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AGRICULTURAL DEVELOPMENT AND ADVISORY SERVICE

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Authentication

I declare that this work was done under my supervision according to the procedures described herein and that this report represents a true and accurate record of the results obtained.

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Summary

In trials on brassicas at three centres the phytotoxic effects of pre-planting applications of mercurous chloride and chlorpyrifos, either alone or in combination, were investigated.

At all three sites the incorporation of mercurous chloride into the compost in which the plants were subsequently raised caused an initial growth check which was still detectable at transplanting. The application of mercurous chloride alone did not appear to affect the final yield of produce.

The application of chlorpyrifos as a pre-planting drench also tended to affect the plants' growth, causing a slight check and a temporary partial de-waxing of the foliage. No effect of this treatment on final yield was noted except at one site, where a double rate of the drench caused a 20% yield loss in cabbage.

Where both mercurous chloride and chlorpyrifos were applied in combination, effects differed at the three sites. At two sites no deleterious effects were noted, but at the third, where the plants came under severe drought stress, the final yield of cabbage was reduced by up to 75%, depending upon rates of the two materials.

The preliminary conclusion from this work is that it is safe to incorporate mercurous chloride into the cells in which brassicas are to be raised and then to drench the same plants with chlorpyrifos immediately before planting, providing:

(1) The normally recommended rates of both materials are not exceeded.

(2) The plants are not subjected to severe stress, whether due to drought or other cause.

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Introduction

Recent experimental work has shown that pre-planting drenches of some insecticides applied to cell-raised brassica plants control cabbage root fly (Delia radicum) very effectively. Similarly, incorporating calomel (mercurous chloride) when filling trays can give good control of clubroot (Plasmodiophora brassicae) in cabbage, cauliflower and calabrese.

Previous experience of using both calomel and chlorpyrifos granules incorporated in peat blocks has shown the combination to be phytotoxic to brassicas. Little however was known of the phytotoxic effects of using chlorpyrifos drenches applied just before planting to plants raised in calomel-treated compost in loose-filled cells.

This experiment was designed to identify phytotoxic combinations of calomel and either chlorpyrifos or fonofos, when used to treat cell-raised brassicas.

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Materials and Methods

This experiment consists of three trials, each carried out at a different centre on a different brassica crop.

Centre	Evesham	Kirton	Reading
Crop	Brussels Sprouts	Cauliflower	Cabbage
Cultivar	Troika	Andes	Stonehead
Sown - i) 2N Calomel	15.4.87	6.4.87	3.4.87
ii) N Calomel	24.4.87	13.4.87	8.4.87
iii) No Calomel	1.5.87	20.4.87	14.4.87
Planting date	29.6.87	16.6.87	14.5.87
Raising tray	Hassy 308	Hassy 308	Hassy 228
Capacity/cell	14ml	14ml	17ml
Planting site	Luddington EHS	Kirton EHS	Millets Farm, Frilford
Soil type	Sandy gravelly loam	Medium silt	Sandy loam

Trial design	Randomised block	Randomised block	Randomised block
Replicates	4	3	3
Treatments as follows:			
1) Untreated	+	+	+
2) Calomel (N)	+	+	+
3) Chlorpyrifos (N)	+	+	+
4) Calomel (2N)	+	+	+
5) Chlorpyrifos (2N)	+	+	+
6) Calomel (N) & Chlorpyrifos (N)	+	+	+
7) Calomel (2N) & Chlorpyrifos (N)	+	+	+
8) Calomel (N) & Chlorpyrifos (2N)	+	+	+
9) Calomel (2N) & Chlorpyrifos (2N)	+	+	+

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10) Calomel (N) & Chlorfenvinphos (N)	+	-	-
11) Calomel (N) & Fonofos (N)	+	+	+
12) Calomel ($\frac{1}{2}$N) & Chlorpyrifos ($\frac{1}{2}$N)	-	+	-

The letter N (in brackets) denotes that the manufacturer's normal recommended rate of treatment was used. 2N = double rate, $\frac{1}{2}$N = half rate.

Normal rates of application are as follows:

Birlane Granules (Chlorfenvinphos 10%). No recommendation for cells. 0.5 kg/640 l peat (blocks).

Calomel (mercurous chloride 100%): Apply 1.5 kg per m^3 of compost.

Dursban 4 (chlorpyrifos 48% EC): Apply 50 ml product per 5000 cells in 5-10 litres of water.

Cudgel (microencapsulated fonofos, 43.3%): Apply 100 ml product in 40 litres of water per m^3 of compost, or 25ml product in 100 litres of water per 10 m^2 of tray surface, pre-sowing. In addition apply 25 ml product in 100 litres of water per 10m^2 tray surface pre-planting.

Plants were propagated in plastic trays under protection.

Previous experiments have shown that incorporating calomel into compost slows the growth of plants subsequently sown in it. In order to obtain plants that were approximately equal in size at planting, staggered sowing dates were adopted. Plants to be grown in compost containing 2N calomel were sown first: those to be grown in compost containing N calomel were sown approximately 1 week later, and those to be grown in untreated compost were sown about 1 week later still.

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The calomel (dust formulation) was applied to the compost and thoroughly mixed in, before filling the trays. Where fonofos was to be incorporated it was first diluted before thorough mixing and tray filling. The pre-planting applications of both chlorpyrifos and fonofos were applied to the plants by watering can. In the case of chlorpyrifos, the foliage was dampened before application and then rinsed immediately after application was completed, in order to prevent foliar scorch.

Visual assessments of germination and vigour were made, the latter both before and after planting. Vigour was scored on a scale of 0-5, 0 representing least vigour and 5 the maximum.

The yields of crop were recorded in each case, and any other effects noted. This data was subject to analysis of variance.

Samples of roots were assessed at harvest to determine the level of clubroot infection and cabbage root fly larval mining.

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Results & Discussion

None of the pre-sowing treatments had any adverse effect on germination of any of the brassicas grown. The lowest germination rate recorded in a tray was 88%, measured one week after sowing. At each site the final germination rate reached approximately 95% and 98% was achieved in some trays. This was well up to expectations.

Vigour scores were made at various stages in the plants'growth. These are summarised in Table 1. The initial effect noted during propagation was that plants grown in trays treated with calomel were less vigorous than the remainder. The higher rate of calomel used reduced vigour more than the lower. The effect was such that, at transplanting the plants grown in calomel-free compost were generally larger than the others, despite being sown 1 or 2 weeks later.

Application of the chlorpyrifos drench also had a visible effect. Chlorpyrifos is dissolved in xylene and the presence of this solvent in the diluted drench applied to the plants stripped some wax off the leaves. The plants then appeared a brighter, paler green.

Field assessments of plant vigour after planting showed that the symptoms of slow growth and discoloured plants caused by the inclusion of calomel in the compost were eventually overcome and the plants grew normally in most cases. The exceptions to this were where either the calomel or the chlorpyrifos, or both, were applied to the plants at more than the manufacturers' current recommended rate. This reduced vigour in the treated plants for at least a month after planting.

The yields of the crops in the three trials are summarised in Table 2. Yields of cabbage, cauliflower and Brussels sprouts are normally expressed in different ways, ie for cabbage - weight/plot of heads above 0.5 kg, for cauliflower-crates of 12 heads per hectare and for sprouts - weight of buttons above 12 mm diameter per plot. For this reason direct comparison of the results obtained at each of the three sites is difficult but to help in assessing treatment effects the yields of all treatments have been expressed as a percentage of the appropriate untreated yield.

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The yield results from two of the trials (Evesham and Kirton) showed no real pattern of effects. There was little variation in the yields of treatments that could be put down as effects of those treatments. Even where a significant increase in yield for a treatment was recorded - for instance, at Evesham the double rate chlorpyrifos drench gave a 50% yield benefit compared to the untreated - there was no obvious reason for this. At all trials the levels of pest or disease were too low to affect yields. None of the treatments at the Kirton or Evesham sites appeared to have lasting phytotoxic effects that threatened yields.

At Reading however the picture was different. Where chlorpyrifos was applied to the cabbage at double the recommended rate, or where both chlorpyrifos and calomel were applied, yield losses were recorded. These ranged from 25% where 2N chlorpyrifos was applied to 75% where both materials were used at double the recommended rates. The combination of calomel with fonofos did not affect yield.

The results obtained at Reading are therefore very different from those from the other two sites. It seems unlikely that cabbage (as grown at Reading) is significantly more sensitive than cauliflower (Kirton) or Brussels sprouts (Evesham) to chemical damage. The reason for the differences in effects at the three sites appears much more likely to be due to local conditions. At Kirton, the soil is moisture-retentive silt, and due to the wet growing season in 1987 the plants were never short of water. Irrigation was available for the sprouts at Evesham and was used as necessary. At Reading however the plants were grown in a sandy loam soil without irrigation, and for a four-week period after transplanting there was no rainfall. The cabbage suffered severe drought stress resulting in the near death of some plants. Under these conditions of drought stress it is likely that brassica plants are less able to tolerate chemical application.

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Conclusions

Used alone at the recommended rates on cell-raised brassica plants, neither calomel nor chlorpyrifos have permanent phytotoxic effects, though symptoms of damage may be present temporarily. Even at double the recommended rates phytotoxic damage is unlikely to be severe.

No phytotoxic reaction will result when plants are grown in calomel-treated compost and are subsequently drenched with chlorpyrifos pre-planting as long as they do not suffer growing-season drought stress. If calomel and chlorpyrifos-treated plants are subject to drought stress after transplanting then a severe reaction resulting in yield loss is likely to result. The higher the rate of either chemical, the greater the subsequent effect will be.

The application of a fonofos drench to calomel-treated plants does not result in a phytotoxic reaction and consequent yield loss, even when the plants are subjected to drought stress after transplanting. This combination may therefore be safer to use on plants grown where no irrigation is available.

Recommendations

This work should be repeated for a second year. This will confirm that it is drought stress and not brassica type that influences the reaction to treatment with calomel and chlorpyrifos. It will also confirm that calomel and fonofos are potentially a safer combination.

Storage of Data

Results of these trials are held at the three Entomology Departments participating in this experiment. Results from Reading and Evesham are also held at Kirton.

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Table 1 COMMERCIAL - IN CONFIDENCE **APPENDIX I**

Effects of calomel, chlorpyrifos, fonofos and chlorfenvinphos treatments on the vigour of brassica seedlings.

Treatment	Evesham		Kirton		Reading	
	Assessed 2.6.87 tray	Assessed 22.7.87 field	Assessed 10.6.87 tray	Assessed 10.7.87 field	Assessed 7.5.87 tray	Assessed 29.6.87 field
1) Untreated	5	5	5	4	5	4
2) Calomel (N)	2	4	4	3	4	5
3) Chlorpyrifos (N)	3	5	5	5	5	4
4) Calomel (2N)	1	3	3	3	4	5
5) Chlorpyrifos (2N)	5	5	5	5	5	3
6) Calomel (N) & chlorpyrifos (N)	2	3	2	3	4	3
7) Calomel (2N) & chlorpyrifos (N)	4	3	3	2	4	3
8) Calomel (N) & chlorpyrifos (2N)	2	1	4	2	4	1
9) Calomel (2N) & chlorpyrifos (2N)	5	2	3	2	2	1
10) Calomel (N) & chlorfenvinphos (N)	2	2	–	–	–	–
11) Calomel (N) & fonofos (N)	2	4	2	3	3	5
12) Calomel ($\frac{1}{2}$N) & chlorpyrifos ($\frac{1}{2}$N)	–	–	1	4	–	–

Table 2 **APPENDIX II**

Effects of calomel, chlorpyrifos, fonofos and chlorfenvinphos treatments on the yield of brassica crops.

Treatment	Evesham - Sprouts (kg/plot) 12mm+	% of control	(Duncan's mrt)	Kirton - Cauliflower (crates/ha)	% of control	(Duncan's mrt)	Reading - Cabbage (kg/plot)	% of control	(Duncan's mrt)
1) Untreated	2.94	100	(a)	2525	100	(a)	27.4	100	(e)
2) Calomel (N)	3.49	119	(ab)	2890	114	(a)	28.5	104	(e)
3) Chlorpyrifos (N)	3.71	126	(ab)	2558	101	(a)	27.3	100	(e)
4) Calomel (2N)	3.25	111	(ab)	2658	105	(a)	26.1	95	(de)
5) Chlorpyrifos (2N)	4.51	153	(b)	2492	99	(a)	22.0	80	(cd)
6) Calomel (N) & chlorpyrifos (N)	3.26	111	(ab)	2425	96	(a)	20.3	74	(c)
7) Calomel (2N) & chlorpyrifos (N)	4.12	140	(ab)	2425	96	(a)	19.7	72	(c)
8) Calomel (N) & chlorpyrifos (2N)	2.85	97	(a)	2458	97	(a)	13.5	49	(b)
9) Calomel (2N) & chlorpyrifos (2N	3.16	107	(ab)	2757	109	(a)	6.8	25	(a)
10) Calomel (N) & chlorfenvinphos (N)	3.51	119	(ab)	-	-		-	-	
11) Calomel (N) & fonofos (N)	4.27	145	(ab)	2591	103	(a)	28.8	105	(e)
12) Calomel ($\frac{1}{2}$N) & chlorpyrifos ($\frac{1}{2}$N)	-	-		2824	112	(a)	-	-	

Duncan's mrt - treatments with the same letter are not significantly different from each other (P=0.05)