POSTHARVEST TECHNOLOGY and METHODS
for
Grapes and Raisins

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1. TABLE GRAPE POSTHARVEST PRACTICES

1.1 PREHARVEST CONSIDERATIONS

Table grapes should not be harvested until ready to eat, since they do not ripen after harvest. They should be picked only after they reach the optimum stage of acceptability in appearance, flavor and texture.

The key criteria for harvest are:

Color

- adequate coloring is required within the clusters
- there are minimum color requirements, in terms of percentage of the berries in the cluster showing characteristic color, which vary according to variety

Sugars

- adequate accumulation of sugars is required
- Soluble Solids Concentration (SSC) and/or SSC/Titratable Acidity (TA) ratio are measured to determine maturity; SSC typically need to be above 14 to 17.5%, depending on cultivar and production area

The progress of fruit maturity and the determination of initial harvest can be monitored by measuring percentage coloration in the clusters and/or quantification of soluble solid levels in randomly selected berry samples.

Steps should be taken to prepare the vineyard for harvest to facilitate the operation. Before harvest, it might be necessary to prune long shoots or strip leaves to allow for better grape coloration and offer pickers easier access to the fruit. Irrigation should be suspended several days earlier, early enough to allow the ground to be stable for harvesting traffic, yet late enough to avoid an overly dry ground to cause dust being lifted during operations.

If rain wets the clusters thoroughly, it is prudent to suspend harvest for at least 3 days. If the rain does cause fungus infection to take place, this period will allow symptoms of the infection to develop to the extent that pickers can detect and trim out infected berries. Even so, fruit picked this soon after a rain should be sold immediately or if stored kept segregated and monitored closely for any development of decay.

1.2 HARVESTING AND PACKING

Although grape crops can be packed in sheds or packing houses, packing the crop in the vineyard has several advantages that make it of greater interest under certain conditions, including less investment in facilities and materials. Packing can take place:

1. Under the vine
   Clusters are picked, trimmed and packed directly into the shipping container. The picker is also the trimmer and packer.

2. In small shaded packing stands at the head of the row of vines
   Clusters are picked, trimmed and placed in lightweight trays, before being transported to the head of the row for packing.

The cleanliness of the field containers in which picked grapes are collected is highly important. Special attention will need to be paid to keeping these clean, by washing and/or disinfecting them between uses. Plastic crates seem most convenient.

During field packing, grape clusters need to be picked and carefully trimmed with shears to eliminate occasional defective berries. Clusters need to be held by the stem to minimize rubbing of the berries and destroying the bloom (waxy layer on the skin). The following are considered defective berries to be removed:

- sunburned	- scarred	- mildewed
- decayed	- raisined (dried)	- cracked
- crushed	- undersized	- irregular-shaped

The picker should completely discard or include in a low grade category the following kinds of clusters:

- inadequately colored clusters
- clusters so compact that the interior cannot be examined for defective berries or stems
- straggly clusters (inadequately filled with excessively exposed stems)
- clusters filled with shot berries
- clusters that are too small
- clusters filled with an excess of defective berries
- clusters with sunburned, decayed, mildewed, shrunken or blackened stems

The inside of the shipping boxes should be lined and/or padded. Lining, which should especially be considered in wooden boxes in order to avoid abrasion, can be provided by thin plastic or paper sheets, while padding is most important for the bottom of the box by use of a cushioning material. Since the crop will need to quickly be cooled to maintain product quality, it is important that containers have vents and the liners be perforated for easy air circulation. The packed boxes need to promptly be transported to a facility for cooling.

In order to reduce high fruit temperatures during harvest, which accelerate deterioration and demand less energy for cooling, the following two practices are highly recommended:

1. Harvest should be carried out early in the morning.

2. Harvested grapes should be kept shaded all along until cooling.

Handling of grapes at harvest, and during trimming and packing, and of the boxes in every stage afterwards needs to receive special attention if market quality is to be insured.

1.3 COOLING

No phase is more critical in the postharvest handling of grapes than that of cooling – removal of the sensible or field heat from the fruit after harvest. Cooling is necessary to reduce the rate of fruit respiration, retard the development of decay and most importantly to minimize water loss from the fruit.

Harvested grapes will deteriorate more in 1 hour at 32ºC than they will in 1 day at a temperature of 4ºC or in 1 week at a temperature of 0ºC. In fact, the amount of time between fruit harvest and cooling is key for final fruit quality, as is also that of cooling to optimum temperatures.

Assuming that harvest is carried out early in the morning and that harvested fruit is always kept in the shade after picking, the amount of cooling needed to decrease fruit temperature will be minimized.

If access is available, forced air-cooling, as a rapid method of removal of field heat from grapes, would perhaps be the most suitable cooling method worth consideration. In a cold room set apart for this purpose, a portable forced air-cooling tunnel can be used due to its convenience and effectiveness. By setting up a pressure gradient across the package, there is a positive flow of cooling air through the container from one side to the other, providing direct contact with the packed fruit. Airflow and temperature gradients need to be monitored regularly to insure uniform and effective cooling.

In order to control decay of table grapes, fumigation with sulfur dioxide is a common practice. Due to the expert management such fumigation would require, the use of sulfur dioxide pads in packages might represent a better alternative. However it is important to consider that grapes treated with sulfur dioxide will necessarily call for storage under low temperatures.

1.4 STORAGE

Under favorable storage conditions, and if cooling has been carried out appropriately, different varieties can be held for varying periods in order to obtain better prices or sale conditions. The best temperature to attain the full storage potential of table grapes is -1ºC. The relative humidity of the air should be as high as practicable – 95 to 98% if possible. Frequent and close inspection of the grapes during storage is necessary to detect any disorders early and dispose of fruit before market quality is impaired significantly.

2. HARVESTING AND HANDLING RAISIN GRAPES

The harvesting and handling is a fairly simple process, which must time many external factors to maximize the quality and minimize risk to the product including:

- When to harvest
- Preparation for harvest
- Harvest
- Handling

2.1 DECIDING WHEN TO HARVEST

There are many dynamics that must be considered when deciding when to harvest. The grower should consider the four most important: yield, quality, rain risk, and availability of labor.

2.1.1 Yield

As grapes mature, the soluble solids (sugars) inside the grapes increase due to the influx of water. During this time berry growth will increase about 5% per week while Brix increases about 1 to 1.5° per week. Although the rate of this accumulation can be altered by weather, crop load, and vine canopy conditions. Once harvested, the biggest change that occurs as the grapes turn to raisins is the loss of water. Raisins, when dried down to 15 percent water, will contain about 74 percent sugar by weight. Hence the greater the percentage of sugar in the fresh grapes the greater the raisin yield.

The amount of raisin weight or yield obtained from a given amount of fresh grapes is the drying ratio. For all intensive purposes, this ratio is dependant upon the sugar content of the fresh grapes. High quality grapes can expect a 4.5:1 ratio of fresh to dry weights. Lower quality grapes can expect 3.5:1. This ratio can have an impact on harvest costs as well, because more favorable drying ratios will increase tray weight. In other words, fewer trays will be needed to make 1 ton of raisins. If fewer trays are required then harvesting costs decrease. This includes picking, turning, rolling, and boxing labor.

2.1.2 Quality

Any condition that affects food value or attractiveness is a factor of quality. Such conditions are varietal flavor and seediness or seedlessness of raisins is determined by the grape variety used. Additional factors of raisin quality include: a) size of the raisin berry, b) hue, uniformity and brilliance of color, c) condition of the berry, d) texture of the skin and pulp, e) moisture content, f) chemical composition, g) presence of decay (rot), mold and yeast of foreign matter and h) insect infestation or contamination by insect remains.

Higher-maturity fruit produces higher quality raisins as well as higher raisin yields. Thus, raisin quality considerations should also influence the time of harvest. Generally, high quality raisins are plump, meaty, and fine wrinkled, the result of having harvested grapes at a high soluble solid (sugar) content.

For every week that harvest was delayed, the better grades increased by an average of 11.5%. This only includes the time frame when the grapes are still expanding.

2.1.3 Rain Risk

The date of harvest is strongly influenced by calendar date. As harvest date is pushed back, cooler temperatures/poor drying weather and an increased risk of rain. If rain does occur, significant damage can occur because moisture will be held in the soil, especially underneath trays.

2.1.4 Availability of Labor

A grower must analyze labor availability when determining the optimal harvest date. This will sometime declare specific timing impossible because of other conflicting events.

2.1.5 Other considerations

Vineyards with a north-south row orientation usually are harvested earlier than those with an east west orientation. This is because the morning and afternoon shading by vine canopies causes grapes to take longer to dry in north-south rows. Fruit drying in north-south rows will have only 5 to 6 hours of direct sunlight each day in early September eat-west rows will have about 12 hours. Typically, it takes 7 to 10 days longer to dry in north-south rows.

2.1.6 Sampling Grapes for Maturity

The best way to set the picking date is to harvest raisin grapes based on soluble solids content as indicated by a representative field sample. The sample must be collected correctly to give you an accurate reading of fruit maturity. The types of sampling methods available are sampling whole vines, clusters, or berries.

To get an accurate indication of the field maturity of the grapes collect 150 – 200 berries and place them in a plastic bag, crush with your hand and pour off the juice onto a refractometer. Use a temperature compensating refractometer when available or adjust for discrepancies. Be sure to wipe the glass prism clean with a damp cloth and dry it with a clean cloth between readings.

2.2 PREPARATION FOR HARVEST

2.2.1 Cane Trimming

You only need to trim canes in vigorous vineyards where the bottom of the vine canopy may interfere with terracing and raisin drying. Trim the shoots that are trailing down from the trellised canopy back to 12 to 24 inches from the vineyard floor. This can also be used on the north side of an east-west row to enlarge unshaded area.

2.2.2 Soil Terracing

Soil terracing is when growers slope, smooth, and firm the soil, which the trays will rest. This is important in optimizing drying conditions and minimizing the potential for rain damage. To accomplish terracing in an east-west row a raised bed should be established through the middle of the row with a southern slope. This will enable rain to run off into the furrows on both sides and maximize light. Sloping is not necessary for north-south rows, only leveling and smoothing. A small slope (5-10%) will help drain rainwater. The later the harvest usually correlates with a larger slope to best capture the suns rays.

2.2.3 Tray Selection

Trays are used to keep raisin off of the ground when drying them in the field. They help negate the effects of rain and keep the grapes relatively free of debris. In most cases the only trays available will be regular paper. It is necessary to keep raisins from drying on the ground.

2.3 HARVEST

2.3.1 Picking and Spreading

The necessary tools for picking are a shallow pan and a curved-blade knife or pruner. The pan should be able to hold approximately 20 – 22 lbs (9-10 kg) of fruit. The pan should not be overloaded and fruit should not be stacked extensively because of the risk of breakage. The following are important concepts to remember when picking and spreading:

1. Place the pan directly under the fruit to be picked to catch loose clusters or berries.
2. Use a knife to cut clusters from the vine and to cut tangled clusters in half. Do not jerk or strip the clusters off.
3. Keep rot off of the tray by avoiding clusters with rot cutting the rotten portion out.
4. Avoid cutting or crushing berries. The juice accumulates soil, attracts vinegar flies and dried fruit begins to rot.

5. Spread the fruit evenly on the trays, being careful not to mash the berries remove all leaves and refuse. Keep loose berries from rolling off of the bottom end of the tray by placing several clusters along the bottom before spreading.
6. Keep the trays uniform in weight for even drying. Do not overload trays, since that will slow drying and increase the potential for rot, especially in the event of rain. Trays of 20-22 pounds (9.1 –10 kg) are a common goal for optimum or maximum weight. Lighter trays increase the costs of harvest but result in faster drying and less need to turn.
7. Very large clusters may dry better if cut into smaller ones. However, you should avoid this practice if the clusters are so tight that you cannot avoid cutting or crushing berries.
8. Keep foot traffic out of the drying area.
9. Do not kick sand onto the drying trays.
10. Place the trays far enough north on the terrace to minimize shading.

2.3.2 Turning, Rolling, and Boxing

Turning

Turning is not always an essential operation. Turning is a way to mix the grapes on the tray to facilitate faster and more even drying. Turning is necessary in the following situations: with clusters that are too large to avoid the inclusion of an excessive amount of green, un-dried berries; with late harvests or slow drying conditions such as cool weather or north-south rows; with heavy trays or trays in which some rot is progressing in the bottom-most fruit; or after a rain. Turn when the berries on the top layer are brown and shriveled.

Fig 1. Turning trays help to even drying.

Rolling

The rolling operation greatly slows the drying process, protects the fruit from over-drying or caramelization, provides rain protection, and facilitates raisin pickup and boxing. Timing for rolling is mostly based on experience and judgment of raisins' moisture content. You will need to examine enough representative trays daily to follow the progress of differences among individual

trays, rows, soil types, and pickers, as well as harvest date. **The fruit to be rolled will continue to cure and equalize their moisture in the rolls and bins.**

Fruit temperature should be considered when judging rising moisture content. It is best to check in the midmorning when they are closer to an average ambient temperature. This is because very warm fruit in the afternoon will be very pliable and will feel like high=moisture fruit. The same fruit in the cool morning will be firm as if it were of lower moisture.

Trays at the end of the rows do not dry as quickly. This is probably because temperatures are higher in the middle of the rows due to reduced air circulation.

Timing of rolling will also depend on current drying conditions and the type of roll used. At 95°F (28°C) or above, it is best to roll the raisins on the heavy side to prevent over drying and carmelization. Drying will continue at a safer/slower rate in the roll. If you use a more open, ventilated roll such as a cigarette or flop roll, you can roll the raisins at higher moisture content than with a biscuit roll.

One must be careful about over-drying and carmelization. Raisins that are turning reddish black rather than the normal, brownish purple color can indicate carmelization. The fruit will have a burnt sugar taste. This will occur first in raisins that are already dry, exposed to the sun, and lying directly on the tray.

The type of roll used is based on preference and experience:

- **Biscuit roll** – offers the most protection and the slowest drying time. They have no open ends so the timing of boxing is less important. Shifting those clusters so they will end up in the top of the roll can facilitate drying of heavy clusters. This roll should not be used with poly-coated trays, since water vapor from high-moisture content will be unable to escape.
- **Cigarette roll** – easier to shake out during boxing but does not offer much protection from weather. Use when rolling higher moisture content fruit, because increased ventilation increases drying ability. Can be reopened to help complete drying.
- **Flop roll** – provide the least rain protection. Easiest to make and shake out. Use when the trays are not turned.

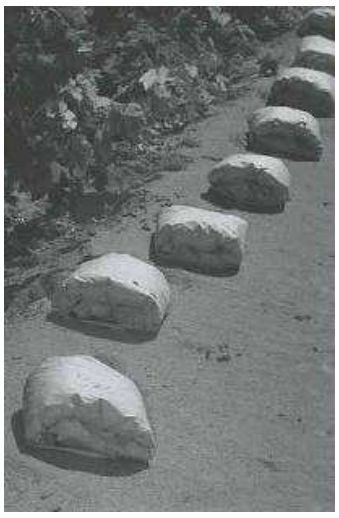

Figure 2-4. Types of rolls from left to right: biscuit, cigarette, and flop.

Boxing

Raisins must be at 16% or less moisture content to achieve high quality. Lower moisture content receives greater price in the market. There are two main ways to box raisins. Yard Boxing is where the raisins are collected and then sorted before boxed. Field Boxing is when raisins are picked up and put into containers in the field.

2.4 HANDLING RAINED-ON AND HIGH MOISTURE RAISINS

Proper handling of rained-on and high-moisture raisins is critical to minimizing mold infection, fermentation, and imbedded sand. Smashed or broken berries, immature fruit, and fruit already infected with bunch rot are especially subject o rot infection on the tray following rain. Fungi may also grow on fruit exudates on the paper tray, causing the fruit to stick to the tray. Should rain occur, follow these practices to minimize damage and infection:

1. Slip trays 1- 2 inches to prevent their sticking to the soil.
2. Turn trays as soon as possible to expose bottom fruit.
3. Discard fruit stuck to the bottom of the trays, use new trays as needed.
4. Pick moldy and rotten fruit off the trays as needed.
5. Get rolled fruit out of the field as soon as possible. Do not fill binds with raisins above 18 % moisture content.

3. EU STANDARDS FOR GRAPES

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ANNEX

STANDARD FOR TABLE GRAPES

I. DEFINITION OF PRODUCE

This standard applies to table grapes of varieties (cultivars) grown from *Vitis vinifera* L. to be supplied fresh to the consumer, table grapes for industrial processing being excluded.

II. PROVISIONS CONCERNING QUALITY

The purpose of the standard is to define the quality requirements for table grapes after preparation and packaging.

A. **Minimum requirements**

In all classes, subject to the special provisions for each class and the tolerances allowed, bunches and berries must be:

— sound; produce affected by rotting or deterioration such as to make it unfit for consumption is excluded,

— clean, practically free of any visible foreign matter,

— practically free from pests,

— practically free from damage caused by pests,

— free of abnormal external moisture,

— free of any foreign smell and/or taste.

In addition, berries must be:

— intact,

— well formed,

— normally developed.

Pigmentation due to sun is not a defect.

Bunches must have been carefully picked.

The table grapes must be sufficiently developed and display satisfactory ripeness. The development and condition of the table grapes must be such as to enable them:

— to withstand transport and handling,

and

— to arrive in satisfactory condition at the place of destination.

B. **Classification**

The table grapes are classified into three classes defined below:

i) *'Extra' class*

Table grapes in this class must be of superior quality. In shape, development and colouring the bunches must be typical of the variety, allowing for the district in which they are grown, and have no defects. Berries must be firm, firmly attached, evenly spaced along the stalk and have their bloom virtually intact.

ii) *Class I*

Table grapes in this class must be of good quality. In shape, development and colouring the bunches must be typical of the variety, allowing for the district in which they are grown. Berries must be firm, firmly attached and, as far as possible, have their bloom intact. They may, however, be less evenly spaced along the stalk than in the 'Extra' class.

The following slight defects, however, may be allowed, provided these do not affect the general appearance of the produce, the quality, the keeping quality, and presentation in the package:

— slight defects in shape,

— slight defects in colouring,

— very slight sun-scorch affecting the skin only.

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iii) *Class II*

This class includes table grapes which do not qualify for inclusion in the higher classes, but satisfy the minimum requirements specified above.

The bunches may show slight defects in shape, development and colouring, provided these do not impair the essential characteristics of the variety, allowing for the district in which they are grown.

The berries must be sufficiently firm and sufficiently attached, and, where possible, still have their bloom. They may be less evenly spaced along the stalk than in Class I.

The following defects are allowed provided the table grapes retain their essential characteristics as regards the quality, the keeping quality and presentation:

— defects in shape,

— defects in colouring,

— slight sun-scorch affecting the skin only,

— slight bruising,

— slight skin defects.

III. PROVISIONS CONCERNIG SIZING

Size is determined by the weight of the bunch.

The following minimum size requirements per bunch are defined for table grapes grown under glass and for open-grown table grapes, large-berry or small-berry varieties respectively.

	Table grapes grown under glass	Open grown table grapes	
		Large berry varieties	Small berry varieties
'Extra' Class	300 g	200 g	150 g
Class I	250 g	150 g	100 g
Class II	150 g	100 g	75 g

A list of varieties grown under glass and open-grown large-berry and small-berry varieties appears in the Appendix to this standard.

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For all classes: in each consumer package, not exceeding 1 kg net weight, one bunch below the required minimum weight is allowed to adjust the weight indicated, provided the bunch meets all other requirements for the specified class.

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Where the name of the variety on the marking does not appear on the list in the Appendix hereto the minimum weight for large-berry varieties is required.

IV. PROVISIONS CONCERNING TOLERANCES

Tolerances in respect of quality and size shall be allowed in each package for produce not satisfying the requirements of the class indicated.

A. **Quality tolerances**

i) *'Extra' class*

5 % by weight of bunches not satisfying the requirements of the class, but meeting those for Class I or, exceptionally, coming within the tolerances of that class.

ii) *Class I*

10 % by weight of bunches not satisfying the requirements of the class, but meeting those of Class II or, exceptionally, coming within the tolerances for that class.

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iii) *Class II*

10 % by weight of bunches satisfying neither the requirements of the class nor the minimum requirements, with the exception of produce affected by rotting or any other deterioration rendering it unfit for consumption.

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B. **Size tolerances**

i) *'Extra' Class and Class I*

10 % by weight of bunches not satisfying the size requirements of the class, but meeting those of the class immediately below.

ii) *Class II*

10 % by weight of bunches not satisfying the size requirements of the class but weighing not less than 75 g.

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V. PROVISIONS CONCERNING PRESENTATION

A. **Uniformity**

The contents of each package must be uniform and contain only bunches of the same origin, variety, quality and degree of ripeness.

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In the case of grapes packed in small consumer packages of a net weight not exceeding 1 kg, uniformity of variety and origin is not required.

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In the case of the 'Extra' Class, the bunches must be of more or less identical size and colouring.

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The inclusion in each package of bunches of different colours for decorative purposes shall be allowed in the case of the variety Chasselas.

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The visible part of the contents of the package must be representative of the entire contents.

▼M2

Notwithstanding the preceding provisions in this point, products covered by this Regulation may be mixed, in sales packages of a net weight of less than three kilograms, with different types of fresh fruit and vegetables on the conditions laid down by Commission Regulation (EC) No 48/2003 (1).

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B. **Packaging**

The table grapes must be packed in such a way as to protect the produce properly.

In the case of the 'Extra' Class, the bunches must be packed in a single layer.

The materials used inside the package must be new, clean and of a quality such as to avoid causing any external or internal damage to the produce. The use of materials, particularly paper or stamps, bearing trade specifications is allowed provided the printing or labelling has been done with non-toxic ink or glue.

Packages must be free of all foreign matter, although a fragment of vine shoot no more than 5 cm in length may be left on the stem of the bunch as a form of special presentation.

VI. PROVISIONS CONCERNING MARKING

Each package must bear the following particulars in letters grouped on the same side, legibly and indelibly marked, and visible from the outside:

(1) OJ L 7, 11.1.2003, p. 65.

▼B

A. **Identification**

— Packer and/or dispatcher: Name and address or officially issued or accepted code mark. However, where a code (symbol) is used, the words 'packer and/or dispatcher' (or an equivalent abbreviation) must appear close to this code (symbol).

B. **Nature of produce**

— 'Table Grapes', if the contents are not visible from the outside,

— name of the variety or, where applicable, varieties,

▼M1

— 'under glass', where applicable.

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C. **Origin of produce**

— Country (or, where applicable, countries) of origin and, optionally, district where grown, or national, regional or local place name.

D. **Commercial specifications**

— Class.

E. **Official control mark *(optional)***

4. GRAPE PHYSIOLOGICAL DISORDERS

4.1 Berry Shrivel

By Fred Jenzen

Occurrence: Seeded grapes, particularly Emperor & Calmeria

Importance: Affects Emperor, particularly on resistant rootstocks, and sometimes older, own-rooted vines. Five to 30% of clusters may be discarded. Occasionally so severe that vineyard is removed. Affects own-rooted Calmerias; up to 20% of clusters may be culled. Both varieties are decreasing in importance.

Symptoms: After ripening begins, Emperor berries become flaccid and sunken. Some affected berries develop color; some remain white. The flaccid berries are usually interspersed with normal ones, but occasionally several berries at the tip of a lateral or at the cluster apex are affected.

With Calmeria, whole clusters may be involved. Sometimes the disorder is difficult to recognize. The clusters may be a slightly duller green but the berries must be touched to confirm the flaccid condition. The amount of fruit involved usually increases up to harvest.

Physiology: The cause is unknown. With Emperor, 16 grams per acre of gibberellin applied about two weeks after fruit set when the berry diameters average 10-15 mm will reduce the shrivel by 50 to 70% compared to the compared to the untreated. Similar treatments are not tolerated by the Calmeria variety.

4.2 Shatter

By Fred Jenzen

Occurrence: Seedless varieties, particularly Thompson Seedless and Flame Seedless

Importance: Shatter can reach levels of 20% or above and represents serious loss. The percentage varies among vineyards and years.

Symptoms: Shatter refers to the loose berries, those that have detached from the stem.

Physiology: For some reason, seedless varieties are usually less well attached to the capstem than seeded varieties. This is defined with less of a "brush" than in seeded varieties. When a seeded variety is pulled from the capstem, a

substantial amount of flesh remains attached to the stem. Conversely, a seedless variety may be removed with little or no flesh. The force required to remove a seedless berry from its capstem is much below that required for a seeded berry.

In general, shatter increases in severity with increasing maturity and/or the longer the fruit remains on the vine. It is also believed to be associated with any stress to which the fruit is subjected such as heat, water insufficiency, weakly growing vines, etc. Shatter varies considerably from season to season, and among vineyards.

Girdling at fruit set, as done for berry weight increase, also increases the strength of the berry attachment to the capstem and so reduces the shatter potential. However gibberellin, also applied at fruit set, weakens this attachment and is dosage dependent. As the rate of gibberellin is increased, the berry weight benefit decreases with each additional increment, but the shatter potential continues to increase.

Shed packing, with some delay between harvesting and packing, decreases the shatter somewhat as compared to field packing where the fruit is packed soon after harvest. Much of the shatter occurs during the packing operation itself with additional shatter all the way to the final retail sale. Bagging the clusters reduces the shatter during packing. Also the loose berries are inside the bag and are sold along with the cluster. With bagging less fruit is packed per box. This in itself reduces shatter because the fruit is not so crowded. Over 60 percent of the grapes were bagged for the 1995 season.

4.3 Waterberry

By Pete Christensen

Occurence: Table grape

Importance: Many table grape cultivars are susceptible but problems are most common with ‘Thompson Seedless,' ‘Flame Seedless,' ‘Calmeria,' and ‘Queen.' The disorder also affects wine and raisin grapes and is known in other areas as ‘bunchstem necrosis' (Australia), ‘palo negro' (Chile), ‘shanking' (New Zealand), ‘Stiellahme' (Germany), and ‘dessechement ed al rafle' (France). Severely affected vines can have nearly 100% of the clusters showing some symptoms and with a 50% crop loss in pack-out. More commonly, crop losses are in the range of 5-20% in affected vineyards. Labor to trim affected berries from cluster is an additional cost factor.

Symptoms: The affected berries become watery, soft, and flabby during ripening due to the interrupted flow of sugar and other constituents into the berries. The affected berries tend to have a more metallic, opaque, or dull green appearance; berry color will be lighter and more variable in red and black varieties. This

results from the breakdown and necrosis of the cluster stem structure supporting cluster parts as well as individual berries. Ultimately, water movement may be affected, causing berry shriveling and drying. The earliest symptom is the development of small (1-2 mm) dark spots on the cap stems (pedicles) and/or other parts of the cluster framework. These spots become necrotic, slightly sunken, and expand to affect more areas. The cluster tips, shoulders, and upper laterals are most affected; the entire framework may be involved in severely affected clusters. The nectroic cluster stem tissue will have a dark brown to purplish-black or black color.

Physiology: Waterberry is thought to be a physiological disorder which appears more in certain cultivars, years, and individual vineyards. It is associated with fruit ripening and most often begins to develop shortly after veraison (berry softening).

Studies in California have shown it to be associated with vineyard areas with a high nitrogen status; symptoms can be induced by foliar spraying with nitrogen compounds or fertilizing a low nitrogen status vineyard. Clusters with symptoms have higher total nitrogen and ammonium levels in the stem structure. Vine canopy shading and/or cool weather during veraison (berry softening) and fruit ripening can increase waterberry, further suggesting nitrogen metabolism involvement in this disorder. Other mineral nutrients such as calcium, magnesium, and potassium have not shown a direct relationship to waterberry; applications of these elements have not influenced the incidence.

Control: There is no known control. However, it is recommended to avoid over fertilization with nitrogen due to waterberry's association with a high nitrogen status. Folier nutrient sprays of nitrogen should be avoided in waterberry-prone vineyards. Likewise, ammonium or urea fertilizers should not be applied via drip irrigation near the beginning of or during fruit ripening. Trellising and canopy management practices such as shoot thinning that minimize shading within the canopy may be beneficial. Supplementing other nutrients such as calcium, magnesium, and potassium has not been effective. Crop load differences or gibberellic acid treatments have not been shown to affect waterberry. Ethephon may possibly hasten its development but not increase the overall incidence by harvest. It has been well demonstrated that no pathogen is involved; fungicidal spray treatments are ineffective. Trimming off affected berries during harvest and packing is a common practice, although labor intensive. A delay between picking and packing may enhance the ability to see affected berries for trimming. This is because waterberries will tend to welt first on a cluster. However, the advantage of this practice must be weighed against the effects of water loss from the frtui to be packed.

5. References

Christensen, L. P. 1982. Waterberry -- what we know today. Table Grape Seminar Proceedings, pp 12-14, Feb. 10, 1982, Dinuba. Univ. Of Calif. Cooperative Extension and California Table Grape Commission.

Christensen, L. P. and J. D. Boggero. 1985. A study of mineral nutrition relationships of waterberry in Thompson Seedless. Am. J. Enol. Vitic. 36:57-64.

6. Plate I – Grape Diseases

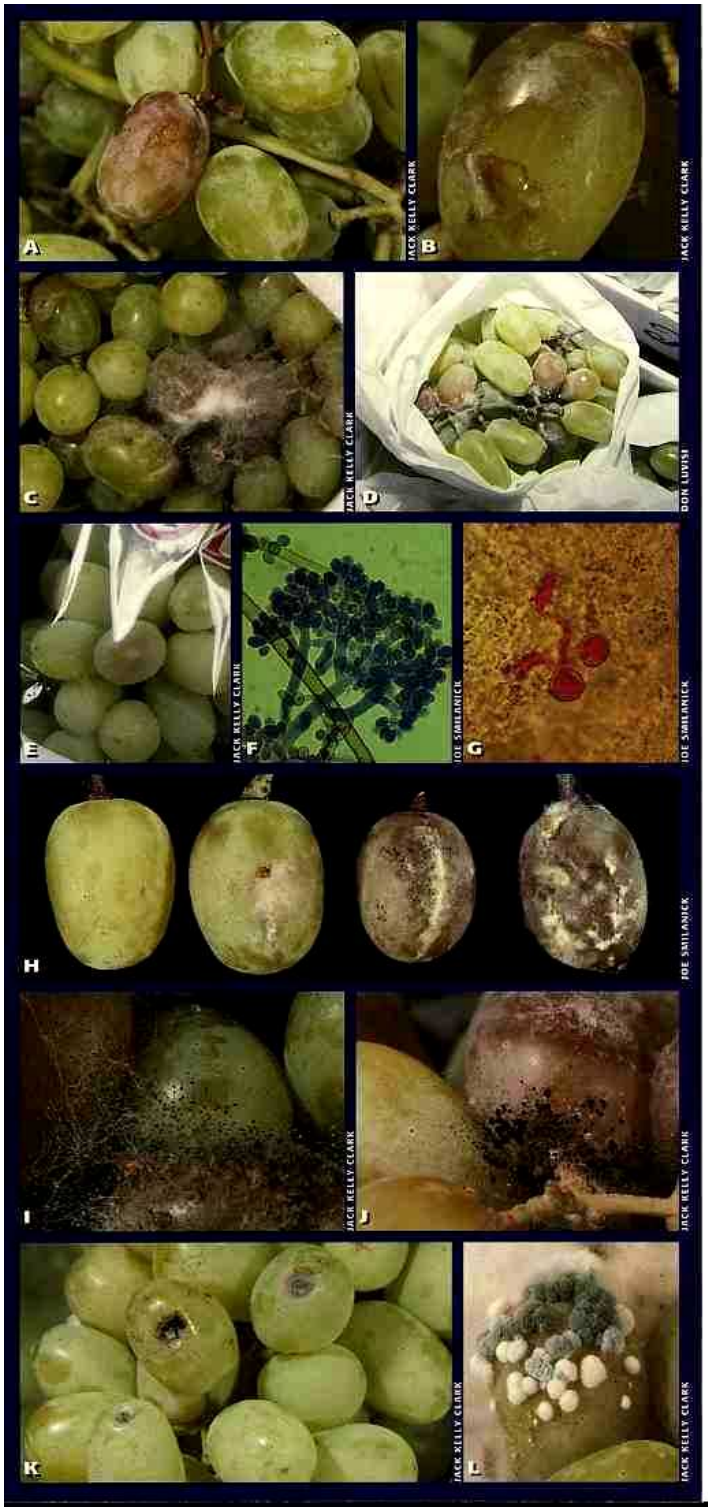

Plate I

Diseases

A. Typical brown coloration of a Botrytis-infected Thompson Seedless berry. This condition is often the result of a preharvest infection that continues to develop under cold conditions.

B. When berries are infected with Botrytis, the skin separates from the berry. This condition, called "slipskin," is a diagnostic characteristic of Botrytis infections.

C. An advanced Botrytis infection from a single berry has produced a surface growth infecting adjacent berries. The mycelial spread to adjacent berries is known as a "nest," or "nesting."

D. Tissue-wrapped Thompson Seedless grapes with Botrytis-infected berries. This fruit missed the initial fumigation. Subsequent storage fumigations prevented mycelial growth, but did not eliminate or prevent the internal growth of latent infections. The "nest" in plate I-C did not receive adequate SO_2 during storage.

E. Thompson Seedless grapes in a polyethylene bag with no SO_2 fumigation. Note the development of a Botrytis infection on a single berry.

F. Cluster of conidia (spores) of *Botrytis cinerea*. Germination requires about 20 hours of moist conditions at 50°–70°F (10°–21°C), or about 7 days at 32°–36°F (0°–2.2°C).

G. Germinating spores can penetrate directly into berries under moist conditions, although wounds or injuries are major points of entry.

H. Progressive development of Botrytis infections on Thompson Seedless grapes 5, 10, 15, or 20 days at 10°C after inoculation with Botrytis spores.

I. *Rhizopus* sp. infection of Thompson Seedless grapes. Although this organism causes rapid nested decay, it does not develop under refrigeration. Its appearance indicates poor temperature management.

J. *Aspergillus niger* is called "smut" because of its black, sooty spores. It requires warm temperatures, and can also cause nested decay.

K. *Cladosporium herbarum* is one of several fungi that cause "black spot" of grapes in storage. The fungus develops under cold conditions and does not cause nested decay. Black spot is more prevalent on grapes harvested after rain.

L. *Penicillium* spp. cause "blue mold" in storage. The pathogen enters the berry through a wound. Blue mold does not cause nested decay, and is rarely a significant problem.

7. Plate II - Disorders

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Plate II

Disorders

A. Powdery mildew, caused by *Uncinula nectrix,* on the rachis of Redglobe grapes.

B. This crack on a Redglobe grape berry, caused by an insect feeding injury, has become infected by *Botrytis cinerea* before harvest.

C. Rain-damaged grapes that have been colonized by *Botrytis cinerea*. Gray spores are visible.

D. The rachis on the Redglobe cluster at left shows the collapsed, straw-brown color characteristic of drying, while the cluster at right is unaffected.

E. Although SO_2 treatment cannot stop the rachis from drying, it does help retain a straw color as shown, rather than the dark brown color that would appear without SO_2.

F. Sulfur dioxide has penetrated the wounds on this Redglobe grape and severely bleached the surrounding tissue.

G. Brown, bleached areas on excessively gassed Thompson Seedless grapes. The brown areas, which develop after removal from cold storage, severely reduce the grapes' marketability.

H. Internal browning, shown here in a Thompson Seedless grape, is a physiological problem that develops during cold storage.

I. Berries 1 and 4 show internal browning; berry 2 is a normal, undamaged berry; and berry 3 shows freezing, or low-temperature injury.

J. A crushed berry (*arrow*) in a packed box. Crushed, split, and damaged berries increase SO_2 residues, since the gas seeps into the areas surrounding the wounds and bleaches them.

K. Field decay in Perlette grapes resulting from bird damage. Note the Botrytis-infected berry adjacent to other bird-damaged berries.

L. Field decay in Perlette grapes. When trimming away decayed grapes, all surrounding infected berries should be removed.