CONTROLLED ATMOSPHERES AS A POTENTIAL QUARANTINE TREATMENT FOR TABLE GRAPES

Elizabeth J. Mitcham[1], Miguel Ahumada[1], and Harry Shorey[2]
[1]Department of Pomology, University of California, Davis, CA
[2]Kearney Agric. Center, UC Davis

A quarantine treatment is needed for export of table grapes from California to Australia. Pests of quarantine concern to Australia include Omnivorous Leaf Roller (OLR) (*Platynota stultana*), Western Flower Thrips (WFT) (*Frankliniella occidentalis*), Spider Mite (SM) (specific mite as yet undetermined), and Grape Mealy Bug (GMG) (*Pseudococcus maritimus*). With the current uncertainty surrounding the future of methyl bromide, fumigation is not a promising treatment. Controlled atmospheres (CA) with elevated carbon dioxide and/or reduced oxygen concentrations have been demonstrated to be effective against a number of insect pests as reviewed by Carpenter and Potter (1994). These treatments have the benefit of creating no residues on the product. Also, the technology exists to conduct CA quarantine treatments during marine shipment. In addition to the data we have collected thus far, there is data in the literature which supports the potential for success with CA quarantine treatments. WFT were controlled on strawberry with 50 to 90% carbon dioxide for 1 to 2 days at 2.5°C (Aharoni et al., 1981) and New Zealand flower thrips have been controlled on asparagus with 4.5 days of 60% carbon dioxide at 1°C (Corrigan and Carpenter, unpublished data). Green headed leafroller (*Planotortrix excessana*) was controlled on persimmon with 4 days of 5% carbon dioxide and 0.5% oxygen at 20°C. Longtailed mealybug (*Pseudococcus longispinus*) were found to be cold sensitive and CA increased mortality at higher temperatures (Potter et al., 1990). Because of the demonstrated benefits of sulfur dioxide in combination with carbon dioxide for control of Black Widow Spiders (Shorey, 1993), there is also potential for controlled atmospheres in combination with sulfur dioxide to be effective for quarantine control of these pests if low oxygen and/or high carbon dioxide alone are not completely effective.

Omnivorous Leafrollers were reared in the laboratory at UC Davis with the assistance of Vicky Yokoyama. Western Flower Thrips were greenhouse collected. Our initial data are very encouraging for control of Omnivorous Leafroller with controlled atmospheres. We have found that the pupae are the most difficult stage to kill by this method following by the fifth instars (Tables 1 & 2). Four days in 35% carbon dioxide and 0.5% oxygen at 20°C (68°F) was effective for 100% mortality of 2nd and 3rd instars and resulted in 90% mortality in 5th instars and 55% mortality in pupae. In comparison, 45% carbon dioxide with 0.5% oxygen was 100% effective for all life stages after 4 days at 20°C (68°F).

Similar experiments are being conducted at 5°C (41°F). It appears that, pupae, the most difficult stage to kill, will be killed after only 6 days in 35% carbon dioxide with 0.5% oxygen. The low temperature may be contributing to the stress on the insects. Testing has also been conducted to determine the relative importance of high carbon dioxide verses low oxygen. Technically, it would seem easier to achieve one or the other while the combination will create greater technical challenges. Also, table grapes may tolerate high CO2 treatments better with high O2 concentrations. Table 3 outlines the results from these tests. It appears that there is an additive effect of low oxygen in combination with high carbon dioxide. However, the effect of low

oxygen appears to be minimal. We need to test the time required for insect mortality with 45% carbon dioxide with the balance as oxygen (11.5%).

Limited data on control of Western Flower Thrips is available at this time. However, the work of Cantwell, Reid and Parrella at UC Davis has previously demonstrated control of thrip adults with 30% carbon dioxide at 5°C (41°F) for 4 days. This data fits in with the Omnivorous Leafroller data quite well; however, other life stages of Western Flower Thrips must be tested as larvae may be more resistant than adults. We will be continuing with Western Flower Thrips and will begin testing of Spider Mite to determine its relative resistance to the treatments. We feel that the controlled atmosphere treatment could be accomplished as a preshipment fumigation or perhaps an in-voyage treatment as is the cold treatment of grapefruit.

The tolerance of 'Thompson Seedless' table grapes to controlled atmosphere treatments effective against Omnivorous Leafroller has been explored. Freshly harvested grapes were exposed to the CA treatments at 20°C (68°F) for 4 days or 5°C (41°F) for 7 days. Grapes were evaluated for firmness, soluble solids, rachis condition, berry shatter and browning and weight loss of the cluster. There were minimal effects on grape quality. The most noticeable difference was a decrease in titratable acidity in treated grapes. There was no consistent effect on berry shatter, weight loss, or soluble solids. Consumer taste tests are being conducted.

We are also exploring the effectiveness of sulfur dioxide in combination with high carbon dioxide concentrations. One percent sulfur dioxide with 6% carbon dioxide for a 30 minute treatment was effective for control of Black Widow Spiders (Shorey, 1993) and nearly effective for Omnivorous Leafrollers (Wood and Shorey, 1992). We plan to test higher carbon dioxide concentrations in combination with the sulfur dioxide fumigation to determine if faster treatments than CA alone can be developed. This work is just beginning this Fall.

References:

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Table 1. Percent mortality of Omnivorous Leafroller life stages after exposure to various CO2 atmospheres at 0.5% O2 at 20°C (68°F).

Stage	% CO2	Days	% Mortality
2nd Instar	35	4	100
3rd Instar	35	7	100
5th Instar	35	4	90
5th Instar	45	4	100
pupae	35	4	55
pupae	45	4	100

Table 2. Percent mortality of Omnivorous Leafroller fifth instars/pupae after treatment for 1 to 4 days under 35, 45, 55, or 65% CO2 with 0.5% O2 at 20°C (68°F).

% O2	% CO2	Mort. Day 1	Mort. Day 2	Mort. Day 3	Mort. Day 4
0.5	35	56	85/75	95/-	100/100
0.5	45	60/15	95/80	100/88	100/100
0.5	55	55	95/85	100/100	100/100
0.5	65	65	95/90	100/100	100/100

Table 3. Effect of oxygen concentration on effectiveness of high CO2 for mortality of Omnivorous Leafroller at 20°C (68°F).

% O2	% CO2	1 day	2 days	3 days
21	45	35	71	84
0.5	45	15	69	91
0	45	25	90	99
0	100	30	80	100

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