California Avocado Society 1968 Yearbook 52: 97-101

END SPOTTING AND CORKING OF AVOCADO FRUITS

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Avocado fruits in California are subject to two related defects that detract from their appearance and thereby impair their marketability. These defects are known in the industry as "end-spotting" and "corking."

They seem to be peculiar to California for the senior author did not see them in Australia, Hawaii, Florida, Jamaica, Trinidad, Venezuela, Colombia, the Mexican State of Chiapas, and the several countries that comprise Central America. And they have not been reported in the published literature as occurring on any appreciable scale in these countries or any other in which the avocado is grown.

End-spotting is confined almost entirely to a small disk-like region of the exocarp surrounding the style at the apical end of the fruit

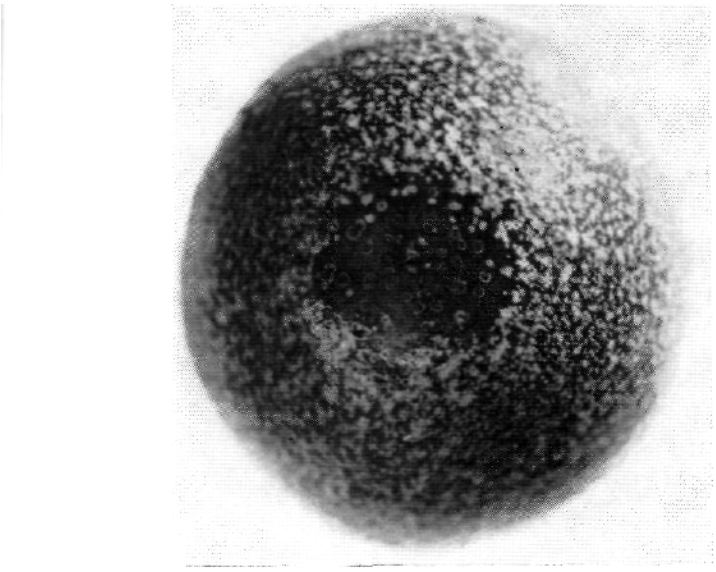

Figure 1. Young fruit showing the basal disk well differentiated from surrounding exocarp tissue.

(Figure 1). This region is differentiated histologically from, the rest of the exocarp. It is associated with the basal portion of the style, i.e. the portion of the fruit popularly called the "blossom end."

The cuticle here is usually darker green and smoother than other fruit exocarp tissues. Lenticels are few in number or may be entirely absent.

End-spotting may appear very early in the development of the young fruit, even within a few weeks after fruit-set. It begins with cork formation at the base of the style, the cork then progressing radially toward the periphery of the blossom-end disk. Eventually, the cork may cover the entire disk; it may spill over into small surrounding islands of russet (Figure 2).

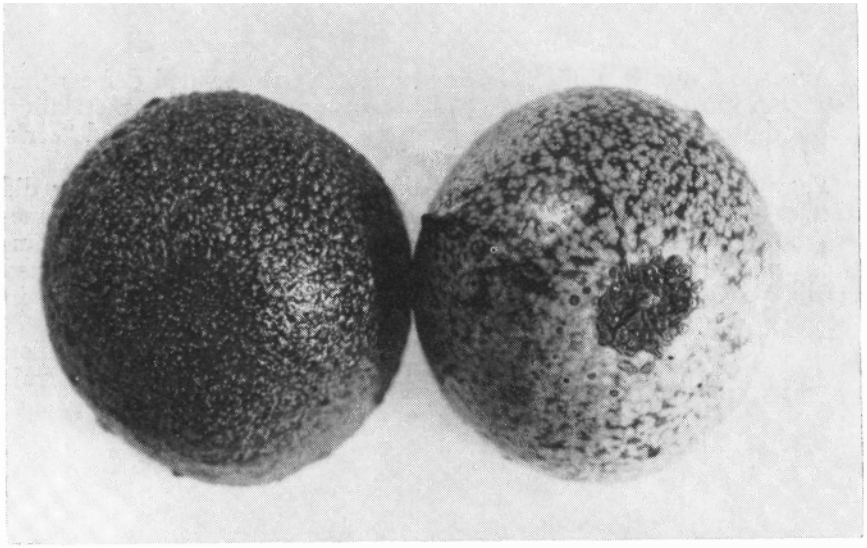

Figure 2. Young fruits of two seedlings showing complete absence of end-spotting in the one on the left and serious end-spotting in the one on the right. (The variety on the right has more yellow ground color than the one on the left.)

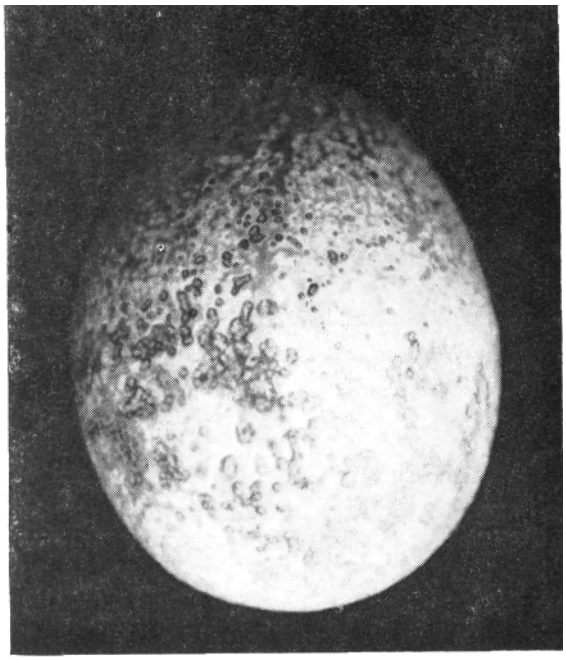

Figure 3. Young fruit showing initial state of corking in lenticels.

It has the typical roughness of epidermal cork. It is light brown in color, contrasting with the typical green and yellow (or purple-black) of avocado skins (Figure 2).

Corking, on the other hand, occurs on the main surface of the fruit, and seldom invades the blossom-end disk. It is a condition which results from cork formation in lenticels (Figure 3). It generally begins toward the apex of the fruit where lenticels are most numerous, and spreads toward the base as the fruit develops.

In less severe cases, corkiness may be confined to the immediate area around a lenticel, and appear as brown spots over the surface of the fruit (Figure 3). In severe cases, the cork spreads and that of one lenticel coalesces with that of another until nearly the entire surface of the fruit is russetted and scabrous (Figure 4).

This form of cork is found in the basal disk only when lenticels are present (Figure 1).

The susceptibility of the fruit to either or both of the defects depends upon the genetic constitution of the tree. For example, most seedlings of the Zutano have a typical end-spot.

But the genetic factors responsible can express themselves only under certain environmental conditions. This explains why fruits of a given variety may show one or another (or both) of the defects in certain localities, and not show any in other localities.

For example, fruits of Bacon and especially of Zutano develop end-spotting very early in Riverside, and are severely marred by the time they are mature. In Tulare County, they are reported to have only minimal, inconspicuous spots. In San Luis Obispo County, they are entirely free from the defect. (Neither variety is subject to appreciable corking in any locality.)

Corking shows a similar variable response to variable environment. The fruits of the variety Fuerte, for example, is initially free from any blemish in Riverside County, but develop it gradually as the season progresses. It may be unblemished up to November or December, develop cork gradually through January and be badly russeted by February or March.

By way of contrast, Fuerte fruits produced in San Diego, Ventura, and Santa Barbara counties commonly remain unblemished on the trees right up to the end of the crop season in April or May. (Fuerte is free from the factors for end-spotting.)

Breakdown from over-maturity should not be confused with end-spotting. This is a darkening, shrinking, cracking, and eventual decay of the basal region. It results from leaving the fruit on the tree past the time when it is fully mature. If one cuts the fruit open he may find that the seed has begun to germinate and the flesh has a "cheesy" taste.

This blossom-end breakdown usually occurs only in varieties such as Fuerte, Zutano, Racon, and others which do not drop at maturity. It is not often found in Mexicola, Duke, Stewart, Hass, and others which drop when fully mature.

The genetic factors which determine end-spotting are independent from those determining corking. So in an environment such as that of Riverside (in which the development of both is enhanced), one might expect to find all four classes of possibilities among the fruits from trees of varieties and hybrids.

Varietal observations are given in Table 1. Table 2 lists the ratings of a progeny set of 28 seedings from the cross, made in Hawaii, of Jalna x Okinaga (a variety of the West Indian race).

TABLE 1. Observations on end-spotting and corking of avocado varieties growing at Riverside (—, largely absent; +, present; ++, severe).

Variety	*End-Spotting*	*Corking*
Arturo	—	+
Bacon	+	—
Clifton	—	+
Covocado	—	+
Duke	—	—
Edranol	—	++
Elsie	—	—
Emerald	—	—
Ettinger	++	+
Fuerte	—	+
Gehee	—	—
Hass	—	—
Irving	—	—
Jalna	—	+
MacArthur	—	+
Mexicola	—	—
Nowels	—	+
Regina	—	++
Rincon	—	—
Ryan	—	—
Strong	—	+
Yama	—	—
Zutano	++	+

TABLE 2. Observations on end-spotting and corking in 28 avocado seedling trees from the cross Jalna x Okinaga growing at Riverside.

Neither defect	*End-spotting only*	*Corkiness only*	*Both defects*
5	6	6	11

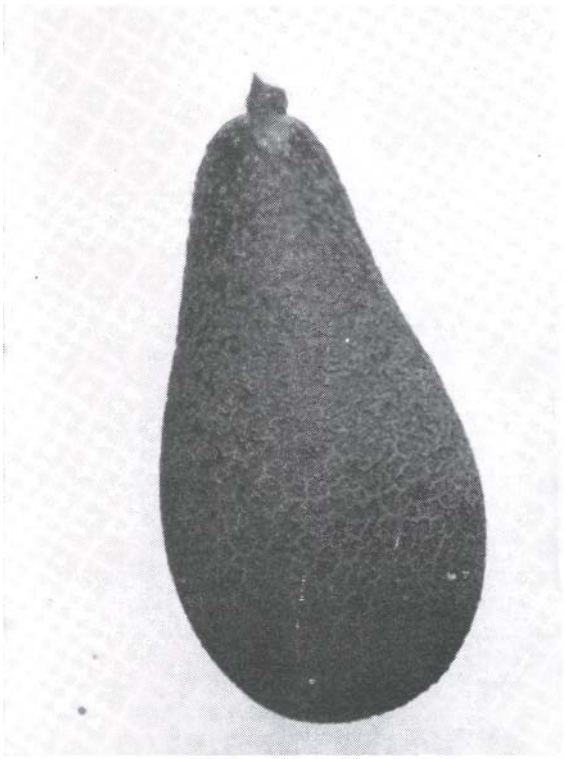

Figure 4. General, coalesced corking.

Studies to date indicate quite strongly that end-spotting and corking are heritable characters but that they are expressed only in certain environments. These conclusions suggest the following procedures for precluding or minimizing the defects.

1. Before any new variety is planted on a commercial scale in a particular climatic zone, it should first be adequately tested in that climatic zone.

2. Such testing will be minimized and dangers lessened if all new potential commercial varieties are first grown in a region where avocados are highly susceptible to corking and end-spotting, such as Riverside. One can reasonably expect that a variety which has neither defect in Riverside will have neither elsewhere in the region in avocado production.

3. In view of the fact that the characters are genetic, breeding for blemish-free hybrids is an obvious approach. Such parents as Hass, Irving, Yama, Duke, and Elsie are especially promising.

A question that should interest the plant physiologist and biochemist is this: What environmental factors influence the expression of the defects?

Superficial observations suggest that the factors relate to conditions of the atmosphere rather than of the soil or water. Reports from the region along the foothills of the San Gabriel Mountains to the east of the city of Los Angeles and from Orange County to the south indicate that corking has developed where it was previously unknown and is gradually getting worse. An obvious but unverified assumption is that it is caused by

some air pollutant, i.e. smog.