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Effect of Thrips Scars on Table Grape Quality[1]

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Abstract. **Scars caused by the ovipositional and feeding activities of the western flower thrips, *Frankliniella occidentalis* (Pergande), on 'Thompson Seedless' and 'Calmeria' table grapes, *Vitis vinifera* L., had no effect on many measurable quality attributes of the fruit. Scarred berries showed no apparent differences in size or average weight when compared to undamaged fruit. However, scarred 'Thompson Seedless' berries had a higher soluble solids content. The acid content was not affected by any type of scar and all fruit had soluble solids to acid ratios of at least 20:1. Scarring did not affect the weight loss of fruit in short-term storage at 0.6°C, and scarred berries were not injured by sulfur dioxide fumigation.**

Of many arthropod pests found on grapes, the western flower thrips, *Frankliniella occidentalis* (Pergande), is reported to damage the foliage and fruit (3, 10, 11). Damage to the fruit results from the feeding or ovipositional activities of the insect (4). Scars on the surface of the fruit are believed to be caused by thrips that feed under floral caps which adhere to the berries (6, 14). However, scars may also be caused by gibberellin sprays or abrasion (7, 14).

Scars are visual imperfections that detract from the appearance of the cluster. The damage is unimportant in grapes used for raisins and wines, but scars on table grapes can be objectionable. When the injury is extensive the fruit is not marketable because of high consumer expectancies and legal standards of quality that restrict insect damage (2).

Insecticide control practices are often directed at phytophagous insects that affect the appearance of the fruit (1). In the concept of integrated pest management a certain level of insect damage must be tolerated in order to decrease the use of insecticides. Superficial damage also referred to as cosmetic damage caused by insects in fresh produce may not actually affect the food value of the commodity. This possibility has not been investigated and such information is needed to develop tolerable insect damage levels. Although thrips damage on table grapes is only an occasional problem, this study is an attempt to determine the effect of scars on storage properties and other objective attributes of table grape quality.

Materials and Methods

Table grapes. In 1972 samples of mature 'Thompson Seedless' table grape clusters were obtained from a commercial vineyard in Tulare County, California. Samples of 'Calmeria' table grapes were taken from a vineyard in Fresno County, California. The clusters were selected for fruit scarred by the feeding and ovipositional activities of thrips. The samples were held in plastic bags at about 0.6°C during the 6 week period in which they were evaluated.

Evaluation of scar damage. For quality evaluation studies individual berries were removed from the cluster by cutting the pedicel about 5 mm above the top of the fruit. Berries with

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rot or broken skins and very small berries were discarded. The fruit was sorted into categories by the type and extent of scars. Scars on the surface of each berry were rated by the number of polar quadrants with suberized tissue and described as follows: Category 0 = berries with no scars; Category 1 = berries with slight scars or 1 quadrant scarred; Category 2 = berries with moderate scars or 2 quadrants scarred; Category 3 = berries with extreme scars or 3 quadrants scarred (Fig. 1). All berries with 1 or more ovipositional scars were grouped in a scar category designated as Egg. When both suberized surface and ovipositional scars occurred on a berry, it was rated by the greatest amount of damage and placed in the corresponding group. The average berry weight in each scar category was determined for 6-12 clusters.

The site and area around the ovipositional scar was removed from the berry in a section to examine the nature of the histological damage. These sections as well as sections from undamaged berries were killed and fixed in formalin-aceto-alcohol (FAA). Microtome sections mounted in lactophenol or fuchsin-aniline blue-iodine-lactophenol (FABIL) stain were made for microscopic examination.

Damage to the cluster was described as none, slight, moderate, and extreme by the most extensive type of scarred fruit in the bunch. Slightly damaged clusters had categories 0 and 1 scarred berries, moderately damaged clusters had categories 0, 1 and 2 scarred berries, and extremely damaged clusters had categories 0, 1, 2 and 3 scarred berries. Only a limited number of extremely damaged clusters were found.

Soluble solids-to-acid ratio. The effect of scars on the soluble solids and titratable acidity of the 'Thompson Seedless' and 'Calmeria' samples was determined from 2 replicates of 8-15 berries in each scar category in each of 1-12 clusters. The berries were crushed in a garlic press and the juice passed through a No. 60 standard sieve. ^{o}Brix of the sieved juice was determined with a temperature compensated hand refractometer (Series 25-A, American Optical, Buffalo, NY). The juice was centrifuged at 2500 RPM for 3 min and 10 ml of the supernatant was diluted with 50 ml of CO_2 free distilled water and titrated with 0.1 N NaOH to determine the acid content.

Storage. To study the effect of scars on short-term storage properties, 20-50 berries in each damage category from each of 4 'Thompson Seedless' clusters and 4 'Calmeria' clusters were used to determine weight loss during storage. The berries were placed in square, plastic mesh fruit baskets (about 9 cm wide by 6.5 cm high). 'Thompson Seedless' samples were treated with

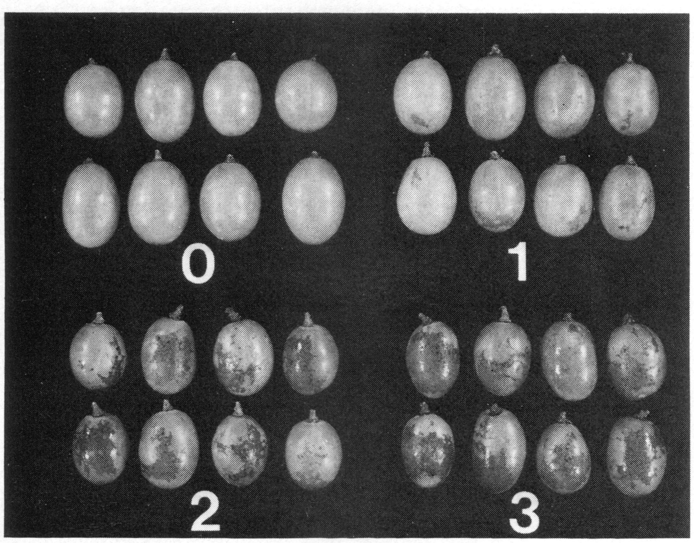

Fig. 1. Evaluation of scars on 'Thompson Seedless' berries: 0 = no scars, 1 = slight, 2 = moderate, and 3 = extreme scars. Rating is based on the number of polar quadrants with damaged tissue.

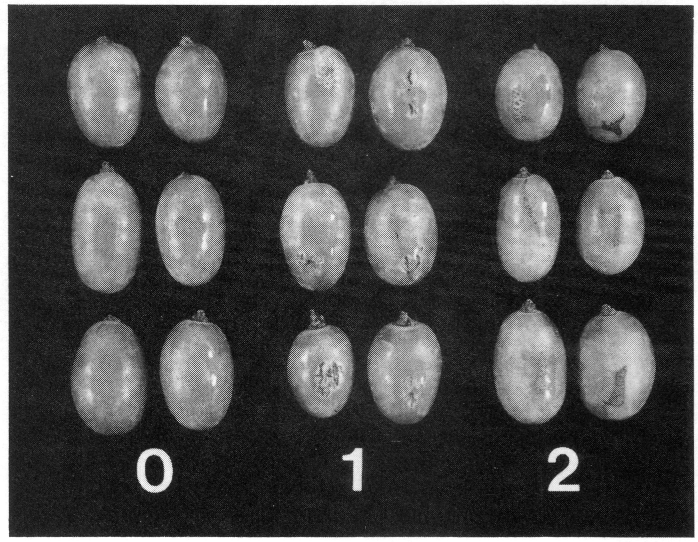

Fig. 2. Evaluation of scars on 'Calmeria' berries: 0 = no scars, 1 = thrips ovipositional scars, 2 = slight scars.

1% sulfur dioxide for 30 min to control *Botrytis* rot and to determine if the scarred fruit was susceptible to fumigation injury. The baskets were stored in open wooden containers (40 cm wide by 45.5 cm long by 13 cm high) in refrigerated temperature cabinets at about 0.6^{o}C. This was slightly above recommended storage temperatures of -1.1^{o} to -0.6^{o}C (9).

Results and Discussion

Suberized scar damage on the surface of the berry was the most prevalent type of injury in 'Thompson Seedless' grapes (Fig. 1). Ovipositional scars were more important in the 'Calmeria' and suberized surface scar damage was only slight (Fig. 2). There is a tendency for the western flower thrips to oviposit in 'Calmeria' grapes (5). The insect seems to have a cultivar preference for egg laying. Berries often have more than one scar. They appear as suberized areas circular in outline or irregular and slash-like in shape, and are surrounded with a diffuse white or light area referred to as a halo. Inspection of the tissue beneath the scars revealed that extensive cellular proliferation had occurred, and many cells beneath the halo region were filled with granular inclusions. The pale, lusterous appearance of the halo is probably a manifestation of these cells.

Berry weight of 'Thompson Seedless' grapes was not affected by either a slight or moderate amount of scarring (Table 1). Although berries in damage category 3 appeared smaller, it could not be determined from the small sample if extreme scars affected fruit size. Berries with ovipositional damage in 'Calmeria' samples showed no weight differences from berries with no scars (Table 2). Even though the damage occurs when the insects lay eggs in the immature berries (14), the development of the eggs does not affect the ultimate growth of the fruit.

The soluble solids concentration of the juice appeared to be affected by surface scars on 'Thompson Seedless' grapes. An increase in the ^{o}Brix was related to an increase in damage on berries within a cluster (Table 1) and between clusters (Table 3). Although the soluble solids content is not a reliable criterion of taste, it seems to be enhanced by extensive scarring. This may be advantageous when cultivars such as 'Thompson Seedless' are used for wine and raisin production, and the amount of sugar in the grapes is used to establish grades.

In 'Calmeria' neither slight surface scars nor ovipositional scars affected the ^{o}Brix (Table 2). This is similar to the report of Luvisi and Kasimatis (7), who indicated that berry scars caused by gibberellin sprays did not affect the soluble solids.

Table 1. Effect of scars on 'Thompson Seedless' table grape quality.

Variable	Berry scar category 0	1	2	3
Berry weight (g)[z]	4.2 ± 0.8	4.5 ± 0.8	4.2 ± 0.8	3.5[x]
°Brix[y,*]	17.6 ± 1.5	18.5 ± 1.1	20.4 ± 1.0	21.5[x]
Titratable acid[y] (% tartaric)	0.81 ± 0.06	0.83 ± 0.08	0.82 ± 0.12	0.84[x]
Ratio[y] (°Brix/acid)	21.8 ± 2.6	22.5 ± 2.8	25.0 ± 3.5	25.6[x]
Weight loss[w] (%) (14 days at 0.6°C)	5.1 ± 0.9	4.2 ± 0.3	5.1 ± 0.9	

[z]Mean ± SE of the avg wt in 7-12 clusters.
[y]Mean ± SE of the avg of 2 determinations for each damage category in 5-12 clusters.
[x]Values determined from 1-2 clusters.
[w]Mean ± SE of 4 clusters.
*Significant difference at the 1% level.

Table 2. Effect of thrips scars on 'Calmeria' table grape quality.

Variable	Berry scar category 0	1	Egg
Berry weight (g)[z]	6.5 ± 0.5	6.8 ± 0.6	6.8 ± 0.6
°Brix[y]	22.7 ± 0.8	22.8 ± 0.4	22.5 ± 0.6
Titratable acid[y] (% tartaric)	0.66 ± 0.05	0.64 ± 0.04	0.65 ± 0.04
Ratio[y] (°Brix/acid)	34.5 ± 3.2	36.0 ± 3.0	34.6 ± 3.1
% Wt loss[x] (24 days at 0.6°C)	4.4 ± 0.9	4.4 ± 0.7	4.3 ± 1.0

[z]Mean ± SE of the avg wt in 6 clusters.
[y]Mean ± SE of the avg of 2 determinations for each damage category in 4 clusters.
[x]Mean ± SE of 4 clusters.

The different types of scars had no effect on the acid content of fruit from 'Thompson Seedless' or 'Calmeria' grapes. When the sugar to acid ratios were calculated for 'Thompson Seedless' fruit, the values were affected by an increase in scar damage and °Brix (Table 1). Although the ratios for 'Calmeria' fruit were uninfluenced by scarring (Table 2), it cannot be inferred that scars had no effect on the taste of the fruit. Taste results from 4 perceptions of which only 2 were evaluated, sweetness by the soluble solids content (13) and sourness by the acid content. Taste and palatability would surely be affected if scars had textural differences that could be perceived. Nonetheless, the most reliable objective criterion of palatability and maturity is the soluble solids to acid ratio (8, 12), and all samples met the California maturity standards for table grapes with ratio values of at least 20 (2).

When the weight loss of 'Calmeria' grapes in storage was determined at about 7 day intervals, berries with scars showed no appreciable differences in weight loss from undamaged berries (Table 2). This was also observed for 'Thompson Seedless' grapes. Moderately scarred fruit did not lose weight at a different rate than undamaged fruit (Table 1). Furthermore, there were no indications of sulfur dioxide injury in the samples that had been fumigated prior to storage.

Scars caused by the feeding and ovipositional activities of thrips on table grapes have no effect on many measurable quality attributes of the fruit. The damage is primarily subjective and the scars are unesthetic marks. It seems possible to reevaluate quality standards and tolerate a certain level of thrips damage to avoid the use of excessive cosmetic chemical treatments.

Table 3. Comparison of the °Brix of juice from 'Thompson Seedless' clusters with different degrees of scarred berries.[z]

Cluster damage	°Brix, Berry scar category 0	1	2
None	15.9 ± 0.4		
Slight	18.1 ± 1.2	18.0 ± 0.9	
Moderate	18.4 ± 1.4	19.2 ± 1.1	20.2 ± 0.9

[z]Mean ± SE of the avg of 2 determinations for each damage category in 3-5 clusters.

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