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# POSTHARVEST FUMIGATION OF FRESH ASPARAGUS WITH DICHLORVOS

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**Summary**

The use of conventional pesticides as fumigants for the export trade in fresh asparagus has not been actively investigated. The potential for the utilisation of an insecticide with a high vapour action and short residual life such as dichlorvos appears promising.

In preliminary trials on unpacked asparagus, 100% insect mortality was achieved with rates of insecticide as low as 1 g $m^{-3}$ at temperatures of 10°C or more. At lower temperatures thrips mortality was unreliable, although aphid mortality was high at the low rate of insecticide (1 g $m^{-3}$) at temperatures as low as 0°C.

In experiments on packed product mortality was unacceptably low at even 5 g $m^{-3}$. However the use of a forced draught fumigator gave 100% insect mortality at 1 g $m^{-3}$ at ambient temperature.

Further research is needed to define minimum rates with the forced draught fumigator and the relationship with product temperature and fumigation time. The residues left after fumigation with 1 g $m^{-3}$ dichlorvos will be carried out before the next asparagus season.

## Introduction

Insect infestation of asparagus spears for fresh export is a major problem, depending on stand management (Watson & Townsend 1981) and unknown seasonal factors. When infestations do occur it severely inhibits 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 & van der Mespel 1986; Carpenter & Lill 1987). 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 $CO_2$ as an accelerant (Bond 1984).

This report summarises research into the applicability of dichlorvos for postharvest disinfestation of fresh asparagus.

## Materials and Methods

The asparagus cultivars used were Mary Washington or Rutgers Beacon from trial plots on 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) and field collected NZ flower thrips (Thrips obscuratus).

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. Application was with a "Gunjet 30" high pressure gas gun which delivered 6.6 g/second of produce with a Teejet 00050 nozzle or 1.1 g/second of product with Teejet 00009 nozzle.

Insect mortality was assessed by dissecting all the bracts off each spear and removing all the 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.

The preliminary experiments were replicated twice and carried out with 10 spears held in a plastic container.

The experimental conditions were 1, 2.5 and 5 g $m^{-3}$ of dichlorvos at 0, 5, 10, 15 and 20°C. All experiments in this series were assessed after 12 hours after applying the fumigant to allow time for insect mortality to occur.

The next series of experiments evaluated the effect of fumigation duration (time from application to ventilation of the fumigation chamber) with durations of 30 minutes, 1 hour and 24 hours at the rates of dichlorvos and the temperatures defined in Table 4. Each treatment was replicated twice. The efficacy of an

application of 1 g $m^{-3}$ was assessed with one application of the whole amount being compared with two applications of 0.5 g $m^{-3}$ 30 minutes apart. This was replicated 3 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 $m^{-3}$ at 5°C. The treatments were replicated 4 times and insect mortality was assessed after 12 hours.

The final series of experiments involved fumigating packed asparagus. spears were packed in 3 kg export boxes supplied by Turners & Growers Ltd. Fumigations were carried out at ambient temperature and at rates of dichlorvos of 1, 1.5, 2, 4 and 5 g $m^{-3}$. Each experiment was replicated three times. These were carried out in a 584 ℓ fumigation chamber. These experiments were extended by using a forced draught fumigation (Figure 1). With this system, 4 boxes were fumigated at one time and the experiment was repeated twice. 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 for insect recovery.

**Results and Discusssion**

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 at 2.5 and 5 g $m^{-3}$ dichlorvos and all rates at 15°C and 20°C, mortality was 100% for thrips. At 0°C and 5°C, thrips mortality was lower than that for aphids. At all temperatures and rates except at 0°C and 5 g $m^{-3}$ dichlorvos aphid mortality was 100%. In time any live insects would have died as they were lethargic, but applying the "quarantine dead test", they were still alive at the point the produce would have been shipped thus contravening the requirements for a phytosanitary certificate.

Mortality from split applications (2 applications of 0.5 g $m^{-3}$) of 1 g $m^{-3}$ produced no better mortality than one application (Table 2). Similarly, the use of the 5% formulation was not appreciably different from the 0.5% formulation (Table 3).

Fumigation durations of half and 1 hour were not long enough to permit high mortality to have occurred before insect assessment was carried out (Table 4). Thus all subsequent fumigations were left for 12 hours.

As 1 g $m^{-3}$ 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 increased by 0.5 g $m^{-3}$ in an endeavour to find a treatment that gave 100% mortality. Even at 5 g $m^{-3}$ insect mortality was significantly below 100% in packed asparagus (Table 5).

Previous research had shown that 5 g $m^{-3}$ dichlorvos gave unacceptably high residues (D. Snowball pers comm.), it was therefore apparent that some other approach was needed to keep the rate of dichlorvos needed down to a minimum. A simple forced draught fumigator was built using a 12 cm fan mounted in a vertical board against which asparagus export boxes could be

stacked to give a moderately tight seal. This was then covered with a wooden framed plastic tent, in which there was a hole to allow application of the fumigant. The apparatus is shown schematically in Figure 1.

When the forced draught fumigator was used 1 g $m^{-3}$ gave 100% insect mortality (Table 6) (2 replicates of 4 boxes each with no insects surviving). No lower rates were tested as the season had ended.

The last 4 boxes of asparagus were fumigated and then 2 were ventilated. One ventilated box and one non ventilated box were then subjected to simulated air transport and two similar boxes were subject to simulated sea transport using the techniques and transport regimes described by Downs (1985). These samples were frozen at the end of the simulated transport and await residue analysis, as do samples immediately post fumigation.

## Conclusions

There is no doubt that with the use of a simple forced draught fumigator dichlorvos will give cheap and effective levels of insect mortality on infested asparagus. It is now important that the residues be determined and it is likely that the rate of dichlorvos needed may be less than 1 g $m^{-3}$, although this will need further research.

## Acknowledgements

Technical assistance was provided by Nigel Grant and Gordon MacArther of NZIG, Lower Hutt. Ross Lill designed the forced draught fumigator and Bruce Dobson and helpers harvested the asparagus. Turners and Growers Ltd, Otaki, supplied export boxes for asparagus. Without the help of all these people this project would not have been as successful as it was.

**References**

Beever, D.J., Yearsley, C.W., Sutherland, B.A., & Scott, R.A. 1983. Post-harvest fumigation of asparagus: 1983 trials on spear quality after fumigation. Internal Report, Division J. Horticulture & Processing, DSIR, Auckland.

Bond, E.J. 1984. Manual of fumigation for insect cntrol. FAO Plant Protection and Production Paper 54. FAO, Rome.

Carpenter, A., & Lill, R.E. 1987. Controlled atmospheres for insect suppression on fresh asparagus. Report to the NZ Asparagus Council.

Downs, C.G. 1985. Cut flower and foliage transportation study. Technical Bulletin No 10, Horticultural Research Centre, Levin.

Lill, R.E., & van der Mespel, G.J. 1986. The effect of controlled atmosphere storage of asparagus on survival of insect passengers. Proceedings of the 39th NZ Weed & Pest Control Conference: 211-214.

Scott, R.A. 1983. Asparagus fumigation. Internal report, Division of Horticulture & Processing, DSIR, Auckland.

Watson, R.N., & Townsend, R.J. 1981. Invertebrate pests on asparagus in Waikato. Proceedings of the 34th NZ Weed & Pest Control Conference: 70-79.

TABLE 1: Percentage mortality of thrips and aphids at a range rates of dichlorvos at various temperatures

| Temperature (°C) | | Rate ($g/m^{-3}$) | | |
|---|---|---|---|---|
| (A) | | 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 |
| (B) | | | | |
| APHIDS | 0 | 100 | 100 | 96 |
| | 5 | 100 | 100 | 100 |
| | 10 | 100 | 100 | 100 |
| | 15 | 100 | 100 | 100 |
| | 20 | 100 | 100 | 100 |

TABLE 2: Mortality (%) of thrips and aphids reuslting from split applications 30 minutes apart fompared with one application at the same rate.

| Application type | Temperature °C | Mortality(%) | |
|---|---|---|---|
| | | Thrips | Aphids |
| Split application | 5 | 89 | 96 |
| | 10 | 100 | 100 |
| One application | 5 | 95 | 97 |
| | 10 | 100 | 100 |

TABLE 3: The effect of formulation of dichlorvos on fumigation efficacy at 1 g $m^{-3}$ at 5°C.

| Formulation | Mortality (%) | |
|---|---|---|
| | Thrips | Aphids |
| 0.5% dichlorvos | 92 | 81 |
| 5.0% dichlorvos | 94.3 | 94.6 |

TABLE 4: The effect of fumigation duration on fumigation efficacy. (Data for 12 hours duration are presented in Table 1)

| Duration | Rate g $m^{-3}$ | 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 |

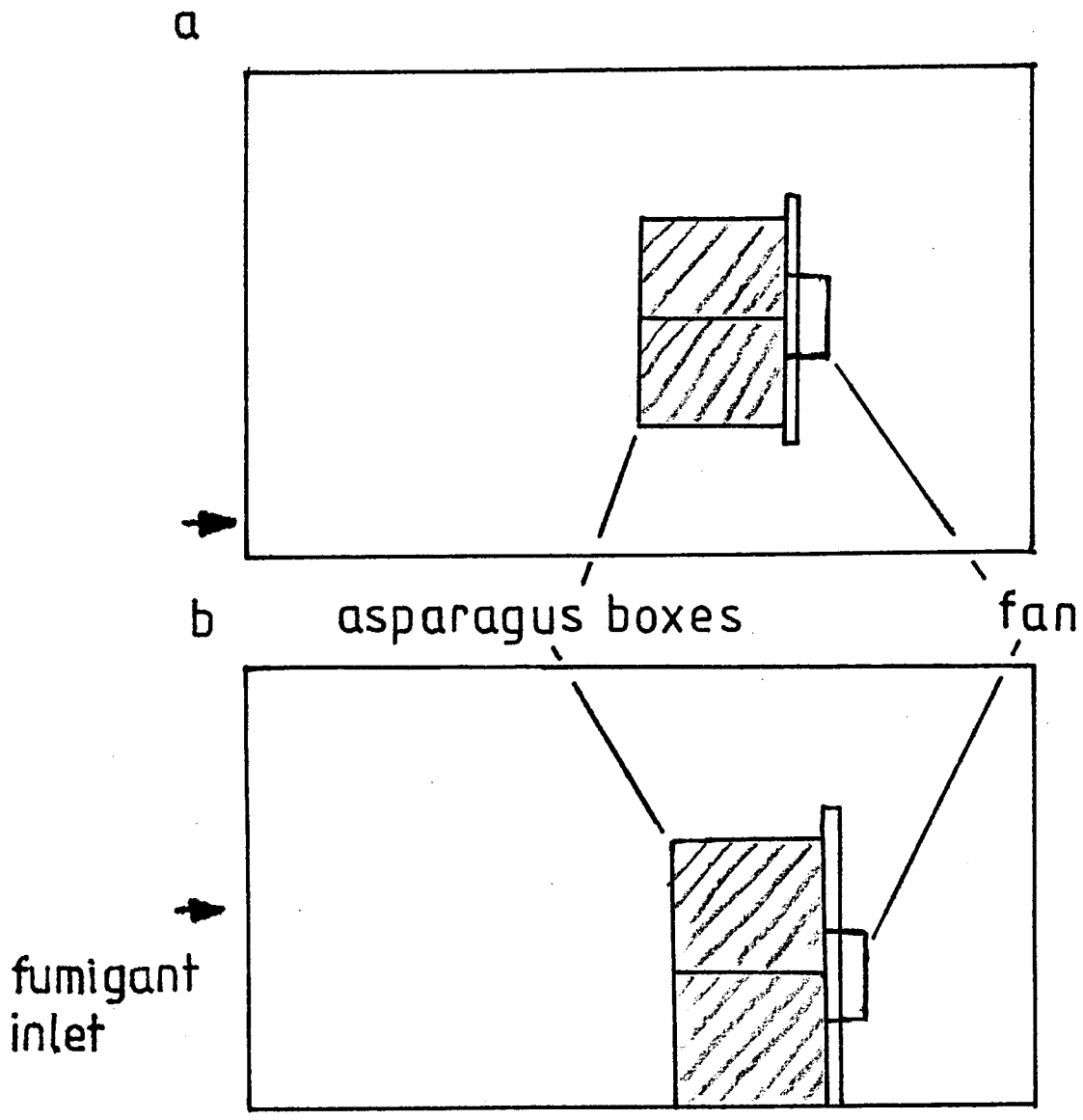
TABLE 5: Mortality of thrips and aphids in boxes of asparagus packed for export and fumigated at ambient temperature

| Rate of insecticide ($g\ m^{-3}$) | Mortality (%) | |
|---|---|---|
| | Thrips | Aphids |
| 1 | 95 | 75 |
| 1.5 | 98 | 87 |
| 2 | 96 | 67 |
| 4 | 95 | 94 |
| 5 | 91 | 50.6 |

TABLE 6: Mortality of thrips and aphids in boxes of asparagus packed for export and fumigated using the forced draught fumigator at 1 g $m^{-3}$

| Run number | Mortality (%) | |
|---|---|---|
| | Thrips | Aphids |
| 1 | 100 | 100 |
| 2 | 100 | 100 |

FIGURE 1: The forced draught fumigator
a = plan, b = elevation. Scale: 1 mm = 1 cm



## Research Costs

| | |
|---|---|
| Insect rearing | $235.00 |
| Fumigant | $120.00 |
| Application apparatus | $271.00 |
| Rooms 20 days @ $15/day | $300.00 |
| Misc. stores | $ 39.50 |
| Asparagus 78 kg @ $1.50/kg | $117.00 |
| Science time | $7,920.00 |
| Total | $9,002.50 |
| NZAC Grant | $2,500.00 |
| Net cost to HRC to date | $6,502.50 |
| Dichlorvos residues (yet to be carried out) | |
| 27 samples @ $67ea. | $1,809.00 |
| Total cost to HRC | $8,311.50 |