Agricultural Development and Advisory Service

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Control of Phytophthora Crown Rot of Parsley 1987/88

Undertaken for HDC

ADAS

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Summary

Previous trials work has shown that Fubol 58 WP (metalaxyl + mancozeb) is effective in controlling crown rot of parsley caused by Phytophthora primulae. However, the number and timing of drenches necessary for control had not been clarified. This aspect was investigated in the work reported here and a comparison made between Favour 600 FW (metalaxyl + thiram) - a replacement material for Fubol 58 WP - and the protectant fungicide zineb.

Favour 600 FW was applied as a drench at one of six single monthly timings between September and March or on each occasion to trial plots on a commercial holding. Zineb was applied on each of the same six occasions or at 2-3 week intervals. Control treatments received an equivalent volume of water on the six occasions; one control treatment remained uncut at the first harvest in December. At this time, samples of plants were taken from certain Favour 600 FW, zineb treatments and controls and analysed for dithiocarbamate and metalaxyl residues.

Crown rot appeared in the trial in autumn 1987 and developed rapidly over the winter. By March 1988 only Treatment 8 which received six drenches of Favour 600 FW had a good coverage of plants. Single treatments in November and December gave a reasonable stand but all other treatments showed high levels of crown rot. At the full assessment in April, only Treatment 8 had given an acceptable degree of control of crown rot although a single drench in November had also decreased severe infection slightly.

Plants which had received one or three drenches of Favour 600 FW by mid-December showed only low residue levels of metalaxyl and dithiocarbamate. Plants from both zineb treatments had very high levels of dithiocarbamate present.

It was concluded that drenches of Favour 600 FW would control crown rot if applied early in the autumn and repeated at least through to the first cut in December. Probably three to four drenches would be necessary for satisfactory control and should not give unacceptable residue levels. Zineb did not control the disease and gave very high residue levels.

There is no label recommendation for the use of Favour 600 FW on parsley. On the basis of this work, an application has been made for Off-Label Approval for the related product Fubol 58 WP for control of Phytophthora crown rot of parsley.

Introduction

Crown and root rotting of plants is a recurrent problem for growers of overwintered parsley. It is particularly prevalent on heavy soils in North Cheshire but can also be a problem on lighter soils in the Vale of Evesham. The symptoms are usually first observed as a yellow discolouration and wilting of the foliage, associated with rotting of the petioles and crowns. Severe infection causes collapse of the tissues, stunted growth and eventually death of the plants. This disease is caused by the soil-borne fungus Phytophthora primulae (Stamps, 1985), although other Phytophthora spp. and also Pythium spp. have also been associated with root and crown infections (Baker, 1972; McCracken, 1984).

There is little documentation on the disease but it is known to be favoured by close rotations of parsley and by waterlogged soils (MAFF, 1984). Clarkson and Phillips (1987) found that, contrary to historical reports, growing parsley on ridges rather than on the usual flat beds did not offer any control of Phytophthora crown rot.

Field trials to investigate fungicidal control of the disease showed that metalaxyl + mancozeb (Fubol 58 WP) drenches gave significant control of the disease whereas other Phytophthora - specific fungicides were less effective (Clarkson and Phillips, 1987). However, timing of the drenches was less clear as late applications appeared to give the best disease control but early applications gave increased plant cover.

This project was designed to investigate further the efficacy and timing of a metalaxyl-based fungicide in controlling Phytophthora crown rot of parsley and to compare it with a protectant fungicide, zineb. Plants were also subjected to post-harvest analysis in order to determine residue levels of the two fungicides applied in the trial.

Materials and Methods

Site

The single trial was located on a grower's holding at Burton, Wirral, Cheshire.* Residue analysis of the plants was performed at the MAFF Harpenden Laboratory, Hertfordshire.

* Site details are given in the Appendix.

Design

The trial was of a randomised block design with four replicate blocks. The plot size was approximately 2 m^2. The plants were raised in blocks from thiram-soaked seed and planted out in beds in August.

Fungicides

Table 1 Fungicides, active ingredients (ai) and dose rates

Fungicide	ai	Amount ai in product	Dose rate product/ha
Favour 600 FW*	metalaxyl + thiram	100g + 500g/litre	12.0 litre
Unicrop Zineb	zineb	700g/kg	2.0 kg

* Code number SL 329

Treatments

Table 2. Treatments and timing of fungicide drenches

1.	Control - water applied 8/9, 14/10, 17/11, 16/12, 29/1 and 15/3
2.	Favour 600 FW applied 8/9/87
3.	Favour 600 FW applied 14/10/87
4.	Favour 600 FW applied 17/11/87
5.	Favour 600 FW applied 16/12/87 (post-cutting)
6.	Favour 600 FW applied 29/1/88
7.	Favour 600 FW applied 15/3/88
8.	Favour 600 FW applied 8/9, 14/10, 17/11, 16/12, 29/1 and 15/3
9.	Unicrop Zineb applied 8/9, 25/9, 13/10, 28/10, 17/11, 2/12, 16/12 7/1, 29/1, 18/2, 15/3 and 8/4
10.	Unicrop Zineb applied 8/9, 14/10, 17/11, 16/12, 29/1 and 15/3
11.	Control - uncut - water applied 8/9, 14/10, 17/11, 16/12, 29/1 and 15/3

Fungicide application

The fungicides were applied in 5 litres water per plot as a drench by watering-can. Favour 600 FW was applied at single monthly timings between September 1987 and March 1988 or on each of these occasions (Treatment 8). Zineb was applied at 2-3 week intervals between September and April (Treatment 9) or at monthly intervals between September and March (Treatment 10). The first control treatment received 5 litres of water per plot on each treatment date between September and March (Treatment 1). The second control treatment also received water on the same dates and also remained uncut in December (Treatment 11).

Assessments and records

The trial was monitored regularly for presence of Phytophthora crown rot and suspect plants were tested in the laboratory for the causal organism. The trial area was subjected to the same husbandry as a commercial crop and was therefore harvested on 14/15 December 1987 (except Treatment 11) and then allowed to re-grow until the spring. The percentage plant cover of all plots

was assessed on 15 March 1988. A full disease assessment was performed on 19 April 1988 when all plants in each plot were assessed as either healthy, rotting or dead. Yields were not determined due to the high levels of plant death resulting from crown rot in most treatments.

Statistical analysis

The assessment data were subjected to an analysis of variance. Treatment means were separated using Duncan's Multiple Range Test.

Residue analysis

At the time of the grower's first cut (14/15 December 1987), two 1 kg samples of parsley from treatments 1, 4, 8, 9 and 10 were sent immediately to MAFF Harpenden Laboratory for analysis of residues of i) dithiocarbamates in all five treatments, and ii) metalaxyl in treatments 4 and 8. The methods employed were as follows:-

(i) Dithiocarbamates

50g sub-samples of uncomminuted parsley were analysed for residues of dithiocarbamates, determined as carbon disulphide (CS_2) by gas chromatography with a flame photometric detector, using a headspace method which has been tested and proven in use at Harpenden Laboratory, during the last eighteen months. For those samples containing very high residues of dithiocarbamates, it was necessary to reduce the sub-sample size to 10g to prevent saturation of the detector used in the analysis.

(ii) Metalaxyl

A 500g portion of each sample was comminuted and mixed and a 30g sub-sample was analysed for residues of metalaxyl. The analysis employed a multi-residue method (based upon extraction with ethylacetate, clean-up on a micro-column of deactivated neutral alumina and gas chromatography with a nitrogen/phosphorus detector) which has been tested and proven in use at Harpenden Laboratory, during the last four years.

Analytical quality assurance (AQA) recovery data were generated for both pesticides during the work to ensure the validity of the results.

Results

Disease assessments

Symptoms of crown rot appeared in the trial area in November 1987 and laboratory tests confirmed that Phytophthora primulae was present in the infected tissues. Disease development then progressed rapidly over the winter months. Once regrowth had occurred in the spring, assessments were made of percentage plant cover (Table 3) and disease levels (Table 4).

Table 3. Mean percentage plot cover by parsley plants, 15 March 1988

	Treatment	% plot cover	
1.	Control - water on 6 occasions	0	a
2.	Favour - September 1987	15.0	bc
3.	Favour - October 1987	16.8	bcd
4.	Favour - November 1987	40.0	d
5.	Favour - December 1987 (post cutting)	30.0	cd
6.	Favour - January 1988	2.0	ab
7.	Favour - March 1988	0	a
8.	Favour - on 6 occasions	78.0	e
9.	Zineb - on 12 occasions	13.2	bc
10.	Zineb - on 6 occasions	2.5	ab
11.	Control (uncut) - water on 6 occasions	40.0	d
	SED (43 df)	11.17	
	CV (%)	73.2	

Treatment means followed by the same letter do not differ significantly (P = 0.05).

Crown rot infection was severe with 100% plant death recorded in the Control treatment (1) and in treatment 7 which did not receive a Favour treatment until March. All treatments except 6 (Favour in January), 7 (Favour in March) and 10 (Zineb on 6 occasions) significantly increased the percentage plant cover. However, treatment 8 (Favour on 6 occasions) was the only outstanding

treatment, with acceptable cover also recorded in treatments 4 (Favour in November) and 5 (Favour in December just after cutting). Treatment 11 (uncut Control) had 40% cover but a high proportion of the plants were rotting.

Table 4. Mean percentage of healthy and infected parsley plants, 19 April 1988

	Treatment	% Healthy		% Rotting		% Dead	
1.	Control - water on 6 occasions	0	a	0	a	100.0	c
2.	Favour - September 1987	0.6	ab	1.4	a	98.0	bc
3.	Favour - October 1987	3.6	abc	1.4	a	95.0	bc
4.	Favour - November 1987	6.1	c	5.8	a	88.1	b
5.	Favour - December 1987 (post cutting)	4.7	bc	3.1	a	92.2	bc
6.	Favour - January 1988	0	a	0.6	a	99.4	bc
7.	Favour - March 1988	0	a	0	a	100.0	c
8.	Favour - on 6 occasions	22.2	d	22.0	b	55.8	a
9.	Zineb - on 12 occasions	0	a	0.3	a	99.7	bc
10.	Zineb - on 6 occasions	0	a	0.3	a	99.7	bc
11.	Control (uncut) - water on 6 occasions	0.8	abc	11.7	a	87.5	bc
	SED (43 df)	3.529		5.48		7.46	
	CV (%)	144.2		186.2		11.4	

Treatment means followed by the same letter do not differ significantly (P = 0.05).

The full disease assessment on 19 April showed that only treatment 8 gave an acceptable level of control in terms of reduction in the percentage of plants killed by crown rot. However, many plants in this treatment were starting to show signs of rotting. Treatment 4 gave a slight, significant reduction in the percentage of plants killed. All other Favour and both Zineb treatments were ineffective in controlling the disease. The uncut control treatment (11) did not show a significant reduction in disease compared with Treatment 1.

Residue analysis

The results of the analyses for residues of dithiocarbamates and metalaxyl in parsley plants sampled in December are given in Tables 5 and 6.

Table 5. Residues of dithiocarbamates in samples (determined and expressed as mg CS_2 per kg)

Treatment number (and applications up to 16 December)		CS_2 (mg/kg) Sample A	Sample B
1.	Untreated control	0.45	0.21
4.	Favour applied 17 November	3.88	4.84
8.	Favour applied 8 Sept, 14 Oct and 17 Nov	3.05	2.63
9.	Zineb applied 8 Sept, 25 Sept, 13 Oct, 28 Oct, 17 Nov and 2 Dec	1651.35	1661.16
10.	Zineb applied 8 Sept, 14 Oct and 17 Nov	446.89	1305.63
	Harpenden Control	< 0.10	< 0.10

Under the conditions used for these analyses, samples of untreated parsley obtained by Harpenden Laboratory contained no detectable CS_2 (< 0.1 mg/kg) and this concentration was adopted as the reporting limit for the study. The control samples (Treatment 1) from the trial contained detectable residues of CS_2 which may have been due to cross-contamination between the samples or to spray drift between the plots. Samples from Treatments 9 and 10 contained very high residues and consequently a small degree of contamination by either route could account for the dithiocarbamate residues found in the control samples. The variation in the results for Treatment 10 may in part be due to the small sub-sample size required for Treatments 9 and 10 to bring the quantity of CS_2 generated within the operating range of the detector used in the analysis. Analytical quality assurance data for the recovery of two dithiocarbamates, zineb and in Fubol (67.5% mancozeb + 7.5% metalaxyl), from parsley were satisfactory. The results in Table 5 are <u>not</u> corrected for recovery. To convert CS_2 data to thiram, results may be multiplied by a factor of 0.6333 and, to zineb, by a factor of 0.5507.

Table 6. Residues of metalaxyl in samples (mg metalaxyl/kg)

Treatment number (and applications up to 16 December)	Metalaxyl (mg/kg) Sample A	Sample B
4. Favour applied 17 Nov	< 0.05	< 0.05
8. Favour applied 8 Sept, 14 Oct and 17 Nov	< 0.05	< 0.05

The limit of determination for the analysis of metalaxyl in parsley (as determined on untreated parsley obtained by Harpenden Laboratory) was 0.05 mg/kg and this was adopted as the reporting limit. Samples from Treatments 4 and 8 were analysed for metalaxyl but no residues above the reporting limit were found. This is perhaps not surprising as the proportion of metalaxyl in the formulation used is relatively small compared with that of the dithiocarbamate. Recovery data for metalaxyl were also satisfactory. The results reported in Table 6 are not corrected for recovery.

Discussion

This site is heavily infested with Phytophthora primulae in the soil and high levels of crown rot develop in overwintered parsley each year. In this trial, crown rot started to infect plants in the autumn and was widespread by January. It was apparent from the trial that Favour (metalaxyl + thiram) will control crown rot to some degree provided that drenches are applied early in the autumn and repeated through to at least the first cut in December. The November and December (post-cutting) treatments appear to be crucial; a total of 3 to 4 drenches from establishment to first cutting is probably necessary for satisfactory control.

From the residue analyses, Favour gave rise to only low residue levels of both metalaxyl and dithiocarbamate. Also, the plants which had received three applications of Favour did not have higher residue levels than those which received only a single drench.

In contrast, the performance of the protectant fungicide zineb was disappointing. Neither a programme of six drenches nor twelve drenches offered any control of the disease. Both these treatments gave high dithiocarbamate residue levels ; this was expected as these plants would have received approximately five times more dithiocarbamate than those treated with Favour.

There are no Maximum Residue Limits for dithiocarbamates or for metalaxyl in parsley accepted or proposed by either the FAO/WHO Codex Alimentarius Commission or the European community, and none is proposed in UK legislation. However, by any standard the residues of dithiocarbamates resulting from zineb in Treatments 9 and 10 must be regarded as being high.

It should be noted that there is no label recommendation for the use of Favour 600 FW on parsley. It only carries a recommendation for use on lettuce at a rate much lower than that used in this trial. The high rate of 12 litres per hectare used here was equivalent to that recommended for Fubol 58 WP for

control of cavity spot in carrots. Fubol 58 WP was the fungicide used successfully in earlier trials (Clarkson and Phillips, 1987) and is due to be superseded by Favour 600 FW eventually.

As a result of this work, an application has been made by a grower for an Off-Label Approval for the use of Fubol 58 WP to control Phytophthora crown rot of parsley. Favour 600 FW had not been marketed when this application was made.

Acknowledgements

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References

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Storage of Data

The raw data will be stored by the ADAS Regional Plant Pathologist, MAFF, Woodthorne, Wolverhampton, WV6 8TQ for a period of ten years. HDC will be consulted before disposal.

APPENDIX

Site details

Variety	New Dark Green
Sowing date	25 July 1987 (in blocks)
Planting date	28 August 1987
Fertilisers	Ammonium sulphate base dressing
Fungicides	Benlate (routine sprays)
Insecticides	Hostathion 30 August 1987
	Hostathion 15 October 1987
First harvest	14 and 15 December 1987
Second harvest	None
Previous cropping	1987 Lettuce (prior to parsley)
	1986 Cabbage, lettuce
Previous crop residue	Ploughed
Soil texture	Medium loam
Drainage	Moderate
Soil analysis	N Index 0
	P Index 6
	K Index 3
	Mg Index 3
	pH 6.7