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POSTHARVEST INSECT CONTROL ON HARVESTED *DENDROBIUM* ORCHIDS

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ABSTRACT

Controlled atmospheres (CA) and/or elevated temperatures are often used for postharvest control of insect pests. A postharvest treatment to control western flower thrips and melon thrips is being sought for harvested *Dendrobium* orchids. The effect of high temperature (35ºC) in combination with 55% carbon dioxide (CO_2) or 1.5% oxygen (O_2) was tested. In addition, several chemical fumigants (acetaldehyde, methyl formate and ethyl formate) were tested as alternative postharvest control measures. Complete insect mortality occurred at 48 h in 1.5% O_2 and at 12 h in 55% CO_2 (35ºC). Although the 55% CO_2 treatment resulted in a shorter exposure time for insect control, the 1.5% O_2 treatment resulted in less damage to orchids. Of the fumigants, acetaldehyde (Aa) proved to be the most promising. Pretreatment with 0.5-1.0% Aa followed by exposure to air or 1.5% O_2 at 35ºC resulted in high insect mortality and minor phytotoxicity.

INTRODUCTION

Two of the most serious pests in Hawaii's orchid industry are western flower thrips (WFT) *Frankliniella occidentalis* (Pergande), and melon thrips *Thrips palmi* Karny. Both insects are quarantine pests and are vectors of *Tospovirus*. Thrips prefer tight enclosed spaces, often deep inside flowers. This makes them difficult to control with conventional insecticide sprays. Hot water baths, insecticidal dips, and chlorpyrifos-impregnated packing material have been tested for insect control on harvested orchids. In general, these methods provide a sufficient level of insect control but negatively affect market and/or vase life. Our study examined the response of WFT and *Dendrobium* orchids to a series of treatments using combinations of CA, hot air, and chemical fumigants.

MATERIALS AND METHODS

Dendrobium orchid (Jaquelyn Thomas 'Uniwai Princess') inflorescences were placed in clear ventilated plastic sleeves (4-5 per sleeve). Sleeves were placed in PVC tubes (1 per tube) that had been modified for use as airtight treatment chambers. Orchids were then treated with various combinations of hot air, controlled atmospheres (CA), and chemical fumigants. After treatment, inflorescences were removed to a room with a constant temperature of 20ºC, 60% r.h. and a L:D ratio of 8:16. Orchids remained under these conditions during evaluation. Hot air treatments were conducted at 35ºC (70-80% r.h.). CA treatments at 1.5% O_2, or 55% CO_2 in air, were applied at 35ºC. The fumigants methyl formate (MF), ethyl formate EF) or acetaldehyde (Aa) were introduced into the chamber via a small inlet port and onto filter paper. Exposure time for all fumigants was 1 h at 24ºC. Phytotoxicity was evaluated based on a numerical scale of 1 (no injury) to 9 (severe injury). The marketable life was terminated when the average rating of inflorescences for a given treatment reached 3 (10% of flowers wilted, discolored or damaged). Vase life was terminated when the average rating reached 6 (50% of flowers wilted, discolored or damaged).

WFT were treated in small portion cups with ventilated lids. A section of fresh green bean was placed in the cup as a food source. Portion cups were placed inside plastic sleeves with orchids for treatments. Mortality assessment was conducted 48 h after removal from treatment. To test insect mortality on infested plant material, inflorescences were artificially infested with WFT and placed in silk-screen bags. Bags were then placed in treatment chambers and exposed to treatments as described previously.

TABLE 1
Mean % mortality (SD) for western flower thrips exposed to 55% CO_2 in air or 1.5% O_2 at 35°C

Atmosphere	Exposure time (hours)	Mean % mortality (SD)	Number of insects
Control	0	8.9 (6.7)	784
Air	60	23.3 (20.1)	599
55% CO_2	8	93.1 (7.3)	402
55% CO_2	12	100.0 (0.0)	684
1.5% O_2	8	40.7 (7.9)	421
1.5% O_2	24	89.2 (4.0)	623
1.5% O_2	48	99.6 (0.81)	794
1.5% O_2	60	100.0 (0.0)	514

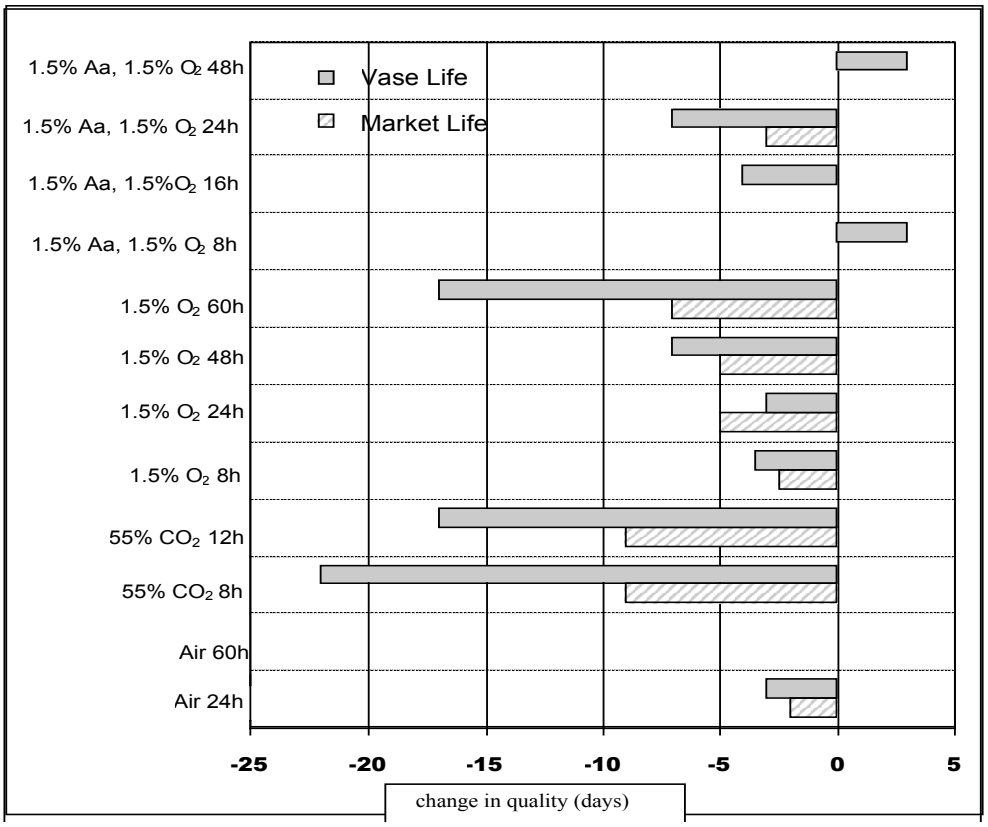

Fig. 1. Market and vase life relative to untreated orchid inflorescences (0). Inflorescences were exposed to 1.5% O_2 or 55% CO_2 at 35°C. A 1 hour pretreatment with 1.5% acetaldehyde (Aa) at 24°C preceded some treatments with 1.5% O_2 at 35°C.

RESULTS AND DISCUSSION

The response of individual inflorescences to treatment was variable. Treatment with hot air (35ºC) alone produced variable results, but in general did not have a marked effect on vase or market life and did not result in satisfactory insect mortality (Fig. 1, Table 1). While orchids tolerated 1.5% O_2 at 35ºC for up to 48 h with little loss in vase and market life (Fig. 1), complete insect mortality did not occur until 60 h of exposure (Table 1). Exposure to 55% CO_2 (35ºC) required 12 h for compete mortality (Table 1), but orchids exhibited a drastic loss in vase and market life when exposed to this treatment, even at the shortest exposure time of 8 h. (Fig. 1). Exposure to EF or MF greatly reduced both market and vase life at both concentrations tested (Fig. 2). Although insect mortality proved to be high with MF or EF (data not shown), the loss of market and vase life due to burned pollen caps preclude these chemicals from being effective disinfestation treatments. Orchids treated with 1,7 and 2.3% Aa at 24ºC showed minor to moderate damage

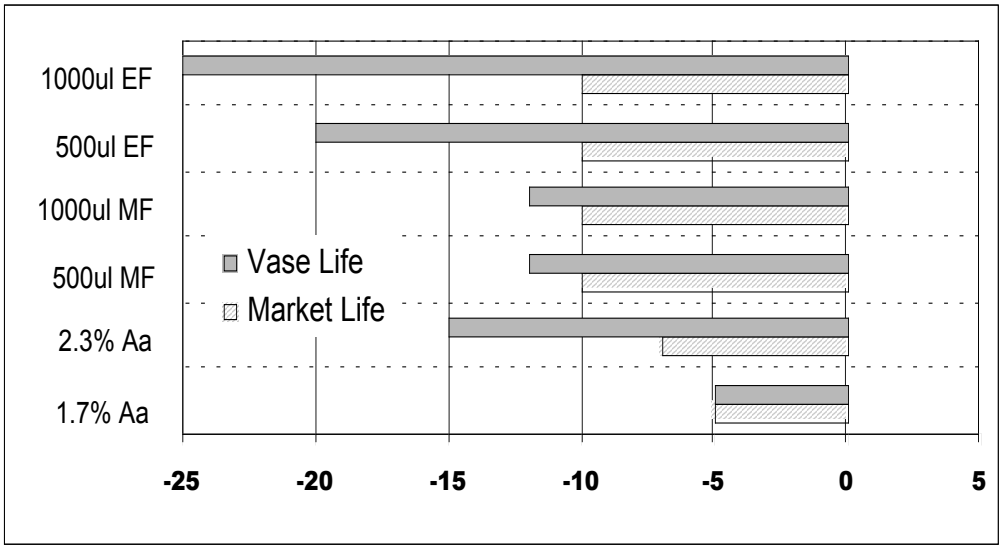

Fig. 2. Market and vase life relative to untreated orchid inflorescences (0). Inflorescences were exposed to acetaldehyde (Aa) (1.7or 2.3%), methyl formate (MF) (500 or 1,000 μL), or ethyl formate (EF) (500 or 1,000 μL) for 1 h at 24°C.

respectively (Fig. 2). Treatment with 1.5% Aa followed by 1.5% O_2 at 35ºC did not appear to increase damage compared with treatment with Aa alone (Figs. 1 and 2). Pretreatment with lower concentrations of Aa (0.5 or 1.0%) at 24ºC followed by 1.5% O_2 at 35ºC (exposure time up to 36 h) did not detrimentally affect vase or market life (data not shown) and resulted in high insect mortality (Table 2). Artificially infested inflorescences were exposed to 1.5% O_2 at 35ºC or a 1.0% Aa pretreatment followed by air at 35ºC. These treatments resulted in high insect mortality (Table 3). Preliminary results indicate a pretreatment with Aa followed by air or 1.5% O_2 could result in complete thrips mortality with little effect on orchid vase and market life. We plan to explore this two-step treatment approach to develop a quarantine level treatment for WFT and melon thrips on *Dendrobium* orchids.

TABLE 2
Mean % mortality (SD) for western flower thrips exposed to a 1 hour pretreatment of 0.5 or 1.0% acetaldehyde (Aa) at 20°C, then exposed to air or 1.5% O_2 at 35°C

Pre-Treatment	Treatment	Exposure time (hours)	Mean % Mortality (SD)	N
0	-	0	17.4 (11.0)	870
0.5% Aa	-	0	66.7 (n/a)	156
1.0% Aa	-	0	95.9 (4.5)	649
-	Air	18	46.3 (16.1)	927
-	Air	36	41.9 (6.2)	1058
0.5% Aa	1.5% O_2	8	95.7 (3.2)	537
0.5% Aa	1.5% O_2	24	99.3 (0.6)	469
0.5% Aa	1.5% O_2	36	99.8 (0.3)	358
1.0% Aa	1.5% O_2	18	100.0 (0.0)	694
1.0% Aa	1.5% O_2	24	100.0 (0.0)	552
1.0% Aa	1.5% O_2	36	100.0 (0.0)	1197

TABLE 3
Orchid inflorescences infested artificially infested with western flower thrips (WFT) and exposed to 35ºC for 8 and 24 hours in air or 1.5% O_2. For acetaldehyde (Aa) pretreatment, an inflorescence was treated with 1.0% Aa for 1 hour then placed in air at 35ºC. Mean % mortality for WFT shown below

Atmosphere	Exposure Time (hours)		
	0	8	24
Air	22	23	35
1.5% O_2		92	99
1.0% Aa/Air	97	100	99