POSTHARVEST FUMIGATION OF FRESH ASPARAGUS WITH DICHLORVOS

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SUMMARY

Dichlorvos was used as a fumigant to control thrips and aphids on fresh asparagus. In laboratory tests 100% insect mortality was achieved with rates of dichlorvos as low as 1 g ai/m³ at temperatures of 10 °C and higher. At lower temperatures thrips mortality was unreliable. Aphid mortality was high at 0 °C at a rate of 1 g ai/m³. Experiments on product packed for export found that insect mortality was below the 100% required by the export trade, even at rates of 5 g ai/m³. This precludes the use of dichlorvos for fumigation of asparagus for the fresh export trade.

INTRODUCTION

Insect infestation of asparagus spears for fresh export is a major problem, depending on stand management (Watson and Townsend 1981) and unknown seasonal factors. When infestations do occur they severely inhibit the fresh export trade, as both major markets, Japan and USA, operate stringent quarantine barriers against insects on asparagus.

The standard procedure of fumigation with methyl bromide or hydrogen cyanide for disinfestation is hampered by phytotoxic responses of the produce (Beever *et al* 1983) and residue levels after fumigation (Scott 1983).

Given the sporadic nature of insect infestation on asparagus, and the deleterious effect of quarantine fumigation on quality, it is desirable to have some flexible means of dealing with infestations as needed. Controlled atmospheres offer one possibility (Lill and van der Mespel 1986). Another is to use a pesticide with a high vapour pressure and short residual life, that can be readily applied in packhouses, and that has a high insecticidal activity. Such a compound is dichlorvos, which can be formulated with CO₂ as an accelerant (Bond 1984).

MATERIALS AND METHODS

The asparagus cultivars used were Mary Washington or Rutgers Beacon from trial plots at the Horticultural Research Centre, Levin. Asparagus was freshly picked for each experiment.

Natural insect infestations were augmented with glasshouse reared green peach aphid (*Myzus persicae* [Sulzer]) and field collected NZ flower thrips (*Thrips obscuratus* [Bagnall]) after the asparagus had been picked and trimmed.

Dichlorvos was supplied by NZ Industrial Gases as either 5% or 0.5% w/w in carbon dioxide, in steel cylinders containing 6 kg of product (Insectigas). Application was with a "Gunjet 30" high pressure gas gun which delivered 6.6 g/second of product with a Teejet 00050 nozzle or 1.1 g/second of product with a Teejet 00009 nozzle. All rates of dichlorvos are given as g ai/m³.

Insect mortality was assessed by dissecting all the bracts off each spear and removing all insects found. An insect was deemed dead if it did not move at all when the thorax was prodded, the test used by Japanese quarantine officers.

A. The effect of rate of dichlorvos and temperature.

These experiments were replicated twice and carried out on 10 spears held upright with their bases in a plastic container. Fumigant was applied through a 1.5 cm aperture in the top of an otherwise airtight 120 litre fibreglass drum. The treatments were 1, 2.5 and 5 g/m³ of dichlorvos at 0, 5, 10, 15 and 20 °C. All experiments were assessed 12

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hours after applying the fumigant to allow time for insect mortality to occur.

B. The effect of duration of fumigation.

These experiments evaluated the effect of time of fumigation, from application to ventilation of the fumigation chamber. Durations were 30 minutes, 1 h and 24 h at the rates of dichlorvos and the temperatures defined in Table 2. Each treatment was replicated twice.

C. The effect of split applications and fumigant formulation.

One application of 1 g/m³ was compared with two applications of 0.5 g/m³, 30 minutes apart. This was replicated three times and carried out at 5 and 10°C. Insect mortality was assessed after 12 hours.

The effect of formulation of dichlorvos was tested by comparing 0.5% dichlorvos with 5% dichlorvos at 1 g/m³ at 5°C. The treatments were replicated four times and insect mortality was assessed after 12 hours.

D. Commercial validation

The final experiments involved fumigating packed asparagus. Spears were packed in 3 kg export boxes supplied by Turners and Growers Ltd. Fumigations were carried out in a 584 litre fumigation chamber at ambient temperature and at rates of dichlorvos of 1, 1.5, 2, 4 and 5 g/m³. Each experiment was replicated three times.

Insect mortality was assessed after 12 hours. All the spears in each box were tapped firmly to dislodge any insects to mimic the inspection method used by Japanese quarantine inspectors, and a subsample of 15 spears per box was completely dissected.

RESULTS

A. The results of the preliminary experiments to determine the relationship between rate of dichlorvos and temperature are shown in Table 1. At 5 and 10°C and rates of 2.5 and 5 g/m³ dichlorvos, and at all rates at 15°C and 20°C, mortality of thrips was 100%. Between 0°C and 10°C, thrips mortality was lower than that for aphids. At all temperatures and rates, except at 0°C and 5 g/m³ dichlorvos, aphid mortality was 100%.

TABLE 1: Percentage mortality of thrips and aphids at three rates of dichlorvos and various temperatures. Values are the mean of two replicates.

Temperature (°C)		Rate (g/m ³)		
		1	2.5	5
THRIPS	0	27	92	75
	5	84	100	100
	10	88	100	100
	15	100	100	100
	20	100	100	100
APHIDS	0	100	100	96
	5	100	100	100
	10	100	100	100
	15	100	100	100
	20	100	100	100

B. Fumigation durations of 30 mins and 1 h were not long enough to permit high mortality to have occurred (Table 2). Thus all subsequent fumigations were left for 12 hours before venting and insect assessment.

C. Mortality from split applications (2 applications of 0.5 g/m³) of 1 g/m³ produced no better mortality than one application (Table 3). Similarly, the use of the 5% formulation was not appreciably different from the 0.5% formulation (Table 3).

D. As 1 g/m³ had provided 100% mortality at a range of temperatures (Table 1), this was used as the base rate for the fumigation of packed boxes. Sequential fumigations at increased rates of dichlorvos were then carried out in an endeavour to find a treatment that gave 100% mortality. Even at 5 g/m³ insect mortality was only 91% for thrips and 51% for aphids (Table 4).

TABLE 2: The effect of fumigation duration on fumigation efficacy. (Data for 12 hours duration are presented in Table 1).

Duration	Rate (g ai/m ³)	Temperature °C	Mortality (%)	
			Thrips	Aphids
30 minutes	1	5	67	—
	5	5	93	78
1 hour	1	5	77	100
	2.5	20	100	100
	5	20	100	100
24 hours	2.5	20	100	100
	5	20	100	100

TABLE 3: Effect of (a) a single or split application, and (b) formulation of dichlorvos on percent mortality of thrips and aphids.

Treatment	Rate (g ai/m ³)	Temperature °C	Mortality (%)	
			Thrips	Aphids
(a) Split application	0.5 (2x)	5	89	96
		10	100	100
	1.0	5	95	97
		10	100	100
(b) 0.5% dichlorvos	1.0	5	92	81
	5.0% dichlorvos	5	94	95

TABLE 4: Mortality of thrips and aphids in boxes of asparagus packed for export and fumigated at ambient temperature.

Rate of dichlorvos (g ai/m ³)	Mortality (%)	
	Thrips	Aphids
1	95	75
1.5	98	87
2	96	67
4	95	94
5	91	51

It was not possible to carry out a CO₂ control in this research as the technology was not available at the time. It is possible that the level of CO₂ applied with the dichlorvos might have an insecticidal or anaesthetic effect on the insects. In Table 5 the levels of CO₂ in the fumigation chamber at each fumigation rate and with both formulations of dichlorvos are shown as percentage CO₂ by volume. These data have been calculated using the ideal gas equation from the grams of liquid CO₂ applied.

DISCUSSION

These experiments were designed to give a functional profile of the usefulness of dichlorvos for disinfestation of asparagus with the aim of determining a rate to be used in fumigation of packed asparagus. For markets with quarantine barriers, 100% control of insects is required. This level of control was not obtained in the experiment on packed produce reported here.

The use of the stringent "quarantine dead test" affected the level of mortality found at lower temperatures in the experiments investigating the relationship between rate and temperature and fumigation efficacy. All insects that were not dead when mortality was assessed had died 2-3 days later. Unfortunately these insects would still be alive at shipping, and would prevent a phytosanitary certificate being issued for the export of the product as "essentially insect free". Thus, 100% mortality would occur

TABLE 5: Carbon dioxide concentrations (% volume) present in fumigation chambers as a function of fumigation rate, fumigant formulation and volume of fumigation chamber. Values are calculated using the ideal gas equation.

Rate of dichlorvos g ai/m ³	Chamber size (litres)	% dichlorvos	
		5%	0.5%
1	120	.88	.92
2.5	120	2.21	2.32
5	120	4.43	4.64
1	585	4.32	
1.5	585	6.48	
2	585	8.64	
4	585	17.29	
5	585	21.61	

eventually, but only after dispatch of export consignments which, therefore, could not be certified at departure as being insect free.

The results of the split application and the comparison of two formulation experiments were similar to data from the first series of experiments. Only at 10°C was 100% mortality reliable, and the experimental variables other than temperature had no effect on the results.

The levels of CO₂ produced in the fumigation chambers were likely to be high enough to affect any insects present by its action on respiration (Richards and Davies 1957). There is no information on how long the elevated CO₂ levels would have persisted as the fumigation chambers were not absolutely gas tight.

All the laboratory experiments indicated that there was potential for the use of dichlorvos for the disinfestation of asparagus. When the fumigant was used on asparagus packed in boxes suitable for fresh export, however, insect mortality was too low to be acceptable, even at 5 g/m³ dichlorvos which gave unacceptably high residues in other trials (D. Snowball pers. comm.). The configuration of boxes in the fumigation chamber in relation to the injection of fumigant may help to increase the effectiveness of the process.

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