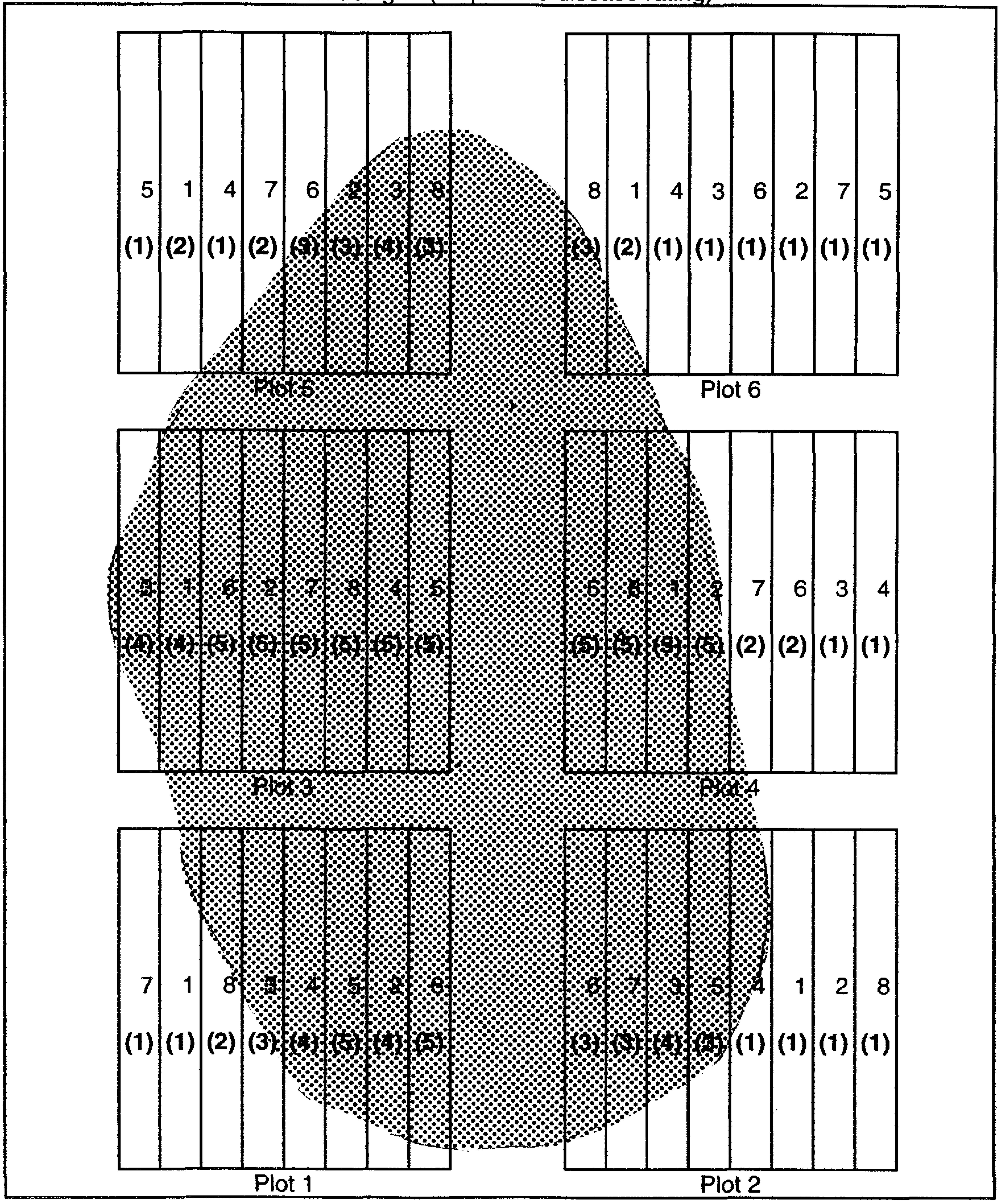
There was no statistically significant differences in the percentage of healthy roots between all of the fungicide treatments and the untreated control (Table 2).

Table 2: **Mean percentage of healthy roots of carrots harvested from field plots in violet root rot- infested soil to which different fungicide treatments had been applied.**

No.	Treatment	Healthy root (%)[1]
1.	azoxystrobin	70.2
2.	fludioxonil	70.5
3.	flusulfamide	61.1
4.	hypochlorous acid	65.1
5.	pencycuron	74.8
6.	quintozene	72.0
7.	tolclofos-methyl	73.0
8.	Untreated	76.2
	LSD (P=0.05)	20.9

[1] Means of four blocks (Blocks 1, 2, 5 and 6 in Figure 4), calculated at the average level of disease score to enable fair comparison.

Evaluation of fungicides for violet root rot on carrots
Trial design (Top score disease rating)



Treatments
1. azoxystrobin
2. fludioxonil
3. flusulfamide
4. hypochlorus acid
5. pencycuron
6. quintozene
7. tolclofos-methyl
8. Untreated control

Disease rating **(in bold)**

1 = green, healthy
2 = slight discolouration
3 = some yellowing, slight wilts
4 = very wilted, discoloured
5 = dead

Figure 4: An area (shaded) of violet root rot infected patch on carrots.

4.2.2 Yield

Analysis of variance also showed that there were no significant differences in yields between the fungicide treatments and untreated control (Table 3). There was a strong correlation between the disease score and the yield, i.e. the higher the disease score the lower the yield.

Table 3: Yields of carrots from field plots of violet root rot- infested soil to which different fungicide treatments had been applied.

No.	Treatment	Yield (kg/plot)[1]
1.	azoxystrobin	9.6
2.	fludioxonil	9.7
3.	flusulfamide	7.6
4.	hypochlorous acid	7.1
5.	pencycuron	9.7
6.	quintozene	9.8
7.	tolclofos-methyl	9.0
8.	Untreated	8.7
	LSD ($p \leq 0.05$)	3.2

[1] Yield of carrots from 3 m per plot. Means of four blocks (Blocks 1, 2, 5 and 6 in Figure 4), calculated at the average level of disease score to enable fair comparison.

5 DISCUSSION

Our results show that soil incorporation of fungicides did not control violet root rot of carrot or increase carrot yields. In our previous trial (Cheah et al. 1998a) we had similar problems controlling violet root rot using soil fumigation with metam and Calcium cyanamide. In that trial, we found that soil fumigation with metam at 600 ℓ/ha reduced disease incidence and increased yield but these results were not statistically different from the untreated controls. One of the possible explanations for this is that *R. crocorum* produces thick pinkish mycelial mats on the soil surface during winter (Fig. 5). These mycelial mats may join with the adjacent mats to form a larger mat covering the soil surface. We have also seen large fragments (3-4 cm) of these mats still remaining in the soil despite the soil having been ploughed and well rotary-hoed. Soil fumigation or soil incorporation of fungicides may not be effective in penetrating the thick mycelial mats to give a complete kill of the fungus. We have also noticed that infected soil within the diseased patches has become much stickier than the uninfected soil. The cause of this is not known, but this may partially explain why the disease cannot be controlled under such soil conditions.

Since most commercial carrot cultivars appear to be susceptible to violet root rot (Dalton et al. 1981) and so far no chemicals are effective against the disease (Snowdon 1991), the main control measures against this disease should involve cultural practices, e.g. crop rotation (with cereals), good soil drainage, early harvesting of crops and preventing the spread of infested soil. It is important to detect the disease early before the formation of mycelial mats. The disease areas or infected patches should be fenced up to prevent the spread of infested soil. The soil should be fumigated with metam before growing other non-host crops, e.g. cereal or grasses. It is also important to remove and destroy the mycelial mats and alternative hosts (e.g. beetroot and potatoes) to prevent build-up and spread of the disease.

6 RECOMMENDATIONS

1. Since most commercial carrot cultivars are susceptible to violet root rot, and no chemicals have been shown to be effective against the disease, the main control measures should involve cultural practices, (crop rotation with cereals, good soil drainage, early harvest of crops and prevention of the spread of the disease).

2. The disease areas or patches should be fenced up to prevent the spread of infested soil. The soil should be fumigated with metam before growing other non-host crops, e.g. cereals or grasses.

3. Mycelial mats of the violet root rot pathogen should be removed and destroyed, and alternative hosts should be avoided to prevent the build-up and spread of the disease.

7 ACKNOWLEDGEMENTS

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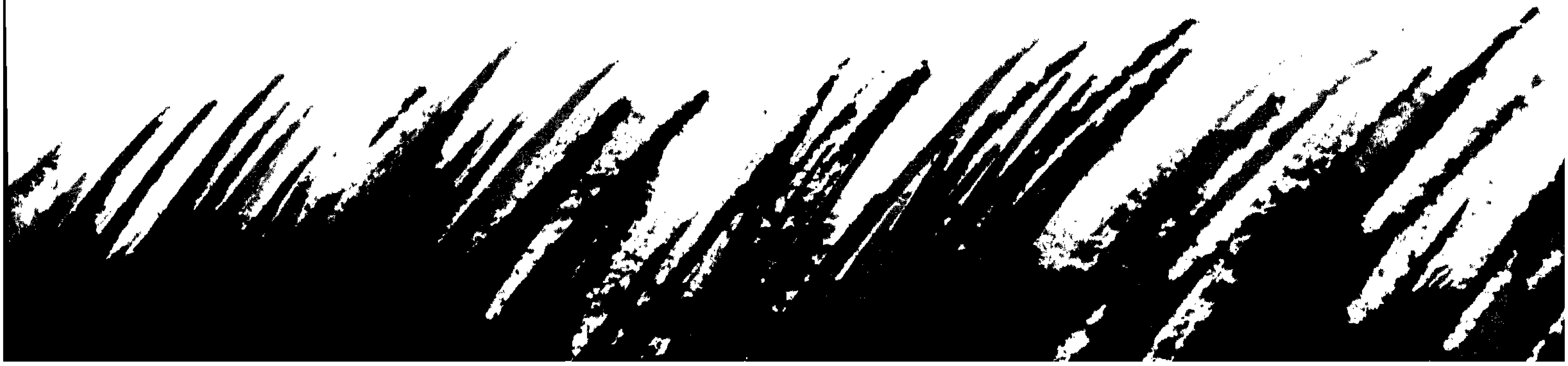

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