

ENVIROSOLS AS POSTHARVEST FUMIGANTS FOR ASPARAGUS AND CUT FLOWERS

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SUMMARY

Envirosols are pesticides dissolved in carbon dioxide and delivered through a special high pressure system as an aerosol. We evaluated envirosols based on dichlorvos, permethrin and natural pyrethrins as postharvest fumigants for cut flowers and asparagus. Effective control of two-spotted mites, aphids and thrips was achieved at rates in the range of 0.6-1 g ai/m³. Flowers were damaged if the aerosol was sprayed directly onto them. If used with care it is possible envirosols may overcome postharvest insect problems on specialised crops.

Keywords: fumigant, thrips, aphids, mites, cutflowers

INTRODUCTION

Envirosol is the term used by Commonwealth Industrial Gases (Australia) for pesticides dissolved in carbon dioxide under high pressure and delivered as aerosols. These products have been widely utilised as space sprays for insect pests in warehouses and food premises, and are increasingly being used in Australia for the control of grain pests (Skinner 1987). It seemed that envirosol technology might be useful for postharvest disinfestation.

Exports of cut flowers and fresh asparagus earn New Zealand about \$45 million a year (Dept. of Statistics 1991). Both industries are characterised by dispersed production areas, small packhouses and several exporters and both crops have problems with insect infestation in the key Australian, Japanese and U.S.A. markets. Asparagus normally takes 2-3 days from spear emergence to harvest but still becomes infested with a wide range of insects (Watson and Townsend 1981). It is difficult to use a pesticide in this situation without leaving residues on the crop. Pest populations on protected flower crops can be kept below damaging levels but the low numbers persisting to harvest can cause quarantine problems.

Research on control of insects to meet quarantine needs is caught in a dilemma. Pesticide efficacy studies usually use high numbers of insects, yet quarantine problems are caused by low numbers of pests. To be realistic, postharvest treatments must be assessed against natural (low) pest levels, yet these tests do not give statistically useful measures of the efficacy of a pesticide. No adequate solution to this problem has yet been proposed. In our research we have attempted to meet both requirements, perhaps not always successfully.

In earlier work, Carpenter (1987) showed that an envirosol containing dichlorvos would control thrips and aphids on asparagus spears in experimental situations but found problems with penetration into packed product. The research reported here extends the previous work to packed asparagus and investigates the efficacy of envirosols for insect control on cut flowers, using both natural and augmented pest levels.

METHODS

All envirosols were supplied by N.Z.I.G-Special Gases, Lower Hutt. Concentrations of pesticide/m³ are detailed in Tables 1-4. Application was via a stainless steel hose and a Gunjet 30 hand gun with either a 00050 nozzle (to deliver 6.6 g product/second) or a 00009 nozzle (to deliver 1.1 g product/second). The product consists of a pesticide, any additives and carbon dioxide.

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The pesticide formulations tested were:

Floragas: 20 g/kg permethrin and 1 g/kg pyrethrum

Hortigas: 75 g/kg dichlorvos

Permigas: 4 g/kg permethrin, 1 g/kg pyrethrum and 5 g/kg piperonyl butoxide

Pestigas: 4 g/kg permethrin and 20 g/kg piperonyl butoxide

Insectigas: 50 g/kg dichlorvos

These pesticides were tested on several insect species at a range of temperatures (Tables 1 and 2). Insects were either exposed directly to the pesticides in fumigation chambers or subjected to treatment while in association with cut flowers or asparagus. The insect species included in the tests were: diapausing two-spotted mites, (*Tetranychus urticae* Koch) (tsm), longtailed mealybugs (*Pseudococcus longispinus* (Targioni-Tozzetti)) and leafroller caterpillars (*Epiphyas postvittana* (Walker)) (light brown apple moth) (LBAM), supplied by the insect rearing group of DSIR Plant Protection; non-diapausing two-spotted mites which were raised on carnations at MAF Technology Levin; New Zealand flower thrips (*Thrips obscuratus* Crawford), collected from cabbage tree flowers; passion vine hoppers (*Scolypopa australis* (Walker)) and New Zealand wheat bug (*Nysius huttoni* White) which were collected from around Levin. Green peach aphids (*Myzus persicae* (Sulzer)) were reared on peppers and carnations in a greenhouse.

For tests on cut flowers and asparagus fumigation structures were made from 50 x 50 mm timber frames over which clear plastic was stretched and stapled in place. Specification of the plastic sheet was not important, it merely needed to be in good condition with no holes. Joints were sealed with 50 mm wide PVC builders tape.

Asparagus chambers were always 2.5 x the gross volume of product being tested (= 40% chamber loading). Asparagus was packed in 5 kg wooden boxes; fumigations were aspirated with a 11 cm radial fan. Fumigations were carried out on asparagus straight out of cool storage (0-1°C) at ambient temperatures (14-18°C) and out of direct sunlight. Spear temperature was not controlled during fumigation.

Phytotoxicity was assessed by treating four boxes with Hortigas and subjecting them, and four untreated boxes, to the same temperatures they would experience during airfreight to Japan (rising to 26-27°C for a period), and then assessing spears for tip rot, desiccation, feather tip and diseases.

Some tests were carried out with the natural insect population present. For others N.Z. flower thrips and green peach aphids were added into the top of boxes before they were closed up, the boxes were then left for two hours for the insects to settle in. All boxes were held for 48 hours at 20°C before insect mortality was assessed. Twenty spears were selected randomly from each box and completely dissected. All the remaining spears were tapped to dislodge insects.

For flowers, chamber size depended on the flower type being treated. One cubic metre was always left free from flowers to allow expansion and warming of the carbon dioxide propellant before it contacted the blooms and hence chilling damage was avoided. Flowers were loosely placed in buckets of water for fumigation. Fumigations were carried out within a fumigation structure in a refrigerated shipping container at 8-12°C. Flowers tested were cymbidium orchids, *Zantedeschia*, nerines and carnations. When natural pest populations needed to be augmented a minimum of 10 green peach aphids, 5 N.Z. flower thrips, 10 two-spotted mites and 20 LBAM caterpillars were added to the bloom of each replicate and left for 24 hours to acclimate. All treatments were replicated four times. Forty-eight hours after fumigation all blooms were pulled apart to locate all the pests present. Phytotoxicity was assessed by comparing the quality of treated blooms with untreated blooms at 20°C. Display life had ended when over 50% of the petals on each bloom had wilted.

For all tests pests were defined as alive if they moved at all when prodded.

RESULTS

Effect on insects

Passionvine hopper, N.Z. wheat bug, and longtailed mealybug were all killed by Permigas and Insectigas at rates of 0.5 g ai/m³ and above at both 0°C and 15°C

(Table 1). At 15°C Permigas was effective against passionvine hopper at 0.005 g ai/m³ and against the other two pests at 0.05 g ai/m³. Efficacy of Insectigas at the low rates was variable. Efficacy of Pestigas was rather more variable, especially at 0°C.

TABLE 1: Mean percent mortality of three insect species after treatment with different envirosols at two temperatures. Range of percent mortality is given as measure of variability in efficacy. Rate is g ai/m³.

Treatment	Rate	% mortality (range)					
		Passionvine hopper		Wheat bug		Mealy bug	
		15°C	0°C	15°C	0°C	15°C	0°C
Permigas	0.005	100	17 (11-34)	69 (45-85)	20 (0-50)	73 (50-80)	50 (0-100)
	0.05	100	27 (7-50)	100	23 (20-40)	100	25 (0-100)
	0.5	100	100	100	100	100	100
	1.0	100	100	100	100	100	100
	5.0	100	100	100	100	100	100
Insectigas	0.005	100	56 (25-66)	62 (25-100)	37 (0-40)	40 (0-50)	83 (50-100)
	0.05	50 (33-60)	88 (40-100)	93 (90-100)	71 (60-75)	100	67 (0-100)
	0.5	100	100	100	100	100	100
	1.0	100	100	100	100	100	100
	5.0	100	100	100	100	100	100
Pestigas	0.005	100	21 (0-28)	33 (16-42)	60 (33-100)	75 (50-90)	75 (50-100)
	0.05	100	17 (0-42)	29 (20-40)	33 (20-66)	100	75 (66-100)
	0.5	100	100	100	77 (50-100)	100	100
	1.0	100	100	100	100	100	80 (0-100)
	5.0	100	100	100	100	100	100

TABLE 2: Percent mortality and numbers of diapausing two-spotted mites treated with Floragas at 5 rates (g/m³) and four temperatures (°C).

Rate g ai/m ³	% mortality (number tested)			
	0°C	7.5°C	15°C	22°C
untreated	40 (631)	52 (656)	55.5 (534)	38 (478)
0.25	94.9 (735)	100 (578)	100 (597)	100 (537)
0.5	99 (708)	100 (585)	100 (730)	100 (523)
1.0	100 (718)	100 (482)	100 (587)	100 (523)
3.0	100 (1009)	100 (548)	100 (732)	100 (514)

Table 2 shows the efficacy of Floragas for control of diapausing two-spotted mites at a range of temperatures. At 0°C and 0.25 and 0.5 g ai/m³ mortality was 94 and 99%. At all other temperatures and rates, mortality was complete.

The effect of Hortigas on thrips and aphids on asparagus is shown in Table 3. Thrips control was 100% in all tests except one, but aphid control was rather more variable.

Results of the flower fumigation tests are given in Table 4. In two tests thrips control differed; where mortality was below 100% it was because of the occurrence of an unidentified tubuliferan species. All New Zealand flower thrips were killed. LBAM caterpillar control was 97% at 1 g ai/m³. Efficacy against non-diapausing mite was low (73-83%). Aphid mortality at the higher rate was complete.

TABLE 3: Efficacy of Hortigas for fumigation of packed asparagus. Tests were with added insects and natural populations.

Test Number	No. of boxes of asparagus checked (total boxes in test)		Total numbers thrips	aphids	% mortality thrips aphids	
A. Insects added						
1	4	(4)	444	292	100	100
2	4	(4)	560	168	99.9	97
3	6	(60)	432	222	100	98
4	6	(60)	534	762	100	99
5	6	(60)	414	538	100	100
B. No insects added						
1	6	(94)	44	89	100	100
2	6	(94)	45	80	100	100
3	4	(4)	112	66	100	74
4	4	(4)	36	126	100	69
5	4	(10)	56	104	100	89
6	4	(10)	12	48	100	100
7	2	(2)	110	0	100	-
8	2	(2)	140	0	100	-

TABLE 4: Percent mortality of different pests after treatment of carnations (Expts 1-6) and nerines (Expt 7) with Floragas at different rates and temperatures^a. LBAM - Light brown apple moth, tsm = two spotted mite.

Experiment	Rate g ai/m ³	Blooms /replicate	Replicates	Pests	No. of insects in experiment	% mortality
1	0.6	45	4	thrips	4	100
	1.0	45	4	thrips	7	100
	0	30	2	thrips	4	25
2	0.6	10	4	thrips	20	95
	1.0	10	4	thrips	20	97
3	1.0	22	6	LBAM ^b	180	97
	0	22	2	LBAM ^b	96	0
4	0.6	10	4	tsm ^b	40	83
	1.0	10	4	tsm ^b	40	73
5	1.0	40	4	tsm	328	100
	0	45	1	tsm	58	13
6	0.6	10	4	aphids ^b	40	98
	1.0	10	4	aphids ^b	40	100
7	0.6	35	1	thrips	2	50
	1.0	35	1	thrips	12	100
	0	25	1	thrips	12	0

^a Temperatures - expts 1 and 3 were at 8°C, expts 2, 4, 6 and 7 were at 10°C and expt 4 was at 20°C.

^b Natural populations of insects were augmented.

Phytotoxicity

No damage was caused by permethrin or natural pyrethrins on the five cultivars of cymbidium orchids that were tested. A pale pink cultivar was prone to handling damage but this was made worse by the fumigant. *Zantedeschia* were susceptible to chilling damage if the carbon dioxide contacted the blooms directly. This showed as a discolouration of the bloom. Similar problems were found with carnations and nerines if the envirosol was sprayed directly onto blooms. In all cases damage was independent of rate of product used.

A dichlorvos envirosol caused damage and discolouration on all the flowers tested. When the dichlorvos envirosol was tested on asparagus (1 g ai/m³) it had no effect on spear quality after a simulated shipment by air to Japan. In contrast methyl bromide (56 g/m³) caused spear desiccation, tip rot and fungal decay (unpublished data).

DISCUSSION

The experiments where the pests were not on plants were used to give some idea of rates, pesticides and temperature interactions over a range of pests. This was further refined using diapausing two-spotted mites as a 'difficult-to-kill' species. From the understanding derived from these experiments Floragas and Hortigas were developed and these two envirosols were used in the substantive research on asparagus and cut flowers.

Exporters of asparagus and cut flowers all face the risk that their crops may fail plant health certification in New Zealand, or quarantine inspection in their intended market, and thus they need a flexible approach to risk management of their crops. The data presented in this paper show that pesticides formulated as envirosols are effective against pests that can be encountered on flower and asparagus crops. However in researching the use of these envirosols there are several issues that need to be considered.

The number of test insects is always problematic. Good husbandry during production is essential in export crops, so there should be low numbers of pests present at harvest. Yet for pesticide testing, it is assumed that large numbers of insects should be used. For export asparagus, two thrips per 100 spears is a realistic upper limit for export. As there are about 250 spears per 5 kg box, there may be five thrips per box and it is efficacy at this level of infestation that is important to industry.

Phytotoxicity is also difficult to research on an industry wide basis. There are over 20 cultivars of asparagus in production in this country, from several different gene banks, and grown in many different situations. There are several thousand selections of cymbidium orchids and unknown numbers of selections of carnation, nerine, *Zantedeschia* and several hundred other species/cultivar combinations grown for export. It is impossible to test all the combinations. It is only through trial by industry that any problems will be identified.

Receiving countries have concerns about pesticide residues. Thus Hortigas must not be used on export crops without clearance from the receiving country. Cut flowers are less problematic as they are not usually eaten although there can be problems from residues for people handling the crop. It is important that the appropriate regulations are followed when exporting fumigated crops.

Despite these problems it is clear that formulation of pesticides as envirosols at a rate of about 1 g ai/m³ can effectively control pests after harvest using cheap structures under easily attained conditions. It is likely that the technology will be of value to sectors that need to meet quarantine restrictions on exports.

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