THE EFFECT OF CONTROLLED ATMOSPHERE STORAGE OF ASPARAGUS ON SURVIVAL OF INSECT PASSENGERS

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SUMMARY

Export consignments of fresh asparagus are plagued by insect passengers. The most troublesome are thrips and aphids. The usefulness of controlled atmosphere conditions for disinfesting asparagus prior to shipment was tested in 1985. Mortality of thrips (*Thrips obscuratus*) reached 98% after 18 days storage in controlled atmosphere conditions (7% O₂, 8% CO₂) compared with 38% in air storage. The mortality of aphids (*Myzus persicae*) reached 89% and 73% for the wingless and winged forms respectively under the same controlled atmosphere conditions. Although the mortality of both species was higher under controlled atmosphere conditions than in air, the method was not sufficiently effective, both in terms of rapidity and extent of insect mortality, for use as a pre-shipment disinfestation procedure.

INTRODUCTION

International trade in fresh asparagus from New Zealand is hampered by contamination of the produce with insects, particularly thrips and aphids. Various methods have been attempted to reduce the problem including field spraying, postharvest dipping in insecticide, and fumigation before transit. Field spraying has not been completely effective because of the rapid growth of the crop and because the insects migrate freely into the fields. Dipping in insecticide was also not wholly effective although it substantially reduced live insect numbers on the spears. Resistance to this method is now coming from Japan. Fumigation in New Zealand would seem to be a useful measure as approximately 80% of consignments are now fumigated on arrival in Japan. Local fumigation would provide greater control over the process which should result in less product damage. However fumigation in methyl bromide reduces shelf life and affects the flavour of the product (Beever *et al* 1985).

In the 1983 and 1984 seasons several shipments of asparagus were exported by sea in controlled atmosphere conditions. These shipments appeared to be free from insects. Controlled atmosphere (CA) tests demonstrated that after 14 days storage (2% oxygen, 10% carbon dioxide; and 7% O₂, 7% CO₂) 100% mortality of thrips had occurred (Batchelor *et al* 1985). Sea freight of asparagus has been discontinued because the produce had a short shelf life after the freight period.

This apparent effect of controlled atmospheres on insects could be useful as a treatment prior to air freight. If rapid insect death occurs, a short CA treatment could be used for disinfestation with little effect on shelf life.

Controlled atmospheres have been tested in USA for control of western flower thrips (*Frankliniella occidentalis*). The only treatment which killed 100% of the thrips was 90% CO₂ for 48 h (Aharoni *et al* 1981). This very high level of CO₂ affected the flavour in the strawberries even though strawberries are one of the few products which are tolerant of high CO₂ concentrations. It seems very likely that asparagus would be damaged under these conditions.

The experiment described here was carried out to determine the mortality of thrips and aphids, infesting asparagus stored in a CA known to be suitable for the product.

METHOD

Infested asparagus was supplied by the NZ Asparagus Council from a field near Hamilton. The asparagus was stored in glass jars closed with tissue paper to prevent *Proc. 39th N.Z. Weed and Pest Control Conf.*

insect escape yet allow free gas exchange. Six spears were placed in each glass jar.

The natural infestation was supplemented with insects collected at Levin to ensure that sufficient numbers of both aphids and thrips were present to give useful results. Approximately 20 aphids (*Myzus persicae*) and 10 thrips (*Thrips obscuratus*) were added to each jar of asparagus spears just prior to storage.

The asparagus was stored at 0-1 °C, either in air or in CA of 7% O₂ and 8% CO₂. Both the air and the CA gas were humidified before flowing through the gas-tight containers in which the jars were held.

Samples were taken for assessment of insect mortality before storage and at intervals of 2 days thereafter until 14 days. A final sample was assessed after 18 days of storage. Four jars were taken from each gas treatment on each sampling day. Separate gas-tight containers were used in the CA treatment for each sampling time to ensure no disruption to the atmosphere surrounding the remaining jars.

Each spear was dissected removing each bract and bud. Insects were classed as thrips, winged aphid, or wingless aphid, and as either alive or dead. If affected insects twitched at all when disturbed then they were classed as alive. Assessment, particularly of spears from controlled atmosphere storage, was carried out after the jars had been in ambient conditions for at least 2 hours. This assessment included insects which were not yet dead but obviously affected by the treatment.

RESULTS

More thrips were found dead in CA than in air after 4 days (Table 1). Mortality in air reached 41% whereas mortality in CA had increased to 87% after 10 days and 98% after 18 days. The live thrips remaining in the CA treatment in the latter stages of the test appeared very sluggish although they still responded when disturbed.

TABLE 1: Mortality of thrips on asparagus spears stored in air or controlled atmosphere (CA).

Storage time (days)	Mortality (% dead)		Statistical significance†
	Air	CA	
0	14	—	—
2	35	33	NS
4	39	65	*
6	29	63	**
8	18	49	**
10	32	87	**
12	32	94	**
14	41	93	**
18	38	98	**

†Significance level of a Chi-square test is indicated using NS = not significant; * = significant at $p = 0.05$; ** = significant at $p = 0.01$.

Winged aphids first showed significantly higher mortality in CA than in air after 6 days (Table 2). Maximum mortality was 73% observed after 14 days of the test. Mortality in air ranged from 6-34%.

Wingless aphids were also susceptible to the CA conditions, showing significant mortality after 6 days (Table 3). Mortality in CA reached 89% after 18 days but mortality in air also increased during the test, reaching 59% after 18 days.

DISCUSSION

These results indicate that CA conditions can be damaging to insects, and that different species and different forms of the same species vary in their sensitivity. Within the period of the test complete mortality was approached only for thrips, with a substantial proportion of aphids remaining alive. Wingless aphids were more vulnerable than the winged form, under both CA and air storage.

TABLE 2: Mortality of winged aphids on asparagus spears stored in air or controlled atmosphere (CA).

Storage time (days)	Mortality (% dead)		Statistical significance†
	Air	CA	
0	6	—	—
2	25	16	NS
4	28	30	NS
6	14	40	*
8	7	42	**
10	19	61	**
12	30	62	*
14	15	73	**
18	34	55	NS

†Significance level of a Chi-square test is indicated using NS = not significant; * = significant at $p = 0.05$; ** = significant at $p = 0.01$.

TABLE 3: Mortality of wingless aphids on asparagus spears stored in air or controlled atmosphere (CA).

Storage time (days)	Mortality (% dead)		Statistical significance†
	Air	CA	
0	10	—	—
2	4	5	NS
4	33	24	NS
6	14	48	**
8	23	52	**
10	44	77	**
12	62	76	NS
14	46	83	**
18	59	89	**

†Significance level of a Chi-square test is indicated using NS = not significant; * = significant at $p = 0.05$; ** = significant at $p = 0.01$.

For CA to be of value as a disinfestation procedure nearly complete mortality would be required within a short period to avoid damage to a highly perishable commodity such as asparagus. Unacceptable loss of quality would occur if the procedure were to exceed a week. These requirements have not been met in this experiment for either of the insect species tested.

The use of CA for short term disinfestation of fresh asparagus does not seem practicable at this stage unless modification of the atmosphere can be made to greatly enhance its insecticidal activity. The method, however, is of interest as a potential substitute for methyl bromide if that chemical should ever be withdrawn from use. Further investigation of the response of insects to variations of carbon dioxide and oxygen concentrations, storage temperature, and duration of exposure should be made before the concept is discarded.

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