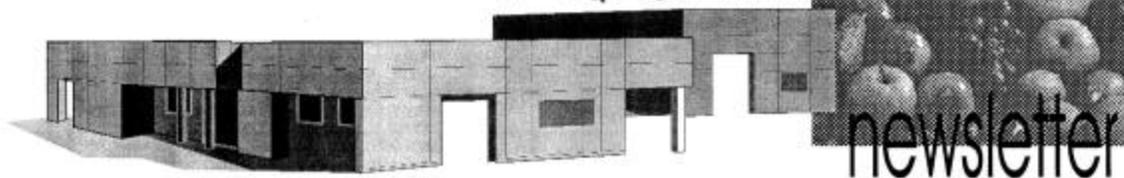




# Central Valley **POSTHARVEST**



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Carlos H. Crisosto, Editor

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## **TABLE GRAPE PACKAGING INFLUENCES ‘FLAME SEEDLESS’ AND ‘REDGLOBE’ STORAGE QUALITY**

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**Carlos H. Crisosto, Pedro Corzo, Lluís Palou, and F. Gordon Mitchell**  
University of California, Davis  
Pomology Department

Table grapes are subject to serious water losses during postharvest handling. Rachis browning, which occurs as a consequence of water loss, reduces table grape postharvest quality. Cumulative water losses occurring during postharvest handling may lead to stem browning,

berry shatter, and wilting and shriveling of berries during marketing. In our previous research, we developed critical cluster water loss threshold values for stem browning of ‘Perlette’, ‘Thompson Seedless’, ‘Flame Seedless’, ‘Fantasy Seedless’, and ‘Redglobe’ table grape cultivars. At the same time, our survey of potential cluster water loss during harvesting operations indicated that a short cooling delay at high air temperatures contributed to stem browning. These low critical cluster water loss threshold values, in combination with the high level of water loss measured during harvesting operations, illustrate the need to minimize cooling delays

and the importance of developing techniques to reduce cluster water loss during harvest and/or postharvest handling.

During the 1999 season, 88% of the approximately 17.5 million boxes of 'Flame Seedless' grapes produced in California were packed using plastic cluster bags and approximately 32% (3.5 million boxes) of 'Redglobe' production were bagged. Based on this, one practical approach to limit water loss may be the use of restricted ventilation cluster bags (RVCB) and/or box liners (BL). In our previous work (Crisosto et al., 1994), we recommended the use of a ventilated box liner with or without a SO<sub>2</sub> pad as one successful technique to reduce water loss during field packing and postharvest handling of grapes.

The use of a restricted ventilation cluster bag (RVCB) approach has been tested on several table grape cultivars (Davis, et al., 2000). For example, 'Ruby Seedless' grapes were packed by using the commercial cluster bag (CCB) with approximately 60% ventilation, or the restricted ventilation cluster bag (RVCB) with approximately 1.4% ventilation in foam boxes. During the storage period, grapes packed using the restricted ventilation and commercial cluster bags did not show excessive condensation. Under a high SO<sub>2</sub> application, SO<sub>2</sub> penetration was adequate in both types of cluster bags during the initial treatment and weekly fumigations. The results indicate that the RVCB was more effective to reduce water loss and maintain stem freshness without interfering with the SO<sub>2</sub> penetration than the currently used commercial cluster bag. The use of the RVCB with 1.4% ventilation reduced stem browning and increased the buyer's opinion grade without affecting decay or bleached berries as compared to grapes stored in bags with approximately 60% ventilation. During these trials, fruit packed with the restricted ventilation cluster bag (1.4% ventilation) had less shatter than fruit packed with the commercial bag (60% ventilation).

Based on these results we evaluated the performance of restricted ventilation cluster bags with a vented area of 0.5 to 1.2% on storage quality of 'Flame Seedless' and 'Redglobe' table grapes.

### **Materials and Methods**

'Flame Seedless' and 'Redglobe' table grapes were commercially harvested and packed using different cluster bag types. To attain cluster bags with different venting areas (VA), bags with different sized holes (1/4" or 1/8" diameter holes) and number of ventilating perforations (16 – 70 holes per bag) were used. A box liner (BL) with a VA of 0.57% in combination with the restricted ventilation cluster bag (RVCB) was also included in the treatments. In this treatment, a slow-release sulfur dioxide pad was placed over the grapes, and enclosed by the box liner (Table 1).

For 'Flame Seedless', each treatment consisted of 36 corrugated boxes. Grapes were picked and packed into nine cluster bags per 19-pound box. Harvesting was carried out during the hottest part of the day on July 12, 2000 in Ducor, California.

For 'Redglobe', 234 styrofoam boxes of grapes were harvested in a commercial vineyard on September 11, 2000 at Famoso, California, 20 miles north of Bakersfield. For each treatment a pallet of 78 styrofoam boxes was used and each box contained nine cluster bags. Grapes packed using a box liner were packed in RVCB-1.4% and placed inside the box liner (0.57% VA) using a bottom pad, and the slow-release sulfur dioxide pad was placed over the grapes and inside the box liner. For the other two treatments, grapes were packed using RVCB-1.4% and RVCB-0.8%. Each pallet had 13 tiers; those between position 3 and 9 (named from the bottom to the top) were used for data collection. In each of these tiers, three boxes were used for quality evaluation and three for nesting observation. A total of 42 boxes per pallet were used for observations.

Additionally, 12 boxes per pallet were used for SO<sub>2</sub> readings and water condensation measurements.

For both cultivars, grapes were held at 33°F and 85% RH for a three-week period ('Flame Seedless') and 16 weeks ('Redglobe'), then moved to room temperature (68°F and 60% RH) for a 4-day period. SO<sub>2</sub> applications were carried out initially and weekly following Nelson's SO<sub>2</sub> fumigation protocol (Nelson, 1985). Sulfur dioxide penetration was measured initially and weekly placing sulfur dioxide reading tubes 5D and 5DH in box 6 of each treatment. Water condensation on the berries and/or inside polyethylene liners was measured under two temperature handling conditions. The first temperature handling condition was on warm picked grapes after precooling and during cold storage period (cold storage). The second temperature handling condition was on cold stored grapes after being moved to warm room temperature (warm display).

**Quality Evaluations.** 'Flame Seedless' and 'Redglobe' storage and quality evaluations were carried out at the Kearney Agricultural Center, Parlier, CA. Quality evaluations included SSC, TA, rachis browning, berry shatter, bleached berries, and botrytis-induced decay development. Table grape stem condition and berry appearance were determined after cooling and also during the cold storage period. Stem browning symptoms were evaluated using the following scoring system: healthy = entire stem including the cap stems (merging point between berries and rachis) green and healthy; slight = only cap stems showing browning; moderate = cap stems and secondary stems showing browning; and severe = cap stems, secondary and primary stems completely brown (Crisosto et al., 2001).

**Decay Evaluation.** A controlled decay incidence test was performed on 'Redglobe' by using inoculated berries ("bombers"). Each "bomber" was internally inoculated with 10 µl

of a suspension containing 10<sup>6</sup> spores ml<sup>-1</sup> of *Botrytis cinerea* with a Hamilton™ syringe. Before their use in the experiment, inoculated berries were incubated at 68°F and 95% RH for 3 days. One "bomber" was placed in the center of each cluster bag. Each box contained nine cluster bags, and three boxes per each of the three treatments were inoculated. One box for each treatment was placed in each tier of each pallet. Three pallets with a total number of 21 boxes per pallet per treatment were used.

Decay was evaluated by counting the number of berries per box (excluding "bombers") showing gray mold (nesting). Bleached berries were evaluated by counting the number of berries per box showing bleaching symptoms. Data was collected every 3 weeks during a 16-week cold storage period.

## **Results and Discussion**

**Condensation under Warm to Cold Conditions.** The amount of condensation varied among the different cluster bag treatments for 'Flame Seedless' packed in corrugated boxes. The RVCB-1.4% treatment had the lowest condensation level measured immediately after forced air-cooling. After 7 and 14 days of cold storage, the level of condensation decreased in all of the treatments but still it was the lowest in the RVCB-1.4% after forced air-cooling and 7 days of cold storage. RVCB-1.4% also had significantly lower moderate plus severe condensation levels than the other treatments measured immediately after forced air-cooling and 7 days of cold storage (Table 2). Immediately after cooling, RVCB-1.4% had 44% of moderate plus severe condensation in comparison to 81-98% for the rest of the treatments. By one week of cold storage, grapes packed in the RVCB-1.4% treatment had 15% of moderate plus severe condensation while it ranged from 56 to 74% in the other treatments. Among the other treatments, grapes packed under treatment RVCB-0.7% and RVCB-0.6% showed the lowest condensation. By 14 days,

moderate plus severe condensation was very low (0-4%) except for RVCB-0.5% and RVCB-1.4%+BL with 11% and 6% levels, respectively.

Amount of condensation varied among the different cluster bag treatments for 'Redglobe' packed in foam boxes. Grapes packed using the RVCB-1.4% treatment did not show any condensation problems immediately after forced air-cooling and during the 42 days cold storage. There were no significant differences in condensation appearance and amount between grapes packed in the RVCB-0.8% and the RVCB-1.4%+BL within this evaluation period (Table 3). Twenty-four hours after packing, under cold storage (33°F and 85% RH), the lowest significant value of condensation was shown by RVCB-1.4%.

RVCB-1.4% also had significantly lower moderate plus severe condensation levels than the other two treatments measured immediately after forced air-cooling and during the 42 days cold storage period (Table 4). Immediately after cooling, RVCB-1.4% did not show any grapes with moderate plus severe condensation in comparison to approximately 60% for the rest of the treatments. By 21 days of cold storage, condensation was not observed in any of the three treatments.

### Condensation under Cold to Warm

**Conditions:** When 'Flame Seedless' grapes from these different cluster bag treatments were moved to warm conditions, high condensation (condensation score of approximately 3.5) quickly developed in all treatments. However, there were no significant differences in condensation scores among RVCB treatments. Condensation remained high during the first 3 days after removal to warm conditions. By day 4, these condensation scores decreased close to 1.2 (data not shown).

Approximately 90% of the grapes packed in the different cluster bags had moderate plus severe condensation by the first days at warm

temperature. High percentages of grapes (69-98%) packed in the different cluster bags had moderate plus severe condensation by two days at warm temperature. Grapes within the moderate plus severe condensation category decreased to 4-24% by day 4. Despite no significant differences in condensation measurements, it appears that condensation disappeared faster in grapes packed by using the RVCB-1.4% treatment than in any of the other RVCB treatments (data not shown).

**Grape Quality Evaluations.** After three weeks of cold storage, there were no significant differences in 'Flame Seedless' stem condition, berry shatter, bleached berries, and berry decay between treatments. The same situation occurred during the 4 day warming period, except by day 4 of warming, grapes packed using RVCB-1.4% had a more severe stem browning (2.4 score condition) than grapes packed in the RVCB-0.7% treatment (2.0 score condition). However, after 4 days at warm temperature, stem condition on grapes from all of the RVCB treatments was acceptable (approximately 2.0 score condition). Stems only showed the first symptoms of dehydration at the cap stems.

Under low SO<sub>2</sub> application, there were differences in sulfur dioxide penetration measured during the initial fumigation among the treatments. Percentages of SO<sub>2</sub> penetration were calculated based on the highest penetration. The RVCB-1.4%, RVCB-1.4%+BL, RVCB-1.2% had the highest SO<sub>2</sub> penetration (100%), followed by the RVCB-0.5% and RVCB-0.7% with approximately 80% SO<sub>2</sub> penetration. The lowest SO<sub>2</sub> penetration (60%) was measured on the grapes packed in RVCB-0.6%. During poor SO<sub>2</sub> fumigation conditions, the RVCB-1.4%, RVCB-1.4%+BL, RVCB-1.2% had the highest SO<sub>2</sub> penetration (100%), followed by the RVCB-0.5%, RVCB-0.7% with approximately 57% of SO<sub>2</sub> penetration. A very low SO<sub>2</sub> penetration of only 16% was measured on the grapes packed in RVCB-0.6%.

During 12 weeks of cold storage, there were no significant differences in 'Redglobe' stem condition, berry shrivel, and berry shatter among the three packaging treatments. After 9 weeks of cold storage, the stem condition of grapes from all of the treatments was acceptable (approximately 2.0 score condition). By 12 weeks, stems only showed the first symptoms of dehydration at the cap stems especially in grapes from the RVCB-1.4% and RVCB-0.8%.

Under high SO<sub>2</sub> application, there were no differences in SO<sub>2</sub> penetration measured during the initial and weekly fumigation among the treatments. In most of the cases the dosimeter tubes were over 600 C.T., thus, it was impossible to collect reliable data.

#### **Bleached Berries and Decay Development.**

Bleached berries became important by 9 weeks of storage, reaching its maximum expression by 16 weeks. Bleaching damage was nearly three times greater on grapes packed in the RVCB-1.4% than grapes packed in RVCB-0.8% or RVCB-1.4%+BL. Reduction of SO<sub>2</sub> by the RVCB-0.8% was determined in our previous test using 'Flame Seedless'. Even though RVCB-1.4%+BL had a low SO<sub>2</sub> penetration, botrytis was controlled as well as with RVCB-1.4%.

Initial and periodic sulfur dioxide fumigations, and low storage temperature were very effective in preventing gray mold development and nesting from the "bombers" on grapes packed using the three packaging systems (Table 5). Botrytis became visible after 9 weeks of storage in two of the three treatments but the amount of botrytis was not related to the treatments until week 16. By week 16, grapes packed using the RVCB-0.8% had the highest botrytis incidence. Grapes packed in RVCB-1.4% and RVCB-1.4%+BL had the lowest botrytis development. Grapes packed with the RVCB-0.8% that were exposed to a high and long condensation period after forced air-cooling had the highest decay development.

However, grapes packed using the RVCB-1.4%+BL were also exposed to a high and long condensation period but did not show high decay development. This may be explained by the use of a SO<sub>2</sub> pad, which should have provided a constant SO<sub>2</sub> application during storage, which may have compensated for the poor room SO<sub>2</sub> penetration into the boxes. The influence of inner packaging on free water inside the package may have also been influenced in a different way by this packaging system. We cannot conclude that high decay development was solely due to the fact grapes were exposed to a long condensation period because these grapes also had the poorest SO<sub>2</sub> penetration.

#### **Conclusions**

- There were differences in the time and length of condensation period between the different restricted ventilation cluster bags. The RVCB-1.4% had the least condensation after forced air-cooling and during cold storage conditions without limiting SO<sub>2</sub> penetration (warm to cool test).
- There were no differences in condensation among grapes packed with different cluster bags that were warmed up after 21 days in cold storage. Under these conditions, all of the RVCB treatments had high condensation (cold to warm test).
- In general, table grape stem and berry quality attributes were not affected by any of these RVCB packaging treatments, except for decay incidence.
- The most condensation and poorest SO<sub>2</sub> penetration was found on grapes packed in RVCB-0.6% (cluster bags with 70 1/8" holes) after forced air-cooling and cold storage conditions (33°F and 85% RH).
- Under a long commercial storage period, grapes packed using the RVCB-0.8% were exposed to a high amount of condensation and a long condensation period on the

surface of the berries. Grapes packed with the RVCB-0.8% also had low SO<sub>2</sub> penetration ending with high decay development.

- This work demonstrates that reducing the venting area of packaging components is a good approach to maintain green rachises but its relationship to SO<sub>2</sub> penetration, cooling operations, and condensation should be studied in detail. Development and implementation of new restricted ventilation packaging (cluster bags and box liners) systems should be carefully evaluated before any commercial implementation.
- This work points out that packaging ventilation affects both the amount and length of the condensation period and the penetration of SO<sub>2</sub> to the grapes, and it is associated with decay development expressed later during cold storage and postharvest handling.
- These results also suggest that number, size and location of holes in cluster bags influence potential decay in table grapes. Further studies must be carried out varying number, size and hole placement on the cluster bags.

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Table 1. 'Flame Seedless' table grape cluster bag specifications.

TREATMENTS	CLUSTER BAG SPECIFICATIONS					
	Holes Location	Cluster Bag Area (Sq. inches)	Hole diameter (inches)	Number of Holes	Area of Holes (Sq. inches)	Venting Area Percentage (VA)
RVCB-1.4%	Top/Bottom	162	1/4	46	2.26	1.4
RVCB-1.4%+BL <sup>z</sup>	Top/Bottom	162	1/4	46	2.26	1.4
RVCB-1.2%	Top/Bottom	162	1/4	40	1.96	1.2
RVCB-0.5%	Top/Bottom	162	1/4	16	0.79	0.5
RVCB-0.7%	Top/Bottom	162	1/4	24	1.18	0.7
RVCB-0.6%	Top	151	1/8	70	0.859	0.6

<sup>z</sup> Box liner: Chilean standard box liner, 1/4" holes on 4" centers was used in combination with the RVCB. Treatments 1-5 used bags vented equally top and bottom. Treatment 6 included holes on the top and sides of the cluster bag only.

Table 2. Berry condensation scores of ‘Flame Seedless’ table grapes packed in six different types of cluster bags evaluated after forced air-cooling and then 7 and 14 days cold storage (warm to cold).

TREATMENTS	MEAN CONDENSATION SCORE <sup>z</sup>			MODERATE PLUS SEVERE CONDENSATION (%)		
	After forced air cooling	COLD STORAGE		After forced air cooling	COLD STORAGE	
		7 days	14 days		7 days	14 days
RVCB-1.4%	2.4	1.7	1.1	44	15	0
RVCB-1.4%+BL	3.6	3.0	1.5	98	70	6
RVCB -1.2%	3.4	2.9	1.6	92	74	4
RVCB -0.5%	3.7	3.3	1.7	94	83	11
RVCB -0.7%	3.1	2.6	1.6	81	56	4
RVCB -0.6%	3.7	2.6	1.1	94	57	0
P-value	<.0001	<.0001	<.0005	<.0001	.0002	.0245
LSD 0.05	0.46	0.53	0.37	21	27	6.8

<sup>z</sup>Condensation score: 1=none, 2=slight, 3=moderate, and 4=severe.

Table 3. Berry condensation scores of ‘Redglobe’ table grapes packed in three different types of cluster bags evaluated after forced air-cooling and during cold storage (warm to cold).

TREATMENT	MEAN CONDENSATION SCORE <sup>z</sup>					
	DAYS AFTER COOLING					
	0	1	2	3	21	42
RVCB-1.4%	1.07	1.02	1.00	1.00	1.00	1.00
RVCB-0.8%	2.63	2.72	2.70	2.13	1.26	1.05
RVCB-1.4%+BL	2.59	2.81	2.83	2.37	1.40	1.13
P-value	.0014	.0001	<.0001	.0001	.0104	.1222
LSD 0.05	.83	.725	.718	.6671	0.2447	NS

<sup>z</sup>Condensation score: 1=none, 2=slight, 3=moderate, and 4=severe.

Table 4. Percentage of ‘Redglobe’ table grape boxes showing moderate plus severe condensation when packed in three different types of cluster bags evaluated after forced air-cooling during cold storage (warm to cold).

TREATMENT	MODERATE PLUS SEVERE CONDENSATION (%)					
	DAYS AFTER COOLING					
	1	2	3	4	21	42
RVCB-1.4%	0	0	0	0	0	0
RVCB-0.8%	59	57	54	43	2	0
RVCB-1.4%+BL	52	65	65	52	4	0
P-value	.0044	.0003	.0004	.0021	.3419	-
LSD 0.05	34.49	28.30	28.30	27.06	NS	-

Table 5. Number of berries per bag showing symptoms on 'Redglobe' table grapes stored at 32°F under commercial conditions.

Symptom	Treatment	Number of berries per box <sup>z</sup>				
		Storage period (weeks)				
		3	6	9	12	16
Botrytis (Gray mold)	RVCB-1.4%	0	0	1	3	21 b
	RVCB-0.8%	0	0	1	1	65 a
	RVCB-1.4%+BL	0	0	0	0	24 b
	<i>P</i> -value	-	-	0.2295	0.1270	<0.0001
Bleached berries	RVCB-1.4%	0	0	12	14	130 a
	RVCB-0.8%	0	0	13	16	49 b
	RVCB-1.4%+BL	0	0	0	19	50 b
	<i>P</i> -value	-	-	0.2040	0.1392	<0.0001

<sup>z</sup> Values are the means of nine bags per each of the three boxes.

## UPDATE ON REDGLOBE BREAKDOWN PROJECT

**Lisa Basinal, Lluís Palou, and C. H. Crisosto**  
University of California, Davis  
Department of Pomology

Studies are currently being done to learn about Redglobe Breakdown, which we first saw in October of 2000. We began the project by making cultures from Redglobe grapes showing breakdown symptoms, and found that they contained yeasts and bacteria, and no filamentous fungi. The bacteria and yeasts were isolated and purified on specialized media, and their morphological and growth characteristics were observed. Twenty-two different isolates were used in the pathogenicity

studies. Wounded and non-wounded Redglobe grapes were inoculated with a concentrated cell suspension and incubated at 25°C and 95% R.H. Disease incidence (number of diseased berries) and severity (lesion area) were measured twice a week. We found that some microorganisms showed pathogenicity on wounded grapes, but none of them showed pathogenicity on non-wounded grapes. Studies comparing different inoculum densities were performed with isolates that showed pathogenicity. We are currently studying the effect of inoculation of Redglobe grapes with mixtures of the pathogenic microorganisms and the effect of cold storage on disease development. The next step is identification of the pathogenic microorganisms.

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## University of California Cooperative Extension



### WINTER TREE FRUIT MEETING



**Wednesday, December 5, 2001**

**Dinuba Memorial Hall, 249 S. Alta Avenue, Dinuba**

- 8:00 - 8:30 a.m.      Registration
- 8:30 - 8:40 a.m.      Welcome
- 8:40 - 9:00 a.m.      **Carlos Crisosto**, Postharvest Physiologist, Kearney Agricultural Center  
*Understanding the Role of Ethylene During Stone Fruit Cold Storage*
- 9:00 - 9:20 a.m.      **Scott Johnson**, Pomology Specialist, Kearney Agricultural Center  
*Experiences with Chemical Thinning of Plums*
- 9:20 - 9:40 a.m.      **Shawn Steffan**, Staff Research Associate, Kearney Agricultural Center  
*Summary of Infestation and Costs in the Stone Fruit Pest Management Alliance*
- 9:40 - 10:00 a.m.      **Kevin Day**, Farm Advisor, UCCE Tulare County  
*Pruning as an Aid for Labor Savings*
- 10:00 - 10:25 a.m.      Break
- 10:25 - 10:40 a.m.      **Harry Andris**, Farm Advisor, UCCE Fresno County  
*What's New on the Disease and Pest Front*
- 10:40 - 10:55 a.m.      **Shawn Steffan**, Staff Research Associate, Kearney Agricultural Center  
*New Pest Pressure from Some Old Pests: Katydid and Diabrotica Beetles*
- 10:55 - 11:25 a.m.      **Vito Polito**, Professor, Dept. of Pomology, UC Davis Campus  
*Flowering, Pollination and Fruit Set*
- 11:25 - 11:55 a.m.      **Ted DeJong**, Professor and Pomology Department Chair, UC Davis Campus  
*Environmental and Cultural Factors Limiting Fruit Growth and Size*
- 11:55 - 12:20 p.m.      **Video, UC Davis Communications Department**  
*Water Above and Below*
- 12:20 p.m.              Lunch – Catered by the *Safari Club Restaurant*, Dinuba

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