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FEB 14 1997  
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Final Report for The California Cut Flower Commission

*Controlled Atmospheres as an Alternative to Methyl bromide for  
Disinfestation of Perishable Commodities*

from  
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This report summarizes work completed in relation to the proposal submitted jointly to the Department of Pesticide Regulation and the CCFC.

1. Work Performed

*Arthropod Mortality and Cut Flower Vase Life*

Studies were conducted at the Levin Research Centre, New Zealand, to determine the efficacy of low oxygen and high carbon dioxide controlled atmosphere (CA) treatments to kill green peach aphids, *Myzus persicae*, melon aphid, *Aphis gossypii*, and diapausing two-spotted spider mites, *Tetranychus urticae*.

All studies were conducted in walk-in controlled temperature rooms at 0.5°C. CA gases were humidified to 100% rH and delivered through 100 liter stainless steel chambers in a flow-through system at 350-450 ml/min. Chamber atmospheres were analyzed via gas chromatography with a Shimadzu GC-9A gas chromatograph with thermal conductivity detector attached to a Hewlett Packard 3392A integrator. Preliminary experiments indicated that complete green peach aphid mortality resulted from ≤96 hours exposure to 0.1% oxygen in nitrogen of ≥60% carbon dioxide in air, at 0.5°C.

A sequential CA experiment was run in four replicates to test the efficacy of 10 treatments using combinations of 4% and 60% carbon dioxide, with 0.1% oxygen (see Table 1). Arthropod mortality and cut flower tolerance were evaluated in this experiment. Groups of insects, mites, and various cut flowers<sup>1</sup> were placed into each stainless steel chamber at 0.5°C. At the end of 6 days of CA exposure, insects and mites were placed at room temperature for 48 hours to allow for

recovery prior to mortality evaluations (Table 2). Cut flowers were immediately removed, stems recut, and placed into Floralife® solution in a room at 20°C, 45% rH, and 20 microeinsteins/M<sup>2</sup>/sec illumination, with a 12:12 light:dark photoperiod. Vase life evaluations were conducted at 1, 3, 5, 7, 9 11, and 14 days following CA exposure (Table 3).

<sup>1</sup>Yellow carnation (Mediterranean Candy)  
Orange carnation (Mediterranean Candy)  
Chrysanthemum (Minstral)  
Rose (Gabriella)  
Paphiopedium orchid (Sandrae)

## 2. Summary and Conclusions

As the arthropod mortality show, we were successful in controlling both green peach and melon aphids with most of our CA treatments. However, spider mite mortality was too low for any of the treatments to be considered effective.

All CA treatments reduced cut flower vase life, though by greatly varying degrees. The 60% CO<sub>2</sub> treatments followed by air or 4% CO<sub>2</sub>/4% O<sub>2</sub> were best for carnations and roses, while the 0.1% O<sub>2</sub> treatments followed by air or 4% CO<sub>2</sub>/4% O<sub>2</sub> were best for chrysanthemums and orchids. This demonstrates that no single CA treatment will likely be suitable for all cut flower species, or perhaps even varieties. We know how to control the insects with this approach, but need more research to determine how cut flowers will tolerate the various CA treatments.

**Table 1. In-Transit Sequential CA Disinfestation Trial - Levin Research Centre**

<u>Treatment</u>	<u>Day 1</u>		<u>Day 2</u>		<u>Day 3</u>		<u>Day 4</u>		<u>Day 5</u>		<u>Day 6</u>	
Check	Air	→	Air	→	Air	→	Air	→	Air	→	Air	→
Check 2	4% O <sub>2</sub>	→	4% O <sub>2</sub>	→	4% O <sub>2</sub>	→	4% O <sub>2</sub>	→	4% O <sub>2</sub>	→	4% O <sub>2</sub>	→
	4% CO <sub>2</sub>		4% CO <sub>2</sub>		4% CO <sub>2</sub>		4% CO <sub>2</sub>		4% CO <sub>2</sub>		4% CO <sub>2</sub>	
3	60% CO <sub>2</sub>	→	Air	→	Air	→	Air	→	Air	→	Air	→
4	60% CO <sub>2</sub>	→	4/4	→	4/4	→	4/4	→	4/4	→	4/4	→
5	60% CO <sub>2</sub>	→	0.1% O <sub>2</sub>	→	0.1% O <sub>2</sub>	→	Air	→	Air	→	Air	→
6	60% CO <sub>2</sub>	→	0.1% O <sub>2</sub>	→	0.1% O <sub>2</sub>	→	4/4	→	4/4	→	4/4	→
7	0.1% O <sub>2</sub>	→	0.1% O <sub>2</sub>	→	Air	→	Air	→	Air	→	Air	→
8	0.1% O <sub>2</sub>	→	0.1% O <sub>2</sub>	→	4/4	→	4/4	→	4/4	→	4/4	→
9	0.1% O <sub>2</sub>	→	0.1% O <sub>2</sub>	→	60% CO <sub>2</sub>	→	Air	→	Air	→	Air	→
10	0.1% O <sub>2</sub>	→	0.1% O <sub>2</sub>	→	60% CO <sub>2</sub>	→	4/4	→	4/4	→	4/4	→

**Table 2. Sequential CA Arthropod Mortality (Mean % Mortality  $\pm$  SE - 3 Reps.)**

<u>Treatment</u>	<u><i>Myzus persicae</i></u>	<u><i>Aphis gossypii</i></u>	<u><i>T. urticae</i></u>
Air Check	95.3 $\pm$ 3.7	94.7 $\pm$ 1.4	6.3 $\pm$ 1.2
4% CO <sub>2</sub> /4% O <sub>2</sub>	98.5 $\pm$ 1.5	99 $\pm$ 1.0	6.8 $\pm$ 0.7
60% CO <sub>2</sub> →Air	100 $\pm$ 0	100 $\pm$ 0	8.4 $\pm$ 3.5
60% CO <sub>2</sub> →4% CO <sub>2</sub> /O <sub>2</sub>	100 $\pm$ 0	100 $\pm$ 0	6.8 $\pm$ 2.5
60% CO <sub>2</sub> →0.1% O <sub>2</sub> →Air	100 $\pm$ 0	100 $\pm$ 0	17 $\pm$ 6.1
60% CO <sub>2</sub> →0.1% O <sub>2</sub> →4% CO <sub>2</sub> /O <sub>2</sub>	99.7 $\pm$ 0.3	100 $\pm$ 0	5.4 $\pm$ 1.3
0.1% O <sub>2</sub> →Air	100 $\pm$ 0	99.7 $\pm$ 0.3	15.6 $\pm$ 2.9
0.1% O <sub>2</sub> →4% CO <sub>2</sub> /O <sub>2</sub>	100 $\pm$ 0	100 $\pm$ 0	8.4 $\pm$ 0.9
0.1% O <sub>2</sub> →60% CO <sub>2</sub> →Air	100 $\pm$ 0	100 $\pm$ 0	32.9 $\pm$ 18.9
0.1% O <sub>2</sub> →60% CO <sub>2</sub> →4% CO <sub>2</sub> /O <sub>2</sub>	100 $\pm$ 0	100 $\pm$ 0	13.6 $\pm$ 6.2

**Table 3. Sequential CA Vase Life Data (Mean no. Days - 4 Reps.)**

<u>Treatment</u>	<u>Y. Carn.</u>	<u>O. Carn.</u>	<u>Chrysan.</u>	<u>Rose</u>	<u>Orchid</u>
Air Check	11	13.5	8.5	7	7
4% CO <sub>2</sub> /4% O <sub>2</sub>	10.5	11	8.5	7.5	12
60% CO <sub>2</sub> →Air	9.5	9.5	7	6	4
60% CO <sub>2</sub> →4% CO <sub>2</sub> /O <sub>2</sub>	10	8	7.5	5.5	7
60% CO <sub>2</sub> →0.1% O <sub>2</sub> →Air	6.5	3	3	4.5	5
60% CO <sub>2</sub> →0.1% O <sub>2</sub> →4% CO <sub>2</sub> /O <sub>2</sub>	7.5	4	6.5	3.5	4.5
0.1% O <sub>2</sub> →Air	7.5	5	9	3	9
0.1% O <sub>2</sub> →4% CO <sub>2</sub> /O <sub>2</sub>	7	7.5	9.5	3.5	10
0.1% O <sub>2</sub> →60% CO <sub>2</sub> →Air	1.5	0	1.5	1	1
0.1% O <sub>2</sub> →60% CO <sub>2</sub> →4% CO <sub>2</sub> /O <sub>2</sub>	0.5	0	1	1	1.5