CLUBROOT CONTROL IN CABBAGE AND CAULIFLOWER BY ADDING FUNGICIDE TO THE COMPOST USED FOR RAISING TRANSPLANTS IN LOOSE-FILLED CELLS

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ABSTRACT

In trials on cabbage and cauliflower, adding mercurous chloride to peat-based propagation compost used for raising transplants in 13 ml loose-filled cells, gave good protection against clubroot (Plasmodiophora brassicae) in the field and prevented substantial yield loss. Mixing the chemical in the propagation compost with chlorfenvinphos (10% a.i. granules; Birlane Granules) or with chlorpyrifos (48% a.i. liquid; Dursban 4) as a drench just prior to planting was also effective. However, mercurous chloride added to compost prior to use slowed growth of seedlings during propagation, the effect becoming more pronounced as fungicide dose increased.

Thiophanate-methyl (50% a.i. liquid; Cercobin Liquid) and captafol (48% a.i. liquid; Sanspor) gave some protection against clubroot but were inferior to mercurous chloride and unsatisfactory where clubroot attack was severe. Thiophanate-methyl added to compost prior to use was phytotoxic.

INTRODUCTION

Recent years have seen a dramatic increase in the proportion of vegetable brassica transplants raised in small cells loosely filled with peat-based propagation compost. Plants so raised generally establish quicker and more uniformly than those raised in soil.

In trials in which fungicides were incorporated into compost used for raising cabbage and cauliflower transplants in peat blocks, mercurous chloride, added to the compost prior to blocking gave good protection against severe clubroot (Plasmodiophora brassicae) and prevented serious yield loss (Ann et al. 1985). The purpose of the trials reported here was to determine whether the technique of incorporating fungicide into

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compost could be successfully used where transplants were being raised in loose-filled cells as small as 13 ml. In one of the trials effects of mixing fungicides with insecticides used against cabbage root fly (Delia radicum) were examined.

MATERIALS AND METHODS

Field trials were conducted at locations, on crops and at times as indicated in Table 1

TABLE 1

Details of trials to determine effects of fungicides incorporated into compost used for loose-filled cells.

Trial Number	Location	Crop	Sowing date	Trans-planting date	Harvesting Period
1	Efford EHS, Lymington, Hants	Summer cauliflower (cv. Nevada)	15 April'83	25 May'83	25 July - 18 August'83
2	"	Summer cauliflower (cv. White Fox)	2 May'84	14 June'84	16 August - 11 Sept'84
3	ADAS, Starcross, Devon	Winter cauliflower (cv. St. Agnes)	28 June'83	9 August'83	January and February'84
4	West of Scotland College of Agriculture, Auchincruive, Ayr	Summer cabbage (cv. Golden Acre)	14 May'84	18 June'84	10-22 August'84

Treatments

Powder, liquid and granular pesticide formulations and ground limestone were incorporated into propagation compost just prior to filling of loose-filled cells; some powder and liquid formulations were applied as pre-planting drench treatments within 7 days of transplanting. Fungicide formulations used in the trials were mercurous chloride (100% a.i. powder), thiophanate-methyl (50% a.i. liquid; Cercobin Liquid) and captafol (48% a.i. liquid; Sanspor). Insecticide formulations used were chlorfenvinphos (10% a.i. granules; Birlane Granules), chlorpyrifos (48% a.i. e.c.; Dursban 4) and carbofuran (5% a.i. granules; Yaltox).

In Trial 1, mercurous chloride was either incorporated or applied as a drench to give 0.035 g and 0.05 g/cell. Thiophanate-methyl was applied

as a drench to give 0.05 g and 0.15 g/cell. Some cells received no fungicide to provide an untreated 'check'. Plants were propagated in Hassy 308 trays containing Fisons Levington Transplant Compost in 13 ml cells. The day after planting chlorfenvinphos was band applied to control cabbage root fly.

In Trial 2, mercurous chloride was incorporated at 0.01, 0.02 and 0.04 g/cell. The 0.01 g/cell incorporation rate of the chemical was also used in combination with thiophanate-methyl as a drench at 0.2 g/cell and with a drench of captafol at 0.1 g/cell. Ground limestone was incorporated at a rate aimed to achieve pH 7.2. Some cells received no chemical to provide an untreated 'check'. Plants were propagated in Hassy 308 trays containing Fisons Levington Transplant Compost in 13 ml cells. Immediately after planting chlorfenvinphos was band applied to control cabbage root fly.

In Trial 3, mercurous chloride incorporated at 0.19 g/cell was used in combination with chlorfenvinphos incorporated at 0.003 g/cell and with chlorpyrifos as a drench at 0.003 g/cell. Thiophanate-methyl was applied as a drench to give 0.075 g and 0.15 g/cell and these same rates as drenches were also used in combination with a drench of chlorpyrifos at 0.003 g/cell. Chlorpyrifos as a drench at 0.003 g/cell was also used alone. Plants were propagated in Veg Wedge trays containing Vermipeat compost in 45 ml cells.

In Trial 4, mercurous chloride was incorporated at 0.01 g and 0.04 g/cell. The 0.01 g/cell incorporation rate was also used in combination with thiophanate-methyl as a drench at 0.2 g/cell. Captafol incorporated at 0.1 g/cell was used in combination with thiophanate-methyl as a drench at 0.2 g/cell. Some cells received no fungicide to provide an untreated 'check'. Plants were propagated in Hassy 308 trays containing Fisons Levington Transplant Compost in 13 ml cells. Immediately after planting carbofuran was band applied for the control of cabbage root fly.

Trial layout

Randomised block design with Trials 2-4 having 4 replicates and Trial 1 having 5 replicates per treatment.

Vigour of growth

Plant vigour was scored at transplanting and at maturity in Trials 1 and 2. In Trial 1, least vigorous plants scored 1 and most vigorous ones scored 3 at transplanting and 5 at maturity. In Trial 2, least vigorous plants scored 1 and most vigorous ones scored 5 at transplanting and 9 at maturity.

Clubroot assessments

Severity of clubroot damage was assessed at all sites by digging out plants and examining roots for extent of clubbing. In Trials 1 and 2, severity was assessed using ADAS Disease Assessment Key 3.1.1 (Anon, 1976)

which has a 0 (no clubbing) - 3 (severe clubbing) scale. In Trials 3 and 4 damage was assessed using a 0 (no clubbing) - 5 (severe clubbing) scale.

Yield

Yield of marketable cauliflower curds was recorded on Trials 1 and 2 (27 plants per plot) and in Trial 3. In Trial 4, yield of marketable heads of cabbage was recorded on 27 plants per plot.

RESULTS

In Trial 1 mercurous chloride treatments diminished severe clubroot attack and gave highest marketable yields. Thiophanate-methyl treatment was less effective against the disease but at the higher dose marketable yield was significantly greater than the untreated check. Incorporation of mercurous chloride in the compost, especially at the higher rate, noticeably reduced plant vigour during propagation.

TABLE 2

Vigour scores, estimates of clubroot damage and yield of cauliflowers in Trial 1 with summer cauliflower (cv. Nevada)*

Application method/ fungicide	Dose (a.i./ cell)	Vigour scores at planting	Vigour scores maturity	Clubroot 6 weeks after planting	Score at harvest	Marketable yield (crates/ha)
Untreated check		3	1	3	3	8 c
In compost						
Mercurous chloride	0.05g	2	5	0.3	1.9	1032 a
	0.035g	2	5	0.4	2.0	1063 a
Plant drench						
Mercurous chloride	0.05g	3	4	2.2	2.3	964 a
	0.035g	3	4	2.1	2.3	1176 a
Thiophanate-methyl	0.15g	2	2	2.6	2.8	419 b
	0.05g	3	1	2.9	2.9	168 bc

* In each column figures sharing a common suffix do not differ significantly ($P<0.05$)

In Trial 2 mercurous chloride treatments alone or in combination with captafol diminished severe clubroot attack and gave highest marketable yields. A marketable yield significantly greater than the untreated check was obtained with mercurous chloride treatment combined with thiophanate-methyl. Addition of ground limestone to propagation compost was ineffective. Incorporation of mercurous chloride in compost noticeably reduced plant vigour during propagation.

TABLE 3

Vigour scores, estimates of clubroot damage and yield of cauliflowers in Trial 2 with summer cauliflower (cv. White Fox)*

Application method/ fungicide	Dose (a.i./ cell)	Vigour scores at planting	at maturity	Mean Clubroot Score 6 weeks after planting	harvest	Marketable yield (crates/ha)
Untreated check		5	2.0	2.4 b	3 a	63 a
In compost						
Mercurous chloride	0.04 g	3	8.0	1.7 de	2.2 c	1328 c
	0.02 g	4	8.3	1.9 cd	2.3 c	1332 c
	0.01 g	4	6.5	2.0 c	2.8 ab	1139 c
Compost (C)/ drench (D) combinations						
Merurous chloride (C) + Thiophanate-methyl (D)	0.01 g) + 0.2 g)	4	4.3	2.0 c	2.8 ab	397 b
Mercurous chloride (C) + Captafol (D)	0.01 g) + 0.1 g)	4	7.5	1.5 e	2.5 bc	1153 c
In Compost						
Ground limestone	sufficient to achieve pH 7.2	5	2.8	2.7 a	2.9 ab	291 ab

* In each column, figures sharing a common suffix do not differ significantly ($P<0.05$).

In Trial 3, clubroot was severe where treatment was only with chlorpyrifos. Combining this insecticide as a drench just prior to transplanting with mercurous chloride added as a compost mix, or using a treatment combining mercurous chloride and chlorfenvinphos as compost mixes, significantly reduced clubroot severity and increased marketable yield. Thiophanate-methyl incorporated into compost mix was so phytotoxic that plants were unfit for transplanting.

TABLE 4

Estimate of clubroot damage and yield of cauliflowers in Trial 3 with winter cauliflower (cv St Agnes)*

Application/method Fungicide	Dose (a.i./cell)	Mean clubroot score at harvest	Marketable yield (t/ha)
In compost			
Mercurous chloride	0.019g)	2.8 c	10.37 a
Chlorfenvinphos	0.005g)		
Compost (C)/drench (D) combinations			
Mercurous chloride (C)	0.019g)	2.8 c	9.03 ab
Chlorpyrifos (D)	0.003g)		
Plant drench			
Thiophanate-methyl	0.15 g)	4.0 b	8.71 ab
Chlorpyrifos	0.003g)		
Thiophanate-methyl	0.075g)	3.8 b	7.5 bc
Chlorpyrifos	0.003g)		
Chlorpyrifos	0.003g	4.5 a	6.11 c

* In each column, figures sharing a common suffix do not differ significantly ($P<0.05$)

NB. Treatments with thiophanate-methyl as a compost mix caused severe necrosis of leaf margins and plants so treated were unsatisfactory for transplanting.

In Trial 4, clubroot was less severe. Treatments with mercurous chloride alone gave good control of the disease and the largest increases in marketable yield. Combining thiophanate-methyl treatment with calomel was significantly less effective than using calomel alone. A treatment combining captafol with thiophanate-methyl gave useful clubroot control and increased marketable yield compared with the untreated check.

TABLE 5

Estimates of clubroot damage and yield of cabbages in Trial 4 with summer cabbage (cv Golden Acre)*

Application method/ fungicide	Dose (a.i./ cell)	Mean clubroot score prior to maturity	Mean clubroot score at harvest	Marketable head yield (t/ha)
Untreated check		0.5 a	3.7 a	29.6 c
In compost				
Mercurous chloride	0.04 g	0.1 b	1.7 d	55.9 a
	0.01 g	0.1 b	2.0 c	52.2 a
Compost (C)/drench (D) combinations				
Mercurous chloride (C) + Thiophanate-methyl (D)	0.01 g + 0.2 g	0.2 b	2.3 b	39.6 b
Captafol (C) + Thiophanate-methyl (D)	0.1 g + 0.2 g	0.2 b	2.5 b	45.0 b

* In each column, figures showing a common suffix do not differ significantly ($P<0.05$)

DISCUSSION

Trials reported in this paper show that incorporating mercurous chloride into compost used for raising cabbage and cauliflower in loose-filled cells gave useful protection against clubroot, particularly during the first few weeks after transplanting. This earlier protection is important as severe clubroot attack at this stage severely checks growth.

Mixing mercurous chloride into propagation compost slowed growth during propagation, the effect becoming more pronounced with increasing dose. This effect was observed in all trials and resulted in plants taking longer to reach transplanting stage. This effect with mercurous chloride has been reported in trials involving its incorporation into compost used for raising brassica transplants in peat blocks (Ann et al. 1985). For this reason drench application of mercurous chloride just prior to transplanting was examined. It gave less satisfactory clubroot control than mixing with propagation compost but achieved comparable yields. However, as mercurous chloride has very low solubility in water and can only be kept suspended by vigorous and continuous agitation, the technique would be risky to adopt commercially.

A possible means of minimising the effect of mercurous chloride on plant vigour was to supplement the lowest rate of this chemical used as a compost mix with either captafol or thiophanate-methyl. However, neither of these combinations was signficantly better than mercurous chloride

alone. Yields obtained with mercurous chloride plus thiophanate-methyl combinations were disappointing despite reasonable clubroot control, suggesting a possible post-planting phytotoxicity problem.

Thiophanate-methyl alone or in combination with captafol was examined to see whether it would provide an effective and more acceptable alternative to mercurous chloride. Although these fungicides gave some protection against clubroot they were unsatisfactory in situations where clubroot damage on check plants was severe. Furthermore, adding thiophanate-methyl to propagation compost prior to use was sometimes phytotoxic.

In commercial brassica growing, protection of brassicas raised in loose-filled cells against cabbage root fly attack is achieved by pre-planting insecticide application. In ADAS trials (Saynor et al. 1986) mercurous chloride and a granular form of chlorfenvinphos mixed into the propagation compost had no detrimental effect on the plants, whereas mixing mercurous chloride and a granular formulation of chlorpyrifos into propagation compost was exceedingly phytotoxic. In Trial 3 reported in this paper, satisfactory performance was obtained with mercurous chloride as a compost mix either with chlorfenvinphos similarly incorporated or with chlorpyrifos as a drench just prior to transplanting. The effects of mixing mercurous chloride with other pesticides are unpredictable and need further investigation.

The technique of mixing mercurous chloride into propagation compost to protect cabbage and cauliflower transplants raised in loose-filled cells against clubroot is now commercially recommended and used in the UK. However, there is still need for an effective alternative which is safer to use and environmentally more acceptable.

ACKNOWLEDGEMENTS

We thank colleagues at the various trials locations and at Reading for their assistance.

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