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CONTROLLED ATMOSPHERES FOR INSECT SUPPRESSION ON FRESH ASPARAGUS

Research Report to the NZ Asparagus Council on Research Contract L86/18C

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SUMMARY:

Access to overseas markets for the ever increasing flow of fresh and processed asparagus from NZ is hampered by persistent problems with insect infestations. Previously, Lill & van der Mespel (1986) had shown that controlled atmospheres (CA) had some promise for disinfestation over periods greater than 2½ weeks. As this time span was too great for such a perishable product the research reported here was designed to improve the insecticidal efficacy of CA on asparagus and to shorten the time to 100% mortality.

The use of CA for asparagus has two advantages; spear quality is maintained better than in air and thrips mortality is greater than in air. Aphid mortality was not as high. The use of high stress CA systems greatly enhanced insect mortality but the effects of high CO_2, low O_2 and low humidity on asparagus are unknown.

For sea shipping to northern Pacific markets there may be no advantage to disinfestation using CA where shipping times are 2 weeks. For air freight, high stress disinfestation before the product leaves New Zealand may provide a means of avoiding the costs and deleterious effects of fumigation.

INTRODUCTION

The disinfestation of fresh asparagus for export is a continuing problem. Lill & van der Mespel (1986) demonstrated that the use of controlled atmospheres (CA) had some potential for disinfestation of aphids and thrips but found that even after 18 days storage a proportion were still alive, which would make access to the Japanese market difficult.

There is little likelihood that asparagus could be disinfested using CA in the short time that air shipping takes to Japan. Thus our efforts must turn to seafreight, which takes about 16 days to Japan and USA, so any CA disinfestation technique needs to be effective within that time frame.

This report covers research into the use of CA for asparagus disinfestation that was partially funded by the NZ Asparagus Council and some further experiments that were totally funded by Government.

METHODS & MATERIALS

(a) Asparagus (cvs Limbras and Mary Washington) was obtained fresh on the day each experiment started from research trials at the Horticultural Research Centre.

(b) Thrips were obtained from flowers of Ceonothus and Cordyline. The two most common species were NZ Flower Thrips (Thrips obscuratus) and Flower Thrips (Frankliniella sp). Only adults were tested. Aphids were obtained from crops around the Research Centre. Green Peach Aphid (Myzus persicae) and Black Bean Aphid (Aphis craccivora) were the species used.

(c) Gas mixtures were supplied ready mixed for the experiments with 9% CO_2, 7% O_2 and 9% CO_2, 2% O_2 by NZIG. Air came from the compressor at HRC. Other mixtures were hand calibrated from cylinders of oxygen, carbon dioxide and nitrogen. The stability of the experimental mixtures was tested using a Phillips Gas Chromatograph.

(d) Experimental system. Asparagus spears were put in bundles of six into 1 litre Agee jars. Then a minimum of 10 aphids and 10 thrips were added to each jar, the top covered with tissue paper secured with rubber bands. The jars were then placed in CA containers of 120 litre volume, which were then flushed with nitrogen and the CA was then connected with the flow rate set at 100 ml/minute.

Humidity was maintained close to 99.5% RH by bubbling the CA through water at ambient temperature. The CA containers were placed in controlled environment rooms at appropriate temperatures.

(e) Assessment: After appropriate periods jars were removed and allowed to warm up for about an hour and then all the bracts were dissected off the spears and any insects found were classified alive or dead. Any insect that moved at all when prodded was regarded as being alive.

(f) Experiments: All treatments were replicated 4 times.

(i) Time series mortality.
The gas mixtures tested were air; 9% CO_2, 7% O_2, 9% CO_2, 2% O_2, all humidified. Four replicates of each mixture were assessed for insect mortality at 0, 2, 4, 6, 8, 10, 12, 14 and 17 days from commencement of the experiment on 11 November 1986. The experiment was carried out at 0°C.

(ii) Temperature/CA relationship. Using the CA mixtures as in (i), 4 replicates of each were assessed after 9 days storage at 0, 3, 6 and 10°C.

(iii) Humidity. The effects of humidity were assessed using 9% CO_2, 7% O_2. Insect mortality was assessed after 5 and 8 days with 4 replicates at each date with: no humidification, one humidifier (95-97%RH) and two

humidifiers (99.5%RH) of the atmosphere at ambient temperature. The experiment was carried out at 0°C.

(iv) High stress CA. Mixtures of 15% CO_2, 1% O_2 and 15% CO_2, 7% O_2 hand calibrated and compared with Air for 4 and 8 days at 0^oC, and 4 replicates of each treatment were assessed. The experiment was carried out at 0^oC.

RESULTS AND DISCUSSION

No attempt was made to separate the mortalities of the various species used. As asparagus is naturally infested by a wide diversity of insects (Watson & Townsend 1981), any disinfestation techniques needs to be robust and non-specific if it is to be of commercial application.

(a) Time series experiment: This was effectively a repeat of the experiment of Lill & van der Mespel (1986) using rather different gas mixtures. The data are shown for thrips in Fig.1 and wingless aphids in Fig. 2. So few winged aphids were available the data have not been used.

Generally the mortality curves for all three treatments were similar. For both thrips and aphids 100% mortality was attained by day 14 of the experiment. For thrips mortality was in the vicinity of 98% from day 8. These data contrast with those of Lill & van der Mespel (1986) who found mortality

in CA was statistically greater than that in air, and after 18 days thrips mortality was 98% and aphid mortality was only 89%. They found mortality in air was a minimum of 30% less than what it was in CA. There is no obvious reason for the differences between the two experiments; especially as the CA used by Lill & van der Mespel (1986) of 7% CO_2, 8% O_2 is so similar to 9% CO_2, 8% O_2 as to suggest no functional difference.

(b) Temperature relationships: This experiment was run for 9 days as Lill & van der Mespel (1986) found that after 8 days mortality was about 50% in CA. If temperature was to have a synergetic effect on the effectiveness of CA, it should have been obvious after 8 days. The data are shown in Figure 3. In CA 100% mortality of thrips was found at all temperatures. In air mortality was 100% at 0 and 6°C, 72% at 3° and much lower at 20% at 10°C. The variation of the data obscure any statistical trends but the lower mortality at 10°C must be biologically real.

For both winged and wingless aphids the data are more variable and less positive. Mortality of both groups was lowest in 9% CO_2, 2% O_2 and highest in air and 9% CO_2, 7% O_2 at 0°C. In air there was also high mortality of both groups at 6°C.

If the experiment had run on longer, higher and more consistent mortality may have occurred of both aphid types. However, as the product (asparagus) deteriorates more quickly at higher temperatures, elevated temperatures for periods of more than

a few days are not commercially viable.

(c) Humidity levels: Humidity appeared to have little effect on thrips mortality after 8 days storage (Table 3). At the high level of humidity thrips mortality was less than at the 2 lower levels of humidity after 5 days. Aphid mortality was greatest at the lowest humidity after both 5 and 8 days storage.

(d) High stress CA experiment: In this expriment higher levels of CO_2 (15%) and lower levels of 0_2 (1%) were used than is normal in order to see if, particularly, aphid mortality could be enhanced. The results for thrips are shown in Table 1 and for aphids in Table 2. For both groups mortality was higher in CA than in air, with there being no significant differences between the 2 CA mixtures used. After 4 days mortality was much higher in CA than in air but the differential decreased at day 8. At day 8 thrips mortality was much as would be expected from the time series mortality experiment (Fig 1 above). Aphid mortality was higher than would have been expected.

Visually there appeared to be no difference between spears from the three atmospheres but this would need proper verification as CO_2 levels above 10% are commonly regarded as phytotoxic.

In the latter two experiments there is a strong indication that the bulk of aphid mortality occurred between day 4 or 5 and day 8 and this follows the trends established in the time series mortality

experiment. This is an important consideration for the use of CA for air freighted produce as it indicates that around eight days storage is needed for good aphid disinfestation provided the CA method applies enough stress (high CO_2 or low humidity). Under normal CA aphid mortality is not reliably high until about 14 days.

The effects of high stress CA systems on the postharvest quality of asparagus would need investigating and the disinfestation experiments repeating for verification before any commercial application could be recommended.

CONCLUSIONS

The use of CA for asparagus shipping has two benefits. The postharvest quality is maintained better than in air; and thrips mortality is more rapid than in air. Aphid mortality is more difficult to achieve under normal CA than is thrips mortality.

The use of high stress CA systems greatly enhanced mortality but the effects of high CO_2, low O_2 and low humidity on asparagus are unknown.

For sea shipping to northern Pacific markets there may be no advantage to disinfestation using CA where shipping times are 2 weeks. For air freight, high stress disinfestation before the product leaves New Zealand may provide a means of avoiding the costs and deleterious effects of fumigation.

ACKNOWLEDGEMENTS

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REFERENCES

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.

Watson, R.N., & Townsend, R.J. 1981. Invertebrate pests on asparagus in Waikato. Proceedings of the 34th NZ Weed & Pest Control Conference: 70-75.

FIGURE 1: Percentage mortality of thrips on asparagus in 3 different atmospheres over 21 days storage.

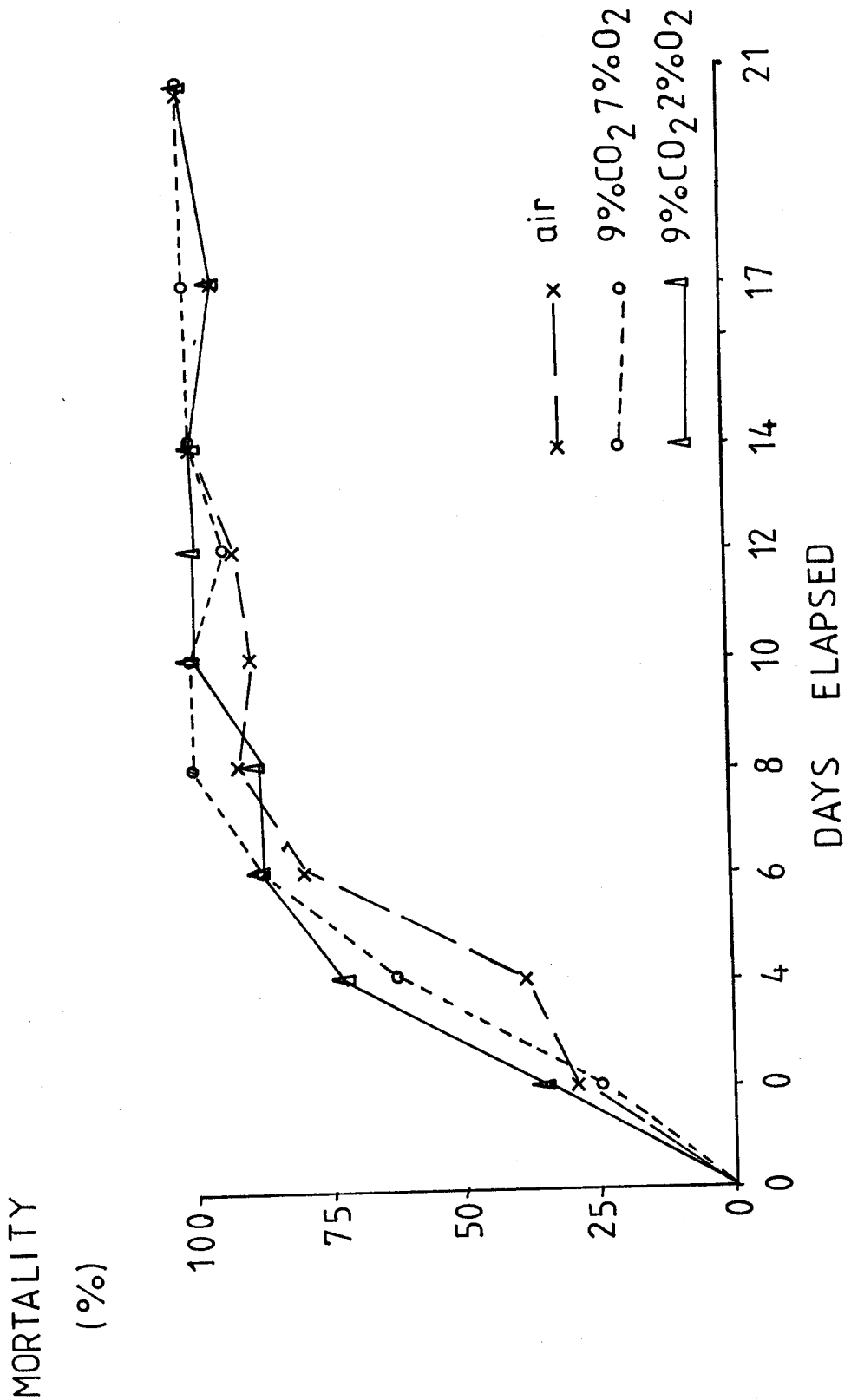

FIGURE 2: Percentage mortality of aphids on asparagus in 3 different atmospheres over 21 days storage.

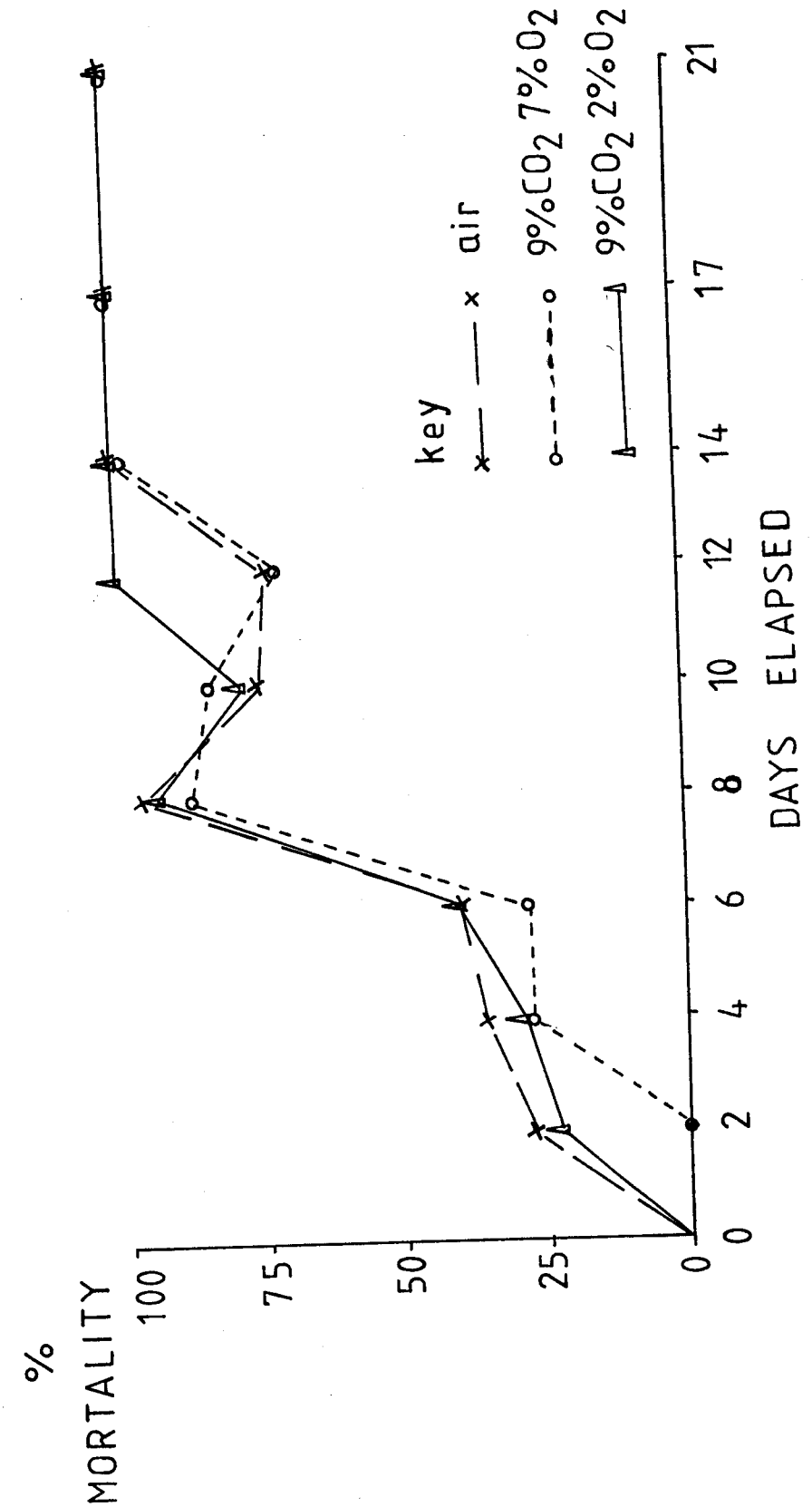

FIGURE 3: Percentage mortality of thrips, alate aphids and wingless aphids on asparagus in 3 atmospheres at 4 temperatures after 9 days storage.

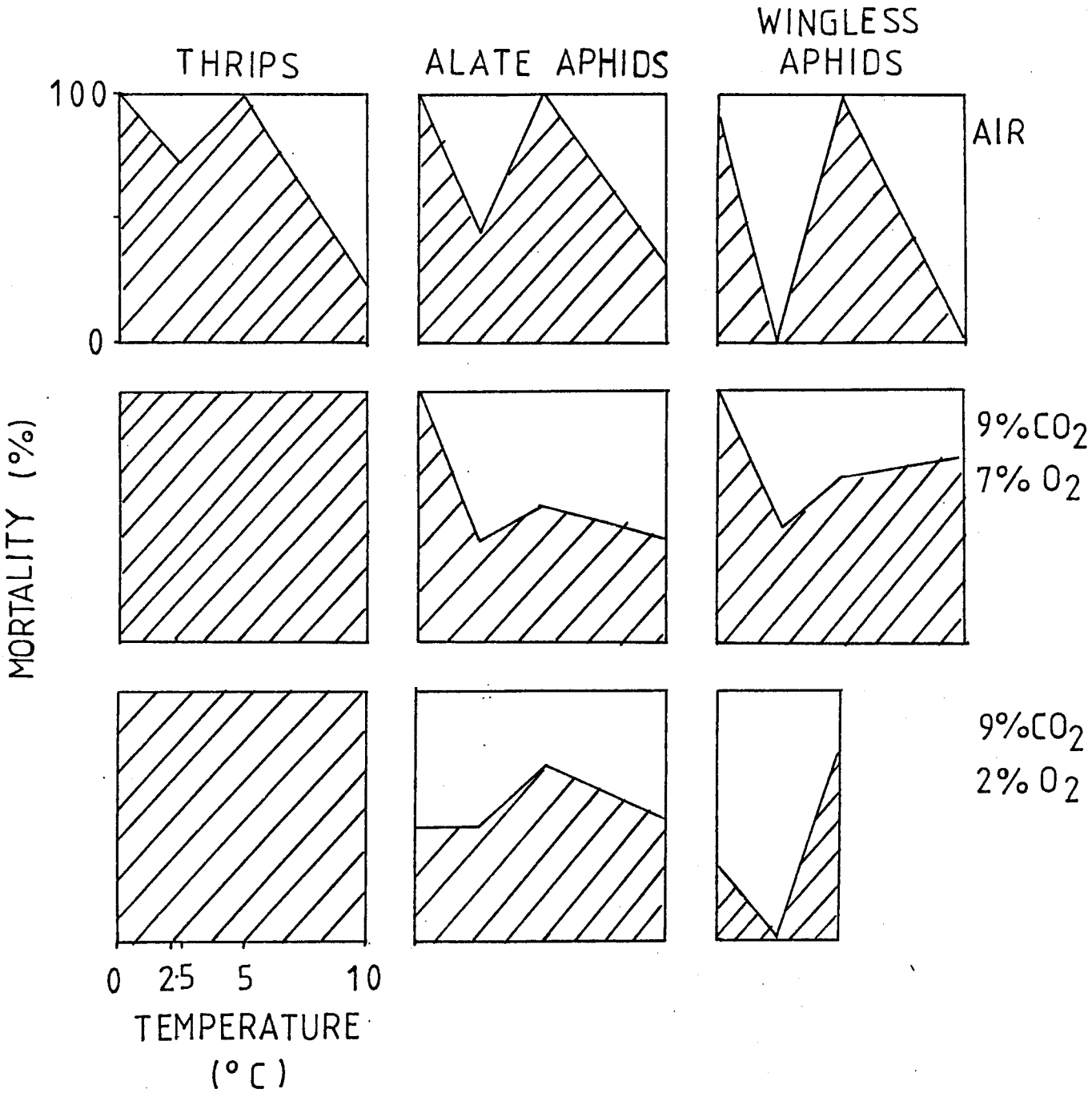

TABLE 1: Thrips mortality in 3 atmospheres after 4 and 8 days at 0°C.

	Percent mortality	
Atmosphere	4 days	8 days
Air	63	81
15% CO_2, 8% O_2	85	98
15% CO_2, 1% O_2	84	98

TABLE 2: Aphid mortality in 3 atmospheres after 4 and 8 days at 0°C.

	Percent mortality	
Atmosphere	4 days	8 days
Air	16	94
15% CO_2, 8% O_2	80	100
15% CO_2, 1% O_2	85	100

TABLE 3: The effect of humidity on thrips mortality after 5 and 8 days storage in 9% CO_2, 7% O_2.

	Days Storage	
Humidity (% RH)	5	8
0	72	98
95%	71	95
99.5%	48	93

TABLE 4: The effect of humidity on aphid mortality after 5 and 8 days storage in 9% CO_2, 7% O_2

	Days Storage	
Humidity	5	8
0	43	98.5
95%	3	95
99.5%	6	81

COSTS CA DISINFESTATION

Insect rearing	$115.00
Gas supply	$750.00
Rooms 50 days @ $15 day	$750.00
Misc stores	$100.00
Asparagus 25 kg @ $1.50	37.50
Science time	$5,640.00
	$7,392.50
NZAAC grant	$3,000.00
Net cost to HRC	$4,392.50