MINISTRY OF AGRICULTURE AND FISHERIES
TE MANATU AHUWHENUA AHUMOANA

MAF

Report to

NZ Asparagus Council
P.O. Box 74107
Auckland

Controlled Atmospheres for Commercial Disinfestation of Export Asparagus

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Executive Summary

The high stress controlled disinfestation system was applied to 45 x 5 kg boxes of fresh export asparagus prior to its export to Japan. The asparagus was sold at auction in Tokyo.

Japan MAFF was unable to find any insects on the shipment, despite there being insects present at packing. This venture demonstrates that controlled atmosphere disinfestation prior to export is a viable option for the exports of fresh asparagus.

Application of controlled atmospheres in commercial practice that may be relevant to the asparagus industry is reviewed.

Contents

A. Trial Export

Introduction

In 1990 we recommended to the New Zealand Asparagus Council (NZAC) that it fund the export of a small shipment of asparagus to Japan that had been subject to our disinfestation treatment. The NZAC accepted our recommendation although the level of funding provided meant that the work had to be reduced over what had been originally proposed.

Our research over the last 3 years showed that high stress controlled atmospheres could be used to control thrips and aphids on fresh export asparagus without seriously impacting on product quality. Within the asparagus export sector there was considerable concern that the time taken to treat the crop prior to export would:

(a) make the crop unsaleable
(b) make logistic management of the export process difficult

The research reported here was designed to show that treated crop was saleable and that the logistical difficulties were manageable.

Material and Methods

Asparagus was grown in the Horowhenua. For two pre-shipment tests local market product was used. For the export consignment only top quality product was used. All product was packed in 5 kg wooden boxes at the Parkin packhouse at Ohau by Levin.

The controlled atmosphere was applied using a standard plastic tent. The plastic tent was erected over a frame made out of p.v.c. pipe and with its bottom edges held in a water trough with steel bars. The troughs were sealed to a hardboard base. The controlled atmosphere was introduced through a pipe through the hardboard base at a rate of 1 ℓ per minute.

The atmosphere was maintained at 60% CO_2 + 8 O_2, balance nitrogen ($\pm$ 2%). A small fan inside the tent ensured adequate gas circulation within the tent.

Two small practice lots were treated on a trial basis. This allowed practical difficulties to be sorted out on cheaper product.

Trial Shipment

The asparagus for shipment to Japan was found to have thrips and aphids present but at levels within the guidelines of MAFQual for export to Japan. After packing the crop was cooled. It was collected from the packhouse early on Friday afternoon. It was placed in the tent and the atmosphere quickly established.

The atmosphere was maintained until 5.30 pm the following Tuesday (i.e. slightly over 4 days), when the asparagus was returned to the packhouse from where it was collected by refrigerated truck for overnight transport to Auckland to catch the Japan Air Lines flight to Japan on the Wednesday morning.

The asparagus was sold at auction.

Problems

1. Breaking the coolchain: The trial required shifting the product twice more than would normally be the case. In normal practice the atmosphere would be applied either in the packhouse coolstore or by the freight forwarder in Auckland, thus the coolchain would not be broken in the same way.

2. Getting 45 boxes treated as an individual consignment meant freight costs were rather more costly than normal which affected the cost structure of the project.

3. We normally recommend 5 days treatment with the controlled atmosphere. Four days treatment plus time in transit Ohau - Tokyo appears to have had an equivalent effect on insects of a 5 day treatment.

4. Only one of 3 temperature recorders could be recovered from Tokyo.

Cool chain

The temperature recorder that was reclaimed showed that temperature control of the asparagus was poor once it left the packhouse. On the truck to Auckland the temperature rose to 16°C, it only dropped to 8°C in the freight forwarders and rose to 24°C once in the air over the Pacific (Table 1). There can be no doubt that cool chain management is a major problem for the industry.

MAFF Japan

On behalf of the research team MAFQual informed MAFF Japan of the asparagus

shipment and our objectives. MAFF Japan inspected the shipment and could find no insects. In this situation we can assume that they inspected very thoroughly and as they found nothing, despite there being insects present at the time of packing.

The Way Ahead

We have demonstrated that it is possible to use controlled atmospheres for asparagus disinfestation in practice. It is possible that we may be able to further reduce the treatment period if the air transport effect is additive.

Further development must depend on industry direction.

Conclusions

Controlled atmospheres are a viable way of asparagus disinfestation for export to Japan and USA. Further development must be industry led.

The NZAC has now partially funded the development of two different disinfestation technologies. Hortgas is available for those needing a pesticide for local market product (it is intended to have export registration by October, 1991). High stress controlled atmospheres are available for those with a need for a more environmentally acceptable technique.

Acknowledgements

MAFQual and MAFF Japan assisted with technical aspects of the project. Don Brash supplied temperature recorders. NZ Trade Development Board set up retrieval of the temperature recorders.

Table 1. Temperature management of the trial asparagus shipment to Japan.

Journey Sector	Temperature °C	
	Maximum	**Minimum**
Levin HRC→Packhouse	7	7
Packchouse	7	2
Truck to Auckland	16	2
Freight forwarders	9	9
In airplane	24	8
In Japan	18	8

B. Options for Application of Controlled Atmosphere Disinfestation of Fresh Asparagus for the Japanese Market

1.0 Treatment at growers coolstores

Many asparagus growers have facilities installed for precooling and holding a small amount of product. This limited storage capacity means that many stores would have to be expanded to enable the CA treatment to be undertaken here. Any CA treatment requires monitoring and control of CO_2 levels for safety and to maintain efficacy of disinfestation. The duplication of these at many facilities would place an unnecesarily high cost on the industry.

2.0 Treatment at centralized facilities

The locations where sufficient storage capacity is available for treating large volumes of asparagus are storages where loads are consolidated. These are generally larger grower's, freight forwarder's and exporter's stores. It will be most economic to locate at a single CA treatment facility at Mangere, however several smaller facilities would still be practical.

Structures

There are two alternative methods available for containing a controlled atmosphere, a specialised gas-tight coolstore, or gas tents inside a coolstore. A gas-tight store may need to be constructed, or an existing coolstore may be divided into a series of sealed rooms. Special care is required to ensure that all joints between walls, roof, floor and doors are well sealed to reduce leakage. The rooms also require special vents to compensate for atmospheric and temperature fluctuations. The advantage of this system is the ease of operation. When all the asparagus is loaded the door can be sealed and atmosphere generation begun, after five days the door is opened and product removed.

The more common option used in New Zealand for CA atmospheres is the use of a plastic tent. A typical layout is shown in Figure 1. Pallet loads of asparagus are stacked in the corner of a store, and a single sheet of 75-125mm polythene film is

draped over a wooden or PVC frame placed over the top of the boxes. The frame may be built in place, or lowered by pulley from the roof. The sheet is sealed to the floor to prevent gas leakage. A fan is installed in the tent to circulate air and keep the centre of the block of product cool. The airflow needs to be carefully balanced to ensure effective cooling, while avoiding excessive weight loss from the product. The tent is connected to a CO_2 supply, and the outside, by two pipes taped into the skin.

The building and breakdown of the tent for each shipment is a time consuming exercise. The tents will last 4 to 5 seasons before they will require replacement. The advantage of a tent system is that the store can be used for other product at the same time that the asparagus is being treated, however it is necessary to run the main store at approximately 2°C below the temperature required in the tent.

The approximate cost for a tent to hold 25 tonnes of asparagus is $1300.

Gas Supply

Asparagus treatment will require approximately 4kg CO_2 (2.0m^3) per tonne of product. It can be supplied in a gaseous or liquid form. Liquified CO_2 is supplied in a 160kg liquid vessel, and the gas supplied in 33kg gas bottles. Gas can be injected in to chamber as shown in Figure 1 using a regulating valve and flow meter.

The cost of the liquified CO_2 is 70-80c/kg and the gaseous CO_2 85c/kg.

An initial period of development will be required to determine the correct quanitity of CO_2 which will be needed to compensate for leakage and diffusion of gas. After the behaviour of the facility is known a weight of CO_2 can be metered into the chamber to produce the desired gas concentration.

Safety

Exposure to over 15% CO_2 in air can cause headaches, nausea and even death if exposure is extended over several hours. It is therefore important that operator safety is considered when planning such a treatment facility. Carbon dioxide is heavier than air and will thus rapidly dispense when a door is opened. If the facility is a specialised gas tight coolstore with a well ventilated (exposed) door then the operation will be safe. If the treatment is in a tent which is located in part of an existing store then it will be necessary to install a CO_2 alarm to detect tent leakage

resulting in high levels of CO_2 in the remainder of the room where people may be working.

3.0 Treatment in moveable storages

An alternative system which may offer more flexibility is a modular approach based on refrigerated sea containers. Used containers can be purchased for $7,000 - $10,000. These containers have passed their economic life for sea voyages, but are still reliable for land-based uses. It would be possible to upgrade and gas seal these and use them as treatment chambers for asparagus. The proceedure for establishing the CA atmosphere would be similar to that for a fixed store as described in Section 2.0.

The use of containers offers several advantages; 1) there is no necessity for extra storage space to be made available to hold product for the required five days, 2) the modular approach means that only a porportion of the crop may be treated with this technique initially, 3) there may be several containers at different locations to suit grower, transporter and exporter requirements, and 4) there is an opportunity to begin treatment in transit. The treatment of product in transit from areas such as Horwhenua has several advantages, it minimises delays in establishing the CA, and also improves the coolchain and hence storage life of the crop. Full containers could be offloaded at Auckland and empty containers returned on the truck for a further load.

4.0 Treatment during air transit

Most asparagus from New Zealand is shipped to Japan on open airline pallets and not sealed in containers. In order to treat the product during transit each pallet would have to be wrapped in a polythene liner, CO_2 could then be introduced as dry ice. The sublimation of the dry ice during the 10 hour transit voyage would provide some additional refrigeration to improve the product coolchain. The economics of pallet wrapping would need to be compared with the use of sealed containers if they could be made available.

This pallet wrapping would have to be undertaken in conjunction with CA treatment in New Zealand, and as such represents an additional cost. It will enable the length of time between harvest and market to be minimised, and improve the coolchain. The major advantage may be that a sealed package will arrive in Japan which will enable

the MAF to check the atmosphere and verify that the product has been treated.

5.0 Estimated Costs

CA Tents

The estimated cost for converting an existing store to a CA treatment facility using six, 25 tonne capacity tents, and including CO_2 monitor and alarm is $15,000.

This assumes a facility will be available, and that no modifications are required. This can therefore be treated as a minimum cost.

CA Containers

The estimated cost to purchase, upgrade and gas-seal six sea containers, with a capacity of 5.6 tonnes asparagus each, is $72,000.

Gas Useage

In order to treat the 1500 tonnes of asparagus exported to Japan would require 6.0 tonnes of CO_2 at 75c/kg, $4,500 per season.

Other Costs

Further costs in the first year of implementation which will need to be considered are those of researching the optimum system, and determining operating parameters, and the costs involved in establishing the methodology to satisfy of the Japanese quarantine authorities.

6.0 Recommendations

The CA disinfestation of asparagus as detailed in this report has been proven to provide an effective alternative to current methyl bromide techniques. Technology currently exists which may be adapted for this application.

There are three options suggested as practical for the industry to operate:

1. CA tents at a centralised facility near Auckland Airport.

2. A modular approach based on used sea containers

3. A specialised new facility.

A full feasibility study, and negotiation with the relevant industry personnel will be required to define the best option.

There will be a requirement for research and development to establish the operating parameters of the system (gas leakage, permeation and absorption, temperature and humidity control) before it can be applied to an export crop of asparagus.

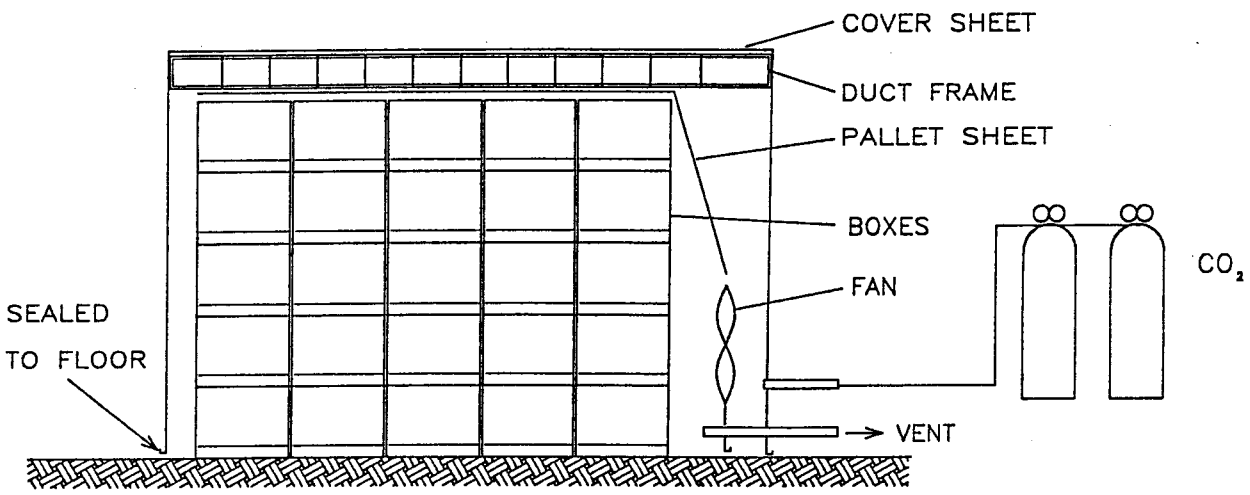

Figure 1. Typical CA tent layout for high $C0_2$ disinfestation of Asparagus.